Multidisciplinary Research Workshop at 50 Years of Bangladesh

バングラデシュ建国 50 周年記念学祭研究ワークショップ 2022

The Tokyo International Forum, Tokyo, 11–12 August, 2022

Sponsor: Network of Bangladeshi Researchers in Japan (NBRJ)
Workshop Website: https://nbrj.jp/workshop2022/

Workshop Proceedings

Editors: Sharifu Ura, Mohammad Abdul Malek, and Mahfuzul Islam

12 August 2022, Tokyo

Memo:

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Preface

The Network of Bangladeshi Researchers in Japan (NBRJ) was initiated in 2020. It is a network of researchers from Bangladesh who work at Japanese universities, research organizations, and industries. NBRJ's vision is to become a leading research and policy advocacy group regarding Bangladesh affairs. Its goal is to contribute to Bangladesh's technological and developmental initiatives. In order to meet the goal, NBRJ undertakes the following activities: 1) organizing webinars and conferences, 2) publishing newsletters and books, 3) facilitating academia-industry research collaborations, and 4) providing a forum for debating policy alternatives. The focus of these activities is Bangladesh.

Since its inception, NBRJ has successfully been organizing webinars sharing the personal stories of some of its members. It also maintains a dedicated website (https://nbrj.jp/). This website disseminates information regarding NBRJ's activities.

NBRJ planned an onsite workshop titled "Multidisciplinary Research Workshop at 50 Years of Bangladesh" to be held on 26-27 March 2022 at the Tokyo International Forum, Tokyo—a world-class multi-purpose exhibition center only a 5-minute walk from the Tokyo station. The goal is to facilitate networking among its members. However, the workshop date was postponed to 11-12 August 2022 due to the COVID-19 pandemic.

On the first day of the two-day-long workshop, a welcome dinner was organized at the Oven American Buffet (Aqua City Odaiba 6F, 1-7-1 Daiba, Minato-ku, Tokyo 135-0091). The participants enjoyed the food and engaged themselves in informal discussions.

On the last day of the two-day-long workshop, four technical sessions, a general meeting, a panel discussion session, and a concluding session was organized. The first technical session was on Business, Humanities, and Social Science. In this session, four outstanding papers were presented. The second technical session was on Agricultural Sciences. In this session, three outstanding papers were presented. The third technical session is on Medical, Pharmaceuticals, and Public Health. In this session, four outstanding papers were presented. The last technical session was on Natural Sciences, Engineering, and ICT. In this session, six outstanding papers were presented. During the lunch break, a general meeting was organized to discuss the mission, vision, goals, objectives, and outcomes of NBRJ. The participants enjoyed the traditional food of Bangladesh as well during this session. The panel discussion session summarized the workshop's outcomes and highlighted the improvement avenues. Finally, in the concluding session, NBRJ was formally declared. In addition, the Ambassador of the People's Republic of Bangladesh to Japan delivered a speech.

Pages 18–44 of this proceedings present the eighteen accepted abstracts and an extended abstract, respectively.

The workshop officials thank the authors, session chairs, contributors of the concluding sessions, participants, and NBRJ members for their invaluable contributions and wholehearted support. At the same time, the workshop officials gratefully acknowledge the financial support of some of the NBRJ members.

During this two-day-long workshop, the participants could know each other in person, cordially exchange their views, and learn from each other. Thus, the workshop successfully fulfilled its goal—facilitating networking among NBRJ members.

NBRJ invites you all to attend similar events next time.

Sharifu Ura, Workshop Chair

Concluding Speech
by
H.E. Mr. Shahabuddin Ahmed, Ambassador of Bangladesh in Japan

Distinguished Members of Network of Bangladeshi Researchers in Japan (NBRJ),
Ladies and Gentlemen. A very good afternoon to you all. Konnichiwa.

Thank you for inviting us to this very important workshop. It is my great pleasure to be able to speak in front of so many talented professionals, scholars and researchers of Bangladesh in Japan. This is a great opportunity for us to learn about NBRJ and its activities. Thank you once again for organizing this event as part of the golden jubilee of Bangladesh's independence which we have celebrated last year.

First of all, I pay my deepest respect to the architect of our independence, greatest Bengali of all time, Father of the Nation Bangabandhu Sheikh Mujibur Rahman. I also remember with reverence the contribution of our four national leaders and valiant freedom fighters who made the supreme sacrifice for our independence. Moreover, I recall the contributions of our foreign friends and supporters during the war of liberation in 1971, especially Japan.

Bangladesh is a fast-growing emerging economy. Despite the manifold hurdles, we have achieved significant success in attaining high GDP growth over the years with reduced poverty rate. We have accomplished remarkable progress in UN Human Development Index and Women empowerment. We are graduating from LDC status in 2026. Under the visionary leadership of our Prime Minister Sheikh Hasina, Bangladesh is marching ahead with strong commitment and positive determination.

You are aware that we have observed the 50th anniversary of Bangladesh-Japan diplomatic relation on 10th February this year. Over the past 50 years, both countries have built a strong relationship, binding our cultures, peoples, and economies. As a result, both countries have been able to effectively expand the people-to-people exchange and cooperation. Japan has been the single largest bilateral development partner of Bangladesh. Both countries have worked together to complete many important infrastructure projects in Bangladesh, such as Bangabandhu Bridge on the river Jamuna, Meghna-Gumti bridge, etc. Currently, many more projects are undergoing with JICA's cooperation, including Bangabandhu Sheikh Mujib Railway Bridge, Dhaka Mass Rapid Transit system, Hazrat Shahjalal International Airport Terminal-3, Matarbari Sea Port, etc.

You are aware that our Embassy has been undertaking many programs and events for promoting Bangladesh to Japan and its people. For example, we have organized a seminar at the Embassy in June 2022 on the theme of 'JICA with Bangladesh: Reaching 50th Year and Way Forward'. The seminar was attended by high officials of the Government including Ministry of Finance, Ministry of Foreign Affairs, Ministry of Economy Trade and Industry (METI), Japan External Trade Organization (JETRO), members of the industry, academia and civil society. We have organized Bangladesh-Japan IT business collaboration networking event in June 2022. The participants were top-level executives from Japanese IT companies, NRB-established IT companies, and Bangladeshi IT professionals and researchers. The Embassy have also organized 'Bangladesh Seminar on Trade, Investment and Skilled Human Resources' in Saitama city, where METI, JICA, JETRO, UNIDO, and many Japanese companies and human resource recruiting agencies were present. We have organized similar events in various cities of Japan including Yokohama, Shizuoka, etc. Besides, the Embassy also organized many online seminars and meetings where relevant stakeholders from both Bangladesh and Japan attended. For example, a webinar on the 'Investment opportunities in economic zones of Bangladesh' has been organized by the Embassy in collaboration with BEZA in June 2022. All these events are helpful to bring new opportunities for individuals and organizations in Bangladesh and Japan.

Today I am glad to note that NBRJ have been able to gather academics and experts from a number of renowned universities and research organizations across Japan covering various disciplines. We are really impressed by the findings of their hard work. What touched me most is that you are engaged in researches keeping in mind the interest of Bangladesh. Your attention was fully focused on our beloved motherland. It makes me hopeful about our brighter future. I am sure that the results of the researches that you have completed and those that you are continuing to do, will benefit Bangladesh immensely in the coming days. I must acknowledge that today's workshop has been quite a success.

Finally, I take the opportunity to congratulate the distinguished members of NBRJ for their dedicated contributions. I believe that they will continue to organize similar events every year on a regular basis. I wish them best of luck and more success in the future. Let me reassure that our Embassy will extend all possible cooperation and support to NBRJ whenever necessary.

Thank you very much. Arigatou Gozaimashita.
Joi Bangla.
May Bangladesh Live Forever!

