Proceedings of
3rd International Conference
on Environmental Aspects
of Bangladesh

October 13 ~ 14, 2012
University of Kitakyushu, Fukuoka, Japan

Organized by
Bangladesh Environment Network Japan [BENJapan]
www.BENJapan.org
PROCEEDINGS OF INTERNATIONAL CONFERENCE ON ENVIRONMENTAL ASPECTS OF BANGLADESH

ICEAB 2012
http://www.BENJapan.org/ICEAB

October 13~14, 2012

VENUE
University of Kitakyushu
Kitagata campus, Kitakyushu
Fukuoka, Japan

ORGANIZED BY
BENJapan
Bangladesh Environment Network Japan
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ICEAB 2012

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Proceedings of International Conference on Environmental Aspects of Bangladesh

General Chair:
Md. Atiqur Rahman Ahad, University of Dhaka, Bangladesh
Hiroyuki Miyake, University of Kitakyushu, Japan
Suehiro Otoma, University of Kitakyushu, Japan

Secretary:
Zahid Parvez Sukhan, Kyushu University, Japan
Contact: zpsukhan@kyudai.jp

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ICEAB 2012
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SUPPORTED BY
City of Kitakyushu
It is my great pleasure to hold ICEAB 2012 in the University of Kitakyushu, continued from the last two years. As a social geographical researcher as well as a member of a supporting team of JICA’s Capacity Development project on waste management, I sometimes visit Dhaka, the capital of Bangladesh. This year, one big surprising thing has occurred. It is the separation of Dhaka city on administrative and manageable base. Although Bangladesh is rapidly changing as mentioned above, it is not so famous and popular among Japanese and still unknown to Japanese. But, if anyone visits Bangladesh, he/she can easily understand the interesting character of culture and people as well as nature. It cannot be denied that most Bangladeshis are pro-Japan and they like Japanese people more, compared at other countries.

Bangladesh Environment Network Japan (BENJapan), whose main work is to inform the reality of Bangladesh by not only international conference but also website, is a member of Kitakyushu ESD council. ESD stands for ‘Education for Sustainable Development’. In 2002, United Nations declared to expand varied projects of ESD in Rio+10 international conference held in South Africa. In 2013, Asian-wise international conference on ESD will be held in Kitakyushu. BENJapan, hopefully, will play an important role to make RCE-ESD Asian conference succeeded.

For holding ICEAB, BENJapan faces acute financial problem every year. And even having such a severe budget condition, we have decided to hold an international conference every year to construct a bridge between Japan and Bangladesh to promote smooth exchange of human and science.

I hope ICEAB2012 will have a good fruit by mutual cooperation of participants and BENJapan members.

*This message was from one of the General Chairs of the ICEAB12.
WELCOME MESSAGE

Conference Secretary
ICEAB 2012

Zahid Parvez SUKHAN
Coordinator, Bangladesh Environment Network Japan [BENJapan]
Kyushu University, Japan

It is my great pleasure and honor to welcome you to the 3rd International Conference on Environmental Aspects of Bangladesh 2012 [ICEAB], 13~14 October 2012 at the University of Kitakyushu, Fukuoka, Japan. The ICEAB is a platform to share research, ideas, review of various environmental issues of Bangladesh (specifically), Japan and other regions.

ICEAB 2012 has a strong working committee from different countries. After rigorous peer-review process and registration, we finally publish 45 full papers (out of 168 submitted papers) in the proceedings from more than 12 countries. I am very glad to inform you that four distinguished Keynote speakers and eleven renowned Invited Speakers will deliver expert talks. I cordially thank all Keynote and Invited speakers for their kind presences. All members of the organizing committee have given their best effort for the conference. I am really grateful to them. I would like to thank especially to the General Chairs – Hiroyuki Miyake, Suehiro Otoma, and Md. Atiqr Rahman Ahad for their relentless efforts. H. Miyake has given splendid efforts for the ICEAB 2012. Ahad has shown extraordinary skill and will in management of the conference; and he was the key person of the conference.

My special gratitude goes to Mohammad Riazul Islam (Program Co-chair) for his great support managing the papers and programme update. Abdullah Al-Mahin, Kazi Kamrul Islam, Md. Azizul Moqsud, and Harunur Rashid worked well to manage the review process. Enamul Kabir, Kenji Kurokawa, Shahera Hossain, Mohin Mahtab, Ahmed Boudissa, Yaser Qudaib, and Mohammad Washim worked hard for various management issues throughout the conference commencement and preparation. I would like to thank our valuable volunteers for their supports. Especial thanks to the volunteers (planned and organized by Kenji Kurokawa) who worked hard to arrange Japanese O-chá party and Kimono-wearing programs for the participants. Hope that you will enjoy these traditional Japanese cultures.

Thanks to Microsoft Research for allowing us to use the CMT for ICEAB. I thank to the University of Kitakyushu, Kitagata campus for hosting the conference and providing necessary materials; Ms. Seiko Kubo, International Environmental Strategies Division Environment Bureau, Cit of Kitakyushu for providing 1-day bus tour around Kitakyushu and Shimonoseki; the West Japan Industry and Trade Convention Association for bags; and others to help the ICEAB and providing supports.

Selected papers will be invited to submit for the International Journal of Environment [IJE], http://benjapan.org/IJE - however, anyone can submit his/her good works for the IJE.

I hope that BENJapan & BEN members around the World, and conference participants will work together to make this conference a successful one; and will exchange ideas, make collaboration on research and development, so that more people get benefit from the outcome of the conference. A good effort has been done to organize the conference in a profound manner and for any mistakes, on behalf of the ICEAB 2012, I would like to request you to forgive us; and inform us, so that we can do it better in coming years based on your sincere feedback.

Let’s work for a better world, a better environment-friendly world.
This is my great pleasure to write this message as a Program Co-chair for the 3rd International Conference on Environmental Aspects of Bangladesh. I personally feel very happy to see the successive achievements of this event for the last few years. We were highly motivated and inspired to conduct this event in this year for the third time. Therefore welcome you all in this conference.

This year, we received a total of 168 papers in different environmental areas and related to the subject matter of this conference. All the articles were found highly significant, emphasizing different environmental issues from different corners. We were really surprised to see the diversity of research in these burning issues. All the articles went under peer-review process by expert reviewers and this event was coordinated by the distinguished Track Co-chairs, whom I would like to thank for their great support. We finally selected 45 papers from four different areas that were included in the proceedings. I would like to thank all the authors who have submitted their work for this conference.

This year we also found many renowned researches among us as keynote or invited speakers, who are famous in their respective fields and will share their work and knowledge among us. This will definitely inspire us to think for the next step in creating a sustainable world. I would like to thank all the keynote and invited speakers for joining this conference.

It should be mentioned here with great satisfaction that BENJapan, the sole organizer of this event, started his journey just few years back, and now enriched with many enthusiastic personalities and working in collaboration with different organizations. I wish our mutual cooperation will bring this group far ahead.

At last I would like to especially thank to the University of Kitakyushu for hosting the conference, City of Kitakyushu for arranging bus tour on 15th October, and others for their participations and moral supports. I hope through this conference you will enrich your knowledge and will aware people from the global environmental threats and to raise the voice for “Think Globally, act locally”.

Mohammad Riazul ISLAM
Assistant Professor, University of Dhaka, Bangladesh
LOCAL INFORMATION

Tourism information
Fukuoka:  http://fukuoka-tourism.net/e/index.html
Kitakyushu:  http://fukuoka-tourism.net/e/kitakyushu.html

Venue
University of Kitakyushu
Address: 4-2-1 Kitagata, Kitakyushu, Fukuoka, 802-8577, Japan
http://www.BENJapan.org/ICEAB/travel-information.html

Access
From Fukuoka Airport:
By train:
1. Take the Fukuoka City Airport Line subway and get off at 'Hakata' station.
2. Transfer to JR Kagoshima Line bound for Mojiko and get off at 'Kokura'.
3. Transfer to Kitakyushu Urban Monorail and get off at 'Keibajomae' station.

By high-way bus:
Take the high-way bus for ‘Kokura’. It will take around 90 minutes from the Fukuoka Domestic Airport to Kokura station [Kokura eki mae station]. Those who will stop at Fukuoka International Airport – take the shuttle bus [free] from Int. terminal to Domestic terminal  →  then take bus or train to be in Kokura.

From Kitakyushu International Airport:
1. Take the bus bound for 'Kokura Ekimae' and get off at 'Kokura Ekimae' bus stop.
2. Walk to 'Kokura' station and take Kitakyushu Urban Monorail.
3. Get off at 'Keibajomae' station.

For other route search, please use this English site:  http://www.hyperdia.com/en/

Electricity
The electrical power supply is 100 volt in Japan, and the frequency is 60 Hertz in Western Japan, including Fukuoka. The Japanese electrical plugs have two flat pins.

Contact
Tel:  +81-80-3379-3545 (from outside Japan); 090-3379-3545 (within Japan)
E-mail:  zpsukhan@kyudai.jp
International Conference on Environmental Aspects of Bangladesh (ICEAB 2012)

**FINAL PROGRAM**

PROGRAM LAYOUT AT A GLANCE

**DAY-1** 13 October 2012 (0800 ~ 2030)  
Registration Desk: 0800~1700

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<tr>
<th>Time</th>
<th>Program</th>
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</thead>
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<tr>
<td>0830~0840</td>
<td>Welcome Speech: Conference Chair</td>
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<tr>
<td>0840~0920</td>
<td>Keynote Speech-1 (KS1)</td>
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<tr>
<td>0920~0940</td>
<td>COFFEE BREAK</td>
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<tr>
<td>0940~1040</td>
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<tr>
<td>1050~1120</td>
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<td>1125~1155</td>
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<tr>
<td>1155~1300</td>
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<td>1300~1330</td>
<td>Special Talk-3 (ST3)</td>
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<td>1410~1440</td>
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<td>1500~1530</td>
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<td>1535~1650</td>
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**DAY-2** 14 October 2012 (0800 ~ 1730)  
Registration Desk: 0800~1500

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<tr>
<td>1645~1730</td>
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## PROGRAM DETAILS

### DAY – 01 October 13, 2012 SATURDAY

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<tr>
<td>Welcome Speech</td>
<td>Conference Chairs</td>
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<tr>
<td>Hiroyuki Miyake</td>
<td>University of Kitakyushu, Japan</td>
</tr>
<tr>
<td>Suehiro Otoma</td>
<td>University of Kitakyushu, Japan</td>
</tr>
<tr>
<td>Time 0840~0920</td>
<td>Keynote Speech-1 (KS1)</td>
</tr>
<tr>
<td>TITLE</td>
<td>An assessment model for water environmental improvement policies in a river basin</td>
</tr>
<tr>
<td>SPEAKER</td>
<td>Seirou SHINODA</td>
</tr>
<tr>
<td></td>
<td>Gifu University, Japan</td>
</tr>
<tr>
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<tr>
<td>Time 0940~1040</td>
<td>Scientific Session – 01 (S01)</td>
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<tr>
<td>0940~0955</td>
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<tr>
<td>Keisuke OHASHI</td>
<td>Grain sizing survey on river bed by computational photography</td>
</tr>
<tr>
<td></td>
<td>Gifu University, Japan</td>
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<tr>
<td>0955~1010</td>
<td>ID : 69</td>
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<tr>
<td>T. OIKE</td>
<td>Characterization and filtration performance of pressed non-woven membrane</td>
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<td></td>
<td>Sepa-Sigma Inc., Japan</td>
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<tr>
<td>1010~1025</td>
<td>ID : P11</td>
</tr>
<tr>
<td>Masakazu TANI</td>
<td>The State of Arsenic Mitigation in Bangladesh and Estimate of the Size of Risk Population and of Unidentified Arsenicosis Patients</td>
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<td></td>
<td>Kyushu University, Japan</td>
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<td>1025~1040</td>
<td>ID : 116</td>
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<tr>
<td>Md. Bodruddoza MIA</td>
<td>Effect of upstream dams of Teesta River on surface water bodies in Northwest Bangladesh: A satellite remote sensing approach</td>
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<td></td>
<td>Kyushu University, Japan</td>
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<tr>
<td>Time 1050~1120</td>
<td>Special Talk-1 (ST1)</td>
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<tr>
<td>TITLE</td>
<td>Improvement of the anaerobic digestion efficiency for municipal secondary sludge using partial oxidation process</td>
</tr>
<tr>
<td>SPEAKER</td>
<td>Hidenari YASUI</td>
</tr>
<tr>
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<td>University of Kitakyushu, Japan</td>
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<tr>
<td>Time 1125~1155</td>
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<tr>
<td>TITLE</td>
<td>Paradox of ship recycling as green industry: Bangladesh perspective</td>
</tr>
<tr>
<td>SPEAKER</td>
<td>Iftekhar Uddin CHOWDHURY</td>
</tr>
<tr>
<td></td>
<td>University of Chittagong, Bangladesh</td>
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<td>Time 1155~1300</td>
<td>LUNCH BREAK</td>
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<tr>
<td>Time 1300~1330</td>
<td>Special Talk-3 (ST3)</td>
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<tr>
<td>TITLE</td>
<td>Land and soil degradation in Bangladesh</td>
</tr>
<tr>
<td>SPEAKER</td>
<td>Md. Jahiruddin</td>
</tr>
<tr>
<td></td>
<td>Bangladesh Agricultural University, Bangladesh</td>
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<tr>
<td>Time 1335~1405</td>
<td>Special Talk-4 (ST4)</td>
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<tr>
<td><strong>TITLE</strong></td>
<td>International environment strategies in Kitakyushu</td>
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<tr>
<td><strong>SPEAKER</strong></td>
<td>Ms. Seiko KUBO</td>
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<table>
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<tr>
<th>Time 1410~1440</th>
<th>Special Talk-5 (ST5)</th>
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<tbody>
<tr>
<td><strong>TITLE</strong></td>
<td>Aquaculture development constraints and potentials in Bangladesh in the perspective of environmental impact and change</td>
</tr>
<tr>
<td><strong>SPEAKER</strong></td>
<td>Md. Jahangir ALAM</td>
</tr>
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| Time 1440~1500 | **COFFEE BREAK** |

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<th>Special Talk-6 (ST6)</th>
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<td><strong>TITLE</strong></td>
<td>Betel leaf cultivation on forest loss in the Teknaf Peninsula</td>
</tr>
<tr>
<td><strong>SPEAKER</strong></td>
<td>Masakazu TANI</td>
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<tr>
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<td>1535~1550</td>
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<tr>
<td></td>
<td>Cheng-Di Dong</td>
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<tr>
<td>1550~1605</td>
<td><strong>ID : 95</strong></td>
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<tr>
<td></td>
<td>Banani BISWAS</td>
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<tr>
<td>1605~1620</td>
<td><strong>ID : p8</strong></td>
</tr>
<tr>
<td></td>
<td>Asifur RAHMAN</td>
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<tr>
<td>1620~1635</td>
<td><strong>ID : 5</strong></td>
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<tr>
<td></td>
<td>Mohammad U.H. JOARDDER</td>
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<tr>
<td>1635~1650</td>
<td><strong>ID : 10</strong></td>
</tr>
<tr>
<td></td>
<td>Knut Fournier</td>
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| Time 1650~1800 | **BREAK** |

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<td><strong>Md. Atiqur Rahman Ahad</strong></td>
<td>University of Dhaka, Bangladesh</td>
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<tr>
<td>Time 0800–0830</td>
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<td><strong>Time 0830–0930</strong></td>
<td>Scientific Session – 03 (S03)</td>
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<tr>
<td>0830–0845</td>
<td>ID : P10</td>
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<tr>
<td></td>
<td>Akinori OZAKI</td>
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<tr>
<td>0845–0900</td>
<td>ID : 102</td>
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<td></td>
<td>Md. Shoriful Alam MONDAL</td>
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<td>0900–0915</td>
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<td></td>
<td>Nazmun NAHER</td>
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<td>Muhammad Mosleh UDDIN</td>
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<td>Keynote Speech-2 (KS2)</td>
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<tr>
<td>TITLE</td>
<td>From engineering knowledge to wise adaptation</td>
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<tr>
<td>SPEAKER</td>
<td>Kazuya YASUHARA</td>
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<td>Hiroshi TSURUTA</td>
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<td>Nomana Intekhab HADI</td>
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<td><strong>Time 1135–1205</strong></td>
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**PRESENTATION DETAIL FOR SCIENTIFIC SESSION**

[1] 10 min PPT presentation + 5 min Question-Answer → total 15 min per presentation (1st warning after 7 min, Finishing Presentation at 2nd warning, After 3rd warning – total time is over)


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**KEYNOTE SPEECH**

**An Assessment Model for Water Environmental Improvement Policies in a River Basin**

Seirou SHINODA

Information and Multimedia Center, Gifu University, Japan; e-mail: shinoda@gifu-u.ac.jp

In general, water environment at a local point is evaluated by the condition of water quantity, water quality, kinds of inhabitants and so on. On the other hand, in the case of the environmental assessment on a regional area where various human activities affects the water environment, it becomes necessary to investigate on the whole watershed or river basin.

Since the watershed is composed of various kinds of land coverage related with human activities and their continuous connection, it is important to evaluate the mass transport process from each source. For example, eutrophication can be understood as the problem caused by the excess nutrients provided to the system or the accumulation of nutrients in the system. This example means that almost of environmental problems must be caused by the obstruction or the oversupply in the mass transport system. As the regional water environment is essentially influenced by water and mass balances in the watershed, an estimation of the mass transport process becomes important and the soundness of watershed environment can be evaluated by the continuity of the mass transportation.

In recent years, various accurate physical, chemical and biological models of the mass transport process in the watershed have been proposed and have become useful to assess the watershed environment. Although it is necessary to give the pollutant load factors related with human activities as the model parameter, deciding values for non-point sources such as agricultural lands is not easy. The load of pollutant at a point is composed of various source loads provided from each area in the watershed with the process of self-purifications and it is possible to estimate the pollutant load factors of non-point source by solving the inverse problem for the mass transport system.

In this keynote speech, the example of the total nitrogen (TN) transport in the Nagara River basin located on the central Japan is presented; the presentation consists of the method to estimate the pollutant load factors by using multivariate analysis and GIS for the TN transport, the continuity parameter of the TN transportation as the index to evaluate the soundness of watershed environment, and the method to assess the water environment improvement policies.

**KEYNOTE SPEECH**

**Emerging Directions in Jute Gene Technology**

Haseena KHAN

Department of Biochemistry and Molecular Biology, University of Dhaka, Bangladesh; e-mail: haseena@univdhaka.edu

Jute is a natural fibre obtained from the bark of the jute plants. It is mainly grown in south Asia. Jute’s high capabilities in absorbing carbon and emitting oxygen have a positive influence in improving the atmospheric environment. High moisture absorption capacity, flexibility and drainage properties are key features characterizing jute as an eco-friendly fibre. This fibre possesses high tensile strength and is resistant to heat and fire. These natural characteristics of jute, together with its excellent antibacterial, acaricidal and anti-mildew activity and UV protective function have always attracted the attention of the environmentalists.

However there is very little information on jute at the molecular level. But the necessity for genetic improvement of this important cash crop cannot be overemphasized. Molecular approaches can help in modifying jute so that the plant itself may overcome both biotic and abiotic stresses which it encounters during its growth in inhospitable terrains. In order to broaden the genetic base of jute it is necessary to implement an efficient jute breeding and transformation programme for developing stress-adapted jute. In this background our group has successfully developed a tissue culture independent method of efficient jute transformation and have identified a number of genes differentially expressed when jute is grown at temperatures below its base temperature of 20°C and under different stress conditions.

Plant associated microbes, generally bacteria and fungi that live inside plant as an integral part of the host architecture are referred to as endophytes. Despite endophytes’ crucial roles in plant growth and metabolic regulations, very few attempts have been undertaken to study them in jute. We have characterized both culture dependent and independent endophytic bacteria and fungi from jute seeds and seedlings and have identified a number of microorganisms which may provide jute with a growth advantage.

**KEYNOTE SPEECH**

**From Engineering Knowledge to Wise Adaptation**

Kazuya YASUHARA

Institute for Global Change Adaptation Science, Ibaraki University, Japan; e-mail: yasuhara@mx.ibaraki.ac.jp
Improvement of the Anaerobic Digestion Efficiency for Municipal Secondary Sludge using Partial Oxidation Process

Hidenari YASUI
Recycle Engineering Laboratory, Faculty of Environmental Engineering, The University of Kitakyushu

Paradox of Ship Recycling as Green Industry: Bangladesh Perspective

Iftekhar Uddin CHOWDHURY

To turn the world’s discarded ships into scrap, equipose impetus has been contributing to the fast growing of recycling to meet the demand of iron in Bangladesh, India and China since the beginning of 1990’s. It provides 90% of steel contents and 10% assortment of matters like brass, copper, lead, asbestos, plastics, pipes, cables, wood and wooden things supplying about 70% of raw materials to produce mild steel rod and other products particularly in Bangladesh. A man bearing a terrible load on his shoulder, working in mud in the tropical heat with severe dangers of explosion, hauling the metal up the beach, lifting great weights with skinny arms, carrying steel ropes and heavy pipes and filth for a pittance is the common portrait of persons working in the yards of ship recycling in Chittagong, Bangladesh. Covering an area of 20 km with coastal Sitakunda, about 14 km from the center of the port city of Chittagong ship recycling generally is generally corrosive, noisy and dusty in nature and a threat indeed for emission of toxic and pollutants gases to both the terrestrial and marine environment and the human health hazards as well. The environmental issues relevant to Persistent Organic pollutants (POP’s), asbestos, heavy metals, oil pollution of sea water and shore, impact on biodiversity and so on impairs ecological settings on one hand, and on the other should it be treated compatible with employment and revenue generation. How can it lead to address ship recycling to a substantive connotation of green industry from socio-economic benefits of recycling steel scrap, electrical cables, chilling compressors, engines, furniture, generators, re-roll able steel, motors, pipes, kitchen wares, spare parts, pumps etc. is the opening of the discourse of dilemma and the presentation is to explore the nature and extent of its facade.

Land and Soil Degradation in Bangladesh

Md. Jahiruddin

Agriculture in Bangladesh contributes about 19% of GDP and supports more than 60% of labour force. This sector is now threatened due to occurring of some land degradation processes. These processes are either natural or human induced. So, there is a scope of arresting land degradation. The present paper focuses on the extent and severity of land and soil degradation and the strategies for arresting land degradation in Bangladesh. There are a number of land degradation processes occurring in Bangladesh which include soil salinization, erosion, water-logging, acidification, heavy metal pollution and fertility depletion. Salinity is a major concern of land degradation particularly in the coastal regions of this country. The major saline affected districts are Satkhira, Khulna, Pirojpur, Barguna, Patuakhali, Noakhali and Cox’s Bazar. Both magnitude and extent of soil salinity are increasing with time. In 1973 the salinity area was 0.83 mha and now it has become 1.06 mha. The critical challenge is to manage coastal resources and to adapt the production system with the climate change scenario. Physiographically, Bangladesh has three categories of lands: floodplains (80%), terraces (8%) and hills (12%). Hilly (Chittagong Hill Tracts) and terrace areas (Madhupur, Barind and Akhaura terrace) due to steep slopes are susceptible to soil erosion. Every year huge amount of soil loss occurs due to water erosion during monsoons. Soil acidity is another issue of land degradation. Geomorphologically acid sulphate soils, peat soils, acid basin clays, terrace soils and hill soils are moderately to strongly acidic in reaction. Acid soils with low pH values and aluminium toxicity are a big constraint to crop production in more than 30% area of this country. Depletion of soil fertility has arisen in this country due to intensive land use without appropriate nutrient management. With advancement of time micronutrient deficiency has arisen. Zinc and boron deficiency are now widespread. In Bangladesh, floodplain soils are formed due to action of four major rivers the Padma (Ganges), Meghna, Brahmaputra and Jumuna, and their tributaries & distributions. Flood and inundation are regular seasonal phenomena in this country. About 2.6 mha area is affected by water-logging which include bilis, jhils, haors and baors. Industrial discharge, sewage sludge and municipality wastes are the major sources of heavy metal contamination in Bangladesh soils. Lead, cadmium, arsenic, mercury, chromium and nickel are the significant contaminants. Industrials wastes and effluents are being discharged randomly onto soils, into canals, rivers, along the road sides or in the vicinity of the industrial areas without any treatment. All the issues stated above are presented in this paper.

International Environment Strategies in Kitakyushu

Seiko KUBO

International Environmental Strategies Division, Environment Bureau, City of Kitakyushu
Aquaculture Development Constraints and Potentials in Bangladesh 
in the Perspective of Environmental Impact and Change

Md. Jahangir ALAM
Faculty of Fisheries, Bang Abdullah Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh
e-mail: alammj_bfri@yahoo.com

Bangladesh is naturally rich in fisheries resources. The fisheries sub-sector has been contributing significantly to national economy, nutrition, and poverty alleviation through employment generation. While inland fisheries focuses largely on the domestic market, the coastal and marine fisheries is gradually becoming more and more export oriented. Though the overall fish production has been increased many folds during the last five decades, contribution of capture fisheries has been declined significantly from 88% to 34% and that of aquaculture has been increased from 12% to 47%. In the context of increasingly vulnerable capture fisheries, aquaculture is becoming increasingly necessary to maintain fish supplies for domestic demand as well as to growing export market.

Shrinking and unplanned alteration of natural water resources, water pollution, indiscriminate fish catch, fluctuations in seasons, etc. are the major reasons making the capture fisheries vulnerable. All these factors are also affecting aquaculture in many ways, particularly in supplying with quality broodstock resources and seed. With the pace of development, aquaculture also raises certain environmental and social concern, particularly in destruction of mangrove and wetlands, self-aqua pollution, salinization, use of water and other resources, use of antibiotics, drugs and chemicals, etc. However, environmental damage by aquaculture so far is no greater than that of many other human activities of equal or smaller scale, but there are several reasons why culture methods should be improved. Some of the climate change impacts such as increased precipitation, water logging, increased temperature, etc. may positively be utilized for increase fish production practicing suitable aquaculture systems.

The aquaculture production systems in Bangladesh mainly comprised of homestead and entrepreneurial pond fish farming, cage fish farming and rice-fish farming in freshwater environment, and shrimp farming in brackishwater environment. Though a significant progress has been achieved in case of freshwater aquaculture, with a production range of 3-40t/ha, and of brackishwater aquaculture, with a production range of 150-700 kg/ha, there is further scope of intensification for increased production. The paper presents the current status and constraints of aquaculture development in Bangladesh, and discusses the future potentials considering the possible climate change consequences and environmental impact.

Betel Leaf Cultivation on Forest Loss in the Teknaf Peninsula

Masakazu TANI
Environment and Heritage Design, Faculty of Design, Kyushu University, Japan
e-mail: tani@design.kyushu-u.ac.jp

Forest degradation in the Teknaf Peninsula has become critical. It is said that a cause of such forest destruction is over-exploitation of the forest for fuel wood, especially, by the poor for living. While the influence of fuel wood collection on the forest is serious, our research has found that betel leaf cultivation also a significant impact on the condition of the forest in the peninsula. We have conducted surveys in a village (MB) on the west coast of the peninsula in 2010 & 2011. I reported a preliminary result of the study in the last year’s ICEAB12. I will present the result of further analysis of the role of betel leaf cultivation in the village and to estimate its influence on the forest.

While rice is the major crop of this village’s agriculture, due to the characteristics of land form of this area, the extent of rice field is limited in narrow strips along the coast, and its productivity is low compared to that of fertile delta areas. As a result, the production of rice in the village does not seem to fulfill its needs. A total rice yield is 55.5 tons in a total of 23.8 ha (0.11 ha per household), or only 280 kg per households. Therefore, in order to sustain the livelihood, many households need other sources of income.

Betel leaf is cultivated in facilities called “pan boroz.” A total area of pan boroz in the village is only 9.3 ha, about 25% of the rice fields. But, if it is successfully done, betel leaves produced in a one-half kani (0.08 ha) plot can be worth about 70,000 taka. A total yield of the 9.3 ha pan boroz would be 8.1 million taka. This amount would buy 270 tons of rice (30 taka/kg), or 5 times as much as its rice production. Therefore, betel leaf cultivation may appear to be able to compensate the short fall of the livelihood.

On the other hand, the construction of pan boroz requires forest resources, such as poles and sticks. Because it is difficult to estimate the weight of small parts of pan boroz, only major poles for the framework is calculated. There are 152 pan boroz in the village and their average size is 0.38 ha. In these pan boroz, it is estimated that a total of 170,000 poles are used. Using 1 kg per pole, it would be 170 tons. This village has about 130 ha of the forest, and the annual production of organic materials by the forest of this area is 3718 tons per year. Therefore, 4.6% of all annual production would be consumed by pan boroz.

Another way of influence of betel leaf cultivation on the forest is the fact that many pan boroz are constructed in forest area. Trees may have cleared when a pan boroz was constructed and as long as the pan boroz exists the forest would not come back. Of the 152 pan boroz, 41 are located in the flat land, and 111 in the slopes where the forest used to have been. Since the total area of these 111 pan boroz is 7.0 ha, this 7 ha will not go back to the forest. Thus, the influence of pan boroz on this aspect is 5.4 % of the forest area.

In summary, betel leaf cultivation is a major source of subsistence in MB; without it, many people may not survive. Pan boroz for betel leaf cultivation consumes a large amount of forest resources, equivalent to 4.6% of annual regeneration, or 6 ha of the forest. Pan boroz constructed in the forest area also keeps the forest regenerating; it affects 5.6 % of the (former) forest or 7 ha.

A total of 13 ha, or 10.0% of the forest is consumed by betel leaf cultivation.

SPECIAL TALK - 05

SPECIAL TALK - 06
SPECIAL TALK - 07
Rapid Screening of Organic Micro-pollutants in the Aquatic Environment
Kawao KADOKAMI
Faculty of Environmental Engineering, The University of Kitakyushu; e-mail: kadokami@kitakyu-u.ac.jp

SPECIAL TALK - 08
Utilization of Field Monitoring Information to Agriculture - Potential of Informatization Agriculture in Bangladesh
Takashi OKAYASU
Bioproduction Engineering Laboratory, Faculty of Agriculture, Kyushu University, Japan
e-mail: okayasu@bpes.kyushu-u.ac.jp

SPECIAL TALK - 09
Recycling Method of TSUNAMI Sediment Caused by Tohoku Region Pacific Coast Earthquake
Kiyoshi OMINE
Department of Civil Engineering, Nagasaki University, Japan; e-mail: omine@nagasaki-u.ac.jp

SPECIAL TALK - 11
BEN, BENJapan & BAPA: Impact on Environmental Aspects of Bangladesh
Md. Atiqur Rahman AHAD
Applied Physics, Electronics & Communication Engineering, University of Dhaka, Bangladesh
e-mail: atiqahad@univdhaka.edu
Dwinding Freshwater Bounties of Bengal Delta: Bleak State of Fish and Habitat Diversity

Mostafa A R HOSSAIN

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The lives of Bangladeshi centre around and depend upon fish and water. The country is a transitional zone of flora and fauna, because of its geographical settings and climatic characteristics. It is natural that the water resources of the existing extent and magnitude should harbour and support populations of a large variety of vertebrate and invertebrate aquatic living organisms. Bangladesh’s water bodies are known to be the habitat of 270 freshwater fishes, 475 marine fishes, 23 exotic fishes and a number of other vertebrates and invertebrates. The number of openwater species, however, is declining at an alarming rate with some species, in recent years, having become extinct due to a number of reasons. Many species are already in crisis and despite mere conservation initiatives it may already be too late to save them from extinction. Sadly, most Bangladeshis are oblivious to the diversity of species that inhabit its innumerable waterbodies – how sad it is to think that a significant proportion of these splendid, vibrantly coloured fish could be lost forever – their names unknown, their beauty and value never fully appreciated.

Bangladesh is most at risk from climate change. The country will face the biggest risks from global warming in the next 30 years. Poverty and large low-lying coastal regions prone to floods and cyclones were among factors making Bangladesh the number one exposed country to climate change. Climate change impacts gradually over a wide range of livelihoods in different settings. Drought and salination together are reducing the wintering habitat for the fish species resulting in less recruitment into the fishing ground to grow open water inland fisheries. Reduced water flow in the Ganges rivers basin has resulted in a severe depletion of fisheries. Due to the decrease in groundwater and surface water, tremendous pressure has been exerted on wetlands to convert them to agricultural land, resulting in a serious decline in the numbers of fish species and the fish production as a whole. Indeed, there may be no where in the world where effects of climate change and other natural/anthropogenic activities on fish biodiversity are more apparent than Bangladesh. The floodplains of the country are now among the fastest disappearing of all ecological systems. Fishing pressure from an ever-growing population has increased dramatically and has seriously affected the abundance of nearly half of the inland fishes of Bangladesh, particularly small fishes like minor carps, loaches, barbs, minnows, catfishes, parchlets, gobies, featherbacks, snakeheads and eels.

Most of the indigenous fish are migratory and rely on seasonal flooding for spawning cues and access to larval rearing habitat (floodplain). Almost all dams and embankment interfere directly with the successful completion of the fish migration (breeding and feeding). Agriculture (excessive removal of surface water and extraction of groundwater for irrigation), pollution (domestic and industrial), and unregulated discharge of untreated industrial and farm effluents, habitat destruction also have significant impact, as does the regular overflooding and lack of flooding rain in the last few decades. Introduced species (primarily tilapia, Chinese carp, African magur, Piranha and Thai pangas) are significant contributors to aquaculture production, but also threaten the biodiversity of indigenous fishes. In past, stocking of rivers and floodplain is carried out with both indigenous and introduced species by government and through different projects. The effectiveness of stocking activities has generally not been well assessed. Furthermore, the impacts of aquaculture (both commercial and small scale) have not been accurately assessed in this country. Capture fisheries in inland waters which are based on natural productivity generally have reached the level of overexploitation. The inland open water fisheries, where the floodplains assume an important position in the livelihoods and nutrition of the rural poor have now been under serious threat of resource depletion due to various man-made and natural causes. The majority of the waters of this type have been depleted to an alarming state and warrant urgent interventions for conservation and sustenance. Some rivers and floodplains have been modified to a level where they are only recognized as narrow ditches and paddy fields. During 1960s, the inland capture fisheries contributed about 90% of the country’s total fish production. Due to the rapid increase of aquaculture production and sharp decrease of capture fishery production, in 2007-08, the aquaculture contributed almost equally (about 40%) as inland capture fisheries in total fish production of the country. Since 1970, the annual flooding of approximately 2-3 million ha of floodplain has been either controlled or prevented altogether by means of sluice gates or pumping stations or embankments or levees. This reduction in area is believed to be one of the major reasons for declining floodplain fisheries in Bangladesh.

There are serious concerns surrounding the slow decline in the condition of openwater fish stocks which have been negatively impacted upon through a series of natural and anthropogenic induced changes. These include disturbances resulting from rapid growth of population coupled with lack of proper management policy, water management programmes including the large scale abstraction of water for irrigation and the construction of water barrages and dams, human activity resulting in the overexploitation of fish including use of harmful fishing gears and system (fishing by dewatering, poisoning, using explosives), road communication, siltation of water bodies by natural process, the unregulated introduction of alien stocks and pollution from industry and agrochemicals. As a consequence, many Bangladeshi species have become critically endangered like – Hemibagrus menoda, Barilus barila, Dermogenys brachynopterus, Botia dayi, Raimas bula, Psylophrynchus sucatio, Scistura corica, Labeo pangusia, Labeo angra, Botia lohachat, Barilus barila, Chagunius chagunio, Gogangra viridescentes, Silonia silondia, Setipinna phasa, Laguvia shawi, Crossochelus latius or many more. Biodiversity status of many of the fishes have now changed from that listed in the IUCN Red Book almost a decade ago. The results of the survey conducted by FMBC (2011) found following fishes as extinct from Bangladesh water - Neoeucirrhichthys maydelli, Pangio pangia, Salmostoma sardinella, Esomus lineatus, Garra annandalei, Neolissochilus hexagonolopes, Osphocheilus hasseltii, Raimas gattatus, Mystus armatus, Laguvia shawi, Pseudecheneis sulcata, Alidia punctata, Ambassus nalu, Channa barca and Pseudophoxinus capanus and a few more.

In recent years, GoB and the donors have placed major emphasis on capture fisheries, conservation, management, and development of institutional framework and need-based training. All concerned and working for the betterment of the fishery sector of Bangladesh – the fishers, fish farmers, general people, local leaders, researchers, policy makers, GO and NGO workers should come forward to conserve the precious fish and ecosystem diversity of the country and to increase the fish production through effective coordination, long-term programme and sustainable approaches. This is the high time to care for the aquatic biodiversity – both habitat and species – the pride, heritage and livelihood of Bangladesh before they are lost forever. The national and international bodies should come forward to conserve aquatic ecosystems and organisms using both in situ and ex situ approaches.
The State of Arsenic Mitigation in Bangladesh and Estimate of the Size of Risk Population and of Unidentified Arsenicosis Patients

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ABSTRACT

All kinds of arsenic mitigation activities have been carried out in Bangladesh since the recognition of arsenic contamination of ground water in 1992. These efforts have provided safe water to millions of people and treated tens of thousands arsenicosis patients. In spite of such activities, it seems that there are many more people who still have no access to safe water, and there are many more arsenicosis patients remained undetected. This study screens related statistics and analyzed related data generated by intensive arsenic mitigation projects carried out in Jessore district in order to estimate the size of population still at risk of arsenic, and the number of still-undetected arsenicosis patients. It finds that about 20 million people in Bangladesh seem to still using arsenic contaminated water, and that 300 to 600 thousand undetected patients may exist.

INTRODUCTION

Ever since arsenic contamination of ground water was discovered in 1992 in Bangladesh, there have been many projects implemented in order to mitigate the calamity of arsenic contamination. These mitigation activities are classed into two major categories: (1) safe water supply and (2) arsenic awareness. The first type is, of course, the most urgent so that people do not intake arsenic contaminated water. Nonetheless, the second type is also very important because people need to know the danger of arsenic before they can act on avoiding arsenic intake. Knowing the danger is especially important because arsenic has no color and no taste, which means that people may not be able to sense the presence of arsenic. In the last almost 20 years, therefore, these two types of mitigation activities have been carried out by the Bangladesh Government, international organizations, those in the public sector, such as UN organizations and foreign governments, as well various international and national NGOs.

Despite of these efforts, there are many people who are still exposed to arsenic contaminated water, and many people suffer from arsenicosis. As a result of the intake of contaminated water, the poor suffer more from this calamity, and arsenicosis patients would become even poorer.

The purpose of this paper is two-fold: first, to estimate the size of population who are not using arsenic safe water by reviewing published statistics; and, second, to estimate the number of arsenicosis patients who have not been identified by any public institution, and therefore, have been received little support and treatment. In order to make the argument clearer, this paper first briefly describes the structure of arsenic mitigation in Bangladesh. In other words, it schematically shows that each kind of mitigation activity is directed to what kind populations.

MATERIALS AND METHODS

Basis of the following discussion is mainly from published reports on statistics of arsenic mitigation. Especially, a detailed compilation of relevant statistics made by a DPHE-JICA report called “Situational Analysis of Arsenic Mitigation in Bangladesh 2009” (hereafter referred as SA) [1] provides a comprehensive set of information to this exercise.

In order to the estimate of patients, SA used mostly existing records at Directorate General of Health Services (DGHS) supplemented with interviews with Upazila Health Complexes. These records have been generated as by-products of routine activities of health personnel, rather than systematic surveys. Therefore, in order to estimate yet-identified arsenicosis patients, patient data based on systematic surveys by two Asia Arsenic Network (AAN)-led arsenic mitigation projects conducted in Jessore District are used [2, 3]. The occurrence rates of patients in different degree of arsenic contamination in these data sets are used to generate projections of the number of patients to be found.

RESULTS

A. The Structure of Arsenic Mitigation

Groundwater arsenic contamination becomes a problem when it imposes grave health risk on people who use contaminated water for drinking and cooking. Therefore, a simple solution to this problem is that no people intake contaminated water. But, this simple solution may not be easily achieved.

![Fig. 1. Schematic diagram of relevant populations to arsenic mitigation](Image)

A schematic structure of arsenic mitigation is presented in Fig. 1. The first column of the figure indicates the entire population, in which two groups of people exist: One group consists of those who are exposed to arsenic (Group A); and the other is not (Group B). The first step of arsenic mitigation is to reduce the number of people who drink contaminated water (Group A). In order to achieve that goal, there are mainly two ways of doing. The first method is the provision of safe arsenic-free water. The other is to be achieved through people’s awareness of arsenic risks, so that they would avoid contaminated water.

The second column of Fig. 1 includes only the exposed population (Group-A). Among them, a certain proportion of population develops arsenicosis (Group C), and the remaining people have not been clinically affected by arsenic yet, in spite of their exposure (Group D). Among Group C, only a portion of this group has been recognized as arsenicosis patients by public medical-health institutions. Arsenic mitigation is 1) to identify those who did go through the first net to develop arsenicosis as soon and as many as possible, and 2) to regularly monitor those arsenicosis patients for providing proper care not to become more serious.
The third column of the figure contains all arsenicosis patients (i.e., Group C), both already identified (Group E) and unidentified (Group F) patients. Arsenicosis patients as patients of other chronic illness tend to suffer from not only health problems but financial problems because their capability of earning diminishes.

B. Exposed Population

A first estimate of exposed population in Bangladesh was released by British Geological Survey (BGS) & Department of Public Health and Engineering (DPHE) in 2001 [4]. According to this estimate based on samples of tubewell testing, the number of people who were exposed to arsenic contaminated water with more than 0.05 ppm of arsenic was between 30 million and 40 million. In 2002, the Bangladesh Government conducted more detailed estimate by different types of water sources yielded a figure of 29.24 million. Therefore, the following analysis uses 30 million as the size of population exposed to arsenic contamination in Bangladesh.

Since the confirmation of arsenic contamination in 1993, Bangladesh Government and international organizations have conducted many projects for arsenic mitigation. Especially since the Bangladesh Government set a national policy for arsenic mitigation in 2004, the size of population who has access to safe water has been increasing.

Despite of such efforts, a substantial size of population who has no access to safe water still exists. Situational Analysis (SA) [1] published by DPHE&JICA in 2010 estimates that 54 % of the exposed population have access to safe water. According to this result, the size of risk population who still drink arsenic contaminated water would be 13.8 million people (originally exposed 30 million x 0.46 = 13.8 million).

On the other hand, a drinking water survey conducted by Bangladesh Statistical Bureau and UNICEF [5] shows that among 13,301 drinking water samples tested, 12.6 % of the samples contain arsenic of 50 ppb or higher concentration. Because the drinking water survey was conducted regardless of arsenic contamination, the result of the survey represents the entire population of Bangladesh. Assuming the size of population in Bangladesh at the time of the survey in 2009 as about 150 million [6], those who are in risk by drinking arsenic contaminated water would be 150 million x 0.126 = 18.9 million. The difference between the two estimated of risk populations, approximately 5 million, may represent people who do not use alternative safe water devices even if they are available, or alternative safe water devices in their vicinity are out of use for some reason.

Using these results of analyses and surveys, approximately a little more than 10 million people have become free from arsenic contamination of drinking water because of 20 years of arsenic mitigation activities. On the other hand, about 20 million people are suspected to still use contaminated water.

C. Unidentified Arsenicosis Patients

Whereas the primary aim of arsenic mitigation is to prevent people from developing arsenicosis, unfortunately, a certain portion of population has become arsenicosis patients (Group C in Fig. 1). These people are, first, to be identified, and then they should receive medical and other supports. Based on information provided by DGHS and interviews conducted at upazila health complexes, SA estimated arsenicosis patients having characteristic skin lesions as 37,039 in 2009 [1]. But, there seem to be more unidentified patients. The following is a trial calculation of how many arsenicosis patients actually exist.

The scope of SA’s analysis is based on 301 upazilas where arsenic contamination is severe. SA compiled the number of patients per 100,000 people by different levels of arsenic contamination (Table 1).

Table 1. Population, the number of patients, the proportion of patients, and patients per 100,000 people

<table>
<thead>
<tr>
<th>Arsenic Contamination %</th>
<th>Population</th>
<th>No. of Patients</th>
<th>Patients per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20%</td>
<td>43,464,588</td>
<td>5,390</td>
<td>12.3</td>
</tr>
<tr>
<td>≥20% to &lt;40%</td>
<td>11,681,173</td>
<td>5,000</td>
<td>42.8</td>
</tr>
<tr>
<td>≥40% to &lt;60%</td>
<td>7,614,753</td>
<td>3,780</td>
<td>49.6</td>
</tr>
<tr>
<td>≥60% to &lt;80%</td>
<td>7,572,934</td>
<td>4,197</td>
<td>55.4</td>
</tr>
<tr>
<td>≥80%</td>
<td>11,004,897</td>
<td>18,672</td>
<td>169.7</td>
</tr>
<tr>
<td>Total</td>
<td>82,074,993</td>
<td>73,039</td>
<td>45.1</td>
</tr>
</tbody>
</table>

To begin with, the number of patients in the area outside of the SA calculation is examined. There are 486 upazilas in Bangladesh, and the total population at the time of SA survey (2009) was 149,772,364 (about 150 million) [6], while SA only dealt with 301 upazilas and 82 million people. Although the contamination rate of the 175 upazilas excluded from SA’s scope should be low, there must exist a certain number of patients. Since the contamination rate of the area outside of SA’s study area should be lower than 20 %, if we use the half of the patient rate of the 20 % area (6.1 patients per 100,000), the number of patients in the remaining area would be 4,163. With this estimate, a total number of patients would be roughly 41 thousand.

There is an indication, however, that SA’s estimate should be regarded as minimum, and that an actual number of arsenicosis patients would be much more than these identified number of patients.

Asia Arsenic Network (AAN) conducted an arsenicosis patient support project (PSP) in Abhaynagar Upazila, Jessore between 2010 and 2012 funded by JICA [2]. The number of identified patients by DGHS in Abhaynagar was 179 (76.2 patients per 100,000 people) before the PSP project started. During the project, the number of patients in the upazila increased by 122 to 301, a 68% increase. The contamination rates in Abhaynagar are not very high, and range from 9% to 30%.

In addition to this, data from the Chaugachha Upazila are compiled, where thorough recording of arsenicosis patients was performed by DGHS and another arsenic mitigation project by AAN with JICA project [3]. These results are presented in Table 2.

Table 2. The number of arsenicosis patients per 100,000 in Abhaynagar before and after PSP projects, and that in Chaugachha.

<table>
<thead>
<tr>
<th>Contamination Rate</th>
<th>No. of Patients</th>
<th>Patients per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before PSP</td>
<td>Abhaynagar</td>
<td>122.2</td>
</tr>
<tr>
<td>After PSP</td>
<td>Chaugachha</td>
<td>6.4</td>
</tr>
<tr>
<td>Difference in factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥20% to 40%</td>
<td>122.2 ± 177.8</td>
<td>345.0</td>
</tr>
<tr>
<td>≥40% to 60%</td>
<td>N/A ± N/A</td>
<td>1068.8</td>
</tr>
</tbody>
</table>

Contamination rate; 2Patient rate before PSP; 3Patient rate after PSP; 4Patient rate in Chaugachha; 5Patient rate in SA’s 301 upazilas; 6Differences in factors between SA and the two intensively surveyed areas.

As Table 2 shows, the difference between SA’s figures and those based on intensive projects is not very large at the class of low contamination rate (less than 20%). The patient occurrence rates of the intensive projects are 1.7 and 5.3 times as much as that of SA. But, the differences become larger as the contamination rate becomes higher. The patient occurrence rates of the intensive projects are 4.2 and 8.1 times higher than that of SA. In the category of the highest contamination of this table, the difference between the Chaugachha Project and SA is 21.5 times.
These results seem to suggest at least two things. One is that there would be more patients if an area is more closely surveyed. Another indication is that currently missed patients by public registration would incrementally increase as the rate of contamination becomes higher. Therefore, because intensive arsenic mitigation projects are still limited in extent, many arsenicosis patients still remain to be identified.

Then, how many arsenicosis patients actually exist and wait for help? Table 3 is a result of trial calculations using patient occurrence rates recorded in those intensive project areas. For the population excluded from SA, approximately 68 million, the one half of the lowest rate of SA (12.3 per 100,000) is used for its patient rate for all trials. A moderate estimate uses the lower Abhaynagor-PSP numbers. Because there exist only two contamination classes, the remaining rates for this estimate are projected using SA’s rates. The higher estimate is generated by using rates in Chaugachha, and again, rates for the last two classes are project using SA’s rates. The results of these estimates suggest surprisingly high number of patients who have not been detected, and are left out suffering from the effects of arsenicosis. The lower PSP-based estimate for a total number of patients is about 330,000, and the higher Chaugachha-based estimate is almost 650,000 patients.

CONCLUSION

After 20 years of arsenic mitigation, 16 million among the 30 million exposed population have access to some kind of safe water. Therefore, it means that the remaining 14 million people use contaminated water. On the other hand, another statistics suggests that 19 million people are still to be identified.

While the prevention of arsenicosis is first and foremost important, many people have developed illness due to arsenic poisoning. Therefore, arsenicosis needs to be detected as early as possible, so that the illness can be treated at an early stage. At present, approximately 40,000 patients have been recognized by DGHS and upazila health complexes. The comparison of statistics between the registered patients and intensive arsenic mitigation project carried out in Jessore District reveals two points. One is that there are more patients to be found when people are screened more closely. The second is that the rate of missed patients becomes higher as arsenic contamination becomes higher. Estimates that this study conducts based on the data generated by those intensive arsenic mitigation projects suggest that the currently registered patients may be only a fraction of actual arsenicosis patients.

ACKNOWLEDGMENT

Patient data are compiled from two arsenic mitigation project conducted by Asia Arsenic Network funded by Japanese International Cooperation Agency (JICA).

Table 3. Patient estimates using patient occurrence rates obtained from intensively surveyed areas (the PSP area and Chaugachha Upazila)

<table>
<thead>
<tr>
<th>Arsenic Contamination %</th>
<th>Population</th>
<th>SA’s estimate</th>
<th>PSP based estimate</th>
<th>Chaugachha based estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Patients per 100,000 population</td>
<td>No. of Patients</td>
<td>Patients per 100,000 population</td>
</tr>
<tr>
<td>not included in SA</td>
<td>68,252,019</td>
<td>6.1</td>
<td>4,163</td>
<td>6.1</td>
</tr>
<tr>
<td>&lt; 20%</td>
<td>43,646,588</td>
<td>12.3</td>
<td>5,390</td>
<td>21.3</td>
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<td>169.7</td>
<td>18,672</td>
<td>1881.8</td>
</tr>
<tr>
<td>Total</td>
<td>14,977,234</td>
<td>41,212</td>
<td>329,717</td>
<td>647,136</td>
</tr>
</tbody>
</table>

REFERENCES

Effect of Upstream Dams of Teesta River on Surface Water Bodies in Northwest Bangladesh: A Satellite Remote Sensing Approach

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ABSTRACT

The study area includes Teesta River floodplain and its downstream in Northwest part of Bangladesh. The prime objective was to delineate land-covers (LC) and monitor surface water bodies from 2000 to 2009 by using NDVI (vegetation index) and NDWI (Water index) methods in our study area. We used Landsat ETM+ image of 19/02/2000 and Landsat TM image of 03/02/2009. We divided the LC into four types based on NDVI values as water body, bared, mixed and vegetated land. The results showed that surface water bodies were reduced about 61-78% coverage area from 2000 to 2009 within the Tista River and its downstream part of our study area. Area of water bodies were also reduced about 81-86% within the Teesta River floodplain during the study period. Consequently, the vegetated region had been increased significantly about 68% due to reduce water level within the floodplain region. Though mixed land area was unchanged but bared land reduced and converted to agricultural land. Otherwise, vegetated land were also increased about 8 times from 2000 to 2009, that may be due to increased rice/corn/tobacco production using groundwater within downstream region of Teesta River in Bangladesh.

INTRODUCTION

The study area, ‘Teesta River and its downstream region’, is about 4270 sq. km situated to the Northwest part of Bangladesh (Fig. 1). We also studied only Teesta River floodplain here about 540 sq. km area as a separate case study of whole Teesta River in Bangladesh. Teesta River originates from Chitamu Lake in the Sikkim Himalayas at an altitude of about 7,200 m, enters into Bangladesh at the Kharbari border of Nilphamari district and then, after passing through Lalmonirhat, Rangpur, Kurigram and Gaibandha districts falls into the JAMUNA River south of Chilmari riverport [1]. The total length of Teesta River is about 315 km, of which nearly 115 km lies within Bangladesh. There are a number of dams and barrages have been built on the river Teesta on its 315 km journey from its source in Sikkim to the coast of Bangladesh i.e., Teesta Barrage in Bangladesh, Teesta Barrage Project at Gajoldoba in West Bengal, two hydro-electricity dams in Sikkim — one at Kulekhani and other at the upstream. The Indian government is also planning to construct two more hydro-electricity dams over the Teesta. The Teesta Barrage was built in 1998 at Doani, Lalmonirhat with an ambitious objective to bring 750,000 hectares of land under irrigation command area with net irrigation area of 540,000 hectares to augment agriculture production. But presently the Teesta has been drying up at different points during the dry season threatening the boro cultivation in six northern districts in Bangladesh. Once the mighty Teesta is now bereft of water following construction of a number of upstream dams and barrages at Gajoldoba point in Jalpaiguri of the Indian state of West Bengal. The average lowest discharge of Teesta was above 4000 cubic metre/sec before construction of the two barrages — one at Doani in Bangladesh and another at Gajoldoba in West Bengal but after construction of two barrages the lowest discharge has drastically reduced to 529 cubic meter/sec in 2000 and just after five years in 2005 it came down to just 8 cubic meter/sec [2]. Recently, the daily newspaper published an article about decline of Teesta River water flow [3]. Due to the shortage of water flow in Tista River, farmers are switching rice to tobacco/nuts/corn production now in this region. Such information is our motivation to monitor the spatial distribution of surface water bodies using satellite remote sensing techniques in our present research work in this area. Satellite remote sensing techniques provide us important capabilities to map landuse-landcover and monitor the dynamics of surface features including water bodies. Landsat TM/ETM+ images have been used extensively for many environmental studies i.e., vegetation studies, land-use change studies, landscape ecology, and urban planning within the last 30 years [4].

The objectives of our study were: (1) to delineate land-covers on the floodplain of Teesta River and its downstream region of Bangladesh using NDVI (Normalized Differential Vegetation Index) and NDWI (Normalized Differential Water Index) methods; (2) to monitor water bodies both in the flood plain of Teesta River and its downstream part in the NW Bangladesh using vegetation and water index from 2000 to 2009.

MATERIALS AND METHODS

We used two Landsat images on the basis of availability; one was Landsat ETM+ image of 19 February 2000 and other was Landsat TM image of 03 February 2009 for our study region. Both are multispectral 8 bands satellite images where 4 visible, 2 SWIR, 1 TIR bands are 30 meter in resolution and 1 PAN band is 15/30 m (ETM/TM) in resolution. The Landsat images were acquired under highly clear atmospheric condition, and the image was acquired through the USGS Earth Resource Observation Systems Data Center, which has corrected the radiometric and geometrical distortions of the images to a quality level of 1G before delivery. The Landsat image was further rectified to a common geographic (Lat/Long) coordinate system based on 1:24,000 scale topographic maps, and was resampled using the nearest neighbor algorithm with a pixel size of 30 by 30 m for all bands including the thermal band. The resultant RMSE (root mean square error) was found to be less than 0.5 pixels. We applied the following our image processing steps for land-cover mapping using Landsat images; firstly, we have analyzed all images for atmospheric correction, where we had applied the dark object subtraction method for atmospheric correction process; then, in second steps, we applied the formula for calculating reflectance value for each band with band specific information from header file and Landsat user handbooks by using the ERDAS imagine 9.3 module; in the third steps, we calculated NDVI which is a process for calculating the vegetation index of any region, that is the ratio of reflectance value of red (band 3) and near infrared (band 4) region of electromagnetic spectrum [5]. Actually, NDVI is the indication factor of vegetation growth state, used as an index of vegetation abundance, which is related to biomass, chlorophyll content and water stress. In general case,
Fig. 1. Location map of study area at Teesta River and its downstream region centered at 25° 44' 04.44"N, 89° 04' 23.20"E taken from Google earth image of 6 April 2012. Study area boundary shown with a bold maroon color polygon.

Vegetated areas have high reflectance in the near infrared and low reflectance in the red visible region. The NDVI value ranges from -1 to +1. In this index green vegetation has high values, water has negative values and bare soil has value around 0. Finally, we calculated the normalized difference water index (NDWI) by using the McFeeters (1996) method of NDWI calculation, defined as: $\text{NDWI} = \frac{\rho_{\text{green}} - \rho_{\text{NIR}}}{\rho_{\text{green}} + \rho_{\text{NIR}}}$, where $\rho_{\text{green}}$ and $\rho_{\text{NIR}}$ are the reflectance of green and NIR bands, respectively. The NDWI value ranges from -1 to 1. McFeeters [6] set zero as the threshold, i.e., the cover type is water if NDWI >0 and it is non-water if NDWI ≤0.

Fig. 2. (a) Land-covers of our study area in 2000, (b) LC in 2009, (c) water bodies shown with blue color and land with grey in a 2000 thematic map, and (d) water bodies with blue and land with grey color in a 2009 thematic map shown of our study area.
RESULTS AND DISCUSSION

First, we analyzed the images for land-cover (LC) mapping of our study area using NDVI method. We divided into 4 types of land-covers such as water body (NDVI<0), bared land (NDVI=0.2), mixed land (NDVI=0.2 to 0.5) and vegetated land (NDVI>0.5). Results showed that LC was found about 0.89% of water bodies (3803.7 hectares), 35% bared land (147758 hectares), 61% mixed land (261362.9 hectares) and 3% vegetated land (14033 hectares) in 2000. In the year of 2009, the results of LC showed about 0.34% area coverage’s for water bodies (1461 hectares), 10% bared land (41551.5 hectares), 61% mixed land (259562.8 hectares) and 29% of vegetated land (124259 hectares) of our study area (Fig. 2). We estimated surface water bodies’ area by using NDWI method. The NDWI value less or equal to zero was used for water and above zero was for land. We found about 8.7% of our study area (4702.6 hectares) as surface water bodies in 2000 but we obtained only 1.2% (640.7 hectares) water bodies in 2009. We also applied the same NDVI and NDWI methods to monitor the changes of LC within the Teesta River water bodies and its floodplain in Bangladesh portion. We found that about 7% and 8.7% of the study area were water bodies in NDVI and NDWI methods respectively in 2000 but in 2009, water bodies were about 1.3% and 1.2% respectively for NDVI and NDWI analysis which corresponds to about 540 sq. km Teesta floodplain in our study area (Fig. 3). Because of decreasing water bodies within the Teesta River, vegetation coverage in the floodplains was increased about 68% from 2000 to 2009. Although the area of mixed land type was unchanged but bared land areas were reduced about 49% within the Teesta River floodplain from 2000 to 2009. From our study we could infer that the vegetated coverage areas were increased surprisingly within the Teesta river bed and its floodplain reduced area of water bodies within this period of our study area. Otherwise, winter season agricultural production is depending nowadays on ground water as scarcity of Teesta river water flow and also increases IRRI/BIRI rice crops by using deep tube wells in our study area. Another reason of increased vegetation in 2009 is that rice cultivation is switching to tobacco/corn fields during our study time. Teesta river water flow may also be reduced for using ground water excessively by deep tube wells in this region.

CONCLUSION

Both NDVI and NDWI analysis results showed that the total surface water bodies decreased about 0.55-1.3% of our whole study area from 2000 to 2009; and water bodies were also reduced about 5.63-7.5% of total Teesta River floodplain from 2000 to 2009. Although the area of mixed land was unchanged but the bared land reduced about 25% of total study area from 2000 to 2009. Surprisingly, vegetated regions also augmented about 8 times area of 2000 in 2009 in our study region. In conclusions, because of surface water scarcity in this area, the rice cultivation reduced on this region using surface water and as a result, agricultural productions are depending on ground water. Alternatively, farmers are also switching from rice production to tobacco/nuts/corn production with groundwater. If this trend of reducing Teesta River flow continues, ultimately the region could be an arid region in future.

ACKNOWLEDGMENT

We would like show our sincere acknowledgment to USGS Landsat archives for providing the images data with free of cost.

REFERENCE

Assessment of Water Quality Index of Water Bodies
Along Dhaka-Mawa-Bhanga Road

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ABSTRACT

The objective of this paper is to find out water quality index (WQI) of several water bodies to sum up huge amounts of water quality data into understandable language. Water quality parameters of 6 different water stations along the Dhaka-Mawa road and 6 different water stations along the Mawa-Bhanga road were collected to determine water quality index. Six most important parameters - pH, total dissolved solids (TDS), dissolved oxygen (DO), biochemical oxygen demand (BOD) and electrical conductivity (EC) were taken for the calculation of WQI. The calculation of WQI was made using weighted arithmetic index method. According to the arithmetic mean method WQI values vary between 59 to 129. The values of the WQI showed that the water of the maximum stations are poor and very poor in condition, no one can be referred as good or excellent for human consumption. Also if they need more water badly they can not use and even for drinking purpose. Local people living along these areas can mark out the best water source available.

INTRODUCTION

WATER is the principal need of life on earth, and is an essential component for all forms of lives, from micro-organism to man [1]. Water has no alternatives, in fact the essence and sustenance of life is based on water [2].

Quality of water is defined in terms of its physical, chemical and biological parameters. However, the quality is difficult to evaluate from a large number of samples, each containing concentrations for many parameters [3]. One of the most effective ways to communicate information on water quality trends is with indices. Since then a great deal of consideration has been given to the development of index methods. A water quality index (WQI) provides a single number that expresses overall water quality at a certain location on several water quality parameters and turns complex water quality data into information that is understandable and useable by the general people [4].

The objective of an index is to turn complex water quality data into information that is understandable and useable by the public [5]. Importance of water bodies along the roadside is evident in terms of water quality, biodiversity conservation and use for aquaculture, as maximum of the water bodies of Bangladesh are expected to be productive (esrindia.com). So utilization of the existing resources is very much vital. In the way to improving the condition of these water resources, its proper management is very much necessary and for doing this all information on the resources namely physico-graphic, chemical and biological characteristic of these water resources must be collected. The objective of this paper is to determine the WQI of 6 water bodies along Dhaka-Mawa road and 6 water bodies along the Mawa-Bhanga road. Drinking water contamination and variation of drinking water quality in pre-monsoon is the basis of calculated values of WQI as concentrations of different water quality parameters tend to be at its worse condition during pre-monsoon season. Based on the WQI an assessment was made whether these water bodies are acceptable for domestic use and even for drinking purpose. Local people living along this road are completely dependent on these water bodies as there is no proper water supply made to meet their needs. For this reason, this analysis is extremely necessary so that people living in these areas can mark out the best water source available. Also if they need more water badly they can also determine which water bodies can used after proper treatment is done.

Fig. 1. A satellite view of the sampling area.
The examination and analysis of the water bodies including laboratory analysis was done as per the standard methods of USEPA, (2004) and Trivedi and Goel, (1986) [9-10]. The calculation of WQI was made using weighted arithmetic index method [11]. Finally assessment of surface water quality based on water quality index was done. Table 1 shows the details of analysis methods and necessary equipment.

Table 1. Details of the analysis methods and required equipment for the physico-chemical parameters.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter</th>
<th>Method</th>
<th>Equipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>Visible</td>
<td>Sensaso-CL410, HACH, USA</td>
</tr>
<tr>
<td>2</td>
<td>Dissolved Oxygen</td>
<td>Visible</td>
<td>Dissolved Oxygen Meter (Model-YK22 DO),USA</td>
</tr>
<tr>
<td>3</td>
<td>BOD</td>
<td>Laboratory</td>
<td>Dissolved Oxygen Meter (Model-YK22 DO),USA</td>
</tr>
<tr>
<td>4</td>
<td>Conductivity</td>
<td>Visible</td>
<td>Conductivity Meter (Model CD4302,USA)</td>
</tr>
<tr>
<td>5</td>
<td>TDS</td>
<td>Visible</td>
<td>Sensaso-CL410, HACH, USA</td>
</tr>
</tbody>
</table>

A. WQI Calculation

For calculation of WQI selection of parameters has great value. The water Quality index will too widen if too many parameters are used. Importance of various parameters depends on the intended use of water. Five physicechemical parameters namely - pH, TDS, EC, DO, BOD were used to calculate the WQI by the weighted arithmetic index method. Several steps are given below in the following steps:

a) Calculation of Sub Index of Quality rating (q_n)

Let there be n water quality parameters where the quality rating or sub index (q_n) corresponding to the nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value [12]. The value of q_n is calculated using the following expression.

\[
q_n = 100\left(\frac{V_n - V_i}{S_n - V_i}\right) \quad (1)
\]

Where, \(q_n\) = quality rating for the nth water quality parameter;
\(V_n\) = estimated value of the nth parameter at a given sampling station;
\(S_n\) = standard permissible value of nth parameter;
\(V_i\) = ideal value of nth parameter in pure water; All the ideal values (\(V_i\)) are taken as zero for drinking water except for \(pH = 7.0\) and dissolved oxygen = 14.6mg/L. (Sisodia2006)

b) Calculation of Quality rating for \(pH\)

For \(pH\) the ideal value is 7.0 (for natural water) and a permissible value is 8.5 (for polluted water). Therefore, the quality rating for \(pH\) is calculated from the following relation:

\[
q_{pH} = 100\left\{\frac{(V_{pH} - 7.0)}{(8.5 - 7.0)}\right\} \quad (2)
\]

Where, \(V_{pH}\) = observed value of \(pH\) during the study period.

C. Calculation of Quality Rating for Dissolved Oxygen

The ideal value (\(V_{DO}\)) for dissolved oxygen is 14.6 mg/L and standard permitted value for drinking water is 5 mg/L. Therefore, quality rating is calculated from following relation:

\[
q_{DO} = 100\left\{\frac{(V_{DO} - 14.6)}{(5 - 14.6)}\right\} \quad (3)
\]

Where, \(V_{DO}\) = measured value of dissolved oxygen.

D. Calculation of Unit Weight (\(W_n\)); Calculation of unit weight (\(W_n\)) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

\[
W_n = \frac{K}{S_n} \quad (4)
\]

Where, \(W_n\) = unit weight for nth parameters; \(S_n\) = standard value for nth parameters; \(K\) = constant for proportionality

c) Calculation of WQI; WQI is calculated from the following equation.

\[
WQI = \sum_{n=1}^{\infty} q_n W_n / \sum_{n=1}^{\infty} W_n \quad (5)
\]

RESULT

A. \(pH\)

\(pH\) is one of the most important factor that serve as an index for the pollution [13]. The experimental water bodies were found to be approximately neutral or slightly alkaline. The highest value of \(pH\) was 9.45 at Thandu Chowdhury pukur along the Mawa-Bhanga road and lowest was 6.8 at Pachhor Bajar khal along the Mawa-Bhanga road. The mean value of \(pH\) was 7.9 along the Dhaka-Mawa road and 7.65 along the Mawa-Bhanga road. A \(pH\) between 6.7 and 8.4 is suitable, while \(pH\) below 5.0 and above 8.3 is detrimental. In the present investigation \(pH\) values were within the ICMR standards (7.0-8.5) [13]. Maximum water quality sub-index for \(pH\) is found 25 at Bawor pitty sharok o janapath station along the Dhaka-Mawa road and 37 at Thandu chowdhury er pukur along the Mawa-Bhanga road according to Brown’s method. Minimum Sub water quality index for \(pH\) was found -3.0 at Pachchor Bajar Khal according to Brown’s method.

B. Total dissolved solids

The TDS level found to fluctuate from 169.4 mg/l to 306 mg/l within the water bodies along the Dhaka-Mawa road and 97mg/l to 340mg/l along Mawa-Bhanga road. The TDS content was maximum at Dhaleshwari along the Dhaka-Mawa road and at Bogail Beel along the Mawa-Bhanga road. The amounts of total solids are influenced by the activity of the plankton and organic materials. Slightly high value of TDS were recorded at only one sampling stations and other values were less than the WHO limit. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supply. Water quality sub index for TDS is found almost 0 for all stations.

C. Dissolved oxygen

The value of DO varied from 1.3 mg/l to 10.4mg/l. The maximum DO value (10.4mg/l) was recorded in Thandu Chowdhury er pukur and minimum value (1.3mg/l) was recorded in Shirajdikhan,Kuchiamara. The mean value of DO was 4.7mg/l. Concentrations below 5 mg/L may adversely affect the performance and survival of biological communities and below 2 mg/L may lead to fish mortality. Water without adequate DO may be considered wastewater. Maximum water quality sub-index for DO was found 50 at Pachchor Bajar khal and minimum sub water quality index for DO was found 17 at Pachchor Bajar Khal.

