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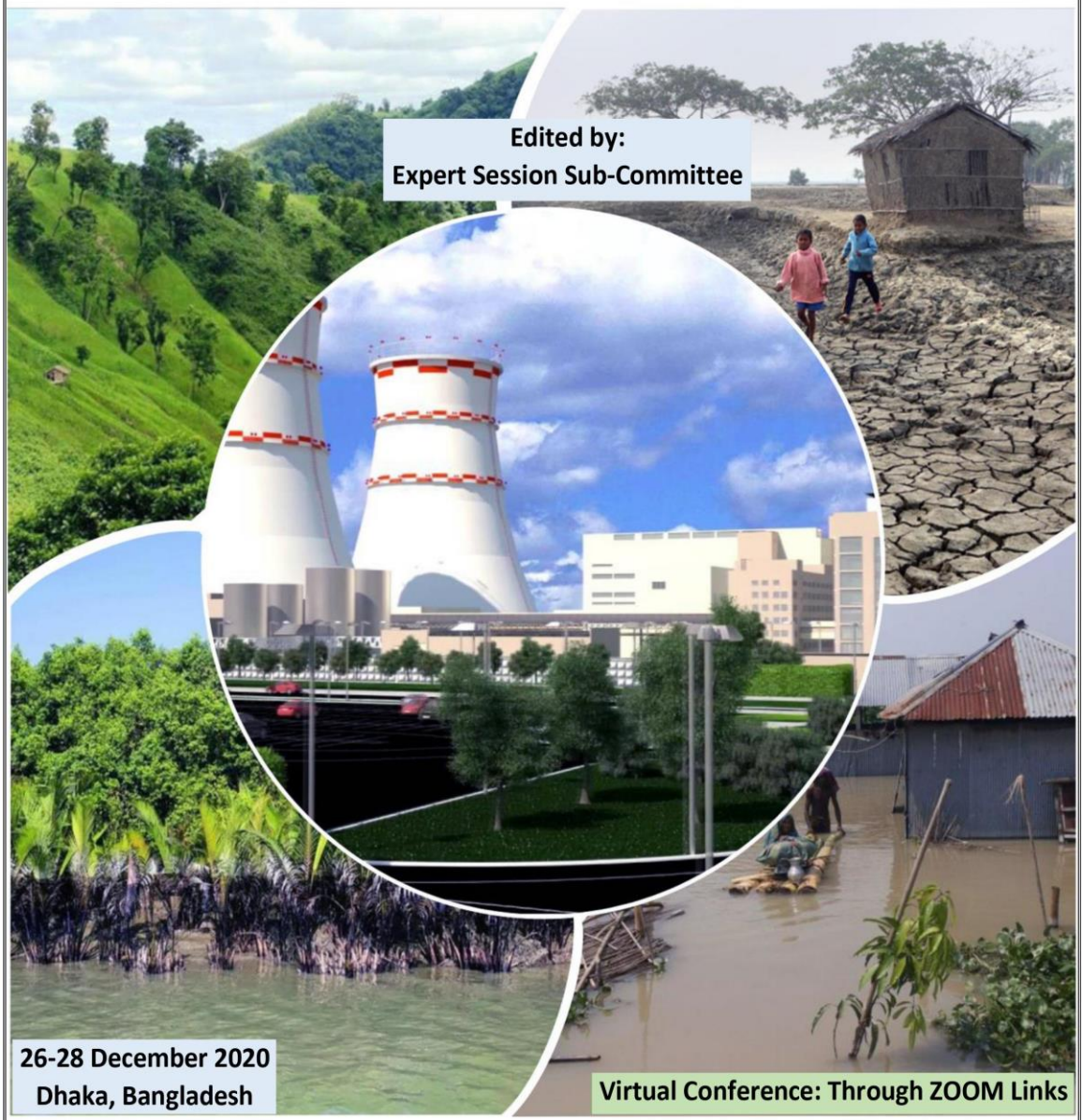

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Theme Abstract

TWENTY YEARS OF *BAPA*:

Past Experiences and Future Challenges

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Bangladesh Poribesh Andolon (BAPA) was formed in July 2000, on the crest of the wave of enthusiasm, generated by the hugely successful 1st International Conference on Bangladesh Environment (ICBEN-1), held in January of that year. Bangladesh Environment Network (BEN), the pro-environment organization of non-resident Bangladeshis, formed two year earlier in 1998, played the initiating role in ICBEN-1 and formation of BAPA. Since then, BAPA and BEN have been working together for protection of Bangladesh and global environment. Many successes have been achieved over the last two decades – some of which are concrete and visible, while others are diffused and less visible. In many cases, pro-environment decisions foundered on lack of or bad and sometimes perverse implementation by the bureaucracy. However, both the adoption of pro-environment policies and their implementation by the bureaucracy ultimately depend on the political leadership of the country. The struggle for protection of environment therefore cannot achieve expected success unless the environment movement can be politically more influential. The challenge before BAPA and BEN now is to convert the environment movement into a mass movement, which can help the environment movement to achieve the necessary political influence. In the context of Bangladesh, greater political influence of the environment movement can be beneficial for the country in many other ways.

Keywords: *BAPA; BEN; environment movement; ICBEN*

JEL classification: Q28; Q58;

Plenary Abstracts

(Arranged in the order of the last name)

Emissions Gap to Attain Goals of Paris Agreement

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Since 2010, UNEP has been assessing emissions gap to keep temperate rise below 2°C and 1.5°C targets. While the Copenhagen Accord of 2009 and the Cancun Pledges of 2010 are the origin of the 2020 emissions gap assessments, Paris Climate Change Agreement and Nationally Determined Contributions (NDCs) are basis for 2030 emissions gap assessments. During 2010 to 2014, pre-Paris Climate Change Agreement, assessment was focusing on question "will there be a gap in 2020 between emissions expected under full implementation of Cancun Pledges and the level consistent with the 2°C target". Over the 2010–2014 period, the gap estimates for 2020 ranged from a low of 5 GtCO2e (billion tones) according to the most ambitious pledges and measured under strict accounting rules to a high of 13 GtCO2e in 2020 according to the least ambitious pledges and more relaxed accounting rules. The estimated emissions gap in 2030 to be 13 $GtCO_2e$ with full implementation of conditional NDCs and levels consistent with least-cost pathways to the 2°C target. If only the unconditional NDCs are implemented, the gap increases to 15 $GtCO_2e$. This presentation will cover changes of emissions gap overtime and against temperature targets and list of possible options to reduce gap.

Reducing Climate Change Impacts in Bangladesh by Knowledge-based Community Actions

Soumya Dutta

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By all estimates and from all kinds of studies, Bangladesh has been identified as one of the most vulnerable countries from multiple impacts of the increasing climate crisis. The physical impacts like increased flooding and river bank erosion, stronger tropical storms and cyclones submerging and salinizing more land and causing coastal destruction are exacerbated by the particular geography and demography, and also international relations of the country with its immediate neighbours, particularly India. The huge silt load brought in by the three major Himalayan rivers coupled with the extremely low gradient from north to south (towards the Bay of Bengal) creates impediments to drainage of flood waters. This couples with the very high population density, which makes leaving room for a rivers necessary flood-plains extremely difficult, making river bank erosion a huge driver of displacement and impoverishment. In the south, the delta regions high biological productivity and population-poverty combination has caused high density in very vulnerable coastal regions, complicating an already hazardous situation. Nearly 70% of the country is estimated to be flood prone – both from northern river flooding and tidal and storm surges from the south. And heavy dependence of subsistence farming and small scale fishing brings in huge numbers of ill-equipped poor people in close proximity to these very hazards – not only the climate extreme events, but also to the more extensive Slow-onset impacts. Studies have shown that up to one in seven persons in Bangladesh might face either permanent of temporary displacements due to climate change impacts by 2050, with nearly 1.8 million suffering that from sea level rise and consequent salinization. The north-west part of Bangladesh also faces the prospect of droughts, due to both climatic and upstream water use. The most recent study by CAN-SA and Action Aid has estimated that, by 2030, up to two million people might be displaced and forced to migrate in Bangladesh due to the impacts ofsea-level rise, water stress, crop-yield reduction, drought and other eco-system losses, with the current level of Pledges and Targets adopted by countries (not accounting for recent announcements). These numbers may reach over 3.3 million by 2050. Faced with these very high levels of threats, the Bangladesh government is trying to opt for very expensive "Hard Engineering solutions" like massive concrete embankments, extensive dredging and the like. Simultaneously, many 'economic developments' policies like promoting coastal tourism, building very expensive and critical infrastructure in the vulnerable coastal areas and the like – are both increasing the pressures on the fragile ecosystems, and putting more people and economic resources deliberately in harm's way. That's not very prudent for a country that lacks the financial resources for these big hard infrastructure projects, and have to look for huge borrowings for these. The other big disadvantage of such costly hard infrastructure is their inflexibility. When one considers that one of the key features of the climate crisis is increasing unpredictability of temporal and spatial climate, these hard infrastructure projects make even less sense. One approach that is flexible and adaptable to changing climatic conditions is to combine existing and evolving knowledge with community actions, mostly through soft engineering and Nature based Solutions. Many such knowledge based actions have been demonstrated to be effective in – if not eliminating the risks, at least in reducing these substantially. And these can always be changed or adapted to evolving knowledge and social situations. That's a far better course of action for a country with little financial resources, huge human resources and massive climate risks.

Effect of An East-West Connecting Road on The Flood Behavior of Jamuna River: A Case Study

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Flood is a common natural hazard for Bangladesh and every year almost one-fifth of the country is inundated by flood. Moreover, climate change and sea level rise will increase the vulnerability of flood. Furthermore, change in land uses, increase in urbanizations, construction of roads, culverts and levees will affect the overall characteristics of flood. As country's natural land slope is mostly dominated in North-South direction, flood flow is also dominated in the same direction. Therefore, any construction of roads along East-West direction may act as a barrier and which may affect the free flow of flood water. Therefore, in this study, an East-West connecting road, i.e., Bogra-Sariakandi road and the upper flood plain area of the road have been selected as a case study. HEC-RAS 2D model, a two dimensional (2D) hydrodynamic model, has been used to simulate the flood flow for the selected study area. The total study area includes Jamuna river from Bahadurabad to Sirajganj and its flood plain. A 2D hydrodynamic model has been developed for the study area and calibrated and validated with 2004- and 2005-year flows. The developed model is then used to simulate major flood events, i.e., 1988, 1998, 2004 and 2007 flood flows with the existing road and without the road. It has been observed from the simulation that with the addition of road flood inundation area has been increased by 8% to 15% of without road's inundated area and the flood water level has been increased by approximately 0.6 m. Furthermore, effect of different culvert openings, i.e., 10% 20%, 30% and 50% have been simulated and it is found that with the maximum increase in openings, flood water level can be reduced up to a maximum of 0.3 m and inundation area can be reduced up to a maximum of 22%. This type of simulation can be done with other roads to quantify the effects and to take possible mitigation measures.

Keywords: *HEC-RAS 2D; Jamuna River; East-West Connecting Roads; Effect of Culverts; Flood Inundation.*

Water and Flood Management Perspectives in Bangladesh

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Inflows from the 57-transboundary Rivers and runoff from local rainfalls are concentrated into a six-month wet season from May to October in Bangladesh Delta. In this period rainfall is more than twice the potential evapotranspiration. In the remaining six months, evapotranspiration is only about one-third. Water resource management is a very big task and challenge with the twin problems of too much water during floods and too little water during lean flow season. The life and livelihood of the people, flora and fauna of Bangladesh depends very much on water management in an integrated manner. Bangladesh being the lower riparian country with low topography, the Ganges, the Brahmaputra and the Meghna discharge into the Bay of Bengal through the heart of Bangladesh. These river systems rise in the Himalayas and drain a very large catchments area totaling about 1.72 million sq. km., which spreads over China, Nepal, India and Bangladesh. The huge discharge, of the order of 1.15 trillion cubic meters per year and enormous sediment loads, of the order of 1.2 to 1.6 billion tons per year, received from the catchments area of this river system create flooding and drainage problems acute. It may be noted that Bangladesh has an area of about 147,000-sq. km., with a population of about 170 million makes her the most densely populated and worst flood hit country of the world.

At least 18% of the area is flooded annually in Bangladesh. Everyday life is adapted to this pattern of events but in exceptional circumstances, the proportion of land flooding rises: about 36% in moderate flood, 60% or more in case of severe flooding along with inundation of 85% of the net cultivable area. Severe floods, which need to be managed through protection measures, both structural and nonstructural are caused by mainly three factors. These are local intense rainfall, huge trans-boundary inflows and consequent over bank spill from rivers, and cyclone induced surges. Interior flooding is occasionally aggravated by the drainage congestion due to rise of water levels in the Bay of Bengal. Anticipated Sea level rise due to climate change would aggravate the existing flooding condition and it is projected that about one-third area in the coastal zone will be permanently inundated if a one meter rise of mean sea level occurs in 2100. Since Bangladesh Delta and its floodplain is support human and their activities, it is important to manage water resources and floods so that the damage does not exceed an acceptable level. This paper presents water and flood management perspectives in Bangladesh with some focus on impacts of climate change. Plans and initiatives made so far has also been discussed. Regional cooperation is also advocated for proper management of flood and water resources of Bangladesh.

Impact of Climate Change on extreme precipitation, river flooding, droughts, agriculture, cyclone and storm surges in Bangladesh

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The Paris Agreement has provided an opportunity to strengthen the global action on climate change. The Paris Agreement emphasizes for limiting global temperature at 2°C and even at 1.5°C above pre-industrial conditions to avoid the potential adverse impact of climate change. Recent studies showed that holding warming to 1.5°C versus 2°C can significantly reduce the potential loss due to climate change. People in South Asia, where people's livelihoods are highly dependent on water resources, can be affected disproportionally under the warming world. The Ganges-Brahmaputra-Meghna (GBM) river system plays a key role in the survival and development of more than 670 million people in South Asia. A country of the population as large as Bangladesh has marked as one of the most vulnerable countries in the world considering climate change issues. Bangladesh is highly vulnerable due to its low adaptive capacity, dense population, flat topography and exposure to various natural disasters such as cyclone, storm surges, sea-level rise, floods, bank erosion etc. In addition to present vulnerability, climate change will bring detrimental impact on socio-economic performance, health and livelihood of the population. Climate change beyond 2°C, 4°C and 6°C is expected to impact severely as a result of the changes in extreme events to occur in upcoming years. A study (HELIX-The High-End cLimate Impacts and eXtremes) has been recently conducted for the high-end climate scenarios beyond 2°C, 4°C and 6°C and possible warming of the world upon different biophysical systems of the country like agriculture, water resources, ecology, infrastructure, health, socio-economy etc. HELIX is a collaborative project funded by European Union, with sixteen participating institutions led by the Exeter University was focused on both global and regional scale climate change impact under a range of physical and socio-economic condition with consideration of different adaptations scenarios. It has been found that climate change will change dramatically the future vulnerability profile of the country, which will be alarming for the agro-ecological systems. It has also found that freshwater availability and climate extremes such as floods and droughts of the GBM river basins will likely be affected by global warming at different specific warming levels. The understanding of the potential implications of climate change will be helpful for developing appropriate adaptation guidelines to meet the agricultural and water management challenges of the country.

Haor Inhabitants-A Disaster Resilient Community in Bangladesh

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On March 30, 2017, a disastrous flash flood broke through the earthen embankments (Dyke) protecting the haor area and inundated the haors in Bangladesh affecting over 3.5 million inhabitants and causing loss of about 1 million ton of boro rice and death to 2,000 tons of fish and 20,000 ducks. The haor is the local name of the saucer-shaped, naturally depressed areas of Bangladesh encompassing an area of 8,000 $km^{2,}$ and are home to 20 million people. Haors are unique, in terms of rich ecosystems and bio-diversity. Despite the economic importance of the haors proving over 28% of fish supply, the people in the region are poorer than the rest of the country and lives below Lower Poverty Line. Natural disaster such as flash flood is the main reason of the poverty. Flash floods occur normally in mid-May due to heavy downpour in the hills of Assam and Meghalaya in India and the flash floods are brought into the haors through 59 mountain streams. This year alone 5,000 mm of rainfall was recorded in nine days at Cherapunji (India), which is only 20 kms away from the haor area and it took only 5 hours for the flood water to reach the haors.

The resilient haor people face several vulnerabilities. The first and foremost vulnerability is the chronic homestead erosion by the wave actions that may occasionally destroy the entire village. The second is the flash floods which periodically destroys the only crop, boro rice cultivated in winter. During rainy season, July through November, the entire area is submerged and the haor people live on fishing and duck rearing. During dry season (December through April), the water is completely drained by gravity and the area returns to fertile land for high yielding boro rice cultivation. In the last two decades, the residents of haor have faced problems of food scarcity and road communications. Food scarcity is primarily due to flash floods. Since 1996, the government of Bangladesh and Non-Government Organizations, in cooperation with the haor residents tried to develop various techniques to protect the homesteads from wave actions as well as boro crop from flash floods. Traditional local method included long stem grass and bamboo mattress; and conventional methods included earthen embankments (Dyke) armored with concrete blocks, gabion (Reno) mattress and reinforced concrete flood walls. None of the methods have been fully successful and there is a need for a fundamental change in the design. This paper discusses the proven solutions practiced in the United States that has much better chance of success in protecting the haors.

Climate Change and its impact on Extreme Rainfall Events and Landslide Hazards in Darjeeling Himalaya, India

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A total of 5318 non-seismic landslides occurred from 2004 to 2017 globally, out of which 3285 landslides were triggered by rainfall. In the context of the Indian Himalayas, during the same period, 580 landslides occurred with 477 triggered by rainfall, thereby contributing 14.52% of the global landslides. The effect of global warming and the corresponding changes to climate and geohazards is expected to affect landslide events. However, forecasting and understanding the impact of climate change on landslide activity still poses a challenge. Darjeeling Himalaya region is largely affected by climate change such as changes in rainfall behavior which invites extreme rainfall events and causing severe landslides hazards frequently. The pattern of rainfall intensity in the Himalayas varies from west to east, thereby precipitation patterns being affected by western disturbances and summer monsoon. The lack of studies in a region such as the Himalayas, which is prone to severe landslides and other geohazards, is a matter of concern. In the present day, the lack of inclusion of climatic variation in landslide studies for the Indian Himalayan region is the unavailability of data both in spatial and temporal context. But, in the last two or decades the occurrences of extreme rainfall events have invited frequent destructive landslides in Darjeeling Himalaya. Darjeeling Himalay is very prone to landslides due to the fragile lithology, the complex geological setting, the high energy of the relief with steep slopes, and the high topographic roughness. Moreover, most of the area is seismically active and subject to extreme precipitations, and the situation has been further worsened with the increase in anthropogenic activities and the advent of climate change. It is a well-established fact that most of the landslides in this area have been primarily triggered by rainfall, the focus of the present review is only on the studies considering rainfall triggered landslides.

The Dajreeling Himalaya comprises several town i.e. Darjeeling, Kalimpong, Kurseong, Mirrik etc. where population density and settlement density are very high which put enormous pressure slope and make the slope more susceptible to landslides. Most of the populated areas are very much prone to landslides triggered by rainfall events. The climate change induced cyclonic disturbances and extreme rainfall events are the main causes of landslides in Darjeeling Himalaya. The present study is dealt with the assessment of rainfall character i.e. rainfall intensity and duration and estimation of critical rainfall for the occurences of landslides due to climate change phenomena. The calculated critical rainfall of two major landslide prone parts of the Shivkhola watershed of Kurseong Su-division is 105.88mm/day (Tindharia T.E.) and 88.93mm/day (Lower Paglajhora) which may invite landslides in Darjeeling Himalaya. For the management of climate change induced landslides, the study on rainfall and its probability is of immense important. Besides, extreme rainfall events contribute huge amount of water to mountain streams which promotes active down cutting and loss of basal support and makes the valley sides slope more landslide prone. Climate change induced sudden precipitation liquefy minerals and reduce rock-soil cohesion by chemical weathering process and invites landslides. In Darjeeling Himalaya, south, south-east, west and east facing slope receives more orographic rainfall where landslide activities are dominant. The knowledge in regard to rainfall, growth and development of mountain streams, slope saturation and reduction of soil cohesion may contribute a lot in landslides management and mitigations in Darjeeling Himalaya.

Keywords: *Climate change, rainfall events, critical rainfall, drainage network development, slope saturation, landslide Hazards and management, Darjeeling Himalaya.*

Management of Trans-Boundary Rivers in The Region: How to Move Forward

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A river whose basin covers two or more sovereign countries is termed as Trans-boundary River. In a federal type of government when a river traverses through two or more states, its management approach is more or less similar to that of a trans-boundary river. In most cases, intense negotiations are held between/among the upper and lower riparian countries (and states as the case be). These negotiation process is often lengthy and may even be acrimonious.

Most of these consultation process are controlled by the countries/ states concerned, and are termed as Track-1 process. The factors that are involved in the negotiation/ consultation process can be categorized as Technical, Environmental, Social, Diplomatic, Economic and Financial, Institutional, and Political. In most of the cases, the Technical considerations receives most attention and technical personnel play most dominant role.

To support the Track- 1 process, to arrive to an acceptable resolution of the dispute, civil society organizations and many bi-lateral and multilateral organizations, often take initiatives and bring various actors in discussion forums. Basic premise of these consultations, termed as Track-2 level (without participation of Track-1 players) or, as Track 1.5 level (with non-committal participation of Track 1 operatives), is obviously to facilitate collaboration, among the co-riparian countries. This is to be attained through advocacy where both opportunities that could be generated through cooperative approach as well as cost of lack of cooperation will be highlighted. The aim of such consultation is obviously to move towards win-win situation for all stakeholders through optimization as well as sustainable management of the common resources of the basin.

Over the last four decades many such consultations/ meetings/ workshops have been held with participation of delegates from co-riparian countries of the Ganges-Brahmaputra-Barak/Meghna region. In these sessions, opportunities, especially in hydro-power generation and navigational facilities development have been highlighted; imperatives for collaboration especially for flood and drought management have been articulated; also, environmental and social constraints have been flagged up; and, political constraints have been noted. In my view there is no apparent pronounced disagreement on the need for collaboration and supportive actions. But how to push the four co-riparians of the Brahmaputra, namely, India, China, Bangladesh and Bhutan on a working table remains a far cry. Similarly is the situation with the three co-oriparians of the Ganges, namely Nepal, India and Bangladesh. For the Dharla and the Dudhkumar, the two rivers basins shared between Bhutan, India and Bangladesh consultation is not moving at all.

The stakes of each co-riparian is different. Achievement of the overall cooperative approach is not easy but efforts must not stop. Bangladesh and India have already agreed through an agreement signed (in 2011) to follow a “basin wide” and “basin wise” management approach for all rivers that are common between the two countries. Possibly the consultation that are being carried under BBIN (Bhutan, Bangladesh, India and Nepal) process will eventually bring all the four countries under one consultation process. In view of this author the most important element are the political factors; and not other elements as spelt out in paragraph-2. In this presentation, steps will be recommended for forward movement towards cooperation and collaboration in management of trans boundary rivers in the region.

The Changing Coast line of Bangal: 1917-2020

Kalyan Rudra

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The Ganga-Brahmaputra and Meghna system carries one billion tons of sediment load/year into the Bay of Bengal leading to formation of the largest delta of the World. Many scholarly papers dealing with the Geology and sedimentary succession of the GBM delta have been published during preceding decades but the issue disproportionate growth of the littoral tract of Bengal has not been addressed. It seems to be an apparent paradox that while land along the Meghna estuary has been fast prograding southwards, the retrogradation ofWest Bengal coast has been alarming. The dynamic coast line can be appreciated by comparing multi-dated maps and satellite images. The image of 2020 overlaid on topographical sheet of Survey of India (1917) helps to realize the century-scale change of the coast line of Bengal. It is observed that the Bay of Bengal has encroached northwards during the period under consideration and more than 200 km^2 area have eroded from the eight islands of West Bengal. On the contrary, the process of accretion along the Meghna estuary has pushed the sea southwards causing emergence of 451 km^2 new land.

The latest report of IPCC (2019) said that the global sea-level has swelled at the rate 3.6mm/year during 2006-2015 due to combined impact of melting of glaciers and thermal expansion of the Sea. The situation in Bengal coast has been further aggravated due to subsidence of land at the average rate of 2.90mm/year. Thus SL of Bay of Bengal is changing at the rate +6.5mm/year and this seems to be highest since 1850. The increasing sea-surface-temperature favours the formation cyclones and storm surge over the Bay of Bengal. While 37 cyclones struck Bangladesh between 1960 to 2918, two recent disastrous cyclones Bulbul(09.11.19) and Amphan(20.5.2020) have changed the coastal configuration at Sagar, Mousuni and G-plot swallowing chunks of land. Since these islands were deforested, the cyclones got easy access into the land.

The Sea has encroached drastically along the Hugli, Saptamukhi, the Thakuran and the Matla estuaries. The islands of Sagar,Namkhana, Mousuni, G-plot and Bulcheri have been reduced in size. The estuarine islands of Hatiya, Lalmohan, Rangabali and Kuakata in Bangladesh have been enlarged and the coastline has shifted southwards more than 33km from Noakhali since 1780. The Meghna estuary, being the principal conduit of sediment flow into the Sea, is obviously the most fast changing littoral tract of Bengal. Thus the coastal configuration of Bengal has changed due to combined effects neo-tectonic, climate change and human intervention into fluvial regime of GBM delta.

হাওরে বজ্রপাতে মানুষের আর গবাদি প্রানির মৃত্যু বাড়ছে

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বজ্রপাতকে জাতীয় দুর্যোগ হিসেবে ঘোষণা করা হয়েছিল ২০১৫ সালে। ওই বছর বজ্রপাতে নিহত হয়েছিলেন ১৮৬ জন। অবস্থার এখনো তেমনউন্নতি হয়নি।
বাংলাদেশে বছরে গড়ে ৮০ থেকে ১২০ দিন বজ্রপাত হয়। যুক্তরাষ্ট্রের কেন্ট স্টেট ইউনিভার্সিটির ডিপার্টমেন্ট অব জিওগ্রাফির অধ্যাপক ড. টমাস ডাব্লিউ স্মিডলিনের 'রিস্ক ফ্যাক্টরস অ্যান্ড সোশ্যাল ভালনারেবিলিটি' শীর্ষক গবেষণা বলছে,''প্রতিবছর মার্চ থেকে মে পর্যন্ত বাংলাদেশে প্রতি বর্গ কিলোমিটার এলাকায় ৪০টি বজ্রপাত হয়। বছরে দেড়শ'র মতো লোকের মৃত্যুর খবর সংবাদ মাধ্যম প্রকাশ করলেও প্রকৃতপক্ষে এই সংখ্যা পাঁচশ' থেকে এক হাজার।

সংবাদ মাধ্যমে প্রকাশিত খবরের সুত্র ধরে দুর্যোগ ফোরামের হিসাব অনুযায়ী ২০১০ থেকে ২০১৯ পর্যন্ত বজ্রপাতে মোট মৃতের সংখ্যা ২৫৩১জন। বজ্রপাতের ঘটনা ও মৃতের সংখ্যা হাওর এলাকাতেই বেশি। ক্রমশ এটা হাওর এলাকার একটা বিভীষিকায় পরিনত হচ্ছে। যেহেতু এই দুর্যোগে কর্মক্ষম পুরুষ বেশি মারা যান (মৃত২৫৩১ জনের ১৬৭৩ জনই ছিলেন পরিবারের প্রধান উপার্জক) ফলে এর একটা সুদুর প্রসারি সামাজিক সংকটের দিকও আছে। দুর্যোগে হতাহতের স্বতঃসিদ্ধ ধরন আনুযায়ি এক্ষেত্রেও যতো মানুষ নিহত হন তার চেয়ে তিনগুন মানুষ আহত হন। এদের চিকিতসার কোন সতন্ত্র প্রটোকল এখনো তৈরি করা হয়।

হাওরে বন সৃজন বজ্রপাতকে প্রতিহত করবে তবে সেটা একটা দীর্ঘ মেয়াদি সমাধান কিন্তু কিছু ত্বরিত সমাধানের পথও আমাদের ভাবতে হবে। লাইটেনিং এরেসটার দিয়ে নেপাল ভাল ফল পাচ্ছে। বজ্রপাতের প্রতিকার হিসেবে সরকার সারাদেশে ১০ লাখ তালগাছ লাগানোর সিদ্ধান্ত নিয়েছিল। তবে শেষ পর্যন্ত তালগাছ নয়, বিভিন্ন রাস্তার পাশে ২৮ লাখ তালের আঁটি রোপন করা হয়েছে। মনে রাখতে হবে বজ্রপাতে মানুষ মারা যায় ধানের ক্ষতে ফসলের মাঠে , খোলা জায়গায় । রাস্তার পাশে তালের আঁটি পুতে তাদের রক্ষা করা যাবে না। হাওড়ের তিনটি বা চারটি বজ্রপাত প্রবন উপজেলা বেছে নিয়ে পরীক্ষামুলকভাবে লাইটেনিং এরেসটার লাগিয়ে এক মৌসুমেই তার ফলাফল যাচাই করা যায়।

Abstract from Bangladesh

(Arranged in the order of the last name of the first author)

Abdal

COVID-19 Protective Gears: Protectors or Annihilators?

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In the year of advanced technologies and progressive societies, COVID-19 or SARS-CoV2 put all the progresses and advancements of human civilization to a halt. No matter the reason, political or natural, humans are facing one of the deadliest challenges of their lives. On the brighter perspective, the Earth started to show signs of healing. The AQI started to present high air quality, turbidity and pH of water bodies started to become healthy, the soil started to show more fertility due to absence of continuous grazing and browsing. Familiarity to the virus's abilities has led to drastic increase in plastic uses such as: N95 masks, plastic gloves, and many other non-biodegradable PPEs. These COVID protective gears are efficient only because of their non-biodegradability. The gears are made of polypropylene (PP) [For masks], Latex plastic [For medical gloves], Polyvinyl Chloride (PVC), Polyamide fabric [For protective suits] and Neoprene and they show resistance to heat, moisture, chemicals, or oil, etc. The dilemma is, however, that if biodegradable gear is used, the efficiency to protect personnel from COVID attack is sacrificed. Despite the high efficiency of non-biodegradable masks and gear, they have created pressure on our planet due to lack of biodegradability. Even if they are properly disposed, the microorganisms fail to decompose them and return them to the nature by biogeochemical cycles. This paper focuses on the COVID-19 protective gear and their tremendous effects on the Earth. The PPE are used all over the globe for protection from the dangerous disease, often ignored the fact that the protective gear is also enhancing the end of the world. This paper also discusses the probable outcomes of the management scenario of PPE as well as what the ideal strategy should be. The paper further recommends the proper precautions and care for PPE and how to instigate the proper decomposition process of protective gears of COVID19.

Keywords: *COVID-19, gears, protectors, PPE.*

Plankton Diversity and Abundance in Relation to Biophysical Conditions around Kutubdia Island, East Coast of Bangladesh

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Kutubdia is an Island located in the Bay of Bengal is in threat of submerging due to climate change and sea-level rise. The present study attempted to identify the plankton diversity and abundance in relation to biophysical conditions in the surface water of Kutubdia Island from November 2017 to March 2018. Samples were collected during the summer and winter seasons from 8 stations (4 stations during high tide and 4 stations during low tide) around Kutubdia Island. Frequently occurring diatoms were *Coscinodiscus sp., Thalassiosira sp., Thalassiothrix sp., Planktoniella sp., Ditylum sp., Thallassionema sp., Chaetoceros sp.,* and *Rhizosolenia sp* etc. Associated with the large volume of freshwater supply and interrelated oceanographic, biological and sedimentary processes are driven by the monsoon winds of the Bay of Bengal, species abundance shows significant variations in percentage contribution of individual species to total phytoplankton population in Monsoon and also in winter. Seasonal changes in abundance and diversity of phytoplankton significantly differed showing maximum diversity in winter and minimum in summer. Phytoplankton density ranged approximately from (1085 – 10985) cells / L in winter and (2199- 129310) cells / L in summer respectively. Freshwater from the rivers largely influences the coastal northern part of the Bay, which involves a variety of salinity (24-33parts per thousand) in surface water of Kutubdia Island. In the southern part of Kutubdia high wave action has been recorded. For the identification of cells, imaging software Motic and for showing correlation statistical software SPSS was used. Correlation studies of total cell count to physicochemical variables show a significant correlation with Sea Surface Temperature (SST), pH, salinity and dissolved oxygen (DO) wherein two seasons SST variation is detected from 27.3 °C to 31.7°C, pH ranges from 5.9 to 8.4 and DO is observed from 6.69 mg/L to 10.81 mg/L.

Keywords: *Biophysical condition, Diatoms, Dinoflagellates Kutubdia, Plankton*

The Impacts of Environmental Degradation and Social Transmission on Health Hazards: A Case Study on Riverine areas of Dhaka City

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Health hazards have been serious concerns irrespective of local community, country, region or the entire world. Different environmental factors may cause the appearance of exposed inhabitants and disappearance of quality air, water or soil environment. Deterioration of environmental issues such as air, water or soil endangers the public health issues. However, the level of social transmission may influence the level of consequence of environmental degradation that ultimately affects the totality of health hazards. The amount of research works is very limited on the issue and hence, the present study attempted to reveal impact of environmental degradation on health hazards in riverine areas of Dhaka City. The study also aimed to unearth the role of social transmission on health hazards. A survey method has been adopted with structured questionnaire to collect data from the inhabitants of riverine areas of Dhaka City. A total of 324 local people including a good number of outsiders who have gone there as tourists have been responded spontaneously. The study reveals that the depletion of natural resources has impacted on health hazards in the riverine areas of Dhaka City. Surprisingly, social transmission has been a great concern on the level of health hazards. The study suggests that there should have proper governmental monitoring activities whether natural resources are contaminated or not. Several other stakeholders may assist governmental initiatives in protecting environmental resources for limiting the level of health hazards.

***Keywords**: Environmental degradation, social transmission, health hazards, riverine areas, Dhaka city*

Human Health Impact Assessment of Exposure to PM2.5 Using Airq+ in Bangladesh

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The aim of the present study is to assess the impact of air pollution on the health of people living in five different cities of Bangladesh. In this study, the mortality due to exposure to particulate matter smaller than 2.5 microns is evaluated by AirQ+ software developed by WHO European Centre for Environment and Health. The AirQ+ software provides valuable information about the importance of air pollution and the substantial impacts of PM2.5 on the society. Therefore, the study estimates all-cause mortality and mortality from Acute Lower Respiratory Infection (ALRI), Lung Cancer (LC) and Chronic Obstructive Pulmonary Disease (COPD) attributed to long-term exposure to ambient PM2.5 for the years 2016 and 2017. Concentration of PM2.5 was used to assess human exposure and health impacts in terms of attributable proportion of the health outcome and seasonal (Summer, Winter and Wet) number of excess cases of mortality. Health effect model for quantification is used which is based on Baseline Incidence (BI), Relative Risk (RR) and Attributable Proportion (AP). Results of the study indicate the magnitude of health impact estimated and it helps the policymakers to take urgent action to reduce the health burden of air pollution.

Keywords: *Air pollution, exposure, human health, relative risk*

Forecasting Concentration of Particulate Matters (PM2.5 & PM10) By Using ANFIS Model: A Case Study of Dhaka, Bangladesh

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The present study aims to forecast the daily concentrations of PM 10 and PM 2.5 in the atmosphere of Dhaka city using Adaptive Neuro-Fuzzy Inference System (ANFIS). In Dhaka, particulate matter (PM) is the most harmful air pollutant to public health. So to forecast the concentration of PM in atmosphere is important for the development of cost effective control strategies to alert and protect the population. On the basis of constructing a set of fuzzy IF-THEN rules, with appropriate membership functions, ANFIS generates the stipulated input-output pairs. In this study, the ANFIS model predictor considers five meteorological factors (pressure, temperature, relative humidity, wind speed, and rainfall) and previous day's pollutant concentration in different combinations as the inputs to predict the same day air pollution concentration. In order to reduce the computational cost and time, the collinearity tests and forward selection (FS) technique are applied to remove the dispensable input variables and select the different combinations of input variables, respectively. Root mean square error (RMSE), Coefficient of determination (R^2), Normalized Mean Square Error (NMSE), Index of Agreement (IOA), and Fractional Bias (FB) are applied for the performance testing of the model. Since ANFIS is a combination of neural and fuzzy logic are capable of representing knowledge acquired from human experts and which further improves the prediction. From this study the PM2.5-PDPM2.5-T & PM10-PDPM10-P model performed well for prediction.

Keywords: *ANFIS, forecasting, PM2.5, PM10*

Conservation of Environmental and Biodiversity State of the Feni River Estuary, Chattogram: An Exploratory Study

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The Feni River is a significant water body of the 'Coastal and Marine' ecosystem of the east coast of Bangladesh. The Feni River estuary was selected as the study area, within which five source points of pollution were taken as the sample areas. The heavy metal concentration in the estuarine water was selected as the environmental indicator, while the heavy metal and CaCO3 concentration in mollusk shells were selected as biodiversity indicators for the study. The main theme of the study was to reveal the cause and effect relationship between environmental and biodiversity state of the study area due to anthropogenic activities. To meet the theme, objectives of the study were to (i) measure heavy metals concentration in water, (ii) measure physio-chemical quality of water, (iii) measure heavy metals concentration in mollusk shells, and (iv) measure $CaCO_3$ concentration in mollusk shells, and (v) explore anthropogenic causes of environmental and biodiversity deterioration in the study area. The water was collected in 'Point Sampling' method and measured by Atomic Absorption Spectroscopy (AAS) method. Average heavy metal concentration hierarchy in water samples was: Fe> Pb> Zn>Cu>Cd. Four physio-chemical parameters- (i) Potential of Hydrogen (pH), (ii) Electric Conductivity (EC), (iii) Total Dissolved Solids (TDS), and (iv) Temperature of water were selected to measure physio-chemical state of water at the Feni River estuary. Average (pH 6.0) of the Feni River was within standard range for brackish water fish resource. Average temperature (23.1°C) showed slight increase than standard average (22°C, Banglapedia, 2015), while the TDS (01 mg/L) and EC (average of 7.38 mS /Cm) was within normal range. The mollusks of the Feni River estuary were selected as biodiversity indicator. The heavy metal concentration in mollusk shells were measured by AAS method and average concentration hierarchy was: Cu > Pb> Zn > Fe >Cd. The $CaCO_3$ concentration in mollusk shells was detected by 'Calcium Carbonate Content Detection' method, and average concentration of $CaCO_3$ in mollusk shells was 1.87 mg/L. The heavy metal toxicity in water and mollusk shells, as well as declining concentration of $CaCO_3$ in mollusk shells were due to anthropogenic interventions, such as obstruction in normal water flow due to construction of the Muhuri Closure dam (MCD), changes in agricultural land use, discharge of toxic effluents from industries, factories, fish and fruits farms, water vehicles and dried fish processing areas along both banks of the river estuary. Hence, the study attempted to establish a 'Cause and Effect' relationship between 'Environmental and 'Biodiversity' state of the Feni River estuary, ensued by anthropogenic activities with a Pressure-State-Response model.

Keywords: *AAS method, biodiversity, estuary, mollusk*

Ahmed

নদী রক্ষায় আইনের বাস্তবায়ন নাই

মোসলেহ উদ্দিন আহমেদ
অধ্যাপক, কুমিল্লা মেডিকেল কলেজ ও সভাপতি, বাংলাদেশ পরিবেশ আন্দোলন, কুমিল্লা

দখলে দুষণে দেশের অনেক নদী মৃত প্রায়। দখলের জন্য অনেক নদী ভরাট হয়েছে। নাব্যতা হারাচ্ছে, দুষণের কারণে নদীর পানি ও প্রাণীবৈচিত্র নষ্ট হয়ে যাচ্ছে। আদালতের রায় ও নির্দেশনা নদী রক্ষায় অত্যন্ত গুরুত্বপূর্ণ কিন্তু সরকারের বিভিন্ন ব্যক্তি ও প্রতিষ্ঠান এ রায় বাস্তবায়নে উদাসীন। দেশের সকল নদীবন্দর থেকে নৌযানের ব্যবহৃত দুষিত তেল এবং বিভিন্ন শিল্পকারখানা থেকে অপরিশোধিত বর্জ্য ফেলা হয় নদীতে। জাতীয় নদী রক্ষা কমিশন নদীর দূষন নিয়ন্ত্রণে ২১টি সুপারিশ করেছে। নাব্যতা বৃদ্ধিতে ৩০ দফা, আইনি মোকাবেলা বিষয়ে ১০ দফা, গবেষনায় ১০ দফা ও জনসচেতনতা বাড়াতে ৯ দফা সুপারিশ করেছে। বুড়িগঙ্গ, তুরাগ, বালু ও শীতলক্ষ্যা- চারটি নদীর দূষণ, দখল ও বিভিন্ন স্থাপনা নির্মাণের বৈধতা নিয়ে হিউম্যান রাইটস এন্ড পিস ফর বাংলাদেশের পক্ষে সুপ্রিম কোর্টের পাঁচ আইনজীবী ২০০৯ সালে হাইকোর্টে একটি রিট কালে এবং এর চুড়ান্ত শুনানী নিয়ে ওই বছরের ২৪ ও ২৫শে জুন হাইকোর্ট রায় দেন। জাতীয় নদী রক্ষা কমিশন গঠনসহ ৯ দফা নির্দেশনা ঐ রায়ে দেয়া হয়। নির্দেশনায় সিএস এবং আরএস ম্যাপ অনুসারে নদীগুলোর সীমানা জরিপ করা। নদী রক্ষায় প্রয়োজনীয় নির্দেশনা প্রনয়ন, সীমানা পিলার স্থাপন, নদী খনন ও পলিথিন ব্যাগসহ অন্যান্য বর্জ্য অপসারণসহ কয়েকটি বিষয় রয়েছে। ২০১৯ এর ৩০শে জানুয়ারী ও ৩রা ফেব্রুয়ারী প্রতিরোধমূলক ব্যবস্থাসহ ১৭ দফা নির্দেশনাসহ রায় দেয় হাইকোর্ট। এই রায়ে তুরাগ নদীকে জীবন্তসত্তা ঘোষণার পাশাপাশি বলা হয় এ বাংলাদেশের মধ্যে দিয়ে প্রবাহিত সকল নদ-নদী একই মর্যাদা পাবে। দুই তীরের অবৈধ বসতিরা একটু একটু করে নদীর অংশ ভরাট করে নদী দখলে নিচ্ছে। নদীতে বাড়ীর সেনিটারি লাইনে বর্জ্য নি:সরণ, ময়লা আবর্জনা ফেলে নদীর পানি ও চারপাশের পরিবেশ দুষিত করে তুলছে। নদীর স্বকীয়তা, প্রয়োজনীয় পরিচ্ছন্ন পরিবেশ ও সৌন্দর্য্য রক্ষায় বাংলাদেশ পরিবেশ আন্দোলনের পক্ষ থেকে জেলা প্রশাসন ও সিটি কর্পোরেশনকে স্মারকলিপি ও দাবী জানিয়ে আসছে। দেশের সর্বোচ্চ আদালত বলেছেন, নদ-নদীর মালিকানা ও স্বত্ত্ব জনগনের, এমনকি রাষ্ট্রেরও নয়। এই মালিকানা ও স্বত্ত্ব রক্ষা করার দায়িত্ব রাষ্ট্রের এবং রাষ্ট্রের অধীন বিভিন্ন প্রতিষ্ঠান ও সংস্থার। সাহস করে সরকারি কর্মকর্তাদের আইনের প্রয়োগ করে যেতে হবে।

A Sustainable Approach for Reducing Water and Carbon Footprint by Optimizing Wet Process and Use of Green Chemicals in Textile in Bangladesh

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Textile is the world's first dominant industry and its thriving is still going on. The majority of the modern textile industries have been shifted to Asia now so that Asian countries are more prone to textile hazards. They are affected directly by the water footprint created from the textile water consumption and contribute to global warming by carbon footprint created from the textile emission. Bangladesh is also a larger textile product provider and is seriously oppressed by its textile footprint. This research aims to conduct a parallel study on WF and CF of textile wet processing industries and find out the distinguishing role of textile industries in contribution to water consumption and carbon emission. A baseline study was conducted to collect the data and set a goal for the textile wet processing industries. Later on, water-saving technology was applied to the willing factories and continuous monitoring was implemented. After a certain period, an assessment was conducted to assess the present condition of the textile wet processing units to find if there any improvement. During the whole operation, no types of machinery were changed or replaced or removed willingly without any accident or equipment damage so that the real scenario can be captured. The only proposal was given to change the low twist yarn with high twist yarn; to use cold brand dyes and chemicals, new generation dyes; to use direct dyes instead of conventional dyes, use cationic dyes instead of dispersing dyes and effective use of dyeing machines. The idea was reducing water consumption leads to less energy production, which lessens carbon emission. The result has shown triumph for 16 wet processing units. 90% of factories were able to cut off WF and CF from the baseline year during the assessment year. 10% of factories were not successful or achieved a partial success. As an individual, factory A10 showed outstanding performance, reduced 155,366 m^3 of groundwater, and cut off 787.9 tons of carbon emission. The combined endeavor of 16 factories alleviated 9,095 tCO_2e greenhouse gases and saved 1,586,944 m^3 of groundwater in one year from which Dhaka city could drink for 15 days.

Keywords: *Carbon footprint, eco-friendly dyeing, green chemicals, water footprint, ZDHC*

Coping Strategies for Climate Induced Disasters by the Charland Women: A Case of Shariatpur District in Bangladesh

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Due to the recurrent climatic hazards and their devastating impacts, women in *char* areas have adapted to live with hazards through their own coping mechanism that enabled them to survive with hazards. The Kunder Char union of Shariatpur district is one of the most adversely affected by several climatic hazards such as flood and river bank erosion, storms, cold wave, drought and Char Chandia union of Feni district as the exposed coast of the Bay of Bengal and is also subject to multiple hazards in every year. The continuous efforts for coping with hazards have made the life and livelihood of the charland women very different than that in other areas of Bangladesh. The present study attempted to explore the coping strategies for climate induced disasters by the charland women in Bangladesh. The coping strategies of both types of *char* land women are influenced by their activities, knowledge, culture, social norms, skills, resources as well as their experiences. Different tools of Participatory Rural Appraisal (PRA) such as seasonal hazard calendar, seasonal livelihood calendar, ranking of hazard impact matrix on women activities at household and community level were used and interviews at household level were conducted. The study identified that women play a crucial role in local coping strategies in both the char lands to protect their houses, homesteads areas, other physical structures and their livestock, crops and managing their financial needs, drinking water collection, sanitation, meal preparation and cooking, caring of children and family members and other daily activities to live with multiple disasters. The women of the sites have different types of capacity and experiences to cope with the different types of hazards to reduce their vulnerability.

Keywords: *Charland women, climatic hazards, coping strategies, vulnerability*

Positive Impacts of COVID-19 on Environment and Biodiversity of Bangladesh

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Coronavirus disease 2019 (COVID-19) being a global pandemic has affected almost the entire globe. Despit peoples death toll and economic recession it has some positive impacts on Bangladesh environment as well s biodiversity. Air pollution and greenhouse gas emissions have decreased to a greater extent in Bangladesh which has been evident from different environmental agencies and daily newspaper. The wild animals and different sea creatures are surprisingly returning to and also reclaiming their previous habitats occupied by humans and some of them started to breed in a peaceful environment which will save them from the brink of extinctions to some extent. The COVID-19 has created the opportunities to adopt and rebuild a sustainable, greener, low-carbon and resilient Bangladesh.

Climate Change, Disaster and Gender Vulnerability in Bangladesh

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Gender-specific climate change, its effects and resulting insecurity, magnifies the current differences between men and women. Owing to their gender-differentiated positions and absence of access and power over wealth, women are the most affected. In order to minimize the degree of adverse consequences, identification of weaknesses and risks in the face of shifting climates is of paramount importance for better decision-making. Standard risk evaluation approaches are essentially based on the common usage of participatory instruments that include qualitative measurement of socioeconomic assets and may not provide access to the total gender level of the vulnerability associated with climate change. Bangladesh has become associated with natural disasters caused by climate change. Not only does climate change need significant technical solutions, but it also has political and socio-economic consequences that have consequences for policy and practice in progress. Many of its manifestations underlie issues of globalization, equality, and the allocation of healthcare and power, and its impacts are not only extreme, but also unevenly dispersed. There are some strong correlations between gender and the environment, both positive and negative. The environmental effects of climate change impact men and women differently. Research shows that disasters strengthen, exacerbate and increase gender disparity, worsening women's bad situations. The most vulnerable group to experience such disasters is people of all classes, particularly the poor. In addition, poor women are seriously affected by the climate change-induced environment when compared to men. A number of high-profile catastrophes have recently occurred in Bangladesh, including the disastrous cyclone Amphan and annual floods. Poverty is both a source of vulnerability and a result of the effects of hazards. Evidence that the affects of disasters on women are greater is inconclusive or variable. In emergency situations, we need to think about the position of women, their particular vulnerabilities and coping mechanisms. Women are more seriously affected, however surreptitiously endure their weakness and rarely display any remonstration. These show that the impact on women of climate change-related incidents are very noticeable relative to their men equivalents. In the build-up to the World Summit on Sustainable Development (WSSD), examples of women campaigning for progress around sustainable development issues show how women's engagement will transform into more gender-sensitive outcomes.

Detection of Urban Surface Water Bodies in Chattogram City by using GIS and Remote Sensing Techniques

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Surface water is the most recognizable part of the water cycle such as rivers, lakes, and reservoirs etc. that influence the ecosystem and climate significantly. The aim of the present study is to investigate the spatiotemporal changes of urban water bodies in Chattgram city for the period from 2000 to 2020 by using Landsat 5 TM and Landsat 8-OLI satellite images from the United States Geological Survey (USGS). In this context, different indices were tested including Normalized Difference Water Index (NDWI), Modified NDWI (MNDWI) to extract surface water. These methods are scientifically used to classify the data into two categories consisted of water and non-water objects. The procedure derives the Normalized Difference Water Index (NDWI) from high resolution, multi-spectral imagery to detect the surface water, and then incorporated vector-based data layers within a GIS environment to identify detectable water bodies. The NDWI is elicited from the different reflectance of water in the two channels of satellite images, (i.e.green and near infrared) and the equation of NDWI is (GREEN-NIR/GREEN+NIR). The result reveals the intensified and diminished water body areas of the region. Surface water body area not only conserved biodiversity but also retain an excessive amount of water during dry seasons. Authority can take sustainable practices to protect the probable vulnerability of the outcomes through change detection.

Keywords*: GIS, MNDWI, NDWI, Remote sensing, spatiotemporal*

স্বাস্থ্য ও পরিবেশ রক্ষায় শিক্ষার্থীদের হেঁটে বিদ্যালয়ে যাতায়াতের উপর একটি সমীক্ষা

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ঢাকা শহরের একটি অন্যতম সমস্যা হলো যানজট। কোভিড পূর্ববর্তী সময়ের কথা বিবেচনা করলে দেখা যাবে, বিদ্যালয়ে যাতায়াতের সময় এ যানজট তীব্র আকার ধারণ করে। এর একটি অন্যতম কারণ হলো অধিক মাত্রায় ব্যক্তিগত গাড়ির ব্যবহার। একটি শিশুর জন্য একটি গাড়ি ব্যবহার হওয়ায় এ সমস্যা প্রকট আকার ধারণ করে। শুধুমাত্র যানজট নয়, অধিক জ্বালানী ব্যয়ের কারণে বাড়ছে দূষণ। বর্তমান যাতায়াত ব্যবস্থার নেতিবাচক প্রভাব রয়েছে নগরবাসী, বিশেষত শিশুদের উপর। বর্তমানে শিশুদের পর্যাপ্ত শারীরিক কার্যক্রমের সুযোগ নেই। উপরন্তু ব্যক্তিগত গাড়িতে যাতায়াতের ফলে তাদের শারীরিক ক্রিয়া আরো কমে যায়, ফলে নানাবিধ অসংক্রামক রোগের আশঙ্কা বৃদ্ধি পায়। যান্ত্রিক যানবাহনের উপর নির্ভরশীলতার ফলে সৃষ্ট বায়ু ও শব্দদূষণ শুধুমাত্র পরিবেশ নয়, শিক্ষার্থীদের স্বাস্থ্যের উপরও নেতিবাচক প্রভাব ফেলছে। দীর্ঘ সময় যানজটে আটকে থাকার ফলে তাদের উপর মানসিক চাপ তৈরি হচ্ছে এবং তারা সৃজনশীল কাজের সুযোগ হারিয়ে ফেলছে। তবে বিদ্যালয়ে যাতায়াতে ব্যক্তিগত গাড়ি ব্যবহারের পেছনে কিছু কারণও রয়েছে। যার মধ্যে অন্যতম হলো নিরাপদ ও স্বাচ্ছন্দ্যময় হাঁটার পরিবেশ না থাকা এবং প্রতি এলাকায় সমমানের স্কুলের অনুপস্থিতি। বর্তমানে ঢাকায় ৩০% স্কুল ট্রিপ পায়ে হেঁটে হয়ে থাকে। ওয়ার্ক ফর এ বেটার বাংলাদেশ ট্রাস্ট এর গবেষণা থেকে দেখা গেছে, নিম্ন আয়ের এলাকায় প্রায় ৯৫ শতাংশ শিশু হেঁটে যাতায়াত করে থাকে। হাঁটার নিরাপদ পরিবেশ না থাকা স্বত্বেও তারা প্রতিনিয়ত ঝুঁকি নিয়েই যাতায়াত করে। হাঁটার নিরাপদ, স্বচ্ছন্দ এবং প্রাণবন্ত পরিবেশ তৈরির মাধ্যমে যেমনই হেঁটে যাতায়াতের পরিমাণ বাড়ানো সম্ভব, তেমনি বিভিন্ন অসংক্রামক রোগের ঝুঁকি কমিয়ে আনা সম্ভব। বিশ্ব স্বাস্থ্য সংস্থার তথ্যানুযায়ী, বর্তমানে বাংলাদেশে ৬৭% মৃত্যুর কারণ হলো অসংক্রামক রোগ। প্রয়োজনীয় শারীরিক পরিশ্রম অসংক্রামক রোগের ঝুঁকি কমিয়ে আনতে পারে বহুগুণে। হেঁটে যাতায়াতের মাধ্যমে যাতায়াত এবং শারীরিক কার্যক্রম উভয় চাহিদাই পূরণ হবে। পাশাপাশি শব্দ ও বায়ুদূষণ কমিয়ে এনে পরিবেশ রক্ষা করাও সম্ভব হবে।

Future land use planning in the context of COVID-19 Pandemic Situation in Bangladesh

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Review of status of land use in Bangladesh shows that the country is continuously facing rapid land cover and land use changes due to various anthropogenic and natural reasons. Rapid urbanization for increasing population, intensification of agriculture, industrialization, development activities, poldering, shrimp cultivation, brick manufacturing, surface and subsurface mining (gravel, sand, coal etc.), temporary shelters for forced migration etc. are some of the examples of anthropogenic causes whereas natural reasons include flood, cyclone with storm surge, erosion, landslide and infrequent earthquake events. Both human activities and natural processes influence surface-runoff, soil erosion, soil cover depletion, gullying, deforestation (afforestation as well), modification of landscape, subsidence, salinization of soil and water, obstruction to natural flood flow, water logging, sediment depositional pattern, liquefaction etc. Moreover, the country is combating challenges of sea level changes due to climate change and their consequences, and recently added COVID-19 pandemic. Changes are being taken place in various geological and geomorphological environments, and due to variation in their characteristics the effects are also varied. Such changes make different types of damages to natural environment and ecology – temporary (may be repairable), long-term and permanent. However, emergence of infectious disease like COVID-19 with global, deep and long-term impact has appeared as a great threat to the humankind on the earth. This pandemic has made an important issue visible that during land use planning process geological and geomorphological aspects should be given more weight than before, since it is feared that there might have relationship between land use and transmission of zoonotic diseases. Under the above context review of existing land use and relevant policies and strict implementation of those are needed. Because of its global impact, every nation should take careful steps in planning and monitoring in future, and share their knowledge and experience with others.