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Sponsor: Network of Bangladeshi Researchers in Japan (NBRJ)

Workshop Website: https://nbrj.jp/workshop2022/

Workshop Officials

General Chair:

Sharifu Ura (Kitami Institute of Technology)

Co-Chairs:

Mohammad Abdul Malek (University of Tsukuba)

Mahfuzul Islam (Kyoto University)

Program and Organizing Committee:

Mohammad Abdul Malek (University of Tsukuba)

Mahfuzul Islam (Kyoto University)

Jubair Shamim (The University of Tokyo)

Mehadi Aman (Sharp Corporation)

Sharifu Ura (Kitami Institute of Technology)

Organized Session Committee:

Khondaker Mizanur Rahman (Nanzan University)

Chowdhury Mahbubul Alam (Fukuoka Women's University)

Nazmul Ahsan (The University of Tokyo)

Tofael Ahmed (University of Tsukuba)

S. M. A. Hakim Siddiki (Tokyo Metropolitan University)

Website Committee:

Mahfuzul Islam (Kyoto University)

Mehadi Aman (Sharp Corporation)

Memo:

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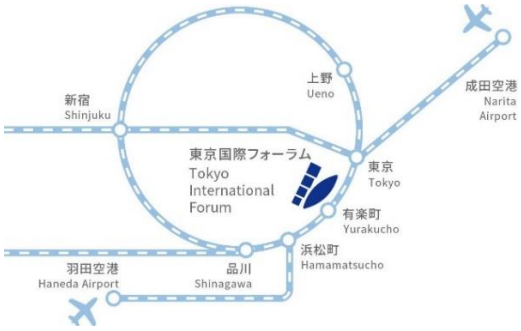
Venue and Program at a Glance

	Access: 5-1 Marunouchi 3-chome, Chiyoda-ku Tokyo 100-0005, Japan TEL: +81- (0)3-5221-9000 (Main) 1-minute walk from Yurakucho Station 5-minute walk from Tokyo Station

Program at a Glance	
Thursday, 11 August, 2022	
17:00 – 20:00	Welcome Dinner at The Oven American Buffet (Halal foods available) Address: Aqua City Odaiba 6F, 1-7-1 Daiba, Minato-ku, Tokyo 135-0091 Tel: 03-3529-2093
Friday, 12 August 2022	
08:30 – 14:00	Registration
09:00 – 10:00	Session 1: Business, Humanities, and Social Science
10:00 – 10:15	Coffee Break
10:15 – 11:00	Session 2: Agricultural Sciences
11:00 – 11:15	Coffee Break
11:15 – 12:30	Session 3: Medical, Pharmaceuticals, and Public Health
12:30 – 13:30	Lunch Break and General Meeting
13:30 – 15:00	Session 4: Natural Sciences, Engineering, and ICT
15:00 – 15:15	Coffee Break
15:15 – 15:45	Session 5: Panel Discussion on the Workshop
15:45 – 16:00	Coffee Break
16:00 – 16:45	Session 6: Concluding Session

Memo:

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Workshop Program

Welcome Dinner	
Day	Thursday, 11 August, 2022
Time	17:00 Hours – 20:00 Hours
Venue	The Oven American Buffet Aqua City Odaiba 6F, 1-7-1 Daiba, Minato-ku, Tokyo 135-0091 Tel: 03-3529-2093
Coordinator	Jubair Shamim

Registration	
Day	Friday, 12 August 2022
Time	08:30 Hours – 14:00 Hours
Venue	Tokyo International Forum: Conference Room G404
Website	https://nbrj.jp/workshop2022/registration/
Coordinator	Program Committee

Session 1: Business, Humanities, and Social Science	
Day	Friday, 12 August 2022
Time	09:00 Hours – 10:00 Hours
Venue	Tokyo International Forum: Conference Room G404
Chair	Khondaker Mizanur Rahman (Nanzan University)
Presentations	
Paper ID 001	*Socio-Economic Development in Bangladesh: Findings from Long-Term Panel Data and a Glance Ahead* Mohammad Abdul Malek, Aiko Kikkawa, Abdul Kalam Azad, and Yasuyuki Sawada
Paper ID 002	*Historical Development of Social Business Enterprises in Bangladesh* Sufia Jahan
Paper ID 003	*Does Board Structure Matter in CSR Spending of Commercial Banks? Empirical Evidence from an Emerging Economy* Bishnu Kumar Adhikary and Ranjan Kumar Mitra
Paper ID 004	*How Bank-specific Factors Affect Access to Financing for SMEs: Evidence from an Emerging Economy* Sadia Noor Khan
Coffee Break: 10:00 Hours – 10:15 Hours	

Session 2: Agricultural Sciences	
Day	Friday, 12 August 2022
Time	10:15 Hours – 11:00 Hours
Venue	Tokyo International Forum: Conference Room G404
Chair	Mohammad Abdul Malek (University of Tsukuba)
Presentations	

Paper ID 005	*Assessing Damaged Agricultural Lands by Recurrent Tropical Cyclones in Coastal Region of Bangladesh* Md. Shamsuzzoha, Ryozo Noguchi, and Tofael Ahamed
Paper ID 006	*Investigating the Effect of Climate Change on Food Loss and Food Security in Bangladesh* Mohammad Saiful Islam, Kazunobu Okubo, AHM Saiful Islam, and Masayuki Sato
Paper ID 007	*Introducing a Damage-Based Crop Insurance System and Yield Prediction Algorithms for Future Flash Flood Affected Farmers: A Multidisciplinary Approach* Md. Monirul Islam, Kiyokazu Ujiie, Ryozo Noguchi, and Tofael Ahamed
Coffee Break: 11:00 Hours – 11:15 Hours	

Session 3: Medical, Pharmaceuticals, and Public Health	
Day	Friday, 12 August 2022
Time	11:15 Hours – 12:30 Hours
Chair	S. M. A. Hakim Siddiki (Tokyo Metropolitan University)
Venue	Tokyo International Forum: Conference Room G404
Presentations	
Paper ID 008	*Effect of Enamel Matrix Derivative on Avulsed Tooth Treatment* Md Riasat Hasan
Paper ID 009	*Dentin-Bonding Efficacy of Two New Dental Bonding Agents* Arefin Alam, Abu Faem Mohammad Almas Chowdhury, Monica Yamauti, and Hidehiko Sano
Paper ID 010	*Catalysis in Fine Chemical Synthesis: Industrial Prospects in Bangladesh* S. M. A. Hakim Siddiki
Paper ID 011	*Future Aspects of Cancer Immunotherapy in Bangladesh* Tania Afroj

Paper ID 012	*A Simplified Analytical Model to Evaluate Hospital Preparedness for Earthquake Emergency Response* Md. Shakhawat Hossain, Fahmida Alam Bintu, Md. Zillur Rahman, Md. Khairul Islam, ASM Maksud Kamal, and Abrar Hossain
Lunch Break and General Meeting: 12:30 Hours – 13:30 Hours	

Session 4: Natural Sciences, Engineering, and ICT	
Day	Friday, 12 August 2022
Time	13:30 Hours – 15:00 Hours
Venue	Tokyo International Forum: Conference Room G404
Chair	Nazmul Ahsan (The University of Tokyo)
Presentations	
Paper ID 013	*Twenty-Five Years of Experience and Recent Activity in Photonics: A MEMS-Based Widely Tunable VCSEL for SS-OCT* Mohammed Saad Khan
Paper ID 014	*Potential of Desiccant-Assisted Hybrid Air-Conditioning for Cold Storage of Agro-Commodities in Bangladesh* Jubair A. Shamim
Paper ID 015	*The Quest for Sustainability in Energy and Electricity Sectors of Bangladesh* Jubair Sieed
Paper ID 016	*Recent Development in Display Technology and its Industrial Perspective in Bangladesh* Mehadi Aman
Paper ID 017	*The Role of Semiconductor Chips in Modern Civilization and Opportunities for Bangladesh* Mahfuzul Islam
Paper ID 018	*Shear Wave Velocity Estimation using Horizontal-to-Vertical Analysis in the Sylhet Basin in Bangladesh*

	Atikul H. Farazi, Md. Shakhawat Hossain, Yoshihiro Ito, and José Piña-Flores
Coffee Break: 15:00 Hours – 15:15 Hours	

Session 5: Panel Discussion on the Workshop	
Day	Friday, 12 August 2022
Time	15:15 Hours – 15:45 Hours
Venue	Tokyo International Forum: Conference Room G404
Moderator	Mohammad Abdul Malek (University of Tsukuba)
Panelists	Khondaker Mizanur Rahman (Nanzan University) S. M. A. Hakim Siddiki (Tokyo Metropolitan University) Nazmul Ahsan (The University of Tokyo)
Coffer Break: 15:45 hours – 16:00 hours	

Session 6: Concluding Session	
Day	Friday, 12 August 2022
Time	16:00 Hours – 16:45 Hours
Venue	Tokyo International Forum: Conference Room G404
Moderator	Sharifu Ura (Kitami Institute of Technology)
Formal Declaration of NBRJ	Khondaker Mizanur Rahman (Nanzan University)
Concluding Remarks	His Excellency Mr. Shahabuddin Ahmed, The Ambassador of the People's Republic of Bangladesh to Japan
End	

Memo:

Abstracts/Extended Abstracts

Economic Development in Bangladesh: Findings from Long-Term Panel Data and a Glance Ahead

