



বাপা-বেন আয়োজিত

বাংলাদেশের পরিবেশ সংস্কার: প্রয়োজনীয়তা এবং করণীয়
বিষয়ক জাতীয় সম্মেলনে উপস্থাপিত প্রবন্ধসমূহের সার-সংক্ষেপ
(প্রথম লেখকের শেষ নামের আদ্যক্ষরের ক্রম অনুযায়ী সন্নিবেশিত)

Volume of Abstracts
of the Papers Presented at the National Conference on
Environmental Reforms in Bangladesh: Necessity and Task
(Arranged in the order of last name of the first author)



স্থান: কৃষিবিদ ইন্সটিটিউট বাংলাদেশ (কেআইবি), ঢাকা
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সম্পাদকমন্ডলী

মোঃ শহীদুল ইসলাম

মোঃ খালেবুজ্জামান

আহমদ কামরুজ্জামান মজুমদার

হোসাইন আজম

আয়োজনে

বাংলাদেশ পরিবেশ আন্দোলন (বাপা)

বাংলাদেশ পরিবেশ নেটওয়ার্ক (বেন)

সহ-আয়োজক

বাংলাদেশের বিভিন্ন বিশ্ববিদ্যালয়, গবেষণা প্রতিষ্ঠান, পেশাদারী সংগঠন
বেসরকারি পরিবেশবাদী সংগঠন এবং নাগরিক সংস্থাসমূহ



বাপা-বেন আয়োজিত
বাংলাদেশের পরিবেশ সংক্রান্ত সংস্কার: প্রয়োজনীয়তা এবং করণীয়
বিষয়ক জাতীয় সম্মেলনে উপস্থাপিত প্রবন্ধসমূহের সার-সংক্ষেপ
(প্রথম লেখকের শেষ নামের আদ্যক্ষরের ক্রম অনুযায়ী সন্নিবেশিত)

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তারিখ: ৯-১০ জানুয়ারি, ২০২৬

সম্পাদকমন্ডলী

মোঃ শহীদুল ইসলাম (সহ-সভাপতি, বাপা)

মোঃ খালেকুজ্জামান (সহ-সভাপতি, বেন)

আহমদ কামরুজ্জামান মজুমদার (যুগ্ম সম্পাদক, বাপা)

হোসাইন আজম (বেন)

সহযোগিতায়

আশিকুল ইসলাম এবং মো: নাছির আহমেদ পাটোয়ারী

আয়োজনে

বাংলাদেশ পরিবেশ আন্দোলন (বাপা)

বাংলাদেশ পরিবেশ নেটওয়ার্ক (বেন)

সহ-আয়োজক

বাংলাদেশের বিভিন্ন বিশ্ববিদ্যালয়, গবেষণা প্রতিষ্ঠান, পেশাদারী সংগঠন,
বেসরকারি পরিবেশবাদী সংগঠন এবং নাগরিক সংস্থাসমূহ

Abstracts

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

বাংলাদেশে পরিবেশ-সম্মত কৃষি চর্চার ব্যত্যয়সমূহ চিহ্নিতকরণ এবং তা নিরসনে বাস্তবসম্মত ও অনুসরণযোগ্য সমাধানের সুপারিশ

মোহাম্মদ জয়নুল আবেদীন ও মহিদুল হক খান

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উৎপাদন বৃদ্ধির পাশাপাশি বাংলাদেশের কৃষি পরিবেশের মারাত্মক ক্ষতি সাধন করছে এবং দেশে মূলধারার এই কৃষি চর্চা মোটেই টেকসই নয়। তথাকথিত সবুজ বিপ্লবের ফলে উচ্চফলনশীল জাত, রাসায়নিক সার ও কীটনাশকের অত্যধিক ব্যবহার মাটির উর্বরতা, পানির গুণগতমান ও জীববৈচিত্র্য নষ্ট করছে। এছাড়া এই কৃষি নিজেই মিথেন, নাইট্রাস অক্সাইড নির্গমনের মাধ্যমে জলবায়ু পরিবর্তনে ভূমিকা রাখে।

পরিবেশ-সম্মত কৃষি চর্চার প্রধান প্রতিবন্ধকতাগুলোর মধ্যে রয়েছে: রাসায়নিক সারের ওপর অতিনির্ভরতা, ক্ষতিকর কীটনাশকের অবাধ ব্যবহার, ভূগর্ভস্থ পানির অপচয়, ফসলের বৈচিত্র্যহীনতা, জৈব সারের অভাব, কৃষকের সচেতনতা ও প্রশিক্ষণের ঘাটতি, জৈব পণ্যের বাজারে অস্বচ্ছতা, জলবায়ু পরিবর্তনের বিরূপ প্রভাব এবং সরকারি নীতিতে অসামঞ্জস্যতা।

এ সমস্যা সমাধানে বেশ কিছু বাস্তবসম্মত পদক্ষেপ প্রয়োজন। কৃষিতে জলবায়ু পরিবর্তনের প্রভাব মোকাবিলায় অভিযোজন ও প্রশমন কৌশল (যেমন AWD পদ্ধতি, খরা সহিষ্ণু জাত, অ্যাগ্রোফরেস্ট্রি (কৃষির সাথে গাছপালা লাগানো) প্রচলন; ক্ষতিকর কীটনাশক নিষিদ্ধকরণ ও জৈব বালাইনাশকের ব্যবহার উৎসাহিতকরণ; জৈব সার ও প্রাকৃতিক কৃষি পদ্ধতির বিস্তার; কৃষকদের জন্য ব্যাপক প্রশিক্ষণ ও প্রদর্শনী খামার স্থাপন; রাসায়নিকের ভর্তুকি কমিয়ে জৈব চাষে প্রণোদনা দেয়া; জৈব পণ্যের নির্ভরযোগ্য সার্টিফিকেশন ব্যবস্থা গড়ে তোলা; এবং গবেষণা, গণমাধ্যম ও স্থানীয় সরকারের মাধ্যমে সামগ্রিক সচেতনতা সৃষ্টি করা।

উপসংহারে বলা যায়, বাংলাদেশের খাদ্য নিরাপত্তা ও টেকসই উন্নয়নের জন্য পরিবেশ-সম্মত কৃষি চর্চা অপরিহার্য। এ জন্য দৃঢ় রাজনৈতিক সদিচ্ছা, সমন্বিত নীতি ও সম্মিলিত সামাজিক উদ্যোগ প্রয়োজন।

মূল শব্দ: পরিবেশ-সম্মত কৃষি; সবুজ বিপ্লবের প্রভাব; টেকসই উন্নয়ন; জলবায়ু অভিযোজন; জৈব কৃষি নীতিমালা।

In Vitro Antibacterial Activity of Different Nanoparticles on Bacteria (*Pantoea Agglomerans*) of Rice Plants

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The aim of this study was to find innovative, sustainable, and eco-friendly approaches for plant disease management. This study evaluates the antibacterial activity of five different types of silver-based nanoparticles, silver nanoparticle synthesized from *Pantoea agglomerans* bacteria (Ag.P NPs), silver and zinc oxide composite nanoparticles (Ag/ZnO NPs), silver nanoparticle synthesized from betel leaf (Ag NPs), silver nanoparticle synthesized from *Xanthomonas campestris* pv. *campestris* bacteria (Ag.X NPs), and silver nanoparticle synthesized from mixed supernatant of *Pantoea agglomerans* & *Xanthomonas campestris* pv. *campestris* bacteria (Ag.A NPs) against the phytopathogenic bacterium *Pantoea agglomerans* of rice plants. The nanoparticles were tested at four different concentrations (150, 100, 50, and 25 $\mu\text{g/mL}$) using an in vitro inhibition zone assay to determine their antibacterial efficacy. Among the nanoparticles, Ag.P NPs exhibited the strongest antibacterial activity, with inhibition zones decreasing from 13 mm at 150 $\mu\text{g/mL}$ to 9 mm at 25 $\mu\text{g/mL}$. Ag NPs showed comparable activity, ranging from 12 mm to 8.5 mm. Ag/ZnO NPs and Ag.X NPs demonstrated moderate antibacterial effects, with zones ranging from 11 mm to 8 mm and 10.5 mm to 8 mm, respectively. Ag.A NPs showed the least antibacterial activity, with zones ranging from 9 mm to 7 mm as concentration decreased. The antibacterial activity of all nanoparticles was concentration-dependent, with higher concentrations producing larger inhibition zones. These findings highlight Ag.P NPs as the most potent antibacterial agent against *Pantoea agglomerans*, followed by Ag NPs, Ag/ZnO NPs, Ag.X NPs, and Ag.A NPs. The study suggests that silver-based nanoparticles, exhibit amazing antibacterial properties that will support their commercial use as bio-bactericide for controlling the pathogenic bacteria *Pantoea agglomerans* in eco-friendly sustainable agricultural fields.

Keywords: *Plant Deases; Phytogetic; Sustainable Agricultural Fields.*

Understanding the Pollutant Influx in Urban Environment: A Proxy-Based Approach

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Urban environmental degradation, particularly in rapidly growing megacities like Dhaka, has become an urgent concern due to unregulated development, pollution, and ecosystem stress. This study investigates the long-term pollution history of Dhakeshwari Temple Pond in Old Dhaka using a proxy-based sediment core analysis. A 100 cm core was extracted and analyzed for geochemical indicators (XRF), organic matter content (TOC), and diatom assemblages to assess pollution intensity and ecological change over time. Complementary land use and land cover (LULC) analyses contextualized these findings within broader urbanization trends. Results reveal four distinct zones of contamination, with the 25–50 cm segment recording peak pollution loads, as indicated by high enrichment and contamination factors for lead and zinc, and a dominance of pollution-tolerant diatom taxa. This contamination aligns with phases of intensified land conversion and the decline of ecological buffer zones. Historical land use activities—including truck workshops, plastic factories and informal settlements—combined with modern urban runoff and atmospheric deposition, have contributed to cumulative and ongoing pollution. This study underscores the utility of multi-proxy approaches for reconstructing urban pollution histories and highlights the need for integrated planning to preserve urban water bodies in Dhaka and similar cities.

Keywords: *Multi-proxy Approach; X-ray Fluorescence (XRF); Diatom Assemblages; Total Organic Carbon (TOC); Pollution History Reconstruction.*

Water Pollution and Waste Management

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Water pollution in developing countries is primarily driven by untreated or partially treated industrial effluents, untreated domestic sewage, and open dumping of solid waste. It is estimated that around 40% of water pollution originates from untreated sewage and solid waste dumping in low-lying areas, while the remaining 60% results from indiscriminate industrial discharges into surface waters. Sustainable Development Goal (SDG) Target 6.3 aims to improve water quality by reducing pollution, eliminating dumping, minimizing hazardous discharges, and halving the proportion of untreated wastewater by 2030. However, merely reducing untreated wastewater is insufficient to restore natural water quality. During the dry season, excessive wastewater discharge causes septic conditions around urban and industrial centers. Moreover, existing effluent quality standards for sewage and industrial wastewater are too lenient and require rationalization based on the assimilation capacity of receiving water bodies. Waste management is closely linked to water pollution and environmental degradation. Waste includes discarded materials no longer considered useful, while waste management covers generation, collection, transport, treatment, recycling, and final disposal. In Bangladesh, approximately 20,000 tons of municipal solid waste are generated daily by city corporations and municipalities, with an additional 10,000 tons from non-municipal urban areas. Only about 55% of this waste is collected, 20% is recycled, and 25% remains uncollected, often entering drains, rivers, wetlands, and low-lying areas, worsening pollution and drainage congestion. Limited composting facilities and land scarcity have hindered landfill development, while high-cost incineration and Clean Development Mechanism (CDM) projects have largely failed. Fecal sludge, generated from pit latrines and septic tanks, has a very high pollution potential, releasing just 5m³ of untreated sludge is equivalent to open defecation by 5,000 people. Although treatment options such as drying beds, composting, co-composting, and advanced processes exist, comprehensive and sustainable fecal sludge management remains inadequate. Plastic waste poses a growing threat, with about

977,000 tons generated annually in Bangladesh and nearly 70% mismanaged. Plastic fragmentation into microplastics contaminates water bodies and food chains. E-waste (about 3 million tons per year) and medical waste further intensify environmental and health risks due to poor segregation and disposal practices. Sustainable waste management in Bangladesh requires improved collection systems, stricter regulation, investment in recycling and composting, sanitary landfills with methane recovery, and integrated management of fecal sludge, plastic, e-waste, and medical waste to achieve long-term environmental sustainability and SDG targets.

***Keywords:** Water Pollution; Industrial Effluents; Municipal Solid Waste; E-Waste; Medical Waste; Sustainable Development Goals; Circular Economy; Environmental Sustainability.*

Integrating Trade, Logistics and Environmental Sustainability in Bangladesh and Beyond

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Global trade and logistics systems play a critical role in shaping environmental outcomes. While trade liberalization and global value chains have accelerated economic growth, they also intensify resource extraction, carbon emissions, and ecological stress. In Bangladesh and comparable developing economies, export-oriented industries—particularly textiles, agro-based products, and shipbuilding—depend on efficient logistics networks, yet these systems often rely on fossil fuel-intensive transport and poorly regulated port operations that heighten environmental degradation. Integrating green logistics and circular trade practices is therefore vital. This paper explores pathways to align trade competitiveness with environmental sustainability through cleaner transport corridors, digital port management, renewable energy-based logistics hubs, and eco-certification for export industries. Drawing on global examples from East Asia and emerging green port initiatives in South and Southeast Asia, it argues

for national policies that incentivize low-carbon logistics, strengthen environmental compliance in trade facilitation, and build regional cooperation under frameworks like BIMSTEC and the Blue Economy strategy. Sustainable trade is not only an environmental imperative but also a competitiveness agenda for the 21st century.

Keywords: Sustainable Trade; Green Logistics; Environmental Reforms; Export Industries; Blue Economy.

Assessing and Predicting the Impact of Urban Development on Riverbank Change of Balu River Using Remote Sensing and CA–Markov Modeling

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The research investigates long-term riverbank dynamics and morphological changes of Balu River in relation to expanding urban development from 1990 to 2025, with a future projection for 2035. Using multi-temporal Landsat imagery, the waterbody was delineated through the Modified Normalized Difference Water Index (MNDWI) to capture spatial and temporal variations in river width, Bankline shifting, channel contraction or expansion, and overall morphological transformation. Concurrently, urban development patterns were quantified using the Normalized Difference Built-up Index (NDBI) within the Google Earth Engine (GEE) cloud-computing platform, enabling efficient processing and analysis of long-term urban growth trends adjacent to the river corridor. The integrated analysis reveals a strong spatial correlation between accelerated urban expansion and intensified riverbank instability, including increased bank erosion, channel narrowing in heavily built-up zones, and localized river course modification due to land reclamation and infrastructure encroachment. To assess future dynamics, the Cellular Automata–Markov (CA–Markov) model was applied in the TerrSet software to simulate riverbank and urban land-use transitions for the year 2035 based on historical change probabilities and spatial neighborhood rules. The predictive results indicate continued urban encroachment toward the riverbanks, potentially amplifying morphological stress,

reducing active channel space, and increasing flood and erosion risks if current development trends persist. This study demonstrates the effectiveness of integrating spectral indices, cloud-based remote sensing analysis, and spatially explicit predictive modeling to evaluate human–river interactions over time. The findings provide critical insights for urban planners, river engineers, and environmental managers, highlighting the need for river-sensitive urban development policies and sustainable river corridor management to mitigate future geomorphological and ecological risks.

Keywords: *Riverbank Dynamics; NDVI; Morphological Stress; Bankline Shift.*

Microplastic Variability Due to Tide

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The Karnaphuli River flows through the southern part of Chattogram city, Bangladesh and eventually leads to the southeastern part of Bay of Bengal. Due to its unique position and surface runoff from municipal areas it is very prone to microplastics (MPs) contamination. This study aims to evaluate the MPs contamination of Karnaphuli River's water and sediment (4 sites) within a tidal cycle. MPs are isolated from water and sediment samples through oxidative digestion, density separation, and filtration. The polymers of the isolated MPs were identified using Fourier Transform Infrared Spectroscopy (FTIR). The average concentration of MPs in surface water is 15 ± 2.49 , 25 ± 3.07 , 29.15 ± 4.16 and 30 ± 3 items/L at stations S1, S2, S3, and S4 respectively during low tide, whereas 12.15 ± 1.97 , 20 ± 3.02 , 24.5 ± 6.08 and 25 ± 3.19 items/L at stations S1, S2, S3, and S4 respectively during high tide. In addition, the average concentration of MPs in sediment (dry weight) are 1965 ± 151.09 , 3251 ± 144.57 , 4221 ± 161.82 and 5205 ± 187.33 items/kg at stations S1, S2, S3, and S4 respectively during low tide; while, 1830 ± 108.22 , 2125 ± 160.88 , 3590 ± 189.295 and 5145 ± 213.19 items/kg at stations S1, S2, S3, and S4 respectively during high tide. There is a very close relationship in MPs distribution between the different tidal periods. A

significant difference ($p < 0.05$) has been found in the concentration of MPs in surface water and sediment of the Karnaphuli River within the stations during different tidal periods. Small sized ($< 1\text{mm}$; $< 1\text{mm}^2$) MPs are found throughout the whole study where fibers are the most dominant microplastic particle. Different color types of MPs are observed in this study in which white is the dominant color. FTIR analysis, polyamide (PA) or nylon is found as the most dominant polymer in both surface water (35%) and sediment (37%) of the Karnaphuli River. In addition, the Bay of Bengal (BOB) receives almost 2761×10^9 items microplastic particles per day through the water discharge of the Karnaphuli River. MPs load are increasing day by day at an alarming rate in the BOB which can adversely affect its aquatic ecosystem as well as its organisms.

Keywords: *Karnaphuli River, water, sediment, tidal cycle, microplastics, FTIR.*

Time Series-Based Electricity Demand Forecasting for Efficient Energy Management

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Bangladesh's power sector is currently facing persistent challenges which include overcapacity, rising capacity payments, reliance on imported electricity, and minimal integration of renewable energy. These issues are largely driven because of inaccurate electricity demand forecasting, leading to excessive establishment of fossil-fuel-based power plants that remain underutilized. Nearly 30% of installed generation capacity is currently idle, while the renewable energy penetration remains below 1%, far from the 10% target, set by the national policy. Therefore, explicit real-time forecasting becomes crucial for coherent energy management and sustainable planning. This research proposes a time-series based approach to forecast electricity consumption in Bangladesh, employing historical data along with exogenous factors embracing temperature, humidity, seasonal indicators and day variations (weekday/weekend/ holiday). Machine Learning Models including deep learning models such as LSTM, Bi-LSTM, GRU and Bi-GRU are developed and evaluated

for both short and long-term prediction accuracy. Eventually, Feature engineering and data preprocessing are gonna be applied for missing values, seasonal effects, and trend patterns, ensuring robust and reliable predictions. The outputs exhibit that time series models significantly outstrip traditional linear forecasting methods, capturing complex patterns with temporal dependencies and seasonal variations in electricity consumption. Accurate demand predictions allow policymakers and utility operators to enhance generation scheduling, lessen unused capacity and shorten financial losses of capacity charges. Additionally, precise load forecasting facilitates the integration of renewable energy sources including solar, wind, water and other sources by providing optimized planning for variable outputs and grid stability. By linking predictive modeling with policy and planning, this research enlightens the contribution of time series analytics in pointing out methodical inefficiencies in the energy industry. In addition, it implies that data-driven forecasting can boost operational decisions, reduce reliance on imported electricity, and create a foundation for more sustainable, environmentally friendly energy management. Ultimately, merging time series-based demand prediction into national energy planning can support the stability between supply and demand, reduce overcapacity and abet the transition to a renewable-focused power system.

***Keywords:** Electricity Demand Forecasting; Capacity Payments; Renewable Energy Penetration; Energy Management.*

Influence of Irrigation Pump Type on Heavy Metal Contamination in Rice and Health Risks in Southwestern Bangladesh

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Heavy metals from both natural and anthropogenic sources accumulate in soils and crop plants, contributing to serious environmental contamination and food safety concerns. In Bangladesh, where rice

provides nearly 90% of daily caloric intake for the majority of the population, long-term consumption of rice contaminated with heavy metal(loid)s poses substantial public health risks. This study assessed heavy metal contamination in rice grown in the southwestern region of Bangladesh and evaluated the associated human health risks. A total of 30 rice samples were collected from waterlogged areas of Monirampur Upazila in the Jashore District, sourced from fields irrigated either by electric pumps or diesel pumps. Heavy metals (Fe, Zn, Mn, Cu, Pb, Cd, and Cr) were extracted using di-acid digestion and quantified using atomic absorption spectrophotometry (AAS). Health risk assessments were performed based on established international guidelines. Results showed that rice from diesel pump-irrigated fields contained higher trace metal concentrations than rice from electric pump-irrigated fields. Average concentrations of Fe, Zn, Mn, Cu, Pb, Cd, and Cr were 0.28, 0.04, 1.68, 0.23, 0.22, 0.25, and 0.28 mg kg⁻¹, respectively, with most samples exceeding USEPA/WHO acceptable limits. Hazard Index (HI) values for both males and females exceeded the safe threshold (HI > 1), indicating significant non-carcinogenic risk, with females showing slightly lower HI values due to lower consumption rates and body weight. Incremental Lifetime Cancer Risk (ILCR) and cumulative cancer risk (Σ ILCR) assessments revealed that 63% of samples posed carcinogenic risks, with 42.10% of electric pump-irrigated and 100% of diesel pump-irrigated rice samples falling within the risk range. Overall, the findings indicate that rice consumption in the studied region poses both carcinogenic and non-carcinogenic health risks. Adoption of cleaner irrigation practices, including increased use of electric pumps, use of clean petroleum fuels for diesel pumps, and regular monitoring of heavy metal pollution, is essential to safeguard public health.

Keywords: *Heavy Metals; Crop Plants, Atomic Absorption Spectrophotometry (AAS); Non-Carcinogenic Risk.*

Fishing Through Poisoning in the Sundarbans: A Great Threat to the Diversity and Sustainability of Aquatic Ecosystems

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Aquatic resources. As a protection barrier, the Sundarbans safeguards this country from devastating calamities. Fishing through poisoning in Sundarbans is increasingly become very common among fishermen which is a serious threat to this mighty protector and overall aquatic ecosystem. Local fishermen intentionally or forcefully by their mahajon use different types of poisons to capture more fish or shrimp within a short period. They mainly select pesticides or herbicides as a poison with a target to catch white fish or shrimp, or both. During the direct application of poison in the water or the use of poison with bait, oxygen deficiency happens, and almost all the lives, including fish, shrimp, crabs, etc., start to float to the water surface and consequently die. Fishermen then collect the fish and sell them to the market. Not only fish or aquatic lives living in the water dies or are affected, but also birds or other wild animals are also adversely affected by the poisons. It has been observed that the area where the poison has already been used becomes void of any kind of living organisms for more than one week. The dangerous effect of the poison is also found in the soil. Above all, the whole biodiversity becomes at a stake. Intake of fish or shrimp captured by poisoning cause liver damage, kidney damage, other deformities and cancer in humans due to the presence of carcinogenic components in the poisons. There are some notable reasons for this illegal poison fishing, such as: lack of effective rules and their proper application, lack of collaboration between the forest and fisheries ministry, strong prevalence of syndicates, corruption of officials, improper management of the banned period or area of Sundarbans. To protect the Sundarbans, it is crying need to stop this devastating method of fishing. It's our duty to save the ecosystem which safeguards this delta country from any strong calamities. With a hope to control this poison fishing, some amendments in the policy are badly needed and some practices should be commenced or followed such as: sensor-based fishery management during banned period with proper support to the local fishermen, control in herbicide

or pesticide or other agrochemicals' marketing, and awareness raising about the acute and chronic effect of poisons they are using for fishing and instant profit.

Keywords: *Aquatic Ecosystem; Illegal Fishing; Biodiversity; Food Safety; Carcinogenic Components; Agrochemicals Marketing.*

Dhaka-Centric Urbanization and Policy Gaps: The Need for EIA-Driven Planning Reforms in Bangladesh

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Recent population growth, infrastructure expansion, and economic activities in Dhaka have driven an unsustainable pattern of urbanization in Bangladesh, exacerbated by regional imbalances and policy gaps. Although multiple national policies and frameworks exist—such as the Environmental Conservation Rules (ECR 2023), Detailed Area Plan (DAP 2022), National Water Policies (1999), Bangladesh Water Act (2013), Air Pollution Rules (2022), National Housing Policy (2016), and RAJUK building codes—weak enforcement, institutional fragmentation, and limited environmental monitoring have led to unplanned construction, traffic congestion, and loss of green and blue spaces. These trends increase vulnerability to disasters including waterlogging, urban flooding, earthquake risk, and pollution. Policy breakdown, inadequate fire safety compliance, and insufficient Environmental Impact Assessment (EIA) practices in urban development further undermine DAP, building codes, and housing policies, creating long-term uncertainties. The study used a mixed-methods approach, combining GIS-based land-use analysis, Key Informant Interviews, policy document reviews, and literature review. RAJUK's dual role as regulator and developer introduces conflicts of interest, while coordination gaps among RAJUK, the Department of Environment, Dhaka Transport Coordination Authority, and city corporations delay effective action. Public

participation in decision-making remains minimal, and EIA and Environmental Management Plans (EMP) are rarely integrated into development projects. Strategic Environmental Assessment (SEA) and Cumulative Environmental Impact Assessment (CEIA) are largely absent from higher-level planning, leaving long-term impacts on ecosystem services unaddressed. For instance, the JICA-funded metro rail project has faced criticism for insufficient EMP adherence and the loss of significant green and blue spaces. The study emphasizes the urgent need for policy reforms that prioritize inclusive, environmentally and socially sensitive urban development. Recommendations include effective land-use planning, mandatory EIA and EMP preparation, GIS-based monitoring, transparent public participation, and strict enforcement of construction legislation. An integrated institutional reform agenda is proposed to incorporate SEA, CEIA, EIA, and EMP frameworks and promote coordinated urban governance in Dhaka.

Keywords: *Environmental Impact Assessment; Strategic Impact Assessment; Cumulative Impact Assessment; Policy Reform; Land use Policy.*

Ecotoxicity of Alpha-cypermethrin, Chlorpyrifos, and Imidacloprid to Non-Target Freshwater Crustaceans: Implications for Rice-Field Biodiversity

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The increasing use of pesticides is causing harmful impacts on non-target aquatic species worldwide. This study evaluated the acute toxicity of three commonly used insecticides viz. alpha-cypermethrin (Pyrethroid insecticide, Ustaad 10EC), chlorpyrifos (Organophosphate insecticide, Dursban 20EC), and imidacloprid (Neonicotinoids, Confidor 70WG) on two locally abundant crustaceans, the freshwater prawn *Macrobrachium lamarrei* and

the freshwater crab *Sartoriana trilobata*. Aquaria-based bioassays were conducted at the Department of Agricultural Chemistry, Bangladesh Agricultural University, to determine mortality patterns and behavioral alterations under individual and combined insecticide exposures. For freshwater prawn, acute toxicity tests were done with individual insecticides at concentrations of 0.00, 0.10, 0.25, 0.50 and 1.00 mg L⁻¹ for 15 min to 24h. For freshwater crab, acute toxicity tests were done with individual insecticides at concentrations of 0.00, 2.50, 5.00, 10.00, 15.00 and 20.00 mg L⁻¹ for 15 min to 24h. Ecotoxicological assessment were done after either individual or combined dose insecticide exposure. For *M. lamarrei*, the alpha cypermethrin 15min-LC50, 30min-LC50, 45min-LC50, 1h-LC50, and 2h-LC50 were calculated as 0.448, 0.233, 0.114, 0.069, and 0.015 mg cypermethrin L⁻¹, respectively; the chlorpyrifos 45min-LC50, 1h-LC50, and 2h-LC50 as 0.599, 0.461, and 0.015 mg chlorpyrifos L⁻¹, respectively; and the imidacloprid 2h-LC50, 3h-LC50, and 24h-LC50 were calculated as 5.651, 1.314, and 0.364 mg imidacloprid L⁻¹, respectively. For *S. trilobata*, alpha-cypermethrin 2h-LC50 and 3h-LC50 were determined as 11.736 mg of L⁻¹ and 2.469 mg alpha-cypermethrin L⁻¹ respectively; the chlorpyrifos 1h-LC50, and 2h-LC50 were calculated as 15.650, and 4.138 mg chlorpyrifos L⁻¹, respectively; the imidacloprid 2h-LC50 and 3h-LC50 were determined to be 16.120 mg and 8.334 mg imidacloprid L⁻¹, respectively. Kaplan–Meier survival analysis revealed that for *M. lamarrei*, toxicity followed the order alpha-cypermethrin > chlorpyrifos > imidacloprid for individual exposure and CYP+CRF+IMI > CYP+CRF > CYP+IMI > CRF+IMI for combined exposures. For *S. trilobata*, the toxicity ranking was chlorpyrifos > alpha-cypermethrin > imidacloprid, with combined doses showing dose-dependent mortality. Overall, imidacloprid exhibited lower toxicity to both crustaceans, likely due to its shorter half-life in aqueous environments resulting from photolysis. These findings demonstrate that risk assessments based solely on single-pesticide tests may underestimate the ecological threats posed by pesticide mixtures commonly found in agricultural ecosystems, highlighting the need for considering combined exposures when evaluating pesticide impacts on aquatic biodiversity.