***Keywords**: COVID-19, land use, natural environment*

A Multi-criteria Analysis based Technique to Integrate Socio Economic and Geo-physical Aspects in Formulating Disaster Resilience Capacity Zoning: A Case Study on Galachipa and Rangabali Upazila of Patuakhali District in Bangladesh

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The operationalization of the concept of urban disaster resilience is an important milestone in understanding both the characteristics that contribute to urban resilience to natural hazards and the interactions necessary to build and maintain them. While much attention has recently been paid to measure resilience capacity to urban disasters, yet there is no optimal approach to operationalize the concept and therefore more empirical studies are needed on what constitutes resilience to disasters and how to assess it. Bangladesh is a developing and densely populated country and the urbanization process is increasing day by day in this country. But planned development is challenging here because is the largest delta in the world and her geographical location makes her naturally prone to disasters. Unfortunately, that's not the only issue to be worried, Bangladesh is also under the thread of global warming and climate change related issues. As because Bangladeshi land is not to high from mean sea level, sea level rise due to global warming may submerge most of the land area of Bangladesh. Although Bangladesh is not contributing much to global greenhouse gas increase, Bangladesh is one of the largest victims of the adverse impacts of global warming and climate change. To reduce the impact and damage it is necessary to formulate risk reduction land use zoning by incorporating socioeconomic and geo-physical aspects. Disaster vulnerability depends on two factors. Those are infrastructural strength and economic condition. Strong physical infrastructure ensures proper connectivity and safety, on the other hand strong economy helps to recover quickly. This study intended to integrate socio economic and geo-physical aspects in formulating disaster resilience capacity zoning with the help of multi-criteria analysis technique. These types of socioeconomic and geo-physical condition analysis can help making clear understanding on the study area for making risk sensitive land use zoning.

***Keywords**: Climate change, disaster, infractural strength, multi-criteria analysis resilience.*

Alam

দূষণ-দখলে জর্জরিত কীর্তনখোলা নদীসহ নগরীর খালসমূহ, বিপর্যস্থ পরিবেশ-প্রতিবেশঃ প্রেক্ষিত বরিশাল

মোঃ রফিকুল আলম
সদস্য, কেন্দ্রীয় কমিটি বাপা ও সমন্বয়ক, বরিশাল বিভাগ

বরিশাল অঞ্চলটি নদীবেষ্টিত এলাকা। ভৌগলিক অবস্থানের কারণে উজানের ৫৭টি নদীসহ উত্তর ও উত্তর-পূর্বাঞ্চলের বন্যার সমস্ত পানি এই বরিশাল অঞ্চল দিয়ে নেমে বঙ্গোপসাগরে মিলিত হওয়ার একটি ড্রেনেজ ক্ষেত্র। বলা যায় পদ্মা, মেঘনা ও আড়িয়াল খাঁর মিলনের ৩টি সাব-সেক্টর একদিকে লোয়ার মেঘনা-শাহবাজপুর ও ইলিশা হয়ে সন্দ্বীপ চ্যানেল হয়ে বঙ্গোপসাগরে মিশেছে, আরেকটি অংশ কালাবদর, তেঁতুলিয়া- আমতলী, লোহালিয়া, রাবনাবাদ, বুড়াগৌরাঙ্গ নদী সিস্টেম, আরেকটি আড়িয়াল খাঁ থেকে জয়ন্তিয়া-কীর্তনখোলা-বিঘাই-খয়রাবাদ নদী হয়ে ধর্মেগঞ্জ হয়ে পায়রার সাথে মিশেছে; সেই সাথে কুমার-ঘাঘর-বিষারকান্দি নদী হয়ে আড়িয়াল খাঁ-সন্ধ্যা-কচা-বলেশ্বর, বুড়িশ্বর, বিষখালী, পায়রা নদী; পাশাপাশি সমূহ প্রবাহিত হয়ে বঙ্গোপসাগরে মিশেছে। মূলত লোয়ার মেঘনা থেকে শুরু করে প্রতিটি নদীতে কোন না কোন স্থানে ডুবো চর রয়েছে, অধিকাংশ নদী হয় তার নাব্যতা হারিয়েছে নতুবা নদী তার গতিপথ পরিবর্তন করেছে। সমন্বয়হীন ড্রেজিং ও উপযুক্ত পলি অপসারন অব্যবস্থাপনার কারণে কোথাও কোথাও নদীর মাঝে চর পরে দু-তিন ভাগে বিভক্ত হয়ে ছোট নদী ক্ষীণ ধারায় প্রবাহিত হয়েছে। দক্ষিণাঞ্চলের বরগুনা, পটুয়াখালী ও পিরোজপুরে মধ্যে ছোট-বড় ৪২টি নদ-নদীর ৮২৯ কিমিঃ এলাকায় ডুবোচরের কারণে নদীগুলো স্বাভাবিক চরিত্র হারাচেছ। যার ফলে নাব্যতা সৃষ্টি, নৌপথ সংকুচিত, পরিবহণ ঝুঁকি, পরিবেশ-প্রতিবেশ ও কৃষিভিত্তিক অর্থনীতি হুমকী সৃষ্টি হয়। নদীর নাব্যতা সংকটের কারনে বর্ষাকালে উজানের পানির চাপ (হাউড্রোলজিক্যাল প্রেসার) সইতে না পেরে সৃষ্টি হয় ব্যাপক নদী ভাঙ্গণ। শুধুমাত্র নদী ভাঙ্গণের কারণে দক্ষিণাঞ্চল হতে প্রতি দিন প্রায় ১,২০০ অধিক মানুষ বাস্তুচ্যুত হচ্ছে, প্রতি দিন প্রায় ২ শতাংশ ভূমি নদীগর্ভে বিলিন হচ্ছে। পাশাপাশি জলবায়ুজনিত কারনে উপকূলীয় মোহনা বিশেষ করে তেঁতুলিয়া, ইলিশা, সন্দিপ চ্যালেন, পায়রা, বলেশ্বর, বুড়াগৌরাঙ্গ নদীর তলদেশ উচু থাকার কারনে ডিম ছাড়ার জন্য মা ইলিশ উপরে আসতে বাধাপ্রাপ্ত হচ্ছে। অপর দিকে শুষ্ক মৌসুমে সমুদ্রের লবণাক্ত পানির তেঁতুলিয়া নদী পর্যন্ত অনুপ্রবেশ ঘটে। এছাড়াও উপকূলাঞ্চল বিশেষ করে কলাপাড়া ও বড়গুনাতে পায়রা বন্দরকে কেন্দ্র করে কয়লাভিত্তিক তাপবিদ্যুৎ কেন্দ্র নির্মাণে টেংড়াগিরি সংরক্ষিত বনসহ পায়রা নদী, রামনাবাদ চ্যানেল ও আগুনমূখা নদী মোহন ঝুকিপূর্ণ অবস্থানে রয়েছে। বৈশ্বিক উষ্ণতার ফলশ্রুতিতে উপকূলীয় অঞ্চলের মানুষ উপর্যোপরি ঘূর্ণিঝড়, জলোচ্ছাসের ক্ষতি সামলে উঠতে না উঠতে পুনরায় তাদের আরেকটি ঘূর্ণিঝড় বা জলোচ্ছাসের মোকাবিলা করতে হচ্ছে। বিশেষ করে ভোলা, পটুয়াখালী, বরগুনা, পিরোজপুরের উপকূলীয় চরাঞ্চলগুলোতে এক ধরনের ভীতিকর পরিস্থিতি বিরাজ করছে। সম্প্রতি কীর্তনখোলা নদীর দখল-দূষণ চিত্রের তথ্যানুসন্ধানে এক জরিপে লক্ষ্য করা গেছে যে, কীর্তনখোলা ও আড়িয়াল খাঁ সংলগ্ন সায়েস্তাবাদ এলাকায় 'মলগিরি খাল'টি দখল করে মসজিদ, বাজার ও টোলঘর স্থাপন ও মৎস্য চাষা করা হচ্ছে। এছাড়াও দপদপীয়া এলাকা পর্যন্ত নদীর ৬টি পয়েন্ট বিভিন্ন শিল্প কারখানাসহ খোদ সিটি কর্পোরেশন এমনকি জেলা প্রশাসনের উদ্যোগে নদীর প্লাবনভূমির অংশ দখলকবলিত, অপর দিকে 'প্রাচ্যের ভেনিস' খ্যাত বরিশাল নগরীর ২৩টি মূল খালের মধ্যে ভাটার খাল ও নবগ্রাম খাল ২টি সম্পুর্ণ বিলুপ্ত, জেলখালসহ ১৮টি খাল দূষণ ও দখলের কারনে হয় অর্ধমৃত নতুবা মৃতপ্রায়। ২৫টি শাখা খালগুলো আজ ড্রেনে রূপ নিয়েছে। নগরীর স্যুয়ারেজ ব্যবস্থা না থাকাসহ সমন্বিত ড্রেনেজ ব্যবস্থার অভাবে সামান্য বৃষ্টিকে নগরীতে জলাবদ্ধতা সৃষ্টি হয়। অপর দিকে ৮টি শিল্প-কারখানার তরল রাসায়নিক বর্জ্য সম্পূর্ণ ইটিপিকে পাশ কাটিয়ে ড্রেনের মাধ্যমে খাল ও নদীতে নির্গমনের কারনে নদীর পানি ব্যাপক দূষণ সৃষ্টি হয়। তাছাড়া যাত্রীবাহি নৌযানের পোড়া তেল-মবিলসহ যাত্রী কর্তৃক নদীতে পলিথিন নিক্ষেপের ফলে বন্দর এলাকায় নদীর তলদেশে ব্যাপক পলিথিন বর্জ্য জমাটের কারনে সঠিক ভাবে ড্রেজিং পরিচালনায় বাধা সৃষ্টিসহ নাব্যতা সংকট ও ব্যাপক ভাঙন নদীর অস্তিত্বের আরোকটি হুমকীর কারণ।

FM Based Portable Disaster Awareness System

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Bangladesh is widely known as a land of natural disasters and is highly vulnerable to floods, cyclones, and river erosion. These disasters have become a regular phenomenon and cause suffering to millions of people in the country for many decades. During disaster our communication system severely hampers. Red Cross and CPP teams are working for to people make aware they using hand mick, whistle, etc. However, when all the physical means of communication go down, radio communication might be a good option for communication during that time. FM radio might be a good option in this regard. In FM broadcasting, the frequency of the carrier wave is modulated to encode the sound. A radio receiver extracts the original program sound from the modulated radio signal and reproduces the sound in a loudspeaker. Now a day's most of the rural people in Bangladesh use android and normal mobile phone, where all mobiles have FM radio features. A portable FM transverse device needs to introduce. Using this device a government licensed Radio operator can make a station in the affected area and that can transmit all information using a selected frequency so in that areas people can easily get any information by using their FM radio in their mobile phone. It is also possible to use SSTV stands under this system for Slow Scan TV. This will allow us to send images as data to each other radio. To send and receive messages, it needs to connect our radio rig to a computer for using a software to send and decode images.

Keywords: *Communication, disaster, FM radio, SSTV*

Alam

Formulating Disaster Resilience Capacity Zoning for Galachipa and Rangabali Upazila, Patuakhali using Multi-Criteria Analysis Based Technique for Integrating Socio Economic and Geo-Physical Issues

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The operationalization of the concept of urban disaster resilience is an important milestone in understanding both the characteristics that contribute to urban resilience to natural hazards and the interactions necessary to build and maintain them. While much attention has recently been paid to measure resilience to urban disasters, as yet there is no optimal approach to operationalizing this concept and therefore more empirical studies are needed on what constitutes resilience to disasters and how to assess it. Bangladesh is a developing and densely populated country and the urbanization process is increasing day by day in this country. But planned development is challenging here because is the largest delta in the world and her geographical location makes her naturally prone to disasters. Unfortunately, that's not the only issue to be worried about, Bangladesh is also under the threat of global warming and climate change related issues. As because Bangladeshi land is not too high from mean sea level, sea-level rise due to global warming may submerge most of the land area of Bangladesh Although Bangladesh is not contributing much to global greenhouse gas increase, Bangladesh is one of the largest victims of the adverse impacts of global warming and climate change. To reduce the impact and damage it is necessary to formulate risk reduction land use zoning incorporating socioeconomic and geo-physical aspects. Disaster vulnerability depends on two factors. Those are infrastructural strength and economic conditions. Strong physical infrastructure ensures proper connectivity and safety, on the other hand strong economy helps to recover quickly. This study intended to integrate socio economic and geophysical aspects in formulating disaster resilience capacity zoning with the help of multi-criteria analysis technique. These types of socioeconomic and geo-physical condition analysis might be helpful for making clear understanding on preparing risk sensitive land use zoning.

Keywords: *Climate resilience, climate change, capacity zoning, infrastructural strength; multi-criteria analysis*

Evaluation of Groundwater using Single Cell Thana Model for Pirgachha Upazila of Rangpur District

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The country has a unique position at the downstream end of three major rivers: Ganges, Brahmaputra and Meghna (GBM). The flows of the three rivers drain into the Bay of Bengal. In this basin where Teesta River is flowing around Pirgachha Upazila at the north-western part. The upper aquifer of this upazila is directly connected with the river which has a significant role of aquifer recharge. The model, which is used in this study, is Single Cell Thana Model was developed for the simulation of groundwater resource potential on a Thana basis. In Bangladesh, water is mainly used for irrigated purposes and particularly in a large urban area where consolidation has seen tremendous growth during the past 25 to 30 years. In the agricultural sector, this has led to large scale coverage of irrigated cropping during the Rabi season (15 October-15 March) and enormous growth in food production. It has been recognized that Bangladesh experiences water shortage in the dry season and water abundance in the wet season which disrupts significantly the agro-environmental practices and socio-economic activities of the country. Nowadays the actual condition of the north-western part of the country especially in the study area is touch-and-go. To address the problems encountered due to such water shortage, co-operation in the co-basin countries is needed, as well as proper utilization, conservation and development of water resources has to be practiced and urgently need to be recognized the actual synopsis of the groundwater.

Keywords: *Groundwater, river, single cell thana*

Integrated Solid Waste Management Master Plan for Narayanganj City Corporation of Bangladesh

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The present situation of direct dumping of waste without proper inspection and separation leaves a serious impact on environmental pollution resulting in the tremendous growth of health-related problems. As there is a significant link between the improper management of urban solid wastes and environmental pollution, domestic, industrial and other wastes are causing environmental pollution and have become perennial problems for mankind. The generation of a huge amount of solid waste and its mismanagement has become one of the major concerns social and environmental issues in both urban and rural areas in Bangladesh. Narayanganj City is no exception. Narayanganj City Corporation, which is predominantly an industrial area is one of the most populated urbanized areas of Bangladesh with a population of 7, 09, 381, and almost 10,000 people per sq. kilometer. A huge quantity of industrial waste is generated here daily, estimated to be around 120 to 125 tons every day. Out of which about 50% is disposed of in the landfills and the rest left unattended and locally dumped. The NCC Solid Waste Management project is targeting the protection of NCC city dwellers for the prevention of diseases, as well as the promotion of hygiene and proper sanitary standards. In line with developing a solid waste management system, it is planned to construct a new infrastructure facility covering a sanitary landfill and a material recovery facility. Sanitary landfill will be the near-term foundation of the integrated waste management disposal system, which over the long-term will include an appropriate level of materials recovery, and composting, based on market conditions for materials, soil amendment, and energy. The area of the project site is 23 acres. The project site is proposed in Siddirganj Jhalkuri Road considering its transport, locational suitability. As there are no major sensitive environmental receptors (such as hospitals, schools, etc.), physical cultural resources on-site, or in its proximity the proposed landfill is suitable for the City Corporation considering its socio-economic benefits for the community and also reduction of environmental hazards by solid waste management.

Keywords: *Community, environmental hazard, solid waste, sanitary landfill*

Heavy Metals Contamination in Ground water and Probable Health Risk Appraisal: A Review

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Groundwater has been recognized globally as one of the major reservoirs of freshwater. However, the quality of groundwater depends on the occurrence of various chemical components, which are influenced by the recharge and geological characteristics of the aquifer. The fate and occurrence of toxic components in groundwater from point and non-point sources result the contamination and have serious ramifications in public health. The aim of this study is, therefore, to comprehend and scrutinize the possible source of heavy metals contamination in groundwater, controlling factors, probable health hazards, and risk evaluation. It is reported that over the last decades, a notable steady decline has been observed in the quality of groundwater because of several anthropogenic activities such as excessive extraction, encroachment, farming activities, urbanization, and industrialization. Furthermore, groundwater is also contaminated by various trace elements derived from erosion and weathering of rocks, wastewater discharges, landfill leaching, mines, and geothermal waters. Hence, these contaminants profoundly asserted consequential health jeopardy due to their toxicity, persistency, and carcinogenicity. Heavy metals or trace elements are the significant contaminants that affect groundwater quality and pose a culminating health risk to mankind. Although certain trace elements e.g. cobalt (Co), zinc (Zn), iron (Fe), copper (Cu) are indispensable for the human body in permissible amount, high intakes can lead to untoward health effects such as; shortness of breath, cancer, asthma, gastrointestinal problem, neurological malady, vascular illness, lung disease, and reproductive effects. Besides, exposure to particular toxic heavy metals such as lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr), beryllium (Be), arsenic (As), manganese (Mn), nickel (Ni), etc., can lead to various chronic diseases such as high blood pressure, liver seizures, kidney disorders, skin inflammation, and so on. However, there are several indices which may assist to appraise the groundwater quality and human health risks such as water quality index (WQI), heavy metals evaluation index (HEI), heavy metals pollution index (HPI), degree of contamination (DC), corrosion and scaling index (CSI), hazard index (HI), and carcinogenic risk in terms of ingestion (CR_{ing}). Thus, monitoring and assessment of heavy metal concentrations by using these indices in groundwater are very essential in order to ascertain threats to human health.

Keywords: *Carcinogenic, groundwater, health hazard, heavy metals, risk assessment.*

Immeasurable Water Flow in Assasuni and Koyra Upazilla: people's Unfolding Stories in the Coastal Area of Bangladesh

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Bangladesh is known as a disaster prone country. People who are living in the coastal area are considered as the most sufferers. Every year, a lot of people are turned to be homeless and losing earning sources because of cyclones and tidal waves. Environmental Justice Foundation Charitable Trust (EJF), a registered charity in England predicts, “By 2050, with a projected 50 cm rise in sea level, Bangladesh may lose approximately 11% of its land, affecting an estimated 15 million people living in its low-lying coastal region”. Now the reality has become visible. Aila, Sidr, Amphan, and many other cyclones have changed the scenario of the Coastal areas in Bangladesh. People of many coastal regions are yet now suffering in their living and regular life. In 2020 Immeasurable Water Flow, a new catastrophe has evident in coastal areas specially Assasuni and Koyra Upazilla. This paper is prepared through both quantitative and qualitative approaches by using primary and secondary resources. This paper is focusing on the unfolding stories especially the dilemmas and suffering of the people in coastal areas of Bangladesh for Immeasurable Water Flow.The immeasurable Water Flow breaks many embankments of Sriula and Protapnagar union of Assasuni Upazilla and Uttar Bedkashi Union of Koyra. This situation is now out of control and almost whole areas have filled up with water. The situation was seen after many cyclones but it's normal all over the year. In these areas, thousands of people have lost their lands, collapsing housing systems, destroying roads, increasing salinity, and inadequate safe water, collapsing sanitation system, increasing insecurity in health, education and so many sectors. Those people who have the ability to resettle, are migrating. But, those have not, their sufferings are knowing no bounds.

Keywords: *Coastal area, cyclone, water flow*

Introduction of Invasive Exotic Fish Species Pterygoplichthys spp. : A Potential Threat to Aquatic Ecosystems of Bangladesh

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*Pterygoplichthys spp.(*Family : Loricariidae, Order : Siluriformes) is not a Bangladeshi native fish species; it's native to the Amazon river basin and figured out as one of the most effectual invasive taxa due to achieve it's global distribution. Though being familiar as an aquarium fish species, it has been first reported during 2007 in the native ecosystem of Bangladesh, which is a matter of increasing concern as this types of invasive alien fish species may cause the greatest threats to native commercial fishery ecosystems and unique indigenous aquatic biodiversity. The main objectives of this paper is to highlight all probable socio-economic and environmental threat that may be created in future by this fish species in terms of aquatic ecosystem of Bangladesh for wising up government and proper stakeholders as well for concernment and to give apt recommendation of this fact by analyzing it's typical features and invasive biology, global distribution, impacts of distribution in different regions worldwide, scenario of Bangladesh and it's a control mechanism. This paper has been done by surveying all available scientific literature on *Pterygoplichthys spp*. The findings of this review are that this opportunistic invader can reproduce rapidly, consume large amounts of food which disrupt aquatic food chain , keep impact on the native species and also on the surrounding environment ; due to this terror fish species report on fishermen's economic loss also has been found. Though this species has been found in local ecosystems of Bangladesh, the effects of this introduced fish has not been properly assessed. More research is needed to record the number of this species existing in the country's environment and finding out their impact on the native ecosystem. Creating awareness among people, government surveillance, trans boundary management with neighboring countries are important for lessening the risk of this invasive alien species.

Challenges of Disaster and Human Security Management: A Case Study on SIDR

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Super cyclonic storm 'SIDR' was formed in the central Bay of Bengal and eventually made landfall in the south-western part of Bangladesh on 15/16 November 2007 causing a death toll of approximately 4000 and damaged property of about $ 450 million USD. The damage was very extensive. Many have described the damage as being even worse than that from the 1991 cyclone. The whole country was united for the cause of 'SIDR' in the name of 'Operation Ashar Alo'. This research is basically exploratory in nature following a mixed approach (both qualitative and quantitative), based on both Primary and Secondary data. The methods involved in the present study were survey, experience, observation, data collection and appropriate data analysis. Primary data were collected from serving experience, observation, different reports and opinions of the affected people. Secondary data were collected from printed documents, internet information, books, and journals etc available on Sidr. The paper made an endeavor to initially describe the horrific consequence of 'SIDR' in Jhalokathi district, then analyses how Bangladesh Armed Forces encountered post-SIDR initial challenges of disaster and human security, then it highlights midterm and long term challenges accomplished under critical scenario and at the end, derives important takeaways to formulate disaster and human security management strategy for future.

Keywords: *Cyclone, disaster, SIDR*

Potentials of abandoned service corridors of Government housing projects in Dhaka city

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In 1961-62, proposal for Government Housing projects was done in policy level. National Housing Authority (previous HSD), Public Works Department (previous C&B) and Rajuk (previous DIT) were involved in designing Government housing in site and service scheme. About 18 housing projects were completed by these authorities. It has so far established 34 housing estate throughout the country with all civic and infrastructure facilities. However, service corridors in the hpousing projects were provided to collect solid waste from individual residence that was located backside of the house. After providing sewerage line these service corridors were abandoned and have became a basin for garbage dumping, container of waste water, source of mosquito production, shelter of rats as well as a dirty corridor to pollute the environmental and social pollution. In some cases this is used illegally by some informal source of income. This paper aims to study the scope and potentials of these neglected corridors. For this, two type of data were required (i.e., identifying the previous Layout of the housing cluster to mark the service corridor and to find out their present condition). Both secondary and primary data were collected for the present study. Secondary data were collected from Government housing authority of the study area and from reviewing existing literature. Primary data were collected by direct observation with a observation check list, Key Informant Interview with representative of concerned authority and inhabitants of housing to understand the changing scenario of these corridors. Collected data were analyzed to synthesize the results. The results of the study shows that some service corridors are grabbed by adjacent plots, some are used as source of pollutants and some are used as informal business in Housing Estate at Mohammadpur in Dhaka. National Housing Authority is the owner of the housing. But there is not sufficient found to take propoer initiatives for these linear service corridors. However, there is a lot of possibilities to convert this dirty corridors as resource of recreation and income by cleaning, designing and policy level planning for improving the environmental and aesthetic value of the housing.

***Keywords**: Government housing, policies, planning, service corridor,*

Destiny of Incidental Open Spaces in Government Housing Projects in Dhaka

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Open space provides an array of social, health, economic and environmental benefits to individuals and to the community as a whole. Open space is an essential ingredient for enhancing the livability of an area and improving the quality of life of its residents. Open spaces in neighbourhood level is classified as play lot, playground, play field, park and incidental open spaces. Since 1959, Government has developed about 18 housing projects under the Site and Service Scheme in Dhaka. As a basic element of neighborhood, open spaces were part of these housings. The stock of open space is found to be declining in Dhaka during the last 20 years by unplanned construction and encroachment. Many parks and playgrounds have already been grabbed mostly by governmental organizations and a few of them by non-governmental organizations. This research is aimed to study the layout type, number of incidental open spaces in the approved master plan and their present condition of Housing Estate at Mohammadpur. Also it finds out their changes in term of layout type , number, use and identify the factors responsible for changes of selected incidental open spaces. Both primary and secondary data were used in the study. Secondary data were collected from Government housing authorities of the study areas, literature review and Google image. Primary data were collected with direct observation with a observation check list, Key Informant Interview (KII) with representative of concerned authorities. The study reveals that most of the incidental open spaces are converted into plots, some grabbed by adjacent plots, some are partially grabbed and changed into plots and a few of them are partially remain unused. Conversion occurred with the involvement of the allocating authority and their interest. The incidental open space those are survived in small size may be designed as green corner and grabbed area may be revived. Learning from this findings would be helpful to understand what type of incidental open space should be designed that would not have scope of grabbing and how to protect and use this type of open space.

Keywords: *Destiny, incidental open spaces, Government housing project*

The Intensity of Environmental Hazards and Risks in Dhaka City based on Social Perceptions of City Dwellers

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Dhaka, the megacity of Bangladesh, has been grown up as an unplanned and unprecedented development where accommodated 60% of the urban population of Bangladesh. Due to the overpopulation and congested settlements, the city has already lost its scenic beauty but accelerating excessive hazards and risks. This paper examines the social perceptions against the existing overall environmental hazards and pollutions of different residential areas of Dhaka Metropolitan area. The empirical data were collected through a semi-structured questionnaire from 180 households survey. The findings of the study reveal that the residential areas are unequal in facilities and more vulnerable to environmental hazards. Furthermore, various pollutions have become common environmental phenomena of residential areas for unruly behaviors of dwellers and mismanagement of respective authorities. Lack of open space is a burning question for the city dwellers, which causes a ventilation crisis. Moreover, slum dwellers are more deprived and living in unhygienic conditions, making them more prone to fire hazards and health disorders. The study suggests that policymakers and city corporation authorities should be more concerned and implemented proper initiatives about multifaceted issues for creating a sustainable environment for city dwellers.

***Keywords**: Environmental hazard, pollution, social perception, slum*

Climate Crisis: Bangladesh Perspective and Our Action

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Earth is one and only planet in the universe which is suitable for living. But the earth, we have today, was not exactly the same in the past. And also observing current consumption pattern of human beings, we fear that the situation will worsen in future. Climate change has emerged as one of the major concerns of the present world. Scientists have found out that, human kind is largely responsible for global warming. A major cause of rapid global warming is the emission of carbon dioxide and other greenhouse gases. People around the world burn fossil fuel (coal, oil and gas) for energy. As a result greenhouse gases are released into the atmosphere. By burning fossil fuel and leading an unhealthy and non-environment friendly life people are instigating climate change. In addition various natural calamities such as flood, drought, intense storms, and wildfires are attacking frequently. Those, in turn, cause famine, water scarcity, epidemic and sometimes war. Climate change must be considered a crisis and an alarming threat to the living beings on earth. Though climate crisis is a major concern worldwide but low lying countries like Bangladesh are in greatest threat. Bangladesh uses very little fuel and thus does not make a significant contribution to the climate crisis. However, Bangladesh will be one of the most affected countries. Rapid and large reductions in greenhouse gas emissions need to happen very soon in order to prevent the worst damage to our planet. Bangladesh is need to send messages to the wealthiest people on the planet about the need to curtail their emissions in order to save the world for all of us. Although our actions will not save Bangladesh, we can lead by example. People are more likely to listen to us if we change our own behavior, showing that reduced emissions do not mean lower quality of life. Avoid using cars and motorbikes, choose fuel-free transport, walking, cycling, and rickshaws are some of the measures to tackle the issue. We can promote tree plantation instead of building factories in the name of economic growth (which also emit greenhouse gases). We should give up using plastic bottles or box, avoid wasting energy take the stairs instead of using the lift.

***Keywords**: Climate change, fossil fuel, greenhouse gas, transportation*

The Imperatives of Avoiding Plastic Products for Public Health and Environmental Protection

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Plastic (one time use) products are not environment-friendly and due to production and trashing in the city's drainage system, plastic pollution is created in water, environment, air and land. It is dangerous for public health. The government has to spend huge amount of money to manage and remove these plastic products. Plastic waste is a threat to animals, marine life and the environment. Howevr, to reduce the expenditure on health and to achieve SDG's target level, it is necessary to stop the use of plastic products. To prevent public health and to control the soil, environment and environment pollution, plastic product use has to be stopped and concentration should be on using metal accessories. Our traditional pottery utensils can be used with aluminum, steel, brass. Water bottles can be metal or glass. It can be hazardous to public health, unless proper measures are taken to prevent such plastic from the government level. The Institute of Wellbeing Bangladesh is working on making people aware of the harmful effects of plastic products. They have been campaigning in many universities of Bangladesh. This campaign's work needs to be more dynamic. The aim of the campaign's is encouraging people to use glass, ceramic, metal and various utensils made from clay instead of plastic.

***Keywords**: plastic, public health,*

Environment-Friendly MICP Technique to Stabilize Deltaic Soils of Bangladesh

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Bengal Delta is the largest delta in the world occupying about 35% of the total land of Bangladesh. Floodplains of the deltas are formed by sandy deposit. Due to the unavailability of other suitable construction materials, roads, coastal/flood embankments etc. need to be constructed mainly using silty sand collected by dredging from riverbed or floodplain. However, these dredged materials are highly erodible and continuous maintenance is required for infrastructure constructed with such soil. To improve the durability of such constructions, it is necessary to stabilize this type of soils. Different methods such as stabilization by cement and lime are among many practices. Unfortunately, these are expensive methods and not environment-friendly on the contrary causes greenhouse gas emission. In recent years, Microbial Induced Calcite Precipitation (MICP) technique has grabbed attention of the geotechnical engineers all over the world for its eco-friendly, sustainability and cost effectiveness. MICP is a natural method by which soil can be stabilized by precipitated $CaCO_3$ inside the soil pore depending on the metabolic activity of bacteria. Till date, MICP has confirmed its applicability in stabilizing different types of soils, mainly sandy soils, in many micro and macro level experiments. In this study, the suitability of MICP in stabilizing deltaic soil of Bangladesh is analyzed based on available past researches. To assess the feasibility of MICP for the proposed purpose, improvement in strength and permeability characteristics of similar types of soils used in different studies are summarized. Cost-effectiveness and environmental impacts of this technique are also assessed. An effective field application methodology is suggested for stabilizing deltaic soils. Use of this MICP technique can be extended to different civil engineering applications such as road and embankment construction, strengthening of foundation of existing infrastructures like dam, coastal/flood embankment.

Keywords: *Delta, floodplain, soil stabilization, MICP*

Creating Youth Leaders to Address Climate Change

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Throughout the world, it is young people who are leading movements to address various social problems, including the climate crisis. Students can be effective activists, but they need appropriate information and techniques to channel their energy and concern for the future. We have started the Bangladesh Youth Climate Network as a forum to engage and educate youth to take action to push high-emitting countries to reduce their emissions and thus reduce the climate crisis. We regularly conduct youth leadership trainings and organize international and local seminars to bring different youth together to learn about the climate crisis and learn how to take action. We also are starting a youth ambassador program to encourage youth to take the lead within their educational institution. Youth as social agents are vital for a healthy future and planet.

***Key words**: climate change, youth, leadership, activism*

Coastal Tourism and Its importance of Bangladesh

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Abstract

Bangladesh is the largest deltaic country all over the world. It has lots of off-shore and coastal area and it has most potentiality. This deltaic country is full of natural sceneries, cultural, historical and archeological beauties for local and foreign tourists. This paper shows how much significant is coastal tourism on GDPs and find the most potentiality of the off-shore island of Bangladesh. Coastal Tourism has become a very emerging and the fastest growing industry both in the foreign and local blue economy, and particularly in the coastal countries. Besides, the World Tourism Organization (UNWTO), the specialized organization of the UN for tourism has emphasized on sustainable use of marine resources for tourism development, which will contribute to achieve Sustainable Development Goals (SDGs) within 2030.

Keywords: *Coastal Tourism, Shape, potentiality, Blue economy, Tourist, culture, sustainable development.*

Rethinking the Values of Culture and Norms in Development of Haor Basin

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Adverse impact of climate change has started posing a serious threat to the nature conservation and preservation believes and norms in the Haor basin of Bangladesh. The changes in weather have altered the characters of months in a calendar that makes many cultural practices 'not fitting with the day'. The environment and state of ecosystem in a month described in the Baromashi song of Haor areas are no more representing the character of the calendar months. Many norms in the Haor basin are based on or associated with the local biodiversity. The people of Haor gain their livelihoods from wetland and floodplain resources such as fish, swamp forest, reeds, aquatic fruits and vegetables, and wildlife. The objective of the study was to identify the impact of climate change and environmental degradation on the local culture and norms and its resulted consequences. Direct field observation and community consultations were conducted in the year 2020 in the Media Haor of Nasirnagar Upazila under Brahmanbaria District. Sustainable harvesting of the natural resources was a part of culture of the community. Due to the environmental challenges and climate change impact many norms and practices are being forgotten, not in practice and or modified. The number of the secret groves in the Medir Haor has been reduced by half and also the size of the area; thirty-six fauna were recorded from a secret land of that Haor. Around 15 species were found conserved in the Medir Haor because of cultural norms, unfortunately population status of those culturally conserved wildlife is rare locally. The development interventions are not that proactive towards the environmental betterment. Moreover, the cultural norms and practices are not well documented. Sustainable nature conservation approach must be a holistic approach, where the anthropologic attention must not miss the facts of natural science. In the culture of a community the science and management of ecosystem are blended as norms. Development guiding documents which are considered as living documents in policy, like the Bangladesh Delta Plan 2100 and Bangladesh Climate Change Strategy and Action Plan, etc., must consider the value of the culture and norms in planning development actions.

Keywords: *Wetland, culture, climate change, biodiversity, development*

Assessment of Urban Cooling Island Variation on Urban Microclimate as well as on Urban Planning and Environment: A spatio-temporal analysis in Chittagong City

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The rate of urbanization is accelerated dramatically in Bangladesh, and it triggers noteworthy changes in the urban microclimate condition. Urban Heat Island (UHI) is one of the drastic changes of urban microclimate condition which ultimately generates Surface Urban Heat Island (SUHI). However, Urban Cooling Islands (UCIs) can be treated as a significant compensator to control this alteration. The variation in UCIs (specifically green spaces and water bodies) have a profound impact on the urban microclimate and can play a serious role to reduce the intensity of this alteration. The aim of the study is to identify the changing thermal behavior of the Chittagong City Corporation (CCC) area by assessing influence of urban cooling island (UCI) effect on Land surface temperature (LST). As an outcome of the study, it is expected that the change detection in surface urban heat island (SUHI) and LULC (land use land cover) types will be more conducive for the reduction of urban temperatures leading to SUHI mitigation. To fulfill the objectives, Landsat L1TP satellite images has geometrically and topographically corrected along with radiometric and atmospheric correction (DOSI) in semi-automatic plugin of QGIS. NDVI, NDWI and land surface temperature has also been calculated. Moreover, extraction of land surface temperature values and land use land cover map has been prepared by using supervised classification technique. The research reveals changing trend and present condition of urban cooling islands, as well as spatial and temporal variation of thermal behavior within the city. It is utmost important for the city planners to take necessary steps to increase the green spaces and waterbodies in the city areas to lower down the UHI impact. The results of the study might be an effective direction for urban land use planning and sustainable urban development by considering UCIs to mitigate severe thermal impacts and adapt with the urban microclimate change as well as with the changed urban environment.

Keywords: *Cooling islands, Landsat, microclimate, UHI*

Situation Study of Solid Waste Management of Rajshahi City Corporation

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Solid waste is increasing in Rajshahi city due to the growth of population, urbanization, higher per capita income and standard of living, changing lifestyle and food habits. There is a section in the City Corporation office named conservancy section, which carries out the works of solid waste management. About 150 ton of solid waste is generated in the city every day. The conservancy services of Rajshahi City Corporation are neither adequate nor satisfactory in managing the solid wastes of Rajshahi City. The wastes in the city are mainly of non-hazardous type and these are food wastes, weeds, ashes, papers, package, plastic bags, polythene, broken glass, tins, warm clothes and many other things. The collection, segregation, storage, transports and processing of solid waste needs planning and more investment. Clean city improves standard of living by reducing different diseases. Government and Municipal Corporation (MC) must encourage local management through collection, transport and segregation and disposal of solid waste. Public awareness and segregation at source, rules and regulations related to solid waste will bring good changes in solid waste management.

Keywords: *Lifestyle, Management, RCC, Solid Waste,*

Dust Bin Free Dhaka City – Establishment of Circulatory Dust Van for Dynamic Waste Management and Pollution Control Strategy

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On a contemporary situation, Dhaka city is facing enormous environmental crises. Waste generation and management is one of the alarming issues. Due to technological advancement the quality of daily life is improving, however resource consumption is increasing day by day at an irregular rate. As a result, waste generation rate is growing as well in Dhaka city. Dhaka South City Corporation (DSCC) and Dhaka North City Corporation (DNCC) both has all the responsibilities to accumulate & governing the waste. Both city corporation and their associates collect domestic waste from house to house. The collected waste dumped into a road-side open stationary dust bin through small vehicles followed by informal separation, load in a truck and dispose to the landfills. In this conventional system, road-side dust bins create different types of negative impact on human health and surrounding environment like emitting bad odor, chance of exposure to the pathogenic contaminants which lead to be a severe public health issue. This situation is now going to be exacerbated and uncontrolled.
On this circumstance, an emerging “Circulatory Dust Van” can bring a smart solution to solve this problem. A “Circulatory Dust Van” is a smart, dynamic and compacted van which has two chambers, one is for septic substances and another one is for non-septic substances. This van amasses waste from a specific zone in a certain periods of time by a circulatory dynamic way in the city. There will be some selected zone or transfer station where the van can collect the waste meticulously from the entitled small vehicles those collect waste from door to door. These small vehicles have portable cover; therefore, waste will have less chance of exposure to the environment. Circulatory Dust Van has significant “Emergency sirens” as like ambulance that helps to commute faster from transfer station to the landfill or final disposal destination where the collected waste can convert into energy through microbial degradation. The advantage of using this “Circulatory Dust Van” is no fixed dust bin will be needed on those particular zones as a result there will be no or less human health issues and surrounding environment will be neat and clean. Circulatory dust van system mitigate nuisance, odors from roadside waste. It will bring green vibe throughout the surrounding environment. Collected dust will be used for landfill gas utilization Solid particle from waste will remove through incineration. Waste is the source of pollution so if we manage waste properly, it can help to mitigate pollution. it's a new concept for this modern dynamic world. As, the country is developing day by day, This concept will help to build a sustainable, smart and environment friendly city.

Keywords: *Dust bin, Dhaka city, waste management*

Access of the Urban and Rural Unprivileged People to Basic Needs

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In Urban Planning both rich and poor have similar rights to get basic needs because both dwellers contribution is necessary for a planned, well-established city. As a part of proper urban and rural planning the citizens are tobe provided with the basic needs such as water, sanitation, health care, education etc. The rich and privileged people can easily get those services as they have money, network, power, accessibility. But the scenario of the poor people is not so smooth in both rural and urban areas. This paper discusses on the condition of getting basic needs of the people, what are the obstacles they face while getting the services from people's perspectives. Providing services for the urban poor, compared with the rural poor, appears to be more challenging because of the population density in slum areas, where the urban poor usually live. The challenge is there, but the government needs to understand that it is not any fault of the urban poor, but for the failure of the government to reach them. When local government agencies have been able to significantly reduce maternity and neonatal death and to implement immunization programmes in slums, it is unacceptable that they cannot make basic services available in slums. Such negligence to the urban poor also stems from a flawed poverty reduction policy where approaches have been focused on rural areas while millions of the urban poor, as studies show, have been left out of poverty reduction plans. Being excluded, the urban poor are increasingly surrounded in problems such as low-quality housing, inadequate drinking water, absence of drainage and sewerage facilities, pollution and congestion along with an increased number of homeless people. This paper discusses what are the assigned services for the poor and unprivileged people, how much plan are implement by authority and showing a clear compared study of prevailing condition of urban and rural unprivileged people and proposed solutions based on urban and rural perspective. This paper focuses on the theoretical plan and practice of scenario about the getting of basic needs of the unprivileged people. A problem has multiple solutions.

Diversified Role of Social Media in Increasing Climate Change Awareness among Youths in Dhaka City

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In the present time, climate change is one of the alarming issues that calls for immediate actions from the authorities and common people. For the first time in the history of the earth, the fact has been established that human inhabitants are responsible for altering the climate of the earth through the emission of greenhouse gases. The overall range of effects due to the human influences of climate change is not fully understood even though the basic science is now clear. The fact is known that the impacts of climate change will be more significant in the next hundred years. Best estimates predict a rise of 1.8ºC and 4ºC in the average global temperature. Climate change awareness is one of the crucial indicators of ensuring positive climate actions and limiting the rise in global temperatures. Although various kinds of media are working to establish greater levels of climate change awareness, social media is presumed to be one of the most effective one because of its wide reach in the technological realm and massive acceptance and approval among the youths. This study aims to contemplate the impact of social media in climate change awareness using a mixed methodology. Since Dhaka city is the central point of industrial activities and carbon emission, this unprecedented study has derived some intriguing outcomes. Due to rapid urbanization, industrialization and carbon emission, this city is contributing greatly to the temperature rise at the national and global level. Also, a majority of the city dwellers are youths who have the potential to achieve policy making role. The study is directed towards understanding the role of social media in climate change awareness by using quantitative survey conducted on 150 youths who were chosen through purposive random sampling. Also, key informant interview was conducted among 6 policy makers in order to find out their perception about engaging the youths using social media. The primary analysis reveals that the social media usage among the youths is prominent and they come across decent amount of climate change related information from social media. A majority of the respondents also find the climate change related information as credible and trustworthy which compels them to act on the issue more prominently. Furthermore, the qualitative part of the study reveals that the policymakers acknowledge the importance of engaging the youths in climate actions. This is why, they are willing to embrace social media as a prominent tool to increase climate change awareness among youths. Nonetheless, the process of mainstreaming social media in government policies and strategies is yet to be acknowledged.

"Time Series Analysis of Land Use Land Cover Change Induced Impacts on Land Surface Moisture and Temperature: A Remote Sensing-based Growth Dynamics Comparison Between Two Major Cities of Bangladesh."

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Economic growth being a boon to urbanization taking place with its concomitant formation of heat island, causes fractious effect on micro climate and surface runoff pattern. Proliferating built up area accounts for the surge of surface temperature in urban area while impeding the intrusion of rain water through the soil surface. This study aims to scrutinize the growth dynamic of two cities of Bangladesh, Barisal and Mymensingh, to understand the repercussions of Land Use Land Cover (LULC) change on surface moisture and surface temperature of the two cities. A comparative study was also conducted to apprehend the extent of urban growth of the two cities within the time period. Satellite imagery from 2005 to 2020 at an interval of 5 years in terms of Landsat 5 TM, Landsat 7, Landsat 8 OLC were exploited thoroughly to investigate the phases of Land Surface Temperature (LST), Normalized Difference Buildup Index (NDBI), Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI) over the time through ArcGIS, QGIS, ERDAS IMAGINE respectively. Time series analysis through IDRISI Selva was carried out to recognize the shifting of land use pattern being an indicator of urbanization transformation as to growth dynamics. One of the spatial analysis shows in Mymensingh about 37.56% agricultural land decreased and third-fourth of them was transformed into buildup area whether in Barisal about 21.78% agricultural land decreased and fourth-fifth of them was transformed into buildup area over a certain time horizon of 2005 to 2020 and as a result it's obvious that the urban growth dynamics is happening more swiftly in Mymensingh than Barisal. Statistical tools were utilized to observe the correlation and significance among the indices. The spatial operation depicted a change of 4.31% and 6.52% increment of built area for Barisal and Mymensingh respectively, which see to the escalation of surface temperature of 4.1°C and 5.8°C, respectively, which is ratified by an R^2 value of 0.887.

Keywords: *Urbanization, Land Use-Land Cover, Urban Growth Dynamics, Land Surface Temperature, NDBI*

Impacts of Plastic Shopping Bags and its Alternatives for Bangladesh

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A type of plastic bag made from various kinds of plastic that is widely used worldwide is known as plastic shopping bags or plastic grocery bags. It is used by consumers worldwide since the 1960s. At the same time, the plastic and plastic goods sector began its journey and has became an emerging sector in Bangladesh. Over the next four decades, plastic bags have been spread in the country at a huge rate. In 2002, Bangladesh has banned plastic shopping bags as the 1st country in the world. However, the present scenario is the same as before the ban on plastic shopping bags. Every day, 3000 tonnes of plastic waste is generated among which plastic bags are a major part. Some 14 million pieces of polythene bags are used every day in Dhaka city. These polythene shopping bags have a highly bad impact on the environment and health. After single-time use, plastic bags falls into the canal, drain, roadside, etc. The final destination of plastic shopping bags is in the ocean. It has been estimated that there will be more plastic than fish by 2050. Therefore, it is high time to look for an alternative to plastic shopping bags. There are good alternatives in the world and many countries are using these alternatives. For instance, cotton and jute can be the best alternative for Bangladesh. Moreover, paper, re-usable plastic, non-woven polypropylene (PP), compostable and woven polypropylene (PP), re-cycle denim bags, basket bags can also be the good alternatives of single-use plastic shopping bags.

Keywords: *Plastic, polypropylene, shopping bag*

Natural Disaster-Induced Displacement: An Empirical Study on Displaced Women in Dhaka City

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Natural disasters are particularly related with climate change. Now-a-days natural disasters are becoming one of the leading causes for forced displacement. It is worth mentioning that, the experiences of disaster-induced displacement consequence are different for men and women. The present study attempted to explore the experience of women after the situation of disaster-induced displacement. An exploratory survey was conducted to analyze the post disaster displacement situation and women contribution for their family sustenance, and how it impacts on their relevant issues. The findings of the study indicate that women are mainly clutch their family after disaster displacement situation through managing living place, income, making social networks, doing both public and private work, such kinds of way women are taking the family responsibilities on their shoulder to cope up with the disaster damage after displacement. Moreover, providing contribution of family it has some positive impact on women as changing their traditional role. Women are capable to involve in public world, increasing access to mobility, getting the opportunity to engage in income generating activities, and access to decision making power in family, these are the significant conditions for building a pathway of women empowerment. In this regard, after natural disaster related displacement women are changing the typical patriarchal rules and adopting new roles and responsibilities, which will help to build up the women agency and empowerment.

Keywords: *Agency, displacement, natural disaster, women's contributions*

Dharmadhikary

Sustainability Study for the Development of Inland Waterways between India and Bangladesh

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India and Bangladesh in 2015 agreed to make mutually beneficial arrangements for the use of their inland waterways for commerce purposes for the passage of goods between the two countries. Between 2015 and 2020, inland waterways connectivity has gained impetus in this region. New routes have been added in the Indo-Bangladesh Protocol routes for inland waterway connectivity. The movement of cargo increased from 1.65 lakh tonnes in 2015-16 (till December 2015) to 3.46 lakh tonnes in 2019-20. The importance of Indo-bangladesh connectivity through waterways has been contextualised with respect to the trade potential between the two countries. However, a small but growing body of literature also reflects on the need to situate the adverse impacts of the interventions associated with inland waterways within the realm of long-term sustainability of the riverine ecosystem. In this paper, we draw from the literature available with respect to the sustainable development of the waterways. We propose a comprehensive framework to investigate the sustainability of proposed and developing inland waterways between India and Bangladesh. Findings of this study help in building specific strategies for the development of inland waterways in this region.

Keywords: *Development, sustainability, waterways,*

Estimation of Missing Rainfall Data by Interpolation Techniques for Sangu River Basin in Bangladesh

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In meteorological and hydrological researches, rainfall data is an important climatic parameter and missing data is a serious problem in many climatologically time series. The problems of missing rainfall data were due to a shortage of the techniques used for estimation of rainfall datasets, transferring of the rain gauge stations and malfunctioned of the instrument. In order to estimate any missing observations in data, many techniques have been used in the whole world. However, the lack of previous studies on this topic for Bangladesh is a practical problem. Regarding this problem, this study is aimed to select a suitable method for the estimation of missing data and to validate the method. The interpolation techniques that have been studied for estimation of the missing data are the Arithmetic Average (AA) method, Normal Ratio (NR) method, Inverse Distance (ID) method and Coefficient of Correlation (CC) Method. Forty years (1973-2012) of daily rainfall data of the Sangu River basin located in the Southern region of Bangladesh were used for this study. For estimation of missing rainfall data, four rainfall stations of the Sangu river basins such as Anwara, Patiya, Satkania and Bandarban were used. For validation which method is the best in evaluating missing values of the rainfall data at the target stations using the rainfall from the neighboring stations (in the radius range of 60km) was verified. To estimate the missing values at the target station using the rainfall data from nearby stations, the analysis has been divided into four different percentages namely 5%, 10%,15% and 20% in order to represent various simulated cases of missing data. The performance of the best estimation methods was done based on the estimation error; with tests such as Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Correlation Coefficient (R) and S-index tests. This study result could be useful for hydrological research to complete the missing rainfall data, especially for rain gauge stations in the Southern regions of Bangladesh.

Keywords: *Coefficient correlation, interpolation technique, inverse distance, missing data, normal ratio*

Declining Rights of the Garo Indigenous People over the Sal Forest of Modhupur in Bangladesh

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The Modhupur Garh, a part of Pleistocene terrace area of central Bangladesh, is situated over the uplands of Mymensingh and Tangail districts of central Bangladesh. The region is famous for the dry deciduous sal (*shorea robusta*) forest and forest dwelling ethnic communities, especially the Garos. Although the gradual degeneration of the Modhupur forest commenced since the colonial period, the problem turned intense in 1956 after the official ban on jum cultivation (a form of shifting cultivation) by the then Pakistan government. Jum, the basic ingredient of Garo life cycle, was stringently forbidden by the then State of Pakistan and the hapless indigenous Garo community started to change their earlier lands for jum cultivation into crop fields like the Bengalis in the plains. Now-a-days, most of the forest land has been denuded, degraded and encroached upon or taken over for commercial or industrial plantation of rubber or fuel wood with exotic species. The forest was further proclaimed as a "reserved forest" in 1955 and some portion of the forest was marked as "national park" by 1962 while implying ban on free movement of the forest dwellers. It resulted in the collapse of centuries old female-forest relationship in the Modhupur *garh*. In recent years, the greens of Modhupur forest had often turned into vermillion red in the bloodshed of Piren Slan against government induced Eco Park project or a slain Chalesh Richil by army during the caretaker government regime in 2007. Apart from loss of collective rights of the indigenous people over forest resources, the gradual migration of the Bengalis from the plain land and tyranny of forest officials in the Modhupur forest area had largely changed the distinct status of women in the Garo matrilineal society to a large extent.

Keywords: *Indigenous, modhupur sal forest*

Applicability of Contemporary Tools to Increase Surge Capacity: A Study Identifying the Major Themes of Emergency Health Management Based On Lesson Learned From Recent Urban Disasters of Dhaka City

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Emergency health care management early after an urban disaster in response phase is one of the foremost integral parts of disaster management. From several urban disasters with heavy life toll, especially the fire incidents in last couple of years in Dhaka city emphasized on the importance of improvised emergency victim management with effective and modern health management systems to be implemented involving several steps and performance of various sectors. The respective study attempts to identify the lesson learned focusing on most important themes affecting the healthcare management in urban disaster scenario. Likewise, the paper scrutinized the plausibility of implications of three contemporary emergency health management tools to manage the urban disaster settings of Dhaka city.

The objective of the study is to identify the themes in emergency health care based on lesson learned from recent urban disasters affecting the healthcare management and to scrutinize the plausibility of implications of three contemporary emergency health management tools to manage the urban disaster settings of Dhaka city.

In the study qualitative methodology with a content analysis approach, in-depth interviews along with detailed and comparative case study on the most recent Churihatta (Chawkbazar) tragedy and Banani Fire are taken into account. Moreover, diverse resources were reviewed for the historical analysis linking the Rana Plaza, Nimtoli Fire and other incidents.

Nine major relevant themes affecting healthcare management in disasters were identified. These themes were related to human resources management, resources management, victims' transfer management, mental health control, inter-agency coordination, training, technology involvement, information and communication management. Amidst several tools, four contemporary tools/models were found effective in the context of Bangladesh: (i) Health Sector Self-Assessment Tool (Preparedness phase); (ii) WHO Emergency Preparedness Strategic Framework; (iii) Reverse Triage System (emergency response phase) and (iv) Public Health Preparedness and Response Core Competency Model Version 1.0 (preparedness and response phase).