Table 2. Drinking water standards and unit weight

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Recommending Standard</th>
<th>Ideal Agency</th>
<th>Assigned Value (S)</th>
<th>Value (V)</th>
<th>Assigned Weight Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>ICMR</td>
<td>8.5</td>
<td>7</td>
<td>0.226</td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>WHO</td>
<td>500</td>
<td>0</td>
<td>0.0038</td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>WHO</td>
<td>1400</td>
<td>0</td>
<td>0.00137</td>
<td></td>
</tr>
<tr>
<td>DO</td>
<td>WHO</td>
<td>5</td>
<td>14.6</td>
<td>0.384</td>
<td></td>
</tr>
<tr>
<td>BOD</td>
<td>ICMR</td>
<td>5</td>
<td>0</td>
<td>0.384</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Biochemical oxygen demand

BOD varied between 0.7 mg/l to 9.8 mg/l among the different sampling stations. The minimum values were found in Sirajdikhan, Kuchiamara which is in Dhaka-Mawa road. The Maximum value was recorded in Thandu Chowdhury er pukur which is along the Mawa-Bhanga road. The mean value of BOD was 3.6 mg/l. Maximum water quality sub-index for BOD was found 75 at Thandu Chowdhury er pukur. Minimum water quality sub-index for BOD was found 5 at Sirajdikhan Kuchiamara (Brown Method).

E. Electrical conductivity

Conductivity is measured in terms of conductivity per unit length, and meters typically use the unit micro Siemen /cm. [14] The values of water conductivity (2ms/cm) varied from 203 μs/cm to 632 μs/cm among the water bodies. The value of
conductivity was recorded lowest in Dhaleshwari along the Dhaka-Mawa road and maximum in Pulia Bajar along the Mawa-Bharga road. The mean value was 503 μs/cm. Sub water quality index for Electrical Conductivity is almost 0 at all stations (Brown’s Method). Standard and ideal values of different water quality parameters have been shown in Table 2. Guidelines are recommended by World Health Organization (WHO) and Indian Council of Medical Research (ICMR).

Table 3. Status of water quality based on Arithmetic WQI method (Brown et. al. 1972) [Quoted by Mishra and Patel, 2001]

<table>
<thead>
<tr>
<th>Water Quality Index</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25</td>
<td>Excellent</td>
</tr>
<tr>
<td>26-50</td>
<td>Good</td>
</tr>
<tr>
<td>51-75</td>
<td>Poor</td>
</tr>
<tr>
<td>76-100</td>
<td>Very poor</td>
</tr>
<tr>
<td>Above 100</td>
<td>Unsuitable for drinking and propagation of fish culture</td>
</tr>
</tbody>
</table>

Table 4. Location wise calculated values of Water Quality Index for pre monsoon period along Dhaka-Mawa Road

<table>
<thead>
<tr>
<th>Station Name</th>
<th>WQI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bawor bity sarok</td>
<td>89</td>
</tr>
<tr>
<td>janapather pokur</td>
<td>81</td>
</tr>
<tr>
<td>Dhalashri (1)</td>
<td>80</td>
</tr>
<tr>
<td>Dhalashri (2)</td>
<td></td>
</tr>
<tr>
<td>Shirajdi Khan Kuchhiamara</td>
<td>64</td>
</tr>
<tr>
<td>Chaltipara Pokur</td>
<td>75</td>
</tr>
<tr>
<td>MasurgowKhal</td>
<td>67</td>
</tr>
</tbody>
</table>

Table 5. Location wise calculated values of Water Quality Index for pre monsoon period along Mawa-Bharga Road

<table>
<thead>
<tr>
<th>Station Name</th>
<th>WQI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pachchor bajar khal</td>
<td>59</td>
</tr>
<tr>
<td>Thandu Chowdhurir Pokur</td>
<td>129</td>
</tr>
<tr>
<td>Ariel Kha</td>
<td>73</td>
</tr>
<tr>
<td>Pulia bajar pokur</td>
<td>102</td>
</tr>
<tr>
<td>Bogail Beel</td>
<td>63</td>
</tr>
<tr>
<td>Bhanga Khal</td>
<td>66</td>
</tr>
</tbody>
</table>

Table 6. Maximum, Minimum and Average values of different water quality parameters

<table>
<thead>
<tr>
<th>Groups</th>
<th>Max&lt;sup&gt;m&lt;/sup&gt;</th>
<th>Min&lt;sup&gt;m&lt;/sup&gt;</th>
<th>Avg.</th>
<th>Std. Dev&lt;sup&gt;s&lt;/sup&gt;</th>
<th>Std. Err.</th>
<th>Variance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.66</td>
<td>7.37</td>
<td>7.90</td>
<td>0.48</td>
<td>0.19</td>
<td>6.08</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>5.4</td>
<td>1.50</td>
<td>3.93</td>
<td>1.51</td>
<td>0.62</td>
<td>38</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>3.7</td>
<td>0.70</td>
<td>2.55</td>
<td>1.05</td>
<td>0.43</td>
<td>41.18</td>
</tr>
<tr>
<td>Conductivity (2ms)</td>
<td>632</td>
<td>353</td>
<td>536.7</td>
<td>108.67</td>
<td>44.37</td>
<td>20.25</td>
</tr>
<tr>
<td>TDS</td>
<td>306</td>
<td>169.4</td>
<td>260.2</td>
<td>53.26</td>
<td>21.7</td>
<td>20.5</td>
</tr>
</tbody>
</table>

**F. Assessment of Water Quality Based on WQI**

WQI has been classified into 5 classes quoted by Mishra and Patel, 2001. Table 3 represents the 5 classes of water quality based on WQI. The observed range of water quality index along the road in pre monsoon is 59 to 129 by the arithmetic mean method. Maximum WQI was 129 at station Thandu Chowdhurir pokur and minimum is 59 at Pachchor Bajar. Not a single Station’s water quality can be expressed as excellent. Water quality of station Shirajdkhan, Chaltipara and Mashurgow Khal along the Dhaka-Mawa road and water quality of water bodies namely Bhangla Khal, Bogail Beel, Ariel kha, Pachchoor Bajar along the Mawa-Bharga road can be expressed as poor water. Water quality is unsuitable in Thandu chowdhurir pokur and Pulia Bajar pokur. Rest of the water stations can be classified as very poor. Stations with WQI values more than 90 can be classified as unsuitable for both domestic and aquaculture purposes. So that Thandu Chowdhurir pokur and Pulia Bajar pokur turned out to be unsuitable as WQI value is more than 90. But rest of the stations can be used for both domestic and aquaculture purpose by taking proper disinfection procedure.

Table 4 and Table 5 show the WQI values of the 12 stations measured in pre monsoon period. Pachchor Bajar khal can be classified as the best stations among all though it has been classified as poor water. Table 6 represents the maximum, minimum and average value of different water quality parameters.

**CONCLUSION**

It is important to remember that the WQI alone should not be used to make hasty decisions to clean up a water body. For instance, should an impairment to the water quality of a system be noticed, this is an indication that further investigation is needed into the potential problem area. WQI of the stations along the Dhaka-Mawa-Bharga road for the pre monsoon season was found high according to the Brown method, as concentration of water quality parameters are maximum during pre-monsoon. In accordance with Brown method it was found from the calculation that parameter which shows the highest favorable value gives a low statistical value to the index. BOD, DO were found to be the most important parameters as it contributes the most for the WQI calculation among the five parameters. All the 12 water bodies bear potential to become a source of drinking water with proper treatment.

**REFERENCE**


Grain Sizing Survey on River Bed by Computational Photography

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ABSTRACT
Computational photography method has been suggested as a modern high-efficiency survey of river bed grain sizing, and the reliability for understanding fluvial phenomenon is discussed from the standpoint of sediment hydraulics. This high-efficiency method actualizes high spatial resolution information of grain size distribution. Thus, photography method brings much information and has availability to express the stream flow condition better than traditional grain sizing methods. The grain sizing by image processing provides the appropriate result which has a good agreement with stream condition qualitatively. Moreover we estimate critical diameter from hydraulic figure in order to compare to observed diameter. According to the result, complete agreement is not found between them. However observed mean diameter indicates the intermediate figure against variation of critical diameter along longitudinal distance. Meanwhile discontinuity of distribution curve is seen at 13.2 mm diameter which is distinguishing either photography or sieving. This result indicates that it is necessary to give the threshold diameter much larger than the limit of image processing.

INTRODUCTION
Image processing technology is being applied to many industrial products. In river engineering or erosion control engineering, image processing technique for grain sizing which is measurement of river bed material size is suggested [1]. It has been pointed out that the measurement accuracy of the image processing technique is uncertain. The uncertainty is caused from technical or theoretical issue. The technical issue is a limit of image recognition against grain shape and the recognition error becomes problem in automated grain sizing especially [2]. The grain sizing procedures are a transforming, a filtering, shape recognition of grain and converting from pixel to actual size unit sequentially (Fig. 1). The automated shape recognition of grains does not have enough accuracy to measure on natural river bed condition yet. The theoretical issue means that the measurement by only vertical image as two dimensional information is not available to get volume as three dimensional information [3, 4] (Fig. 2). Therefore estimation is necessary to calculate grain volume from image and it is considered that these estimations bring measurement error. Nevertheless, photography method has meaningful not only for survey efficiency and a fiscal cost, but the survey efficiency is also capable to complement the accuracy of measurement by the quantity of sampling conversely. Thus we are trying to investigate whether photography method for river bed grain sizing is helpful for understanding fluvial phenomenon.

METHODS
A. Outline of Study Area
Our study area has a 150 m length meandering stream whose catchment is about 2 km² and there is a check dam, which was built for keeping sediment from flowing out, at downstream terminal. Although the check dam is not full of sediment, it seems that the dam would be full in near future. Stream bed material is composed of gravel whose mean diameter is about 100 mm. Hence, it is considered that the most of bed material was transported as bed load. (Fig. 3) shows a relative height contour map, surveying transverse sections and bed material sampling points in study area. Stream gradient between the transverse sections 0-10 m, 10-50 m and 50-150 m are about 18 %, 3.0 % and 2.5 %, respectively.

B. Surveying of grain size distribution
Grain size was surveyed from 0 m to 50 m every 5 m longitudinally and 3 samples at center of stream and its both sides were taken transversely in each transverse section. The sampling was conducted by using two methods. Photography method was applied to coarser grain than 13.2 mm by instruments mentioned above, and sieving test was applied to finer grain. This 13.2 mm threshold is defined from both sieve size and a resolution of photo image. In photography method, contours of grain were determined by computer mouse manually in order to avoid recognition error. Number of samples is determined as 196 for keeping statistical significance [5] and contours of grain by Manual Grain Sizing (MGS) as shown in Fig. 4A and Fig. 4B. From coordinate of points of contour, projected area of grain is calculated. Under a...
hypothesis that grain has spherical shape, volume or mass of grain is estimated by sediment density 2650 kg/m$^3$.

\[ d_{c} = \frac{\mu_{c}}{\sigma} \left( \frac{\rho_{w} u_{c}^{2}}{\gamma} \right) \]  

\[ \tau_{c} = \rho u_{c}^{2} \]  

where, $\tau_{c}$, $\rho$, $\sigma$, $u_{c}$, $d$ are density of water and sediment, respectively, $u_{c} = 80.9d$ if diameter $d \geq 0.3030$ cm by using Iwagaki’s equations and mean diameter $d_{m}$ is substituted for $d$. Shear velocity $u_{c} = \sqrt{\frac{\gamma R}{i}}$, hydraulic radius $R$ is approximated as water depth $h$, $\gamma$ is gravitational acceleration and $i$ is energy gradient. Water surface profile, given latest flood discharge, are analysed [6], and shear velocity converged into steady state is accepted as $u_{c}$ in (1).

RESULTS AND DISCUSSION

A. Characteristics of grain size distribution

Fig. 5 shows grain size distribution at each transverse section where the center and the both sides were surveyed. In all transverse sections, discontinuity of distribution curve is seen at 13.2 mm diameter which is distinguishing the analysis method. It is considered that this is a human error due to sampling the larger grain relative to the smaller one unintentionally. This fact indicates an importance of decision a threshold diameter larger enough than a photo resolution for shape recognition. According to Fig. 3, the stream flows through the right side towards the downstream. Such flow condition is reflected in grain size distribution and it is evident that grain size is coarser on the right side where stream flow lies. Fig. 6 and Fig. 7 show mean diameter by only MGS and
by MGS-sieving test combined, respectively. Only MGS data is homogeneous transversely and changing smoothly along the longitudinal distance. Conversely MGS and sieving test data has a large deviation transversely. It seems that coarser grain has been transported as bed load broad under the flood condition, and with a decrease of discharge at the left bank side, where water depth is small relatively, finer sediment has deposited.

**Fig. 7.** Mean diameter by MGS ($d \geq 13.2$ mm) and sieving test ($d \geq 13.2$ mm) of each transverse section

**Fig. 8.** Calculated water surface under flood discharge by supercritical and subcritical flow analysis

**Fig. 9.** Estimated water head

### B. Appropriateness of grain size in sediment hydraulics

We tried to compare between observed and critical diameter for inspection of appropriateness in sediment hydraulics. Water surface profile is calculated giving the closest recorded flood discharge and shown in Fig. 8. The result of surface indicates super- and subcritical flow state including hydraulic jumps. An analysis below ignores adverse gradient points in which a hydraulic jump occurs because of calculation in order to let energy gradient positive, and it is shown in Fig. 9. Therefore result of critical diameter $d_c$ is indicated as Fig. 10. We have to pay attention to the mention that calculated $d_c$ is transverse average value. The observed $d_{max}$ lie at intermediate variation of $d_c$ along longitudinal distance.

**Fig. 10.** Comparison between critical diameter and observed diameter

### CONCLUSION

We tried to investigate whether photography method which has high survey efficiency for river bed grain sizing is helpful for understanding natural phenomenon. An approximate whole surface surveying was conducted applying the high-efficiency. The result of grain size distributions indicated a good agreement between stream flow condition and diameter size qualitatively. Furthermore, in a comparison by using water surface profile analysis between observed and critical diameter, the result did not shows a complete agreement between them. Nonetheless, observed mean diameter lay on the intermediate of variation of critical diameter along longitudinal distance. Meanwhile discontinuity of distribution curve is seen at 13.2 mm diameter which is distinguishing either photography or sieving. This result indicates that it is necessary to give the threshold diameter larger enough than the limit of photo resolution.

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### REFERENCE


Environment Regeneration Policy for Buriganga River Watershed Area in Bangladesh

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ABSTRACT

Industrial pollution is a growing concern of the present days. The watershed environment of Buriganga River in Bangladesh is under increasing pressure from the hazardous industrial wastes, emanating from Hazaribagh tanneries. A large amount of toxic wastes from Hazaribagh have eaten up all oxygen in Buriganga and the water quality parameter, Dissolved Oxygen (DO) has fallen down drastically. But Hazaribagh tanneries play a significant role in Bangladesh economy in terms of its export contribution. Along with the increase in export of leather sector, water quality of Buriganga deteriorated severely. There exists trade-off relation between the export trend of leather sector and DO values in Buriganga. Inadequate wastewater management system, insufficient capital, lack of effective pollution control measures and their strict enforcement may be largely responsible for this alarming problem. Improved policies for the maintenance and regeneration of Buriganga watershed environment are the needs to be considered urgently.

INTRODUCTION

RIVER pollution is viewed as one of the top environmental problems in Asian region. Many of the rivers get polluted with industrial effluents, municipal waste, agricultural waste, sewage disposal, etc. The Buriganga River in Bangladesh is subject to severe pollution and considered as one of the most polluted rivers in the world. In the context of South Asian region, specifically in Nepal, India and Bangladesh, pollution of surface waters has become more severe and critical near urban stretches due to huge amount of pollution load discharged by developing and industrial activities.

From past decades, Bangladesh has been facing the problem of environmental degradation of Buriganga and other linked rivers around the capital city Dhaka. Especially, the development of tannery industry at Hazaribagh, which is a great factor for the development of Bangladesh economy, is causing pollution and the disruption to the watershed environment and ecosystems of Buriganga. Hazaribagh tanneries discharging their solid wastes and liquid effluent containing toxic chemicals, heavy metals, suspended solids, organic matters etc., in most cases drain directly to the Buriganga without any treatment [1]. Ministry of Environment (MoE) reports that the tanneries collectively dump 22,000 liters of toxic waste including cancer-causing chromium into Buriganga everyday [2]. But it is a potentially rich manufacturing sector in terms of both financial return and social benefits (Ahmed, 2005) as Bangladesh earned US$ 401.64 million in 2009-2010 from this leather sector.

Global studies have indicated that many rivers are polluted by large amount of heavy metals like mercury, cadmium, chromium contamination due to the industrialization and urbanization. Water contamination has negative effects on human health through food cycle. The infamous Itai-itai disease in Japan pointed out the danger of environmental cadmium exposure and has led to a plethora of publications (Lalor, 2008). J.S. Amarnath and S. Krishnamoorthy (2001) analysed various negative externalities on land, water, crops, human and animal health including socio-economic consequences due to untreated or not properly treated tannery effluent at Tamil Nadu in India. The uncontrolled dumping of huge industrial wastes of point and non-point sources is even extremely hazardous when the pollutants are heavy metals and cannot be treated easily by conventional methods. The tanneries of Hazaribagh, are such point sources of the city environment. The specialist speculates that a vast number of people will die in this area in near future. But economy is being given priority to environment, which is very common in any developing country. Failure to improve the wastewater treatment and management systems, lack of development and effective implementation design of policies for maintenance and regeneration of the environment and inadequate sewerage and infrastructure facilities are leading to worsening of the situation. The main objective of this study is to consider some environment regeneration policies for Buriganga watershed area.

TOXIC EFFECTS ON BURIGANGA RIVER

During Mughol regime (1526-1858s) and afterwards, the surrounding area of Buriganga was the hub of all social, economic and recreational activities of the Dhaka dwellers. It was the breeding place for all types of fish. It was once the main source of drinking water for the residents of Dhaka and the water treatment plant at Chandanighat produced 17 million liters per day (MLD) of drinking water drawn from Buriganga [3]. But now it is like a tank of toxic black gel and there is no fish or aquatic life apart from zero oxygen survival kind of organisms [4].

Thousands of industries alongside the Buriganga, are disposing their untreated wastes directly in the river. Hazaribagh tanneries are the most harmful among these, which dispose about 12,000 m3 of untreated wastes daily in the Buriganga [5]. Several studies have identified that the water quality of Buriganga is deteriorating at a rapid rate and other water quality parameter like Biochemical Oxygen Demand (BOD) concentration is much higher concentration than the Environmental Quality Standard (EQS, 1997). Analysis of data available from Department of Environment (DoE) demonstrates that the DO levels of Buriganga have gone down much the acceptable limit at many places during the past decades and the degradation values are very high. At present DO levels of Buriganga for all the critical locations become zero, which indicates severe water pollution and environmental degradation of Buriganga and other linked rivers around Dhaka. Thus it is said that Hazaribagh tanneries are killing Buriganga [6].

CONTRIBUTION OF LEATHER SECTOR IN BANGLADESH ECONOMY

Hazaribagh tannery city was established in 1940-50s on just 62 acres of land. 90% of Bangladesh’ 270 registered tanneries are located in Hazaribagh [7]. The industries of 65-year-old tannery complex are processing 220 metric tons of hide a day. The tannery industry in Bangladesh is expanding from economic point of view despite of the environmental pollution. Development of tannery industry at Hazaribagh leads to the export trend of leather in Bangladesh economy. Bangladesh earns a good amount of foreign exchange from leather and leather goods. Leather sector accounts for 85% of total exports, combined with garments and shrimp (Dhaka Chamber of
Commerce and Industry, 2005:3). This sector plays a very significant role in contributing GDP and alleviating unemployment in Bangladesh economy. Information obtained from a number of credible sources exhibit that in total 741,000 people are employed directly or indirectly in leather and its subsectors. But the unplanned tanneries at Hazaribagh, do not have supporting infrastructure facilities. Most of the tanneries are not properly modernized and are using non- mechanized or semi-mechanized systems and antiquated processing methods. No tannery in Hazaribagh has effluent treatment facilities, posing a grave threat to environment [8]. The tanneries dispose their liquid wastes directly to the open drains beside the roads without any treatment, which finally connect to the Buriganga. Buriganga receives in average 19 tons of suspended solids and 7.5 tons of BOD in one day from the tanneries. Industrial waste with such concentration of pollution is not allowed to be discharged in natural water bodies in any developed country [9]. Thus along with the development of tannery industries at Hazaribagh, water quality of Buriganga is degrading seriously.

CONSIDERATION OF ENVIRONMENT
REGENERATION POLICY

Hazaribagh tanneries discharge highly toxic wastes directly to the Buriganga without any treatment. Tannery effluents require elaborate treatment before disposal to prevent pollution of the receiving body of water. But there is no waste management system at Hazaribagh. Most of the tannery owners are poor and they are using primitive technology in their production process, which is very harmful for environment. Besides the low wage rate and poor enforcement of environmental laws and rules have given the country’s leather sector a comparative advantage in the world market [10]. Moreover, the country enjoys duty exemption under the GSP (Generalized System of Preference) from most of the importing countries of the developed world. Due to these advantages, Bangladesh has adopted an export-led growth strategy, for its economic development. But for sustainable development, a country has to consider the natural environment. If the tannery owners keep consideration to the environment, they have to install modern technologies in their production and waste management systems. The production cost will go up then and it may turn to be a big constrain for Bangladesh to compete with others in the global market. Due to this trade-off relation, environmental problems of developing countries cannot be solved so easily. Inadequate waste management systems, lack of capital and infrastructure facilities and insufficient open spaces can make the problem acute. In this situation it is very urgent to consider some environment regeneration policies for Buriganga watershed environment.

A. Innovating Cheap Waste Management System

For environmental regeneration, this policy is very important for any developing country. Government and concerned organizations should take a notice and step forward for a useful solution. If cheap modern technology is innovated, all tanneries can continue their production and survive in the export market without damaging the environment. The Government also has to concentrate on providing proper sewerage and infrastructure facilities. Hence the problems of lack of capital and infrastructural facilities may be removed.

B. Merging of Small Tanneries and Cooperative Production Structure

It is reported that at present, 114 units, large and medium by the local standards are registered to the Directorate of Industries. Others are mostly of small and cottage type and are not on the register. In this situation, different groups of medium and small tanneries can make co-operative or collaborate industrial structures to run their production. Then they can be able to maximize their production and minimize environmental degradation by installing modern technologies. Co-operative system is also fruitful in the area of waste management system. Japan has taken the lead in a co-operative production of value in the area of waste management. For almost 30 years Japan evolved waste management as a fundamentally co-operative process [11].

C. Strict Enforcement of Industrial and Environmental Rules and Policies

It may be possible to curb pollution by the policies. The existing rules should be amended by strict enforcement. Under this policy, all tanneries have to clean their effluents before disposal and install environmentally friendly technologies. Those who are unable to obey the rules have to close their tanneries and Governments have to support them to switch in other sectors. As a large number of tanneries get collapsed under this policy, the existing tanneries will get some open space to build Effluent Treatment Plant (ETP) and Central Effluent Treatment Plant (CETP). Thus the problems of inadequate waste management and insufficient open space can be solved.

D. Execution of Hazaribagh Relocation Project

Most of the European Union (EU) counties are set to pass new policies that will bar import of products from industries that pollute environment with harmful chemical agents and do not have CETP [12]. But Hazaribagh is too congested to build CETP and redevelop. The Government has launched a relocation project of Hazaribagh tanneries to a new area, located at Savar near Dhaka to save Buriganga. But this relocation project proves to go in vain because of unwillingness of the tannery owners to move and in terms of the cost effectiveness and potential environmental threat of the new area [13]. Though the Government is persuading the tannery owners to start shifting their factories from Hazaribagh to Savar, the CETP has not been built yet. Moving to Savar, without a CETP and proper infrastructure facilities, will result in the same way as Hazaribagh. So, the shifting should be completed as early as possible impending EU legislation keeping in mind, otherwise it may hurt this export-oriented industry.

E. Recycling Policy and Practice

Recycling is re-using of products, a mean of waste reduction. Government may introduce or innovate new technologies for recycling to reduce or manage solid wastes. It is possible to recycle the solid wastes from tannery industries as poultry and fish feed, hard board, glue etc. So recycling policy and practice may be a fruitful policy for environmental regeneration and developing activities.

CONCLUSION

Pollution of Buriganga is now reaching epidemic proportion. As the apparel industry and the leather product industry are being shifted from China to Bangladesh for its cheap labor cost, further pollution of the watershed environment is assumed. The improvement of the water quality of Buriganga, development and design of policies for the maintenance and the regeneration of the watershed environment are the nation’s important problem. But as Bangladesh is a developing country, the existing rules of proper industrial waste treatment have always been ignored by the owners of the industries. Lack of implementation of rules by the concerned Government agencies has aggravated the environmental pollution problem. DoE should take the leading role to implement the rules with the help of law enforcing agencies. However, political commitment is necessary to avoid and overcome the socio-political implications, which may curb pollution and regenerate the watershed environment of Buriganga River.
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REFERENCE


Study on Noise Pollution due to Traffic Flow in Sylhet

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ABSTRACT
The study was performed to obtain the Equivalent Noise Level, Traffic Noise Index (TNI), Noise Climate (NC) and hazard due to noise pollution at eight different intersections in the Sylhet city. Due to increase of population, road traffic is increasing day by day which causes noise pollution in the environment. Now-a-days it becomes a serious environmental issue. The study was carried out from 8:00 am to 8:00 pm to assess the noise level at various intersections in Sylhet city. The maximum Equivalent Noise Level was 78.00 dBA at Amberkhana during the period of 5:00 pm to 8:00 pm whereas Subidbazar was identified as noise prone area characterized with Traffic Noise Index (TNI) and Noise Climate (NC) of 77.70 dBA and 13.90 dBA respectively.

INTRODUCTION
The level of the noise pollution is very closely related with urbanization and motorization. Traffic noise can interrupt speech communication, sleep and relaxation and reduces the ability to perform complex tasks [1]. Surveys of many countries have shown that traffic noise is the principal environmental nuisance in urban areas [4]. Noise from the motors and exhaust systems of large trucks provides the major portion of highway noise and provides a potential noise hazard to the surrounding people and driver as well [3]. In Sylhet city, the main sources of noise pollution are the motors and exhaust systems of autos, smaller trucks, buses, and motorcycles. This type of noise can be augmented by narrow streets and tall buildings, which produce a “canyon” in which traffic noise reverberates [5].

Throughout dozens of studies, noise has been clearly identified as an important cause of physical and psychological stress [8]. Stress directly influences the activities of our body mechanism and thereby noise can easily be associated with many of the disabilities including heart attack, high blood pressure, headaches, fatigue and irritability [6]. Among the health hazards related to noise, hearing loss is the most commonly treated by health professionals [7]. Noise that causes annoyance and irritability in healthy persons may have serious consequences for those who are already ill in mind or body [2]. The other hazards are harder to pin down. The main objectives of the study were

- To obtain the Equivalent Noise Levels at different intersections of the Sylhet city
- To obtain the Traffic Noise Index (TNI) and Noise Climate (NC) of the intersections
- Identification of the noise prone intersections among them
- To obtain public opinion ad their susceptibility to noise pollution
- To recommend some possible measures to reduce noise pollution

MATERIALS AND METHODS
Eight major intersections in Sylhet city were selected to assess the noise level. The major intersections were Madina Market, Subidibazar, Amberkhana, Chowhatta, Zindabazar, Niorpool, Bondor and Rikabibazar. Noise levels were measured during the period of 8:00 am to 8:00 pm of the workdays. The four time intervals were

- 8:00 am to 11:00 am
- 11:00 am to 2:00 pm
- 2:00 pm to 5:00 pm
- 5:00 pm to 8:00 pm

Before the measurement being started, calibration was performed. The NL- 04/NL-14 simultaneously calculates the Leq, LI, Lmax, and Ln. After processing, the display was switched to show any of the above values.

Noise levels were measured at the road side as well as at distances (near hospital building) away from the road side. The sound level meter was switched to fast response position.

During each hourly interval, sound levels were measured for 10 minutes for a couple of times. The average values of these measurements were recorded as the sound level for the corresponding location and time interval.

Traffic Noise Index (TNI) and Noise Climate (NC):
TNI and NC were computed by using the following equations; TNI and NC measured as dBA:

\[ TNI = L_{eq} + (L_{eq} - L_{50}) \]
\[ NC = (L_{10} - L_{90}) \]

RESULTS AND DISCUSSION
Public opinion says, noise irritates them mostly, they can’t sleep and it also disturbs their concentration at work. According to field survey it was found that most of the people feel noise as a hazard but very few of them know about its impact on health. From Fig. 1, it is seen that health hazards like hearing loss, concentration loss, mental stress, irritation is the highest in Madina market (45%), Niorpool (29%), Zindabazar (18%) and Subidibazar (22%) respectively. Among them Madina market, Chowhatta and Niorpool are the most vulnerable.
The study also observed that the noise levels at four time intervals are almost same. The following table shows the different parameters of noise level at various intersections.

In the residential areas the range of variation in noise level is much higher as implied by the values of noise climate (NC). Such variations of noise create shock wave which severely affect patients of heart disease.

**Table 1. Equivalent Noise Levels (dBA) at Various Locations**

<table>
<thead>
<tr>
<th>Time interval</th>
<th>Madina Market</th>
<th>Subidbazar</th>
<th>Amberkhana</th>
<th>Chowhatta</th>
<th>Zindabazar</th>
<th>Rikabibazar</th>
<th>Niorpool</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 am - 11:00 am</td>
<td>70.56</td>
<td>68.00</td>
<td>71.00</td>
<td>69.00</td>
<td>70.50</td>
<td>68.67</td>
<td>67.00</td>
</tr>
<tr>
<td>11:00 am - 2:00 pm</td>
<td>72.88</td>
<td>70.00</td>
<td>77.90</td>
<td>71.00</td>
<td>72.00</td>
<td>70.50</td>
<td>69.80</td>
</tr>
<tr>
<td>2:00 pm - 5:00 pm</td>
<td>68.96</td>
<td>69.40</td>
<td>75.00</td>
<td>70.70</td>
<td>71.00</td>
<td>71.00</td>
<td>71.70</td>
</tr>
<tr>
<td>5:00 pm - 8:00 pm</td>
<td>74.00</td>
<td>70.00</td>
<td>78.00</td>
<td>72.00</td>
<td>73.80</td>
<td>72.00</td>
<td>72.60</td>
</tr>
</tbody>
</table>

**Table 2. Values of NC and TNI at various locations**

<table>
<thead>
<tr>
<th>Location</th>
<th>NC (dBA)</th>
<th>TNI (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modina market</td>
<td>8.90</td>
<td>56.90</td>
</tr>
<tr>
<td>Subidbazar</td>
<td>13.90</td>
<td>77.70</td>
</tr>
<tr>
<td>Amberkhana</td>
<td>5.60</td>
<td>60.30</td>
</tr>
<tr>
<td>Chowhatta</td>
<td>7.70</td>
<td>58.20</td>
</tr>
<tr>
<td>Zindabazar</td>
<td>8.50</td>
<td>52.00</td>
</tr>
<tr>
<td>Bondor</td>
<td>4.90</td>
<td>65.70</td>
</tr>
<tr>
<td>Niorpool</td>
<td>8.40</td>
<td>55.90</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The study says, Madina market, Chowhatta and Niorpool are the most vulnerable intersections for hearing loss, concentration loss, mental loss and irritation (Fig. 1). At various time intervals equivalent Noise Levels are the highest in 5:00 pm-8:00 pm (Table 1). In Amberkhana intersection equivalent Noise Level is the highest 78.00 dBA. Table 2 also shows the highest noise prone area is Subidbazar (NC and TNI are 13.90 dBA and 77.70 dBA respectively). From the analysis of data it was observed that average noise level in the road side is about 74 dBA which exceeds the acceptable limit of 45 dBA set by the Department of Environment (DOE). The following measures can be adopted to control noise pollution:

- Tree plantation can be encouraged. They act as a barrier. They absorb the sound energy and reduce noise level.
- Control of noise sources can be adopted; drivers can be trained with proper vehicular maintenance. Traffic can be controlled, geometric and structural design of the roads can be controlled.
- Noise path can be controlled by using appropriate barriers that can reflect and diffuse noise.
- Buffer zones can be created between roads and the house holds to provide a distance over which noise can be attenuated.
- Awareness programs can be carried out to make the people known about the hazards of noise. It can be helped to control noise pollution at the receptor site.

**REFERENCE**

Assessment of Spatial Variation of Water Quality of Tunggak River Adjacent to Gebeng Industrial Estate, Malaysia

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ABSTRACT
Anthropogenic impact on the Tunggak River is as a result of rapid industrialization in the study area. The study was conducted with the objective to explore the spatial variation of the water quality of the river due to anthropogenic activities. Water samples were collected monthly from selected sites and analyzed applying APHA & HACH standard methods. Trace elements were determined using Inductively Coupled Plasma Mass Spectrophotometer (ICP-MS). SPSS statistical software was used for data analysis. The study revealed that point sources especially industrial wastes contributing the major pollutants. Less amount of dissolved oxygen (DO) and higher concentration of chemical oxygen demand (COD) & ammoniacal nitrogen and trace elements made the water unusable. Based on Department of Environment-Water Quality Index (DOE-WQI) Malaysia, maximum stations except lower and uppermost were categorized as class IV (highly polluted). Pollution was higher in the middle stations due to addition of most of the industrial effluents to those sites.

INTRODUCTION
Water is the most delicate part of the environment which is essential for human and industrial development. Due to increasing population and rapid growth of industrialization the demand of fresh water rises tremendously in the last few decades [1]. The rate of fresh water deterioration by anthropogenic activities is coupled with the ever-growing demands of water resources [2]. Malaysia is subsidized with a bounty of natural water resources which is contributing significantly to the socio-economic development of the country [3]. But the situation is changing day by day with population growth, urbanization and industrialization. According to the Environmental Quality Report 2009, 46% river water of Malaysia is polluted which is higher than previous couple of years [4]. The Tunggak is one of the important rivers in Pahang which is adjacent to Gebeng the main industrial area in Kuantan, Pahang, Malaysia. The town Gebeng is located near Kuantan Port; where industrial development is growing rapidly. These industrial activities are generating effluents which contain high concentrations of conventional and non-conventional pollutants that deteriorating the water quality of the river. In the study area, non-point source associated with runoff from construction sites of newly developing industrial areas and the point source contributing the maximum pollutants especially industrial wastes. Industries like, petrochemical, medicinal, wooden and mining are discharging their effluents in the river through various drain/channels. As a result the water of the river contains high amount of ammoniacal nitrogen (NH3-N), less DO and many other components that deteriorate the water quality. The industrial waste water of the study area contain nickel (Ni), mercury (Hg), cadmium (Cd), zinc (Zn), chromium (Cr), lead (Pb) and copper (Cu) [5]. So, the river water quality becomes more polluted. Therefore, the study was done with a view to identify the behavior of the water quality parameters and to disclose the spatial variation of the pollution status of the surface water.

MATERIALS AND METHODS
A. Study Area and Selection of Station
The Tunggak River is situated in between 3°56'06" to 3°59'44" N and 103°22'42" to 103°24'47" E adjacent to the Gebeng industrial town holding several types of industries (Fig. 1). Station selection was done considering the land use-pattern, point-sources of pollution, vegetation and river network. Starting from lower stream 10 stations was selected for sampling.

B. Sampling, Data Collection and Analysis
Water samples were collected monthly from pre-selected 10 stations. Three (3) samples were collected from identical 3 positions in every station for replication. Data regarding the position of the station was collected using GPS. BOD samples were carried using separate BOD bottle. APHA & HACH standard procedure was followed during sampling and samples preservation [6-7]. Using YSI in-situ data of pH, Temperature, DO, Turbidity, Salinity, Electrical conductivity (EC), and total dissolved solids (TDS) were also collected during the sampling. For chemical parameters HACH spectrophotometer was used. BOD was calculated with the initial reading collected just after sampling and the final reading after 5 days incubating at 20°C temperature. TSS analyzed by using gravimetric method and heavy metals were determined by ICP-MS. All parameters were analyzed within 7 days of sample collection.

RESULTS AND DISCUSSION
C. Data Analysis
The main aim of environmental research is to identify for underlying factors which are not observable directly in database, for this factor analysis technique is suitable [8]. For the factor analysis SPSS statistical software was used to analyze the data. For this study data were analyzed for mean, standard deviation (SD), range, correlation and Analysis of Variance (ANOVA).
from 26.16°C to 35.24°C among the stations. In most of the stations temperature was within the normal limit of Malaysian standard but the temperature of station 6 to 8 were beyond the standard limit [11] (Table 2). Regarding pH values, it was varied from station to station. The highest pH value 9.12 was recorded in station 6 followed by station 5 and station 7. These three stations received most of the effluents of the industrial estate consist of polymer, chemical, metal, gas & power industries. On the contrary, the lowest value 4.16 was recorded in station 8 followed by station 9 and 10. It was might be because of the industrial effluents at the area of station 8 and 10 contained acidic substances and due to submerge condition at station 9 pH was also low (Table 2). Only the value of pH in station 1 was within the permissible range [11]; perhaps it was due to the tidal interference from South China Sea (Table 1).

Table 1. Physico-chemical parameters of different sampling sites and classification based on INWQS of Malaysia

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Station no. (total station)</th>
<th>Value/ amount</th>
<th>Water Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>1 (1)</td>
<td>6.0 – 9.0</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>2 – 7 (6)</td>
<td>6.5 – 8.5</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>8 – 10 (3)</td>
<td>5.0 – 9.0</td>
<td>Class III</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>1.5, 7.8 (4)</td>
<td>3.12 – 3.38</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>2 – 6, 9 – 10 (6)</td>
<td>1.58 – 2.71</td>
<td>Class IV</td>
</tr>
<tr>
<td>EC (µS/cm)</td>
<td>1 – 2 (2)</td>
<td>10880-18013</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>3 – 7 (5)</td>
<td>1068 – 1585</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>8 – 10 (3)</td>
<td>24 – 750</td>
<td>Class I</td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>1 – 2 (2)</td>
<td>5.685 – 9.38</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>3 – 6 (4)</td>
<td>0.52 – 0.715</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>7 – 10 (4)</td>
<td>0.01 – 0.34</td>
<td>Class I</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>1 – 8 &amp; 10 (9)</td>
<td>6.59 – 23.44</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>3.87</td>
<td>Class I</td>
</tr>
<tr>
<td>TDS (mg/L)</td>
<td>1 – 2 (2)</td>
<td>6250-16137</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>3 – 6 (4)</td>
<td>613-767</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>7 – 10 (4)</td>
<td>8.15 – 365</td>
<td>Class I</td>
</tr>
</tbody>
</table>

EC readings of the stations were mostly within the normal limit except the 1, 2 & 3 (Table 2). This was because of entering the saline water in these stations during tide from the South China Sea. Concentration of DO recorded very low in all of the stations varies from 1.1 mg/L at station 2 to 4.4 mg/L at station 1 (Table 2). According to INWQS, Malaysia the stations were categorized as class III and IV based on DO concentration (Table 1).

TDS concentration was higher in the lower stream stations compare to the uppermost. Station 1 and 2 contained the highest amount of TDS due to tidal disturbance, forested area and there were some agricultural activities adjacent to the station 2. Meanwhile, TDS of station 7-10 were in permissible limits 500 mg/L [11] (Table 2). Turbidity level varies from 2.1 NTU at station 9 to 34.5 NTU at station 5 (Table 2); only station 9 was in normal level whether rest of all contained higher value of turbidity according to the INWQS, Malaysia.

B. Ex-situ Parameters

Collecting samples from sampling sites were analysed in laboratory for determining the amount of Sulphate (SO₄²⁻), NH₃-N, Nitrate-nitrogen (NO₃⁻N), Phosphate-phosphorus (PO₄³⁻), BOD, COD and TSS. Results showed that the amount of sulphate was highest in station 1 followed by 2 and 7 (Fig. 2).

It was due to station 1 & 2 are located near the sea and station 7 is adjacent with some industries which discharge sulphur reach effluents into the river. The amount of NH₃-N varies from 0.25 mg/L at station 9 to 3.47 mg/L at 3 (Fig. 3). The values were beyond the permissible limit of INWQS of Malaysia [11]. NO₃-N level was within the safe level (<0.4) [9] except station 5-7 (Fig. 3); these three stations received most of the effluents from the industries including polymer, chemical, metal, gas & power and wooden industries in Gebeng. From the analysis PO₄³⁻ recorded highest 6.3 mg/L at station 10 (Fig. 3) while the other stations contain relatively low PO₄³⁻. Meanwhile PO₄³⁻ amount was in permissible level at station 7-9 [11].

Biochemical parameters BOD and COD were analyzed and the result revealed that BOD was the highest 32.88 mg/L at station 7 and the lowest was 4.23 mg/L at 9 (Fig. 4). The BOD values at all stations were beyond the permissible limit [11] and it was due to the discharge of industrial wastes in the river flow. In the same way COD value recorded higher at station 7 and lesser at station 9 (Fig. 4). However, COD level recorded safe at station 9 & 10 [11]. Due to the addition of industrial effluents with the river water the quality of water deteriorated and based on the types of industry pollution level of the river differ from station to station.

Heavy metals were determined by ICP-MS and demonstrated in Fig. 5. Result showed that water of the river bearing especially the middle stations containing Co, Cd, Cu, Pb and Cr beyond the permissible level [11]. Adjacent to the river the major industries are chemical, polymer, metal, petrochemical and gas & energy; those effluents bear the toxic heavy metal as a result polluting the surface water of the river.
Table 2. Range, mean and SD for in-situ parameters for 10 sampling stations with geographical coordinate

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Location GPS</th>
<th>Temperature (°C)</th>
<th>pH</th>
<th>Conductivity (µS/cm)</th>
<th>DO (mg/L)</th>
<th>TDS (mg/L)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35.04°N and 23.12°E</td>
<td>Range</td>
<td>27.05-30.17</td>
<td>5.66-7.02</td>
<td>14200-27080</td>
<td>2.62-4.40</td>
<td>9040-24300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>28.78</td>
<td>6.23</td>
<td>18013</td>
<td>3.30</td>
<td>16137</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>1.07</td>
<td>0.52</td>
<td>4946</td>
<td>0.61</td>
<td>7691</td>
</tr>
<tr>
<td>2</td>
<td>19.44°N and 22.94°E</td>
<td>Range</td>
<td>28.04-29.2</td>
<td>6.97-7.71</td>
<td>7700-13660</td>
<td>1.10-2.17</td>
<td>5160-7270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>28.55</td>
<td>7.28</td>
<td>10880</td>
<td>1.58</td>
<td>6250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.59</td>
<td>0.34</td>
<td>2836</td>
<td>0.41</td>
<td>1088</td>
</tr>
<tr>
<td>3</td>
<td>39.6°N and 23.64°E</td>
<td>Range</td>
<td>29.01-29.8</td>
<td>7.32-8.40</td>
<td>1244-1800</td>
<td>1.33-1.80</td>
<td>650-869</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>29.34</td>
<td>7.69</td>
<td>1395</td>
<td>1.69</td>
<td>767</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.38</td>
<td>0.38</td>
<td>207</td>
<td>0.36</td>
<td>112</td>
</tr>
<tr>
<td>4</td>
<td>54.18°N and 23.86°E</td>
<td>Range</td>
<td>30.92-32.5</td>
<td>7.51-8.51</td>
<td>1119-1320</td>
<td>1.62-4.12</td>
<td>527-821</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>31.74</td>
<td>7.95</td>
<td>1212</td>
<td>2.71</td>
<td>613</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.75</td>
<td>0.35</td>
<td>95</td>
<td>0.96</td>
<td>108</td>
</tr>
<tr>
<td>5</td>
<td>54.54°N and 23.28°E</td>
<td>Range</td>
<td>30.63-34.14</td>
<td>7.25-9.12</td>
<td>1423-1740</td>
<td>1.56-3.16</td>
<td>649-778</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>32.88</td>
<td>8.01</td>
<td>1585</td>
<td>2.32</td>
<td>715</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>1.35</td>
<td>0.76</td>
<td>164</td>
<td>0.79</td>
<td>68</td>
</tr>
<tr>
<td>6</td>
<td>33.6°N and 23.14°E</td>
<td>Range</td>
<td>33.2-35.24</td>
<td>6.77-8.60</td>
<td>923-1210</td>
<td>2.85-3.93</td>
<td>203-529</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>33.78</td>
<td>7.65</td>
<td>1068</td>
<td>3.28</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.88</td>
<td>0.62</td>
<td>149</td>
<td>0.51</td>
<td>171</td>
</tr>
<tr>
<td>7</td>
<td>13.44°N and 23.92°E</td>
<td>Range</td>
<td>32.5-34.14</td>
<td>4.66-5.42</td>
<td>51-58</td>
<td>2.78-4.25</td>
<td>19.6-24.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>33.27</td>
<td>4.96</td>
<td>55</td>
<td>3.38</td>
<td>21.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.56</td>
<td>0.29</td>
<td>3.31</td>
<td>0.59</td>
<td>2.25</td>
</tr>
<tr>
<td>8</td>
<td>16.44°N and 23.46°E</td>
<td>Range</td>
<td>26.16-27.4</td>
<td>4.23-6.70</td>
<td>20-27</td>
<td>1.93-3.05</td>
<td>7.7-8.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>26.78</td>
<td>5.13</td>
<td>24</td>
<td>2.34</td>
<td>8.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.61</td>
<td>1.04</td>
<td>3.39</td>
<td>0.38</td>
<td>0.47</td>
</tr>
<tr>
<td>9</td>
<td>27.42°N and 23.18°E</td>
<td>Range</td>
<td>31.12-31.75</td>
<td>5.14-6.40</td>
<td>713-787</td>
<td>2.36-3.01</td>
<td>333-379</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>31.45</td>
<td>5.86</td>
<td>750</td>
<td>2.66</td>
<td>354</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>0.29</td>
<td>0.44</td>
<td>36.01</td>
<td>0.22</td>
<td>22.12</td>
</tr>
</tbody>
</table>

C. Water Quality Index

DOE-WQI was calculated to classify the water quality of Tunggak river. The computed values categorized the river water of Tunggak as Class IV (highly polluted) except the lower stream station 1 and upper stream stations 9 & 10. Regarding those three stations, they were categorized as polluted and slightly polluted respectively. That was perhaps at station 1 there was tidal interference and forested areas; and at station 9 & 10 there was less industrial activities generating comparatively lesser effluents. However, according to the Interim National Water Quality Standards of Malaysia, water of the river was found to be unusable without irrigation [11].
CONCLUSION

This study revealed that the pollution level was comparatively higher in the middle stream stations because of maximum wastes discharged to those stations from the industries. On the other hand due to tidal interference at lower stream and less industrial activities at the upper stream caused less pollution in lower and upper stream stations. Considering the analytical results and data analysis it is clear that the major source of pollutant was the industrial activities. To reduce the water pollution level close monitoring of industrial activities should be ensured and emphasis should also be given on recycling of industrial wastes of their own before discharging to the river flow.

ACKNOWLEDGMENT

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REFERENCE

Characterization and Filtration Performance of Pressed Non-woven Fabric Membrane
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Sepa-Sigma Inc., Japan

ABSTRACT
Low cost membranes for water treatment using non-woven fabric membrane are proposed. The non-woven fabric membranes are applied in the novel separation technologies that are the pore diffusion separation and the flow fractional separation. The compression ratio, surface roughness and pore size of the membrane were evaluated in the correlation of their filtration performance. It was able to reduce the membrane thickness, the surface roughness and the average pore size of the non-woven fabric membrane by pressing in wet state. It was confirmed the particles with more than 10 μm could be removed completely and it was maintained almost stable between two days (3000 minutes) and almost no clogging was observed.

INTRODUCTION
Due to the increase in the world population and the economic development, the water shortage has become a serious problem. To solve the water shortage, many technologies of water treatment have been developed. The water treatment required for developing countries must be small size, easy to handle and low cost, since it is not easy to build large-scale infrastructure. A problem of a centralized city is also needed to concern. Due to old facilities of domestic infrastructure, it will be good chance to convert them to such small-scale equipment.

In the case of installing small devices, the operation system must be simple, because the local people have to operate them. A membrane separation may be the most effective. The membrane separation device currently on the market is very expensive. The reason of the price increases is the high production cost of the membrane.

In this paper, one of the low cost membranes for water treatment is proposed. The membrane using non-woven fabric is manufactured by mass production. The authors think the non-woven fabric membrane can be applied for water treatment and it is possible to develop a novel separation membrane having a micron pore size.

The pore diffusion, defined as the diffusion of a substance in a pore of a membrane, is the technique to separate the large particles and water [1]. Water molecule passes through the inside of the membrane with a multilayer structure by diffusion and also is filtered through a bulk flow. The particles shift their position to the place where shows the higher flow rate. The particles cannot be entered to the internal pores of the membrane, and then, is separated from water. One of the features of the pore diffusion is high level of particle removal ability. On the other hand, slow filtration rate is a disadvantage. Non-woven fabric membrane can be satisfied for the demand of low cost in membrane technology.

The flow fractionation separation has been proposed for the porous membrane [2]. The separation mechanism is based on the flow fractionation effect (or the collection axis effect) that occurs by quickened flow rate [3] (Fig. 1). The flow fractionation effect is observed in blood flow within the human body [4]. By the use of this effect we may maintain a stable long-term filtration performance. For example, red blood cells move to the center of the blood vessel by the effect resulting the stable filtration [5, 6]. When we use this effect in the filtration proses of aqueous solution, it is possible to separate particles and water by low pressure filtration. The flow fractionation effect is observed only in the case of the shear stress to the particles exceed over the critical value that originates the rotational motion of the particles in a flow stream. This indicates that the flow stream of a given aqueous solution must be the laminar flow and the flow should give the shear rate to the particles. The shear rate, τ, is given by the following equation (1).

\[ \tau = \frac{V}{t} \]  
(1)

Where, V is the flow rate (mm/s), t is the width of the flow path (mm). When the particles size is a sub-micron, more than 20 sec⁻¹ shear rate works effectively on the rotational motion of the particles.

Even in the case of the non-woven fabric membrane, the flow fractionation is available and also the pore diffusion is applicable. We can expect the development of the novel low cost and small scale equipment for water treatment.

In this paper, we will prepare a prototype non-woven fabric membrane by pressing a commercial available non-woven fabric. The pressed non-woven fabric may be evaluated compression ratio, surface roughness and an average pore size. The wastewater containing particles of a certain particle size may be employed and the separation performances including particle removal ability and filtration speed may be evaluated. We intend to evaluate the potential application for the novel separation technology.

METHODS
A. Non-woven fabric filament
Regenerated cellulose filament non-woven fabric (The non-woven fabric membrane) was prepared by copper ammonium process (100g / m² basis weight, 390 μm thickness, Ra=21.1 μm surface roughness), and roller pressed or hot pressed in a wet condition. Hot press was operated by hand with a heated iron. Roller press machine was used for the roller press. The average pore size of the original regenerated cellulose filament non-woven fabric was about 100 μm including support mesh pore size.

Fig. 1. The flow fractionation effect diagram
B. Compression Ratio

The compression ratio was calculated with the thickness of the membrane before and after pressing. Compression ratio is given by the following eq. (2).

\[ \text{Compression ratio} = \frac{(T1 - T2)}{T1} \times 100 \]  

Where T1 is the thickness of non-woven fabric membrane before pressing, T2 is the thickness after pressing.

C. Surface Roughness

The surface roughness of the pressed non-woven fabric by the roller press was measured. The surface roughness is represented by the average roughness Ra. When the highly of the surface of the fabric is expressed in \( y = f(x) \), in micrometers (\( \mu m \)), Ra value was determined by the equation shown in the Fig. 2, the roughness curve.

\[ R_a = \frac{1}{L} \int_0^L |f(x)| \, dx \]

D. Average Pore size

Average pore size of the membrane, more than 50% compression ratio, was measured by the filtration rate of distilled water by the following formula (3).

\[ \text{Average Pore size} = \frac{J \times \Delta P \times \eta}{A \times \text{Pr} \times \rho} \]  

Where \( J \) is the flow rate (mL/min), \( \Delta P \) is pressure difference (mmHg), \( A \) is the membrane area (m²). These are using the measured values. Prp is \( "1 - (\text{cellulose density} / \text{membrane density})". \( \eta \) is the viscosity.

E. Evaluation of filtration performance

The separation performance was evaluated by filtering waste water through the non-woven fabric membrane. The waste water includes the large particle of toxic flocculated materials by using flocculating agent (nucleating agent). The flocculated materials, about 20 \( \mu m \) particle size (measured by DLS, Dynamic light scattering) (Fig. 3), were stirred by a pump of the flow fractionation separation unit and crushed by shear force to smaller particles about 10\( \mu m \) to be around. The particles were filtered through the pressed non-woven fabric membrane.

RESULTS AND DISCUSSION

A. Non-woven fabric membrane

Regenerated cellulose filament non-woven fabric by copper ammonium process was pressed by roller press machine at 30 C in wet condition.

The cross-section of the pressed non-woven fabric membrane was observed with a microscope. Distribution of fiber was measured as a function of the distance from the surface of non-woven fabric and total fiber number per cross-sectional area unit. The number of fiber cross-section present in the layer of 500 \( \mu m \) length and 50 \( \mu m \) depth of the cross-sectional view was more than 10 in any layer. Pulsion of the number had been within 2 times of the number and the average number of 0 and those values are the number of fiber cross-section present in the layer at 500 \( \mu m \) length 10 \( \mu m \) depth cross-sectional direction also. The pulsation indicates that non-woven fabric membrane has a laminated multilayered structure. This multilayered structure is one of the most important factors for the separation by the use of a membrane. Thus this prototype non-woven fabric membrane can be expected having a certain separation performance.

B. Compression ratio

Compression ratio of the pressed non-woven fabric membrane was measured. The observed compression rate of the hot pressed membrane was 11.8%. The edge of the Roller Pressed membrane was 52.6% and at the center of it was 43.2%.

C. Surface roughness

Surface roughness was measured before and after the press of the non-woven fabric membrane. The original non-woven fabric was Ra (\( \mu m \)) = 21.1, the hot Pressed membrane was Ra (\( \mu m \)) = 13.9, roller pressed (center) Ra (\( \mu m \)) = 17.1, (edge) Ra (\( \mu m \)) = 7.7. For water treatment, it might be necessary to make the surface roughness small as like less than Ra = 10 to realize laminar flow. It is necessary to clarify the condition of the edge of the roller pressed non-woven fabric membrane in order to get the reproducible manufacturing. Fig. 6 represents the value of Ra for four membranes.

D. Average pore size

Pressed non-woven fabric membranes were prepared in industrial scale under the conditions of 52.6% compression
rate. The average pore size of the membrane was measured through the water filtration rate method. The average pore size was about 8 μm degree, as shown Fig. 6.

![Fig. 6. Surface roughness Ra. 1. Original, 2. Hot press, 3. Rollar press (center), 4. Rollar press (edge)](image1)

**Fig. 6.** Surface roughness Ra. 1. Original, 2. Hot press, 3. Rollar press (center), 4. Rollar press (edge)

![Fig. 7. Change in pore size with thickness of membrane; prepared by compression rate 52.6 %](image2)

**Fig. 7.** Change in pore size with thickness of membrane; prepared by compression rate 52.6 %

E. Evaluation of filtration performance

By using the non-woven fabric membrane prepared in industrial scale, a wastewater was filtered and its separation performance was evaluated. After filtration, large particles with more than 10 μm in the waste water were almost cleared by visual inspection.

The filtration rate in this filtration experiment could maintain at a stable filtration rate about two days (3,000 minutes) and almost no clogging was observed.

![Fig. 8. Filtration performance](image3)

**Fig. 8.** Filtration performance

It was possible to compress and reduce the thickness of the non-woven fabric membrane in the wet state. It was able to reduce the surface roughness and the average pore size of the non-woven fabric membrane by pressing. It was confirmed the particle removal performance for 10 μm particle size. The performance maintained almost stable between two days (3000 minutes) and almost no clogging was observed under the flow fractionation and the pore diffusion.

**REFERENCE**

A Case Study on Fire Hazard in Rajshahi City, Bangladesh

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ABSTRACT

Rajshahi city, which is one of the important metropolitan cities in Bangladesh, has been developed with the wheel of civilization is known as one of the most environment friendly, liveable and hazardless cities in this country. Moreover, in the recent past, several developments in the commercial sector have been occurred. Furthermore, with the commercial and industrial development several human induced hazards have also been introduced here. Fire hazard is one of them which have become one of the biggest causes for the headache of the city. The state of environment of the city has noticeably changed for this issue, which is into a burning oven, since last decade. Recent history of fire occurrence of fire hazard, in consequence lost property and amount of rescued property has been reviewed as well. A specific zone which seems to me most vulnerable to the hazard occurred by fire has been taken for the subject matter of the study and the probable occurrence of the hazard and their cause has been analyzed in this study. Mainly, most of the fire is occurred due to short circuit and blast as well as burning of flammable things such as wood, gas cylinder etc. Moreover, the hazard due to this occurrence is not only due to these accidents only, it is also induced due to the inaccessibility of fire fighters in time. For a sustainable solution of these hazards, some preventive measures have been proposed that includes the immediate improvement of the infrastructure of the city and enhancement of the public facilities which is the instant need of this city.

INTRODUCTION

Since the first step of human being in this globe, hazard has become part and parcel of them. Hazard is always unwanted but human being has faced this unwanted thing repeatedly. The hazards can be primarily classified into two categories i.e. natural hazard and man-made or man induced hazard. Natural hazard is of such type which can hardly be avoided but the other one i.e. man induced hazard is predictable and also manageable. Fire hazard can be classified as some sort of semi natural and semi man made hazard. In presence of air (oxygen), combustion of combustible materials (fuels) results fire. In order to start a fire there should be initially sufficient heat (just equal or above the ignition temperature) to ignite a fuel and also the combustion reaction should also produce enough heat to maintain the combustion temperature above its ignition temperature for the sustainment of the fire. A fire develops itself in three stages such as namely -Incipient stage, Smoldering stage & Flame stage. In a nutshell, for a fire to break out, the three essential components are Fuel, Oxygen and Heat [1].

Public attitudes toward fire have changed significantly over the past two decades and that educating the public about fire and its management has become a matter to be concerned about [2]. Large numbers of people are killed or injured every year in Bangladesh in industrial accidents, fires and building collapses. The limited building and safety regulations are rarely enforced and routinely flouted. Fires due to short-circuits, substandard wiring and electrical faults are common, essentially due to building contractors and landlords seeking maximum profits [3]. We have to suffer worse because of our densely populated country as well as poorly constructed buildings. Most recent hazard occurred in Rajshahi city was in January 22, 2011, fire raged at Rahman Jute Mills at Paba, Rajshahi [4]. Seven fire-fighting units were present there but atrociously due to lack of water and unavailability of any closely reachable water source it has taken time around 16 hours to manage the fire. The damage was relatively high with approximately 60,000 metric tons of jute, worth taka 80 million which was piled inside the depot [4]. This is the example of the recurring fire events in Bangladesh.

MATERIALS AND METHODS

The map of Rajshahi city has been collected from the authority (Rajshahi City Corporation) [5] and the layout of road network has also been reviewed. Possible vulnerable zones has been selected based on different factors consideration like the reach-ability of firefighting vehicles based on the average road width of that zone, distance between the affected zone and the fire service, location of nearest water body and the source of water, and the questioner survey report that has been done by questioning the fire service authority and the firemen. The recent history of fire occurrence has also been reviewed from collected data from the fire service authority of Rajshahi city i.e. Fire Service, Rajshahi. All the information about the amount of property, resources and other valuable things rescued and the amount that is lost during fire hazard has also been collected based. The source of this information is the survey of the fire service authority which is done after any occurrence of fire hazard by estimating the amount of the each type of property and valuable things damaged as well as rescued. Finally the total amount is calculated in terms of the present market and demand value of those things. The possible temporary and permanent solutions has been tried to propose based on the study on the several considered conditions of different zones.

RESULTS

A. Recent History of Fire Occurrence and Their Cause

Fire has occurred frequently in the city since last years. The main causes of those fire occurrences are short circuit, blast of gas cylinder, from flammable materials, from wooden fuel ovens etc. Fig. 1 shows the recent history of fire occurrence since last ten years. It has been noticed that, appreciable amount of loss of property has been occurred and the rescued amount is also noticeable as shown in Fig. 2 and Fig. 3 which has been collected from the database of the Fire Service authority, Rajshahi. More or less, it has been noticed that the amount of fire hazard occurrence has not been decreased or changed its pattern much. So, it can be said that the cause problem of the fire occurrence is more or less all the similar. Atrociously, it has been seen that in the year 2011, 2003 and 2002, the fire hazard has occurred the record amount of damage of the public property. Eventually, the amount of property rescued is more in the year 2011 as well as in 2002. The last biggest fire occurrence was at Rahman Jute Mills, Paba, Rajshahi in January 22, 2011 which showed its devastating feature. Seven units of fire fighters worked relentlessly for 16 hours to manage that fire. Lots of property damaged and hence the mill has been closed in consequence.

30
Fig. 1. Number of Fire Occurrence in recent years (Source: Fire Service Authority, Rajshahi)

Fig. 2. Loss of Property due to fire occurrence (Source: Fire Service Authority, Rajshahi)

Fig. 3. Rescued Property while fire occurrence (Source: Fire Service Authority, Rajshahi)

Fig. 4. Map used by the Fire Service Authority (Source: Fire Service Authority, Rajshahi)

Fig. 5. Fire fighting vehicle, instrument and Manpower in Fire station near CNB point, Rajshahi City

Fig. 6. Selected areas for the study (Source: Rajshahi City Corporation: RCC)

B. Fire Service at Rajshahi City

The infrastructure of Rajshahi fire service is not very good because there are lots of technical problems and lack of modern instruments. The fire service authority have a map of Rajshahi City which shows the water source and warden posts located in different areas of the city. But recently the source of water supplies have reduced and the map shown in Fig. 4 has become less efficient and unauthentic.

C. Possible vulnerable zones

Based on the collected information from the authority of fire service of Rajshahi City and field survey, the area Shaheb Bazaar has been indicated as possibly the most vulnerable to fire hazard. Surprisingly because of the absence of enough water bodies and other source of water needed for fire-fighting, Shaheb Bazaar is the main commercial area of Rajshahi City where billions of BDT transactions is done every day and thousands of people’s daily income is dependent on this area. That is why the Shaheb Bazaar and its surrounding area have been selected for the concern of this study. The map shown in Fig. 6 shows the selected area for this study.

Some modern instruments have been procured recently but there is still necessity of procuring more. The amount of fire fighting vehicle shown in Fig. 5 is sufficient at this moment and there is also sufficient manpower that are really dedicated and efficient in their work.

D. Cause of Vulnerability

Determining the fire source is one of the most important parts of performing a fire hazard analysis [6]. The prime cause of vulnerability of fire has been pointed out as the lack of source of water instantly after occurrence of any fire. This has
been the most problematic thing which has been a headache of the authority and others who are thinking about the fire occurrence at that zone. Form the questioner survey among the peoples of that zone and the fire service authority it has been indicated as the prime cause of fire hazard. Another thing is that, the improper access of fire service vehicles due to unmanaged road network and inadequate road width has also been taken into account as the probable cause of fire hazard. Whereas, it is found that minimum 18 ft width of road is needed for the access of fire-fighting vehicles. Moreover, there is provision of fire-fighting in elevated places by ladders only up to three stories which is extremely inadequate for some situations when it is needed to climb more than that. On the consequence of the mentioned causes the management of fire occurrence has been very much time consuming and less effective.

E. Possible Solution

Following the fire fighting system of the developed countries as a role model, the possible solution to overcome the problem of inadequate source of water may be the use of fire hydrant as shown in Fig. 7. There should be adequate amount of fire hydrant in specially that zone in suitable interval. The installation of adequate amount of fire hydrants might be very costly but the necessary steps should be taken by the authority by using the optimum amount of fire hydrants for the safety of that zone. As temporary basis, some other steps may be taken personally by the consumers by arranging some temporary firefighting measures. Another thing is that, authority should strictly enforce rule about the building by law and should also take some necessary steps for increasing the accessibility of the area by the fire service vehicles.

DISCUSSIONS

From the above study of accessing the vulnerability of fire hazard, it has been noticed that there are some zones where there is even no accessibility of small firefighting vehicles whereas there should be minimum 10 feet wide road for entering a firefighting vehicle. So the reserved water from the vehicles could not be used for firefighting. That is why it is really urgent to take step for the vulnerability mitigation by introducing modern technologies. Since the whole infrastructure of that zone is not ready for defending fire, adequate amount of fire hydrant is necessary for the firefighting. Furthermore, the authority should take necessary steps for increasing the accessibility of vehicles. Moreover, the occurrence of such type of event may cause endless sufferings, damage of public property and even death.

CONCLUSION

Present state of the fire safety condition of Shaheb bazaar zone has been discussed in the study and it is strongly recommended that authority should take the necessary steps against this burning issue.

ACKNOWLEDGMENT

The author would like to acknowledge the authority of Rajshahi City Corporation and Fire Service of Rajshahi City for providing valuable information related to this study.

REFERENCE

Baseline Assessment of Short-lived Climate Pollutants in Bangladesh

Scott Randall

ABSTRACT
Bangladesh has local urban air quality problems affecting the health of the countries inhabitants, in addition to being a top greenhouse gas (GHG) emitter. The Short-Lived Pollutants (SLCPs) of methane, black carbon (BC), and tropospheric ozone are seen as a new indicator of pollutants which are forcers impacting the climate at a much greater/faster rate than the traditional GHGs. Global emissions databases, inventories, and models were used as sources to compile SLCP emissions for Bangladesh for the most recent years available, in addition to limited historic and future emissions analysis. This baseline assessment of SLCPs for Bangladesh shows that emissions of methane, BC, and ozone pre-cursor gases have been increasing over the last decades, where the particular source sectors for each component are identified.

INTRODUCTION
Dhaka can be considered the mega-city with the world’s worst urban air quality [1]. A combination of numerous local emission sources in addition to special local and regional winter meteorological conditions gives the city exceedingly high air pollution concentrations throughout the year, and especially during the winter season [2, 3]. The exposure of the city’s estimated 15 million residents to this alarmingly poor air quality poses the greatest health risk of the top mega-cities in the world and demands attention [4], including immediate research and corresponding mitigation [2, 3]. The World Health Organization (WHO) estimates that up to 10,000 pre-mature deaths are associated with outdoor air pollution annually in Bangladesh [5].

While urban air quality is a major health issue at the local level in Bangladesh, there are also particular issues regarding local emissions impacting the global climate - Bangladesh is noted as one of the top 25% worst greenhouse gas (GHG) polluting countries in the world [6]. Recently, the Climate and Clean Air Coalition To Reduce Short-Lived Climate Pollutants initiative [7] was established between the U.S., Canada, Sweden, Mexico, Bangladesh, and Ghana to address the short-lived climate pollutants (SLCP’s) which are impacting the global climate at the highest rate, and are now seen as more threatening forcers in the short term than just GHGs in general, or CO₂ alone [7, 8]. SLCPs include the main pollutants of methane (CH₄), Black Carbon (BC) and tropospheric ozone (O₃); in addition, hydrofluorocarbons (HFCs) can also be included as an SLCP threat [8].

The Malé Declaration compiled the first baseline emissions inventory specifically for Bangladesh with data up to 1998 [9]. Since this initial inventory, a comprehensive assessment or inventory of country-wide emissions for the suite of criteria pollutants is lacking, and no assessments have been made specifically for the new pollutant grouping of SLCPs and their corresponding emissions at the national level in Bangladesh. This paper will present an initial assessment and compilation of SLCPs, examining the sectors, sub-sectors, and activities making up these current and projected future atmospheric emissions for Bangladesh. The assessment for these emissions will be based on top-down regional and/or global emissions database sources, where multiple sources are necessary to cover the range of pollutants making up SLCPs.

MATERIALS AND METHODS
Various emissions database/inventory sources were utilized to compile the different components examined in this assessment for Bangladesh: Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)[10, 11], Emissions Database for Global Atmospheric Research (EDGAR) [12, 13], Transport and Chemical Evolution over the Pacific (TRACE-P)[14], Intercontinental Chemical Transport Experiment B (INTEX-B) [15], Regional Emission Inventory in Asia (REAS) [16, 17], and Multi-Sensor Re-analysis of total ozone (MSR) [18, 19].

The GAINS South Asia model (Final Report, Baseline8 scenario) was utilized to compile methane emissions for the years 1990-2030 for Bangladesh, in addition to identifying the sectors and activities making up these emissions. EDGAR database (v4.0-4.2) was utilized to investigate and compile methane emissions for 1970-2008, and ozone pre-cursor emissions for 2008 in Bangladesh. TRACE-P/INTEX-B databases were utilized to investigate BC emissions in Bangladesh for 2000 and 2006 respectively. REAS inventory (v1.11) was utilized to compare methane, BC, and ozone pre-cursor emissions for Bangladesh and the region in 2000. MSR was used to investigate ozone data from 1978-2008 over Bangladesh and region.

RESULTS AND DISCUSSION
The primary components making up SLCPs (methane, BC, and ozone) will be examined for Bangladesh for the most recent data. Where possible, the activities making up these emissions will be identified, and projections up to 2030 estimated. Global methane emissions for 2008 (Fig. 1) show that Bangladesh is located in a region of relatively high emissions exceeding 500 tons per year per 0.1 degree grid cell shown. REAS shows similar distribution patterns as EDGAR for the Asian region.