Keywords: *Pesticides; Acute Toxicity; Non-Target Aquatic Species; Crustaceans; Alpha-Cypermethrin; Chlorpyrifos; Imidacloprid, Bioassays; Combined Exposures.*

Prioritization of Environmental Issues in Industrial Management: Evidence from Green Textile Limited

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The Readymade Garments industries are the leading driver of Bangladesh's economic advancement as it generates more than 83% of Bangladesh's export income establishing it as a fundamental economic pillar for the nation. Industrial expansion creates plenty of employment opportunities and earns huge foreign exchange yearly. Robust expansion of industries in Bangladesh has been created multifaceted problems in terms of environmental issues, leading to ecological imbalance and massive environmental pollution through extensive water and chemical usage, releasing dangerous waste into rivers, creating health hazards, fossil fuel-based energy systems producing greenhouse gas and so on. The RMG sector requires the establishment of green industry through the implementation of eco-friendly practices in production processes and waste management and energy consumption. But the contribution towards achieving eco-friendly practices from both governmental and stakeholders' perspective and work on addressing and developing dynamic environmental management plans are limited. The main aim of this research is to thoroughly evaluate and find out the present condition of Prioritizing Environmental Issues in Industrial Management, to what extent industries are following government policies and regulations. The data of this qualitative research were gathered from observation and unstructured interviews and described in a narrative way. The result of this study highlighted that encourage sustainable production facilities, technologies and environmentally friendly production practice, eco-friendly infrastructure, renewable energy usage, wastewater treatment, and resource efficiency as the key aspects of prioritizing environmental issues where in practice ignorance in monitoring and enforcement of existing policies by both governmental and organizational management are identified. The findings suggest that local environmental authorities should use digital monitoring and enforcement systems, and organizational top management should ensure eco-friendly production facilities on the basis of Corporate Social Responsibility (CSR).

Keywords: *Readymade Garments, Sustainable, Wastewater, Efficiency.*

Assessment of Efficiency of Effluent Treatment Plant: A Case Study

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The washing of industrial denim produces large quantities of chemically contaminated wastewater that is a major threat to water bodies and human health when released into the environment without any treatment. The effluent treatment plants (ETPs) are thus necessary in the reduction of the load of pollutants before they are released into the environment. This study compared the efficiency of the ETP at Danim Wash in terms of the treatment of major physico-chemical parameters (pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), nitrate, and phosphate) at two inlets (K.C Inlet and Windy Inlet) and the final treated outlet. The samples were taken from the inlet and outlet points and subjected to the common laboratory tests. The findings showed that the two inlets were over contaminated with high pH (9.57-10.10), COD (407-536 mg/L), BOD (135-136 mg/L), and had zero DO, which is a sign of severely polluted wastewater. The ETP tremendously improved in several important parameters after the treatment and reached COD (10 mg/L), BOD (9 mg/L), nitrate (1.0 mg/L), phosphate (0.08 mg/L) and pH was adjusted to acceptable levels (8.05). However, there were problems with it particularly, high TDS (965 ppm) and bad DO (3.8 mg/L) that showed that the dissolved solids were not completely eliminated and that there was insufficient oxygenation. The ETP, in general, exhibits an excellent degree of organic load and nutrient extraction, but it has to be enhanced in terms of functioning to attain greater TSS and aeration rates, and the quality of the final effluents. Improved monitoring and treatment would assist in improving environmental compliance and a sustainable management of the wastewater in the textile washing industry.

Keywords: *Effluent Treatment Plant; Wastewater; Pollution; Water quality; Textile industry; Environmental Management.*

Institutional Reformation of the Energy and Power Sector in Bangladesh

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The power sector in Bangladesh has also been experiencing structural problems that go beyond long-term overcapacity (almost 30 percent of power generation capacity is not used) and an adherence to fossil fuels (43-49 percent gas and 27 percent coal) to long-term reliance on energy imports and a very slow pace of renewable development (less than 5% compared to the 10% target set for 2020). These problems have been reinforced by the Power System Master Plans of 2008 and 2016, it prioritized coal despite repeated warnings from civil society groups such as BAPA and BEN. Frequent changes in energy policy, including the new 2025 Renewable Energy Policy that sets a 20% renewable target while many renewable project approvals remain suspended and some coal projects are revived, all these have weakened investor confidence. Meanwhile, institutional flaws, including the monopoly of the BPDB (as a single buyer), over 10 percent losses in the system, and the non-transparency of procurement, have added up to massive financial costs Tk 1,267 billion in subsidies.

This paper claims that institutional reform offers a more realistic and effective path for improving the power sector than frequent policy revisions alone. The study focuses on reforms initiated under the post-2024 interim government, including the repeal of the Quick Enhancement of Electricity and Energy Supply Act 2010, restoring BERC's authority over tariff decisions, strengthening SREDA as the lead renewable energy agency, and introducing the Merchant Power Policy that allows private producers to sell electricity directly to consumers. Through comparative analysis, the paper demonstrates that even new policies fail in the implementation phase, e.g., failure to entice foreign bidders to 5,000 MW of recent renewable tenders, stronger institutions can tackle underlying problems like inaccurate demand forecasting and vested interest networks. This paper highlights recovery and

transition strategies such as better SREDA–BERC coordination for competitive renewable auctions, renegotiation of expensive contracts, grid modernization, and scaling up renewables to an optimized 35 GW by 2030 to meet growing demand, which is projected to reach 25,830 MW. The results underscore the need to include institutional changes to construct a financially stable and sustainable power industry that would be compliant with the NDC-3 commitments and the Bangladesh Delta Plan.

Keywords: Merchant Power Policy; Renewable Energy; Sustainable Power Industry.

Environmental Xenobiotics and Carcinogenesis in a Changing World

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Cancers are rising around the world. The trend is especially concerning among young people, with a significant ~79% increase in cases among those under 50 between 1990 and 2019. Predicted contributing factors for this disturbing trend include obesity, lack of physical activities, processed foods, and environmental exposure. While food and other lifestyle factors are frequently discussed, the contribution of our environment is relatively less emphasized. However, environmental changes and contamination are playing pivotal roles in many physiological anomalies. The food chain, water, and air are now contaminated with xenobiotics. Pesticides, antibiotic residues, and other contaminants are harming our physiological processes, leading to cancers. Arsenic compounds, certain insecticides, and glyphosate are considered probable causes of lymphoma. Organochlorines, phenoxy herbicides, and organophosphates have been linked to specific cancers. These chemicals are now coming to the environment from large scale industrialised agricultural practice. Antibiotics in the environment and foods are creating microbial dysbiosis leading to increased risk of cancers. Heavy metals used in tannery and garment industries are

also known cancer-causing risks. Rising temperatures of the planet and changes in seasonal patterns all contribute to the disruption of our ecological parameters, leading to carcinogenesis. The picture is so complex that it is now difficult to untangle all these elements from each other, as they have been part of the system for a long time. It is imperative that any occupational exposure to known factors should be strictly limited so that cancer can be curbed. Strengthening environmental safety regulations is essential to mitigate long-term public health risks arising from the growing burden of cancers.

Keywords: Cancer; Environmental Exposure; Arsenic; Heavy Metal; Health Risk.

From Soil to Plate: Institutional Capacity and Enforcement Challenges in Food Safety Governance in Bangladesh

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Agricultural soil contamination has emerged as a critical environmental and food safety challenge in Bangladesh, largely driven by the excessive and often unregulated use of chemical fertilizers, pesticides, and polluted irrigation water. Toxic substances, including heavy metals and chemical residues, are transferred from soil to crops and ultimately to consumers, posing severe risks to public health and ecological sustainability. Although Bangladesh has

established various food safety policies, standards, and regulatory frameworks, their effectiveness remains limited in practice. This study argues that the persistence of food contamination is not due to policy absence, but rather to weak institutional capacity for monitoring and enforcement across the agricultural and food supply chain. Fragmented institutional responsibilities, inadequate laboratory and technical infrastructure, insufficient field-level inspections, and poor coordination among regulatory agencies significantly hinder effective governance. Using a qualitative review of policy documents, institutional arrangements, and secondary literature, this paper examines the roles and capacities of key agencies involved in monitoring agricultural inputs, soil quality, and food safety. The analysis identifies critical gaps in enforcement mechanisms along the soil-to-plate pathway. The findings highlight the urgent need for institutional strengthening through clearer mandates, enhanced inter-agency collaboration, improved monitoring systems, and robust enforcement mechanisms. By emphasizing institutional reform over policy formulation alone, this study contributes to environmental governance debates and offers practical pathways toward safer food systems and sustainable agriculture in Bangladesh.

***Keywords:** Food Safety Governance; Soil Contamination; Institutional Capacity.*

Assessment of Gaps and Deficiencies in Bangladesh's Solid Waste Management System

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Solid waste management (SWM) in Bangladesh faces escalating challenges due to rapid urbanization, population growth, and limited infrastructure. Despite policy reforms since the 1980s, the current system remains largely reliant on open dumping, informal collection, and minimal recycling. This results in significant environmental and public health risks. Bangladesh lags significantly behind in terms

of SWM than most of the developing countries. Bangladesh fails at basic waste segregation, resource recovery, and using modern technology. A critical gap persists between policy formulation and implementation. Continuing deficiencies in coordination, funding, technical expertise, and community engagement have been highlighted in the previous studies. Most policies are with limited stakeholder participation, and often fail to address the specific needs of both urban and rural areas. This review aims to systematically assess the current SWM system in Bangladesh, identify policy and operational gaps, and compare alternative approaches from other countries. This involves a comprehensive literature review, policy analysis, and synthesis of qualitative and quantitative data from recent studies, government reports, and international case comparisons. Recent researches found limited progress on the SWM sector with most of the initiatives remaining significantly underdeveloped. Informal recycling sectors play a significant role but lack regulatory support. Bangladesh lacks the key features of successful global waste management models. These successful models rely on integrated approaches, advanced technologies, and strong public-private partnerships. Bangladesh's SWM framework suffers from fragmented responsibilities, weak enforcement, and outdated regulations. There is a pressing need for updated, context specific policies that promote stakeholder collaboration, technological innovation, and community participation. Bridging the gap between policy and practice is essential for sustainable SWM in Bangladesh. Strengthening stakeholder coordination, investing in modern waste treatment technologies, enhancing public awareness, and adopting international best practices tailored to local contexts are vital to transform Bangladesh's SWM system into an environmentally sound and economically viable model.

Keywords: *Solid Waste Management; Policy Gaps; Framework; Stakeholders; Public Health Risk.*

Spatio-Temporal Assessment of Above-Ground Biomass Changes in Relation to Vegetation Cover in Sharsha Upazila, Jashore

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This paper evaluates the spatiotemporal variation of above-ground biomass (AGB) and vegetation cover in Sharsha Upazila which falls within the Jashore-Benapole corridor of southwestern Bangladesh and between 2017 and 2023. The study measured land use and land cover (LULC) transitions and their impact on AGB dynamics using GIS based analysis and Sentinel-2 satellite images. The estimation of AGB with the help of NDVI-based vegetation productivity and related climatic variables including Photosynthetically Active Radiation (PAR) and air temperature was conducted using a Light Use Efficiency (LUE) model. The findings showed that there was a great amount of land change during the six years which was mainly caused by high urbanization and development of infrastructures. Settlement areas have been increasing by about 100.7 and tree-covered land has been decreasing by 61.55 resulting in a decrease of AGB by 30.56 per cent- in 2017 2.5 Mg/ha to 2023. These alterations mean a significant depletion of the carbon storage capacity and ecological robustness. The results indicate that sustainable land management, reforestation and policy intervention are necessary to revive the ecosystem productivity and strike the right balance between development and environmental conservation. The paper can serve as a useful baseline information on carbon tracking, ecological planning, and realization of the Sustainable Development Goals (SDG 13 and SDG 15) in Bangladesh.

Keywords: Above-Ground Biomass (AGB); Vegetation Cover; Land Use Land Cover (LULC); Carbon Sequestration.

Evaluation of the Elements of the Sanitation Service Chain with a Focus on Gender Issues in Slums of Dhaka City

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Sanitation services are a vital part of public health, yet large parts of the sanitation service chain (SSC) remain neglected. The SSC includes the entire process of human waste management, from containment and emptying to transportation, treatment, and reuse. This study focuses on two key aspects: access to toilets and the emptying and disposal process. It also highlights gaps in the citywide inclusive sanitation (CWIS) system, especially a limited understanding of the SSC, gender inequities, and the economic challenges faced by low-income communities. The aim is to assess the current sanitation situation in Dhaka, with particular attention to gender-specific issues. This research examines the intricate relationship between gender and sanitation in three slum areas: Molla Basti (specifically in Illias Molla, Sattar Molla, and Wabda), Duaripara, and Jamidarbari. A mixed-method approach is used, combining both quantitative and qualitative surveys, with a strong focus on data analysis and statistical testing. During data analysis, survey variables were tested using chi-square tests, supported by Phi, Cramér's V, and residual analyses. A Bonferroni correction was applied to reduce the likelihood of false positives in post-hoc testing. Results show that toilets built by NGOs outperform locally constructed toilets in nearly every aspect. They provide more reliable water sources, stronger structures, and better maintenance, while locally built toilets often suffer from poor design, limited resources, and frequent user issues. Households relying on local toilets are much less likely to have improved facilities and face more problems during daily use. Concerning waste containment, a large number of households either never empty their septic tanks or do not have one, indicating serious fecal sludge management risks. Gender disparities are significant. Women are often excluded from decisions about toilet installation, shoulder the main burden of daily water collection, and have much lower awareness of menstrual

hygiene. The findings emphasize the need for infrastructure improvements, gender-sensitive designs, expanded water networks, increased community engagement—especially involving women and targeted health programs to reduce sanitation-related risks.

Keywords: *Sanitation; Service Chain; Citywide Inclusive Sanitation; Gender; Low-Income Communities.*

Lead in Paint: A Hidden Threat in Bangladesh

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Lead contamination in paint remains a significant yet under-recognized public health threat in Bangladesh. Despite the adoption of a 90 parts per million (ppm) lead limit for architectural coatings by the Bangladesh Standards and Testing Institution (BSTI) in 2018, recent evidence indicates widespread non-compliance, particularly among imported and small-scale unregistered manufacturers. This study critically reviews findings from the Environmental and Social Development Organization’s (ESDO) 2025 Lead Exposure Elimination Project, which analyzed 161 household paint samples collected from Dhaka and Chattogram using Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES). The results reveal that 42.2% of the samples exceeded the BSTI limit, with some brightly colored decorative paints containing lead concentrations as high as 190,000 ppm—over 2,000 times the permissible level. Elevated lead levels were predominantly associated with pigments and additives such as lead chromates, lead molybdates, and lead oxides, commonly used in solvent-based formulations. In contrast, all major domestic paint manufacturers complied with regulatory standards, and independent laboratory testing confirmed undetectable lead levels in select lead-free products at reporting thresholds as low as 10 ppm. The study also highlights critical gaps in labeling and consumer protection, as several paints falsely claimed to be lead-free despite containing hazardous lead concentrations. These findings underscore the urgent need for

comprehensive regulation covering all paint categories, strengthened enforcement mechanisms, mandatory product testing and labeling, and sustained collaboration among government agencies, industry bodies, and civil society. Eliminating lead from all paints is essential to protecting public health particularly that of children, and to achieving a safer, lead-free environment in Bangladesh.

Keywords: Lead Exposure; Decorative Paint; Environmental Health; Heavy Metals; Children's Health; Paint Regulation.

Reviving Dhaka's Lifelines: The Cholo Khaal Bachai Campaign and the Restoration of Urban Canals

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Dhaka, once known as the “Venice of the East,” was historically sustained by an interconnected system of canals that supported trade, transportation, and flood resilience. Rapid urbanization, encroachment, and waste mismanagement have resulted in the disappearance or degradation of most of these waterways. This research explores the historical significance, decline, and contemporary restoration efforts of Dhaka's canals, with a focus on the #CholoKhaalBachai# campaign led by Berger Paints Bangladesh and Footsteps Bangladesh. Using a qualitative review of reports, studies, and project documentation, the paper analyzes the environmental, social, and climate resilience implications of canal loss and revival. The restoration of the Bottola Mazar Canal is presented as a case example demonstrating how multi-stakeholder collaboration can reduce flooding, improve health outcomes, and restore ecological functions. The study concludes with policy recommendations and a future vision for sustainable waterway management in Dhaka.

Keywords: Venice of the East; Waterways; Flood Resilience; Encroachment; Sustainable Waterway Management.

Coastal Sedimentation and Accretion Trends Along the Bangladesh Coast (2013 - 2025)

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The Bangladesh coast faces growing vulnerability from accelerated sea-level rise and associated environmental pressures including coastal degradation, salinity intrusion, and ecosystem stress. Critical questions remain about whether sediment delivery from the Ganges–Brahmaputra–Meghna (GBM) system remains sufficient to maintain land stability and buffer against these compounding threats. This study presents an updated assessment of sediment-driven land change from 2013 to 2025 using the Normalized Difference Water Index (NDWI) derived from Landsat imagery, validated with Sentinel-2 optical and Sentinel-1 radar observations. We find that the Meghna Estuary region continues to accrete new land at rates of ~ 11 km²/year, whereas the Sundarbans coast remains nominally stable with localized erosion in some sectors. MODIS turbidity data show relatively stable interannual variability with no strong directional trend in suspended sediment concentrations over the last decade. However, Sentinel-1 VV backscatter and NDVI analysis indicate that significant portions of new surfaces lack vegetation cover or structural consolidation, implying ephemeral sediment deposits rather than permanent terrain—raising concerns about their effectiveness as buffers against storm surge, salinity ingress, and coastal vulnerability. Our findings suggest that while the GBM delta remains geomorphically active with measurable sediment-driven land formation, the persistence, ecological stability, and functional resilience of these gains remain uncertain. The implications for coastal protection, agricultural salinity management, and ecosystem sustainability warrant careful consideration as climate-driven sea-level acceleration continues. Future work should harmonize long-term datasets across methods and sensors to better assess multi-decadal trends in sedimentation resilience and evaluate the delta’s capacity to mitigate environmental degradation under changing boundary conditions.

Keywords: Coastal Sedimentation; GBM Delta; Remote Sensing; Land Accretion; Coastal Vulnerability.

Modern Agriculture at a Crossroads: Environmental, Health, and Institutional Challenge

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The agricultural progress achieved through high-yielding varieties (HYVs) and requirements for external agricultural inputs. The implemented farming practices have resulted in reduced genetic crop diversity and depleted soil purchase expensive farming techniques which lead to unsustainable operations. The situation becomes worse because of malpractices which waste disposal and insufficient safety protocols has resulted in environmental contamination and health risks including pesticide exposure and antimicrobial resistance. The environmental damage from these patterns includes soil deterioration and waterbody eutrophication. The crisis worsens because of institutional failures, market instability, climate impacts, resource distribution inequalities and widespread instability in farming operations. It is necessary to develop a sustainable agricultural system which unites agricultural output with environmental defense, social health and human wellness. The implementation of agroecological intensification requires systems. The combination of new biotechnology developments with digital farming systems and climate-resistant plant breeding methods enables farmers to construct stronger food production systems. The institutional changes which include improved regulations and subsidy alignment to develop their capacity while changing their behaviors and implementing natural resource management systems that serve local communities is earnestly desired. The bottom line is this: modern agriculture should not be abandoned; rather, it is impossible to overcome the agricultural crisis without introducing a sustainable agricultural system that rises above the misuse of science, lax implementation of government policies, business malpractice, and the lack of farmers' awareness.

Keywords: *High-Yielding Varieties (Hyvs); External Agricultural Inputs; Pesticide Exposure; Antimicrobial Resistance; Agroecological Intensification.*

Post Flood Settlement and Built-up Regeneration and Surface Water Dynamics in Tanguar Haor, Sunamganj Based on MNDBI and MNDWI Analysis (2016-2024)

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The Sylhet Basin of Bangladesh contains numerous haor wetlands highly exposed to seasonal and flash flooding, with Tanguar Haor being one of the most ecologically significant as a Ramsar-designated site. Located in Sunamganj District, Tanguar Haor experiences recurrent inundation driven by intense upstream rainfall from the Meghalaya Plateau, substantially affecting surface water dynamics, settlements, and land use patterns. While previous studies have explored flood hazards and land use change in the haor region, limited attention has focused on the long-term interaction between surface water variability and settlement regeneration after repeated floods. This study examines spatiotemporal changes in surface water extent and settlement dynamics in Tanguar Haor from 2016 to 2024 using Google Earth Engine and Landsat 8 surface reflectance imagery. The Modified Normalized Difference Water Index (MNDWI) assessed changes in surface water, while the Modified Normalized Difference Built-up Index (MNDBI) detected settlement-related surface changes. Change detection was conducted for four sequential periods-2016–2018, 2018–2020, 2020–2022, and 2022–2024-representing pre-flood conditions, flood-affected years, and post-flood recovery phases. Results reveal substantial temporal variability in hydrological conditions and settlement patterns. MNDWI analysis shows notable surface water expansion during the 2020–2022 flood period, followed by contraction in 2022-2024, indicating post-flood stabilization. MNDBI change analysis indicates gradual settlement growth during non-flood periods, disruption during the extreme 2022 flood, and renewed regeneration afterward. Pixel-wise Pearson correlation demonstrates a strong, statistically significant inverse relationship between MNDBI and MNDWI

changes ($r = -0.56$ to -0.64 , $p < 0.001$), with the weakest correlation during the flood period, reflecting temporary disruption of typical land–water spatial dynamics. Overall, settlement regeneration in Tanguar Haor follows a cyclical pattern of expansion, disturbance, and recovery driven by flash flood dynamics. The study provides empirical evidence of the close spatial coupling between surface water variability and settlement change, offering valuable insights for flood-resilient settlement planning and wetland-sensitive development strategies in Bangladesh.

Keywords: Flash flood; Settlement regeneration; MNDWI; MNCBI; Google Earth Engine.

Spatiotemporal Patterns of Flash Flood and Settlement Regeneration in the Tanguar Haor Area (2020–2024): A Google Earth Engine based Study

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The Sylhet Basin of Bangladesh contains 373 haors across seven districts, with Sunamganj alone hosting 95, most of which experience deep flooding during the monsoon season (Yasmin, 2018). Floods have emerged as the most frequent and destructive natural disaster in the region, causing significant social and economic losses (Bisht et al., 2018; Saha et al., 2022). Tanguar Haor, a Ramsar site in Sunamganj, is particularly vulnerable, with over 80% of the local population directly affected by flash floods (T. Khan et al., 2020). By 2022, floods had damaged 186,703 houses, of which 157,113 were Kutchha structures, with Sunamganj and Sylhet accounting for 45% of total damage (UNDP, 2022). The primary drivers of these floods are intense upstream rains from the Meghalaya and Assam regions (Kamal et al., 2018; Saha et al., 2022). Previous studies have focused on land-use changes, livelihood impacts, and spatiotemporal flood dynamics (Abedin and Khatun, 2019; Ahmed et al., 2024; Akter et al., 2022; I. Haque, 2021; Md. I. Haque and Basak, 2017; Islam

et al., 2020; Md. S. Khan et al., 2021; R. H. Khan et al., 2024; T. Khan et al., 2020; Saha et al., 2022; Yasmin, 2018), but settlement regeneration over time remains underexplored. This study examines how recurring flash floods affect settlement reconstruction in Tanguar Haor between 2019 and 2024 using Google Earth Engine (GEE). Settlement changes will be analyzed within three buffer zones (200 m, 500 m, and 1000 m) using Landsat-8 imagery, applying MNDWI for flood detection and NDBI for settlement tracking. Shifting settlement patterns will be assessed through supervised classification in ArcGIS Pro, and Pearson correlation will evaluate the relationship between floods and regeneration. The findings aim to inform resilient policy and planning, enhancing settlement sustainability and disaster preparedness in the Haor region.

Keywords: *Flash flood; Settlement Regeneration; MNDWI; NDBI; Google Earth Engine.*

Investigating the Dune Systems of Coastal Bangladesh Using Unmanned Aerial Vehicle (UAV): A Case Study at Sonadia Island

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Dunes are distinct aeolian geomorphological features commonly found in arid and semi-arid environments, while coastal dunes in particular play a vital role in supporting rich ecological functions, providing habitat for diverse floral and faunal communities, and acting as natural barriers against disasters such as flooding and cyclones. The use of Unmanned Aerial Vehicles (UAVs) has greatly advanced the study of dune morphology by enabling the collection of aerial imagery at high spatial and temporal scales. Bangladesh, being highly prone to cyclones, places immense value on the presence of coastal dunes for coastal protection, yet research on their characteristics remains limited. In this study, UAV-based imagery was used to classify coastal dunes according to their morpho-ecological characteristics, height, and degree of human intervention. The results indicate that incipient

foredunes constitute the highest proportion (40.65%), followed by parabolic dunes (39.35%), relict foredunes (8.87%), and established foredunes (6.61%), with more than half of the dunes found to be either highly or partially degraded due to deforestation, salt farming, and agricultural expansion. In addition, statistical analyses were conducted on 22 morphological, meteorological, oceanographic, and anthropogenic factors across the different morpho-ecological classes. A one-way ANOVA test, with a significance level of $p < 0.01$, and an XGBoost model with a Jackknife test identified dune width, area, and length as key morphometric parameters, along with distance from shoreline and proximity to land-use areas, as key sensitive factors in distinguishing dune classes. These findings provide valuable insights for stakeholders, highlighting the urgent need for sustainable dune restoration strategies to conserve the ecological functioning of coastal dunes and to develop a disaster resilient coastal community in Bangladesh.

***Keywords:** Coastal Dunes; Unmanned Aerial Vehicle; Morpho-ecology; XGBoost Model; Disaster Resilience.*

Bangladesh Power and Energy Sector Reform: Necessity and Way Forward

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The power and energy sector of Bangladesh is at a critical turning point, as rising electricity demand, fiscal pressures, dependence on imported fuels, and climate commitments require deep and coordinated reforms. Reform is no longer optional; it is essential to ensure long-term energy security, affordability, and sustainability. Key institutional reforms are needed, including a comprehensive review of development works in the power generation, transmission, and distribution sector. Greater coordination rather than competition or conflict among power sector institutions is essential, along with stronger alignment with related sectors such as energy and mineral resources, transport, and industrial consumers. Power sector development must also align with national economic growth

strategies and environmental objectives. Policy reform should prioritize integrating higher shares of variable renewable energy, gradually phasing out fossil fuels, and using nuclear energy to provide reliable baseload power. Demand-side changes must also be addressed, including electrification of transport with vehicle-to-grid (V2G) systems, electrification of cooking, shifting consumption patterns, and growing electricity demand from artificial intelligence, data centers, and the Internet of Things (IoT). It is important to think carefully about the role of captive power and industrial self-consumption. Finally, the abstract highlights the need for resilient and flexible planning in the face of global geopolitical uncertainties and volatile energy markets and proposes a forward-looking reform pathway for Bangladesh.