In the context of urban settings like Dhaka city, providing effective emergency health care support in disasters requires a comprehensive look at the various aspects to tackle the primary surge of victims. Effective factors on the success of healthcare in disaster are not limited to the scope of healthcare. There should be a close relationship and interaction between different sectors of disaster management through comprehensive and contemporary models to fill in the gaps this study found evaluating these themes.

Keywords: *Victim management, emergency response, healthcare, disasters, fire, urban disaster.*

Addressing the impact of climate change in the coastal areas of Bangladesh: Some Concerns

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The coastal areas of Bangladesh are highly vulnerable to various types of natural calamities. The impact of climate change is another catastrophe that requires effective interventions to address the problems and thereof issues holistically. In this direction, the Government of the People's Republic of Bangladesh has undertaken a project named Coastal Towns Environmental Infrastructure Project (CTEIP). The project aims at strengthening climate resilience and disaster preparedness in ten vulnerable coastal Paurashavas of Bangladesh viz. Barguna, Patuakhali, Bagerhat, Amatali, Galachipa, Daulatkhan, Pirojpur, Kalapara, Amtali and Bhola. The project takes a holistic and integrated approach to urban development providing climate-resilient municipal infrastructure and strengthens institutional capacity, local governance, and public awareness for improved urban planning and service delivery considering climate change and disaster risks. The key infrastructure investments include drainage, water supply, sanitation, cyclone shelters, and other municipal infrastructure including emergency access roads and bridges, solid waste management, bus terminals, slum improvements, boat landings, and markets. All these investments will benefit the poor and women. Two departments of the Ministry of Local Government, Rural Development and Cooperatives (MLGRDC) such as the Local Government Engineering Department (LGED) and the Department of Public Health Engineering (DPHE) are the executing agencies of the project. It is anticipated that the impact of the project will improve the wellbeing of the people living in these coastal towns. The outcome of the project activities in terms of structural and non-structural measures will increase climate and disaster resilience in coastal towns benefiting the poor and women. However, the present paper critically examines how far the quality of the life of the beneficiaries has been improved due to intervention of the subject project and discusses thereof concerning issues which are needed to be addressed.

Keywords: *Beneficiaries, climate change, coastal area, resilience*

Impact of Climate Change in the Coastal Areas of Bangladesh: Some Disaster Preparedness Concerns

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The coastal areas of Bangladesh are very much vulnerable to various types of natural calamities. The impact of climate change is another catastrophe that requires effective interventions to address the problems and thereof issues holistically. In this direction, the Government of the People's Republic of Bangladesh has undertaken a project named Coastal Towns Environmental Infrastructure Project (CTEIP). The project aims at strengthening climate resilience and disaster preparedness in ten vulnerable coastal Paurashavas of Bangladesh viz. Barguna, Patuakhali, Bagerhat, Amatali, Galachipa, Daulatkhan, Pirojpur, Kalapara, Amtali and Bhola. The project takes a holistic and integrated approach to urban development providing climate-resilient municipal infrastructure and strengthens institutional capacity, local governance, and public awareness for improved urban planning and service delivery considering climate change and disaster risks. The key infrastructure investments include drainage, water supply, sanitation, cyclone shelters, and other municipal infrastructure including emergency access roads and bridges, solid waste management, bus terminals, slum improvements, boat landings, and markets. All these investments will benefit the poor and women. Two departments of the Ministry of Local Government, Rural Development and Cooperatives (MLGRDC) such as the Local Government Engineering Department (LGED) and the Department of Public Health Engineering (DPHE) are the executing agencies of the project. It is anticipated that the impact of the project will improve the wellbeing of the people living in these coastal towns. The outcome of the project activities in terms of structural and non-structural measures will increase climate and disaster resilience in coastal towns benefiting the poor and women. However, the present paper critically examines how far the quality of the life of the beneficiaries has been improved due to the intervention of the subject project and discusses thereof concerning issues which are needed to be addressed.

Keywords: *Climate change, CTEIP, disaster, LGED*

Double Exposures of Women Migrants of Khulna Slums: Examining Their Adaptation Pathways

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There is considerable debate whether outmigration is failure of in-situ adaptation or a strategy of progressive adaptation of disaster victims in vulnerable coastal tract of Bangladesh. Khulna city as the largest and closest urban center to the vulnerable coastal region, always attracts a huge number of such migrants. Growing body of research conclude their findings saying- disaster victims failed to adapt and migrated to urban centers. Little efforts are observed to explore how the displaced disaster victims especially the women migrants are adapting to urban setting which is often very new and unfamiliar to newly arrived women migrants. This study is first of this kind that has examined the pathways how disaster victim women migrants addresses the challenges of adaptation in new urban setting in Khulna's slum. This research heavily draws on qualitative inquiry and the empirical part was conducted taking Rupsha slum in Khulna city as a case. The qualitative study examines the pathways of adaptation of women migrants by looking at their gender role, access to resources, institutions, market infrastructure, and employment markets. A total of 9 FGDs of different age cohort temporary and permanent women migrants, 3 case Studies and 10 Key informant interviews were conducted. To assess the women vulnerability the Integrated Approach (United Nation Framework Convention on Climate Change (UNFCC) bottom-up assessment framework) to vulnerability research tradition was followed. Therefore, vulnerability to climate change is understood as a function of exposure, sensitivity, and adaptive capacity.

Finding reveals that after major disasters like cyclone *Sidr* and *Aila*, as an adaptation strategy many affected population including women migrated either temporarily or permanently to this slum. The adaptation pathway of these women migrants to this slum was not so smooth. They have had the experience of double exposures; first, in place of origin before displacement and the second, in environmentally degraded slum settlements in Khulna. In two settings the nature of exposures are different but complexities to adapt to them remains the same. It was found that the migrants women encounters about a half a dozen of factors including tenure security, poverty, inadequate service provision, institutional exclusion, and poor networking ability that limit their adaptive capacity against new form of urban vulnerability in environmentally degraded urban slum. Finding also reveals various adaptation practices of migrant women employ in Rupsha slum to reduce new set of urban environmental vulnerabilities; it also has surfaced different barriers of effective adaptation against these urban environmental vulnerabilities. The barriers that hampers effective adaptation are related to lack of a socio-political platform, ineffective support from public institutions, and limitations in the way these institutions operate and influence people's agency.

The policy implication of the research is that both the government and non-government institutions must initiate program of tenure security as a first step toward reducing women migrants' vulnerabilities. Moreover, in addition to VGD/VGF special program could be launched to target the vulnerability of elderly migrant women living in urban slums

Sustainable Use of Marine Resources towards Achieving the Delta Plan and SDGs

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The total sea area of Bangladesh is approximately 2,07,000 square kilometers, 1.4 times greater than its total land area. The country has about 710 km long coastal belt. The continental shelf of the country is about 37,000 square kilometers having up to 50 meters depth. A total 453 species of birds, 42 species of mammals, 35 reptiles and 8 amphibian species were recorded from the coast of the Bay of Bengal of the country. Around 301 species of mollusks and over 50 species of commercially important crustaceans and 76 species fish have been recorded from the sea so far. The livelihoods of the local communities are mostly dependent of the natural resources of the coast and marine ecosystems. The goal number 3 of the Bangladesh Delta Plan 2100 ensures the sustainable and integrated river systems and estuaries management. The coastal zone and the estuaries have been considered as hot spots in the Bangladesh Delta Plan. Sustainable Development Goal 14 aims conserve and sustainably use the oceans, seas and marine resources for sustainable development. Towards the SDG 14 the Prioritized Indicator for Bangladesh is 'expand the coverage of the protected areas in relation to marine areas by 5%'. Local communities with the supports from development organizations have been taken number of initiatives towards the betterment of the coastal and marine ecosystems to ensure the livelihood sustainability. Those initiatives have been contributing towards the objectives and targets of the Bangladesh Delta Plan 2100 and the SDGs. The community actions need to be considered and assessed in the Blue Economy of the country, a new 'Development Space'. The paper aims to have a review on the activities of the development interventions to enthusing the capacity of the community on sustainable use of our marine resources towards Delta Plan and SDG. The community were consulted to know the brief of their development interventions and the action plans they have been implemented with the supports from development organizations.

Keywords: *Bay of Bengal, Bangladesh Delta Plan 2100, SDG, community, development organization*

Gosh

Hydraulic Impact on Fish Migration in a Sariakandhi Fish Pass of Bangladesh.

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The importance of open water fish in our socio-economic regime has recently drawn the attention of the policy makers of the country. FCD/FCDI projects mainly serve the agricultural interests, but it interfere fish migration. This inevitably affects the open water fisheries sector as migratory routes. Nursing grounds of many species of fish are hampered and disturbed for these projects also. In order to permit fish migration in rivers, it is necessary to maintain conditions that help migrants reach their spawning grounds. To overcome obstacles, such as hydraulic structures, placed in the path of migrating fish, structures must be designed to assist the fish to pass them. The periodic and directed travel of fish mainly for feeding, breeding and over coming adverse climatic conditions is called migration. Fish passes are constructed to allow normal breeding migration and to ensure natural route of fish movement.

The concept of a fish passes is relatively new in Bangladesh. At present, two Fish passes and two fish friendly structures are constructed. These are Fish Pass in Jamuna to Bangali River at Sariakandi in Bogra, fish Pass in Kawadighi Haor of Monu river in Moulovibazar, fish friendly structure in Lohajong river of Tangail and fish friendly structure at Morichardanra in Chapainawabganj. Fish fry, spawning and hatchling movement from Jamuna to Bangali River was the main objective of Sariakandi Fish Pass Project. The Fish Pass Project of Sariakandi is necessary for the development of the dominant fishes like catfish and small fishes. The structures will also aid in efficient development of the carp fishes. Spawning migration, mainly in carp fish, in the study area was found to begin at the 2nd week of May and continue up to the 3rd week of July. Catfish migrations began at the last week of March and continue up to the 2nd week of June.

Fish fry and hatching movement from Jamuna to Bangali river was the main objective of Sariakandi fish pass project. The study also found that there were seven major category migratory species in the project area and the fish pass is contributing positively for growth of fishery resources in then study area. During the monsoon carp fish is the dominating migratory species. Carpfish migrates in a higher velocity, whereas, catfish migrates in a lower velocity. Some problems were found in the operation and management of fish pass.

Key word: *FCD/FCDI projects, nursing grounds, hydraulic structures, natural route, dominant fishes, peak migration.*

Characterization of Particulate Matter (PM_{10}) in Some Selected Sites of Dhaka City for Associated Human Health Risks

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Studies were carried out to characterize particulate matter for human health risks in different locations, namely CARS, Chittagong Road, Doyel Chattar, and Postogola of Dhaka City from November 2018 to August 2019. The highest concentration of PM_{10} was found in Postogola (239.2 to 408.9 µg/m^3) and the lowest concentration in Doyel Chattar (185.2 to 308.6 µg/m^3). From the elemental analysis, Zinc (Zn) concentration was found to be the highest (2984 ng/m^3) among the trace elements and aluminum (Al) concentration was found to be the highest (3847.70 ng/m^3) among the crustal elements. Enrichment factor (EF) analysis suggested that the sources for Zn, Pb, Cu, Cr and Cd in PM_{10} were mainly non-crustal. Five polycyclic aromatic hydrocarbons (PAHs), namely benzo(a)pyrene, benzo(k)flurothracene, benzo(a)anthracene, pyrene, and indeno(1,2,3-cd)pyrene were analyzed by Gas Chromatography and benzo(a)pyrene (423.47 ng/m^3) and benzo(k)flurothracene (554.19 ng/m^3) were detected in all the locations. Equivalent spherical diameter (ESD) values were found between 3.87 and 5.33 which are greater than 0.93, meaning the particulate matter collected constitute mainly the respiratory fraction. Significant relationships were found from the Pearson correlation analysis between PM_{10} and Mg, Cu, Mn, Al and Pb ($p < 0.05$). PM_{10} was also found to correlate well with benzo(a)pyrene and benzo(k)flurothracene, indicating the carcinogenic risks associated with PM_{10} present in the studied locations. Health risk assessment revealed that the risk values for humans were below the guidelines of the hazard quotient (HQ) (safe level = 1) and above the cancer risk (10^{-6}), indicating that there are potential cancer risks stemming from PM_{10}. However, the mutagenic risk was found to be higher than the carcinogenic risk.

Keywords: *Hazard, human health, particulate matter*

Proposed Redevelopment of a Suburban Hub: Land Use Redesign in Hathazari Municipality, Chattogram

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Redevelopment can be defined as the process of land use development with the existing one. It combines the redevelopment of infrastructure, connectivity, accessibility, rezoning of a specific zone. Hathazari is one of the oldest Suburban areas of Chattogram which was established as Municipality in 2012. It acts as a major transportation hub of the Rangamati and Khagrachari Hill districts. Because of rapid urbanization, Hathazari is going through redevelopment faces. But due to unplanned development, this municipality is under growing various problems. The center point of the municipality has a 'Y' junction point which divides Khagrachari and Rangamati roads. The CBD of Hathazari has grown surrounding this node point. So it is now very congested with commercial facilities, bus stand, and other functions. Also, the internal roads of this area are narrow and not connected. The present paper analyzes existing land use data, building height data, nodes, and internal road networks. It provides design strategies on how this satellite town can be developed. It explains some functional design solutions which will improve accessibility across this municipality for people. This study attempts to find an appropriate strategy which will take care of the context and improve the living environment of Hathazari reducing existing problems such as congestion, traffic jam, inconvenient change of transportation modes, lack of recreational spaces. The present study also proposes a master plan on this regard. Moreover, redevelopment of wider roads and their connectivity, bus station and railway halt station, a commercial complex in the CBD zone, redesigning of water body has been proposed for this suburban area.

Keywords: *CBD, redevelopment, suburban, urbanization*

Analysis of the trend of tropical cyclones in Bangladesh over the past Thirty-five years (1985-2019)

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The geographical location of Bangladesh makes it more vulnerable to cyclonic hazard of the Bay of Bengal. The funnel shape Bay along with the change in depressional belt are responsible for higher degree of damage in this part of the world. The scenario became more worsen with the changing climatic environment. The broad aim of this research work was to explore the trend of cyclonic storms in Bangladesh between 1985 and 2019 and explore the role of changing nature of weather variable. For this purpose, secondary data were collected from different sources. This includes collection of satellite imageries, cyclonic track, depression area and cyclonic velocity and weather data from Bangladesh Meteorological Department. ArcMap software was used to analyze the collected data. The images were interpreted, and cyclone tracks were extracted in ArcMap. Hot Spot analysis was conducted on the velocity of the cyclonic tracks. The study founds that two major hot spots are prominent near the coast of Bangladesh. One is near Barguna coast and another one is near the Sandwip coast. The measures of geographical distribution such as mean center, median center, geographic mean, standard direction of cyclones were also analyzed and found the mean geographic center is near the Barguna-Patuakhi with a direction from south-west to north-east. The cyclone damage data were also analyzed, and simple correlation method applied to check whether there is any consistency between cyclone magnitude and damage of life and livelihood. A strong correlation 0.804 with significance level of 99% was found in this case. The random cyclonic trend and pattern indicates a change in climatic variability of this region over the said 25 years. However, the strong positive correlation between damage and cyclonic magnitude indicates effective adaptation policies and mitigation measures taken by the government and also for the higher resilience capacity of the local people.

Keywords: *coastal region, cyclonic magnitude, climatic variability, tropical cyclone,*

How environmental profiling helps to plan for a sustainable environmental management?

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In Global context, environment has become a concerning issue. It is an ecological complex of physical, chemical, and biological factors influencing an individual, population, or ecological ecosystem. The environmental profile assesses environmental indicators that reflect impacts occurring globally, regionally and locally in the air, water, land and also impact human's health. Bangladesh has a different climate condition in different region. It has a great influence on the agricultural sector, socio-economic condition and health because of rising temperature, salinity problem and sudden natural calamities. Being the third largest metropolitan city, Khulna has a different climatic condition, located in the lower delta of the Ganges-Brahmaputra basin of Bangladesh. The study area was selected in ward no 02, Khulna city. The present research mainly focuses on the existing scenario of environment profile and also find out the impact of human health and environment component. For collecting primary data (elements of the environment, existing features and socio-economic condition) both questionnaire survey and field survey ware conducted and the secondary data (e.g. soil type, elevation, temperature, humidity, precipitation, evaporation, drainage density, Emission of carbon-di-oxide, and Population) were collected from the ward council office and others relevant sources. The deformation of the water body, changes of environmental elements within the time of years and the pollution sources are represented with the help of the Geographic Information System (GIS). Total emission of CO_2 in family is 9,662,237 kg/month. Comparison of site Suitability within weighted score method for residential healthy life among the three times (2010>2015>2020) in Study area. Cause-Effect Framework of Environment Degradation and water pollution were represented. 75% of People have responded to the unconsciousness about environment element. This study will further help for a researcher in any kind of environment management plan that minimizes the environmental negative impacts towards the human and ecosystem services.

Keywords: *CO_2, deformation, environmental profiling*

A Case Study to Assess NGOs Activities and It's Influence as a Development Factor

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Right now Non-Governmental Organizations or NGOs have become an extensively discussed theme in the third world countries like Bangladesh. The NGOs as well as micro finance program have appeared as the saviour of countless number of people those are depriving from basic needs. It also helps for the development of a city. Generally, it is seen that the area where NGOs activities are more, there development also high. Hence, people have a tendency to migrate in the developed areas from less developed areas. Using five criteria (i.e. illiteracy rate, number of NGO office, number of NGO school, employment rate and drop out of children) in formal regionalization of 64 districts in Bangladesh were delineated into six regions and found out where NGO activities and development were high. By using modified gravity formula in functional regionalization of the influence area of three district (Jessore, Jhenaidah and Magura) were calculated to find out the dependency of people of surrounded areas. The findings of the study shows that the city within the moderate region has the bigger influence than its surrounded area. The probable reason indicates the influence of NGOs activities. People are highly interested to migrate there for getting all kinds of facilities. Two districtes namely, Jessore and Jhenaidah are in this catgory. Besides, Magura was identified as the moderately low influenced district where NGOs activities were identified as low and hence, the development was also low. The study represents a clear view of a new region which is done according to the NGOs activity in Bangladesh and the influence area of three district. This finding draw the attention to the government for the development of those area where NGOs activity and influence area are less.

Keywords: *Development, migration, regionalization, modified gravity formula,*

Securing Drinking Water: A Case Study from Mirpur Area of Dhaka City

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Despite the global improvement in access to safe drinking water all over the world, the World Health Organization (WHO) reports that access to safe drinking water in urban areas has not been changed significantly or has stabilized in particular countries. Assessments of national drinking water for Bangladesh does not reflect local variability or temporal differences. This study has reported on the findings of an interdisciplinary investigation of drinking water insecurity, taking Mirpur area as the study area. Mirpur is one of the the most populated area in Dhaka City, where more than 0.2 million people live in the slum area. Mirpur is an area with inadequate water and sanitation facilities giving rise to diseases such as Cholera, diarrhoea and typhoid. The study has reported drinking water insecurity and drinking water security challenges in Mirpur area to discover the key issues people are facing regularly related to drinking water. Both Qualitative and Quantitative methods were applied to notice whether pollution is happening during collection or transportation or storage of drinking water by comparing the water quality. Drinking water quality has been accessed by a comparison of locally measured concentrations to National levels and water quality criteria. A laboratory test was carried out to identify Odour, Colour, Temperature, Turbidity, P H, BOD, COD, TDS etc. A Socio-economic the survey was also carried out about drinking water. The outcome of the study will help water authorities and various agencies working in Mirpur area to provide sustainable water and sanitation facilities to improve the wellness of the people of the area. The outcomes will also provide useful information and strategic direction to the global scientific and development communities who are working in slum areas in other parts of the world, to tackle drinking water security challenges.

Keywords: *Dhaka City, drinking water, insecurity*

Adsorptive Removal of Dye from Textile Effluent and Methylene Blue from Synthetic Aqueous Solution Using Medical Waste Incineration Fly Ash

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Medical waste incineration (MWI) fly ash was used as a cost-effective adsorbent, characterized and studied for the removal of dye from textile wastewater and Methylene Blue (MB) dye from synthetic aqueous solution. Various parameters such as pH, adsorbent dosage and contact time were studied by performing batch experiments in the laboratory. The optimum percentage of dye removal efficiency was obtained as 98% for textile wastewater and 97% for MB infused aqueous solution. The adsorbent dose has been optimized as 0.75 g/100ml for textile dye and 0.5 g/100ml for MB dye. Optimum contact time was found to be 20 minutes for both textile wastewater and synthetic aqueous solution while an increase in adsorption rate was observed at higher pH. Batch experiments showed that the removal mechanism could be better characterized by the Freundlich isotherm model as it had a better agreement compared to the Langmuir model for both textile and MB dye. These experimental results suggest that MWI fly ash can be considered as a very effective adsorbent capable of removing a significant amount of dye which can be an efficient solution to treat textile dye effluents and promote environmental sustainability.

Keywords: *Dye, medical waste, textile*

Assessment of Radiation Risk on Public Health around Three Large Hospitals in Dhaka city, Bangladesh

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One of the leading factors having menacing impact on environment as well as human health in 20th century is pollution. Pollution also can be occurred due to radiation, but this genre of pollution is often shadowed by more and widely discussed pollutions, such as: air, soil, and water. The radiation pollution occurs when medical institutions fails to take proper precautionary practice while using their ionizing instruments. Most prominent medical institution uses ionizing radiation (i.e.: X-ray, PET scan etc.) to diagnose and treat patients. Ionizing radiation coming from these instruments when hit air particles gets immediately scattered and have damaging impacts on general people around the hospital. It is now a well-known fact that ionizing radiation, e.g.: gamma radiation or beta particle while passing through the nucleus of cells can cause damage and even leads to death. Recommended dose rate for general public is 1mSv/yr. The present study aimed to measure the real-time radiation dose rate around three large hospitals in Dhaka city, such as BSMMU, Shaheed Suhrawardy Medical College and Hospital (SSMCH) and Delta Hospital Ltd and estimation of excess life-time cancer risk (ELCR) on public health. The current study was conducted in the months of February-October 2020. Real-time radiation data in 80 locations were collected around the BSMMU, SSMCH and Delta Hospital Ltd. by using digital portable radiation monitoring device through In-Situ method. The monitoring points were marked out using GARMIN eTrex GPS device and the digital portable radiation monitoring device was set on a tripod at 1m height from the ground level. The average, range of the annual effective dose and ELCR on public health around the three hospitals. The study identified that the recommended annual effective dose for general public is 1 mSv and measured annual effective dose is 4.125 mSv, 0.271 mSv and 0.952 mSv accordingly. The average measured ELCR around subject institutions are 2.31×10^{-3}, 1.09×10^{-3} and 1.23×10^{-3} accordingly, which is higher than the average standard value of $0.29\times10^{-3.}$ It can be estimated from the result that in every thousand people, one person is at the risk of developing cancer caused by the radiation pollution. Target Hazard Quotient (THQ) less than or equal to 1 indicates that adverse effects of radiation exposure are not likely to occur but since the analyzed THQ of the collected radiation data is 4.125, 0.271 and 0.952 so it indicates the exposed public will likely experience a detrimental effect which may take several years to develop into serious health threat if it develops at all.

Keywords: *Hospital, pollution, public health, radiation*

Assessing the risk perception of a community on Cyclone vulnerability: A case study of Pratapnagar, Satkhira

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The paper investigated the influence of risk perception of Cyclone vulnerability of a community of Partapnagar, Satkhira. The study was conducted based on assessing their knowledge of risk, mentality to the disaster and level of adaptation of the coping initiatives. The level of the community's perception is examined by using Focus Group Discussion (FGD) method and destruction level using D form, then reached to the result. The participants were having two types of perception. Group 1 had positive propensity to the risk and another group had the negative propensity to the risk. The primary findings were divided into two groups. Based on the findings, it is examined that the disparity of the destruction between these two groups is huge. Group 1 had to face the lesser impact than the other group. Again, the economy loss largely differs between these two groups. The group 1 had to pay a very minimum amount comparing to others. There are some factors such as previous experience, lack of early warning credibility, oversight to risk etc. drives them to having the inattentive manner to the risk. Based on these findings, it can be identified that the risk perception is a key determinant whether a person adopt those initiatives to reduce the adverse impact of the disaster. By driving them to have a better perception may play an important role to enhance their resilience capacity.

Keywords: *Disaster, risk perception, Risk attitudes, Vulnerability*

An approach to sustainable municipal solid waste management: A Case Study on Barishal City Corporation

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Waste management is one of the most inevitable parts of sustainable development along with an alarming increase of population. This study demonstrates a sustainable waste management approach including waste generation, source, collection, transportation, and dumping. The study selected Barisal City Corporation as a case.. The primary objective of the study was to find out major drawbacks of the current waste management system under rising rate of urbanization. The study also attempted to find out the best alternative of the current system and most importantly to attenuate the waste-induced pollution. Hence, a number of methods were followed (a) categorizing wastes from its generating source (b) stacking the wastes in different label bags based on category (c) assessing the waste generation rate with a rising urbanization rate based on GIS and remote sensing techniques (d) assessing the effect of waste management on the city dwellers' life. Moreover, the study shows that the current waste management system is not compatible with its generation of waste. In addition, the capability of waste processing is running out. Lastly, there is an absence of any proper plan or design for the waste management system. However, it needs to implement a proper plan or design. It also needs to make sure the health safety of the waste management workers' in the study area.

Keywords: *Development, management, solid waste, urbanization*

Effects of Soil Properties and Topography on Tree Biomass Stock in the Tropical Hill Forest Ecosystems of Bangladesh

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Soil edaphic factors, topography and climate change are considered as principal driver of tropical forest ecosystem functioning. Within this context, the effects of climate change on above-ground ecosystem functioning is studied in a growing number of studies around the world. However, the study regarding the effects of soil factors and topography on above- and below-ground biomass production is very limited. Therefore, the present study was conducted to know how soil properties and topographic features can modify tree biomass production in tropical forest ecosystems. Three study areas of this research work were Khadimnagar National Park (KNP), Lawachara National Park(LNP) and Satchari National park (SNP), located in the north eastern Sylhet region of Bangladesh. A total number of 120 plots were randomly selected (40 from each study site) by using GIS-based data for the study. Five soil samples were collected from each plot with aboveground plot data (number of plant species and their individuals; tree height; tree diameter). All the soil samples were tested for measuring the responses of several soil properties: Moisture Content (%), Soil Bulk Density (g/cm3), Soil pH, Soil silt %, and soil clay %. Elevation and slope data were recorded in each plot during field work. In this study, three sites were compared regarding total biomass stock, topography and soil properties. In case of total biomass stock, it was observed that LNP (14103Ton/ha) had highest total biomass followed by SNP and KNP had lowest tree biomass (7114Ton/ha). Topographic features did not vary significantly within the three study sites. Five soil properties were observed namely soil moisture content, soil pH, bulk density, silt % and clay %. In case of moisture content, LNP (28.99&) is richer than other two sites but in case of pH, LNP (5.69) and KNP (5.73) are almost same which is higher than SNP (4.75). From the study we can say that, Soil of KNP is more compact than the other two sites. Soil silt % of LNP (58.29%) is way much higher than the other two sites. Similarly, soil clay % is also higher in LNP (9.39). Results showed that topographic features such as elevation and slope had no significant impacts on tree biomass stock. Soil moisture content has significant ($p=0.0005$) impact on tree biomass stock. Soil pH had marginal significant ($p=0.0415$) impact on tree biomass stock. In this study, soil clay % had significant ($p=0.0059$) impact on tree biomass stock. Co-relation matrix and PCA analysis showed that total tree biomass production was positively related with soil moisture content ($R=0.31$), Clay % ($R=0.25$), silt % ($R=0.40$) and soil pH ($R=0.18$). The present study concluded that soil properties are more important drivers of tree biomass production than topographic features in the studied three protected areas (LNP, SNP and KNP) of north-eastern Bangladesh. The study findings will help the forest managers and policy makers to manage the forest for higher biomass production which can help mitigating climate change through carbon sequestration.

Keywords: *Climate change, primary production, tree biomass stock, tropical forest ecosystem, Soil Edaphic factors.*

Drinking Water Quality and its Impact on Human Health in Dhaka City, Bangladesh

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Dhaka is the capital city of Bangladesh. DWASA (Dhaka Water supply & sewerage authority) is responsible for providing water supply in Dhaka city. Water is considered safe when it is free from contamination. The majority of the distribution system has been weak because of the intermittent water supply, leakage, and pollution from old and dilapidated sewerage pipes and storm drains. Drinking tap water in Dhaka is not safe. Dhaka city dwellers suffer from water borne diseases like Typhoid, cholera, paratyphoid fever, dysentery, jaundice, etc., for using this contaminated water. The aim of this study was to identify the water quality conditions (pH, DO, BOD, COD, TDS, TSS, SS, total coliforms, heavy metals, turbidity, temperature, alkalinity, salinity, odor, and color etc.), identify the impacts of water quality on human health and to have a perception of the local dwellers on the supplied water they consumed. Total 74 articles were reviewed. A few research papers have been published about water quality analysis of Dhaka City and corresponding health effects. This study provides an in-depth analysis of the water quality assessment and its impact on human health and information obtained from laboratory investigation reports, survey questionnaires, key informant interviews and field surveys. For observing water quality previous water investigation reports collected from DWASA. In the groundwater reservoir, total coliforms were found. But there were no coliforms in the supply line and pump water. The laboratory tests were compared with Bangladesh standards & WHO guidelines. This research has been conducted by using both qualitative and quantitative method. An in-depth interview was also conducted. For the purpose of this research Mohakhali, Banani and Gulshan area had been selected. One of the largest slums ‘Korail Basti’ is situated here. Most of the slum people drink the supply water without any treatment. Many incidents of water borne diseases were identified. About 56% of the respondents were suffered from water borne diseases in the last one year. It was found that about 48% of the respondent are not consuming the supplied water by DWASA due to bad smell. On the other hand, about 36% respondents are consuming DWASA supplied water for drinking purposes by using the boiling water method. About 56 % of the respondents agreed that the faulty water distribution line is the main reason for water contamination. The obtained information will help the concerned personnel to adopt suitable modalities for the improvement of the water supply system. This will ultimately ensure the safety and security of human health and keep the environment pollution free.

Keywords: *BOD, COD, human health, water quality,*

Plastic Pollution from Waste of River Mathabanga of Chuadanga District in Bangladesh

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Mathabanga is the main river in Chuadanga and the main branch of the Padma River in Bangladesh. The Mathabanga is the main source of livelihood in 4 sub-districts in Chuadanga. Acknowledging the containing pollution caused by humans, the condition of this river is now endangered. There is no way to protect Mathabanga, one of the mainstays of life and livelihood from this pollution. Home to almost a million people, and covering an area of more than 1,100 square kilometers, Chuadanga district has the Kushtia district of Bangladesh on its northeastern border, with Meherpur to the northwest, and Jhenaidaha to the south and southeast. The Nadia district in the state of West Bengal lies on the southwest border of Chuadanga district. Along the way, the river is acknowledging various natural and man-made pollutants, one of which is the pollution of plastic waste. Passengers, Boatmen and inhabitants of river-oriented people are throwing their plastic waste into the river. Besides sewerage garbage and industry wastages are fallen into the river and polluted the freshwater of the river. Along with floating alluvium make the layer of the river high and for that in the rainy season containing the power of the water of the river is reducing day by day and always seen overflowed by floodwater. It creates bad affected and influenced in the life of general people and the inhabitants of the river embankment. These perishable plastic wastes (such as water bottles, pay-packets, and plastic disposable items) continue to pollute the river, causing catastrophic disasters for the river and future generations. To ensure the life and livelihood of future generations through Protecting the river Mathabanga from the pollution of plastic products by stopping the dumping of these wastes. An awareness and responsibility campaign among all through various programs including distribution of leaflets, stickers, posters, workshops, installation of dustbins on boats, Memorandum submit to DC-Chuadanga and protesting against pollution of water of the Mathabanga river through Human Chain. A sense of responsibility and awareness among passengers, boatmen, inhabitants of riverside and also general people and by this way river pollution will be significantly reduced and people with the next generation can live pollution free live in the river embankment.

Keywords: *Pollution, river, waste*

Alternative Source of Electricity by Hybrid Solar-Hydro Power Plant in Sakhoi Para of Bandarban District in Bangladesh

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In the 21st century, solar energy is expected to become increasingly attractive as a renewable energy source because of its inexhaustible supply and its nonpolluting character, in stark contrast to the finite fossil fuels coal, petroleum, and natural gas. Energy scarcity is one of the major impediments to the growth and development of rural economies in developing countries, including Bangladesh. As they do not have direct access to electricity, highly polluting firewood and other biomass are used as sources of energy supply. Bangladesh's government is recently investing heavily in renewable energy. However, one of the challenges for achieving this goal is that most populations live in rural areas e.g. Hill Tracts in Chittagong where national grids are not reachable and the traditional method of electricity supply is difficult and inconvenient. A closed-loop renewable-energy micro-grid for supplying electricity to a hill-tracts village (80 households), Shakhoi Para (Tongkaboti), Bandarban has been proposed by SEMWaves. Presently, this area lacks electricity facilities. This electricity will be supplied for use of the inhabitants of this remote area of Bandarban Hill Tracts. PV solar panels will generate electricity during daytime with a capacity up to 25kW to run a solar motor to pump water from a natural source to an elevated reservoir (>20m). At nighttime water from an elevated reservoir is released to flow through a turbine to generate electricity supplying the village. The same water will be recycled day/night and this project will not use any fossil fuel or other form of energy. So, there will be no polluting waste since this project will only use solar energy. A key output will be a demonstrator of closed-loop 24-hour uninterrupted power supply that will serve the local community for years. It will provide an optional system for drinking water and irrigation systems for the ethnic community as well. The proposed technology is innovative in several aspects. It will also harvest rainwater to generate electricity during monsoon which is a major drawback of the current off-grid solar system. This technology is SEMWaves' first development in the past three years. Hydro storage has been reported earlier, however, there are no such systems installed commercially to date in remote hilly terrain. The proposed energy supply system bears economic significance in more than one aspect. The most obvious benefit is the accessibility to energy which is environment-friendly and cost-effective and efficient rather than traditional battery storage which is harmful to the environment. Another major advantage is that this hybrid hydro-solar power system will enable them to enjoy basic civil rights and enable the ethnic community to progress economically, socially, and in the education sector as well.

Key Words: *Environment, hybrid, off-grid, solar-hydro power*

Retrofitting with Green Refrigerant

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The environmental concerns with the impact of refrigerant emissions lead to the importance in identifying a long-term alternative to meet all requirements in respect of system performance and service. Even though HFC134a and HC blend (containing 55.2% HC600a and 44.8% HC290 by weight) have been reported to be substitutes for CFC12, they have their own drawbacks in respect of energy efficiency/flammability/serviceability aspects of the system. In this present work, experimental investigation has been carried out on the performance of an ozone friendly refrigerant mixture (containing HFC134a/HC blend) in two low temperature systems. The oil miscibility of the new mixture with mineral oil was also studied and found to be good. The HFC134a/HC blend mixture that contains 9% HC blend (by weight) has better performance resulting in 10–30% and 5–15% less energy consumption (than CFC12) in medium and low temperature system, respectively.

Good servicing practices-HC based refrigerators and Retrofit of old HFC/CFC appliances with HC Blend

Θ Safe venting of HCs
Θ Removal of left over refrigerant by vacuum pump
Θ Cleaning and flushing
Θ Repair
Θ Flushing and choke testing
Θ Leak detection
Θ Evacuation & Vacuum holding
Θ Charging Refrigerant
Θ Sealing process tube
Θ Checking for proper Operation

UV Base Disinfection/Air Purify for HVAC System

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The factors that determine the design parameters of ultraviolet germicidal irradiation (UVGI) systems are addressed. The methods that can be used to size systems more effectively are discussed. The information presented may lead the industry back to the path of continuous improvement although the goal of eliminating airborne disease might remain unachievable.

The 2 mm pleated Pd-TiO_2/VUV photocatalyst exhibited the highest activity for simultaneous MS2 inactivation and ozone degradation, and the catalytic activity was effective regardless of relative humidity. Considering the gas phase and catalyst surface effects, and the natural inactivation of VUV-irradiated but live MS2 viruses, the 2 mm pleated Pd-TiO_2/VUV and succeeding UV photocatalysis showed more than 90% in the overall inactivation efficiency with residual ozone of 35 ppb at an irradiation time of 0.009 s (flow-rate: 33 l/min). In contrast, most UV-based purifiers take longer times for disinfection. This system has the potential for an alternative to conventional UV-based air purifiers.

Governance Perspective for Climate Change Adaptation: Conceptualizing Policy Landscape in Bangladesh

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Climate change adaptation is currently an important component in the Delta countries like Bangladesh. The government in collaboration with international development agencies is trying to promote the different adaptation programs and projects in the coastal area of Bangladesh. The adaptation activities are mainly occupied the perspective of the Limit To Reactive (LTR) rather than Proactive To Adaptation (PTA). When a climate change agent like Aila, Sidr hit in the locality of coastal zone in Bangladesh, they followed this LTR approach: e.g., provided some relief and asked them to take refuge in a shelter place for a limited time and scale. In addition to this LTR perspective, this adaptation follows piecemeal and top-down approach which is not helpful for local people in the sustainability discourse. Some other effects like river bank erosion, water stagnation, and salinity intrusion caused from these climatic concerns are not coordinated in this LTR adaptation perspective. Under the circumstances, this paper conceptualizes the adaptation landscape in Bangladesh based on the findings of the research project, DEltas, Vulnerability and Climate Change: Migration and Adaptation (DECCMA) established in 2014-2018 in Bangladesh, Ghana, India, and the United Kingdom. The data were collected with 1384 survey respondents, 19 Focus Group Discussions (FGDs), and 3 workshops. The findings of the paper argue that the government needs to focus on the Proactive To Adaptation (PTA) in policy, programs, and project with the governance approach. Local community participation, consultation, and representation are essential part of this PTA perspective in adaptation policy formulating and execution. Moreover, this participatory approach needs to be respectful in the different geographic and community context as they have the different types of opportunities and challenges for coping with their localized pattern of climatic concerns. In addition to this participatory approach, it is also important to maintain the vertical and horizontal coordination between the different agencies in government, non-government, and private sectors. This governance approach can identify the different dynamics of PTA perspective based on the negotiated understanding of these multiple stakeholders.

Keywords: *Adaptation, climate change, LTR, PTA*

Adaptation Practices of Indigenous People to Cope with Drought: A Case Study of Niamatpur Upazilla of Naogaon District, Bangladesh

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Drought is one of the most damaging climatic disasters in Bangladesh and it has significant impacts on the livelihood of the people especially those who are dependent on the agricultural sector. Existing literature pays attention only to the general population. Therefore, indigenous groups are being overlooked. This study intended to fill this gap by paying concentration on the indigenous group (i.e. Santal of Niamatpur upazilla of Naogaon district). Niamatpur Upazilla of Naogaon district is located in the northwestern part of Bangladesh that is very vulnerable to drought. The aim of this study was to identify the adaptation strategies of the Santal community focusing on the irrigation system, cropping system, livestock, food, homestead and migration. A mixed-method strategy is followed to conduct this study. A combination of quantitative data through household questionnaire survey, focus group discussion, key informant interview and qualitative data through rapid rural appraisal are obtained. The result shows that Santal community has agricultural, health, social and economic impacts due to drought. Therefore, Santals apply adaptation practices to reduce the impacts of drought. Santals encourages the use of deep tube well, drought-resilient crop cultivation, less water-required cultivation, inter-cropping system, making mud house and re-excavation of pond or canal. Among identified adaptation techniques, using deep tube well is widely practiced. Finally, the result suggests some solutions to overcome existing challenges and encourages the involvement of government and other non-government organizations to improve the livelihood of the Santals.

Keywords: *Adaptation Practices, Drought, Indigenous, Santals*

Water Diplomacy as an Effective Approach to Ecological Resilience: A Case Study Farakka Barrage Impact on Bengal Delta

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Farakka Barrage has introduced significant changes in the ecosystem of the Bengal delta through its discharge rate of water. More water flows from this Barrage in the monsoon season has significantly increased the flooding pattern in Bangladesh. On the contrary, the reduced flow rate of water from the same site in the dry season has created a negative impact on the hydrological pattern. The reduction in flow rate has resulted in an increase in seawater in the upstream areas and falling water tables and greater salinity downstream and badly hampered the ecology and livelihood pattern especially in the southwest coastal region. The crisscrossed network of rivers throughout the southwest coastal region depends on the water supply of the Ganges. Apart from stereotypical upstream-downstream syndromes, a lack of good faith in cooperation, an atmospheric hostility, asymmetric information, a lack of negotiation and mediation practices, and a lack of monitoring and cooperation practices make these situations more complex. This study provides the current scenario of ecological disturbance in southwest coastal Bangladesh due to Farakka Barrage and designs appropriate transboundary water policy in terms of protection of ecology, and common interest of India and Bangladesh. To fulfill the research objectives, the study extensively uses historical reviews to design a better transboundary water policy. Historical reviews cover the literature on different forms of water diplomacy, dialogue, books, journals, online documents, research reports, and newspaper articles. Based on the findings from the literature, this study suggests that water diplomacy should be inclusive, transparent, effective, open, and ecologically friendly. The findings of this will be useful for national and international policymakers and stakeholders, in promulgating effective transboundary water policy.

Keywords: *Ecology, Farraka dam, Ganga basin, Salinity,*

Can Nature-based Solutions (NbS) Save Our Wetlands?

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In today's world, we face wide range of societal challenges, namely climate change adaptation and mitigation, disaster risk reduction, water security, food security, human health, economic and social development, and environmental degradation and biodiversity loss. Nature-based Solutions (NbS) are the actions we take to address these challenges by using natural processes or ecosystem services. International Union for Conservation of Nature (IUCN) defines NbS as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." NbS is an umbrella concept. It means, diverse ecosystem-based activities, like ecosystem-based adaptation, coastal afforestation or green belt creation, biologically important protected area management, integrated coastal zone management, green or natural infrastructure creation, and restoration of degraded landscape or forests all fall under NbS. Bangladesh has been practicing NbS since long in different terrestrial forests, freshwater wetlands, and coastal ecosystems. In case of freshwater wetlands, Bangladesh offers rich experience of participatory, community-based management of its wetlands and their resources since the late 1990s. Over-exploitation of aquatic resources and hindering wetland-dependent people from rightfully accessing these resources have been the core challenges of sustainable management of our wetlands. In this paper, Tanguar Haor -- a globally important wetland in north-east of Bangladesh -- is taken as a case to explain NbS. The leasing system that exploited this wetland since the 1930s, entered into a new management era around the turn of this century as it was declared as a Ramsar Site in 2000 and Ministry of Land handed over the haor to the Ministry of Environment and Forests (MoEF) in 2001 and the harmful, all-destroying leasing system stopped. In 2006, this wetland was brought under 'Community-based Sustainable Management of Tanguar Haor' project of the MoEF, which ran till late 2016 with uninterrupted financial support from the Swiss government. In an unprecedented move, the MoEF continued supporting the participatory management of Tanguar Haor from its own resources over the next few years. This paper critically discusses the achievements, challenges, and lessons learnt from collaborative management of Tanguar Haor during 2006-2020 as an important example of NbS in Bangladesh wetland. With rapidly increasing enthusiasm towards NbS in the recent years, there is a possibility of misunderstanding and misusing of the NbS concept and approaches. IUCN's "Global Standard for Nature-based Solutions" (2020) is the most recent attempt to offer concrete guidance to practice NbS on the ground, effectively. The present paper checks our practices so far in managing Tanguar Haor against the IUCN NbS Standard as one of the first attempts of this kind. The paper concludes by highlighting several emerging opportunities to practice NbS in protecting and sustainably managing Bangladesh's wetlands.

Changes in Ambient Air Quality of Dhaka City during COVID-19 Induced Lockdown and General Holidays

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A worldwide pandemic of COVID-19 has forced to implement a lockdown during April-May 2020 by limiting people's movement, the shutdown of factories and automobiles in Dhaka, Bangladesh to prevent the spread the virus. This type of stringent measures returned a consequence of the decreasing of urban air pollution around the world. The goal of the present study is to investigate the reduction of the concentration of pollutants in the air of Dhaka City as well as the reduction of the Air Quality Index (AQI). Necessary time-series data of the concentration of $PM_{2.5}$, NO_2, SO_2, and CO have been collected from the archive of the U.S. Environmental Protection Agency (US-EPA) and Sentinel-5P. The time-series data have been analyzed by descriptive statistics as well as AQI has been calculated by an appropriate formula recommended by US-EPA based on $PM_{2.5}$ concentration. The study found that the concentrations of $PM_{2.5}$, NO_2, SO_2, and CO have been reduced by 23, 30, 07, and 07% during April-May 2020, respectively, compared with the previous year's concentrations. Moreover, the AQI has also been reduced by up to 35% than the former year in April-May 2020. However, the magnitude of pollution reduction in Dhaka is lower than other cities and countries globally, including Delhi, Sao Paulo, Wuhan, Spain, Italy, USA, etc. The main reason might includes the poor implementation of lockdown (especially in the first week of April and the second fortnight of May) and transboundary pollution. The findings will be useful for policymakers to find a way to control the air pollution by limiting anthropogenic emission sources to enhance Dhaka's air quality.

Keywords: *Air quality, COVID-19, holidays, lockdown*

Assessment of Drought Risk on Women at Lalpur Upazila of Natore District in Bangladesh

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Lalpur upazila under Natore district in northern part of Bangladesh is highly susceptible to drought hazard due to highest temperature and low rainfall. Drought is a slow onset natural disaster which creates a threat to socio-environmental balance in the study area. The risks from drought hazards are much higher for the rural communities especially for women. The present study attempted to assess the drought risks at household and community levels on rural women and their livelihoods. Different tools of Participatory Rural Appraisal (PRA) such as seasonal hazard calendar, seasonal livelihood calendar, ranking of hazard impact matrix on women activities at household and community level were followed and interviews at household level were conducted for assessing the drought risks on the Ramkrisnapur village under Lalpur upazila of Natore district in Bangladesh. The survey results found that women face various types of problems due to drought hazards like crisis of health-care services, fuel collection, meal preparation, cooking, and collection of drinking water, sanitation facilities and other household activities etc. The most vulnerable people in the study area are the poor, whose dependence on natural resources and low resilience exposes them to potentially devastating impacts from even minor changes in environmental conditions. The present study recommends that a systematic process using administrative directives, organizational and operational skills, and capacities to implement strategies, policies, and measures for women-friendly improved coping capacities in order to prevent, mitigate, and prepare against the adverse impacts of drought in the study area.

Keywords: *Community, drought risk, vulnerability, women,*

Investigation of Chlorophyll *a* as an Indicator for Detecting the Trophic State Index at the Kaptai Lake Ecosystems for Fisheries Management in Bangladesh

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The study was conducted to determine the present condition of water quality in terms of its suitability for fisheries/aquaculture and other uses throughout the February 2019 to January 2020. Water samples were collected from four sampling stations during of March, August and January where these months were considered as pre-monsoon, monsoon and post-monsoon seasons, respectively. Samples were analyzed in the laboratory of Department of Environmental Science and Resource Management, and Department of Biochemistry and Molecular Biology in Mawlana Bhashani Science and Technology University, and Bangladesh Fisheries Research Institute (BFRI) laboratory, Mymensingh. Results of the study shows that physicochemical parameters such as water temperature, transparency, pH, DO, TDS, EC, total hardness, total alkalinity were found 20.9 to 31.8°C, 17 to 303 cm, 6.82 to 7.96, 6.1 to 7.65 mg/L, 40 to 105 mg/L , 75.33 to 172.33 mg/L, 35 to 190 mg/L, 37 to 83 mg/L, respectively. However, nutrients like as NH_3, SO_4^{2-}, PO_4^{3-}, NO_3^{2-}, NO_2^{-}were found 0.01 to 0.05, 0.3 to 1.9, 0.01 to 0.04, 0.03 to 2.21, and 36 to 96 mg/L, respectively and Chlorophyll *a* and TSI were found 0.70 to 2.12 µg/L and 27.43 to 37.79, respectively. Study reveals that average concentrations of SO_4^{2-}, DO and TDS were higher than the recommended level for aquaculture throughout the study period. On the other hand, concentrations of NH_3, PO_4^{3-}, NO_3^{2-}, NO_2^{-}, temperature, transparency, pH, EC, total hardness, total alkalinity, Chlorophyll *a* and trophic state index (TSI) were within the standards level for aquaculture. Moreover, concentrations of PO_4^{3-}, NO_3^{2-}, NO_2, Chlorophyll *a*, and TSI (CHL) showed no significant variation with seasons. Conversely, TDS, transparency, EC, Alkalinity, hardness, and SO_4^{2-} contents were lower in monsoon compared to pre-monsoon followed by post-monsoon season. Besides, temperature and concentrations of NH_3, DO, and TSI (SD) were higher in monsoon season. Results of the study exposed that the Kaptai lake reservoir is in mesotrophic condition with CHL (TSI) value less than 40, and prominently there was a positive relationship between Chlorophyll *a* and trophic state index (TSI). So, the study stated that major nutrients and chlorophyll a concentration in the Kaptai lake reservoir water could have some effects on aquatic ecosystem. Thus, proper monitoring and management of the Kaptai lake water as well as aquatic ecosystem by concerned authority should be taken notably.

Keywords: *Chlorophyll a, seasonal variation, TSI, Water quality, Kaptai Lake*

Reviewing Existing Mechanisms in Utilizing Shared Water Resources of South Asian Co-riparian Countries

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UN reports referred to the increased risks of melting down high-altitude snow and ice by the end of this century if the world continues to carbon emission in present rate. Possible consequences are twenty-two percent of the world population and half of the world biodiversity hotspots will be affected. The trans-boundary Indus river basin and Ganges-Brahmaputra along with few other natural water tower systems in Asia are more vulnerable than rest of the world due to overpopulation and agricultural dependence in the region. The complex political environment existing in this continent has made the issues of sharing common river water and utilizing its resources more difficult. The present study aimed at finding the existing mandates to resolve trans-boundary river water related disputes in South Asia with special reference of India and Bangladesh. Besides, the study attempted to draw a draft framework for both the countries which might be worked out to meet such differences. The study followed by a descriptive method with critical analysis of both the states concern and steps undertaken to address the issues in post 1970s. Available documents and information were carefully reviewed for the study. The study identified that bilateral relations between different South Asian countries has been challenged due to the difficulties in sharing trans-boundary river water, intervention through dams, barrages and overlooking the existing agreements. Further research is required in this exclusive arena to strengthen sub-regional power in South Asia.

Keywords: *Co-riparian countries, South Asia, trans-boundary, water sharing, water scarcity*

Conceptualizing the Paradigm to conserve the Tropical Mangrove Forest in the Southwestern Region of Bangladesh

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The ecologically critical Area (ECA) like Sundarban (tropical mangrove forest) in the coastal zone area of Bangladesh encounters the major threat for multiple reasons like natural calamities and human interventions. The lack of proper policy and coordination causes further challenges for this ECA. Although there are many forums and government bodies working for a long time to protect this UNESCO-declared World heritage Tropical Mangrove Forest, the progress is not up to the mark. The participation and representation of the youth from gender perspective in the development process might be an effective mechanism not only for environmental conservation, but also for youth's capacity building and women empowerment. The study used Geographical Information System (GIS) and conducted focus group discussion (FGD), participatory rural appraisal (PRA), and individual meeting (IM) with key informants (KI) to identify the major social and ecological gaps along the existing forest conservation management following a model, 'Zero Emissions Research and Initiatives (ZERI) of Africa' that ensure sustainable solutions for society, from outreaching poor communities to corporations inspired by nature based solution to conserve the tropical mangrove forest involving youth and women. The study tested the model (ZERI) in few districts, i.e., Satkhira, Khulna and Bagerhat. The findings of the study indicate that engagement of youth including women in the Sundarban management and development process and their empowerment with capacity building and livelihood generation would enhance to conserve the mangrove forest and restore ECA.

Keywords: *Conservation, mangrove, ZERI, forest*

What influence evacuation decisions at cyclone shelters? Empirical evidence from Bangladesh

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As a consequence of climate change, the frequency and intensity of extreme events is increasing globally these years. Considering as prone to cyclones, the government of Bangladesh and international cooperation agencies are trying to mitigate the damages and losses of cyclones through the construction of cyclone shelters in the coastal belt of the country. This research aimed to find out the influence of the socio-spatial distribution of refuge shelters on evacuation decisions. An empirical study was conducted in Charmadras Union of the Charfasson Upazila of Bhola district in Bangladesh. Employed a structured survey questionnaire, a total of 115 individual households were interviewed along with some critical key informants of the Upazila. The spatial distribution of the cyclone shelters is analyzed using the satellite images of 1997, 2009 and 2017 and different statistical tools are explored with the primary dataset. Results show that the spatial distribution doesn't affect the evacuation decisions at all, rather than a set of social factors influence on the people's evacuation decisions. Among them, the cyclone shelter construction process, the spatial condition of the cyclone shelters and the household locations, the respondents' risk perceptions, better cyclone shelter facilities including the facilities for women and access to information and preferences can influence the evacuation decisions. Since cyclone shelter is one of the major programs of DRR measures, the study finding is helpful for future policy planning in the face of climate change.

Keywords: Coast, cyclone shelter, DRR, evacuation

Delineation of the Influenced Area of Upazila by Functional Regionalization Process: A case of Gazipur, Mymensingh, Kishoreganj Districts in Bangladesh

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A functional region is a territorial unit organized around a central hub or focal point, characterized by continuous flow to and from the central hub and surrounding areas which means the frequency of intra-regional interactions and surrounding places depend on the focal point by social and economic activity. The Upazilas which aren't properly sufficient to serve their inhabitants must rely upon the encompassing Upazila to fulfill their needs. This research aimed to delineate the Upazila boundary area through a modified gravity model and to find out the influencing area and unserved area in Gazipur, Mymensingh, and Kishoreganj Districts by functional region. The study area covers three districts including 30 Upazilas of Bangladesh which shared their geographical area. Bangladesh Bureau of Statistics (BBS) is the main source of data from where population data have been collected and distance between the Upazilas have been found out from ArcGIS map10.2 software. The influencing area shows the capabilities of the upazilas to serve basic facilities for the inhabitants living in the area. The lower influencing and unserved areas indicate the areas which are neglected in respect of serving primary services such as education, health and job opportunity facility.

