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Training on River and Delta Morphology

## Upcoming

- ESIA on Construction of LGED Roads and Bridges in Haor Areas
- Web Application on Water Resources Mapping
- Integrated River Management through Capital Dredging
- Re-excavation, Renovation and Development of Khals for Mitigating Water Logging Problems in Chittagong City
- River Port and Jetty Development in Different Locations for BIWTA

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the CEGIS NEWSLETTER

Quarterly Newsletter of the Center for Environmental and Geographic Information Services (CEGIS)

# Visit of Executive Director, CEGIS to Belgium and the Netherlands as High Level Bangladesh Delegation Member

*1. (Top) Engr. Md. Waji Ullah, Executive Director of CEGIS with the high level members of Bangladesh Government Delegation at Belgium, 2. (Bottom middle) Engr. Ullah is seen with the audience in a technical session at Belgium and 3. (Bottom left and right) The Executive Director of CEGIS observing dredging simulation*

Pursuant to the decision of the office of the Prime Minister, an investment and business delegation, comprising of senior level government officials and prominent private sector businessmen visited Belgium and the Netherlands from 18th to 25th April, 2018 to attend different investment seminars and network development process and business meetings. The Bangladesh Investment Development Authority (BIDA) and the Dutch-Bangla Chamber of Commerce and Industries jointly organized the program titled "BIDA-DBCCI Investment and Trade Delegation 2018" for creating investment and development of trade and commerce in Bangladesh with the EU countries. The program was assisted by the Embassy of Bangladesh in Brussels and the Embassy of Bangladesh in the Hague respectively. Engr. Md. Waji Ullah, Executive Director, CEGIS participated as a high level member of the Bangladesh Government Delegation. The delegation was led by Mr. Kazi M. Aminul Islam, Executive Chairman, BIDA. Among others the Bangladesh Government Delegation member included Mr. Md. Abdus Samad, Secretary, Ministry of Shipping, Mr. Kabir Bin Anwar, Secretary in Charge, Ministry of Water Resources, Ms. Hosne Ara Begum, ndc, Managing Director (Secretary), Bangladesh Hi-Tech Park Authority and the Ambassadors of Bangladesh in Belgium and the Netherlands.

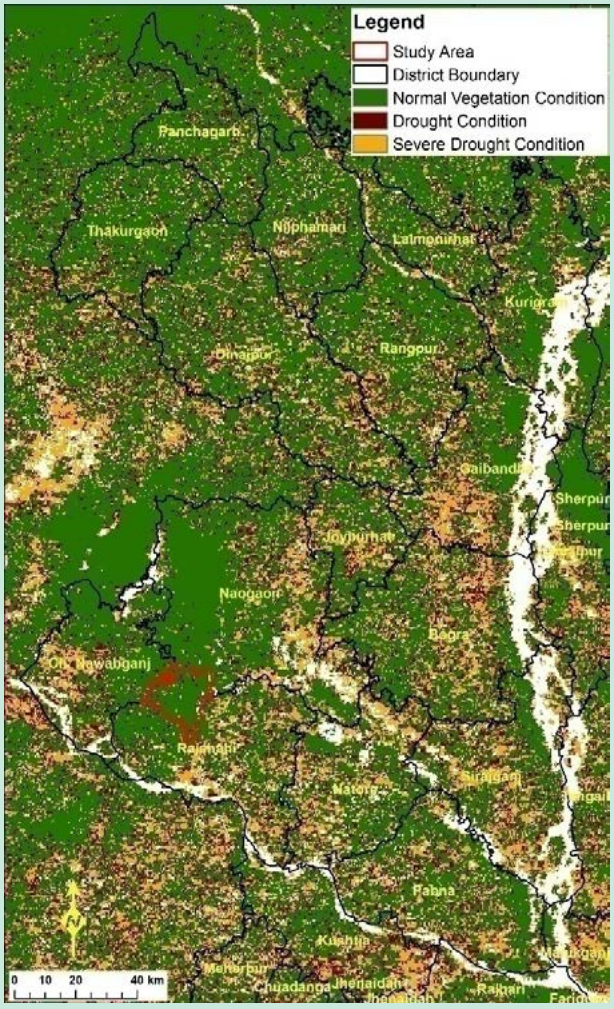
The visit was aimed to explore business opportunities for the international business communities in Bangladesh and to establish network building among the EU Countries. The areas identified for developing network were a) Agro-Processing; b) Water Resources Management and Appropriate Technologies; c) ICT and d) Research and Development (R&D). Two international seminars took place in both the countries. Executive Director, CEGIS attended both the seminars and participated actively in the discussions and interacted with the business communities, scientists and technical experts for boosting bi-lateral trade and explore business