Keywords: *Institutional Reform; Energy Transition; Sectoral Coordination; Energy Security.*

From Compliance to Restoration: A Framework for Environmental Action in Rapidly Developing Nations

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Bangladesh faces severe environmental challenges, but they are not insurmountable. Solutions exist based on scientific understanding and proven experience; what is required is decisive action guided by four elements: compliance, action, restoration, and sustainability. Environmental degradation follows physical and chemical laws that groundwater depletes if extraction exceeds recharge, rivers remain polluted if emissions continue, and air quality deteriorates without controls. These are inevitable outcomes unless addressed. Cost-effective remediation offers a practical pathway. Integrating geophysical methods, such as electrical resistivity imaging and ground-penetrating radar—with targeted drilling enables comprehensive subsurface characterization in fluvial geology while reducing costs and borehole requirements. This approach builds local technical capacity through

training and technology transfer. Bioremediation and phytoremediation using native plants can treat petroleum hydrocarbons and heavy metals efficiently, while monitored natural attenuation allows natural processes to remediate contamination under suitable hydrogeological conditions. Strategic monitoring ensures effectiveness with minimal cost. Decades of implementation demonstrate that full integration of compliance, action, restoration, and sustainability is essential; partial approaches fail. “Cost-effective” means achieving complete remediation objectives intelligently, matching Bangladesh’s technical, geological, and resource conditions. For policymakers, the message is clear: environmental restoration requires full commitment. The cost of action is modest compared to the escalating expense of delayed remediation. Environmental quality and economic prosperity are complementary, not competing, goals. Nature can restore itself only if conditions allow; Bangladesh must act now, harnessing local knowledge, scientific tools, and available resources to secure sustainable development. The choice is clear that the will to act remains.

Keywords: Environmental Restoration; Cost-effective Remediation; Monitored Natural Attenuation; Geophysical Methods.

Economic Valuation of Pollution: Transforming Environmental Waste into Marketable Resources to Reduce Environmental Waste in Bangladesh

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Pollution has become a critical global challenge, and in Bangladesh its impacts continue to intensify despite increasing awareness. Complete elimination of pollution is unrealistic in a modern industrialized world, making innovative approaches that integrate environmental protection with economic benefits essential. This thesis explores the economic valuation of pollutants, treating environmental waste as a resource that can be converted into valuable products through advanced technologies. Examples include transforming carbon

emissions into fuels and fertilizers, recycling plastics into fuels, furniture, or construction materials, and converting organic waste into biogas or biofertilizer. The ‘pollution-to-product’ or ‘waste-to-wealth’ model encourages industries and communities to assign financial value to pollutants, thereby reducing environmental degradation while generating income and employment. By demonstrating how pollution can be transformed into marketable resources, the study highlights a sustainable pathway for Bangladesh, contributing to environmental conservation, economic development, and progress toward key Sustainable Development Goals (SDGs).

Keywords: Economic Valuation; Waste-to-Wealth; Pollution-to-Product; Circular Economy; Sustainable Development.

Transnational Distress, Environmental Disasters, and Marginal Lives in Tahirpur: A Study of Climate Mobility

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Tahirpur Upazila, located in Sunamganj, a border district, is approximately 300 kilometers from the capital, Dhaka, and situated at the foothills of Meghalaya. Often referred to as the land of clouds, mountains, Niladri Lake, and the magical Jadukata River, the region is renowned for its natural beauty. Yet beneath this allure, Tahirpur is gradually succumbing to deepening hardship and disaster. Tahirpur stands at the frontline of a growing environmental crisis. Cross-border mining in Meghalaya, India, has triggered landslides and floods that are burying Bangladeshi villages under sand and stone. Bangladesh also has no initiatives for the stones and sand that gradually swallow the hilly streams, haor and cultivable landscapes as well as affected the biodiversity and environment of this area. Apart from Bengali, there also live various indigenous marginal population such as Hajong, Khasi and Mandi who uprooted from their agrarian livelihoods; many residents have been forced to become wage laborers. Some of these rural people have lost their houses and habitat due to this disaster and gradually migrated to various villages and cities of greater Sylhet and Mymensingh for their livelihood. Mobility

has considered as solution to livelihood and risk management strategy in the context of environmental disaster and climate change. This research finding directs the importance and presence of addressing human mobility and the intersecting environmental and social determinants that persuade people's movement in this circumstance. This study suggests climate mobility research in a specific locality and concern, which includes our understanding of multiple drivers of mobility/immobility and multi-directional movement that also indicate interconnection of diverse geopolitical factors that determine mobility as well as immobility of this region.

Keywords: Landslide; Mining; Climate Mobility.

Urban Waterlogging and Its Impact on Working Women: A Sociological Study in Barisal Metropolitan Areas

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Urban waterlogging is a perennial environmental challenge in Bangladesh, above all during the monsoon season, which continues to generate big social, economic and health problems for the urban population. The gendered experiences of working women have already been underexplored because most of the past research mainly have focused on the infrastructure and the environmental impacts. This study has examined the impacts of waterlogging on the socio-economic conditions, livelihood patterns, and coping strategies of working women in Barisal city. For conducting this research both quantitative and qualitative research methodology has been used. Quantitative data has been collected from a 100-working-woman structured survey, while qualitative research has come via five high-level informant interviews. The findings show that women suffer greatly from frequent waterlogging. The reasons behind these sufferings are poor drainage systems, unregulated urban construction, heavy rainfall

and pavement that does not absorb fast enough. As a result, there is much more fatigued, worse for wear feeling about stations or work benches and even verbal abuse on task sites. In addition, waterlogging degrades health and environmental conditions. Suffering increases with the spread of waterborne diseases, skin maladies and menstrual problems due to an absence of safe water facilities, sanitation and healthcare as well as prevalent flooding. Among working women, several coping strategies can be observed involving cutting back on food, depending on their savings or borrowing informally, and temporarily changing their livelihood activities. However, these are chiefly stop-gap measures that do not deal with the root problem. The findings point to a significant lack of gender sensitivity in current urban water management and disaster response policy. The research has concluded that effective urban waterlogging mitigation requires not only to improve infrastructure on an interconnected multiple level but also direct and gender-sensitive planning, regulation and intervention. To reduce vulnerability and ensure sustainable urban livelihoods, integrating women's views is essential.

Keywords: Waterlogging; Working Women; Gender Sensitivity; Coping Strategies; Vulnerability.

Ensuring the Right to Safe Drinking Water in Bangladesh: Legal Challenges and Policy Solutions

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Access to safe drinking water is a fundamental human right, recognized under international frameworks such as the UN General Comment No. 15 on the ICESCR and the Sustainable Development Goals (SDGs). Despite Bangladesh's abundant water resources, many regions face acute scarcity of potable water due to pollution, salinity intrusion, and inadequate infrastructure. This qualitative study reviews legal provisions, policy documents, and reports from national and international organizations, analyzing the implementation of water rights in Bangladesh with a focus on constitutional guarantees, statutory regulations, and the effectiveness of water supply authorities. Findings indicate that, although the

Constitution (Articles 15 and 32) guarantees basic necessities, including water, practical access remains limited. Industrial waste, untreated sewage, and agricultural runoff have severely polluted surface and groundwater, particularly in urban centres like Dhaka. Transparency International Bangladesh reports that residents spend approximately 3.32 billion BDT (\$38.77 million) annually to purify contaminated water. Coastal areas face rising salinity, further restricting access. Legal actions against Dhaka WASA underscore persistent contamination, with outbreaks of waterborne diseases such as cholera and diarrhoea reported in 2023. Although measures such as chlorination and infrastructure upgrades have been introduced, enforcement and monitoring remain inadequate. Effective realization of the right to water requires stronger legal implementation, regular monitoring, and stricter penalties for violations. Public education on water purification, affordable access to treatment technologies, and partnerships with non-profits and the private sector are essential. Investment in desalination and improved industrial waste management are also recommended. Ensuring safe drinking water in Bangladesh is both a constitutional and international obligation, as well as a matter of justice and public health. Strengthening legal frameworks, infrastructure, and awareness is critical for building a healthier, more equitable society.

Keywords: Safe Drinking Water; Contamination; Purification.

Environmental Reforms to Promote Sustainable Hygiene Practices in Bangladesh

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Environmental degradation in Bangladesh has been a major factor indirectly affecting the country's hygiene conditions through, among others, unsafe sanitation, water pollution, improper fecal sludge management, and inadequate solid waste disposal. Most

hygiene promotion programs strongly focus on behavioral change and thus, give only minimal attention to the environmental aspects that should support sustainable hygiene practice. This research that is proposed intends to investigate how environmental reforms can support and strengthen sustainable hygiene outcomes in the urban and peri-urban areas of Bangladesh. The research will look into the environmental and sanitation policies, institutional arrangements, and the practices at the ground level to identify the critical gaps that prevent environmentally sound hygiene management. A mixed-method approach will be applied, which is a combination of policy analysis, secondary data review, key informant interviews, and selected community case studies. The research mainly intends to explore the interrelationships between environmental management, hygiene behavior, and public health risks, particularly in the areas of waste containment, water quality protection, and drainage systems. The anticipated result is a series of evidence-based proposals for the integration of environmental reforms into hygiene and sanitation planning. The study is expected to provide guidance to policymakers, environmental advocates, and civil society organizations on how to promote environmentally accountable and sustainable hygiene practices in Bangladesh.

***Keywords:** Environmental Reforms; Sustainable Hygiene; Sanitation Governance; Water Quality; Public Health; Waste Management.*

Chittagong Seaport: Government Decision to Lease out Three Container Terminals and Probable Consequences

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The Chittagong (Chattogram) Seaport functions as the principal maritime gateway of Bangladesh, handling approximately 92% of the country's total trade volume and over 70% of its export–import cargo, while also serving India, Nepal, and Bhutan through transshipment. Strategically located on the banks of the Karnaphuli River, the port possesses a long and distinguished history: it appeared in Ptolemy's 2nd-century map as one of the finest harbours of the Orient, remained

active since at least the 4th century BCE, and was well known to Mediterranean traders and Arab sailors by the early Common Era. The modern port was formally established in 1887 under British colonial rule, with subsequent geopolitical and economic significance highlighted after 1947. Despite immense sacrifices during the Liberation War of 1971 and post-war challenges, the port expanded rapidly in the post-independence period, particularly with the development of heavy industry, logistics infrastructure, and the New Mooring Container Terminal in the early 21st century. Recently, the government's decision to lease out the Laldia and New Mooring Container Terminals, along with the Pangaon Inland Container Terminal, to foreign operators has sparked intense debate. While authorities argue that foreign management will improve efficiency and reduce operational bottlenecks, critics contend that such a move undermines national sovereignty, institutional development, and domestic capacity-building. Against this backdrop, this paper examines the probable economic, strategic, and governance consequences of leasing key container terminals of the Chittagong Port to foreign companies.

Keywords: Chittagong Seaport; Port Governance; Foreign Leasing; Maritime Trade; Logistics Infrastructure.

Assessing Land-Use Impacts on Particulate Matter (PM_{2.5} & PM₁₀), Humidity and Human Health in a Metro-Rail Environment

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Rapid urbanization and megacity growth, such as in Dhaka, challenge SDG 11 and sustainable development. Metro rail, while cleaner and low-emission, interacts with land use and air pollution in complex ways that remain underexplored. This study measured PM_{2.5}, PM₁₀, and relative humidity along the Agargaon–Uttara metro route

using low-cost Air-beam monitors, combined with LULC analysis and heavy metal assessment in leaves near stations. A local health survey evaluated population susceptibility. ArcGIS contour mapping identified pollution hotspots. Findings reveal spatial and temporal variation in air quality, linking metro corridors, land use, and public health, providing evidence for sustainable urban transport planning in Dhaka. The results showed higher afternoon pollution levels than morning with the higher values being monitored in Mirpur areas (Morning: $PM_{2.5}$ = 10-48, 11-91, 12-73 and PM_{10} = 10-77.33, 11-163, 12-127; Afternoon: $PM_{2.5}$ = 10-101, 11-81.67, 12-64.33 and PM_{10} = 10-183, 11-146, 12-109.67 $\mu\text{g}/\text{m}^3$) indicating major air pollution hotspots with lower levels being recorded in planned residential areas like- Uttara Morning: $PM_{2.5}$ = North-25, Center-20, South-16 and PM_{10} = North-33, Center-25, South-17; Afternoon: $PM_{2.5}$ = North-50, Center-34, South-49 and PM_{10} = North-81, Center-50, South-79 $\mu\text{g}/\text{m}^3$) and Mirpur DOHS (Morning: $PM_{2.5}$ = 25.67 and PM_{10} = 34.33 $\mu\text{g}/\text{m}^3$). According to 24-hour standard values for $PM_{2.5}$, which is 15 $\mu\text{g}/\text{m}^3$, and PM_{10} , which is 45 $\mu\text{g}/\text{m}^3$, provided by WHO. Local surveys revealed that traffic is the prime cause of air pollution and that the metro rail is perceived as contributing to pollution reduction and sustainability. This study highlights PM and RH variability, influenced by land-use patterns and traffic intensity, etc., and health risks, and the importance of urban planning for achieving SDG 11.

Keywords: *LULC; Spatial and Temporal variation; PM_{10} ; $PM_{2.5}$; ArcGIS; Metro Rail Corridor; SDG 11.*

Assessment of Noise Pollution in the Recreational Areas in Dhaka City

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Noise pollution has been recognized as one of the most vital environmental pollutions that is affecting urban area's quality of life. Sound levels at different points of the study area have been recorded and presented spatially by Geo-statistical analysis. In this study, noise levels have been measured at different selected points of different

parks (Bahadur Shah Park, National Botanical Garden, Nikunjo Park-1, Justice Shahabuddin Ahmed Park, Rayer Bazar Boddhobhumi) during the working period (8am to 6 pm) of the day. The time period of the day was divided into three slots (morning, noon and evening) for clear perception. It was observed that at all the locations, the noise levels remain far above the acceptable limit for all the times. The highest levels were found in the afternoon and evening. Bahadur Shah Park and Rayer Bazar Boddhobhumi consistently recorded the highest noise levels. Traffic, recreational activities, and entertainment venues are the main sources of higher noise levels. The National Botanical Garden is the quietest place, especially in the morning and evening. This is perhaps due to a bigger, greener area and is less urbanized. These findings underscore the need for integrated policy approaches such as city planning, law enforcement as well as NGOs should take initiatives to control noise pollution in these recreational places.

***Keywords:** Noise level; Noise Exposure; Recreational Park, Traffic; Public health; Urban noise.*

Urban Transformation Through Reforms: Rethinking Urbanism, Countrywide Physical Planning and Public Transportation

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Bangladesh is undergoing rapid and uneven urban transformation, driven by accelerated population growth, economic concentration, and infrastructure expansion. However, this transformation has largely taken place in the absence of coordinated countrywide physical planning and integrated public transportation systems, resulting in congestion, environmental degradation, spatial inequality, and declining urban livability. This paper examines how urban transformation can be guided through systemic reforms by rethinking urbanism, countrywide physical planning, and public transport-oriented development. The paper critically analyzes existing urban development patterns, highlighting the consequences of centralized growth, fragmented planning frameworks, and automobile-oriented transport policies. Drawing on national planning instruments, policy

reviews, and selected city-level examples, it identifies key structural and governance gaps that undermine sustainable urban development. Particular emphasis is placed on the absence of integrated land-use and transport planning, weak regulatory enforcement, and the marginalization of public transport, walking, and cycling. The paper argues that sustainable urban transformation requires a shift towards interlinked reform agendas: the establishment of a national or countrywide spatial planning framework to guide balanced territorial development, integrated land-use and transport planning, decentralization of urban growth, mainstreaming of blue-green infrastructure towards people-centered, climate-resilient, and spatially balanced planning reforms with the prioritization of public transport, walking, and cycling within an integrated land-use–transport planning system. It further emphasizes the importance of embedding climate resilience, social equity, and urban livability into planning and investment decisions. By framing urbanization as a governance and planning challenge rather than merely an infrastructure issue, this paper aims to contribute to policy discourse on building inclusive, resilient, and livable cities in Bangladesh.

Keywords: Urban Transformation; Urbanization; Spatial Planning; Public Transportation; Land-Use and Transport Integration; Urban Governance; Spatial Inequality; Climate-resilient; Sustainable Cities; Planning Reform

Weaving the Blue Network: Water Urbanism Strategies for Climate-Resilient Cities

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Bangladesh has historically rich blue ecosystems due to its rivers, canals, wetlands, ponds, haors, and natural drainage networks, are undergoing unprecedented and multidimensional degradation driven by rapid, unregulated urban expansion, widespread encroachment, industrial and municipal pollution, and persistent institutional weaknesses that have destabilized the national hydrological regime.

Dhaka represents the most acute manifestation of this crisis: once interlaced with more than 70 functional canals and extensive wetlands, the city has lost over 60% of its waterbodies in the past four decades and more than 120 km of canals over the last 80 years, resulting in chronic waterlogging, intensified urban heat-island effects, declining groundwater recharge, and widespread ecological dysfunction. Similar trajectories are evident in Chattogram, Khulna, Rajshahi, Sylhet, and rapidly urbanizing district towns, where ponds, retention basins, and natural drainage corridors have been systematically filled or severed by culverts, roads, and unplanned development. At the national scale, urban morphological change is equally stark, with 308 rivers losing navigability and nearly 500 considered severely impaired or functionally extinct. Encroachment along major urban rivers, including the Buriganga, Turag, Balu, and Shitalakshya—has removed up to 40% of riverbanks, constricting channels, accelerating sedimentation, degrading water quality, and amplifying flood risks. This degradation undermines urban livability while simultaneously jeopardizing rural livelihoods, biodiversity, food systems, and climate resilience. As climate change intensifies rainfall variability and heat stress, Bangladesh’s fragmented and degraded water systems are increasingly unable to perform essential regulatory and buffering functions. In this context, an integrated Blue Network—conceived as a continuous, city-to-river hydrological system linking canals, wetlands, retention areas, and waterbodies—emerges as a critical framework for restoring resilience. However, significant obstacles persist, including data gaps, institutional fragmentation, political resistance to removing encroachments, weak enforcement, and persistent disconnects between policy ambitions and implementation. Advancing Blue Network restoration therefore requires robust scientific foundations, watershed-based planning, decentralized wastewater management, participatory governance, and strong cross-agency coordination within a unified water-urbanism framework. Ultimately, Blue Network restoration is not merely an environmental intervention but a foundational pillar for sustainable urban development, public health, disaster-risk reduction, and long-term climate adaptation in Bangladesh.

Keywords: *Water Urbanism; Blue Network; Hydrological and Hydraulic Modelling; Watershed-based planning.*

Reforming Bangladesh's Energy Governance: A Gender-Responsive, Decentralized Renewable Pathway for Environmental Transformation

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Bangladesh's energy sector is at a critical crossroads. Decades of centralized planning, fossil fuel dependence, and institutional inertia have led to persistent overcapacity, rising capacity payments, slow adoption of renewables, and widening energy poverty, particularly among women in rural and remote areas. Despite clear policy intentions and master plans, implementation gaps, regulatory fragmentation, and profit-driven decision-making have hindered meaningful progress toward a sustainable energy transition. Effective reform requires dual action: policy transformation and institutional restructuring, with gender-responsive, decentralized renewable energy at its core. The sector faces three structural weaknesses: reliance on fossil fuels contrary to climate goals, institutional misalignment favoring large infrastructure projects over equitable energy access, and systemic exclusion of women and marginalized groups, resulting in missed economic and environmental opportunities. Evidence from solar interventions in Netrokona demonstrates that decentralized solutions can reduce emissions, address rural energy deficits, and enhance climate resilience, while women's access to clean energy significantly amplifies socioeconomic and environmental benefits through education, income generation, and community services. A reform blueprint is proposed around three pillars: establishing binding renewable energy targets and gender-responsive frameworks; restructuring incentives, improving transparency, and decentralizing decision-making to empower local governments and communities; and creating an independent Energy and Environment Monitoring Council to ensure compliance and prevent environmentally harmful projects. In light of upcoming national elections, political manifestos should explicitly commit to renewable energy expansion, gender-inclusive planning, and evidence-based institutional reform. A people-led, knowledge-driven energy transition is essential for Bangladesh's sustainable environmental future.

Keywords: *Energy Governance; Energy Reform; Gender-Responsive; Policy; Renewable Energy.*

Environmental Reform Without a Commission: Assessing the Capacity and Limits of Civil Society in Bangladesh

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Bangladesh does not have a special Environmental Reform Commission, which leads to continued policy coordination and institutional accountability across major sectors of the environment. In this regard, civil society groups, particularly Bangladesh Poribesh Andolon (BAPA), have stepped in to respond to policy and governance failures in water resources, energy and urban planning. This paper is a critical analysis of the potential and constraints of civil society to play a role in environmental governance without formal institutional processes. It differentiates substitutive, complementary and symbolic functions of civil society and examines the circumstances in which these interventions can go beyond episodic success to bring about lasting effects on policy and institutional practices. The study has adopted a methodology of comparative sectoral analysis of interventions led by BAPA and a network analysis of advocacy coalitions, as well as semi-structured interviews with policymakers, bureaucrats and civil society actors. They are process tracing to de-contaminate civil society inputs with facilitating state actions or political contingencies and a longitudinal lens to assess the sustainability of results being seen. Results suggest that civil society works well in agenda-setting, norm diffusion, and disruptive policy catalysis, but the structural disadvantages, political entrapment, and legitimacy issues restrict its ability to completely replace formal state processes. This paper suggests a hybrid type of governance that identifies the roles that civil society is best suited to assume, those that need the involvement of authoritative power and how civic knowledge and advocacy can be institutionalized with non-co-opted solutions. The study offers value to the conceptual comprehension of people-led governance and practical formulation of inclusive and sustainable environmental reform systems in Bangladesh.

Keywords: *Civil Society; Environmental Governance; Institutional Absence; and Hybrid Governance Model.*

Water Quality, Health Risks, and Community Perceptions: A Comprehensive Assessment of Public Water Points in Kushtia Municipality, Bangladesh

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Access to safe drinking water remains a critical public health challenge in urban Bangladesh. This study assessed the physicochemical, microbiological, and public health risks of water from public water points (PWP), community-accessible sources mainly used by low-income populations, in Kushtia Municipality, Bangladesh. Seven PWP water samples were analyzed for 13 physicochemical and 5 microbiological parameters using standard protocols. Six parameters, alkalinity, hardness, dissolved oxygen (DO), biological oxygen demand (BOD₅), temperature, and iron, exceeded national standards (Bangladesh Environmental Conservation Rules 2023). Water quality index ranged from 195.03 to 228.68, indicating all sources were unfit for consumption. Pollution index and Nemerow pollution index (NPI) identified BOD₅, hardness, and alkalinity as the dominant pollutants. Microbiological analysis revealed fecal coliform contamination in 71.4% of samples and *Pseudomonas* spp. in 57.1%. While chemical health risks from iron and arsenic were negligible, quantitative microbial risk assessment showed a 100% annual infection risk in five of seven PWP for both adults and children. A questionnaire-based cross-sectional KAP (Knowledge, Attitude, Practice) survey among 305 PWP users was conducted following a multistage sampling method. The analysis from the KAP survey revealed moderate knowledge (mean = 0.57), attitude (0.58), and lower practice (0.50) levels. PCA-weighted KAP score was 0.57. Regression analysis indicated that occupation, education, and water use duration significantly influenced KAP scores. Respondents prioritized regular maintenance, water testing, and treatment upgrades. This study underscores the urgent need for microbial risk reduction, improved treatment systems, and public awareness to ensure safe water access in low-income urban communities.

Keywords: *Public Health; Community Perception; Public Water Point.*

Physicochemical and Microbial Risks of Public Water Points (PWPS) in Kushtia Municipality, Bangladesh: Implications for Public Health and Community Practices

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Access to safe drinking water remains a critical public health challenge in urban Bangladesh. This study assessed the physicochemical, microbiological, and public health risks of water from public water points (PWP), community-accessible sources mainly used by low-income populations, in Kushtia Municipality, Bangladesh. Seven PWP water samples were analyzed for 13 physicochemical and five microbiological parameters using standard protocols. Six parameters, alkalinity, hardness, DO, BOD₅, temperature, and iron, exceeded national standards. Water Quality Index (WQI) ranged from 195.03 to 228.68, indicating all sources were unfit for consumption. Pollution Index (Pi) and Nemerow Pollution Index (NPI) analyses identified BOD₅, hardness, and alkalinity as the dominant pollutants. Microbiological analysis revealed fecal coliform contamination in 71.4% of samples and *Pseudomonas* spp. in 57.1%. While chemical health risks from iron and arsenic were negligible, Quantitative Microbial Risk Assessment (QMRA) showed a 100% annual infection risk in five of seven PWPs for both adults and children. A cross-sectional KAP (Knowledge, Attitude, Practice) survey among 305 PWP users revealed moderate knowledge (mean = 0.57), attitude (0.58), and lower practice (0.50) levels. PCA-weighted KAP score was 0.57. Regression analysis indicated that occupation, education, and water use duration significantly influenced KAP scores. Respondents prioritized regular maintenance, water testing, and treatment upgrades. This study underscores the urgent need for microbial risk reduction, improved treatment systems, and public awareness to ensure safe water access in low-income urban communities.

Keywords: Hazard Quotient (Hq); Public Water Points (Pwps); Quantitative Microbial Risk Assessment (Qmra); Water Quality Index (Wqi).

Rainfall Trend Analysis in Eastern Bangladesh (1991-2020) Using Non-Parametric Methods

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Bangladesh is among the world's most hazard-prone regions due to its low elevation, dense river network, and monsoon-dominated climate. The eastern part of the country, shaped by the hilly terrain of India's Tripura State and intersected by numerous transboundary rivers, faces heightened exposure to rainfall extremes and flash floods. The devastating floods of August 2024, when Feni recorded 1,787 mm of rainfall within a month and 832 mm in just five days, demonstrated the region's severe vulnerability. This study investigates long-term rainfall Trend across 14 stations of the Bangladesh Meteorological Department (BMD) located in eastern Bangladesh over the period 1991-2020. Daily rainfall records were aggregated into monthly totals, and trends were analyzed using the non-parametric Mann-Kendall (MK) test along with Sen's slope estimator at both annual and seasonal scales. The results shows that annual rainfall trends across all stations were statistically insignificant ($p > 0.05$), indicating general stability in long-term precipitation patterns. Nevertheless, spatial variations were evident. Teknaf (-14 mm/year) and Comilla (-10.4 mm/year) exhibited the most distinct declining tendencies, whereas Sandwip (+22.3 mm/year) and Chattogram (+14.2 mm/year) showed modest upward slopes, even though all were statistically insignificant. At the seasonal level, a statistically significant increasing trend was detected at Sitakund during the monsoon season (+29.8 mm/year), suggesting a localized intensification of rainfall. While pre-monsoon, post-monsoon, and dry-season rainfall remained largely stable across the region, Chattogram exhibited a relative declining tendency, with Sen's slope values of -10.95 mm/year in the Pre-Monsoon and -0.92 mm/year in the Dry season, both showing marginal statistical significance ($p = 0.0707$ and $p = 0.094$, respectively). In contrast, Hatiya recorded a minor positive post-monsoon slope (+8.36 mm/year; $p = 0.113$), indicating a weak but consistent upward tendency. Overall, the findings suggest that rainfall in eastern Bangladesh has remained relatively stable over the past three decades, although localized increases indicate emerging

hydroclimatic shifts. These results produce a valuable empirical basis for advancing future research on regional rainfall dynamics and for developing climate-resilient strategies in flood-prone and monsoon-dependent environments.

Keywords: *Rainfall Trend; Mann-Kendall Test; Sen's Slope Estimator; Hydroclimatic Variability; Eastern Bangladesh.*

Status of Air Pollution in Dhaka-Tangail Highway During Agricultural Waste Burning Event

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Agricultural waste burning is a major source of air pollution that affects air quality, public health, local, regional and global climate. Concentration of the major air pollutants ($PM_{2.5}$, PM_{10} , CO_2 , SO_2 , CH_4 , NO_2 , NH_3 , and Cl_2) along the Dhaka-Tangail highway before and during agricultural waste burning event were investigated in this study. To measure concentration of air pollutants in ten locations of Dhaka-Tangail highway a sensor based portable air quality monitoring device (Aeroqual Series-500) was used. The findings indicate that the average $PM_{2.5}$ and PM_{10} concentration were 0.12 mg/m^3 and 0.16 mg/m^3 , respectively and were risen by 15% and 11% during agricultural waste burning event than that of prior. Interestingly, concentration of NO_2 is 2.5 times higher than that of non-burning period. Similarly, concentration of CH_4 was 7.4 mg/m^3 , which is 1.4 times higher than that was measured prior to agricultural waste burning, indicating the significance of agricultural residual burning in global greenhouse gases emissions. Moreover, overall AQI rating for Dhaka-Tangail high way during this event was 232 to 500, which belongs to “very unhealthy to hazardous” category. This study demonstrated that extended agricultural waste burning during the study conducted has worsen the air quality nearby Dhaka-Tangail highway. To address the issue of air quality and climate change, maintenance of public health and ensuring sustainable agricultural practices all the stake holders must collaborate.