Keywords: *Functional region, gravity model, influencing area, unserved area*

Assessment of Physico-chemical Parameters of Water Samples Collected from the Southern Part of Bangladesh

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Bangladesh has a large volume of natural water resources. The coastal regions of Patuakhali district including Kuakata sea beach area are very important for using water in agriculture, industry, drinking, aquaculture and household activities etc. Since lots of waste materials are discharged in water, assessment of physicochemical parameters of natural water is necessary. The present work was conducted to investigate physicochemical parameters of water bodies from coastal delta and assessment of human health risk from water pollution. In order to determine water quality parameters thirty water samples were collected from the southern part of Bangladesh including Patuakhali district and Kuakata sea beach area during dry season. The pH of thirty water samples was measured with a pH meter at 25 – 30 ºC in the laboratory. Conductivity of water was measured which is directly related to the concentration of ions in the water. The membrane electrode method (Section 4500-O.G) was used to determine initial dissolved oxygen (DO) in all samples. The biological oxygen demand (BOD) took 5 days to complete and is performed using a dissolved oxygen test kit. Inorganic total Carbon (TC) component was eliminated by acidifying the water samples to pH 2 to 3. The remaining carbon was measured to determine total organic carbon (TOC). pH of water samples were ranged from 7.58-8.77 with an average of 8.15 ± 0.32. Average conductivity value for water samples was 8.83±2 which indicates lower ion presence in the water samples. Average DO was 8.33±1.82 mg/L and BOD was 0.31±0.03 mg/L indicating that the water system was well oxygenated and good quality with low pollution. . Total Organic Carbon (TOC) were found in a range of 0.78 to 1.78 mg/L with an average 1.24 mg/L which is very low indicating less amount of pollution by plant, animal residue and other wastes. Concentration of NO_3^-, SO_4^{2-} and PO_4^{3-} were determined by ion chromatography and only SO_4^{2-} was in a very low concentration. Water samples from different sources were analyzed for 5 metals such as Pd, Cd, Mn, Hg and As by Atomic Absorption Spectroscopy (AAS) and the contamination of metal elements were found Pb < 0.2 mg/L, Cd < 0.01 mg/L, Mn < 0.02 mg/L, Hg < 0.001 mg/L and As < 0.005 mg/L, respectively. pH of water samples indicates lower ion presence in the water samples. Dissolved oxygen and biological oxygen demand shows that the water system were well oxygenated and good quality with low pollution. Low level of contamination was observed.

Keywords: *BOD, coast, heavy metals, water*

Plastic Pollution from waste at the River Padma in Bangladesh

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Padma is one of the sources of fresh water and the third major river in Bangladesh. The Padma River is the main source of livelihood in nine districts of the country. Acknowledging the continuing pollution caused by humans, the condition of this river is now endangered. The River Padma joins the Meghan River after flowing 109 km through nine districts of the country after entering Bangladesh through neighboring India. Along the way, the river is acknowledging various natural and man-made pollutants, one of which is the pollution of plastic waste. Passengers and sailors are throwing their plastic waste into the river. This perishable plastic waste (such as water bottles, pay-packets, plastic disposable items) continues to pollute the river, causing catastrophic disasters for the river and future generations. Among the waterways established on the river Padma, Passengers and sailors on the Daulatdia-Paturia and Mawa-Kawrakandi waterways regularly dump their plastic waste in the river. Protecting the river Padma from pollution of plastic products by stopping the dumping of these wastes. To create awareness and responsibility among all through various programs including distribution of leaflets, stickers, posters, workshops, installation of dustbins on boats. There will be a sense of responsibility and awareness among passengers and sailors and river pollution will be significantly reduced. To ensure the life and livelihood of future generations by protecting the river by preventing river pollution.

Keywords: *Padma, plastic, pollution*

Assessment of the Consequences of Tropical Cyclone Aila Using Remote Sensing and GIS for Kalabogi, Dacope Upazila

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Bangladesh is one of the most vulnerable countries in the world for natural disaster where tropical cyclone, storm surge, flood, bank erosion, waterlogging, tidal waves etc. are common phenomena. Every year, a lot of coastal people become homeless due to the impacts of natural disaster over there. Today, as a consequence of global warming, the intensity and frequency of tropical cyclones are being climbed up. Owing to worldwide global warming, the sea surface temperature has been increasing gradually every year that facilitates the mentioned disastrous natural events and Bangladesh has become an extremely affected country. The aftermath of climate change is already evident in Bangladesh, specifically in the coastal region. This study was carried out at Kalabogi, an immensely vulnerable and remotely coastal village of Sutarkhali union in Dacope upazila. The village has been disappearing due to the prolonged impacts of devastating tropical cyclones. In addition, the land use pattern has become changed rapidly as well as the local people is being migrated because of an uninhabitable condition caused by riverbank erosion, backwater effect, tidal waves, waterlogging, storm surge, salinity, soil infertility etc. the onset of these impacts were introduced significantly since 2009 when the severe tropical cyclone Aila struck to the south-west coast of Bangladesh. The current study was carried out by conducting a questionnaire survey in order to gather primary data. Remote Sensing (RS) methods and Geographical Information System (GIS) were used to collect process and analyze the secondary data as well as to prepare different models and maps of the study area. In addition, TCX and Surfer software were used to create elevation profiles of the most affected portion of the study area to visualize how much land has been consumed due to riverbank erosion. Immediate sustainable action should be taken along with proper rehabilitation by the government to protect the rest of the part of Kalabogi otherwise the endangered village will vanish completely near future.

Key Words: *Climate Change, Cyclone Aila, GIS, Global warming, remote sensing*

Islam

Sustainable Development Goals (SDGs) and 4th Industrial Revaluation (4IR): A Paradoxical or a Parallel journey?

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Sustainability has received a mentionable attention from researchers, businesses, NGOs and policymakers worldwide over the last decades. This spirit has gained further momentum further due to the global commitments intended for cutting carbon emissions, addressing resource insufficiency, and altering the waste management system. Eventfully, the United Nations adopted the Sustainable Development 2030 Agenda after the successful accomplishment of MDGs which contains 17 goals with 169 targets aimed to assist all the parts of society to advance lives and to build the planet a more comfortable, secured, safe and sustainable place to live and work. The 17 SDGs are an interrelated approach to promote sustainable practices and solutions for addressing the core issues of society. In that connection, it can be mentioned that sustainable development cannot be attained without innovations. Meanwhile, the era of 4IR has come to our door and it encompasses almost every aspect of life. This technology driven industrial revolution (4IR) will help to optimize the innovations and the perspective is linked up with the achievement of the SDG targets, especially concerning the industrial sector. If directed rightly, digitalization can open up new hopes for economic development and prosperity. However, there is often a development and policy dilemma: the hurry for achieving rapid economic development exploiting 4IR technologies (e.g. Job cuts, e-Waste) often negatively affects the accomplishment of SDGs. This paper is qualitative in nature and performed a systematic literature review to identify and understand how the 4IR could contribute and/or restrain to achieve the SDGs. The papers were first sorted and further scrutinized in order to identify the links between 4IR and the SDGs. Findings show that the CE-I4.0 nexus directly benefits almost all the SDGs except 1 and 2. The paper revealed that 4IR is a great enabler to achieve SDGs and these outweigh the negatives of 4IR. .Further research could quantitatively address to investigate the nexus between SDGs and 4IR further to draw specific research implications and it is also suggested to consider specific country and/or industry for looking closely. The study will be proven useful for decision-makers of businesses and governments to understand and adopt the right strategies to attain SDGs and exploit 4IR.

Keywords: *Industry 4.0(4IR). sustainable development goals (SDGs), sustainability*

Coping Practices of Environmental Hazards and Disasters at Urban Poor Community in Dhaka City

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The urban poor community in Dhaka city is vulnerable to various environmental hazards and disasters e.g. fire, flood, water-logging, diarrhea etc. The situation is worsening for the increasing tendency of the hazards due to the climate change effects. The inhabitants do some coping practices, as well as the government organizations and NGOs, have some activities to reduce the risks and impacts. The present paper analyses the relations of major environmental hazards and disasters with housing and urban basic services, the situation of mitigation and preparedness activities to reduce the risks and impacts and the situation of response and recovery practices after the hazards and disasters at the urban poor community in Dhaka city. The data has collected from primary and secondary sources as well as field observation as the requirement of the study. It is found that types of housing, materials of the houses and the congested situation are strongly related to some hazards. There is a lacking of urban basic services i.e. cooking gas supply, waste management, sewerage and drainage, which have relations with many hazards as water-logging, diarrhea, cholera, dengue etc. The mitigation activities (e.g. keeping valuable in a safe place, maintaining life insurance, road expansion etc.) are very poor as the proportion of the surveyed households those are important to reduce the risks and impacts. Early preparedness activities are also poor, which are taken to reduce the impacts of fire, flood, water-logging and earthquake. The emergency response activities are hampered for the narrow roads and no road connection according to a large proportion of households. The relief provision as the recovery activity is helpful to survive in the post hazard and disaster situation but not adequate as the needs. A large proportion of the households have to bear the burden of loans for a long time due to be indebted for fulfilling their urgent needs in post hazard and disaster situation. Their socio-economic development is hampering for the poor coping practices of the hazards and disasters. It is necessary to improve the coping practices to ensure the sustainable development.

***Keywords**: Disaster, mitigation, preparedness, response, recovery*

Evaluation of Land Use Land-Cover (LULC) change detection of Dhamrai Upazila, Dhaka: A Remote Sensing and GIS Approach

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Information acquired from Land use land cover (LULC) change detection helps to plan, manage and monitor programs at local, regional and national levels by providing a better insight into land utilization. Therefore, the purpose of this study is concerned with identifying the change in land use and land cover detection of Dhamrai. We have collected time series (1990, 2000, 2010 and 2020) satellite images include Landsat MSS, TM, ETM+ and OLI. The classification was done with four classes such as vegetation cover, bare land, settlement and water body. Analyzing and visualizing the data was accomplished by ArcMap 10.8 software and Microsoft excel. By analyzing and comparing the images the historical trend of land cover change at Dhamrai areas is revealed. This study indicated that in the last 10 years period, bare land and vegetation areas had increased by 25.43% and 13.08% respectively. On the other hand, Water body and Settlement areas are decreased by 26.54% & 3.35% respectively.

Keywords: *LULC, Detection, Change, Vegetation, Settlement*

Flash floods vulnerability and practice of nature-based solution (NbS) to build resilience in northeastern haor communities in Bangladesh

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This case study highlights climate related vulnerabilities of northwestern low-lying Haor basin which is exposed to recurrent early flash flooding that damages the standing rice crops which the farmers can only grow in a year during winter. Rest of the year, the haor basin remains flooded and the poor people can fish for the limited time when leasing control is less in monsoon months. The presentation describes alternative farming systems and crop diversification (viz. short duration rice varieties and farming other cash crops) as measures of NbS coupled with EWS and dissemination that increases the chances of safely harvest the crops before the visit of the flash floods.

Effect on capture fisheries due to climate change: an evidence from Jamuna river, Bangladesh

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Urbanization is also taking place in Bangladesh in line with other countries of the world. As a result, like other countries, the climate of Bangladesh is also becoming complicated. Although the developed countries have not suffered much from the effects of this change, it is showing an adverse reaction in agriculturally dependent countries like Bangladesh. The result is not only in foreign trade but also in the diet of the people of our country. The people of our country consume most of the protein from fish. In Bangladesh, fish collect in both culture and capture methods. However, most of the fish collect through capture. But through this paper, we have found that the condition of both capture fishery and fishers is alarming. Climate change is responsible for many more factors, including urbanization. However, the fishermen of the study area are not aware any of this factor. They are not even familiar with these words. They only realized that they are not getting much fish from the river now. They are living on the margin, which has become difficult for them. Most of them are not interested in this profession now. Also, they are moving to the city thinking about the future of their children. Such a story portrays from 510 fishers of Jamuna river in Sariakandi of Bogra district. For the betterment of the fisheries sector in future, some procedure enlightened in this study. It does not matter how much we move towards the culture fisheries, part of the vast protein will remain behind without capture fishery with less toil. Also farmed fish can never be a substitute for river fish. The diet of river fish produces its nutritional and better taste, which cannot be obtained by farming. But the way of fish stocks and fishers reducing both, we will lose possession of capture fish near future.

MAR Model with IWRM Approach in Barind Tract: An Adaptation Tool for Alleviating Water Scarcity in Thirsty Hard-to-Reach Area in NW Bangladesh

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The nexus between drought (moderate high risk) and groundwater resources development issues has aid a sign for better management planning in the drought-prone Barind Tract in NW Bangladesh — the granary. In this context, the adaptation plan with Managed Aquifer Recharge (MAR) model of the Integrated Water Management Plan (IWRM) strategy with '4R' (Recharge, Reuse, Recycle, Restore) principles for hard-to-reach livelihood in the Tract [implemented by Swiss Red Cross (SRC) - DASCOH Foundation and funded by Swiss Development Corporation (SDC)] has taken into consideration. It is a time blessing approach to alleviating water scarcity through application of rainwater harvesting (RWH) technique by augmenting groundwater resources through recharge well (RW) and dug well (DW). The study area in the Tract covers Godagari, Tanore, Nachole, Gomastapur, Porsha, Sapahar, and Niamatpur Upazilas of Rajshahi, Chapai Nawabganj, and Naogaon districts covering an area of 2586 km^2 and 1,417,928 inhabitants. In the study area, the groundwater based irrigation demand has increased drastically over the years resulting groundwater withdrawal at an alarming rate. The declining trend of rainfall amount, frequent droughts, extension of irrigated and cultivated area, increasing crop production, etc. are influencing factors for rapid declining trend of groundwater table. It adds vulnerability to the groundwater resource that creeps toward hardship in water management plan—a burning issue for the Tract. Moreover, bimodal distribution annual rainfall pattern in rainy season (> 500 mm) shows high RWH potentiality during rainy season. Since 2015, 201 MAR models have implemented in 150 households; 3 *Paurashava and* 39 Union Parishad (UP) buildings; 4 industries; and 5 institutions (school building) with respective roof catchment area of 365-1950 m^2 in household; 525-3295 m^2 in *Paurashava and UP;* 7620-13716 m^2 in industry — a pioneer and successful attempt to augment groundwater resource for drinking and agricultural use in the Tract. The estimated recharge of groundwater from the total implemented MAR is 85 million liter/year considering 1300 mm of average rainfall. The model is anthropologically, economically, and environmentally justifiable to inhabitants. Moreover, they are very much optimistic about sustainability of implemented MAR models in the Tract along with addressed issues of good governance. The cost-benefit analysis of implemented MAR models reveal that total cost is BDT 13,668,000 of which the local government institutions have contribution of 5% and the rest 95% from implementing agency (SRC-DASCOH Foundation). Moreover, for sustainability of the implemented MAR model, effective maintenance work should be operated on a regular basis. Finally, MAR model of IWRM strategy with governance issues must be addressed for achieving the Vision 2021 of the GoB and visioning the SDGs and targets by 2030 as proclaimed by the General Assembly of the United Nations.

Keywords: Barind Tract, Governance, IWRM, MAR, RWH.

Restoration of Moribund River- a Serious Issue in Bangladesh

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Water, river, waterways are part and parcel of the environment and a central pivot of our life and living. Due to ignorance of environment, the impact of our living is adulterated in the naked eyes. Restoration of river may be a simple asking question but the answer is nor so simple. For instance, Turag is very significant during lean period for supplying drinking water supply to Dhaka city. Now going to Padma and I am worried where it may go after some time! Turag appears local but it has lengthy linkage even beyond our territory through Bangshi, Jamuna, Bhramaputra and Tista with their vast populated river basin, uplandforested watershed. The ecosystem functions of this waterways on the ground of economy and ecology deserves attention. Moreover, Halda river is unique in Bangladesh passing through a special topographical features of both right and left lies vast upland area. The river has got a length of only 106 km but huge water during wet season coming down the river with little use and storage. The dry season runs shortage for irrigation, industries and domestic use. This short length practically local river is miraculously international because CARP Fish from any water territory moves to HALDA for spawning –a biotechnical process, wonderful gift. Appropriate management strategy for study of water, water sources, the water holding capacity, the vegetative watershed, the agriculture basin, haor, baor, beel, khal, the population activities, and their pressure is a must for right assessment. Stock taking of total precipitation, percolation, ground water table, run off, evaporation loss, dissecation, natural storage, water logging, flooding, drainage volume and system is a must. Integrated work program needs to be regularly practiced.

Seasonal Changes of Soil Salinity and Nutrients in the Coastal Bhola Island of Bangladesh

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The study was conducted to explore the seasonal variation of soil salinity and nutrients status in three selected upazilas of Bhola district during the period from January to December, 2019. Soil samples were collected randomly from agricultural land covering the seasons of dry (November to May) and wet (June to October), respectively. Soil salinity and nutrients such as exchangeable Potassium (EK), electrical conductivity (EC), total organic matter (TOM), total nitrogen (TN), available phosphorus (AP), available sulphur (AS) and exchangeable magnesium (EMg) were analyzed in the laboratory of the Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Tangail. Results of the study revealed that the pH and EK were varied significantly among the studied upazilas. The soil pH was found 6.35, 6.47 and 6.88 in Bhola sadar, Daulatkhan and Manpura upazila, respectively. However, the EK content was found 0.18, 0.16 and 0.30 meq/100g for Bhola sadar, Daulatkhan and Manpura upazila, respectively. Moreover, the soil pH was found 6.35 in dry season indicated slightly acidic nature, whereas soil pH (6.79) of wet season showed neutral in nature. The soil EC varied significantly between the dry and wet season, and revealed no excessive salinity in the examined soil of Bhola district. The TOM, TN, AP, AS and EMg were not assorted significantly among the investigated upazilas. The study also exposed that in dry season, soil EC was positively correlated with AS and EK, whereas negatively correlated with TOM, TN, AP and EMg. Besides, during wet season, EC was positively (significant, r=0.722, $p \leq 0.05$) correlated only with EMg. The study concluded that construction and repair of coastal embankment, cultivation of native high yield verities, proper fertilizer application, implementation of integrated soil nutrient management, and adaption of integrated coastal zone management (ICZM) may increase soil fertility level that ultimately leads to rise up crop production in the coastal Bhola Island in Bangladesh.

Keywords: *Coastal island, soil salinity, soil nutrients, seasonal variation.*

Fresh and Hardened Properties of Rubberized Self-Compacting Concrete: An Approach towards Waste Tire Management

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Self-compacting concrete (SCC) is a highly flowable form of concrete that needs no or a little mechanical vibration. If natural aggregates of SCC are replaced with rubber aggregates then it will be defined as Self-compacting rubberized Concrete (SCRC). It is estimated that about 90,000 metric tons of tires become scrap and are disposed of every year in Bangladesh, which results in a major potential waste and environmental problem. A large number of the used tires are being burnt as fuel in the brickfields, in road construction, and other industrial purposes producing harmful gases like CO_2, CO, SO_x, and NO_x resulting in great environmental pollution. On the other hand, most of these scrap tires are simply dumped under the open sky as well as used for landfill. Open dumping may result in accidental fires with highly toxic emissions or may act as ideal breeding grounds for disease-carrying mosquitoes and other vermin with the aid of rainwater. The absence of degradation capability creates pollution to the soil and a threat to the agriculture sector also. So, waste tire management is a great concern for a developing country like ours. Among various ways, one of the effective and sustainable management of tires is to use them as an aggregate for construction works. Rubber can be used in lightweight concrete structures used for structural applications, with strengths equivalent to normal concrete, as they reduce dead loads making savings in foundations and reinforcement. This study aims to develop information about the fresh and hardened properties of SCRC at replacements of coarse aggregates by 5%,10%, and 20% using waste tire rubber aggregates and find out the optimum percentage of coarse aggregates replacement with rubber aggregates from the waste tire for making lightweight concrete. A total of four concrete mixtures were cast for this research. The fresh properties were investigated by the slump flow, J-ring, and V-funnel tests following the EN 12350. Compressive and splitting tensile strengths tests were conducted as per ASTM standards after 7 days & 28 days. The rubber aggregates used were collected by cutting the waste rubber tires having a maximum size of 16 mm. A mix ratio of the binder: coarse aggregates: fine aggregates=1: 1.036: 1.76 was used. The replacement of coarse aggregates by waste tire particles was done at a proportion of 0%, 5%, 10%, 20% by weight also with 7.5% replacement of cement with silica fume with a constant w/b ratio of 0.39 and 1% superplasticizer for each four mix IDs identified as control, SCRC5, SCRC10, and SCRC20 respectively. The test results indicate that there was decrease in workability and hardened properties as rubber aggregates increased compared to the SCC one. It was observed that 5% replacement of coarse aggregates with rubber showed the best results however 10% replacement with rubber aggregates is applicable towards a sustainable and cost-effective design, creating light weight concretes and manages a vast amount of rubber tire waste in an efficient environment friendly way.

Keywords: *ASTM, J-ring, self-compacting concrete, V-funnel*

Waste Management Techniques and Suggestive Recycling Procedures for Dhaka South City Corporation: Bioenvironmental Viewpoints

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Waste management in Bangladesh is undoubtedly an important environmental issue from bioenvironmental perspective as the country itself is overwhelmingly overpopulated. At the same time, the country is moving very fast towards urbanization where the community people every day has to pile up a huge amount of garbage for disposal in both urban and rural areas of the country. Rapid urbanization and congested living in the city areas in Bangladesh has made waste management a serious problem especially in the urban areas of the country; it generates every day approximately 16,015 tons of waste which cumulatively may add up to 5.84 million tons every year. Improper management of such waste often degrades the environment in the city areas which alternatively could be utilized for the proper economic benefit of the country making them transformed into consumer utility. In fact, there are two important steps in this context: proper collection of waste through proper techniques is the first way to utilize the waste safely to protect the environment, and then to use them for recycling economically deriving benefits from them. The present paper thus focuses on two aspects: firstly, waste collection mechanisms of Dhaka South City Corporation and transforming them strategically for proper use of them. Based on the discussion, the study suggests some mechanisms for better utilization and management of this waste through more technologically efficient procedures.

Keywords: *Bioenvironment, recycling, waste management*

Study on the Human Discomfort Index and its trend in Bangladesh

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Attempts have been made to compute the Human Discomfort Index over Bangladesh with the help of daily ambient temperature and relative humidity for the period 1981-2016. With the starting of the pre-monsoon season, temperature of Bangladesh starts increasing attains the highest maximum temperature and heat waves occur during the season. In the monsoon season, the average temperature is higher than the pre-monsoon season and heat waves also occur at times in this season and the atmosphere remains laden with huge moisture. During the pre-monsoon and monsoon seasons, higher temperature combines with moisture and produce heat stress, causing discomfort to the human being in the country. Heat stress on human beings is determined in terms of the Human Discomfort Index (HDI) using the Thom's empirical formula. The present study has been undertaken to investigate the heat stress over Bangladesh and the impact of heat stress on human beings, its trends and to delineate the areas affected by heat stress over Bangladesh. The Human Discomfort Index (HDI) indicates that under 50% of the population of Bangladesh starts feeling discomfort in March whereas above 50% of the population of Bangladesh feels discomfort from April to October. HDI values are maximum in the southwest monsoon season mainly due to higher mean temperature and relative humidity when most of the people feel discomfort at times. People do not feel any discomfort in the winter season and in the month of November. Country-averaged HDI is found maximum in the southwest monsoon season with 27.25 ^{o}C and the secondary maximum is 25.60 ^{o}C in the pre-monsoon season. In the post-monsoon season, about 50% of people feel discomfort and people do not feel any discomfort in the winter season. The study has revealed that most of the population feels discomfort in May and June in the southwestern part of Bangladesh, and over 50% population feels discomfort in July-October. The trends in seasonal and annual HDI have been also studied, which gives the climatological change in HDI over Bangladesh. HDI has increasing trends in the pre-monsoon, monsoon, and post-monsoon seasons at most places over Bangladesh, and the increasing rates are statistically significant whereas, in the winter season, HDI has decreasing trend at many places. Annual HDI has also increasing trends at many places over the country with statistical significance of the increasing rates.

Keywords: *HDI; ambient temperature; relative humidity; spatial distribution and trend.*

Assessing the Potential Effects of Temperature Variability Stress on Madhupur Deciduous (Sal) Forest

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Plant species are highly sensitive to temperature. A slight moderation in the temperature generates an imbalance in the ecosystem productivity of the forest. Deciduous forest of Bangladesh which commonly known as Sal forest due to dominance of *Shorea robusta*, generally dispersed in the central to *the* southern part of the country. Geographical location of this forest ecosystem is vulnerable to extreme climatic circumstance over the decades characterized by very high temperature and low precipitation in the dry season. Thus, the current research focused on identify and establish a link between temperature variability stress on Madhupur sal forest in decadal-scale from 1990-2019. Temperature data reveals that average decadal dry season temperature is 33.9°C, which has been widely fluctuated over the years. To capture the temperature variation strain on forest NDVI is a useful tool. Analysis of data from 1981-2009 shows that high dry season temperature exposed high level of stress on Madhupur forest where NDVI ranges from 0.01-0.37 that indicates elevated stress on forest ecosystem. Whereas, moderate dry temperature from 2010-2019 restored forest health as NDVI varied from 0.45-0.77 in places. Besides, to link between regional temperature and NDVI values, a correlation coefficient was performed. Correlation between the variables discloses imperative results. Elevated temperature imposes stress on deciduous forest whereas near optimum temperature restores the forest health. The outcome of the present study is essential to understand climate change impacts on country's forest resource and also management of the deciduous forest.

Keywords: *Deciduous (sal) forest, Potential effect, Temperature variability*

Assessing Climate Change Adaptation Action Plan at Macro and Micro Levels in Bangladesh

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Life and Livelihood cover wide spectra of basic human needs, e.g. food, safe drinking water, safe house, clothing, health care, education, basic civic amenities, income and job, quality of life, formation of assets, disaster mitigation, environmental management, etc. Earth is getting warmer due to the increase in Greenhouse gases in the atmosphere. Temperature rise affects rainfall pattern, melts the glaciers, raises the sea level, increases evaporation. The condition of Bangladesh will further be worsen due to the withdrawal of Bangladesh water from the upstreams. Bangladesh becomes highly vulnerable to climate change because of high dependency on the natural resource base. The present paper reviewed the climate change adaptation action plans based on secondary data and information. The study reveals some action plans that includes strict laws enforcing population control and family planning. Flood markers showing the highest flood level must be installed all over the country in both urban and rural areas to facilitate flood disaster risk reduction. All schools and buildings should be extended vertically upwards to save horizontal space and to facilitate disaster risk reduction. Resiliency of the poor against disaster should be increased by massive poverty alleviation programs. Moreover, Government should strengthen local level institutions and encourage community participation in disaster management by developing appropriate Coping Mechanism through local initiatives. However, climate change adaptation should be included in school curriculum of primary, secondary and high schools. Enhancing resilience of urban infrastructures and industries to impacts of climate change is also vital. It needs to promot climate change adaptation to coastal safe drinking water, agriculture and fisheries to combat increased salinity due to sea level rise. It is also urgent to reduce climate change hazards through coastal afforestation. Promotion of research on saline tolerant varieties of crops to facilitate adaptation will be highly effective.

Keywords: *Adaptation, climate change, flood*

Khan

পরিবেশ সুরক্ষা ও নিরাপদ খাদ্য নিশ্চিতকরণ: অভিন্ন চ্যালেঞ্জ ও উত্তরণের রূপরেখা

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খাদ্যের গ্রহণযোগ্য সংজ্ঞার একটি অতি অবশ্যকীয় উপাদান হলো একে পুষ্টিমান সমৃদ্ধ ও নিরাপদ হতে হবে। ২০১৩ সালে প্রণীত বাংলাদেশ নিরাপদ খাদ্য আইনেও এর স্বীকৃতি রয়েছে এবং ২০১৫ সালে গঠিত বাংলাদেশ নিরাপদ খাদ্য কর্তৃপক্ষ এই নিয়ে কাজ করছে। এই খাদ্য কর্তৃপক্ষসহ বিভিন্ন সরকারি বেসরকারি সংস্থা ও সংগঠন নিরাপদ খাদ্য নিশ্চিতকরণে কাজ করে চলেছে। এই পথপরিক্রমায় বাজারে প্রাপ্ত খাদ্যপণ্যের নিরাপদতার ব্যাপারে আমরা কতটুকু আস্থাশীল থাকতে পারছি? দেশের বাজারগুলোতে খাদ্যপণ্যের কোন অভাব নেই কিন্তু কোন ক্ষতির আশংকা ছাড়াই আমরা যে তা নিঃশঙ্ক চিত্তে কিনতে ও খেতে পারছি? এই আকাংখ্যা আমাদের সবার কিন্তু কীভাবে এই অর্জন সম্ভব? এই নিশ্চয়তা আমরা কার কাছ থেকে পাব?

বাংলাদেশে খাদ্য দূষণ নানাভাবে ঘটে থাকে। একটি গোষ্ঠী ইচ্ছাকৃতভাবে অধিক মুনাফার লোভে খাদ্যে ভেজাল মেশায় বা বিভিন্ন অপকৌশলের মাধ্যমে নকল খাবার তৈরী করে। এটি অপরাধমূলক কাজ এবং এদের নিবৃত্ত করতে বিদ্যমান আইনের যথাযথ প্রয়োগ জরুরী। আর মূলধারার খাদ্যদূষণ হয় সজ্ঞানে বা অনেকক্ষেত্রে সরকারী পৃষ্ঠপোষকতায়। কৃষি উৎপাদন বৃদ্ধি, সংরক্ষণ ও বিপণন প্রক্রিয়ার নানা স্তরে রাসায়নিক সার ও কীটনাশক সহ নানাবিধ ক্ষতিকর রাসায়নিক উপাদান মিশিয়ে আমাদের খাদ্যকে বিষাক্ত করে ফেলা হচ্ছে। এর বাইরেও শুধুমাত্র অজ্ঞতাজনিত পরিবেশ দূষণের কারণেও আমাদের খাদ্য অনিরাপদ হচ্ছে। আমরা সবাই জানি, পরিবেশ তথা খাদ্য দূষণের কারণ বহুমাত্রিক ও তা ক্রমবর্ধমান।

এই ভেজাল, নকল ও অনিরাপদ খাদ্য-পানীয় ও ঔষধে বাজার সয়লাব হলেও তথ্য নির্ভর গবেষণার অভাবে এর কোন সঠিক হিসাব আমাদের জানা নেই। মাঝে মাঝে কর্তৃপক্ষ বা সরকারের তরফ থেকে পরিস্থিতি অগ্রগতির দাবি করা হয়। কিন্তু এই সমস্যার পরিধি যে কত গভীর ও বিশাল তা আমরা গণমাধ্যমে প্রচারিত বিভিন্ন প্রতিবেদন এবং ক্লিনিকে/চেম্বারে ও হাসপাতালে রোগীর আধিক্য দেখে অনুমান করতে পারি। এতসব সত্ত্বেও আমাদের গড় আয়ূ বাড়ছে। কিন্তু স্বাস্থ্য ব্যয় বাড়ছে তার চেয়েও বহুগুণ। বিজ্ঞানীরা বলে থাকেন, দূষিত পরিবেশের প্রভাবে মানুষের খাবার যেভাবে দূষণের শিকার হচ্ছে তাতে আগামীতে জনস্বাস্থ্য মারাত্মক হুমকির মধ্যে পতিত হবেই। শুধু ওষুধ এবং চিকিৎসা নির্ভর হয়ে মানুষের বেঁচে থাকা অবশ্যই কাঙ্খিত নয়। এই আয়ু বৃদ্ধি পরিবার, সমাজ বা দেশের কোন উপকারেও আসে না।

খাদ্যযোদ্ধা হিসেবে আমরা যখন খাদ্য নিরাপদতার কথা বলি তখন সাধারণত পরিবেশের সামগ্রিক বিষয়টি সামনে আনা হয়না। আবার অনিরাপদ খাদ্যের ঝুঁকি সার্বজনীন হওয়া

সত্ত্বেও পরিবেশবাদীরাও কৃষি বা খাদ্য সংশ্লিষ্ট পরিবেশ বিষয়ে তেমনভাবে সোচ্চার নন। কিন্তু আমাদের জানা উচিৎ আপাতঃদৃষ্টিতে পরিবেশবান্ধব মনে করা হলেও আমাদের কৃষি উৎপাদন ব্যবস্থা কত ভিন্ন ভিন্ন উপায়ে ও মাত্রায় পরিবেশ দূষণ বা এর ক্ষতিসাধন করে থাকে। এসবের মাঝে উল্লেখযোগ্য হলো- ব্যাপক ইউরিয়া সার ও সেচ নির্ভর ফসল উৎপাদন, জমিতে বছর বছর একই ধরণের ফসলে চাষ, গবাদি পশু ও গোবর থেকে কার্বন নিঃসরণ, অনিয়ন্ত্রিত মাছ ও হাস-মুরগি খামার, বিষ প্রয়োগে মাটির গুনাগুন, জীববৈচিত্র্য হ্রাস ও বায়ুদূষণ প্রভৃতি। তাই আমাদের চারপাশের প্রাকৃতিক পরিবেশ কলুষমুক্ত রাখতে শিল্পদূষণ নিয়ন্ত্রণ করার পাশাপাশি কৃষি উৎপাদন সংশ্লিষ্ট দূষণের প্রতি নজর দিতে হবে যা একইভাবে দীর্ঘমেয়াদে খাদ্যের নিরাপদতা অর্জনেও সহায়ক ভূমিকা পালন করবে।

সম্মেলনে পঠিতব্য মূল প্রবন্ধে কোভিড-১৯ পরবর্তী বাংলাদেশের নিরাপদ খাদ্য নিশ্চিতকরণে বিদ্যমান চ্যালেঞ্জ সমূহ নির্দিষ্টকরণ ও তার পরিবেশ সহায়ক সমাধানের উপায় নিয়ে বিস্তারিত আলোচনা করা হবে এবং সংশ্লিষ্ট পক্ষসমূহের করণীয় বিষয়ে বাস্তবভিত্তিক সুনির্দিষ্ট সুপারিশমালা পেশ করা হবে।

Khan

গাজীপুরে ঐতিহ্য শালবন উজার ও বনভূমি দখল

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জেলার প্রাকৃতিক পরিবেশের অন্যতম উপাদান ভাওয়াল গড়ের বনভূমি বেদখল হচ্ছে। উজাড় হচ্ছে বনজ সম্পদ। গাজীপুরের ঐতিহ্যবাহী ভাওয়ালগড়ে এক দশকে ৭৯ ভাগ বনাঞ্চল ধ্বংস করা হয়েছে। কতিপয় বন কর্মকর্তাদের গোচরেই কল- কারখানার মালিক ও প্রভাবশালীরা বিভিন্ন কৌশলে সংরক্ষিত বনাঞ্চলের জমি গ্রাস করছে। এতে সবুজ বেষ্টিত বন ধীরে ধীরে সংকুচিত হয়ে যাচ্ছে। গাজীপুর জেলায় সরকারি গেজেটে মোট বনভূমি ৫২ হাজার ৭৩৭.১৫ একর এবং রিভিশনাল সার্ভে (আর এস) রেকর্ড অনুসারে বনভূমি ৪৫ হাজার ৬৮৫.৬৬ একর। এর মধ্যে গাজীপুরে সাড়ে ১১ হাজার একরের বেশি বনভূমি বেশ কয়েকটি নামিদামি শিল্প কলকারখানাসহ বিভিন্ন ব্যক্তির দখলে রয়েছে। গত দেড় বছরে গাজীপুরে ১৩৫.২৮ একর বনভূমি উদ্ধার হলেও সেটি বণ্যপ্রানী ব্যবস্থাপনা ও প্রকৃতি সংরক্ষণ বিভাগের অর্জন। গাজীপুরে বন বিভাগের পাঁচটি রেঞ্জ অফিসের মধ্যে রাজেন্দ্রপুর রেঞ্জে সবচেয়ে বেশি বনভূমি দখল হয়ে গেছে। বনের জমি দখল করতে কোটি কোটি টাকার বিপুলসংখ্যক মূল্যবান গাছ আগুনে পুড়িয়ে ধ্বংস করা হয়েছে। দখলকৃত এসব জমিতে গড়ে তোলা হয়েছে শিল্পকারখানা, মৎস্য খামার, হ্যাচারি ও পোলট্রি ফার্ম। শিল্পকারখানার মধ্যে আছে ডাইং, স্পিনিং, স্টিল, সিরামিকস, ফার্মাসিউটিক্যাল, নিটওয়্যার, রাবার- যাদের অধিকাংশই মারাত্মক পরিবেশ দূষণ করছে। এছাড়াও নিয়মনীতির তোয়াক্কা না করে গাজীপুরের কালিয়াকৈর, শ্রীপুরসহ বিভিন্ন এলাকায় বনের ভেতর অবৈধভাবে একের পর এক করাতকল গড়ে উঠছে। রাতে এসব করাতকলে বন বিভাগের সড়কের পাশেই শত শত গাছ চেরাই করা হচ্ছে। আবার সিটি করপোরেশন এলাকায় অবৈধ ইটভাটার কারণে পরিবেশ ধ্বংস হচ্ছে প্রতিনিয়ত। টনের পর টন গাছ এসব ইটভাটায় জ্বালানি হিসেবে ব্যবহার করায় পরিবেশে কার্বনের পরিমাণ যেমন বাড়ছে তেমনিভাবে কমছে গাছের সংখ্যা।

সংকটাপূর্ণ পরিবেশে ধরিত্রী তথা বাংলাদেশ

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এক নৈসর্গিক মনোমুগ্ধকর দৃশ্যের এই বাংলাদেশ। নদীই আমাদের জীবনের সাথে ওতোপ্রোতভাবে জড়িত। ফসল উৎপাদনে নদী-খালের পানির তুলনা হয় না। নদীগুলির নাব্যতা যখন ছিল তখন পাওয়া যেত বিভিন্ন প্রকারের মাছ। বর্ষাকালীন সময়ে সেই হিমালয় থেকে আগত বর্ষা ও বরফগলা পানি নদীতে একটানা পলিযুক্ত ঘোলা পানির স্রোত বইত,সেই পানিতে বাহিত হত পাললিক শিলাসহ বিভিন্ন খনিজদ্রব্য, যাকে আমরা পলি মাটি বলে থাকি।কোটি কোটি বছর ধরে সেই পলি মাটি দ্বারাই গড়ে উঠেছে এই ব-দ্বীপ অঞ্চল বা পলল ভুমি। ভারত বর্ষের ভূ-প্রকৃতি বা ভূমির গঠন বিশ্লেষণ করলেই নদীর সৃষ্টি ও প্রবাহের গতি প্রকৃতি বা নিয়ম-নীতি জানা যাবে। প্রাকৃতিকভাবেই নদী সৃষ্টি হয়েছে এবং তার গতিধারা প্রকৃতির নিয়মেই চলা উচিত। কোন দেশ বা এলাকা সেচ ব্যবস্থার মাধ্যমেই নদীর পানি ব্যবহার করা ন্যায়সঙ্গত, কিন্তু নদীতে বাঁধ তৈরী করা সম্পূর্ণ অযৌক্তিক ও অনৈতিক। ষাটের দশকে কুষ্টিয়া জেলাতে জি,কে প্রকল্প করে বাংলাদেশের দক্ষিণ-পশ্চিম অঞ্চলের নদীগুলির নাব্যতা বন্ধ করে দিয়েছে। পাক সরকারের আমলে পানি উন্নয়ন বোর্ড ও সত্তরের দশকে ভারত ফারাক্কা বাঁধ তৈরী করে (নিয়ন্ত্রিত পানি দিয়ে) বাংলাদেশকে মরুভূমিতে পরিণত করেছে। যখন বর্ষাকালীন সময়ে পূর্বে নদী ভরে পলিযুক্ত কর্দমাক্ত ঘোলা পানির স্রোত বইত সেই উপচে পড়া পানি খালে বিলে ভরে জমিতে পলি স্তর পড়ায় কৃত্রিম সার প্রয়োগ করা লাগত না ও বোরো মৌসুমে সামান্য জৈব সার ব্যবহারেই পর্যাপ্ত ফসল পাওয়া গেছে ও মাটিও জীবন ফিরে পেয়েছে। নদী,খাল-বিল ভরা পানিতে পর্যাপ্ত পরিমাণ মাছ জন্মাতো ও পাট বাহন খরচ ছাড়াই খালে বিলে জাগ (পচানো) যেত। পাট পচানো সবুজ সারটাও মাঠেই থকত। এখন পাট মৌসুমে খাল বিলে পানির অভাবে মরা নদীতে যতটুকু পানি থাকে তাতেই মাঠ থেকে পাট অতিরিক্ত খরচ দিয়ে নদীতে এনে পচানো কাজটি বাধ্য হয়ে সম্পন্ন করছে কৃষকেরা। পূর্বে হাজার হাজার বছর ধরে হিমালয়ের মিষ্টি পানি খুলনা বিভাগের (বৃহত্তর কুষ্টিয়া,যশোর ও খুলনা জেলা) উপর দিয়ে প্রবাহিত হত তখন সাগরের লোনা পানির চাপ জোয়ারের প্রভাবে খুলনা শহরের উত্তরে আসতো না কিন্তু এখন আংশিক যশোর,মাগুরা ও নড়াইল জেলাতেও লবণ পানিতে প্লাবিত হচ্ছে ও লবণ তলানি পড়ে নদীর গভীরতা কমে যাচ্ছে। এতে সকল প্রকার ফসলাদীর ক্ষতি হচ্ছে এবং অদূর ভবিষ্যতে মাটির গুনাগুন নষ্ট হলে ভবিষ্যত অন্ধকার। নদী ও খালের পানির অভাবে বোরো মৌসুমে চাষের প্রয়োজনে ভূগর্ভের পানি উত্তোলনের ফলে টিউবয়েলের পানির স্তরে আর্সেনিকের প্রভাব ক্রমাগত বৃদ্ধি পাচ্ছে। মাত্রাতিরিক্ত আর্সেনিক মিশ্রিত পানি পান করা মানব দেহের জন্য যেমন ক্ষতিকর তদ্রুপ সেচ পদ্ধতিতে আর্সেনিক মিশ্রিত পানি ব্যবহার করলে ঐ সকল সবজী ও ফসলে আর্সেনিক বিদ্যমান থাকে যা মানব দেহের জন্য বিপদ ডেকে আনে। আর্সেনিক দূষণ থেকে বাচতে হলে একমাত্র পূর্বের ন্যায় হাজার বছরের ইতিহাস অনুযায়ী হিমালয়ের পানি প্রবাহ খুলনা বিভাগের সকল নদীগুলির মধ্য দিয়ে চলমান রাখতে হবে। বি,এ,ডি,সি ও পানি উন্নয়ন বোর্ডের মাধ্যমে মাঠে নদী ও খালের পানি দ্বারা সেচ ব্যবস্থা চালু করতে হবে। সেচের ক্ষেত্রে কমপক্ষে আশি শতাংশ স্যালো ও ডিপ টিউবয়েল বন্ধ করা ব্যতিত আর্সেনিক দূষণ বন্ধ হবে না বরং ক্রমাগত বৃদ্ধি পেতেই থাকবে। সামুদ্রিক ঝড়ের প্রতিবন্ধকতা সৃষ্টিকারী একমাত্র ঐ

সুন্দরবন। প্রকৃতির নিয়মে কোটি কোটি বছর হিমালয়ের মিষ্টি পানি ও সাগরের লোনা পানি এই দুই এর সংমিশ্রণে সুন্দরবন গড়ে উঠেছিল হিমালয়ের পাদদেশে। গাঙ্গেয় অববাহিকা/সমতল ভূমি তৈরী হওয়াতে সুন্দরবন স্থানান্তরিত হতে হতে আজ দুই বাংলার দক্ষিণাংশে বঙ্গোপসাগরের উপকূলে সুন্দরবন। এখন খুলনা বিভাগের উপর দিয়ে পূর্বের ন্যায় হিমালয়ের মিষ্টি পানি না যাওয়ায় সাগরের একচ্ছত্র জোয়ারে অধিক লবণাক্ততার কারণে "সুন্দরী গাছ" মরে সুন্দরবন ধ্বংসের মুখে। সুন্দরবনে জঙ্গল আছে কিন্তু পূর্বের ন্যায় স্থান ভেদে ষাট থেকে সত্তর ভাগ সুন্দরী গাছ মরে যাচ্ছে বা গেছে। বছরের চার মাস (আষাঢ়, শ্রাবণ, ভাদ্র ও আশ্বিন মাস) একটানা ঐ হিমালয়ের ঘোলা মিষ্টি পানির স্রোত সুন্দরবনকে প্লাবিত করে সাগর পর্যন্ত গড়িয়ে যায়, এতে সুন্দরবনের মাটির লবনাক্ততা কমে গেলে সুন্দরী গাছ আর মরবে না। সুন্দরবন বাঁচলে বাঘ, হরিণ, বানরসহ সকল জীববৈচিত্র বেঁচে থকবে। সমগ্র বিশ্বের বিজ্ঞানীরা বলছেন, বৈশ্বয়িক তাপমাত্রা বৃদ্ধির কারণে এন্টারটিকা মহাদেশ সহ গ্রীনল্যান্ড ও উত্তর মেরু অঞ্চলের বরফ গলা শুরু হয়েছে। আগামী পঞ্চাশ বছরে বরফ গলা পানিতে সমুদ্রের পানির উচ্চতা তিন ফুট পর্যন্ত বৃদ্ধি পাবে, প্রভাবে বাংলাদেশের দক্ষিণ অঞ্চল তলিয়ে যাবে। কিন্তু ইতিহাস বিশ্লেষণ করলে দেখা যায় যে, পরিকল্পিতভাবে বর্ষাকালীন সময়ে হিমালয়ের পলিযুক্ত পানি যদি দক্ষিণ অঞ্চলের ভূমির উপর দিয়ে প্রবাহিত করা যায় তাহলে পঞ্চাশ বছরে সমুদ্রতলসম ভূমির উচ্চতা লাভ করবে। এতে অবশ্যই বাংলাদেশের দক্ষিণ অঞ্চল তলিয়ে যাবে না। সর্বোপরি স্বাদু পানির চাহিদা ক্রমাগত বৃদ্ধি পাচ্ছে। বর্তমানে দেশে উত্তোলিত ভূগর্ভস্থ পানির ৭০ ভাগই খরচ হয় কৃষিকাজে, শিল্প কারখানায় ২০ ভাগ ও গৃহস্থালী সহ খাবারের জন্য ১০ ভাগ পানি ব্যবহৃত হয়। জাতিসংঘের " দ্যা ওয়ার্ল্ড ওয়াটার ডেভেলপমেন্টের" প্রতিবেদনের পরিপ্রেক্ষিতে বলতে হয়ঃ- ধারণা করা হচ্ছে তেলের মত স্বাদু পানি নিয়ে বিশ্বযুদ্ধের আশংকা। সমগ্র বিশ্বের জনগন নানাবিধ কাজে প্লাষ্টিক/পলিথিন জাতীয় পদার্থ ব্যবহার করছে, এটা আদৌ বন্ধ করা যাবে না তবে সচেতনাতার সাথে ব্যবহার ও এর বর্জ্য সংরক্ষণ করলে কোন ক্ষতির সম্ভাবনা নেই। তার জন্য প্রয়োজন জনগন ও সরকারের সচেতনাতা ও দায়িত্ববোধ। প্রত্যেকটি উন্নয়নের পাশাপাশি ক্ষতি থাকবেই। তবে বাস্তবসম্মত ও পরিকল্পনা মাফিক এনার্জি বা বিদ্যুৎ যদি উৎপাদন করা হয় তাহলে ক্ষতির পরিমাণ এড়ানো সম্ভব। কয়লা ভিত্তিক তাপ বিদ্যুৎ কেন্দ্র এটা প্রাণীজগতসহ ফসলাদি ও বায়ুমন্ডলের তুলনাহীন ক্ষতি করে। আনবিক বিদ্যুৎ কেন্দ্র প্রত্যন্ত অঞ্চলে তৈরী করা উচিত। পরিবেশের ক্ষতি হয় না একমাত্র "উইন্ডমিল" এর ব্যবহার। পানি বিদ্যুৎও পরিবেশের খুবই কম ক্ষতিকারক।

Land Use and Land Cover Patterns of Nilphamari District Detected by Remote Sensing and GIS

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Land use and land cover change (LULC) occur by natural processes but their intensity is dramatically increased by anthropogenic actions in many regions of the world. This study aims to investigate the land cover change of the Nilphamari district of Bangladesh in the last thirty years by analyzing Landsat images. Time series satellite images namely Landsat MSS, TM, ETM+ and OLI were collected for the years: 1990, 2000, 2010 and 2020. By analyzing and comparing the images the historical trend of land cover change in Nilphamari district was revealed. Analyzing and visualizing the data was accomplished by Arc Map 10.2.1 software and Microsoft excel. The analysis revealed that the vegetation cover was 68.2 % in 1990 followed by 23.4% of settlement area. In 2000, the vegetation cover reduced to 36.2% which is almost half of the reduction compared to previous year. Besides, settlement increased to 41.5 % and bare land to 19.3% in 2000. In 2010, the vegetation is almost same with 2000 but settlement increases to 52.6%. In 2020, vegetation slightly increased though settlement decreased and bare land increased in Nilphamari district. The comparison of classified image of the year 1990 and 2020 has shown that settlement area of the study area has been decreased largely. Here 544.8 km^2 vegetation and 13.2% water body transformed into settlement (338.8 km^2) and bare land (219.1 km^2).

Keywords: *Change detection, LULC, settlement, urban, vegetation*

Designing Pedestrian and Eco-Friendly Transport Facilities: A Study in Rayer Bazar Area, Dhanmondi, Dhaka

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Pedestrian friendly transportation increases the social interaction, ensures the safety for children, women and old citizens, and also improves the public health and environment. The major purpose of this study is to design a safe, vibrant and pedestrian friendly transport facilities as well as improve eco-friendly behavior. The objectives of the study are to analyze the existing transport facilities, improve walkability through design guideline and improve circulation pattern ensuring eco-friendly behavior of the study area. A neighborhood of Rayer Bazar area in Dhanmondi is selected as study area where the roads are mainly local road. For conducting a survey, roads are divided into 12 segments according to similar characteristics. The survey results indicate that most of the road width is between 12-18 feet only, while only three segments have width more than 25 feet. All the roads are carrying two way motorize and non-motorize vehicles. The results also show that out of 12 selected 12 segments, 11 segments have no footpath for pedestrian, nevertheless pedestrian volume is so high for most of the roads. As the area has no arrangement for the pedestrian, people comprised with school going children and women have little safety and security while they are walking. Air Pollution, sound pollution and odor pollution are also other problems in the area. This study recommends on ensuring pedestrian and eco-friendly transport facilities which have high feasibility to solve those problems in this area. Thus, all the roads of the study area need to be classified into four categories in which roads having width more than 25 feet will be designed for motorize and non-motorize vehicle including footpath for pedestrian, roads having width between 15 to 25 feet will be designed for non-motorize vehicle and pedestrian only, roads having width less than 15 feet will be designed for only pedestrian use and vendors and dead end roads will be designed for pedestrian, social gathering, children playing etc. purpose. Those categorized roads would help to make the neighborhood more pedestrian and environment friendly.

Keywords: *Transportation, pedestrian, eco-friendly*

Present Urban State for Dhaka Metropolitan City: A Perfect Plan or a Curse?

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Dhaka- the capital of Bangladesh is the ninth-largest and the sixth-most densely populated city in the world, with a population of 8.9 million residents within the city limits, and a population of over 21 million residents in the Greater Dhaka Area. The total urban area of the largest Dhaka city is about 306 km^2 (118 sq mi) and the metro area is about 2,161.17[2] km^2 (834.432[2] sq mi). Within this area, the total population of the metro area of Dhaka in 2020 is 21006000 while in 2019 it was 20,284,000, 3.56% increase from 2019. In 2018 the population was 19,578,000 which is a 3.61% increase from 2019. And in 2017 the population was 18,894,000, a 3.62% increase from 2018. Such a growth rate is observed each year. Now the question is, is the city able to provide sustainable residence for all the people it already has with the other people who come every day searching for livelihood or a better life? The condition of some places like Kazipara and Shewrapara along with the old Dhaka city, it can be observed that an unplanned urban settlement has developed there for years after years. The houses have no safe distance from each other to protect them from urban disasters. Waterlogging is a prominent case there. If there is a fire hazard occurs by accident the roads have no such width through where a fire vehicle can enter and rescue people. Over the years, the city has had an inconsistent transformation of land use. Traffic jam is a common issue there as the roads are narrow. They do not even have a specific location to dump the garbage. The children do not have the proper place for playing. The pedestrian is too narrow and possessed by the small dwellers everyday unethically. The newcomers who come to find a life, what should they do? Leave the city? The coastal migrated people who are affected by the disasters, lost everything, come to the Dhaka city in a hope to find livelihood- what should we do with them? The rural people who are solvent enough to buy plots and develop residents in Dhaka city with the high cost and built a house with an inconsistent transformation of land use and destroys others chances, what should the govt. do? The study shows that Dhaka city is gradually developed owing to the unplanned urbanization yet many solemn and highly risky problems are perceiving and detecting for both human and environment such as overpopulation, haphazard housing service, health burdens, urban poverty, crime, child labor, erratic education system, mismanagement of waste, air, water, sound and soil pollutions, carbon emission, environmental hazards, the improper drainage system, vulnerable ecosystem, medley lifestyle, and culture etc. Finally, I am hopeful for the study where I can find a solution.

Keywords: *Dhaka city, population, urbanization*

Comparing Scientific and Social Dimensions of Hazard for Formulating an Effective Management Plan

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Scientific approach of disaster study relies on the investigation of processes (triggering forces) involved, effective forecasting, intensive use of technology and planning for evacuation, rescue and rehabilitation. Generally, these scientific techniques of management and mitigation are transferred from rich to poor countries and in most cases, those become inappropriate, unaffordable and offer false sense of security. High technology-centric management is capital intensive and benefits the socially powerful sections which reinforces the situation of poverty, exploitation, discrimination and leading to underdevelopment. Natural hazards affect more the marginalized (geographically and economically) people, but strikes rich and poor countries equally likely without any discrimination. Disaster losses are mostly controlled by social attributes, prior experience of hazardous events, systems of belief, psychological factors, economic and social circumstances especially poverty and illiteracy. Proper approach for hazard management might combine both scientific as well as social dimensions to understand complex relationship between hazard and society. Scientific and social dimensions together lead to uniqueness of places. One should consider that places are unique. So, no unified and universal framework of hazard management is effective, instead site-specific plans based on social attributes are need of the day.