(Cont'd on page 3 ...)

# Development of Crop Specific Drought Severity Index for N-W Region of Bangladesh

*Motaleb Hossain Sarker, Ecology, Forestry and Biodiversity Division*

Climate change induced natural disasters especially the drought risk has gradually been increased and impacting the crop agriculture of the country. The study upazila is also highly drought vulnerable due to changing climatic and hydrological conditions. The drought conditions i.e. water stress and water shortage conditions in the dry period is also adversely affecting the social and economic development of Bangladesh. However, the water stress condition in the soil impacted on the crop quickly and resulted in yield reduction. Water stress condition denoted as the drought which impacted environment, agriculture as well as livelihood in the study area. So far, Bangladesh faced 3 categories of droughts, they are (i) Meteorological Drought, (ii) Hydrological Drought, and (iii) Agricultural Drought. The Drought Severity Index study was concerned with Agricultural Drought Severity Index for a specific upazila and specific crop season. Thus the study was conducted at Tanore Upazila under Rajshahi District of Bangladesh. CEGIS has carried out the study with the funding from Bangladesh Water Partnership (BWP).




*Drought Severity Map for the period 14-22 September 2017*

The main objective of the study was to assess the crop specific drought stress and development of Drought Severity Index (DSI) by using SADMS (South Asian Drought Monitoring System) Model and Satellite Images for North-West Region of Bangladesh. The specific objectives were: (i) identify the crop specific drought stress, (ii) find out the Vegetation Condition Index (VCI) and Temperature Condition Index (TCI) by using RS and GIS, (iii) Identification of Drought Severity Index (DSI) and (iv) validate the DSI based on ground truthing and field survey.

Satellite based drought indicators calculation widely used to study the droughts characteristics using surface parameters. Normalized Difference Vegetation Index (NDVI), Vegetation Condition Index (VCI), and Temperature

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# Impact Assessment of Structural Interventions in Haor Ecosystem

*Ahmmed Zulfiqar Rahaman, Climate Change and Disaster Management Division*

Haor area of Bangladesh is of great importance due to its unique and rich ecosystem that provides ecological safety net and livelihood opportunities for about 20 million people actively supporting the sustainable economic condition of the country. A study has been recently completed by CEGIS on this area for Department of Bangladesh Haor and Wetlands Development, Ministry of Water Resources, Government of the People's Republic of Bangladesh to assess the impact of structural interventions so far undertaken and introduce some eco-friendly innovative solutions.

Glimpse of impact evaluation for BWDB schemes on the selected indicators are as follows:

***Water Resources and Navigation***

Risk of entrance of early flash floods reduced significantly due to implementation of BWDB projects by delaying entrance of water from mid-April to 15 May through constructing submergible embankments and compartmental dykes with 10 year return period design crest level. Flood once in 5 year return period is normal in haor area and flood up to 10 year return period must be allowed in consideration with sustainable ecosystem of the haor area. Drainage situation has deteriorated in most of the visited schemes due to high sedimentation. Boats ply over the years smoothly other than pre-monsoon season.