Fig. 1. Global methane emissions for 2008 (Source: EDGAR v4.2)

The EDGAR database also reveals that methane emissions for Bangladesh have been variable each year from 1970-1990 (between 4.0-4.4 Mt CH₄/year), while from 1992-2008 emissions have steadily increased 15% during this period to over 4.6 Mt CH₄/2008. GAINS also shows a similar increase of approximately 15% for methane emissions for the similar overlapping period of 1990-2010, and also projects this increase to remain steady through 2030 with emissions of 5.0 Mt CH₄/ year. The agricultural sector consistently makes up the vast majority (between 75-80%) of the increasing methane emissions from 1990-2030 in Bangladesh (Fig. 2). Emissions from the industrial sector are also increasing over time but at a rate which is consistently about 2.5 million tons/year less than the agricultural sector. Methane emissions from the other sectors of residential and traffic are very low in comparison as expected.

GAINS calculates that the sole activities of rice cultivation (1.8 Mt CH₄/year) and cattle (1.4 Mt CH₄/year) make up the agricultural sector emissions of methane for 2010 in Bangladesh,
in which this is 42% and 33% of the total methane emissions respectively for that year. EDGAR also shows rice cultivation as the greatest contributor to methane emissions in Bangladesh, which has decreased from approximately 3.2 Mt CH\textsubscript{4}/year in 1970 to 2.2 Mt CH\textsubscript{4}/year in 2008 for this single activity. EDGAR on the other hand shows that the next greatest contributing activities to methane emissions of cattle (enteric fermentation) and wastewater treatment are greatly increasing for the period 1970-2008 at approximately 30% and 130% respectively, with 2008 emissions for methane from cattle at 0.9 Mt CH\textsubscript{4}/year and for wastewater treatment at 0.7 Mt CH\textsubscript{4}/year. REAS data is not presented or compared to other data sets for methane because the values are up to a factor 1000 greater than the EDGAR and GAINS data presented, which possibly suggests data errors in REAS.

Asian BC emissions for 2006 (Fig. 3) shows Bangladesh is in a specific region with high BC emissions of 750 – over 1000 tons per year per 0.1 degree grid cell shown. This spatial representation from INTEX-B presents a similar distribution as other global BC distribution map found [20, 21] which shows that Bangladesh and the surrounding region has some of the highest BC emissions in the world. In addition, REAS Asian BC maps also show Bangladesh in a hot-spot region for Asia in 2000.

INTEX-B registers Bangladesh with 43.1 kt/year total BC emissions for 2006, increasing at approximately 10% from 39.1 kt/year for 2000 as found in TRACE-P. The sector distributions of the BC emissions for these two years (Fig. 4) show emissions from the industrial sector are surprisingly low (0.1 kt/year for 2000 and 2006). There are 3000+ brick kilns as BC sources which operate in the country, so it is assumed that these industrial sector emissions in INTEX-B are severely underestimated; doubts have been raised regarding the emission factors used for brick kilns in the INTEX-B database [22], which can explain part of this underestimation. REAS presents BC for Bangladesh at 67.1 kt/year for 2000, which is almost double the value presented in TRACE-P for the same year.

Global mean ozone values using monthly averages for 1978-2008 taken from MSR show that Bangladesh is located in an area of lesser ozone (as per indicated Dobson Units) than other areas around the globe (Fig. 5a). In addition, the anomaly map presented for the year 2008 (Fig. 5b) shows that Bangladesh experienced lesser ozone for this year (as indicated by approximately -5 Dobson Units) than the mean value of the previous 30 years. When looking closer in at Bangladesh in the South Asian region (Fig. 5c), it is apparent that the 30 year mean for ozone is slightly greater (at a range of approximately 5 Dobson Units) in the northern areas of the country closer to the Himalayas. During the year 2008, the anomaly map (Fig. 5d) shows ozone is slightly less overall for the country (at a range of approximately -2 to -4 Dobson Units) for this year in comparison to the mean value of the previous 30 years.
gasses have been increasing during the period 1970-2008, somewhat contradicting the MSR data that 2008 ozone values were lower than the mean of the data from 1978-2008. During this 30 year period, methane has increased approximately 10% where as previously indicated the primary contributor to these emissions are from the agricultural sector (rice and cattle); CO has increase 40% where a majority of these emissions are coming from the residential sector; NMVOCs have increased 70%, also coming from the residential sector; and NOX increased 200%, coming from transport and residential (including electricity production) sectors.

Table 1. Summary of SLCP emissions for Bangladesh.

<table>
<thead>
<tr>
<th>Component</th>
<th>Emissions</th>
<th>Contributing Sector</th>
<th>Global</th>
<th>Hot Spot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane BC</td>
<td>Increasing</td>
<td>Agriculture</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Ozone</td>
<td>Increasing</td>
<td>Residential/Industrial</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Methane</td>
<td>Increasing</td>
<td>Agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMVOCs</td>
<td>Increasing</td>
<td>Transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOX</td>
<td>Increasing</td>
<td>Transport/Residential</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

This paper presents an overview of the current SLCP emissions in Bangladesh, including historic value comparisons, and future emissions projections for select components. Bangladesh is in one of the most polluted regions (hot-spot) of the world for SLCPs of methane and BC in which each are increasing at the national level, in addition to the increase of ozone formation pre-cursor gasses, while Bangladesh is not necessarily located in a hot-spot for this pollutant (Table 1). Methane emissions have increased 15% from 1990-2010, and are expected to continue at this rate through 2030. A majority of these emissions are coming from the agricultural sector, primarily rice cultivation and cattle. BC emissions are increasing 10% between 2000 to 2006, in which sources used indicate the majority of these emissions are originating from the residential sector; doubt has been expressed regarding this sector distribution, in which the industrial sectors must contribute more than is being indicated. Emissions of ozone pre-cursor gasses have increased between 10-200% from 1970-2008, where the bulk of these emissions are originating in the residential and agricultural sectors.

ACKNOWLEDGMENT

The author would like to recognize Philipp Schneider (Research Scientist, NILU) for compiling the Ozone data from MSR, as well as Vo Thanh Dam (Engineer, NILU) for assistance with the INTEX-B/TRACE-P database. Appreciation is also given to Bjørne Sivertsen (Associate Research Director, NILU) for support, and Cristina Guerreiro (Senior Research Scientist, NILU) for guidance and quality control. In addition the author would like to thank Dr. Md. Nasiruddin (Joint Secretary, Ministry of Environment and Forests in Bangladesh) for identifying the need for the assessment presented in this paper, and encouraging its completion.

REFERENCE


INTRODUCTION

Environment provides us all the life supporting elements and services in our everyday life. But this environment is being polluted in many ways. Among them, manmade pollution is a significant one. This pollution has emerged since 18th century’s industrial revolution.

While industrial growth is inevitable for the development of a country, a pollution free environment is also inevitable for a typical human life. In this regard, there must be a balance in between industrialization and clean environment for the overall development and a typical living standard of its inhabitants. But the failure to maintain this balance in Hazaribagh area, which is located in the capital city Dhaka in Bangladesh has placed it in the “World’s Worst Polluted Places” in 2006, ranked by Blacksmith Institute [1].

As a result of the extreme pollution, it has become very grim to live here. Even though, people live in Hazaribagh to avail some facilities like lower house rents and other living expenditures. But living in such a polluted area is cursed with different diseases in both short and long run. While trying to save living expenditures, people are being subjected to other health related expenditures. So, this research traces the rationale of living in Hazaribagh.

The economy and environment are highly interlinked. There are many links between these two systems. First, the environment provides the economic system with inputs of raw materials and energy resources, including minerals, metals, food and many others. Most of the time, these inputs are transformed into outputs by the economic system which consumers demand. Second, the economy uses the environment as a waste sink in the production system. Waste may also be produced from the consumption activities. Basic types of these wastes are: solid, air and water borne. But the environment has a limited capacity to absorb and transform into harmless substances. Third, the environment provides households with a direct source of amenity. Finally, the environment provides the basic life supporting services to the economic system [2].

In the context of Hazaribagh, the tannery industries using inputs from the nature to fulfill consumers demand by producing finished leather. While processing the raw leather, tanneries create many negative externalities including air and water pollution. These hazardous wastes have exceeded the nature’s assimilative capacity in Hazaribagh. As a result of this pollution environment has failed to provide any amenity values to its residents, rather it provides disturbances or sufferings. These sufferings come with expenditures.

Knowing all those sufferings and costs, people still prefer to live in such a polluted area, but why? For several decades this has been a burning question regarding Hazaribagh. Needless to say about hundreds of reports that have failed to clarify the reason and identify the impacts of living in this region.

This research tries to find out whether living in this area really generates any benefit for the dwellers or not. In other words, the main objective of this research is to find out the net gain or profit/benefit people achieve living in this area, if there is any. In this study, the living costs and benefits were compared with costs and benefits of living in another area which is free from tannery pollution and consists of other general characters of the targeted area Hazaribagh.

The study aims at addressing the following objectives: a) To evaluate the benefits that people achieve living in this area, b) To evaluate the costs they bear living in this area, and c) Finally, a comparative analysis of living in this area.

MATERIALS AND METHODS

A. Field Work and Research Methods

The research is quantitative in nature. Primary and secondary data were collected for supporting the analysis of the research.

a) Research area

Research areas are located in Hazaribagh thana1 and Rayer Bazar thana. These areas were preferred based on their environmental, socio economic and security conditions. The pattern of the housing or infrastructural development was not unnoticed too. Number of tanneries located in Hazaribagh area made this the first choice as one of our fields of research. Selection of the second area or the control area, Rayer Bazar was based on the prevailing socio economic condition that we found matches with Hazaribagh most and the environmental condition that differs from the prevailing scenario of Hazaribagh.

b) Primary data

For primary data, 50 households were selected from each area of interest. Based on the structure of the buildings interviewed households can be categorized in 4 categories. These categories are Kacha, Semi-Pacca, Pacca2, Multi Storied. Respondents were interviewed with a semi-structured questionnaire so that they can add their comments if necessary.
c) Secondary data

Information from newspaper articles, books, journals, periodicals, project reports, NGO reports and government reports including census reports were used as the source of secondary data for the analysis of this study.

B. Methodology

After collecting primary and secondary data from fields and different sources, data were rigorously analyzed and interpreted. This research, being quantitative in nature demanded use of several statistical tools and methods for achieving the result and to be able to come to a conclusion and predict for further policy purposes.

C. Methods to Evaluate Environmental Pollution

There are several scientific ways to estimate or evaluate prevailing standards in an area. The techniques available for valuing the environmental goods and services can be categorized into revealed preference and stated preference approaches. Revealed preference techniques rely on observations of actual market behaviors of the actors for evaluating them. This approach observes the behavioral changes with the change of the environmental condition as they assume the fact that some marketed goods are bundles of characteristics [3]. These techniques are chosen when peoples’ acts reflect the condition of the environment. The most practiced revealed preference techniques are travel cost method (TCM) and the hedonic pricing method (HPM).

For the analysis of the acquired data, different statistical tools (mean, standard deviation, t-test) were used. For the house rent and health cost comparisons, mean of the collected data were used. Then the rent and health cost differentials were obtained and further compared to revile the benefit or costs appear to the residents of Hazaribagh.

The framework for the analysis is

For to the utmost surprise, we found that only about 2% people chose Hazaribagh as they believed to have low living cost, 10% for availing low housing cost while 24% and 8% people live in Rayer Bazar to avail the low living scopes and low housing opportunities respectively. 32% of the surveyed inhabitants of Hazaribagh inherited their property and only 20 inhabitants of Rayer Bazar are found living on inherited property. But, almost half of the people (46%) living at surveyed area Gozmahal. Hazaribagh prefers to avail minimum distance to their workplace and choose to live there. In contrast to this situation, 32% people living in Rayer Bazar prefer to aim for their nearer workplaces.

RESULTS AND DISCUSSION

A. Choice of Living

It is coherent that only occupational preference cannot explain people’s choice of living. There are other factors influencing the choice of housing for the individuals. The most viable reasons influencing people’s choice of the area of living are observed by the authors. Most of the time their behavior is subjective to the distance of the workplace, schools of their children, low housing cost and low living cost. Another major influencing agent is the paternal property location.

To the utmost surprise, we found that only about 2% people chose Hazaribagh as they believed to have low living cost, 10% for availing low housing cost while 24% and 8% people live in Rayer Bazaar to avail the low living scopes and low housing opportunities respectively. 32% of the surveyed inhabitants of Hazaribagh inherited their property and only 20 inhabitants of Rayer Bazar are found living on inherited property. But, almost half of the people (46%) living at surveyed area Gozmahal, Hazaribagh prefers to avail minimum distance to their workplace and choose to live there. In contrast to this situation, 32% people living in Rayer Bazar prefer to aim for their nearer workplaces.
is low and the second chart shows that this portion of inhabitants living in Hazaribagh for not more than 1 year. And this decreasing housing cost represents high degradation of environment in Hazaribagh within last few years. The argument above is clearly proved in the following chart.

### B. Infrastructure and the Rent causal Relationship

![Diagram showing the impact of infrastructure on rent](image)

#### Table 1. Group Statistics

<table>
<thead>
<tr>
<th>THANA</th>
<th>Building Structure</th>
<th>YRL_YRNT</th>
<th>MED_EXP</th>
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<td>Semi</td>
<td>221.4387</td>
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<td>Pacca</td>
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<td>12440.0000</td>
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<tr>
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</tr>
<tr>
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<td>Multi storied</td>
<td>199.2857</td>
<td>60000.0000</td>
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</table>

The Table 1 shows the relation between the yearly rent and the medical expenditure in both the areas of Hazaribagh and Rayer Bazar. The table reviled the secret relationship of house rent per square feet and the age of the building. While in Rayer Bazar, we could not find any significant relation with the age of the building, in Hazaribagh there is a strong relationship between them. The rent per square feet per year gradually decreased with the increased age of the building. Here, the impact of tannery wastes to the substances of a building is clear enough. As a result, inhabitants are found to be using cement made shed of buildings, which was supposed to be made of tin. Another respondent showed his mobile getting damaged due to the air pollution or gaseous substances released from the tanneries.

The Table 2 shows the group statistics of the 100 household surveyed on ground. The information it comprises is very much vital for understanding the research. The variables REN_YR represents rent per square feet for each of the households per year, and MED_EXP represents medical expenditures of each household in the last year. The statistics represents that, only 38 households live in rental houses in Hazaribagh, and rests are the permanent residents. While, in Rayer Bazar, 44 households live in rental basis. The mean rent per square feet per household in 235.59 ± 19.55 taka in Hazaribagh and 298.64 ± 19.70 taka in Rayer Bazar.

#### Table 2. Group Statistics

<table>
<thead>
<tr>
<th>THANA</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>Mean</th>
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<td>REN_YR</td>
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<tr>
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<td>38</td>
<td>235.58</td>
<td>120.50</td>
<td>19.54</td>
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</tr>
<tr>
<td>Rayer Bazar</td>
<td>44</td>
<td>298.63</td>
<td>130.68</td>
<td>19.70</td>
<td></td>
</tr>
<tr>
<td>MED_EXP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazaribagh</td>
<td>42</td>
<td>14911.19</td>
<td>27377.89</td>
<td>4224.50</td>
<td></td>
</tr>
<tr>
<td>Rayer Bazar</td>
<td>33</td>
<td>12536.36</td>
<td>17998.58</td>
<td>3133.15</td>
<td></td>
</tr>
</tbody>
</table>

In terms of sick reports, 42 households in Hazaribagh reported at least one of their members being sick, and 33 households responded from Rayer Bazar in this context. Mean medical expenditure per year per household in Hazaribagh is 14911.20 ± 4224.5 taka and in Rayer Bazar 12536.36 ± 3133.1 taka. This research found that the prevalence of different diseases in Hazaribagh is considerably higher in contrast to Rayer Bazar. In Hazaribagh, more than 52% households suffered from diseases more than 1, while in Rayer Bazar only 22% households had diseases more than 1 last year.

#### Table 3. Disease prevalence

<table>
<thead>
<tr>
<th>Area</th>
<th>% of households suffering more than 1 disease last year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazaribagh</td>
<td>56%</td>
</tr>
<tr>
<td>Rayer Bazar</td>
<td>22%</td>
</tr>
</tbody>
</table>

These are the observations and findings the authors found from the research fields.

While there is environmental pollution caused by the tanneries, these are also providing more income generating opportunities. This availability of income generating activities pull in people from different regions and areas. Thus, the increased demand of living in this area creates higher demand for housing and the price of housing goes up. Even than the present cost of housing significantly differs from the housing cost of Rayer Bazar. But the expenditure of health cost does not differ significantly. Although the prevalence of diseases in Hazaribagh differs highly, it is seen as insignificant one, representing no relation between environmental pollution and health purpose expenditures. Due to a very high variance in the medical expenditure of the residents of these areas may be a reason behind this representation.

**CONCLUSION**

Housing property valuation is the most used and relied method for valuing the environmental pollution. In our country, housing market structure is not like other countries. So, instead of using housing price, we used the rent of houses based on their area. Rent of these houses highly depend on the structure and most importantly in Hazaribagh, the rent of houses highly decline over time. This represents high damage of building structure by the tannery pollutants.

In terms of health, people living in Hazaribagh are having many different health related problems. Some of the
inhabitants lost their limbs permanently like kidney, eye etc. Some of them are suffering from chronic diseases. Most of the people have a regular headache, fever and other dermatological diseases. 15% of the respondent of Hazaribagh found suffered from yellow fever last year. But in Rayer Bazar, these diseases are less severe and less people are affected from those diseases.

At the beginning of the research, from the literature reviews and understanding the rational human behavior it seemed that peoples’ choice of living is mostly influenced by the lower cost of living or lower cost of housing. While researching, it has come to the our attention that motivation behind living in such a polluted area is not the low living cost or lower housing cost, rather the availability of income generation activities, inheritance is the major factor motivating to live people here. Living in this area also allows them to pay more attention to their occupation minimizing their transportation cost and travelling time. This phenomenon is also supported and found viable in this research. As a result of paying more attention to works regarding tanneries, people are more exposed to the pollutants and wastes. Life is becoming a threat for them silently. Finally a noticeable verse from a newspaper article should be noted - "It is their (tannery industries) living which is causing our death; we need foreign currency from exports of tannery items alright, but by no way should it be at the cost of lives and the environment."  

ACKNOWLEDGMENT

For the successful completion of this research we must show our gratitude to Professor Mahbub Ullah. We are very lucky to have the chance to work under his close supervision. We must address our heartiest gratitude to Hasina Begum for supporting us in all the ways possible for successful completion of this research. We must mention our gratitude to Dr. Mahfuzul Haque, Sharif Abdul Wahab, Ruhun Wasata, Tasfi Salsabil, Abdul Hamid, Shahriar Tommoy, Jubayer Ahmed, Sayeed Islam who helped us whole heartedly in collecting data from the research fields. We are grateful to Motia Israt Janah, A.B.M. Abul Hasnat Mollah and finally Touhida Khan Khushbu, for valuable comments and recommendations regarding the research work.

REFERENCE


1 Thana is a unit of police administration. In 1792 by the government of the Bengal Presidency, the district magistrates were asked to divide their respective districts into police jurisdictions called ‘thana’. Initially, a thana was purely a police jurisdiction. After 1982, each thana was upgraded into a upazila (sub-district). The upazila system has since 1999 been revived. There are now 496 thanas in the country including those in metropolitan police jurisdictions. With the creation of circle system, particularly after 1961, thana became the main centre of development activities with most of the development departments of the provincial government having their own functionaries at that level

2 Kacha house refers to houses constructed with bamboo, wood, tin and other vulnerable partitions, Semi pacca house refers to the houses constructed with concrete partitions and walls but roof made of vulnerable or weak materials and finally Pacca house refers to single storied houses that consists of concrete partitions, walls and roof too.

3 Last year represents a year (September 2010 to September 2011) before the research was conducted.
Factors Affecting Adoption of Compressed Natural Gas (CNG) Vehicle in Bangladesh - An Application of Bass Model

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ABSTRACT

Environment friendly products have been widely accepted by the people not only in developed countries but also in developing countries. There are certain reasons for adoptions. In this paper diffusion model used to see the factors affecting in CNG conversion vehicle in Bangladesh. The study finds out both imitation and innovation effect has evident in adoption of CNG vehicle. From economic to social reasons are influenced people to adopt CNG conversion vehicle. High imitation effect with high impact of word of mouth clearly increased this adoption rate. Environment friendliness, ease of use, price competitiveness and adaptive with lifestyle are some of the major reasons behind the adoption as well.

INTRODUCTION

Adoption studies not only highlight the past phenomena rather many cases it shows the future direction. This paper mainly used data from Bangladesh to check the adoption of CNG vehicle and influencing factors as a general. But more specifically, some influencing factors of CNG adoption can relate to the relevant other industry in a more dynamic fashion by which we can give some policy recommendations for these area. In this regard, this paper used basic view point of Diffusion of Innovation (DOI) model given by [1].Later the paper will discuss about the findings from application context.

Bangladesh has natural gas resources and the country start using it as alternative vehicular fuel called Compressed Natural Gas (CNG). Earlier people got a wrong idea or myth about CNG about its safety issues and the storage cylinder is occupying the space etc. In fact the cylinder using in CNG as storage is looks like ammunition and general people got the wrong idea by seeing a cylinder. Later, by the awareness program of government and private organization people perception changed and adoption boomed. Now people find a cylinder as a friend sitting inside the vehicle saving his/her money and help the environment of the country.

Bangladesh has experiencing high rate of growth in CNG. At this stage total numbers of CNG vehicle users are 175499 in the year 2012 which reflect more than 30% of the total vehicle. From 2000 and onwards market was open for various competitors and within a short time, it reached to a high rate of adoption. This adoption phenomenon inspired us to investigate the reasons behind it.

LITERATURE REVIEW

The product life cycle is always treated as an important aspect for understanding current state and future trend. In past literature concept of imitation has been revealed as a notion of following others action, accepting views and taking decision in this regard [2]. Griliches investigated the diffusion of hybrid corn technology in United States [3]. But in this domain, Roger’s Book of “Diffusion of Innovation” made considerable interest on researchers in social science area [4–6]. The idea of diffusion has been investigated in many forms and in many disciplines. While adopting any new product and services, certain factors stimulate to the adopters. For example, mobile technology has been widely accepted by the mass people because of individual and social need. People find it usable for meeting their needs. At the same time, if any product or service is easy to use then, its adoption can be faster than others. People also consider psychological aspects while using a product or services. In examining such effects Bass Model proposes innovation effect [6]. On the other hand by nature people influenced by social pressure and consider word of mouth in adopting the product which Bass describes as imitation effect.

In this study, innovation and imitation effect of Bass model uses as a basis for investigating reason for adopting CNG vehicles in Bangladesh. So in describing innovation effect, this paper means as usefulness [7], ease of use and self-efficacy [8]. While meaning of imitation effect is conceptualizing as the aspects of the subjective norm [9, 10] and Word of mouth [11–17].

MATERIALS AND METHODS

Time series data of CNG vehicle from 2003 to 2009 has been used to derive factors influencing CNG diffusion in Bangladesh. Data has been taken from the government website of Ruantari Prakritik Gas Company Limited which is a company of Petro Bangla (A Government organization in relevant field, http://www.rpgcl.org.bd/expand.php?itype=exp_stat). Nonlinear least square method had been applied to infer the result [18]. Curve fitting approach followed where exponential curve has been fitted with consideration of least error margin. R software has been used for this quantitative analysis.

The following model used to testify the data

\[
S(t) = \frac{\alpha}{1 + e^{-(t-\beta)/\gamma}}
\]

Where, \(P\) = Innovation effect, \(q\) = Imitation effect, \(m\) = number of eventual adopters.

RESULTS AND DISCUSSION

The following result (Table 1 and Fig. 1) focuses the impact of innovation and imitation parameter which clearly shows high imitation effect exits in Bangladesh.

Table 1. Result of estimation parameters

<table>
<thead>
<tr>
<th>Adopters in Bangladesh</th>
<th>Innovation effect (p)</th>
<th>Imitation effect (q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNG (2003-2009)</td>
<td>0.001007***</td>
<td>0.607500***</td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1
Number of iterations to convergence: 11

A. Imitation Effect:

Usefulness: there are certain aspect first of all eco friendliness; Improvements have been seen in air quality in Dhaka city (capital of Bangladesh) through the increased use of CNG operated vehicles. The Department of Environment has measured decreases in the amount of particulate matter (PM10) following the implementation of the CNG project. Research had shown that CNG operated cars for instance emit around 10–20% less carbon dioxide up to 25% less nitrous oxide and 80% or less Carbon mono oxide, non-methane...
hydrocarbons and other smog forming emissions in comparison gasoline car used in Bangladesh. Diesel contains Sulfur component and produces SO2 which cause acid rain, but the processed natural gas in Bangladesh is Sulfur free.

Economic savings: CNG and octane tariff are taka 30 /m3 and Taka 94/Litre respectively(1 litre octane equivalent 0.81 m3 of CNG).So a litre octane equivalent of CNG cost taka 24.3, that means 69.7 taka savings on per litre fuel consumption.

Indirect benefits: Since the fuel cost is cheap in CNG so the overall transportation cost is low. So it got an impact on the people to spend more money on their own necessities. Consumer and other goods prices has positive impact which has a direct relation with transportation cost.

Ease of use: CNG is a natural resource of Bangladesh, so as alternative fuel CNG is available within most of the major area of the country. There are 556 no of CNG filling station in Bangladesh to serve the 203,587CNG running vehicles. There are 180 CNG conversion workshop & servicing center in Bangladesh. A private car can run 50-60 km by one filling (considering a 60 ltr. cylinder and a 1500 cc car). These are indicating the reasons for adoption.

Self efficacy: People of Bangladesh also find CNG vehicle more worthy while examining it from the self efficacy context. Users have positive views regarding ecological aspect and economical aspect which helps to develop this positive view.

B. Imitation Effect:

Subjective norm: There are certain key role players who are acting as a catalyst for high rate of adoption. In Bangladesh taking decision by consulting others is quite a common practice and many cases people get the positive sides of CNG conversion.

Word of Mouth: There are 3 million people are directly related with CNG and enjoying its benefits (here we include vehicle user, people in CNG station, people in CNG conversion center, people in CNG related company both in govt. & private). These people are spreading the word CNG on their surroundings. The people who got its direct benefits they become the campaigner of CNG.

CONCLUSION

As developing country Bangladesh has enormous opportunities to capitalize the benefits of CNG. CNG has changed the everyday routine of people in Bangladesh. So, both Government and private relevant organizations should be focused on CNG and its regulatory issues. At this stage the industry facing almost growth stage so intensive competition is exist, So both innovation effect and imitation effect can be examined further to explore market nourishment and ensuring environment in a greater context.

REFERENCE

**Polycyclic aromatic hydrocarbons in sediments of Love River, Taiwan**

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**ABSTRACT**

The distribution, sources, and potential biological effects of 16 priority polycyclic aromatic hydrocarbons (PAHs) of the surfaces sediments, collected from ten sampling sites in Love River basin, Taiwan, were investigated by gas chromatography/mass spectrometry (GC/MS). The total concentrations of 16 priority PAHs ranged from 240 to 1,008 ng/g dry weight (dw) with a mean concentration of 633±121 ng/g dw. Base on the total concentrations of PAHs, sediments from Love River were moderately contaminated. Diagnostic ratios showed that the possible source of PAHs in the Love River could be a mixture of pyrolytic and petrogenic with a major pyrolytic predominance. The toxic equivalent concentrations (TEQacarc) of PAHs varied from 22 to 133 ng TEQ/g dw, with an average of 71±42 ng TEQ/g dw. As compared with the US Sediment Quality Guidelines (SQGs), the observed levels of PAHs at most studied sites in Love River should not exert adverse biological effects. Although at some sites the fluorene may exceed the effects range median (ERM). The results indicated that sediments in Love River should have potential biological impact, but should not have impairment. Because only one time was analyzed in this study, more work is needed to confirm the sources and toxicity of PAHs in Love River.

**INTRODUCTION**

Kaohsiung City is the largest industrial city in Taiwan with 2.2 million residents. Love River is 16 km long with watershed of 62 km² that covers about 40% of total Kaohsiung City. Originated near Tsoo-Gong irrigation channel, Love River flows through the downtown area of Kaohsiung City and is finally discharged into Kaohsiung Harbor (Fig. 1). During earlier years, Kaohsiung City lack of sanitary sewer system causes un-treated raw wastewater to be discharged directed into adjacent water bodies that leads to serious deterioration of river water quality. Although in recent years, Kaohsiung City actively promotes the construction of wastewater collection and treatment systems, [2] in 2009, the wastewater system can only serve 56% of the city in 2009 [1]. Additionally, Kaohsiung City also actively involves in public projects on renovating rivers (e.g. Love River) by constructing river intercepting stations near the middle section of the river to divert the upstream polluted river water to a wastewater treatment for alleviating the downstream pollution problem. However, during the wet season, the river water intercepting gate is opened for by-passing the sudden surge of river flow brought over by storms that will discharge the upstream pollutants to downstream sections. Regions along Love River have dense population with prosperous business and industrial establishments. The major pollution source includes domestic wastewater discharges, industrial wastewater discharges (e.g. paint and dye, chemical production, metal processing, electronic and foundry), shipping, municipal surface runoff, and transportation pollution [2]. All the pollutants will eventually be accumulated in the bottom sediment.

Hydrophobicity, and can be sorbed strongly by water-borne organic and inorganic particles. They may eventually brought down to the bottom sediment as sink in the aquatic system; the PAHs found in the sediments are resistant to bacterial degradation in an anoxic environment. Even under favorable conditions, the sorbed PAHs will be released to the water as an extended source to threaten the aquatic ecosystem through bioaccumulation in food chains [4]. Thus, understanding the pollution levels, sources, and potential toxicological and biological impacts are essential and important for appropriately managing PAHs levels in the environment.

The objectives of this study were to: (a) examine the spatial distribution, composition, and relative pollution levels of PAHs in the surface sediments of Love River, (b) identify possible sources of PAHs, and (c) evaluate the potential toxicological and biological impacts on humans and the environment.

**MATERIALS AND METHODS**

Surface sediment samples were collected at ten stations along the Love River (Fig. 1) in October, 2011 with Ekman Dredge Grab. Immediately after collection, the samples were scooped into glass bottles, which have been pre-washed with n-hexane and kept in an icebox, and then transported to the laboratory for analysis. In the laboratory, the samples were freeze-dried for 72 h, ground to pass through an 0.5 mm sieve and fully homogenized [5]. The dried sediments were placed at -20°C in pre-washed with n-hexane amber glass bottles covered with solvent-rinsed aluminum foil until further processing and analysis.

Particle size was determined with Coulter LS Particle Size Analyzer. Organic matter (OM) was analyzed according to Standard Methods 209F [6]. PAHs (e.g., naphthalene (NA), 2-methylnaphthalene (2-MP), acenaphthylene (ACE), acenaphthene (AC), fluorene (FL), phenanthrene (PH), anthracene (AN), fluoranthene (FLU), pyrene (PY), benzo[a]anthracene (BaA), chrysene (CH), benzo[b]fluoranthene (BbF), benzo[k]fluoranthene (BkF), benzo[a]pyrene (BaP), indeno[1,2,3-cd]pyrene (IP), dibenz[a,h]anthracene (DBA), and benzo[g,h,i]perylene (BPI) were analyzed following the methods described in Chen and Chen [7].

**RESULTS AND DISCUSSION**

A. Concentrations of PAHs in Sediments

The grain size (sand, silt, and clay) distribution and OM content in sediment samples are shown in Table 1. Results from the grain size analysis indicate that the sediments were mainly sandy silts. The fine particle property of the sediments would cause the significant sorption effect on PAHs. Results from Table 1 indicate that higher OM (up to 23.5%) was...
observed in sediment samples. The high organic contents of the sediment indicate that the accumulation of organics would cause the significant variations in sediment properties. The organic abundant characteristic of the sediment would cause the decrease in oxygen measurement in sediments, and thus, the sediments would be reduced to anaerobic conditions.

Table 1. Grain size and OM contents in surface sediments of Love River

<table>
<thead>
<tr>
<th>Station</th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>OM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 Hou-Gang Bridge</td>
<td>8.3</td>
<td>84.9</td>
<td>6.8</td>
<td>4.2</td>
</tr>
<tr>
<td>L2 Cai-Jin Bridge</td>
<td>78.3</td>
<td>20.2</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>L3 Ding-Sin Bridge</td>
<td>10.9</td>
<td>85.2</td>
<td>3.8</td>
<td>23.5</td>
</tr>
<tr>
<td>L4 Long-Hua Bridge</td>
<td>0.0</td>
<td>90.9</td>
<td>9.1</td>
<td>10.2</td>
</tr>
<tr>
<td>L5 Long-Xin Bridge</td>
<td>0.0</td>
<td>92.4</td>
<td>7.6</td>
<td>2.5</td>
</tr>
<tr>
<td>L6 Chi-Ping Bridge</td>
<td>0.0</td>
<td>87.6</td>
<td>12.4</td>
<td>8.8</td>
</tr>
<tr>
<td>L7 Zhong-Da Bridge</td>
<td>87.8</td>
<td>11.4</td>
<td>0.8</td>
<td>2.6</td>
</tr>
<tr>
<td>L8 Chien-Kuo Bridge</td>
<td>0.0</td>
<td>91.7</td>
<td>8.3</td>
<td>2.7</td>
</tr>
<tr>
<td>L9 Chi-Hsiea Bridge</td>
<td>0.0</td>
<td>86.5</td>
<td>13.5</td>
<td>6.6</td>
</tr>
<tr>
<td>L10 Kaohsiung Bridge</td>
<td>0.0</td>
<td>92.4</td>
<td>7.6</td>
<td>10.3</td>
</tr>
</tbody>
</table>

The PAHs concentrations in sediments collected at different sites are given in Table 2. The total amount of PAHs (ΣPAHs) varied from 240 to 1,008 ng/g dw, with a mean concentration of 633±12 ng/g dw. The sediment in Stations L1, L2, L5, and L7 have lower concentrations of ΣPAHs (290±59 ng/g dw) than other stations (862±125 ng/g dw). Based on the pollutant levels suggested by Baumard et al. (1998): (a) low, 0 to 100 ng/g; (b) moderate, 100 to 1,000 ng/g; (c) high, 1,000 to 5,000 ng/g; and (d) very high, >5,000 ng/g, the PAHs levels in sediments can be classified as high for Stations L3 (Ding-Sin Bridge), and moderate for the other stations.

In this study, Pearson correlations of the particle size, OM, and ΣPAHs concentration in sediment of Love River were examined. Results of linear regression analysis show that the ΣPAHs is obviously a significant correlated to OM (r = 0.760; p<0.05), but not to particle size (p>0.05) for all sediment samples. The results suggest that organic matter played important roles in controlling the PAHs distribution in sediments [5].

B. Composition and Source of PAHs in Love River

According to the number of aromatic rings, the 16 PAHs were divided into three groups: (a) 2- & 3-rings, (b) 4-ring, and (c) 5- & 6-ring PAHs. The percentage compositions are 33.4 to 51.3% for 4-ring, 20.1 to 46.7% for 5- & 6-ring, and 15.0 to 35.5% for 2- & 3-ring. The 4-ring or 5- & 6-ring PAHs are the predominant PAHs congeners in the sediments collected from all locations. The result suggests that the PAH contamination in Love River comes essentially from an identical source and is indicative of a pyrolytic origin.

In general, characterized by predominant of parent compounds with four or more aromatic rings, pyrolytic PAHs are derived during combustion. In contrast, petrogenic PAHs (from petroleum and its products) contain only two or three aromatic ring compounds. Therefore, a ratio of low (2- & 3-ring) to high (4- to 6-ring) PAHs has been used to identify pyrogenic (<1) and petrogenic (>1) sources of PAHs in sediments [7–8]. In all Love River stations, the ratios of Σ2PAHs/ΣHPAHs were in the range of 0.18–0.55 (Table 3), indicating they originated from pyrogenic sources. In addition, several PAHs isometric ratios have been used to identify different sources that contribute PAHs to environmental samples [9–14]. The common ratios used to identify different sources of PAHs for sediment samples include AN/(PH + AN), FLU/(FLU + PY), BaA/(BaA+CH), and IP/(IP+BP) [7, 11–12, 15–17], as summarized in Table 3. The ratios of AN/(PH + AN) in the surface sediments form Love River were 0.54±0.09 (range 0.41–0.66), clearly suggest that a pyrogenic source could be possible source of PAHs. The ratios of FLU/(FLU + PY), BaA/(BaA+CH), and IP/(IP+BP), with values of 0.5±0.29 (range 0.29–0.94), 0.42±0.19 (range 0.13–0.76), and 0.54±0.18 (range 0.14–0.75), respectively, it can be concluded that PAHs input to Love River mainly originated from domestic biomass burning and fossil fuel combustion. Some petrogenic characteristics were also found in the sediments. Results from the ratio calculations suggest that PAHs input to the Love River mainly came from domestic combustion-related activities.

C. Sediment Biological Effects Based on PAHs

A widely used sediment toxicity screening guideline of the US National Oceanic and Atmospheric Administration provides two target values to estimate potential biological effects: effects range low (ERL) and effect range median (ERM) [18]. The guideline was developed by comparing various sediment toxicity responses of marine organisms or communities with observed PAHs concentrations in sediments. These two values delineate three concentration ranges for each particular chemical. When the concentration is below the ERL, it indicates that the biological effect is rare. If concentration equals to or greater than the ERL but below the ERM, it indicates that a biological effect would occur occasionally. Concentrations at or above the ERM indicate that a negative biological effect would frequently occur.

Table 2 shows the measured concentrations of PAHs in comparison with the ERM and ERL values. Among the 10 sediment samples collected, the Σ2PAHs, ΣHPAHs, and ΣPAHs were below the ERL. For an individual PAH, FL was above ERL but below ERM in stations L3, L4, L6, and L8-L10, which indicate that biological effects would occur occasionally. The results indicated that sediments in all sites should have potential biological impact, but should have no impairment.
D. Sediment Potential Toxicity Based on CPAHs

The assessment of sediment toxicity in this study was performed based on the total concentration of potentially carcinogenic PAHs (i.e., BaA, CH, BbF, BkF, BaP, IP, and DBA). The ΣCPAHs concentration varied from 72 to 510 ng/g dw, with a mean concentration of 267±165 ng/g dw. The ΣCPAHs accounted for 30 to 51% of ΣPAHs in sediments of Love River.

<table>
<thead>
<tr>
<th>PAHs</th>
<th>Petrogenic</th>
<th>Pyrogenic</th>
<th>Biomass (grass, wood &amp; coal)</th>
<th>Fossil fuel</th>
<th>Results from the present work</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΣPAHs/ΣHPAHs</td>
<td>&gt;1</td>
<td>&lt;1</td>
<td>–</td>
<td>–</td>
<td>0.34±0.13 (0.18-0.55)</td>
</tr>
<tr>
<td>AN/(AN+PH)</td>
<td>&lt;0.1</td>
<td>&gt;0.1</td>
<td>–</td>
<td>–</td>
<td>0.54±0.09 (0.41-0.66)</td>
</tr>
<tr>
<td>FLU/(FLU+PY)</td>
<td>&lt;0.4</td>
<td>&gt;0.4</td>
<td>0.5</td>
<td>0.4-0.5</td>
<td>0.58±0.29 (0.28-0.94)</td>
</tr>
<tr>
<td>BaA/(BaA+CH)</td>
<td>&lt;0.2</td>
<td>&gt;0.2</td>
<td>0.2-0.35</td>
<td>&gt;0.35</td>
<td>0.42±0.19 (0.13-0.76)</td>
</tr>
</tbody>
</table>

The potential toxicity of sediment was evaluated using the total toxic BaP equivalent (TEQ*) (7.17,19-20). The TEQ* for all CPAHs was calculated using the following equation: 

$$\text{TEQ}^* = \Sigma C \times \text{TEQ}^*_{\text{pot}}$$

where C is the CPAHs concentration (ng/g dw); TEQ* potency represents toxic equivalency factors and is the toxic factor of carcinogenic PAHs relative to BaP. Among all known potentially carcinogenic PAHs, BaP is the only PAH for which toxicological data are sufficient for derivation of a carcinogenic potency factor [21]. According to US EPA [3], TEF for BaA, CH, BbF, BkF, BaP, IP, and DBA are 0.1, 0.001, 0.1, 0.01, 1, 0.1, and 1, respectively. In this study, the total TEQ* values of sediment samples varied from 22 to 133 ng TEQ/g dw, with the mean value of 71±42 ng TEQ/g dw. These values were similar to those of surface sediments from Huaihe River, China [22] but lower than other literature-reported sites, such as surface sediments of Kaohsiung Harbor, Taiwan [7], Naples harbor, Italy [23], and Meiliang Bay, China [17]. Among different CPAHs, contribution to the total TEQ* decreased in the following order: BaP (73.4%), BbF (7.7%), DA (6.5%), IP (6.5%), BaA (5.4%), BkF (0.39%), and CH (0.06%).

CONCLUSION

The 16 priority PAHs in the surface sediment samples collected from various locations in Love River, and their possible sources and potential toxicologic significance have been identified. The CPAHs concentrations in sediments ranged from 240 to 1,008 ng/g dw with a mean concentration of 633±12 ng/g dw. Based on the total concentrations of PAHs, sediments from Love River were moderately contaminated. The possible source of PAHs in Love River could be biomass burning and fossil fuel combustion. From an ecotoxicological point of view, potential adverse biologic impact is probable for FL in the study sites. Because only one time was analyzed in this study, more work is needed to confirm the sources and toxicity of PAHs in Love River.

REFERENCE

ABSTRACT

Pilea brevicornuta Hayata (Urticaceae) is a perennial herb with stolons, widely distributed in the Ryukyu Archipelago and Taiwan. As contrasted with its extensive morphological variations, almost all individuals of Pilea brevicornuta had uniformly 2n=24 chromosomes except of individuals with 2n=36 from a locality on Okinawajima Island. As basic chromosome number of the genus Pilea is reported to be X=12, 2n=24 and 2n=36 chromosomes are regarded as diploid and triploid respectively. Triploid individuals of this species are reported for the first time.

INTRODUCTION

The Ryukyu Archipelago comprises approximately 200 subtropical islands extending southwestward from the southern Japanese island of Kyushu to northeastern Taiwan. More than 1600 vascular plants, including a number of endemics or taxa of phytogeographical interest are distributed in this chain of Japanese islands [1-3].

Morphological features of Pilea brevicornuta were fluctuating among the Ryukyu Islands and Taiwan. This widely variable species was divided into four different species based on morphological characters, but later considered as single species having high morphological variation. It prefers moist forest edges, forest floor and small ravines with high humidity. Japanese name of this plant is Shima-Mizu (island Pilea) or Arisan-Mizu. Four related taxa of Pilea brevicornuta has been known in the Ryukyu Archipelago named as P. brevicornuta Hayata from Mt. Arisan [4], P. cuneatifolia Yamamoto from Yaeyama and Amamioshima [5], P. minor Yamamoto from Remugan, Amamioshima [5] and P. amamiana Ohwi from Amamioshima [6]. Later on, Hatusima [7] considered Pilea brevicornuta to be an extremely variable species and suggested all the three as synonym of Pilea brevicornuta. This opinion was supported by Walker [8]. Further morphological, cytological and molecular information is needed to revise its taxonomic treatment. Kanemoto [9] reported chromosome number of 2n=24 in Pilea brevicornuta. We further investigated the chromosome number of Pilea brevicornuta in samples from an entire distribution area of this species.

RESULTS AND DISCUSSION

In total, 115 individuals were collected from seven different islands of the Ryukyu Archipelago, named as Kikaijima, Amamioshima, Tokunoshima, Okinawajima, Ishigakijima, Iriomotejima and Tonagunujima and four different localities from Taiwan named Mt. Nangan, Taipei, Mt. Lala and Mt. Beidawu (map shown in Fig. 1). Collection localities presented in Table 1. All plants collected were subsequently cultivated in the greenhouse of the University of the Ryukyus to be used for cytological investigation. Root tips were obtained from cultivated plants and mitotic chromosomes were observed using the aceto-orcein squash method as described by Kanemoto and Yokota [10]. Part of plant materials used for cytological investigation was deposited as voucher specimen in the herbarium of Faculty of Science, University of the Ryukyus (RYU).

Fig. 1. Map showing the sampling islands (Ryukyu Islands and Taiwan).

Fig. 2. Photomicrograph of somatic chromosomes, A=diploid (2n=24), B=triploid (2n=36), Nekumachiji, Okinawajima (Scale 2µm).
Another urticaceaeous species *Elatostema suzuki* shows autopolyplidy in Yambaru, Okinawajima [12]. In case of *Elatostema suzuki* five cytotypes could not be distinguished using morphological characters. Other than Urticaceae, some studies reported that, polyploidy have important role on ongoing speciation process within the Ryukyu Islands. Some examples are role of polyploidy in the evolution of the genus *Lonicera* [13], polyploid cytotypes of *Ixesir nakazonei* and hexaploid *I. debilis* [14]. Intensive cytological and morphological studies are necessary to clarify the cytological features and taxonomic treatment of *Pilea brevicornuta*.

Table 1. Localities, chromosome number and number of individuals investigated

<table>
<thead>
<tr>
<th>Name of locality</th>
<th>No. of Individual</th>
<th>Chromosome number (2n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yamada, Kikaijima</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Onutsu, Kikaijima</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Kawamitsu, Kikaijima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Suniyo River, Amamiohshima</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Kinsukabaru, Amamiohshima</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Yuwan, Amamiohshima</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Inutabu, Tokunoshima</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Myogan jin, Tokunoshima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td><strong>Mt. Nekumachihi, Okinawajima</strong></td>
<td><strong>2 36</strong></td>
<td><strong>24</strong></td>
</tr>
<tr>
<td>Mt. Katsu, Okinawajima</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Yona River, Okinawajima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Ohgimi Village, Okinawajima</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Okuni Road, Okinawajima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Hiji River, Okinawajima</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Nago, Okinawajima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Tano, Nago, Okinawajima</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Yonaha, Okinawajima</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Oku, Okinawajima</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Yofuku River, Okinawajima</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Sueyoshi Park, Okinawajima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Tomino, Ishigakijima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Pensan River, Ishigakijima</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Miyara River, Ishigakijima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Urauchi River, Iromotejima</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Tabaru River, Yonagunijima</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Nangkan, Taipei, Taiwan</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Taipei City, Taiwan</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Lala, Taoyuan, Taiwan</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Mt. Beidawu, Pingtong, Taiwan</td>
<td>3</td>
<td>24</td>
</tr>
</tbody>
</table>

**CONCLUSION**

*Pilea brevicornuta* possess tiny chromosome size (approximately 1-2μm) and thus become harder to compare size variation. The morphological features of this species are very much fluctuating although cytological features are almost constant. In the Ryukyus, polyploidy has been shown to be of considerable importance in the speciation process of some plant taxa [3, 13-15]. Further cytological studies using more sampling plants will be conducted to explain the overall cytological variation of *Pilea brevicornuta*. Along with morphological and cytological features ecological aspects will be taken into consideration. Finally, all these results will determine the speciation process occurred in *Pilea brevicornuta*.

**ACKNOWLEDGMENT**

We thank Dr. Koh Nakamura, now working in Academia Sinica, Taiwan for supplying plant materials and Dr. Goro Kokubugata, National Science Museum, Tokyo, for his kind help during collecting samples. This study was funded by Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan.

**REFERENCE**

Toxicity of Diazinon on Embryonic and Larval Development of Stinging Catfish, Heteropneustes fossilis
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ABSTRACT
Diazinon, an organophosphorus pesticide used in the paddy fields has great negative impact on the ontogenic development of aquatic animal. An experiment was conducted to determine the sensitivity of embryonic and larval stages of stinging catfish Heteropneustes fossilis to diazinon-induced toxicity, to the degree of toxicity in particular. Three concentrations (145, 230 and 314µg/L) of diazinon under three different treatments (T1, T2, T3) each having three replications against a control (C) was carried out in glass aquaria at the backyard hatchery under Faculty of Fisheries, Bangladesh Agricultural University. Embryo samples were collected at every 6hrs interval and larval samples were collected at every 12hrs and 24hrs interval. Faster embryonic development and degeneration of eggs was evident to diazinon exposed treatments compared to unexposed ones. On the other hand, diazinon exposure during larval stages resulted various types of deformities like edema, deformed body structure, curved notochord, deformed mouth, jaw and caudal fin, damaged caudal fin etc. Moreover diazinon exposed larvae showed slower development of mouth, jaw and barbel. Movements of larvae exposed to diazinon decreased gradually compared to control. The mortality rates of larvae gradually increased (29, 59, 62 and 71% in control, 145, 230 and 314 µg/L diazinon, respectively) in response to increased diazinon concentrations. The findings of this research mainly highlight that exposure of H. fossilis to diazinon at the critical and sensitive stages of the life cycle significantly reduce the number of returning adults.

INTRODUCTION
Various types of insecticides and pesticides are used indiscriminately in agricultural land for bumper production of crops in Bangladesh and about 300 pesticides have so far been registered for marketing [1]. Organophosphate pesticides are a group of chemicals which act by inhibiting the enzyme acetylcholinesterase (AChE) in the nervous system. Toxic effects of AChE inhibition vary with the degree of exposure and the type and concentration of organophosphate pesticides. Insecticides and pesticides may produce extensive damage in ovary i.e., degeneration of follicular wall, ooplasm and connective tissues [2]. Pesticides effected eggs have very low hatching rate and fry dies soon after hatching [1].

Diazinon is an organophosphate pesticide developed by Novartis in the early 1950s used to control a wide variety of sucking and leaf eating insects. Worldwide, nearly 2.6 million pounds of diazinon were used each year prior to 80’s [3]. After application of diazinon on crops and plants, it is easily washed into surface waters and enters ground water. Because of its aquatic distribution, diazinon affects a wide range of non-target organisms, like invertebrate, mammals, birds and fishes especially those inhabiting aquatic environment [4]. In fishes, diazinon exposure in sublethal doses is known to affect the nervous system by inhibition of AChE activity [5]. Early life stages of fishes are often the most sensitive to toxic effects of diazinon [6].

H. fossilis, commonly known as stinging catfish and locally called shing, is commercially an important fish species in many Asian countries. This catfish is native to Bangladesh, India, Pakistan, Nepal, Sri Lanka, Burma, Thailand, Indus Basin, and Laos including the Andaman Islands. H. fossilis is one of the rarest species in Southeast Asia. H. fossilis breed during monsoon, their eggs, embryo and larvae are often exposed to the toxicity of insecticides and pesticides. Considering the toxic effects of diazinon discussed above, an attempt was made to conduct a research on the diazinon toxicity on the embryonic and larval development of stinging catfish H. fossilis.

MATERIALS AND METHODS
To conduct this experiment, healthy broods of H. fossilis were collected from Sharnalata Agro-feeding Ltd., Radhaknai, Fulbaria, Mymensingh. During breeding season, mature male and female fishes were selected on the basis of secondary sexual characteristics. For collection of sperms and eggs from male and female fishes, previously prepared HCG solution was administered on the dorsal region above the lateral line just beneath the dorsal fin at the doses of 500 and 3333 IU/kg body weight respectively and was placed in separate spawning tanks. After 12 hours of hormone administration, when the ovulation was seemed to complete, ovulated eggs were collected by stripping of female. For collection of milt, males were sacrificed and testes were dissected out from the body cavity and were macerated in 0.89% NaCl solution. Eggs were fertilized by the sperm by gentle stirring with soft feather. Twelve glass aquaria (36x10x12 inch³) were used for this experiment. Three concentrations of diazinon (145µg/L, 230µg/L and 314 µg/L) under three different treatments (T1, T2, T3) respectively each having three replications against a control (0µg/L) were exposed to observe the degree of deformity of eggs and larvae. Diazinon solution was prepared by serial dilution in 40L water for each aquarium. Then the fertilized eggs in the same amounts were released in each aquarium very carefully and ensured continuous water supply. Egg samples (5 eggs) were collected from each aquarium at every 6hrs interval till hatching to conduct this experiment. But larval samples (5 larvae) were collected at every 12hrs interval until yolk sac absorption. Collected samples were observed under a digital microscope (Olympus CX 41) fitted with a camera (Magnus analytics, Model-MIPS). The development stages of H. fossilis were determined according to embryonic and larval stages of this species [7].

RESULTS AND DISCUSSION
A. Diazinon Exposure and Deformity During Embryonic Stages
6 hrs after fertilization (Fig. 1), eggs in treatment-1 were advanced to 70% epiboly stage where dorsal side of the blastoderm was thicker than the ventral side and germinal ring was damaged (GrD) on some parts. Treatment-2 showed the same stage but embryo became more blackish in colour (BC). But in treatment-3, fertilized eggs showed faster development and reached to 75% epiboly stage where enveloping layer was expanded uniformly over the yolk sphere and embryonic shield became less distinctive. Whereas in control, normal development was observed and fertilized eggs reached to shield stage.
After 12hrs of fertilization (Fig. 2), eggs from treatment-1 reached to 6-8 somites stage but the optic cups were not clearly distinguished and yolk sac became dark brown (DB) in colour. Same stage was observed in control and optic cups and notochord were clearly distinguished here. The cephalic portion was broadened and the embryo was embedded in the yolk mass over all its length. In treatment-2, 8-12 somites stage was observed at the same time and yolk sac became dark brown (DB) in colour. Same stage was found in treatment-3 but sign of deformity (D) on dorsal side was distinct. Acute lethality, such as coagulation, irregularities in somite formation were evident in zebrafish embryo exposed to bifenthrin [8].

**B. Diazinon exposure and deformity during larval stages**

20hrs after hatching (Fig. 3), edema (E) was formed on the dark coloured yolk sac and abnormal notochord was found in T1 larvae. Damaged caudal fin (CD) was observed on different parts of tail region. Larvae of T2 showed abnormal yolk sac (AY) with deformed size and colour and notochord was not straight (ND) in the caudal region. At the same time pigmented eye spot was not developed. T3 larvae also showed abnormal growth i.e. absence of any pigmented eye spot and abnormal head (AH) and jaw formation were noticed. Caudal fin was damaged (CD) on different parts of tail region. But in control, normal growth was observed. Pigmented eye spot appeared on the anterior part of the head.
32hrs after hatching (Fig. 4), large edema (E) was formed on the yolk sac of T₁ and T₃ larvae. Notochord deformity (ND) was evident in T₂ and squeezed mouth (MD) on T₃. Edema is a prevalent feature of vertebrate embryo-toxicity in general and this is true for fishes as well [9]. But control group of larvae showed normal growth. Flathead minnow larvae are also very sensitive to toluene and showed deformity [10]. 56hrs old larvae (Fig. 5) showed edema (E) on the yolk sac, deformed mouth (MD), jaw, burble, caudal fin and abnormal eye formation T₁, T₂ and T₃. On the otherhand larvae in control showed reduced yolk sac and dark and prominent eye ball. Mouth cleft well formed with a well developed lower jaw. Elongated barbel and prominent around the mouth was also found. Abnormal head (HD), deformed notochord (ND), edema (E) on the abdomen of the larvae were evident in T₁, T₂ and T₃ after 80hrs of hatching (Fig. 6) but in control they showed normal physiological growth. Edema and curved body axis was evident in zebrafish larvae exposed to bifenthrin ranged of 50 to 200μg/L and deformity was increased significantly compared to control and it was concentration...
dependent [8]. 102hrs old larvae (Fig. 7) showed serious notochord deformity (ND) in T1, T2, and T3. Movement of larvae was slowed down according to the increase of diazinon concentration. In control, larvae resembled that of adult and showed vigorous movements inside the aquarium and took exogenous feed. A decrease in swimming speed after exposure to organophosphates and carbamates has been detected in several fish i.e. carbamate exposed medaka Orezius latipes [11], rainbow trout Oncorhynus mykiss [12].

C. Larval Mortality

Mortality rates were increased gradually with the increase of concentration of diazinon (Fig. 8).

Table 1. The water quality parameters in control (C) and three concentrations of diazinon (T1, 145µg/L; T2, 230µg/L; and T3, 314µg/L).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>C</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>25.2</td>
<td>25.4</td>
<td>25.00</td>
<td>25.2</td>
</tr>
<tr>
<td>pH</td>
<td>8.00</td>
<td>7.5</td>
<td>7.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Dissolved O2 (ppm)</td>
<td>10.5</td>
<td>9.8</td>
<td>9.4</td>
<td>9.00</td>
</tr>
</tbody>
</table>

CONCLUSION

This research finding provides understanding of the developmental toxicity of crop insecticide diazinon to early life stages of H. fossilis and different types of deformities were observed. It will help the policy makers to make people conscious about impact of insecticides used in crop production indiscriminately on normal physiological development of fish and fish related species.

REFERENCE

[1] F Lovely. 1998. Toxicity of three commonly used organophosphorus insecticides to Thai sharpunti (Puntius gonionotus) and African catfish (Clarias gariepinus) fry. An M.S. Thesis Submitted to the Department of Fisheries Biology and Genetics. Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. 83pp.
The study on the impact of betel leaf cultivation on the local forest in the Teknaf Peninsula

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³Dept of Agricultural Extension Education, Mymensing, Bangladesh

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ABSTRACT

In the Teknaf Peninsula, located in the south east of Bangladesh, much betel leaf cultivation is being conducted. Betel leaf is grown under shade provided by the structure called pan boroj. A large amount of wood is used in construction of a pan boroj. Therefore, betel leaf cultivation is considered to be one of the factors of deforestation in this area. This paper examines the impact of betel leaf cultivation on the local forest in the Teknaf Upazila. To evaluate the impact, we calculated the proportion of the wood consumption by betel leaf cultivation in the annual production of the local forest. We found that the intensive betel leaf cultivation in the western 2 unions, the Bharchhara and the Sabrang has the impact on the wide range of the local forest in the Teknaf Upazila.

INTRODUCTION

Since betel quid chewing is a widely common habit, betel leaf is the important commercial crop in Bangladesh. The Teknaf Peninsula is one of the regions where many people are making their lives by betel leaf cultivation. In this area, betel leaf is grown under shade provided by the structure called pan boroj. Pan boroj is constructed to protect the plants from sunlight since the plants grow better under shade [1]. On the other hand, a large amount of trees are cut down continuously to provide enough material for construction of pan boroj. And the forest area in the peninsula has been decreasing [2]. Therefore, betel leaf cultivation is considered to be one of the factors of deforestation in this area. This paper examines the impact of betel leaf cultivation on the local forest in the Teknaf Peninsula.

MATERIALS AND METHODS

In this study, we are going to discuss the problem in terms of environmental anthropology. We collected both quantitative and qualitative data by conducting the social survey in the study area.

We selected 5 unions in the Teknaf Upazila as the study area. The area covers southern half of the Peninsula, where the most intensive betel leaf cultivation is being conducted. Teknaf Upazila consists of 6 unions (Table 1). In this study, S.T.Martin Dwip was excluded from the study area since the union is a remote island from the peninsula and betel leaf cultivation is not conducted there.

Table 1. Unions in the Teknaf Upazila

<table>
<thead>
<tr>
<th>Upazila</th>
<th>Unions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teknaf Upazila</td>
<td>Whykong, Nhilla, Bharchhara, Teknaf, Sabrang, (S.T.Martin Dwip)</td>
</tr>
</tbody>
</table>

To evaluate the impact of betel leaf cultivation on the local forest in the study area, we calculated the proportion of wood consumption by betel leaf cultivation in the annual production of the local forest (Table 2).

The annual production of the forest is the amount of organic matter produced by the forest per hectare in a year in oven dry weight. To compare the wood consumption by betel leaf cultivation with the annual production of the local forest, the wood consumption by betel leaf cultivation was also needed to be given by the oven dry weight.

At first, we calculated the volume of wooden parts used in one pan boroj, then we calculated the oven dry weight of the wooden parts used in the pan boroj from their volume. The volume of wooden parts used in one pan boroj was calculated by the measurement of a typical pan boroj measures 22m×23 m in Jahajpura, a village located in Bharchhara Union on 14th Mar, 2012. We recorded the number, diameter, length of wooden parts used in the pan boroj to calculate the volume. To calculate the oven dry weight of wooden parts used in the pan boroj from the volume of them, we specified the species and moisture content of wooden parts used in the pan boroj. Since genus Acacia is mainly planted in the study area, we used the specific gravity of hybrid Acacia for the calculation [3]. The wooden parts used in the pan boroj dried in the air after they were cut down. Therefore, we considered that the wooden parts were under the air dry condition. Under the air dry condition, moisture content of the wood was assumed to be 12% [3]. Based on these specifications, we calculated the oven dry weight of wooden parts used in the pan boroj in the following way. First, we multiplied the volume and the specific gravity of hybrid Acacia, then, we subtracted the weight of water which equaled to the 12% of the apparent weight of the wooden parts from the result of previous calculation (1). Next, we counted the number of pan borojs in the study area using satellite images provided by Google. The images were selected according to the date they were recorded. We selected the images recorded during the dry season, when more pan borojs are constructed (Fig. 1). Using these images, we plotted the locations of pan borojs and counted the number of them. Wood consumption by betel leaf cultivation in the study area was calculated from the number of pan borojs and the weight of wooden material used in one pan boroj (2).

Secondly, the annual production of the local forest was calculated by multiplying the forest area and annual forest productivity (3). We calculated the forest area using the satellite images (Fig. 1) since there was not the official data of forest area for each union and we used the annual forest productivity of tropical rain forest in Thailand [4] in the calculation of the annual production of the local forest.

<table>
<thead>
<tr>
<th>Calculation method</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The weight of wooden parts used in one pan boroj (g)</td>
</tr>
<tr>
<td>2</td>
<td>The wood consumption by betel leaf cultivation (10⁵ kg)</td>
</tr>
<tr>
<td>3</td>
<td>The annual production of the local forest (10⁵ kg/ha/year)</td>
</tr>
<tr>
<td>4</td>
<td>The proportion of wood consumption in the annual production of the local forest (%)</td>
</tr>
</tbody>
</table>
Finally, the proportion of the wood consumption by betel leaf cultivation in the annual production of the local forest was calculated (4).

RESULTS AND DISCUSSION

At first, from the measurement of the pan boroj, we got the volume of wooden parts used in one pan boroj. Wood was used as 5 different parts (Fig. 2). For each parts, we calculated the volume from length, diameter and number (Table. 3). Then, we calculated the total weight of wooden parts used in one pan boroj in the following way. First, we multiplied 1.8×10^6 (the total volume) and 0.58 (the specific gravity of hybrid acacia). Then, we subtracted the weight of water contained in the wooden material from the result of previous calculation (5). We got the result that 4.4 × 10^3 (the weight of wooden parts were used for construction of the pan boroj). By counting the number of pan boroj, we found that there were 5961 pan boroj in the whole study area (Fig. 3). Then, we calculated the wood consumption by betel leaf cultivation by multiplying 5961 (the number of pan boroj) by 0.92 (the weight of wood used in one pan boroj) (6). We got the result that wood consumption by betel leaf cultivation in the study area equals to 5.5 × 10^3 × 10^3 kg.

Secondly, we calculated the annual production of the local forest in the study area by multiplying 1.5×10^6 (the total forest area in the Teknaf Upazila) by 28.6 (the annual forest productivity of tropical rain forest in Thailand) (7). We got the result that 4.4 × 10^5 × 10^5 kg of forest resource is produced in the local forest annually.

Table. 4. Result of calculation

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The weight of wooden material used in one pan boroj (10^2 kg)</td>
<td>1.8 × 10^6 (cm^3) × 0.58 (g/cm^3) × 100-12 / 100 (%) = 918720 (g)</td>
<td>918720</td>
</tr>
<tr>
<td>2</td>
<td>The wood consumption by betel leaf cultivation (10^2 kg)</td>
<td>5961 (Nos) × 0.92 (10^3 kg)</td>
<td>5.5 × 10^5 (10^3 kg)</td>
</tr>
<tr>
<td>3</td>
<td>The Annual production of the local forest (10^3 kg)</td>
<td>1.5 × 10^4 (ha) × 28.6 (10^3 kg / ha / year) = 4.4 × 10^5 (10^3 kg / year)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>The proportion of wood consumption in the annual production of the local forest (%)</td>
<td>((5.5 × 10^3) / (4.4 × 10^5)) × 100 (%) = 1.3 (%)</td>
<td></td>
</tr>
</tbody>
</table>

Table. 5. Calculations for each union

<table>
<thead>
<tr>
<th>Union</th>
<th>Size (ha)</th>
<th>Pan Boroj (Nos)</th>
<th>Density of pan boroj (Nos/100ha)</th>
<th>Forest use by betel leaf cultivation (10^2 kg)</th>
<th>Forest area (ha)</th>
<th>Annual production of the local forest (10^3 kg/year)</th>
<th>Consumption (10^2 kg/year)×100(%)</th>
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</thead>
<tbody>
<tr>
<td>Whykong</td>
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<td>305</td>
<td>2.7</td>
<td>2.8 × 10^3</td>
<td>4.7 × 10^3</td>
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<td>2163</td>
<td>20</td>
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<td>9.8 × 10^3</td>
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<td>1644</td>
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<tr>
<td>Teknaf Upazila</td>
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<td>5961</td>
<td>16</td>
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<td>1.5 × 10^5</td>
<td>4.4 × 10^5</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Finally, the proportion of 5.5 × 10^3 (the wood consumption by betel leaf cultivation) in 4.4 × 10^5 (the annual production in the study area) was calculated as 1.3 percent (8).
Detailed data for each union are presented in Table 5. Almost 5500 Nos, 92 percent of pan borojs in the study area, were located in the western 3 unions, the Teknaf Union, the Bharchhara Union and the Sabrang Union. In addition, the density of pan borojs was much higher in these 3 unions than the Whykong Union and the Nhilla Union. The density, the number of pan borojs per 100 hectare was 20 in the Teknaf Union, 110 in the Bharchhara Union and 26 in the Sabrang Union.

![Geography of Marishbonia located on western area](image)

On the other hand, there is little forest area in the Bharchhara Union and the Sabrang Union. Therefore, the proportion of wood consumption by betel leaf cultivation in the annual production of the local forest was much higher in these 2 unions. The proportion was 55% in the Sabrang Union, and 8.7% in the Bharchhara Union. In the whole study area, the proportion was 1.3%. We found the impact of betel leaf cultivation on the local forest was much higher in the Bharchhara Union and the Sabrang Union than other 3 unions in the study area.

In the Bharchhara union and the Sabrang Union, the part of wooden material for construction of pan boroj was provided from other unions. In the survey, some betel leaf cultivators in the Marishbonia, a village in the Bharchhara union, told us that they got the wooden material for pan boroj from the Nhilla Union. The betel leaf cultivation in these 2 unions appears to be supported by other union.

Then, we are going to discuss why the most of pan borojs are concentrated on the specific area. We found that the geographical condition of the western area, especially in the Bharchhara Union and the Teknaf Union, appears to cause the intensive betel leaf cultivation. The western area has relatively less flat land for farming than the eastern area since the Mt. Arakan runs the west of the center of the peninsula from the north to the south. The geography of western area tends to be steep and hilly such as Marishbonia (Fig. 4). Therefore, the western local farmers have to earn enough money to make their life in their small farm land. In the study area, it is reported that the betel leaf cultivation generate higher income than the rice cultivation, the most major crop in Bangladesh [6]. Moreover, betel leaf can cultivate even a gentle slope where rice cultivation cannot be conducted (Fig. 4). Therefore, the betel leaf is adaptive crop more than rice, under the geographical condition of the western area.

**CONCLUSION**

In this study, we clarified that betel leaf cultivation is conducted intensively in the western 3 unions, the Teknaf Union, the Bharchhara Union and the Sabrang Union. 2 of the 3 unions, which means the Bharchhara Union and the Teknaf Union is more suitable for the betel leaf cultivation geographically. On the other hand, in the Bharchhara Union and the Sabrang Union, some amount of the forest resource appears to be provided from eastern area for construction of the pan boroj. Therefore, we conclude that the intensive betel leaf cultivation in the Bharchhara Union and the Sabrang Union has the impact on the wide range of the local forest in the study area, beyond the boundary of these Unions.

**ACKNOWLEDGMENT**

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**REFERENCE**


NGOs, Missing Link in Conservation of Wetlands and Rivers in Iran
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ABSTRACT
Since 1960, and especially during the past two decades, ecosystems have been destroyed in the name of development and modernity. Wetlands and rivers are invaluable ecosystems which have been deteriorating due to various causes. Conservation of wetlands and rivers is intertwined with public and local participation in a way that people’s participation has become an essential part to any measure of conservation. To find out more about participation at different levels in Iran, a Social Ecology Model has been applied. It was found that “participation”, especially at meso level by NGOs, is the missing link. Participation has been mentioned in Iran’s Constitution in various principles, however, there is a major gap in environment law on “participation” and participatory management. Meanwhile, NGOs have to be empowered to play a mediatory role too, and to create a network to scale up successful local empowerment projects for conservation of wetlands and rivers.