Keywords: *Disaster, hazard, management*

People's perception regarding Impacts of Air Pollution on Reproductive Health: a Self-reported Study

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Air pollution has been a major challenge worldwide particularly in the developing world. This study aimed to evaluate the peoples' perception regarding impacts of air pollution on reproductive health. We have used Google form to create questionnaire and conducted this study on 107 respondents. We have conducted exploratory factor analysis (EFA) and cross tabulation with chi square test to test hypothesized value. The age group ranged from ≤11-20 to ≥50, with the majority (33.6%) in 21-30 years age group. It was observed that 60.7% of the respondents were private service holder, followed by students (12.1%). Most of the respondents live in urban area (82.2%) while 16.8% are from rural area. The Kaiser-Meyer-Olkin (*KMO*) index was .76 exceeding the recommendation value of .6 (Kaiser, 1970), and Bartlett's Test of Sphericity (Bartlett, 1954) reached statistically significant (X^2 = 312.2, p <.001) indicating that the data were suitable for factor analysis. The percentage of basic knowledge regarding Air Pollution did not differ by demographical characteristics except living area (p > .05). Almost all null hypothesis were accepted except knowledge of air pollution vs impacts on neurodevelopment, cognitive ability etc. The most were willing to pay less than 5% of their annual income. It can be concluded that, the respondents have clear perception regarding air pollution induced reproductive health damage.

Keywords: *Air pollution, perception, reproductive health*

Majumder

People's perception of the Impacts of Air Pollution on Social Life in Perspective of Bangladesh: A Self-reported Study

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This study aimed to evaluate the peoples' perception about air pollution induced social impacts. We have used Google form to create questionnaire and conducted this study on 240 respondents. One sample independent t-test was conducted to test hypothesis value. The age group ranged from ≤11-20 to ≥50, with the majority (72.3%) in 21-30 years age group. It was observed that 63% of the respondents were students, followed by private service (33.2%). Most of the respondents live in urban area (48.3%) while 33.6% are from rural area. In this study we found that, 53% respondents said it is very unsafe to go outside due to air pollution while 33% respondents said working energy extremely reduced due to air pollution. 63% respondents agreed that, air pollution causes occupational health hazard. 84% respondents are agreed that air pollution has greater impact on social life. 66% respondents are worried that air pollution has greater impact on social life. 50% people think, public awareness through media will be fruitful minimization of air pollution from our society. Most of the individual questions rejected the null hypothesis except question no 8 and 9. It can be concluded that, the respondents does not have clear perception regarding air pollution related social impacts.

Keywords: *Air pollution, perception, social impacts,*

A Bibliometric Analysis of Scientific Production on Air Pollution Studies in Bangladesh from 1995-2020

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The aim of this study was to analyze the research works on air pollution which published in online from 1995-2020 in Bangladesh. We summarized the characteristics of published documents, of the contents and number of citations and most profiles authors. This study is based on research findings on air pollution exposure from pertinent sources such as peer-reviewed articles, proceedings, national and international report. In this study, a total of 143 scientific documents were found in online. The first publication on air pollution in Bangladesh was revealed in 1995 while the highest number of publications has been published in 2019. Most of the publications were based on primary data which is 51% of the total retrieved article. The number of journal articles, proceedings and reports were 72.2% (104), 21.0% (30) and 6.3% (9) of the total publication respectively. The most frequent encountered keywords were particulate matter/aerosol 54 times and effects on human health 25 times and Particulate matter and Gaseous 29 times. It has been found that, among 143 articles 62.2% are based on Dhaka city.

***Keywords**: Air Pollution, Bibliometric analysis, Review*

Majumder

Spatiotemporal Variation and Trends of Air Quality Index (AQI) in Bangladesh during 2014-2019

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The object of the study to show the proportion of six classes AQI of four different seasons, identify the monthly mean of AQI in six different district and find the relationship between AQI and $PM_{2.5}$ from 2014-2019 . For research purpose AQI data was collected from six stations of CAMS. Study found that in this six stations winter was in most polluted category followed by the Monsoon season. It has been revealed that the air quality status of the area has been declining from 2014 to 2019. It revealed that 167.37% day was very unhealthy and 135.30% was extremely unhealthy in the Barisal district, 166.35% day was very unhealthy and 84.17% was extremely unhealthy in the Chattogram district, 111.24% day was very unhealthy and 308.67% was extremely unhealthy in the Gazipur district, 108.26% day was very unhealthy and 22.8% was extremely unhealthy in the Sylhet district. Nevertheless, another two district Dhaka and Narayanganj didn't get any good air. Their most of the proportion of AQI found to be unhealthy and extremely unhealthy. It shows strong relationship between $PM_{2.5}$ and AQI. However, in all the cities the AQI was increasing with the increasing concentration of $PM_{2.5}$. Monthly mean AQI was found to be higher in the month of January, February, march, November and December and lower in the May, June and July. In the study we has been applied Statistical and Duncan's multiple range test to the result one-way analysis of variance based on different seasons and stations. Where one-way analysis of variance test shows the F-values as 117.163and 110.162 based on seasons and stations respectively which is found to be significant.

Keywords: *Air Quality Index, Monthly and seasonal variation, ANOVA, Particulate Matter ($PM_{2.5}$).*

Air Pollution Induced Respiratory Diseases in Bangladesh, a Perception-based Learning

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Air Pollution has tremendous effects on the human body, especially in the respiratory system. The impact of air pollutants on the respiratory system has been widely and consistently reported in recent years. This study aimed to evaluate the peoples' perception of air pollution-induced respiratory health. We have used Google form to create a questionnaire and conducted this study on 325 respondents. One sample independent Chi-Square test was conducted to test the hypothesis value. A study found that the participation of female respondents was less than males in this study and the age group ranged from ≤11-20 to ≥50, with the majority (37.2%) in the 31-40 years age group. It was observed that 44.9% of the respondents were non-govt. job holder, followed by business (16.0%). Most of the respondents live in urban areas (82.2%) while 16.8% are from rural areas. It has been reported that 37% of respondents said that ambient air pollution condition is extremely unhealthy, 29% said it's very unhealthy, and 30% said it's unhealthy. It has been also found 26% of respondents agree that air pollution-induced in respiratory disease. However, 16% (52) found to be Asthma, 3.7% suffering from COPD. The study also found that 43% of respondents have breathing difficulties. The study also found that 23% of respondents taking regular medicine for respiratory & airborne diseases. The study further found that 48% of respondents visit doctors 1-5 times in 2019 due to respiratory & airborne diseases. It has found that 20% of respondents get admitted 1-5 times in 2019 due to respiratory & airborne diseases. It has been reported that 56% of respondents are worried that air pollution has a greater impact on the respiratory. It was found that 80.3% of respondents ready to spend below 5% of their annual income and only 2.8% agree to spend 10-15% of their annual income for controlling air pollution. Burning fuel, use of insecticides and pesticides, fertilizers in agricultural activities, waste in landfills exhaust from factories and industries, brick kilns, fumes of vehicles, dust from construction sites are the most commonly responsible factor for air pollution identity by the respondent.

Keywords: *Air pollution, Respiratory Disease, Questionnaire*

People's Perception on Impacts of Air pollution on Plants in Bangladesh

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Air pollution worldwide is a growing threat to human health and the natural environment. The present study was conducted to investigate peoples' perception level and awareness of air pollution and the impact of air pollution on plants. The relationship of independent variables (age, educational qualification, Profession, Living Area) with the peoples' perception level and awareness of air pollution and the Impacts of Air pollution on Plants was done to understand the objectives of the study. We have used Google form to create a questionnaire and conducted this study on 230 respondents were selected for collecting data during the period of 17 August 2020 to 25 August 2020. The findings revealed that about 7 percent of the peoples had medium perception and awareness, 0.9 percent had no idea and 92.2 percent had high perception and awareness about air pollution. The age group ranged from below 20 to 50 years, with the majority (67.4%) in the 21-34 year age group. It was observed that 60% of the respondents are private job holders 15.7% public jobholders, others followed by students are (3.5%). Most of the respondents live in urban areas (59.1%) while 40.9% are from rural areas. Independent variables, three variables such as educational qualification, age, and living area had a positive and significant relationship with their perception and awareness of air pollution.

Keywords: *People's Perception, Impacts, Air pollution, Plants, Questionnaire, Bangladesh*

How much has COVID-19 improved the air quality of Dhaka city?

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The Economist's Intelligence Unit publishes a list of uninhabitable cities every year and sadly in 2019 Dhaka was identified as the third least livable city in the world. Air pollution is one of the regulators, which is responsible for bringing Dhaka down to an uninhabitable city. Analyzing the data collected through the advanced atmospheric research center at the US Embassy's own premises in Baridhara, Dhaka, it is seen that the first 24 days of March 2020 (104 µg/m3) in Dhaka the averages air quality was 15 percent and 20 percent better compared to for the year 2018 (116µg/m3) and 2019 (123µg/m3) respectively. The upward trend (average 106µg/m3) of air pollution can be noticed in the next four days after the closure of educational institutions on 16th March 2020 (from 17th March) as the movability of the scary people has increased as many people start to move to the village. Similarly, after the announcement of general holiday on 25th March (from 26th March) after a break of two days, the people are busy leaving the capital on 25th to 27th March which increases PM2.5 for about 19 percent (124µg/m3) higher than the average (104µg/m3) of before the general holiday (1 to 24 March 2020). Despite the limited movement of people during this time, it took a long time for the particles floating in the air, the long-standing dust on the leaves of trees and the dust in other installations to subside. The air quality in Dhaka started getting better from 28th March and a minimum of 49µg/m3 was recorded on 30th March. With the exception of the first three days, the general holiday (44 days) from 28th March to 10th May, the average PM2.5 level in the air at this time (only 54µg/m3, but the average from March 25th was only 59µg/m3) before the announcement of the general holiday. The day i.e. 1 to 24 March 2020 was about 52 percent lower than the average level (104µg/m3). The data analysis shows that the number of reasonable days (Good, moderate, and cautious) in 2020 (AQI score up to 150 and the average number of days within 65µg/m^3) increased by 3% compared to 2017, 13% compared to 2018, 40% compared to 2019. That means the number of good days has increased during 2020. But it has declined by 15% compared to 2016. That is, the continuous decline in air quality since 2016 has been triggered by the coronavirus in 2020. On the other hand, the number of bad days (unhealthy and very unhealthy) has declined during COVID-19 in 2020 by 4% compared to 2017, 25% from 2018, and 43% from 2019. The number of bad days in 2020 has increased by double compared to 2016 alone. Aerosol Optical Depth (AOD) is the main optical parameter for measuring airborne particles based on satellites. According to a study by the Stamford Center for Atmospheric Pollution Studies (CAPS), the average AOD in Bangladesh declined from February 1 to May 1 in 2020 compared to the previous year. The downward trend of AOD in the atmosphere indicates a decreasing trend in air pollution. In Bangladesh, in 2017, 2018, 2019, and 2020 (March 26 to May 1), the AOD values were 0.94, 0.86, 0.74 and 0.58 respectively. From these data, it is understood that in 2020 air pollution in Bangladesh was much lower than the previous years during the COVID-19 induced lockdown.

Keywords: *AQI; Air Quality, COVID-19, Dhaka, general holiday*

Perception on Transboundary Air Pollution in Bangladesh

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Transboundary air pollution is the problem that has become increasingly evident in East Asia in recent years. For Atmospheric environment, there is a attention need to build an effective framework for international cooperation. However, there are gaps among countries regarding on air pollution and to their views on transboundary air pollution and their stances on international cooperation. We have used Google form to create questionnaire and conducted this study on 312 respondents. The age group ranged from ≤11-20 to ≥50, with the majority (33.0%) in 15-20 years age group. It was observed that 22.8% of the respondents were students, followed by Private Service (11.5%). The participation of male respondents was more than females in this study, here Male are 67% and followed female are 32.7%. Study found that, the percentage of knowledge about of air pollutants in Bangladesh did not differ by knowledge regarding Air Pollution $p > .05$. These findings indicate that, the percentage of opinion that wind direction is the main factor of transboundary air pollution did not differ by sources of air transboundary pollution. These findings also indicate that, the percentage of opinion that season is more responsible for transboundary air pollution did not differ by sources of air transboundary pollution $p > .05$.

Keywords: ***A****ir pollution, Transboundary, Questionnaire, Bangladesh*

Role of News Media to Combat Air Pollution in Bangladesh

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Air pollution is one of particular health concern in Bangladesh where it places as the fourth risk factor for mortality in worldwide. However, Bangladesh has been named the world's most polluted country for $PM_{2.5}$ exposure while Dhaka has emerged as the second most polluted city in the 2019. Whereas the news media are an important social actor in the building of the public understands of the complex relationships between air pollution and their health consequences. Media coverage of air pollution issues plays a serious role in influencing public opinion, creating a good awareness and thriving demand for action on air pollution reduction policy. Therefore, this study was designed to assess media coverage of air pollution in Bangladesh and its synthesis for making awareness in general people. Different coverage is found to be here, air pollution and health impact, air pollution, and people awareness, air pollution, and its sources, prevention of Air pollution, policy for air pollution, and how to minimize air pollution in different time sphere. Through the greater analysis of air pollution-related coverage and evidence-based policy actions, it is shown that the media can play a critical role in dynamic Bangladesh's action on air quality. It has been suggested that Media advocacy and greater public and policy engagement to address issues around air quality in Bangladesh.

Keyword: *Air Pollution, Media, People Awareness, Policy Maker*

Majumder

A Study of Indoor Air Quality and Its Impacts on Human Health at Kamranggirchar Slum of Dhaka City

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Now-a-days, environment pollution has become a vital issue for human being as we are continuously doing this being aware or unaware of it. Indoor air pollution is one of such activities which is conducted by the affected people by themselves. This study attempts to unveil some of our daily activities which are affecting us and gradually making us ineffective in our lives. This study is aims to identify indoor air quality and its impacts on human health at kamranggirchar slum of Dhaka city. A questionnaire was developed based on the objectives of the study and interviews were performed with numbers of persons from different households. Individual household characteristics were recorded and the dwellers health status was identified. Total 50 respondents were taken under this survey. Among them 24% respondent were male and 76% respondent were female. Individual indoor environment was identified by testing different indoor air quality parameter (CO_2, $PM_{2.5}$ and PM_{10}). Concentration of carbon dioxide in sample site. Maximum concentration was 684 ppm in the sample station 32. Highest concentration of $PM_{2.5}$ was 4958 Nos/m^3 and PM_{10} were and 1316 Nos/m^3. Only 14% were use mask or handkerchief and 86% weren't using any kind of mask. 72% repondents use mosquite coil on their house. Concentration of CO_2, $PM_{2.5}$, PM_{10} was high in many respondents house. As a result 78% were allergy sensitive 44% had skin irritation, 80% has eye irritation, 22% got nausea, 80% suffer from sneezing, 48% got frequent cough. Study found that where the indoor air quality and ventilation system aren't good people are suffering few health problem. Finally, it has been recommended that, reduce indoor air pollution, ventilation must be provided as well as general awareness on environment pollution and their effects should be raised up by conducting campaigns and advertisements.

Keywords: *Indoor air quality, health impact, home ventilation, carbon dioxide, particulate matter*

Effect of COVID-19 Lockdown on Air Quality: Evidence from South Asian Megacities

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During the corona virus outbreak in 2020, anthropological activities were greatly restricted in many regions of South Asia from mid-March which created an opportunity to observe the effectiveness of sources reduction of air pollutants. The objective of this study is to analyze the change in the concentration of nitrogen dioxide (NO_2) and Particulate Matter ($PM_{2.5}$, aerodynamic diameter ≤2.5 μm) among five megacities (Dhaka, Kolkata, Delhi, Lahore and Kathmandu) in South Asian countries from April 1 to May 31 over the past three years (2018–2020). For this, satellite based daily NO_2 vertical column densities (VCDs) in the troposphere were derived from the Dutch-Finnish Ozone Monitoring Instrument (OMI) and ground based hourly $PM_{2.5}$ data were collected from World's Air Pollution: Real-time Air Quality Index Project. The present study observed a decrease of NO_2 VCDs in selected cities in 2020 compared to previous years (2018-2019) during the same time period. The mean daily reading of $PM_{2.5}$ was also 36.56% and 45.44% less in Delhi; 12.67% and 23.46% less in Dhaka; 28.32% and 37.42% less in Kathmandu; 41.02% and 34.08% less in Kolkata in 2020 than 2018 and 2019 respectively during this time period. For both pollutants the daily mean difference in concentration during that observed time between the studied years was significantly lower at $\alpha = 0.01$ level. This outcome indicates that some restrictions in pollutant emitting activities can provide a safer environment and may persuade the policymakers to combat future air pollution in Bangladesh and other South Asian countries.

Keywords: *Corona Virus; Lockdown; South Asian Countries; Air Quality; $PM_{2.5}$; NO_2*

Floating Macroplastic in Coastal Areas of Bangladesh: A Remote Sensing Approach

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Plastic pollution has been considered as one of the most pressing global environmental issues. The rapidly increasing production of disposable plastic products has adverse effects on marine organisms and biodiversity as well as on human livelihoods, economy and environment. The dependence on plastic materials for modern life has led to an increase in plastic waste in coastal systems. Macroplastics are relatively large particles of plastic found especially in the marine environment (typically more than about 5 mm). At present, macroplastic found to cause water and soil pollution and pose an environmental hazard for aquatic animals in freshwater and ocean water through various processes. In addition, it is transported from aquatic animals to humans through the food chain. This study aims to detect, spatial distribution and quantification of macroplastics in the coastal zones of Bangladesh by using remote sensing technique. The study covered the floating macroplastic analysis in the coastal areas of Bangladesh including water bodies and coastal sediment. There are four (04) coastal zones have been analyzed from the coastal areas of Bangladesh. It has been found that 36.18 sq-km are occupied by plastic which is 0.75% of the total selected areas. Besides, the suspected plastic materials were 28.76 sq-km (2.10%) in coastal areas of the south-east zone of Bangladesh. In the present study maximum suspected plastic are identified in Cox's Bazar coast (2.7%) followed by the south-east coast area of Bangladesh. This study urges to conduct for more detailed investigation for understanding the level of micro beads in the lake water bodies of Dhaka city and fish species.

Keywords: *Macroplastic, coastal areas, detection, distribution, quantification, Remote Sensing*

Status of Noise Pollution in Bangladesh Secretariat: Before and After Declaring the Area as Noise Free Zone

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Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is. According to the study conducted from December 14 to December 22, sound level in the area surrounding and adjacent to Bangladesh Secretariat was more than 70 decibels for 87.57% of the time of the study (6am to 9pm) before the ban. However, people in the area were exposed to sound levels of 70 decibels or more for longer (96.03% of the time of the study) after the ban, indicating the deterioration in sound pollution. The maximum recorded noise of daily maximum was 100.5dbA on December 15th in Shikkha Bhaban. The minimum recorded noise of daily minimum was 61.4dbA on December 16th at gate no 6. The level of noise pollution fluctuates from 70.6 to 127.6dbA in Zero poin area. The maximum level of noise are all above 110dbA except 3 which are still above 95dbA in Paltan bus station. The maximum recorded noise was 124.1dbA which is extremely high on December 21st with another daily maximum exciding 120dbA.

Keywords: Noise Level, Bangladesh, Secretariat

Assessing Health Seeking Behaviour of the Rural People in Bangladesh

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The illiteracy rate of Bangladesh is 26.09% in 2020. The rate is higher in rural areas of the country. However, health care facilities is not satisfactory in rural areas for improving the health condition of rural people. Along with the facilities, the awareness, economic conditions, and positive health-seeking behavior of the rural people are also not satisfactory. The present research is highlighting these features in a very wider manner. A rigorous sample survey is made all over the country and documented the response of more than 1900 respondents. From the respondents, it is explored that they are suffering from at least 26 different types of diseases for different reasons. The results of the study reveals that the rural people are highly reluctant to go the doctor or consultant or for any check-up due to the lack of awareness, or poor financial condition or illiteracy or because of the psychological problem or shyness. This health-seeking behavior is hampering the willingness to get treatment and recurring more sufferings. The study infers that it is important to develop a need-based health care delivery system according to the behavioral pattern of the rural people in Bangladesh.

Keywords*: Awareness, disease pattern, health care facilities, health seeking behavior*

Natural Disaster and Human Displacement: A Case Study of South-west Coastal Area of Bangladesh in the Context of Cyclone Amphan

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The South-west coastal area of Bangladesh is one of the most disaster prone areas in the country. The present research indicates that natural disasters cause an increased human displacement in the coastal areas of Bangladesh. On 20th May 2020 Cyclone Amphan hit the coastal areas of Bangladesh. After cyclone Amphan, a number of people has been displaced from that area. A census survey was conducted to identify the displaced people of the area. The most affected 6 unions were selected for the purpose. Four unions of Shyamnagar and Assasuni Upazila under Satkhira district and two unions of Koyra Upazila under Khulna District were surveyed using close and open ended questions. The study identified both temporary and permanent human displacement from that area. The resulting data provided descriptive and analytical statistics. Logistic Regression Analysis and factor analysis were used to show that both push and pull factors induced human displacement. Factors like destruction of household, damaging agricultural production and communication system, scarcity of food and drinking water arising because of Cyclone Amphan, employment, better facilities, relatives support are used in this analysis. The study also pointed the present living places of the displaced people after cylone Amphan. Side by side the research has investigated the various problems facing by displaced people at their destination such as unemployment, lack of hygiene food, water, health facilities and education facilities.

Keywords: *Cyclone, disaster, displacement,*

Residents' Participation in Household Solid Waste Management in Urban Slum of Khulna City

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Poor solid waste management is among the major Challenges facing urban slums in developing countries like Bangladesh. The study was carried out to assess residents' participation in household solid waste management in urban slum of Khulna city. The study specifically identified the categories of solid wastes generated, reviewed the current practices and knowledge of household solid waste management and their constraints and also the level of awareness and attitude towards participation in solid waste in the area. The research was conducted in Rupsha Slum of Khulna city and made use of primary data through a structured questionnaire for 70 households using purposive random sampling technique. The results reval that among other wastes, kitchen (organic, vegetable) waste, plastic and paper are the most generated waste in the area. The socio-economic characteristics have less influences than the supporting factors on sorting, recycling and composting activities. Majority of the households do not engage in waste separation and most households engage in solid waste management based on their personal initiatives. Statistical analysis was carried out to show the results. The study also investigated the challenges facing by the residents in managing the household waste. The study suggests some strategies (e.g. waste reduction training programs, information dissemination, and need for authorities to engage residents) to improve the participation and awareness and to reduce waste generation.

***Keywords**: Management, residents, slum*

Establishing Eco-friendly waste and Resource Management plant in Kushtia, Bangladesh

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Waste management is still a daunting task for developing countries as without proper handling of the waste public health and hygiene is in risk. Unfortunately, most districts of Bangladesh don't have proper treatment and disposal plant. Disposal of medical waste is utmost necessary to stop spreading of COVID-19. Without ameliorating the treatment plants of Bangladesh, the situation will exacerbate. This study was conducted to evaluate the current treatment trends available in Kushtia and indicates most of the solid wastes (SW) is not safely handled. The municipality has only one treatment plant and the capacity of the plant is not satisfying daily needs. There is no plant or containment facility for medical and hazardous waste. Using GIS mapping and observing urbanization of Kushtia it was quite evident that the municipality needs another treatment plant. Moreover, the current pandemic has greatly affected the municipality treatment plant as most of the time it is in abeyance. The proposed plant in this paper includes: sorting of degradable waste, safely handle of all kind of solid waste, recycle of plastic & paper, establishing a vermicomposting plant, obtaining Bio-gas from the manure and SW, incineration of medical wastes using De Montfort medical waste incinerators. Last but not least, dumping hazardous and non usuable solid waste into landfill. To ensure better environment, every worker should be obtaining a Personal Protective Equipment (PPE) per day.

Keywords: *De Montfort, disposal, management, waste*

Present Status of Socio-economic Condition and Agricultural Pattern under the Flooding Situation in Tangail Region of Bangladesh

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Nowadays, flooding is a serious problem in Bangladesh. For excess rainfall, poor drainage pattern and the inability of the soil to store much water, etc. are the common causes of flooding in the country. Tangail district of Bangladesh is prone to riverine flood. The purposes of the present study were to find out the effects of flooding on socio-economic and agricultural pattern and to observe the possible soloution to the problem. The study was conducted at Tangail Sadar, Nagarpur, Delduar, Bhuapur, Kalihati, Dhanbari, Gopalpur, Basail and Mirzapur upazilas. The investigation was based on field visits, secondary data sources and review of relevant literature. The study conducted interviews, group discussion and survey methods to obtain qualitative information from the flood victims. Hence, a semi-structured questionnaire survey with sample size 100 was conducted at household level. To find out possible remedies existing drainage system in certain location was observed for mitigating the effects of flooding in the area. The study observed that there are some places in the area where remain stagnant water for long time due to the lack of proper drainage system that create adverse impacts on daily life. Flooding in the area is highly responsible for the changes in livelihood pattern and the economy. About 84% household members opined that they have changed their housing pattern due to flooding. Floods inundate almost about 90% lands in the area. Due to flooding the residents are constantly affecting from diarrhea, typhoid, skin diseases and viral disease of eye. About 52% tube well was affected due to flooding. The present study suggests that the development works associated with the flooding should be managed in proper ways and recommended that Environmental Impact Assessment is prerequisite for the development activities.

Keywords*: Agricultural pattern, drainage system, flooding, land pattern*

Climate Change Adaptation through Socio-cultural Transformation: A Case Study on Shyamnagar Upazila of Satkhira District in Bangladesh

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The climate is changing and impacts negatively on lives and livelihood of people. Until recently, adaptation has most often been approached in an instrumental way, by promoting technical interventions and capacity-building program aimed at helping people to minimize the risks associated with specific climate impacts. This research aims to assess the extent to which adaptations of coastal communities transform to support their climate-resilient livelihood. This research has identified the local adaptive techniques and potential capacities through the perception and practices of local community and experts relevant to the field. A mixed method research approach was used for the study. Both qualitative and quantitative methods were followed for the research where data were collected by interview transcripts, field notes from observations, a wide variety of records and historical documents and questionnaire. The survey was conducted focusing on the level of knowledge of local people related to climate change adaptation, their experiences with adaptation, the barriers preventing them from incorporating adaptation into their work and their perceptions of climate impacts. Three processes were followed for obtaining the outcome of objectives (i.e. data collection, coding, and analysis). The findings of the research indicates that, reinforcement of community level socio-cultural practices on climate change adaptation are more feasible than the technical interventions to minimize the risks of climate change.

Keywords: *Adaptation, climate change, transformation*

Environmental Changes of Rauar Beel of Tanguar Haor: An Application of Litho-Biostratigraphic Approach

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Environment is detected by analyzing the surface water quality and the contaminants in the bottom sediment. Results show that the litho-biostratigraphic sequence of the site has different layers, which are mostly dominated by silts and clays with little layers of biogenic sediments, indicating evidence of past environmental change. This might be induced from the transformation of a high-energy environment to a low energetic calm fluvial environment. Moreover, the water quality parameters (pH, DO, BOD, TDS, Turbidity, Ammonia, Nitrates, etc.) of the area is within the permissible limit all the year-round and the intensity of contaminants (Cu, Fe, Zn, Mn) in the lake sediments are also within the standard limit. This indicates the present condition of the environment which is suitable for aquatic species. Despite having some limitations, the study attempted to provide a concept about the past and present environmental condition and causes behind any environmental changes of Rauar beel of Tanguar haor region based on a litho-biostratigraphic approach and is expected to be helpful for further study as a fundamental study in this region.

Keywords: *Environmental Change, Litho-biostratigraphy, Troels-Smith Scheme*

Do Urban Green Spaces Support Towards Sustainable Cities? A Review of Literature and Implications for Bangladesh

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Urban green spaces (UGS) are private, communal or publicly owned managed accessible natural vegetated areas within urban landscapes, commonly used for recreation and other leisure activities. These include parks, gardens, children's playgrounds, mountain trails, golf courses, and other open natural areas, and may be large or small, have trees, open areas, water bodies, and are sometimes equipped with equipment for games and exercise. In this review, I will discuss how UGS positively influence social, economic, and environmental outcomes, which are the basic goals of sustainable cities, and draw useful policy implications towards sustainability of UGS in Bangladesh. UGS encourage neighbouring residents to engage in outdoor activities which in turn promote a general sense of community feelings, regular social interactions, and decrease feelings of loneliness needed for social support, leading to greater personal resilience, well-being, and the generation of social capital and cohesion. Green exercise, socializing, and viewing scenic landscapes in UGS bring positive effects on human well-being through psychological, social, and direct health benefits. Ecosystem services of UGS help to improve urban environmental quality, provide habitats for urban wildlife, and thus support local biodiversity conservation. These health and well-being benefits translate into economic benefits including savings to public health service and increased economic output due to a reduction in ill health and absence from work. Research shows that a 30-minute walk three days a week by 2.12 million individuals in the UK can generate an economic benefit of £1.75 billion per year. In Bangladesh, the importance of UGS as one of options of nature-based solution to sustainable cities has not yet been substantially realised either through research or policies. We have very limited research on UGS and only few studies so far have been carried out in Dhaka and Chittagong focusing on accessibility, connectivity, and health outcomes. Based on 2006 data, Dhaka has only 8.5% green coverage against an ideal 20%, while in Chittagong currently per capita open spaces is 0.18 m^2 against the recommended 9 m^2. Moreover, there are instances of illegal occupation of public UGS across the country. In order to approach towards sustainable cities in urban Bangladesh, I suggest the promotion and support for UGS in Bangladesh be seen as an integrated policy intervention, which requires effective coordination of relevant stakeholders.

A Perspective Study on Urban Green Space of Dhaka City

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Green spaces are a significant aspect of a sound environment. As the capital and one of the busiest cities in Bangladesh, Dhaka is losing its greener portion for the past several years. Unplanned urbanization and rapid growth of industries have fastened the process. The increasing growth of population has made the settlements denser and green spaces scattered. Not only Dhaka is one of the most densely populated cities but also migration from other cities is high thus it has been selected as the study area for this paper. In this study, the green spaces of Dhaka metropolitan city between 1989 and 2020 are analyzed using GIS and Remote Sensing approach. With a 10-year date range, 30-meter resolution Landsat 4-5 and Landsat 8 satellite data were collected from USGS earth explorer. Images are more suitable when cloud-free hence their collection time ranged from the end of March to early April for the years 1989,1999,2009 and 2020. Although green spaces are more visible in rainy seasons, cloud-free images of the time could not be found. Atmospheric correction was done using ERDAS Imagine 2014 as the free sources of data often have flaws. The study followed supervised classification method using ArcMap 10.3 to identify the green areas. For validation check, the acquired results were matched with google earth images and aerial photographs, as well as ground-truthing in several spots of the study area was done. Calculation and comparison of green areas show the decreasing trend since 1989 along with the increase of urban expansion. A certain amount of green space is necessary for healthy living. The study suggests that it needs to be a balance between urban and green space to keep the environment clean and aesthetically beautiful. Hence, it is important to manage the green spaces of Dhaka city properly and need to give more attention on this matter.

Keywords: *Dhaka city, green space, urban*

Lead Pollution and Its Toxicity in Bangladesh: A Critical Review

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Lead (Pb), a dangerous heavy metal, can pose a serious threat to human and the environment. Worldwide, Pb production and consumptions have increased at an alarming rate along with improper industrialization and urbanization, lead smelting, lead acid battery processing etc. The inappropriate management of Pb containing elements is mostly responsible for Pb pollution. Eventually, due to the long persistence in nature and bioaccumulation in the food chain, Pb can lead to adverse health impacts. The present study aimed to exhibit the sources of Pb contaminated sites in Bangladesh as well as its concentration in atmospheres, water, sediments, soil, vegetables, fish and foodstuff in Bangladesh. The present study investigated a total of 210 peer-reviewed articles in the Science Direct, Web of Science, Springer, PubMed, DOAJ, BanglaJOL platforms and in renowned university libraries and finally selected 85 articles. Moreover, the relevant findings on Pb exposure, sources, routes, diet and impacts in Bangladesh were synthesized and the outcomes were processed following a cross-tabulation technique. In those literatures, almost 175 lead contaminated sites have been identified through soil samples assessment in which Dhaka and Khulna are marked as highly polluted. Most of the studies indicate that Pb concentration in local air, river water and sediments, fish, vegetables and diet has crossed all the guidelines given by WHO, FAO, USEPA and BSTI. This study also found that all soil near to industrial areas is severely polluted by Pb in Bangladesh. High concentration of Pb has been found in fish muscle, foodstuff including leafy and non-leafy vegetables collected from different places in Bangladesh. Ultimately, the lead contaminated foods enter the human body through dietary intake and consequently causes long-term adverse health effects. This study may help to policy makers to formulate national policies with effective mitigation plan to combat adverse health impacts of Pb in Bangladesh.

Keywords: *Concentration, contamination, lead, pollution*

Waterlogging in Rajnagar Bankabarsi, Bangladesh: A Focus on the Impacts on the Life and Livelihood

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Waterlogging is one of the major environmental global issues, and Bangladesh seems to be one of the worst sufferers in this aspect. Especially, the south-western part of the country has been experiencing water logging since the 1980s. The situation compounded with the construction of polders under the Coastal Embankment Project (CEP). The present study has been conducted to investigate the causes and impacts of waterlogging on people's life and livelihood in the Rajnagar Bankabarsi village of Jashore district. Based on primary data such endeavor has been carried out through a questionnaire survey, FGD, and KII methods. Temporal variation of waterlogging in the study area has been presented through GIS and Remote Sensing techniques. The present study is a comparative assessment of different variables depending on different periods of time which is the most remarkable part of this research and tried to investigate the reason behind the disaster. The findings of the study indicats that the area experienced severe prolonged waterlogging; about 65 percent of respondents opined that waterlogging continued almost 4 months in a year for many years making life more vulnerable. More than half of the respondents (51%) indicated the rising river bed as the main cause of waterlogging. Few FGD participants blamed '*Gher*' as the major cause for the water logging in the study area. From the comparative assessment, it has been found that there is an increase of *pacca* and *semi-pacca* type of houses in the study area. Field data also identified the changes in the livelihood pattern. Analysis on income groups through Gini-coefficient found that the disparity of income increases with time, indicating poor people are the main victims of the disaster as they cannot adjust to the changed environment after waterlogging. The local people adopted themselves with different types of homestead levels and in the agricultural sector to adjust with the changed physical condition.

Keywords: *Environment, polder, waterlogging*

"Climate Change Impact: Evidences from Agriculture and Food Security in Coastal Areas in Khulna Region, Bangladesh"

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At present, Bangladesh is one of the most vulnerable to climate risk. It has been facing a great threat in the sector of agriculture and food security. Climate change adaptation policies are professed as a key sustainable development vision for Bangladesh. Being an agricultural country, climate change mostly affects the agricultural sector, damages crops, reduces the productivity and has the adverse impact on GDP. It is high time the climate change adaptation had been introduced. This paper aims to assess and forecast the impact of climate change in agriculture and food security of Koyra and Paikgachha upazila, Khulna. Almost 300 native and key stakeholders have been surveyed to collect the primary data (i.e. productivity, income, land, profit or loss and types of crops etc.). Secondary data (i.e. temperature, wind, humidity, rainfall, salinity, coastal flood, tropical cyclone, deforestation) have been collected from several government and non-government organizations like Bangladesh Agricultural Research Institute (BARI), Center for Environmental and Geographic Information Services (CEGIS), etc. Geographic Information System (GIS) related software like-ArcGIS and several statistical softwares (IBM-SPSS, Spectrum) etc. have been used for analyzing and forecasting. Yet it is found salinity and cyclone Aila are the most impactful factors in this case and the magnitude of impact on livelihood also be found through the study. In future, this research will help to provide the innovative & technical solution for the adaptation of climate change in agriculture and food security aspect in coastal area.

An Allelopathic Effects of *Litchi Chinensis* on Mungbean and Soybean Crops

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A pot experiment was conducted to detect the allelopathic effects of Litchi tree (*Litchi chinensis*) on two agricultural crops like mungbean (*Vigna radiata*) and soybean (*Glycine max*). The experiment was conducted at the Agroforestry research field of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. Five treatments were applied in this experiment and those were: T_1 (topsoil of litchi tree base), T_2 (root zone soil of litchi tree), T_3 (soil mulched with litchi dry leaf), T_4 (soil watered with aqueous litchi leaf extract) and T_5 (control i.e. fresh garden soil). Factorial Randomized Complete Block Design (RCBD) with four replications was used in this experiment. So, there was a total of 40 pots. The results of the study showed that all the treatments in the experiment inhibit the germination and growth of both mungbean and soybean over control. Inhibition of germination and growth parameters of mungbean and soybean were varied according to different parts of plants and soil collected from different places of the tree root zone. The allelopathic effects of the litchi tree were as the following order: T_3 (soil mulched with dry leaf)>T_4 (soil watered with aqueous leaf extracts)>T_1 (topsoil of tree base)>T_2 (tree root zone soil)>T_5. So, litchi leaf has more allelopathic effect than litchi base and root zone soil. Again, the dry leaf has more allelochemical effect than that of the green (fresh) leaf. Therefore, for litchi-based agroforestry systems, regular cleaning of the dry leaves is very important. On the other hand, between the two crops, soybean was more inhibited than mungbean.

''Assessing the Community Service Gap of An Urban Unit and Recognizing the Urban Engagement of The Community: A Case Study on Ward- 28, 29, 30 Of Khulna City Corporation''

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Urbanization is alluring people having a fancy lifestyle in terms of getting all sorts of services and facilities at a faster rate and time but at the same time the community facilities aren't homogenously distributed among all the people in accordance with the urban needs and community size whereas the rural people are always intending to find a way to move to the nearest urban unit to get access to the urban community facilities and so the urban populations is uprising with respect to time and space. Despite being one of the divisional cities, scarcity of community facilities has been seeming apparent in Khulna city. A Proper assessment of the existing public services and so identification of the service gap of a certain locality through a standard catchment is stood necessary to indicate the phase of of community services and so for this purpose a study has been carried across ward-28,29,30 in Khulna City Corporation (KCC) with having some inclusive questionnaire which have been distributed among various class of people of the community ensuring a proper statistical sampling. Basically, Remotely Sensed data and geographical information systems have been used to initiate the core research. Area and size of Severed, Unserved, Overserved of School, Colleges, Mosques, Markets been identified which shows the locality lacks from a bit of proper services despite having facilities in a large number yet the needs and urbanization can't satisfy the community demand at standard. The research has manifested that ward-30 is of almost zero percentage unserved concerning market facilities wherever around 9.28% and 33.94% of ward-28,29 is unserved respectively and so 66.79% community people tend to move to other parts of the KCC and 22.31% tend to move to the neighboring wards in order to receive the desired community services from market and bazar and hence neutralizing the unavailability of their shopping and all kind of market behavior accessibility. Similarly, all other community services have been identified and the study shows a few of the facilities have been overserved in a shorter scale and a statistical analysis between urban engagement and community services of R^2 of 0.73 carries a significant interpretation. However, this study can be used in the process of city infrastructural planning and management.

Keywords: *Unserved Area, Remote Sensing, Community Service, Urbanization*

Occupational Exposure to Pesticides among Vegetable Growers and its Health Effects: A Case Study in Jashore, Bangladesh

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In the unsafe and indiscriminate use of pesticides in agriculture represents a major hazard to the environment and human health. The aim of the study was to assess the levels of knowledge, attitude and practices of vegetable growers regarding the safe use of pesticides. A total of 75 vegetables growers participated in the present study through in-depth interviews and observations on-farm. The study was conducted within the four villages of Haybatpur union of Jashore sadar upazila in Jashore district of Bangladesh. Data were collected from randomly selected vegetables growers through a fully defined structured questionnaire. The study identified that the level of knowledge of pesticide safety of the farmers is insufficient. Most of the farmers (i.e. 50%) get experienced from practical use of pesticides. Most of the farmers do not have sufficient knowledge about the negative impacts of pesticides on human health and environment. Only about 58 % farmer's belief that the use of pesticides might have negative effects on human healt. About 70% of the farmers did not read or follow the instructions labled on pesticides. The study suggests conducting a motivation programme among farmers for creating awareness about the safe use of pesticide in the study area.

Keywords: *Environment, farmer, health impact, pesticide, vegetables grower.*

Right to Environmental Self Determination of Indigenous People: A Reflection on Human Rights and Environmental Protection in Bangladesh

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In comparison with the general human rights, the attention of the international organizations dealing with human rights was drawn much later to environmental rights. The right to the environment or the environmental right of the people begun to bloom when the covetous hands of modernization with its all embellishments had already gulped most of the world. The right to the environment was at first considered as the third-generation human right, the contexts, contents, and implications of which are yet to be established. However, the sudden and accelerated degradation of the environment resulting in climate change causing natural catastrophes forced international organizations to rethink the status of the right to environment. The attempt to define the right to environment and to expand its contents gave rise to the concept of the right to environmental self-determinism. This newly emerged concept of environmental self-determinism is substantially connected with the word indigenous or more particularly to indigenous people. This is so as the life of the indigenous people is surrounded by nature and their spiritual connection to nature. This discourse of indigenous people's right to environmental self-determination connotes that they have a right to survive in their own otherness, right not to be interfered with by the Government for the sake of policies and regulations that hinder their natural, cultural and physical interdependence with nature. This is a proactive and restorative approach that streamed from the idea of the right to environment coupled with the right to environmental justice. For the idea of indigenous people's right to environmental self-determination to have been materialized, it needs to be needled with fundamental human rights. The broadened and inclusive notion of the right to life which is now established as a fundamental human right both nationally and internationally necessitates that right to the environment with its contents, contexts, and implications be included within the contexts covered by it. This also requires that the contents of the right to life be distinct for the indigenous people to include the right to self-determination as part of their right to life. The general governmental policies should not interfere with the indigenous peoples' natural, cultural, and physical way of living which will jeopardize their right to environmental self-determination. Therefore, the government must take dichotomized national policies that will consider the environmental needs that are coherently connected with indigenous people.

Keywords: *Environment, indigenous, self-determinism*

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প্রকল্প কর্মকর্তা, ওয়ার্ক ফর এ বেটার বাংলাদেশ ট্রাস্ট
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যান্ত্রিক যানবাহন থেকে পৃথিবীতে প্রায় ২৪% কার্বন নিঃসরণ হয়ে থাকে। নিরাপদ হেঁটে যাতায়াতের পরিবেশ নিশ্চিত হলে যেমনই আমাদের পরিবেশ এবং স্বাস্থ্যগত উনড়বয়ন সাধিত হতো তেমনি যানজট ও জ্বালানী ব্যয় হ্রাস করা সম্ভব হতো। ঢাকা শহরে প্রতিদিন প্রায় ৩ কোটি ৪৯ লক্ষ ট্রিপ সংঘটিত হয়। ঢাকা শহরে ব্যক্তিগত গাড়িকেন্দ্রিক পরিকল্পনার ফলে শহরে যানজট, দূষণ, জ্বালানী ব্যয় বেড়েছে বহুগুণে। ঢাকা শহরে গাড়ির সংখ্যা ও ব্যবহার বৃদ্ধির সাথে সাথে পার্কিং এর চাহিদাও বেড়ে চলেছে। অনেকেই মনে করেন রাস্তার পাশে পার্কিং এর ব্যবস্থা করে (অন-স্ট্রীট পার্কিং) বা নতুন অবকাঠামো ঙতরি করে পার্কিং চাহিদার যোগান দেয়া প্রয়োজন। আসলেই কি এটি প্রকৃত সমাধান? নাকি মানুষের মৌলিক চাহিদাগুলোর যোগান দেয়াই জরুরী। সড়ক একটি অন্যতম গুরুত্বপূর্ণ গণপরিসর। এতে সকল মানুষের সমান অধিকার আছে। পার্কিং এর জন্য অবকাঠামো ঙতরি অত্যন্ত ব্যয়বহুল। ব্যক্তিগত গাড়ির সংখ্যা বৃদ্ধির সাথে যেমন পার্কিং এর জন্য জায়গার চাহিদা বৃদ্ধি পাচ্ছে, তেমনই সড়ক দুর্ঘটনার সংখ্যাও বৃদ্ধি পাচ্ছে। বর্তমানে ঢাকা শহরে ৩,৩০,৯৬৮টি নিবন্ধিত ব্যক্তিগত গাড়ি রয়েছে। প্রতিটি গাড়ির পার্কিং এর জন্য প্রায় ১২০ বর্গফুট জায়গার প্রয়োজন। প্রতিটি গাড়ির জন্য ১২০ বর্গফুট জায়গা হিসেবে ৩,৩০,৯৬৮টি গাড়ির শুধুমাত্র পার্কিং এর জন্যই প্রায় ৮ কোটি বর্গফুট জায়গা প্রয়োজন। এ ৮ কোটি বর্গফুট জায়গায় ২৬ লক্ষ মানুষের কর্মস্থল অথবা ৫৩ লক্ষ মানুষের আবাসন বা ৯১ লক্ষ মানুষের কমিউনিটি সেন্টার বা ৫ কোটি মানুষের খেলার মাঠ বা অন্যান্য গণপরিসরের সুযোগ সৃষ্টি করা সম্ভব। বর্তমানে ঢাকা শহরে মাত্র ৯% মানুষের ব্যক্তিগত গাড়ি রয়েছে। এ অল্প সংখ্যক মানুষকে সুবিধা দিতে গিয়ে ৯১% মানুষকে প্রবেশগম্যতার অধিকার থেকে বঞ্চিত করা হচ্ছে। ব্যক্তিগত গাড়ি নিয়ন্ত্রণ করে নিরাপদ ও পরিবেশবান্ধব যাতায়াত মাধ্যমগুলোকে কার্যকর করা প্রয়োজন।

Public Bicycle Sharing Service in Bangladesh: Alternative Public Transport and Sustainable Option

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Public bicycle sharing service (PBSS) or bicycle hire scheme (BHS) is a system where bicycles are strategically placed in a network of stations and offered for public use. The PBSS provides social, economic and environmental benefits, therefore, it is now available in many cities globally. PBSS users can take advantages of biking without the responsibilities of bike purchase and maintenance. The PBSS in Bangladesh (called 'Jobike') was first introduced in Cox's Bazar and Jahangirnagar University in June 2018. During the last two years, PBSS was introduced in five other different locations of the country, however, not all of them are functioning now. The present paper provides a brief history and background of PBSS in Bangladesh, current scenario of operations and services, the major problems or issues in providing service and the users' opinions about PBSS services. Relevant secondary information was collected, in-depth discussion with Jobike authority was done and the responses of 871 PBSS users were collected through online questionnaire. The results show that the PBSS provides an alternative mode and it is cheaper. Almost 90% of the users are satisfied with the services, however, a number of them reported technical difficulties in Smartphone App while unlocking or locking the bike. A number of vandalisms was reported by the service provider. There are several problems related to Jobike App, smart lock and vandalism. The findings of this research might be helpful to improve the services and operations of PBSS and thus to sustain the scheme.

***Keywords**: Public bicycle sharing service (PBSS), bicycle, transport, trip, user.*

Assessing the Importance of Parks, Playgrounds and Open Spaces for Leisure Activities of Adolescents in Dhaka City

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There are not many parks, playgrounds and open spaces in Dhaka city. Not having adequate parks or playgrounds may have an adverse effect on physical and mental growth of city dwellers. The aims of the present study is to explore the existing leisure activities of adolescents in Dhaka city, to identify the significant factors that influence outdoor leisure activities and to visualize the importance of playgrounds and open spaces on leisure activities. A total of 152 adolescents were selected through snowball sampling from 20 different areas of the city. Participants' note for a week was used to explore their current leisure practice and 108 valid responses were received. Following the participants' note, a questionnaire survey of the adolescents was conducted for the study. Moreover, a parent of each adolescent was interviewed over phone. Subsequent reasons-based thematic analysis was done to investigate the impacts of open spaces and playgrounds on leisure activities. Existing leisure activities of the respondents revealed a very low rate of outdoor or physical activities but a very high rate of screen-based activities (e.g. TV, phone, internet use). Socio-economic factors such as gender, age, adult's accompany to school, friends in neighborhood and residency length significantly influence the adolescent's outdoor leisure practices. Teenagers' attitude to leisure activities, their safety perception and parents' control over outdoor leisure, residency floor, access to rooftop and garage as well as the width, crowd and cleanliness of adjacent street significantly influence outdoor leisure activities. The quantity, proximity, size and safety of the open spaces have significant impacts on outdoor leisure activities of teenagers in Dhaka city.

Keywords: *adolescent, leisure activities, playground, open space, outdoor*

Spatial Method to Determine Energy Inefficiency in relation to Pollution by Synthesizing Structural, Social and Behavioral Aspects

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Accumulation of greenhouse gases in atmosphere has experienced a drastic rise after industrial revolution which has impacted upon the steady rise of temperature and degradation of air quality. Increasing burning of fossil fuel due to the ever rising human demand and consumption of energy is the key driving force of air pollution. Along with shift towards renewable energy, efficient use of energy is also highly significant. Inefficient system or technology as well as inefficient usage of energy leads to generation of more energy that will contribute to air pollution by combusting fossil fuels. Present study focuses to determine energy inefficiency by synthesizing structural, social, behavioral components. It tries to build up a relationship of energy inefficiency with socio-physical structure of space. Spatial analysis was conducted with the support of GIS and RS techniques. To organize and synthesize the multiple variables of this study, Analytic Hierarchy Process (AHP) and other statistical methods were used. The present research identified that inevitable well ventilation and light-availability is useful for efficient energy consumption. Moreover, proximity to waterbody, open space or urban heat island also influence energy use of any community. Not only the structural and locational elements, but also the social and behavioral elements like education, affordability, social class, consumers' preference, cognitive process etc. are connected with energy inefficiency.

Keywords: *Air pollution, energy consumption, energy inefficiency*

Health Care Waste Management Initiative in Bogura Municipality: A Case Study of Sapno, an NGO

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Increased number of healthcare facilities due to rapid population and urban growth are generating huge amount of healthcare wastes in the urban areas of Bangladesh at present days. Healthcare waste contains highly toxic chemicals, heavy metal and pathogenic virus and bacteria. This creates pathological dysfunction of the human body, thereby posing threat to environmental and occupational health. This study conducted during 2017-2019, examined the overall management of healthcare wastes of Bogura municipality with special focus of the initiatives of SAPNO, an NGO since 2010. SAPNO, in collaboration with the municipality has been trying to develop improved healthcare waste management practice since 2010 to minimize the risks and for better environment in Bogura. To reduce this adverse health risk, certain healthcare waste management components, safe carriage and storage, segregation of autoclave containers, autoclave treatment, recycling sterilized plastic and metal parts, training, equipment maintenance etc. needs to be ensured before final disposal.

Keywords: *Autoclaving, color code, healthcare establishments, health risk, segregation,*

The COVID-19: Infection, Proliferation, and Interventions on Public Health and Global Economy

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The ongoing coronavirus disease 2019 (Covid-19) is caused after mild or chronic exposure to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). SARS-CoV-2 has been accountable for human-to-human transmission worldwide along with fatality. COVID-19 pandemic has a great rampant influence on economic growth, mass education, and public health services which must have posed a transgenerational socioeconomic outcome. Addressing a detailed academic deliberation in the field of public health may be an efficacious way to perceive the impediments caused by the pandemic situation. Also, strategic and medicinal countermeasures need to be taken to save human existence. In this review, the origin, mechanism, extent, pathophysiology, epidemiological aspects, pathogenesis, and preventions of COVID-19 have been summarized. Additional evidence on the possible influence of global economic descent has also been analyzed. Alongside, the chronology of events during this viral infection has been highlighted. This review will be a summary of novel coronavirus, and the preventive counteractant to defend human health and global economy. To stop resurgences of COVID-19 along with its fatalities, implementing interventions at various levels might be appeared the most promising means to combat against the COVID-19.

Assessing NGOs Activities and It's Influence in Primary Education in Contrast with Government Contribution to Primary Schools

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Due to scarcity of resource, facilities and lack of collaboration between government and private sector, inequity takes place almost in all sectors. Especially it has been observed a huge difference between the government and no government organizations in case of health service, employment, education, facilities etc. So it is necessary to know the inequity level which prevails in various sectors. Aim of this paper was to ascertain the inequity between the Government run primary schools and NGO run primary schools. To assess this, the value of Gini co-efficient was determined first. Several pairs of criteria (six) were considered to determine three value of Gini co-efficient to describe the inequity of three different cases. First pair of criteria was the number of total Government run primary school and the number of NGO run primary school students, second pair of criteria was the total number of female school going students in government run primary schools and the number of female students in NGO run primary schools. Students per teacher in both the cases was the final pair of criteria. Using each pair of criteria, the value of LQ was first determiner. After that the cumulative percentage of those result were used to determine the Gini co-efficient value and Lorenz curve. The study shows that the value of Gini co efficient of all three cases respectively as 0.3949 (which mean there prevail medium inequity), 0.243944 (less inequity prevail) and 0.3949 (medium inequity prevail). In this study, all primary schools (both government and non-government) in Chattogram city corporation area have been collected for assessing the wash facility and represent in GIS maps. The result shows that maximum (both government and non-government) schools have under the standard toilet facility, dabbling of authority's management they aren't functional though. From this study it is seen that in case of female education the contribution of NGOs is significance as their inequity is comparatively less. The further scope of this method is to analyze the per capita GDP, the Gini coefficient demonstrates how income has changed for poor and rich. If the Gini coefficient is rising as well as GDP, poverty may not be improving for the majority of the population.

Key Words: *Collaboration, female education, Gini co-efficient, Lorenz curve, wash facilities.*

Assessing the Management of Faecal Sludge of Kushtia Municipality in Bangladesh

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Waste is one of the most pivotal issues of the world. For a better hygienic lifestyle and ensuring better living atmosphere WHO and many international organizations are trying to introduce waste management system. Faecal sludge management (FSM) in one of the vital elements of sanitization management, Recently, few municipalities have upgraded their municipal system and Kushtia is one of them. The study was conducted to evaluate FSM in Kushtia Municipality (KM) and the sanitization achievement of it. Through the survey and obtaining data from the municipality the FSM current situation and parameters of FSM were determined. It was found that KM has three working vacutugs and they empty FS for a fixed amount set by the authority. The municipality authority established a composting plant where the solid portion of faecal sludge and degradable municipal waste is used for making fertilizer. Moreover, the extracted water from FSM is being used in farming. Though it is a revolutionary work and lot of opportunities are available in comparison with the current scenario of other municipalities in Bangladesh, there are some challenges faced by the KM authority. After collecting required data, Map was depicted using GIS and paths & time from different areas to plant is shown. Lastly, the excreta flow diagram (SFD) was obtained to easily depict the entire FS management.