Mohammad Abdul Malek[1a], Aiko Kikkawa[2], Abdul Kalam Azad[3], and Yasuyuki Sawada[4]
[1]University of Tsukuba, [2]Asian Development Bank, [3]University of Dhaka, [4]The University of Tokyo
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Keywords: Bangladesh; Rural Development; Panel Data; Evidence-Based Policy Making

Session: Business, Humanities, and Social Science

Submission ID: 011 *Presentation ID*: 001

Abstract: This paper presents the historical context, sampling evolution, survey structure and methodology, academic and policy contributions, and a glance ahead regarding Mahabub Hossain Panel Data (MHPD). MHPD, introduced in 1988, has been tracking households for nearly three decades (1988-2014), with five waves of household surveys covering over 2,800 households. It has collected a wide range of information on household composition, schooling of household members, assets, cropping intensity, and patterns, including cost and return, employment and income, consumption, and participation in different government and non-government programs. In this paper, we review several books and journal articles authored by Mahabub Hossain and related academic papers and documents on MHPD. In particular, the following items are reviewed: (*i*) mapping out information on past and ongoing panel or cross-sectional household survey data series in Bangladesh; (*ii*) undertaking the review of all past rounds of MHPD survey documents such as survey implementation plans, questionnaires, codebooks, databases, and processed data; (*iii*) consulting relevant stakeholders, including the past implementers of the surveys and the users of the data as needed to validate documented information; (*iv*) taking stock of the contribution of MHPD to academic literature and policy development; and (*v*) drawing several lessons learned for future data collection and policymaking. The outcomes of this paper are as follows: 1) It serves as a comprehensive reference document for scholars and policymakers who wish to understand MHPD for possible use in their research. 2) It provides a comprehensive baseline from which we can consider ways to enhance MFPD further to continue contributing to understanding contemporary economic and social issues. 3) It offers a historical landscape of Bangladesh's social and economic development and a credible explanation for Bangladesh's development model for global comparison. This study is supported by the Asian Development Bank project KSTA 6556-REG (Challenges and Opportunities of Population Aging in Asia: Improving Data and Analysis for Healthy and Productive Aging), funded by the Japan Fund for Poverty Reduction of the Government of Japan.

Historical Development of Social Business Enterprises in Bangladesh

Sufia Jahan
Graduate School of Social Sciences, Nanzan University
Corresponding Author's E-mail: suj.kanta@gmail.com

Keywords: Bangladesh; Grameen Bank; Bangladesh Rural Advancement Committee (BRAC); Social Business (SB); Social Business Enterprises (SBEs)

Session: Business, Humanities, and Social Science

Submission ID: 002 *Paper/Presentation*: 002

Abstract: This study presents the historical development of social business enterprises in Bangladesh based on the survey of research literature, interviews of social business (SB) activists/leaders/scholars, reviews of social business enterprises' published and unpublished documents, government laws and documents, and a firsthand investigation into the origin of social business enterprises (SBEs) in Bangladesh namely Grameen Bank, Grameen Family of Companies, and Bangladesh Rural Advancement Committee (BRAC). This study divides the SB concept into three perspectives to understand its global impact, namely, *a*) American perspective, *b*) European perspective, and *c*) Bangladesh perspective. Findings are summarized as follows: Firstly, at the beginning stage, both Grameen and BRAC focused on the concept of diversification to establish a nonprofit organization and welcomed American and European perspectives equally. Initially, microfinance played a role in the common origin of BRAC and Grameen Bank initiatives. Both organizations were set up in response to the crisis right after the independence war of Bangladesh. However, when the freedom war refugee scenario changed positively within a couple of years, BRAC was transformed from a short-term emergency initiative to a long-term development organization. In the next phase, both BRAC and Grameen Bank initiated nonprofit business with a mission to achieve organizational sustainability and decrease donor dependency. In this stage, they emphasized convergence of the nonprofit sectors and declared their nonprofit business as a part of the non-dividend business. As a result, profit was used for business expansion rather than returning donors' funds. In the third phase after 2010, Muhammad Yunus introduced his nonprofit business concept, whereby SBs would go through his "non-loss, non-dividend" theory, which was thought to be an innovative form of SBs in Bangladesh and the rest of the world.

Does Board Structure Matter in CSR Spending of Commercial Banks? Empirical Evidence from an Emerging Economy

Bishnu Kumar Adhikary[1a] and Ranjan Kumar Mitra[2]
[1]Graduate School of Business, Doshisha University, Japan
[2]Department of Accounting and Information System, University of Dhaka, Bangladesh
Corresponding Author's E-mail: badhika@mail.doshisha.ac.jp

Keywords: CSR expenditures; Board Structure; Corporate Social Responsibility (CSR); Commercial Banks; Bangladesh

Session: Business, Humanities, and Social Science

Submission ID: 016 *Paper/Presentation ID*: 003

Abstract: This paper examines the impact of board structure on corporate social responsibility (CSR) expenditures of listed commercial banks in an emerging economy, considering Bangladesh as a case. In doing so, we hand-collected necessary data from annual reports of 30 listed commercial banks in Bangladesh over the period 2007–2020. We adopted the OLS model with two-way clustering to measure the impact of key elements of board structure such as board size, independent directors on the board, female representations on the board, and frequency of board meetings on CSR spending. Our results confirmed that factors such as independent directors, female directors on the board, and board size have a significant and positive relationship with CSR expenditures. In contrast, board meeting has no such connection. Besides, control variables such as firm size, age, and leverage influence CSR spending of commercial banks. The findings of the study are expected to have significant policy implications. However, we note that future studies should warrant other corporate governance elements such as ownership structure and audit quality to add further knowledge of the CSR spending of commercial banks.

How Bank-specific Factors Affect Access to Financing for SMEs: Evidence from an Emerging Economy

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Corresponding Author's E-mail: sadiakhan@du.ac.bd

Keywords: Access to Financing; Bank Financing; SME; State-Owned Bank; Private Bank; Foreign Bank; Distress Bank; Rural Branch; Bangladesh

Session: Business, Humanities, and Social Science

Submission ID: 015 *Paper/Presentation*: 004

Small and Medium Enterprises (SMEs) are instrumental in shaping the world economy. SMEs create many jobs and, thereby, help sustain most economies. This is particularly true for developing countries. However, similar to large enterprises, SMEs need financing from banks. Therefore, studying SME financing is an important research topic. This study empirically elucidates how bank-specific factors can affect the access to financing for SMEs operating in Bangladesh. Accordingly, this study tested hypotheses regarding the impact of bank size, ownership structure, branch location, and distress condition on the access to financing for small and medium-sized enterprises (SMEs). The empirical analysis was conducted using data obtained from scheduled banks operating in Bangladesh (banks listed under the Bangladesh Bank Order, 1972) and SMEs operating in Bangladesh. The results suggest that SMEs in Bangladesh have greater access to financing when their application for financing is made to small banks, domestic private banks, or rural branches of scheduled banks. On the other hand, bank distress appears to have a negative impact on the provision of financing to SMEs. Furthermore, SMEs' access to financing is lower when their application for financing is made to state-owned or foreign banks. The outcomes of this study can be used to develop pragmatic policies regarding financing SMEs.

Assessing Damaged Agricultural Lands by Recurrent Tropical Cyclones in Coastal Region of Bangladesh

Md. Shamsuzzoha[a,b*], Ryozo Noguchi[c], Tofael Ahamed[d]

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Corresponding Author's E-mail: s1936029@s.tsukuba.ac.jp

Keywords: Agricultural Land; Cyclone Amphan; Cyclone Bulbul; Damaged Type Classes; Damaged Area Assessment; Satellite Remote Sensing

Session: Agricultural Sciences

Submission ID: 005 *Paper/Presentation*: 005

Abstract: Two consecutive tropical cyclones, Bulbul and Amphan, entered into Bangladesh coast on November 10, 2019, and May 20, 2020, within six months. Both cyclones caused massive damage to agricultural lands in south Asian countries. Hence, it is essential to assess damaged agricultural lands by recurrent cyclones within the same calendar of crops and cyclones. This study was conducted in the Kalapara sub-district of the Patuakhali district, Bangladesh, to assess damaged agricultural lands. The hitting time of cyclone Amphan was mainly the harvesting period of Boro-rice, groundnut, mungbean, chili, potato, and seeding time of Aus-rice crops in the study area. Before Amphan, another super cyclone named Bulbul had destroyed entire transplanted Aman-rice fields. Using satellite remote sensing techniques (Landsat-8 OLI and TIRS datasets), we found that the cyclone Bulbul was more destructive than the cyclone Amphan. A total of five damaged type classes were assessed over the 309.079 km2 agricultural lands of the sub-district as (*i*) not damaged (ND); (*ii*) slightly damaged (SD); (*iii*) moderately damaged (MD); (*iv*) very damaged (VD) and extremely damaged (ED). The ND, SD, MD, VD, and ED areas for the cyclone Bulbul were 7.709, 32.960, 79.000, 131.560, and 57.850 km^2 and for the cyclone Amphan 10.956, 51.993, 102.407, 89.756, and 53.967 km^2, respectively. In the study area, 8.919 km^2 (2.886%) and 39.861 km^2 (12.897%) of agricultural lands were extremely damaged and very to extremely damaged respectively by both cyclones. Nine intersection-type areas were calculated, including 420 ground reference points data to validate the study. In the study area, 8.919 km^2 (2.886%);

39.861 km^2 (12.897%); and 68.944 km^2 (22.306%) lands were ED; very-to-extremely damaged (VD-ED); and moderately-to-extremely damaged (MD-VD-ED) by both cyclones correspondingly. Therefore, this study could help to prepare damage assessment maps and new adaptive policies to help cyclone-affected farming communities in all disaster-prone global south countries.