INTRODUCTION
Since 1960, and especially during the past two decades, the environment and ecosystems have been destroyed in the name of development and modernity. Wetlands and rivers are invaluable ecosystems which have been deteriorating due to various causes such as unawareness, less recognition, over-population, or wrong ideas such as uselessness of wetlands. Sustainable development with its practical definition of use of resources for the present generation and their maintenance for the next generation has three significant cornerstones: people, resources and participation. To conserve ecosystems, full and active participation of all stakeholders and non-stakeholders are necessary [1].

Conservation of wetlands and rivers is fully intertwined with public and local participation in a way that people’s participation has become an essential part to any measure of conservation [2-4]. People’s participation is regarded as part of the social pillar of sustainable development and, as Agenda 21 has recommended in its Chapter 28, people have to be encouraged to participate at all the stages of decision-making, planning and implementation [5].

There are many wetlands and rivers in Iran, and therefore, it is needed to have a multi-level and well-defined structure for participatory conservation of wetlands and rivers. However, there has been little research on participatory management. Researchers such as Mohebi and Solthtan expressed their concern in their concluding remarks on Lake Urumia over people’s awareness and participation to conserve the lake [6]. Others in their study of Shadegan International Wetland reviewed the economic value of wetlands and showed how wetlands were underestimated in vital development decisions; also in another research paper, the authors studied the tourist attractions of Chaghakhor wetland and showed that there was not any positive relationship between local people’s livelihood and the tourists who visit the place [7].

The present paper intends to present an institutional view of the wetlands protection, focusing on institutions that connect the local level to the national level, trying to show how institutions facilitate people’s participation for conservation of wetlands and rivers in Iran. The paper aims to analyze the challenges and to offer certain solutions to strengthen local people and groups’ involvement in protection of wetlands and rivers.

MATERIALS AND METHODS
A Social Ecology Model or Social Ecological Perspective was used to study the conservation of wetlands and rivers in Iran. The model which is a practical means to picture a natural situation and the influence of people on that, acts like a framework for studying the effects and especially a multi-level tool for examining the interrelatedness of social elements in an environment. The model has been used in various disciplines such as a study on behavioral change in Malaria [8], or for “adolescent interpersonal violence prevention” [9] or even in community health promotion [10, 11]. The model is a systems theory approach to understand how a development process happens in different levels; and illustrates stakeholders’ interactions and shows how they influence each other at each level.

In the present research, the Social Ecology Model is used in three different sectors (individuals, institutions, and regulations and policies) and at three levels (micro-, meso- and macro-level). Here, ‘Macro level’ or ‘macro-system’ means the whole laws and regulations that govern the society and regulates the interaction between people and the environment, the general culture and values that predominate the society, and the major institutions that organize the society and administer the system and all the important people at top level that can influence the society. The ‘Meso-level’ or ‘meso-system’ means those institutional factors or norms or values that connect the two macro and micro levels. Mostly, in this level, we can find non-governmental organizations (NGOs) that have access to local level and at the same time, they can influence the top level too. Here, there are also certain regulations, values and norms that only govern this part of the society. For instance, the values of voluntary work for society can be easily found here at meso level. Certain researchers consider two middle levels: one meso level and one exo-level or exo-system [12]. The ‘micro-level’ or local one means all the values, culture, regulations that govern the local area that might be different from one community to another. At this level, everyone counts; institutions and local groups can affect the community. Neighborhood relationship can be easily noticed.

Two research fields were selected in Guilan province where there is a major river (Sefid-Rud) and two important wetlands (Boujagh and Anzali), both registered in Ramsar Convention. Sefid-Rud or white river is the second longest river in Iran that starts in Alborz Mountains and flows to the northeast to the Caspian Sea. Many fishes inhabit in this river, especially sturgeon and Caspian Trout. A major dam on this river has created a large reservoir which allows both agricultural irrigation and flood controlling for extensive rice plantations in its delta, as well as production of hydroelectric power with certain negative impact on its fisheries potentials since the dam controls the flow of the water. Sefid-Rud does not flow only in nature, but in fact, it flows through the people whose livelihood depends largely on the river. Anzali Lagoon (Mordab Anzali) is a coastal lagoon in the Caspian Sea, near Bandar-e Anzali in Northern Province of Guilan. In fact, the lagoon divides the city into two sections and has certain biodiversity values. Despite the existing pollution in the lagoon, it is still a very attractive place for bird-watchers. The lagoon has been designated as a Ramsar site in 1975 [13].

Bujagh wetland or Bandar Kiashahr Lagoon is part of the National Park of Bujagh which is situated just to the east of the...
mouth of Sefid-Rud. The wetland has been designated as a Ramsar Site in 1975. The importance of this wetland lies in the fact that it hosts different species of migratory birds, and has been for years the wintering site for Siberian Crane.

For data gathering, a matrix of with three rows (micro-, meso- and macro-) for three levels and three columns (individuals, groups and institutions, environment) was created. The data were collected from the people whose livelihoods have been depended on these two wetlands and the Sefid-Rud river. Respondents were selected from Bandar-e Anzali, Kiashahr, and certain villages near Sefid-Rud flow. Environment experts, active NGO members from Rasht and Anzali (two nearby cities) and other experts from governmental bodies were among those who were interviewed.

Data collection has been done based on multi-level interviews and observation, were gradually inserted into the matrix while needed, more interviews were carried out. The matrix was then analyzed to find out gaps, interactions and relationships.

RESULTS

At the local level, people living near two wetlands or the river (where they mostly earn their life by using the resources of wetlands or rivers) did not know much about the role that the two wetlands and the river played in their life, while they knew well that their life was depended on the water. Of course, people from previous generations knew much more. They have correctly understood that if they did not protect the water, they would lose it. They said that there had been certain unwritten regulations or norms for protecting the river.

In certain places, local groups have been established, but they were not active institutions at local level aimed at protecting the groups. The groups were not connected to each other, while as the groups were from one province, some of them knew each other; however there was not an organized network of the local groups. Local groups referred to certain individuals (facilitators) or NGOs that have been influential in empowering them, but they also mentioned that such visits were not well organized to produce results.

No regulations or even local values existed to protect the wetlands. Some referred to the past when there have been local values for conservation of the rivers (especially old fishermen living in Kiashahr near Sefid-Rud).

At meso level, a major gap was observed; in fact, there were not enough individuals that could act as connectors or facilitators between the two levels of micro and macro. Also, the same gap was observed in both governmental and non-governmental institutions. NGOs mentioned that they could play a major role, not only as facilitators but also as the main connectors between the two levels, but they had limited resources; also there were few active NGOs. The relationships between the existing active NGOs were not well defined, and therefore there have been certain tensions among them. No rules or regulations have been found at this level.

At macro level, there were certain governmental institutions such as the Department of Environment that has been responsible for management of the wetlands (by the time they were considered natural parks or protected areas). The Department of Environment had a special deputy for training and research, and within that deputy, an office for training and people’s participation has been established. This office has supported certain projects by NGOs and other groups, while it seemed that the Department has not defined any clear strategy in working with NGOs at provincial level.

Participation has been mentioned in Iran’s Constitution in various principles such as Principle 50 (the conservation of the environment is the duty of all citizens), Principle 3 - paragraph 8 (general principle on participation), and Principles 19 to 40 (indirect references and in an interpretative way). But it seems that the other existing regulations in Iran are not clear about participation or participatory management.

DISCUSSIONS

There are two significant influence flows within these three levels. First the top-down flow of information that seems to be mostly impartial towards the irresponsible behavior of people at local level; while it could be an effective channel for increasing awareness among people about the importance of wetlands and rivers resources, since it has the government support; but decisions are taken at the macro level without considering the feedback from the community members. An obvious example is the Sefid-Rud river which is losing its biodiversity and the government could not be successful in changing the behavior of fishermen. Guarding and protection mechanisms are in place, but illegal fishery continues to be the dominant pattern. Although governmental warnings are given to fishermen each year, overfishing still threatens the eco-system. The meso level seems to act only one way from top-to-down and as a medium to transfer governmental policies down to the local level. One major point regarding the existing governmental institutions is that they lack a participatory approach, especially in conservation of rivers and wetlands, however they do not impede the projects supported by GEF/SGP or by NGO initiatives, while in certain cases, the government bodies at local level even cooperate with NGOs in implementing community-based projects.

The second is the bottom-up influence that is not powerful enough to be transferred from the local level to the top. It means that people’s voices from communities are not heard. As the meso level is not institutionally enough powerful, such effect could not be transferred, since active and recognized representative individuals (such as Majlis deputies) or institutions or networks at meso level (such as NGOs or their networks) are not involved in the process of conservation. If anything happens to people, if they have any need or demand, their voices are ignored.

NGOs are among important stakeholders for conservation of wetlands and rivers since they are connected to people in communities, and are easily accepted by the community members; they have the power to mobilize the people for sustainable use of wetlands [14]. They can raise funds, do various conservation activities and offer their consultations when needed. They have a linking power and capacity building position within the meso level. That is why the international environmental conventions and declarations such as Ramsar Convention, Stockholm, Rio and Johannesburg declarations, and Agenda 21 and many others have paid special attention to NGOs as a key stakeholder.

NGOs act at both local and meso levels, but in our selected research fields, there were few NGOs. Those active were not connected to each other. There is not any network on wetlands or rivers, or an active NGO network with plans on conservation of wetlands or rivers. It means that the connecting level has not enough capacity. In this case, even if both community members at local level and authorities at macro level are interested to act for conservation of water, but as they are not informed of each other, the government does nothing since the officials do not know about community concerns and the community does not act since they do not know whether the government supports or not. Nothing happens since there is a weak meso level, and no interaction shapes to create an action or a project at local level. Meanwhile, if anything happens at local level by voluntary initiative of people, it will remain limited without any possibility to scale up in other places where such conservation is necessary too.
The challenging result of this missing link (NGOs) will be certain active sub-systems without being connected or even informed about each other, while the top system is ignoring what is being done down there. Hence, NGOs can play as a bridge between grassroots at the local level and the Department of Environment at the macro levels. As facilitators, they can help the message of conservation goes to other communities [15], while they can constantly inform top authorities about local demands, concerns and the support they need. They can advocate for new regulations or create local agreements. NGOs can connect each other in a network to exchange their best practices, and to transfer knowledge and experiences. NGOs can also transfer science to practical knowledge of conservation [16], and bringing universities outputs into the field [17]. Such interactions have to be recognized as a vital part of this approach.

Any scale-up of the projects to empower people or to encourage their participation in communities requires an active bridging level for transfer of experience, knowledge or patterns to other communities. Without active institutions at meso level, practical knowledge remains limited, successful patterns cannot be used in other places, and experience of best practices will not be transferred. This could be the reason why a successful participatory project to conserve a wetland or a river cannot be followed by other communities. An active NGO or a media organization can be a practical route for transferring the knowledge at meso level, from one community to another or from one community to the macro-level or from one community to many others through a network of awareness-raising. The people should have access to these success stories, while the stories can be part of a training course or even a documented text or video.

Participation is an integrated part of any management plan of a wetland or a river [18]. However it has to be legally defined within a country to guarantee that there is enough institutional capacity for participation. It seems the legislative system in Iran needs to integrate other forms of legal acts such as local agreements between the local groups and NGOs as one party and other governmental bodies as other parties. This will facilitate the work of the NGOs that are involved in community-based conservation. Also, it will help local groups to have the government support for their conservation activities.

CONCLUSION

NGOs are the missing link in the community-based conservation of rivers and wetlands in Iran. While there is a fundamental need for precise and clear regulations encouraging participation at different levels, NGOs have to be strengthened and trained for building their own capacities to be involved in community-based projects aimed at conservation of rivers and wetlands.

If NGOs can have connections with community members, as they are non-governmental, people trust them easily; and thus they are able to train people for wetlands protection or even recognize the possible unique local knowledge on wetlands conservation. The NGOs can also help the people to use this beneficial local knowledge once more. The local knowledge may contribute to better conservation, especially if it is merged with conservation values and economic potentials.

Certain NGOs are involved in community-based conservation in different places in Iran, while they have to be connected to each other to act like to network. In this way, they can play a connecting role at meso level that may influence individuals, institutions and policies at macro-level and creates more scale-up at local level. That is why one important suggestion of the present research is that the existing NGOs have to be enough strengthened and empowered to play such mediatory role. In addition, they have to be skillful in community building; Also they have to be connected to each other, and shape a strong and knowledgeable network of community-based organizations for conservation of wetlands and rivers in Iran.

Meanwhile, another suggestion is a comprehensive review of the existing laws and regulations regarding participation in Iran and to see how they have to facilitate people’s participation, community-based conservation and other participatory methods of protection.

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REFERENCE

White Rot of Dalbergia sissoo Roxb. and Swietenia macrophylla King, by Schizophyllum commune


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ABSTRACT

The present study was intended to identify the causal agent of the fence post degradation in Khulna region, Bangladesh. Fungi affected fence posts of Dalbergia sissoo and Swietenia macrophylla were investigated. Isolation of fungi from fence posts revealed three major types of fungi isolates that denoted as A, B, and C. From the percentage of various types of fungi yielded, isolate type A was the most dominant and it was identified as Schizophyllum Commune. From the result it was conferred that S. Commune might be responsible for weight loss of fence posts. S. Commune was found to yield the best diameter growth on 2% Malt Agar (MA) medium at 35°C temperature. Incorporation of different concentrations of Copper-Chrome-Arsenic (CCA) on 2% MA media showed that 0.2%, 0.1%, 0.05%, 0.025% and 0.015% CCA inhibited the growth of S. Commune entirely. Significant weight loss was found in D. sissoo wood rather than S. macrophylla due to fungal attack.

INTRODUCTION

Dalbergia sissoo Roxb. belongs to the family Leguminosae, and is planted at almost all over Pakistan, parts of India, Assam and also in Bangladesh. No other timber species, except teak (Tectona grandis), is so extensively planted in the Indo-Pak-Bangladesh subcontinent. Most of the reports consider D. sissoo as an exotic in Bangladesh [1, 2]. Dalbergia sissoo is a very important tree species in agroforestry and social forestry plantations and in village homesteads in the North Bengal of Bangladesh. According to the recent study carried out by the Village and Farm Forestry Project (VFFP) of Switzerland Development Corporation (SDC), over the last 15 years, 80% of the trees planted in the North Bengal of Bangladesh were of D. sissoo [3].

Swietenia macrophylla King belongs to the family Meliaceae, is a large deciduous tree with an umbrella shaped crown frequently reaching height over 30 meters and Diameter at Breast Height of over 1.5 meter. Swietenia macrophylla is a wonderful broad-leaved species of the tropics [4] and famous for its aesthetic beauty, high growth and potentiality as a plantation species. This is a medium height broad leaved tree with large tree leaves and gray barks [5]. Swietenia macrophylla is widely distributed through latitude 23° N in Central America to latitude 18°S in South America. It is extensively cultivated in gardens, along roadsides and in the forests since nineteenth century. The farmers of northern and western parts of Bangladesh have been planting this species along roadsides, around farmlands and homesteads.

Schizophyllum commune Fr is a macro fungus, commonly called the "Split-Gill." It looks like a polypore but has uniquely splitting gills, and has been placed in its own family, the Schizopyllumaceae, by most taxonomists. These small bracket-like fungi are whitish, hairy, with tough leathery flesh. Natural outdoor habitat of this fungus is hardwood sticks, stumps, and logs, with a worldwide distribution [6].

Schizophyllum commune is a white rot fungus, and can utilize the cellulose, hemicellulose and lignin components of wood; this fungus degraded the wood components by secreting the respective enzymes. Schizophyllum commune grows on decaying logs and branches forming a fan shaped basidiocarp [7]. Due to the availability of D. sissoo and S. Macrophylla people use these species as indoor furniture as well as the outdoor use like fence post. But in the exposed condition the wood of these two species was subject to the decay by the fungi. So the aim of our research was to identify the causal agent of the degradation of fence post of D. sissoo and S. macrophylla.

MATERIALS AND METHODS

A. Collection of Affected Fence Post

Fence posts of D. sissoo and S. macrophylla, on which fruiting bodies of wood decay fungi were developed, were collected from Khulna University campus, Bangladesh. Five posts from each species were taken in order to isolate the causal fungi associated with the decay development. The posts were cleaned by using a brush and then cut into 1 cm thick discs by using a band saw.

B. Isolation of Fungi from Decay Affected Post

Wooden inocula were taken from different regions of the wood discs and marked R1 inocula from near the periphery of the wood discs. R2 type inocula were taken from inner locations than R1 zone. Similarly R3 zone was deeper than R2 zone, R4 zone was still deeper than R3 zone and finally R5 zone was the innermost portion of the wood discs near the pith zone. After cutting small wood pieces from R1, R2, R3, R4 and R5 zones of the wood discs of D. sissoo and S. macrophylla, the pieces were surface sterilized using 0.035% sodium hypochlorite. Then small inocula pieces (about 2 mm x 2 mm) were cut aseptically using sterile scalpel in a Laminar Air Flow. Then five inocula pieces were plated onto 90 mm diameter Petri dishes of Malt Agar media. A total of 250 wood samples were used for fungus isolation (5 post x 2 species x 5 isolates per zone). The plates were then placed in an incubator at about 25°C. The bacterial contamination was overcome by using streptomycin sulphate solution, which was added to the media just before pouring the culture medium on the Petri dishes [8]. At two days interval the inoculated plates were observed. The yielded numbers were counted up to 10 days, which is the optimum range for maximum fungal growth after inoculation.

C. Growth Performance of Fungal Isolates at Different Temperatures

The growth performance of fungal isolates of A, B and C at three different temperatures (i.e., 10°C, 30°C and 35°C) after 1, 2 and 3 days were observed in the laboratory. The effect of temperature on the mycelial growth was determined based on linear diameter growth on 2% MA media. The inoculum of 7 mm in diameter was collected from the subculture. Thus 7 plates from each replicate were inoculated at 10°C, 30°C and 35°C temperature. At each time interval, every fungal colony was measured in mm along two perpendicular lines passing through the center of the inoculums plug and thus an average diameter growth for a particular colony was recorded.

D. Weight Loss of Affected Wood Samples

For determining the weight loss 10 samples of affected D. sissoo and S. macrophylla fence posts were taken individually. Similarly 10 sound samples of same dimension from each species were also taken for comparison. Thus the volume of 40 wooden sample were measured using the formula \( \pi r^2l \) (where \( \pi = 3.14, r = \text{radius} \) and \( l = \text{length of a wooden piece} \)). Then the samples were dried to constant weight at 105°C. The obtained
data were used to calculate weight loss due to decay as compared to healthy samples of both D. sissoo and S. macrophylla. The weight loss of D. sissoo and S. macrophylla were measured in percentage.

E. Growth Performance of S. commune

To inhibit the mycelial growth of S. commune, Copper-Chrome-Arsenic (CCA) was used in the experiment (in-vitro). The preservative concentrations used for the study were 0.2%, 0.1%, 0.05%, 0.025%, 0.015%, 0.00625%, 0.003125%, 0.001562%, 0.000781%. Different concentrations of CCA were mixed in 2% MA media and then poured on sterilized Petri dishes. After solidification of the medium, the Petri dishes were inoculated separately with mycelial agar plug inocula of S. commune in an inverted position. The linear radial growth of fungal colony was measured in mm in two directions at right angle to each other after 2, 4 and 6 days respectively. The average radial growth of fungal colony for each treatment was calculated.

RESULTS AND DISCUSSION

A. Isolation of Fungi from D. sissoo and S. macrophylla Wood

The fungi were isolated from the selected wooden inocula taken from R1 position (outermost), R2, R3, R4 positions and R5 position (innermost wood) from D. sissoo and S. macrophylla posts. From the isolation three types of fungus A, B and C were reported as shown in Table 1. 250 wood samples were using for fungus isolation.

Table 1. Summary of yielding (%) of Fungus A, B and C

<table>
<thead>
<tr>
<th>Species</th>
<th>Position</th>
<th>MY*</th>
<th>MY (%) of fungus A</th>
<th>MY (%) of fungus B</th>
<th>MY (%) of fungus C</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. sissoo</td>
<td>R1</td>
<td>97.78</td>
<td>88.89</td>
<td>2.22</td>
<td>6.67</td>
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<tr>
<td>D. sissoo</td>
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<td>97.78</td>
<td>80.00</td>
<td>2.22</td>
<td>15.56</td>
</tr>
<tr>
<td>D. sissoo</td>
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<td>86.67</td>
<td>86.67</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>D. sissoo</td>
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<td>97.78</td>
<td>88.89</td>
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</tr>
<tr>
<td>D. sissoo</td>
<td>R5</td>
<td>95.56</td>
<td>86.67</td>
<td>4.44</td>
<td>4.44</td>
</tr>
<tr>
<td>S. macrophylla</td>
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<tr>
<td>S. macrophylla</td>
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<td>0.00</td>
</tr>
<tr>
<td>S. macrophylla</td>
<td>R5</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*MY= Mean Yield

Table 1 showed that isolation of fungus A was the most dominant in case of D. sissoo fence posts. There was no significant variation (P>0.05) in isolation of fungus A from R1, R2, R3, R4 and R5 zones of the wood discs. Very little isolation of this fungus was obtained from S. macrophylla wood discs. Fungus A was identified as S. commune as this fungus developed the typical fruit bodies from pure culture in Petri dishes in the laboratory.

The mean of isolation (%) of fungus A, B and C from inocula of D. sissoo and S. macrophylla wood discs are presented in the pie chart in Fig. 1 and 2. Fig. 1 shows most dominant isolation of fungus A (S. commune) from D. sissoo wood disc inocula. But in case of S. macrophylla fence posts did not yield any major fungus. Fungus A or B could not cause any remarkable decay to S. macrophylla fence post, but fungus A was most intricately and severely associated with the decay of D. sissoo fence posts under the same prevailing environmental conditions (atmospheric and soil) in which S. macrophylla fence posts were exposed.

B. Growth Performance of Fungus A, B and C at Different Temperatures

The results of diameter growth (in mm) of fungus A, B and C on 2% MA media at three different temperatures (i.e., 10°C, 30°C and 35°C) after 1, 2 and 3 days in the laboratory are shown in Table 2.

Table 2. Mean diameter growth of fungus A, B and C at different temperatures.

<table>
<thead>
<tr>
<th>Isolate No.</th>
<th>Days of incubation</th>
<th>Diameter growth (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10°C</td>
<td>30°C</td>
</tr>
<tr>
<td>Fungus A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>5.00</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>16.86</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>26.86</td>
</tr>
<tr>
<td>Fungus B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>5.83</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>22.00</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>36.33</td>
</tr>
<tr>
<td>Fungus C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>15.43</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>80.57</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>86.40</td>
</tr>
</tbody>
</table>

After 1 day’s incubation at 30°C and 35°C fungus A showed significant different diameter growth performance but after 2 day’s incubation it is not significant. Further after 3 day’s incubation it showed significant growth performance. The same trend was observed in diameter growth of fungus B. In case of Fungus C, after 1, 2 and 3 day’s incubation at 30°C and 35°C showed significant growth performance.

C. Weight Loss of the Attacked and Healthy Wood of D. sissoo and S. macrophylla

The weight loss (%) of healthy wood samples and attacked wood samples due to decay fungus, prominently S. commune, after one year use in outdoor situation as fence posts in Khulna University campus are shown in Table 3. Analysis of data presents that significant variation in weight loss was found in D. sissoo wooden posts due to S. commune. But in case of S. macrophylla there is no significant variation in weight loss. White rot fungi S. commune degraded the lignin of Syzygium cumini woods rather than the holocellulose component.

Fig. 1. Mean isolation (%) of fungus A, B and C from D. sissoo sample.

Fig. 2. Mean isolation (%) of fungus A, B and C from S. macrophylla sample.
whereas simultaneous degradation of lignin occurred in the case of *Mangifera indica*. Eight percent loss of holocellulose was caused by *S. commune* in Syzygium wood [9]. *Schizophyllum commune* invades woods primarily by growing through the lumen of vessels, tracheids, fibers and xylem rays. Adjacent parenchymatic cells in the xylem tissue are invaded via simple or bordered pits. As a consequence of this approach to invasion, cellulose, hemicellulose or pectin can serve as the primary carbon source for *S. commune* [10].

Table 3. Volume and weight relation of the fungal attacked and healthy wooden sample.

<table>
<thead>
<tr>
<th>Species</th>
<th>Sample type</th>
<th>Volume of the sample (v) in m³</th>
<th>Weight of sample/m² in kg.</th>
<th>Weight loss (%) due to wood decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. sissoo</td>
<td>Healthy</td>
<td>0.009</td>
<td>883.73</td>
<td>51.62</td>
</tr>
<tr>
<td></td>
<td>Attacked</td>
<td>0.012</td>
<td>427.56</td>
<td></td>
</tr>
<tr>
<td>S. macrophylla</td>
<td>Healthy</td>
<td>0.009</td>
<td>615.05</td>
<td>16.12</td>
</tr>
<tr>
<td></td>
<td>Attacked</td>
<td>0.010</td>
<td>516.16</td>
<td></td>
</tr>
</tbody>
</table>

**D. Growth Performance of *S. Commune***

Myceclial growth of *S. commune* on 2% MA media incorporated separately with nine concentrations (i.e. 0.2%, 0.1%, 0.05%, 0.25%, 0.15%, 0.00625%, 0.00312%, 0.00156% and 0.000781%) of CCA were tested in *vitro* in the laboratory. Five replicate agar plates for 2, 4 and 6 days for each concentration were taken. The diameter growths of *S. commune* on these concentrations of CCA are summarized in Table 4.

Table 4. Diameter growth of *S. commune* on 2% MA media with CCA preservative.

<table>
<thead>
<tr>
<th>Concentration (% of CCA on 2% MA media)</th>
<th>Mean dia. growth (mm) after 4 days</th>
<th>SD of 4 days growth</th>
<th>Mean dia. growth (mm) after 6 days</th>
<th>SD of 6 days growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.05</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.025</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.015</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.00625</td>
<td>0.00</td>
<td>0.00</td>
<td>3.60</td>
<td>3.36</td>
</tr>
<tr>
<td>0.00312</td>
<td>0.00</td>
<td>0.00</td>
<td>10.00</td>
<td>1.58</td>
</tr>
<tr>
<td>0.00156</td>
<td>5.00</td>
<td>2.92</td>
<td>17.00</td>
<td>1.22</td>
</tr>
<tr>
<td>0.000781</td>
<td>10.00</td>
<td>1.58</td>
<td>32.00</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Data provided in Table 4 reveal that 2% MA incorporated with 0.2%, 0.1%, 0.05%, 0.025% and 0.015% CCA did not yield any growth of *S. commune* up to 6 days of incubation, but on 0.00625%, 0.00312%, 0.00156% and 0.000781% CCA, growth of *S. commune* occurred to varying extents. It is therefore, suggested that treatment of *D. sissoo* fence posts with CCA preservatives at 0.015% concentration or slightly higher concentrations would be effective in controlling the attack of *S. commune* and thereby increasing the service life of such fence posts. Fungi exhibited problems in degrading wood impregnated with preservative. During 12 weeks wood exposed to different strains of *Artrodia vaillantii* lost maximum 3% mass. Exposure *Trametes versicolor* resulted in the same mass loss. But *S. commune* did not induce any mass changes [11].

**CONCLUSION**

In the study three major types of fungi were isolated, of which *S. commune* was the most dominant. *Schizophyllum commune* significantly degraded the fence posts. *Schizophyllum commune* was found to yield the best diameter growth on 2% MA media at around 35°C temperature. Method of mass propagation of the fungus *S. commune* should be developed for carrying out experiment to test the efficacy of CCA against this fungus.

**REFERENCE**

ABSTRACT

Extreme decrease in population of Persian Wild Ass (Equus hemionus onager) and the division of its previously connected population into two separated populations in Iran has led into the fact that this species has been regarded as Critically Endangered and thus needs an urgent action to prevent the process of extinction of this species. The present research aims to formulate a management strategy to conserve this species in Touran National Park. The major management tool is an analysis of strengths, weaknesses, opportunities, and threats (SWOT Matrix) and Quantitative Strategic Planning Matrix (QSPM) using qualitative and quantitative research methods. Information was collected from primary and secondary data and then they were analysed using various matrixes. According to the results, five important strategies should be considered for the conservation of this species: increasing the level of protection; training activities, involvement of stakeholders in protection, advocacy and prohibition of any habitat destruction by any livestock and camels.

INTRODUCTION

In the past, Persian Wild Ass could be easily seen in many plains in various provinces in Iran such as Khorassan, Semnan, Isfahan, Yazd, Kerman, Fars and Sistan-Baluchestan. Unfortunately, destruction of habitats, their decreased populations, habitat fragmentation and hunting have been among the major causes for the existing small and dispersed populations of Persian Wild Ass in a way that only two entirely separated populations are remained in Touran Biosphere Reserve in Semnan Province and Bahram-e Gour in Fars Province [1]. Based on these facts, this species has been considered to be a critically endangered species. Each of these two above-mentioned protected areas is encountered to numerous management and protection problems. For instance, drought and lack of enough water resources, overgrazing inside the habitats, insecurity caused by bandits and illegal hunting and so on, have made managers face various challenges in protecting the habitat and the remaining populations of this species [2–4]. That is why it is difficult to formulate an appropriate management strategy under the present circumstances. In other words, to formulate a strategy, much information is required regarding management issues such as opportunities, threats, weaknesses, and strengths, and its collection seems to be a difficult task due to scattered sources of information and lack of reliable information. Therefore, considering the need for a prompt action to prevent the extinction of this valuable species, the present study aims to formulate certain functional management strategies based on opportunities, threats, weaknesses and strengths in Touran protected area as one of the remaining regions for conservation of Persian Wild Ass.

The objectives of this paper are to identify strengths, weaknesses, opportunities and threats of the species as well as the studied region; and to identify participatory management strategies based on present situation of Persian Wild Ass and to increase the level of protection of this species in studied region.

METHODOLOGY

A. Study Area

Touran (the habitat of Persian Wild Ass) which is among the vastest protected areas in Iran covering an area of 1,464,992 hectares, between 35°00′– 36°25′N latitude and 55°00′–57°00′E longitude. Touran was announced as a Biosphere Reserve by UNESCO in 1977. Its central part was promoted to a National Park in 2002. The area enjoys a very special faunal and floral diversity [2, 5]. Based on the existing studies, 41 species of mammals, 167 species of birds, 42 species of reptiles, 2 species of amphibians and one species of fish have been found in Touran protected area and Wildlife Refuge [6].

B. Data collection

The present research was carried out through library and field studies, using questionnaires and semi-structured interviews, holding Focus Group Discussions (FGDs) in the selected villages to produce data and information to be used in SWOT matrix as well as QSPM. Management strategies were achieved through these various tools and methods and in three phases: A) identifying and evaluating the Internal Factors (IF) and External Factors (EF); B) data matching through SWOT matrix; and C) making decision through QSPM [7].

The main information needed to formulate strategies was determined. Then matrix of the internal factors evaluation (IFE) and the external factors evaluation (EFE) were used to give a better understanding of the involved factors. After identification of strengths and weaknesses that are the core content of any IFE and EFE matrix, a weight is assigned from 0.00 to 1.00 to every factor based on result of SWOT questionnaire. The sum of all weights must be 1.00. Rate is assigned from 1 to 4 to each factor. For the factor which represents a major weakness/threats (rating = 1), a minor weakness/threats (rating = 2), a minor strength/opportunities (rating = 3), or a major strength/opportunities (rating = 4). Weighted score is simply result of multiply of rate and weight. The sum of weighted score is IFE or EFE. Then various choices of strategies were analysed to select the best possible strategies [8–10].

One of the major sources of information was the people living around Touran protected area. From among the 50 villages located around Touran, eight villages had to be randomly selected as sample ones for filling in the questionnaires and holding FGD workshops. Then the villages were categorized based on five criteria of “possibility of illegal hunting in a village from people's point of view; number of livestock in a village; number of camels in a village; access to Persian Wild Ass habitat; and population of the village”. These classes were obtained through semi-structured interviews and FGD meetings. Participants were requested to give a weight to the classes, Then using Cochran formula, the sampling size (n) was calculated for the selected villages [11]. In this formula;

\[ n = \frac{t^2 pq}{d^2} \left(1 + \frac{1}{N} \left(\frac{t^2 pq}{d^2} - 1\right)\right) = 360 \]

Where,
\( t \): is the level of confidence (in this case, 95% equal to 1.96),
\( p \): is the percentage of the population having the attributes (here 0.36),
\( q \): is the percentage of the population not having the attributes (here 0.64),

\( d \): is the level of confidence (in this case, 95% equal to 1.96),
\( N \): is the population size (in this case, 360).
Table 1. IFE Matrix  (S=strength, W=weakness)

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weight</th>
<th>Rating</th>
<th>Weighted score</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Familiarity of people in Touran villages with the habitat of Persian Wild Ass</td>
<td>0.062</td>
<td>4</td>
<td>0.248</td>
</tr>
<tr>
<td>S2 Familiarity of people in Touran villages with the herbs and plants that Persian Wild Ass uses</td>
<td>0.062</td>
<td>3</td>
<td>0.186</td>
</tr>
<tr>
<td>S3 Awareness of people in Touran villages about the wild life of their own region</td>
<td>0.066</td>
<td>4</td>
<td>0.264</td>
</tr>
<tr>
<td>S4 DOE concerns for conservation of Persian Wild Ass</td>
<td>0.070</td>
<td>4</td>
<td>0.280</td>
</tr>
<tr>
<td>S5 Water springs and resources established by DOE in Touran Biosphere Reserve</td>
<td>0.066</td>
<td>3</td>
<td>0.198</td>
</tr>
<tr>
<td>S6 Local environmental groups in Touran villages</td>
<td>0.059</td>
<td>4</td>
<td>0.236</td>
</tr>
<tr>
<td>S7 Use of people’s participation in wild life conservation, especially Persian Wild Ass by DOE</td>
<td>0.062</td>
<td>4</td>
<td>0.248</td>
</tr>
<tr>
<td>S8 Existence of green local funds in Touran villages</td>
<td>0.052</td>
<td>3</td>
<td>0.156</td>
</tr>
</tbody>
</table>

Table 2 – EFE Matrix  (O=opportunity, T=threat)

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Weight</th>
<th>Rating</th>
<th>Weighted score</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1 Tourists’ visit to Touran Biosphere Reserve</td>
<td>0.066</td>
<td>3</td>
<td>0.198</td>
</tr>
<tr>
<td>O2 Profits of Persian Wild Ass for local people in Touran</td>
<td>0.052</td>
<td>3</td>
<td>0.156</td>
</tr>
<tr>
<td>O3 Student theses on Persian Wild Ass in Touran Biosphere Reserve</td>
<td>0.063</td>
<td>3</td>
<td>0.189</td>
</tr>
<tr>
<td>O4 Conservation of Asiatic Cheetah Project (CACP)</td>
<td>0.071</td>
<td>3</td>
<td>0.213</td>
</tr>
<tr>
<td>O5 Research projects on training of local communities in Touran Biosphere Reserve</td>
<td>0.063</td>
<td>4</td>
<td>0.252</td>
</tr>
<tr>
<td>O6 International Organizations interest in supporting projects in Touran Biosphere Reserve</td>
<td>0.058</td>
<td>4</td>
<td>0.232</td>
</tr>
<tr>
<td>O7 Environmental Laws for Conservation of Persian Wild Ass</td>
<td>0.058</td>
<td>3</td>
<td>0.174</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threats</th>
<th>Weight</th>
<th>Rating</th>
<th>Weighted score</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Drought and decreased water resources during recent years</td>
<td>0.075</td>
<td>1</td>
<td>0.075</td>
</tr>
<tr>
<td>T2 Livestock overgrazing in Touran Biosphere Reserve</td>
<td>0.069</td>
<td>1</td>
<td>0.069</td>
</tr>
<tr>
<td>T3 Camels overgrazing in Touran Biosphere Reserve</td>
<td>0.071</td>
<td>1</td>
<td>0.071</td>
</tr>
<tr>
<td>T4 Livestock owners moving within Touran Biosphere Reserve</td>
<td>0.048</td>
<td>2</td>
<td>0.096</td>
</tr>
<tr>
<td>T5 Drug traffickers moving within Touran Biosphere Reserve (and Persian Wild Ass hunting by them)</td>
<td>0.057</td>
<td>2</td>
<td>0.114</td>
</tr>
<tr>
<td>T6 Hunters of Persian Wild Ass</td>
<td>0.070</td>
<td>1</td>
<td>0.070</td>
</tr>
<tr>
<td>T7 Superstitions about Persian Wild Ass among villagers in Touran</td>
<td>0.047</td>
<td>2</td>
<td>0.094</td>
</tr>
<tr>
<td>T8 Hunting of Persian Wild Ass by shooting or using motorcycles</td>
<td>0.065</td>
<td>2</td>
<td>0.130</td>
</tr>
<tr>
<td>T9 Professional equipment of hunters and law-breakers</td>
<td>0.072</td>
<td>2</td>
<td>0.144</td>
</tr>
</tbody>
</table>

\[d:\] is deduction of real proportion of the attributes to estimated size by the researcher which is here five per cent (0.05),

\[N:\] is the percentage of the whole population (that is equal to 0.36).

RESULTS AND DISCUSSION

Internal and external factors were listed through interviews with the experts of the Department of Environment (DOE) as well as villagers and based on the results of 360 questionnaires. These factors acted as input information for SWOT matrix. A study of the internal factors led into eight strengths and eight weaknesses. Based on the internal factors, IFE matrix was formulated (Table 1). According to Table 1, IFE calculation is 2.542. To evaluate the external factors, opportunities and threats were first discussed and listed in Table 2. Based on the external factors, EFE matrix was formulated (Table 2).

According to the Table 2, EEF is calculated as 2.277 and a review of the IFE and EFE for conservation of Persian Wild Ass in Touran reveals that strengths dominate weaknesses (since IFE is bigger than 2.5) and threats dominate opportunities since EFE is less than 2.5 [10, 12]. It shows that there is enough potential within Touran to conserve Persian Wild Ass, however the threats such as hunters or lack of water resources are so powerful. The SWOT matrix was shaped at this phase based on a comparison of the internal and external factors to generate strategies. This phase was done in a participatory workshop in Biarjomand with participation of local groups, people from villages and experts from related governmental bodies and non-governmental organizations. Sixteen strategies (St) were proposed as follow:

St1: Strengthening of tourism among local people and their involvement as eco-tourism guides
St2: Strengthening of local groups for offering necessary trainings on eco-tourism
St3: Raising awareness of local people in conservation of wildlife especially Persian Wild Ass by the environmental local groups in Touran

St4: Strengthening of local groups for offering necessary trainings on eco-tourism
St5: Strengthening of local groups for offering necessary trainings on eco-tourism
St6: Strengthening of local groups for offering necessary trainings on eco-tourism
St7: Strengthening of local groups for offering necessary trainings on eco-tourism
St8: Strengthening of local groups for offering necessary trainings on eco-tourism
St9: Strengthening of local groups for offering necessary trainings on eco-tourism
St10: Strengthening of local groups for offering necessary trainings on eco-tourism
St11: Strengthening of local groups for offering necessary trainings on eco-tourism
St12: Strengthening of local groups for offering necessary trainings on eco-tourism
St13: Strengthening of local groups for offering necessary trainings on eco-tourism
St14: Strengthening of local groups for offering necessary trainings on eco-tourism
St15: Strengthening of local groups for offering necessary trainings on eco-tourism
St16: Strengthening of local groups for offering necessary trainings on eco-tourism
St4: Facilitation of implementing international projects by local people to conserve Persian Wild Ass in Touran
St5: Supporting student theses at masters and PhD levels on the related issues
St6: Increase of access to water resources in Touran for the wild life especially for Persian Wild Ass
St7: Increase of conservation level of Persian Wild Ass through capacity building of human resources and conservation equipment
St8: Formulation of pasture management strategies in Touran Biosphere Reserve
St9: Formulation of a plan for participatory management of pastures in cooperation with local people in Touran
St10: Advocacy for involving international organizations for implementing projects to conserve Persian Wild Ass in Touran
St11: Training of owners of livestock and camels on conservation issues in Touran
St12: Strengthening of game guards and police cooperation in dealing with illegal hunters and offenders
St13: Involvement of people and members of local groups as honorary game guards
St14: Formulation of water resources management plan in Touran
St15: Legislation of new laws in dealing with hunters of Persian Wild Ass including cash penalties and preventive punishments
St16: Prevention of livestock and camels entrance by local people to habitats of Persian Wild Ass.

The Quantitative Strategic Planning Matrix (QSPM) was used to prioritize strategies; to do that, quadric factors (strength, weaknesses, opportunities and threats) from IFE and EFE matrices were extracted [8,9]. A score from 1 to 4 was allocated to each factor. If a factor had not any important role in strategy selection process, it would not receive any score. In the next step, sum of attractiveness of each strategy was computed. When strategies were sorted based on their importance, they were categorized in three significant groups of “important”, “less important” and “weak” strategies. The important five strategies accordingly (St7, St11, St13, St10 and St16) were selected as the most important management strategies for Touran Biosphere Reserve to conserve Persian Wild Ass [15].

Based on the key strategies, an increase in protection level of Persian Wild Ass through capacity building of the human resources and conservation equipment is the first strategy to be adopted; this is very urgent since the population of Persian Wild Ass is severely decreasing. Also, training of the owners of livestock and camels in Touran is of the second importance since if they know well about the importance of Wild Asses, their habitat and behaviour, then there is the possibility that they may change their behaviour, especially if the drought continues to happen. In this case, they would cooperate in guiding the cattle to be out of the protected area. Moreover, there is a need for a participatory management plan of Touran pastures; that’s to pave the way for people to have more ownership on Touran and its Wild Asses.

It seems that people’s participation, especially local groups’ involvement as honorary game guards is also much necessary. In fact, people have to feel that they are the real owners of Wild Asses. In other words, the local people should consider Wild Asses as a unique natural heritage of Touran which not only belongs to them but to their children too. They should not think that Wild Asses are properties of the DOE. Such feeling of pride among local people will result in an effective conservation of environment and change in their own life style.

The fourth strategy is an advocacy for international organizations to implement projects of Persian Wild Ass protection. Unfortunately, no action has been taken yet. It seems that the DOE as a responsible body for conservation of biodiversity in Iran should pay more attention to this strategy. Camels and livestock should not enter in the protected areas and this would happen only if people are trained while they have to be able to benefit from the region too. That is why certain functional solutions are needed to decrease the existing tensions between conservation management and people’s life.

CONCLUSION

According to the results of this study, drought, lack of enough water resources, overgrazing inside the habitats, insecurity caused by bandits and illegal hunting are the weaknesses and threats. For protection of Persian Wild Ass and prevention of reducing its population in Iran, an inclusive approach with a focus on the participation of all stakeholders should be adopted.

Based on strength, weaknesses, opportunities and threats points, 16 management strategies were planned which among of them four out of five main ones are related to capacity building, participation and involvement of different groups of stakeholders in the process of the conservation of this species. The main idea in this process is that, it would be a mutual process in which the trend of Persian Wild Ass extinction will be controlled and at the same time stakeholders, especially community members and local groups, will be empowered and take responsibility of the conservation of their habitat and its biodiversity in a sustainable way [14].

REFERENCE


62
Ontogenetic Development of Climbing Perch, Anabas testudineus

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ABSTRACT
An experiment on the ontogenetic development of climbing perch, Anabas testudineus was studied under laboratory conditions at Field Laboratory Complex and Wet Laboratory of the Dept. of Fisheries Management, Bangladesh Agricultural University. The sperms and eggs were collected from males and females by administration of pituitary gland extracts at the doses of 2 and 6mg/kg body weight respectively. The fertilized eggs were adhesive, transparent and floating with a diameter ranged of 0.7±0.01mm and were incubated in hatching tray. After 15min of fertilization, first cleavage was observed at the temperature ranged of 28±1°C. Hatching started 18.5hr post-fertilization and continued for 2hr at the same temperature. The newly hatched larvae were slender, straight and semi-transparent with an average length of 1.9mm. Larvae started first feeding 48-60hr post-hatching. When the larvae was 5.5mm, yolk sac was absorbed completely. Thus the findings provide valuable information for establishing the culture techniques of A. testudineus.

INTRODUCTION
Presently, aquaculture practices have increased dramatically to meet the protein demand of the increasing population in Bangladesh. Major culturable fish species in Bangladesh are Indian major carps, Chinese carps, common carps and tilapias. But more indigenous fish species should be cultured to ensure the sustainability of the aquaculture industry. Indigenous koi has the potentiality to habituate this fish in aquaculture system. Koi is a tasty and nutritionally rich fish fetching comparatively high price in the market. It contains high amount of physiologically available iron and copper essential for haemoglobin synthesis [1] and considered as a valuable item of diet for sick and convalescents [2]. During the last few years natural fish population has been declining rapidly due to ecological changes of the breeding ground. 54 fish species of inland water are in endangered to critically endangered situation [3]. Like other endangered species, there is possibility of extinction of koi if there are no steps like induced breeding and culture practices are taken immediately. There are no reports or information on the early development of this species. The aim of the present research works was to investigate and to provide detailed information of various stages of embryonic and larval development A. testudineus.

MATERIALS AND METHODS
Healthy broods were collected from the nature and stocked in the earthen pond fed with high protein content (35%) artificial feed at the rate of 4-5% body weight. During breeding season both male and female fishes were induced to breed at the PG dose of 2 and 6mg/kg body weight respectively. Eggs and sperms from female and male were stripped upon ovulation into plastic bowl and mixed thoroughly by using clean and soft feather. The fertilized eggs were incubated in the hatching tray at 28±1°C temperature with continuous water supply. The fertilized egg samples were collected randomly from the hatching tray to study the embryonic developmental stages of A. testudineus at every 15 minutes, 30 minutes and 1 hour interval till completion of morula, gastrula and hatching stages respectively. The egg samples were taken in absolute distilled water for immediate study and in 5% formalin for further study. At least 10 eggs undergoing embryonic developmental process were observed to obtain precise information about developmental stages. In case of larval development study, at least five larval samples were collected from the hatching tank. Initially samples were collected at every four hour and then only once a day until metamorphosis. The early developmental stages were observed by digital microscope (Olympus CX 41) and their image was taken by using Camera (Magnus analyitics, Model-MIPS) fixed on a digital microscope. The diameter of the eggs was measured by using an eye piece micrometer and graph paper was used to measure the length of the larvae [4].

RESULTS AND DISCUSSION
A. Embryonic Development
The unfertilized eggs of A. testudineus were transparent, spherical and brownish in colour measuring 0.6±0.01mm diameter (Fig. 1A). While the fertilized eggs were found adhesive, sticky, floating and brownish-yellow in colour with a diameter of 0.7±0.0mm (Fig. 1B). Adhesiveness of eggs is the special character found in some catfishes and carps such as Claries gariepinus [5], Mystus montanus [6], Pangasius shutia [7] and Cyprinus carpio [8]. Due to the adhesiveness of the egg, they adhered to the substratum. Ten minutes post-fertilization, fertilized eggs were characterized by reddish spot (blastodisc) at the animal pole (Fig. 1C).

B. Cleavage Stages
The first cleavage occurred within 15min post-fertilization at 28±1°C temperature that divides the blastodisc into two equal blastomeres (Fig. 1D). Second cleavage (4 cells) was observed after 30min fertilization and third cleavage (8 cells) was appeared within 45min post-fertilization at the same temperature range (Fig. 1E and 1F). The fourth (16 cells) and fifth (32 cells) cleavages reached after 1hr and 1.25hr of fertilization. In case of N. nandus, the same series of stages appeared after 31, 50, 70 and 95min of fertilization respectively [9] and in case of Labeo bata, these stages were appeared after 40, 55, 1.20 and 1.50min of fertilization respectively [10], a relative species of the experimental fish. The blastomeres after repeated cleavages resulted into early morula stage (64 cells) were recorded at 1.50hr after fertilization (Fig. 1G). Subsequently the blastodermal cells (128-256 blastomeres) became smaller than those of the previous stages and the number of marginal cells was increased. This was the late morula stage observed within 1.75hr after fertilization.

After 2.25-2.50hr of fertilization, flattening of the cellular material occurred and the embryo attained the blastula stage (Fig. 1H and 1I). Following the late blastula stage, after 2.75hr of fertilization the blastoderm was flattened down onto the yolk sphere resulted a dome shape structure (Fig. 1J). 3.00hr of post-fertilization, the blastoderm was begun to expand (30% epiboly, Fig. 1K) over the surface of the yolk sphere and epiboly was progressively advanced and within 3.50-4.0hr after fertilization, about ½ of the yolk sphere was covered by the blastoderm (Fig. 1L). At the late stage of gastrulation, about 75% of the yolk was covered with the blastoderm and embryonic
Fig. 1. Developmental stages *Anabas testudineus*.
(A) Unfertilized egg, (B) Fertilized egg (C) Blastodisc stage, (D) 2-Cell stage, (E) 4-Cell stage, (F) 8-Cell stage, (G) Early morula stage, (H) Early blastula stage and (I) Late blastula stage (J) Dome stage, (K) 30% Epiboly stage, (L) 50% Epiboly stage, (M) Germ ring stage (N) Shield stage (O) 75% Epiboly stage, (P) 90% Epiboly stage and (Q) Bud stage.

Fig. 2. Developmental stages *Anabas testudineus*.
(A) 2 somite stage, (B) 4 somite stage, (C) 6 somite stage, (D) 8 somite stage, (E) 10 somite stage, (F) 12 somite stage, (G) 14 somite stage, (H) 15 somite stage, (I) 19 somite stage, (J) 23 somite stage, (K) Prim-5 stage, (L) Prim-15 stage, (M) Prim-25 stage (side view), (M) Prim-25 stage (ventral view), (N) High-pec stage, (O) Advanced high-pec stage, and (P) Just before hatching.

Fig. 3. Developmental stages *Anabas testudineus*.
(A) 0-hr old larva, (B) 6-hour old larva, (C) 1-day old larva, (D) 2-days old larva, (E) 3-days old larva, (F) 4-days old larva, (G) 6-days old post larva, (H) 7-days old post larva, (I) 8-days old post larva, (J) 9-days old post larva, (K) 10-days old post larva and (L) 12-days old post larva.
shields became less distinctive (Fig. 1M, 1N, 1O). 5.50hr after fertilization, the yolk sphere was nearly covered (90% of the yolk) by thin blastoderm leaving small area around the vegetal pole (Fig. 1P). 5 and 8.11hr are required to reach the morula and gastrula stages in Nandus nandus [9] proved that A. testudineus has short embryonic period and fast development. The head (rudimentary brain) was recognized anteriorly in the distinct embryonic body. Within 6.0hr post-fertilization, a solid optic bud (rudimentary eye vesicle) was appeared on each side of the cephalic end and a blastopore at the vegetal pole was formed with a small part of the yolk sphere (Fig. 1Q).

C. Segmentation stages

The first somatic furrow was formed after completion of epiboly and the blastopore was completely closed. At the end of the 3 somite stage, two slight knobs were recognized behind the optic vesicles. In 4 somite stage, a paired placode of otic (auditory) vesicles was appeared at the posterior region of the head and three parts of the brain (the fore-, the mid-, the hind-brain) were discernible. These stages were observed from 7.50 to 9.50hr after fertilization (Fig. 2A and 2B). Within 9.50-11.50hr of fertilization, small otic vesicles were appeared but they were lack of otolith and three regions of the brain were well defined and the neural fold (neurocoele) were seen as a median line along the body (Fig. 2C). In 8 somatic stage, tubular heart (heart anlage) was appeared underneath the head from the posterior end of the mid-brain to the anterior end of the hind-brain (Fig. 2D). At the beginning of 10 somite stage, the body cavity was extended further toward posterior end of eye vesicles (Fig. 2E) and a pair of semi-circular Cuvierian ducts (12 somatic stage) was observed (Fig. 2F) and at the end of 14 somite stage, spherical optic lenses were completed within 11.50-13.00hr post fertilization (Fig. 2G). After 13.0-14.50hr of fertilization, in 15-19 somite stages, Kupffers vesicles were disappeared completely and tail was completely free from the yolk sphere (Fig. 2H and 2I). In 23 somite stage, pectoral fin bud and melanophores were developed. At the same time vacuolization of the notochord occurred within 15.0hr post-fertilization (Fig. 2J).

D. Pharyngula Stages

Distinct kidneys and air bladder formed at prim-5stage within 15.50hr post-fertilization. At this stage notochord was completely vacuolated to the end of the tail (Fig. 2K). At prim-15 stage, blood vessels formed completely and blood circulation was begun through the internal tissues of the head and the viscera to Coviers ducts after 16.50hr of fertilization (Fig. 2L). With the progress of ontogenic development, embryo reached the prim-25 stage with the formation of heart and pericardial cavity within 17.50hr post-fertilization (Fig. 2M). At the end of the pharyngula stages, spleen was recognized as a small reddish globule dorsal to gut tube beneath left region of the 3rd–4th somites. A large well-developed gall bladder was identified and both eyes moved actively (Fig. 2N and 2O). Hatching started 18.50hr post-fertilization and lasted for 2hr. Whereas, in Tilapia nilotica, 3 days is required for hatching out of embryo [11]. The same stage reached within 20.30hr post-fertilization in case of O. pabda [12]. The development of embryo and the variability of hatching time of fertilized eggs of most fishes are generally influenced by the water temperature [13]. Before hatching, larvae started twisting movement inside the egg shell and continuously beat the egg shell and finally emerged as a newly hatched larva (Fig. 2P).

E. Larval and Post-larval Development

The newly hatched larva was slender, straight and semi-transparent with average length of 1.9mm (Fig. 3A). Six hour old larva had more pigmentation and membranous median fin and tail were developed (Fig. 3B). One-day-old larval mouth was elliptical in shape and inferior in position. Gill was appeared in the form of comb and the supply of yolk was diminished gradually. Pectoral fins were paddle shaped and the movements of pectoral fins were marked (Fig. 3C). Two days after hatching, the larva was 2.7mm in length, yolk sac was reduced to half size and becoming more and more transparent. The brain formed completely and continuous heart beat was visible. Mouth turned in terminal position (Fig. 3D). The larva started feeding 48-60hr after hatching. N. nandus larvae started feeding within 56hr post-fertilization [9], which strongly supports the findings of this experiment. The length of the three days old larva was about 3.5mm and the mouth gap was quite large. The head was broadened than body and became round in shape (Fig. 3E).

Yolk sac was absorbed completely when the post-larva was six days old. 7.5 days old larva showed complete yolk absorption in O. niloticus at 26°C [14], which strongly supports the findings of this experiment. Fin rays (9-12) were developed in the pectoral fin, while only rudiments in other fins were observed. Segmentation was appeared on the notochord (Fig. 3G). The ten days post-larva was about 9 mm in length. At this stage scales started to appear on the body and the larva lost its transparency. The pelvic and pectoral fins were become elongated (Fig. 3K). The length of 15 days post-larva was increased to 15mm. The fry or larva started to engulf air at the water surface between 11 to 13 days (Fig. 3L) and 15 days old larva was habituated air breather. Superbranchial chambers were developed in the form of pharyngeal pouches over the gills and the labyrinth organ was developed on the first epibranchial. Average water quality parameters such as temperature, dissolved oxygen and pH were 28°C, 9.5ppm and 6.9 respectively.

CONCLUSION

The findings of the present work provide information on the early life history and first feeding time for larval rearing. This study will help to enrich the knowledge of biology and ecology of the fish, which also might be helpful to take measure for sustainable development of culture or management technology of A. testudineus. Besides these, it may helpful to protect the species from being extinct.

ACKNOWLEDGEMENT

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REFERENCE


Climate induced changes of precipitation extremes over Bangladesh

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INTRODUCTION

Bangladesh is well known for its natural disasters such as cyclone, storm surges, floods, droughts and river erosions. Precipitation is the major meteorological variable which plays a significant role in the hydrological cycles as well as these extreme climatic events. Under the greenhouse warming condition, extreme daily precipitation will be increasing despite the decrease of mean precipitation. According to Wasimi, climate change has profound impact on rainfall intensity and variability [1]. Global climate models showed that global warming will increase the intensity of extreme precipitation events [2]. Alexander et al. [3] has shown that observed trends of extremes in precipitation is increasing globally and consequently the heavy precipitation indices are increasing. A recent study shows that extreme rainfall events over Central India during the summer monsoon period, 1951–2002 has significantly rising i the frequency and magnitude of extreme rain events [4]. Rajendra et al. [5] has found that increasing trends of frequency and intensity of heavy precipitation events over India using regional climate model at the end of 21st century. Considering the results of the above studies, this paper investigated changes of extreme precipitation events using the future climate change projections over Bangladesh.

MATERIALS AND METHODS

A. Study Area

Bangladesh is located between 20°34'N and 26°33'N latitudes and 88°01'E and 92°41'E longitudes; and bounded by India in the west, north and east, Mayanmar in the southeast, and the Bay of Bengal in the south. Bangladesh is a flood plain delta of the three major rivers: the Ganges, the Brahmaputra and the Meghna which meet inside Bangladesh before discharging to the Bay of Bengal through a single outfall. Most of Bangladesh consists of extremely low and flat land with elevation ranges between 1 and 5 meters. Coastal areas in the southern parts of the country are prone to cyclonic and storm surge hazards. Drought has been found in the north-west parts of the country. Every year roughly 25% of the area has been normally flooded from the spills of three major rivers during the monsoon season. Flash floods are normally occurred in the premonsoon (MAM) seasons in the northeast parts of the country. Changes of precipitation patterns will change the intensity and frequency of these natural hazards and extreme events which can cause major catastrophes.

B. Regional Climate Model output

PRECIS (Providing Regional Climate for Impact Studies) developed by the Hadley Centre of the UK Meteorological Office is used in this study. PRECIS was developed to generate high-resolution climate change information for as many regions of the world as possible. RCMs are full climate models and physically based. The PRECIS RCM is based on the atmospheric component of the HadCM3 climate model [6]. In this study, PRECIS model domain for South Asia has been set up to determine climate change impact over Bangladesh with a horizontal resolution of 30x50 km. This domain approximately stretched over latitudes 3.5°-36.2° N and longitudes 65.8°-103.3° E and has 88x88 grid points (Fig. 1). This domain allows full development of internal mesoscale circulation and regional forcings at the regional level. The SRES A1B scenario of IPCC was used to derive the lateral boundary conditions of the simulation using three dimensional ocean-atmospheric coupled model (HadCM3Q) to generate diagnostic variables over the simulated domains over the Indian subcontinent which includes Bangladesh [7].
then again increased for 2050s and 2080s time slices. Pre-monsoon (March to May) precipitation also follows same trends as winter precipitation. However, monsoon (June to September) and post monsoon (October to November) precipitation will constantly increase in all three future time slices. Variability of the monsoon precipitation will be much higher in future than other seasons of the year. At the end of 21st century, mean monsoon precipitation will be increased about 23% from the present condition (1980s) and variability will be increased about 70% (212mm).

The spatial patterns of changes of seasonal one day maximum precipitation, RX1 as simulated by PRECIS for the future time slices of 2050s and 2080s from the baseline period are shown in Fig. 2 and Fig. 3, respectively. During premonsoon season, precipitation will increase in the northern parts of the country than the central and south. However, during monsoon and post monsoon seasons, there will be mixed pattern of changes of seasonal one day maximum precipitation for 2050s. However, changes of one day maximum precipitation will be observed all over the country during monsoon season for 2080s. During the post monsoon season for 2080s, increase of one day maximum precipitation will be found in the northern parts and Haor areas of the country.

Spatial patterns of changes of days when precipitation is more than 20 mm over Bangladesh for three future time slices are shown in Fig. 3. Frequency of heavy precipitation (>20mm) shows increasing trends in future time slices in the northern parts of the country. However, these increasing trends will be observed during the monsoon season. Days of heavy precipitation will be increasing more for 2080s than for 2050s and 2020s. Heavy precipitation will be more frequent in the greater Rangpur areas and Haor areas of Bangladesh.

Probability distribution functions (PDFs) are calculated for indices of precipitation extremes for baseline, and three future time slices. Fig. 5 shows the PDFs for (1) daily intensity (SDII, mm/rainy days); (2) five-day maximum precipitation (RX5, day, mm); (3) count of days when rainfall exceeds 20mm (R20mm, days) and (4) maximum spell of continuous wet days (CWD, days) for baseline and three future time slices, respectively.

Table 1: List of Indices used in the study

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>R20mm</td>
<td>Frequencies in days</td>
<td>Number of days with precipitation &gt; 20mm</td>
</tr>
<tr>
<td>R99p</td>
<td>Frequencies in mm</td>
<td>Extremely wet days due to heavy precipitation event exceeding 95%</td>
</tr>
<tr>
<td>R99p</td>
<td>Frequencies in mm</td>
<td>Very wet days due to heavy precipitation event exceeding 99%</td>
</tr>
<tr>
<td>RX1day</td>
<td>Intensity in mm</td>
<td>One-day maximum precipitation</td>
</tr>
<tr>
<td>RX5day</td>
<td>Intensity in mm</td>
<td>Five-day maximum precipitation</td>
</tr>
<tr>
<td>CDD</td>
<td>Longest spell in days</td>
<td>Consecutive dry days when precipitation &lt; 1mm</td>
</tr>
<tr>
<td>CWD</td>
<td>Longest spell in days</td>
<td>Consecutive wet days when precipitation &gt; 1mm</td>
</tr>
<tr>
<td>SDII</td>
<td>Daily intensity</td>
<td>Simple Daily Intensity index in mm/rainy days</td>
</tr>
</tbody>
</table>

Table 2. Simulated seasonal and annual rainfall of Bangladesh for baseline and three future time-slices.

<table>
<thead>
<tr>
<th>Years</th>
<th>DJF</th>
<th>MAM</th>
<th>JJAS</th>
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<th>Annual</th>
<th>DJF</th>
<th>MAM</th>
<th>JJAS</th>
<th>ON</th>
<th>Annual</th>
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<td>276</td>
<td>918</td>
<td>91</td>
<td>1337</td>
<td>35</td>
<td>114</td>
<td>131</td>
<td>50</td>
<td>141</td>
</tr>
<tr>
<td>2020s</td>
<td>44</td>
<td>229</td>
<td>962</td>
<td>112</td>
<td>1347</td>
<td>28</td>
<td>107</td>
<td>159</td>
<td>51</td>
<td>223</td>
</tr>
<tr>
<td>2050s</td>
<td>84</td>
<td>288</td>
<td>1012</td>
<td>98</td>
<td>1481</td>
<td>70</td>
<td>130</td>
<td>149</td>
<td>48</td>
<td>257</td>
</tr>
<tr>
<td>2080s</td>
<td>67</td>
<td>279</td>
<td>1130</td>
<td>125</td>
<td>1602</td>
<td>42</td>
<td>144</td>
<td>222</td>
<td>65</td>
<td>289</td>
</tr>
</tbody>
</table>
Fig. 3. Spatial pattern of changes of one day maximum precipitation (RX1) over Bangladesh during pre-monsoon, monsoon and post-monsoon seasons for 2080s from the baseline year 1980s, respectively (from left).

Fig. 4. Spatial distribution of changes of days when precipitation is more than 20 mm over Bangladesh for future time slices of 2020s, 2050s and 2080s from baseline year 1980s, respectively (from left).

Fig. 5. Probability distribution functions (PDFs) of daily intensity (mm/rainy days), Five days rainfall (mm), number of days when rainfall > 20 mm, and consecutive wet days over Bangladesh.
CONCLUSION

Changes of intensity, duration and frequency of the precipitation extremes are examined through a number of widely used indicators. Using results from regional climate models, future changes of extreme climate event has been quantified which would have profound impacts on human society, natural resources, and ecosystem. It has been found in general, that intensity and frequency of extreme events will be increasing. Monsoon precipitation exhibits increasing trends which is an indication towards the wetter climate, with notable increases in summer monsoon precipitation extremes.

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REFERENCE

Rural Households Motivating to Biogas Technology in Bangladesh: Perspective of Environmental and Financial Issues

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ABSTRACT
Bangladesh is already threatened to regenerating limit of biomass below exist compare to its demand. Biogas produced from biomass under anaerobic condition could have played a role to mitigate the existing energy crisis and environmental degradation. The paper estimates environmental factors as well as economic, social and technological factors for adopting the biogas users in Bangladesh. Cross section data have used to estimate the relationship between adoption procedure and partial budgeting, and two- sample mean t-test has applied for statistical mean differences of various factors. The result found comparison to mean value of environment and economic factors have no statistical difference, but compare to social and technological factors have meaningful statistical difference for considering the adoption of biogas plants. Partial budgeting approach estimates the net change value is positive (21645.66 Taka per plant) means of biogas technology is a profitable business considering of economic and social issues.

INTRODUCTION
Biogas is a renewable form of energy, could supplement conventional energy sources. It is produced by anaerobic fermentation with consists of methane between 40% and 70%, the remaining being mostly CO₂, hydrogen sulphide and others trace gases. About 16 million family size domestic biogas plants are functioning across the world. Successful use of biogas technology is the result of not only gas production and bio-fertilizer production but also other environmental and social benefits including sanitation, reforestation and reduction of imported fuel oil. Smoke-free indoor cooking systems attract to the rural people for reducing ocular and respiratory infections and they lead to diminishing the family expenditures. It has a growing popularity across the country in Bangladesh where about forty thousand small scale biogas plants are functioning since 1972 and contribute to national economy.

Environment-friendly bioenergy production could be an instrument for rescuing the existing energy problem of Bangladesh where having potentials of fulfillment by 10 percent of total energy. About 60% of total energy consumption of the country is being met from biomass. The government targets of electricity generation by renewable energy technologies (RETs) are 5% of the total power generation by 2015 and 10% by 2020. Government has actively participated through subsidy distribution to the biogas users extending over the country.

Researchers have been conducting various studies of biogas plants in developing countries. Various advantages and few obstacles by using the gas have been mentioned, as have been positive externalities, opportunities and constraints, socioeconomic impact in rural area and the estimated costs and benefits. But, former research has not emphasized which motivating factors rural people have for taking the decision on plant implementation with considering the partial budgeting in developing countries.

The present study attempts to determine key factors influencing biogas adoption in rural areas in Bangladesh and to estimate the partial budgeting of new biogas plants. The research will emphasize environmental impact as well as financial issues in relation to biogas plants.

This paper at first intends to study the previous findings in relation to find the importance of biogas technology and second section covers the materials and methods. Result and conclusion with policy recommendations are in the final part of this paper.

MATERIALS AND METHODS
This study based on a survey conducted period of June to September 2011. Primary data collected from 150 households. Purposive stratified random sampling technique has applied due to the number of biogas users in comparison to total number of households was rather smaller in the sample areas.

The motivating factors divided into four major groups including environment, economic, technical and social issues. Partial budgeting approach useful for estimating the net effect of biogas implementation. Partial budgeting has four basic parts like increase income, reduction of costs, increase in costs and reduction of income. It has two groups including i) added income plus reduced cost and ii) added cost plus reduced income. Added income consists of additional earning income from using the savings time to other income activities and value of bio-slurry. Added costs consist of labour cost for regular use the raw materials, construction costs, interest, cow dung cost and maintenance cost. Reduced costs include save money from disease, less cost for alternative traditional fuel and chemical fertilizer cost and finally, it has not been found any activities reduce income for using of biogas technology.

Empirical Model: Two sample mean test has used for showing the statistically meaningful differences among the four major factors.

The null hypothesis $H_0$: $\mu(X) = \mu(Y)$ and the alternative hypothesis $H_1$: $\mu(X) \neq \mu(Y)$

$t statistic = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{n_1} + \frac{S^2}{n_2}}}$ with (n-2) d.f......(1)

Where $\mu(X)$ and $\mu(Y)$ are respectively the population mean of the two populations from which two sample have been drawn. $X$ presents only environmental issues and $Y$ will be used three factors including financial followed by social and technological issues. $S$ and $n$ denotes standard error and number of sample size. Stata 10.1 applied to calculate the statistical significant level in this paper.

RESULTS AND DISCUSSION
The main substrate of biogas plants was cow dung collected from grazing animals normally used into the agricultural field instead of burned as fuel. Farmers are in dire need of fertilizer for maintaining agricultural production as well bio-slurry organic fertilizer is eight times as high as the same quantity of chemical fertilizer as well as slurry has better manorial values as compare to the raw animal waste Biogas team. Table 2.1 state that about 60% of sample farmers under environmental issue were considered the plant adoption in order to soil fertility preserve.

Greenhouse often forms from deforestation as well methane (CH₄) is the another source of greenhouse, though it is a minor by-product of burning coal and also comes from venting of natural gases as well as realize from the animal dung left in the field. The biogas burning provides clean and smoke free domestic fuel and alternatively, bio-slurry reduces the demand of chemical fertilizer assist to improve ecological friendly
farming system. The twofold benefits of the production of environmentally caring fuel and manure from the domestic farm animal is lost by either directly burning the same dung in the form of dried dung cakes or alternatively using it directly for producing organic manure creating the negative environmental impact [10].

The following Table 1 presents that 62% people were motivated to adoption of biogas with protection of deforestation.