Keywords: *Excreta, FSM, vacutug, waste,*

Radioactive Waste Management Safety Systems of Atomic Energy Centre in Dhaka, Bangladesh

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Atomic Energy Centre Dhaka (AECD) was established within Dhaka University campus in 1963. AECD was the only solid radioactive wastes management facility of Bangladesh before 2005. Various types of low-level solid radioactive wastes were kept in the special concrete holes of a large room (L-shape) of the AECD (Fig.1). High activity solid radioactive wastes were buried at the shallow land in the special concrete structures of a large room (L-shape) of the AECD (Fig.2). The number of special concrete holes in the L-shape room is 20. The height of the special concrete wall is 85 cm and depth of the each hole is 64 cm. The special concrete walls act as shielding materials for solid radioactive wastes, which is required for minimizing the radiation hazard to the public and the environment. Continuous indoor & outdoor radiation monitoring of AECD campus is carried out using the Thermoluminescent Dosimeter (TLD) and real-time radiation monitoring devices in order to ensure the safety of the public and the environment from unnecessary radiation hazard (if any) releasing from the solid radioactive wastes of the AECD. The maximum mean dose rate and the estimated maximum mean annual effective dose in the solid radioactive wastes room were found to be 11.23 ± 3.611 µSv/hr and 17.09 ± 5.272 mSv, respectively at 10 cm distance from the special concrete walls. The estimated mean annual effective dose to the public due to the solid radioactive wastes at AECD was 0.402 ± 0.026 mSv, which is lower than the acceptable annual dose limit (1 mSv) as per the Nuclear Safety and Radiation Control Rules-1997 of Bangladesh as well as the International Commission on Radiological Protection recommendation.

Keywords: *AECD, atomic energy, TLD, waste*

Investigation of Drinking Water Quality in Selected Residential Areas in Dhaka City, Bangladesh

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Assessment of drinking water quality in Dhaka city (Lalmatia, Mohammodpur, Dhanmondi) was the main purpose of this study. Pure and safe drinking water quality are major concerning issues in all over the world. This research focuses on the status and trends of Drinking Water Quality in Dhaka City. The required data have been collected from Pump Station, and End Users sources to determine the concentration of Different parameters of drinking water quality at three different locations in Dhaka city. This study was conducted to evaluate the physical, chemical and microbial quality of municipal supplied water and its impacts in Dhanmondi, Lalmatia, Mohammodpur Dhaka. The selected water samples was examined for the concentration of pH, Turbidity, Hardness, TDS (Total Dissolved Solids), TSS (Total Suspended Solids), Chloride Physical and Microbial Total coliform, Fecal Coliform in the Mods zone 3, Dhanmondi, Dhaka. In this regard, 4 water samples were collected from 4 selected pump station and 6 different consuming points that represent the total study area. The study also incorporates the evaluation of impacts due to the consumption of municipal water. The analyses were performed to trace the presence of indicator organisms and pathogens such as Escherichia coli. According to the biochemical observation Escherichia coli pathogenic bacterial were isolated among the 10 water sample. The presented data preferred that the quality of municipal supplied water are not safe for the consumer and also indicate that this water venerable for diarrhea, dysentery, typhoid fever, shigellosis, salmonellosis, parasitic worm infection, hemolytic uremia syndrome, hepatitis, and gastroenteritis. The overall study states that, the municipal water supplied by DWASA at MODS Zone 3 in Dhaka is not safe at all for domestic use, Almost 84% Household user get contaminated water particularly for drinking purpose, and consumption of this highly contaminated water may be the prime cause of the water borne health hazards suffered by the peoples of MODs Zone 3.

Keywords: *Drinking water, quality, impact, Dhaka City.*

People's perception on apiculture practices of mustard field in Hakaluki haor of Bangladesh

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Hakaluki haor is the ecologically important critical area and largest haor (bowl or saucer-shaped shallow depression) of Bangladesh. To escape the loss due to the pre-monsoon flood, farmers of this area usually cultivate the short-day crops in the winter season. Among the short-day crops, mustard is cultivated in large areas of this hoar. Recently, farmers claimed that they are not getting the mustard yield up to their expectation level. Mustard is a cross-pollinated crop where different pollinators are the key agents for pollination and subsequent production. Honey bees, as top pollinators in mustard fields, can ensure additional income by increasing their production. To evaluate the people's perception of the importance of apiculture introduction in this area, a cross-sectional survey was conducted in Hakaluki haor at Moulvibazar district of Bangladesh. Among the total respondents, about 55 percent of farmers cultivate more than one oil crop including mustard in their field. The farmers generally cultivate local mustard variety and did not use any insecticide in their field. Around 73 percent of farmers had a positive perception of pollinators especially honey bees whereas only 9 percent of people had a negative perception about the pollinators. The rest of the farmers have no idea about the pollination in the mustard field. In spite of having a positive perception, most of the farmers did not receive minimum training on apiculture practices. Only 18 percent of the farmers received training on apiculture. Forty percent of the farmers received training through government organizations. This research will provide the baseline information for the apiculture industry in Bangladesh.

Keywords: *Apiculture, haor, perception*

Selecting suitable landfill site with multi-criteria evaluation and GIS: a case of Rajbari District in Bangladesh

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The higher rate of waste generation and treatment process is one of the most burning issues in developing countries. Use of landfill for dumping the waste is comparatively more dangerous way especially for a over populated city. Here In this study we have considered "Rajbari" district of Bangladesh as our study area. Though it has a slow rate of urbanization and industrialization, we have considered bunch of policies and regulations for evaluating all the necessary criteria. Social, environmental and economic parameters were highly considered during identifying the most suitable place for landfill. The quantity of unused land, population density in the urban areas, life span of barren fields, water and vegetation land, roads suitable for carrying waste and geomorphological parameters were assessed for evaluating the most suitable place. An appropriate site selection is one of the major problems in waste management. The main objective of this work was to identify suitable landfill site. Considering environmental and public heath safety was the top most priorities. Since this was a very intricate process because of a number of social and environmental parameter, ignoring any of these particular factors might cause miscalculation and lead to selection of a wrong landfill site which could have negative environmental, economic and ecological impacts.

Keywords: GIS, landfill, multi-criteria

Economically Important Insect Species of Agarwood Trees *(Aquilaria malaccensis)* in Bangladesh

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Agarwood (*Aquilaria malaccensis*) is one of the most precious non-timber forest species globally, under the family Thymelaeaceae. The resinous agarwood has tremendous value for the extraction of agar oil. In Bangladesh, two types of agarwood are available. These are screw injected agarwood and insect-infested agarwood. Local exporters claim that insect-infested agarwood chips are almost ten times precious than the screw injected chips. To evaluate the insect infected agarwood tree status a comprehensive survey was conducted in different agar forest growing areas of Bangladesh. A total of two economically beneficial insect species viz. *Zeuzera* sp. and an unidentified coleopteran grub was found in the harvested agarwood of the agar processing factories. However, most of the infestation symptoms were evidenced by the *Zeuzera* sp. On the basis of the infestation of the above insect species, we inspected the abundance of *Zeuzera* sp in different aged 1000 agar trees of Sylhet and Rangamati districts. It was found that the insect infestation rate was higher in the Rangamati district compared to the Sylhet district. In Rangamati, 1 out of every 3 trees was infested, whereas, in Sylhet, only 1 out of 10 trees was infested by *Zeuzera* sp. In the Sylhet region, the agar forest ecosystem is disrupted due to the uneven cut down of trees and unwise use of pesticide in neighboring crop fields of agar trees resulting in the reduction of the population of *Zeuzera* sp. As the abundance of the insect species is lower in the Sylhet district, the farmers rely on the artificial pinning process (screw injected) to produce agarwood that is less valuable. To produce sustainable and profitable agarwood, conservation of the agar forest ecology will surely increase the abundance of beneficial insect species.

Keywords: *Agarwood, insect, tree*

Ecosystem Management to Reduce Climate Impacts and Food Security

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Ecosystems provide food to all organisms living there. To secure energy and nutrients, healthy and functional ecosystems are required. Most of the ecosystems are vulnerable to anthropogenic activities and climate change and have lost their productivity. The hydrological cycle has been obstructed due to deforestation, construction of dams and embankments, unplanned infrastructures, and agricultural expansion, and thus food security is under threat. So, it is urgently needed to restore healthy and functional ecosystems. Some practices are mentioned in the present paper for ecosystem-based adaptation, among them traditional flood plain management and rural home-centered aggregated farming is important.

Keywords: *Climate, deforestation, ecosystem*

Climate Change Mitigation Framework of Saudi Arabia – An Overview

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There is currently a growing interest in the role of rapidly growing developing countries in climate change mitigation. The main causes of global warming are attributed to the releasing of greenhouse gas (GHG) emissions by various anthropogenic activities. In line with the Kingdom of Saudi Arabia's commitment to sustainable development, it has been considering climate change issues on top of the list of priorities. Based on the UNFCCC decision 24/CP.18, the Kingdom put forward national climate change mitigation efforts following a framework which emphasizes on economic diversification and climate change mitigation co-benefits. The Kingdom's initiatives aim to maintain rational use of energy by (i) providing sufficient access to energy services and (ii) inducing reduced energy consumption through efficiency, savings, conservation, and smart energy use behavior. The versatile initiatives of the Kingdom with mitigation co-benefits aim to (i) ensure rational use of energy sources, (ii) develop renewable energy resources, (iii) support demand management of resources, (iv) support R&D activities, (v) develop institutional framework and business models, (vi) support circular economy approach, and (vi) encourage behavioral changes of the public towards energy-efficient lifestyle. This study will illustrate major climate change mitigation initiatives of the Kingdom.

Rahman

Fire Hazard Assessment and Emergency Preparedness: Social Appraisal and Enhancing Resilience for Safer city

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Ensuring emergency preparedness regarding fire hazard in a city corporation area is essential to minimize loss of lives and property. As in our country, occurrence of fire incidence and loss of numerous lives as well as valuable properties are common phenomenon. For the sustainable emergency management of an area, this research project will be able to observe for availability of an emergency evacuation plan on study area for fire hazard. An emergency situation caused by a fire or an earthquake for example, may only need an evacuation covering the residents in its neighborhood. Evacuation planning may deal with either short-term or long-term issues. A short term evacuation plan needs to be enacted quickly, as an emergency response to an identified or predicted hazardous event. A long-term evacuation plan, on the other hand, is generally proposed for a potential emergency area in which some natural disaster may have frequently occurred in history and is expected to occur again in a foreseeable future as earthquake. In the social and emergency response study, five sectors for evacuation preparedness in household level is selected which have five indicators each. Each sector will have score range of 0 to 5, where 0 is the lowest and 5 is the highest score. The sampling method will be purposive sampling method and the sample size will be 380 individuals coming from various points of the socio-economic spectrum, based on age, gender, education and monthly income. Regression will be used to analyze the factors for influencing evacuation preparedness through SPSS in this research. In our research, vulnerability for the emergency response/accessibility/critical services (ambulances, fire brigades, etc.) in study area will be termed by GIS-based Network Analysis models. The model will be applied by GIS by considering accessibility of fire brigades, ambulances etc., time, distance and road blockage. The accumulative special effects of accessibility in each and every area of the study area will be evaluated by networking analysis. The research will be conducted according to primary information gathered through a questionnaire survey by the residents within jurisdiction area as well as secondary information which will be collected from the city corporation authority and Fire service and civil defense authority. This research paper will cover an effective attempt to present a suitable plan on the basis of fire risk zones. The research will also try to address about establishing mutually benefiting relationship between development processes by local authority and disaster management.

Land Use Change & Growth Management: Measuring Land Use Performance and Planning Responses in Mymensing City Corporation

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Mymensingh Municipality was upgraded to a city corporation with an area of 91.315 square kilometres (35.257 sq mi) on 2 April 2018. The development of this area has been continuing over many years and developing infrastructure and modern facilities drives mass people to migrate to the city corporation. As a result, population increasing and authority have to initiate more development project to cope with changes. Developments take place and land use has been changes. A significant amount of agricultural land has been changed to commercial and residential buildings. In this research paper we will try to find out the direction of this development, change of land use and its causes and effects. Land use performance will also be measured with some index as like as land consumption relative to population growth, land use mix and change, growth management etc. We will examine the land use change in time interval by Image classification with Erdas Imagine software and by analyzing the Master Plan. In this context geospatial technologies and remote sensing methodology will provide essential tools which will be applied in the growth detection analysis with planning responses. This research paper will be an attempt to assess the growth occurred in different wards in study area by using GIS. Then Land use performance will be justified with growth management tools. A determined questionnaire survey among community participants will also be conducted to get the community responses with master plan justification. This survey will show the local efforts to Influence land use change and growth management. Rising awareness adoption of so-called growth control and management will possible to bring in this research by community participation. The survey with the official will show, the actions of local governments takes to pursue to smart growth or growth management and their effectiveness. This research will be able to address land use plan and performance are effective in growth management and what are the gaps between plans and land use performance impacts on the city corporation.

Rahman

যাতয়াত ব্যবস্থায় রেলওয়ের গুরুত্ব

মোঃ আতিকর রহমান

প্রকল্প কর্মকর্তা, ওয়ার্ক ফর এ বেটার বাংলাদেশ ট্রাস্ট

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বাংলাদেশ রেলওয়ে একটি রাষ্ট্রীয় সেবা প্রতিষ্ঠান। ঐতিহ্যবাহী প্রতিষ্ঠানটি শুধু যাত্রী ও মালামাল পরিবহনই নয় বরং পরিবেশ দূষণরোধ, যাতায়াত নিরাপত্তা, স্বল্প খরচে মালামাল পরিবহন, ভূমির পরিমিত ব্যবহার, নিরাপদ, সাশ্রয়ী ও আরামদায়ক পরিবহন, যানজট নিয়ন্ত্রণ, বিকেন্দ্রীকরণ সর্বপরি নগরের সঙ্গে গ্রামের যোগাযোগের সেতুবন্ধনে যে গুরুত্বপূর্ণ অবদান রেখে রাখছে।

ঢাকা থেকে নারায়ণগঞ্জের ট্রেন ভাড়া ১০ টাকা। বাসভাড়া তিন গুণেরও বেশি ৩৫-৪০ টাকা। ট্রেনে মাত্র আধাঘণ্টায় এই পথ পাড়ি দেওয়া সম্ভব। আর বাসে লাগে দুই থেকে আড়াই ঘণ্টা। ৬০টি ওয়াগনের একটি মালবাহী ট্রেন মাত্র এক গ্যালন জ্বালানি তেলে এক কিলোমিটার যেতে পারে। অথচ সড়ক পথে একই ওজনের পণ্য পরিবহনে লাগবে ২১০টি ট্রাক। এসব ট্রাক এক কিলোমিটার চলতেই পুড়বে ২১ গ্যালন জ্বালানি। যাত্রী পরিবহনের ক্ষেত্রে দেখা গেছে, ঢাকা-চট্টগ্রাম রুটে ট্রেনে যাত্রীপিছু জ্বালানির খরচ বহন করতে হয় ০.৯৫-১.০৬ লিটারের। আর একই পথে বাসে যাত্রী প্রতি বহন করতে হয় ৪.০০ থেকে ৬.২২ লিটারের জ্বালানির খরচ।

দেশের ক্রমবর্ধমান জনসংখ্যার যাতায়াত সুবিধা নিশ্চিত এবং জ্বালানী সংকট নিরসনে রেল ব্যবস্থার উন্নয়ন খুবই জরুরী। রেল ব্যবস্থা গুরুত্ব প্রদান করা হলে আপামর জনসাধারণের যাতায়াত ব্যবস্থা আরো সার্বজনীনতা অর্জন করবে। রেল ব্যবস্থা উন্নত ও সম্প্রসারণের মাধ্যমে দেশের অর্থনীতিতে গুরুত্বপূর্ণ ভুমিকা রাখবে। গ্রাম এবং শহরের মধ্যে চমৎকার সমন্বয় সাধিত হবে। আমাদের যোগাযোগ ব্যবস্থা হবে নিরাপদ ও স্বাচ্ছন্দ্যময়।

Environmental Restoration of Degraded Wetlands in Refugee Impacted Landscapes in Kutupalong Mega Camp In

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The case will highlight the degradation of a large hill stream named Madhur Chhara in Ukhiya upazila that originating from hill forests from the middle reach of Teknaf Peninsula and passes through host communities and Rohingya refugee camps and finally ended up with Naf River bordering Myanmar. This paper describes the measures taken by the project in restoration a section of the stream with several nature-based solutions (NbS) interventions such as stream widening and deepening, riparian and block plantation in the basin, vetiver and grass hedging to control erosion and protection of banks, reservoir creation to hold water year round, establishment of biological-mechanical wastewater treatment facilities, conservation agriculture in the basin and community awareness. The paper also highlights replication of the approach in other stream watershed facing similar problems within and beyond refugee camps in Cox's Bazar area.

Vulnerability of Coastal Communities and Pathways to Resilience: A case study from a social-ecological production landscape in coastal Bangladesh

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Briefly describe the context and climate-disaster vulnerability of three project villages highlighting the key problems faced due to shortage of freshwater. Reasons freshwater due to degradation and conversions of canal networks in the area and contribution of canal rehabilitation and crop diversification as a package of NbS that retain rainwater and helped communities diversify their farming systems with climate smart technologies including use of stress tolerant varieties and use of water for fisheries and aquaculture which in turn helped communities enhancing their livelihoods. In addition, a case will be presented as to how the project restored a canal which was elite captured and later in 7-month time the communities, local stakeholders and local government jointly restored the canal by evicting the encroachers and re-established community control. It will highlight a pathway of building coastal resilience.

Exploring the Opportunities to New Source of Energy: Bangladesh and World Perspectives

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The world is warming up! Emission of CO_2, SO_2 NOX, SOX, radioactive wastes and few other pollutants are causing the serious global warming and Acid Rain. All these particulates are the outcome of power generation by fossil fuel notably by coal, liquid fuel, nuclear reactor, natural gas etc. However, power and energy are the integral part of national development. It can be said that, no power meaning no development. Around 70% of power is being produced from fossil fuel and nuclear energy where hydro and other renewable resources are being used to produce only 12 to 13%. We see that power being produced by the fuels to tune of 70% which are totally responsible for this global warming, acid rain, environmental pollutions and damaging the eco-system of the earth. Can we stop or reduce this non-environment friendly power production impeding economic development to keep the world clean? The clear and proven answer is renewable energy which can totally replace the existing fuel based Electricity. The resources of renewable energy are continually replenished such as sunlight, wind, rain, tides, sea waves and geothermal heat. In year 2019 about 4.81 of global final energy consumption came from renewable resources, with 0.45% of all energy from traditional biomass and 2.88% from hydroelectricity with new renewable growing very rapidly. Wind power and PV are growing at the rate of 30% annually. In Bangladesh with enormous amount of renewable resources huge clean power can be produced within a very short time. But thousands of MW have been planned to install from fuel like coal and nuclear which are enormous pollutant emitter.

***Keywords**: Coal, energy, global worming*

Site selection and environmental risks assessment of medical solid waste landfill for the City of Barishal- Bangladesh

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In this study, an integration of multi-criteria evaluation, geographic information system, and remote sensing techniques were used for site selection of medical waste landfills in city of Barishal. As it has higher rate of urbanization and industrialization , it is an upmost necessary to select appropriate place for landfill. The city of Barishal has an emerging number of hospitals and clinics including “Sher- E –Bangla Medical College and Hospital”, one of most oldest hospital in southern region of Bangladesh. As landfill is one of the most dangerous way to dump waste because it has high probability of environmental risk, it is oftenused in developing countries specially in the absence of permanent waste treatment and composite plant. As medical waste contains infectious dieses, it becomes more lethal for human and environment if it is not dumped in proper place. On the other hand, the recent outbreak of “SARS COVID -19” has added a new dimension in this era. The waste produced by facial mask and the personal protective equipment (PPE) will cause a great harm not only to the humans but also to the environment if right steps are not taken. We have considered a number of parameters like social, communal and environmental factor. We have also studied the assessments of unused land, population density, land with rapid urban growth rates, water and vegetation land, industrial area, shopping malls, and at last road analysis for finding the suitable route. . Since this was a very intricate process because of a number of social and environmental parameter, ignoring any of these particular factors might cause miscalculation and lead to selection of a wrong landfill site, which could have negative environmental, economic and ecological impacts.

Assessing the Socio-econimic Impacts of COVID-19 on Urban Poor in Dhaka city of Bangladesh

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This paper describes the potential impact of the COVID-19 pandemic on the urban poor in Dhaka city, Bangladesh. According to World Health Organization, the eruption was initially identified in Wuhan city, China, in early December 2019, and on thirty Jan, World Health Organization declared the eruption a Public Health Emergency of International Concern, pandemic on eleven March. Officials confirmed the first case outside of China found in Thailand on thirteenth Jan. In Bangladesh, the first case of the COVID-19 coronavirus was detected on 8th Mach 2020. Lock-down effective from the twenty-sixth of March. Dhaka, the capital of Bangladesh is one of the inhabited cities all over the world. Lots of folks board this town below the poverty line and also the variety of middle-income families is large. Urban poverty clench this city from a long past. Many people live their life by day leboure or regular office work. When the govt. declared lock-down individuals couldn't move out and those poor were in real bother. The present study identified the socio-economic impact, food, and nutrition impact, adolescents impact and educational impacts. Urbanization and the condition of urban poor are alos identified in the study. Weekly and monthly COVID-19 confirmed cases and deaths analysis are shown through completely different graphics and maps. Graphs are prepared by using Microsoft excel and maps are prepared by using ArcGIS software. The sources of data were Worldometer, Director General of Health Services (DGHS) and Institute of epidemiology, disease control, and research (IEDCR).

Keywords*: COVID-19, urban poor, worldometer.*

Estimating the changes in Urban Sprawl and Vegetation Cover in Barisal City Corporation Area by using Landsat Images

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Bangladesh, as a developing country, has undergone rapid development since its independence. The increased rural to urban migration has contributed to bringing about astonishing growth of urban infrastructures and consequently accelerated the changes in land cover. The divisional centers of Bangladesh have encountered extensive urban growth and the Barisal City Corporation area is of no exception. Incorporating GIS and Remote Sensing techniques, this study estimated the changes of built-up area and vegetation cover in the Barisal City Corporation area over a period of 30 years, using open-source Landsat data. For this purpose, Landsat 5 satellite images of 1990, 1995, 2000, 2005 and 2010 and Landsat 8 satellite images of 2015 and 2020 during November to late January were used to detect urban expansion and the decrease of vegetation cover of the study area. The findings suggest that the built-up area has expanded from 54.18 ha (0.8%) to 1259.1 ha (18.5%) in 1990 to 2020 respectively. On the contrary, the vegetation cover has declined from 2826 ha (41.56%) to 2315.43 ha (34.1%) in the study area. This study will provide the policymakers with a better understanding of what better steps can be implemented in the future to ensure sustainable urbanization.

Keywords: *Landsat, urban area, vegetation*

An Assessment of Livelihood Vulnerabilities and Adaptation Strategies to Tidal Surges for the Urban Poor Community in Khulna City

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The major objectives of the present study are to understand the vulnerability of urban poor community in the context of natural disaster and to explore strategies those they are adapted to be resilient against natural disaster. This study selected a slum area within Khulna City Corporation jurisdiction. In order to understand the vulnerability, eight pro-poor households were selected for in-depth interview. Purposive sampling approach is designed to choose the respond where the intention was to get an overview of pro-poor livelihood. The study indentified that slum dwellers are mostly experienced from tidal surge. Their houses are flooded twice by the water of tidal surge. The study found that NGOs play a crucial role in providing services for the poor to make them adaptive and resilient against disaster through different initiatives. The NGOs are working to empower the poor people and to make them educated and aware about different adaptation techniques and to cope with strategies in response to tidal surges. Though in this slum, community latrine, tube-well, drainage, road and electricity are available, all household within community are not equally got the services. The social capital makes a huge difference to get the services and opportunities. Other capitals such as social, economic, physical and institutional capital can also play vital role to make them resilient against natural disaster. Although they have some particular resilience building adaptation strategies, still some extreme and even moderate class poor people cannot properly adapt the resilience building mechanism.

Keywords: *Adaptation, livelihood, vulnerability*

Identifying the Impacts of Climate Change on Agricultural Productivity and Future Food Security in Katakhali Upazila at Rajshahi District

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Bangladesh is listed as one of the most vulnerable countries to climate change and according to the world bank study (2000), by the year 2050, the average temperature will increase by 1.8^0C. The increase in temperature create water scarcity in summer season especially in Barind region of Bangladesh which directly impact on agricultural productivity and food security. The Rajshahi metropolitan city located in the north bank of the Padma River facing temperature rise because of its geographical location and increase in urban development activities in the last 20 years. Also due to climate change, seasonal variations also noticeable in this region. This study aims to identify the loss of agricultural land and agricultural productivity in the last 20 years (1999,2009 and 2019) influenced by climate change. Finally, using participatory rapid appraisal tools (key informant interviews, focus group discussion and cause-effect diagram) identify the impact of agricultural productivity on food security influenced by climate change. The loss of agricultural land was estimated using remote sensing techniques. The study identifies that almost 11% of its agricultural land and 2.50% water bodies have been reduced in past 20 years. The enormous percentage of agricultural land depletion increased the maximum temperature 12^0c and minimum temperature 10^0c in the last 20 years. Due to the reduction of the agricultural land and increase of land surface temperature, a significant food security concern has been identified in Katakhali Upazilla. The agricultural productivity is mainly hampered by the irrigation process, less availability of ground and surface water, water quality, long duration of the summer session, deficiency of soil moisture due to the increased rate of evapotranspiration and less knowledge about suitable crops harvesting seasons among farmers. Policies should be aimed at to improve agricultural productivity by providing technological support, resource allocation and diversity in crops cultivation pattern which will help to provide food, income, and employment for the rapidly increasing population.

Keywords: *Agriculture, climate change, food security, land surface temperature*

A Study On Suitable Desalination Process In Bangladesh

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Bangladesh is blessed with immense storage of fresh water both above and under the ground. In recent years withdrawing much ground water has caused the decreasing of water level, moreover the quality of water is also decreasing day by day for the increasing amount of pollution. Both the scenarios result in fresh water deficiency. The problem is most acute in coastal areas. The coastal area of Bangladesh consists of 19 districts, which contains 32% of the country and provides shelters for more than 35 million people. According to World Bank research Bagerhat, Barguna, Barisal, Bhola, Khulna, Jhalakati, Pirojpur, and Satkhira districts are the most salinity prone areas. The study estimated that the salinity will increase to 26 percent in these areas with a possibility to cross 55 percent in the most affected areas like Chittagong, Barisal and Khulna by 2050. The increased salinity will cause acute deficiency of drinking water, irrigation problems and degradation in fishery productivity. In a bigger picture it will change the aquatic ecosystem, mangrove forestry and eventually leads to a huge human migration from the coastal area. Desalination of sea water in such areas can be an affordable source of fresh water for the inhabitants. According to the international desalination association, nearly 17000 plants are currently in operation in 120 countries. We have Qatar charity (QC) desalination plant and Paigasa desalination plant in Bangladesh for the benefit of more than 20000 people. Some solar based small scale research projects have been conducted in southern part of Bangladesh. The need for safe and reliable water quantity in Bangladesh continues to increase day by day following the expected population expansion by the year 2050. Further, the drawdown of ground water sources, desalination remains the best option that can meet domestic, public and industrial water demands. It does not only address the immediate water needs but also plays significant role in addressing Bangladesh's long term issue of water security. Thus the research report studies different information regarding the desalination technologies, the impacts associated with those technologies and overall cost implications. Different desalination processes implemented in countries like India, China, Australia and Saudi Arabia have been contemplated. Emphasis have been specified on the processes practiced in different countries to find out a more suitable solution in view of the economic condition, geographical and climatic characteristics of Bangladesh. The study examined the advantages and disadvantages of each desalination technology for global situation of Bangladesh, and the determinant factors for each technology. This study also proposes a most suitable and practical desalination plant to overcome the huge fresh water scarcity for Bangladesh in future.

Keywords: *desalinization, fresh water, technology*

Analysis of land covers changes: agricultural land and water body at Sylhet, Bangladesh using GIS and RS

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Land cover changes due to anthropogenic activities in developing countries are continuous process although this slow for others. Water body and agricultural land are the two important components of our environment. Land changes can be understood by the changing of this parameter. This study is conducted the identification of latest change as well as the trend of land cover in Sylhet using Geographic Information System (GIS) and Remote Sensing (RS) image classification among the period since 1990 to 2020. Sylhet positions among Indian state Meghalaya is in the north, Assam in the east, Maulvibazar district in the south, and Sunamganj and Habiganj district in the west. Selection of study area and projection of shape file are converted final Area of Interested (AOI) using ArcGIS from GCS- WGS-1984 to WGS- 1984- UTM- Zone 46 N. Spatiotemporal image Landsat- LT –04, 05 and Landsat LC 08 RS data are used for water body NDWI and agricultural land NDAI variation. Three different time periods are selected within 15 years' time interval as 1990, 2005 and 2020. Hence, stacked the images using ERDAS and compare the trend among aforementioned schedule. From 1990 to 2005 water bodies increase 15.67% but in the last 15 years it is decreases 16.56% and turned into 1766.56 km^2. On the other hand in case of agricultural land first 15 years are in a decreasing trend instead of last decades and the numerical value is 20.74% increment occurs during 2005 to 2020 time period.

Keywords: *Land cover, GIS, RS, Spatiotemporal image, landsat LC 08, increasing trend.*

Understanding the Socio-economic and Demographic Impacts of Climate Change on Vulnerable Groups in the Coastal Areas of Bangladesh

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The main objectives of this study is to know the possible scenario of socio-economic and demographic features due to climate change on coastal areas of Bangladesh by focusing the conditions of women, children, and elderly people. Climate change is perhaps most widely discussed issue among the recent global environmental change and research studies. Climate change links to natural disasters that are affecting the social and economic wellbeing of populations. The impact of Climate change will be felt in different parts of the world and by different people. Poor countries like Bangladesh is going to be worst hit. Bangladesh is considered as one of the worst victimes of climate change. The coastal area of the country is highly vulnerable. As a result, the unfavorable health condition both physical and mental stress and disruption of socio-economic condition of the affected people makes than more vulnerable to various emerging disaster and other problems.During 1991 Cyclone and Storm surge in Bangladesh, the death rate in case of women, children and elderly people was almost five times higher than the men. They are especially vulnerable due to gender inequalities under existing socio-economic conditions of the country. It needs to take into account for environmental protection, forestry and climate change and it is directly related with economic development. There are strategies and plans, but they are weak in their execution. The 7th FYP (2016- 2020) repeatedly addresses these issues to eliminate obstacles.

Keywords: *coastal area, gender inequalities, demographic features. vulnerability*

Landslide Management: A Case Study on Rangamati Region

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Recent landslide in Rangamati has sparked discussions whether natural or anthropogenic causes or both were responsible for triggering devastating landslides in the hill tracts region of Bangladesh. The geological formation of hills in those areas, although not very young, is still in the process of degradation and reformation through weathering or other natural processes. Destabilization of hill slope may happen due to increased gravity load due to rainfall, other natural or anthropogenic actions on hill slope. In this backdrop, this paper aims at discussing observations of a survey done at selected locations of Rangamati where recent devastating landslides have caused immense loss of lives and properties. Rangamati was chosen as the study area and information were obtained through a field visit survey on landslide-affected areas. The study found that the types of soil play a significant role while heavy rainfall, hill cutting, deforestation, unauthorized human settlements and faulty infrastructure construction act as a catalyst behind the landslide. This paper also identified some causes that induced the landslide in Rangamati region and presented an overview of the existing protection measures and the feasibility of these infrastructures to prevent landslides. A comparison of damages of last five years should be focused to understand how awareness worked on landslide management.

Keywords*: awareness, comparison of damages, landslide, management.*

Everyday Spatial Negotiations of the "Domestic" During Flood

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While much is talked about climate vulnerability and also resilience, less narratives exist about the daily lived experiences of households and individuals in their process of adaptation. The study attempts to establish a relationship between the natural and built environment at the intersection of hazard and rural housing. It explores the everyday lived experiences of rural household's adaptation with the submerged dwellings through a lens of gender. It is situated in two villages of Manikganj district and based on narratives of women and community leaders though interviews and FGDs. While majority family members are found to be taking refuge in flood shelters, a lot of women–homemakers–tend to stay back in the submerged houses, sometimes with toddlers, for various reasons. The study is an exploration into the negotiation of domestic spaces by these women to capture the minutes of everyday living with floods. The major understandings from this study of women and space is that during flood the entire domestic sphere of the affected households operates through the multiple use of a *macha* (bamboo platform) and in this whole process women are the primary service providers. While women are today at the center of resilient development the housing sector is still a male dominated area and lack participation from women. The study hence is also about demonstrating women's intensive engagement with dwelling spaces and contributing to an agency turn in the discourse of environment and climate change adaption. Therefore, it aims to shed light upon women's role in everyday negotiation with floods at individuals levels contributing to the overall community's adaptation from the domestic arena.

Keywords: *Spatial negotiations, rural homestead, women, flood.*

‘‘An Exploration of Environmental Impact Assessment (EIA) in Bangladesh Using SWOT Analysis’’

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Environmental Impact Assessment (EIA) has been used formally in Bangladesh since enactment of the Environment Conservation Act (ECA), 1995. In a developing country like Bangladesh, Environmental Impact Assessment (EIA) is very important to predict the impacts of any development project on the environment. So, it’s very essential to explore both positive and negative side of this environment management tool to evaluate its effectiveness. This study aims to evaluate the Environmental Impact analysis as well as focusing the various coercions, limitations of Bangladesh EIA guidelines. This study shows that despite of being effective some provisions of this act needs to be modified which are hindering its efficiency. The Strength, Weakness, Opportunity and Threat (SWOT) analysis of legal rules of EIA in Bangladesh has been thoroughly done. The strengths and opportunities have been highlighted external, internal positive factors of EIA guidelines such as public awareness, fusion of environmental consideration in plans and policies, communities for sustainable development projects. The weakness and threats have been focused on limitations of EIA guidelines for-instance deficiency of management system, lack of celerity in economic sector, corruption etc. The Bangladesh EIA Guidelines can get suggestions from this study to increase robustness of the EIA system and improve the process of development projects to ensure the sustainability of environment.

Keywords: *Environmental Impact Assessment, SWOT analysis, Bangladesh, Sustainability, Efficiency.*

Effects of Eucalyptus Plantation on Soil Properties and Litter Decomposition Processes

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Plantation of Eucalyptus (*Eucalyptus* spp.) has been increasing worldwide for the multiple benefits including fast growth, massive biomass production and quick economic returns. However, plantation with this exotic species has created enormous concerns regarding its ecological impacts. The present study investigated the effects of Eucalyptus plantation on the soil properties and examined the influence of Eucalyptus leaf litter on the decomposition processes of the litter of other plant species. Soil properties of the plots planted with Eucalyptus was compared with that planted with *Acacia auriculiformis* and *Lagerstroemia speciosa*. Results showed that significant effects of plantation with Eucalyptus on soil properties depended on the identity of species with whom effects were compared. Significant difference on soil conductivity (P = 0.0001) and P content (P = 0.0310) appeared between plots planted with Eucalyptus and *A. auriculiformis*, however, that on soil moisture (P = 0.0001), organic carbon (P= 0.03), pH (P = 0.0001) and total P content (P = 0.0015) appeared between plots planted with Eucalyptus and *L. speciosa*. Effects of Eucalyptus leaf litter on the decomposition and nutrient release rates were studied by incubating leaf litter of Eucalyptus with that of *Swetenia mahogoni*, *Axonopus compressus* and *Tectona grandis* for 12 months under controlled soil moisture and light condition in the room temperature. Results revealed that leaf litter of Eucalyptus significantly affected the mass loss rate of that of *S. mahogoni* (P = 0.023) and *A. compressus* (P = 0.019) but not that of *T. grandis*. Nitrogen release rate from the leaf litter of the selected three species was not significantly affected by leaf litter of Eucalyptus. Difference in litter decomposition rate among the selected plant species could be explained by the chemical composition of the litter of the different species used in the study. Over all, results of the present study indicated that plantation with Eucalyptus might have potential influence in altering soil properties as well as decomposition rate at ecosystem level although such effects depended on the identity of species with whom comparison was made.

Morphological Changes of Rivers in a Poldered Ecosystem in Lower Bengal Delta of Bangladesh

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Fluvial geomorphology studies the planform of streams and their interaction with the landscape around them. Response of rivers to various natural forces and human activities is important for effective management of rivers. The present study deals with the morphodynamic characteristics of a river, namely Hari River, along with its six tributaries. This study deals with only a portion of Hari River that runs within the polder 24-25 of the Lower Bengal Delta, Bangladesh situated in Khulna division of the southwest coastal zone of the country. Among the six tributaries studied, three run through polder 24 and the other three run through polder 25. Understanding the changes occurring in these rivers and their responses to the various drivers of such changes that act on it is essential to improving the livelihoods of the dwellers of these polders. Morphodynamics of Hari River and its tributaries were analyzed over the period 1975 to 2019 using nine dry season multispectral and multitemporal Landsat images. Sinuosity ratio of Hari River and its six tributaries were estimated and the analysis shows that all the seven rivers have become more sinuous as time forwards. It was also found that Hari River has slightly migrated towards the east during this 44-year study period. Images depict that shifting of Hari River is not abnormal and so it is still not alarming for the existence of the local people. Such information will help the local river management authority in planning and designing a proper management scheme.

Keywords: *Morphodynamic, planning, polder, river management*

Status of Noise Pollution in Chattogram City Corporation: a GIS Approach

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Noise is an Environmental Pollutant, another product of the technological age. It is simply an unpleasant sound that causes discomfort. According to World Health Organization, noise can be defined as the level of sound that exceeds the acceptable level and creates annoyance. For this, in the near future, noise issues may become unmanageable unless the government takes action to benefit the general public. With this background, the present study has been carried out to assess the status of noise pollution in different zones of Chattogram City Corporation (CCC). Five different zones were selected in the CCC based on land use. Three samples were collected from each sampling site. Each and every places noise level measurement has been taken 3 times in a day. It has been found that, the maximum noise level was in north Baklia followed by EPA circle area. In Natunpara maximum noise level was 100.8 dBA and minimum was 69.4, in Bahaddarhat maximum noise level was 93.2 dBA and minimum was 69.9, in Alonkar mor maximum noise level was 90.9 dBA and minimum was 79, in Chawkbazar maximum noise level was 97 dBA and minimum was 71.6, in Kodomtoli maximum noise level was 96.7 dBA and minimum was 75.6, in Anderkilla maximum noise level was 99.4 dBA and minimum was 73.2, in Laldidigi maximum noise level was 94.2 dBA and minimum was 68.8 dBA. But from our study we found that, all the locations the noise level has exceeded the National Standard Level.

***Keywords**: Hearing quality, noise, traffic policemen,*

Assessing to Role of Tobacco Companies in Causing Global Warming

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The human health impacts of tobacco use are well-documented. The impact that tobacco has on the environment is less recognized. Although tobacco's effect on the environment is lethal, not much attention has been placed towards this issue. The present study collected data from several research works to explore tobacco's diverse effect on various aspects of the environment. Billions of tons of Carbon dioxide are released into the atmosphere every year as a result of coal, oil, and gas production. Human activity is producing greenhouse gas emissions at a record high, with no signs of slowing down. According to a ten-year summary of UNEP Emission Gap reports, we are on track to maintain a "business as usual" trajectory. The last four years were the four hottest on record. According to a September 2019 World Meteorological Organization report, we are at least one degree Celsius above preindustrial levels and close to what scientists warn would be "an unacceptable risk". The environmental lifecycle of tobacco can be roughly divided into four stages: (1) tobacco growing and curing; (2) product manufacturing and distribution; (3) product consumption; and (4) post-consumption waste. Tobacco smoking leads directly to the emission of 26,00,000 tonnes of carbon dioxide and about 5 200 000 tonnes of methane. Data from 66 low and middle-income countries showed that tobacco growing and curing caused significant deforestation between 1990 and 1995, amounting to approximately 2000 hectares – on average, 5% of each country's estimated deforestation during that five-year period. Worldwide, approximately 13 000 000 hectares of forest are lost due to agriculture or natural causes each year, and of this, at least 200 000 hectares are for tobacco agriculture and curing. One estimate of the impact of deforestation in tobacco agriculture and curing is that it causes almost 5% of global greenhouse gas production.

Keywords*: Deforestation, environment, global worming, tobacco,*

Assessment of Municipal Solid Waste Management System

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Bangladesh is a developing country. With the time period of the development, the amount of waste is increasing and the effective management and legislation of this waste has become an important issue. Every year, this solid waste tends to increase; it will inevitably create a great solid waste management (SWM) burden for local administrations. Solid waste is becoming a major problem in Dhamrai Municipality. The study is to looking for the existing solid waste management practices, analyze the present waste management system and find out some basic problems related to solid waste management system in Dhamrai Municipality. This study reveals that ward 5 and ward 6 in Dhamrai Municipality represent a different scenario of solid waste management. Primary data collection includes questionnaire survey, observation survey, photographs taking, interview of the officials, etc. was made for find out an overall perception of the study area which is related to solid waste management system in the study area. This study finds out that almost 50% solid wastes dump on a roadside and 30% dumping in vacant land. 30% waste used to recycle process. Almost 45% wastes are responsible for environment pollution. That's why people suffered from different kinds of diseases like fever, dysentery, malaria, skin diseases, etc. Disposal of solid wastes is a stinging and widespread problem in municipal areas. Unfortunately, the conventional disposal method employed by most local administrations is open dumping without considering health, hygiene and environmental issues. This study reviews the storage, collection, disposal, management, and recycling policies for SWM in Dhamrai Municipality. The sources and quantities of waste generated as well as their impacts on the encompassing environment are identified. SWM is related with tangible and intangible factors namely environment, health, community, education, finance, technology, governance, policy and regulation. If these factors are addressed properly, SWM can be sustainable and can enhance governments capabilities.

Plastic Pollution, the Environment and Human Health

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Plastic is a wide term which applies to a wide range of materials that can be extruded, moulded, cast, spun or applied as a coating. There are different groups of plastics and each has own grades and varieties. However, plastic has the potential to transport organic and inorganic contaminants. Plastic debris is broadly divided into mega-plastic (>20 mm), macro, or meso-plastic (20-5 mm) and micro-plastic (<5 mm). Microplastics (MPs) are ubiquitous in nature and are found from the poles to the equator. It is estimated that more than 260 species are already affected by plastic debris or MPs through entanglement or ingestion. Plastics can act as a source of environmental contaminants such as organochlorine pesticides, polycyclic hydrocarbons, heavy metals, and contain potentially toxic chemicals including bisphenol-A, phthalate plasticizers, flame retardants. MPs have been considered as emerging contaminants and can be harmful to wildlife and human health. All these chemicals are also endocrine disruptors and carcinogenic. Human exposure to MPs and other organochlorine pesticides is via dietary, inhalation and occupational exposure. Thus different communicable and no communicable disease including cancer, liver diseases, cardiovascular, neurological, reproductive, and developmental toxicity, impairment of the immune system may be generated due to the exposure of plastic and microplastics. The overall purpose of the present work was to measure the plastic pollution and other chemical contaminants in the Bay of Bengal and their impacts on human health. Marine and fresh water fish (n=60), water (n=110), soil (n=30) samples were collected to order to investigate the presence of microplastic and other chemical contaminants *i.e.*, organochlorine pesticides and heavy metals. The dissection of the entire gastrointestinal tract of fish samples was conducted and digested by NaOH or KOH to isolate plastic litter from the organic tissue for the presence of MPs. Suspected plastic pieces were separated from tissue residue under dissecting microscope at 4-40x magnification. Chemical structure of isolated plastic was confirmed by Fourier Transform Infrared Spectroscopy (FT-IR). Among all species studied, Sharpunti, Kholla, Chapila, Koral, Datina, Chub mackerel, Poa, Tular dandy, Tuna, Pabda, Pholy, Deshi puti, Bhagna and Baim were found to be contaminated with microplastics. Detected MPs were mostly irregular, filament, angular and round shapes. Suspected polymers recovered from the fish were fibre, polyethylene, silicone rubber, elastomer and Styrofoam. Twenty organochlorine pesticides and heavy metals (Cd, Cr, Hg, As and Pb) were analyzed by *gas chromatography coupled with electron captured detector (GC-ECD) and atomic absorption spectroscopy (AAS), respectively.* Low level of pesticides and heavy metals were found in the analyzed fish species.

Keywords: *Chemical, environment, plastic, pollution*

Assessment of Environmental Impact of Rohingya Influx in Cox's Bazar

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Almost 900,000 Rohingya refugees were sheltered at cox's Bazar, Bangladesh from 2017 which is the largest and densest refugee camp in the world. This is the vulnerable situation due to health risk factors, reduction of land, shortage of safe food and water, local biodiversity damages. As a densely populated developing nation with emerging economies, the marine ecosystem is facing multiple progressive challenges including unplanned coastal development, plastic pollution and environmental degradation, sequential depletion of fish stocks, and loss of ecological processes. In addition, overcrowded Rohingya camps become exposed to new environmental factors that place them at further risk for high rates of malnutrition, waterborne diseases including cholera and diarrhea, diphtheria, measles/rubella, suspected hemorrhagic fever, confirmed malaria, meningitis, acute flaccid paralysis, adult and neonatal tetanus, dengue, outbreaks of hepatitis E and typhoid which are intensified during Monsoon (approximately June–October). Government of Bangladesh (GoB) plans to implement a major work programme to develop an important pathway to sustainable economic development, and the Ministry of Environment and Forests (MoEF) and United Nations Development Programme (UNDP) were jointly identified eleven environmental impacts that have been or could potentially be exacerbated by the Rohingya influx. Six of these were physical environmental impacts on: groundwater, surface water, acoustic levels, indoor air quality, solid waste management, and soils and terrain, and the remaining five were impacts on ecosystems: natural forests, protected areas, and critical habitats, vegetation, wildlife and marine, and freshwater ecosystems. After that they proposed an environmental management plan, a series of actions to address the high environmental risks related to the influx. UNHCR reported that out of 860,240 population of total refugees, woman & children 78%, Adults 45%, Children 52%, Elderly 4% and specific need 5%. According to UNHCR, 1638 families received community education, 86% of children in primary education, 53% of students enrolled in lower secondary education and youth lifelong learning program. To observe all of the statuses, we visited several camps with the help of the Refugee, Relief and Repatriation Commission (RRRC), Cox's Bazar and talked to different communities, interviewed people, and collected blown water (n=10) and soil (n=10) samples were bought in our laboratory then analyzed by atomic absorption spectroscopy (AAS). In this study, water quality such as microplastic availability, pH range of 6.34-7.54, conductance, total suspended solids range of 34-255 mg/L were examined and the heavy metals range of As, Cr, Hg and Pd were found 0.50-2.62, 6.10-33.9, 0.12-0.80, and 6.98-22.3 mg/kg in soil samples, and below than 0.005, 0.005, 0.001, and 0.01 mg/L in water samples, respectively.

Keywords: *Environment, pollution, RRRC, Rohingya*

Quality of life in Mymensingh City: A Case Study

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Quality of Life is an important issue in the modern era and every citizen of any region always tries to improve his/her living quality up to the best standard level. Ensuring quality of life (QOL) among its residents is a critical part of all city's role. The aim of this study is to assess the quality of life in Mymensingh city through field study and questionnaire survey, with a random sample of those living in the study areas. A total of 674452 people live in the study area of which about 93% are Muslims, about 6% are Hindus and the rest are Christians, Buddhists, and others. The study showed that about 20% of people in the study area are graduated and are engaged in Government and Non-government job. About 24% of people in the study area earn their livelihood by agricultural activities. Only about 10% respondent's income was more than 50000 Tk. while about 30% of respondent's income was 30000-35000 Tk and about 30% of people of the study area had an income of less than 10000 Tk. Most of the people use water from their personal tube-wells, submersible taps, and WASA supply and water quality levels were in good agreement with standard values. Only about 35% of people in the study area use supply gas while 25% of the people use LPG cylinders and 20% use firewood for their cooking and other household activities. Only about 20% of people in the area expressed their satisfaction with health care facilities while 16% of people express their satisfaction with security services. Water quality parameters of drinking water were within the acceptable limits. Thus, the study showed a socio-economic scenario of the study area that will help the policymakers to plan for its development.

Keywords: *Socio-economic status, quality of life, water quality*

Spatiotemporal analysis of the Land use, Land cover (LULC) and it's impact on the Land Surface Temperature (LST) of Dhaka Metropolitan Area between years (1990-2020)

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Dhaka city is facing a major challenge because of the essentially high pace of physical and populace development since 1981, which has made huge tension on metropolitan land, utility administrations, and different enhancements of metropolitan life. A generous development of developed territories for example metropolitan improvement is changing progressively the scene from normal cover types to Impervious Surface (IS), which has an unfriendly impact on the metropolitan environmental change, for example, sudden temperature rise, whimsical precipitation, corrupting air quality. The objective of this project is hence set to discover the effects of metropolitan advancement, land use, land cover (LULC) areas, and land surface temperature (LST) in Dhaka city over the time of 1990 to 2020. To accomplish this objective, the research is done to evaluate the connection between the land surface temperatures (LST) and land use, land cover (LULC) zone from both quantitative and subjective points of view. In this investigation, the proposed study zone is limited to the Dhaka Metropolitan Area (DMA). Satellite pictures of the DMA region over the time of 1990 to 2020 is incorporated from the USGS site as zip format. To direct this research, two notable software specifically ArcGIS Desktop 10.7 and ENVI 5.1 are used. Spatial simulation and investigation are completed utilizing advanced Geographic Information System (GIS). Supervised classification method has been taken to set up the LULC maps and LST is gotten from the thermal band of Landsat TM/ETM+ utilizing the recipe to change over DN into Radiance, at that point radiance to BT, & transformation of the degree kelvin to degree Celsius utilizing ArcMap. GIS-based spatial simulation has been directed to build up the relationship of LULC and LST. The outcome shows that the class of urban built-up the area is developed 23.53%-53% in consistent development rate and it was transformed from the classifications of water bodies and vegetation Land Cover during the time of 1990 to 2020. The changing of LST is straightforwardly associated with LULC progress and LST is expanding in those zones where LULC of developed and earth fill or sand classes (urban development) are grown up. What's more, it is likewise demonstrated from the outcome that the measure of vegetation (NDVI) adversely corresponds with LST. Consequently, the developed regions for which NDVI value is more noteworthy have been found to have low LST value. Alongside, the NDBI value is emphatically related to the LST. The pattern of LST and LULC change shows that LST of Dhaka city will be suddenly expanded in the not so distant future. The result subsequently got from this project would address the future outcomes of changing both LULC areas and LST in Dhaka and would propose a key guide to lessen LST as a one of a kind commitment to the information base of academic network or scientific community.

Keywords: Environment, LULC, NDVI, spatiotemporal

Performance of Co-management Organizations towards Conserving the Sundarbans Mangrove Forest

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It was well reported that the conservation efforts of the world's largest single mangrove forest the Sundarbans were challenged. The traditional top-down management approach was not enough to consider the interests and opinions of a wide range of stakeholders of the Sundarbans who could affect or were affected by various decisions solely taken by the Bangladesh Forest Department and its aligned ministries. Therefore, it warranted the change of management approach to improve its conservation status considering the active participation of the local stakeholders. Consequently, currently, the mangrove forest is being managed through a new bottom-up management approach i.e., collaborative management or co-management since 2009 aiming to promote its improved and governance system in strengthening its conservation efforts by reducing various vulnerabilities particularly illegal anthropogenic threats. To achieve such a target various local co-management organizations (CMOs) have been formed which are considered as the new 'powerhouse' of the management of the Sundarbans. However, even after implementing several co-management focused projects, there are scarce studies, evidence, and experiences on the process and performance of these CMOs in conserving the Sundarbans. Considering these, the overall aim of the qualitative study is to assess the overall performance of CMOs in conserving the Sundarbans mangrove forest with particular reference to the Chandpai and Soronkhola range. The findings identified the process of relationships with concerned stakeholders of the CMOs. It revealed various roles of leaders in these CMOs and their leadership played a key role to make the approach more effective. It assessed the governance process within and among those CMOs and found some issues related to the members' participation, ruling status, and decisions making process, and so on. The study also unfolded that the alternative income generation (AIG) facilities were poor in the study area due to a lack of financial support to the CMOs for creating AIG opportunities. Moreover, CMOs warranted better guidance, logical, and institutional support from various government and non-government organizations. Findings are expected to assist in policy decisions for the management of protected areas in Sundarbans mangrove forest to manage the forest in a sustainable way and conserve the resources as well.

Keywords: *Co-management approach, co-management organizations, leadership, Sundarbans*

A Review of the Climate Change and Groundwater Level Fluctuation in Rajshahi District Of Northwest Bangladesh: An Issue of Concern

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Climate change causes precariousness to the supply of water resources across the environmental compartments. Among all the fresh water sources, groundwater is the largest source of fresh water in Bangladesh. Changes in the temperature and rainfall pattern resulted in the increased dependency on groundwater resources of the localities and subsequently affected the state of groundwater system. Also, decrease in the surface water areas in this region has been recorded since 1990. Since all the rivers are dried up during dry seasons, dependency on groundwater increased rapidly. For agricultural purposes and other uses, people of Northwest Bangladesh directly depend on the groundwater resource. About 75% of the water that is used for irrigation in Northwestern Bangladesh, comes from the groundwater which resulted in the depletion of groundwater table. Several studies have been conducted from time to time for determining the trend of groundwater fluctuation in Northwest Bangladesh. This study focuses on understanding the temporal changes in hydro-climatic variables of Rajshahi, one of the districts of the northwest Bangladesh. Rajshahi had been experiencing meteorological and hydrological drought since long ago. Increasing trend in the annual average maximum and minimum temperature, and declining trend in the annual rainfall in the Rajshahi district intensified the problem. Groundwater, that is recharged from the water of rivers and streams and possibly from rainwater percolation, is thus not replenished as fast as it is consumed. This resulted in the declination of groundwater table in Rajshahi and affected the livelihood of the people living in that area. The declining trend of groundwater table indicates the unsustainable withdrawal of groundwater for irrigation purposes in Rajshahi. For proper management of the study area, analyzing these trends is a must to predict the future consequences and to take actions accordingly.