***Land and Agriculture Resources***

Implementation of BWDB schemes has created enabling environment for agriculture expansion. It is found that, in 2015-16, around 52% of the haor area was predominantly covered by Boro Crops which is almost 100% higher than that of in early 70s. The cropping intensity in the study area has increased by about 24% from that of the pre-project situation due to crop diversification in the area. Currently (2015-16), Boro production has been increased to around 370% than early 70s due to implementation of interventions and agriculture extension services. Crop damage area is increasing day by day due to reduction of height of submersible embankment, malfunctioning of the sluice gates, regulators, pipe sluices and reduced water carrying capacity as well as retention capacity of surrounding rivers, khals and beels. After implementation

**(Cont'd on page 3 ...)**

Impact Assessment of Structural ... (Cont'd from page 2)

of the project, the demands of irrigation water have been increased but availability of surface water has been reduced due to siltation in surrounding rivers, khals and beels. Scarcity of irrigation water has normally been observed from early February to end of March in most of the years. Use of agro-chemical use has been increased due to agriculture expansion and practice of more HYV varieties.

***Fisheries Resources***

Fish habitat area has been decreased by only 2%, but fish production has been increased around 9 times due to enabling environment created by BWDB and autonomous development by fisheries extension agencies. The production in Floodplain and Beels has drastically increased due to floodplain stocking with carp fingerlings, Beel Nursery Program, and strengthening of conservation measures. The production trend of other habitats of the capture fishery was found to remain more or less steady. Fish habitat quality and water quality has been found to be degrading due to incremental use of agro chemicals, pesticides, fertilizer and pollutant from different sources. Few imbalance has been observed in fish species distribution over the area in all the haors. Lateral fish migration is highly obstructed in case of Kairdala Ratna Haor, Kalner Haor and Surma River System.

Fishing cat has decreased/disappeared due to loss of habitat area. Habitat condition and diversity of aquatic flora has been decreased. The submerged vegetation has also been reduced due to agriculture practice, leasing of beel for fisheries purposes.Wetland dependent mammal species (Eurasian Otter-Lutralutra, Fishing Cat-Prionailurusviverrinus), turtle population (Spotted flap-shelled turtle- Lissemyspunctata. water dependent frogs etc. have been reduced due to loss of connectivity between haor and river in some areas. Diversity and population of migratory waterfowl have decreased due to habitat exploitation, hunting and toxic trapping. Reeds and Swamp Forests in most of the haor areas have been squeezed due to conversion into crop field, human settlement and cattle grazing etc. However, secondary plantation and other conservation efforts have been taken by different GO, NGO programs in few areas which has boosted upprovisioning services i.e. food, fuel wood, medicinal plants, genetic resources of flora and fauna.

***Socio-economic Resources***

Agricultural production based income has risen to around BDT 32 billion due to the increased crop production. Agricultural labor employment opportunity has been increased by about 11% while agricultural wage based income has been increased by 37%. Safety and security

***Ecological Resources***

None of the interventions are directly responsible for the changes of status of the ecological indicators. A large percentage of perennial waterbodies has decreased due to agriculture expansion. Therefore, natural vegetation coverage has reduced due to crop cultivation and human habitation, increase of fuel demand. Karach, Pitali, Barun, Hijaletc have reduced in the surrounding sites of homestead and kanda areas. Terrestrial faunal like small Indian Civet,

of settlement area has improved due to protection from flash flood. Seasonal labor migration has increased while permanent migration has decreased. The communication system has improved due to the interventions like roads and submergible embankments. Increased affordability and accessibility has improved the quality and standard of life (i.e Health, Education and Sanitation etc). However, lack of participatory governance and monitoring system is creating obstacles in solving the emerging problems on the livelihood issues in the haor regions.