Table 1. Motivating factors of biogas adoption in Bangladesh.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Motivating factors (percent)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>Subsidy (60), Credit (48), Economic benefit (58), No. of livestock (69)</td>
<td>59</td>
</tr>
<tr>
<td>Social</td>
<td>Neighbours plant owners (58), NGOs (47), Advertisement (0), Local Government (0),</td>
<td>24</td>
</tr>
<tr>
<td>Technological</td>
<td>Time and energy savings(62), Fuel shortage (28), Service providers (6), Training (4)</td>
<td>26</td>
</tr>
<tr>
<td>Environmental</td>
<td>Health benefit(66), Forestation (62%), Soil fertility (60)</td>
<td>63</td>
</tr>
</tbody>
</table>

It seems to clear that rural people mostly motivating and considering environmental factors by 63 percent for implementing the biogas plant.

Good health is an acute part of well-functioning of economic development process. Biogas technology is producing the clean gas that makes the people with good health. Many hazardous incidences have been occurring by the burning of dung cakes, agricultural residues, firewood, etc. Since primitive age, women are used to cooking indoor tend to several health problems. These particles from the smoke create few respiratory diseases that are contact to the cooking as well as eye infections. An important issues that identified by uses having the traditional cooking system increased the child mortality [13].

Usually, unmanaged cowdung is widely spread in the soil and it form few contaminated diseases include itching, vomiting, diarrhea, stomach cramps, skin related problem etc. Biogas reduces the probability of diseases. Cooking with biogas is easier as it not necessary keep the fire burning. About 60% of biogas users considered all these above health issues for taking decision on new biogas plants in rural areas in Bangladesh.

Second most motivating factor is economical aspects motivating the rural household by 59 percent. Thus, new technology should have economic benefits that execute the adoption policies. People are more attentive on economic issues for new technology implementation.

Social and technological issues have motivating power to enlarge the business of new biogas technology by 24 and 26 percent, respectively.

Table 2. Mean difference of environmental and others factors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Err.</th>
<th>p-value</th>
<th>Mean-diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>62.66</td>
<td>2.35</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Economical</td>
<td>58.83</td>
<td>2.29</td>
<td>0.96</td>
<td>1.81</td>
</tr>
<tr>
<td>Technological</td>
<td>25.33</td>
<td>1.60</td>
<td>0.00</td>
<td>15.70*</td>
</tr>
<tr>
<td>Social</td>
<td>26.00</td>
<td>1.39</td>
<td>0.00</td>
<td>13.56*</td>
</tr>
</tbody>
</table>

Note. *Significant at 1 percent level (P<0.01)

According to Table 2, two-sample mean value of $t$ test of environment with economical factors, social and technological is 1.81, 11.91 and 15.70 with 1% level of significance. Thus, there is no significantly difference between motivating factors on environment and economic issues. But social and technological factors compare with environmental factor has significantly mean difference.

**PARTIAL BUDGETING**

Partial budgeting has four basic components with two columns. The left column calculates the positive effects and the right column estimates the negative effects discretely of a new business [11]. Added income normally estimated if the components are to be added. The following Table 3 shows biogas users normally save time and employed time to additional income earning and it is estimated 18009.34 BDT (Taka in Bangladesh). The saving times used for additional activities including handicraft, livestock and poultry rearing, home gardening, recreation, child care and teaching etc. Bio-slurry item added the income of 5714.41 BDT per year.

All additional costs are included that could be considered for production purposes. This list also includes the cost of labour, simple depreciation, interest of loan, cowdung and maintenance are 4000.00, 1112.53, 1481.82, 8499.95 and 400 BDT per year, respectively (Table 3).

Table 3 also presents diseases are diminishing due to adopts the domestic biogas plants. Respiratory diseases, eye problem were happen more before biogas technology adoption but after adoption the technology saved about 1015.00 BDT per year. Traditional fuels like firewood, dry dung, agricultural wastage uses have radically reduced and saving the money about 12103.11 BDT.

Table 3. Partial budgeting of a biogas plants (BDT/yr)

<table>
<thead>
<tr>
<th>Added income (i)</th>
<th>Added cost (ii)</th>
</tr>
</thead>
<tbody>
<tr>
<td>savings time</td>
<td>labour</td>
</tr>
<tr>
<td>18009.34</td>
<td>4000.00</td>
</tr>
<tr>
<td>bio-slurry</td>
<td>depreciation</td>
</tr>
<tr>
<td>5714.71</td>
<td>1112.53</td>
</tr>
<tr>
<td></td>
<td>interest</td>
</tr>
<tr>
<td></td>
<td>1481.82</td>
</tr>
<tr>
<td></td>
<td>cowdung</td>
</tr>
<tr>
<td></td>
<td>8499.95</td>
</tr>
<tr>
<td></td>
<td>maintenance</td>
</tr>
<tr>
<td></td>
<td>400.00</td>
</tr>
</tbody>
</table>

Reduced cost (iii) Reduced income (iv)

<table>
<thead>
<tr>
<th>disease</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>1015.00</td>
<td></td>
</tr>
<tr>
<td>alterna. fuels</td>
<td>12103.11</td>
</tr>
<tr>
<td>297.80</td>
<td></td>
</tr>
<tr>
<td>Sub-total (+)=</td>
<td>(i)+ (iii)</td>
</tr>
<tr>
<td>37139.96</td>
<td></td>
</tr>
<tr>
<td>Sub-total (vi)=</td>
<td>(ii)+ (iv)</td>
</tr>
<tr>
<td>15494.30</td>
<td></td>
</tr>
</tbody>
</table>

Net change: 37139.96 - 15494.30 = 21645.66

Finally Table 3 shows net change is positive (21645.67 BDT) indicating that this project could be adopted with considering the financial issues.

**CONCLUSION**

Rural people are aware with their existing livelihood with minimal environmental degradation, however, need to motivational activities to reaching optimal level of environmental balance. Environmental issues have been considering more for adopting biogas technology by the rural people rather financial, social and technological issues. Environmental and financial issues have not significant difference with respect to adopting the biogas plant but compare with social and technological having significant differences. Partial budgeting approach has been showing the positive net effect on taking decision on biogas adoption in rural areas. The finding indicates that biogas technology could be implemented across the country. Any component has not found apart from reduced income section of partial budgeting but has it adding income and reduced cost. Government has been playing a notable role to expanding the biogas technology throughout the county by sanctioning the subsidy.
to the rural people and NGOs and private entrepreneur also assisting with government policy.

ACKNOWLEDGEMENT

I have received much assistance from different level of expertises. I could not mention all of them although, few of them are taking a place into my heart and fully acknowledged to them namely: Prof. Dr. S. Bauer, JLU, Giessen, Germany, German Academic Exchange Services (DAAD), Biogas Sample Users; Mr. Gofran, Grameen Shakti, Manjunatha Arahalli Venkataronappa, DAAD Fellow, JLU, Giessen, Germany.

REFERENCE

Co-operative Solar Energy: A proposal to Enlighten the Tribal people in Bangladesh


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ABSTRACT

Global warming is the crucial problem in present world and carbon emission is the main reason behind this. Of the total carbon emission of the world, 6% come from the household activities. The people of Bangladesh are too poor to use modern equipments to light their house at night. A survey was done on the tribal people to observe their energy consumption. They suffer a lot for the energy crisis and use kerosene lamps in their houses at night. These lamps give light with very poor luminance and emit much carbon which contribute to global warming and cause health hazards. We have a proposed a method to eliminate both of this. The proposal is to replace the kerosene lamps by the solar powered lamps which will give much luminance, stop carbon emission and reduce health hazards too. Since the rural people of Bangladesh are very poor, they cannot afford the complete solar system individually and our proposal is to establish a co-operative base solar power distribution system to facilitate them with light to enlighten their life. This will help in preventing global warming and will also contribute a lot to the socio-economic development of the tribal people as well as all poor people of the country.

INTRODUCTION

Global warming is the most talked concern in the world now. The developed countries are mainly responsible for the global warming but the countries like Bangladesh are affected more adversely by the global warming for being a coastal country.

The main reason behind global warming is the emission of carbon which reacts negatively with the ozonosphere of the earth. The developed countries like America are emitting a lot of carbon, in the other hand, trees are being cut down and global warming is accelerated due to this imbalance.

All the countries are trying to resolve this global issue, but the carbon emission is increasing day by day. The industries, brick fields, vehicles, electric power plants and so on are emitting carbon every moment in a large amount. The scenario is almost same all over the world. Thus the carbon emission has taken a great concern of the whole world.

In Bangladesh, people use Kupi (Kerosene Lamps) to light at night, who, more than 55%, are not connected with electricity and those who have the electricity also suffer a lot from load-shedding especially in time from evening to midnight [1]. By this time, rural people use these kupies to light their houses using kerosene as fuel which emits a huge amount of carbon.

A survey has been taken in three tribal villages of Bangladesh where more than 90% people are not connected to the national electric grid. The survey took their daily usage of fuel and made an advance calculation on the emission of carbon, the affects of the carbon emission on the nature and its adverse effect on the global warming.

These carbons are mainly emitted in the form of CO2 (Carbon-di-oxide) which is not only harmful to the environment but also harmful to the human health. Especially in case of kupies, here the CO2 are produced in the room where the people live. Additionally, the kupies produce smoke which harms human eyes very badly.

Considering all the adverse effects, a proposal is given to introduce a co-operative solar lighting system which will completely remove the carbon emission of the kupies by replacing them with solar lamps powered by the green energy of solar. This co-operative solar powered system will develop the socio-economic life of the rural poor people by reducing the fuel cost and giving them LED solar lights with more luminance, giving more light and more time to search their livelihood. Moreover, the school going children can’t study due to lack of adequate clean light at night. This co-operative solar lighting system will give an opportunity to the children, so that they can study at night and be educated for the upcoming future.

MATERIALS AND METHODS

Let's take a brief look in the Earth's present atmospheric condition. The atmospheric elements show the following percentages:

Here, the graph shows that the current concentration of the CO2 in earth’s atmosphere is 0.0387% or 387 ppm [2]. The main sources of this CO2 consists of both the natural sources and man-made sources. The nature produces 220 giga-tones of CO2 each year by the volcanic gassing, the combustion of organic matter, the respiration processes of living aerobic organisms, virus microorganisms from fermentation and cellular respiration and many more [2]. The man-made resources produce 13%-40% of the total CO2 emission of the earth every year [2]. These resources include fossil fuels, power generation and transport, industries and so on.

The fossil fuels produce a minimum of 31.8 giga-tones of CO2 each year (Data-2008) [2]. In this burning race of fossil fuels, kerosene plays a vital role too. Kerosene burning equation shows that:

\[ \text{C}_2\text{H}_2\text{O}_2(\text{g}) + \frac{3}{2} \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 13\text{H}_2\text{O}(\text{g}) \ldots (1) \]

Equation [1] shows, each molecule of kerosene produces twelve molecules of CO2 and each liter of kerosene produces 2.58 kg of CO2 [4]. This rapid production of CO2 affects the atmosphere adversely and gives rise to the global warming consequently.

This huge amount of carbon contributes to the global warming in a great extent. This scenario is only for a developing country like Bangladesh, but if considered for whole world, the amount will be too large. Of the total carbon emission around the world, 6% is emitted by the household activities [5].
To observe the carbon emission by the rural tribal people of Bangladesh by their household activities and to make a prospective solution, a survey was carried out in three rural tribal villages of Bangladesh. The most painful matter is that most of the tribal people are illiterate and live below the poverty line. They are so poor that they cannot afford two times meal a day to their family properly, where education is a far way.

The survey focused on their livelihood and to give them an approach so that they can change their life. Furthermore, the survey has concentrated on the education of their children and noticed that 90% of their children are getting schooling and surprisingly only 60% of them are studying at night due to the scarcity of fuel to light their lamps.

Proposed Idea

The proposed idea after the consequent result of the survey is to replace the kupies by the green energy solar lamps. The lamps will be charged by solar energy as the villages are not connected to the grid. Since the initial cost of the solar system is very large, it is impossible for the poor people to implement a complete system individually. So the idea proposes to introduce a co-operative base solar lighting system.

A sample questionnaire of the survey is given in Fig. 4.

<table>
<thead>
<tr>
<th>Name</th>
<th>Occupation</th>
<th>Religion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Family Members</th>
<th>1-5</th>
<th>6-10</th>
<th>11-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studying</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study at Night</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of Going to Bed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Room</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Kupi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Fuel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance of Grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wants of Electricity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Problem

In this proposed system, there will be a central charging station which will be operated by the solar powered DC current system. The required solar PV panel will be bought by all the tribal families in a co-operative planning basis. The system will consist of only solar panel without DC to AC converter and backup batteries. This is because, the solar powered charger lamps need not AC current to be charged, and rather DC current is sufficient for charging. As all the people will charge their lamps at the day time, there is no backup battery needed. As these people don’t have the capability to afford much for a whole system, this small system with only the solar PV panel and some wiring can be easily implemented by them in co-operative. Each tribal family will be provided with at least two solar lamps to enlighten their family, this number of lamps can be increased with their increased investment. When the implementation will be done and the project starts running, number of lamps can be increased. It is proposed to take BDT 4 (USD 0.05$) daily from each of the families for the further maintenance of the equipments and managing other miscellaneous expenses.

RESULTS AND DISCUSSION

Considering the carbon emission of the three villages surveyed, it has been observed that the emission of carbon from the kupies contributes in a great extent to the global warming perspective. The survey shows that each family of the tribal village uses an average of 250ml of kerosene per day and produces an average of 0.645 kg of CO2 every day. If we consider that about 50% people in Bangladesh are using kupies and burning kerosene as fuel, each family consisting of 5 people on average, then the total carbon emission in Bangladesh for the kupies will be 9.5 thousand tons per day and 3.48 million tons per year. Including the whole world’s scenario, the amount will unimaginable.

Additionally, as these kupies are used inside the rooms, it produces a lot of smoke which is very hazardous for people’s health especially for their eyes. Moreover, the produced carbon is mixed in the air of the room and causing various diseases as described by the surveyed people.

The proposed project will stop this emission of carbon completely by replacing the kupies with green energy solar lamps.
Fig. 5. Carbon emission has been stopped after using co-operative solar lamps.

Fig. 6. Expense for lighting per month by a family has been reduced after using co-operative solar lamps.

Additionally, as the poor people are not capable of buying the solar panel individually, the proposed co-operative base solar panel installment and lighting system is very suitable for them to implement. This will cost a little for individual family and give them lights with more luminance to improve their socio-economic conditions, making them able to work at night, making their children able to study at night, removing the fuel cost and removing the health hazards too.

CONCLUSION

Co-operative base solar panel and light distribution system will be very economical and helpful for the poor people of the rural areas all over the world. This will help the people economically by reducing their fuel cost and give them a convenient place to live by stopping carbon emission and smoke production and thus removing health hazards. And more importantly this will stop the production of CO$_2$ by burning kerosene fuel with kuppies and other burner lights completely. This stops carbon emission greatly and thus plays a vital role in reducing global warming and keeping the earth atmosphere parameters stable. Moreover, the introduction of green energy to these rural people will certainly strengthen their socio-economic condition; give them new era for searching their livelihood, giving their children a comfortable atmosphere to study and improving their lifestyle. Thus, this co-operative base solar energy and light distribution system is the perfect and real time idea for the rural people of the developing world and also for the world atmosphere.

REFERENCE


Potential of Informatization Agriculture in Bangladesh - Installation and Utilization of Field Monitoring System in Agriculture

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ABSTRACT

In order to grow up the agricultural potential in Bangladesh, an informatization agriculture might be one of the most effective tools for agricultural managements since many government and non-government organizations have made a lot of efforts to enhance their information technology. These efforts lead Bangladesh people to be able to access and utilize communication technologies such as mobile phone, Internet, etc. In fact, even rural people can use their mobile phones freely and can access the Internet at some community space which is managed by public or private organizations. In general, an informatization agriculture is being considered as an applicable technology in the developed countries. However we could see strong potentiality of the informatization agriculture in Bangladesh through our survey and project. In this paper, we would like to introduce one of the trial verifications for the informatization agriculture by using simple web-based field monitoring system named FMS (Field Monitoring System).

INTRODUCTION

Bangladesh is an agricultural based country. The overall contribution of the broad agriculture sector at constant price is 19.95 percent of GDP in FY 2010-2011 [1]. About 43.6 percent of the total labor forces of the country are engaged in agriculture sector [1]. However, it has been achieved under massive and improper usage of fertilizer and pesticide. There are fears that such usage of the fertilizer and pesticide affect human health due to contaminated products and expand ground pollution.

In order to improve the chemical dependence farming in Bangladesh, several NPO, NGO, Research Institute, etc. have conducted enlightenment activities which are able to break away from chemical dependence farming. Our joint project named IGPF (Income Generation Project for Farmers using ICT) is also one of the project which aims at encourage the chemical free farming. IGPF is three years project proposed by Kyushu University, Japan and sponsored by JICA (Japan International Cooperation Agency). IGPF started since June 2010. IGPF aims to improve the farmer’s living conditions and generate their income by providing the knowledge for chemical free farming through ICT. IGPF has two rural model sites namely Ekhaspur (Ekhaspur, Matlab uttar, Chandpur) and Kapasia (Mirjanagor, Sammania, Aral Bazar, Kapasia, Gazipur) and 50 model farmers have conducted IGPF chemical free farming. Before starting the IGPF project, IGPF had conducted several surveys regarding the farming customs/ problems, the access to agricultural information and the usage of tele-center in Bangladesh. Here, “tele-center” is some community space which is provided by the government or non-government organizations. From those surveys, we found mainly following things: 1) Available agricultural information was limited, 2) Some of the farmers relied on the tele-center as source of agricultural information, 3) Many farmers wanted to their farm environment information to avoid the weather disaster. To summarize these findings, we might be able to point that the farmers want to get more information about agriculture especially for their farm environment and tele-center has a possibility to be a key station for information transmission.

Regarding the transmission of farm environment information, it has some possibility to reduce the crop damages which are caused by weather variations and to obviate the reduction in yield. Therefore, if we created the transmission system, the system might increase the farmer’s income.

Regarding the transmission of farm environment information in Bangladesh, field environment monitoring and web-based data provision system might have high possibility because the Bangladesh government has expand her information technology with the slogan “Digital Bangladesh” and as these results the opportunity which make the Bangladesh people to be able to touch the information technology have been rapidly increased [2]. Not only the urban area people but also even the rural people can use their mobile phones freely and access the Internet at tele-center [3]. It means that if we facilitated the web-based monitoring system, even the rural people could obtain the environment information by using their mobile phone or at the community space. From these trends of information technology in Bangladesh, we believe that a field monitoring system has a potential to be able to dramatically change the agriculture in Bangladesh.

In this paper, we would like to introduce our trial experience which we have installed our web-based field monitoring and data provision system into Bangladesh and to raise the problems and solutions related to installation and running of the FMS.

MATERIALS AND METHODS

A. Field Monitoring System

IT (Information technology) has been currently applied in several fields of agriculture to improve an agricultural productivity. There are many kinds of IT Agriculture applications that already used for supporting agricultural production such as environmental monitoring, precision agriculture including spatial data collection, precision irrigation and supplying data to farmers, facility automation including greenhouse control and animal-feeding facility, and so on [4].

Regarding the environmental monitoring, Hirafuji [5] and Fukatsuand & Hirafuji [6,7] have developed representative field monitoring systems called “Field Server” This system consists of monitoring sensor, built-in web-based data logger device and the self-programmed agent system. Field Server has following steps for collecting the monitoring data: 1) Agent systems collect the monitoring data, 2) The monitoring data is stored periodically into database server via Internet. Therefore, when the agent systems stopped irregularly the
Field Server could not collect the monitoring data. Such problem should be avoided especially for long-term field monitoring. In order to solve this problem, the authors have developed a new conceptual field monitoring system named “FMS” [8, 9]. Instead of installing the agent systems, the function of e-mail sender have been installed into FMS. Device configuration of FMS is shown in Fig. 1. FMS mainly consists of sensors for environmental monitoring, logger circuit board with e-mail transmission, network supply unit and power supply unit. Logger circuit board has eight channel input port for analog sensors. A port capacity for analog-digital conversion is ten bit and input voltage is zero to five volt. FMS can be connected various sensors such as temperature, humidity, solar radiation, CO₂ concentration, electric conductivity, etc. The monitoring data is sent automatically to an e-mail server and then collected by database system. The data are protected securely since we use the commercial mail server. It means that we could keep the data even if some database system trouble was occurred. The database system can get the data after recovered.

While the FMS at BSMRAU did not require the UPS since BSMRAU had a special electricity line supported by the government. The specification of UPS which is used at both sites is shown in Table 2.

![Fig. 1. Devices configuration of FMS](image)

B. Data Provision System

For the construction of provision system for FMS information, we used the following open source ware; MySql (database system), PHP (programming language) and Xoops CMS (contents management system). Xoops CMS consists of the core system, contents manager, and modules. Various extension modules such as user management, news, forum, schedule, link etc. have been developed by many programmers in the world. These extension modules can be downloaded from related websites freely. Our provision system also has been developed as one of the extension module. The module mainly consists of the following sub-functions;
1) Configuration of the field monitoring device,
2) Monitoring data viewer and manager,
3) Multi-data viewer and manager, etc.

We can configure/manage the all monitoring conditions and adjust the monitor through the Internet browser.

C. Installation Site and Conditions for FMS at Bangladesh

Fig. 2 shows the installation site for FMS. We set the FMS at three sites in Bangladesh. Every three sites are related to IGPF project. IGPF office is the project coordination office at Dhaka, BSMRAU (Bangabandhu Sheikh Mujibur Rahman Agricultural University) is one of the cooperation partners of IGPF and Ekhaspur is model site for chemical free farming. In Ekhaspur, we have use a community space called tele- center where have the Internet environment. Table 1 shows the running conditions for FMS. Due to their serious gap between supply and demand problem [10]. In order to supply the electricity during power outage, UPS (Uninterruptible Power System) is commonly used for electric devices. In this our trial monitoring the FMS at IGPF office and Ekhaspur were connected to UPS after short period running without UPS.

<table>
<thead>
<tr>
<th>Site</th>
<th>1. IGPF Dhaka</th>
<th>2. BSMRAU</th>
<th>3. Ekhaspur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting Date</td>
<td>5, June 2012</td>
<td>5, June 2012</td>
<td>10, May 2012</td>
</tr>
<tr>
<td>Measurement Items</td>
<td>Air Temp.</td>
<td>Humidity</td>
<td>Solar Radiation</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>2 minutes</td>
<td>5 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Support System for Power outage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. IGPF Dhaka</td>
<td>UPS was attached on 9 July 2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. BSMRAU</td>
<td>BSMRAU has special electricity line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ekhaspur</td>
<td>UPS was attached on 27 June 2012</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Specification of UPS

<table>
<thead>
<tr>
<th>Item</th>
<th>IGPF Dhaka</th>
<th>Ekhaspur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>2000 VA</td>
<td>1000 VA</td>
</tr>
<tr>
<td>Battery</td>
<td>12 V × 2 = 24 V</td>
<td>12 V × 2 = 24 V</td>
</tr>
<tr>
<td>Supply hour</td>
<td>2 hour</td>
<td>2 hour</td>
</tr>
<tr>
<td>Required hour for full charge</td>
<td>8 hours</td>
<td>8 fours</td>
</tr>
</tbody>
</table>

A. Availability of FMS

Fig. 3 show the test monitoring results obtained at Ekhaspur during 15 June to 15 July 2012. The figures show the air temperature, humidity and solar radiation respectively. In these figures we could see long slope during three terms. These slopes indicated FMS could not obtain the data due to some errors. The main error was occurred due to power outage. Detail discussion about the power outage is in later section. Regarding the tendency of the temperature, the value might have been little bit high compared with sensible temperature. This might have been occurred by the sensor design of FMS since the FMS has been developed for plastic green house in Japan. Therefore we need to improve the design of FMS. However we could general variation for the weather by using FMS. The obtained data have availability for the decision making of agricultural activities.

B. Power Outage Problem

As we mentioned above we could not obtain the data from FMS during power outage term. The power outage problem is unavoidable problem in Bangladesh. Therefore it is important
for running FMS to deal well with the power outage problem. Fig. 4 shows the obtained solar radiation and power outage term at three sites from started date to 27 July. In these figures the black lines show the power outage term. We could see the long term power outage at IGPF Dhaka office from 11 to 23 July. This was due to the main FMS power line cut by mouse. It was really surprising thing the mouse had cut the power line for FMS, however, we eliminated this problem for the discussion of power outage. Obviously we could find that the effect of the special electricity line at BSMRAU and UPS at IGPF Dhaka office and Ekhlaspur. After we had set the UPS on 9 July at Dhaka and 27 June at Ekhlaspur, the blackout term were decreased at both the sites. Fig. 5 shows the frequency of power outage at three sites. Most of the power outage term was less than one hour. These results indicated that the UPS had enough capacity for running FMS to supply the electricity during power outage term. It means that if we consider the running of FMS and obtaining the general weather information through our FMS, the alternative power supply by UPS might be enough for FMS running.

A. How Can We Utilize FMS Information?

In the previous section we mentioned about the test monitoring results and running availability of FMS with UPS. From here, we would like to introduce the way how we can apply the FMS information to agriculture in Bangladesh. It is obvious that the weather information is important factor for agriculural activities since the farmer should decide their farming activities by checking the weather variation. Therefore if we could construct the information distribution system of FMS, the farmer could conduct correct farming. For the information distribution the FMS, information technology environment in Bangladesh might be effective because even the rural people have the environment to be able to use their mobile phones and can access to the Internet at their community space. We have already started the information distribution of FMS as a part of IGPF activities at Ekhlaspur tele-center. When the model farmers want to know tendency of the weather variation the farmers visit to tele-center or call to tele-center staff and get the information. And based on the information the farmers could decide their farming activities. For example, when high humidity level, which has a possibility to spread some virus disaster, continues for a few days the farmer protect their crops by using nylon film. In this way FMS information could help the rural farmer if we could cooperate with community space. Therefore we may need some tie-up with the government or some organizations which tackle the information distribution thorough information technology.
B. Sustainable FMS Monitoring

As we mentioned above, power outage is the big impediment to run the FMS. In this trial monitoring, we have used UPS to support the power outage. However, UPS has a limitation for sustainable monitoring of FMS since the capacity of electricity supply is only two hours. Even our monitoring term we could see long power outage term more than two hours. Lack of the monitoring information might be undesirable things for information distribution. In order to solve this power outage problem, a solar panel generation might be effective for the sustainable running of FMS. Therefore we have to develop new type FMS which is attached the solar panel generation.

By the way, we mentioned a little about the accident occurred by the mouse, some of the unforeseeable accident might be occurred in Bangladesh. Not only is the mouse, a thief also to be the impediment for sustainable monitoring. Therefore, it is one of the important factors for sustainable monitoring to make well protection.

C. Future Vision for Informatization Agriculture

Through this trial monitoring and test information distribution at tele-center, we could get a certain possibility of FMS information distribution at rural village. We could find that our IGPF model farmers seemed to get more information about agriculture. However, in the case of the information distribution at tele-center, the distance from the farmer’s house to tele-center might be negative effect for the farmer. Actually some of the model farmers who live in more than two kilometer far from tele-center did not come to see the information frequently. From this, we may have better to consider the other way for the information distribution. One of the alternative ideas is a utilization of SMS (Short Message Service) of mobile phone. As mentioned above, even the rural people can use the mobile phone network and most of the rural people have their own mobile phone. Therefore, if we constructed an automatic FMS information distribution system through SMS, we could increase the convenience of information distribution. This work would be high priority work of our FMS information distribution.

CONCLUSION

In this paper, we discussed the utilization potential of FMS in Bangladesh. The following things could be found as some ideas, solutions, and improvements for running FMS and FMS information distribution:
1. UPS could support the FMS running to some extent. However in order for more sustainable running we might consider the utilization of solar panel generation as the alternative method of UPS.
2. For the sustainable FMS running we should care about not only the power outage problem but also every possible impediment such as capers by animal and thief.
3. We could see active farmers who want to get more FMS information at the tele-center. In order to respond to highly expectations from the farmers we should increase the measurement items of FMS and provide the effective information to the farmers.
4. In order to distribute FMS information more effectively we need to consider the information distribution system which utilizes the SMS of mobile phone.

ACKNOWLEDGEMENT

This research was achieved as one of project activities of IGPF which founded by JICA. Here, we would like to express great appreciation to JICA.

REFERENCES

INTRODUCTION

Agricultural machinery play an important role to reduce drudgery of farm works as well as minimize operational time and production cost. Land preparation and sowing are expensive and time-consuming operations for up land crops cultivation. Proper placement and distribution of seeds and fertilizers into the soil is necessary for good germination and plant establishment for better yield [1]. Strip till planting system in which tilling the planting strips and seeding can be accomplished simultaneously thereby reducing the number of field operations which is environment friendly because of low fuel consumption and less soil erosion. In this system land is remain untillled between the two seeding lines. No till facilitates improvement of soil quality, reducing the surface soil erosion and keep residue over the soil surface which restrict moisture loss [2, 3].

Farmers of Bangladesh are becoming more dependent on mechanical power. Nowadays, two wheel tractors (power tillers) are available all over the country. There are about 350000 two wheel tractors in operation [4]. Survey results showed that 11%, 17% and 55% of wheat growers used power tillers for cultivating wheat in 1991, 1992, and 1994, respectively [5, 6]. Wheat sowing period is very limited in Bangladesh. After harvesting of T. Aman (Monsoon rice), farmers do not have enough time for land preparation with traditional ploughing system.

Delay in planting is one of the main constraints to increasing wheat yields; generally 10-22 days are required for conventional tillage. This conventional tillage includes 4-5 passes plough followed by 3-4 times laddering. Power tiller operated seeder (PTOS) performs tillage operation, seeding in line and seed covering simultaneously. During last few years, performance of strip till seeder was demonstrated at different locations of North West Bangladesh. Strip tillage system crop residue on the soil surface helps to preserve moisture and resist growing weeds especially in dry farming areas.

The objectives of the study were (i) to establish crop under strip tillage seedling system utilization of residual soil moisture; (ii) to demonstrate and evaluate strip tillage performances for different crops cultivation in dry areas and (iii) to compare the cost of planting by strip tillage seeder than that of the conventional methods.

MATERIALS AND METHODS

Power tiller operated seeder (PTOS) has 48 numbers of rotating blades for shallow tilling the soil. The seeding part attached with power tiller replacing the rotator part of the power tiller. In strip till system, rotating tynes were reduced to 24 numbers. Only 4 tynes remain in the gang at front position of seed furrow opener for tilling and creating a strip in the soil. Between the two seeding lines soil remain untilled. The tynes of the seeder were rotating at the speed of 450 rpm. Seeding operation was completed by the drill in one pass –as tilling and creating a strip of wide 4-6cm, seed and fertilizer placed in the strip, and seed covering by the press wheel of the drill (Fig.1).

The experiment was conducted in Chargat, Godagari, Puthia area of Rajshahi district during 2008-2011. Wheat, lentil planted after T. aman harvested land and mungbean planted after wheat harvest immediate after harvesting the previous crop utilize the residual soil moisture of land. The average height of the rice residue was 15 – 20 cm. Recommended fertilizer was used and placed during seeding. Each block was separated into three parts for the three methods of tillage: (i) Strip tillage (ii) minimum tillage by PTOS, that means full shallow tillage in one pass and (iii) conventional methods. Collected data were (i) Depth of seed placement (cm), (ii) Travel speed (km/hr), (iii) Effective field capacity (ha/hr), (iv) Field efficiency (%), (v) Fuel consumption (l/hr), (vi) No. of plant/m², (vii) Soil moisture (%), (ix) Yield/m² (x) Cost.

RESULTS AND DISCUSSION

Field observations and comparisons with the standard tillage system over 3 years period in several farmers field indicate that wheat can be established immediate after rice harvest using the strip till system. Performance of strip tillage, minimum tillage by power tiller operated seeder (PTOS) and conventional tillage were shown in the Table 1.

The effective field capacity of the seeder in strip till method was (0.19 ha/hr) more than minimum till seeding (0.15 ha/hr). In strip tillage method, seeder moved comparatively faster (19%) than the minimum tillage due to work load variation. It was also found that the fuel consumption was less (21%) than normal minimum till. It was due to the load reduction on rotary blades. During operation it was also found that the crop
residue were chopping by high speed rotation of the rotary tynes and not plugging the rotary units.

depth of planting. Wheat yield in strip tillage (4.90 t/ha) which was 41% higher than conventional (3.5 t/ha) method (Table 3). Similarly lentil and mungbean yields were more than that of conventional method.

Farmers can complete seeding operation in strip tillage method one hectare land by 5.26hrs compare to 6.7 hr and 17.5 hr of minimum till and conventional method, respectively. Strip till save time 69% compare to conventional method. Depth of seed placement was found uniform (3-4 cm) in the strip tillage and seeding depth can be controlled accurately. Depth of planting strip can be increased up to 5-7 cm. Width of strip 4-6 cm was enough for crop establishment. Plant population varies among the different seeding methods (Table 2). Plant population in strip tillage and minimum tillage methods were higher due to the utilization of residual soil moisture but in conventional system plant population was less due to moisture faster loss (Fig. 2). Applied seed rates 120 kg/ha were same in both strip till and minimum till method. The farmers were generally used seed rate 155 kg/ha which was about 29% higher than recommended. Fig. 3 showed the plant stand under strip till method.

Crop yield was higher in strip tillage method due to more soil moisture during plant establish period. Necessary plant nutrient was available near the root zone area of crops. In conventional method plants growth was uneven due uneven

The cost of planting in different planting methods is shown in Table 4. Among the three planting methods the cost of strip tillage system was minimum (Tk.1850.0/ha) and the highest was in conventional method (Tk.4900.0). Strip till saved cost 62% compare to conventional method. The planting cost can be afford by the farmers both strip tillage and minimum tillage methods.

Break-even point of crops for strip till drill is shown in Fig. 4. Break-even point is calculated on the basis of fixed cost and variable cost of strip seed drill considering purchase price, interest on investment, machine life, etc [7]. Cost per hectare decreased with the increase of land area used annually. Breakeven point of strip tillage was found 4.0 ha which indicated that it is the point where no loss or no profit occurs. The owner of the strip seed drill must plan for profitable use of seeder over 4.0 ha land yearly.

Table 1. Working performance of strip till and minimum till seed drill

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter</th>
<th>Strip tillage</th>
<th>Minimum tillage</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Travel speed (km/hr)</td>
<td>2.5</td>
<td>2.1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Effective working width, cm</td>
<td>120</td>
<td>120</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Effective field capacity (ha/hr)</td>
<td>0.19</td>
<td>0.15</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Drive wheel slippage (%)</td>
<td>6</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Fuel consumption (lit/ha)</td>
<td>5.8</td>
<td>9.3</td>
<td>13.6</td>
</tr>
<tr>
<td>6</td>
<td>Total time requirement (hr/ha)</td>
<td>5.26</td>
<td>6.7</td>
<td>17.5</td>
</tr>
</tbody>
</table>

Table 2. Comparative performance of strip tillage, minimum tillage and conventional tillage method in 2011

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Strip tillage</th>
<th>Minimum tillage</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed rate (kg/ha)</td>
<td>120</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Wheat</td>
<td>120</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Wheat</td>
<td>155</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Wheat</td>
<td>5.3</td>
<td>3.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Wheat</td>
<td>255</td>
<td>180</td>
<td>23-35</td>
</tr>
<tr>
<td>Wheat</td>
<td>25</td>
<td>205</td>
<td>28</td>
</tr>
<tr>
<td>Wheat</td>
<td>275</td>
<td>30</td>
<td>195</td>
</tr>
<tr>
<td>Wheat</td>
<td>255</td>
<td>205</td>
<td>28</td>
</tr>
</tbody>
</table>
Table 3. Yield performance of strip tillage over minimum tillage and conventional method

<table>
<thead>
<tr>
<th>Tillage method</th>
<th>Crop yield (t/ha)</th>
<th>Wheat</th>
<th>Lentil</th>
<th>Mungbean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip tillage</td>
<td>4.96</td>
<td>1.4</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Minimum tillage</td>
<td>4.80</td>
<td>1.2</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>3.50</td>
<td>0.8</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td>0.5</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>(CV%)</td>
<td>12</td>
<td>14</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Cost of planting in different tillage methods

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Planting methods</th>
<th>Cost of planting (Tk./ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strip tillage</td>
<td>1850.0</td>
</tr>
<tr>
<td>2</td>
<td>Minimum tillage</td>
<td>1873.0</td>
</tr>
<tr>
<td>3</td>
<td>Conventional</td>
<td>4900.0</td>
</tr>
<tr>
<td>SE</td>
<td></td>
<td>247</td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

1 US$=Tk.84.0

CONCLUSION

Based on the results of strip tillage crop response and field performance evaluation of this system the following opinions and conclusions were made.
1. Strip till produced a good seed bed 4-6 cm wide and maintains better seed-soil contact. Plant populations were more due to extended period utilization of residual soil moisture.
2. The rotating strip blades can operate in moderate residues without plugging.
3. Seed saving is 29% over conventional broadcasting seeding method.
4. Field capacity of the strip seeder increased 19% and fuel consumption reduced 21% compared to minimum tillage system.
5. Strip till saved cost of planting 62% compared to conventional seeding method.

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The authors are pleased to acknowledge International Maize and Wheat Improvement Centre (CIMMYT) and Australian Centre for International Agricultural Research (ACIAR) for financial and technical support to conduct the research works both on station and in the farmers’ field.

REFERENCE

ABSTRACT

Highly Pathogenic Avian Influenza (HPAI), a pandemic disease around the world, had first spread its arm towards Bangladesh in the early 2007. Since then the country has been going through the epidemic waves of the disease every year resulting a huge destruction in the poultry industry. Recently introduction of new mutant of the virus has also found indicating new threat to the country. Many risk factors are found to be responsible for the spread of the disease among which human activity seems to have a significant effect. Zoonotic risk of the disease is nowadays also in increase. The present review has been carried to show the current situation of HPAI in Bangladesh which might help to determine the further studies needed to be done in this field in the country.

INTRODUCTION

The world has been suffering from the global threat of highly pathogenic avian influenza (H5N1) since its first introduction in 2003 from Far East and Southeast Asia. HPAI is responsible for the death or forced culling of more than 400 million domestic poultry and has caused more than $20 billion economic damage all over the globe [1]. This disease has taken attention of researchers and veterinary practitioners for its both veterinary and public health concern. Although in Bangladesh first outbreak occurred in the beginning of 2007 [2], the disease has already caused a huge damage to the poultry industry within the course of 5 years circulation in the country. Many studies regarding various aspects of this disease have been done already. Still FAO has urged more preparedness and surveillance due to the resurgence of HPAI caused by new mutant of the virus in last year. In Bangladesh the huge population and poor enforcement of legislation increase the gravity of threat of pandemic outbreaks as well as socioeconomic effects due to huge loss of life. Therefore more careful investigation needs to be taken in the country to stimulate the preparedness and response activities against the outbreaks. This review article has summarized all available epidemiologic and clinical studies conducted about HPAI along with the updated information of the disease throughout the country.

OUTBREAK OF HPAI IN BANGLADESH

First outbreak of HPAI in Bangladesh was noticed in February 2007 [2]. Though the exact origin of outbreak is not confirmed yet, but it is suspected that migratory birds can be the main source of this deadly H5N1 virus in Bangladesh [3]. Spread of HPAI outbreak in Bangladesh was with a latitudinal direction [4]. Until April 2012, a total of 545 cases (22 cases in 2012) of Avian Influenza have been reported in 53 of the 64 districts in Bangladesh [2]. According to FAO, Bangladesh is one of the 6 countries (Bangladesh, China, Egypt, India, Indonesia and Vietnam) where H5N1 is endemic in poultry [1]. Since the first HPAI outbreak, Bangladesh has faced five epidemic waves in five consecutive years where 2008 has seen the highest number of outbreaks followed by two mild waves of outbreak in 2009 and 2010.HPAI again rose progressively in 2011 with 164 events on that particular year. In the year 2012, 22 cases have already been identified. In each wave of outbreak involvements of new districts indicate the continuous spreading of the virus all over the country [2]. HPAI cases in Bangladesh are more available during cool (average daily temperature of 15-20°C) and dry winter months (December – March), whereas no event was identified during the hot (average daily temperature of 30°C) and wet summer season (June – August) [5].

In Bangladesh, from the beginning of HPAI outbreak only clade 2.2 viruses were found to be circulated. A recent study [6] reported a new introduction of clade 2.3.2 and 2.3.4 HPAI viruses in Bangladesh. From these new clades 2.3.2 viruses found phylogenetically related to the newly designated clade 2.3.2.1, which according to FAO is the reason of recent increase in outbreaks of HPAI across East Asia [1]. Though clade 2.3.2 viruses in that particular study found in crow, quail and duck but the author speculated it is obvious that the same virus is also circulating in chickens.

CONFIRMATION AND CONTROL STRATEGY OF H5N1

Diagnosis of HPAI outbreak in Bangladesh is based on 3 stages [5]. Normally HPAI outbreak is suspected with its high morbidity and mortality along with the observation of clinical signs in chicken. Biswas et al. (2011) identified major signs observed during HPAI outbreak in chickens in Bangladesh [7]. In almost all cases in both commercial and backyard chickens comb and wattles became cyanotic. Edematous heads & faces and drowsiness & huddling signs were more common in backyard chickens. On the other hand diarrhea and neurological dysfunctions were mostly found in commercial chickens. Other important signs were ecchymotic discoloration of the leg shanks, indurate crops assessed by palpation and excessive lacrimation. Secondly, a positive rapid antigen tests (The Flu DetectII Transcriptase polymerase chain reaction test at the National Reference Laboratory for HPAI near the capital Dhaka. For the confirmation of H5N1 and sequencing of isolates tracheal samples from chickens are sent to the Veterinary Laboratories Agency, UK.

In Bangladesh, vaccination against Avian Influenza in chicken is prohibited. The common measures applied after detection of any case are commonly: stamping out, movement control inside the country, disinfection of infected premises/ establishments. Usually there is no treatment for affected population (OIE).

RISK FACTORS OF HPAI

Several epidemiologic studies have revealed that various risk factors are responsible for the continuous spread of HPAI in Bangladesh. The ecological factors causing spread of the disease in sub-district level were studied by different authors. The important ecological risk factors for outbreaks of HPAI in any sub-district in Bangladesh were determined by Loh et al. (2010) [5]. According to their findings three significant risk factors were identified: the quadratic log-transformation of human population density, the log-transformation of the total population, and the log-transformation of the temporal variation of temperature.
commercial poultry population and the number of roads per sub-district.

A study by Ahmed et al. (2012) showed the other ecological determinants related with the risk of HPAI-H5N1 outbreaks at sub-district in Bangladesh [8]. The most important determinants found were: migratory birds’ staging areas, river networks, live bird markets and literacy rate. 21 species among the 244 species of migratory birds’ visit in Bangladesh can be carrier of HPAI H5N1 [9]. The staging areas of migratory birds and HPAI outbreaks hotspots in Bangladesh coincide with east and central Asian flyways [10]. The finding of Ahmed et al. (2012) [8] supported the relation of HPAI outbreaks with presence of migratory birds’ staging area in a sub-district. Moreover increased risk of HPAI outbreak was also found in the sub-district crossed by or situated at the banks of main river networks. The reason might be dumping of dead chickens or transporting of infected poultry or contaminated poultry products through a river [11-13]. Risk of HPAI outbreaks was higher in sub-districts with high number of live bird markets. Literacy rate was also an important finding for the awareness about HPAI. The sub-district with higher literacy rate had higher probability of reporting outbreaks. Unlike to other south-east countries [14-16], duck density and crop intensity did not show any association with outbreak of HPAI in Bangladesh. This might be because of different duck husbandry in Bangladesh.

Risk factors associated with farm and farm managements have also been well studied. In Bangladesh, there are 3 kinds of poultry rearing system: large commercial farm, small commercial farm and backyard free range poultry rearing system. In large commercial farm disease spread found to be dependent on two main risk factors: farm accessible to feral & wild animals and footbath at entry to farm/shed [3].

Small commercial poultry farming acts as an important factor in economy and living of many people of the country. Biswas et al. (2011) has checked the risk factors of small scale commercial chicken farms (FAO defined system 3) [17]. According to their findings House Crow (Corvus splendens) plays an important role to transmit HPAI viruses to the commercial chickens. In 2008 HPAI H5N1 found as the causative agent for the mass mortality in crows. Other sources of contaminants to the chickens of small commercial farms were: practice of exchanging egg trays with market vendors and contact with infected backyard chickens due to poor fencing systems in the farms.

About 89% households in rural area in Bangladesh rear backyard poultry [18] having free movements. Such free access of poultry to its environment makes them more prone to HPAI. Biswas et al. (2009) identified major risk factors causing HPAI infection in backyard poultry [19]. The main risk factors found were: Nearby (<0.1 km) body of water, contact with domestic pigeons and offering slaughter remnants of purchased chickens. Water bodies can be a cause of infection because those places are often shared by virus-shedding ducks. Pigeons can be a mechanical transmitter of virus as they easily get close contact with secretions of the infected or dead chickens or fomites. Because of the economic situation of poor people in Bangladesh they often sell apparently healthy and even clinically diseased chickens at cheap price. This allows other villagers to offer the remnants of slaughter, inedible parts of those diseased poultry to the healthy birds. However, Biswas et al. (2009) also found that keeping chickens and ducks in different shelters at night can reduce the chance of contamination [19].

ZOONOSES AND OTHER ENVIRONMENTAL RISKS

Besides the risks for the host population HPAI also poses a great threat of human pandemic and other environmental risks. Until May 2, 2012 total number of confirmed human cases of avian influenza A (H5N1) throughout the world were 603, among them 356 were fatal [20]. This picture clearly describes the zoonotic threat of HPAI. Since 2007, there were 6 human H5N1 cases in Bangladesh without any fatality. The first human event reported in 2008, after that 2 cases found during 2011 and 3 more cases have already diagnosed in 2012 [20]. This figure might indicate an alarming increase in human infection with this virus in the country.

Cases of deaths by H5N1 have been reported in several animals probably after ingestion of contaminated birds. For example, in Thailand H5N1 has been found in cat [21], dog [22] and tiger [23]. Birds other than chickens are also not out of risk. Several species of birds like crow, quail have already recorded to be found as H5N1 positive. In Bangladesh, poor hygienic condition can increase such risk of HPAI infection in different species of animals and birds.

CONCLUSION

Poultry industry is a very important sector in an agro-based country like Bangladesh. HPAI, the deadly viral disease is destroying the interest of poultry farming all over the country. The zoonotic risk of this HPAI has also been posing an alarming threat. This review has summarized all the published works done about HPAI in Bangladesh, but there might be some other unpublished works also done in this field could not be included in the current review because of unavailability.

The present review argue that although various studies have already detected the key factors responsible for the spread of the disease, still specific effective measures and regulations for the control of the disease are yet to be found. To save the poultry sector in the country from this pandemic disease more attention should be given on the research about this disease.

REFERENCE


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A Solution of Power Crisis in Bangladesh: Prospect of Solar Tower Power Plant

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ABSTRACT

In this work several contemporary research papers and books regarding solar tower power plants have been reviewed and propose a solution of energy crisis by incorporating solar tower system in power sector of Bangladesh. She is situated between 20°13′40″ –26°13′80″ degrees north latitude and 88°01′10″–92°14′10″ degrees east, which is an ideal location for solar energy utilization. Daily average solar radiation varies between 4 and 6.5KWh/m². Maximum amount of radiation is available in the month of March–April and minimum on December–January. Out of 365 days we have 340 to 345 days of sunshine. Power tower systems, reflect and concentrate sunlight onto a central tower-mounted receiver where the energy is transferred to working fluid. The main advantage of solar power towers is the ability to provide high-temperature superheated steam, leading to higher power generation efficiencies without environmental pollution.

INTRODUCTION

The standard of living and quality of life of a nation depend on its per capita energy consumption. Bangladesh is one of the poorest developing countries (147 out of 179 in the IDH rank established by the PNUD and 83% of the population living with less than $2 per day). Here per capita energy consumption in 2005 stands at 227 kgsOE (kilograms of oil equivalent), which is much below the world average of 1778 kgsOE. The energy consumption mix was estimated as: indigenous biomass 60%, indigenous natural gas 27.45%, and imported oil 11.89%, imported coal 0.44% and hydro 0.23% [1]. Bangladesh has one of the lowest per capita power generations (only 236 kWh) in the region and about 51% of its 155 million populations have no access to power. The government of Bangladesh has undertaken a master plan under the vision-2021 to reach electricity facilities to every village of the country. Approximately 48,754 villages out of 87,372 villages have been brought under electricity facilities till April 2011[2]. Even then, the national power generation capacity is only 4500-4750 MW against a peak demand of 6000 MW. At the current rate of increase in consumption 10% annually [3]. The generation predominantly depends on the indigenous natural gas accounting for about 88.39% of the generated power. Rest of the power is produced by Diesel, Hydro, and Coal. The cumulative efforts of exploration for oil and gas resources in Bangladesh has resulted in the discovery of 23 gas fields of various sizes producing 2000 mmcf of natural gas. Currently, from our 5 discovered mines only Barapukuria Coal Mine is producing at this stage. In 2008 it produced about 0.8 million tones. The estimated reserves of coal are close to 3300 million tones, while the proven reserve is about 884 million tones. The scope of hydropower generation is very limited in Bangladesh because of its plain lands, except in some hilly region in the northeast and southeast parts of the country. At present only 230MW of hydropower is utilized in Karnaphuli hydro station through 5 units of Kaplan turbine [4]. Traditional energy sources, i.e., those that produce a substantial amount of the power currently used, include coal, oil, natural gas, hydropower, and nuclear fission. Bangladesh is situated between 20°13′40″ to 26°13′80″ degrees north latitude and 88°10′10″ to 92°14′10″ degrees east, which is an ideal location for solar energy utilization. Daily average solar radiation varies between 4 and 6.5kWh/m². Maximum radiation is available in the month of March–April and minimum in December–January. Out of 365 days we have 340 to 345 days of sunshine; even if it is raining we have sunshine in between the rains. The solar thermal technologies that are of interest in Asia are solar hot water systems, solar dryers and solar cookers. While solar water heaters for hotels and hospitals could bring down electrical loads, solar cookers should conserve biomass and solar dryers would be useful for drying timber, paddy, fruits and vegetables with benign environmental effects. Only BRAC has propagated this technology in the field by installing 260 Hot Box cookers. The NGO has a future plan to install more 5000 Hot Box cookers all over the country [5].

SOLAR THERMAL POWER GENERATION TECHNOLOGIES

Solar Thermal Power systems, also known as Concentrating Solar Power systems, use concentrated solar radiation as a high temperature energy source to produce electricity using thermal route. Since the average operating temperature of stationary non-concentrating collectors is low (max up to 120°C) as compared to the desired input temperatures of heat engines (above 300°C), the concentrating collectors are used for such applications. These technologies are appropriate for applications where direct solar radiation is high. The mechanism of conversion of solar to electricity is fundamentally similar to the traditional thermal power plants except use of solar energy as source of heat. In the basic process of conversion of solar into heat energy, an incident solar irradiance is collected and concentrated by concentrating solar collectors or mirrors, and generated heat is used to heat the thermic fluids such as heat transfer oils, air or water/steam, depending on the plant design, acts as heat carrier and/or as storage media. The hot thermic fluid is used to generate steam or hot gases, which are then used to operate a heat engine. In these systems, the efficiency of the collector reduces marginally as its operating temperature increases, whereas the efficiency of the heat engine increases with the increase in its operating temperature.

A. Concentrating Solar Collectors

Solar collectors are used to produce heat from solar radiation. High temperature solar energy collectors are basically of three types:

a) Parabolic trough system: at the receiver can reach 400°C and produce steam for generating electricity.

b) Power tower system: The reflected rays of the sun are always aimed at the receiver, where temperatures well above 1000°C can be reached.

c) Parabolic dish systems: Parabolic dish systems can reach 1000°C at the receiver, and achieve the highest efficiencies for converting solar energy to electricity.
B. Power Tower System

Solar thermal power uses direct sunlight, so it must be sited in regions with high direct solar radiation. Among the most promising areas of the world are the South-Western United States, Central and South America, North and Southern Africa, the Mediterranean countries of Europe, the Middle East, Iran, and the desert plains of India, Pakistan, the former Soviet Union, China and Australia. For all practical purposes, Solar Energy is inexhaustible. The yearly irradiation on total earth amounts to more than 1 billion terra watt hours. That is more than 60,000 times the global power demand [6]. By storing heat from solar radiation in storage tanks and hybridizing with fossil fuels solar plants are able to provide clean and reliable electricity throughout the day. This energy source is more evenly distributed in the Sunbelt of the world than wind or biomass, allowing for more site locations [7].

Solar power towers generate electric power from sunlight by focusing concentrated solar radiation on a tower-mounted heat exchanger (receiver) as shown in Fig. 2. The system uses hundreds to thousands of sun-tracking mirrors called heliostats to reflect the incident sunlight onto the receiver. The high accuracy 2 axis sun tracking that is required for projecting sun disk image onto the receiver is provided by a mechanical drive guided by a local control system. This local control system takes the responsibility of receiving sun position information.

It is also in charge of detecting heliostat current position and comparing it to the required to attack the receiver at a pre-selected aiming point. As a result of the integration of optics, mechanics and control, the heliostat is ready to concentrate solar flux on the top of the tower [8]. These plants are best suited for utility-scale applications in the 30 to 400 MWe range. In a molten-salt solar power tower, liquid salt at 290°C (554°F) is pumped from a ‘cold’ storage tank through the receiver where it is heated to 565°C (1049°F) and then on to a ‘hot’ tank for storage. When power is needed from the plant, hot salt is pumped to a steam generating system that produces superheated steam for a conventional Rankine cycle turbine/generator system.

From a higher control level that calculates sun azimuth and elevation values employing high accuracy correlations.

From the steam generator, the salt is returned to the cold tank where it is stored and eventually reheated in the receiver. Solar thermal power plants typically require 1/4 to 1 square mile or more of land. One silver lining of global climate change and human impact on the land is that more and more farmland is becoming unsuitable for agricultural production. This land, presumably originally chosen for its sun exposure, begs to be used for solar thermal energy production. Utilization of desertification can prove to be a boon for solar thermal real estate procurement and growth. With solar thermal technologies being developed and advanced by companies such as eSolar, Brightsource, Abengoa, Acciona, Ausr and Schott Solar, the world has a new alternative. Land use for years 2000 and beyond is based on systems studies [9, 10]. It is investigated from the recent solar thermal plant that these take yet a huge amount of land.

One of the main tasks in the conversion of solar energy into electricity by solar power plants is to work out an optimized plant design. In this type of plant, the energy collector subsystems (heliostats, field, and receivers) represent a very important part of the cost break-down structure. Therefore, the use of detailed computer programs is of great interest in order to optimize the plant design. The two main conceptual ingredients for a solar plant optimization code are:

1. Reduction of the plant design to the value of certain design variables.
2. An optimization criterion: This means having a function that computes the objective quantity (i.e. total annual power output, cost per produced power, etc.) as a function of the design variables. In general we will use the cost of the energy produced by the plant as the optimization criterion, and therefore use the terms optimize and minimize as interchangeable [11].

C. The Significance Solar Thermal Power Plants for Energy Policy

Solar thermal power plants have been barely considered by a wider public until a few years ago. This is all the more surprising since they not only offer the promise of relatively low power costs (under mass production), but also have a notable advantage over other large - scale energy technologies: owing to their rather simple structure, consisting of conventional, straightforward components such as mirrors, systems of piping, insulated containers, and steam power plant blocks, they could be produced in large numbers within a fairly short time. If the necessary preconditions for such a rapid implementation were met, the whole “energy turnaround” including the development program could be completed within 15 – 20 years [9]. For solar power plants, several aspects are important which distinguish them fundamentally from conventional power plants. These will be discussed here using the example of solar tower power plants:

a) The simplest technology (the solar field)

This applies in particular to the mirror systems, the main cost item of solar power plants. For solar tower power plants, these are the heliostats. The consequence of their technical simplicity is that their development can be carried out very rapidly. It is indeed true that the heliostat field of a solar tower power plant is exceedingly large. However, since this field is completely modular – consisting of many simple, identical...
structural elements – we can see that “large size and high cost” are by no means synonymous with “great development effort.”

b) Construction from mass - produced components

This has the consequence that the development tasks (regarding the solar field) can be concentrated more strongly on production aspects than on the technology of the heliostats themselves. The reliable predictability of mass – production costs is here an important – and for power - plant construction unique – element of the required research and development.

c) Mainly conventional technology for the remaining power - plant components

A solar power plant has a completely conventional electric power generating system (power block), as in a coal - fired power plant. The heat - storage system also consists simply of insulated containers filled with molten salt. This salt is a mixture of sodium and potassium nitrates, two materials which have been produced by the fertilizer industry in large quantities for many years. Therefore, the heat - transfer circuit (molten - salt circuit) of a tower power plant is in fact nothing new. The salt piping, the pumps, the associated control facilities, the construction materials, etc. need only to be optimized for the application at hand.

d) Separate development of the components is possible

In contrast to other power plants, solar power plants involve a relatively simple technology even for the parts outside the mirror field. A similar conclusion holds for the interactions of these plant components with each other and with the mirror field. There is no complex overall process (such as in particular in a nuclear power plant with its many safety systems, redundancy of components, and the associated intricate control facilities), but rather the individual subsystems (mirror field, tower circuits, heat - storage systems, molten - salt piping, steam circuit with its cooling system) are essentially simply connected in series, without complex feedback effects. The result is that the individual components of the plant can be operated during the developmental phase essentially independently, that is, they can be developed and tested individually. For this purpose, only certain ancillary facilities are required, which replace the remaining power - plant components for the purposes of operational testing. One requires no solar field and no receiver to perfect all these components; instead, the molten salt can be heated using a gas - fired test facility.

e) The interdisciplinary character of the development program

Development of solar energy cannot be limited – in contrast to the development of nuclear or coal - fired plants – to a particular special subject area. Nearly all the topics for research require a broad - based, interdisciplinary approach. By this, we mean that only a very small portion of the tasks lies within the field of development of solar technology in the narrow sense. Most of the tasks are situated in other areas; an example is the determination of the costs for mass production of the heliostats.

D. Assessment of Solar Towe Plant Potential in Bangladesh

Renewable energy potentials are classified into different categories, namely theoretical potential, available potential, technical potential and economic potential [15]. The GeoSpatial Toolkit provides the solar map of Bangladesh and it shows that the solar radiation is in the range of 4–5 Kwh/m2/ day on about 94% of Bangladesh. Data on monthly solar radiation (Fig. 3) were taken from NASA SSE for 14 widely distributed locations in Bangladesh using the Hybrid System Optimization Model for Electric Renewables (HOMER) software [16].

Here we consider the findings of a number of studies regarding solar PV to anticipate the potential of solar tower power plant as it is beyond the scope of this study to provide data in connection of Solar thermal plant due to lack of availability. The average annual power density of solar radiation is typically in the range of 100–300 W/m\(^2\). Thus, with a solar tower efficiency of 10%, an area of 3–10 km\(^2\) is required to establish an average electricity output of 100 MW, which is about 10% of a large coal or nuclear power plant [17]. Unlike other energy conversion technologies, solar energy technologies cause neither noise, nor pollution; hence they are often installed near consumers to reduce construction costs. Thus, identification of suitable locations for application of solar energy is practically the search for suitable rooftops and unused land. A study suggested that 6.8% (10,000 km\(^2\)) of Bangladesh’s total land is necessary for power generation from solar PV to meet electricity demand of 3000 kWh/capita/year [18]. Another study found that total household roofs area is about 4670 km\(^2\) [19] which is about 3.2% of total land area of the country. In urban area (Dhaka city) 7.86% of total land is suitable for solar PV electricity generation [20].

Fig. 3. Monthly average solar radiation in Bangladesh

BARRIERS

Solar thermal power plants need detailed feasibility study and technology identification along with proper solar radiation resource assessment. The current status of international technology and its availability and financial and commercial feasibility in the context of Bangladesh is not clear, therefore, it is still at an embryonic stage. There are plenty of barriers obstructing the widespread deployment of solar Tower plant. Different types of barriers experienced from the past are described below.

A. Policy barriers

• Lack of legal, regulatory and policy framework for market oriented

• Renewable energy based provision of modern energy services is dealt with by various ministries, agencies and institutions.

• Lengthy and difficult process for permission.

B. Technical barriers

• Lack of standards and quality control for solar tower power plant (STP) equipment.

• Local manufacturing and/or assembly of solar tower power plant components are currently very limited.

• Limited technical capacity to design, install, operate, manage and maintain STP based modern energy services, mainly as a result of lack of past activities in this new field.
C. Market barriers

- Limited knowledge on the STP market potential.
- Market distortions by subsidies or grant-based hardware installation programs.
- Government budgets for subsidizing renewable energy (RE) projects are limited as the demand for financing the various national priority areas (health, education, disaster management, etc.) is great.

D. Economic, financial and financing barriers

- High initial capital costs.
- Financial institution biases and unfamiliarity with financing STP projects.

E. Information barriers

- Lack of information about STP resources, technical information, and equipment suppliers.
- Lack of awareness of STP in public, industry, utility, financial institutions and policy-makers.
- Little empirical knowledge on the costs and benefits of the range of technologies available for providing STP based modern energy services exists.

F. Human resource barriers

- Limited expertise in business management and marketing skills.
- Limited in country capacity for STP data collection and analysis.
- Lack of expertise and services in system design, installation, operation and maintenance of renewable energy technologies.

CONCLUSION

Bangladesh Government has a vision to electrify entire country by the end of year 2020. Resource assessment, technological aptness and economic feasibility are the basic requirement of project evaluation. The solar radiation is available sufficiently over the country. The solar tower power and point focusing dish type plants are popular worldwide. The solar energy based power generating systems can play a major role towards the fulfillment of energy requirements of industry. Appropriate decision and financial aid from the government and NGOs will be the cornerstone of the solar tower power plant in Bangladesh.

REFERENCE


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Innovation in Climate Change Adaptation: Examples from Northern Bangladesh

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ABSTRACT

Impacts of climate change are so intense that traditional knowledge, which the rural communities have been using for centuries in adapting to environmental change, is not enough to fully secure livelihood of the affected community. Innovation, thus, requires both in knowledge and practice to face the challenges of climate change. By definition, all innovation must contain a degree of novelty. However, it is not just the invention of a new idea, but covert idea into practice and developing comprehensive methodology to achieve certain goals. Taking into account the observed and potential impacts of climate change on agriculture and resultant food insecurity, the RESOLVE has introduced two innovative agriculture practices in Northern district of Gaibandha and Sirajgonj based on local agro-climatic factors targeting specific needs of groups of people.

INTRODUCTION

Since the dawn of civilization, human has been adapting to environmental change for their survival. In the course of time, various technological and non-technological innovations have helped to shape and form current anthropocene. However, much has been lost to reach the current state, particularly causing irreversible modifications in the nature. Consequently, humanity has been facing revenge of nature in the form of increased frequency of natural disasters. For many no alternative remains unless adapting to this climate change. Therefore, both the policy makers and academics are recognizing climate change as the most significant environmental, economic and security threat that humanity facing.

Continuous search and research is going on developing and promoting innovative ways to respond to climate change. However, poor communities of developing countries mostly rely on traditional knowledge to find adaptive solutions to shocks. Being one of the worst victims of climate change, Bangladesh’s development has been repeatedly obstructed by floods, riverbank erosion, drought, salinity, cyclone, cold wave etc. Agricultural productions are being hampered differently for different climate change impacts and causing food insecurity for the poor. Innovation is thus essential if countries and communities are to recover from the climatic shocks.

Agriculture is one of the most affected sectors from climate change, where both direct and indirect loss incurred. Direct loss mainly occurs when different natural hazards destroy agriculture production and indirect loss is related to reduced production due to changing different parameters of climate like rainfall, temperature etc. Introducing innovative climate resilient practices for promoting sustainable agricultural and secured livelihood is very much essential for the people who are more vulnerable from climate change. With the aim of making rural communities more resilient towards adverse impacts of climate change and to increase food security the RESOLVE (Regenerative Agriculture and Sustainable Livelihoods for Vulnerable Ecosystems) is being implemented in the Northern and Central part of Bangladesh. The paper presents outcomes of some of the interventions targeted in improving livelihood of the rural poor in response to climate change.

METHODOLOGY

The study employs qualitative approaches to describe the process of intervention. Basically the RESOLVE is an on-going action research project and it is too early to have a final output. The study therefore did not attempt to draw any conclusion, rather based on two FGDs in three projects areas and observation, tries to make a rationale of introducing these innovative practices and their acceptance to the project beneficiaries.

INNOVATIONS AT RESOLVE FIELD

Sustainable management of land and water resources for intensification of agriculture and poverty reduction in many developing regions has remained one of the most challenging policy issues for a long time. Due to climate change the agro-ecosystems have been degrading more abruptly than before that gradually deprives the poor of key productive resources and affects communities whose livelihoods heavily rely on utilization of these resources. Degradation of land and water resources gradually diminishes the capacity of individual farmers and communities to undertake critical investments needed to reverse the situation. This in turn reduces opportunities for addressing nutritional and other necessities and depletes the ability to buffer shocks, thereby increasing vulnerability of livelihoods [2].

Taking into account the observed and potential impacts of climate change on agriculture and resultant food insecurity, the
RESOLVE has introduced two innovative agriculture practices for Northern District of Gaibandha and Sirajgonj. The interventions were designed based on local agro-climatic factors targeting specific needs of specified groups of people. For instance, in Gaibandha, a water scare area, Integrated Fish-Duck- Vegetable introduced to optimize water use and increased protein and vegetable supply for the poor communities using their tiny land who otherwise unable to afford their minimum nutritional requirement.; In Sirajgonj RESOLVE has introduced Compartmental Homestead Poultry to increase protein supply for the communities of Remote Island who usually take protein rarely once in a month and suffer from acute malnutrition.

A. Integrated Fish-Duck-Vegetable Cultivation (Gaibandha)

The RESOLVE has targeted to transform landless or small holders farmers of Gaibandha into dual economic agents engaging simultaneously in the production and consumption of the same commodities and investments in improving productivity and sustainability of natural resources. Hence, smallholder farmers could be referred as farm-households. Right holders at Gaibandha are characterized by small land ownerships or no lands, mostly engaged in sharecropping. With the aim of increasing income within limited homestead area, Integrated Fish-Duck-Vegetable cultivation introduced in Gaibandha where a 15 feet long and 7 feet wide pond developed for fish cultivation, the whole pond was covered with small net to protect the small fish from duck, at the dyke of pond seasonal vegetables were grown. The water for pond comes from a tube-well through a pipe, where women can supply water easily by hand pumping only half an hour every day in dry season; in rainy season the pond receives pond from rain. Another advantage of watering everyday by tube-well is it helps mixing oxygen is water that is essential for fish growth. Along with training on different components such as fish culture, duck rearing and vegetable production, RESOLVE has been providing right holders with quality seeds, improved variety of duck and fish seeds. Moreover, a tubewell has been provided and erected which serves drinking water and water for fish culture in dry season (Fig. 1).

In addition, RESOLVE is providing all kinds of technical supports such as how to use land properly, how to manage water, how to produce organic fertilizer by managing different kinds of wastes and how to market additional products. It seems right holders’ income has increased by practicing Integrated Fish-Duck and Vegetable along with increasing nutritious food consumption which implies that they are more resilient to climate change in case of livelihood options.

B. Compartmental Poultry at Homestead Area (Sirajganj)

Most of the right holders under RESOLVE are living in remote river island of Sirajganj who are landless poor, small and marginal landowner and about 75 percent of them are engaged in agriculture either as wage labourer or sharecropper. However, most of them are struggling to fulfill their household’s food and other basic demands. Moreover, due to climate change their survival becomes harder.

As most of the households are poor and marginal farmer, in case of any climatic impacts they lose their limited livelihood options and fall into deeper vulnerability. Being located in remote river island, those people remain detached from mainland for the whole rainy season. In that time, they have to rely on their own production for survival. Moreover, their income opportunity reduces drastically. To address the challenges and also to find a sustainable solution, RESOLVE has introduced compartmental poultry in Island of Sirajgonj. Poultry rearing is a traditional practice at households in rural Bangladesh. Mostly, women are engaged with the activity besides other household activities. Here RESOLVE slightly modified the traditional practice by introducing compartmental poultry cage. In each cage there would be four compartments, where in one compartment the mother poultry stays. They are transferred to another chamber when they started hatching eggs (Fig. 2).

As soon as they complete hatching, they again return to their original compartment and the eggs are used for consuming or selling. Some of the eggs are stored for breeding in another compartment. Through this separation of mother poultry from egg they become started hatching egg within short time than the normal interval period. A poultry cage occupies very small amount of area, even can be managed within household. Moreover, using this technique the household can easily increase their income three times that traditional chick rearing.

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REFERENCE

INTRODUCTION

We have reconfirmed the following fact from our recent survey carried out in a village in Bangladesh: production around the homestead can be an effective means for ensuring food and nutrition security in the rural areas. The marginal farmers and agricultural labors become jobless in-between/after the cultivation and harvesting seasons. During this period, they go through a serious financial constraint which results malnutrition among the children and women. An alternative income source is necessary to support them to get rid of this financial stress. Our survey shows that 74% of the farmers do have underutilized fallow land and they have their time to spend to produce dairy products, vegetables and fruits. A portion of the farmers (78%) are involved in selling the produces to earn an extra income. However, this is not a popular case yet. There are challenges to sell the products in the local market due to the absence of a reliable financial transaction. We carried out a survey in a village in Bangladesh to measure the underutilized land area and to reconfirm the missing link to motivate the farmers to produce vegetables in their homestead. We introduce the concept of e-village vendor, an entity to buy produces from one door and sell them to the other. The financial transaction will be done by our developed “eSebaPass” system. We also discuss how our eSebaPass can bring social, economical and environmental benefits by encouraging the masses to grow green vegetables.

