Government of the People's Republic of Bangladesh
Ministry of Power, Energy and Mineral Resources
Energy and Mineral Resources Division

GEOLOGICAL SURVEY OF BANGLADESH

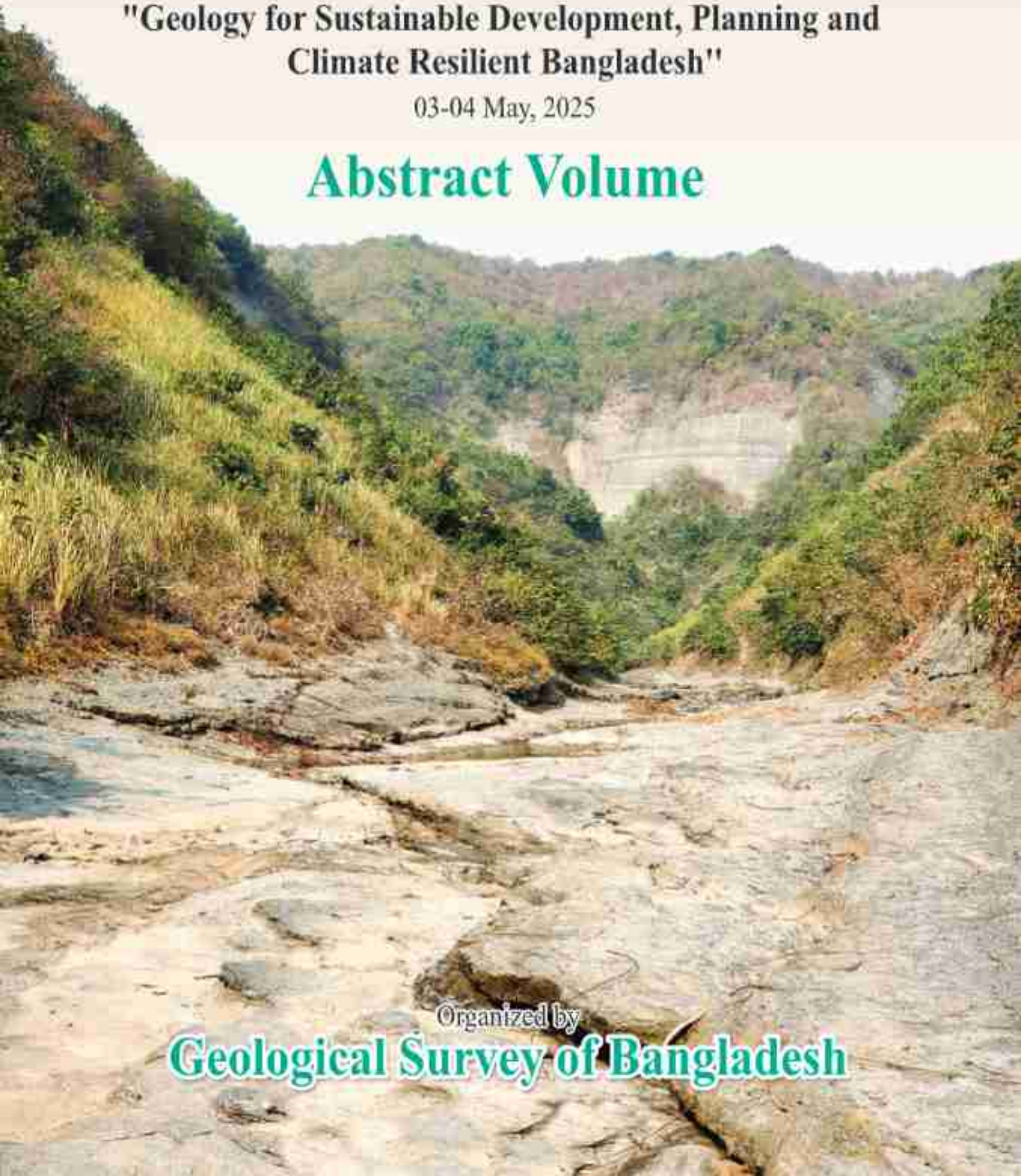
National Seminar

on

"Geology for Sustainable Development, Planning and Climate Resilient Bangladesh"