Visit of Executive Director, CEGIS ... (Cont'd from page 1)

in the EU countries. Mr. Kabir Bin Anwar, Secretary in Charge, Ministry of Water Resources presented a paper on Potential Scope of Land Reclamation from River and Estuary in Bangladesh for Water Resource Management point of view, highlighting the existing land reclamation through water management and innovation.

The Bangladesh delegation also attempted to explore the interesting agencies and sectors of EU countries so that they can invest in Bangladesh as a compatible and investment friendly environment which is now prevailing in Bangladesh under the present Government. Such investments from EU countries might further contribute to the developmental activities and thereby boost up national economy of Bangladesh which it is trying to become as a Middle income country by 2021.

Apart from that, Government delegation members also visited the Rotterdam Port, the largest Port in Europe as well as the Antwerp Port of Belgium to observe the existing port facilities, the maintenance of navigability of the river through dredging determined by dredging simulation.

Engr. Md. Waji Ullah, Executive Director CEGIS and Member (Engineer), Joint Rivers Commission, Bangladesh also paid a courtesy visit to the Deltares, the Netherlands and discussed with their top management about the possibility of signing a new MoU between CEGIS and Deltares, the Netherlands for future research collaboration between these two organizations.

# International Exposure Visit of LGED and CEGIS officials on Sustainable Management of Wetland Ecosystem and its Biodiversity in the Republic of Korea

CEGIS has conducted a study for Local Government Engineering Department (LGED) titled "Social and Environmental Impact Assessment (ESIA) on Construction of Prime Minister's Committed Roads and Bridges in Haor Area of Sunamgonj and B-Baria District". As a part of the study, CEGIS organized a week long exposure visit for LGED and CEGIS officials during 2 - 9 June, 2018. The visit was aimed to enhance participant's knowledge and experience on ecological tools and application of hydrological analysis in engineering intervention, especially for road and bridge construction activities. Asia Water Council (AWC) Korea hosted the training program. Engr. Md. Waji Ullah, Executive Director of CEGIS joined the team at the later stage for awarding certificates and to develop Research and Business Partnership Collaboration with Korean Water and Environmental Organizations.


*Top (left): Engr. Md. Waji Ullah, Executive Director of CEGIS handing over CEGIS Brochure to Mr. Jinuk Lee, Program Director, Asia Water Council*
*Top (right): Certificate distribution at Asia Water Council*
*Bottom: Executive Director of CEGIS with AWC, LGED and CEGIS team*

The exposure visit was designed comprehensively in combination of classroom lectures, field visits and consultation meeting with relevant environmental and water organizations, so that the objective of the training is achieved. In order to orient the participants with Korean good practices in Ecosystem based planning and design of road infrastructures in wetland areas - AWC also organized field visits and meetings with number of relevant organizations including (i) Suncheon Bay International Wetland Center, (ii) Ramsar Regional Center, East Asia, (iii) School of Civil, Environmental and Architectural Engineering, Korea University, (iv) K–Water Institute, Government of Korea, (v) Asia Water Council (AWC), and (vi) UNESCO, Korea.

CEGIS took advantage of its top management present in Korea and a process has been initiated for signing a Memorandum of Understanding (MoU) with K-Water, Korea and membership with the Asia Water Council (AWC), Secretariat which is in proces.

# Training on River and Delta Morphology: Evolution, Dynamics and Prediction at CEGIS

For the last two decades CEGIS has developed tools and techniques mainly using spatial data which include historical maps, time series satellite images, to conduct study on fluvial, tidal and coastal morphology, especially applicable for very dynamic system. In order to disseminate this new knowledge and experience, CEGIS organized a three day long training program on "River and Delta Morphology: Evolution, Dynamics and Prediction". Relevant officials, professionals and academicians from government, non-government and other relevant organizations such as BIWTA, BWDB, RHD and IWM attended the training program. The training was held from 16 to 18 April, 2018 at CEGIS premises. The focus of the training was to enhance knowledge and capacity of the government/non-government officials, professionals and academicians. The training was inaugurated by the Executive Director of CEGIS Engr. Md Waji Ullah. Ambassador Mr. Tariq A Karim, Former High Commissioner of Bangladesh to India