Investigating the Effect of Climate Change on Food Loss and Food Security in Bangladesh

Mohammad Saiful Islam[a, b,*], Kazunobu Okubo[c], AHM Saiful Islam[d], Masayuki Sato[a]

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[b]Bangladesh Livestock Research Institute, Savar-1341, Dhaka, Bangladesh

[c]Graduate School of Economics, Ryutsu Keizai University

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Keywords: Climate Change; Food Security; Extreme Climatic Events; Vector Auto-Regression; Bangladesh

Session: Agricultural Sciences

Submission ID: 006 *Paper/Presentation*: 006

Abstract: Climate change and extreme climatic events cause massive food grain loss, adversely impacting food availability, import, and other economic factors. Bangladesh has been combating climate variability and extreme climatic events to abate agricultural production loss for a long time. In this article, we investigated the relationship between food grain loss and food security regarding extreme climatic events in Bangladesh, based on data from 1984 to 2017. We used the vector auto-regression (VAR) model and derivative analyses and suggested policy implications related to the existing national agricultural policy. Five time-series variables were judiciously considered: food availability, food loss, food import, gross domestic product (GDP) growth rate, and inflation rate. The results show that the variable, food grain loss, has a reverse association with food security—it escalates import from the world food market, causing import dependence. Moreover, food loss significantly instigates inflation. However, the GDP growth rate was found to be a weak provocateur. Overall, climate change and climatic extremes jeopardize the country's food security and hinder its pursuit of sustainable development goals, especially stand-alone goals 1 and 2. Therefore, it is concluded that changes in climate and their correlations are detrimental to Bangladesh's food security and economy.

Introducing a Damage-Based Crop Insurance System and Yield Prediction Algorithms for Future Flash Flood Affected Farmers: A Multidisciplinary Approach

Md. Monirul Islam[1], Kiyokazu Ujiie[2], Ryozo Noguchi[2], Tofael Ahamed[2]*
[1]Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan
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Keywords: Crop insurance; Yield prediction; GIS and Satellite Remote Sensing; Econometric Approaches; Flash Food

Session: Agricultural Sciences

Submission ID: 007 *Paper/Presentation*: 007

Abstract: Asia experiences significant changes in monsoon time due to climate change. Irregular monsoons cause flash floods before harvesting paddy, and significant damage is observed in this region. In order to support wetland areas and rice production, an integrated approach of remote sensing-based vulnerable area mapping, yield prediction, and consideration of socio-economic criteria is required to support farmers in assessments of damage due to flash floods. Bangladesh, one of the most climatically vulnerable countries measured by flash floods, floods, droughts, and cyclones, was selected for this study. First, an accurate flash flood vulnerability map was developed with a high accuracy level of over 75% by integrating standard and easily accessible flash flood-inducing criteria, followed by a bivariate statistical regression-based frequency ratio (FR) model. Second, 40 selected respondents from each vulnerable group were interviewed to assess their vulnerability and coping strategies against flash floods using field survey data and the composite livelihood vulnerability index (CLVI). The CLVI outcome represents a potential exposure situation for the different flash flood-vulnerable households. Third, rice yield prediction models were generated using satellite remote sensing-based vegetation indices at the optimum harvesting time before flash flooding. The developed models can predict yields over more than two-thirds of the study area with a high level of accuracy. Fourth, a new damage-based crop insurance system was developed by integrating GIS, satellite remote sensing, and econometric models to support the flash flood-affected farmers. The lowest insurance premium rate was observed for the high coverage and moderately damaged classes at $23.82/ha, and the highest rate was seen for marginal coverage and highly damaged areas ($39.49/ha). The generated models could be applied to the regional level yield forecasting and damage assessment of paddy to introduce crop insurance in flash flood-affected wetland areas to improve livelihoods and minimize risks of damage.

Effect of Enamel Matrix Derivative on Avulsed Tooth Treatment

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Keywords: Ankylosis; Emdogain; Periodontal tissue; Transplantation; Avulsion

Session: Medical, Pharmaceuticals, and Public Health

Submission ID: 003 *Paper/Presentation*: 008

Abstract: After dental avulsion, re-implantation treatment can adequately function, but in most cases, ankylosis might be present. Milk is commonly recommended as a tooth storage media during dental avulsion. Nevertheless, our previous study showed that milk causes periodontal ligament (PDL) disturbance followed by ankylosis. The enamel matrix derivative Emdogain (EMD) has been found to improve periodontal regeneration after replantation. The purpose of the present study is to observe the effects of EMD on the degraded periodontal tissue after immersing the tooth in milk for one hour using the transplantation method. Five-week SD male rats' maxillary first molar teeth were extracted under general anesthesia. Extracted teeth were immersed in milk for one hour. Then teeth were transplanted in a receiving pocket within the abdominal wall (control group). In the experimental group, after an hour of immersion in milk, EMD was applied to the tooth's root surface and transplanted. Rats were fixed one and two weeks after transplantation, and the teeth were carefully excised with the surrounding tissue. The examinations were done histologically & immunohistochemically. After one week, more CD68 positive cells appeared in the control group than in the experimental group. In PDL, more PCNA-positive cells were observed in the experimental group than in the control group. After two weeks, alveolar bone formation was observed in the control and experimental groups. The experimental group had more bone formation than the control group. In the case of the control group, a rough surface was observed in the cementum area, and ankylosis was observed in some samples. On the other hand, in the experimental group, no ankylosis or rough surface in the cementum area was observed. Many cathepsin K-positive cells were observed in the control group around the alveolar bone and cementum area. More CD68 positive cells were detected in the control group than in the experimental group. EMD promotes periodontal ligament fibroblast proliferation and stimulates the release of autocrine growth factors from periodontal ligament undifferentiated mesenchymal cells. In the present study, regeneration of degraded periodontal tissues may relate to this key feature of EMD. This work was supported by a Grant-in-Aid for Early-Career Scientists from the Japanese Society for the Promotion of Science KAKENHI-PROJECT (grant number 20K18541).

Dentin-Bonding Efficacy of Two New Dental Bonding Agents

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Keywords: Adhesion; Bonding; Dentin; Microtensile Bone Strength

Session: Medical, Pharmaceuticals, and Public Health

Submission ID: 004 *Paper/Presentation*: 009

Abstract: Background: The use of adhesive biomaterials for restoring dental caries or decayed teeth is growing since the adhesive materials now manufactured are highly effective and more cosmetic, requiring just a bonding agent for strong tooth adhesion. A bonding agent's ability to interact with tooth/restoration should be quick and adequate. Its inability to do so frequently results in restoration failure. Despite recent advancements in bonding technology, the complex chemical formulations of the bonding agents are often mismatched to the dynamic structures of the tooth. *Purpose:* This study evaluated the dentin-bonding efficacy of three bonding products *in vitro* with micro tensile bond strength (μTBS) test. *Experiments:* 1mm2 resin-dentin sticks were prepared from 600-grit SiC-ground occlusal-dentin of human premolars (n = 3) by bonding in self-etch mode with three light-cured bonding agents [Scotchbond Universal Plus Adhesive (SP), 3M, USA; G-2 BOND Universal (GB), GC, Japan; Clearfil Megaband 2 (MB), Kuraray, Japan]. The bonded resin-dentin sticks were stressed under tension until fracture (500N; 1mm/min) for μTBS, followed by fracture-pattern analysis with a stereomicroscope (50×). Additional resin-dentin slices (n = 3) bonded similarly were observed under SEM for micromorphological characterization of the tooth-bond-restoration junction. Data were analyzed using the Kruskal-Wallis H test with Dunn-Bonferroni (α = 0.05). *Results:* The μTBS of SP (54.8 ± 7.4 MPa), GB (55.6 ± 5.4 MPa), and MB (60.7 ± 6.3 MPa) were statistically similar (p > 0.05), and all of them showed a predominance of non-adhesive fracture. As observed in SEM, all the adhesives showed an abundance of resin tags, especially SP. GB obtained the thickest adhesive layer (~28 μm), SP the thinnest (~6 μm), and MB was ~18 μm thick. *Conclusion:* The recently marketed SP and GB demonstrated satisfactory immediate bonding efficacy comparable to the established gold-standard self-etch adhesive MB. The long-term bonding performance of SP and GB remains to be evaluated to comprehend their effectiveness better.