A Review on Metals in Urban Dust and Significance of Roadside Plants as an Indicator of Heavy Metal Pollution

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Rapid industrialization and urbanization profoundly threatened the urban areas with several environmental pollutants including toxic trace metals namely As, Se, Cd, Cr, Cu, Pb, Sb, Ag, Tl, Zn, Be, Hg and Ni. Exposure to such metals are culminating in adverse impact on human health. This paper encapsulates the diversified sources that contribute in the prevalence of these metals in the urban dust. Metals are present in the environment since the Earth's formation by undergoing the process of mineral weathering and distributed by erosion through wind and water runoff. Besides, volcanic outgassing, combustion of carbonaceous materials, acid precipitation, active fault structure and some other marine sources, are the main natural sources of the heavy metals on the earth. With time, anthropogenic activities incremented the concentration of heavy metals in the environment and atmosphere through industrial and heavy construction activities of automobile industries, ore processing plants, metal and steel industries, thermal power plants and so forth, in addition to heavy traffics, exhaust and non-exhaust vehicular emissions, electronic waste, improper solid waste management, electroplating metals and other activities. From these anthropogenic sources, pollutant metals are distributed through atmosphere and deposits in urban dust. Moreover, different studies are conducted to perceive the effect of anthropogenic related pollutions on metal accumulation and physiological change in roadside plants. In various plant species or types, the absorption/accumulation, aggregation and translocation of heavy metals may vary due to anatomical and physiological differences. The sensitive or susceptible plant species serve as biological indicator of heavy metal pollution, while resilient plants mostly used for urban greening in order to enhance environmental health. Roadside trees serve as good indicator to show trend of metal accumulation over a long period of time, and it is easily available than herbs, moss or lichens. The bark accumulates more metal than leaves to provide valid result. Such analysis helps to determine the hyperaccumulator or tolerant plant species for urban greening purpose. Roadside plants have both advantages and disadvantages, however the benefits have over shadowed the disadvantages. Metals being toxic in high concentration enters human body through inhalation, ingestion and dermal contact and pose a threat to human health. Most of the metals like Cr, Ni, Pb, Cd, Zn, As, Hg and Cu have carcinogenic effect in human health. Children are the most sensitive group as metal exposure is more in children than adults. Metals also disrupts digestive, cardiovascular, hepatic, respiratory along with circulatory systems in human body. For these reasons, the significance of metal analysis in urban dust and roadside plants are rising among the researchers around the world due to its cost effectiveness and validity of result.

Impact of Climate Change on Children's Heath at Mirpur 12 of Dhaka City

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The burning of fossil powers causes the discharge of carbon dioxide, which builds up within the environment and causes Earth's temperature to rise.. Upstream burning of fossil fuels produces heat-trapping poisons that are discharged into the discus, hurting our wellbeing downstream. The objective of this study is to identify the main health impacts of climate change on children in the study area. The study identified the most vulnerable age group (infant to 6 or 6 to 12) and the precautions that are needed by their parents and community people. Primary data were the base of this research and collected by field survey, at least 90 respondents from the community to know about their initiatives, 90 parents to know about their perception and the impacts, 1 FGD of the community people, and one from slum people. Secondary data from the articles, journals, and books. Based on the survey, this paper was prepared a pair-wise ranking, spider diagram, disease calendar, and pie chart for data analysis. Analysis and results reveal that from infant to 6 years old children are more vulnerable and are mostly impacted by dengue fever.. Community people think that the climate, uneven precipitation, and urban development are the main culprits. The government should be taking initiatives for this chaotic situation and build awareness among society and community.

Keywords: *Climate change, children, disease calendar, pair wise ranking, spider diagram,*

Analyzing the Lake Users' Willingness to Pay in the context of Dhaka City

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Against the debasement of the urban environment quality and the negative outcomes of rapid urban growth, urban lakes can play a significant role to preserve the urban ecological system and can effectively develop a connection among the mental, physical and cultural wellbeing. But it has been seen that the existing condition of the major lakes of Dhaka city has been degrading day by day. So, it is important to explore the perspective of the lake users' on the improvement of the existing condition of the lakes of Dhaka city. Along this line, the study aims to assess the lake users' willingness to pay (WTP) to improve the lake condition by using the contingent valuation method. To conduct the study, a total of 384 lake users of twelve lakes were surveyed through the questionnaire. As the target group, both the city people and the adjacent area people were chosen. Then, the target population was divided into five strata based on age and the sample was selected from each stratum randomly. The study revealed that 70% of the lake users are satisfied with the existing condition of the lakes but still many of them want to contribute in improving the condition irrespective of their satisfaction. About 73% of the lake users show their eagerness to pay for improving the condition of the lakes while 27% of them refuse to pay. The study showed the likely range of willingness to pay in a month varies from max 100 TK to min 10 TK whereas individuals' average monthly willingness to pay is estimated at 38 TK. To identify the factors that affect users' willingness to pay, total nine variables - gender, age, education, occupation, income, distance, purpose of visiting, frequency of visiting, and satisfaction level were selected. Among them, gender, age, education, occupation, and income were categorized as socio-economic factor, distance was categorized as demographic factor and purpose of visiting, frequency of visiting, and satisfaction level were in behavioral and attitudinal factors. Age, education, income, distance, purpose and frequency of visiting were found significantly associated with the users' monthly willingness to pay. The study revealed that compared to the socio-economic and demographic factors, behavioral and attitudinal factors have a more significant impact on WTP.

Keyword: *Urban lake, Lake users, Dhaka, Willingness to Pay, Contingent valuation method.*

Review Article on Coral Reef and its Importance on the Marine Life and Human Life

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The coral reef is a unique and complex ecosystem and it is the largest ecosystem in the world. Where it covers just one percent of the ocean but it supports or provides habitats for almost twenty-five percent of all marine species. That's why it is called the "rainforest of the sea" because it has higher biodiversity than the tropical rainforest. To build a coral reef corals are the principal architects. Corals are made with thousands of tiny animals called polyps, which is an invertebrate. These polyps have tentacles, which they use to feed on plankton at night and play host to zooxanthellae, which are symbiotic algae that live within their tissues and give the coral its color. In coral reefs, coral and zooxanthellae have a symbiotic relationship. To survive and grow coral reef needs specific conditions (like, in shallow water level less than 100m, and where the sea is usually warm, the temperature is between 25° and 29°C). For that, coral reefs are located within the latitude of 30°N to 30°S, only in tropical seas. Other areas also contain few coral species but in less amount. In Bangladesh, corals are found in latitude 20° 34'N to 20° 38.8'N and 92°18' to 92°20.8'E, which is mainly in the Narikel Jinjira, St. Martin Island. Coral reefs protect coastlines from wave action and tropical storms, it is the source of nitrogen and other essential nutrients for marine food chains, coral reefs also assist in carbon and nitrogen-fixing, it also helps with nutrient recycling. Though coral reefs have various importance on the marine ecosystem and human livelihoods but it is threatened by various anthropogenic activities or natural processes coral became stressed. Where this coral reef is threatened by various anthropogenic activities like overfishing, coral mining, water pollution, mangrove destruction, etc. Also, climate change, coral bleaching, sea-level rise, ozone depletion, ocean acidification adversely affect coral reef and all other species which are dependent on the coral reef. Even in a proper condition coral reefs grow very slowly. To form a large coral, it takes thousands of years. So, it is necessary to protect the coral reef for the earth's welfare. Only, proper management of anthropogenic activities can be able to protect coral reefs from extinction. Because the loss of coral reefs is not only harmful to the marine environment but also all other terrestrial species, including humans.

Solutions to Climate Change in Protecting the Earth from Suffocation

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Climate change is a global problem. There is no national boundary to this problem. For this we need to work together as a global community. Climate change not only destroys natural diversity, it also impedes sustainable development. Man-made climate change is one of the major factors in the extinction of the earth's natural diversity. The effects are already being seen through receding glaciers, long time flood or flash flood, ocean acidification, increase in ambient temperature and an increasingly vulnerable food supply. So it has become very urgent to find solutions to climate change. We need to know what the key response are the climate change and also we have looked at the sustainable development goals relate to climate action. From where we live, our income, national politics and other factors are related on our capacity to respond to climate change. We can take three main ways to respond: adaptation, mitigation and geo-engineering. We know that the United Nations set the Sustainable Development Goals are 17 targets with including ending poverty, reducing inequality and taking climate actions. The goals are linked with each other because we are one globalised species living on one planet. Basically climate change is expected to have its impacts on the poorest and most vulnerable communities, so it's closely to reducing inequality and poverty alleviation. Climate change doesn't just threaten the ecosystem; it could also interrupt the Sustainable Development Goals. Rising sea level will submerge low areas and result in migration. Increasing global warming is the terrible of invasive pest species to agriculture and the spread of disease. Ocean acidification threatens the health of coral reefs and may compromise the fisheries that depend on them. Climate change is already impact public health, food and water security, migration, peace and security. If we unchecked climate change, will roll back the development gains we have made over the last decades and will make further gains impossible. It has become urgent to come up with some solutions to prevent climate change. The study identified the effectiveness of four sustainable development goals- (i)13-climate action (ii)14-Life below water (iii)15-Life on land (iv)11-Sustainable cities and communities. The present study also explored the solutions for climate change, including mitigation, adaptation and geo-engineering, which can help avoid the most dangerous climate changes and increase the adaptability of societies and ecosystems to climate changes that cannot be avoided.

Keywords: *Climate change, development, earth*

Transformation of Rural Homestead in Spatial Setting of Rural Bangladesh

Case Study: Settlement of Village Taltala, Bagatipara Upazila,Nator

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Household is the basic economic decision-making unit in rural settings. It is essential to understand householders' livelihood strategies to make sense of what they are doing and understand how they perceive opportunities for changes. Today, the transformation refers to the loss of identity of the spatial settings of the rural settlements whereas the concept of 'sustainable rural livelihoods' is increasingly centralized to the debate about rural development and its transformations.

This paper will involve with an assessment regarding searching for the root as well as the regional identity of rural Bangladesh and how those can be under consideration of sustainability. However, each part of the country bearing its own identity with history and glory, those identities became loss with the rapid transformation of rural settlements.

The purpose of the study is to search for the settlement character in past as well as to compile the scenario with the today's house form. In such way, we could track the features of transformation, characteristics, and the reason behind transformation.

The core methodological procedure will use to understand the spatial approach of the transformation of the settlement. Thus, the study of this spatial setting of this settlement, the historical method might consider an opportunity to perceive the evolution of the housing development concerning individual homestead.

The outcome will be the consideration as well as recommendations regarding arrangement of settlements and tends a guideline regarding to preserve the identity for keeping their values with regional identity. So that the transformation would be more sustainable for better survival.

Household Filtration Cost of Drinking and Cooking Water for City Dwellers of Dhaka

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Currently, safe water supply has become a crucial crisis in Dhaka city due to overpopulation and industrialization. Along with other citizen amenities, it has emerged as a challenge for being contaminated with magnesium, minerals, hormones, E-coli Bacteria heavy metals and even high levels of pesticides resulting water purification or filtration system at household levels. This study is aimed estimate the cost of drinking water filtration and boiling in Dhaka city. A questionnaire survey was conducted among 110 families to estimate their required boiled and filtered water in daily activities. The results found that the yearly average total filtration cost is BDT 12,940 per household. Which is equivalent to BDT 20,403,093,240. In addition, each of the households use an average of 60 watt electricity which BDT 160 per month.

Keywords: *Boiling cost, filtration, water treatment*

Reasons and Impacts of Retail Food Waste for Selected Retail Markets in Mohammadpur of Dhaka City

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Food waste occurs in every step of the supply chain from its harvesting to consumers' plate. However, producing retail food waste contributes comparatively less than consumer waste but still, it can make potential detrimental effects. Food waste releases greenhouse gases like carbon dioxide, methane, etc. Likewise, in any other big city, the environment of Dhaka City is affected by urbanization and most importantly overpopulation. Every day tons of retail food waste are accumulated all around the city and this waste is primarily thrown in open places which are very close to human connection, so people and the environment are initially effected by this waste and after the disposal, this waste cannot be maintained in a good manner. There is an urgent need to take appropriate measures to reduce the food waste burden by adopting standard management practices. There exist few studies that estimate the solid waste generation in Dhaka city, However, no study has been found that dealt with retail food waste. In this study, by employing a mixed-method (both qualitative and quantitative methods), we estimated the reasons and impacts of retail food waste, along with find out the practices which are used for handling surplus food taking Mohammadpur as the study area. Data shows that considerable agreement between the predicted and actual amounts of food waste generation and also find out various variables that stimulate food waste. Data were collected from both primary and secondary sources. The primary data were collected through interviews with different groups in three retail markets located in the Mohammadpur area. And secondary data were collected from reports, articles. After finishing the data analysis, it is obtained that proper handling rule of food waste and surplus food is absent in this city. The reason behind this loophole is the lack of studies conducted in this area. In the end, a framework has been proposed that links research and policy making to encourage its effectiveness in order to secure a good food waste management system.

Keywords: *Estimation, retail food waste, surplus food*

Impact of Tobacco Cultivation on Soil and Human Health in Agricultural Ecosystem at Tangail Region, Bangladesh

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The study was conducted to determine the impact of tobacco cultivation on soil and human health in agricultural ecosystem at Bhuapur and Kalihati upazila in Tangail, Bangladesh during the year 2019. A total of 40 soil samples were collected, whereas, 20 samples from each studied upazila. Moreover, 10 samples were collected from tobacco land and 10 samples from non-tobacco land; from 0 to 15 and 15 to 30 cm soil depth, respectively. The soil pH, total organic matter (TOM), total nitrogen (TN), available phosphorus (P), available sulfur (S), available zinc (Zn), exchangeable potassium (K), exchangeable magnesium (Mg), and exchangeable calcium (Ca) were analyzed. In Kalihati upazila, tobacco land showed significantly higher content of TOM (1.46%), TN (0.07%), P (12.38 µg/g), K (0.16 meq/100g), S (15.8 µg/g), and Zn (0.42 µg/g) but lower level of pH (7.46), Mg (2.26 meq/100g) and Ca (4.93 meq/100g) than non-tobacco land. Conversely, there was no significant variation between tobacco and non-tobacco land on soil properties in Bhuapur upazila. In both upazilas all the nutrients except Ca and Mg were lower than optimum level in both tobacco and non-tobacco land which was not suitable for crops cultivation. Results also revealed that manures and pesticides use intensity were higher in tobacco land than non-tobacco land in both upazilas. In correlation analysis, N and TOM, and Ca and Mg showed significant positive correlation, indicated that possibly the common sources of origins which may be anthropogenic and similar pathways into the terrestrial environment. However, a large number of farmers (36%) said that they were suffering from various diseases due to tobacco cultivation and curing. Therefore, this study concluded that tobacco cultivation degraded soil properties, hampered human health and deteriorates environment. Thus, the study recommended that tobacco land must be shifted by high demanding crops like vegetables, fruits and other cash crops in the study areas to achieved food safety and security.

***Keywords**: Fertilizer, human health, soil nutrients, tobacco*

Spatial and Temporal Analysis of Rainfall and Temperature Trends of Bangladesh

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In this paper, temperature and rainfall data series of 34 meteorological stations distributed throughout Bangladesh over a 30-year period (1989 to 2019) were analyzed for present trend detection and time series analysis of these climatic variables. Statistical and spatial methods like, Mann Kendall test, Sen's slope test, inverse distance weighted interpolation techniques and geographical information systems were used to detect trend variation and spatial patterns of temperature and rainfall. Autoregressive integrated moving average time series model was used to simulate the temperature and rainfall data. The result shows a change of mean temperature in Bangladesh with an upward trend (0.40 °C per decade) in pre monsoon season. The north western, southern, south central and southeastern areas like, Syedpur (1.1°C per decade), Sandwip (1°C per decade), Rangamati (0.7°C per decade), Hatia (0.97°C per decade), Chandpur (0.6°C per decade) and Teknaf (0.8°C per decade) are found to be prone to increase of maximum temperature in all seasons. The highest upward trend in minimum temperature are observed in the northwestern, northeastern, central and southern parts of Bangladesh like, Chattogram (0.65°C per decade), Barishal (0.4°C per decade), Srimangal (1.05°C per decade), Dhaka (0.54°C per decade) and Bogra (0.42°C per decade). Southern areas like Sandwip (34 mm/year) and Chattogram (24 mm/year) has faced maximum increase in rainfall amount in monsoon and pre monsoon seasons. Less rainfall is mostly faced by central regions, like Madaripur (-17.55 mm/year) and Faridpur (-12.28 mm/year) throughout monsoon and winter seasons. However, during post monsoon season, these two stations have faced an exceptionally higher increment of rainfall which is almost 32.75 mm/year and 32.38 mm/year respectively. The forecasted temperature shows an increment of 0.013 °C per year in 2020–2030. A greater rise in maximum temperature is projected in the southern, central and northeastern part like, Dhaka (0.072°C per year), Sandwip (0.132°C per year), Srimangal (0.07°C per year), Mymensingh (0.046°C per year). Increment of rainfall is projected maximum in southern and northeastern part like, Chattogram (0.43 mm/year), Sandwip (0.31 mm/year), Sylhet (0.32 mm/year); where, declination of rainfall is projected mainly in central and north western part like, Dhaka (-0.2 mm/year), Dinajpur (-0.6 mm/year), Bogra (-0.175 mm/year) and a dry condition may exist in these parts during pre and post monsoon season.

Keywords: *Mann Kendall, rainfall, temperature,*

Traffic Induced Noise Pollution and Its Impact on Human Health in Dhaka

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Noise is one of the most pervasive environmental problems. Excessive noise has become one of the major concerning of urban life. Dhaka, the metropolitan city of Bangladesh, is one of the nosiest cities of the country. With economic development, the situation is expected to worsen farther. Motor vehicles are the principal source of noise pollution in the city. This study illustrates the level of noise pollution in Dhaka city corporation and its impacts on city dwellers. The noise level was measured at 7 important locations of Dhaka city road areas namely: Science Lab, Dhaka College, New Market, TSC- Dhaka University, Shamsunnahar Hall-DU, BUET, Lalbagh residence area. Time-weighted average noise levels have been measured at the roadside. From the study it was observed that the highest noise level in the roadside in Dhaka city was about 95dB found at Science Laboratory and New Market areas, which far exceeded the acceptable limit of 60 dB set by the Government of Bangladesh. The level of noise pollution is closely related with traffic volume, particularly with the number of heavy vehicles like trucks, buses as well as auto rickshaw have been observed during the study. Questionnaire survey was done during the study to determine the health impacts on the city dwellers. Most of the common problems, the dweller suffering from noise pollution are headache, bad temper, sleeplessness, aggravation, hearing problems etc.

Keywords: *Environmental problem, health effects, noise pollution*

A Study On The Extinction Of Shyama Sundari Canal And Its Impact On Rangpur City

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A canal is a manmade waterway and used to transport water for irrigation and other purposes. In the past, canals were one of the means of transporting goods. But in the course of time, even though that system has been abolished, the canal is still making a significant contribution to our public life. Most of the canals in Bangladesh are now in danger. The 130 years old historic SheyamaSundori Canal flowing through the Rangpur City is one of them. Geographically the elevation of the main Rangpur City has been lower compared to the surrounding areas and the drainage system was defective. As a result abundance of mosquitos was noticed and malaria was one of the common diseases in this area. In 1890, the chairman of the Pourosova and the king of DimlaJankiBollov Sen had dug the canalto overcome waterlogging. The canal is spread over 15.80 km throughout the Rangpur City Corporation area and the width varies from 23 to 90 feet according to the areas. But the historic SheymaSundori Canal is now in the verge of destruction. Garbage has been dumping with ease. The canal has become a common dustbin according to the residents. For poor municipal waste management system and low maintenance most of the municipality waste find their way out to the canal. The canal has become chocked with solid waste materials and water hyacinth in many places which driving into water logging after unprecedented torrential rain in recent years. The water spreads extremely unbearable odor throughout the year especially in rainy season and makes walking beside the canal very difficult. Continuous seizing, fill up and lack of proper maintenance have made the canal extinct. Houses have been made over the canal illegally. Steps have been taken several times to remove the illegal houses but the situation is more or less the same after some times. The daily domestic waste as well as the fecal waste go straight into the canal. Despite of being a solution to the drainage problem, the canal itself is causing an adverse impact on the environment adding air, water and soil pollution to the city due to lack of proper reforms. Though several crores taka have been invested previously to reconstruct the canal but that is not enough . The study focuses on the chronological condition of the canal and its significant role in the drainage system of Rangpur city. A questionnaire survey is also conducted to find out the major factors and environmental impacts caused by the canal on the locality. The extinction of this canal will accelerate and prolong the water logging situation and increase the pollution rate in Rangpur city. Proper reconstruction and activeness of this canal can provide relief from the waterlogging, insects and diseases spreading and can regain its serenity and natural balance.

Keywords: *canal, garbage, waterlogging*

A STUDY ON WATER LOGGING PROBLEM OF RANGPUR CITY

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Rangpur is one of the major metropolitan cities in the Northern part of Bangladesh. It has become a metropolitan city in 2018 with a population of almost 16000000. Water logging is one of the major problems in the Rangpur City. In recent years most of the city has been inundated due to heavy rainfall in a short period of time during monsoon season. This year a 433 mm rainfall for 12 hours made the whole city water logged almost for 2 days. The major causes working behind this situation are weak and unplanned drainage system and topographical condition. Geographically the elevation of the main Rangpur City is lower compared to the surrounding areas which results in water logging. The drainage system was also unplanned and defective from the beginning of the formation of Rangpur city. Inadequate and poor drainage system, low maintenance and lack of dredging are making the condition worse. Unplanned building construction and increased population in locality has accelerated and prolonged the water inundation. Due to the up growing inhabitance, number of open lands and ponds are decreasing and moreover the poor drainage system is preventing the rainwater from draining away. The inactiveness and endangered condition of the Shama Sundori canal flowing throughout the city enhanced the acuteness of water logging. The sufferings in daily life have no bound among the residents due to water logging in the rainy season. . The water bound people have no pure drinking water and food and have lost their valuable assets, furniture, houses, cattle and crops. This also causes physical damages to the roads and buildings as well as environmental damages. The study focuses on the recent scenarios of water logging and tries to find out and analyze the causes of water logging. The report also proposes a more effective solution to reduce the on growing threat of water logging problem for Rangpur city.

A Review of Groundwater Management Scenario and Development Options in the Ganges Delta

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Currently Bangladesh is facing a foreboding water depletion scenario in north-west especially the Barind tract near the Ganges delta due to unrestrained groundwater abstraction caused by drastic agricultural growth. An extremely high population density is observed in North Bangladesh, and the dense population, mostly under-privileged by global comparison, is expected to increase in the next three decades and spawn demand for additional water resources which is going to put more pressure on limited groundwater resources near Ganges basin. This study aims to find out the key determinants of groundwater exploitation of Northern Bangladesh and explore suitable strategies for improved management of the Ganges Delta. Especially, it focuses on the geological characteristics of the shallow and deep aquifers, their seasonal variation of water fluctuation level, and analysis of tube well abstraction data along with the water supply and demand scenario. The paper also provides a variety of adaptable management options for sustainable groundwater development. To perform this research, literature published between the years 1990 and 2020 has been systematically reviewed to analyze the historical pattern of groundwater consumption. The result showed that there is a huge imbalance between groundwater discharge and recharge causing a threatening environmental cost and that is triggered by the fact that most of the stakeholders who are the main consumers of groundwater have limited knowledge about its sustainable management. Lack of strong understanding about aquifer recharge, their abstraction pattern, the current condition, and future scenarios, and the effects of unrestrained irrigation are badly comprehended by the farmers and policymakers. Regardless of facing these imminent challenges, groundwater conservation is still not taken seriously by the policymakers and its management is not high on the stakeholders' agenda. The result suggests that modern farming strategies (e.g., reduction of abstraction rate, rotating cropping pattern, and a balanced timing of aquifer recharge and discharge) support the mitigation of groundwater exploitation. In this context, the management options should be taken into consideration by relevant stakeholders for a promising development of the Ganges Delta.

Keywords: *Development, groundwater, management*

A study on Ground Water Level Depletion in Dhaka City

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Dhaka city, having a population of more than eighteen million, exclusively depends on Groundwater (GW) as a source of quality drinking water. Over the years, the use of GW has steadily increased and diversified in agricultural, domestic, industrial, and commercial sectors also. Due to the excessive and indiscriminate withdrawal of GW in Dhaka city, the water table is depleting during the last several decades. This is likely to cause an environmental disorder in near future. Effective management of the GW system is essential to meet the increasing demand for water supply in Dhaka city. In recent decades the city is encountering groundwater diminution and the declining scenario is dissimilar in different parts of the city. This research aims to discuss the groundwater depletion in different parts of Dhaka city from 1980 to 2012 along with the causes and consequences. The main focus of the study was to observe the level of fluctuation and recharge conditions in Dhaka city. The data for the past 33 years indicates that due to rapidly increasing demand, the abstraction of GW is increasing resulting in a gradual declination of GW level in Dhaka city and the amount of recharge is not sufficient in comparison to the amount of abstraction. Groundwater level data of different locations of Dhaka city were collected from Bangladesh Water Development Board (BWDB). The data were processed and analyzed using SPSS and Excel Worksheet. The results show that groundwater in Dhaka city is depleting at an alarming rate; the central part has the worst situation followed by the south-western part. In contrast, the northern part has also the worst groundwater condition. Moreover, the peripheral zone exhibits a better condition because of the existence of rivers and wetlands. The interviews reveal that population density and overexploitation are mainly responsible for groundwater depletion; however, various other factors such as the deliberate establishment of deep tube wells, reduction of recharge capacity due to the rapid growth of urban structures altogether results in the huge drop in water level throughout the city. As the city has a huge paved zone, so the rate of GW recharge is too low. From this Study, it also can be concluded that the highest depletion of GWL is 67.28 m within the last 30 years and the average depletion rate of GW is 2.78 m/year, which is alarming. If this rate of depletion is continued, then the upper aquifer will deplete permanently.

Keywords: *Abstraction, depletion, groundwater*

Diversity of Plant Species at Kamalganj Upazila of Moulvibazar District in Bangladesh

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The study was conducted at Kamalganj Upazila of Moulvibazar District in Bangladesh during January to September 2015 to observe the diversity of plant species in the homestead area with their arrangement and to explore the relationships of plant diversity with the selected characteristics of the respondents. Face to face interview was performed with 135 respondents with the help of individual questionnaire. A total of 92 plant species, 45 vegetables species were recorded in the homestead of the study area. Out of different categories of plant species, 35 timber, 36 fruits and 21 medicinal and other plants were recorded. Most of fruit plants and medicinal and other plant species were found in front yard and Back yard of homestead area. Timber trees were dominated at boundary side than any other side of homesteads. Diversity of fruit (0.79-0.99), timber (0.77-0.93) and medicinal plant species (0.77-0.96) were high in most of the unions. Mango Jackfruit, Papaya, Coconut were dominant fruit species. Acasia hybrid and Mehogony were dominant timber species. Coriander (*Coriandrum sativum),* Areca nut (*Areca catechu*), Tulsi (*Ocimum americanum*), Neem (*Azadirachta indica),* Bamboo (*Bambusa sp*), Pudina (*Mentha spicata*) and Bohera (*Terminalia bellerica*), were dominant medicinal and other plant species. There was a positive correlation between plant diversity with most of the selected characteristics of the respondents. Results conclude that plant diversity in homestead areas of Kamalganj upazila could be a good option for improving the livelihood of the respondents.

Keywords: *Correlation, homestead, plant species diversity, shannon-weaver diversity index*

A Review on the Factors Affecting Particulate Matter Emission and Prioritizing Them by Applying FUZZY TOPSIS

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Particulate matter (PM) is one of the major elements of ambient air which has a great impact on climate change and a source of toxicity for human health. In the upper atmosphere, particulate matter influences the earth's radiation, cloud formation, visibility of air traffic, and other natural conditions. Whereas in the lower atmosphere, the adversity of particulate matter is highly significant. The most alarming issue is that it degrades human health and impact environmental systems, such as forests, wildlife, and coastal regions. Air quality is continuing to deteriorate with the presence of PM. To overcome this issue, it is essential to know the root causes of pollution. PM comprises a wide range of different finest particles that could exist in the air for a long period and enter respiratory tracks and lunge. The characteristics and differences in the concentrations of chemical elements of PM depend on the origin of these elements. Significant changes in the concentrations of particulate matter are caused by crystal matter, road traffic and combustion of fuels, urbanization, industrialization, meteorological change, natural resources, and others. This paper will review and help to identify and characterize the emission sources of PM to address the issue in context to Bangladesh. In addition, the factors associated with PM emission and estimated emission rate are also discussed in this paper. Moreover, to prioritize the factors of PM, FUZZY TOPSIS logic was applied which will help to understand the harmful sources of PM emission from all the general sources.

Keyword: *Ecosystem, FUZZY TOPSIS, meteorological change, particulate matter, urbanization*

A Review on the Factors Affecting Particulate Matter Emission and Prioritizing Them by Applying FUZZY TOPSIS

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Particulate matter (PM) is one of the major elements of ambient air which has a great impact on climate change and a source of toxicity for human health. In the upper atmosphere, particulate matter influences the earth's radiation, cloud formation, visibility of air traffic, and other natural conditions. Whereas in the lower atmosphere, the adversity of particulate matter is highly significant. The most alarming issue is that it degrades human health and impact environmental systems, such as forests, wildlife, and coastal regions. Air quality is continuing to deteriorate with the presence of PM. To overcome this issue, it is essential to know the root causes of pollution. PM comprises a wide range of different finest particles that could exist in the air for a long period and enter respiratory tracks and lunge. The characteristics and differences in the concentrations of chemical elements of PM depend on the origin of these elements. Significant changes in the concentrations of particulate matter are caused by crystal matter, road traffic and combustion of fuels, urbanization, industrialization, meteorological change, natural resources, and others. This paper will review and help to identify and characterize the emission sources of PM to address the issue in context to Bangladesh. In addition, the factors associated with PM emission and estimated emission rate are also discussed in this paper. Moreover, to prioritize the factors of PM, FUZZY TOPSIS logic was applied which will help to understand the harmful sources of PM emission from all the general sources.

Keyword: *Ecosystem, FUZZY TOPSIS, meteorological change, particulate matter, urbanization*

OBD-009
Bhattacharya

Estimations of the Sedimentation Rates in the Bengal Delta

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After the last 8,000 years of slow sea-level rise during the Holocene epoch, the onset of rapid climate change during the 20th century has initiated an accelerated rate of sea-level rise. Hence, it is important to know if the current sediment flux and the sedimentation rates are enough to counteract the rising sea at the Bangladesh coast. In our estimate, the total amount of sediment flux has declined from 2 billion tons/yr in the 1960s to about 1 billion tons/yr during recent years. It remains a question whether this reduced flux will be enough to keep pace with the rising sea level at a global rate of 3-4mm/yr.

Even though the sedimentation rates across the Bengal Delta are only a few mm on a millennium scale (1000 years), as it is for all the deltas of the world, the pulsed sediments in the fluvial Bengal Delta could reach rates of a few cm/yr or higher in select places, such as behind the breached embankment. Some recent analyses by other experts using direct sedimentation measurements and short-lived radionuclides from the fluvial delta west of the Meghna estuary propose that transport processes and lateral sedimentation are highly variable across the delta and the overall aggradation rates average about a few cm/yr in the flood plains of the lower central delta, west of the Meghna estuary and east of the Sundarbans. In this work, we review the feasibility of these results with respect to our previous estimates.

Man-made structures upstream are likely to decrease sediment flux to rivers in downstream Bangladesh. It is our opinion that large-scale structures are not a solution for the long-term sustainability of the Bengal Delta in the era of climate change. With the dynamic fluvial conditions that are present in the Delta, with intense subsidence, such structures would cause further inundation, in addition to impe ding the sediment flow needed to compensate for the sea-level rise. In order to counter the rising sea level and retain the stability of the Delta, we need to assure that the sediment supply remains unhindered across the Delta. It is imperative that a proper sedimentation model be built for the entire Delta that would allow for better calculation and prediction scenarios about the fate of the Delta in the face of climate change scenarios.

Bowler

Subtle Movements at the Grassroots in Rural Bangladesh

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While on sabbatical in southwestern Bangladesh in 2016 doing an American Institute of Bangladesh Studies supported re-study of a village, I had begun studying during my dissertation research in 1991-1992, I noticed several emerging trends that I wanted to examine relating to environmental progress. These trends may develop into subtle movements that have this impact on environmental health for the long term.

In 2016 there was much more migration in and out of this village than 1992: students going to universities where they were studying, university graduates going off to new, well-paying jobs in Dhaka, women being married and migrating to the nearby city of Jessore, laborers finding jobs in Jessore, Dhaka, West Bengal, and even further abroad in Southwest and Southeast Asia. There was also migration back to the village. This consisted of several divorced women with young children moving back to their home village after living in their ex-husband's villages. In asking a class of students from the secondary school how many of them thought they would stay in the village as adults, only one of twenty-five students thought they would, with most of the others expecting to move and live in either Jessore or Dhaka. Not only do I see these divorced women as the crucial anchors in the village for their families, they will also have a long-term stake in village environmental health and sustainability. The departed siblings retain interest and financial support for their remaining family in the village, but they will put their trust in these anchor women including in environmental preservation of their beloved *bari.*

The key environmental problem is arsenic poisoning from village shallow tubewells which is highly correlated with cancer. There are only two government installed deep tubewells in the village located in the middle of the village near the secondary school and another on the western edge of the village next to home of a former union *porishad* member. Additionally, a nearby rich agricultural *beel* to the east of the village where many own or labor on other villagers' land, is suffering from waterlogging caused by the failure of the *beel* drain after the inundation brought in the rainy season. Those out-migrating from this village as laborers and university-educated professionals will send money back to the village to improve land, homes, and begin to address these environmental problems with more deep tubewells and drainage schemes for the *beel.* It will be these anchor women and their families who will remain in the village and be involved in the decision-making about the programs in which to invest this money. The community does recognize the toll that arsenic toxicity, waterlogging, and extreme heat is taking on their village surroundings although it is only the younger, more educated that can explain the dynamics overtaking them.

As income comes into this village and homes and land continues to improve, there will be increasing opportunities to also improve the environment and sustainability. Solar back up electricity including lighting as well as fuel from methane sources exist with more added to provide reliability and reduce cost. Sustainability improvements with reforestation, tile-making, and organic agricultural production could be funded by siblings and overseen by anchor sisters, as well as better healthcare through a new village clinic.

Water crisis and Ecological Destruction due to Development Activity in Chittagong Hill Tracts (CHT)

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Natural forest streams are the main water source for the people who live close to forests in the Chittagong Hill Tracts (CHT) in Bangladesh. The indigenous people of the CHT have carried on Jhum (slash and burn) cultivation in those forests in a sustainable manner for centuries. Over time, these water sources and Jhum cultivators have developed various symbiotic relations. However, during the last several decades, these forests and Jhum fields to turn into mono culture tree plantations as part of national market-driven development efforts. Locals believe that the streams are drying up as a result, and people living close to forest in hilly areas are facing water scarcity during the dry season. Some streams have dried up completely and are lost.

Locals are trying to cope with this change by adopting modern technology such as using tube wells, etc. The use of these technologies has created market dependency, consequently transforming many aspects of the economy and society.
Through a research project involving focus groups, we unearth this process of ecological destruction of water sources faced by the indigenous peoples who live in this area, as well as the cumulative effects of social, cultural and economic change.

We find that there have been problems of increased time to procure water, such time burden falling particularly on women. Water collection now entails traveling further distances than in the past, creating safety uncertainty for women who travel. Such safety issues are exacerbated because of increases in economic activity, settlers, and the general movement of people, given the trauma of the historical conflicts between indigenous groups and Bengalis. In addition, because of the new technologies used for water collection, the need for income has increased, leading to increased agriculture to sell the surplus, which in turn is increasing deforestation and drying up water resources further.

Building design for energy efficiency

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Bangladeshi cities and their hinterlands are having a growth spurt typical of all emerging economies. Demand for energy is rising exponentially at all urban centers for commercial buildings as well as for its industrial buildings. The country is desperately trying to keep up with its demands for both electricity and gas, where the current needs are being met with "band-aid" solutions employing means of generating electricity that are having disastrous consequences to its environment. There also seems to be a dearth of natural gas that is leading to a crisis that the nation is struggling with.

While increased production of energy sources are direly needed to keep up with the demand and the consequent development of Bangladesh's growing economy, it is time that we looked into "conservation" of energy at a micro level and try to design our buildings more efficiently. The trend has been to emulate the inefficient buildings prevalent in the west, and not consider the local constraints in both environments, as well as materials and mode of production. After all, buildings do consume a significant part of our energy output through lighting, air-conditioning and both high and low voltage power needs.

Ironically, it is the Western nations who have been and continue to be the largest carbon emitters, and the same nations are now at the forefront, investigating possibilities at both ends, i.e. "energy production" and "energy conservation'. The West has understood that energy production is costlier to achieve than lowering the demands on energy, and as such the Intergovernmental Panel on Climate Change (IPCC) considers energy efficiency as a key "energy source"!

This paper will look at some of the approaches being considered in the West, focusing on California. The paper will also look at how 'Building Codes' that had concentrated on structures and life-safety for over a century, are now including Energy Codes as a mandatory body of codes to comply with for any construction project. While there is indeed an increased interest in Bangladesh on some of the prevalent Western guidelines emulated often by imposition of requirements by Western Clients on our vendors in the garment industry, such requirements are often punitive and not relevant to our local environment. Our local 'Authorities Having jurisdiction' need to consider regulations that deter design of buildings that become huge carbon footprints, that adversely affects Bangladesh, already considered the most vulnerable nation due to Global warming.

OBD-006
Deka

A GIS based study of morphometric parameters and LULC Change in Jonai Korong Watershed, North East India

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A watershed is a most suitable geomorphologic unit for organization of all kinds of human activities and natural processes continuing within it. Knowledge of watershed characteristics becomes an important prerequisite to evaluate the basin hydrology. The amount of water reaching a stream system is dependent on the morphometry of the watershed, total precipitation, losses due to evapotranspiration and absorption by soil and vegetation. Evaluation of morphometric parameters requires preparation of drainage map, contour map, ordering of streams, measurement of catchment area, perimeter, relative relief, relief ratio, length of streams, drainage density, drainage frequency, bifurcation ratio, texture ratio which further helps in understanding the watershed environment. Similarly Land use change due to natural causes as well as human interferences is a common phenomenon in almost each and every river basins of Northeast India. The changes that have taken place in the watersheds due to human activities have been accelerated in the last few years. Such changes have been identified as the cause of many environmental problems in the region. For this, accurate monitoring and management of land use/ land cover is very much necessary. The present study involves the Remote Sensing and Geographic information System (GIS) analysis technique to evaluate the morphometric analysis of Jonai Korong watershed as well as monitor the changing pattern of Land Use/Land Cover of the said watershed.

Keywords: *watershed, morphometry, environment, LULC change, GIS, Remote sensing*

OBD-039
Farooque

Towards a 21st Century Participatory Model for Citizen Engagement for Environmental Protection in Bangladesh

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Looking at the environmental and other challenges faced by Bangladesh in the late 1990s and the opportunity afforded by growing Internet connectivity to tap into the disparate expertise of the Bangladeshi Diaspora spread across the Western world, some of us saw a tremendous opportunity to fill what we perceived as a combination of accountability, technical and resource gap. We believed that non-resident Bangladeshis (NRBs) could help resident Bangladeshis (RBs) break free from excessive and undue reliance on international donors and experts and directly shape the policy agenda so it addresses their local needs, priorities and aspirations. However, we differed on what we thought was needed.

In launching the Expatriate Bangladeshi 2000 (EB2000), I thought the technical and cultural expertise of the Bangladeshis diaspora ought to be used to build institutional and operational linkages to specific problems and issues. I was therefore envisioning a hybrid of U.S. Peace-corps and United Nation's TOKTEN models. NRB experts would work with RB experts and organizations to address issues and needs overlooked or not attended to by government and multi-lateral organizations. In other words, my emphasis was on issues and projects with Non-Resident Bangladeshi Organizations (NRBOs) playing a match-making role between NRB and RB experts. The Bangladesh Environment Network (BEN) led by Dr. Nazrul Islam however articulated a broader vision. Dr. Islam's assessment was that what was lacking, particularly in the area of environmental degradation, was not only in the realm of experts but also in the realm of civic awareness and consciousness. What he envisioned was a citizen-led non-political socio-cultural movement focused on the protection of Bangladesh Environment.

Fast forward to the present, we see the limitation of mine and the wisdom and fruitfulness of Dr. Islam's vision. EB2000 is long gone. BEN is not only running strong but celebrating a 20-year partnership with Bangladesh Poribesh Andolon (BAPA)—a grassroots environmental platform with local chapters all across Bangladesh and an impressive record of civic mobilization on a variety of issues from air and water pollutions to river encroachments and forest protection.

An older and hopefully wiser me will now like to argue that the time has come for us to update our model of civic engagement on environmental issues. I will build on recent experiences with citizen assemblies, citizen consultations, participatory technology assessment, citizen science and deliberative democracy to propose a new community-based model of citizen engagement for the protection of the environment in Bangladesh and what role BEN and BAPA can play in fostering it.

REDEFINING ISLAMIC FINANCE IN THE LIGHT OF MAQASID AL-SHARIAH AND SUSTAINABLE FINANCE

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The lex loci applicable to Islamic finance is Shariah. Islamic finance has been criticized for focusing only on Shariah compliance since its inception and development in the world and as such, there is a call to redefine Islamic finance in the light of objectives (maqasid) of Shariah. The objective of this paper is to discuss the ways in which Islamic finance could be redefined in the light of maqasid al-Shariah. Using a maqasid-al Shariah approach in Islamic finance it is evident that not only the prohibitions such as riba, excessive gharar and maysir shall be eliminated in Islamic finance; but there should be the practice of eliminating all harm that is found in the society and promote good to the society by promoting circulation of wealth in the society in the view of achieving shared economic prosperity which will be obtained via considering the duty of care owed to society and environmental sustainability-focusing on people, planet and profit. This ought to be the yardstick that should be used in innovating products and services in Islamic finance industry to align with maqasid al-Shariah. There is a gap in implementing maqasid-al Shariah in Islamic finance and there is need to formulate a road map to fill this gap. It is recommended in this research that maqasid-al-Shariah can be adopted in Islamic finance via merging the concepts of SDGs, environmental sustainability, circular economy, impact investing, ethics and Value based investing.

Using a large and extended global dataset of non-financial firms (4,624 listed entities from 2002 to 2018), we provide the first empirical evidence on how ESG and *Sharia* screenings interact and influence market risks. We link two contrasting literature streams: the risk reduction role that the stakeholder theory attributes to ESG scores, and the opposite effect for *Sharia*-compliance anticipated by the portfolio and agency theories. We find that when ESG scores are not considered, *Sharia* certification increases risks. We prove that engagement in sustainable activities mitigates risks for both *Sharia*-compliant and conventional firms. More interestingly, we show that *Sharia*-compliant firms obtain a larger risk-mitigating effect for greater levels of ESG scores. These results are robust to endogeneity and to extensive additional checks. Our findings validate the hypothesized complementarity between ESG and *Sharia* screenings.

Keywords: Ethical finance, Islamic finance, maqasid al-Shariah, environmental sustainability, circular economy, impact investing, green banking, ESG and SDG.

GEOSPATIAL TECHNOLOGY AND SOCIAL LEARNING FOR INDO-BANGLADESH TRANSBOUNDARY RIVER BASIN MANAGEMENT

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Geospatial technology defines a set of modern tools contributing to the geographic mapping and analysis human societies of the Earth. Satellites allowed images of the Earth's surface and human activities there with certain limitations. Computers allow storage and transfer of imagery together associated with software, digital maps, and big data on socioeconomic and environmental phenomena, collectively called geographic information systems (GIS). Changes in river water storage affect the gravity field sensed by orbiting satellites is giving information about seasonal and inter-annual shifts in the surface mass distribution. Over land, the filling and emptying of water pools is the main contributor of gravity changes subtracted from the total gravity signal to estimate the change in river water storages. GRACE satellite measures earth's gravity field from orbits at about 500 km height. The way of representing river water resources Data is *ArcHydro*- an ArcGIS data Model for water resources. It opens the way to build Hydrologic Information System (HIS) synthesizing geospatial and temporal water resources data that operate within ArcGIS to support hydrologic analysis and modeling. IKONOS high-resolution satellite data is useful for mapping of turbidity of river water and assessing concentration of fluvial suspended sediments. Image analysis using Remote Sensing and GIS techniques gives the spatio-temporal variations of salinity in coastal river systems. Indo-Bangladesh transboundary groundwater basins almost coincide with transboundary river basin in alluvial terrain, and somewhere river water is hydraulically connected with groundwater. An integrated water resources management (IWRM) plan considering both river water and groundwater resources transboundary basin wise is urgently necessitated to effectively manage the uneven spatiotemporal distributed water resources between India, and Bangladesh. Geospatial technologies are extensively used efficiently for IWRM planning and operations through development of a decision support system (DSS). To check and restore the health of India-Bangladesh river systems, the riparian communities have a common interest must be encouraged psychologically through social learning- a promising approach for transboundary river basin management.

Keywords: *geospatial technology*, *integrated water resources management* and *social learning*

Counting Gender for Sustainable Climate Change Adaptation: Reflections from Coastal Bangladesh

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Bangladesh is in the front line of climate change, a country with a huge risk of climate change challenges and frequently faces challenges of natural disasters. Climate change has a wide range of impacts on community and individual, and female inhabitants living in coastal areas have proved particularly vulnerable. This paper aims to understand why gender matters in understanding climate change adaptation and attaining sustainable adaptation. The paper uses a multiple exposures in Coastal Social-Ecological Systems (CSESs) and Feminist Political Ecology (FPE) lens to understand and analyze the social-ecological changes in the South-western parts of Bangladesh. We follow a qualitative case-study method, which includes in-depth semi-structured interviews, focus group discussion, participant observation and secondary data analysis. We organize our findings as follows: first, we present our empirical case-study on shrimp farming, which has been widely accepted climate change adaptation mechanism in the South-west coastal region of Bangladesh. However, despite being the second most important export item for Bangladesh, shrimp farming brought further challenges for CSESs and its inhabitants. It diminishes the coastal agriculture by increasing the level of salinity, causes livelihood change and re-enforces internal migration. Second, we present the gender implications of shrimp farming through feminist intersectional analysis. The shrimp boom re-generates the class system in the society and consequently makes the landowners and urban elites richer and farmers poorer. It (re)introduces gender division of labor assigning women to catch the baby shrimps and men to work in the shrimp farm. Third, we bring a discussion on how gender regimes interact with shrimp farming in CSESs through a multiple exposures analysis. In conclusion, we stress that climate change research needs to recognize the role of gender in understanding climate change impacts and responses, shaping adaptation and eventually, creating a path for sustainable adaptation in CSESs.

Keywords: *Climate change, gender, sustainable adaptation, shrimp farming, Bangladesh.*

Anticipating the future based on the past: the relevance of Earth's history to the climate change challenge

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Predicting the future is challenging, but the scientific basis of such predictions relies on an understanding of how physical and biological processes work naturally in the Earth and universe today, and on the results of their activity in times past. The record of the past informs us of what has happened previously in our history in terms of the sequences of past events, from which we seek to determine cause and effect based on our understanding of how nature operates today. Our planet is one in which the surface is constantly changing due to the fortunate coincidences of the prior history of our solar system, and of the size and distance of Earth from the Sun. This activity has resulted in an extraordinary variety of physical (i.e. varieties of rocks and minerals) and biological species now occupying our planet's surface. Recent progress in our ability to date past events has revealed important information of the speed of ancient episodes of climate change. This information is relevant to our consideration of the current, human-induced episode of rapid environmental change - but only if we accept that the historical chronology that science tells us reflects reality. If we do, there is an urgent need for us to understand what the record of the past is saying that is relevant to understanding our future, and to sharing this knowledge as widely as possible. With respect to the latter, we have begun various geoscience education outreach initiatives in the Indian subcontinent and in Southeast Asia.

Bangladesh 2050: A Low-Emissions Development Path

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Paris Agreement requires all parties to plan and act for a low carbon future by reducing their GHG emissions to 60% of the 1990 level by as early as 2030. Most of the rich countries have already started strong actions commensurate with the onus put on them given the polluting path they have taken to reach where they are today. Developing countries in contrast face a development-climate trade-off. Despite the patronization promised in Paris, the adoption of low-emission development strategies might put a brake on the rapid growth that many of these countries have been experiencing till the onset of the current pandemic.

Bangladesh faces multiple challenges in following a low-emissions path to development. Some of the challenges are systemic, for example, a large population with a rising level of affluence. Institutional inadequacies like the lack of regulation and research push the country further towards a low-efficiency high-emission path. Growing structural inequalities exacerbate the problem by limiting the distribution of efficiency innovations.

The proposed paper presents an integrated assessment of low-carbon futures for Bangladesh with a 2050 horizon. International Futures (IFs) model is a multi-sector dynamic model with endogenous representations of key relationships among population-economy-energy and environment variables for 186 countries interacting in the global system. IFs model allows scenario development using assumptions on the unfolding of systemic uncertainties, for example, the discovery of reserves, costs of renewables, and, simulating policy interventions towards quantified goals and targets.

The study assesses emission scenarios involving both energy use and supply of energy. On the consumption side, starting from simple rules like the Kaya identity, the study computes emissions within the frames of uncertainties in the areas of population, affluence, and technology. On the production side, the study charts an aggressive but reasonable shift towards renewables in the context of known trends, e.g., depleting global reserves, as well as, technology foresight, for example, efficiency and costs of photovoltaics.

This is a macro study intended for a broad overview and assessment of a low-carbon future for Bangladesh. Policy recommendations coming out of the study can work as guiding principles. The study does not come up with any suggestions about specific engineering and technology solutions.

Agriculture, Food security and climate change nexus: policy context of Bangladesh

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Changes in weather and climate-induced hazards will certainly lead to a decrease in agricultural productivity and will threaten food security in the years to come. Agricultural productivities, such as crops cultivation highly depend on the combination of different elements of the weather — changes in an individual element, impacts on the production of particular crops. For example, Paddy cultivation requires the highest amount of rainwater (average rainfall between 15-25 cms monthly) than any other crops; changes of precipitation also cause changes in rice production. In Bangladesh, the average monthly rainfall in the monsoon (June to August) is 12-30 cm, which makes this country one of the highest rice producers in the world (Hasan et al. 2019).However, researchers have observed that in recent past due to climate change the monsoon season is coming late, the average summer season temperature is increasing by 0.07°C per decade (Ministry of Foreign Affairs of the Netherlands 2018), and erratic rainfall is affecting rice production in Bangladesh (Rahman et al. 2017). In addition, according to the IPCC report (2014, p. 3), "Climate change will significantly affect crop productivity and efficiency and will lead to important changes in agricultural outcomes". However, Bangladesh is known as an agriculture-based country, where 65 per cent of total employment directly or indirectly rely on this sector and 20 per cent has contributed to the national gross domestic product (GDP). Therefore, since 2000, the country's food supply mostly has relied on its own production (Hossain and Majumder 2018) rather than imports. Therefore, impacts on agriculture will significantly directly impact on the food security. Although the country developed a policy 'National Adaptation Program of Action (NAPA)' in 2005, which is an overall policy guideline for adaptation to climate change, no such specific policy addresses food security (Kishore et al. 2019).

This report synthesises an overview of the impacts of climate change on agricultural production in Bangladesh based on a recent literature review which shows the nexus between climate and food security. The report first presents particular climate change impacts on agriculture, specifically temperature rises, erratic rainfall, flooding, droughts, sea-level rises and salinity. It then examines the dimensions of food security impacted by climate change and investigates the current policies of Bangladesh regarding food security and what should be undertaken in future policy formation.

OBD-036
Jehne

Regenerating resilient soils and bio-systems: Our only means to limit intensifying dangerous hydrological climate extremes.

Walter Jehne
Regenerate Earth

Thank you for the opportunity at the end of 2020 to outline the harsh reality before us.
After 50 years of warning but minimal effective action all of us will need to face the harsh reality of accelerating dangerous climate extremes.
Not just the abnormal rise in CO2 levels and its greenhouse effect as modelled by the IPCC but the inescapable intensifying reality of dangerous hydrological climate extremes.
A reality of increasing; storms, typhoons, floods, droughts, wildfires, desertification and collapsing water, food, health, habitat and social stability; over the next decades.
Whether we survive these realities will depend, not on more talk or emission reductions, but on the resilience of our residual bio-systems and the communities that depend on them.
On how effective local grass roots action has been to regenerate resilient soils and bio-systems so as to help buffer, mitigate, adapt to and survive these hydrological extremes.
As in nature we can regenerate resilient soils, water and food systems and healthy equitable communities to minimize such risks and survive these extremes.
To do this we must rapidly increase the carbon content, structure and ability of our soils to infiltrate, retain and make available rain water to buffer these hydrological extremes and sustain healthy plant growth and life.
Practical agro-ecological strategies such as zero budget natural farming and agroforestry confirm they can help do this and thereby buffer and limit these hydrological extremes.
Innovative farmers globally confirm they can practically bio-sequester up to 10 tons carbon per hectare per annum to regenerate the health of their soils, food production and future.
Our imperative is to extend such practical land regeneration practices globally this decade so as to secure resilient viable farming systems on which all of us ultimately depend.
Extended globally we can practically draw down up to 20 billion tons carbon per annum to achieve negative net emissions but more importantly regenerate our soils and hydrology.
The paper will outline the science governing these regeneration and resilience outcomes and how they can be implemented in different situations to secure humanity's safe future.

Using water hyacinth to remove toxic chemicals from rivers and industrial wastewater in Bangladesh

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Water hyacinth (WH) is the fastest growing aquatic plant in the planet and it is abundant in Bangladesh. It is considered as a weed, but research in our laboratory [1-3] has shown that this plant is useful for removing toxic elements from water including arsenic, cadmium, lead and chromium. We have used living WH plants to remove toxic elements from a highly polluted river in Wales [3]. Furthermore, dried WH roots removed a range of toxic elements from water that are problematic in Bangladesh including arsenic, cadmium, lead and chromium. These and other toxic elements are generated from industrial activities. Rivers in Bangladesh are also polluted through human activities in countries upstream of Bangladesh. Differences in pollution between upstream and downstream sections of a river has been reported [4-5]. The concentration of toxic elements in downstream sites are 1.8- to 4.10-fold higher in a section of river Ganges in India [5]. Reasons for this included agricultural and untreated urban–industrial wastewater. Cadmium and lead levels were higher downstream. We propose that WH plant and/or its biomass is used to clean industrial and urban wastewater before discharging into rivers in both India and Bangladesh. Pilot studies with industrial effluents and urban wastewater in Bangladesh can be conducted to assess the performance of the method. This can be an inexpensive and sustainable approach for protecting human lives and the environment by using a widely available plant. Local communities can participate in the project by collecting WH and cooperating with industry, universities and the government to solve a common problem.