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# New Faces

**Mr. A .L.M. Abdur Rahman ndc,** former Secretary to the Government, Joined CEGIS in June 24, 2018, as Senior Advisor, in Human Resources and Business Development Division. He is well experienced in Human Resources Management, Public Policy, and National Security issues, Total Quality Management, Governance and Business Negotiation. He has published 10 articles in high valued national journals. He did Masters in Economics from Chittagong University, NDC from National Defense College and M.Phil from Bangladesh University of Professionals (BUP). He studied at the University of Manchester, UK, Civil Service College in UK, Asian Institute of Technology (AIT), Bangkok, Civil Service College, Singapore and Open University, Malaysia.

**Khondaker Shamim Ara** joined CEGIS in May 2018 as Associate Consultant in Business Development Division. She has completed her Masters in Islamic Studies from National University and Post-Graduate Diploma in Personnel Management from Bangladesh Institute of Management. She facilitated the day to day performance of the Country Representative of IUCN Bangladesh and arranged many national and international dialogues, meetings and trainings as per the need of the organization. She used to coordinate and evaluate members' status and facilitate their roles and activities on Membership in Bangladesh as part of organizational development activities. She has received a training on IUCN Membership in 2009 from IUCN HQ, Gland, Switzerland.

# IEE, EIA and SIA Study for Gazipur 100 MW Heavy Fuel Oil Fired Power Plant

*Deeba Farzana Moumita and Md. Azizul Haque, Power Energy and Mineral Resources Division*

The Government of Bangladesh has committed to provide electricity to all by 2021. Accordingly, the Government has prioritized power sector and has formulated Power System Master Plan (PSMP, 2010 and PSMP, 2016). In line with PSMP and based on the Government directives for installing 100 (±10%) MW Power Plants, Rural Power Company Limited (RPCL) has planned to do so at Kodda, Gazipur which is accessible through road and waterways. The proposed plant site is located within the boundary of acquired land of RPCL, on the left bank of the Turag River and adjacent to the existing 52 MW Power Plant of RPCL and 150 MW HFO based Power Plant of Bangladesh Power Development Board (BPDB) and RPCL.

The Plant will have 6 four stroke diesel cycle engine as prime mover coupled with generator of 18.415 MW rating with stack height of 60 meter. Light Fuel Oil (LFO) and Heavy Fuel Oil (HFO) will be used as fuel for this Power Plant. In addition, the Plant will be designed ensuring minimum pollution to the environment maintaining all standards to meet the Best Available Control Technology (BACT) for limiting emissions. In accordance with the ECR, 1997, the proposed Power Plant Project as a Red Category Project, will require Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from DoE. Moreover, the Plant site is not ecologically sensitive due to its location.


*Location of project area in the Google Map*

Considering availability, transportation of the fuel and cost effectiveness, Heavy Fuel Oil (HFO) has been selected as the best suitable option. Engine based radiator type cooling machine would be used for this Project. Presently, fuel would be transported through the Turag River during monsoon only and could be transported in dry season in future too when the dredging of the Turag River is completed.

Environmental and social baseline conditions have been analyzed by collecting and analyzing primary data and secondary data.The local people showed positive attitude towards the project. According to the baseline survey, activities related to the Power Plant might deteriorate the adjacent fish habitat quality slightly during operation phase. To analyze social status, BBS 2011 database were used as secondary data. Important Environmental and Social Components (IESC) for physical environment, biological environment and socio-economic environment have been identified to assess the impacts along with the respective mitigation measures and probable EMP against the impacts for the study area. Moreover, valuable suggestions has also been taken from the stakeholders as well as from the local people during discussions at the time of field visits. Potential hazards associated in various stages of this Power Plant Project have also been assessed to avoid the impacts by incorporating safety plans in both planning and design process.