Catalysis in Fine Chemical Synthesis: Industrial Prospects in Bangladesh

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Keywords: Catalysis; Fine Chemicals; Active Pharmaceutical Ingredients; Alternative Fuels

Session: Medical, Pharmaceuticals, and Public Health

Submission ID: 013 *Paper/Presentation*: 010

Abstract: Chemistry and its allied fields (e.g., catalysis) play a fundamental role in the efficient manufacturing of products we use nowadays, though the consumers can hardly apprehend its role. For example, the manufacturing of agrochemicals, flavors, fragrances, nutritional ingredients, dyestuffs, adhesives, pharmaceuticals, alternative fuels, and energy harvesting devices depends on catalytic processes ranging from several 100 kgs to several 100,000 tons per annum. Moreover, with increasing demands for more environmentally friendly processes in larger volumes at lower prices, catalysts and catalytic processes ideally facilitate this change, now and in the future. In addition, new catalytic methodologies developed in industry and academia are finding application on an industrial scale for synthesizing (poly) functional molecules, which will only increase in the future. This advantage makes the field of catalysis a challenging area. Bangladesh is a very prospective geographical place with enormous possibilities for chemical developments currently and in the future to meet up the considerable need for fast-growing modern infrastructures and the related consumption of civilized society. The primary field of chemical development is active pharmaceutical ingredients, agrochemicals, alternative fuels (bio-diesel), polymers, and many other daily-uses materials. Unfortunately, most raw materials, components, and intermediates are imported from available global markets to a large extent. It is high time to overcome these trends by seeding a new catalysis-chemical-industrial era. The paramount possibilities of fine chemicals in Bangladesh could start with the cooperation of local and foreign Bangladeshi scientists under an industry-academia collaborative and venture research work. In addition, the possible infrastructural and financial support from the government will also accelerate the envisioned development with proper materialization.

Future Aspects of Cancer Immunotherapy in Bangladesh

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Keywords: Cancer; Immunotherapy; Bangladesh

Session: Medical, Pharmaceuticals, and Public Health

Submission ID: 014 *Paper/Presentation*: 011

Abstract: Immunotherapy is now at the forefront of cancer treatment and has achieved unprecedented efficacy in some subsets of cancer patients. Cancer immunotherapy harnesses one's immune cells to attack the tumor cells, providing durable clinical responses in multiple difficult-to-treat tumor types, including advanced-stage tumors. The advent of numerous novel approaches to cancer immunotherapy, including immune checkpoint antibodies, adoptive transfer of CAR (chimeric antigen receptor) T cells and TCR (T cell receptor) T cells, NK (natural killer) cells, T cell engagers, oncolytic viruses, and vaccines, is revolutionizing the treatment for a variety of cancers. Some are already in the clinic, and many others are underway as clinical trials. In comparison to traditional anti-tumor therapy (chemotherapy, radiotherapy), immunotherapy does have incomparable advantages over it and can prolong progression-free survival (PFS) and overall survival (OS) even in advanced metastatic cancers. In some cases, a complete cure of cancer is even observed with immunotherapy, specifically chimeric antigen receptor (CAR-T) therapy. Unfortunately, this revolutionary cancer treatment option can only be found in the textbook and is obviously, not yet practiced/prescribed in Bangladesh, where at least 273 people die from cancer daily. Thus, with the limited availability of immune therapeutics, Bangladesh encounters health tourism mostly to India and Singapore. While the biggest proportion of cancer patients suffers and wait for death. Henceforth, I will discuss the future perspective of cancer immunotherapies in Bangladesh. What strategies will be impactful in introducing cancer immune-therapeutics (including cons and pros), and the approaches to overcome the limitations and clinical usefulness for evaluating cancer immunotherapies in Bangladesh.

A Simplified Analytical Model to Evaluate Hospital Preparedness for Earthquake Emergency Response

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Keywords: Earthquake Emergency Response; Analytical Model; Hospital Preparedness; Casualty Treatment

Session: Medical, Pharmaceutical, and Public Health

Submission ID: 017 *Paper/Presentation ID*: 012

Abstract: Casualty management is highly crucial after an earthquake for seismic risk-prone countries. To reduce the fatalities and maximize the number of saved lives after a mega-earthquake disaster, the presence of a comprehensive emergency response plan is essential for all sectors, especially in emergency health care services. Post-earthquake emergency health care services greatly depend on the level of hospital preparedness. This research proposes a simplified analytical model to evaluate hospitals' preparedness for earthquake emergency response. The proposed model considers not only the number, severity, and distribution of injuries in the affected region but also the seismic vulnerability, hospitals' existing resources, and the timeline. As a result, the model can predict different levels of preparedness for different numbers of casualties as well as estimate the number of saved lives. Emergency managers and policymakers can utilize the proposed model to determine the current status of hospital preparedness and, as a result, to take the required actions to bridge the gap between post-earthquake hospital demand and capacity.

Twenty-Five Years of Experience and Recent Activity in Photonics: A MEMS-Based Widely Tunable VCSEL for SS-OCT

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Keywords: Laser; Wavelength tunable; MEMS; VCSEL; OCT

Session: Natural sciences, Engineering, and ICT

Submission ID: 001 *Paper/Presentation ID*: 013

Abstract: Photonics began with the invention of the laser in 1960. However, the WTO negotiations on Basic Telecommunications Services, which were successfully concluded in Geneva on 15 February 1997, initiated a steady and rapid growth in the telecommunication and photonics industry. Furthermore, fortunately, I have had a diverse set of experiences in this industry since then. The rapid growth of the optical coherence tomography (OCT) imaging technique, particularly the swept-source (SS)-OCT, has had profound effects on ophthalmology and has potential for various industrial applications, including laser welding monitoring and LiDAR. These applications require a novel swept light source balanced in performance, reliability, and cost; preferred performances are long coherence length for better imaging depth, wide wavelength tunability for better resolution, and high power for easier system design and detection. Here, we report a MEMS (microelectromechanical systems) based tunable VCSEL SS-OCT application. An electrically pumped half-VCSEL with a semiconductor bottom DBR is used for its superior reliability and simple optical configuration as a light source. The developed tunable VCSEL is composed of an SOI-MEMS-based diaphragm mirror with a high reflective coating and is mounted by the thermo-compression bonding of gold onto a half-VCSEL chip with strained InGaAs multi-quantum wells gain medium. Wavelength tuning over 88 nm is achieved. This corresponds to an 8.3% tuning ratio, which is currently a record for electrically pumped tunable VCSELs. Furthermore, we integrated the tunable VCSEL chip with an SOA (Semiconductor Optical Amplifier) inside a hermetic package for higher power and reliability, which enables balanced performance for practical applications.

Potential of Desiccant-Assisted Hybrid Air-Conditioning for Cold Storage of Agro-Commodities in Bangladesh

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Keywords: Desiccant; Hybrid Airconditioning; Cold Storage; MFBDD; M.S. Gel

Session: Natural Sciences, Engineering, and ICT

Submission ID: 008 *Paper/Presentation ID*: 014

Abstract: Abstract: Despite dramatic progress in industrialization in Bangladesh, agriculture remains an irreplaceable element for the sustainable growth of the economy. However, due to the absence of appropriate and energy-efficient cooling technology, post-harvest losses are enormous, which tremendously affect the well-being of the farmers as well as attributes to a significant variation in seasonal prices of agro-commodities. Recently, with new classes of mesoporous and microporous materials with extraordinary water vapor adsorption capacity, desiccant-assisted hybrid air-conditioning system has emerged as sustainable and energy-efficient technology. If such systems can be employed for cold storage of post-harvest agro-commodities in Bangladesh, it can save a significant amount of primary energy from the grid and reduce the facility's usage cost. Herein, we demonstrate the concept of a novel multilayer fixed-bed binder-free desiccant dehumidifier (MFBDD) designed further to improve the operational efficiency of a hybrid air-conditioning system. A distinct microsphere silica gel (M.S. Gel) with uniform pore size distribution was used as the adsorbent in the proposed MFBDD device. Experimental results demonstrated that MFBDD could outperform the conventional desiccant systems in air humidity reduction.