Keywords: *Air Pollution; Agricultural Waste Burning; AQI; Dhaka-Tangail Highway; $PM_{2.5}$.*

Sustainable E-Waste Regulation: Lessons for Bangladesh from Japan

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The management of electronic waste (e-waste) is a growing challenge in Bangladesh, with significant implications for public health, environmental sustainability, and the achievement of the United Nations Sustainable Development Goals (SDGs). With over 3 million metric tons of e-waste generated annually, Bangladesh faces significant challenges due to informal recycling practices, limited public awareness, and weak regulatory enforcement. In contrast, Japan's technology-driven and legally robust e-waste management system offers valuable insights for effective policy and practice. Effective e-waste management is directly linked to several SDGs, notably SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 17 (Partnerships for the Goals). This study adopts a qualitative comparative approach, utilizing grounded theory and expert interviews to analyse the legal frameworks, implementation strategies, and stakeholder experiences in both Japan and Bangladesh. Data sources include recent legislation, policy documents, and field studies. The Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment (2012, revised 2018) and the Home Appliance Recycling Law (2001) form the backbone of Japan's e-waste regulation. These laws enforce Extended Producer Responsibility (EPR), requiring manufacturers to design for recyclability, finance collection and recycling, and meet strict recycling targets. Japan's system is supported by advanced recycling technologies, transparent tracking, the 3Rs (reduce, reuse, recycle) strategy, and strong public-private collaboration. Conversely, Bangladesh's Hazardous Waste (E-waste) Management Rules, 2021, mark progress but suffer from weak enforcement, infrastructural gaps, and a dominant informal sector, despite emerging public-private partnerships and willingness-to-pay initiatives. Findings highlight that Japan's success stems from clear legal mandates, robust enforcement, and integration of technology at every stage, incentivizing innovation and eco-friendly design. For

Bangladesh, bridging enforcement gaps, investing in infrastructure and technology transfer, formalizing the informal sector, and fostering multi-stakeholder collaboration are critical. A human-centered, technology-driven approach rooted in strong legal frameworks and inclusive engagement can transform e-waste management in Bangladesh, paving the way for a safer, more sustainable, and circular economy that protects both people and the environment.

Keywords: E-Waste; Sustainable; Management; Infrastructural Gaps.

Advancing Energy Independence in Bangladesh: Pathways for Renewable Integration and Lessons from the Global Leaders

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Bangladesh remains heavily dependent on fossil-fuel imports to meet its growing energy demand. Its primary energy mix includes domestic natural gas, imported oil and LNG, biomass, coal, and a small share of renewables. In FY 2023–24, total primary energy consumption was approximately 58.38 Mtoe, with natural gas and LNG supplying 40–46%, biomass 22–23%, and the remainder from oil, coal, and other fuels. Since independence, energy policy has successfully achieved near-universal electrification (over 99%) and expanded installed capacity from 547 MW in 1971 to about 31,452 MW today. However, over-reliance on domestic gas created a structural vulnerability, necessitating costly imports of LNG, oil, and coal as reserves declined. Renewable electricity remains minimal, contributing only 2% of generation in 2024, with solar and wind at roughly 1.3%. To address this, the government has strengthened its policy framework. The draft Renewable Energy Policy 2025 aims for 20% electricity from renewables by 2030 and 30% by 2041, while

institutions like the Sustainable and Renewable Energy Development Authority (SREDA) promote public–private investment and rural/off-grid deployment. Yet progress is slow due to bureaucratic inertia and high import dependence. Lessons from global leaders show the potential: in 2024, U.S. solar and wind supplied over 21% of utility-scale electricity, while Australia’s renewables contributed nearly 40% of total electricity in 2023, aided by over 4 million small-scale solar installations. For Bangladesh, a mixed strategy—accelerating rooftop and agrivoltaic solar, wind deployment, bioenergy, and future low-carbon fuels—combined with streamlined permitting, feed-in tariffs, and investment in smart grids and storage, can gradually reduce fossil-fuel imports. With coherent policy execution and international lessons, Bangladesh can move toward a sustainable, secure, and domestically powered energy future.

Keywords: *Low Carbon Fuel; Feed in Tariff; Natural Gas Reservation.*

Effect of Different Weed Management Practices at Growth Stages of Boro Rice (*Oryza Sativa L.*)

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Paddy is the predominant cereal crop in Bangladesh, essential for food security and livelihoods. This study assessed the effectiveness of herbicide-based weed management practices on BRRI dhan101 compared to farmer’s practices. The experiment was conducted in a randomized complete block design with three replications and six treatments such as T0 = control (no weeding), T1 = hand weeding (2 times), T2 = pre-emergence, T3 = early post-emergence, T4 = post-emergence, and T5 = Integrated (hand weeding + pre-emergence). Hand weeding (T1) and the integrated treatment (T5) were superior in growth, yield, and weed control compared with no-weeding and herbicide-only treatments. In T1, the highest plant height (65.5, 85.4, and 103.6 cm at 6 WAT, 8 WAT, and maturity), tiller numbers (11.2 at 6 WAT, 17.2 at 8 WAT, and 12.6 effective tillers), leaf area index (5.4, 7.3 cm²) and chlorophyll content (54.6 μmol/m²) were recorded. Yield attributes, including panicle weight (5.2 g), panicle length (29.1

cm), grains per panicle (211.2), and 1,000-grain weight (20.7 g), were maximized in T1. Producing the highest grain yield (9.0 t/ha), straw yield (8.0 t/ha), and harvest index (52.8%). Weed suppression was most effective in T1, with the lowest weed species (3.9), density (6.4), dry weight (8.2 g/m²), and biomass (329.6 kg/ha). Protein (9.2%) and antioxidant content (1.3 mg/mL) were also highest in T1. These findings suggest that integrated weed management is a sustainable approach for optimizing yield and quality in Boro rice production.

Keywords: BRRI Dhan 101; Weed Management; Herbicide Application; Integrated Weed Management; Growth Parameters; Yield Attributes.

Advancing AI-Driven & GIS Urban Greenhouse-Gas Detection for Climate Monitoring in Complex City Environments

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Urban areas present a highly complex environment for greenhouse gas (GHG) monitoring, with overlapping CH₄ and CO₂ sources from traffic, buildings, and industry, making accurate detection extremely challenging. Dense building structures, vegetation, and fluctuating humidity often confuse AI models primarily trained on simple industrial scenes, leading to misinterpretation of heat reflections, shadows, or structural edges as gas plumes. Passive infrared imaging further limits detection by providing only rough thermal patterns, reducing identification and measurement accuracy. CNNs and transformer-based models that perform well in open, low-clutter environments frequently underperform in dense urban imagery. Converting column-based atmospheric concentrations into ground-level emissions introduces additional uncertainty due to unstable wind fields, cloud cover, and limited ground-truth measurements. Many studies rely heavily on synthetic datasets, which often fail to

represent real urban conditions accurately. While GIS layers such as building footprints, land-use maps, and surface characteristics could improve interpretation of complex city structures, they remain underutilized in most AI workflows. This study outlines the weaknesses of current AI-based urban GHG detection methods and evaluates how integrating GIS data can enhance plume segmentation, source identification, and emission estimation. We review optical gas imaging, multispectral and hyperspectral sensors, AI-driven plume segmentation, and inverse modeling techniques, emphasizing realistic data, atmospheric variability, and GIS-informed spatial interpretation. AI models trained on simple scenes often misclassify thermal artifacts, struggle to separate nearby emission sources, and produce unstable estimates under varying meteorological conditions. Incorporating GIS layers improves spatial accuracy, reduces false detections, and strengthens source attribution. Reliable urban GHG monitoring will require multimodal sensing, realistic urban datasets, GIS-enhanced modeling, and physics-informed AI that accounts for atmospheric transport and uncertainty.

Keywords: Greenhouse Gas Detection; Urban Emissions; Methane; Carbon Dioxide; Optical Gas.

Insights from Nationally Representative Data on Empowering Women and Building Resilience through Financial Inclusion in Coastal Bangladesh

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Coastal women in Bangladesh face disproportionate climate vulnerability, confronting cyclones, flooding, tidal surges, salinity intrusion, and unstable livelihoods. Evidence shows that women's autonomy, income participation, and post-disaster coping are significantly strengthened through financial inclusion, which encompasses access to banks, mobile phones, and mobile money services. This study examines geographic differences in women's financial inclusion between coastal and non-coastal areas using data from the Bangladesh Demographic and Health Survey 2022 and explores its relationship with resilience indicators. Among 30,078

women surveyed, 36.6% resided in coastal areas, where employment rates (29.7%) were lower than in non-coastal regions (35.0%). Coastal women also exhibited slightly lower decision-making autonomy and control over resources, alongside marginally higher mobile money usage but reduced bank account access. Logistic regression results indicated that coastal residence reduced employment probability (AOR = 0.89), while older age increased it (AOR = 1.04). Wealth had an inverse effect on employment, reflecting prevailing gender and household norms. The interaction model revealed that education significantly predicted employment for non-coastal women but had a smaller effect for coastal women (interaction AOR = 0.84). The findings demonstrate notable disparities in employment, financial inclusion, and decision-making power linked to environmental challenges. Mobile phones and mobile money services enhance women's resilience by supporting income-generating activities, but in coastal areas, climate-related constraints limit these benefits, and education does not translate into equitable employment. These results underscore the need for gender-responsive climate adaptation policies, including targeted livelihood programs and digital financial access. Integrating financial inclusion into national adaptation initiatives can strengthen women's autonomy, stabilize livelihoods, and reduce long-term vulnerability in Bangladesh's climate-exposed coastal regions.

Keywords: *Women's Empowerment; Digital Finance; Climate Resilience; Coastal Bangladesh; Livelihood Resilience.*

টেকসই উন্নয়নের জন্য মাধ্যমিক স্তরে পরিবেশ শিক্ষার গুরুত্ব ও করণীয়: বাংলাদেশ প্রেক্ষিত

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ভৌগোলিকভাবে বাংলাদেশ একটি পরিবেশ স্পর্শকাতর দেশ। বাংলাদেশে প্রতি বছর পরিবেশগত সমস্যার কারণে বিভিন্ন ধরনের প্রাকৃতিক দুর্যোগ দেখা দেয়। প্রাকৃতিক দুর্যোগ মোকাবেলার জন্য পরিবেশ শিক্ষা অত্যন্ত গুরুত্বপূর্ণ হাতিয়ার। পরিবেশ শিক্ষায় সবচেয়ে উল্লেখযোগ্য সময় হলো ৬ষ্ঠ থেকে ১০ম শ্রেণি পর্যন্ত শিক্ষাকাল। ৬ষ্ঠ থেকে ১০ম শ্রেণির

পাঠ্যক্রমে পরিবেশ শিক্ষার বিষয়াবলী অর্ন্তভুক্তির মাধ্যমে দ্রুত সচেতনতা বাড়ানো ও উন্নতি সম্ভব। বাংলাদেশের শিক্ষা ব্যবস্থায় ৬ষ্ঠ থেকে দশম শ্রেণি পর্যন্ত পাঠ্যক্রমে পরিবেশের কোন কোন বিষয় অর্ন্তভুক্ত রয়েছে তা বিশ্লেষণ করা এবং পরবর্তী কার্যক্রম সম্পর্কে করণীয় নির্ধারণই এই গবেষণার মূল লক্ষ্য। জাতীয় শিক্ষাক্রম ও পাঠ্যপুস্তক বোর্ড কর্তৃক রচিত মাধ্যমিক পর্যায়ে সাধারণ শিক্ষা, মাদ্রাসা শিক্ষা, কারিগরি শিক্ষার ৬ষ্ঠ থেকে ১০ম শ্রেণির যে সকল বইয়ের পাঠ্যক্রমে পরিবেশ শিক্ষার বিষয়গুলো অর্ন্তভুক্ত রয়েছে তা পর্যালোচনা করা হয়েছে। প্রাপ্ত ফলাফলে দেখা যায় পরিবেশ শিক্ষার ইস্যুগুলোকে আরো বেশি গুরুত্ব সহকারে মাধ্যমিক পর্যায়ের পাঠ্যক্রমে অর্ন্তভুক্ত করা উচিত। বিশেষভাবে ৬ষ্ঠ থেকে ৮ম শ্রেণির বইতে পরিবেশ শিক্ষার মূল বিষয়গুলো অর্ন্তভুক্ত করা প্রয়োজন। বাংলাদেশের মোট জনসংখ্যার ১০-১৪ বয়সের প্রায় ২৭.৪৪% শিক্ষার্থী পরিবেশ শিক্ষা থেকে বঞ্চিত। পরিবেশ শিক্ষায় বিভিন্ন অংশীজনের গুরুত্ব বাড়ানো, পরিবেশ শিক্ষার প্রতি মানুষের আগ্রহ ও দায়িত্ববোধ গড়ে তোলা, এবং মানুষকে পরিবেশ সচেতন নাগরিক হিসেবে গড়ার জন্য গণপ্রজাতন্ত্রী বাংলাদেশের সংবিধান এর ধারা: ১৫ (ক) 'মৌলিক উপকরণ' এর মধ্যে পরিবেশ শিক্ষা অর্ন্তভুক্ত অথবা মাধ্যমিক পর্যায়ের শিক্ষার্থীদের জন্য পরিবেশ শিক্ষাকে 'মৌলিক অধিকার' হিসেবে অর্ন্তভুক্ত করা প্রয়োজন।

মূল শব্দ: টেকসই উন্নয়ন, মাধ্যমিক স্তরের শিক্ষা, পরিবেশ শিক্ষা।

Tourism in Tanguar Haor: Impacts and Recommendations

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Tanguar Haor, a Ramsar site and Ecologically Critical Area in northeastern Bangladesh, is renowned for its rich biodiversity. Over the past decade, the wetland has emerged as a major tourist destination, particularly during the monsoon season. However, due to rapid and unregulated tourism environmental pollution is rising day by day. Water, air, and noise pollution from houseboats have become significant concerns affecting both the ecosystem and livelihoods of the people surrounding the haor. This study examines the impacts of tourism induced pollution through four Focus Group Discussions (FGDs) and five Key Informant Interviews (KIIs). local stakeholders, including boatmen, community leaders, fishermen, and teachers have given their opinion in the FGDs and KIIs. The findings highlight the need to restrict houseboats in core areas, promote manually operated

boats in designated areas, install proper septic systems on houseboats, and replace diesel generators with solar energy. The study strongly recommends adopting a community-based ecotourism to ensure sustainable environmental management and equitable livelihood benefits. The benefit of the local people was also a major concern.

Keywords: Ramsar Site; Ecologically Critical Area; Sustainable Environment Management.

Green Transferable Development Rights (G-TDRs) for Urban Environmental Reform: A Nature-based Policy Framework for Dhaka

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Rapid urbanization in Dhaka has led to the steady degradation and loss of small-scale urban green and blue infrastructures, including private gardens, ponds, and neighbourhood green pockets, which are essential for ecological balance and urban resilience. Conventional planning and regulatory instruments have proven inadequate in protecting these dispersed yet environmentally valuable spaces. This paper proposes a Green Transferable Development Rights (G-TDRs) framework as an innovative environmental reform mechanism to balance urban development demands with Nature-based Solutions (NbS) in Dhaka. The proposed G-TDR framework allows development rights to be transferred from environmentally significant green and blue spaces to designated receiving zones, thereby restricting overdevelopment in ecologically sensitive areas while accommodating growth in suitable locations. A GIS-based methodology is employed to identify and evaluate eligible green spaces based on spatial location, zoning regulations, land area, and future development potential. This systematic assessment ensures transparency and ecological relevance in designating transferable development rights. The framework outlines key policy components, including eligibility criteria, transfer procedures, regulatory safeguards, and enforceable restrictions on the utilization of transferred rights. To encourage stakeholder participation, the policy incorporates incentives such as tax relief,

reduced development fees, and public recognition for developers and landowners contributing to urban environmental conservation. Strong monitoring and compliance mechanisms are emphasized to ensure the long-term protection of designated green spaces and to assess cumulative environmental outcomes. In Dhaka's context—where rapid densification frequently threatens wetlands, ponds, and neighbourhood greenery—G-TDRs present a scalable and adaptive environmental reform tool. The framework supports multiple NbS objectives, including biodiversity conservation, urban heat mitigation, air quality improvement, and stormwater management. It aligns with the Detailed Area Plan (DAP) 2022–2035 for Dhaka, National Adaptation Plan of Bangladesh (2023-2050), and the Climate Action Plan (CAP) 2024 for DNCC and DSCC, positioning G-TDRs as a practical pathway for integrating environmental reform into mainstream urban planning in Bangladesh.

Keywords: *Green Transferable Development Rights; Nature-Based Solutions; Urban Environmental Reform; Dhaka; GIS-Based Planning.*

Scopes And Potentialities of Nanoparticles in Plant Disease Management in Bangladesh

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Plant diseases pose a significant threat to food security and agricultural productivity in Bangladesh. Conventional disease management often relies on chemical pesticides, raising concerns over environmental toxicity, pathogen resistance, and human health. This review explores the transformative potential of adopting nanoparticles (NPs) as a sustainable and effective alternative for plant disease management in the Bangladeshi context. We synthesize evidence on the antimicrobial, antifungal, and antiviral properties of metallic (e.g., silver, copper, zinc oxide) and biogenic nanoparticles. Their mechanisms of action, including reactive oxygen species generation, direct cell membrane disruption, and targeted delivery of active ingredients, offer precise pathogen control. In Bangladesh, where resource constraints and climate vulnerability are acute, NPs could provide durable, lower-dose protectants for major crops like rice, wheat, and vegetables. We

evaluate the practical potential for local synthesis using plant extracts (green synthesis) to reduce costs and enhance accessibility. The paper also critically addresses key barriers to adoption, including knowledge gaps among farmers, regulatory uncertainty, biosafety assessments, and the need for scaled-up production. By outlining a pathway from laboratory research to field application, we argue that a strategic investment in nanotechnology, integrated with existing agricultural extension networks, can revolutionize plant protection in Bangladesh, offering a potent tool for enhancing crop resilience, reducing chemical dependency, and securing sustainable yields.

***Keywords:** Nanoparticles; Plant Disease Management; Bangladesh Agriculture; Green Synthesis; Sustainable Crop Protection.*

Sustainable Management of Coastal and Marine Environment of Bangladesh: From Policy to Action

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The coastal and marine areas are two hydro-morphologically unique and ecologically sensitive parts of Bangladesh. The coastal area, which covers about 47,000 sq km and 710 km of long shorelines, is under serious stress due to massive-scale human interventions. During the last four decades there has been much infrastructural development and large-scale change in land use and land cover. The coastal area is now highly vulnerable to prolonged waterlogging, tidal inundation, erosion, pollution, and livelihood challenges. The existing coastal policy of 2005 is not adequate to maintain the equilibrium of the man-environment relationship and to safeguard the environmental sustainability of the coast. After the delineation of the marine boundary with Myanmar and India, the local EEZ of Bangladesh is now around 118,000 sq. km., extending up to 200 nautical miles, which has opened the scope to explore the blue of Bangladesh. However, the marine environment of Bangladesh is highly vulnerable to pollution due to the large-scale influx of pollutants from land-based sources and also from direct dumping

and oil spills. The future plan to explore the blue economy of Bangladesh would not only invite large-scale investments and resource extraction from the sea but also be a challenge for sustainable marine environment and ecology. Before large-scale intervention in the sea, there is an urgent need to formulate and implement marine policy and guidelines. This paper highlights the importance of upgrading the existing policies and guidelines, formulating a new marine policy, and increasing the institutional capacity for the sustainable use of coastal and marine resources and their protection.

Keywords: Coastal Zones; Marine Environment; Policy and Guidelines; Environmental Protection; Institutional Capacity.

Anthropogenic Impact and Ecological Challenges in the Arial Beel: A Geo-environmental Analysis

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Arial Beel is an important sub-basin in the Ganges-Padma floodplain, which covers about 144 km² wetland that has suffered significant deterioration as a result of unauthorized human interventions. This study evaluates the drivers of this decline through a triangulated methodology comprising a multi-methodological approach: drone-based spatial analysis, questionnaires, Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). Findings reveal alarming empirical evidence of ecological decay: 85% of the beel's khals (canals) have been encroached upon, obstructed or entirely lost over the last four decades, approximately 33% of the wetland has been filled for industrial and housing projects, and the Srinagar, Muksudpur, and Dohar khals are now paralyzed by waste dumping and road embankments. These interventions have disrupted the open water regime, leading to prolonged waterlogging and a sharp decline in indigenous fish resources. Drone imagery captured critical obstructions at the Muksudpur khal intersection, where new embankments have paralyzed natural water flow.

Hydrological mapping confirms the total disconnection of eight major feeder canals from the Padma River due to the Srinagar-Dohar embankment. This fragmentation has caused localized waterlogging and excessive nutrient loading. Ecological decay is further evidenced by a decline in fish yield, with native species like boal and koi facing local extinction. The loss of this ecosystem has forced a shift in livelihoods; traditional fishing and boat transport have largely been replaced by day labor and rickshaw pulling. This research advocates for an integrated management reform that prioritizes ecological connectivity and enforces strict restrictions on land-filling.

***Keywords:** Arial Beel; Ecological Decay; Anthropogenic Impact; Wetland Reform; Hydrological Fragmentation.*

A Systematic Review on Mercury Pollution in Bangladesh

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Mercury, as a heavy metal, possesses a significant effect on human health as well as on the environment. Mercury is naturally present in the earth's crust and is found in three different forms: inorganic, organic, and elemental. However, concentrations worldwide are increasing due to anthropogenic activities like unplanned urbanization, industrialization, and uncontrolled waste disposal. Its bioaccumulating nature in the environment and transformation into its toxic form, methylmercury, causes adverse health effects in humans. The present study aims to determine mercury concentrations in surface water, sediments, soil, vegetables, fish, foodstuffs, and beauty products in Bangladesh. Additionally, this study also focuses on understanding the current situation of mercury pollution in Bangladesh and what measures should be taken to mitigate the effects. This study reviewed a total of 116 peer-reviewed studies related to mercury in different sectors in Bangladesh based on predefined criteria (keywords,

peer-reviewed journals, and national prominent libraries like BSTI, Ministry of Health, icddr,b, Ministry of Environment, Forest and Climate Change, and international libraries such as ADB, WHO, Pure Earth, and USGS) and exclusion criteria (predatory journals and the absence of full text in English). Finally, 51 studies were included in this study. The relevant studies on mercury exposure, sources, routes, diet, and impacts in Bangladesh were combined and presented using the cross-tabulation technique. The study determined mercury concentrations in surface water (0.00260–0.603 mg/l, mean 0.14 mg/l), in fish (0.004–2.24 mg/kg, mean 0.1656 mg/kg), in sediments (0.0064–624.601667 mg/kg, mean 89.41179 mg/kg), in soils (0.06–619.8 mg/kg, mean 63.9238 mg/kg), in vegetables (0.0010–0.12 mg/kg, mean 0.0233 mg/kg), in foodstuffs (3.32–0.002606 mg/kg, mean 0.457 mg/kg), and in beauty products (0.25–3.1570225 mg/kg, mean 1.70 mg/kg), of which 100%, 8.04%, 42.85%, 60%, 30.30%, and 50% of samples, respectively, exceeded the related standard levels set by WHO, USEPA, BSTI, FAO, USDA, EU, CCME, and BDS. The present study found that the most mercury-polluted sector in Bangladesh is surface water and also found that the soils of industrial areas, waste disposal areas, and mining areas are highly polluted (0.581–619.8 mg/kg). Additionally, high concentrations have been found in powdered milk and poultry meat. Mercury adversely affects the human body, enters primarily through diet and direct exposure, and leads to long-term health effects. This study may help identify the sources and exposure routes of mercury and assist policymakers in formulating national policies with sustainable mitigation plans to combat the impacts of mercury in Bangladesh.

Keywords: *Hg Pollution; Mercury in Bangladesh; Heavy Metals, Hg Contamination; Impacts of Hg.*

Perceived Biodiversity Loss in the Chalanbil Wetland Ecosystem, Bangladesh: A Community-Based Assessment

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Wetland ecosystems are critical global biodiversity hotspots but are increasingly threatened by anthropogenic pressures and climate change. The Chalanbil wetland in Bangladesh, one of the country's most important aquatic resources, exemplifies this crisis, experiencing severe degradation. This study investigates local community perceptions of biodiversity loss and habitat change in Chalanbil, recognizing that these residents are direct observers and key stakeholders. A cross-sectional, mixed-methods approach was employed, collecting data from 120 respondents across multiple sub-districts, including Singra, Gurudaspur, Baraigram, Faridpur, Vangura, Chatmohor, Taras, Ullapara, and Shadatpur. Data collection included two Focus Group Discussions, Key Informant Interviews, and a structured survey capturing socio-demographic characteristics and perceptions of biodiversity decline across fish, birds, amphibians, aquatic plants, and other species. Descriptive statistics and ANOVA were used for analysis. Results show that 98.3% of respondents perceived a general decrease in biodiversity, with declines most pronounced for fish (88.3%) and birds (80%), followed by aquatic plants (38.3%) and amphibians (35%). ANOVA revealed no significant variation in perception across demographic groups, indicating a broadly shared view of ecological deterioration. Respondents attributed the decline to habitat degradation from siltation and water withdrawal, pollution from agrochemicals, overfishing, and fragmentation from unplanned infrastructure, with

climate change—altered rainfall and increased drought frequency—exacerbating these pressures. These findings highlight the urgent need for integrated, ecosystem-based management strategies, including habitat restoration, community-driven conservation such as fish sanctuaries, sustainable agriculture, and climate-resilient policies, to prevent further ecological collapse and protect the livelihoods that depend on this vital wetland ecosystem.

Keywords: Chalanbil; Wetland; Biodiversity Loss; Local Perception; Climate Change; Community-Based Management.

Management of Water Resources at Bhitargarh Ancient City in Bangladesh

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We cannot deny the importance of water in our life. It is more distinct in the Himalayan piedmont plain where wet and dry seasons are clearly discernible, such as Panchagarh district in Bangladesh. People of the district are suffering in both seasons. Inadequate rain results in reducing water supply and crop crisis in the dry season and floods, devastation and poor water quality during the rainy season. This study is based on the archaeological investigations of water resources - ponds, moats and rivers by the author within the Bhitargarh archaeological site, which is believed to be a ruined city of King Prithu, located in Amarkhana union under Panchagarh Sadar upazila in Panchagarh, the northwestern most district of Bangladesh and attempts to illustrate the traditions and technology through which the ancient inhabitants of Bhitargarh preserved and used water for domestic, irrigation and environmental purposes. The result of the study shows that the people of the past were not only masters of water engineering that involved collection, storage and circulation of water but also possessed knowledge about how to deal with annual seasonal extremes as well as to respond well during droughts and floods. In addition, we learn that with hard work and technical skills people

of the past were able to overcome the limitations posed by climate change through digging massive artificial reservoirs and moats as well as building dams on the rivers. Hopefully, this study will shed new light on the extent to which the ancient inhabitants of Bhitargarh were receptive to science and technology in the past and teach us how to respond to long-term climate change challenges in future.

Keywords: Climate Change; Water Management; Moats; Reservoirs; Bhitargarh; Panchagarh.

Urban Heat and Human Health: Designing & Reforming Climate-Resilient Cities in a Warming World

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Extreme heat, a direct consequence of climate change, is exacerbated in cities as the Urban Heat Island (UHI) phenomenon adversely affects local microclimatic conditions. The UHI is defined by temperatures in a metropolitan or urban area being considerably higher than in neighboring rural or undeveloped areas. This escalating situation poses significant public health risks, especially for vulnerable populations. Although there is extensive research on the environmental impacts of heat, more studies are needed on how heat affects human health and how these health risks can be effectively mitigated. This study investigates the challenge of maintaining comfortable outdoor-living conditions in densely built urban environments, particularly in Dhaka, the capital of Bangladesh, where heat exposure frequently intensifies. A mixed-methods approach is employed, incorporating field observations, questionnaire surveys, scientific literature, governmental reports, and national publications related to Dhaka city to identify the concerning facts about the UHI and its effects on public health. This paper identifies that rapid population migration, the reduction of vegetation and green spaces, and unplanned dense urban development by replacing natural surfaces with impervious materials are major contributors to the UHI phenomenon in Dhaka. Comparative studies suggest that urban areas experience significantly

higher heat exposure due to the Urban Heat Island (UHI) effect, with average summer land surface temperatures measuring 4–7°C higher than those of surrounding rural areas, leading to a rise in heat-related illnesses such as heat exhaustion. Furthermore, the overall mortality rate has been observed to increase by as much as 3–5% during extreme heat events. Implementing effective mitigation strategies can deliver substantial public health benefits. Model projections using ArcGIS Pro and ENVI-MET suggest that increasing urban greening, implementing high-albedo cool roofs, and integrating shaded public amenities can reduce land surface temperatures by 2.2–3.4°C and lower heat-related mortality by 10–15%. Furthermore, providing adequate shade and hydration is a crucial, low-cost intervention to prevent heatstroke and heat exhaustion, especially among outdoor workers. Lessons drawn from such studies are crucial for planners and policymakers, enabling them to improve city planning practices and reform policies aimed at mitigating UHI effects and designing heat-resilient cities in a warming world.