During pre-construction phase, stakeholder engagement plan will be implemented. During construction phase and operation phase suggested management plan, and ecosystem protection plan will be implemented. Emergency Response Plan has been developed to deal with major and minor accidental events effectively and efficiently.

The study, reveals that most of the adverse environmental impacts are localized and short term, although some are permanent and irreversible but can be mitigated with appropriate mitigation measures and regular monitoring of EMP implementation. Thus, the proposed Power Plant could be constructed following the environmental management plan on the basis of identified impacts of environmental and social components. The proposed Project will provide positive socio-economic benefits and will create potentiality of economic and social development of the region.

**Training on River and Delta ... (Cont'd from page 4)**

graced the inaugural session and delivered a speech on the importance of regional cooperation and river basin management. Topics covered in the training included the Geo-Morphological Evolution of the Rivers and Delta, Sediment Transport, Delta Dynamics, Application of Tidal River Management (TRM) process in Water Resources Management, stabilizing major rivers as Jamuna River etc. Dr Maminul Haque Sarker, Deputy Executive Director and Morphological Expert of CEGIS, highlighted the importance of understanding the river behavior and related issues for proper management of rivers and delta areas. Lectures were also delivered by Prof Md. Munsur Rahman of Institute of Water and Flood Management, BUET, Prof. Md. Abdul Matin, BUET and Mr. Knut Oberhagemann of NHC etc. The concluding session was attended by Engr. Mahfuzur Rahman, Director General of Bangladesh Water Development Board. The training concluded with distribution of certificates among the participants.

## Aerial View of downstream part of Chaktai Khal and Rajakhali Khal and its confluence point at Karnaphuli River


WorldView 4 (0.3 meter) satellite images for re-excavation, renovation and development of khals for mitigating Water Logging Problems in Chattogram Development Area (CDA). This high resolution satellite images will help to delineate the detailed drainage network that aid to prepare a drainage layout plan for mitigating drainage congestion in CDA.

## Contract Signing for Different Studies

*Contract signing for Re-excavation, Renovation and Development of Khals for Mitigating Water Logging Problems in Chittagong City between Lt. Col. Rezaul Karim, PD, 34 Engineer Construction Brigade and Engr. Md. Waji Ullah, Executive Director of CEGIS*

CEGIS provides intellectual services, action based research and innovative solutions in the fields of Water Resources, River Morphology and Delta, Environment, Ecology, Agriculture, Fisheries, Forestry, Social and Institutional setting, Architectural Planning and Design, Power & Energy, Climate Change, GIS, RS, Database and IT. It works independently and also in close collaboration with Government and Non-Government Organizations of the country and also with Regional and International Agencies. It recommends technical options based on local realities that are feasible from the environmental, socio-economic and institutional points of view.