ABSTRACT

In Bangladesh, most of the rural families possess a fallow land in their homestead. Some female farmers partly produce vegetables in their homestead for their own consumption and/or for generating extra income. This fallow land can be effectively utilized to produce more vegetables if the female farmers can find a link with a direct tangible financial benefit. In this work, we introduce a traditional village vendor, we call it “e-Village Vendor” with an e-wallet, we call it “eSebaPass” for a safe and reliable financial transaction. We carried out a survey in a village in Bangladesh to measure the underutilized land area and to reconfirm the missing link to motivate the farmers to produce vegetables in their homestead. We introduce the concept of e-village vendor, an entity to buy produces from one door and sell them to the other. The financial transaction will be done by our developed “eSebaPass” system. We also discuss how our eSebaPass can bring social, economical and environmental benefits by encouraging the masses to grow green vegetables.

eSebaPass: A Wallet for the Farmers for Living Green

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Homestead gardens are the cropping of vegetables, fruits, trees and condiments. These produce serves as the supplementary sources of nutrition and income. This cropping is usually done in the homestead but it can be in the land nearby the homestead that is not used for commercial farming. Different techniques of plantation are invented and are suitable in different geographical and environmental conditions.

Village Vendor, an entity to buy produces from one door and sell them to the other. The financial transaction will be done by our developed “eSebaPass” system. We also discuss how our eSebaPass can bring social, economical and environmental benefits by encouraging the masses to grow green vegetables.
vegetables almost all times. Only one of them gives it to the neighbor and the rest sell those in the market. To sell in the market, the quantity must be significant like few Kgs. Selling one egg or few hundred grams of vegetables or fruit in the market is not economically justified. The villagers sell the produces of the homestead in case of excess production as well as at the time of need; like when they don’t have income. Selling in the market is well acceptable to the society. Among those 78 families who have excess produces at different times, 73 families the man of the house sell those in the market.

A point to be noted that although selling the home produces in the market is part of the culture, but selling it to the neighbor is very rare. It is possible to sell small units to the neighbors on the contrary only large quantity is possible to sell in the market. Possibly the buyer as well as the seller is not aware of each other’s demand.

4. On an average each family earns 273 taka per month from its homestead produces. The income varies from 83 taka to 600 taka per month for different families. 50% of the respondents mentioned that because of absence of convenient way of selling the produces and due to lack of working people for production in the family, villagers are not being able to increase the production by utilizing more land. Only 2% of the respondents mentioned that they would not increase the production even if somebody comes and buy the goods in any small quantity on a regular basis. Here the point to be noted is vegetable plantation and livestock rising in the homestead do not demand extensive involvement. The female and senior members of the family can handle it comfortably. Which indicates that the return from gardening cannot provide sufficient incentive.

5. In case of urgent need, buying from the neighbors is a very rare practice. In 98% case they usually need to travel to a distance to buy from village shop and Bazar. Occasionally some of them do buy or exchange from the neighbors. The cost of items bought from some place other than the shops and Bazar is higher and quality is not good.

A. Missing Link:

From the above analysis following points could be concluded:

1. Villagers understand the fact that more production in the homestead garden means increased financial comfort and nutrition. Necessary fallow land exists, high quality & high yield seed is available in the market and various techniques related to plantation in different areas and in different seasons are also available from the local agricultural extension office. Moreover, female and senior members of the family can spare the necessary time in this regard. Most importantly the whole activity can be performed without any significant investment. Still entire available land is not being used or the technologies available in the local support centers are not being adopted by the villagers to increase production. According to the survey, the reason behind this is uncertainty of selling the produces. e-Village Vendor can meet the gap of buying the excess produces in small amount on a daily basis. Since the e-Village Vendor is doing the buying & selling business throughout the village, he is well aware of the production and demand of all villagers. Hence can advice about the salability of different produces.

2. There are two different situations when the villagers need to sell the produces. In the first case they have a small amount of vegetable or fruit that they want to sell. The amount is not enough to go to the market and spend few hours for selling. But it might be enough for a family that need such item. In this case buyer and seller are not aware of each other’s demand. So both miss the opportunity. In the second case the seller have enough produces to sell. In that case spending few hours of time in the market to sell the produces are worth enough for the seller. On the other hand, the villagers need some small amount of different items on a regular basis. May be some of their neighbors are willing to sell the same. Due to unavailability of the information the buyer travel to distant place to buy from a shop. In the first case the e-Village Vendor may appear as the matchmaker to both buyer and seller.

E-VILLAGE VENDOR

e-Village Vendor is a local residence known and trusted to the villagers. He carries the selling items in the box carrier of his bicycle and an IC card reader/writer to perform financial transaction with the villagers. The e-Village Vendor consistently maintains a credit limit of eMoney in the system from the smart center so that he can execute his business smoothly. The villagers who want to participate in this process collect eSebaPass from the Smart Center. eSebaPass is an IC card which among other services offers eMoney service. The villagers can perform secured financial transaction using this system. They can also load and spend eMoney with the e-Village Vendor. The e-Village Vendor visits the villagers' homestead to enquire whether they have anything to sell or buy. While buying from the villagers the e-Village Vendor gives a value approximately 30% lower than the selling price of the same item. The value is loaded into the eSebaPass as eMoney. No cash transaction.
B. eSebaPass & Related System:

eSebaPass is an multipurpose IC card which can offer different services sharing the same platform. The simple reader/writer used for the transaction is a cost effective means of service delivery. It is a low cost microcontroller based device possessing an inbuilt audio system. So it is possible to program the reader/writer to store the item names along with buying and selling price. The audio system confirms the transaction values to the cardholder and save the cost and hazard of printing receipts in a dusty humid climatic condition of rural Bangladesh. The reader/writer can work in both online and offline mode. Once the battery is fully charged it can perform one thousand transactions. The transaction data can be uploaded to the server periodically from the smart center.

![Fig. 3. Simple Reader-Writer & eSebaPass](image)

C. Social, Economical, Environmental Benefit of eSebaPass

People in the rural areas always bear the risk of possessing physical cash. Because of inadequate available financial service, they keep the physical cash in their home, which can be stolen. Before and after transaction they carry the cash and bear the risk of robbery. Even they used to save money in the home, which can be misappropriated by the neighbor or family members. But within the existing socio economic conditions prevail in Bangladesh, it is not possible to make the financial services available to the remote part of the country. The existing eMoney systems offered by the Banks are also not feasible for the small value transactions of 10 or 20 taka. In the backdrop of this situation we introduced eSebaPass. It is a multi service platform. Multiple service providers can offer their own services using this platform. Hence infrastructural overhead is shared by all service providers. This is suitable for small transaction values as well. We hope that eSebaPass platform would be able to offer banking services successfully up to the remotest part of the country, which will allow the villagers to receive savings, spending, remittance services using eMoney and eliminate the risk of possessing physical cash. Besides that many more ICT based services can be offered to the villagers. It is expected that this new money system will able to attract a portion of cash transaction in the rural areas. So less cash will be used in the villages. This will reduce the money management cost for the central bank due to less requirement of printing currency notes. Hence saving environment.

D. Financial Viability:

On an average 300 families live in a village. A rural family spends around 2 thousand taka every month for purchasing food. Assuming 5% of the consumption is done through our proposed system then the transaction volume of an e-Village Vendor is 30 thousand taka every month. If the difference between buying and selling price is 30% then the net income of the e-Village Vendor is 9 thousand taka per month.

CONCLUSIONS

In this work, we proposed an “eSebaPass” system to facilitate a safe and secure financial transaction system which will ultimately motivate the villagers to engage themselves in income generating activities. We carried out a survey to assess the underutilized land area that can be used for growing vegetables by themselves. It is also identified that the farmers would be willing to grow products if the payment system is guaranteed. The “e-Village Vendor” a traditional village vendor with advanced technology visit the doors of the farmers to buy fresh produces from one door and then sell them to another with real-time payment benefits. This income generating program can motivate millions of farmers to grow green vegetables which will ultimately bring social, economical and environmental benefits to the globe. There are risks that the fresh produces will have expiry date and the e-Village Vendor will be in risk when the products are not sold. An effective producer-consumer information management mechanism will be required.

FUTURE WORKS

In our business model for his survival, the e-Village Vendor need produces to buy from the villagers. So he will encourage the villagers for more production so that he can buy from them to sell it to other villagers. On the other hand the villagers will receive money. So this financial benefit will work as continuous motivation for all. After some time the e-Village Vendor would become an expert regarding the future demand and he can predict accurately about over or under production of any specific item.

In coming days we will continue the activity of the e-Village Vendor to observe:
1. The financial sustainability of the e-Village Vendor.
2. Increase in family income form the produces from the homestead.
3. Increase of per capita vegetable intake.
4. Acceptance level of eMoney by the rural people.

Eventually we will refine the business model so that it can be replicated to other villages. Hence the whole country can enjoy the benefit.

Familiarity of eMoney to the rural people will allow us to introduce different ICT based services like eCommerce to the rural population. Moreover eMoney will give security against theft and robbery. In the national perspective, the more money being transacted through eMoney, would incur more savings from currency management cost of the central bank.

ACKNOWLEDGMENT

The Smart Center project was funded by METI, Japan and System LSI Research Center, Kyushu University, Japan, ASA, Bangladesh extended logistic support. The survey was funded by Smart Center Project.

REFERENCE

[2] Food-Based nutrition strategies in Bangladesh; RAP Publication 2007/05; FAO
Integrating Engineering data with geophysics in Carbon sequestration: toward reliable estimation of CO2 saturation in Soil of Bangladesh

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ABSTRACT
The purpose of this paper is to highlight how integrating the knowledge about engineering data (wettability, relative permeability, pressure etc) with geophysical technique can reduce many ambiguities and help geophysicists to obtain a more accurate and reliable results in estimating CO2 saturation in Soil of Bangladesh. An overview of some techniques in estimating the saturation will be given including RST, but the paper will focus on seismic since it can provide estimate of saturation over the whole storage area. Several issues and ambiguities regarding seismic monitoring of saturation in carbon sequestration will be discussed along with how integrating engineering data can be useful in that perspective.

INTRODUCTION
Carbon sequestration is considered to be one of the important contributors to the potential solutions of the global warming problem by reducing the amount of CO2 emissions. However, there are several issues related to this technology that are still under discussion and development. One of the most important aspects related to the carbon sequestration is monitoring the CO2 plume in the subsurface as it develops. By doing so, the extent and saturation of the CO2 can be estimated and monitored. However, integrating engineering data and knowledge can help reducing many uncertainties and ambiguities related to the CO2 monitoring process so that more reliable results can be obtained. This paper was inspired by observing that in some geophysical studies in soil of Bangladesh, time lapse seismic was used to estimate the CO2 saturation in carbon sequestration project but the results indicate saturations that violate what the engineering data (such as relative permeability and fractional) suggests regarding the maximum possible CO2.

METHODOLOGY
A. Techniques for Estimating Carbon Dioxide Saturation
A.1. RST
This reservoir saturation tool uses the pulsed neutron capture to determine changes in saturations when brine is displaced by CO2 in saline aquifers [2]. The parameter collected by this tool is derived from the rate of capturing thermal neutrons which comes mainly from chlorine (rich in water). As CO2 displaces brine, the capturing rate of thermal neutrons decreases which allows estimation of water saturation (and hence CO2 saturation) [2]. Therefore, it is very useful to use a method that gives information about changes over the whole area, which can be achieved by seismic. There are other well logging tools that can be used (such as density and neutron porosity) but they can be used more to have qualitative analysis rather than quantitative estimation of saturation.

Fig. 1. Top most CO2 layer derived based on time-lapse seismic in Sleipner project, the color highlights CO2 saturation. Notice, that that saturation was estimated to exceed 0.9 in many locations [1].

A.2 Time-lapse Seismic
This method includes both cross well seismic and seismic survey conducted at the surface. It technique has been used widely in monitoring CO2 plume development over the sequestration area [1, 3, 4]. Time lapse seismic could be the best method to monitor the extent of the CO2 plume in a qualitative way (to monitor where the CO2 is going in the overall large picture). However, the quantitative conversion of velocity changes to saturation changes requires a rock physics model [5]. Such model describes the relation between changes in acoustic velocity and fluid substitution (changes in saturation). The paper will highlight how the knowledge about some engineering data can help to have better and more accurate use of rock physics models to estimate the CO2 saturation based on time-lapse seismic.

Fig. 2. CO2 saturation at injection well, note how different it is compared to observation well at day10 and 29.

Fig. 3. CO2 saturation at the observation well calculated from RST, the injection stopped at day 10. We can notice how the saturation increases with injection and then started to decrease as the injection stopped and the plume started to develop. Note that saturation calculated in this case represents the zone very close to the pore hole.
B. Integrating Engineering Data with Geophysics to obtain more Accurate Estimation of Carbon Dioxide Saturation

As mentioned earlier, inverting velocity changes observed from seismic to obtain CO2 saturation depends mainly on pressure changes, rock and fluid properties, and style of saturation.

B.1 Pressure changes

Pore pressure and effective pressure in the storage will change as a result of injecting CO2. Such pressure changes (if were large) can induce changes in the acoustic velocities. That is, as CO2 replaces some water, the resultant compression velocity change will not be only a result fluid substitution but also pressure changes. Dependence of velocity on pressure can be estimated using lab measurement or theoretical models [5], but it is out of the scope of this paper. The question here is how to know the changes in pressure as result of CO2 injection and the answer can be obtained from the engineering data. Downhole pressure can be measured before and after injection which can be then used to obtain the pressure build up. Simulation can be used to get information about pressure changes over the whole storage area. If we would like to test the feasibility of monitoring (before injection), then the pressure build up can be estimated using multiphase extension of Darcy’s law combined with the Buckley Leverett solution [6]. Once the pressure build up is known, then the corresponding change in velocity can be estimated. Such change in velocity should be removed from the total velocity change before proceeding with fluid saturation calculation.

B.2 Fluid and rock properties

The most common rock physics model used is Gassmann [5]. An input, that is needed to invert for the saturation of fluids, is the fluid properties (bulk modulus and density). Geophysicists often use Batzle and Wang model to find the bulk modulus of brine and CO2 separately at the reservoir pressure and temperature [7]. Although the supercritical CO2 is immiscible in water, a small portion (around 5%) will be dissolved as shown in Fig. 4 [8]. This chart gives the solubility in pure water, and for brine it will be slightly smaller depending on its salinity [8]. The brine bulk modulus will decrease by about 0.3% when dissolved CO2 is included [5]. Since rock physics models assume no alteration in the rock frame due to fluid substitution, it is then important to model the geochemical effects and their impact on acoustic velocities (velocity decreases as porosity increases). This should be done before using rock physics model to invert for saturation. Fig. 5 [9] demonstrates how the change in porosity can affect the bulk modulus of the rock when CO2 replaces brine (compared with the case when porosity changes are not considered). From this figure, we can notice that for a given CO2 saturation, the rock bulk modulus can have different possible values depending on whether porosity and rock frame alteration have happened or not. Porosity enhancement will decrease the velocity.

Fluid sampling in the storage reservoir can give information about the changes in the fluids compositions and pH which can be used to infer geochemical changes in the rocks.

B.3 Style of saturation

If both pressure and geochemical impacts were counted for in velocity changes, then the remaining velocity changes (and probably the largest) will be due to fluid substitution (CO2 replacing brine). CO2 has lower density and bulk modulus compared to brine and hence, the velocity will decrease when CO2 displaces the brine. The drop in compressional velocity (Vp) can be then inverted to CO2 saturation using a rock physics model. However, there is a significant ambiguity that this inversion suffer from, which is the nature (or style) of saturation. Two possible styles exist which are: uniform and patchy saturation. Fig. 7 demonstrates the two different styles of saturation. It is clear that, the classification of those styles is related to the scale of saturation. This can be characterized by critical diffusion length (Lc= \sqrt{k Kfl/f µ}) where k is permeability, Kfl is the bulk modulus of the fluid substituting (CO2 in this case), f is the frequency of seismic (≈ 100 Hz) and µ is viscosity. If the patch size was larger than Lc, then we will have patchy saturation whereas uniform saturation happens when the size is less than Lc [5]. Different fluids will feel different pressure as the seismic wave goes through the rock.
Based on Fig. 9, we can notice the difference in seismic response between uniform and patchy saturation especially at CO2 saturation up to 40%. This can introduce an ambiguity when interpreting CO2 saturation from time-lapse seismic. For example, as shown in Fig. 8, an observed Vp decrease of 100 m/s will correspond to around 20% CO2 saturation (point B) velocities, observed from time-lapse seismic, to CO2 saturation.

B.3.1 Wettabibility and relative permeability

Reservoir formation rocks are water wet and hence, brine tends to attach itself to the solid surface more than CO2. Also, water mobility is much lower than that of CO2 which means that it will be difficult to displace all water. Fig. 8 shows an example [12] where the relative permeability to water becomes zero around 45% water saturation. This means that we will have at least 45% irreducible water that cannot move. Moreover, when plotting CO2 fractional flow rate versus CO2 saturation (data from [12]) as shown in Fig. 10, we can notice that the CO2 fractional flow rate is equal to one (zero water fractional flow rate) when CO2 occupies around 55% of the pore space. Principally, this experimental result from suggests that the CO2 cannot exceed 55% since the water fractional flow will be zero. This piece of information can be useful to constrain the inversion process to obtain CO2 saturation from velocity changes. If we were dealing with similar rock and the inversion result gives saturation much higher than 55% (especially away from the wells and after the injection stopped), some of the velocity changes might be related to some artifacts (noise...etc) or geochemical impacts that were not counted for. Moreover, for this formation rock, CO2 saturation is expected to be 40-45% on average in the sequestration site. Again, this can be used to constrain and validate the estimation of CO2 saturation from seismic.

The spatial variation in the rock properties can also explain the difference between saturation observed at injection and observation well. Fig. 11 demonstrates the presence of large patches but what about the saturation distribution inside each large patch, it is really uniform? Let us revisit the definition of critical diffusion length ($L_c = \sqrt{\frac{k}{f \mu}}$), which characterizes the size of patch, above which saturation can be considered patchy and it will affect seismic response. We can notice that it depends on both rock and fluid properties. The presence of permeability anisotropy may result in having different $L_c$ at different zones. Moreover, one may infer that permeability anisotropy may result in some preferential paths for the injected fluid and hence, more patchy behavior. The question is how to infer such heterogeneity and what scale are we talking about. According to Mavko et al. [5], $L_c$ varies usually in reservoir rocks from 2 to 30 cm depending on fluid and rock properties. Therefore, such length might be observable at core scale and hence, uniform or patchy saturation might be noticed.

B.3.2 Sub-core scale heterogeneities and permeability anisotropy

Perrin and Benson [12] investigated in their study the effect of sub-core scale heterogeneities on CO2 distribution. It was found that sub-core scale heterogeneity has strong influence on the spatial distribution of CO2 and it may cause channeling through the porous medium. Fig. 12 demonstrates maps of CO2 saturation inside rock samples with different heterogeneity, both were heterogeneous but the second sample (sample B) has larger scale features (low permeability
and porosity bedding parallel to injection direction) [12]. For the first sample (A), high porosity layers correspond to high CO2 saturation and vice versa. On the other hand, for the second sample (B), some high porosity layers are isolated from the inlet face of the core by low porosity layers. The CO2 distribution in this case was largely affected by the orientation of the bedding in the rock (permeability anisotropy) where CO2 bypassed large portion of the core. In this case, the displacement efficiency was limited by such heterogeneities and the residual brine saturation stays higher that of the first sample [12]. Irreducible brine saturation in sample A was found to be 0.44 while it was 0.62 for sample B [12]. That is, larger heterogeneity and permeability anisotropy feature can result in higher irreducible brine saturation. As a result we may infer that sample B tends to have more patchy saturation pattern compared to sample A.

Fig 12. 3D maps produced using CT scan; A and B showing porosity map for two different samples while A’ and B’ show the CO2 saturation distribution at steady state of CO2 fractional flow of 1. Injection was carried out from the right side of the cores [12].

RESULTS

From all the analysis it can be stated that the consistent with the amount of irreducible brine saturation for both samples as mentioned earlier. That is, sample B has more irreducible water which suggests more patchy saturation pattern compared with sample A. Both samples however seem to exhibit patchy saturation pattern although at different extent. This can be again due to the presence of heterogeneity and low permeability (and porosity) zones with certain orientation where CO2 may not displace brine.

Table 1: summary of parameters and results used to obtain the critical diffusion length for both samples, viscosity was obtained from NIST webbook at the conditions specified below.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SAMPLE (A)</th>
<th>SAMPLE (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeability</td>
<td>45md</td>
<td>430md</td>
</tr>
<tr>
<td>Experimental Conditions</td>
<td>T=63C P=12.4 MPa</td>
<td>T=50C P=12.4 MPa</td>
</tr>
<tr>
<td>CO2 viscosity</td>
<td>3.18E-5 Pa.s</td>
<td>4.4E-5 Pa.s</td>
</tr>
<tr>
<td>Bulk modulus of CO2</td>
<td>0.1 GPa</td>
<td>0.1 GPa</td>
</tr>
<tr>
<td>Calculated Critical diffusion length (Lc)</td>
<td>4 cm</td>
<td>9 cm</td>
</tr>
</tbody>
</table>

Uniform fluid saturation might be then expected to happen when the rock is homogeneous or when there is no permeability anisotropy. Examining the previous statement, Lc was calculated for a relatively homogeneous Berea rock and compared with the fluid saturation from the CT scan as demonstrated in Fig. 13. The rock properties and CT scan was obtained from Zuo et al. [13]. From Fig. 13, we can notice that the brine and CO2 saturation are present in a scale smaller than Lc which suggests a uniform saturation pattern for such a homogeneous sample.

Fig. 13. CT scan of the CO2 saturation of a Berea sandstone sample [13]. The Lc of this rock is shown in a black bar. Note that the different saturation patches are distributed randomly within the rock (represented by different colors) where patches are smaller in size compared to Lc. This suggests a uniform saturation pattern. This sample will be referred to as sample C.

DISCUSSION

This paper represents the results for typical irreducible water saturation, fractional flow, sub-core scale heterogeneity analysis and permeability anisotropy suggest that the saturation style tend to be patchy in general in soil of Bangladesh. Rocks usually exhibit sub-core scale heterogeneity and permeability anisotropy which can limit the displacement efficiency and result in patchy saturation as CO2 occupies preferentially some large connected pores. The presence of large heterogeneities and permeability anisotropy features can increase the irreducible water saturation and cause channeling in the distribution of CO2. The comparison conducted between the critical diffusion length and CO2 saturation CT scans revealed that the saturation tends to be patchy.

CONCLUSION

This paper highlighted some aspects related to CO2 saturation estimation in carbon sequestration based on time-lapse seismic in the soil of Bangladesh. It discusses how engineering data and concept can provide useful information regarding some factors that affect the inversion from velocity changes to obtain CO2 saturation in developing countries, like Bangladesh. The following point to be considered:

- Downhole pressure measurement or Buckley Leverett solution (if measurements are not available) can be used to obtain the pressure build up whose impact on velocity should be removed from the seismic 4D signature.
- Fluid sampling in the storage reservoir can give information about the changes in the fluids compositions and pH which can be used to infer geochemical changes in the rocks.
- Core-flood experimental studies can provide useful data average maximum and average expected CO2 saturation which can be used to constrain and validate the saturation estimate from seismic.

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REFERENCE


Cumulative Environmental Impact Assessment of Narail Sub-Project
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ABSTRACT
Cumulative environmental impacts are caused by the aggregate of past, present, and foreseeable future actions. Traditional environmental impact assessment (EIA) usually focuses on single-project development undertaken by single proponents in a narrowly defined physical area and defined time frame but cumulative impact assessment (CIA) means the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects and the effects of probable future projects. That is why cumulative impact assessments especially for water sector project are important and essential. This study has assessed cumulative impact for the compartment one of Southwest Area Integrated Water Resources Management Project (SWAIWRMP) implemented in Narail, Bangladesh. This study screened twelve environmental parameters which are of cumulative in nature. However, detail assessment was done for six parameters based on the importance and available information. The analysis shows the intensity of the impact i.e. additive or multiplicative as well as compare the effect with single project impact. The EIA carried out by SWAIWRMP eventually did not address the cumulative environmental impact. Therefore attempt was taken in this study for investigating such impact and to suggest the mitigation measures to minimize the negative impact due to CI related to water resources.

INTRODUCTION
The Narail sub-project (SP) is located in Narail and Kalia Upazila of Narail district and Abhonagor Upazila of Jessore district. The SP lies between latitude 23º15’ N and 22º55’ N and longitude 89º24’ E and 89º36’ E and is bounded by the Chitra River to the east and Bhairab River and Afra Khal to the west. The study area is under Tularampur Union and denoted by Compartment one. Southwest Area Integrated Water Resources Planning and Management Project aims to rehabilitate and upgrade the existing flood control and drainage/irrigation (FCD/I) schemes in the southwest region of Bangladesh, so as to achieve their maximum development potentials in terms of agricultural and fishery production and incomes of beneficiaries in a sustainable manner. Study area of this research is 1804 ha and situated within Narail Sub-Project in compartment no one. Beside the Afra River six regulators exist in Tularampur union of compartment one. This study area is located in the upstream of the Afra River. There are a number of existing and proposed infrastructures in the Sub-Project area; which might have cumulative impact. Objectives of this study are; a) to identify important environmental parameters for SWAIWRMP, b) to screen parameters which may have cumulative impact, c) to assess cumulative impact of different parameters, and d) to suggest mitigation measures which will address cumulative environmental impacts.

From the study, it has been seen that almost every parameters are cumulative in nature. Cumulative impacts are, in fact, the consequence of many interacting factors; both in the past and the present, and their combined effects are not always well understood according to Abraham (1998) [1]. The impact on capture fisheries is multiplicative in nature and it is negatively affected by the sub-project interventions. Regarding wetland, soil quality and flooding all are affected negatively by the sub-project intervention and the impact of these parameters on people’s livelihood is quite tangible. However, irrigation facility and employment opportunity have positive impact on people’s living. Crop production and employment opportunity of the study area had been increased significantly after completion of regulators. The environmental management plan had been given with potential measures with a view to mitigate the negative impacts. The study made few recommendations for wellbeing of the project stakeholders and future follow up study and research. At last it can be concluded that a project should be taken after conducting cumulative impact assessment rather than conducting traditional EIA considering impact of the single project.

MATERIALS AND METHODS
Primary and secondary data were collected through focus group discussions (FGDs), key informant interview (KII) and individual interview was conducted as well as secondary literatures were reviewed to assess achievement of these objectives and also to assess the cumulative impacts. Besides some field assessment was done e.g. fish catch assessment. Several field visits were performed to get field data and to know the stakeholders perceptions, to observe the physical situation and to understand the project as well. The methodology for analysis of environmental impacts was developed following EIA Manual (FPCO, 1995) [2], Guidelines on environmental issues related to physical planning, Local Government Engineering Department (1994), and also through reviewing related literature.

Among parameters, CIA was analyzed for six parameters based on its importance to the people of the study area and for which data is available. Impacts by parameters which are cumulative in nature had been analyzed first by considering individual project. After that impacts by multiple projects were considered. Qualitative information, conceptual arguments and data is available which was followed for CIA of those parameters. In summary, following steps had been followed for CIA: identification of problem with people participation and scoring. Selection of important environmental parameters and cross verified in study area. Parameters which are cumulative in nature were analyzed by network analysis as well as arguments were given. Based on people view and importance; parameters were selected for cumulative impact analysis (CIA). Cumulative impact was analyzed by using conceptual analysis and framework [5], hydrological analysis with both qualitative and quantitative information. Mitigation measures had been suggested based on the results of the study.

RESULTS AND DISCUSSION
At the beginning, important parameters were selected from secondary literatures and questionnaire survey [3]. By reviewing existing problems in the study area, following parameters given in Table 1 were selected and cross verified during the first field visit. After primary selection, field reconnaissance survey helped to find out the relationship/importance of the parameters within the study area. For more verification, four FGDs had been conducted to check the accuracy of the selected parameters and to select new parameters, which study area people may consider important.

Second objective of the study is to screen parameters which are cumulative in nature. Network analysis and interaction diagram was done to understand the inter relationship among parameters. Network analysis also helped to realize the consequences of the project activities. Rationales [4] are provided below to describe how cumulative impacts are occurring in the study area and how these parameters are considered cumulative in nature.
Capture fisheries are decreasing day by day because no mitigation measures have been taken after negative impact on capture fisheries occurs due to a regulator. Again a new project was taken without taking any mitigation measures to revive this sector. Siapagla regulator was constructed in 1998. It affected capture fisheries both directly and indirectly. However, without taking mitigation measures another new gate namely Debipur was constructed in 1999. That is why in this area cumulative impact is occurring on capture fisheries in a sense that impact of Debipur regulator is now adding with the impact of Siapagla regulator. As a result, more wetlands are shrinking, fish habitat is decreasing. As farmers at present allow only limited water to enter into the project area that’s why interconnection of wetlands during monsoon has been lost.

### A. Aggregate of Past, Present and Future Actions
- Capture fisheries are decreasing day by day because of following reasons:
  - Decrease of habitat due to flooding
  - Decrease of wetlands
  - Increase of sediment trapping
  - Increase of waterlogging
  - Decrease of water
  - Decrease of water body
  - Decrease of fisheries

### B. Cumulative Impact Doesn’t Follow Political or Administrative Boundary
Cumulative impact mainly occurs according to basin wide boundary. That is why all wetland, irrigation, capture fisheries and aquatic habitat outside of project boundary are also affected because of project activities. Cultivable fields in Madhurgarea scheme area are washed away in monsoon season because of spilling of flood water caused by the impact of the adjacent project namely Boramara and Debipur regulator. It can be termed “flood risk transfer” by establishing regulator in the flood affected area namely Madhurgarea. Wetlands of this area are also decreasing because of regulators on both sides. For this reason a new regulator is constructed in Madhurgarea to avoid temporary flooding. Regulators don’t allow water to enter into the project area which decreases salinity intrusion and benefitting crop production beyond the project area as well. That is why people outside the project area are also getting additional crops because of this project.

### C. Effect of Different Activities on Single Component
Different activities such as using fertilizer and pesticides for cultivation, decrease of wetlands and water flow, disruption of tidal effect, increase of sediment trapping all together affect capture fisheries and aquatic habitats negatively. Moreover, reduction of salinity intrusion and better scope for water conservation help irrigation and culture fisheries. As a result employment opportunities are increasing day by day due to better crop production and culture fisheries. There is mostly fertile and high land in Chundilari char area. However, soil fertility is decreasing due to use of excess chemical fertilizer. Moreover, farmers are cultivating lands constantly as land has become protected now from sudden flood. That is why impact on such parameters irrigation, culture fisheries, and employment opportunity are also cumulative in nature because different activities are affecting them at a time.

### D. Agriculture and Fisheries Practice over the Year’s Affects Environment
Traditionally farmers practice same cultivation techniques and use chemical fertilizers, pesticides, hybrid seeds to get more crops. Soil quality is constantly affected negatively because of following same practices which are not affirmative for environment and for not taking any measure to reduce negative impact. It is one of the causes of cumulative impact. As fisherman community are poor and not aware about environment that is why they always catch mother fish and don’t consider the fish breeding period. All of those causes synchronize together and for this reason certain fish species are being lost forever. This is also one of the causes of cumulative impact in the study area.

### E. Repeated Removal of Materials or Organisms Affects Certain Feature in Environment
Though some fish species are endangered species e.g. royna, meni etc in our research area, fishermen continuously catches those fishes instead of conserving them. Crops are being cultivated round the year and soil does not get any rest. Repeated activities are affecting many environmental parameters especially soil fertility, capture fisheries and aquatic habitats.

### F. Repeated Environmental Change is also one of the Causes of Cumulative Impact
In our study area, Farakka barrage disturbs water flow in Afra River which is one of the causes of rising bed in Afra River. That is why sudden flood occurs. Many species such as chital fish, hilsha fish are disappearing because it needs deep water to sustain. Livelihood of people (boatman, fisherman), and landscape are changing. GW table is lowering day by day as there is less water in the river basin. This scenario started after 1972 and same situation continues over the year. That is why impact on landscape, navigation, soil quality, GW table, flooding is considered cumulative in nature.

### Table 1. List of important parameters

<table>
<thead>
<tr>
<th>Group</th>
<th>Name of the parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic Ecosystem</td>
<td>Capture fisheries</td>
</tr>
<tr>
<td></td>
<td>Culture fisheries</td>
</tr>
<tr>
<td></td>
<td>Aquatic habitats</td>
</tr>
<tr>
<td></td>
<td>Water body or wetland area</td>
</tr>
<tr>
<td>Human interested related parameter</td>
<td>Irrigation facility</td>
</tr>
<tr>
<td></td>
<td>Employment opportunity</td>
</tr>
<tr>
<td></td>
<td>Navigation</td>
</tr>
<tr>
<td></td>
<td>Landscape</td>
</tr>
<tr>
<td>Physico-chemical parameters</td>
<td>Soil quality</td>
</tr>
<tr>
<td></td>
<td>Flooding</td>
</tr>
<tr>
<td></td>
<td>Water logging</td>
</tr>
<tr>
<td></td>
<td>GW table</td>
</tr>
</tbody>
</table>

### Table 2. Root causes of decreasing fish production

<table>
<thead>
<tr>
<th>Root causes</th>
<th>Responsible</th>
<th>% of impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreases of wetland</td>
<td>Due to project activity</td>
<td>50</td>
</tr>
<tr>
<td>Canal bed rises, length and width decreases and it can’t accumulate</td>
<td>Human activity</td>
<td>20</td>
</tr>
<tr>
<td>water as per requirement of capture fisheries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses of excess chemical fertilizer and</td>
<td>Due to external</td>
<td>10</td>
</tr>
<tr>
<td>pesticides</td>
<td>project depth for certain fish species</td>
<td></td>
</tr>
<tr>
<td>Catches of mother and egg carrying fish</td>
<td>Impact of adjacent project</td>
<td>20</td>
</tr>
<tr>
<td>River doesn’t have adequate water depth for certain fish species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreasing of wetland, rising of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>canal bed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source: Feasibility report of Siapagla SP and Madhurgarea SP.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### G. Cumulative Impact Assessment for Capture Fisheries
Fish enters into the beel area through canal in Chaitro-Boishakhil and gate remains closed. In Kartik people get much fish because of dewatering from the canal. Sometimes local people don’t catch fish for certain periods inside the canal. It helps to increase fish production. Capture fisheries mainly breed in wetlands, deep pockets etc. As wetland is decreasing so capture fisheries are also diminishing. They are related with each other. Production of capture fisheries are decreasing year by year as river does not have enough flow, regulator controls water, wetlands are used for irrigation, population is increasing, poverty is not decreasing rapidly, and consequently jobless poor people are catching mother fish and fingerlings. These factors all together are responsible for declining of capture fisheries.

### H. Sample Calculation of Assessing Cumulative Impact
Given, Post project production of fisheries in Siapagla khal = 7.20 ton. Existing production of fisheries in Siapagla khal = 3 ton

\[
\text{Change in production} = (7.20 - 3) = 4.20\text{ tons}
\]

**Source:** Feasibility report of Siapagla SP and Madhurgarea SP.
Same procedure has been followed for the calculation of all parameters. After getting percentage value following scale is used to analyze cumulative impact on capture fisheries. Production of capture fisheries after project became less than half before pre project condition (projection on after project condition is also showing the same results). Moreover species are also decreasing due to several causes (Table 2). In this case multiple impacts on single component are seen. To analyze cumulative impact, impacts of other project/activity on respective project and existing field condition in 2008 were identified through FGDs in study area.

Table 3. Decreasing of fish production due to individual and cumulative impact (2008)

<table>
<thead>
<tr>
<th>Name of the SP</th>
<th>Impact due to respective project</th>
<th>Impact of other projects/activity on respective project</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sia pagla (1998)</td>
<td>-3</td>
<td>-1</td>
<td>-4</td>
</tr>
<tr>
<td>Madhurgarea (2008)</td>
<td>-3</td>
<td>-2</td>
<td>-5</td>
</tr>
<tr>
<td>Boramara (1995)</td>
<td>Data is not available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panu (2002)</td>
<td>-3</td>
<td>-1</td>
<td>-4</td>
</tr>
</tbody>
</table>

Source: FGD of this study

Formula: Total impact = sum of individual impact ± impact of other projects

Column 4 = Col 2 + Col 3

Scale used for assessing the cumulative impacts related to % value:

<table>
<thead>
<tr>
<th>&gt;0-20%</th>
<th>&gt;20-40%</th>
<th>&gt;40-60%</th>
<th>&gt;60-80%</th>
<th>&gt;80-100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 4. Summary of result showing CI of selected six parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before project</th>
<th>Projection of single EIA</th>
<th>Existing condition due to CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture fisheries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish production from floodplain</td>
<td>7 ton</td>
<td>Floodplain = 2.80 ton</td>
<td>Floodplain = 7 ton</td>
</tr>
<tr>
<td>permanent water body = 18.66 ton</td>
<td></td>
<td>永久水</td>
<td>洪水</td>
</tr>
<tr>
<td>Floodplain area (F2+F3) = 86.65 ha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent water body = 7.53 ton</td>
<td>3.51 ton</td>
<td>Floodplain = 3.51 ton</td>
<td>Floodplain = 7.53 ton</td>
</tr>
<tr>
<td>Irrigation facility</td>
<td>10518.24 ton</td>
<td>15616.7 ton</td>
<td>18637.36 ton</td>
</tr>
<tr>
<td>Soil condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil condition was good and didn't require much fertilizer</td>
<td></td>
<td>Soil fertility was decreased and it requires more chemical fertilizer and pesticides</td>
<td></td>
</tr>
<tr>
<td>Flooding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood occurred every 2 and 3 years during monsoon</td>
<td></td>
<td>Structures will help to control flood</td>
<td>Flood risk transferred to the adjacent area</td>
</tr>
</tbody>
</table>

I. Justification of impacts of other projects on respective project

Qualitative information from FGD shows that production of capture fisheries decrease after implementation of individual project than earlier period available amount. Qualitative information converted to numerical value for analysis. Nature of impact on capture fisheries is multiplicative. If one breeding season of natural fish affects it decreases production multiplicatively. Adjacent project mainly affects main project area regarding capture fisheries by decreasing wet land area and disturbing fish breeding route.

CONCLUSION

In this study it has been found that availability of capture fisheries has become less than half of the pre project situation and some species have been lost due to cumulative impacts. CI is about 50% of total impact and multiplicative in nature. Decreasing trend of wetlands due to respective and other projects show negative impact on wetlands. After completion of all regulators wetlands will totally disappear in the SP area and CI is 60% of total impact and additive in nature. Impact on irrigation facility is positive. Crop production increases drastically after implementation of respective projects. Moreover other projects also facilitated to increase crop production directly and indirectly beyond project area. CI is 40% of total impact and additive in nature. Employment opportunity was generated during construction of regulator and also after completion of regulator. Impact on employment opportunity is positive in the SP area. It is additive in nature. Flooding is the fact of implementing project for which new projects are demanding in the study area. Scenario of flooding shows us that mitigation measures and CI should be analyzed properly before implementing new project. The consequences of flooding are multiplicative in nature.

ACKNOWLEDGEMENT

The paper was written based on the M.Sc thesis conducted under IFWFM, BUET. Author would like to thank especially SaciWATeRs for giving opportunity to hold a prestigious award SAWA Fellowship and for funding to complete research work successfully. In addition, LGED, IFWFM and CEGIS helped to carry on the research work by providing data.

REFERENCE

Recognition of Climate Change Induced Migrants under Legal Framework: Looking for an Appropriate Way

Badiul Alam

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ABSTRACT
In the 21st century climate change is considered the prime factor behind present and mostly future migration. But unfortunately the impact of climate change on migration was not duly addressed in any legally binding international instruments. The paper focuses on the absence of globally binding legal protection for the climate migrants as well as for the adoption of such an instrument that will encompass unheeded issues of migration. The migrants induced by climate change needs a very special protection under an international legal instrument by which the developed countries will be under compulsion for providing them a special treatment distinct from ordinary migrants and the political refugees. Sometimes in many literatures the terminologies such as “environmental” or “ecological refugee”, “climate refugee”, “internally displaced persons”, “migrant etc. overlap with each other and as a result, because of wrong application of terminology the migrants induced by climate change get deprived of the rights that they are supposed to be entitled.

INTRODUCTION
The intergovernmental panel on climate change (IPCC) estimated that by 2050, 150 million people around the globe could be displaced because of climate change factors. Professor Norman Myers of Oxford University argued that “when global warming takes hold there could be as many as 200 million people displaced by 2050 by the disruptions of monsoon systems and other rainfall regimes, by droughts of unprecedented severity and duration, and by the sea level rise and coastal flooding. Again, Stern review on the Economics of climate change in 2006 and a Christian Aid report in 2007 estimates displacement of respectively 200 million and 250 million people by climate change related reasons. The human rights of the climate induced migrants must be given a special sanction taking into the account of the distinctiveness of the climate migrants from the regular migrants.

IMPACT OF CLIMATE CHANGE IN MIGRATION: A CASE STUDY OF BANGLADESH
One of the most affected victims of climate change is Bangladesh. It is especially vulnerable because 30% of its land falls in the coastal belt where nearly 35 million people live in. Two thirds of the land of Bangladesh is less than 5 meters in height from sea level. Once the people living in the coastal belt are forced to move to the plain land due to climate change, how the country with a high density can accommodate such a large number of populations in this small land. The Global Climate Risk Index 2011 recognized Bangladesh as the country most vulnerable to extreme weather events and the one most affected in the period of 1990-2009. The IPCC estimates that climate change will contribute to 0.6 meter or more of global sea level rise by 2100. According to a World Bank report, Bangladesh will face 30 cm and 50 cm sea level rises in 2030 and 2050 respectively. Coastal inundation, sea water intrusion into fresh water resources and soil salinization are likely to compromise fresh water availability and adversely affect coastal agriculture. Since it is agriculture based country, the affect in agriculture directly injures livelihood of the people. The salt water intrusion from sea level rise in low lying agricultural plains could lead to 40% decrease in the food grain production. Then it becomes the question of existence and livelihood. A recent study has revealed that sea levels in the Bay of Bengal have risen much faster over the past few decades. As a result, low-lying and small islands are at great risk. Recent satellite images show that the New Moore Island or South Talpotti Island in the Bay of Bengal has disappeared due to sea level rise. If the recent trend of climate aggression does not change Bangladesh alone will outnumber the total number of the current refugees worldwide.

CLIMATE MIGRANTS: LOOKING FOR A LEGAL RECOGNITION
The tragedy for the climate victims who are forced to migrate is that they are called by different agencies by different terminology. The different terminologies used to address them are “ecological and environmental refugees”, “climate refugees”, “climate change migrants’, “environmentally-induced forced migrants” etc. The use of the term “environmental refugees” or “climate change refugee” is not justified because the particular term “refugee” is commonly used and legally defined in the 1951 Refugee Convention. According to Article 1A(2) of the 1951 Convention and Protocol Related to the Status of Refugees, the term refugee shall apply to any person who owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality. The basic requirement to fall under the definition of “refugee” there should be a well-founded fear of persecution and of course, persecution is something which is obviously political in nature. The basic distinction between a refugee and a migrant caused by climate change is that the latter does not move because of fear of persecution. Again to qualify as “refugee” as per the 1951 Convention, people must cross international border. But it is not the fact that climate victims leaving the place of their habitual residence are always moving beyond state boundary rather at first step, they move to the other places inside the country. On the other hand, by definition, the internally displaced persons (IDP) are they who flee natural and man-made disasters and remain in their country. But the climate driven migrants of small, low lying and island countries are mostly victim of disasters caused by developed, industrialized countries. Moreover they need to cross border unlike IDP. The attempt to put the “climate related forced displaced persons” into the category of “internally displaced persons” as well as to the “political refugee” will undermine the special protection required for these climate victims.

DO THE EXISTING INTERNATIONAL INSTRUMENTS ADDRESS THE CRISIS?
Still there is no room for the climate related forced migrants in the existing legal framework. The UN Refugee Convention does neither cover nor comply the core characteristics of the climate change induced migration crisis. Since the climate related induced migrants does not fall in the definition of refugee as well as IDP, UNHCR does not have mandate to address these unattended group. On the other hand, United Nations Framework Convention on Climate Change (UNFCC)
has not clearly said anything about migration issues either internal or cross border resulting from climate change. So it is crystal clear that existing international instruments do not rightly address the needs of climate victim from migration perspective.

CONCLUSION

Many people of the globe will be losing their place of birth, motherland, identity, nationhood, ethnicity, history, tradition, values and customs due to climate change. Migration resulting from climate change will be remaining no more a myth but reality soon. Now it is high time to adopt a sustainable approach by creating an international and regional legally binding framework so that the human rights such as right to life and livelihood which are very much inherent to a human being by virtue of being born as a human creature is guaranteed for that unfortunate group of climate induced forced migrants.

REFERENCE

ID 10

International Law and the environmental challenge in Bangladesh: the role of the law schools

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ABSTRACT
The integration of environmental issues in Bangladesh into the wider framework of human rights can provide results, if these rights are taught in a practical way. The creation of legal clinics in Bangladesh, and environmental legal clinical programs in law schools will, based on the example of other Asian countries, provide judicial remedies to a population that is suffering from international environmental law violations. However, because of the situation of legal education in Bangladesh, and the limited involvement of the country in international law instruments, the creation of remedies through clinical programs has a long way to go. The potential for environmental progress in legal education remains huge.

INTRODUCTION
The environmental situation in Bangladesh has been widely documented as one of the most preoccupying in the world. In this paper I will try to present one of the approached to the environmental law that has been neglected so far in Bangladesh: the use of law school clinical programs.

Not only the degradation of the environment resources is widespread and accelerating, but the consequences for the population are among the world's most dramatic. The reliance of the majority of the population on natural resources, either water or forests, creates a development trap for which a multidisciplinary approach, and combined efforts, are necessary.

The fight for the environment can often be summarized by a fight for the preservation of resources. Financial and human resources are necessary at all steps of environmental advocacy; whether judicial or political remedies are sought, they imply costs and no guarantee of benefits, making environmental advocacy, and trans-disciplinary networking, risky choices.

Clinical programs can provide elements of answer to the resource scarcity and environmental degradation that is affecting Bangladesh. Clinical programs are legal offices set up and run by law schools, aiming at offering to the local population legal advice and representation that they cannot afford, whilst providing first-hand professional experience to law students. Typically, large and interesting cases are selected by law professors, who then divide the class into groups who will focus on different aspect of the same case. Through this extensive access to human resources, law school all over the world achieved considerable success in the field of environment. Because complex cases require teams of lawyers focusing on different areas, they often imply legal fees that victims and litigants cannot afford, or that would add to the cost of environmental degradation a heavy financial burden.

The use of legal clinics, in the particular context if Bangladesh environmental protection, presents challenges and opportunities. The opportunities are to be assessed in a comparative perspective, not only with neighboring countries and countries with similar environmental issues, but in a wider perspective that will include elements of environmental law enforcement in developed countries. Indeed, environmental issues are affecting mainly poor populations, regardless of the level of the development of the larger community or the country.

ROLE OF LEGAL CLINICS IN HUMAN RIGHTS, ENVIRONMENT, AND THE RULE OF LAW
Law students have skills and knowledge, and with the coordinating capacity of the classroom setting, can deliver powerful judicial remedies and advice to victims and to the community. From the 70s, clinical programs in the United States and elsewhere expanded their scope of action to include international law. Research on state compliance to international law suggest a strong link between transnational legal advocacy and compliance [1]. The same claim is made about the positive link between environmental protection and legal clinics [2]. The development of legal clinics produced quantity of research on the subject, in an attempt to evaluate the origin of the movement, to determine the relations with other forms of advocacy, and to highlight good practices and possible areas of improvement [3].

In Asia like everywhere else, law students have taken up human rights, immigration, environment and other public-interest related issues. Legal education in Asia is booming, and evidence of the impact of a combination of human rights approaches to environment with clinical legal education makes a strong case for the development of such programs. The implementation of such programs present two challenges: the funding, and the integration of clinical environmental programs with a theoretical background, corresponding to the teaching of environmental law. The recourse to international funds, such as the Asian Development Bank and the World Bank, are made possible by the important potential for development and the emergency of the environmental situation in Bangladesh. The teaching of environmental law can be achieved by integrating advocacy networks and the development of joint programs and partnerships with foreign law schools, in Asia and elsewhere, in a context of internationalization of legal education and higher education in general.

BANGLADESH AND INTERNATIONAL LAW
One of the limits of legal advocacy is the enforceability of existing legal rules. If lawyers, professors and students can pressure on the courts and specific cases, they are toothless if they cannot find the necessary tools for the protection of victims.

Bangladesh is fairly engaged in international law. It has ratified some of the major international law and international human rights instruments, but lacks for instance a commitment to the protection of refugees, which is becoming an increasing issue in relation to the environment [4]. Bangladesh is however very little committed to International Environmental Law: it did not sign or ratify the Aarhus Convention, nor the Espoo Convention; both widely considered being the basis of International Environmental Law. On specific issues, it ratified in 2001 the Montego Bay Convention on the Law of the Sea but, like most South East Asian countries, did not sign the 1972 London Convention on the Prevention of Marine Pollution. Air pollution is not better covered by the country’s international engagement [5]. However, the existing instruments, overall consistent in terms of ratification in a regional perspective, do provide with legal tools that need to be applied to specific situations. International Environmental

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Law provides for mechanisms of information, consultation, responsibility and reparation that can be enforced either at the domestic or at the international level. In particular, outside of the scope of existing conventions, the right to a healthy environment needs to be enforced through the courts, as it has been in India from the 80s [6].

THE LEGAL EDUCATION FRAMEWORK IN BANGLADESH

Environmental education (EE) began in Bangladesh in 1996, at Khulna University, and then at Sylhet University. If EE took off during the last two decades, as a distinctive and independent field of study, its late and slow rise as an academic discipline also illustrated the limits of funding in Bangladeshi higher education institutions [7].

So far in Bangladesh only a handful of universities offer quality legal education. The lack of publicly-funded institutions created a market for poor-quality private education, and study abroad programs driven by profit [8]. This paper makes a case for the reinforcing of practical skill in legal education in Bangladesh. The recent movement towards a strengthening of legal education, including a restructuration of LLM programs, should include clinical education, committed to human rights approaches to environmental law.

CONCLUSION: THE PARTICULARITIES OF LEGAL CLINICS IN DEVELOPING COUNTRIES, AND THE RISKS OF CLINICAL LEGAL ADVOCACY

The example of China provides with a vivid account of the possible impact of legal clinics in developing countries, although the results in China have been less important than expected. The rule of law, absent from China, is introduced by a multitude of ways: advocacy, top-bottom change, and legal actions are part of the vectors of change in China. Considering the fact that environmental protection, in the form of laws, exist in China, the problem resides in its enforcement rather than in legislation [9]. The applicability of environmental laws is often denied by the courts, also because of the lack of lawyers to defend the victims of environmental abuses and violations. A disengagement of the authorities to compensate for the availability of free legal advice is a risk of the development of clinical programs. In the United States, legal clinics are one of the three solutions for indigents to receive legal advice, when the law and the Constitution make clear that this service should be provided by the state. Finally, the risk that needs to be anticipated is that attacks by the state, which often in environmental abuses side with the polluters, for reasons relating to economic development and corruption. The example of the Tulane clinical program in Louisiana serves as a warning against a direct opposition between the state and the clinical advocacy; this is affecting legal education as a whole, and is detrimental for the protection of human rights and the rule of law. This risk, of a crackdown by the government on legal education institutions, seems more prevalent in Bangladesh than in the Western world, because of the extent of corruption [10]. It needs to be assessed and integrated to all reforms undertaken in legal education.

The involvement of NGOs, international organizations such as the World Bank and the IMF, and institutions of higher education from Western countries would partially neutralize the risks of corruption and state opposition to the development of environmental clinical legal programs. Yet, this also requires leadership and good governance from inside of Bangladesh, both from the private and the public sector. This only will allow for innovative, trans-disciplinary programs that will enhance environmental accountability and create legal solutions to environmental crimes.

REFERENCE


[3] Among the proposals made by researchers on clinical programs, the selection of cases is at the centre of many research projects, denoting a strong potential for a maximum impact on policy. See PN Pahn, (2005) “Clinical Legal Education in China”, Yale Human Rights and Development Journal, 8: 539.


[10] Transparency international country profile for Bangladesh, ranking it 120 out of 183 countries according to its Corruption Perceptions Index: http://www.transparency.org/ country/#BGD
The Primary Results of Ecological Situation Koshkar-Ata Tailing Pond after Remediation Actions

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ABSTRACT

The main task of this work is to analyze remediated sites of Koshkar-Ata tailing dump. The results of gamma spectrometry show that exposure rate is decreased at some remediated areas. It was established that 210Pb, 226Ra and 232Th are characterized as main radionuclides of pollutants. The average levels of radioactivity are higher in soil of tailing dump than levels of background object.

INTRODUCTION

The main sources of USSR uranium ore of raw materials mining and processing were situated at Central Asia. Industrial complexes mined and processed rare earth elements with thorium mineralization on their territory Central Asia since 1907. In the results of these activities huge numbers of radioactive wastes were placed at earth surface as tailing dumps. As known tailing dumps are situated near settlements and connected with water channels and high-water bed of boundary rivers which are connecting to water channels of all Central Asia regions. Number of all radioactive waste storages are 96 with total value of radioactive wastes 250 000 000 m³ [1, 2].

The Koshkar-Ata radioactive wastes storage was used as storage of the unused solid wastes of chemical-hydrometallurgical production and tail waters of sulfuric acid plant since 1965 in Mangystau's region of the Republic of Kazakhstan. The total mass of the radioactive wastes is about 180 000 000 tons with total activity 11 000 Cu in this tailing dump according to the data of Mangystau ecological department [3].

This problem is important today because investigation radiation ecological situation of unguarded Koshkar-Ata tailing dump can negative influence to health settlements living near this object. The situation is complicated because the residential population excavate the sub-surface disposal in order to find scrap metal for their further selling to scrap metal or use for construction and household needs. Thus, there is an unapproved spread out of hazardous materials over the region territory.

The aim of this work is to elaborate recommendations for remediation works on Koshkar-Ata tailing dump. This work has done in the framework of ISTC project K-632.

MATERIALS AND METHODS

We made radiometric measurements of the gamma-activity. Gamma-survey was made to determine of horizontal distribution character of radionuclide contamination over the exposed shore zone using radiometer SRP-68-01 with indicating equivalent dose rate. Equivalent dose rate of gamma-ray was measured at altitudes 5 cm and 1 m from surface of earth. We made measurements at 150 points. The points of soil, water and bottom sediments sampling had determined on basis of gamma-survey.

The map of gamma-survey of KOSHKAR-ATA tailing pond was presented at Fig. 1.

The results of equivalent dose rate are varying from 0,10 till 0,50 μZv/h. Also we registered points with equivalent dose rate 700 μZv/h. This obtained result is exceeded limited dose 1.5 times according Norm Document-99 and are treated to the place of temporary storage of radioactive scrap metal by the firm “Aktal-LTD”. The detailed map of gamma-survey of sub-surface radioactive waste disposal is presented at Fig. 2.

The sampling of the following environmental objects as soil, water and bottom sediments was performed with the purpose to evaluate main negative factors of the KOSHKAR-ATA tailing impact on the environment. The points of sampling were chosen on the basis of gamma-survey results.

The sampling of soil objects were produced by standard method of INP NNC RK. The mass of one soil sample is 1 kg. We removed stones, animals bones and foots from soil sample during sampling. Each sample was pocketed with label. The detail of sample were indicated on this label as mass of sample, place of sampling and number of sample. Also we measured exposure rate at each sampling points.

Surface soil samples were taken from the depths 0.5 cm, layer-by-layer – from the horizons 0.5, 5-10, 10-30 cm. For sampling at the shore exposed zone were made 11 bore-pits 1.1-1.3 m deep each. Sampling there was performed at each 10 cm of the pit.
Gamma spectrometry measurements were made by two Ge spectrometers: “Ortec” GEM-20180 ( coaxial) and “Canberra” GX-1520 (planar). The GX-520 detector with a thin Be window gave us possibility to assign the gamma activity using low energy gamma lines as $^{210}$Pb 46.5 keV line, and $^{234}$Th 63.3 keV line. We determined radionuclides in water using a method of radionuclides concentrations from big value of water more 10 liters.

We made samples preparation for gamma-spectrometry measurements in according to elaborated instructions “determination artificial and natural radionuclides by radiochemical and gamma- spectrometry methods” [4]. Soil, bottom sediments and pits samples taken at the shore exposed surface and along the tailing pool perimeter were sealed in cuvettes and aged for 2-3 weeks before measurements to achieve mobile equilibrium between the isotopes $^{222}$Rn and $^{224}$Ra and their decay products.

If samples were wet we dried them in dry rooms not to allow mechanical losses and pollution. Blank was weighed with a margin error ±0,1 g, then it was scattered on a kraft-paper or a tracing-paper and large lumps were kneaded by pestle. Roots of plants, insects, stones, glass, coal and bones of animals were separated off samples. Weight of a remote material was weighed on technical scales with the same error. If the sample was contained with lumps then them were crushed by a wooden pestle. The soil was dried in oven with temperature 100-150 C. Duration of drying process was no more than 24 hrs for the sandy soil and about 48 hours for clay soils.

After drying, the sample is sifted by sieve with diameter 2 mm or automatically by sieve machine. If the fraction of the sample was more 2 mm diameter it was crushed by pestle again and sieved for second time.

The balance of the sample was weighed on a technical scale with an accuracy of ±0.1 g after sieving. But the mass of sample fraction with diameter 2 mm is not limited 4-5% from the original sample weight.

The fraction of the soil with a diameter less 2 mm was scattered on a sheet of extra-strong paper and carefully mixed by 6-7 times from the corner to corner and two test samples were selected by a quartering method. A sample with weight 100-200 g are placed into the measuring container (sample weight depends on the volume of the vessel being measured), record the weight, height, placed sample, the measured diameter of the vessel and transfer to the γ-spectrometric measurements. If mass of a sample was 50 g it was grated till 200 mesh. Then a sample was transferred to radiochemical analysis.

The results of complex investigation of Koshkar-Ata tailing dump show that the more radioactive pollution of soil is on the south part of this tailing dump and also this part of tailing dump is situated closely to Actau city. We started remediation actions from high pollution areas. The first remediation actions were done on the control site #1 (100x90 m²) (Fig. 3). The methodology of remediation actions were presented in the reference [5].

We made gamma-survey of rehabilitated site for estimation efficiency of the applied remediation methods. The results show that the gamma background value of this rehabilitated site is similar to minimum equivalent dose and it is according to normal values (Fig. 4).

### RESULTS AND DISCUSSION

The main value of analytical investigation had done by gamma-spectrometry method with measuring following radionuclides: $^{137}$Cs, $^{210}$Pb, $^{234}$U, $^{226}$Ra, $^{238}$K, $^{232}$Th, $^{214}$Po, $^{210}$Bi, $^{226}$Ra, $^{212}$Pb, $^{212}$Bi, $^{208}$Tl and $^{227}$Th.

The following samples were analyzed: the soil samples were taken from surface and 30 cm depth of KOSKAR-ATA tailing dump territory; soil samples were taken from around territory of KOSKAR-ATA tailing dump; samples of bottom sediments, pits and plants. The value of analyzed samples is big that is why we presented average value of Cesium-137 and natural radionuclides in soil, bottom sediments, pits and plants samples of KOSKAR-ATA tailing dump territory (Table 1).

Table 1. The results of natural radionuclides and $^{137}$Cs in surface layer of soil and bottom sediments of KOSKAR-ATA tailing dump, Bq/kg

<table>
<thead>
<tr>
<th>Radio nuclide, Bq/kg</th>
<th>Sample</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface layer of soil</td>
<td>Bottom sediments</td>
</tr>
<tr>
<td>Cs-137</td>
<td>7.4 ± 0.5</td>
<td>2.3 ± 0.5</td>
</tr>
<tr>
<td>K-40</td>
<td>208 ± 9</td>
<td>377 ± 18</td>
</tr>
<tr>
<td>Th-234</td>
<td>23.3 ± 3.8</td>
<td>20.6 ± 3.8</td>
</tr>
<tr>
<td>Ra-226</td>
<td>444.0±4.5</td>
<td>54.9 ± 1.4</td>
</tr>
<tr>
<td>Pb-214r</td>
<td>441.5 ± 3.6</td>
<td>396.5 ± 3.2</td>
</tr>
<tr>
<td>Bi-214</td>
<td>446.5 ± 5.4</td>
<td>404.6 ± 4.9</td>
</tr>
<tr>
<td>Pb-210</td>
<td>64.0 ± 6.4</td>
<td>730 ± 16</td>
</tr>
<tr>
<td>Ac-228</td>
<td>11.3 ± 1.1</td>
<td>21.1 ± 1.5</td>
</tr>
<tr>
<td>Pb-212</td>
<td>10.2 ± 0.6</td>
<td>18.4 ± 0.9</td>
</tr>
<tr>
<td>Bi-212</td>
<td>12.1 ± 3.7</td>
<td>16.0 ± 5.5</td>
</tr>
<tr>
<td>TI-208</td>
<td>3.2 ± 0.4</td>
<td>7.3 ± 0.7</td>
</tr>
<tr>
<td>U-235</td>
<td>4.2 ± 1.2</td>
<td>24.9 ± 1.4</td>
</tr>
<tr>
<td>Th-227</td>
<td>2.5 ± 1.0</td>
<td>19.9 ± 2.3</td>
</tr>
</tbody>
</table>

The results shows that the concentration of $^{137}$Cs is varied from 0.3 till 19 Bq/kg in surface and deep layer of soil samples, also concentration of Cesium-137 is decreased in some samples and it can be explained by other sources of
cesium pollution near KOSKAR-ATA tailing dump territory. The concentration of $^{234}$Th and $^{238}$U is varies from 10 till 650 Bq/kg. The concentration of $^{226}$Ra is lied at the limits 10-1340 Bq/kg. This result shows that average of relations of $^{226}$Ra to $^{234}$Th is equal to 1.5, but concentration of $^{234}$Th is less $^{228}$Ra. Equilibrium between concentrations $^{226}$Ra and $^{210}$Pb is equal to 0.9 that shows absence redistribution in soil.

The levels of thorium series radionuclides concentrations are about 3-40 Bq/kg there are corresponded to type of soil like Mangystau’s region. The preliminary contribution of $^{234}$U to sum of total activity is 5% from $^{238}$U activity on the basic of the obtained results. The concentrations of the following radionuclides are high in bottom sediments: thorium-234, radium-226, lead-214 and bismuth-214, lead-210, uranium-235, thorium-227.

The concentrations of natural radionuclides are not accumulated in deep layers of pit soil. It can be explained depending on heterogeneity incoming of radioactive wastes to tailing dump during long period of time. The concentration of some radionuclides like $^{226}$Ra, $^{214}$Pb, $^{210}$Bi, $^{210}$Pb, $^{227}$Th and $^{238}$U are higher than background values.

**CONCLUSION**

During investigation, the obtained data can be used to estimate potential danger from tailing dump on the basis of method estimation risks to citizens from radioactive wastes. At the present time we can make the following conclusions:

- Because of samples are exposed by chemical analysis, natural equilibrium is broken in analyzed samples. There are treated as man-caused. In that case sum of a ratio of specific activity and specific activity of minimum concentration are presented as criteria to radioactivity wastes. Minimum concentration of 230Th is equal to 1Bq/kg and other radionuclides are equal 10 Bq/kg. According to data of ISTC if specific activity of toxic radionuclide is higher 0.1 Bq/kg these samples will be treated as radioactive wastes.

- By normative documents of RK, the surface layer of soil of tailing dump is classified as materials with limited using and they cannot create dose more 1mZv per year. The five percent of the specific activity of $^{230}$Th are higher 750 Bq/kg in soil samples with deep 1m. So these results are treated as radioactive wastes with low-level activity. By data of ISTC, the forty percent of soil samples of Koskar-Ata tailing dump is treated as radioactive wastes with low-level activity. The radioactive wastes with low-level activity cannot create dose more 50mZv per year. This value may give rise additional risk of reducing the length of life to 4 10-3 a year.

- If we estimate risk to life influencing of tailing dump it is necessary to take into mind level of toxically in radioactive wastes. Besides radionuclides, there are more 30 toxic chemical elements in soil samples of tailing dump. Some of them are carcinogens. The results are presented in Fig. 3. The obtained results show that potential danger of toxic chemical elements is treated as radioactive wastes with 3-4 level hazards that are increasing radioactive danger.

- It was established that $^{210}$Pb, $^{228}$Ra and $^{226}$Th are characterized as main radionuclides of pollutants. The average levels of radioactivity are higher in soil of tailing dump than levels of background object.

- The gamma background of remediated sites is reduced till normal.

**ACKNOWLEDGMENT**

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**REFERENCE**

ID 30

Responding Natural Disaster in Bangladesh through Alternative Education
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ABSTRACT

This paper presents case study of an alternative education project implemented in two cyclone-devastated districts of Bangladesh as a post-disaster response and recovery initiative. A base line survey was conducted which revealed that the exhausted financial condition of local families along with other problems in the formal education system was causing dropouts and non-enrolment after the massive cyclone ‘Sidr’ that hit in November 2007. Based on a needs assessment the NGO Islamic Relief Worldwide, Bangladesh implemented an alternative education project. The project contributed towards learning lessons in responding to disasters in Bangladesh with alternative education and resulted in retaining a significant number of primary aged children in education after the super cyclone. In doing so it focused on regaining the attention of the dropouts and increased interest of the non-enrolled towards education by offering a learner friendly, joyful education scheme that combined life skills and livelihood skills education with health and wellbeing aspects.

INTRODUCTION

In Bangladesh, over 120,000 primary schools were damaged by floods and 50,000 by cyclones in between 1971 to 2007, and during 2007-2009 education of more than 1.5 million children have been disrupted particularly by cyclones [1]. UNICEF reported in 2010 that about 9,000 of Bangladesh’s 82,000 primary schools had been affected since 2007 [2]. Country’s budget had to allocate BDT 11,196 million in just three years- 2004 to 2007 as recovery cost [1]. No month in the disaster calendar of Bangladesh is free from risk [3] and on average a major flood occurs every four to five years, and a severe tropical cyclone hits Bangladesh every three years [4]. Further to ongoing disaster trend in Bangladesh, it has been recognized as one of the most vulnerable countries to Climate Change effect by both the Scientific and negotiating community and in future it is likely to face more frequent climatic adversities [5]. This, in other ways, means Bangladesh will be exposed to more disruption in its Education system. Despite such reasonable conjecture and also the fact that it has one of the largest primary education systems in the world, the primary education system in Bangladesh is still largely unprepared to meet disaster challenges [2]. Hence, the Government and the stakeholders in development have been continually working towards developing appropriate disaster preparedness and response measure, climate change response policy and programs for the country. Ensuring education in emergency situations induced by natural disasters is being recognized as a priority in these efforts gradually. While government is stepping forward with policy formulation, NGO's in the country are supporting with innovative projects alongside undertaking policy advocacy with the Government. This paper presents a summary of such an education project- “Anondo Biddaloy- Alternative Education for Sidr Affected Children”. It was a post- disaster response intervention implemented by an international NGO-Islamic Relief Worldwide, Bangladesh during February 2009-January 2010 in two coastal districts of Bangladesh- Pataukhali and Bagerhat. The districts were severely affected by a devastating cyclone “Sidr” in November 2007. The project catered the target group with offering of safe educational infrastructure, health support and scope for achieving competency to regain access to mainstream formal education. The specific objectives of this paper are to (1) present the concept and contents of the alternative education initiative in responding natural disaster; (2) share lessons learnt from the implemented project.

RESPONDING DISASTER WITH EDUCATION: A PROJECT EXPERIENCE

In late 2007 Bangladesh experienced a massive devastation by a tropical cyclone, named “Sidr”. On the Saffir-Simpson Hurricane Scale it was measured as category 4, a super cyclonic storm [6]. It impacted upon the lives of a reported 8.9 million people of 2 million families in 31 districts, with 3,347 people killed, 55,282 injured and 871 unaccounted for [7]. 4.2 thousands of schools no longer exist due to the cyclone. Among the most affected 1 million were children [7].