***Keywords:** Dhaka City; Temperature; Health Impacts of Heat; Heat Mitigation Strategies; UHI effects.*

Water Resources in Bangladesh: Needs for Reforms in Policy and Management

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Water resources are the lifeblood of Bangladesh, a deltaic nation where the Ganges-Brahmaputra-Meghna river system sustains over 170 million people through agriculture, fisheries, drinking water, and industry, contributing to 60% of GDP via rice production and aquaculture. The existence of the country depends on unimpeded natural flow of water and sediments that helped to build the floodplain and delta plain of the country. A close examination of physical state and quality of water resources in rivers, haors, beels, lakes, ponds, coastal waters, and groundwater indicates that this bounty faces existential threats from climate change, upstream unilateral control of transboundary rivers and ill management within

the country. Effective protection demands urgent policy reforms, including watershed-based integrated management under reformed Bangladesh Water Act and Environmental Policy Act of 2013, stronger transboundary diplomacy via frameworks like the 1996 Ganges Treaty that needs modification, climate-resilient updates to future treaties, data-sharing with co-riparian nations in the GBM basins, and adherence to international laws to mitigate dam impacts, ratification of UN Convention of 1997, community-driven water resources plans that are based on scientific and ecological best practices, and investments in flow and quality monitoring gaging stations deployed in all major rivers and aquifers in the country. Without these, Bangladesh risks irreversible losses in food security, biodiversity, and human resilience. This paper offers specific reforms needed in philosophical approach in understanding of water resources management in hydrometeorological context in Bangladesh, changes needed to alleviate shortcomings in water and environment-related laws, policies, project proposals that are undertaken at local and regional levels.

Keywords: Reforms in Water Policies; Water Act; UN Convention of 1997; Existential Threat; Delta.

Policy and Institutional Reformation in Agriculture for Reducing Contamination in Crop Production, Soil, and Food in Bangladesh.

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Contamination in crop, soil, and food in Bangladesh is driven by interacting chemical and biological hazards across the “farm-to-fork” chain. Key risks include pesticide and chemical fertilizer residues from non-judicial application and weak stewardship; heavy metals and industrial pollutants transferred from contaminated soil and irrigation water into crops; and microbial hazards linked to unsafe water and post-harvest hygiene gaps. While Bangladesh has established legal and policy foundations—such as the Pesticides Act (2018), the Fertilizer (Management) Act (2006), the Bangladesh

Good Agricultural Practices (GAP) Policy (2020), the Environment Conservation Act (1995), Environment Conservation Rules (1997), and the Food Safety Act (2013) and the Bangladesh Food Safety Authority (BFSA)—contamination persists due to fragmented mandates, limited risk-based surveillance, inconsistent laboratory quality assurance, and weak/no incentives for safer production in informal domestic markets. This article proposes a reform agenda centered on (i) harmonized, risk-based standards for contaminants, inputs, and water; (ii) coordinated enforcement across agriculture, environment, and food safety institutions; (iii) strengthened laboratory governance and transparent surveillance; and (iv) market-linked compliance through scaled Bangladesh GAP, targeted extension, and “traceability-lite” mechanisms suitable for Bangladesh’s value chains. The recommendations prioritize implementable steps within 0–2 years, system-building reforms over 2–5 years, and structural transformation over 5–10 years to reduce contamination while sustaining productivity and livelihoods.

Keywords: Policy; Institutional Reform; Contamination; fertilizer.

Reforming Food Safety in Bangladesh: A Silent Emergency

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For Bangladesh, the national challenge has shifted from achieving food sufficiency to ensuring food safety. The daily diet of millions is increasingly compromised by widespread contamination, creating a silent but severe public health crisis. Hazards permeate the entire food chain. At the production level, farmers frequently overuse toxic or banned pesticides and artificially ripen fruits using calcium carbide. During processing, storage, and retail, unsafe practices intensify: formalin and other chemical preservatives are applied to fish and fruits, while staples such as milk, spices, and edible oils are commonly adulterated with urea, brick dust, industrial dyes, and other harmful substances. Poor marketplace conditions—marked by inadequate

refrigeration, unsafe water, and unhygienic handling—further heighten the risk of cross-contamination. Despite the enactment of the Food Safety Act in 2013, governance failures remain profound. Food safety oversight is fragmented across more than a dozen ministries and agencies, resulting in overlapping mandates, weak coordination, and limited accountability. The Bangladesh Food Safety Authority (BFSA), intended as the apex regulatory body, functions largely as a “toothless tiger,” constrained by insufficient funding, manpower shortages, and limited enforcement authority. Regulatory action is predominantly reactive, relying on sporadic mobile court drives rather than systematic, risk-based inspection. Inadequate laboratory capacity and slow judicial processes mean that violations rarely lead to meaningful penalties, perpetuating a culture of impunity. Addressing this emergency requires a comprehensive and integrated response. The BFSA must be empowered as a single, authoritative regulator with adequate resources, trained inspectors, and modern laboratories. Enforcement should shift toward risk-based inspections, supported by mobile testing units, digital traceability for high-risk foods, and expanded soil and residue testing at the local level. Equally important is stakeholder engagement—educating farmers on safe input use, empowering consumers through awareness campaigns, and incentivizing compliance through certification schemes and support for organic and ecological producers. Embedding food safety education across curricula and promoting responsible food habits are essential for long-term change. Reforming food safety is no longer optional; it is fundamental to safeguarding public health and national well-being.

Keywords: *Bangladesh Food Safety Authority (BFSA); Adulteration; Fragmented Governance; Risk-Based Inspection; Digital Traceability.*

Assessing Climatic Variability Shifts and Their Effects on Tea Cultivation: A Case Study on Tetulia Upazila of Panchagarh District in Northern Bangladesh

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In Bangladesh's agricultural sector, tea cultivation is a crucial part, significantly influencing the economy and rural development. The northern part of Bangladesh, Panchagarh and Tetulia, with favorable climatic conditions, is well-suited for tea cultivation. In Tetulia, the tea industry faces challenges due to climatic variabilities, including fluctuations in temperature, erratic precipitation patterns, and soil conditions. Adopt sustainable practices, better weather forecasting, adjusted irrigation/harvesting, and climate-smart strategies for green tea farming. This study focuses on climatic changes in Tetulia (1990–2022), revealing trends in climatic variabilities and how these influence tea cultivation. The study examined climatic variability and its influence on tea cultivation by applying descriptive statistics, correlation, regression, and trend analysis, carried out with the support of SPSS and GIS tools. Through the study, we noted that seasonal shifts in climatic factors contributed to noticeable changes in climatic variability, which affected tea cultivation. Maximum temperatures decrease during the winter and monsoon, while minimum temperatures rise notably in the pre-monsoon. Average humidity increases in all seasons, with winter experiencing the most pronounced yearly rise, while solar radiation shows a steady decline. Precipitation patterns also shifted, rainfall increasing during the monsoon but limited in winter. These changes collectively affected tea cultivation. Another aim of the study was to assess how climatic variabilities directly affected tea cultivation. The findings indicated that shifts in climatic factors are closely linked to changes in both

yield and production. A significant negative relationship was found between winter temperatures and tea production, and costs tended to rise as temperatures increased. In contrast, higher precipitation contributed to improved yields and helped lower production costs due to lower irrigation needed. Solar radiation displayed varied influences, contributing to lower yields while driving production costs upward due to high evaporation and thus more irrigation requirement. Humidity positively influenced yields while decreased costs contain high moisture. The study highlights that, in light of these emerging challenges, farmers, producers, and other stakeholders need to strengthen their adaptive capacity and adopt practices that enhance the resilience and long-term sustainability of tea cultivation in the face of extreme climatic events. Ongoing research and innovative approaches are crucial for maintaining agricultural productivity and economic stability in the region, helping ensure that tea cultivation can continue to thrive for future generations.

***Keywords:** Tea-Cultivation; Northern Region of Bangladesh; Tea Yields; Production Cost; Climatic Variabilities.*

Spatiotemporal Assessment of Soil Erosion Estimated by the Rusle Model: A Case Study of the Barind Region of Bangladesh

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Soil degradation is a critical environmental challenge in Bangladesh, affecting approximately 43% of the country's land through multiple forms of erosion, including sheet, rill, gully, riverbank, and coastal erosion. The Barind Tract is particularly vulnerable due to its geomorphology, increasing population pressure, unsustainable land management practices, and the progressive sedimentation of wetlands, compounded by both wind and water erosion. This study applied the Revised Universal Soil Loss Equation (RUSLE) integrated with Remote Sensing (RS) and Geographic Information System (GIS) techniques to estimate annual soil erosion rates in the Rajshahi, Chapainawabganj, and Naogaon districts of the Barind region from 2005 to 2024. The RUSLE factors-rainfall erosivity (R),

soil erodibility (K), slope length and steepness (LS), conservation practice (P), and cover management (C)-were systematically derived. The R factor was calculated using annual average precipitation data from NASA POWER, while the K factor was estimated from the FAO soil database. Digital elevation models were used to compute LS and P factors, and the Normalized Difference Vegetation Index (NDVI) was applied to estimate the C factor. Land Use and Land Cover (LULC) changes were mapped using the Google Earth Engine platform and analyzed in ArcGIS to assess temporal dynamics. Results indicate that the highest potential annual soil loss increased from 325-ton ha⁻¹ year⁻¹ in 2005-to-282.34-ton ha⁻¹ year⁻¹ in 2015, sharply rising to 894.97-ton ha⁻¹ year⁻¹ in 2024. Naogaon district consistently experienced the greatest erosion extent, with severely eroded land increasing to 464.74 ha in 2024 and soil loss reaching 464.74-ton ha⁻¹ year⁻¹. The marked increase in soil loss in 2024 highlights the strong influence of recent LULC transitions-particularly the reduction of agricultural land and the expansion of urban and bare land-on accelerating erosion. These findings provide critical insights for policymakers to identify erosion-prone zones and prioritize targeted soil conservation measures in the Barind region.

Keywords: Soil Erosion; RUSLE Model; Barind Tract; LULC Change; Geoinformatics

Opportunities and Challenges of Solar Pump– Based Irrigation: A Case Study of Chithulia Union, Kushtia

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Bangladesh is an agro-based country, with approximately seventy five percent of its population living in rural area and directly or indirectly involved in agricultural activities for their livelihood. Agricultural production requires reliable irrigation facilities to maximize crop yield. These reliable irrigation systems are primarily divided into

disel-powered and electricity driven systems, which are neither cost effective nor sustainable. In this condition, solar irrigations system offers an innovative and environment friendly solution for irrigation purpose utilizing renewable solar energy. This study assesses the key opportunities and challenges associated with the adoption and operation of solar pump irrigation in Chithulia Union under Kushtia District. In Cithulia, 51% inhabitants are engaged in farming activities, cultivating a variety of crops such as paddy, jute, maize, vegetables and tobacco. To promote this agricultural development in the area, the Infrastructure Development Company Limited (IDCOL) has financed seven solar irrigation pumps, following a Grant: Debt: Equity structure which equals to 40:40:20. These solar pumps were installed in the time span of 2014-2015 and were maintained by NGO Resource Development foundation (RDF). Data collection involved both qualitative and quantitative approach including field observations, focus group discussions (FGDs), key informant interviews (KIIs), and structured survey interviews with standardize questionnaire. The respondents included relevant stakeholders as service provider (IDCOL officials, RDF representatives, pump operators) and pump beneficiaries of 105 farmers. The secondary data were collected from various government and non-government sources such as BMDA, BMD, RDF, IDCOL reports, official documents, articles and journals. The findings reveal a significant cost difference- between disel-powered and solar irrigations. The charge of single irrigation of one bigha land with disel is 420Tk whereas single irrigation charge on same land under solar is only 70Tk. This makes disel irrigation six times more expensive than solar irrigation. Solar irrigation is not only cost effective but also provides low operation and maintenance cost, reduce carbon emission, noise pollutions, water contamination. Solar irrigation contributed to higher agricultural productivity, saves time and energy and keep the environment pollution free. However, despite these advantages, there persist several technical and economic challenges such as, high installation cost, lack of knowledge and skill, low salary of operators, managements issues and many more. The study highlights the necessity of overcoming these challenges through targeted investments, capacity-building initiatives, and effective management strategies for long term sustainable solar irrigation.

Keywords: *Solar Pump-Based Irrigation; Cost-Effective; Renewable Energy; Agricultural Productivity; IDCOL.*

Lightning Disaster in Bangladesh- Assessing Vulnerability and Risk through Application of Pressure and Release (PAR) Model

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Lightning is an essential phenomenon that strike 100 times every moment all over the world to maintain balance of electric charges among the earth's spheres. Due to climate change and instability in atmospheric events, it is very recurring in recent time. Among the disasters, in term of causalities, lightning is considered as severe one, especially in Bangladesh. Bearing in mind the situation, Bangladesh government declared lightning a disaster in 2016 when 81 people died in two days. Literatures indicate that, recent upward trend of lightning is typically caused by lack of knowledge, awareness and preparedness of people. Researchers have focused on analyzing vulnerabilities and finding ways to minimize lightning disaster. Considering the fact, this research analyzes people's vulnerabilities due to lightning in Bangladesh based on PAR model. To analyze the model properly, current study uses both primary and secondary data. Model analysis results indicate that people's vulnerability to lightning depend on limited access to modern technology, resource, power, information, quick decision making etc. Subsequently, dynamic pressure such as lack of awareness, education, training, workshop, early warning system, awareness building programs, risk mitigation programs, management system of govt. workers etc. are also enhancing the risk of lightning casualties. Moreover, the noted unsafe condition comprises housing without lightning protection, unprotected crop field, unprotected outside area or below tree, low economic level and rural poverty, lack of local NGO for lightning management, lack of lightning preparedness etc. which are the ultimate phase of vulnerabilities to modify the lightning hazard into lightning disaster.

Keywords: *Lightning; Vulnerability; PAR model; Bangladesh.*

Scoping for Enhancing Food Safety in Horticultural Value Chain of Bangladesh

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The horticulture sector of Bangladesh plays a critical role in ensuring food security and economic resilience; however, it remains burdened by persistent food safety challenges across its supply chain as well as value chain. Despite favorable agro-climatic conditions along with the rising domestic and export demands, the sector struggles with unsafe production practices, overuse of agrochemicals, inadequate postharvest handling, and lack of safety regulations enforcement. This study aimed to explore the existing horticultural value chain for fruits and vegetables while identifying potential food safety risks within the value chains, and propose strategic recommendations, such as Good Agriculture Practices (GAP), for safer and more sustainable production. A mixed-method approach was selected for the study, where primary data from 206 respondents, including producers, traders, and storage facility managers across five regions, was combined with secondary literature and desk reviews. The data collection approach involved focus group discussions (FGDs), key informant interviews (KIIs), and structured consumer surveys using appropriate questionnaires. Findings from the study reveal significant gaps in farmers' knowledge about food safety and its practices, lack of proper training opportunities for stakeholders at different stages, starting from the root, which is the farmers, improper and inappropriate use of pesticides as well as fertilizers, and absence of any kind of certification or regulatory compliance process. Additionally, structural bottlenecks, such as, lack of traceability systems, inadequate storage facilities, and fractured policy implementation, altogether further compromise the safety and quality of harvested crops. However, consumers and stakeholders expressed readiness for improved practices and regulation regarding production and consumption of safe and quality fruits and vegetables. This study underlines the urgent need for capacity-building for all

the stakeholders in the respective value chains, overall infrastructure development, and harmonization of food safety policies with global standards. Moreover, promoting Good Agricultural Practices (GAP) and stronger value chain governance can transform the entire horticultural system into a safer, more competitive, and sustainable model for the country.

Keywords: *Food Safety; Horticultural Value Chain; Good Agricultural Practices; Bangladesh.*

Usage of New Technology in Agricultural Sector of Bangladesh: Farmer's Perception

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We humans have made our lives easier with the use of technology-agriculture is no exception. Technology is providing the world with a variety of opportunities, including the elimination of agricultural problems, the increase of yield and the reduction of farmers' distress. Agriculture plays a vital role in every country, especially in developing countries like Bangladesh. This study examines farmer's perception on using new technology in agriculture of Bangladesh. By conducting research on the farmers of Patuakhali district's Alipura Union, this study investigated what kind of new technologies are used by the farmers and also found out whether the new technologies are useful for the agriculture of this area. It demonstrates that Bangladesh is still far behind on using technology in agriculture. In many cases, it is limited to the use of tractors only. Even over a large area, traditional methods of agriculture are still prevalent. Analyzing 52 samples it is urged discursively that a variety of socioeconomic conditions can have an impact on using new technologies by farmers and they are lagging behind in adopting machinery. Farmers who have adopted new technologies over time have observed an increase in the intensity of their adoption.

Keywords: *Agriculture; Technology; Farmer; Perception; New.*

Beyond Leather: Evaluating Environmental Degradation in Bangladesh's Tannery Zone: A Case Study on Hemayetpur, Savar

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The tannery industry is a cornerstone of Bangladesh's economy, contributing significantly to export earnings and employment. The leather sector contributes a significant portion to Bangladesh's economy, contributing 4% of the country's total exports and 0.5% of the total GDP. The leather sector directly and indirectly employs around 850,000 people. Despite industrial prosperity, the tanning process poses an environmental concern we cannot ignore. Though having massive potential, this growing sector has received much criticism on environmental as well as health issues. Basically, the process of tanning is to retain the skin's natural properties; to stabilize its structure and at the same time to chemically process it so it will no longer be subject to putrefaction. This study investigated the environmental degradation and health hazards linked to tannery operations, focusing on BSCIC Tannery Estate, Dhaka. Using mixed-method approaches, including environmental sampling (odor, water and sediment color, air quality), lab test of water and soil sample, surveys, and stakeholder interviews, the research highlights critical issues such as contamination in water and soil, occupational health risks (e.g., skin diseases, respiratory disorders), and socio-economic challenges of post-relocation. I primarily conducted this research by measuring indicators of water quality, including pH, EC, salinity, TDS, and ORP. Dust particles, chemical fumes, and other airborne contaminants are produced during several tannery operations, including soaking, liming, tanning, finishing, and waste disposal. Because they can enter the respiratory system and harm health. I also focused on measuring particulate matter (PM), more especially PM_{2.5} (particles with an aerodynamic diameter less than 2.5 μm) and PM₁₀ (particles with an aerodynamic diameter less than 10 μm), which are

regarded as the most important factors among them. So, investigation of the Environmental and Health consequences of the industry and minimizing the findings are the urgent need for sustainable practices, regulatory enforcement, and holistic policies to balance economic gains with environmental and human well-being.

Keywords: *Tanning; GDP; Putrefaction; Toxicity; Sustainable; Relocation; TDS; Salinity; Electric Conductivity.*

Loss and Damage in Bangladesh Aquaculture due to Extreme Temperature and Erratic Rainfall

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Bangladesh's aquaculture industry plays a vital role in national and global food and nutrition security. However, increasing environmental challenges and climate-related disruptions are threatening its productivity, with potential consequences for economic stability and food supply. This study assessed the impacts of key climatic stressors, high temperature and erratic rainfall, on pond fish farming and hatchery operations, as well as the adaptation strategies employed. From August to October 2024, a semi-structured questionnaire survey was conducted with 130 fish farmers and 50 hatchery owners, alongside key informant interviews with fisheries officers and aquaculture experts, across five sub-districts: Fulbaria, Mymensingh Sadar, Muktagacha, Trishal, and Bhaluka. Results indicated that Fulbaria experienced the most severe effects of high temperatures, Muktagacha was mostly impacted by erratic rainfall, Trishal emerged as the most affected overall, with farmers experiencing fluctuating incomes and significant economic losses due to the combined effects of high temperature and erratic rainfall. Multivariate analysis of variance revealed significant associations between extreme weather events and decreased production, increased costs, fish mortality, reduced growth, and infrastructure damage. In hatcheries, erratic rainfall was found to significantly reduce breeding success and increase

seed susceptibility to disease. These findings highlighted the urgent need for location-specific adaptation strategies and early warning systems to strengthen climate resilience, safeguard livelihoods, and ensure the long-term sustainability of freshwater aquaculture in Bangladesh.

Keywords: Loss And Damage; Extreme Weather Events; Fish Farms; Fish Hatchery.

A Combined Study of Water Quality Analysis and Human Perceptions in the Buriganga and Turag Rivers

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The Buriganga and Turag Rivers, two major urban waterways flowing through Dhaka, experience severe seasonal deterioration in water quality due to industrial discharge, domestic sewage, and reduced river flow during the dry months. This study compares key physico-chemical and microbial parameters of both rivers during the monsoon and dry seasons, following the standards of the Environmental Conservation Rules 2023 (ECR 2023). This study compares the seasonal variation in key water quality parameters based on ten strategically selected sampling points, including six locations along the Buriganga and four along the Turag River. Samples were analyzed for pH, TDS, TSS, turbidity, salinity, BOD₅, COD, nitrate, nitrite, phosphate, and E. coli to evaluate pollution intensity and seasonal dynamics. The assessment showed a clear seasonal contrast in water quality. In the dry season, reduced flow and limited dilution led to higher concentrations of organic matter, suspended solids, and microbial contaminants. Monsoon flows offered short-term dilution but brought sediment-rich runoff, keeping turbidity high. Across both seasons, the Buriganga consistently showed poorer quality than the Turag due to dense urban settlements, industrial discharge, and encroached riverbanks. A community survey captured local perceptions and river-use patterns. Residents reported continued dependence on the rivers despite recognizing visible waste, foul odor, and reduced aquatic life. Many acknowledged that poor community waste practices

worsen pollution. The survey also revealed health concerns, low trust in institutions, and strong demand for effective restoration and enforcement. The combined scientific assessment and community insights demonstrate that both rivers face intensified pollution during the dry season due to reduced flow and sustained waste discharge, while monsoon flows offer only temporary dilution without substantial ecological recovery. Integrating laboratory findings with community perspectives underscores the urgency of implementing season-specific river management strategies, strengthening public engagement, and improving policy enforcement to restore the ecological and social functions of these vital urban waterways.

***Keywords:** Seasonal Deterioration; Industrial Discharge; Domestic Sewage; Dry Months; River Management Strategies.*

Lithological and Geotechnical Controls on Meander Stability: Evidence from the Madhumati and the Brahmaputra Rivers

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Meander stability is strongly influenced by subsurface lithological heterogeneity and soil strength. This study compares the geotechnical controls on meander behavior between two major rivers of Bangladesh, the Brahmaputra and the Madhumati (Ganges system), using sediment-core stratigraphy, Troels-Smith classifications, and Dynamic Cone Penetrometer (DCP) measurements. Lithological profiles reveal that the Brahmaputra is dominated by older, reddish-to-grey sandy and sandy-silty clay layers with high iron content, moderate organic components, and generally dry, compacted deposits. Correspondingly, DCP values remain consistently low but uniform with depth, indicating a stable but moderately weak substrate that resists rapid lateral adjustment. In contrast, the Madhumati River exhibits younger, wetter, highly heterogeneous silty sand and clayey sandy silt, with abundant herbaceous material, peat, and occasional snail-shell fragments. These recent floodplain sediments produce

high DCP resistance near the surface but a sharp decrease with depth, reflecting loose and weakly consolidated subsurface layers. These geotechnical differences explain the contrasting channel behaviors: the Brahmaputra maintains narrow, elongated, and relatively stable meanders, whereas the Madhumati shows high lateral migration, bank erosion, and wide-open bends. The results demonstrate that meander stability is governed not only by planform geometry but by the age, moisture, consolidation, and vertical strength profile of sandy alluvial materials. The study provides critical insights for erosion management and river training in actively evolving alluvial systems.

Keywords: Lithology; Meandering River; Madhumati River; Brahmaputra River; Stability.

Occupational Health Risks vs. Economic Gains: A Cost-Benefit Analysis of Formalizing the E-waste Sector in Bangladesh

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Every year, about 3 million metric tons of electronic waste (e-waste) is generated in Bangladesh. This figure is expected to rise sharply by 2030. Though this waste stream presents a lucrative opportunity for urban mining and recovering precious metals like gold and copper, more than 90% of it is processed in the informal sector. Places like Dholaikhal and Nimtoli, acid baths, and open burning in up against regulations present substantial risks. Even after the E-waste Management Rules 2021, change to the formal regime is slow. The pressure to generate profits has the potential to harm the environment. The study aims to perform a qualitative cost-benefit analysis for the human dimension of the said trade-off. It is trying to find out why workers continue to work in unsafe conditions, and how they view state regulation. The research intends to answer the following questions: 1) How do informal e-waste workers assess their immediate economic gains and long-term occupational health risks subjectively? 2) What are the perceived socio-economic barriers to

integrating into a formalized, regulated waste management system? Using a phenomenological qualitative design, the study relied on data from 33 in-depth semi-structured interviews and four focus group discussions (FGDs) with scrap dealers, dismantlers, and metal burners in informal recycling clusters in Dhaka. They did some walkthroughs to see what safety practices were in place. Inductive thematic analysis was used to analyze the data to determine the prevailing attitudes towards risk and regulation. Results show that there is “calculated fatalism.” While 85% of respondents agreed that they suffered from respiratory conditions and chemical burns, these health costs were viewed as acceptable in exchange for economic freedom and earning a higher daily wage than in the formal labor market. The “cost” of formalization was not a compliance cost; it was a threat to existence. Workers were very concerned that formalization would lead to a monopoly by corporations and dispossess them of their livelihoods. Current formalization policies do not support health and safety but are seen as exclusionary. According to the research, bans on informal recycling that will punish people will probably not work. Policy must shift towards “inclusive formalization”. This means acknowledging existing informal clusters as recognised micro-enterprises and incentivising their transition through subsidised safety equipment, health insurance, and technical training instead of displacement from large corporations.

Keywords: *E-Waste Recycling; Occupational Health; Inclusive Formalization; Cost-Benefit Analysis; Urban Mining.*

Towards Cleaner Cities: A Reform Framework for Air, Noise and Visual Pollution Governance

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Rapid urbanization, industrial expansion, increasing vehicle density, and uncontrolled infrastructure development activities have resulted in air, noise, and visual pollution becoming a serious environmental crisis in Bangladesh. Although these three types of pollution carry

interrelated and distinct scientific characteristics, their combined effects are constantly damaging human health, urban ecosystems, the economy, and overall quality of life. Air pollution increases the risk of respiratory and cardiovascular diseases, reduces the development of children's brains, and causes numerous premature deaths annually. Noise pollution causes mental stress, hearing loss, and social behavioral changes. On the other hand, visual pollution is seriously degrading the aesthetics of cities, mental peace, and overall cleanliness of the urban environment. Although the country has many policies related to Environmental Conservation Rules, Air Pollution (control) Rules, Noise Pollution Control Rules, and Urban Planning, there is a significant gap in the implementation of these policies and laws at the field level. Weak enforcement capacity, limitations in monitoring and data collection, lack of coordination among relevant agencies, accountability crises, and political-economic pressures are rendering overall environmental management ineffective. As a result, without effective reforms, environmental degradation may have a deeper impact on public health and economic stability in the future. This article presents the framework, scientific analysis, health and ecological impacts, policy gaps, international experiences, and a reform roadmap suitable for the Bangladeshi context of environmental pollution such as air, noise, and visual pollution. The proposed roadmap places special emphasis on data-based decision-making, modern monitoring systems, mandatory application of green technologies in the industrial and transport sectors, urban planning reforms, public awareness raising, empowerment of local governments, integrated policy updates, and strict law enforcement. The article shows that effective environmental reform to control air, noise, and visual pollution is not only an environmental necessity, but also an integral condition for protecting public health, maintaining economic viability, achieving urban sustainability, and protecting the rights of future generations. Therefore, integrated, evidence-based, and long-term environmental reform is the inevitable demand of the time.