During the Second Quarter of the year 2018 (April-June), 13 (thirteen) contracts have been signed between CEGIS and other organizations and clients to conduct EIA, SIA, IEE, RAP, LAP etc. These are as follows: i) "Route Survey from Shahbajpur, Bhola to Barisal Gas Transmission Pipeline Project" with Gas Transmission Company Limited (GTCL) on 05 April 2018; ii) Conducting "Feasibility and Environmental studies of Solar Park at Shwarnadwip, Noakhali" with Hanergy Power Generation Investment Limited on 12 April 2018; iii) "Survey of Minor Irrigation Equipment, Area and Costing" with Bangladesh Agricultural Development Corporation (BADC) on 22 April 2018; iv) "Environmental and Social Impacts Assessment of Technical Cooperation Project in Connection with Flood Management in Bangladesh Yellow River Engineering Consulting Co. Ltd (YREC), China on 25 April 2018; v) "Environmental Impact Assessment (EIA) for Construction of Gas Transmission Pipeline for Mirsharai Economic Zone and KGDCL Gas Distribution Network Up gradation Project" with Gas Transmission Company Limited (GTCL) on 30 April 2018; vi) "Environmental Impact Assessment (EIA) for Construction of Production Boreholes to provide Water Supply to Forcibly Displaced Rohingya People and Communities Hosting them in Ukhia & Teknaf Upazila, Cox's Bazar' with Department of Public Health Engineering (DPHE) on 15 May 2018; vii) "Action Research on Climate Change Forecasting & Participatory Scenario Development and Assessment of the Agriculture & Fisheries Sectors, Exposure to Climate Risk with Local Government Engineering Department (LGED) on 15 May 2018; viii) "Environmental and Social Impact Assessment (ESIA) of Embankment-cum-Road and Water Management Systems for Economic Zone-4 at Sonadia-Ghotibhanga Islands, Moheshkhali, Cox's Bazar" with Bangladesh Water Development Board (BWDB) on 21 May 2018; ix) "Up gradation of BSIIS and GSIIS Software" with NI International on 30 May 2018; x) "Training for the BWDB Professional on EIA and Land Acquisition and Resettlement Management" with FRERMIP-PMO of Bangladesh Water Development Board (BWDB) on 12 June 2018; xi) "Correction of the EIA Report as per ADB Guideline for Construction of new 132/33 kV Grid Sub-stations at Banani Area under DESCO" with Dhaka Electric Supply Company Limited (DESCO) on 14 June 2018; xii) Consultancy Services for "Re-excavation, Renovation and Development of Khals for Mitigating Water Logging Problems in Chittagong City" with 34 Engineer Construction Brigade, Chittagong, Bangladesh Army on 24 June 2018 and xiii) "HVDC Back to Back (BtB) Station at Cumilla for 500 MW Electricity Import from Tripura (India)" with Power Generation Company of Bangladesh (PGCB) on 26 June 2018.

**Development of Crop Specific Drought ... (Cont'd from page 2)**

Condition Index (TCI) have been extensively used for vegetation indices and drought indices mapping. Thus, the study conducted through (ii) detail literature review, (ii) NDVI, VCI and TCI mapping for drought analysis using remote sensing and (iii) drought analysis using field data/observation (ground truthing) and (iv) expert opinions. Based on the remote sensing data the 3 categories of drought severity index that is (i) Normal drought condition, (ii) Drought condition and (iii) Severe drought condition were calculated. Using available satellite images, different drought severity index maps were prepared for the post-monsoon season (e.g. T.Aman Crop). Union level and farmers field level drought severity can be generated using the SADMS Model (if it can also be available and High Resolution Satellite Images. The DSI map will help farmers in crop planning and water management under different water stress conditions to face the challenges of climate change.

# GIS based Delimitation Tool and Database updating for Constitution Boundary Delimitation 2018

*Md. Mostafizur Rahman, GIS and Quality Management and Publication Division, Abul Kashem Md. Hasan, Database, ICT and System Management Division*