03-04 May, 2025

Abstract Volume



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Geological Survey of Bangladesh

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Government of The People's Republic of Bangladesh
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Geological Survey of Bangladesh

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National Seminar

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Geological Survey of Bangladesh (GSB)
03-04 May, 2025

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Abul Kashem Faruki Fahim	Lecturer, Department of Disaster Science and Climate Resilience, University of Dhaka

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MESSAGE

It is my privilege to extend my warmest greetings to all on the occasion of the publication of this abstract volume derived from various geological fields conducted by researchers of Geological Survey of Bangladesh (GSB), academicians, other organizations, scholars, professionals and young geo-scientists. It is both an honor and responsibility to highlight our research outputs to the country on our understanding of the geological issues, advancements of understanding of the hidden story, and applications of the results for the sustainable future development of the country. In this 3rd National Seminar on "Geology for Sustainable Development, Planning and Climate Resilient Bangladesh", the abstract volume represents a culmination of rigorous research, analyses, and innovative solutions through collective expertise and dedication of the researchers.

Climate change and its adverse effect on all development works and sustainability is a reality, especially for a low-lying country like Bangladesh. Adaptation to climate change for sustainable development planning and investment is a big challenge for our future infrastructure, industrial, urban development, agriculture, natural hazard mitigation and economic growth.

A variety of topics including mineral exploration, quaternary and coastal geology, engineering geology, structure and tectonics, stratigraphy, geo-hazard and geo-environmental issues, groundwater management,geophysical methods, geo-tourism etc. enriched this abstract volume contributed by different researchers. Each abstract gives versatile perspective, deep insights, and valuable recommendations for decision makers, planners, professionals and other stakeholders.

I extend my sincere gratitude to all the contributors, organizers, and reviewers who have worked hard and played vital roles in bringing this abstract volume in reality. I hope and wish that GSB will play an important role to build a climate resilient and for sustainable development of the country with their valuable geological knowledge to the nation.

I hope that GSB will continue this type of geological event to promote and disseminate geological knowledge and to aware all stakeholders about the necessity of use of geo-information for all sustainable development planning and works of Bangladesh.

S. M. Moin Uddin Ahmed
Director General (Additional Charge)
Geological Survey of Bangladesh
&
Additional Secretary
Energy and Mineral Resources Division
Ministry of Power, Energy and Mineral Resources.

PREFACE

It is my privilege and honour to introduce this abstract volume to you, which is a combination of the vibrant geological researches presenting in the 3rd National Seminar arranged by the Geological Survey of Bangladesh (GSB) on "Geology for Sustainable Development, Planning and Climate Resilient Bangladesh". More advanced research on geology and different fields of geosciences will help to play its role on the planning and development works of different professional community, stakeholders and for the benefit of the common people. I hope this endeavor is another vital step on the geological research and publication in advancing sustainable progress and prosperity of the country.

This abstract volume represents a snapshot of the diverse range of topics from energy, natural resource management, environmental issues to climate change adaptation and disaster risk assessments etc. It covers multi-disciplinary studies done by different professional and researchers from basic geological studies to applied fields like geo-spatial mapping including quaternary and coastal geology, structure and tectonics, stratigraphy, petrology and mineralogy to groundwater management, engineering geology, geo-ethics, geo-tourism etc. This volume comprises with 93 insightful abstracts.We are happy to see that some geo-scientists presenting their research on advanced methods and tools including deep learning architecture and AI for modeling in different geological fields.I believe that this abstract volume will be a valuable resource for researcher's professionals, practitioners, students and give ideas about current research progress. It is also an excellent reference to express the imperative necessary of geology for the sustainable future of Bangladesh. A seminar proceeding will be published with full scientific papers, which will serve as the official proceedings of the seminar.

GSB has a long history of geological research. Contribution of GSB in the geological fields extend far beyond mere documentation.GSB publishedown Record Series, scientific maps,national and international seminar preceding and abstract volumes so far. GSB has a self-sufficient library meticulously preserved thousands of textbooks, journals, and published reports. It also has a data base housing hundreds of reports with deep insights, which are in the process of publication.