The Quest for Sustainability in Energy and Electricity Sectors of Bangladesh

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Keywords: Energy; Electricity; Sustainable Development; Economy; Bangladesh

Session: Natural Sciences, Engineering, and ICT

Submission ID: 009 *Paper/Presentation ID*: 015

Abstract: Access to affordable and clean energy is one of the basic requirements for sustainable growth. Bangladesh, a developing country, currently faces rapid growth in the energy and electricity sectors. However, this growth might cause energy security issues as natural gas, the main source of primary energy and electricity, is depleting quickly and might be depleted by the next decade if no new gas fields are discovered. Local and imported coal could be an alternative to natural gas, which causes environmental pollution by emitting carbon dioxide and other greenhouse gases. Nuclear and renewable energy sources are also considered future solutions to the energy security problem, even though large penetration of such newer technologies often faces poor infrastructure issues in developing regions. This research aims to identify interlinks between Bangladesh's energy and economic sectors and provides a sustainable development plan for the electricity sector considering indigenous resources and the impact of large-scale import dependency. As the SDG7 focuses on access to energy at an affordable cost, generating electricity at a low cost should be one of the primary concerns for Bangladesh. The optimized generation expansion paths infer that nuclear power could be one of the saviors, as natural gas could no longer play a major role. Coal could be a viable option, but the global fight for climate change mitigation no longer supports dirty electricity production from coal. However, modern technologies such as carbon capture could still ensure maximized use of local resources while simultaneously keeping the climate change commitments. Developing grid-connected renewable energy could eliminate current high-cost oil-based peaking electricity generation schemes. By applying maximum efforts to ensure environmental safety and energy security through investment in new, cleaner technologies, Bangladesh could become one of the greatest examples of sustainable development.

Recent Development in Display Technology and Its Industrial Perspective in Bangladesh

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Keywords: Display; Flexible; TFT; LTPO; OLED

Session: Natural Sciences, Engineering, and ICT

Submission ID: 010 *Paper/Presentation ID*: 016

Abstract: Display technologies have attracted worldwide attention, and they have made a significant contribution to the economy. Most people use display devices in their daily lives, and approximately 80% of the information that people have obtained has been captured by visual and some electro-optical devices, such as phones, computers, televisions, and alike. Thus, the display industry is growing exponentially and has become a popular research topic. From CRT to AMOLED, display devices have been evolving rapidly. An active-matrix display consists of a front panel and a backplane. The backplane is incorporated a storage capacitor and thin-film transistors (TFTs) in each pixel. Based on the front panel structure and design of the backplane and corresponding TFT could be varied. This article mainly focuses on the various display technology and require backplane technology for those display. Future display devices like flexible, roll-able, wearable, AR, and VR will also be discussed. A recent breakthrough in backplane technology, namely LTPO (low-temperature polycrystalline oxide), is presented for future low power consumption displays. Due to the limited battery, reducing the display's power consumption is important. One approach to reducing power consumption is adapting pixel circuits for low refresh rate driving. On the other hand, there is also a tendency to require high refresh rate driving (generally up to 120 Hz). 1 To fulfill both requirements, a new type of backplane LTPO has been developed. Finally, the global display market potential and perspective in Bangladesh are discussed.

The Role of Semiconductor Chips in Modern Civilization and Opportunities for Bangladesh

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Keywords: Semiconductor Chip; COVID-19; Information and Communication Technology; Bangladesh

Session: Natural sciences, Engineering, and ICT

Submission ID: 012 *Paper/Presentation ID*: 017

Abstract: Semiconductor chips are the driving engine of modern civilization. The world today heavily depends on a few countries for chip supplies. However, with the outbreak of the COVID-19 pandemic and several wars, the world has seen a massive shortage of chips. As a result, countries with substantial economic growth need to ask themselves the following question. How long should we depend on countries like China for chip supplies? In this talk, I will go through the history of semiconductor chips and their role in modern society. Then, I will highlight some of my recent research works on ultra-low-power sensor devices. Finally, I will explore the opportunities for establishing semiconductor manufacturing plants in Bangladesh.

Shear Wave Velocity Estimation using Horizontal-to-Vertical Analysis in the Sylhet Basin in Bangladesh

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Keywords: Ambient Seismic Noise; Horizontal-to-Vertical Spectral Ratio; S-wave Velocity; Engineering Bedrock

Session: Natural Sciences, Engineering, and ICT

Submission ID: 018 *Paper/Presentation ID*: 018

Abstract: The densely populated Bangladesh occupies most of the part of the Bengal Basin; the basin is located just above the subduction margin extended with an N-S alignment between the Indian and the Burmese Plates. The subduction tectonics along this Indo-Burmese plate boundary has put this locality at high seismic risk, which is also supported by the historical earthquake records. Moreover, being in the foothill of the Himalayan Mountains and the Indo-Burmese Ranges, respectively, to the North and the East, this country has become extremely riverine to be filled with sediments. Soft sedimentary layers over geophysical bedrock, with shear-wave velocity, *VS* > 760 m/s, can significantly amplify earthquake ground motion to cause damage to infrastructure. In addition, bedrock depth significantly controls the phenomena of soil-infrastructure vibration resonance. That is why, for seismic risk evaluation, it is essential to have adequate information on soft sediment thickness or depth to the sediment-bedrock interface. The continuously subsiding Sylhet Basin (SB), a sub-basin within the northern limit of the Bengal Basin, is the flexural depocenter in northeastern Bangladesh with possibly the thickest (~25 km) sedimentary successions. The active Dauki Fault demarcates the northern limit of the Sylhet Basin and the Bengal basin, along which the Shillong Plateau has been uplifted. In this work, we present *VS* velocity up to 3000 m beneath three seismic stations in the Sylhet Basin, namely JAML, SUST, and JAFL, datasets available on the Incorporated Research Institutes for Seismology (IRIS) website. Here, the subsurface *VS* profile is estimated by inversion of the single-station horizontal-to-vertical (H/V) spectral ratio curve within 0.2 Hz to 10 Hz. The H/V curves at three stations are obtained from 15 days of continuous seismic ambient noise data recordings. We use HV-Inv software (García-Jerez et al. A computer code for forwarding calculation and inversion of the H/V spectral ratio under the diffuse field assumption. Computers & Geosciences, 2016. 97, 67-78.) for the inversion, in which the H/V ratio is interpreted under the diffuse filed assumption for full H/V inversion considering

contribution from the full noise wavefield. The inversion process is constrained using the existing general lithological information and unpublishable *VP* data from active seismic surveys of Bangladesh Petroleum Exploration Company Ltd. (BAPEX). From this analysis, we find that geophysical bedrock depth is approximately 153 m, 73 m, and 13 m, respectively, below the stations JAML, SUST, and JAFL. To the best of our knowledge, neither the current approach of *VS* estimation was applied, nor such high-resolution *VS* information of sedimentary successions was reported in the study area previously. Therefore, the presented velocity information could be crucial for engineering development, seismic hazard mitigation, and exploration purposes in the Sylhet Basin.

Extended Abstract: 001

Investigating the Effect of Climate Change on Food Loss and Food Security in Bangladesh

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ABSTRACT: Climate change and climatic extremes cause massive food loss, adversely impacting food availability, import, and other economic factors. Bangladesh has been combating climate variability and extreme climatic events to abate agricultural production loss for a long time. In this paper, we investigated the relationship between food grain loss and food security during extreme climatic events in Bangladesh, based on data from 1984 to 2017. We employed the vector auto-regression (VAR) model and derivative analyses and suggested policy implications related to the existing national agricultural policy. Five time-series variables were judiciously considered: food availability, food loss, food import, gross domestic product (GDP) growth rate, and inflation rate. The results show that the variable, food grain loss, has a reverse association with food security—it escalates import from the world food market, causing import dependence. Moreover, food loss significantly instigates inflation. However, the GDP growth rate was found to be a weak provocateur. Overall, climate change and climatic extremes jeopardize the country's food security and hinder its pursuit of sustainable development goals, especially stand-alone goals 1 and 2. Therefore, it is concluded that changes in climate and their correlations are detrimental to Bangladesh's food security and economy.