However after the catastrophe, majority of the schools had been re-opened in the affected areas and reconstruction of badly-destroyed schools had begun by the mid 2008 but school lessons were not happening as normal yet [7]. Beside need for proper infrastructure deeply affected teachers’ and students’ emotional wellbeing making morale and motivation at school extremely low [7]. The decrease in school attendance since the cyclone had been noted in all areas, together with the economic exploitation of children, school dropout constitutes the most commonly raised concern [7]. The link between the drop in school attendance and the rise in exploitative labour was also evident in different research which also reported children faced added challenges in entering the formal education system due to stigma and shame in school, and inability to catch up [7]. In their circumstances, Islamic Relief Worldwide, Bangladesh, one of the fore front INGO in Bangladesh responding disaster induced emergencies in Bangladesh since the devastating cyclone of 1991 decided to intervene into the issue with some unique approach of child welfare. A base line survey was conducted by Islamic Relief Worldwide in February 2009 to collect the socio- economic information of target children and their families to assess the children’s specific need to formulate a viable action. A total of 690 (Morelganj 395+ Galachipa 295) household has been surveyed. The survey revealed that being mostly engaged in informal primary economic activities (30% day labourer in agricultural or other different sectors, 25% in farming, 15% fisherman) around half of the respondents were earning an average monthly income of US$35 to support a fairly big family (45% family consisting of 6-10 members, rest 1-5). The cyclone devastated the national and regional economy in such a way that the families were struggling for earning livelihoods, where education for children became very less important and this was resulting into school dropout for once enrolled and non-enrolment for eligible school goers [8, 10]. Only 5% of the respondent family had moderate knowledge on health and hygiene issues and rest have no knowledge at all. It also explored less than 1% children used to take any food other than major meal that can be considered as supplementary diet and none of the children in the surveyed households had any trade skills which could make them feel confident having some livelihood skills. With this background, a comprehensive education project had been conceptualised and implemented to address those issues and the project was dubbed as “Anondo Biddaloy”.

A. Project Concept

Based on the needs assessment, the project concept was to set a safer refuge for the children in need which would render services like health support and knowledge of empowerment along with non-formal education to ultimately restore them in mainstream formal education (Fig. 1).

**B. Project Contents**

As per the concept, the project established 20 “Anondo Biddaloy” school. These served as pivotal point for delivering project deliverables. The school had two classes ‘Sikhon’ (Learning) and “Goron” (Developing), both containing 15 students and one teacher per school. Thus the schools enrolled 600 children (20 schools X2 classes X15 students) in total. A unique child-centred teaching-learning method had been endorsed that enabled one teacher to maintain two classes at the same time. Mostly activity based curriculum focusing to grow competency within the students rather than providing formal literacy to them engaged the children most that required teacher’s presence as mere facilitator. Also developing peer-educators for mentoring group members substituted teacher’s presence in every class.

To ensure the health improvement of the enrolled children there had been arrangement for regular monthly health check-up session, regular necessary medicine, de-worming medicine and vitamin-A supplementation twice a year and regular tiffin during school days.

The school curriculum included different life skills focused education for the children. To grow up managerial capacity and leadership among the children the schools formed ‘School Operation Committee’ containing students that also helped the teachers in managing the school properly. The committee also took part in community development work by conducting campaigns and demonstrations.

The students, who were able and eager to gain livelihood skills, had been provided with skills training like basic computer training, garments making, homestead gardening etc. This component of the project was aimed to develop self-dependency and empowerment among the children.

Recreation with indoor games was in-built within the curriculum. Besides, annual sports, excursion, picnic had been arranged for all of the students to provide a recreational window in the schooling.

The project attracted huge community participation. Besides providing free space for school, community people also engaged themselves in monitoring of the school program by forming a formal ‘School Support Group’ for each school.

**C. Location of the Project**

The project was implemented in two districts of south-west Bangladesh- Bagerhat and Patuakhali (Fig. 2).

Being situated near to the sea and on the path of the cyclone they were among the worst affected areas of the country by the Cyclone ‘Sidr’ and the tidal surge occurred due to it. The project area was spread across 6 Unions (Baroiakhali, Boloibunia, Morelganj Sadar, Khaulia, Nishanbaria and Khontakata) of Morelganz Upazila under Bagerhat district and 6 Unions (Galachipa Sadar, Panpotti, Amkhola, Golkhali, Dakua and Galachipa Pourashava) of Galachipa Upazila under Patuakhali district.

**D. Project Outcomes**

There were three precise expected outcome assumed to be achieved to attain the project objective:

- A safe and secured school environment is ensured to bring confidence among the students for regular school presence - The schools rendered 273 days of general education class with on an average 95% attendance of the students [10]. The program team rated it as the highest possible achievement of the expected outcome.

- Children and adolescent are grown as healthy (both physically and mentally) and cheerful - To ensure getting of this outcome the project carried out 9 health and awareness session that rendered service like counselling, basic health check-up, referral service and medicine prescription where necessary [9]. Also the project provided free medicine to 1765 children, de-worming and vitamin supplementation to 594 children, supplementary food like fruits, egg, cake biscuit etc. during the school days to 111437 children (cumulative no.), 5 items of indoor games facilities and 1 annual sports and 1 picnic [9]. However, the achievement for this expected result was measured through the attainment of outputs; the final achievement of the objective implies the success of achievement for this outcome.

- Capacity of the children is built - The project worked towards building and improving capacity of the children in different ways like by enabling them to pursue a livelihood skill, growing self-esteem within them. 537 no. of children
(Morelganj 260 and in Galachipa 277) received skills training which includes Tailoring, Basic Computing and Homestead Gardening [9]. Development of skill tends to bring a sense of security among the children such a way that they showed confidence of supporting their educational cost on their own if parents are unable [9, 10]. Formation of 20 School Operation Committee (SOC), successful operation of committee evident through observation of several days of significance (to focus on specific child development issues) and undertaking 114 social works in the locality ranging from activities like tree plantation, campaign against early marriage and dowry, cleanliness campaign, voluntary road repairing etc. [9] demonstrate developed leadership and self-esteem among the enrolled children.

Finally, the project was successful towards achieving its specific objective of endorsing a learner friendly and joyful school environment to attract the cyclone surviving children and adolescents to overcome the psycho-social trauma they had and regularize them in education once again by achieving its outcomes largely which was demonstrated through creating access for 444 children out of 600 enrolled to formal education after the project [9].

E. Lessons Learnt

The project brought some lessons for the implementing organization which is worth sharing here, as it is likely to be of interest to the practitioners and who have an interest in it; major lessons are as follows:

- Alternative education project (offering health care, teaching materials, supplementary food, recreational facilities, engaging student’s in school operation etc.) can ensure higher attendance in school even in a post-disaster situation and regain their interest in schooling
- Providing skills training along with general education can make the distressed children to feel empowered and confident to continue education
- Networking with formal educational institutions, local level government education department is crucial for mainstreaming of dropped out children
- Organized information dissemination to the stakeholders about a project (like the project undertook project inauguration, project completion, monthly support group meeting etc.) can ensure better participation and support of the stakeholders

CONCLUSION

Though the project was implemented about one year after the catastrophe, it was actually devised immediate after the cyclone. The base-line survey also didn’t suggest too changed a context than the aftermath of the disaster. The project lessons and success implies the need and usefulness of such initiative and at the same time beg for carefully judging of its value in the relevant academic school of thought and wider context of disaster response practice for developing countries like Bangladesh.

ACKNOWLEDGEMENT

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REFERENCE


Decolorization of azo dye by the vanadium doped TiO2 catalytic electrode

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ABSTRACT

The color elimination of Acid Red 27 (AR 27) dye by the electrocatalytic technique was studied in this research. The applied electrocatalytic electrode was vanadium ions doped titanium dioxide (V/TiO2) and pure titanium dioxide (TiO2), respectively. Results indicate these electrocatalytic electrodes are effectively remove the AR27 color. The current density ranging from 5 to 15 mA cm-2 is appropriate. The best removal efficiency of dye (97%) could be achieved under the current density of 15 mA cm-2 for 120-min treatment with the V/TiO2 electrode. The V/TiO2 consumed less electricity during electrocatalytic process (i.e., 0.057 KWh L-1 for V/TiO2 and 0.164 KWh L-1 for TiO2). With the comparison of the V/TiO2 and TiO2 electrode, results indicate that V/TiO2 electrode presents cost-effective potential for decolorization.

INTRODUCTION

The textile wastewater possesses some special characteristics such as intensive color, extreme variation of pH, high temperature, high chemical oxygen demand (COD) and low biodegradability. Because environmental rules become stringent, this kind of wastewater is struggling to meet the new discharge standard [1, 2]. Among many discharge standards, the color standard has been corrected dramatically. Azo dyes have been used extensively not only in the textile but also in the printing and cosmetic manufacturing. There are about 800,000 tons of dyes produced each year in the world and one half of dyes are the azo dyes [3]. In order to enhance the color removal in the wastewater, the advanced oxidation processes (AOPs) have been developed and widely used for the organic dye treatment. The AOPs include the photocatalyst, Fenton’s reagent, electrocatalytic oxidation and the combination of different techniques [4-7]. Among them, the electrocatalytic oxidation has excellent color removal efficiency. The electrocatalytic oxidation technique applies the direct current to the electrocatalytic materials (anodes) to yield the strong oxidants and induce the oxidation reaction which can effectively destroy the organic pollutants [6]. The main reagent in the electrocatalytic process is the electron that is one type of clean oxidants [8].

According to previous research, the titanium dioxide modified by doping the transition metals ions such as V, Fe, Mo, Pd, and Nb could enhance the photocatalytic activity significantly due to the reduction of the optical band gap [9]. Especially, TiO2 doped by vanadium ions could reduce the band gap from 3.0-3.2 eV to 2.5-2.7 eV dramatically [10, 11]. Hence, vanadium ions has been widely applied to the photocatalytic materials and show high effectiveness. However, there is little research on such modified catalytic material to the electrocatalytic technique. It is worthwhile to study the degradation performance between the doped and non-doped electrodes for the electrocatalytic treatment. In this work, different experimental conditions were conducted to find out the color removal efficiency and proper operational-parameters.

MATERIALS AND METHODS

A. Electrocatalytic reactor

Acid Red 27 (AR 27) was the target organic pollutant in the electrocatalytic process. Table 1 lists the chemical structure and other properties of AR 27. The sodium sulfate (Na2SO4, purity 98%, Merck) was used as the electrolyte and the pH of wastewater was adjusted by 0.01 M nitric acid and sodium hydroxide, respectively. In this work, a round PVC reactor with 9 cm (diameter) x 18 cm (height) was utilized and its effective volume was approximately 900 mL. The reactor comprised one pair of electrodes, in which titanium dioxide (TiO2) and vanadium ions doped with titanium dioxide (V/TiO2) were employed as the anodes while graphite served as the cathode for all experiments. The distance between cathode and anode was set at 6.0 cm and the size of all electrodes was the identical (16 cm L x 2.5 cm W and 0.3 cm D). A direct-current (DC) power supply (GR Instek, GPR-20H20D) was used to provide the electricity for electrocatalytic electrodes. An electromagnetic stirrer (Corning, Stirrer/Hot) was used to reach uniform mixing of wastewaters.

Table 1. Properties of Acid Red 27.

<table>
<thead>
<tr>
<th>Structure</th>
<th>( \text{C}<em>{20}\text{H}</em>{11}\text{N}_{2}\text{Na}<em>2\text{O}</em>{10}\text{S}_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular weight</td>
<td>604.47 g/mol</td>
</tr>
<tr>
<td>( \lambda_{\text{max}} )</td>
<td>521 nm</td>
</tr>
<tr>
<td>Dye content</td>
<td>85-95%</td>
</tr>
<tr>
<td>Colour Index Number</td>
<td>16185</td>
</tr>
<tr>
<td>CAS NO.</td>
<td>915-67-3</td>
</tr>
<tr>
<td>Source</td>
<td>Riedel-deHaen</td>
</tr>
</tbody>
</table>

B. Preparation of the vanadium doped TiO2 electrode (V/TiO2)

The vanadium doped TiO2 electrode made by Sol-gel method. A titanium plate through an appropriate cleaning process was used as the substrate. Vanadyl acetylacetonate (VO(C5H7O2)3) was the transition metal precursor (purity 98%, Aldrich). In this work, there was other prepared chemicals including the titanium tetraisoproxide (Ti(OC4H9)4), TTIP, purity 98%, Merck), acetic acid ((CH3COOH), purity 99.9%, J.T. Baker) and 2-propanol (CH3CHOHCH3), purity 99.9%, J.T. Baker). The detailed preparation process of the V/TiO2 electrode will be described in other article.

C. Experiments of electrocatalytic degradation for AR 27 dye solution

The AR 27 dye solution of 25 mg L-1 was used for all experiments. The removal efficiency of color was the major index to justify the degradation performance. Table 2 lists the operation conditions. The first part of experiments was conducted to obtain appropriate operation parameters of the TiO2 electrode. The second part of experiments was to test the electrocatalytic behaviors of V/TiO2. All degradation
experiments were carried out under the Na₂SO₄ electrolyte of 7.5 × 10⁻³ M for a 120-min treatment, respectively. The color measurement was conducted by an UV-visible spectrophotometer (Jasco, V-5000) with maximum absorbance wavelength of 521 nm. The color removal efficiency of dye was calculated by the following equation [6].

Color removal efficiency (%) = (Aᵢ − Aᵣ)/Aᵢ × 100 (1)

where Aᵢ and Aᵣ is the absorbance at time of t = 0 and t, respectively.

In addition to the color analysis, the pH, conductivity and temperature were measured every 20 min in each electrocatalytic experiment. A pH meter and a conductivity meter (Hach sensION + MM374) were used.

Table 2. The operation conditions of electrocatalytic experiments.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Anode: TiO₂/TiO₂</th>
<th>Cathode: graphite</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH value</td>
<td>4, 7, 10</td>
<td></td>
</tr>
<tr>
<td>Current density (mA cm⁻²)</td>
<td>5, 10, 15</td>
<td></td>
</tr>
<tr>
<td>AR 27 concentration (mg L⁻¹)</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Treatment time (min)</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

**RESULTS AND DISCUSSIONS**

In order to obtain the wavelength of maximum absorption at different pHs for AR 27 dye. The dye solution was tested under acidic (pH 4), neutral (pH 7) and alkaline (pH 10), respectively, and scanned by UV-visible spectrophotometer with wavelength range of 250-750 nm. Results showed the maximum absorption wavelength was 521 nm for all different pH conditions. This wavelength was used for all experiments.

A. Color removal efficiency of different pHs

Prior to the electrocatalytic experiments, the dye adsorption capacity of TiO₂ electrode was tested in order to clarify that color removal of dye was mainly caused by the electrocatalytic degradation rather than the electrode adsorption. In this work, the initial pH was adjusted in the degradation process. As observed from results, the removal efficiency of AR 27 dye was less than 1% by the electrode adsorption under different pH conditions (data not shown). Hence, the effect of adsorption could be ignored for the color removal.

Fig. 1 shows the color removal efficiency versus time at different pHs (with the TiO₂ used as the anode while graphite served as the cathode under the current density of 10 mA cm⁻²). Referring to Fig. 1, it shows that the AR 27 removal efficiency achieved 87, 88 and 83% at pH 4, pH 7 and pH 10, respectively. This implies that the removal of AR 27 was not significantly affected by pH factor in the electrocatalytic system. Meanwhile, the pH value has no obvious change during the degradation process. Since the initial pH of the dye wastewater is close to neutral, the pH of wastewater was not adjusted for later experiments.

B. Color removal efficiency of different current densities

Fig. 2 shows the removal efficiency of AR 27 dye color at current densities of 5, 10 and 15 mA cm⁻², respectively. According to Fig. 2, the color removal efficiency was 56, 84 and 97% at 5, 10 and 15 mA cm⁻², respectively. The result indicates that the removal efficiency increases with the current density as expectation. Since the yield of hydroxyl radical increase with current density, the color removal increases with current density almost proportionally. The functional groups of azo dye which present color is degraded effectively in the electrocatalytic system.

C. Color removal efficiency of different electrodes

Fig. 4 shows the color removal efficiency of V/TiO₂ and TiO₂ electrode. From Fig. 4, it can be seen that the color removal efficiency of TiO₂ electrode is much higher than that of V/TiO₂ electrode after the first 20-min treatment. Both electrodes approach similar removal efficiency after 80-min treatment. The color removal efficiency of 97% can be achieved after 120-min treatment for each electrode. It should be noticed that the applied voltage of V/TiO₂ electrode was only one third of that of TiO₂ electrode based on the same current density. Likewise, the temperature induced by V/TiO₂ electrode was about 40°C, which was lower than the temperature induced by TiO₂ electrode.
The energy consumption (EC) of two catalytic electrodes under such operational condition was calculated by the following equation [12].

\[
EC = \frac{U \cdot I \cdot t}{V} \tag{2}
\]

where \(U\) is the average voltage during electrocatalytic process (V), \(I\) is the applied current (A), \(t\) is the treatment time (h), and \(V\) is the wastewater volume (L).

Based on the 97% color removal, the energy consumption of \(\text{V/TiO}_2\) and \(\text{TiO}_2\) electrode was 0.057 KWh L\(^{-1}\) and 0.164 KWh L\(^{-1}\), respectively. The \(\text{V/TiO}_2\) electrode presents cost-effective potential for decolorization.

CONCLUSION

1. The color removal of AR 27 was not significantly affected by pH factor during the electrocatalytic system.
2. The color removal increases with current density almost proportionally. The functional groups of azo dye which present color is degraded effectively in the electrocatalytic system.
3. The color removal efficiency of 97% can be achieved after 120-min treatment by \(\text{V/TiO}_2\) and \(\text{TiO}_2\) electrode, respectively.
4. Based on the 97% color removal, the energy consumption of \(\text{V/TiO}_2\) and \(\text{TiO}_2\) electrode was 0.057 KWh L\(^{-1}\) and 0.164 KWh L\(^{-1}\), respectively. The \(\text{V/TiO}_2\) electrode presents cost-effective potential for decolorization.

REFERENCE

A Laboratory Model Studies for Selection of Water Treatment Unit Processes for Proposed Jashaldia WTP near Padma River

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ABSTRACT

It is a great challenge for Dhaka City to ensure water supply in adequate quantity and quality round the year. To improve the water supply situation, a new surface water treatment plant at Jashaldia with intake at Mawa in the Padma River has been proposed. For the selection of treatment units processes/operations, water quality investigation of both field and laboratory model studies have been carried out with three batches of water sampling. The main objective of the study is to identify the water treatment process. The analysis has shown that, plain settling process at the source could be avoided. Alum coagulation-flocculation followed by sedimentation processes would be required to bring down the turbidity and color values with the recommended limits. However, rapid sand filtration process could not be avoided to ensure potable water. Post-chlorination process should be adopted to make the surface water more potable to the consumer.

INTRODUCTION

Dhaka, the capital of Bangladesh, is one of the fastest growing metropolises of the world. It is a great challenge for Dhaka City to ensure water supply in adequate quantity and quality round the year. A water supply Master plan for the Dhaka city was prepared in 1992 for an area of about 360 sq. km, which has now become redundant as the population prediction and water demand has been surpassed. Some ad-hoc measures have been undertaken to meet the growing demand of water supply, mainly dependent on abstraction of groundwater which has already reached its optimum level. It appears that no further abstraction is recommended as the groundwater level is declining very fast. In an effort to reduce the overwhelming dependence on groundwater resources for water supply, groundwater and surface water has been proposed for conjunctive use. Eventually Dhaka Water Supply and Sewerage Authority (DWASA) have developed a strategic development plan to use alternative surface water source. There is an immediate need to initiate the feasibility study to draw water from the river Padma and new construction of surface water treatment plant at Jashaldia near Padma River which will allow 900 MLD (Millions Liter per Day) in two phases, 450 MLD by 2015 and 450 MLD by 2020. The proposed water treatment plant will receive raw water from Padma River.

The purpose of this study is to study water quality at Padma River as an intake location and finally to identify water treatment unit process/operations for Water Treatment Plant (WTP).

CHARACTERISTICS OF RAW WATER

To determine the quality of Padma river water and its variation with season, four batches of water sampling have been collected from the proposed intake site during the month of April, June, July and August, 2010. The water quality results reveal that, there was no significant variation in water composition except turbidity value, suspended solids and Total Coliform (TC) count during the sampling period from April, 2010 to August, 2010. This was because, during the rainy season due to increase of flow of water, sediment load in river water also increased significantly. The turbidity value, dissolve colored impurities value, suspended solid and total solid concentration was around 320 to 541 NTU (Nephelometric Turbidity Units), 206 Pt.Co.Unit, 501 to 865 mg/l and 582 to 950 mg/l with average value was determined as 446 NTU, 153 Pt.Co.Unit (Platinum-Coalt Unit), 655 mg/l and 737 mg/l respectively. Raw water pH increased from 7.12 to 8.02 during the sampling period (from April to July). The average pH, alkalinity, electrical conductivity (EC) value, chloride concentration, COD (Chemical Oxygen Demand) value, total coliform was about 7.65, 45 mg/l as CaCO₃, 126 μS/cm at 25°C, 7.0 mg/l,12 mg/l and 438/100 ml CFU (Colony-Forming Unit) respectively. Raw water ammonia-nitrogen and ammonium-nitrogen concentrations were measured as 0.03 mg/l and 0.67 mg/l respectively which are not very significant. Recent water quality analysis presented that, except lead, presence of other toxic substances like cadmium, mercury, chromium and zinc concentrations were reasonably very low.

LABORATORY MODEL STUDIES FOR THE SELECTION OF TREATMENT UNIT PROCESS/OPERATIONS

River water quality analysis results reveal that except pH value and chloride concentration, all the water quality parameters tested exceeded the permissible limit [2]. For the selection of treatment unit processes/operations, determination of design criteria and optimization of chemical doses, further water quality investigation and different types of model studies both in the field and at the Bangladesh University of Engineering and Technology (BUET) Environmental Engineering Laboratory have been conducted during the four batches of water sampling from April to August, 2010. Type of Model Studies conducted as: (i) Imhoff Cone Test, (ii) Simple Settling Test (iii) Discrete Particles Settling Column Test, (vi) Flocculants Particles Settling Column Test, (v) Jar Test/Flocculation Test.

SETTLING CHARACTERISTICS OF SOLID IMPURITIES AND OPTIMIZATION OF PRE-SETTLING PROCESS

Water Quality Analysis results reveal that presence of suspended solids (turbidity value), dissolved coloring substances (color value), organic matters (COD value) and microorganisms (TC count) are the major problems in surface water sources and treatment would be required to reduce these impurities within the allowable limits. The first step in the surface water treatment process is the removal of settleable suspended impurities through pre-settling process (plain settling by gravity).

A. Type of Solids Present and Settling Characteristics

Imhoff Cone Test results as presented in Fig. 1 shows that on an average total volume of sludge settled during 90 minutes settling period was around 0.87 ml per liter of settled water. Therefore, it may be concluded that volume of generated sludge from the pre-settling process would be approximately 0.087% by volume of treated (pre-settled) water. Therefore, approximately 392 m³ of sludge would be produced per day from the pre-settling process for an
estimated flow of 450 MLD in the first phase. Average total solid concentration in river water during the month of April to August was found around 737 mg/l. Test results also represent that total solid concentration increased to 950 mg/l during the month of June when the flow was comparatively very high (peak flow period). Fig. 2 represents different types of solids found in Padma River.

B. Suspended Solids Removal Performance (Plain Settling and Settling Column Test)

Fig. 3 represents the average discrete particles settling column (around 1800 cm long) test results in the field which reveal that suspended solids removal was at an exponential rate up to 45 minutes settling period and over 57% of suspended solids removal occurred during that period, the removal rate then gradually reduced up to 90 minutes, beyond which the removal performance was very slow. Results presented in Fig. 4, reveals that various types of settleable suspended solids with settling time. Turbidity removal performance was not as efficient as suspended solids removal, because of presence of large percentage of colloidal substances. In 60 minutes detention period only 42 % turbidity value reduced.

C. Pre-settling of River Water and Design Parameters

Pre-settling basin/plain sedimentation tank would be required to settle the quickly settleable suspended particles before conveying/ transmission the river water to the proposed water treatment plant site at Jashaldia which is approximately 1.3 km apart from the river source. However, for the moderately settleable and very slow settle able solids coagulation and flocculation process would be required. Approximately 32,800 m³ (for water) + 24,000 m³ (for sludge) = 56,800 m³ volume space would be required considering the de-sludging frequency period of two months. Minimum three pre-settling units would be required to allow regular de-sludging by gravity flushing. Production of sludge has been estimated as 392 m³/day. Optimum detention time and Surface Over Flow Rate (SOR) has been determined on the basis of ‘Settling Column Test’, as presented in Fig. 5. Therefore, total surface area of the pre-settling basin would be = 17,300 m² (i.e. approximately 3nos. x 100 m x 60 m) and depth would be 3.5 m.

D. Pre-Chlorination and Break Point Chlorination

During the analysis of raw (river) water, it was observed that average COD value and ammonia-nitrogen (NH₃-N) concentration reduced down to 7.0 mg/l from 12 mg/l and from 0.03 mg/l to 0.02 mg/l respectively due to simple settling of suspended particles. As a result average chlorine demand up to 6 mg/l applied chlorine was around 0.7 mg/l. Fig. 6 represents the applied chlorine versus residual chlorine concentration curve (Break Point Chlorination curve). No sharp break point is detectable from the curve; however, only small sag can be marked in the curve beyond 5.00 mg/l applied chlorine. Therefore, pre-chlorination process would be required mainly to prevent the growth of algae in the pre-settling basin.

E. Optimization of Coagulation - Flocculation Process for Colloidal Impurities Removal

Plain (discrete particles) Settling Column Test results in the field reveal that through plain settling process on an
average only 42% reduction of turbidity value can be achieved during 60 minutes detention period and turbidity value reduced from average 446 NTU to 259 NTU. Fig. 3 indicates that reduction of turbidity beyond 60 minutes through plain settling process was not very significant, because of presence of mostly colloidal particles. To reduce this turbidity level below the maximum permissible limit of 10 NTU, coagulation cum flocculation processes followed by sedimentation process would be required. Following design parameters have been developed from the laboratory model studies.

F. Determination of Optimum Operating Conditions

The hydrolysis reaction of alum with water is a strong pH value depended process and the optimum pH value for coagulation process found from test results is around 7.5 (Fig. 7). CAMP (G X t) number range which is a product of mean velocity gradient(G) and flocculation time(t) has significant effect on turbidity removal performance was also determined during laboratory model tests. In the laboratory Jar Test procedure different paddle speeds (revolution per minute) and mixing times (t) were maintained to obtain different CAMP number range. The optimum CAMP Number range is 6000-45000. To determine the optimum detention time required to settle the flocculated particles after coagulation-flocculation processes, it was observed that a minimum detention time around 20 minutes would be required to reduce down the turbidity level below 2.0 NTU. Fig. 8 also shows that the slope of turbidity variation curve with settling time gradually reduces with increased CAMP number, indicating that the effect of detention time diminishes with increased CAMP number.

FACTORS AFFECTING COAGULATION AND FLOCCULATION PROCESS

A. Effect of Type of Coagulant

Effectiveness of a particular type of coagulant has been studied through determining the turbidity, color and total coliform removal performances. Moreover, residual concentrations of metal (Al and Fe) ions have also been measured to compare the suitability.

(i) Turbidity Removal: Test results indicating that raw water turbidity removal efficiency of alum coagulant is comparatively better than ferrous sulfate coagulant at lower doses. Fig. 9 reveals that for settled water coagulation with both the type of coagulants, the difference of turbidity removal performance at all coagulant doses was very insignificant. Therefore, turbidity removal efficiency of alum coagulant appears to be better in comparison to ferrous sulfate coagulant.

(ii) Color Removal: Comparatively better color removal performance was achieved through use of aluminum sulfate coagulant for both raw water and settled water coagulation than ferrous sulfate (Fig. 10).

(iii) Total Coliform Removal: Similarly, Fig. 11 represents that over 99% of total coliform removal was achieved through direct application of aluminum sulfate on river water at a dose 75 mg/l which has been found more efficient than ferrous sulfate coagulant in respect of total coliform removal.

(iv) Residual Iron and Aluminum Concentrations: Test result represents that the average residual aluminum and iron concentration reduced with increased doses of aluminum sulfate and ferrous sulfate coagulant. However, an average
concentration of Al and Fe around 0.7 mg/l and 0.22 mg/l detected even at a coagulant dose of 100 mg/l and around 0.80 mg/l and 0.38 mg/l respectively measured at a coagulant dose of 50 -75 mg/l. Although this residual concentration of Al is higher than the maximum allowable limit of 0.2 mg/l, it can be expected that after sand filtration process this concentration would be within the maximum permissible limit of 0.2 mg/l [2]. On the other hand, Fe concentration is within the allowable limit which is 0.3 to 1.0 mg/l [2].
A detention time (t) around 20 minutes may be considered optimum. (f) Rapid Sand Filtration – Filtration process would be finally required to reduce the turbidity value below the desired allowable limit and improve the microbial quality of water significantly. A filtration rate around 5.0 - 7.5 m$^3$/m$^2$/hour may be considered optimum for pretreated water (through alum coagulation-cum flocculation processes followed by sedimentation process) for single media granular sand filter. (g) Post Chlorination- Chlorination would be required for complete disinfection of treated water and to prevent the contamination of water in the distribution system.

CONCLUSION

It may be concluded from the water quality investigation results that, Plain settling and pre-chlorination processes near the source could be avoided. Alum coagulation-flocculation followed by sedimentation processes would be required to bring down the turbidity and color values within the recommended limits. Optimum doses of coagulant and alkaline chemical would be selected through time to time Jar Test method during actual field operation.

Rapid Sand filtration process must be adopted to ensure potable (physically, chemically and microbiologically safe) quality of water. Post chlorination process should be adopted to make the surface water (Padma River) more potable to the consumers. Optimum dose of chlorine would be decided on final trial basis.

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Authors are acknowledged to IWM; Specially, S M Mahbubur Rahman (Director, Water Resources Planning Division, IWM) and Shahidur Rahman Prodhan (Urban Water Management Specialist, IWM) for their kind cooperation to complete the project.

REFERENCE


Evaluation of Ecological Impact for Proposed Jashaldia Surface Water Treatment Plant near Padma River

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ABSTRACT

In an effort to meet the increasing demand of water supply in Dhaka City, a surface water treatment plant (WTP) at Jashaldia, which will draw raw water from Padma River as water source has been proposed. During construction as well as operational phase of the WTP, a full scale ecological impact assessment has been carried out. The possible ecological impacts of the proposed WTP area were evaluated considering the baseline condition, and the nature and extent of the project activities. It has been found that most of the evaluated ecological impacts fall under the “minor” category and their effects are short-term in nature. No long-term adverse impacts to the floral species as well as to the populations of the mammals, reptiles, amphibian, birds and fishes are expected. Possible risk to flora, fauna and fish species has also been categorized as “low”.

INTRODUCTION

The growth of population in Dhaka, the capital of Bangladesh, is one of the fastest in the world. Over the last 40 years the population of Dhaka City has increased from about 0.9 million to more than 12 million. This huge population growth has triggered the water demand from 150 MLD (Million Liter per Day) to 2500 MLD (including industrial and commercial demand and unaccounted water) between 1963 to today considering consumption rate of 150 liter per day per person [3]. Although the water supply in the Dhaka city started in 1876 with a surface water treatment plant at Chandni Ghat, since the early 1960, water supply has mainly been dependent on groundwater. The Dhaka Water Supply and Sewerage Authority (DWASA) is facing significant challenges in its efforts to ensure water supply in adequate quantity and quality to the growing population of Dhaka throughout the year. The majority (about 87%) of DWASA water supply (about 1940 MLD) comes from about 559 deep tubewells (DTWs) installed in the upper Dupitila aquifer (100-350m) [3]. However, in recent years, the groundwater level has been declining rapidly. Studies conducted by the Institute of Water Modelling (IWM) have confirmed that up to 1994 the water level declination was only 0.55 meters per year, while in the last 15 years the groundwater declined by 3.52 meters per year [3]. It has been observed that in recent years the production from the groundwater has not increased substantially in spite of the fact that the number of DTWs has increased quite significantly over the last few years. This demonstrates that further abstraction from upper aquifer (100-350m) is no longer sustainable. The WTP accounts for the majority (over 90%) of the treated surface water supplied by the DWASA. In an effort to reduce the overwhelming dependence on groundwater resources for water supply, the DWASA is exploring the possibility of constructing a surface water treatment plant, which will draw raw water from Padma River. The proposed surface water treatment plant will have a capacity of 900 MLD to be constructed in two phases, 450 MLD capacity plant under Phase I by 2015 and another 450 MLD capacity plant by 2020 [3]. In August 2009, the DWASA assigned the Institute of Water Modeling (IWM) to carry out the detailed feasibility study of this proposed surface Water Treatment Plant (WTP). As a part of the feasibility study, a full scale environmental impact assessment of the proposed project has been carried out in accordance with the Environment Conservation Rules 1997 [1].

The primary objective of the ecological study was to determine the diversity, distribution, status and extent of biological resources (3F- Flora, Fauna and Fishes) at or near the study sites, and later, to identify and assess project impact (if any) on these resources, and finally, provide possible mitigation measures based on the level of impact identified/assessed.

OUTLINE OF METHODOLOGY

An ecological survey was carried out October 2010 in the study areas to document the existing diversity of flora and fauna. Since the proposed water transmission line will cross a number of rivers and other water bodies, and therefore possible impact of construction activities on aquatic environment of these water bodies is of particular interest in the environmental assessment. The first hand data on floral and faunal diversity of the study sites during day time have been collected. Herpeto-faunal and mammalian survey was done through visual search and also through discussion with local people. Aural and visual searching was the main survey method for ornithological survey. Information on fisheries was collected through fishermen interviews as well as local fish market survey. Rapid Field Survey System (RFSS) [4] and discussion with local people was the main method for floral survey.

STUDY AREA

The following areas (Fig. 1) were considered for assessment of the 3F diversity: 100 meter radius around the location of the proposed water treatment plant; 30 meter corridor along the route of the proposed treated water transmission line; 50 meter radius surrounding the intake canal and intake structure (from the bank of Padma River up to the WTP). The 3F diversity fluctuates seasonally due to the environmental reasons. Seasonal survey (over one year) could provide more detailed information on 3F diversity. However, this rapid survey suggests that some of the proposed study areas have important places to support natural healthy environment for the existing fish, flora and fauna. Based on a rapid survey in October 2010, both floral and faunal diversity including fish resources were assessed. Preliminary
assessment on 3F (Fish, Flora and Fauna) diversity indicates their richness in some parts of the study sites.

ECOLOGICAL IMPACTS

water treatment plant and booster pump station and installation of water transmission pipeline, land clearing and alteration, movement of people and vehicle, materials placement, excavation, accident have some potential impacts (direct and indirect) on the existing ecological environment. Construction activities associated with crossing of rivers/ water bodies (ponds, shallow lowlands) by water transmission line are likely to have some adverse impact on aquatic environment, especially on aquatic flora, fauna, fish and water quality [7]. It should be noted that there are 19 bridges (including 2 major bridges on Dhaleswari River and one on Buriganga River) along the alignment of the proposed water transmission line. During operational phase, major impacts include possible pollution of water bodies by treatment wastes (e.g., sludge) and its impact on aquatic ecosystem [6]. For the proposed project, potential impacts could be divided into two broad categories as (a) direct impact and (b) indirect impact. This paper describes both impacts on 3F (flora, fauna and fish) diversity of the study areas.

A. Potential Impact on Flora

Activities related to construction of WTP, booster pump station, and installations of water transmission lines have some potential impacts (direct and indirect; positive or negative) on the existing ecological environment [7]. Magnitude/ intensity of these impacts may vary from place to place; some could easily be identified while others require long-term study/monitoring. Descriptions of potential impacts on flora for the proposed WTP actions are given below.

B. Potential Impact on Aquatic Flora

In the study area, aquatic flora is further divided into three major types, as tree, shrub and herb. All of these floral species grow in canals, ditches, river, seasonal wetland and low lying agricultural lands as submerge, free-floating, or rooted floating states. The following are the floral species found in the study area: Hydrilla verticillata, Eichhornia crassipes, Utricularia aerea, Lemna perpusilla, Pistia stratoeetes, Salvinia cuculata, Hygrophor arista, Nymphaea sp, Ipomoea aquatic, Vallisneria spiralis, Colocasia esculenta, Ceratophyllum demersum, Fagopyrum hydropiper, Enhydra fluctuans, Monochoria vaginalis, Alternanthera philosoroids, Ipomoea fistulosa, Aponogeton natans [2]. Three types of terrestrial plant habit e.g. tree, shrub and herb exist in the study areas. Except herb and shrub, natural tree (naturally originated) does not exist in the area [2]. Mosquitoes (breeding sites) are of the undergrowth would also have some adverse impacts. Some terrestrial tree may be uprooted from its original habitat. If those are used as wildlife habitat or nesting ground by animals, removal of those will be a significant impact and such types of impact are irreversible. Terrestrial vegetation has great contribution to the existing ecosystem, and clearing or removal of the undergrowth would also have some adverse impacts. Percentage of identified terrestrial floral habit is given in pie chart (Fig. 2), which is an indicative of floral richness.

D. Potential Impact on Fauna including Fish

Construction activities related to the proposed site could have potential impacts (direct and indirect) on the existing aquatic and terrestrial fauna due to their highly sensitive and reactive behavior for disturbance that may occur at or near their habitat (Fig. 3). Fauna species that are sensitive to direct (human activity and traffic) or indirect disturbance (noise) would be impacted most.

Habitat disturbance would reduce habitat availability and effectiveness for a certain period for mammals, reptiles, amphibians, birds and their predators. There are also some possibilities of direct mortality and displacement of amphibians, reptiles, birds and mammals from the use of vehicle or machineries over terrestrial or aquatic faunal habitats. Quantification of these losses is difficult; however, the impact is expected to be low and short-term in nature. Actions near fish habitats may also have some potential impact on fish fauna e.g., mortality, disturbance of fish passage during monsoon, deposition of excavated soil on fish habitat, contamination of water, destruction of shallow fish habitat or saturated ground by movement of project vehicles, etc. Impacts on fish fauna could be quite difficult to assess immediately, but availability of some indicative fish species could be monitored by which potential impacts could be evaluated.
E. Potential Impact on Amphibians

A couple of aquatic (*Rana alticola* and *Euphlyctis cyanophlyctis*) and four terrestrial amphibians (*Polypedates maculatus, Limnonectes limnocharis, Hoplobatrachus tigerinus, Buto melanostictus*) are available in the study sites, of which one (*Rana alticola*) is nationally threatened [2]. It has been recorded at most of the aquatic sites of this proposed project. Amphibians are more sensitive to the environmental changes due to their permeable skin and other biological features. Amphibians use both aquatic and terrestrial habitat for their survival and changes of those habitats have a great impacts for their survival. The proposed plant activities could have some impacts on existing amphibians such as (i) undergrowth or vegetation may be cleared for construction works, (ii) project vehicle and materials may enter into the shallow/ deep freshwater bodies or saturated ground, (iii) increased sediment load or contamination of water due to various actions related to project, etc. These impacts may cause temporary or permanent disturbance of amphibian habitat. Impacts on amphibian population could be evaluated by monitoring the changes of species composition and richness and their relative abundance.

F. Potential Impact on Reptiles

Around one and half dozen aquatic and terrestrial reptiles are available at or near the WTP sites and some of them are nationally threatened [2]. These are turtle (*Xenochrophis cerasogaster*), snakes and lizards [2]. Reptiles are sensitive animal and sometimes used as indicative species for bio-environmental assessment. Burrowing reptiles are bio-sensitive and respond quickly to any man-made or natural activities/calamities. Special care should be taken before conducting any activities in and around the habitats of those animals. If the development activities are conducted during pre or post breeding season of the burrowing reptiles, the entire community could be affected seriously or their life cycle could be jeopardized. To evaluate impacts on reptilian species, relative abundance and changes in species composition could be used as indicators.

G. Potential Impact on Birds

More than four dozen residential bird species (terrestrial and aquatic) are available at or near the study sites, of which one (*Ketupa zeylonensis*) is nationally threatened, and primarily depend on fish [2]. Potential impacts are disturbance due to project related actions and excessive human presence during bird’s foraging, resting and nesting time that might result in reproductive disturbance /failure. Removal of floral (tree, herb and shrub) species for proposed WTP would affect some bird habitat from where they collect food (insects), take rest and also build nests. Potential impacts for those bird species are (i) habitat destruction, (ii) temporary displacement due to increased human disturbance and vehicle movement, and (iii) nest abandonment and/or reproductive failure caused by project related disturbance.

H. Potential Impact on Mammals

At least 10 terrestrial mammalian species are available in the study area of which one (*Prionailurus bengalensis*) is nationally threatened [2]. Some mammalian species may be disturbed and displaced from portions of the project sites for some hours, days or months due to the project activities. They are likely to return to their habitat soon after the disturbance has ceased. Some mammalian species also utilize village vegetation throughout the year or seasonally as permanent or temporary habitat. Project activities, e.g., movement of vehicle and people could displace potential prey species for some mammal within the study area. However, disturbances associated with the proposed plant works are too small to have any measurable effect on the prey for mammals. Effects are expected to be temporary, incidental and minimal.

I. Potential Impact on Fish

More than two dozen freshwater native fish species are available in and around the study areas of which eight (e.g. *Chaca chaca*) are nationally threatened [2]. All of these threatened fishes are commercially important to the local community and are distributed in various aquatic habitats within the study areas. Conservation values of fishes are based on the ability of fish stocks to access ephemeral waters during irregular climatic events (flood, rain etc), and to take advantage of these flows to enhance their reproductive success. Habitat destruction incorporates the need for protection of water quantity, quality and fish passage access to habitat during flow periods. Freshwater native fishes may encounter some potential impacts of the proposed WTP activities such as mortality, disturbance of fish passage, sediment deposition on fish habitat, contamination of water, destruction of shallow fish habitat due to intrusion of project vehicles, dewatering of water bodies, etc. These impacts may vary for different fish habitats (e.g., pond, ditch, *beel*) and also behavior or habit of fish species.

### Table 1. Evaluation of ecological impacts resulting from different project activities

<table>
<thead>
<tr>
<th>Source of Potential Impacts</th>
<th>Ecological Issues</th>
<th>Flora</th>
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[Legend: NOA = Not Applicable, NOE = No Effect, NEE = Negligible Effect, MIE = Minor Effects, MOE = Moderate Effect, MAE = Major Effect, AQ = Aquatic, TR = Terrestrial]
EVALUATION OF ECOLOGICAL IMPACT

For evaluation of ecological impact, the impact can be divided into 4 categories - negligible, minor, moderate and major. Negligible indicates effects which are unlikely to be noticed or measurable against background activities. Minor category represents change which is within the existing variability but can be measured and/or noticed. Moderate evaluates change in ecosystem or activity in a localized area for a short time, with good recovery potential. Similar scale of effect to existing variability, but may have cumulative implications. Finally, major impact indicates change in ecosystem or activity over a wide area leading to medium-term damage (+2 years), but with a likelihood of recovery within 10 years. Table 1 indicates that most of the evaluated ecological impacts fall under the minor category and their effects are short-term in nature. No long-term adverse impacts to the floral species as well as to the populations of the mammals, reptiles, amphibian, birds and fishes are expected.

CONCLUSIONS

It has been found that most of the adverse impacts during construction phase could be minimized or even removed if appropriate mitigation measures are taken. However, a monitoring program needs to be put in place to assess any adverse impacts on the environment. Possible adverse impacts during operational phase are insignificant. Possible environmental impacts of the proposed site have been evaluated and mitigation and abatement measures to reduce or eliminate potential adverse impacts and to enhance beneficial impacts have been suggested. It also presents an environment management plan (EMP), including a monitoring program, identifying the management responsibilities for implementation [5].

ACKNOWLEDGEMENT

Authors are acknowledged to IWM; specially S M Mahbubur Rahman (Director, Water Resources Planning Division, IWM) and Shahidur Rahman Prodhan (Urban Water Management Specialist, IWM) for their kind cooperation to complete the project.

REFERENCE

Comparison of Application Methods of Phosphorus Amendments on Lead Immobilization in Lead-Contaminated Soil

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ABSTRACT
Phosphorus amendments were used to immobilize lead in contaminated soil. The objective of this study is to investigate the comparison of several application methods of phosphorus amendments on lead immobilization in a contaminated soil. The addition of hydroxyapatite (HAp) resulted in a decrease in water-extracted lead in all application methods except for repeated P solution. The sequential extraction analysis showed that the chemical Pb forms of single HAp application, which is the practical methods, did not change significantly compared to the other treatment applied. These results suggested that all the methods including single application of HAp except for repeated application of phosphorus solution are useful for lead immobilization and applicable for lead-contaminated soil.

INTRODUCTION
Lead is one of the most ubiquitous contaminants in the soil and aqueous environments. Soils act as a lead reservoir, and can become an environmental pathway or carrier of lead to biota. Because of lead toxicity to humans and animals, considerable effort has been focused on remediating the lead-contaminated soil [1].

A heavy lead contamination can often be found at shooting ranges where the soil lead concentration sometimes exceeds 10000 mg/kg because of spent lead bullets [2]. In Japan, many of lead-contaminated soil located in mountainous region. It causes the degradation of natural vegetation due to lead toxicity, which may have the potential to augment the extent of lead contamination via soil erosion. In situ immobilization of soil Pb using fixing amendments is a promising technique for remediation of contaminated soil based on minimizing ecotoxicological risk, improving time and cost efficiency. Therefore, the development of cost-effective techniques is necessary to reduce the mobility and bioavailability of lead in soil and water environment.

Phosphorus materials have been used to immobilize lead in situ from aqueous solutions and contaminated soils [3]. The primary mechanism of lead immobilization appears to be through phosphorus material dissolution and subsequent precipitation of pyromorphite-like minerals, though mechanisms such as cation substitution, adsorption and precipitation as other lead minerals are also possible. Hence, phosphate-mineral solubility largely determines the effectiveness of in situ lead immobilization. In addition to phosphorus materials, aqueous phosphate also has been used as the immobilizing amendment into lead-contaminated soils [4].

To overcome the cost issue of the immobilizing amendments, the use of industrial byproduct has been studied as the alternatives to relatively expensive materials. A comprehensive review [4-5] reported that variable organic and inorganic byproducts such as poultry manure, bio-solid compost, and fly ash had been examined for their capacity of lead immobilization and others heavy metals in contaminated soils. A hydroxyapatite synthesized from industrial byproducts (e.g. poultry waste and gypsum mould from the ceramic industry) has been investigated and shown to possess similar or greater capacity of Pb removal from solution compared to pure hydroxyapatite [2, 6].

The research on the ability of the immobilizing materials has been widely investigated, but an application method has not been clarified. In order to improve the immobilizing effect, it is also necessary to evaluate the application methods. The objective of this study is to investigate the comparison of several application methods of phosphorus amendments on lead immobilization in a contaminated soil and also to obtain the effective application methods.

MATERIALS AND METHODS
A. Soil and Amendments Preparation
All the reagents used for analysis in this study were purchased from Kanto Chemical CO., INC.

A lead-contaminated soil was collected from shooting range soil in Gifu, Japan and was ground to pass a 2 mm sieve. The chemical properties of the soil sample are shown in Table 1 and sequential extraction of lead-contaminated soil is shown in Fig. 1. For pH, water-extracted Pb, and dissolved organic carbon (DOC), water extraction procedure referred to the Japanese Ministry of Environment Method Notification No. 18 [7] was applied. Soil sample was weighted and mixed then added to ultra pure water by ratio (1:10) and shaking for 24 hours. The value of pH was measured after shaking. Pb and DOC concentrations in the suspensions filtered through a membrane filter (0.45μm) were measured by inductively coupled plasma-atomic emission spectrometry (ICP-AES) and TOC meter, respectively. For analysis of total Pb, P amounts, 0.25g soil sample was digested with 5 mL HNO3 and 2 mL HCl using microwave oven. After completing digestion, all the solution was diluted in 50 mL, measuring cylinder and filtered through a 0.45 μm membrane, and analyzed the metals concentration by ICP-AES. A sequential extraction analysis was performed on the soil following the procedure referred to [8]. A 1.0 g soil passed through a 0.425 mm sieve was extracted with 25 mL of 1 M MgCl2 solution (exchangeable Pb). The soil remaining after the first extraction procedure was extracted with 25 mL of 1 M sodium acetate solution with pH 5 (carbonate-associated Pb). The soil remaining after the second extraction procedure was extracted with 20 mL of 0.04 M NH4OH-HCl in 25% (v/v) HOAc in a 95 °C water bath with occasional agitation (Fe and Mn oxide associated Pb). The soil remaining after the third extraction procedure was extracted with 3 mL 0.02 M HNO3 and 5 mL 30% H2O2 solution in an 85 °C water bath with occasional agitation. After 3 h of extraction, 5 mL 3.2 M NH4OAc in 20% (v/v) HNO3 was added and the soil was shaken for 20 min (organically- associated Pb). The remaining soil was digested with 5 mL HNO3 and 2 mL HCl using microwave oven (residual Pb) and diluted in 50 mL measuring cylinder. After completing digestion, all the solution was filtered through a 0.45 μm membrane, and analyzed by ICP-AES.

HAp was synthesized from gypsum waste and (NH4)2HPO4 following the procedure referred to [10]. Crystalline phase of the product was analyzed by powder X-ray diffractometry (XRD;model RAD-2B, Rigaku Corp).
The pattern of HAp synthesized was broad, indicating that the HAp was composed of a poorly crystalline hydroxyapatite.

Table 1. Chemical properties of lead-contaminated soil.

<table>
<thead>
<tr>
<th></th>
<th>Water-extracted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>DOC</td>
<td>Pb</td>
</tr>
<tr>
<td>(mg/kg-DW)</td>
<td>(mg/kg-DW)</td>
<td>(mg/kg-DW)</td>
</tr>
<tr>
<td>7.4±0.1</td>
<td>17.2±2.4</td>
<td>103±0</td>
</tr>
</tbody>
</table>

+7 deviation standard

![Fig. 1. Sequential extraction of lead-contaminated soil before the experiment](image1)

B. Treatment and Soil Incubation

Several application methods of phosphorus amendments were used. In single Application method (Treatment 1), HAp was added one time at the start of 4 week incubation, which is practical method used in Japan. In repeated application (Treatment 2), HAp was added four times at once a week during the incubation and the phosphorus amount of each addition was a quarter of the amount in Treatment 1. For repeated application of phosphorus solution (Treatment 3), Na$_2$HPO$_4$ and NaH$_2$PO$_4$ was added to replace the application of HAp as a phosphorus sources and applied four times at once a week with the same total phosphorus amount to that in Treatment 1. HAp also was applied with flooded condition (Treatment 4) and flooded condition with glucose at rate 1%w/w (Treatment 5) to accelerate the reduction condition.

Fifty gram of lead-contaminated soil was placed into a polypropylene bottle. Each of the phosphorus materials was applied into the soil at a rate of 1%w/w and 5%w/w HAp. Then, water was added into the soil to maintain 60% of water holding capacity in soil, except for Treatment 4, 5 where the water is added over the surface of the soil. All bottles were placed into 25°C incubator to incubate for four weeks. The bottles were provided three replicates each treatment.

The soil sample after incubation was air-dried and passed a 2 mm sieve to analyze soil pH, water-extracted Pb, DOC by the water extraction procedure and chemical Pb forms by the sequential extraction analysis described in 2.A.

RESULTS AND DISCUSSION

A. Soil Chemical Properties

From Table 1, it is clearly shown the state of Pb content in the contaminated soil has far exceeded the maximum permissible level of 600 mg/kg and 1000 mg/kg of lead in soil that recommended in areas used repeatedly by children below 12 years old and in areas such as industrial parks or along streets and highways or in parks along streets and highways or in other unfrequented by children, respectively [9]. The highest content of Pb fraction in soil before the experiment was found in carbonate fraction (Fig. 1).

![Fig. 2. XRD pattern of HAp sample synthesized from gypsum powder and diammonium hydrogen phosphate.](image2)

B. Soil pH

Generally, soil pH increased after shaking 24 hours. The concentration of organic anions in organic material plays an important role in soil pH Soil pH change. The decarboxylation of organic anions consumes protons [16] and thus increases soil pH. Soil properties, such as moisture content, soil texture, soil pH, soil available N and indigenous soil organic matter, have great impacts on the decomposition of organic matter and thus on soil pH changes. Fig. 3 in all treatment was almost same to original soil pH in Table 1 even with different amount of phosphorus amendments added. This result suggested that application methods of phosphorus amendments did not influence soil pH.

![Fig. 3. Comparison of pH among each treatment.](image3)

C. Water-extracted Pb

Water-extracted Pb in soil applied 1% and 5% P amendments application was shown in Fig. 4 and Fig. 5, respectively. Except for Treatment 3, there is no significant difference among application methods compared to...
Treatment 1. Water-extracted Pb in Treatment 1, 2, 4, 5 was 2.0-2.6 mg/kg for 1% phosphorus application and 0.01-0.12 mg/kg for 5% phosphorus application, respectively, indicating that application of phosphorus amendment dramatically reduced water-extracted Pb.

An increase in water-extracted Pb in Treatment 3 compared to that in original soil in Table 1 might be attributed to the provision of other forms of phosphorus compounds. Water-extracted Pb might dramatically increase due to applying of P solution that can increase dissolution of the organic matter which has linear correlation with the metal dissolution. High contents of organic matter in the sediment increased the adsorption ability of heavy metals [11]. In natural waters, also, there is a strong affinity between metals and organic matters [12,13]. Dissolved and particulated organic carbons in the soil would have an important role in the mobility of heavy metal. This would be discussed in the following section.

**D. Dissolved organic carbon (DOC)**

Dissolved and particulate organic carbon in the water column act as scavengers for metals, and the scavenged metals may then be incorporated into the bottom sediments. In general, organic matter in sediments tends to decrease the availability of metals to sediment dwelling organisms because of the formation of complexes between metals and organic matter [14]. The presence of organic ligands in sediments appears to be an important factor in determining the bioavailability of several metals, one of them is lead, which correlation coefficient were high for Pb [15].

From Fig 6, DOC in Treatment 3 dramatically increased compared to those in other treatments and original soil. According to [16], there was significantly positive correlation between the adsorption abilities of heavy metals in sediments and organic matter contents. Increase in DOC in Treatment 3 would result in increase in water-extracted Pb. The values of DOC at 5% phosphorus application in Treatments 1, 2, 4, and 5 were decreased compared to the same treatment at 1% phosphorus application. But the DOC result in Treatment 3 was increased than 1% phosphorus application.

E. Sequential extraction

Sequential extraction were used for determination of metal binding forms. The results of chemical Pb forms by the sequential extraction at 1%, 5% phosphorus applications were shown in Fig. 7 and Fig. 8, respectively. The recovery ratios of total amount of each fraction to total Pb amount in Table 1 were ranging from 92-108%.

Sequential extraction of soil added to 1% phosphorus application demonstrated that chemical Pb forms in all treatment were shifted to less soluble ones compared to that in original soil as indicated by decreases in fraction 2 and increase in fraction 5. Precipitation of Pb-phosphate minerals like pyromorphite having a very low solubility probably resulted in increase in fraction 5. The ratio of fraction 5 at 5% phosphorus application was further increased than that at 1% phosphorus application to be almost 100% except for Treatment 3. These results showed that it is useful for Pb immobilization to add the phosphorus amendments to the contaminated soil by any application methods applied in this study except for repeated application of phosphorus solution.

**CONCLUSION**

This study evaluated the effect of application methods of phosphorus amendments on lead immobilization in a lead-contaminated soil. The addition of HAp to the contaminated soil resulted in a decrease in water-extracted lead in all treatments except for repeated P solution treatment as compared to the soil before the experiment. This trend was almost same to results for DOC.

The sequential extraction analysis of soil added at 1% phosphorus application showed that the chemical Pb forms of single HAp application, which is the practical methods, did not
change significantly compared to the other treatment applied in this study. The same pattern also occurred at 5% phosphorus application except for repeated application of phosphorus solution. These results strongly suggested that all the methods including single application of HAp except for repeated application of phosphorus solution are useful for lead immobilization and applicable for lead-contaminated soil.

REFERENCE

Evaluating Efficiency and Impacts of Newly Introduced Compactor Truck based Waste Collection System in Dhaka City

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ABSTRACT

This paper examines the efficiency of compactor truck based collection system of Dhaka City Corporation (currently Dhaka North and South City Corporations) in quantifiable parameters and recommends how the improvement can be made. The aim is to determine quantifiable efficiency indicators. Time and motion survey, analyzing weighbridge data, interview of field staff and focus group discussions were done with flexible list of questions. Findings show that within the round trip haul distance 15 km, it took 6.5 hours to make 2 trips to transport around 3.6 ton of waste using 90% capacity of vehicle. Time efficiency rating of the worker was about 56%. Net speed of the vehicle in the collection area and whole travel route were about 2.78 and 6.6 km/h respectively. Findings also show that social factors can influence the efficiency of the collection system. Collection systems' improvement is possible considering the issues of community participation and crew behaviors in planning process and enhanced monitoring by field staff, conservancy officers and inspectors.

INTRODUCTION

Rapid urbanization of Dhaka city and its fast increasing population over the last few decades have created much pressure on its urban services. The existing services are far too inadequate to serve the inhabitants and solid waste management (SWM) is one of the major problems faced by the authorities and the inhabitants [1]. Almost half of city’s daily generated solid wastes remains uncollected and are being disposed locally which makes environmental condition of the metropolis quite gloomy and dismissal [2]. It is reported in the clean Dhaka Master Plan that in 2004, the managed collection was around 44% as collection amount was 1400 ton/day while the generation amount was 3200 ton/day [3]. To enhance the capacity of waste management department (WMD), 35 compactor trucks are procured and introduced with assistance of Japan International Cooperation Agency (JICA). There is also open truck based collection and container based collection in Dhaka City. The efficiency of newly introduced compactor truck based collection was within the scope of this study.

The objectives of the study; a) to determine efficiencies of solid waste collection system in quantifiable parameters, b) impact of compactor truck collection systems, c) promotional strategy and d) recommendations on improvement of waste collection efficiency. The findings of the study can be used to monitor and cross check the similar collection systems prevailing in Dhaka City to improve the efficiency. This paper may be helpful to introduce fixed time and station based collection system in other municipalities of Bangladesh.

MATERIALS AND METHODS

The study area and method was confirmed in consultation with the engineers and conservancy staff of former Dhaka City Corporation (DCC). The study areas, days of collection, selection of vehicle to study, staffs to be interviewed were selected under careful consideration for rational results aiming to be used as benchmark to some extent for representative results of collection operation in similar conditions.

The qualitative and quantitative data collection methods included focus group discussion [4], interview of staffs and workers, time and motion study [5] and weighbridge data analysis. Data collected by time and motion study were also incorporated in the mathematical equations [6] to check the rationality of result.

In interview, some of the questions were predetermined, while others were open. Questions were asked according to a flexible checklist as a guide for queries but not in the form of formal questionnaire.

Interviews can provide in-depth, inside information if trustful relationship is established with informants [7]. On the basis of this notion, target interviewees, study areas, vehicles to be surveyed were selected. Discussion meeting also took place with high officials (executive engineer, additional chief waste management officer) to select the interviewees.

Study has been carried out in July 2010. DCC has been divided into two separate organizations in December 2011 as Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC). The study area and interviews are belonging to DSCC.

A. Time and Motion Study

The studied compactor truck was 2 ton capacity. It worked in ward 13 (previous ward 36) for first trip and second trip was in ward 10 (previous ward 33). Ward is the smallest administrative jurisdictional area of city corporations; there are total 92 wards in Dhaka after splitting into DNCC and DSCC. The movement of vehicle and time spent in different stages of collection cycle were surveyed to find out the time consumption in different stages of full collection cycle. The variations of time consumptions among different collection systems were compared at the end of survey. Travel lengths of the vehicles were also measured to understand the speed of the vehicle and also to get an idea of time requirement to make trips of certain round trip haul distance. The data were collected from weighbridge installed in the landfill site; physical observation and interviewing related workers, staff and officials - before, after and at the time of time and motion survey.

At the time of time and motion survey crew behaviors were monitored to understand whether improvement could be made. The working efficiency of collection workers were calculated as how many workers spend how much time to load and carry per ton of waste and how much time was required for collecting and disposing per ton of waste. The loading efficiency of vehicles was calculated on the basis of percentage of vehicle's capacity. Wide varieties of efficiency parameters can be generated from time and motion survey and weighbridge data which reflect not only the efficiency of the time, vehicle or crew but also give an idea to take improvement measures. The following efficiency indicators were measure through the study.

\[
\text{Time efficiency rating} = \frac{100 \times (1 - \frac{1}{1 + \text{NP}} \times \text{TTT} - \text{RT})}{(1 + \text{NP}) \times \text{PNWH}}
\]

Where: TTT = Total Trip Time, RT= Recycling Time, BT = Break time, NP= Number of collectors except driver,
TTC = Total time of collection or pickup, TTU= Total time of unloading
TT = total travel time + total pickup/collection time + Weighbridge time + Break time + fuelling time + others,
PNWH = Prescribed number of working hours per shift.

Financial efficiency, as Gross person x minute
/load = [(No. of driver + No. of collectors) x (total trip time)]/ load

Net labor efficiency = (Net person x minute) / load
= [no. of driver x (total trip time – break time or any other time not related to collection and transportation) + No of collectors x (pickup time+unloading time)] / load

Time efficiency rating is also calculated as how much percentage of time labors were actually engaged in work with respect to the total assigned working time

Net loading or pickup rate = net collection time in minute/load in ton. net pickup time/ dustbins or points

Net pickup time/(total no. collection stations or points x no of person)

Net load (kg)/ total no of stations or dustbins
Mean distance between two stations
Mean travel time between two stations
Net speed in the collection area (km/hr)
Gross speed in the total trip time (full collection cycle) as km/hr

B. Working time, number of trips and round trip haul distance relationship

Time and motion survey findings were compared to results coming from following established mathematical equations.

H = [(t1 + t2)+No(Nd(T scs))] / (1-W) , [6,8]

Time from garage to first collection point, t1
Time from final disposal site to the garage, t2
Number of trips to be made per day, Nd
Time per trip for stationary container system in h/trip, T scs = P scs + s + a + bx [6, 8]
P scs = pickup time per trip, h/trip

At site time is t, time to unload waste in the disposal site. ‘a’ and ‘b’ are empirical haul constants determined from the reference graph as stipulated in the book of Environmental Engineering [6, 8].

C. Focus Group Discussion (FGD) and Staff interview

A flexible list of questions were prepared in three aspects to know the promotional strategy of compactor truck as it was first time for Dhaka City, merits and demerits of this new collection system and ways of improvement. Community people and key SWM staffs who were closely involved in the plan, promotion and operation of compactor truck based collection system were involved in group discussion and interview. 9 Conservancy Inspectors (CIs) of 9 wards and 3 conservancy officers (COs) from 3 zones have been selected for interview along with vehicle drivers, workers, community groups and landfill site operators. The criteria of selecting COs and CIs were: working in the study areas, quittance with new system of collection, knowledge on SWM of City Corporation. FGDs were carried out for several groups where time and motion survey findings also shared to judge the rationality.

RESULTS AND DISCUSSION

A. Operating Efficiency of Vehicle

The results show the time ratio for average loading, unloading and traveling times are 21%, 6% and 72% respectively to make two trips per day consuming total 6.8 hours while the round trip haul distance was around 15 km. In the first trip there were 11 stations and in the second trip only 1 station. The net pick up times were 52 and 33 minutes for first trip and second trip respectively while the average unloading time was around 10 minute/trip. FGD showed that unloading time generally take less than 10 minute.

Net speed of the vehicle in the collection area, net speed in whole travel route and gross speed in whole travel route were about 2.78 km/hr, 6.6 km/hr and 4.71 km/hr respectively. It has been found that due to the construction of flyover along the truck route and increase of traffic congestion, the transportation time (travel time) took about 1 hour more than expected time. The collected waste amount in the context of total time consumption and travel distance (starting from garage to back to garage) was 16.4 kg/km/hr.

Study truck has been assigned to make two trips per day but weighbridge data shows slight fluctuations of trips. According to weighbridge record, from January to August 2011, studied truck made 1.95 trips/day and waste amount was 2.165 ton/trip (108% capacity usage i.e., overloading). On the survey dates these results were on an average 2 trips/day and 1.8 ton/trip (90% efficient in terms of carrying capacity) respectively.

Comparison of the findings from time and motion study and established mathematical equations [6, 8] showed the difference was only about 2.5 minutes per trip. However, this difference can be expressed as 1% in 8 hours working shift.

B. Fuel cost efficiency

The fuel costs to transport per ton of waste per km of haul distance were TK 20.73 (1USD=83.50 TK) for studied vehicle (2 ton capacity). This value is calculated as TK 7.64 for 5 ton vehicle working in similar haul distance. No rational analysis was found in management about the requirement of gasoline per km. It is based on traditional working pattern and assumption. However, it has found that the cheapest collection system 5 ton capacity compactor among the open truck and container collection systems. Results showed the correlation exist as the larger the vehicle the lower the fuel cost.

C. Labor Efficiency

Two different methods of picking (loading) were found for two trips and same crews worked in both trips. There were two crews including driver. In the first trip, vehicle picked waste from 11 designated stations in certain times where neighboring community, shops, restaurant and offices brought their wastes in plastic bags, buckets, drum and jute bags and waste workers load the vehicle. On the other hand primary collection rickshaw vans came in the second trip collection station, a fixed station and in certain time. The rickshaw van pullers load the vehicle with the help of shovel, tukri (basket made of bamboo and straw) and aluminum bowl.

Time efficiency rating of the labors was found 57%. The gross labor efficiency was 3.82 person-hour/ton while the net pickup rate was 23.5 minute/ton and net labor efficiency was 2.5 person-hour/ton. Though driver worked less than 8 hours, it was found that driver received overtime allowance and made fewer trips than assigned trips against allocated fuel in general.

D. Promotional Strategy of Compactor Truck based Collection

At first, in the middle of 2008, DCC with the assistance of JICA experts selected probable locations based on several criteria such as field staffs motivation, existing waste discharge pattern, waste amount, type community, existence of primary collection, housing pattern, road condition and traffic conditions. From the probable sites, final selection of site was confirmed with help of priority ranking.

In second step, community peoples are organized as group of volunteers and trained. Local school teachers, young volunteers, retired officials, representatives from neighbor associations, house owners’ association and various Community Based Organizations’ (CBO) are identified and mobilized as community group. Trainings were given to them.
on SWM system of DCC, importance of community or citizens’ participation, packed waste discharge and Community Action Plan (CAP) to improve cleanliness. CAP is the list of priority activities with implementation schedule. The responsible persons from community group, DCC and Primary Collection Service Provider (PCSP) are also stipulated in the CAP corresponding to activities. Several training, group meetings, and informal discussions were held aiming to enlighten and empower community group. The objectives and merits of new collection system and demerits of pervious collection systems were shared in this stage.

The third step was to decide collection routs, time and stations jointly by the community group and DCC field staff (Conservancy Inspector). It was also publicized by door to door campaign, miking, leaflet distribution showing system information and distribution of bins as sample for onsite waste storage of the households.

The fourth step was trial run by open truck before the arrival of open truck in 2009. Since the open truck within the congested community was tough to operate, community started to complain and national newspaper published as SWM mal practice.

The fifth step was inauguration of newly arrived compactor truck as the replacement of open truck (trial run vehicle) in 2010. It took place in all the compactor deployment areas with the gathering of thousands of people. DCC considered compactor introduction or inauguration program as important communication mechanism with mass people of community where it was possible to convey the message on systematic waste discharge and collection easily. In the same time of preparation of the inaugural event, the special training on operation, safety and maintenance of compactor truck was given to the drivers and truck crews in this step.

The final and sixth step was monitoring and feed back to sustain the collection system. It is the continuous activity of DCC. As found in FGD in 2011 for this study, DCC field staff contiguity of advocacy and communication with community leaders, PCSPs, shops, restaurant and temporary vegetable markets in the community of ward 33 and 36.

E. Impacts of Compactor Truck Collection System

From the FGD several positive and negative impacts were identified. The most important advantage of compactor truck based collection system is no container, dustbin or open dumping place in the community is required if nicely harmonized with primary collection. The other positive impacts are its functionality such as quick pickup and short unloading time, fewer odors in pickup and almost no odor in waste transporting, special leachate collection system, easy to load & unload. If community can be mobilized it is the cleanest collection system in comparison with open truck and container based collection system in Dhaka City. It creates fewer public nuisances than any other collection system. Close and packed discharge is aesthetic and operation of the vehicle is smooth. Since DCC does not have sufficient compactor truck relating to the number of wards, there is always high pressure and demand from the community leaders to DCC. Community with compactor deployed areas were found feel more proud for the improvement of waste collection and consequently removal of dustbins and container from their neighborhood. It has found the time consciousness of community, primary collection rickshaw van pullers, workers of shops, restaurants and offices have increased and more punctual than before. Their attitude of the waste generator and discharger also improved towards waste collector.

Since compactor trucks are very special and new to the DCC drivers, they feel pride about their jobs and more careful about regular washing, cleaning and maintenance of the truck than over vehicles. Pedestrians and commuters had complained about the open trucks and container carriers while they were moving in the route but compactor truck does not have such complain.

Compactor truck based collection system has several demerits apart from its high cost. DCC is facing very severe maintenance challenges because of its sophistication and requirement of high skilled mechanics. And spare parts and high quality hydraulic oil are not easily available in the local market.