Proposed Framework for Ganges-Brahmaputra-Meghna Basins Compact

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The contemporary knowledge about water resources management of transboundary rivers promotes basin-scale planning that is founded on the principles of equity, fairness and shared risk for all stakeholders as well as preservation of biodiversity and ecosystems that those rivers support. The existing international laws and conventions also advocate for collaboration among all co-riparian nations living in transboundary river basins. International laws and conventions regulate the management of most of the major river basins around the world .

Bangladesh and India share 54 transboundary rivers. Many of these transboundary rivers are also shared by upstream Nepal, Bhutan, and China. Together, these rivers and their catchment areas form the Ganges-Brahmaputra-Meghna (GBM) basins. Currently, there exists no collaboration among all co-riparian nations within the GBM basins; instead, all existing treaties and collaborations are formulated on a bilateral basis. The Ganges water sharing treaty (the Treaty) between India and Bangladesh is the only agreement between these two countries. The Treaty is set to expire in six years (2026). This paper proposes a framework for an integrated water resources management compact involving all co-riparian nations within the GBM basins that will benefit many sectors, including hydro-power generation, water quality, land use practices, flood and drought mitigation, irrigation, navigation, recreation, augmentation of lean season flow at downstream locations, regional peace, food security, and achievement of the UN's 2030 Vision for Sustainable Development Goals (SDGs).

Keywords: *Transboundary rivers, GBM basins, Ganges Water Sharing Treaty, Compact, SDGs*

School forests and wood energy utilization in Wisconsin, USA: Lessons for Bangladeshi schools

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Wisconsin, a midwestern U.S. state, has about 17 million acres of forests accounting for 48% of the state's total land. There are 247 school forests with 425 forest parcels throughout the state that provide a unique opportunity for nature-based education as well as income opportunities by utilizing different forest products. However, much of the woody biomass from these forests are underutilized. One potential use of this woody biomass is generating bioenergy to heat the school buildings of Wisconsin public school districts. To explore the wood energy utilization potential, we conducted a socio-economic study to assess interest and discover key barriers and challenges of Wisconsin Public School Districts in implementing a woody biomass energy system to heat their school buildings. Methods included the use of online surveys sent to all Wisconsin public school districts' superintendents, directors of building operations and school forest managers. This study is still in progress, but preliminary results from the surveys showed that woody biomass debris is being produced through school forest management practices and that most of that debris is being left on the ground, which shows promise for school forests to produce woody biomass fuel for a woody biomass energy heating system. Results of the study will help identify and address barriers and challenges of using woody biomass energy that could help in the eventual development of a new woody biomass market which would aid in supporting the local economy with renewable energy and creating healthy forests. The findings about managing school forests and their potential benefits for education and income opportunities could provide food for thoughts for Bangladeshi schools.

Cumulative Impact Assessments of Power Generations in Southeastern Bangladesh

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Cumulative assessment is a tool for project developer to try and take into consideration not only its own contribution to cumulative impacts, but also other projects and external factors that may place their developments at risk. This study assessed the cumulative impacts of air emissions from 22 major powerplants in southeast of Bangladesh planned to generate 21,550 MW of electricity. It also includes anticipated growth in small to medium size industries, brick fields, highway traffic, inland water transport, transhippers, jetty, and vessel transports used for transporting fuel resources for these power plants. A 50 km by 50 km airshed is considered for air quality modeling.

Cumulative analysis indicate that predicted maximum ground level concentrations (MGLCs) of NO2 and CO are complying with both Bangladesh National Ambient Air Quality Standards (NAAQS) and World Bank Group (WBG) Guidelines. Daily average MGLC of PM2.5 (62.45 µg/m³) from all sources complies with NAAQS, however, exceeds the WBG Guidelines. Annual PM2.5 concentration (15.45 µg/m³) exceeds NAAQS and WBG Guidelines. The PM10 concentration complies with the NAAQS for both 24-hr and annual averaging times. Annual average concentration (23.12 µg/m³) exceeds WBG Guidelines. Daily average SO2 concentration (102.49 µg/m³) complies with the NAAQS however exceeds the WBG guideline values. High concentrations of PM2.5 and SO2 are due to the contribution of transboundary emission and secondary pollutants in the atmosphere. This dispersion modeling outcome can be used by the policy makers for the pollution reduction strategy.

Coronavirus, Climate Change, the Economy and Renewable Energy: Connecting the Dots & Its Implications for Bangladesh

Sajed Kamal, EdD

Drawing upon epidemiological, public health, scientific and environmental literatures, the paper identifies some causes and interconnections between the coronavirus pandemic and climate change, asserting the need to respond to both as urgent priorities and by converging the solutions. Even after the pandemic phase is over, climate change is here to stay—with potential outbreaks of new infectious diseases and deaths. The coronavirus pandemic is a warning which, by early December of 2020, has already taken a worldwide toll of 68.7 million confirmed cases and 1.56 million deaths. Even with some recent development of vaccines, *equitable vaccination* worldwide is a challenge that the world seems to be poorly equipped to undertake. In the meantime, spikes continue and neither coronavirus nor climate change knows no borders.

Furthermore, both the coronavirus pandemic and climate change are inseparable from the economy. A healthy and sustainable economy depends on the quality of public health and functioning industries and institutions, as well as a healthy environment. These cannot be viewed as conflicting priorities. Moreover, the mounting medical waste, discarded PPE (Personal Protective Equipment), accelerated use of chemicals and toxins, etc., while necessitated to cope with the coronavirus crisis, forebode an environmental nightmare in the making, with a heavy price tag. For some countries that could mean mounting debt beyond bankrupting not only the present, but also the future. Due to their entwined nature, it is futile to talk about solutions to either the coronavirus pandemic, climate change, the collapsing economy or the environmental destruction without holistically addressing their interconnections.

This critical scenario has profound implications for Bangladesh. On the one hand, it is a country with one of the world's highest population density, one that is most vulnerable to climate change, one that is severely ill-equipped with the resources and infrastructures necessary to effectively cope with the spread of coronavirus, and where the nationally encroaching rapid urbanization and unchecked pollution factors—accelerating respiratory illness and other health effects—have already turned Dhaka into one of the most polluted cities in the world.

On the other hand, Bangladesh is richly endowed with a combination of renewable energy sources such as light, heat, wind, water movement and photosynthesis. Numerous research reports suggest Bangladesh has a revolutionary potential for benefitting from renewable energy technologies. With a growing demand from the social spectrum, the need for a transition to renewables is gaining ground. The government's most recent proposal (November 2020) to move away from coal is an indication, but by shifting mainly to liquefied natural gas (LNG) and petroleum for electricity generation, it remains entrenched in the fossil fuel path. The earlier proposed target of generating only 10% of its power from renewable resources by 2020 was a gross underestimation of the potential, and with barely 3% of the country's current total energy production generated from renewable sources, this potential remains practically untapped.

In the latter lies much hope. As the search for sustainable solutions to both coronavirus and climate change continues—reduced carbon emissions, cleaner air, improved public health, rejuvenation of flora and fauna, and sustainable economy, among others—all of which can be enhanced by a paradigm-shifting transition to renewable energy—the urgent need for such a transition, too, must become a topmost national priority.

Water chemistry, sediment geochemistry, and microbial community of different depth aquifer sediments from Chandpur and adjoining area

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The occurrence of high arsenic (As) and other oxyanions (e.g., Mn) has been examined in a ~410km^2 areas within the Bengal Delta from Matlab Upazila (North and South both), Chandpur district, Bangladesh. This research aimed to investigate the role of sediment geochemistry, coupled with microbial community studies and their relations with different colors and grain sizes of sediments, in determining evolved groundwater hydrochemistry. Groundwaters are Ca–Mg–HCO_3^- types in shallow aquifers, Mg-HCO_3^- in the intermediate depths, and Na-K-Cl rich in the deeper aquifers. Dissolved As concentration is high (~781µg/l) associated with shallow grey and dark grey sediments, whereas light grey sediments at intermediate depths contain lower As (<10 µg/l). Dissolved Fe_T on the other hand in both sediment types (light grey and grey), shows a good correlation with dissolved SO_4^{2-}. The plots of $\delta^{18}O$ vs. δD, intermediate and deeper depth aquifer waters plot on the arrays for LMWL and GMWL, which indicates the principal recharge mechanism is likely to be from local precipitation within the shallow aquifers. Only the high As groundwaters deflect from the LMWL, indicating that recharge might be a mixture of precipitation and surficial discharges/infiltrations for these waters. Bulk extraction of sediments showed that grey and dark grey sediments from shallow depths have higher As concentrations (~31 mg/kg), and light grey sediments have comparatively less (~11mg/kg). Sequential extractions for sediment fractionations showed that most of the As was bound to amorphous and poorly crystalline hydrous oxides of Fe and Al phases. Synchrotron-aided bulk-XANES studies conducted on sediments revealed As and S speciation in the core samples at different depths indicating the occurrences of hotspots of As distributed randomly in light grey and grey sediments. As^{3+} is the dominant species in Matlab sediments. More than 101 bacterial families were identified among the eight sediment samples from the South Matlab core and out of them fewer than six families comprised more than ~80% of total bacterial families. These results indicate significant associations between bacterial community structure, grain size fractionation, dissolved As concentration, and sediment C, Mn, and Fe concentrations for these samples. Groundwater extracted from these light grey sediments, in contrast to reduced greyish to dark greyish sediments, contains significantly lower amounts of dissolved As and can be a safe water source for the future. Current research also correlated with adjoining areas sediments color and their geochemical and microbial community for safe drinking water aquifer zone.

Climate Change: Tackling Local Issues with a Global Perspective

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BEN-Australia

Climate change is a pressing issue. Even though the local responsiveness is important in mitigating the causes of climate change, unless governments and international bodies come up with serious climate policies that are enforced, local disjointed efforts will continue to fall short. In Australia, we have initiated a dialog between the Bangladesh Environment Network (BEN) and several Australian environment organizations and political parties. We are making them aware of the role that Australia plays, in connection with Bangladesh, that might exacerbate the climate change, namely the supply of Australian coal to Bangladesh through India for the Rampal Coal Power Plant. Almost 60% of current Australian power generation is from coal. Australia remains the largest coal exporting country in the world with 38% of the share, although movements are underway to shift the economy gradually to renewable energy sources. We feel BEN has an important role to play here by bringing a global perspective, especially with respect to Bangladesh, to Australian activists, scientists, politicians, media, NGOs and industry. We have already embarked on making connections with the above-mentioned parties. One of the outcomes of these interactions is a greater understanding in safeguarding the indigenous lands. We feel that such grass-root communication across the world involving the Bangladeshi diaspora with local communities would go quite a way in helping the climate cause.

With the above perspective in mind, more effort is required by the environmental activists in Bangladesh in building up international connections. This will provide the global community with the knowledge of the climate peril that Bangladesh faces. This is not a one-way street, however. For a successful environmental movement Bangladeshi activists should be knowledgeable of urgent global issues, whether it is the fight of the indigenous people to safeguard their lands or local efforts to clean up rivers across the world.

OBD-043
Krishna

Is Sand Mining and Dredging Killing Ganga River Basin: A Preliminary Inquiry into Cumulative Impact Assessment and Institutional Efforts to Save Ganga

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Ganga river basin seems to epitomise all that has gone wrong with our rivers. This paper undertakes a preliminary inquiry into the cumulative impact of sand mining and dredging in the Ganga river basin approach and its consequences for the health of the river, its environment and people dependent on it. The paper situates the new initiative for rejuvenation of Ganga in a historical context and factors in future conditions in a business as usual scenario. It has been estimated that 32-50 billion tons aggregate sand is extracted globally each year. This threatens the very existence of the riverine habitats. The compartmental approach of scientific community and public institutions has contributed to myopic indiscriminate aggregate mining. The basin of river Ganga drains about 1,060,000 km2 and is the fifth largest basin in the world. Manual sand mining, using country boats, has been in practice in Ganga and its tributaries from ancient times but mechanized industrial scale sand mining at various Ghats of the Ganga and all its tributaries is a phenomenon of recent decades. Sand mining includes large scale removal of sand from the river. It is not confined to dried channel belt or a part of it. The paper dwells on the insensitive policies of governments of Ganga basin countries - India, Nepal, Tibet-China, and Bangladesh. Ganga's catchment area falls in these four countries situated in the Himalayan watershed. The upper stretch of river Ganga, from Gangotri to Haridwar is 294 km. Ganga enters the plains at Haridwar and follows 800 km arching course and continues its journey south east-the stretch of Ganga from Haridwar (downstream of Bhimgoda barrage) down up to Varanasi has been referred as middle Ganga where large abstractions of water for irrigation and generation of power takes place. The lower segment of Ganga from Varanasi to Farakka is 701 km which spreads through five important towns Varanasi, Buxar, Patna, Bhagalpur and Farakka. Lower Ganga downstream of Farraka is up to Gangasagar is 286 km. Gangasagar an island in the Ganges delta, lying on the continental shelf of Bay of Bengal about 100 kms south of Kolkata. Ganga bifurcates near Farakka into a major offshoot Padma, which flows further eastwards to Bangladesh and a minor offshoot Bhagirathi which flows southwards to Bay of Bengal through deltaic region of West Bengal. Below the confluence of river Jalangi with Bhagirathi, the river flows under the name of Hooghly, through Kolkata and Diamond Harbour and finally reaches its destination Bay of Bengal. There is rampant mining of minor minerals in these parts of the Ganga basin. The paper looks at the plans, policies and laws of the public institutions of Ganga basin to ascertain the malaise. The paper attempts a preliminary inquiry into diagnosis based on the cumulative impact assessment and remedy for the crisis in Ganga basin. It draws inferences about economic activities of these countries which are contrary to water cycle in their conceptualisation and implementation and their impact on Ganga basin and Himalayan watershed. Ganga River Basin Management Plan has identified unrestrained gravel and sand mining and dredging as one of the eight main factors adversely affecting the river habitat. Based on the threat assessment, "restrictions on anthropogenic alterations of river morphology by gravel and sand mining as well as by river bed and river bank modifications by structural measures" was considered one of the essential actions to restore the ecological balance" of Ganga. The paper draws conclusion about whether this recognition has altered the business as usual approach towards indiscriminate sand mining, dredging, stone crushing, sediment removal, and mining of other materials from river beds and flood plain of Ganga.

Keywords: *Sand mining, cumulative impact, Ganga, river basin*
OBD-007

আইন ও সমাজ প্রেক্ষিতে পরিবেশ রক্ষায় ছোটরা

দিলরুবা শাহানা

পরিবেশের অন্তর্ভুক্ত মাটি(পাহাড়, পর্বত, টিলা, সমতল) মানুষসহ সকল প্রাণীকুল, জলাধার(সাগর, নদীনালা,খালবিল) বন-জঙ্গল ও বায়ূমন্ডল। বায়ূমন্ডল, পানি দূষিত হলে, গাছপালা ধ্বংস হলে সব প্রাণীই হয় বিপদগ্রস্থ। মানুষ নামের প্রাণীও এই বিপদের শিকার। মনুষ্য সমাজের অংশ শিশু-কিশোর তরুণরাও এ থেকে রেহাই পাচ্ছে না। পরিবেশ রক্ষা ও পরিবেশ নষ্ঠ দু'টোতে মানুষের ভূমিকা হয়ে উঠেছে আলোচ্য বিষয়। ছোটদের এই জটীল বিপদজনক ব্যাপারে যোগ দেওয়া বা অংশ নেওয়া যথাযথ হবে কি? পরিণত বয়স্ক মানুষেরাই এসব বিষয়ে সব কিছু বলার ও কার্যক্রম চালানোর অধিকারী কি? শিশু-কিশোরদের কণ্ঠ শোনার কোন বিধান বা নির্দেশ কি আছে? ছোটরা সমাজে বাস করছে, সমাজ থেকে বিচ্ছিন্ন হয়ে থাকতে পারবে কি?

সমাজ সংসারের নিয়ম কানুন মান্য, শিক্ষার উপাচার সব কিছুর লক্ষ্য থাকে ছোটরা। এই বিশ্বভুবনে স্বাস্থ্য, শিক্ষা, ক্ষুদ্র অথবা বৃহৎ নির্মান যা কিছুই করা হোক তা ছোটদের জীবনকেও প্রভাবিত করে। যা তাদের জীবনকে জড়িয়ে বা তাদের ছুঁয়ে যায় সে বিষয়ে তাদের কিছু বলার থাকতে পারে। এই বলাটা বা বলতে পারাটা তাদের অধিকার। অন্যদিকে ছোটদের মতামত বা কন্ঠ শোনাটাও বড়দের দায়িত্ব। ছোটরা কি তাদের মনের মত সুস্থ সুন্দর একটি পৃথিবী পেতে পারে না? হয়তো পেতে পারে। তবে এ বিষয়ে মহাত্মা গাঁন্ধীর বক্তব্য You must be the change you wish to see in this world.

পরিবেশ রক্ষায় পারস্পরিক দেয়া নেয়া ও প্রত্যাশা প্রাপ্তি দু'টো বিষয়ই জড়িত। ছোটদের জানার প্রত্যাশা যেমন তেমনি কথা শোনা বা নির্দেশ মানটাও কর্তব্য। এই বিশ্বভুবনের পরিবেশ রক্ষায় ছোটদের জড়িত করা তাই গুরুত্বপূর্ণ। কথা হল সমাজ, সংসার, সংগঠন ও সংস্থা কিভাবে ছোটদের ভূমিকাকে দেখছে ও কতটা গুরুত্ব দিচ্ছে এর উপর নির্ভর করবে পরিবেশ রক্ষায় ছোটদের অংশগ্রহণ।

পরিবেশ সংক্রান্ত বিষয়ে শ্রেনী নির্বিশেষে শিশু কিশোরদের প্রতি আহ্বান ও তাদের অন্তর্ভুক্তি কতটা জরুরী? পরিবার, প্রশাসন, জাতীয় ও আন্তর্জাতিক সংস্থা এ বিষয়ে কি ভূমিকা নিয়েছে তা খতিয়ে দেখা যেতে পারে ও শিশু ও পরিবেশ নিয়ে আন্তর্জাতিক পরিসরে গৃহীত উদ্যমে রাষ্ট্রের সংহতি কতদূর যাচাই করা যেতে পারে.

OBD-008
Maity

PRESENT AND FUTURE PANDEMIC SCENARIO OF PINGLA BLOCK, PASCHIM MEDINIPUR, W.B.

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The disease COVID-19 is pandemic. According to media and other various sources newly COVID-19 viruses was detected primarily at Wuhan, China in Dec.2019. This corona virus was initially named as the 2019- novel corona virus (2019-nCov) on 12 January 2020 by WHO. Within a few days virus has spread firstly over the world taking the accountable loss of human lives. Persons having Comorbidity will have 8 times greater life risk than the normal people. The risk is directly related to the low immunity and higher aged persons which may be 4 times for age more than 60 years, for 70 years it is 9 times and for > 80 years this becomes 15 times. According to the available researches it is said that due COVID -19 the death is about only 2% of the total death. The central and state governments have taken several steps to control COVID -19 in India. For control of virus, India government has implemented a magnificent step as lockdown throughout the country that started on 25th March 2020. Central government and State government, also media are taking all possible actions for aware of various protocols of COVID-19. From the study area 50 (randomly) samples (COVID-19) have been collected which includes 09 above 50 years,21 between 20 to 50 years and 20 below 20 years. It is noted that mostly persons having low immunity are affected by COVID-19.
Keywords: *COVID – 19, Future pandemic, WHO.*

Risk of Lead Poisoning in Bangladesh: A Cross-sectional Study

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Introduction: Lead is the number one environmental threat to the health of children. Some populations and geographic areas still remain at a disproportionately high risk of exposure to lead. Due to potential environmental risk of lead poisoning, a cross-sectional study was conducted to determine the extent of and risk factors for elevated blood lead levels (BLLs) in children in Bangladesh during September 2007–July 2009. The study included 919 children aged less than 16 years.

Methods: The children were recruited from six urban locations in Dhaka and one rural area of *Chirirbandar*, Dinajpur. Samples of venous blood (0.5 mL) were collected and transported using heparin tubes, and processed within 24 hours after collection. The BLLs were measured using a portable LeadCare II Blood Lead Test instrument (ESA Inc., Chelmsford, MA, USA). **Results**: In total, 495 (54%) children had high BLLs (>10 µg/dL), with higher BLLs observed among children aged 5-9 years compared to children of other ages (p <0.001). The BLLs among children in urban Dhaka were significantly higher than those in rural areas (13.45 ± 8.21 µg/dL *vs*. 7.29 ± 6.25 µg/dL, p < 0.001). The high BLLs correlated with low body mass index (r = -0.23, p<0.001) and low haemoglobin status (r = -0.10, p = 0.02). On bivariate analysis, proximity to industry (p <0.001), drinking-water from municipal supply or tubewell (p < 0.001), brass or lead water-taps (p <0.001), use of melamine plate (p = 0.001), and indigenous medicinal (*kabiraji*) treatments (p = 0.004) significantly correlated with higher BLLs. Proximity to industry and the use of indigenous medicines remained significant predictors of high BLLs after controlling for the confounders.

Conclusions: Several risk factors for lead poisoning identified in this study are appropriate for future educational interventions to prevent exposure to lead poisoning.

Keywords*: Lead poisoning; Risk factors; Children; Bangladesh*

Community Interventions Ensure Prevention of Lead Poisoning: An Education Intervention in Mississippi

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The burden of lead poisoning is disproportionately high in selected communities, especially in African Americans and in low-income populations in the United States. Therefore, the project aimed to provide educational interventions to raise awareness in "high-risk" communities in Mississippi. *Methods:* Several educational sessions on lead prevention were conducted at health fairs, schools, neighborhood meetings, and community events. The number of participants included: health fairs (*n* = 467), community events (*n* = 469), and Kindergarten classes (*n* = 241). EPA/HUD's online visual training was given to realtors (*n* = 220), and inspectors, contractors, and Do-It-Yourself (DIY) workers (*n* = 75). Training workshops were offered to home-buyers and rental home owners (*n* = 91). The impact of training was evaluated by pre- and posttests. *Results*: Nearly 90% of the participants (*n* = 25) reported the hands-on training was useful. After the EPA/HUD Online training, at posttest, 59.4%, 67.9%, 65.1% of the participants (*n* = 220) identified soil, car batteries and paint as sources of lead in the environment, respectively. Nearly, 70% identified lead as a poison in the environment while 77.5% and 47.2% demonstrated two behaviors which help prevent lead poisoning. A total of 62.3%, 48.1% and 58.5%, at posttest, identified three complications, respectively. The mean posttest score was significantly higher than the pretest scores (7.47 ± 2.07 vs. 6.60 ± 1.68, respectively). All the participants at a 2-month follow-up reported that that they used information obtained during the training on EPA-HUD curriculum on lead. The outcome measurements of home-buyer workshops were not significantly different from those of the online training. *Conclusion*: This training activities were successful in improving knowledge of the community people on lead poisoning prevention. Similar community-based educational programs should be advocated to ensure prevention of lead poisoning.

Keywords
Lead poisoning; training; prevention; outreach; Mississippi; EPA.

Managing the waterlogging problem of Dhaka City

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The city of Dhaka, once filled with canals, lakes and ponds, could no longer rely on nature for urban drainage. This causes waterlogging problem. Caused by uncontrolled development, the waterlogging problem of Dhaka city is a frequent phenomenon. With few inches rain, the water remains stagnant on the road long enough to cause the pedestrians to wade in knee-deep water. This causes significant trouble to the city dwellers.

The city has taken many expensive steps during the last two decades. Many inhouse professions and expert consultants worked on the problem. But the waterlogging problem remained unsolved for decades.

This paper focuses on solving the waterlogging problem of Dhaka City with the applications of multifaced methods of modern technologies. The approach is mainly divided into three different focus areas: (1) source control, (2) system conveyance and its network, and (3) Real Time Control (RTC), and a Decision Support System (DSS).

Potential Danger of Elevated Level of Nitrates in Groundwater of Bangladesh

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Bangladesh has made significant strides in public health, especially in sanitation, in the last three decades. The Department of Public Health Engineering (DPHE) encourages rural communities to adopt water-sealed septic systems and has achieved 100 percent sanitation in certain upazillas. This effort has reduced the public nuisance of open defecation and other unhealthy practices. The DPHE has promoted septic systems of certain types of design to the public. The design of these septic systems is inadequate as they allow nutrient-rich wastewater to contaminate the groundwater. In these improperly designed septic systems, which can be called cesspools at best, the raw sewage settles (primary treatment) and decomposes (secondary treatment) in a single tank of about 10' deep. While the partially treated sewage soaks into the soil, leaches downward, and percolates into deeper soil layers, the sewage gets further treated by microbial reactions and filtering processes (tertiary treatment).

In most rural areas, the hand-pump tube-well works, which means that the groundwater is well within 34 feet depth. In that case, the partially treated sewage does not get enough distance, and so enough time of travel, to get treated before getting into the groundwater table, which means that the groundwater gets contaminated. Even if the organic contents get eliminated and the pathogenic bacterial count gets within tolerance, the nutrients do not get treated fast. The nutrients include nitrates, phosphates, and sulfates, which are fertilizers for plants. Among all these nutrients, the primary concern is nitrates, as its health hazard is significant. The ill effect of nutrients is well known in the medical literature. The same water is then accessed through a hand-pump tube well, resulting in drinking water contamination with sewage decomposition by-products.

With continual addition through the millions of sewage-infiltrating inadequately-designed septic-tanks, nitrates keep accumulating in groundwater. Farm use of nitrate fertilizers enhances the problem even further. For this reason, the USA and other western countries put a significant restriction on the use of septic tanks even though their septic tanks are much better designed and expensive.

First, this paper focuses on the fact that Bangladesh is poised to have the potential looming disaster of nitrate-contamination in groundwater. This concern is alarming as groundwater is the primary source of our drinking water. Next, it emphasizes the following: (a) be vigilant and measure the nitrate contamination in groundwater through an extensive network of tube-wells at adequate time-intervals for many years, and (b) enhance the design of septic systems that reduce groundwater contamination.

OBD-027
Modak

Reusing Treated Wastewater in Textile Process Industry and Advancing Towards Zero-Liquid Discharge

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Once abundant in water resources, Bangladesh now has a dwindling supply of drinking water in specific regions. The main reason is the extraction of massive groundwater, using it for industrial processes, and returning the water as highly polluted wastewater to nature. One of the primary sources of pollution is the textile process industry. It affects the water resources in two ways: (a) it extracts a massive amount of water, causing groundwater depletion, and (b) it pollutes the water resources. While factories can play an essential role in the country's economic contribution, they contribute to significant environmental pollution. Environmental engineering's target would be allowing the factories to contribute to the country's economic development while checking or eliminating environmental degradation.

Bangladesh has environmental standards set by the Ministry of Environment for the wastewater release in nature and wastewater reuse for agriculture. It does not, however, limit the amount of groundwater extraction by the factories. Moreover, most factories are violating environmental rules. Following examples of other countries, Bangladesh may encourage the industries to seek to reuse their wastewater. The factories may reuse up to a specific minimum mandated fraction of its wastewater to reduce the freshwater demand if enacted such a law. One extreme case would be to enforce all textile process factories to become the "Zero-Liquid Discharge (ZLD)" system. ZLD means no environmental water pollution, as there is no wastewater discharge.

The benefit of a ZLD ETP system can be enormous when the environment is concerned. But it will cause a substantial financial burden on the factory owners. However, it is possible to design the system gradually to reuse an enhanced fraction of wastewater in stages. The first stage of the ZLD ETP system is the recovery of the salt and recovery of about 10 percent of water. This stage can lead to significant financial gain as tens of tons of salt can be recovered and reused. This first stage will also eliminate pollution by a significant margin. The subsequent stages will enhance water reuse by up to 50, 75, and 95 percent with an increased cost burden. This paper shows a wastewater treatment system design where the system can be implemented stage-by-stage for increasing percent of treated wastewater reuse. In the final stage, the system can go for the ultimate target of ZLD.

In a textile process factory, about 120 cubic-meters of water is needed to process (bleach, dye, rinse, wash) 1 metric-ton of fabric or yarn. Among this 120 cubic-meters of water, only about 10% is needed for dyebath. The rest of the water is used for rinsing, washing, and other processes. To dye one metric-ton of fabric, 0.4 to 0.5 metric-ton of salt, typically "Glauber salt" (a colorless crystalline sulfate of sodium $Na_2SO_4 \cdot 10H_2O$), is used. The dyebath wastewater is about only 10 percent of the total wastewater but contains about 90% of the unsettled dye and 90% salt. The rest 90% of the wastewater contains the rest 10% of pollution. A typical textile process factory mixes all used water in a single stream and treats the resulting wastewater in a conventional ETP before releasing the treated wastewater into nature. An ideal conversational ETP can probably reduce the color and other contaminants to the standard level in a perfect setting, but in no way can it reduce the salt content. A typical large textile factory, which processes about 40 metric-tons of fabric per day, uses about 16 to 20 metric-tons of salt. Currently, all of it goes to the drain and eventually goes to soil and river. This wastewater elevates the salinity level of soil and water.

This first part of the paper focuses on the recovery of the salt and recovery of about 10 percent of water, which is the first stage of the ZLD ETP system. This process involves separating the dyebath wastewater stream from the general stream, comprehensively treating the dyebath wastewater to remove color and other contaminants, and polishing the resulting brine. The brine is reused in the dyeing process. This process can recover 80% of salt and 10% of water. A typical big textile factory that processes about 40 metric-tons of fabric per day will save 12 to 16 tons of salt per day and at a current market value will save Tk. 1,80,000 to Tk. 2,40,000 a day. The second wastewater stream, which contains much less contamination, becomes easier to treat to get to the standard level using a conventional ETP.

For the first time in Bangladesh, an ETP involving salt-recovery from a textile process industry can show the return of investment. The salt-recovery involves extra capital expenditure and maintenance and operations costs. This cost and benefit can be the subject of break-even analysis and payback period calculation. The later part of the paper touches on the financial analysis of the system.

Sustain Renewable Energy – Lessons for Bangladesh from an interprofessional study conducted in two US counties

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Between 1999–2018, the Global Climate Risk Index placed Bangladesh in the top 10 countries most affected from extreme weather events associated with climate change. Implementation of alternative energy may minimize climate change in vulnerable countries. Our objective was to characterize public knowledge and perceptions of costs and benefits of renewable energy in west Michigan, USA, and recommend areas in which policy discussions on renewable energy should focus. Via **email** and postal service, we distributed a survey to 1,000 randomly-selected university employees, and 1,000 residents of Ottawa and Kent counties in west Michigan (Grand Valley State University Institutional Review Board #20-118-H). A total of 313 respondents completed the survey, including 170 university employees and 122 county residents. Results suggest that 12.5% of people older than age 60, and people with no college degree use alternative energy sources more than other age classes or those with higher education. Females ($p = 0.0636$) and people who have lived in their homes for 10–15 years ($p = 0.0802$) perceived renewable energy as less costly than other sources. Although females perceived less knowledge than males ($p = 0.0001$), there were no differences in perceived knowledge level among respondents of various ages, education levels, careers, salary, or whether they owned a home. Respondents aged 40–49 and 60–69 also perceived lower pollution from renewable energy than other age groups ($p = 0.0393$ and $p = 0.0779$, respectively). With a broader, more diverse population in future work, we anticipate more variability in the responses, but similar trends. The prospect of implementing renewal energy is positive and suggests that policy makers should supply incentives, promote education, and invest resources for effective implementation. The Bangladesh government can support studies to understand peoples' perception of alternative energy sources and explore socially suitable interventions to address climate change.

Keywords: *Renewable; Energy; Sustainability; Policy; Bangladesh.*

OBD-035
Nath

Do Urban Green Spaces Support Towards Sustainable Cities? A Review of Literature and Implications for Bangladesh

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Urban green spaces (UGS) are private, communal or publicly owned, managed and accessible naturally vegetated areas within urban landscapes, commonly used for recreation and other leisure activities. These include parks, gardens, children's playgrounds, mountain trails, golf courses, and other open natural areas, and may be large or small, may have trees, open areas, or water bodies, and are sometimes equipped with equipment for games and exercise. In this review, I will discuss how UGS positively influence social, economic, and environmental outcomes, which are the basic goals of sustainable cities. The paper will also draw useful policy implications towards sustainability of UGS in Bangladesh. UGS encourage neighbouring residents to engage in outdoor activities which in turn promote a general sense of community feelings, regular social interactions, and decrease feelings of loneliness needed for social support, leading to greater personal resilience, well-being, and the generation of social capital and cohesion. Green exercise, socializing, and viewing scenic landscapes in UGS bring positive effects on human well-being through psychological, social, and direct health benefits. Ecosystem services of UGS help to improve urban environmental quality, provide habitats for urban wildlife, and thus support local biodiversity conservation. These health and well-being benefits translate into economic benefits including savings to public health service and increased economic output due to a reduction in ill health and absence from work. Research shows that a 30-minute walk three days a week by 2.12 million individuals in the UK can generate an economic benefit of £1.75 billion per year. In Bangladesh, the importance of UGS, as an option among various nature-based solutions towards sustainable cities, has not yet been substantially studied or implemented . few studies so far have been carried out in Dhaka and in Chittagong, focusing on accessibility, connectivity, and health outcomes. Based on 2006 data, Dhaka has only 8.5% green coverage against an ideal 20%, while in Chittagong currently per person open spaces is 0.18 square meter against the recommended nine square meter ^{2}. Moreover, there are instances of illegal occupation of public UGS across the country. In order to approach towards sustainable cities in urban Bangladesh, I suggest the promotion and support for UGS in Bangladesh be seen as an integrated policy intervention, which requires effective coordination of relevant stakeholders.

OBD-030
Paul

(Wet) landscape of Bangladesh: painting a picture of 2100

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The (wet)landscape of Bangladesh has been fast changing mainly due to anthropocentric causes. Climate Change has been adding to the pressure. Once existed the vast number of wetlands that had been hosting rich biodiversity all across the landscape have increasingly been converted to aquaculture or agriculture. With nearly 50% of the country being wetlands, once up to 300 plant species and some 400 vertebrate species were partly or fully dependent on wetlands for their lifespan, this number is sharply declining. Whilst aquaculture and agriculture both were essential nevertheless, in this manner wetlands and their biodiversity are under threat of mass losses. Unless urgent measures are taken both at local management level and on the climate change front, by 2100 hardly any wetland will remain to support biodiversity and ecosystem service functions. Looking forward, among various measures, co-existence of aquaculture, agriculture and wetland conservation is the best way forward. The paper will paint the above picture and provide a pathway, including the need for technology and tradition working hand-in-hand. Whilst technology is vital for combating climate change and other human-caused impacts, it is also traditional knowledge and techniques that can help reviving the wetland biodiversity.

An Investigation on Causes and Effects of Waterlogging in the Southern Part of Bangladesh: A Case Study in Noakhali Pourashava

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Noakhali Pourashava is an important municipality in southern Bangladesh. This area faces severe waterlogging problem during the monsoon period every year and has become a regular and common phenomenon. The present study aimed to investigate the major causes of waterlogging and its negative effects on life, from the viewpoint of people residing in different areas of Noakhali Pourashava, different government, non-government, development organizations as well as various stakeholders including experts. It has been found that Noakhali Pourashava doesn't have any flood problem from the overflow of the khals but the water logging is experienced during peak monsoon season with high rainfall for a long duration in ward no. 1, 2, 4, 5, and 8. Most of the inhabitants/respondents of the Noakhali Pourashava claimed that lack of drainage facility; excessive rainfall; inadequate, low capacity and conventional drainage system; natural siltation; improper waste management; absence of proper inlets and outlets; and blockage and encroachment of existing drainage are responsible for waterlogging. It has ascertained that the water logging becomes a burden for the inhabitants of the Pourashava and creating adverse effects on livelihood, society, infrastructure, economy and environment. Other notable adverse effects of waterlogging are disruption of traffic movement and normal life, structures and infrastructure damage and loss of income potentials with a lot of sufferings. Water-borne diseases increased due to the mixing of stagnant stormwater with solid waste, domestic waste, clinical waste and various contaminants. The stagnant water acts as a breeding site for the vectors of various diseases and becomes a health hazard to people residing in the waterlogged area. The current study suggests that close coordination among Pourashava authorities, local government agencies and a strong collaboration between public and private sectors as well as local people participation are essential to solve the waterlogging problem effectively and sustainably.

Socio-Economic Challenges of Covid-19 Pandemic in Sri Lanka -Special reference to human wellbeing-

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Sri Lanka's first confirmed COVID-19 patient was identified on the 11th of March 2020; after the Wuhan outbreak in December 2019. Sri Lankan health authority had a great challenge since it doesn't have an effective medicine and 21.4 million people of the country should be protected; minimizing health impacts and socio-economic losses. Sri Lankan Government has taken every step to manage these contradictory situations at a middle point with the support of security forces and health sector professionals, extending various preventive and management strategies, under the provision of quarantine and prevention of diseases law no. 12 of 1952. However, a total of 31,375 people were infected with coronavirus and 23,304 patients have been recovered, and 147 were dead as of 19.11.2020 (Epidemiology Unit, 2020). The objective of this study is to identify the socio-economic challenges, providing more weightage on human wellbeing during this Covid-19 outbreak. The quantitative and qualitative secondary data were predominantly used, extracting from scholarly research articles and published and unpublished data sources of health authority as of 31.10.2020. The collected data have been sorted according to the objective, correlating with human wellbeing related occurrences. The analysis was carried out, following both quantitative and qualitative approaches; while applying the author's viewpoints by interpreting such data into information. The result revealed that socio-economically most affected people are low-income earners, daily wages laborers, and business community due to the curfew and locked down situation and import trade restrictions imposed by the Central Bank of Sri Lanka. Similarly, the security forces, front-line health care workers, quarantined people, and patients associated with long medical history are at higher risk. Their mental health and human wellbeing are beyond normal conditions, due to sleep-deprived workload, stress, frustration, depression, isolation, and genuine psychological fear of being infected by this novel-virus. Apart from this, the cost of living has been increased, while the rising of Colombo Consumer Price Index (CCPI, 2013=100) from 5.7% in January 2020 to 6.4% in September 2020, align with increasing trend prices for essential goods. According to International Credit Rating Agency (2020); the economic loss is 4% of GDP, amounting to LKR 735 billion. Tourist arrival had dropped by 65-75% from January to October 2020. The income source of 65-70% of families had been affected, representing all districts of the Island, while 7-10% lost their entire income. 30-35% of families reduced their food consumption pattern/frequency. 75-80% of families experienced verbal abuse and 7-10% were physically abused and 5-7% had sexual violence. More than 95% of higher education institutions conducted their education over the Internet (University of Ruhuna, 2020). The least cost and more effective tool to mitigate and manage the human health impacts and subsequent drawbacks on human wellbeing is to extend productive education and awareness, among the general public. Further, this study recommends to implement a sustainable recovery plan on human wellbeing by improving personal living standards, maintaining physical and mental health, creating self-employment opportunities, expanding e-business, and promoting self-sufficiency cultivation. The outcome of the study is much more helpful in a long-term decision making purpose and prepare a national contingency plan to face similar situations in the future.

Key Words: *Covid-19, socio-economic challenges, human wellbeing, sustainable recovery, mental health.*

Environment, children in the perspective of society and law

Dilruba Shahana

Issues relating to environment have impact on everything surrounding, including living and nonliving. Climate change is an environmental phenomenon. In simple words climate change means rise in temperature and increase in atmospheric carbon di oxide. This change causes various impact on air, water, production of food and health of people. It is grievously harmful for the very existence of anything. Life style, Activities and consumption pattern of human society all over the globe contribute to climate change or to this dangerous on going occurrence of pollution.

No country, no society is to be exempted from this responsibility. So to protect and to save our surrounding from further environmental degradation each and everybody should have duty to perform and their voice to be heard regarding anything which might bring negative result in climate. Children form not small percentage of population of this planet and impact of climate change on them as well harsh. Worth to mention that little bit more than one fourth of population(26%75 ,2020) represent children under fourteen in Bangladesh. Children are the future of the human society so their well being must be paramount. This does not mean that they should be brought up in cotton ball. Respect legal direction to listen children's voice in this regard and as children are part of society, designate their role as climate ambassador, educate and inspire them to bring change in their habit as well as behavioural pattern in order to save our planet.

OBD-033
SARADAR

Traditional knowledge of Mouley from Lower Gangetic Delta (Sundarban), India.

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The Mouley is an important forest resource collector in Sundarban forest area. They are known as traditional honey collectors. They collect wild honey by the help of traditional knowledge. They depend on traditional knowledge for their livelihood practice. They have acquired this knowledge from their father and forefather through continuous livelihood practices. Indigenous Knowledge is an important cultural trait of a social group. It is an identity and logical creation of a social group and main weapon of livelihood practices. Indigenous Knowledge exhibits technological values, scientific thought and idea. It helps to solve day to day problems, practical works, daily life and livelihood practices.

Key words: Mouley, Indegenous knowledge,Social group,livelihood practices

Sahu

Comments on coal fired power plants under construction at Rampal, Kalapara and Taltali near the Sundarbans World Heritage site of Bangladesh

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My name is Dr. Ranajit Sahu. I am a US-based engineer with over 20 years of experience reviewing coal-fired power plant designs around the world.

I. Maitree Super Thermal Power Plant

I have reviewed the Environmental Impact Assessment (EIA), tender documents, government correspondence with UNESCO, and satellite images of 1320MW Maitree Super Thermal Power Plant at Rampal.

The EIA does not meet internationally accepted standards for environmental assessment.
This plant and its 100 acres of ash ponds (which will contain toxic heavy metals) are located on top of wetlands and directly on the banks of the Passur River. This is a seismically active floodplain rapidly changing with erosion, accretion, natural subsidence, and sea level rise. Contaminants from the coal storage yard and ash ponds will leach into the wetlands and the river.

During storm and cyclone events, the ash ponds will overtop and discharge contaminants directly into the river. Risk of dyke breach and major spill is high, as occurred at a similarly engineered ash pond dumping so-called “high concentration slurry disposal” in Katikela, India, in 2017. Resulting contamination from selenium, mercury, arsenic and lead in the ash will have serious repercussions on downstream fisheries, and the wildlife and people that eat fish from the Sundarbans and the Bay of Bengal.

As an engineer, designing on-site coal ash storage requires a conservative assumption regarding the type of coal that will be burned, and its ash content, over the life of the plant. It is likely that Indian coals with more than 30% ash will be burned at some point at this 1320 MW plant, generating massive quantities of ash. Even if 100% of the ash can be reused elsewhere, having adequate on-site storage is critical because of inevitable disruptions in sending ash offsite. For this reason, on-site storage for at least 30 days or more is a must. But the tender document called for ash storage of only 15 days, with three small silos that will be overwhelmed if the plant continues to run while ash transfer offsite is interrupted even for a few days -- leading to unsafe disposal in the ash ponds on the floodplain of the Passur River.

The plant does not have state-of-the-art pollution controls of a fabric filter or baghouse for particulate matter reduction, selective catalytic reduction for NOx reduction, or activated carbon injection for mercury capture. Flue gas desulfurization (FGD) for SO_2 reduction may be planned, but there is no guarantee it will be used consistently and maintained effectively, as operating FGD systems reduce plant efficiency and cost money. With state-of-the-art air pollution would come greater risks of water pollution, as higher concentrations of heavy metals and other toxins would be sluiced into the ash ponds.

My conclusion is that this ill-conceived and ill-executed project should be stopped in its tracks before it causes irreversible damage for decades. It is not often that one gets to see disaster unfolding before one's very own eyes, but this is definitely such an instance.

II. Payra power plant

I have reviewed satellite images and the 2015 Environmental Impact Assessment (EIA) of the Payra Power Plant Phase I (1320 MW**)** at Kalapara, Patuakhali. The plant began full operation in October 2020. The EIA states the plant is located directly adjacent to a migration sanctuary for Hilsa shad (*Tenualosa ilisha*) and is habitat for endangered dolphins. The EIA states the plant is 65 kilometers from the Sundarbans World Heritage site (though it appears to be 45 kilometers from my measurement.)

The EIA does not meet internationally accepted standards for environmental assessment. According to the EIA, the plant will not have state-of-the-art air pollution controls for nitrogen oxides, mercury or particulate matter. It will emit twice the toxic particulate matter than would be allowed in China for new power plants: for example, PM emissions from Payra are allowed to reach 40 mg/m^3, whereas China's PM limit for new plants is 20 mg/m^3 (EIA at 78).

The EIA states that the ash silos will only be able to contain ash produced for 48 hours of plant operation a safe minimum would be 30 days. The ash ponds of Payra Phase I plus "planned" will be roughly 482 acres (195 ha), or nearly 5 times larger than those at Rampal. Located in a low-lying floodplain on the cyclone-prone coast of Bangladesh, those ponds appear just as vulnerable to flooding and breaching, and contamination of nearby rivers and the Bay of Bengal, as the ash ponds at Rampal.

Dredging, plant cooling systems and wastewater discharge for the plant could easily have tremendous negative impacts on migrating Hilsa shad and other fish, shellfish, and their larvae, as well as the endangered dolphins that are currently common at the site.

The Revisiting Power Sector Master Plan (2016) proposes six additional 1320 MW coal plants at Payra and Patuakhali, for a total of 7920 MW of coal power, plus another 320 MW at Taltali. The ash ponds of those additional plants could cover 1600 acres-- four times the size of New York City's Central Park.

I have also reviewed independent analyses of mercury dispersion and deposition modeling for the Rampal and Payra plants. Those analyses raise credible and serious concerns that the plants will emit and deposit cause significant mercury into the aquatic food chain of the region.

III. Barisal Electricity Company Ltd power plant

Just 20km from the Sundarbans World Heritage site's eastern land boundary, ISO Tech's Barisal Electricity Company Ltd power plant (307 MW) began construction in 2019 along the banks of the Payra River at Taltali. It has no environmental impact assessment or clearance. In September 2020, the National River Conservation Commission called for the BEC plant to be cancelled due to illegal riverbank development. The plant likely poses serious and unassessed risks from increased shipping, dredging, coal storage, wastewater disposal, ash dumping, and toxic smokestack emissions.

Conclusion

I conclude that the coal fired power plants at Rampal, Payra and Taltali will pose unacceptable risks of toxic contamination of the water, air, fish, wildlife and human communities of the Sundarbans and Bay of Bengal.

Pest Management and Food Safety: A Perspective for Bangladesh and Developing Countries

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Global human population is increasing, so is the demand for food production. Pest management is a vital part of food production and long-term storage and distribution system. Agriculture without pest is completely unrealistic. Insects, diseases, and weeds are the three major components of pest management in every part of the world. If not control adequately, these pests can cause heavy economic losses to the agricultural production, disruption of food security, and human well-being. Pests are controlled largely by either chemical or non-chemical methods. Since the mid-1900s, synthetic chemical-based pest management became popular because of its easy-to-use and quick effective control. As a result, over the past several decades the amount of pesticide uses per unit crop-land has increased many folds. Bangladesh is not out of this global phenomenon. In recent years pesticide and other chemical use in food production has become a much-discussed subject in Bangladesh. Pesticide application did reduce crop losses to many extents, at the same time it has brought adverse consequences to food safety, human heath, water contamination, and other environmental concerns, largely due to indiscriminate and unregulated use. It is hard finding the exact data on the number of direct causalities from pesticide related contamination in food products. However, over the past several decades some of the serious illness such as diarrhea, neurological disorder, and kidney malfunction are in increasing trends. Unlabeled use, exceeding labeled rate, and not maintaining post-harvest period are reported as the main sources of pesticide residue contamination in fresh food products in Bangladesh (Nur et al., 2015; Lozowicka et. al., 2015; Chowdhuri et. al., 2014; Hossain et. al., 2013; and Ali et. al., 2012). In 2018, a government institution (BARC) research found 62.5% vegetable samples collected from kitchen market had pesticide residue exceeded human tolerance level. Policy makers are often reluctant to address these issues because of growing food demand and pressure from the profit-hungry groups. To mitigate the adverse impacts of pesticide use, many strategies have been developed and enacted by the policy makers mostly because of continuous pressure from the NGO's and non-profit pro-environmental organizations. However, there is no scope for complacency, the strategic policy should be regularly updated based on evolving research data and scientific information. In this presentation, we will discuss trends in pesticide use in Bangladesh compared to the global trend. We will focus the key mitigation strategies that are followed by the developed countries and will discuss the scope and feasibility of adopting some of the strategies in Bangladesh e.g., development of training tools, digital tracking of pesticide distribution, sales, and use. In recent years, digital information sharing technologies have been extended to the rural level in Bangladesh, the country has a robust agriculture-related research and extension department with staff at rural level. Agricultural production in Bangladesh also shifted from subsistence type to the business model with an export portfolio. More and more well-educated young people are joining the agriculture-related business ranging from direct production to the processing industries and export markets. These infrastructures and changing business dynamics can be efficiently accommodated in developing a science-based strategy to ensure judicious and precise Integrated Pest Management (IPM) program, hence reducing the adverse impacts of pesticide use as well as moving forward to the global agricultural commodity export market.

OBD-041

হাওরাঞ্চলে চলমান ভৌত অবকাঠামোগত উন্নয়ন এবং পরিবেশ সুরক্ষা

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বাংলাদেশের উত্তর-পূর্বাঞ্চলের ৭টি জেলার প্রায় ২০,০০০ বর্গ কিলোমিটার অঞ্চল জুড়ে ২৭৩টি হাওরের অবস্থান, যেখানে দেশের মোট জনসংখ্যার ১২% এই অঞ্চলে বাস করে। হাওর অঞ্চলে দেশের ১৬% ফসল উৎপাদন হয়। অনন্য সাধারণ জীব-বৈচিত্র এবং বৈশিষ্টসম্পন্ন হাওর অঞ্চল সুন্দরবন বাদাবনের পরেই একটি ভূপ্রাকৃতিক লীলাভূমি যেখানে পরিযায়ী পাখীসহ অসংখ্য উদ্ভিদ এবং প্রাণীকুলের আবাস। বর্ষাকালে সমস্ত হাওর একীভূত হয়ে একটি মিঠাপানির "সাগরে" পরিণত হয় এই অঞ্চল। একীভুত মিঠাপানির অবাধ প্রবাহের কারণেই হাওর অঞ্চলে মাছ এবং অন্যান্য জীবকূলের একটি অনন্য বাস্তুতন্ত্রের সৃষ্টি হয়েছে। হাওরের প্রধান সমস্যাসমূহের মধ্যে অকাল বন্যা, নদী ভাঙ্গন, নদীবক্ষ এবং ফসলি জমিতে উজান থেকে ধেয়ে আসা পলিভরণ, অপরিকল্পিত বাঁধ এবং রাস্তাঘাট নির্মাণের ফলে সৃষ্ট জলাবদ্ধতা, শুকনো মৌসুমে নদীসমূহের নাব্যতা হ্রাস, ভূগর্ভস্থ পানিস্তরের অবনমন, জাতীয় হারের তুলনায় শিক্ষার নিম্ন হার, বেকারত্ব, পানীয় জলের অভাব এবং স্বাস্থ্যসম্মত পয়োনিষ্কাশন ব্যবস্থার অপ্রতুলতা অন্যতম। হাওরের মানুষের জীবনযাত্রার মান উন্নয়ন যেমন জরুরী তেমনি জরুরী হচ্ছে হাওরের বৈশিষ্ট্য বজায় রাখা, কারণ এই ধরণের একটি অনন্য বৈশিষ্ট্যসম্বৃদ্ধ ~~একটি~~ বাস্তুতন্ত্র এবং প্রতিবেশ সৃষ্টি করা সম্ভব হবেনা। হাওরের সার্বিক উন্নয়নের জন্য যোগাযোযোগ ব্যবস্থার উন্নয়ন অবশ্যই জরুরী, কিন্তু সেই যোগাযোগ উন্নয়নের লক্ষ্যে নির্মিত রাস্তা, সড়ক, বাঁধ, এবং বেড়িবাঁধ নির্মাণের পূর্বে হাওরের জীববৈচিত্র এবং প্রাকৃতিক পরিবেশের উপর প্রস্তাবিত ভৌত অবকাঠামোর সম্ভাব্য অভিঘাত অবশ্যই বিবেচনায় নেওয়া জরুরী। সাম্প্রতিককালে হাওরের বুক চিরে অস্টগ্রাম-মিঠামইন-ইটনা উপজেলা সদরকে সংযুক্ত করে ২৯.৪ কিঃমি দীর্ঘ একটি মহাসড়কের কাজ সম্পন্ন করা হয়েছে। এই সড়কটি নির্মাণের ফলে সৃষ্ট সম্ভাব্য পরিবেশগত অভিঘাত সরেজমিনে তদন্ত করার লক্ষ্যে এই প্রবন্ধের গবেষকগণ ৩-৫ ফেব্রুয়ারী, ২০২০ তারিখে তিনদিনব্যাপী মাঠ ভ্রমণের মাধ্যমে তথ্য-উপাত্ত সংগ্রহ করেন এবং স্থানীয় জনগণের বিভিন্ন অংশের প্রতিনিধিদের সাথে উঠান বৈঠক করেন এবং তাদের বাস্তব জীবনের অভিজ্ঞতা সংগে তাত্ত্বিক ধারণা মিলেয়ে নিয়ে সুনির্দিষ্ট সুপারিশমালা তৈরি করেন। এই প্রবন্ধে সংগৃহীত তথ্য-উপাত্ত এবং লব্ধ জ্ঞানের নিরিখে নীতিনির্ধারকদের সুবিবেচনার জন্য তৈরি সুপারিশমালা উপস্থাপন করা হবে। আমরা এই মত পোষণ করি যে, আমাদের মাঠ-ভিত্তিক পর্যবেক্ষণ এবং প্রস্তাবিত বিজ্ঞান-ভিত্তিক সুপারিশমালা হাওরের ভবিষ্যৎ ভৌত অবকাঠামো নির্মাণে স্থায়িত্বশীল উন্নয়ন লক্ষ্যমালা বাস্তবায়নে সহায়ক ভূমিকা রাখতে সক্ষম হবে।

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