## *Introduction*

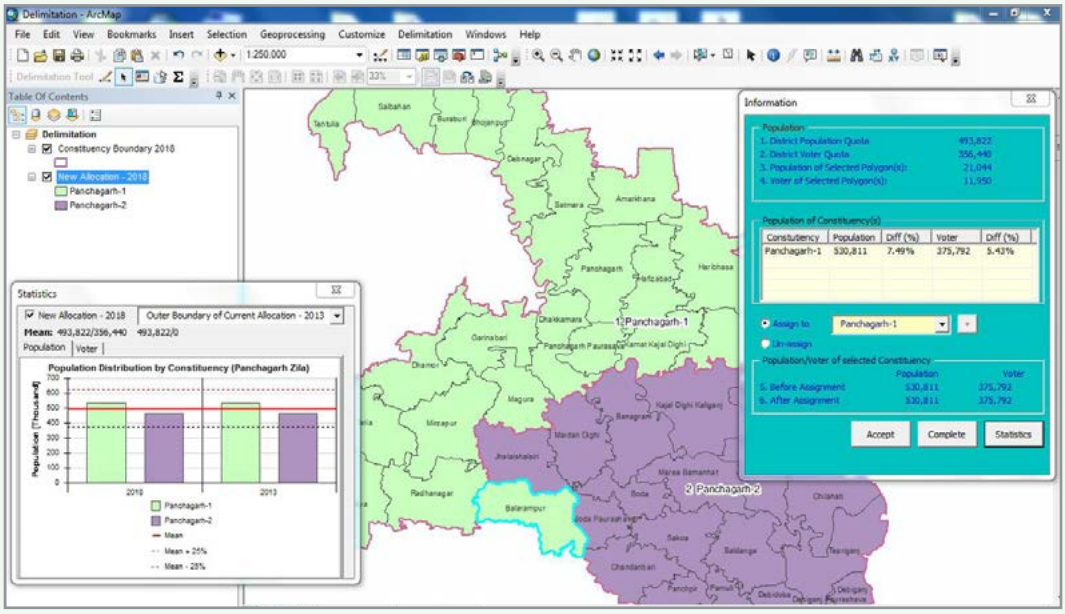
The Bangladesh Election Commission (BEC) is responsible to delimit the constituencies for the purpose of elections to Parliament. Delimitation of boundaries is one of the most fundamental pre-election activities of BEC. The delimitation process is guided by the delimitation criteria, as mentioned in the Ordinance of 1976 that requires constituencies to be delimited with regard to "the distribution of population as given in the latest census report". Two more criterion administrative convenience and compactness are also mentioned in the Ordinance. Considering these criterion, a GIS based delimitation tool and geo-spatial database were developed in 2008. BEC engaged CEGIS to develop this system. BEC used this system in that year to carry out constituency boundary delimitation. In 2018, BEC again engaged CEGIS to update this powerful delimitation tool taking into account the administrative area, population, voter information and other relevant concerns and used this tool to get assistance in delimitation process.

In preparing constitution boundary delimitation for 2018, Election Commission considered several issues namely: (i) Number of constituencies of each district been kept similar to those of 2013, (ii) Upazila boundaries been kept undivided as much as possible, (iii) Unions, Pourashavas and City Corporation Wards have been kept undivided, (iv) New administrative boundaries have been incorporated and (v) Accessibility.

## *GIS based Delimitation Tool*

The GIS based delimitation tool is a dynamic and user-friendly tool considering the requirements of Bangladesh Election Commission (BEC) developed in ArcGIS desktop platform. The delimitation tool is a very effective tool for conducting constitution boundary. It is mainly used for the demarcation of constituency boundary and to assign one geographic unit such as union/pourashava/city ward of a particular constituency to another constituency. The effects of the reassignment based on the population, voter and geographical characteristic of the constituency can immediately reflect on the computer screen, shown in the table under the map and can update automatically. The delimitation tool is developed for exploring the impact on geographic and demographic characteristic of current and proposed changes to the constituency boundaries. The tool can also produce map and report.

The tool is comprised of Delimitation Menu and Delimitation Toolbar in the default ArcGIS interface. Delimitation Menu has a number of sub-menus such as Add Layer, Label Feature, Remove Layer, Filter Layer and Set Language. The Delimitation toolbar contains Index Map, Information Toolbox, Customized Identity, Reports and Statistics tools.




*GIS based delimitation tool*

A number of GIS Data Layers such as Division, District, Upazila, Union / City Ward has been used for constituency boundary delimitation. These GIS layers have been updated using recent administrative information 2017 from BBS and updated voter information 2018 from Bangladesh Election Commission. All administrative boundaries have been developed by dissolving boundary from lower map unit of Mouza Boundary. A relational database has been developed to link the population census and voter information with geographic administrative boundaries. An Open Source Database System MySql is used at the backend.