Keywords: Climate change; Food security; Extreme climatic events; and Vector auto-regression

1. Introduction

As the planet becomes warmer (Acevedo, 2014) and climate change-related natural disasters are expected to rise to pose a significant challenge for poverty eradication and food security (Alamgir et al., 2018) because repeated catastrophic events lead to significant income losses over time. In addition, climate change adversely affects food production and delivery systems (Godfray et al., 2010). The potential impacts of climate change and extreme climatic events vary in scale. For instance, paddy loss due to floods in Bangladesh and India is estimated at 4 MMt/year, which can feed 30 million people. Another important point in the context of climate change is that over 80% of the annual precipitation

received by Bangladesh is discharged during the monsoon season from June to September. The above-stated hydro-meteorological factors make the country vulnerable to extreme climatic events, such as floods, cyclones, and droughts. The latest entry in this list is the Super Cyclonic Storm Amphan, which made landfall on May 20, 2020, and left in its wake losses worth BDT11 billion (equivalent to US$129 million), including damage to 149,000 hectares of agricultural lands and destruction of fish farms worth BDT3.25 billion (equivalent to US$ 36 million).

Climate change, extreme climatic events, and their correlations have left the country vulnerable regarding food security. From early on, Bangladesh's policy planners have wisely equated "food security" with domestic "food self-sufficiency"—this is now jeopardized by frequent floods, flash floods, cyclones, tidal surges, salinity, and droughts throughout the country. Therefore, Bangladesh's national agricultural policy, which duly considers the pernicious effects of nature's whims, emphasizes domestic production improvement via research, agricultural mechanization, agricultural education, environmental protection, and coordination among the government and national and international organizations.

2. Materials and method

2.1 Vector auto-regression model

Sims (1980), introduced vector auto-regression (VAR) as a tool to simplify the joint dynamic movement of a collection of variables. In our study also, we have taken the VAR model considering the following specification of order p, as shown in equation 1.

$$Y_t = C + \sum_{i=1}^{p} \varphi_i y_{t-i} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, $Y_t = (y_{1t}, y_{2t}, \ldots y_{nt})$ is an n × 1 vector of endogenous variables, while y_{t-i} is the corresponding lag order i. φ_i is the n × n matrix of autoregressive coefficients of vector $y_{t-i,}$ for i = 1, 2, …, $C = (c_1, c_2, \ldots c_n)$, and is the n × 1 intercept vector of the VAR model. $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots \varepsilon_{nt})$ is the n x 1 vector of the White Noise process.

Climate change will negatively and detrimentally influence all four dimensions of food security: food availability, food accessibility, food utilization, and food stability systems. In order to address the issue, first, the order of the VAR model is estimated based on some information criteria, and the concrete form of the VAR model is determined with lag order 1. More generally, the specification of the most parsimonious VAR model is as follows:

$$\begin{pmatrix} FS_t \\ I_t \\ L_t \\ GDP_t \\ CPI_t \end{pmatrix} = \phi_0 + \phi_1 \begin{pmatrix} FS_{t-1} \\ I_{t-1} \\ L_{t-1} \\ GDP_{t-1} \\ CPI_{t-1} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \end{pmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

2.2 Data

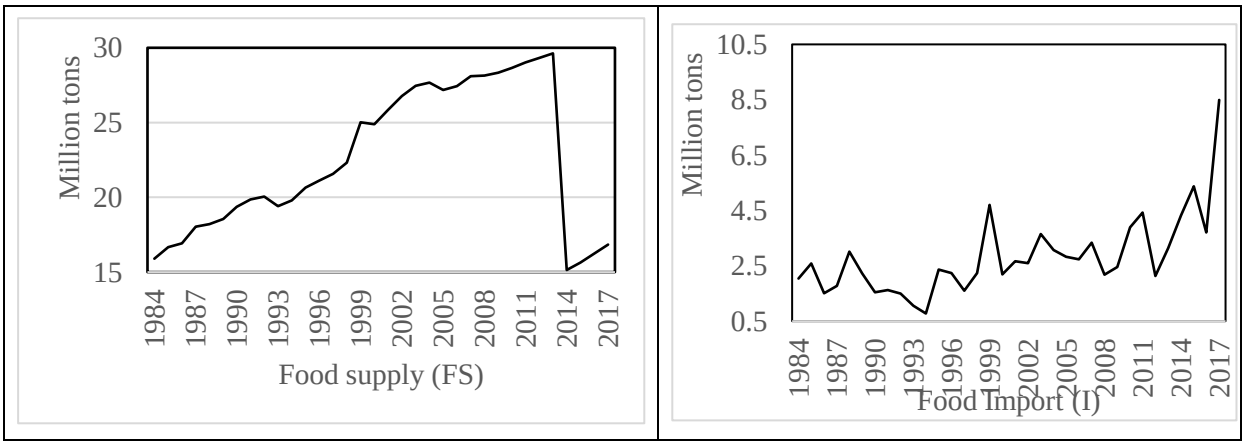
The following five endogenous variables are formed in this unrestricted VAR system.

Table 1 Variable definition, symbol, and data sources

Sl. No.	Variables	Definitions	Data sources
1.	Food supply for	Food supply for consumption predominantly depends	Food and

Sl. No.	Variables	Definitions	Data sources
	consumption (FS) from domestic sources	on domestic food production and import. Here, rice (milled equivalent-tons), wheat, and wheat products are considered the main food grain supply for consumption from domestic sources.	Agriculture Organization web site. (FAOSTAT)
2.	Import of food grain (I)	Bangladesh imports food grain from the world food market to meet the domestic demand deficit. In this case, rice and wheat import data are taken, and the unit is as ton (t).	
3.	Loss of food grains (L)	In Bangladesh, food loss is more acute at the production stage than at the consumption stage (Joardder and Masud, 2019). Food grain wastage at the time of harvesting (33%), post-harvesting (32%), storing and processing (10%), transportation (9%), and consumption waste (16%) (Ananno, et al., 2021). The unit of measurement was a ton (t).	
4.	Gross domestic product (GDP)	The growth rate of gross domestic product is termed **GDP**. We have taken the annual percentage (%).	Bangladesh Bureau of statistics (BBS)
5.	Inflation rate (CPI)	The consumer price index (**CPI**) is the proxy of inflation in the respective country's economy. The annual percentage is considered for estimation.	

The data employed in the estimation ranges from 1984 to 2017, and they are time-series data of 34 years. All variables were log-transformed.