The studied collection system has similarity with bokk collection, kerb-side and door to door collection [9]. So, community and PCSP have to be very careful about the time and station and sometimes they wait if vehicle is delayed. Some cases mismatching in time of collection and stations were reported due to communication gap among city corporation staff, driver, community and PCSP. In practice it found that construction waste was restricted in compactor truck.

CONCLUSION AND RECOMMENDATION

Compactor is very expensive for the city authorities like DNCC & DSCC in the least developed countries. It has environmental value but City Corporation shall have sufficient funding or revenue generating scopes. DNCC & DSCC received compactor trucks from Japanese Environmental Grant Aid Program. Before procuring or receiving the compactor truck, it is necessary to assess the capacity of local government in terms of repair and maintenance facility in workshop and garage.

DNCC&DSCC constructed new workshop for managing the grant aid vehicles but found to be suffering from the lack of sufficient mechanics. Sufficient knowledge, skill and motivation of city corporation staff were found to be very important to promote and operate compactor truck based station collection system. From the interview and FGD, it was found that city corporation staff took specialized training like Participatory Rural Appraisal (PRA) [10]/Participatory Learning and Action (PLA) [11], Training of Trainers, Communication and Facilitation Skills and Training on Ward based Approach (WBA) [12]. To succeed and promote this system community mobilization with awareness raising campaigns were required frequently. In the compactor truck based collection system, vehicles have to come in fixed stations at fixed times. Some community people found to be very patient if vehicle failed to follow schedule but some community people discharged waste on the street after waiting sometime. However, it was recognized as cleanest collection system among various methods of waste collection in Dhaka by the municipal (City Corporation) staff.

Findings show that it is the fastest pickup collection system except hauled container system and take only around 20% time of total trip. To load per ton of waste it requires 23.5 minutes. Efficiency of compactor truck based collection is technical and quantifiable parameters. But the social matters (community participation) are much related to enhance the efficiencies. If community and PCSP follow the station and timing of collection, efficiency will be maximized by minimizing mismatching of time and station. And eventually open dumping points, dustbins and container are possible to reduce from community area.

It has found that waste workers spent time to sort and pick the recyclables at the time of loading which reduced the efficiency of vehicle and labor. The neighboring people of station proposed to stop sorting in the collection stations and requested improved monitoring by municipal staff.
monitoring by the municipal staff and PCSP staff are very urgent to enhance the performance of collection system. FGD showed that the trip per day was higher in the collection area where monitoring enhanced. The coordination and frequent communication among community, City Corporation and PCSP is found to be most effective mechanism to improve the collection efficiency and operational condition of all types of collection systems.

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REFERENCE


**Benefit Estimation of Human Excreta Use as Fertilizer in Agricultural Farming: A Case Study**

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**ABSTRACT**

Bangladesh is an over populated and agriculture based country. It is always struggling to increase crop production to meet up the food demand. Over the time recurrent land use and application of chemical fertilizers for crop production is degrading the soil health gradually and soil organic matter is substantially declining which is below 1%. Recently farmers are facing fertilizer crisis and price hiking problem due to reducing subsidy in agriculture sector by the government. Considering all of these issues now it is important to promote organic fertilizer to overcome that situation. Promotion of organic fertilizer will help to ensure food security. EcoSan toilet, a Urine Diverting Dry Toilet (UDDT) is a sanitation option of ecological sanitation system which can turn human excreta into resource (organic fertilizer). EcoSan toilet has been installing in rural areas of Bangladesh since 2004. The study carried out to investigate the economic benefit of human excreta. In this case human excreta utilized to produce cabbage, okra and onion. Two experiments were conducted at Raicho and Sreemantapur village in Comilla and Naogoan district respectively. From the benefit estimation it was calculated that yearly a toilet user’s family can earn 858 BDT by utilizing excreta in their farm land. In Bangladesh if all farm households use EcoSan toilet and utilizes their produced excreta to their farm land then they can be cultivate 12 % of total farm land without using of any chemical fertilizer. On the other hand, if entire people of the country use this toilet and utilize excreta in agricultural field than it can supplement 22% of total fertilizer demand.

**INTRODUCTION**

Bangladesh is an agricultural based country. Excessive use of chemical fertilizer and pesticide are practicing in agricultural sector for more crop production. Due to this type of practice day by day decline the soil organic matter. The content of organic matter in the soil is now estimated at less than 1% where the critical level is 3% [1]. Now a days, agriculturist, scientist, policy planner and farmer are feeling to adopt in organic farming for productivity, stability and sustainability of our agriculture. At this stage, it is a great concern how to increase soil organic matter. Human excreta and urine can be a source of organic matter in agriculture soil. Human excreta are natural resource. For serving through sanitation and excreta utilization as resources, ecological sanitation (EcoSan) approach has been introduced in Bangladesh in 2004. Usually human urine of healthy person doesn’t contain disease producing organism, while faeces may contain many pathogens [2]. However, urine diverting dry toilet system can reduce this threat and make human excreta as resources. Users can get ash dried feces within a year from this toilet system. It was found that 3 steps such as 6 months onsite storage in the toilet volt, 3-4 days drying under direct sunlight and then next three month secondary storage of ash mixed feces can be free from pathogenic threat [3]. An appropriate human excreta management and utilizing human excreta relates to poverty alleviation through reducing health risk and increasing agricultural productivity [4]. There is no price involvement in human excreta management. In Bangladesh context ash mixed dried human faeces contain N (0.35%), P (0.48%), K (2.75%), and organic matter (3.2%). On the other hand, human urine contains N (0.38%), P (0.04%), K (0.1%) [5]. As human excreta contains plants nutrients of different level, so it is necessary to find out excreta utilization benefit estimation in case of crop production. Keeping the above points in view, the present study has been undertaken considering two objectives. First is to find out the effect of human excreta on the growth and yield of cabbage, okra and onion and second is to estimate excreta use benefit in agricultural crop production.

**MATERIALS AND METHODS**

Two field experiments were conducted under that research on three different crops at two different places. The experiment was conducted at Raicho and Sreemantapur village in Comilla and Naogoan district in Bangladesh respectively.

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**Fig. 1. Experimental lay-out.** A. Urine applied cabbage plot; B. Dried feces applied okra plot; C. Urine applied onion plot
The tested crops were cabbage, okra, and onion. Complete Randomized Design (CRD) and Randomized Block Design (RBD) [6] process were followed in the experiment. The experiment was laid out in RBD in onion case and CRD in cabbage & okra cases. Height of Cabbage plant data were collected in 5 times at 10 days interval. Growths data of okra were measured in 3 times at 30 days at 15 days interval. Tested crops yield data were collected at weight basis. Through variance analysis treatments difference were find out. Individual and total excreta use benefit was find out from the experiment result considering effect of excreta use as fertilizer and estimate a prospective benefit. The doses of chemical fertilizer application for selected crops have been fixed by following the fertilizer recommendation guide [7]. The urine dose fixed up considering 0.38% N/fiter urine as tested results in Bangladesh [5]. Dried faeces dose fixed up by following the cow dung recommendation guide (BARC, 2005). Urine applied in the field by five times dilution with water. Fig. 1A and 1B showing complete randomized experiment design through combination of different fertilizer in different treatment of urine applied cabbage and dried faeces applied okra plot. On the other hand Fig. 1C showing randomized block design of urine applied onion crop. Totally 300 seedlings of onion transplanted at a spacing of 5 cm x 5 cm per plot. In addition, Table 1, 2, and 3 showing the fertilizer application condition rate for cabbage, onion and okra plant in every treatment.

<table>
<thead>
<tr>
<th>Table 1. The fertilizer application condition (Cabbage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>T1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>T2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>T3</td>
</tr>
<tr>
<td>T4</td>
</tr>
</tbody>
</table>

¹T1: Treat-1, T2: Treat-2, T3: Treat-3, T4: Treat-4
²kg/plot: quantity of fertilizer application per an experiment division (36m²)
³DAS- Days after sowing

<table>
<thead>
<tr>
<th>Table 2. The fertilizer application condition (Onion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>T1</td>
</tr>
<tr>
<td>T2</td>
</tr>
<tr>
<td>T3</td>
</tr>
<tr>
<td>T4</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

¹T1: Treat-1, T2: Treat-2, T3: Treat-3, T4: Treat-4
²kg/plot: quantity of fertilizer application per an experiment division (8.2 m²)
³DAS- Days after sowing

<table>
<thead>
<tr>
<th>Table 3 The fertilizer application condition (Okra)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
</tr>
<tr>
<td>Cow dung [kg/Plat]</td>
</tr>
<tr>
<td>Fescas [kg/Plat]</td>
</tr>
<tr>
<td>Cow dung [kg/Plat]</td>
</tr>
<tr>
<td>TSP [kg/Plat]</td>
</tr>
<tr>
<td>Urea [kg/Plat]</td>
</tr>
<tr>
<td>MP [kg/Plat]</td>
</tr>
<tr>
<td>Fescas [kg/Plat]</td>
</tr>
<tr>
<td>TSP [kg/Plat]</td>
</tr>
<tr>
<td>Urea [kg/Plat]</td>
</tr>
<tr>
<td>MP [kg/Plat]</td>
</tr>
</tbody>
</table>

¹kg/plot is quantity of fertilizer application per an experiment division (50 m²)
²DAS- Days after sowing

RESULTS AND DISCUSSIONS

A. Growth and Yield

Table 4 shows the growth of cabbages. It was found that only urine is superior for growth. Growth by chemical fertilizer and combination of urine and chemical fertilizers is sequentially lower than only urine.

<table>
<thead>
<tr>
<th>Table 4. An experiment result (Cabbage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>T1</td>
</tr>
<tr>
<td>T2</td>
</tr>
<tr>
<td>T3</td>
</tr>
<tr>
<td>T4</td>
</tr>
</tbody>
</table>

* DAS- Days after sowing, ** Days to start formation; *** Days to maturity

Fig. 2 showing growth and yield of cabbage respectively. From the figure it was found that urine used (treatment-3) cabbage growth and yield rate is superior then others treatment. Same results also found in second experiment in onion crop. Fig. 3 showing the highest growth and yield of onion by urine application plot (treatment-2), which is superior than other treatments shown in the figure.

Fig. 3. Growth and yield of onion

In case of okra, it is found from the Fig. 4 that among the treatment cow dung used plot (treatment-1) showing highest growth. Whereas dried faeces (treatment-2) and combination of dried faeces and chemical fertilizers (treatment-4) applied okra plant growth is superior to combine used of cow dung.
and chemical fertilizers (treatment-3) and only chemical fertilizers (treatment-5).

**B. Results of Variance Analysis**

Table 5(1) did one-way layout analysis of variance about connecting these four fertilizers application in case of cabbage. From the analysis, the fertilizer application 4th standard for the crop is significance with rejection probability of 0.1%.

Table 5(1). Result of Variance Analysis (Cabbage, 4 standards)

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Degree of Freedom</th>
<th>Unbiased variance</th>
<th>F Ratio</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>variation among group</td>
<td>14850000</td>
<td>3</td>
<td>4950000</td>
<td>1080.53</td>
<td>4.7</td>
</tr>
<tr>
<td>variation within group</td>
<td>348162</td>
<td>76</td>
<td>4581</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>total variation</td>
<td>15198162</td>
<td>79</td>
<td>192582</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, Table 5(2) showed a result from an analysis of variance of 2nd standards did picking up chemical fertilizer and the urine only. About cabbages, superiority of urine only was provided with rejection probability of 2.5%.

Table 5(2). Result of Variance Analysis (Cabbage, 2 standards)

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Degree of Freedom</th>
<th>Unbiased variance</th>
<th>F Ratio</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>variation among group</td>
<td>16000</td>
<td>1</td>
<td>16000</td>
<td>6.13</td>
<td>5.4</td>
</tr>
<tr>
<td>variation within group</td>
<td>99212</td>
<td>38</td>
<td>2611</td>
<td>0.025</td>
<td></td>
</tr>
<tr>
<td>total variation</td>
<td>115212</td>
<td>39</td>
<td>2964</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Experimental results in case of okra (lady’s finger) plot found more superior in chemical fertilizer. In addition, the difference by four conditions except chemical fertilizer is small. Table-7 showing result of variance analysis.

**C. Benefit of Urine Use as Organic Fertilizer**

From experiment result of cabbage and onion crop it is found that the urine has equivalent fertilizing capacity as chemical fertilizer. Table-8 shows cost of chemical fertilizer. For the experiments, chemical fertilizer buying cost was 35 BDT (for cabbage) in 2006 and 2.642 BDT (for onion) in 2009 but in 2012 buying cost of that fertilizer is 75 BDT (for cabbage) and 4 BDT (for onion) respectively. As the used chemical fertilizer is equivalent to 290 and 20 liters of urine respectively and the benefit per liter urine is equivalent to 0.12 BDT in 2006, 0.13 BDT in 2009, similarly on an average 0.25 BDT in 2012. From that two experimental results it was found that per unit urine value is almost same in both cases.

**D. Benefit of Dried Faeces Use as Organic Fertilizer**

From Table 9, it was also found that present market value of 1 liter urine is 0.25 BDT in compare to used chemical fertilizer and its present market price. When it is assumed that 1 household of 5 numbers produce yearly 456.26kg ash mixed dried faeces and use as an organic fertilizer than

(1) The annual benefit of 1 household is 5 × 365 × 0.55 = 20286.5 BDT

(2) Possible covered area per liter urine is 0.125 m²

(3) The urinary fertilizer application possible area of 1 household (when assumed mono-crop agriculture) is 0.125×1×5×365×228 m²

**6. Results of Variance Analysis (Onion yield data)**

<table>
<thead>
<tr>
<th></th>
<th>Degree of Freedom</th>
<th>Mean square</th>
<th>F value</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between treatment:</td>
<td>3</td>
<td>33.2965</td>
<td>10.6031</td>
<td>0.1078</td>
</tr>
<tr>
<td>Between blocks:</td>
<td>3</td>
<td>7.97396</td>
<td>2.1904</td>
<td>0.6289</td>
</tr>
<tr>
<td>Error</td>
<td>9</td>
<td>9.975985</td>
<td>2.1904</td>
<td>0.6289</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>69.2348</td>
<td>2.1904</td>
<td>0.6289</td>
</tr>
</tbody>
</table>

**7. Analysis of variance (60 days data of okra)**

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Degree of Freedom</th>
<th>Unbiased variance</th>
<th>F value</th>
<th>P probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>variation among group:</td>
<td>20.9575</td>
<td>3</td>
<td>6.9508</td>
<td>0.54</td>
<td>0.66</td>
</tr>
<tr>
<td>variation within group:</td>
<td>465.1</td>
<td>36</td>
<td>12.9199</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total variation:</td>
<td>485.975</td>
<td>39</td>
<td>12.461</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From Table 8, it was also found that present market value of 1 liter urine is 0.25 BDT in compare to used chemical fertilizer and its present market price. When it is assumed that 1 household of 5 numbers produce yearly 456.26kg ash mixed dried faeces and use as an organic fertilizer than

(1) The annual benefit of 1 household is 5 × 365 × 0.55 = 20286.5 BDT

(2) Possible covered area per liter urine is 0.125 m²

(3) The urinary fertilizer application possible area of 1 household (when assumed mono-crop agriculture) is 0.125×1×5×365×228 m²

**8. Cost of used chemical fertilizer and urine value**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decom.</td>
<td>6</td>
<td>10</td>
<td>12</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>UOP</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>NP</td>
<td>10</td>
<td>18</td>
<td>63</td>
<td>114</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>32</td>
<td>21</td>
<td>75</td>
<td>4</td>
</tr>
</tbody>
</table>

From Table 9, it was also found that present market value of 1 kg dried faeces is 0.55 BDT in compare to used chemical fertilizer and its present market price. When it is assumed that 1 household of 5 numbers produce yearly 456.26kg ash mixed dried faeces and use as an organic fertilizer than

(1) The annual benefit of 1 household is 5 × 365 × 0.55=402BBDT
(2) Possible covered area per kg dried faeces is 0.50m$^2$.
(3)The ash mixed dried faeces fertilizer application possible area of 1 household (when assumed it mono-crop agriculture) is $0.50 \times 0.3 \times 5 \times 365 = 274m^2$

Table 9. Cost of used chemical fertilizer and dried feaces value

<table>
<thead>
<tr>
<th>Chemical fertilizer</th>
<th>Fertilizer Used in Experiment (kg)</th>
<th>Equivalent of one kg of dry excreta in experiment</th>
<th>Cost of Rs/kg of dry excreta in comparable 2012 market price of chemical fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPK</td>
<td>14.25</td>
<td>11</td>
<td>14.25</td>
</tr>
<tr>
<td>Total</td>
<td>1.25</td>
<td>5.71</td>
<td>14.25</td>
</tr>
</tbody>
</table>

**CONCLUSION**

EcoSan approach is one of the most suitable options so far environment and agricultural development is concerned. In this paper, the authors try to establish human excreta utilization benefit in agricultural crop growth and yield. Yearly a toilet users family can earn 858 BDT from utilize excreta in their farm land. At present in Bangladesh total farm household is 17830000 and total farm land is 73184 km$^2$ (ASSP, 2010). If all farm household are used EcoSan toilet and utilized their produced excreta to their farm land then they can cultivate 12% of total farm land without use of any chemical fertilizer. On the other hand if whole country people use this toilet and utilize excreta in agricultural field than it can supplement 22% of total fertilizer demand. Considering the resource utilization and its benefit it can be concluded that ecological sanitation system is one of alternative sanitation option for villages in rural Bangladesh.

**ACKNOWLEDGMENT**

We are pleased to express profound respect, sense of gratitude, sincere appreciation to the villagers who using EcoSan toilet and utilized human excreta to their farm land. We once again thanks Japan International Cooperation Agency (JICA) to continuing to support rural peoples to improve their living status. We recall the unforgettable support from Bangladesh Academy of Rural Development (BARD) to helping us during the conduction of experimental plot and data collection from the field.

**REFERENCE**

Effect of Cement Replacement with Class F Fly Ash on Strength and Water Permeability of Concrete

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ABSTRACT

This paper discusses the effects of cement replacement with supplementary cementitious material fly ash collected from Boropukuria, Bangladesh on the water permeability and compressive strength development of concrete up to the curing period of 180 days. Three different grades of concrete M28, M33 and M38 made with seven different cement replacement levels (10, 20, 30, 40, 50, 60 and 70%) with fly ash were used for the experimental program. Ordinary Portland cement (OPC) concrete was also prepared as reference concrete. Permeability coefficient of concrete was determined at an age of 28, 56, 90 and 180 days whereas compressive strength was measured at 3, 7, 28, 56, 90 and 180 days. Test results show that coefficient of permeability of concrete decreases with the increase of fly ash level up to an optimum value and then start to increase whereas compressive strength shows reverse trend. Among all the concretes studied, the optimum amount of cement replacement is reported to be 30%, which provides around 16% lower permeability and also around 15% higher compressive strength as compared to ordinary Portland cement concrete.

INTRODUCTION

Sustainability issue in construction sector came forward in last two decades due to concerns regarding using virgin materials as well as emission of greenhouse gases from production of raw materials. Concrete is the second most consumed substance on Earth after water and is an essential product in the building sector. Cement is the prime constituent of concrete and requires energy to produce. It is a fine grey powder and constitutes 7 to 15% by weight of concrete’s total mass. On an average 0.72–0.98 tonne of CO2 is produced for every tonne of cement production [1]. Being emission a key issue to attain sustainability in construction industry, supplementary cementitious materials (SCM) are gaining interest. Numerous researches has shown potential of using SCMs for instance pulverized fuel ash (fly ash) from coal combustion, GBBS from iron industry, Silica Fume and Metakaolin [2]. These SCMs provide dual benefits in concrete construction. Those not only reduce the emission of CO2 in material production but also improve several properties of fresh and hardened concrete, for example, workability, water demand, permeability and finally durability. It is generally agreed that with the proper selection of admixtures, mixture proportioning and curing, supplementary cementitious materials can noticeably improve the durability of concrete [3]. Recently these has been a growing trend for the use of SCMs in the production of composite cement because of ecological, economical and diversified product quality reason.

Fly ash is a by-product produced from pulverized coal combustion in power generation and formed from the non-combustible minerals found in coal. Fly ash contains high amount siliceous and aluminous compounds and has high potential to be used as pozzolanic material to partially replace cement in concrete. Through pozzolanic activity, fly ash chemically combines with water and calcium hydroxide, forming additional cementitious compounds which result in denser, higher strength concrete. The calcium hydroxide chemically combined with fly ash is not subject to leaching, thereby helping to maintain high density. The conversion of soluble calcium hydroxide to cementitious compounds decreases bleed channels, capillary channels and void spaces and thereby reduces permeability. Depending on the location of each power plant, the unused fly ash is disposed at the ponds, lagoons or landfill. When unused fly ash and bottom ash disposed from coal combustion power plants, it makes major negative environment effects such as air pollution and groundwater quality problem due to leaching of metals from the ashes, specially unused fly ash which has very small particle size [4]. According to the ASTM 618, the fly ash is suitable for use in concrete when no more than 34 percent of the particle is retained on the No. 325 (45 μm) sieve. Fineness of ground disposed fly ash plays very important role on compressive strength of concrete. However, the ground disposed fly ashes which have particle sizes retained on sieve No. 325 less than 5% by weight can be used as good pozzolanic material [5].

Water penetrability, namely absorption, permeability and sorptivity are some important measurements to control concrete durability. Permeability of liquid into the concrete consists of permeability through a porous medium, diffusion and absorption. Regarding to this, pores in concrete have an important role to allow the liquid/fluid move through the concrete [6]. It is inversely linked to durability in that the lower the permeability, the higher the durability of concrete. Fly ash minimizes water demand and reduces bleed channels – all of which increase concrete density. These factors yield concrete of low permeability with low internal voids and hence durability is increased. Decrease in permeability reduces deterioration of concrete caused by various factors such as chloride attack, sulfate attack, freezing and thawing, alkali-aggregate reaction, carbonation, etc. Optimum use of fly ash must be ensured to achieve the desired strength as well as durability requirement of the structural concrete. In 2006, two units of 125 MW coal based power plant has started generation in Barapukuria, Bangladesh. Currently one million ton of coal is being produced per annum from this mine of which 65% is being supplied to the 250 MW thermal power plants and other 35% is being used in brick field and other domestic industries. At present, on an average 65 thousand tons of fly ash is being produced from those thermal power plants. Use of these fly ash as partial replacement of cement also ensures the proper utilization of fly ash, in an effective way in which otherwise been dumped making environmental hazard. Limited studies are reported to carry out to investigate the permeability/ transport properties of Boropukuria fly ash concrete as obtained by partial replacement of cement. This experimental program was carried out with a view to study the effects of inclusion of different quantities of Boropukuria fly ash on concrete permeability as well as strength.

MATERIALS AND METHODS

A. Materials Used

Concrete test specimens were cast using ASTM type-I Ordinary Portland cement (OPC), ASTM Class F Fly ash collected from Boropukuria Power Plant, Bangladesh, crushed gravel as coarse aggregate and natural river sand as fine aggregate. Table 1 provides the physical properties and chemical compositions of the OPC and Boropukuria fly ash. 12.5 mm downgraded crushed stone, with fineness modulus

<table>
<thead>
<tr>
<th>Test</th>
<th>OPC</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fineness Modulus</td>
<td>3.2</td>
<td>3.4</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Blaine Fineness</td>
<td>300</td>
<td>320</td>
<td>340</td>
<td>360</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Loss on Ignition</td>
<td>2.5</td>
<td>2.7</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Specific Surface Area</td>
<td>300</td>
<td>320</td>
<td>340</td>
<td>360</td>
</tr>
<tr>
<td>Soundness</td>
<td>100</td>
<td>102</td>
<td>104</td>
<td>106</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>40</td>
<td>42</td>
<td>44</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 1: Physical Properties and Chemical Compositions of the OPC and Boropukuria fly ash.
6.58 and specific gravity 2.70, was used as coarse aggregate. The fine aggregate was river sand with fineness modulus 2.58 and specific gravity 2.61.

Table 1. Chemical Composition (%) of Ordinary Portland Cement and Boropukuria Fly Ash

<table>
<thead>
<tr>
<th>Compositions</th>
<th>OPC</th>
<th>FA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium oxide, CaO</td>
<td>65.18</td>
<td>0.65</td>
</tr>
<tr>
<td>Silicon dioxide, SiO₂</td>
<td>20.80</td>
<td>51.49</td>
</tr>
<tr>
<td>Aluminum oxide, Al₂O₃</td>
<td>5.22</td>
<td>31.60</td>
</tr>
<tr>
<td>Ferric oxide, Fe₂O₃</td>
<td>3.15</td>
<td>2.80</td>
</tr>
<tr>
<td>Magnesium oxide, MgO</td>
<td>1.16</td>
<td>0.28</td>
</tr>
<tr>
<td>Sulfur trioxide, SO₃</td>
<td>2.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Sodium Oxide, Na₂O</td>
<td>--</td>
<td>0.18</td>
</tr>
<tr>
<td>Loss on ignition</td>
<td>1.70</td>
<td>4.2</td>
</tr>
<tr>
<td>Insoluble residue</td>
<td>0.6</td>
<td>--</td>
</tr>
</tbody>
</table>

B. Mix Design and Sample Preparation

Three different grades of concrete namely M28, M33 and M38 were used in the program. Seven different mix proportions of cement fly ash (90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70) were used as cemenitious material. Cement fly ash mix ratio of 100:0 i.e. plain concrete specimens were also cast as reference concrete for comparing the properties of fly ash concrete. Thus the fly ash concrete means the concrete made by using cement and fly ash as cemenitious material with sand, stone chips and water. Relevant information of different concrete mixes is given in Table 2. M38FA60 means grade of concrete is 38 and cement fly ash ratio is 40:60.

Around 200 no’s of cylindrical specimen of size 150 mm diameter and 175 mm high and other 500 no’s of cubical specimens of 100 mm size were prepared according to the mix proportion as described. The small size of specimen i.e. 100 mm cube was taken in order to accommodate large number of specimens in the limited sized curing tanks. The specimens were demoulded after 24 hours of casting and cured in plain water at 27±2°C.

Table 2. Mix proportions and properties of fresh concrete

<table>
<thead>
<tr>
<th>Mixture constituent &amp; properties (kg/m³)</th>
<th>Grade of Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>M28</td>
</tr>
<tr>
<td>Water</td>
<td>218</td>
</tr>
<tr>
<td>Sand</td>
<td>545</td>
</tr>
<tr>
<td>Stone Chips</td>
<td>1150</td>
</tr>
<tr>
<td>w/(c+fa)</td>
<td>0.50</td>
</tr>
<tr>
<td>Slump (mm)</td>
<td>68</td>
</tr>
<tr>
<td>Air content %</td>
<td>1.3</td>
</tr>
</tbody>
</table>

C. Strength Test

The concrete specimens were tested for compressive strength at the ages of 3, 7, 28, 56 and 90 days in accordance with the BS EN 12390-3:2009. At each case, the reported strength is taken as the average of three tests results.

D. Water Permeability Test

Water permeability test was performed in accordance with the EN 12390-8 at the age of 28, 56, 90 and 180 days. The average of two test results was taken for each type of concrete specimen. The specimens were coated with epoxy coating on the circular side to prevent water penetration from that side during the test and a pressure of 5 Bar was applied to the samples. The flow rate reading was taken using burette measuring the changing of volume of water with time. Permeability is measured using Darcy’s Law: K = (QL) / (AH)

Where K = Permeability coefficients, Q = Flow rate, A = Area, L = Depth of specimen, H = Head of water

RESULTS AND DISCUSSION

A. Compressive strength

The compressive strength of OPC and fly ash concrete of three different grades M28, M33 and M38 has been graphically presented in Fig. 1, Fig. 2, and Fig. 3.

At early ages of curing, OPC concretes achieve relatively higher compressive strength as compared to fly ash concrete. Test result shows that 7 days compressive strength for OPC concrete is around 9%, 16%, 26%, 34%, 43%, 59% and 75% higher than M38FA10, M38FA20, M38FA30, M38FA40, M38FA50, M38FA60 and M38FA70 concrete respectively. At initial age of curing, compressive strength is seen to decrease with the increase of fly ash content as a replacement of cement when compared with no fly ash concrete.

For relatively longer period of curing, compressive strength of the fly ash concrete specimens up to 40% replacement level are higher than that of OPC concrete. 90 days compressive strength of OPC concrete of M33 grade is lower by around by 5%, 4%, 9% and 5% respectively for M33FA10, M33FA20, M33FA30 and M33FA40 concrete, whereas the same value is reported to be higher by 3%, 34% and 52% for M33FA50, M33FA60 and M33FA70 concrete respectively. Cement normally gains its maximum percentage of its strength within 28 days. During that period, lime produced form cement hydration remains within the hydration product. Generally, this lime reacts with fly ash and imparts more strength. For this reason, concrete made with fly ash will have slightly lower strength than cement concrete at early ages of curing and higher strength at the later ages of curing. Conversely in
cement concrete, this time would remain intact and with time it would be susceptible to the effects of weathering, loss of strength and durability. Also fly ash retards the hydration of C3S in the early stages but accelerates it at later stages. 180 days compressive strength data shows almost similar trend. 180 days compressive strength for M38FA10, M38FA20, M38FA30, M38FA40 and M38FA50 concrete are respectively 8%, 11%, 16%, 13% and 2% higher than no fly ash concrete; whereas the same value for M38FA60 and M38FA70 concrete are lower by 25% and 39% than OPC concrete.

The progressive decrease in permeability may be connected to the micro voids dispersed in the mortar matrix of the concrete. As the hydration of cement progresses, crystallization of compounds take place as a result of which the concrete micro voids keep on getting subdivided into capillary micro pores of increasingly smaller sizes. Many of the micro pores lose their connectivity with the passage of time. The reduction in pore sizes coupled with the loss of pore connectivity result in a substantial progressive decrease in the permeability.

Test result showed that fly ash concrete has higher resistance against water permeability as compared to OPC concrete. After 90 days curing period, coefficient of permeability values are 10%, 12%, 13%, 16%, and 14% lower for M38FA10, M38FA20, M38FA30, M38FA40 and M38FA50 concretes respectively as compared to OPC concrete of M38 grade. Also for relatively longer curing period coefficient of permeability reduced faster for fly ash concrete compared to OPC concrete. Overall observation showed that for 180 days curing period, coefficient of permeability value decrease around 25% for OPC concrete; whereas the same value decreases around 33%, 35%, 38%, 39%, 36%, 14% and 9% for OPC concrete.

Rate of strength gaining for different types of concrete is observed to vary with the grade of concrete and is higher for the higher grade of concrete. Among all the concrete studied, 180 days compressive strength is increased by about 16%, 24%, 25%, 30%, 28% and 19% for concrete M33FA0, M33FA10, M33FA20, M33FA30, M33FA40 and M33FA50 respectively as compared to 28 days strength of OPC concrete of M33 grade; whereas the same value is increased by around 15%, 25%, 28%, 34%, 30% and 18% for concrete M38FA0, M38FA10, M38FA20, M38FA30, M38FA40 and M38FA70 respectively compared to 28 days strength of no fly ash M38 grade concrete. So it can be concluded that strength gainning is relatively faster for higher grade concrete as compared to lower grade concrete.

The reduction of coefficient of permeability for M28, M33 and M38 grade concrete associated with no fly ash are found 9%, 25% and 35% respectively as compared to 28 days concrete of same grade. From the figure it is clear that permeability decreases very rapidly at the initial ages of curing and the rate depends on grade of concrete.

B. Water Permeability

Permeability characteristics of M28, M33 and M38 grade of concrete exposed to plain water for 180 days of curing are graphically presented in Fig. 4, Fig. 5, and Fig. 6. Lower values of coefficient of permeability are found to associate with relatively higher grade of concrete. After 180 days of curing, the reduction of coefficient of permeability for M28, M33 and M38 grade concrete associated with no fly ash are found 9%, 25% and 35% respectively as compared to 28 days concrete of same grade.
and can react with the products liberated during hydration. It forms secondary C-S-H gel that fills all the pores inside concrete specimen that makes the concrete dense and compact, as a result coefficient of permeability decreases with the increase of FA content up to certain level. Among all the fly ash concretes studied up to 180 days curing period, 30%, 40% and 50% fly ash replaced concrete shows better result from water permeability test point of view.

CONCLUSION

Based on the results of the investigation conducted on different grades of concretes made with various replacement level of cement by fly ash and cured for varying curing period up to 180 days, the following conclusions are drawn:

1. The rate of gain in compressive strength of fly ash concrete specimens is slower than OPC concrete at early ages of curing.

2. The resistance to water permeability of concrete increases significantly with the incorporation of fly ash. Coefficient of permeability value for fly ash concrete is observed to be rapidly decreased with curing ages as compared to OPC concrete.

3. Fly ash concrete with cement replacement level up to 50% exhibited improvement in compressive strength as well as water permeability.

4. From both strength and permeability consideration, the optimum cement replacement by fly ash is observed to be 30%. After 180 days curing, fly ash concretes with 30% replacement level shows around 15% higher compressive strength as well as 16% lower coefficient of permeability as compared to OPC concrete.

5. Higher grade concrete showed around 4% higher gain in strength and 3% lower permeability value as compared to lower grade concrete.

REFERENCE


Biosorption of Zinc from Aqueous Solution by Brown Alga (C. indica): Equilibrium and Kinetic Studies

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ABSTRACT

The biosorption of zinc from aqueous solutions by C. indica brown alga has been studied in a batch system. The biosorption efficiency was determined as a function of pH, contact time, temperature and initial zinc concentration. The results revealed that the uptake of zinc was improved by increasing initial concentration, temperature and contact time, whereas it was declined by decreasing pH of solution. The equilibrium and kinetic of zinc biosorption were also investigated. The biosorption equilibrium was described by Langmuir and Freundlich isotherm models. It was shown that the experimental data could be better fitted by Langmuir equation. Besides, the kinetic studies were examined by applying pseudo-first-order and pseudo-second-order models. It was found that the biosorption process follows pseudo-second-order kinetic model. Fourier transform infra-red analysis of biomass was also carried out. It revealed that carboxyl, hydroxyl, and amino groups are responsible for the interaction between zinc ions and biosorbent.

INTRODUCTION

Industries generate large amount of wastewaters with a wide range of heavy metals, which are normally harmful, toxic and resistant to treatment by conventional methods [1,2]. Furthermore, several various methods such as chemical precipitation, solvent extraction, ion exchange, electroplating and membrane processes can be applied to eliminate contaminants from wastewaters. However, these methods often produce secondary pollution. Besides, they are usually expensive or ineffective [3,4]. Therefore, researches have paid attention to new technologies and processes of heavy metals wastewater treatment that are conducted all over the world [5-7].

Among the proven technologies for removing different sorts of dissolved substances, biosorption process has been recognized as one of the most appropriate methods for low level contaminants [8,9]. It is also identified as a process for the elimination of heavy metals from industrial wastewaters [10]. Generally, in this method cheap adsorbent which are efficient, cost effective, reusable and eco-friendly are used for the removal of heavy metals [9,11]. Moreover, different kinds of biological materials such as bacteria, yeast and fungi have been evaluated for the removal and adsorption processes; however, alga shows more appropriate results than others due to the characteristic of its cell wall [12]. In fact, there are several functional groups like carboxyl, sulfate, hydroxyl and amino groups, which are responsible for biosorption of metals. They also can act as binding sites for metals via both electростatic attraction and complexation [13,14].

Application of biosorbents for the removal of heavy metals, such as Pb2+, Cr3+, Cd2+, Cu2+, and Zn2+ from aqueous solutions has been used by a number of researches. Zinc is considered as one of the most especial concerns for human health that can cause serious injuries in liver, kidney and pancreas. Zinc and its components, have been produced by acid mine drainage, galvanizing plants, natural ores and municipal wastewater treatment plants [15]. Thus, wastewater which is produced by these processes should be treated due to zinc environmental effects.

So far numerous studies have been conducted on biosorption of heavy metals. However, according to authors’ surveys, the biosorption of zinc has not yet been studied by C. indica brown alga. Furthermore, this biosorbent exists in a large amount on the coast of Qeshm in the Persian Gulf, Iran. Therefore, the consumption of C. indica as biosorbent is cheap and cost effective.

The present study has investigated the biosorption of zinc from aqueous solution under batch mode by using brown alga. The series of biosorption experiments in batch method were conducted to evaluate the sorption of zinc in various variables such as pH, contact time, temperature and initial concentration. Equilibrium isotherm and kinetic models were carried out for a better understanding of the biosorption process.

MATERIALS AND METHODS

A. Preparation of Biosorbent

The brown alga (C. indica) was used as biosorbent for the biosorption of zinc ions. The alga was collected from the Persian Gulf in the coast of Qeshm, Iran. It was rinsed several times by deionized water in order to remove attached materials and dirt particles. The cleaned alga was firstly dried in sunlight and ultimately dried in an oven at 70 °C for 12 h. Then, the dried biomass was sieved by a stainless steel standard sieve (1 mm) to produce biosorbent with homogenous particle size. In this study, the biomass with particle size 1 mm were directly used as biosorbent without any pretreatment.

B. Fourier Transforms Infrared Spectroscopy

FTIR spectroscopy was used to show functional characteristics of C. indica brown alga. The C. indica alga was dried and ground before doing FTIR analysis. Twenty milligrams of finely ground biomass were blended and pelleted with 300 mg of KBr (Sigma) in order to prepare translucent sample disks. FTIR spectra were recorded on a Perkin-Elmer Spectrometer (FTIR GX 2000). The spectra were in the range of 400 to 4000 Cm⁻¹.

C. Batch Biosorption Studies

The biosorption of zinc in batch mode by C. indica alga was studied. All biosorption experiments were conducted in triplicate and the results were reported as average. Batch experiments were conducted to determine the effect of pH, contact time, temperature and initial concentration of zinc ions. The effect of pH on the sorption of zinc was studied by adding 100 ml of a fixed concentration (100 mg L⁻¹) of zinc working solution to 0.1 g of biosorbent in 250 ml Erlenmeyer flasks, adjusting the pH to 3, 4, 5 and 6 by using 0.1N H₂SO₄ and 0.1N NaOH. Biosorption experiments were not carried out at pH above 6.0 to avoid any possible interference from zinc precipitation. The mixtures were then shaken by using a flask shaker incubator machine at 150 rpm for 24 hours at room temperature (25±0.5 °C). At the end of the biosorption period, the mixtures were filtered and the concentration of zinc in the filtrate was measured by an atomic absorption spectrophotometer (Varian–spectra–AA–200). The adsorbed zinc was obtained from the difference between the initial and the final zinc concentrations. The percentage of zinc biosorption was determined in the following way: zinc biosorption (%) = ((C₀-Cf)/C₀)×100 (1); Where C₀ and Cf are the initial and final concentrations of aqueous phase (mg L⁻¹), respectively.
In the next stage, the influence of contact time in the intervals of between 5 to 240 min was studied on a batch of zinc solutions with fixed initial zinc concentration, pH, biomass dosage and three different temperatures 25, 30 and 40 °C. At the end of the predetermined time intervals, the biosorbent was removed by filtration, and the concentration of zinc ions in the filtrate was determined by atomic absorption spectrophotometer.

Equilibrium isotherm models are generally categorized into the empirical equations and mechanistic models, based on the mechanism of metal ion biosorption. Indeed, the experimental behavior can be described and predicted by mechanistic models [16,17]. As a matter of fact, the empirical models especially Langmuir and Freundlich equations are used to explain the biosorption equilibrium for single solute systems. They are usually used to describe adsorption equilibrium for water and wastewater treatment applications [18].

Isotherm studies with 1 g L⁻¹ biosorbent dose and different initial concentration of zinc ions (10-300 mg L⁻¹) were conducted. The metal uptake (qₑ) was calculated by the following equation: $qₑ = \frac{(Cₑ-Cₚ)\times V}{m}$ (2); Where $Cₑ$ and $Cₚ$ are the initial and final concentrations of aqueous phase (mg L⁻¹), respectively, V the volume of solution (L) and m the mass of biosorbent (g).

The Langmuir model (L type, based on monolayer adsorption of solute) [19] is determined by the following equation: $qₑ=\frac{qₓₘₐₓ\times b\times Cₑ}{(1+b\times Cₑ)}$ (3); Where $qₓₘₐₓ$ and b are Langmuir constants, respectively. The experimental Freundlich model (F type, developed for heterogeneous surfaces) [20] is shown as follows: $qₑ=K_mCₑ^{1/n}$ (4); Where $Cₑ$ is the equilibrium concentration (mg L⁻¹), $qₑ$ is the content adsorbed (mg g⁻¹) and $Kₘ$ and $1/n$ are constants representing the adsorption capacity and intensity, in the same order. Equation (4) can be linearized in logarithmic form as follows: $\log qₑ = \log Kₘ + \frac{1}{n} \log Cₑ$ (5).

The kinetics studies were conducted by the similar batch adsorption procedure described above by fixing the pH and zinc concentration but varying contact time between 5 and 240 min and three different temperatures.

**RESULTS AND DISCUSSION**

**A. FTIR Analysis**

The FTIR spectroscopy method was carried out in order to obtain information on the nature of possible interactions between cell wall and zinc ions. The FTIR spectrum of C. indica alga is shown in Fig. 1. It can be seen that the FTIR spectrum of C. indica alga before biosorption revealed the main absorption bands at 3448 cm⁻¹ (H-bonded OH groups, and the hydrogen vibration of amide N–H functions), 2341 and 2361 cm⁻¹ (–NH², –NH and –NH groups), 1701 cm⁻¹ (the carbonyl stretching groups), 1652 (C=O asymmetric) and 1560 cm⁻¹ (amid II), 1459 cm⁻¹ (C=O asymmetric), 1399 cm⁻¹ (SO₂ asymmetric) and 1250 cm⁻¹ (C-O carboxyl group). Some bands in the fingerprint area might be related with the phosphate groups. The results showed that after biosorption process the intensity and position of bands have changed. Furthermore, after zinc biosorption, the bands observed at 3448, 2341, 2361, 1701, 1652, 1560, 1459, 1399 and 1250 cm⁻¹ were shifted to 3456, 2345, 2365, 1709, 1648, 1555, 1454, 1395 and 1245 cm⁻¹. Indeed, generally wave numbers were decreased gradually after process because the interaction of bands was increased however the wave numbers sometimes increase slightly. Moreover, there were greater shifts of wave number for hydroxyl, carboxyl and amide groups than other groups. Thus, they were major bands in zinc biosorption process. In addition, it is found that the biosorption is major responsible for the chemical interactions as ion-exchange between the zinc ions and the hydrogen atoms of carboxyl, hydroxyl, and amide groups of the biomass. Similar results for the biosorption of different heavy metals on various biomasses were also reported [12, 21-23].

**B. Effect of pH**

The pH of solution plays an important role in adsorption of zinc ions onto biomass [11,24,25]. The experiments were investigated zinc biosorption, through a pH range from 3 to 6. As it can be seen from Fig. 2, zinc elimination rose with the pH increment of the solution in the presence of biosorbert and reached a maximum at pH around 5.

In investigating the pH effect in metal biosorbtion of alga, it is really of high importance to take the cell wall metal binding sites and metal chemistry into consideration. The FTIR spectroscopic analysis indicated that there were different functional groups in the alga, and some of these groups such as carboxyl and hydroxyl were responsible for biosorption of zinc ions at pH approximately 5.

Furthermore, the pH results showed that there were low zinc biosorption percentages at low pH values. It might be due to solution chemical characteristic of solution as well as the active binding sites on the cell wall which are less available for zinc ions as a result of protonation. Indeed, cell walls are protonated and owning to the repulsive force, the biosorption of zinc cations would be limited. Moreover, the biosorption of zinc ions improved by raising the pH of the sorption system. As the pH increased, the presence of protons in aqueous solution dropped and the electrostatic attraction happened between zinc ions and negatively charged functional groups. In fact, there was an improvement on ionic state of ligands such as carboxyl, hydroxyl and amine by increasing the pH value which could enhance reaction of them with zinc ions. Therefore, the percentage of zinc adsorption rises with increasing the pH; however, a high pH value could cause precipitation of metal complexes, so it had to be avoided during experiments. In this study, the maximum adsorption value was obtained at pH 5. Therefore, other biosorption experiments were performed at this pH value.

**C. Effect of contact time and temperature**

Contact time is another factor that influences the biosorption of zinc. Clearly, the biosorption capacity and the elimination yield of zinc ions by C. indica increase with prolonging the contact time. Practically, due to the efficiency of desorption and regeneration of the biomass, it is essential to optimize the contact time. The results of 10 different contact
times, with the same concentration, biomass dosage, pH at three different temperatures are shown in the Fig. 3. It was observed that the amount of zinc uptake was improved with the passage of time. It was also found that the biosorption rate was fast initially, and about 66.5% of total zinc uptake during 240 min contact time was obtained within first 30 min.

A number of authors have reported that the highest amount of metal biosorption occurs within the first 30 min of contact time which precisely observed in this study [26,27]. As shown in the Fig. 3, the zinc uptake capacity increased with time and quickly reached equilibrium after about 180 min. After this period, the content of adsorbed zinc ions did not significantly change with time. Consequently, the time of 180 min was recognized sufficient for a considerable biosorption of zinc ions. Therefore, it was chosen for all further experiments.

The effect of temperature in the uptake capacity was also evaluated at three different temperatures 298, 303 and 313 °K, Fig. 3 shows that the equilibrium metal uptake increased from 43.51 to 50.01 mg g\(^{-1}\) as temperature rose from 25 to 40 °C. Moreover, the enhancement of zinc biosorption could be due to change in the structure of biosorbent and creation of some new active binding sites, respectively. Perhaps, it is also as a result of increasing on the diffusion rate of zinc ions from the bulk solution to the surface of biosorbent.

Moreover, the results showed that there was a slight increase in the zinc uptake by raising the amount of temperature. However, the amount of zinc uptake which changed by increasing the temperature was not considerable. Thus, experiments were carried out at room temperature since the operation cost at high temperature was not economical.

### D. Effect of initial metal ion concentration

The experiments were carried out by varying the initial zinc concentration from 10 to 300 mg L\(^{-1}\). Obviously, in this stage, the quantity of biosorbent was kept constant. The results indicated that more biosorption capacity of zinc would be obtained with the higher amount of initial zinc concentration (As can be seen in Fig. 4).

Based on the data, the zinc uptake considerably enhanced from 7 to 53 (mg g\(^{-1}\)) while the initial concentration of zinc rose from 10 to 300 (mg L\(^{-1}\)). It was also observed that the percentage of zinc biosorption declined with an increase in initial zinc concentration.

As the results have shown, the biosorption capacity improved by an enhancement of zinc initial concentration which was a result of competition for the available binding sites, i.e. most binding sites are used. Indeed, raising the concentration of zinc in solution led to an increase in the amount of driving force, i.e. concentration gradient.

Furthermore, by rising initial zinc concentration, more zinc ions could be exposed which lead to rivalry between these ions. In fact, more zinc ions discharged unabsorbed in solution which was a result of competition for the available binding sites, i.e. most binding sites are used. Indeed, raising the temperature was not economical.

### F. Biosorption kinetics

Biosorption kinetic studies are essential to design the batch biosorption systems and optimization of hydrodynamic parameters. In order to detect the controlling mechanism of biosorption process such as mass transfer and chemical reaction, batch experiments have been conducted at discrepant contact times and the biosorption kinetics data were analyzed by applying pseudo-first-order and pseudo-second-order.

The possibility of adsorption data following Lagergren pseudo first-order kinetics [29] is shown by ln(q\(_e\) - q\(_t\)) = ln q\(_e\) - k\(_1\)t (8), where k\(_1\) is the pseudo-first-order sorption rate constant (min\(^{-1}\)), q\(_e\) is the amount of metal ion adsorbed at equilibrium by the biomass (mg g\(^{-1}\)) and q\(_t\) is the amount of metal ion adsorbed at any time (mg g\(^{-1}\)). The overall rate constant, k\(_1\) for this biosorption kinetic was calculated from the slope by plotting ln(q\(_e\) - q\(_t\)) versus time. The kinetic parameters were determined. Table 2 shows the constants for pseudo-first-order model.

The pseudo-second-order kinetics can be written as [30]:

\[
t/q\(_e\) = 1/(k_2 q_e^2) + t/q_e
\]

(9), where k\(_2\) (g mg\(^{-1}\) min\(^{-1}\)) is the equilibrium constant of pseudo-second-order kinetic equation. Furthermore, the second order rate constant, k\(_2\) was calculated from the slope by plotting of t/q\(_e\) against t. The rate constants and the correlation coefficients for this model were also determined (Fig. 5). Besides, Table 2 shows the kinetic factors for both pseudo-first and pseudo-second-order equations.

The correlation coefficients obtained by pseudo-first-order modeling were relatively low and the experimental q\(_e\) values were not close to the calculated data. Therefore, the results indicated that the biosorption kinetics data cannot be described by pseudo-first-order kinetics.

### Table 2. Kinetic parameters obtained from pseudo-first-order and pseudo-second-order for total zinc biosorption onto C. indica at different temperatures.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>q(_{e,exp}) (mg g(^{-1}))</th>
<th>k(_1) (min(^{-1}))</th>
<th>q(_{e,cal}) (mg g(^{-1}))</th>
<th>R(^2)</th>
<th>k(_2) (g mg(^{-1}) min(^{-1}))</th>
<th>q(_{e,cal}) (mg g(^{-1}))</th>
<th>R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>43.51</td>
<td>0.011</td>
<td>23.29</td>
<td>0.9057</td>
<td>0.00127</td>
<td>44.64</td>
<td>0.9977</td>
</tr>
<tr>
<td>30</td>
<td>47.05</td>
<td>0.012</td>
<td>24.48</td>
<td>0.9378</td>
<td>0.00165</td>
<td>45.25</td>
<td>0.9979</td>
</tr>
<tr>
<td>40</td>
<td>50.01</td>
<td>0.012</td>
<td>24.88</td>
<td>0.9196</td>
<td>0.00141</td>
<td>50.76</td>
<td>0.9983</td>
</tr>
</tbody>
</table>
The appropriate fit for the biosorption kinetics data was provided by the application of pseudo-second-order kinetic equation. It was observed that pseudo-second-order kinetic showed excellent fitting with the experimental values.

CONCLUSION

This study provided some information on equilibrium, and kinetic studies on zinc biosorption from aqueous solution by C. indica biomass. The results have shown that optimum biosorption conditions depend on pH, contact time, temperature and initial zinc concentration. The Biosorption equilibrium followed well by the Langmuir isotherm model. The maximum zinc uptake of C. indica was found to be 74.07 mg g\(^{-1}\) at pH 5, biomass concentration 1 g L\(^{-1}\), contact time 180 min, and temperature 25 °C. The kinetic studies were better described by the pseudo-second-order in comparison to the pseudo-first-order.

To sum up, C. indica is an appropriate biosorbent for sorption of zinc from aqueous solution because its uptake capacity is fairly higher than other biosorbents and it is cheap and reusable as well. Hence, it is possible to investigate C. indica as an alternative adsorbent for zinc sorption from industrial wastewaters.

ACKNOWLEDGMENT

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REFERENCE

Enhancement of phlorotannins from the brown seaweed *Ecklonia cava* by application of Methyl Jasmonate

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ABSTRACT

The effects of exogenous Methyl Jasmonate (MeJA) on the phlorotannin compounds of *Ecklonia cava* were investigated. *E. cava* was treated with various concentrations of MeJA (0 to 10 µM) in PES media. Individual phlorotannin content was measured by RP-HPLC. Crude phlorotannins was increased by 56% compared to control. Highest amounts of individual phlorotannins such as dieckol, phlorofucofuroeckol-A, phlorotannin compound 2 and 3 were also observed in 2 µM MeJA treatment, which were 85%, 53%, 118% and 37%, respectively higher than the control. For the time course, highest amount of crude and individual phlorotannins were significantly increased after 24 hrs of MeJA treatment. These results indicate that MeJA can effectively enhance the phlorotannins in *E. cava*.

INTRODUCTION

*Ecklonia cava* Kjellman is a brown seaweed distributed only in the coast of Japan and Korea [1] and is utilized as food ingredient, animal feed, fertilizer and medicine [2]. *E. cava* contains variety of compounds including carotenoids, fucoxidans and phlorotannins, playing diverse biological and ecological roles. Phlorotannins are the major polyphenolic metabolites of *Ecklonia* sp. which have been found to be existed only in the brown algae and are formed by the polymerization of phloroglucinol (1,3,5-trihydroxybenzene) [3]. In the brown alga, phlorotannins function as defense against herbivore [4], microbes [5], allelopathic activity against epibionts [6], and harmful effects of UV radiation [7] or as structural components in cell wall hardening [8,9]. Phlorotannins like other phenolic compounds are produced by plant secondary metabolism. Dieckol and phlorofucofuroeckol-A, two most abundant phlorotannins in brown algae have been reported to have some potent biological activities including antioxidant and anti-inflammatory activities [10], acetyl cholinesterase inhibitory activity [11], tyrosinase inhibitory activity [12], α-glycosidase and α-amylase inhibitory activity [13]. Under various biotic and abiotic stresses, plant can responds to produce defensive compounds such as proteinase inhibitor to protect themselves from stresses and also secondary metabolites such as phenolic compounds and terpenoids [14]. Several methods for inducing secondary metabolites have been investigated. Various elicitors such as chitosan, β-glucuron and plants hormonal chemicals such as jasmonic acid (JA), methyl jasmonate (MeJA), salicylic acid can induce secondary metabolites in various plants [15,16]. In higher plant, Methyl jasmonate (MeJA), a naturally occurring compound, plays a role in physiological processes like pollen maturation, flower and fruit development, photosynthesis and defense responses to environmental stresses [17]. It has been reported that post-harvest treatment with MeJA effectively suppresses post-harvest disease of some fruits, and maintains higher level of bioactive compound, and also enhances anti-oxidant capacity. MeJA is also classified by the U.S. Food and Drug Administration as a Generally Recognized As Safe (GRAS) substance. It may have potential commercial applications in post-harvest treatments for quality maintenance by reducing decay and enhancing antioxidant capacity by increasing secondary metabolites [18]. Arnold et al. [19] reported that MeJA induced crude phlorotannins in brown seaweed *Fucus vesiculosus*. To the best of our knowledge, so far no report has been found on MeJA induced individual phlorotannins enhancement in brown seaweed. In this work, we have examined the dose and time effects of MeJA on the individual amount of phlorotannin of *E. cava* tissue using RP-HPLC.

MATERIALS AND METHODS

A. Sample Collection

*E. cava* was collected from Kijang, coast of Busan, South Korea by scuba diving from July to November, 2011. Matured thallus blades were cut into 1 cm2 long piece, washed with autoclaved seawater and sonicated for 1 min to remove epiphytes. For each 1 g of seaweed tissue, 25 mL of Provasoli’s Enriched Seawater (PES) media [20] was added. MeJA was dissolved in 100% ethanol to make stock solution (30 mgmL−1). MeJA solution was applied to the culture system at a concentration from 0 to 10 µM for 24 hrs and 0 µM treated as control. To examine the time effect, *E. cava* was treated with 2 µM of MeJA solution between 0 to 72 hrs and 0 hrs treated as control. Algal tissues were incubated at 20°C under 40 µmolm−2s−1 light intensity and 12 h light dark cycle in an illuminated multi-room incubator (VS-1203PFNL, Vision Scientific Co. Ltd, Korea).

B. Extraction of phlorotannins from *E. cava*

After MeJA treatment, samples were stored immediately at -20°C, lyophilized and ground in fine powder by mortar and pestle. Crude Phlorotannin was extracted from dried *E. cava* powder according to the method of Chowdhury et al. [21] with some modification. The crude phlorotannin was dissolved in 100% methanol and stored at -20°C until use.

C. Separation and identification of phlorotannins

Two major phlorotannins, dieckol and phlorofucofuroeckol-A and two phlorotannins from *E. cava* were separated on a C18, 5 µm (22 mm i.d. × 25 cm) column (Alltima; Alltech, Deerfield, IL) at a flow rate of 5.0 mL min−1. Dieckol and phlorofucofuroeckol-A were analyzed on a JNM-ECP 400 NMR spectrometer (JEOL, Tokyo, Japan), using methanol-d6 (CD3OD) for the 1H and 13C-NMR spectra. FABMS data were obtained from JMS-700 spectrometer (JEOL). Structures of each compound were identified to be identical to the spectral data [10] and confirmed as:

**Dieckol**: light brown powder, FABMS m/z (%): Found: 742.0811 (M+); calcld for C30H32O16: 742.0806; 1H-NMR (400 MHz, CD3OD) δ: 6.14 (1H, s, H-1'), 6.12 (1H, s, H-3'), 6.08 (2H, s, H-2', H-6'), 6.06 (1H, d, J = 2.72 Hz, H-8'), 6.04 (1H, d, J = 3.08 Hz, H-6'), 5.98 (1H, d, J = 2.72 Hz, H-4'), 5.95 (1H, d, J = 2.72 Hz, H-8'), 5.92 (3H, s, H-3'), 5.89 (2H, s, H-2',4',6'); 13C-NMR of 100 MHz, CD3OD) δ: 161.9 (C-1'), 160.1 (C-3'), 157.8 (C-7'), 155.9 (C-8'), 154.5 (C-4a, 4a'), 152.4 (C-3', 3''), 147.4 (C-9a'), 147.3 (C-2', C-1'), 147.2 (C-2), 146.9 (C-9, 9'), 144.3 (C-5a'), 144.1 (C-5a), 143.4 (C-4'), 143.3 (C-4'), 138.6 (C-10a), 138.5 (C-10a'), 126.1 (C-1'), 125.5 (C-9a), 124.5 (C-1), 99.8
Phlorofucofuroeckol-A: light brown powder, FABMS m/z (%) Found: 603.0779 [M+H]+; bp: 602.0693 [M]+ (70). Calcd for C_{36}H_{63}O_{35}: 602.0692; 1H-NMR (400 MHz, CD-OD) δ: 6.64 (1H, s, H-9), 6.41 (1H, s, H-13), 6.27 (1H, s, H-3), 5.97 (2H, d, J = 2.04 Hz, H-2', H-6'), 5.94 (1H, m, H-4'), 5.92 (1H, m, H-4), 5.89 (2H, d, J = 2.04 Hz, H-2', H-6), 13C-NMR (100 MHz, CD-OD) δ:161.6 (C-1), 161.5 (C-1'), 160.0 (C-5'), 159.9 (C-3', C-5', C-3''), 152.9 (C-12a), 151.5 (C-10), 150.9 (C-11a), 148.1 (C-2, C-8), 145.7 (C-14), 143.7 (C-4), 138.1 (C-15a), 135.1 (C-5a), 127.9 (C-14a), 124.8 (C-4a), 124.5 (C-1'), 122.1 (C-11), 105.1 (C-6, C-7), 99.8 (C-9), 99.2 (C-3), 97.6 (C-4'), 97.4 (C-4), 96.0 (C-13), 95.2 (C-2', C-6').

Fig. 1. General HPLC profile of Ecklonia cava. Peak 1, 2, 3 and 4 represent the dieckol, compound 2, compound 3 and phlorofucofuroeckol-A respectively.

Fig. 2. Structures of dieckol (A) and phlorofucofuroeckol-A (B) isolated from the edible brown alga E. cava.

D. Quantification of phlorotannins by RP-HPLC

Individual phlorotannin compounds in E. cava were quantified by RP-HPLC. To measure the amounts of phlorotannins from E. cava, the extracted crude phlorotannin from different treatments were used. Each 100 µL aliquot of 100% methanol dissolved crude phlorotannin was injected into HPLC. HPLC analysis was performed by C_{18}, 5 μm (10 mm i.d.×25cm) column, Waters 600 gradient liquid chromatograph (Waters Associate Inc., Milford, MA), monitored at 290 nm. Data acquisition was carried out by using Waters Empower2 software. A linear gradient solvent system consisted of water and 100% methanol. The gradient was made from 0% water to 100% water at 40 min at the flow rate of 1.0 mL min⁻¹. Then the program was continued in isocratic mode at 100% methanol for 10 min. The column temperature was ambient.

The amount of each compound was assessed by measuring the dimension of HPLC peaks, using the standard curve of each pure compound. Validation of the HPLC quantification was performed for accuracy, precision, limit of detection (LOD), limit of quantification (LOQ), and linearity. The accuracy was determined by analyzing each standard sample at different concentrations. Three replications were performed for each concentration. The % recovery was calculated from the mean concentration of three replications. Peak area was used for quantification purpose, using the equation of Snyder et al. [22]; sample concentration = sample peak area/RF, where response factor (RF) = standard peak area/standard concentration. Accuracy (or % recovery) was calculated as following formula; Accuracy= (actual concentration of analyte/theoretical concentration of analyte) x 100. The precision of the method was expressed by the standard deviation (SD) and related standard deviation (RSD). LOD and the LOQ were determined by analyzing the pure compound solutions that were sequentially diluted in a series with 100% methanol to obtain the lowest level of analyte that gave a measurable response with a signal-to-noise ratio (S/N) of 3 and 10, respectively [22]. Linearity of the quantification for each compound was prepared with three standards ranging from 0 to 100 µg mL⁻¹. Calibration curves for each compound were constructed separately by plotting peak area (y-axis) versus the concentration (x-axis) of the standards. The regression analysis was used to relate each phlorotannin standard concentration individually as the dependent variable with the peak area as the independent variable.

E. Statistical Analysis

All data were assessed as mean ± SE from at least three independent experiments. Statistical comparison of the mean values were performed by an analysis of variance (ANOVA), followed by a Duncan’s multiple range test using SPSS software version 16 (SPSS Inc. Chicago, IL). P-values <0.05 were considered statistically significant.

RESULTS AND DISCUSSION

A. Identification of Phlorotannins Compounds

To investigate the effects of MeJA on specific phlorotannin compounds, the crude phlorotannin was analyzed with RP HPLC technique. Among the various peaks in the chromatograms, four peaks, retention time 32, 36, 37 and 40 min (Fig. 1) respectively were altered with the application of MeJA. From FAB-MS, 1H-NMR and 13C-NMR spectral data, phlorotannins compounds of 32 and 40 min retention time were identified as dieckol and phlorofucofuroeckol-A (Fig. 2). Another two phlorotannins (peak 36 and 37 min) were also quantified. From FAB-MS spectrum of phlorotannin compounds of peak 36 and 37, [M]+ ion at m/z were 974.1183 and 974.1175, respectively. Judging from these results, it is estimated that the compounds 1 and 2 were new and novel phlorotannin compounds and matching the molecular weight and formula with 974 and C_{36}H_{63}O_{35}, respectively.

B. HPLC Analysis Method Validation

HPLC analysis was performed to quantitatively evaluate the four major phlorotannins from different treatments. Amounts of the phlorotannins were measured, by the dimension of the HPLC peaks, using the standard curve of each pure compound. Method of the HPLC quantification was validated for justification of the data by accuracy, precision, LOD, LOQ, and linearity. For dieckol, compound 2, compound 3 and phlorofucofuroeckol-A, the accuracy was calculated as 95.68%, 97.38%, 99.24% and 100.29% and precision was 3.24%, 2.38%, 3.47% and 3.94%, respectively. Standard curves for each compound up to 100 µg/mL were generated. The calibration plots of peak area vs. concentration of pure
compound exhibit a straight linear line. Correlation coefficient ($r^2$) values were 0.9995, 0.9989, 0.9992 and 0.9999, respectively. The validation process is to challenge the method and determine limits of allowed variability for the conditions needed to run the quantification. For the assessment of low-level impurities, precision of 5 to 10% usually accepted [22], which are higher than our precision range. Thus, the quantification of four phlorotannins from different treatments by using HPLC is a reliable and simple method, and does not depend on the degree of multiplicity of seaweed compounds.

### C. Effect of MeJA Treatment on Crude Phlorotannin

Within 24 hrs after different concentration of MeJA treatment (0 to 10 µM) to *E. cava* tissue, the crude phlorotannins was significantly increased. Highest amount of crude phlorotannins was observed after 2 µM MeJA treatments which were 56% higher than control (Fig. 3). A time dependent study with 2 µM MeJA treatment showed that crude phlorotannins were reached maximum at 24 hours. After that it gradually decreased (Fig. 4). Exposure to MeJA, induced the brown seaweed *Fucus vesiculosus* to accumulate phlorotannins. A single hour of exposure to 5.42 to 542 nM MeJA, phlorotannins concentration were increased 1.6 times [19]. Pelletreau [23] also found the same result, which is similar to our results.

![Fig. 3. Amount of crude phlorotannins after treatment with different concentration of MeJA.](image)

**Crude phlorotannins (mg/g dry tissue)**

- Control
- 0.25 µM
- 1 µM
- 2 µM
- 5 µM
- 10 µM

Values are expressed as mean ± SE. Different letters of a, b, c and d indicate significant differences by Duncan’s multiple range test at *p* < 0.05.

![Fig. 4. Amount of crude phlorotannins over time course treated with 2 µM MeJA.](image)

**Crude phlorotannins (mg/g dry tissue)**

- Control
- 6 hrs
- 12 hrs
- 24 hrs
- 48 hrs
- 72 hrs

Values are expressed as mean ± SE. Different letters of a, b, and c indicate significant differences by Duncan’s multiple range test at *p* < 0.05.

### D. Effect of MeJA on Individual Phlorotannins

The amount of four individual phlorotannins such as dieckol, phlorofucofuroeckol-A, compound 2 and compound 3 (Fig 5) were examined after 24 hrs of MeJA treatments (0 to 10 µM). The amount of four phlorotannins were significantly increased after treatment with MeJA. The highest amount of four individual phlorotannins such as dieckol, compound 2, compound 3 and phlorofucofuroeckol-A were observed in 2 µM MeJA treatment, which were 85.72%, 118.23%, 37.70% and 53.07%, respectively higher than the control (Fig 5). In general all four phlorotannins were increased gradually over the first 24 hours and then decreased during the remaining 48 hours (Fig. 6). Significantly (*p* < 0.05) higher levels of dieckol, phlorofucofuroeckol-A, Phlorotannin compound 2 and 3 were observed in 2 µM MeJA treated *E. cava* during the 72 hours compare to control.

![Fig. 5. Amount of dieckol (A), compound 2 (B), compound 3 (C) and phlorofucofuroeckol-A (D) after treatment with different concentrations of MeJA, quantified by RP-HPLC.](image)

**Concentration of MeJA**

- Control
- 0.25 µM
- 1 µM
- 5 µM
- 10 µM

Values are expressed as mean ± SE. Different letters of a, b, and c indicate significant differences by Duncan’s multiple range test at *p* < 0.05.

![Fig. 6. Amount of dieckol (A), compound 1 (B), compound 2 (C) and phlorofucofuroeckol-A (D) over time course treated with 2 µM MeJA and quantified by RP-HPLC.](image)

**Time course of MeJA**

- Control
- 6 hrs
- 12 hrs
- 24 hrs
- 48 hrs
- 72 hrs

Values are expressed as mean ± SE. Different letters of a, b, and c indicate significant differences by Duncan’s multiple range test at *p* < 0.05.

The accumulation of secondary metabolites in plants is part of the defense response against pathogenic attack, which is triggered and activated by elicitors, the signal compounds of the plant defense responses [15]. Therefore, the treatment of plant cells with biotic and/or abiotic elicitors has been a useful strategy to enhance secondary metabolites productions. A number of elicitors such as MeJA have been used successfully of enhancing production of secondary metabolites. MeJA
could diffuse to distal parts of the plant via the vapor phase [24] or by intercellular migration, possibly through the phloem [25]. Gaquerel et al [26] reported that red algae Chondrus crispus uptake the MeJA from sea water and the highest amount of MeJA uptake was occurred after 12 hrs of MeJA application. In C. crispus MeJA activated the oxidative metabolism of C20 and C18 polyunsaturated fatty acids and generated hydroperoxides and cyclo-pentenones, such as prostaglandins and oxygenated fatty acids (Oxylipin). Addition of MeJA to C. crispus also induced increased activities of enzymes such as shikimate dehydrogenase, phenylalanine ammonia lyase (PAL) [26, 27]. The exact biosynthesis pathway for phlorotannins is not clear until now [28]. Polyketide synthase, shikimate or phenylpropanoid pathways potentially involved in the synthesis of phlorotannins [22]. PAL as a key enzyme in the first step of the phenylpropanoid pathway is directly involved in the biosynthesis of phenolic compounds [29]. The transcription of defense related genes in the red alga C. crispus is also up regulated after MeJA addition, including glutathione S-transferase (GST), heat shock protein 20, xenobiotic reductase and phycocyanin lase and down regulated transcripts including glucose kinase, phosphoglucone isomerase and ribosomal protein [30]. In brown seaweed Laminaria digitata, MeJA triggers of an oxidative burst [31].

CONCLUSION

Based on the above findings, our observation is that E. cava is capable to accumulate the MeJA from seawater media. This MeJA can elicit defense related response in E. cava and enhance the crude and individual phlorotannins. For application of MeJA, optimum concentration and time also determined. It was also the first time to report that exogenous MeJA can enhance the individual phlorotannins such as dieckol, phlorofucofuroeckol-A and two novel phlorotannins matching the molecular weight and formula to 974 and C45H26O53, respectively.

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