Keywords: *Urban Environmental Degradation; Public Health; Environmental Governance; Policy Gaps; Sustainable; Reform.*

GHG emission inventory in Agriculture sector in Bangladesh: Assessing Carbon Dioxide Emissions from Urea Fertilization and Proposing Sustainable Reforms

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Bangladesh is an agriculture-based country. With the increasing population, Bangladesh is driven towards intensive rice cultivation, raising livestock populations, and using nitrogen-based fertilizers. Article 6 of the Paris Agreement, carbon markets, and various forms of cooperative approaches allow countries to achieve their NDCs; therefore, in this context, the development of an accurate and sector-specific GHG emission inventory has become an urgent need for the agriculture sector of Bangladesh. Agriculture is a massive sector, so collecting every field's data is nearly impossible from the perspective of Bangladesh, and a critical data gap persists due to the absence of field-level, activity-specific emission factors tailored to Bangladesh's diverse agricultural systems. This study represents the GHG emission inventory of the agricultural sector in Bangladesh, considering data from carbon dioxide (CO₂) emissions from urea fertilization. GHG emissions from the agriculture sector have been estimated using the methodologies and structure of the 2019 Refinement to the 2006 IPCC Inventories Guidelines for National Greenhouse Gas Inventories. All the Results show that carbon dioxide from nitrogen-based urea fertilizers contributes to a significant number of emissions. The study highlights differences in emission intensity across various regions. It also proposes sustainable reforms such as setting limits on the amount of urea usage, promoting environment-friendly fertilizers, implementing training and awareness programs for farmers, offering grants to support research on innovative, low-emission fertilizer practices, and providing subsidies or incentives for the use of fertilizers with lower carbon footprints. These insights are crucial for policymakers, researchers, and others involved in crafting effective

strategies to reduce emissions, encourage climate-smart farming, and fulfil national reporting requirements under the UNFCCC.

Keywords: *Emission inventory; Agriculture; Greenhouse Gas; Carbon dioxide; Reforms.*

Water Quality Assessment of Buriganga River, Bangladesh: Autumn Season Analysis

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The Buriganga, a lifeline of Dhaka city, has been subjected to severe degradation due to unregulated industrial discharge, rapid urban expansion, and poor waste management. This study evaluates the water quality of the Buriganga River by analyzing samples from eight designated locations during the autumn season (mid-August to mid-October) of 2023. Ten physico-chemical parameters temperature, visibility, electrical conductivity (EC), pH, total dissolved solids (TDS), dissolved oxygen (DO), total alkalinity, total suspended solids (TSS), biological oxygen demand (BOD₅), and turbidity were measured and compared with the Environmental Conservation Rules (ECR, 2023). The findings reveal that temperature (28.47–29.27°C), pH (6.47–7.13), TDS (83.33–266.67 mg/L), and total alkalinity (62–130 mg/L) generally remained within acceptable limits. In contrast, several critical parameters exceeded standard values. Dissolved oxygen was satisfactory at most sites (6.0–6.5 mg/L) but fell below the minimum threshold (≥ 5 mg/L) at Dholaikhal (4.1 mg/L), indicating localized oxygen depletion. BOD₅ levels were alarmingly high at all sites (10–110 mg/L), far exceeding the permissible limit of 6 mg/L, with Dholaikhal again recording the worst condition (110 mg/L). Turbidity ranged from 5.77 to 27.95 NTU, with Hazaribag showing nearly three times the allowable level (10 NTU). TSS values (3–32 mg/L) and EC (186.67–550 μ S/cm) remained within permissible ranges but showed localized spikes, particularly at Dholaikhal. The integrated assessment highlights that while some

physico-chemical parameters meet regulatory standards, critical pollution indicators such as BOD₅, DO, and turbidity reveal alarming deterioration, particularly near Dholaikhal, Kamrangir Char, and Hazaribag. The observed causes for the degradation are the water vehicle oil discharge, waste disposal, sewage discharge, laundry and WASA sluice gate. These findings demonstrate the importance of evidence-based river restoration policies like the urgent need for industrial effluent control, proper solid waste management, and strict enforcement of environmental regulations to restore the ecological health and usability of the Buriganga River and aim to contribute to sustainable water resource management in Bangladesh.

Keywords: Buriganga River; Water Quality; Pollution Assessment; Physico-Chemical Parameters; Autumn Seasons.

State of Environment of Chandpur District (Town): A Comprehensive Analysis

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Chandpur, a historically important riverine city of Bangladesh, is uniquely located at the confluence of the Padma and Meghna rivers. This geographical location provides it with abundant water resources and fertile landscapes. However, the district is also vulnerable to environmental hazards. This study presents an integrated assessment of the environmental conditions of Chandpur, including traffic congestion on the city's roads, air pollution, noise pollution, waterlogging in various parts of the city, open defecation, wall writing/posting, begging, and severe river erosion. The number of vehicles, including autorickshaws, in the city is increasing day by day, leading to traffic congestion at times reaching unbearable levels. The levels of noise pollution and air pollution are increasing day by day. During the monsoon, many places experience waterlogging, disrupting communication. River erosion due to unbalanced hydro-morphological conditions and climate change has become a constant threat to land, infrastructure and livelihoods. Furthermore, the study

highlights the issue of Traffic jam, air pollution, sound pollution and water logging, municipal waste into rivers, industrial effluents and agricultural lands, which is rapidly creating an imbalance in the aquatic ecosystem and threatening the living style of people. Air quality in urban areas is also a concern due to industrial emissions and vehicular emissions. The analysis emphasizes the urgent need for integrated and sustainable management strategies. The comprehensive analysis will explore potential solutions to address traffic congestion, air pollution, and noise pollution, waterlogging, implementing riverbank protection measures, ensuring access to safe drinking water, improving waste management systems, and building a climate-resilient future for the community of Chandpur.

Keywords: *State of the Environment (SoE); Environmental Analysis; Chandpur District.*

তিস্তা নদী: পরিবেশগত সংকট ও পুনরুদ্ধার

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তিস্তা নদী বাংলাদেশের উত্তরাঞ্চলের জীবনরেখা-বাস্তুসংস্থান, এবং জনপদের আর্থ-সামাজিক-সাংস্কৃতিক জীবনের মূল ভিত্তি। তিস্তা প্রবাহের উপরেই নির্ভর করে তিস্তা অববাহিকার পরিবেশ ও প্রতিবেশ। তবে নদীর স্বাভাবিক প্রবাহ, মৌসুমি ছন্দ ও অবকাঠামোগত ভারসাম্য বিনষ্টের ফলে কৃষি উৎপাদন, মৎস্যসম্পদ, চরাঞ্চল এবং নদী তীরবর্তী মানুষের জীবন মারাত্মকভাবে প্রভাবিত হয়েছে। শুষ্ক মৌসুমে পানি সংকট এবং বর্ষায় বন্যা এই অঞ্চলের জনজীবনকে নিয়মিত ঝুঁকিতে ফেলে। তিস্তা সংকটকে কেবল প্রাকৃতিক সমস্যা হিসেবে দেখা যাবে না; মানবসৃষ্ট উন্নয়ন সিদ্ধান্ত, একমুখী উন্নয়ন দর্শন, আন্তর্জাতিক নদী ব্যবস্থাপনায় ক্ষমতাগত অসমতা এবং অভ্যন্তরীণ প্রাতিষ্ঠানিক সমন্বয়হীনতার অনিবার্য ফলাফল হিসেবেই এই বিপর্যয়কে দেখতে হবে। তিস্তা সংকটের প্রভাব পরিবেশগত ও সামাজিক-মৎস্য সম্পদ ও সংশ্লিষ্ট প্রাণ বৈচিত্র্যের বিলোপ, অনিয়ন্ত্রিত ভাঙন, নাব্যতা হ্রাস, কৃষি উৎপাদনে বিপর্যয় ইত্যাদিতে সবচেয়ে বেশি ক্ষতিগ্রস্ত প্রান্তিক জনগোষ্ঠী-যারা সব ধরনের উন্নয়ন প্রচেষ্টা সত্ত্বেও দারিদ্র্য চক্রে বন্দি। নদীর সঙ্গে সম্পর্কিত স্থানীয় সংস্কৃতি, সংগীত, আচার ও ঐতিহ্যও ক্ষয়িষ্ণু। এই সকল বাস্তবতা পরিবেশগত ন্যায্যতা এবং উন্নয়ন প্রচেষ্টাকে বার বার ব্যর্থ করে দেয়। এই প্রেক্ষাপটে তিস্তা সমন্বিত ব্যবস্থাপনা ও পুনরুদ্ধার প্রকল্প (TRCMRP) বাস্তবায়নে সরকারের নীতিগত সিদ্ধান্ত গুরুত্ব দিয়ে বিবেচনা করতে হবে। প্রকল্পটি সম্পর্কে বিস্তারিত জানা না গেলেও আশা করা যায় যে এটি কেবল অবকাঠামোগত প্রকল্প হবে না, বরং এতে অন্তর্ভুক্ত হবে এমন এক দর্শনগত পথরেখা-যা নদীকে নিয়ন্ত্রণযোগ্য সত্তা হিসেবে নয়, পুনরুদ্ধারযোগ্য বাস্তবস্থান

হিসেবে দেখবে। জানা যায় যে প্রস্তাবিত তিস্তা মহাপরিকল্পনায় মূল কার্যক্রমগুলো হবে: নদীর স্বাভাবিক ন্যূনতম প্রবাহ পুনঃপ্রতিষ্ঠা, পলি ব্যবস্থাপনা ও চরাঞ্চলের ভারসাম্য, মাছ ও জলজ জীববৈচিত্র্য সংরক্ষণ, নদীতীরের বাঁধ ও তীর সংরক্ষণ, ভূমি পুনরুদ্ধার এবং নৌপরিবহন সুবিধা উন্নয়ন। এছাড়া, প্রকল্পে স্থানীয় জনগোষ্ঠীর অংশগ্রহণ, সামাজিক ন্যায়বিচার, নারী ও প্রান্তিক জনগোষ্ঠীর ক্ষমতায়ন, তথ্যভিত্তিক ও স্বচ্ছ সিদ্ধান্ত গ্রহণ, এবং সরকারি সংস্থাগুলোর মধ্যে সমন্বয় নিশ্চিত করা হবে; এবং জলবায়ু সহনশীলতা ও দুর্যোগ ঝুঁকি হ্রাসের জন্য প্রাকৃতিক প্লাবনভূমি ও চরাঞ্চলকে বাফার হিসেবে ব্যবহার করা হবে। এছাড়া, প্রকল্প আঞ্চলিক কূটনীতি এবং আন্তর্জাতিক নদী ব্যবস্থাপনার প্রেক্ষাপটকে স্বীকার করে তিস্তা সংকটের ন্যায্য ও যুক্তিসংগত সমাধান নিশ্চিত করবে। কিন্তু তিস্তা সমন্বিত ব্যবস্থাপনা ও পুনরুদ্ধার প্রকল্প বাস্তবায়নে প্রধান চ্যালেঞ্জ হলো—দীর্ঘদিনের নিয়ন্ত্রণমূলক মানসিকতা, অর্থায়ন ও অগ্রাধিকার নির্ধারণের দ্বন্দ্ব, স্থানীয়দের অংশগ্রহণের সীমাবদ্ধতা, এবং উজানের নিয়ন্ত্রণ কাঠামোর ওপর বাংলাদেশের সীমিত প্রভাব। সাফল্য অর্জনের জন্য প্রয়োজন ধাপে ধাপে এমন এক দীর্ঘমেয়াদী প্রকল্পের স্বচ্ছ ও অংশগ্রহণমূলক বাস্তবায়ন, যার নকশা হবে নমনীয় এবং যার জন্য বজায় থাকবে দীর্ঘমেয়াদি রাজনৈতিক ও আর্থিক প্রতিশ্রুতি। তিস্তা নদীকে পুনরায় একটি জীবন্ত, পরিবেশবান্ধব, এবং মানুষের সহাবস্থানমূলক বাস্তবস্থানে পরিণত না করতে পারলে উত্তরাঞ্চলের বৃহত্তর অংশকে পরিবেশগত সংকট থেকে রক্ষা করা সম্ভব হবে না। তিস্তা সংরক্ষণ ও উন্নয়নের উদ্যোগ দ্রুত গ্রহণ করার মাধ্যমে, বাংলাদেশের নদী ব্যবস্থাপনা ও পরিবেশগত ন্যায়বিচারের জন্য একটি দৃষ্টান্ত স্থাপন করতে হবে।

মূল শব্দ: নদী পুনরুদ্ধার; পরিবেশগত ন্যায্যতা; সমন্বিত নদী ব্যবস্থাপনা; জলবায়ু সহনশীলতা।

E-waste Management in Bangladesh: An Evaluation of Environmental-Economic Impacts and Policy Gaps

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Electronic waste (e-waste) generation in Bangladesh has increased dramatically as a result of the country's fast urbanization, digitalization, and growing consumer demand for electronics. This study identifies important policy gaps impeding sustainable management and assesses the environmental-economic effects of expanding e-waste streams. Results show that hazardous materials such as lead, mercury, and brominated flame retardants are released into soil, water, and air by informal recycling practices, endangering ecosystems and public

health. Due to the lack of a formal recycling infrastructure, valuable materials like gold, copper, and rare earth elements are still mostly unrecovered, causing large financial losses. To obtain precise data on e-waste generation, accumulation, and current management practices, the study surveyed e-waste processing organizations across Dhaka city. The evaluation identifies significant regulatory flaws, such as careless application of current regulations, a lack of national collection mechanisms, low public awareness, and insufficient integration of producer responsibility. To ensure environmentally sound management and improve resource recovery, the study highlights the need to invest in formal recycling facilities, implement extended producer responsibility (EPR), and create a comprehensive, enforceable policy framework. To reduce environmental risks and maximize the economic potential of e-waste recycling in Bangladesh, it is imperative to strengthen institutional coordination and encourage public-private partnerships.

Keywords: *E-waste; Policy Gaps; Informal Recycling; EPR; Environmental-Economic; Hazardous.*

Assessing Industrial Pollution and Governance Failures in the Turag River: Pathways for Regulatory Reform and Sustainable Management

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The Turag River, an Ecologically Critical Area (ECA) in Bangladesh, has undergone progressive degradation in water quality due to unregulated industrial development along its banks, posing significant threats to the aquatic ecosystem, nearby communities, and public health in Dhaka city. This study investigates the key sources of industrial pollution in the Turag River and evaluates the failures of environmental governance, especially in relation to the Environmental Conservation Rules 2023 (ECR 2023), Environmental Impact Assessment (EIA) regulations, and the implementation of

Environmental Management Plans (EMPs). It also proposes policy and institutional reform pathways to enhance the effectiveness of regulation and the management of water in urban rivers. Multiple field visits, a focused literature review, and key informant interviews with regulatory officials, local residents, and environmental specialists were conducted to assess the current scenario. The major sources that cause pollution include textile, dyeing, tannery, washing units, chemical, pharmaceutical, and metal-processing industries across the Dhaka-Tongi-Gazipur-Ashulia industrial belt. Most industries release untreated effluent and ignore their EMP commitments, as well as the rules of ECR 2023 and EIA requirements. In addition to highlighting the sources of pollution, this study uncovers persistent policy and institutional weaknesses that have enabled the river's ongoing degradation. Regulatory compliance has declined due to inadequate and irregular monitoring, weak enforcement by regulatory bodies, and poor EMP implementation. To reduce industrial pollution in the Turag River, it is recommended to strengthen compliance auditing, mandate fully functional Effluent Treatment Plants (ETPs), implement cumulative and integrated Environmental Management Plans (EMPs), enhance the enforcement capacity of the Department of Environment (DoE), and promote the adoption of cleaner technologies. These actions are essential for ecological restoration of the Turag River as well as for establishing a sustainable and reform-oriented framework for industrial water governance in Dhaka and other urban river systems across Bangladesh.

***Keywords:** Turag River; Industrial Pollution; Environmental Governance Failure, Industrial Reform, Effluent Treatment Plants (ETPs).*

Appraising the Impact of Air Transport Industry on Environment: An Analysis

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The emerging economies and globalization are primarily responsible for the rapid growth of civil aviation, which will triple in the next 15 years. According to estimates, compared to 2021, the number of passengers carried by air grew by 47%. By this year, it's predicted

that there will be more than 9 billion passengers throughout the world, and a potential increase in cargo transportation ratio, as a result of a steep growth in the amount of international trade. At this point, its effects on the environment are extremely obvious. In comparison to other forms of pollution in the aviation industry, such as engine-related environmental damage, airport emissions (AEs), which include both exhaust and non-exhaust particles from aircraft, have received increasing attention in recent years such as airport ground services, maintenance work, heating facilities, fugitive smoke from fueling operations and intermodal transportation systems from the equipment that powers the aircraft during the ground. According to energy analysts at Capital Economics, jet fuel would be the main factor driving the increase in oil demand in this era. In 2025, consumption increased by 1.7 million bpd (Barrels Per Day) . Since ozone levels have grown in the upper troposphere and lower stratosphere due to the atmospheric chemistry of NO_x emissions, this is now the primary concern relating to civil aviation. Secondary pollutant species can also develop in addition to main pollutant species, which originate directly from the source. The latter come up as a result of chemical reactions involving pollutants that were previously discharged. Migration routes, like Gibraltar, where millions of animals congregate, may extend over protected or unprotected land or ocean, but the airspace along these lengthy routes is typically not protected, or in many cases the protection has not been expressly built for numerous aerals. Concerns are raised about the impact this will have on air quality. In comparison to 1960s aircraft, modern airplanes use 70% less fuel. The amount of time spent waiting before landing might also be decreased with improved flight control, and electric motors could be used for taxiing. By taking these steps, the consumption growth predicted for 2040 should be cut in half. Additionally, without modifying the engine, oil firms have created bio kerosene that might replace with fossil fuels.

Keywords: *Civil Aviation; Globalization; Airport Emissions; Exhaust and Non-Exhaust Particles; Bio Kerosene.*

Lignocellulosic Corn Fiber to Compostable PLA: A Waste-to-Value Approach for Reducing Petroleum Based Plastic Pollution in Bangladesh

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Poly(lactic acid) (PLA) is a leading biodegradable polymer that can be produced from corn fiber. Corn fiber is an agricultural byproduct which offers a sustainable alternative to traditional plastics. Key steps of manufacturing this biodegradable plastic include feedstock preparation, hydrolysis, fermentation, purification, and polymerization, with potential yields up to 90% under optimized conditions. Traditional PLA production leverages corn starch via wet milling to isolate glucose, followed by enzymatic hydrolysis, microbial fermentation with *Lactobacillus* species to produce lactic acid, purification through techniques like electrodialysis, and polymerization. This yields high molecular weight PLA (100,000–300,000 Da) with properties suitable for packaging, textiles, and medical applications, boasting a melting point of 173–178°C and biodegradability under industrial composting conditions within 1–2 months. In Bangladesh, feasibility appears promising due to rising corn production which is projected at 5.7 million tons in 2024–25 fiscal year. Government initiatives & policies, including single-use plastic bans implemented in 2024–2025 and incentives like reduced corporate income tax for recycling, align with circular economy goals, as evidenced by material flow analyses showing potential for reducing 2.4 million tons of ocean plastic waste. This research highlights the sustainability, waste valorization, biodegradability, and the direct link to plastic pollution reduction of corn-based plastics. It also shows the opportunities lie in partnerships with global firms and regional firms for fostering local synthesis from fiber to enhance eco-friendly manufacturing.

Keywords: *Plastic Pollution; Poly(lactic Acid) (PLA); Corn Fiber; Biodegradable; Sustainable.*

Hydro-chemical Stress in Coastal Canals Under Accelerated Industrial Development

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The National Special Economic Zone (NSEZ), the largest emerging economic zone in Bangladesh, is located at the estuarine confluence of the Feni River and the Bay of Bengal and currently hosts approximately eleven operational industries. Two major canals Bamonshundor Khal and Shusham Khal traverse the zone, along whose banks most of the current industries are situated. Both canals ultimately discharge into the Bay of Bengal. This study evaluates the water quality at five selected upstream and downstream locations along these canals. Key hydrochemical parameters, including turbidity, electrical conductivity (EC), pH, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), salinity, hardness, calcium, magnesium, total iron, and chemical oxygen demand (COD), were analyzed using standard instrumental and titrimetric techniques. The overall water quality status was assessed using the Water Quality Index (WQI) calculated through the weight rating method. The results indicate a pronounced deterioration in water quality from upstream to downstream in both canals. In Bamonshundor Khal, TDS increased by 64.18% at the downstream site, while hardness rose from 61.17 mg/L to 105.09 mg/L and COD increased from 120 to 128 mg/L. In Shusham Khal, the downstream location at the main sluice gate exhibited TDS, hardness, and COD values of 792.62 mg/L, 210.19 mg/L, and 180 mg/L, respectively, all of which exceeded recommended pollution thresholds and were substantially higher than those at the upstream sites. WQI values categorized all sampling locations as “poor” to “highly polluted,” with the most severe pollution observed at the final discharge points. These findings highlight the urgent need for continuous environmental monitoring, effective pollution mitigation measures, and strengthened regulatory enforcement to safeguard aquatic ecosystems in this rapidly industrializing area.

Keywords: *Hydrochemical Assessment; WQI; NSEZ; TDS; COD.*

Urbanization, Transport Dynamics and Mobility Planning in Bangladesh

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Bangladesh is experiencing one of the fastest rates of urbanization in South Asia, fundamentally reshaping patterns of movement, work, and daily life within its cities. Rapid population growth and horizontal urban expansion have placed intense pressure on transportation systems that are struggling to adapt. Traffic congestion, excessive travel times, rising transport costs, and inefficient mobility options have become routine challenges, particularly in major metropolitan areas such as Dhaka and Chattogram. This research examines how accelerated urbanization is transforming transport dynamics in Bangladesh and identifies the types of mobility planning required to respond to an increasingly complex urban environment. Drawing on secondary data, transport policy analysis, and spatial assessment of key cities, the study reveals deep structural weaknesses in the national mobility system. Unplanned urban growth and fragmented land-use decisions have produced overcrowded road networks, deteriorating air quality, and limited access to dependable public transport. Dhaka, with a population exceeding 20 million, consistently ranks among the most congested cities globally. A heavy reliance on private cars, motorcycles, and informal transport modes intensifies congestion, while pedestrian and cycling infrastructure remains inadequate and unsafe. Emerging cities such as Gazipur, Narayanganj, and Khulna are beginning to face similar pressures as urban growth continues without parallel investments in transport planning and service delivery. The research also evaluates the evolving policy landscape. Initiatives such as the Dhaka Metro Rail, Bus Rapid Transit (BRT), and elevated expressways indicate a move toward modern urban transport solutions. However, weak institutional coordination, enforcement gaps, and poor integration between transport modes limit their long-term effectiveness. At the same time, the expansion of app-based ride services and motorized two-wheelers is reshaping travel behavior, often adding further strain to already saturated road systems. Climate-related risks, particularly flooding and extreme

weather events, further disrupt mobility and underscore the need for resilient transport planning. Overall, the study highlights the urgent necessity of a coordinated, people-centered approach to urban mobility. Strategies such as transit-oriented development, compact city planning, safe walking and cycling networks, and integrated multimodal public transport—supported by strong institutions and data-driven decision-making, are essential for creating inclusive, efficient, and sustainable urban mobility systems in Bangladesh.

Keywords: Urbanization, Transport Dynamics, Mobility Planning, Congestion, Public Transport, Dhaka Metro Rail.

Earthquake Threats in Bangladesh: Vulnerability Assessment and Strategic Pathways to Resilience

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Bangladesh is approaching a critical resilience threshold where rapid urbanization, extreme population density, and escalating seismic signals are converging into a national-level disaster risk. Although earthquakes are low-frequency events, their consequences in Bangladesh would be severe—mass casualties, widespread building collapse, prolonged disruption of lifelines, and cascading secondary hazards such as fires, hazardous material releases, and infrastructure failure. This risk is primarily human-induced, driven by unsafe construction, weak enforcement of building codes, unplanned land use on soft soils, limited preparedness, and insufficient emergency response capacity. Historical earthquakes in the region—including the 1762 Arakan Megathrust, 1897 Great Assam, and 1918 Srimangal events—demonstrate the region’s seismic potential. Major risk zones such as Sylhet, Chattogram, Dhaka-Madhupur, and Narsingdi remain highly exposed, while the absence of a recent large earthquake likely reflects strain accumulation rather than safety. Since 2010, over 550 moderate earthquakes—more than 330 near Sylhet—indicate rising seismic stress, with emerging evidence of new fault

trends further elevating concern. Urban vulnerability is intensified by widespread non-engineered buildings, soft-story structures, unauthorized modifications, and dense development with limited access. Approximately 75% of buildings in Dhaka do not comply with seismic codes, and critical lifelines and emergency facilities lack continuity planning. Bangladesh's earthquake risk is therefore a "not if, but when" scenario. Reducing future losses requires strict enforcement of building codes, risk-based retrofitting of critical facilities, integrated urban planning, strengthened emergency response systems, and sustained community preparedness. Earthquake outcomes will be determined before the event-by governance, construction quality, preparedness, and public awareness.

Keywords: *Earthquake Risk; Urban Resilience; Building Code Compliance; Disaster Preparedness; Risk-based Planning.*

A Comprehensive Review of Water Quality Status and Regulatory Gaps in Bangladesh

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Bangladesh faces a severe water quality crisis that profoundly harms public health and the natural environment. Rapid urbanization, industrialization, agricultural runoff, and inadequate waste management have led to widespread contamination of surface and groundwater with heavy metals, pesticides, pathogens, and emerging pollutants such as microplastics and antibiotic residues. Regulatory frameworks are often undermined by poor enforcement, insufficient monitoring, and outdated standards. This results in persistent loopholes that allow continued pollution and public health risks. This review aims to systematically assess the current status of water quality in Bangladesh, identify regulatory limitations, and propose

a systematic path forward. Concentrations of heavy metals, fecal coliforms, and pesticides frequently exceed national and WHO guidelines in both urban and rural water bodies of Bangladesh. This poses risk of bioaccumulation and biomagnification of toxic metals and microplastics. The system suffers from typical regulatory failures, such as inadequate monitoring, poor surveillance, neglect of climate change impacts, and weak enforcement of effluent standards. The problem is that our water system is failing because policies are not being implemented correctly. The solution requires stronger rule enforcement, updating standards for new pollution, wider water monitoring, and better public education for sustainable water use.

Keywords: Water Quality; Regulatory Gaps; Microplastics; Heavy Metals; Health Risk.

Environmental Impact Assessment of Three Decades of Land Use and Land Cover Change in Dekher Haor, Sylhet, Bangladesh

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Dekhar Haor is a seasonally flooded wetland in Sylhet, northeastern Bangladesh. It provides primary water storage, fisheries, and agricultural services to surrounding communities. As a part of haor system, it also contributes to the regional flood regulation and biodiversity. In recent decades, the haor has experienced growing pressure from unplanned land conversion, drainage modifications and climate-related variability. This study applies an Environmental Impact Assessment (EIA) methodology for the water sector to evaluate the impact of Land Use and Land Cover (LULC) changes in Dekhar Haor over a 30-year period 1995 to 2025 and to identify sustainable wetland management strategies. The assessment follows standard EIA stages. Screening and scoping identify Dekhar Haor as a sensitive wetland and define valued environmental components

(VECs): open water, wetland vegetation, agricultural land and build-up areas. Baseline conditions and trends are established using multi-temporal Landsat 5 TM, Landsat 7 ETM+ and Landsat 8/9 OLI images (30m). After atmospheric correction, cloud masking and clipping to the haor boundary, supervised Random Forest classification is used to generate LULC maps. Accuracy assessment was conducted using confusion matrices and the Kappa coefficient. Results indicate significant loss and fragmentation of open water and wetland vegetation, alongside expansion of agriculture and build-up areas, causing long-term negative impacts of moderate to high severity. These changes reduce dry-season water storage, disrupt habitats, increase farmers' flood risk, and weaken the haor's natural buffering capacity. Using EIA tools such as cause-effect and sensitivity-magnitude analysis, the study identifies major drivers of degradation: embankments, drainage alterations, early cultivation, and unregulated settlement growth, which disrupt the natural hydrological cycle and increase vulnerability to climate variability. By combining remote sensing analysis with EIA-based impact evaluation study recommends protecting core wetland zones; gradual replacement of embankment-dominated schemes with more open, nature-based water management; stricter control on permanent construction within the haor basin; and promotion of wetland-compatible cropping and fisheries practices. In addition, with the Bangladesh Environmental Conservation Rules 2023 (ECR-2023) and the national EIA Guidelines, the study underlines the need to address habitat disruption, ecological and hydrological imbalance, wetland degradation, biodiversity loss and cumulative environmental impacts to ensure sustainable and environmentally compliant management of Dekhar Haor System.