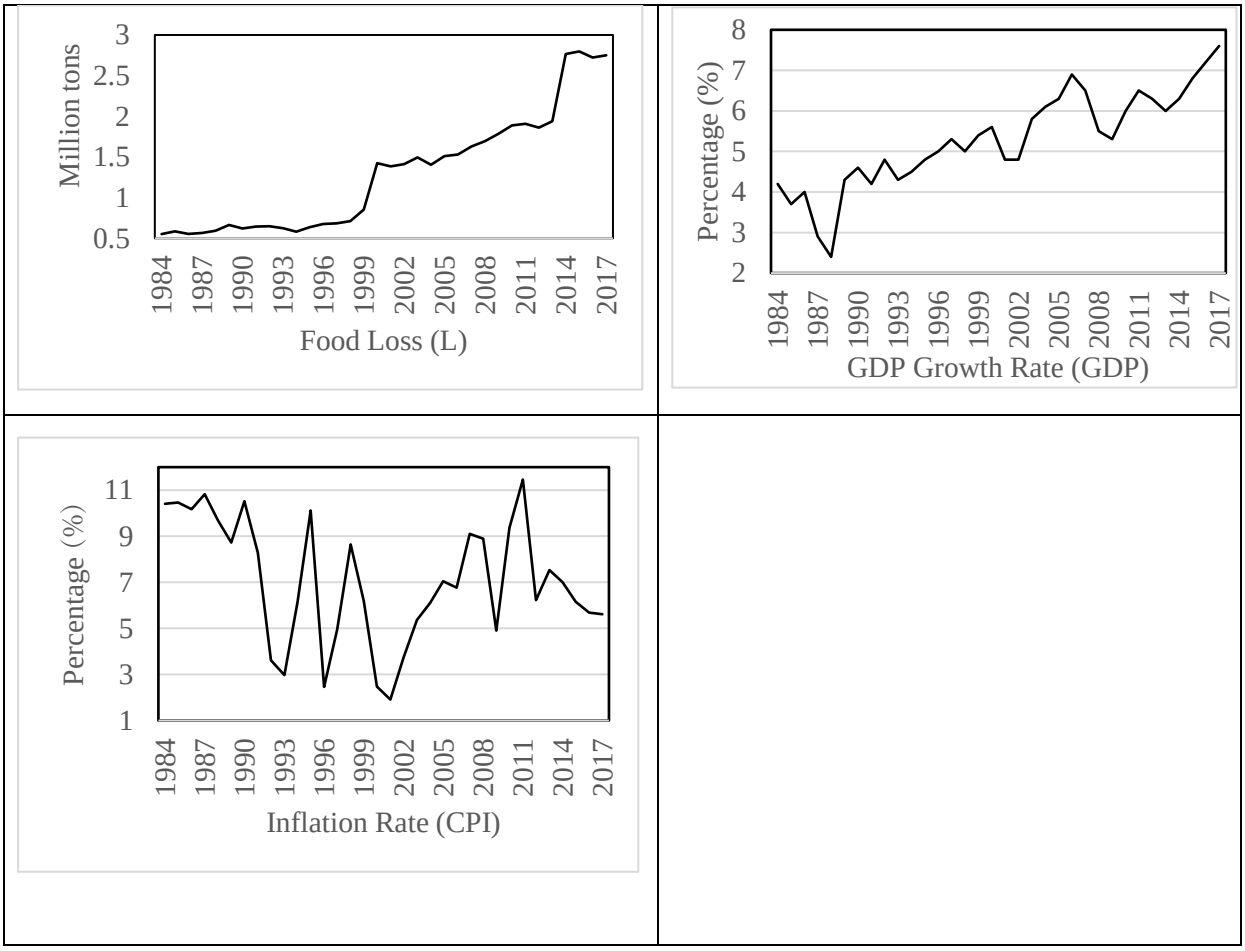


Figure 1. The trend of endogenous variables

3. Empirical results

3.1 Vector auto-regression

We can draw a meaningful message from Table 2 that the predictor variable loss of food grain significantly influenced food grain import under a confidence level of 1%. Furthermore, although food grain loss is insignificant, it has a negative relationship with food grain availability for consumption, which is extremely practical and matches the real-world situation. Our second focus is on the movement of GDP growth rate and inflation rate—we have received highly admissible clarification. At this stage of food grain loss, we can say that it is not a significant player in shaking the country's GDP growth rate. However, food grain loss contributes to swelling the inflation rate at the 10% significance level. Similarly, food grain import has a negative association with the rate of inflation at a 5% level of significance, which complies with our realistic views and insights. It is noted that most food grain imports are done by the government to pave the way for a smooth food supply and to control inflation. This is because the government does not have a profit motive.

Table 2 Vector auto-regression

Dep. Var.	Constant	LnI (-1)	LnL (-1)	LnGDP (-1)	LnCPI (-1)	LnFS (-1)
LnI	8.59*	0.04	0.71***	-0.25	0.16	-0.25
	(0.09)	(0.83)	(0.00)	(0.51)	(0.19)	(0.38)
LnL	-3.30**	0.11**	0.88***	0.04	0.01	-3.30**

	(0.03)	(0.05)	(0.00)	(0.70)	(0.63)	(0.03)
LnGDP	-3.21*	0.12*	0.08	0.54***	-0.04	0.05
	(0.09)	(0.08)	(0.26)	(0.00)	(0.34)	(0.61)
LnCPI	3.21	-0.45**	0.42*	-0.51	0.54***	-0.04
	(0.59)	(0.04)	(0.08)	(0.26)	(0.00)	(0.89)
LnFS	3.26*	0.01	-0.06	0.08	-0.02	0.83***
	(0.07)	(0.8)	(0.40)	(0.54)	(0.54)	(0.00)

Note: ***p<0.01, **p<0.05, and *p<0.1 percent significant level. Values in parentheses indicate the probability.

3.2 Granger causality test

Here, we arbitrarily segregate the whole sample into two sub-samples to determine the more recent climate change effect and explore the estimation results of all three sample periods: 1985–2017, 1985–2000, and 2001–2017. The Granger causality test results for all periods are systematically depicted in Table 3, from which it is observed that during 1985–2017, there was a two-way Granger causality relationship between food grain loss and food grain imports. Under a 1% significance level of confidence, food grain loss Granger causes food grain import, indicating that large-scale damage to food grain production and harvest by extreme natural events in Bangladesh leads to relying on food import and food aid. During 1985–2000 and 2001–2017, we found the same results under a 5% significance level of confidence. This is a threat to the country's national food security and economy.

Table 3 Granger causality Wald tests results

Variables	Null hypothesis (H_0)	df	1985-2017	1985-2000	2001-2017
			χ^2-statistic	χ^2-statistic	χ^2-statistic
InI	LnI does not Granger cause LnL	1	3.78**	1.48	0.54
			(0.05)	(0.22)	(0.46)
	LnL does not Granger cause LnI	1	11.62***	4.46**	4.33**
			(0.00)	(0.03)	(0.03)
LnL	LnL does not Granger cause LnFS	1	0.70	0.07	3.61**
			(0.40)	(0.77)	(0.05)
	LnFS does not Granger cause LnL	1	3.81**	3.29*	2.19
			(0.05)	(0.07)	(0.13)
LnGDP	LnGDP does not Granger cause LnI	1	0.43	0.64	0.19
			(0.51)	(0.42)	(0.66)
	LnI does not Granger cause LnGDP	1	2.96*	0.04	0.30
			(0.08)	(0.84)	(0.58)
LnCPI	LnCPI does not Granger cause LnL	1	0.22	2.55	0.21
			(0.64)	(0.11)	(0.64)

LnL does not Granger cause LnCPI	1	3.03*	1.01	0.51
		(0.08)	(0.31)	(0.47)
LnCPI does not Granger cause LnI	1	1.69	8.05***	1.28
		(0.19)	(0.00)	(0.25)
LnI does not Granger cause LnCPI	1	3.96**	2.43	0.02
		(0.04)	(0.11)	(0.87)

Note: ***p<0.01, **p<0.05, and *p<0.1 percent significance levels, respectively.

3.3 Impulse-response functions analysis

We use the IRFs to determine the dynamic trajectory of food grain loss in the VAR system. The results of the co-integration test (Granger causality test) and the results of the impulse response functions are homogenous. As shown in Figure 2, when considering one standard deviation positive shock of food grain loss on food availability for consumption, in the current phase, it contributes to a gradual negative inclination of food grain availability and then decreases, reaching a minimum in the third period. From the fourth period onward, it moved steadily until the tenth period. This means that certain shocks of food grain loss generate shocks to food grain availability for consumption.

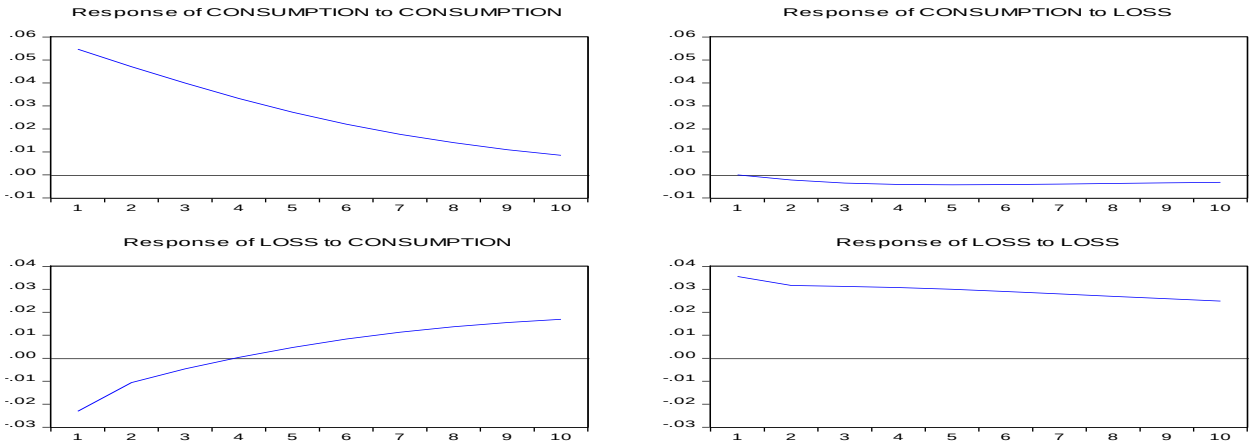


Figure 2. The graph of IRFs of food grain availability (LnFS) and food grain loss (LnL)

4. Conclusion

First, crop loss aggravates the country's long-term dependence on the global food market. We found that food grain loss negatively affects food grain availability for consumption. Additionally, the inflation rate increases significantly at a 10% confidence level. Second, food grain loss Granger causes food grain imports at a 1% significance level. The series of food grain loss and food grain availability for consumption have a one-way causality. Third, food grain availability and loss always have a negative relationship. The impact of the impulse response of food grain availability on food grain loss is steadily negative. Humanity's potential last-ditch effort to stave off these horrendous impacts is developing environmentally friendly and climate-benign sustainable technologies for green agriculture and economy.

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Thank You