Keywords: *Dekhar Haor; Wetland; Water Resources; Landsat; Environmental Reform.*

Seeing The Earth Through Children's Eyes: Visual Representations of Environmental Vulnerability Among Young Bangladeshi Children

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While adult experiences of environmental sufferings are well documented in Bangladesh, little attention has been given to how children internalize and represent such vulnerability. This qualitative study explores how Bangladeshi children under the age of ten visually represent environmental vulnerability through their paintings. Forty children participated in an open drawing competition, where they were free to depict any subject of their choice. The resulting artworks were analyzed thematically by three professional artists experienced in environmental aesthetics. The analysis revealed that despite the open nature of the task, over 50% of the drawings depicted themes linked to environmental degradation-water pollution, air pollution, river erosion, deforestation, and mismanagement of household-waste. The findings suggest that very young children in Bangladesh possess a subconscious awareness of environmental vulnerability, shaped by direct exposure. The study contributes to the growing body of knowledge on environmental behavior for understanding the environmental consciousness in early childhood and the use of art as a qualitative indicator of socio-environmental sensitivity. In addition, Government, policymakers, environmentalists, NGOs, organizations working for environmental safeguarding could develop suitable policies and guidelines to accelerate the childhood visions to ensure the environmental sustainability in Bangladesh. The findings are drawn on the basis of small and localized sample, and subjective artistic interpretations only, which may not fully capture the depth or diversity of children's understanding of environmental vulnerability, which may affect the generalizability of the findings.

Keywords: *Environmental Vulnerability; Child Art; Visual Thematic Analysis.*

Integrating Geospatial Analysis and Community Perceptions for Sustainable Island Management in the South-Eastern Coast of Bangladesh

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The south eastern part of Bangladesh, which is comprised of Cox's Bazar, St. Martin Island and Moheshkhali Island is full of natural beauty, ecological and economic potential. This paper discusses land use dynamics, tourism issues and natural hazard threats through field surveys, Satellite based mapping and literature review. A high-resolution satellite image was used to develop a Land Use and Land Cover (LULC) map of Saint Martin Island that was categorized into six classes; agricultural land, vegetation, water bodies, beach or sand, built-up areas, and grassland. Mapping had a high level of reliability with Kappa coefficient of 0.885 and overall accuracy of 92%. This was indicated by survey findings in Saint Martin Island as 76.94 percent of the respondents considered overcrowding a serious issue whilst 83.61 percent cited environmental degradation to poor waste collection and unplanned tourism. Nevertheless, 88.57% of them thought that the island has enormous potential to develop ecotourism provided that they are introduced with better regulations and infrastructure. In the Moheshkhali Island, 76.66 percent of the respondents experienced severities of hazards like cyclones and erosion, and 93.23 per cent indicated they were not well prepared to experience such calamities. The proposed research recommends the development of embankments, enhancement of community sensitization and sustainable tourism as a measure to mitigate the risk and safeguard the surrounding environment. On the whole, the paper demonstrates that there is an urgent necessity to incorporate geospatial monitoring, environmental protection and disaster management to the development of coastal areas in Bangladesh in a sustainable manner.

Keywords: *Geospatial analysis; Sustainable tourism; Coastal vulnerability; Land use change; Disaster resilience.*

Environmental Distribution of Biofilm Forming Escherichia Coli Associated with Plastic Surface Materials

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Plastic pollution is now an emerging issue worldwide, and the number of plastic debris is rapidly increasing day by day in this decade. The surface of plastic contains a wide variety of biofilm-forming microorganisms that can pose a risk to human health. Studies showed that *Escherichia coli* is resistant to numerous classes of antibiotics; however, the prevalence of the bacterium on the environmental plastic surface is still unknown. The current study aimed at identifying biofilm-forming *E. coli* from the plastic surface collected from various environmental origins and determining the antibiotic-resistant pattern. A total of 90 plastic samples were collected from wastewater and open surface environments of Mymensingh Medical College, Bangladesh Agricultural University, and BCIC industrial areas of Mymensingh. Among these, 65 samples were found to be positive for the presence of *E. coli*. The plastic samples collected from drainage sources displayed the highest *E. coli* prevalence. By targeting the *malB* gene of the cultured samples, 36 *E. coli* isolates were positive out of 65, and the prevalence rate was 55.4%. There was a considerable variation in terms of the antibiotic-resistant pattern of the isolates. Randomly, 29 isolates were subjected to an antibiogram study. All of the isolates were resistant to imipenam (100%) and ceftazidime (100%), 79.40% were resistant to ampicillin, and 44.82% resistant to gentamicin. The beta-lactamase-producing genes *bla*TEM were detected in 51% (14/29) isolates that showed resistance to ampicillin. The biofilm-

forming study revealed that 91.16% strong biofilm-forming *E. coli* isolates were resistant to ampicillin. Additionally, 18.18% non-biofilm-forming tetracycline-resistant *E. coli* isolates have been found in this study. In summary, to the best of our knowledge, this is the first study in Bangladesh to isolate and identify biofilm forming antibiotic resistant *E. coli* collected from environmental plastic surfaces, but further pathogenicity tests and resistome analysis are required to know the exact genetic resistance pattern.

Keywords: *Escherichia Coli; Plastic Surface; Biofilm; Antibiotic Resistance.*

Assessment of Physicochemical and Biological Parameters of Gulshan Lake of Dhaka City

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Gulshan lake, located in the upscale diplomatic area of Dhaka, Bangladesh, is an urban water body that serves as an important recreational and environmental resource, but is facing serious degradation due to rapid urbanization and anthropogenic pollution. This study assesses key water quality parameters, including physiochemical such as pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), Amonium, Arsenic, chlorine, electric conductivity, iron, nitrate and microbiological indicators. Water samples were collected from five different places of the surface level of the target lake. Findings of the study showed that the majority of the parameters were within the Bangladesh Environmental Quality Standards (EQS) and World Health Organization (WHO) limits which showed an acceptable state of water in which aquatic life could survive. Nevertheless, the level of iron was detected higher in two different sites of the lake, which implies that it was contaminated by sewage, runoff of fertilizers. The nitrate levels were too higher ranges from (290 - 470) mg/L in all sample locations. The important routes of

entry of nitrogen into water body in this lake may be municipal waste and urban runoff. On the other hand, phytoplankton and zooplankton were identified from the collected water samples. Phytoplankton including diatoms, Spirogyra, chlorophyta, and zooplankton including Rotifers, Copepods were found in water samples, which indicate the suitability of fish farming and aquaculture. The findings of the study indicate the risk of eutrophication and emphasize the need to follow up the lake and ensure proper management to keep the ecological balance of the lake intact. This study will help policy makers to enhance water quality and sustainable management of the urban lakes in Dhaka.

Keywords: Physicochemical Parameter; Biological Parameter; Gulshan Lake; Water Quality; Plankton.

Impacts of Rohingya Refugee-Induced LULC Change on Surface Runoff Dynamics in Cox's Bazar, Bangladesh: An Integrated Machine Learning and Remote Sensing Approach

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The changes of Land Use and Land Cover (LULC) have diverse impact on hydrology by modifications of surface characteristics, alter natural water cycle, changing infiltration, evaporation, and groundwater recharge rates. The massive influx of over one million Rohingya refugees from Myanmar to the Cox's Bazar, Bangladesh, has triggered rapid and extensive LULC changes by removing forested trees to build settlements. This study assesses the influence of rapid land cover change on surface runoff from 2016 to 2024 using machine learning and SCS-CN method using Google Earth Engine. The findings of the study show a drastic reduction in forest cover and shrubland which replaced by built-up areas mostly associated with the refugee camps, leading to a significant increase in the weighted Curve Number (CN). Consequently, mean annual surface runoff increase from 1511.49 mm to 2417.63 mm. The transition

to impervious surfaces has increase the risk of flash floods and soil erosion, which lead to urgent sustainable land management and reforestation. These findings show a baseline for policymakers to develop disaster-resilient infrastructure in ecologically sensitive area. Restoration of hydrological stability is essential to mitigate long-term environmental degradation in the region.

Keywords: Evaporation; Flash Floods; Groundwater; Hydrology; Infiltration; LULC; Surface Runoff; Weighted Curve Number (CN).

Sustainable Environmental Governance for Tackling Emerging Contaminants in the Agroecosystem of Bangladesh

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In modern agriculture, rapid industrial growth and agricultural intensification have introduced legacy contaminants and subsequently a new generation of pollutants as emerging contaminants in Bangladeshi arable lands. These contaminants may include heavy metals, pesticide residues, pharmaceuticals, and microplastics. Primarily, the environmental contaminants may enter the soil through direct application or through secondary sources, including industrial effluents, untreated wastewater irrigation, atmospheric deposition, and unregulated agrochemical use. Once in the soil, they are taken up by crops and transferred along the food chain, posing long-term risks to public health and the environment. Despite the seriousness of the issue, current environmental policies and agricultural management frameworks in Bangladesh have not adequately addressed the challenge posed by these emerging pollutants. This study explores the prevalence, transfer pathways, and implications of emerging contaminants in the agro-ecosystem of Bangladesh. In particular, both scientific and policy perspectives have been addressed for the stakeholders. According to recent studies, it pinpoints hotspots of contamination in peri-urban and industrial agricultural zones. As a potential sink, the interaction between unplanned urbanization

and intensive food production is most pronounced. The scientific analysis reveals systemic policy gaps—such as fragmented regulatory oversight, weak enforcement of effluent standards, lack of soil quality benchmarks, and minimal farmer awareness—which collectively weaken sustainable land and food system management. To address this, the paper recommends a policy transition from reactive to preventive environmental management. First, a National Soil and Food Contaminant Monitoring Framework should be established to standardize data collection and inform decision-making. Second, cross-ministerial coordination—linking the Ministries of Environment, Agriculture, and Industry—is essential to align pollution control with agricultural policy. Third, incentive-based reforms should promote cleaner industrial production, safe wastewater reuse, and adoption of sustainable farming systems such as organic and regenerative agriculture. Fourth, capacity building and farmer education are vital to ensure local implementation and compliance. Overall, this policy-oriented study emphasizes the need for decisive, evidence-based environmental governance aligned with national priorities and global commitments such as SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 15 (Life on Land).

***Keywords:** Emerging Contaminants; Pesticides; Heavy Metals; Environmental Policy; Food Contamination.*

Port-Centric Pollution Mitigation: A Pathway to Sustainable Marine Environments in Bangladesh

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Bangladesh's coastal ports are central to the nation's maritime economy, supporting trade, industry, and employment for millions. However, rapid port expansion and increasing shipping traffic are intensifying pressures on the Bay of Bengal's fragile marine ecosystems. Oil spills, contaminated dredged materials, untreated ballast water, and elevated air emissions contribute to environmental degradation, threatening mangroves, shrimp cultivation areas, and

shallow coral habitats. This study examines the environmental impacts of port activities and explores strategies for balancing economic growth with marine conservation. A mixed-methods approach was employed to capture the multidimensional nature of port-related pollution. Scientific literature, national environmental policies, and International Maritime Organization (IMO) guidelines were reviewed to identify key pollutants and regulatory gaps. GIS-based spatial analysis mapped contaminant dispersal across port zones, shipping corridors, and ecologically sensitive areas. Field assessments at Chittagong Port, Mongla Port, and the Bay of Bengal Gateway Port (BGP) measured water and sediment quality, focusing on hydrocarbons, heavy metals, and microbial loads. Semi-structured interviews with 15 stakeholders—including port authorities, shipping operators, regulators, and community groups—highlighted governance constraints and socio-economic factors influencing pollution management. Results indicate uneven progress. Hydrocarbon levels in port sediments exceed recommended limits by about 30%, and ballast water discharge continues to introduce non-native species. Compliance with the Port-Environment Management Plan (PEMP) remains inconsistent. Nevertheless, initiatives such as low-sulfur fuel adoption, pilot ship-waste reception systems, and community-led mangrove restoration—achieving a 22% reduction in coastal erosion—show promising mitigation potential. Based on these findings, a Port-Centric Integrated Pollution Mitigation (PCIPM) framework is proposed, emphasizing three pillars: stronger regulatory oversight, adoption of environmentally advanced port technologies, and inclusive stakeholder co-management. The study concludes that integrated, adaptive strategies can help Bangladesh develop ports that are both economically dynamic and ecologically resilient, providing a scalable model for sustainable maritime development in other coastal nations.

Keywords: *Coastal Ports; Marine Economy; Port Expansion; Shipping Traffic; Environmental Degradation.*

Agricultural Yield Trends in a Changing Climate: Evidence from Bangladesh

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The study aims on the result of the trend in agricultural yield of Bangladesh during 2011-2023 and its correlation to the climatic variables, rainfalls, temperature, and sun exposure. It uses Exploratory Data Analysis (EDA) and Ordinary Least Squares (OLS) regression to analyze the yield data of five major crops of Bangladesh as rice, wheat, maize, potato, and jute over the period of climate analysis. The findings reveal that there was a steady increase in yields of rice (33.5 to 37 MMT), which were closely associated with the high temperatures (+0.81), but the yield of wheat decline (1.45 to 1.1 MMT) due to the stressors, both climatic and non-climatic. The rainfall showed poor associations with the yields, which means that the variability is reduced by the irrigation and the policy interventions. Minimal impact was in the hours of sunshine. It may also be the role of socio-economic and agronomic variables of soil quality, technology, and subsidies, this study discovered that the viability of climatic variables alone as a regression correlation (R^2) showed only slight explanatory power ($R^2 = 0.001$). It was suggested to adopt the use of heat-tolerant varieties of crops, develop better irrigation systems, and incorporate climate-tolerant policies. This research attracts the view that there is a need to have holistic measures to reduce the impact of climate change on agricultural production in Bangladesh and hence achieve food security and sustainable development.

Keywords: *Agricultural Yields; Adaptive Strategies; Climate Change; Food Security; Temperature Variability.*

Urban Biodiversity Declines in Bangladesh: A Review of Trends, Drivers, and Conservation Needs

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The rapid urbanization in Bangladesh has altered the ecological situations in the major cities. This review looked at literature available to get knowledge on the impact of urban growth on the wildlife and biodiversity. It also evaluated the efficacy of the existing conservation measures, policy frameworks, participation of the community and degree of ecological integration in urban planning. The aim was to determine the key gaps and suggest ways on environmental reforms that can facilitate sustainable urban ecosystems. The review established that the scientific facts regarding the impact of urbanization on wildlife remain scanty and scattered. Majority of the research worked on the birds and butterflies as indicator species. These researches demonstrated definite trends of habitat destruction, decreasing species numberless and variation in species conduct due to diminishing green areas, wetland disappearance, contamination, sound and increasing temperature. Studies of mammals, reptiles, amphibians and ecological corridors were still in few numbers. It was also found that there are no long-term monitoring programs and coordinated biodiversity databases. The review explored city conservation policies and nature-based policies. Planting of trees, rooftop gardens and small-scale wetlands conservation assisted in the preservation of some wildlife, though such measures were typically temporary and project based. Policy discussions included nature-based solutions like green roofs, biodiversity parks and ecological corridors but were seldom practiced. Bangladesh was characterized by high intention and low planning and limited investment as compared to regional cities. An analysis of policies revealed that there were national environmental laws but they failed to provide a clear understanding of urban conservation of biodiversity. Lack of strong enforcement, poor coordination of the various agencies and conflicting land-use decisions also continued to destroy wildlife habitats. Planning documents talked about parks

and open spaces but they did not talk of the ecological quality and connectivity. Community participation was positively involved in terms of awareness and local conservation activities but there were no long-term mechanisms to facilitate the community participation. The review proposed possibilities of ecological reform, such as ecological mapping, green network, restoration of wetlands, and enhanced cooperation of planners, researchers, and communities. The measures can assist in wildlife conservation and ensure a sustainable urbanization in Bangladesh.

Keywords: Urbanization; Biodiversity; Wildlife Habitat; Conservation; Nature-Based Solutions.

A Nature-Based Solution to Eutrophication and Invasive Water Hyacinth Through Integrated Floating Vegetable Garden cum Fish Culture

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The vast inland waterbodies of Bangladesh, which are essential for livelihoods and ecosystems, are affected by eutrophication and the proliferation of invasive water hyacinth (*Eichhornia crassipes*) due to high nutrient loads from transboundary rivers and other sources. This degradation impacts agriculture, aquaculture and ecological health, highlighting the need for effective interventions in water pollution management. This study presents an innovative Nature-based Solution (NbS) to address these challenges in eutrophicated aquatic ecosystems. Drawing on traditional floating garden practices in southern Bangladesh, the approach integrates the cultivation of nutrient-rich vegetables (red amaranth, water spinach, and small pumpkin) on water hyacinth-based floating platforms with the culture of filter-feeding fish species (silver carp, bighead carp, and mola carplet). This low-cost system repurposes the invasive water

hyacinth into productive platforms, operating without external feed or fertilizer and is applicable across diverse water bodies, including southern regions, haor areas, streams, ponds, puddles and small household ponds. The floating beds absorb excess nutrients, while the fish reduce phytoplankton and help mitigate algal blooms. Over the course of three months, vegetable yields reached 5-7 kg per cycle, accompanied by a twofold increase in fish biomass. Water quality improved significantly, with reductions in total nitrate (TN) by 43%, total phosphorus (TP) by 17.5%, ammonium nitrogen (NH_4^+) by 40%, and total organic carbon (TOC) by 15%. Community engagement promoted local acceptance and adoption of the initiative. Piloted at Bangladesh Agricultural University campus and adjacent floodplain wetlands, this NbS demonstrates a sustainable, community-driven approach for restoring eutrophic waters, controlling invasive species, enhancing food production and supporting climate-resilient livelihoods.

***Keywords:** Nature-based Solutions; Eutrophication; Water Hyacinth; Floating Gardens; Filter-feeder Fish.*

Carbon Emission Inventory and Mitigation Pathways for Solid Waste Management in Dhaka, Bangladesh

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Rapid urbanization and population growth have significantly increased solid waste generation in Dhaka, Bangladesh, intensifying concerns over greenhouse gas (GHG) emissions from the waste management sector. This study presents a comprehensive carbon emission inventory for waste management in Dhaka, focusing on emissions arising from waste collection, transportation, treatment, and final disposal processes. Using the Intergovernmental Panel on Climate Change (IPCC) guidelines and locally relevant activity data, emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were estimated for major waste streams, including municipal solid waste, organic waste, and recyclable fractions. Particular emphasis is placed on methane emissions from

unmanaged and semi-managed landfill sites, which constitute the dominant source of GHG emissions in the sector. The inventory identifies key emission hotspots and evaluates the potential impact of alternative waste management scenarios such as source segregation, composting, recycling, and landfill gas recovery. The findings provide a baseline for policy formulation, climate action planning, and the development of low-carbon waste management strategies in Dhaka. This study contributes to improved transparency and accuracy in urban GHG accounting and supports Bangladesh's commitments to climate change mitigation under national and international frameworks.

***Keywords:** Greenhouse Gas (GHG) Inventory; Municipal Solid Waste; Methane Emissions; Climate Change Mitigation; Urban Sustainability.*

Ecosystem-based Adaptation for Enhancing Resilience in the Sundarbans, Bangladesh

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The Sundarbans, an Ecologically Critical Area (ECA) in Bangladesh, is a unique transboundary ecosystem of mangrove forests, marshlands and waterways, rich in biodiversity and natural resources. Although Sundarbans supports thousands of forests dependent community's livelihood in four coastal districts, it faces escalating threats from human interventions and climate change impacts. To address these problems, the NABAPALLAB (Nature-Based Adaptation towards Prosperous and Adept Lives & Livelihoods in Bangladesh) project, funded by the UK-FCDO and led by CARE with consortium partners, has been combining Ecosystem-based Adaptation (EbA) and Nature-based Solutions (NbS) with Assisted Natural Regeneration (ANR). Key achievements till March 2025 include re-excavation of 146,438 m³ earth from six canals, expected to restore freshwater flow to 1,626 hectares of agricultural land, and enhance fish breeding habitats,

thereby boosting fish populations. Under the ANR activities, 114,500 mangrove saplings were planted on 52 hectares in 11 sites, generating 5,777 labour days for the local men and women. This afforestation is projected to remove around 15,258 tons of equivalent carbon per year after 10 years. Additionally, 1,988 hectares of Charland were identified for potential mangrove plantation and regeneration. Beyond ecological restoration, communities are engaged in adaptive livelihood practices, including climate-resilient kitchen gardening, small-scale agriculture, livestock rearing, vermicomposting, freshwater and brackish water aquaculture, which are reducing their dependency on forest resources. Being the primary stakeholder, local communities have shifted from over-extractors to protectors of Sundarbans resources, though damage from intense cyclones remains a pressing concern. Therefore, the EbA and NbS interventions will continue until October 2028 to enhance resilience of the mangrove ecosystem through natural resource and biodiversity conservation, use ecosystem services for social resilience, and reduce climate risks and vulnerabilities.

Keywords: Ecosystem-based Adaptation; Nature-based Solutions; Mangrove restoration; Biodiversity; Ecologically Critical Area.

Climate Change and Human Response during the Last Thousand Years in the Bengal Basin: A Geoarchaeological Perspective

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The Bengal Basin, one of the world's largest and most dynamic deltaic regions, has been shaped over centuries by the interplay of rivers, monsoon climate, tectonic activity, land subsidence, sea-level fluctuations, and human interventions. Over the last thousand years, environmental conditions in the region have been far from static, with gradual shifts in climate and river dynamics influencing settlement patterns, livelihoods, political organization, and cultural adaptation. Archaeological evidence indicates that human communities not

only adapted to these changes but actively responded to climate and ecological processes, shaping their cultural and economic strategies accordingly. This study aims to examine the interactions between climate, environment, and human culture in the Bengal Basin through comprehensive geoarchaeological investigations. Central to the basin is the Ganga–Brahmaputra–Meghna river system, which transports immense volumes of water and sediment from the Himalayas to the Bay of Bengal. Over the past millennium, shifts in river courses, delta formation, and frequent flooding have continuously redefined the landscape. Rivers such as the Ganga and Brahmaputra repeatedly changed channels, creating new land (chars) while eroding older settlements. These geomorphological transformations produced fertile alluvial soils but also introduced instability, compelling human communities to develop adaptive settlement strategies and flood-resilient agricultural practices. Climatic fluctuations have further shaped the environmental and cultural context. The Medieval Warm Period (950–1250 CE) likely intensified monsoon activity, expanding wetlands and forests in eastern Bengal and encouraging the eastward migration of populations who cleared forests and reclaimed marshlands for cultivation. The subsequent Little Ice Age (1300–1850 CE) brought erratic monsoons, localized flooding, and drought-like conditions, prompting communities to diversify crops, cultivate deep-water rice varieties, and develop indigenous systems for anticipating seasonal changes. Overall, the Bengal Basin demonstrates a long history of intertwined environmental and human dynamics. Communities adapted their settlement patterns, agricultural strategies, and cultural practices in response to shifting rivers and changing climate, illustrating the resilience and ingenuity of human societies in a highly dynamic deltaic environment over the past millennium.

Keywords: *Bengal Basin; Monsoon Pattern; Crop Diversity.*

Spatiotemporal Dynamics of Jamuna River Migration and Its Impacts on Flood Risk and Land Use/Land Cover with Projections to 2034

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The Jamuna River in Bangladesh, one of the largest and most dynamic rivers globally, provides livelihoods for millions of people. However, frequent flooding and riverbank erosion force riverside communities to relocate annually, increasing vulnerability and poverty. Changes in land use and vegetation patterns have further reduced biodiversity and ecosystem resilience, highlighting the need for comprehensive studies to inform disaster risk reduction and sustainable management. This study investigates the spatiotemporal variation of the Jamuna River centerline and associated Land Use and Land Cover (LULC) changes across 20 adjacent upazilas from 1994 to 2024, evaluating impacts on vegetation dynamics and predicting future shifts by 2034. The NDWI index was extracted in ArcGIS to compute the river centerline, with the Channel Migration Toolbox assessing migration over time. NDVI and LULC analyses measured afforestation and deforestation processes. The Analytic Hierarchy Process (AHP) weighted thirteen flood-influencing factors, while physical and social vulnerability assessments identified highly exposed communities, enabling comprehensive flood risk zoning. A QGIS-based prediction model projected LULC with an overall accuracy of 87.18% and Kappa of 0.807; validation for 2024 showed a Kappa of 0.965 and minimal error (0.00866), indicating excellent performance. Between 1994 and 2024, Bhuapur, Chauhali, Daulatpur, Kazipur, and Sariakandi were most affected by river migration. The 2004 flood expanded water bodies and reduced cropland and vegetation, reshaping subsequent land use. Cropland peaked in 2014 but declined by 2024, while settlement areas increased, reflecting urbanization. Projections for 2034 suggest continued river dynamics, with accretion adding 22.34 sq km of land and intensified erosion, increasing riverbank instability. Flood risk mapping identifies high-vulnerability zones for 2034. By examining these dynamics, the study supports ecosystem protection, evidence-based policymaking, and risk-informed planning to enhance community resilience (SDG 3) and conserve ecosystems (SDG 15).

Keywords: Jamuna River; Migration; Flood Risk; Modeling; Erosion; Vulnerability.

Food Safety and Agriculture in Bangladesh: Agro-Chemical Contamination, Regulatory Gaps, And Environmental Reform

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Bangladesh has increased agricultural production, but food safety remains a serious problem due to contamination from unsustainable farming practices and weak regulation. Overuse of chemical fertilizers, insecticides, fungicides, and growth regulators has damaged the soil and left toxic residues in food. Higher levels of pesticide and heavy metal residues are now found in vegetables, cereals, fruits, and spices. Poor enforcement of food safety rules, limited residue testing, and unchecked use of agrochemicals worsen the problem. More pesticide and heavy metal residues are being found in vegetables, cereals, fruits, and spices. These chemicals can cause serious long-term health problems like cancer, organ failure, hormone issues, and nerve damage. The growing risks to public health and farming demonstrate that Bangladesh urgently needs environmental reforms, including stronger policies, routine residue testing, organic soil restoration, and strict enforcement of regulations. This paper argues that reform needs to be wide-ranging and coordinated. It should cover better management of farm inputs, restoring soil health, educating farmers, monitoring markets, and protecting consumers. These actions are necessary to ensure a healthy population, good agricultural practices, and safe food for Bangladesh in the years to come.

Keywords: Agriculture; Contamination; Food Safety; Agro-chemicals; Reforms.

Taxonomic Status of Dragonfly from Noakhali District of Bangladesh

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Dragonflies (*Order: Odonata*) are ecologically important insects and widely recognized as bio-indicators of freshwater ecosystem health. The present study documents the taxonomic composition of dragonflies from Noakhali District, Bangladesh, based on field surveys conducted from February to September 2024. A total of 58 individuals were collected and examined, representing 14 species, 13 genera, and 4 subfamilies under a single family, Libellulidae. The recorded subfamilies were Sympetrinae, Brachydiplacinae, Libellulinae, and Trameinae. Species identification was carried out using external morphological characters, including wing venation, coloration, and abdominal and genital structures, following standard taxonomic keys. This study provides the first district-level checklist of dragonflies from Noakhali, contributing baseline data for future biodiversity assessments, ecological monitoring, and conservation planning in coastal Bangladesh.

Keywords: Odonata; Anisoptera; Dragonfly Diversity; Taxonomy; Checklist; Bangladesh.

Advancing Environmental Reform Through Education: Policy and Institutional Pathways for Strengthening Climate Change Education in Bangladesh

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Climate change is a growing concern that requires informed, collective, adaptive responses. Education has become a central strategy in promoting climate resilience, especially through Climate Change Education (CCE). The study explores how CCE is used at a

global level to tackle climate change adaptation and how this concept is incorporated in the Bangladesh context. The qualitative research methodology proposes the synthesis of the global publications, policy documents to identify how education systems are scaling up to boost their adaptive capacities. Thematic analysis of the literature on CCE indicates that there are a number of major initiatives that are currently driving climate education. Such activities include awareness programs in the media, projects on school and community involvement, curriculum reform both at the school and the higher education level and the creation of specialized teaching materials and pedagogical approach. The study also identifies the growing collaboration among the states in order to solve climate issues collectively, emphasizing the common priorities where future action can be undertaken in the field of climate education. Despite growing interest on CCE, this paper identifies some challenges associate to implement the CCE for adaptation. The education planners, policymakers, teachers, and the youth are the underutilized key players in the response activities regarding climate. There are significant gap of the curriculum, teacher development and organizational preparedness to embrace CCE in a holistic manner. Many of the countries such as Bangladesh have shown a low integration of CCE as educational objective. The study presents three main objectives, namely; (1) to identify international CCE initiatives that facilitate climate adaptation; (2) to examine how CCE is represented in the national education policy of Bangladesh; and (3) to explore the challenges and opportunities of advancing CCE as a transformative means of addressing climate change. Combining international experience with national policy analysis, this study highlights the necessity of extensive policy coordination, greater teacher capacity, and increased institutional dedication to climate literacy. Finally, the study focuses on the potential to transform education systems toward active and community-based climate is possible to enhance both national and global resilience.

Keywords: *Adaptation; Climate Change; Climate Change Education (CCE); Future Action; Institutional Reform; Organizational Preparedness.*

Impact of Sustainable Energy on International Trade: Bangladesh Perspective

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Sustainable energy transition extremely reshapes international trade by reducing fossil fuel dependency, creating new commodity markets, and altering comparative advantages. This study analyses how renewable energy adoption influences trade volumes, patterns, and balances through empirical data on exports/imports of solar panels, wind turbines, batteries, and critical minerals (e.g., lithium, cobalt etc.). The objective of the study is also to emphasize the impact of reducing fossil fuel which may include first: emergence of green trade corridors dominated by China and shifts in energy exporters' revenues. Second: supply chain vulnerabilities from mineral concentration in DRC (60% cobalt) and Australia (55% lithium); Third: policy-driven distortions via carbon border adjustments and subsidies. The shift to sustainable energy is transforming international trade by diminishing reliance on fossil fuels, giving rise to new markets for renewable technologies, and redefining global competitive edges. This transition redirects trade flows, creates opportunities in green goods and services, and challenges traditional energy exporters while benefiting innovators in clean energy. It introduces vulnerabilities in critical material supply chains and prompts policy measures that reshape trade rules. Overall, sustainable energy fosters a more diversified and resilient trade landscape, demanding global cooperation to balance economic gains, reduce risks, and support a fair transition for all nations.

Keywords: *Sustainable Trade; Sustainable Energy; Renewable Energy; Economy; Bangladesh.*

Policy Needs Assessment in Landfill and Landfill Leachate Management in Bangladesh

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Bangladesh generates roughly 25,000 tons of municipal solid waste daily, over 70% of which is dumped in uncontrolled landfills such as Matuail and Aminbazar (Dhaka), and Haliashahar and Arefinnagar (Chattagram). These sites produce leachate with extremely high BOD (>35,000 mg/L), heavy metals (Pb, Cd, Cr, As), ammonia, and pathogens, contaminating nearby rivers, coasts, surface water, and groundwater. Co-disposal of medical waste and unregulated ETP sludge further elevates toxicity. Despite these risks, Bangladesh lacks clear technical standards, monitoring protocols, and effective enforcement for illegal landfill and leachate management. This study reviews existing policy instruments, identifies critical gaps, and proposes reforms for sustainable landfill and leachate management. Using secondary data, literature review, and content analysis of key policies, including the Bangladesh Environmental Conservation Rules (BECR 2023), National Environment Policy (NEP 2018), Solid Waste Management Rules (2021), and other relevant legal frameworks, the study finds significant fragmentation. NEP 2018 and the 3R Strategy (2010) focus on waste reduction but do not address leachate treatment or sludge reuse. BECR 2023 classifies landfills as Red Category, requiring an EIA and EMP; however, illegal sites proliferate. EIA Guidelines (2019) recommend liners and leachate systems but do not make them mandatory, nor do they provide technical standards for leachate, medical, or sludge management. Solid Waste Management Rules (2021) emphasize collection and 3R but remain vague on leachate and ignore medical or industrial sludge. Medical Waste Rules (2008) and Sludge Management Standards (2016) outline basic segregation and treatment but lack enforcement. Field data from Matuail and Aminbazar show untreated leachate exceeding limits 100–1000 times. Open burning under Air Pollution Control Rules (2022) also worsens air quality. To address these gaps, Bangladesh should establish dedicated Sanitary Landfill and Leachate Management Rules, amend BECR 2023 to mandate

treatment, integrate medical and sludge waste, create a National Sanitary Landfill Authority, and phase out open dumps in favor of engineered regional landfills.

Keywords: Leachate Management; Sanitary Landfill; Medical Waste; Faecal Sludge; Policy Gap; Environmental Reform.

Spatial and Biophysical Assessment of Water Quality Decline in Rapidly Urbanising Watersheds of Dhaka

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Rapid and unplanned urban expansion of Dhaka has transformed nearly 80% of wetlands and more than 50% of designated flood-flow zones into impervious built-up surfaces, intensifying pollutant runoff and altering watershed hydrology. This study quantifies the ecological impacts of these land-use changes on water quality and aquatic biodiversity across nine major urban waterbodies. Field measurements reveal widespread physicochemical degradation: Biochemical Oxygen Demand (BOD) reaches 8.10 mg/L in the Buriganga River, 7.92 mg/L in Hatirjheel Lake, and 7.40 mg/L in Diabari Lake, all far exceeding the national standard of ≤ 3 mg/L. Even moderately affected systems Dhanmondi Lake (4.79 mg/L) and Balu River (4.44 mg/L) surpass acceptable thresholds, whereas only Gol Tolab Pond (1.97 mg/L) remains within a healthy range. Correspondingly, pH values vary from acidic (5.0 in Dhanmondi Lake; 5.2 in Buriganga) to near-neutral (7.2 in Balu River and Hatirjheel Lake), indicating chemical instability linked to wastewater inflows and organic decomposition. Ammonia and nutrient enrichment drive advanced eutrophication, reflected in high chlorophyll-a concentrations and elevated Trophic State Index (TSI) values. Hatirjheel Lake, Buriganga River, and Bibi Mosque Pond exhibit TSI >70, classifying them as hypereutrophic systems highly vulnerable to algal blooms. Dhanmondi Lake, Turag River, and Shagufta RA Pond fall within the eutrophic range (TSI 55–65), while only Diabari Lake, Balu River, and Gol Tolab Pond maintain mesotrophic–low eutrophic conditions (TSI 50–55). Biodiversity

assessments reveal a strong decline in ecological integrity, with the Shannon–Wiener Index (H') showing strong negative correlation with BOD, ammonia, turbidity, and TSS, and a positive relationship with dissolved oxygen. Pollution-tolerant species now dominate previously diverse systems. Geospatial indicators (high NDBI, low NDVI/NDWI) align with degraded waterbodies, confirming the influence of urban development intensity. The PETER risk assessment identifies multiple hotspots where anthropogenic pressure and pollutant exposure converge, especially in Mirpur, Gulshan, Uttara, and the Buriganga corridor. Overall, these quantitative findings demonstrate that unregulated urbanization is directly driving measurable declines in hydrological function, water quality, and biodiversity across Dhaka's urban watersheds.

Keywords: Biodiversity; Eutrophication; Pollution Load; Watersheds; Water Quality.

From Hydro-Hegemony to Hydro-Coercion: Politics of Precarity in India–Bangladesh Transboundary Water Conflicts

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This article advances the concept of hydro-coercion to analyze how asymmetric power relations shape transboundary water governance between India and Bangladesh, with broader implications for political geography, environmental justice, and the geographies of state power. Focusing on the Ganges, Teesta, and Brahmaputra rivers, the article argues that India's upstream dominance enables it to exercise coercive control over shared water resources through material infrastructure, institutional stalling, and ideational narratives of water nationalism. These practices exacerbate ecological degradation and human vulnerability in downstream Bangladesh, weaponizing transboundary rivers as geopolitical leverage. Drawing on critical hydro-politics, theories of power, and empirical case studies, the article illustrates how control over rivers reconfigures hydro-social territories, deepens regional precarity, and reveals the limitations of existing treaties

and institutional mechanisms. The analysis situates these dynamics within broader regional transformations, including China's upstream interventions that complicate India's dominance and the increasing impacts from accelerating climate change, all of which intensify risks for Bangladesh's deltaic socioecologies. The article posits that a fundamental rethinking of transboundary water governance is imperative, toward a transformed governance paradigm that moves beyond technocratic bilateralism toward multilateral, ecologically just, and politically accountable frameworks. By centering lived experiences of precarity in downstream regions and theorizing hydro-coercion as a mechanism of escalating spatial and geopolitical domination, I emphasize the need for decolonial, rights-based, and ecologically grounded approaches to shared water governance in an era of intensifying climate and political uncertainty.

A Comparative Analysis of Air Pollution Control Policies in Bangladesh with Policies in USA, Japan, China, and South Korea

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This paper examines Bangladesh's current trajectory in air pollution governance using four developed countries as a reference point to assess its alignment with known pathways toward cleaner air. A structured framework of critical governance pillars synthesized by the author serves as the basis for evaluating Bangladesh's policy evolution. The aspects are legal and regulatory instruments, robust monitoring systems, enforcement mechanisms, institutional and intergovernmental coordination, sector-specific emission control strategies, economic and market-based instruments, media engagement frameworks, innovative research capacity, environmental planning and land-use regulation, emergency response protocols, and alignment with international standards and cooperative mechanisms. Drawing on national policy

documents, regulatory developments, and implementation practices, the study constructs a matrix to assess how Bangladesh's efforts correspond with general patterns observed in the USA, Japan, China, and South Korea, who have achieved significant air quality improvements in the past years. The analysis finds that Bangladesh has taken important initial steps articulating national air quality priorities and drafting regulatory instruments. However, challenges remain in ensuring consistent implementation, strengthening institutional coordination, and enhancing monitoring and enforcement capacity. Rather than replicating historical models, Bangladesh has the opportunity to modernize its approach by integrating data-informed governance and adaptive policy mechanisms suited to its context. While the country's direction reflects growing alignment with global norms, sustained progress will depend on reinforcing existing frameworks and fostering institutional resilience. This assessment offers a grounded perspective on where Bangladesh stands and what broad strategic directions may support its transition toward cleaner air.

Keywords: Air pollution; Policy; Governance; Monitoring; Comparative.

Analyzing Eco-Friendly Local Building Materials for Heat Stress Mitigation in Northern Bangladesh

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Eco-friendly local building materials, especially mud for reducing heat stress in rural areas of Northern Bangladesh, where rising temperature and always heat waves increasingly affect indoor space. In many villages, traditional mud houses are being replaced by modern constructions made of concrete, brick and metal sheets which tend to trap heat and increase indoor temperatures, creating health issues for vulnerable populations. By analyzing the use of locally available materials in Nimaidighi village, Bogura District and considering factors such as cost, durability and environmental impact, it becomes clear that mud and other natural materials provide cooler indoor conditions, low-cost construction and minimal sustainable footprint. Local communities recognize the comfort and affordability of mud houses, through challenges such as maintenance, protection from

rainfall and durability design improvements. Combining traditional building knowledge with modern enhancements such as mud blocks, proper plinth design and protective plastering can create sustainable, climate resilient housing. Promoting the use of mud and other eco-friendly materials not only addressed heat stress but also supports environmentally sustainable development, preserve cultural heritage and provides practical, low-cost solution for rural households facing the challenges of climate change in Northern Bangladesh.

Keywords: Eco-Friendly Building Materials; Heat Stress; Traditional Mud Houses; Metal Sheets; Cooler Indoor Conditions.

Crab Farming as a Climate Change Adaptation approach in Shyamnagar, Coastal Bangladesh

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Climate change-induced stressors such as salinity intrusion, cyclones, and tidal surges have severely affected traditional agriculture and shrimp farming in the southwest coastal region of Bangladesh. In response, mud crab farming (*Scylla* spp.) has emerged as a climate-adaptive livelihood strategy, particularly in Shyamnagar Upazila—one of the most climate-vulnerable areas identified by the Multi-Disaster Vulnerability Index. This study examines the transition from traditional livelihoods to crab farming, driven by high salinity tolerance, disease resistance, and growing export demand. Despite its economic importance, a large proportion of farmers face moderate constraints in cultivation. The study explores farmers' perceptions, institutional support from government and NGOs, and key socioeconomic challenges. The findings aim to inform policymakers and extension services in strengthening training, market access, and financial support to enhance livelihood resilience in coastal Bangladesh. The research follows a qualitative approach, using In-Depth Interviews (IDI) and Key Informant Interviews (KII) with crab farmer, local traders, NGO officers, and community leaders in Shyamnagar.

Keywords: Crab Farming, Climate Change Adaptation, Livelihood Resilience; Salinity Intrusion.

Protecting Water, Reviving Fish: An Integrated Approach to Haor Conservation

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The haor wetlands of northeastern Bangladesh are highly productive floodplain ecosystems, yet they face rapid degradation from altered hydrological regimes, siltation, land-use changes, pollution, and overexploitation of fisheries. These wetlands support more than 140 fish species, including nutrient-rich Small Indigenous Species (SIS), and comprise approximately 4.047 million hectares of inland open water, with open-water fisheries contributing 8.3% according to national data. Their ecological productivity relies on natural flood pulses, which create breeding, nursery, and feeding habitats critical for sustaining fish populations. Disrupted geomorphology, fragmented migration corridors, and unpredictable hydrology undermine reproduction, erode genetic diversity, and accelerate fisheries decline. Effective fisheries management is therefore central to maintaining haor ecosystem resilience. Key interventions include enforcing spawning-period bans, establishing fish sanctuaries, restoring beel-channel linkages, and safeguarding broodstock refuges. These measures protect biodiversity while supporting livelihoods and nutrition for millions of rural residents. SIS species such as mola, punti, and darkina supply essential micronutrients—vitamin A, iron, and calcium—directly impacting public health. Declining fish stocks threaten both food security and income stability, highlighting the interdependence of community well-being and sustainable resource governance. Hydrologically, haors buffer monsoon floods, mitigate downstream inundation, support dry-season agriculture, and aid aquifer recharge. Habitat-restoration activities, including desiltation, revegetation, and preservation of wetland depth, enhance fisheries while reinforcing hydrological services. As climate uncertainty increases, haors provide critical nature-based adaptation, reducing extreme rainfall impacts, stabilizing soils, storing carbon, and sustaining resilient ecological networks. This study emphasizes that long-term haor conservation requires evidence-based fisheries management integrated with hydrological restoration, pollution control, and community-led stewardship. Strengthening fisheries biomass and trophic interactions not only secures ecological functionality but also fortifies socio-

economic resilience, ensuring these unique wetlands continue to support both biodiversity and human livelihoods.

Keywords: Haor Wetlands; Floodplain Ecosystems; Altered Flow Regime; Land-Use Transformation; Contamination.

Assessing Socio-economic Impacts of Riverbank Erosion among The Char Dwellers at Sariakandi in Bogura District

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Bangladesh is highly vulnerable to riverbank erosion due to its geographical setting and extensive river network of over 700 rivers, especially along the Brahmaputra-Jamuna system. This geomorphological process, which is particularly severe along the braided and dynamic Brahmaputra River, poses a grave threat with devastating socio-economic and psychological consequences for char dwellers. Bogura District, located under the confluence of the Brahmaputra, is identified by the Bangladesh Water Development Board (BWDB) as one of the nation's most erosion-prone areas. Sariakandi Upazila of Bogura district is very familiar as the erosion-prone area, and people living on the chars in this upazila experience repeated displacement, loss of homestead land, agricultural fields, houses, trees, livestock, and a sharp decline in agriculture-based income. A char village in the dynamic river Brahmaputra under the Sariakandi upazila has been taken for the study. This study assesses the socio-economic impacts of riverbank erosion, examines changes in livelihood patterns and household assets, existing adaptation practices, and identifies gaps in resilience strategies. Both qualitative and quantitative approach has followed to meet the objectives. Interviewing the total number of 106 households increased the scope of the assessment as a community. Primary data were collected through semi-structured questionnaires, FGDs, different PRA sessions, KIIs, and physical observation, and analysed using MS

Excel and SPSS, while Sentinel-1 satellite imagery processed through Google Earth Engine and ArcGIS helped identifying erosion patterns and land transformation. The results show that frequent erosion has caused widespread damage, increased settlement instability, reduced food security, and forced many households to rely on temporary shelters and irregular income sources. That made the community economically vulnerable. But the spirit of fighting against the disaster have made the community bonding stronger. Although communities have adopted local coping measures such as bamboo reinforcement, earthen embankments, elevated plinths, and seasonal migration, these techniques are insufficient to address the rapid and unpredictable nature of erosion. To make the community resilient and withstand riverbank erosion in social and economic aspect, improvement in various dimension is a must. Overall, riverbank erosion imposes continuous social and economic pressure on char dwellers in Sariakandi, and the study highlights the socio-economic impacts and the urgent need for planned resettlement, livelihood diversification, community-based river management, and strong policy support to reduce vulnerability and strengthen long-term resilience.

***Keywords:** Riverbank Erosion; Socio-Economic Impact; Char Dwellers; Brahmaputra River.*

Assessing the Condition of Local Small Water Bodies in Bangladesh: Evidence from Katakhal Khal and Bil Surjo Nodi in Sirajganj

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This study investigates the condition of Katakhal Khal and Bil Shurjo Nodi, located in Sirajganj Sadar and Ullahpara Upazila, Sirajganj District, Bangladesh. It aims to map their hydrological connectivity, assess their current physical and environmental status, and evaluate the feasibility of using Geographic Information Systems (GIS) and remote sensing to analyze chronological changes in small waterbodies. A mixed-methods approach was employed, combining primary data from field observations and structured questionnaires with secondary data from the Sirajganj Water Development Board

and ESRI. Satellite image analysis confirms that both waterbodies are hydrologically connected via the Bangali River and significantly contribute to the local drainage network. Historical accounts from elderly residents indicate that they have played essential roles in drainage, transportation, and livelihoods, forming integral parts of community life. However, due to inadequate maintenance, indiscriminate waste disposal, and limited public awareness, both waterbodies have experienced severe degradation. Field observations and community feedback further highlight this decline. The study identifies challenges in applying the Normalized Difference Water Index (NDWI) via GIS and remote sensing software (ArcGIS, Google Earth Pro) for spatio-temporal analysis of small waterbodies, primarily due to their narrow size and surface coverage by water hyacinth. These limitations emphasize the need to consider small waterbodies within the context of their broader hydrological network rather than as isolated systems. Integrating GIS and remote sensing with historical topographic maps, archival spatial data, and targeted geomorphological field inspections can more accurately reconstruct past hydrologic conditions and channel morphology, revealing the waterbodies' role in regional hydrology.

Keywords: Katakhal Khal; Bil Shurjo Nodi; Sirajganj; Waterbody Degradation; NDWI.

Plant Diversity Management in Bangladesh: A Lesson from University of Dhaka Campus

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Following the Rio Earth Summit agreements, Bangladesh initiated a national commitment to biodiversity conservation and sustainable environmental management. Within this framework, urban green spaces, especially university campuses, serve as vital reservoirs of plant diversity while remaining under intense anthropogenic pressure. The University of Dhaka campus, one of the country's largest and oldest institutional green spaces, was selected as a case study to assess plant diversity, identify management challenges, and propose evidence-based strategies for sustainable urban forestry.

The University of Dhaka Tree Census 2025 represents the first comprehensive inventory of campus woody flora, conducted over eight months (January–August 2025). The survey recorded 17,161 trees belonging to 277 species and 62 families across five major zones and more than 45 sub-units. Data collection involved direct field measurements, including species identification, circumference at breast height, height estimation, health and hazard assessment, and spatial mapping using the Google My Maps platform. The census revealed several management concerns. Although native species account for 58% of species richness, exotic species represent 46% of total tree abundance and contribute 78.5% of total biomass, indicating plantation bias and potential long-term ecological risks. Tree health assessments identified widespread stress from constrained root growth, heavy epiphytic loads, mechanical injuries, and pathogen infestation. Moreover, 2,213 trees were classified as structurally hazardous due to proximity to buildings and overhead utilities, reflecting unplanned plantation and inadequate maintenance. Plantation patterns across sub-units also showed limited purposeful species selection, restricting the delivery of ecosystem services. Based on these findings, the study recommends shifting toward native-dominated, purpose-oriented plantations at the subunit level, gradual replacement of invasive or high-risk exotic species, improved site–species matching, and establishment of a continuous monitoring framework. These measures can enhance tree health, safety, and ecological sustainability on campus and across urban landscapes in Bangladesh.

Keywords: *Urban Green Spaces; Plant Diversity; Urban Forestry; Native and Exotic Species; Tree Health Assessment; Sustainable Management.*

Reforming Environmental Governance: Institutional and Policy Pathways toward Sustainability in Bangladesh

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Environmental governance in Bangladesh has become increasingly critical as the country faces escalating challenges from air and

water pollution, climate change impacts, rapid urbanization, and unsustainable resource use. Despite having a range of environmental laws, policies, and institutions, gaps in implementation, coordination, and accountability continue to undermine effective environmental management. This paper revisits the current framework of environmental governance in Bangladesh with the aim of assessing its adequacy in ensuring a sustainable environment. It examines existing legal and institutional arrangements, identifies key governance challenges such as weak enforcement, limited institutional capacity, fragmented decision-making, and inadequate public participation, and analyzes their implications for environmental sustainability. The study also highlights the role of political commitment, transparency, and stakeholder engagement in strengthening governance outcomes. Drawing on national experiences and relevant international best practices, the paper proposes strategic pathways for reform, including institutional strengthening, policy integration, evidence-based decision-making, and community-centered governance approaches. Revisiting environmental governance is essential not only for protecting natural resources but also for achieving sustainable development goals and ensuring environmental justice in Bangladesh. The findings aim to contribute to policy dialogue and support more effective, inclusive, and resilient environmental governance for a sustainable future.

***Keywords:** Environmental Governance Reform; Sustainable Environment; Policy Implementation; Institutional Capacity; Bangladesh.*

Assessment of Community-based Conservation Needs and Management Measures of Khailshagari Fish Sanctuary in Chalan Beel Region in Bangladesh

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Bangladesh, situated in South Asia's deltaic floodplain, possesses an intricate network of wetlands- beels, haors, baors, and jheels that serve as ecological lifelines and economic backbones for millions. Among these, Chalan Beel stands as the largest and most dynamic wetland ecosystem,

supporting diverse aquatic biodiversity and providing livelihoods through fisheries, agriculture, and other resource-based activities. The sustainability of such ecosystems depends critically on community-based conservation initiatives that integrate ecological preservation with local livelihood security. This study focuses on the Khailshagari Fish Sanctuary in Chatmohor Upazila of Pabna District to (i) identify the key ecological threats and challenges affecting the sanctuary, and (ii) assess community-based conservation needs and management measures essential for its sustainability. Employing participatory rural appraisal, stakeholder interviews, and field observations complemented by relevant secondary data the study investigates both environmental and socio-institutional aspects of sanctuary governance. The results reveal that habitat degradation, siltation, eutrophication, overfishing, and declining water quality pose significant threats to the ecological stability of the sanctuary. Institutional limitations, inadequate enforcement, and low community awareness further exacerbate conservation challenges. However, collective initiatives such as community co-management, enforcement of fishing restrictions, seasonal closure during breeding periods, and restoration of aquatic vegetation demonstrate promising outcomes in habitat recovery and fish stock improvement. Strengthening participatory governance, fostering environmental education, and incorporating traditional ecological knowledge into management frameworks are vital for enhancing resilience and ensuring long-term sustainability. The study highlights that decentralized, community-led management offers a viable model for conserving wetland biodiversity and revitalizing inland fisheries in Bangladesh's dynamic wetland landscapes.

Keywords: *Community-Based Conservation; Fish Sanctuary; Chalan Beel; Ecological Threats; Participatory Management.*

Assessing River Encroachment and its Environmental Impacts: Evidence from the Chiknai River Basin in Bangladesh

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The Chiknai River is very significant in the Chalan Beel (wetland) area as part of the joint river system and for the local community. This river

was beautiful in the past, but at present, the river is facing different types of encroachments which are the cause of the destruction of the river channel. The Chiknai River is situated in the Natore and Pabna districts, covering four upazilas: Baraigram in Natore, and Chatmohar, Atghoria, and Faridpur in Pabna. The Chiknai River originates from the Khalshidingi River in Baraigram and falls into the Baral River in Faridpur. This research focuses on assessing river encroachments and its environmental impacts on the river and local communities along the Chiknai River, located in Northwest Bangladesh. The river is surrounded by rural communities and agricultural land. However, population pressure is increasing day by day, which is the cause of increased encroachments. These encroachments include housing area expansion, village market expansion, waste dumping, pond excavation in the river area, fishing barriers, and heavy sedimentation in the river channel that is harmful to the river channel and its ecosystem. These types of encroachments disrupt the river's natural flow, reduce water quality, and harm aquatic biodiversity. The study uses field surveys, Focus Group Discussions (FGDs), and field observation to collect data on the current state of the river. Moreover, GIS mapping was used to identify river encroachment areas. Field observation data reveal how environmental degradation is occurring and how local communities perceive and respond to these issues. The results show that encroachments have a significant contribution to degrading the river condition. The result of the Likert scale (5-point) ranging from -2 to 2 is -0.56, which represents a negative condition based on the total criteria of the river. For this reason, the government and local people must be strict against encroachments and take steps to save the river. These measures will be suitable to protect the river's ecosystem and improve the livelihoods of local people.

Keywords: *Chiknai River; River Encroachment; Environmental Degradation; Chalan Beel; River Ecosystem.*

Closing the Forecast Gap: Embedding the Riverine Thermal Trap in Next-Generation Warning Systems

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This study identifies the “Riverine Thermal Trap”—one of the most dominant hydrodynamic mechanisms in the Bay of Bengal where

freshwater-induced stratification actively amplifies Marine Heatwaves (MHWs) and which in turn fuel tropical cyclone intensification. By integrating 32 years of satellite and reanalysis data, we detect a regime shift in MHW heat stress, increasing at a rate of $+3.64\text{ }^{\circ}\text{C}\cdot\text{days}/\text{year}$ and culminating in the unprecedented 302-day 2024 mega-heatwave. Mechanistically, we show that stratification traps heat in a shallow mixed layer ($<15\text{ m}$), suppressing the cooling feedback that traditionally limits storm intensity. Our analysis establishes a “Hyper-Fuel” scaling law: cyclones intensify by approximately 10.5 knots per 1°C of pre-storm MHW anomaly. Current operational models, which rely on sea surface temperature alone, critically miss this salinity-stratification driver. We argue that embedding the Riverine Thermal Trap mechanism into next-generation forecasting systems is non-negotiable for closing the forecast gap, enabling accurate prediction of both persistent heatwaves and rapidly intensifying cyclones, thereby transforming coastal hazard warnings for millions in the Bay of Bengal region.

Keywords: *Marine Heatwaves, Bay of Bengal, Tropical Cyclones, Stratification, False Winter, Riverine Thermal Trap.*

Fragmented Governance and Failing Rivers: A Gap Analysis of Water Resource Management in Bangladesh

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In Bangladesh, rivers, wetlands, and floodplains form the backbone of both ecological and socio-economic systems. Decades of embankments, regulators, and other interventions have degraded water bodies, resulting in flawed policies, fragmented institutions, and weak enforcement. This paper conducts a gap analysis of water resource governance, focusing on rivers, to highlight the disconnect between policy frameworks and institutional implementation. Although the National Water Policy (1999), Bangladesh Water Act

(2013), and strategies like the Bangladesh Delta Plan 2100 envision integrated water resource management (IWRM), enforcement remains inconsistent across agencies such as the Bangladesh Water Development Board (BWDB), Bangladesh Inland Water Transport Authority (BIWTA), Department of Environment (DoE), and Rajdhani Unnayan Kartripakkha (RAJUK). Case studies of the Buriganga, Turag, and Baral rivers show that embankment-centric flood control policies have disrupted ecological flows, while institutional inertia has perpetuated unsustainable practices. Environmental Impact Assessment (EIA) frameworks, including the Climate Resilient Integrated Southeast Project EARF (BWDB/ADB, 2023), provide methodological advances in climate resilience and ecological restoration. However, persistent weaknesses in compliance, stakeholder participation, and policy alignment reduce their effectiveness. These challenges are compounded by transboundary water issues, as national policy does not adequately address reliance on upstream flows from India. Recent literature suggests a paradigm shift from embankment-based interventions toward open river restoration, participatory monitoring, and community-led governance. Aligning EIA frameworks with international best practices could strengthen accountability and ecological sustainability. The study argues that Bangladesh urgently needs policy reforms that integrate climate resilience, transboundary cooperation, and ecological restoration into water governance, alongside institutional changes to improve enforcement, revise incentive structures, and create a dedicated environmental reform commission. Without such measures, river systems will continue to suffer from policy misalignment, uneven EIA enforcement, and fragmented institutional responses. By synthesizing lessons from recent research and policy, this study outlines a reform pathway grounded in evidence and public priorities to enhance river governance, support climate resilience, and promote sustainable development in Bangladesh.

Keywords: *River Governance; Institutional Fragmentation; Climate Resilience; Transboundary Water Governance; Community-Led Governance.*

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