Geoscientists' responsibility is also to comply with the global challenge's and issues, which are aligned with our different time-based national perspective goals. In this case geological community has a huge filed of work to contribute for all the related development and planning works, specially focusing on achieving the sustainable development goals-2030. Our collective efforts towards a future where geology becomes synonymous with sustainability and progress.

At the end, I express my heartfelt thanks and appreciation to all those whose unwavering dedication and contributions have made it possible in bringing this abstract volume to life.

Mohammad Ashraful Kamal
Director (Geology)
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Chairman, National Seminar Organizing Committee
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Session Schedule

National Seminar on

" Geology for Sustainable Development, Planning and Climate Resilient Bangladesh "

Geological Survey of Bangladesh (GSB)

03-04 May, 2025

Day	Time	Venue-1: Auditorium, Ground Floor, CIRDAP	Venue-2: 1st Floor, Auditorium, CIRDAP	Venue-3: 1st Floor, Hall Room, CIRDAP
	09.00 – 10.00 hrs.	Registration		
Day 1 03 May 2024	10.00 – 11.30 hrs.	Opening Session		
	Refreshment and Poster Session, Premises of 1st Floor, CIRDAP			
	12.30-13.30 hrs.	Technical Session 1 Theme 1: Quaternary Geology and Delta Building Processes	Technical Session 2 Theme 9: Structural Geology and Tectonics of Bengal Basin and Theme 4: Engineering Geology for Development Planning and Urbanization	Technical Session 3 Theme 12: Geophysical Applications for Exploration and Development Activities and Theme 4. Engineering Geology for Development Planning and Urbanization
	Lunch and Prayer			
	14.30 – 15.30 hrs.	Technical Session 4 Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation	Technical Session 5 Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation	Technical Session 6 Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation Theme 14. Geo-ethics: Geology for the Society and SDGs and Theme 8: Blue Economy, Coastal and Marine Geology
	Tea			
	16.00 – 17.00 hrs.	Technical Session 7 Theme 2: Exploration of Mineral Resources and Theme 7: Hydrogeology, Geochemistry and Water Resource Management	Technical Session 8 Theme 3: Energy and Power for Sustainability	Technical Session 9 Theme 6: Climate Change, Issues, Mitigation and Resilient Bangladesh
		3th Floor, Seminar Room (GSB)	3rd Floor, Conference Room (GSB)	1st floor Seminar Room (GSB)
Day 2 04 May 2024	09.45 – 11.00 hrs.	Technical Session 10 Theme 7: Hydrogeology, Geochemistry and Water Resource Management	Technical Session 11 Theme 7: Hydrogeology, Geochemistry and Water Resource Management	Technical Session 12 Theme 4: Engineering Geology for Development Planning and Urbanization
	Refreshment			
	11.30 – 12.30 hrs.	Technical Session 13 Theme 8: Blue Economy, Coastal and Marine Geology	Technical Session 14 Theme 10. Stratigraphy and Biostratigraphy	Technical Session 15 Theme 11. Petrology and Mineralogy and Theme 2: Exploration of Mineral Resources
	Lunch and Prayer			
	14.30 – 15.30 hrs.	Technical Session 16 Theme 12: Geophysical Applications for Exploration and Development Activities and Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation SDGs	Technical Session 17 Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh and Theme 4: Engineering Geology for Development Planning and Urbanization	Technical Session 18 Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh
	Tea and Prayer			
	16.00 – 18.00 hrs.	Closing Session		

Programme Schedule

Registration: 09.00 - 10.00 hrs

Inaugural Session
Venue: CIRDAP Auditorium, Chameli House, 17 Topkhana Road, Dhaka
Date: 03 May, 2025
Time: 10.00 -11.30 hrs.

Poster Session
Venue: 1st Floor, CIRDAP
Date: 03 May, 2025, Time: 11.30-12.30 hrs.

Technical Session 1
Theme 1: Quaternary Geology and Delta Building Processes
Venue: Venue-1: Auditorium, Ground Floor
Date: 03 May, 2025; Time: 12.30 -13.30 hrs.
Chair: Prof. Dr. Sharif Hossain Khan, Department of Geological Sciences, Jahangirnagar University
Co-Chair: Mr. Abu Syed Mohammed Faisal, Deputy Director (Geology), GSB
Rapporteur: Ms. Tahera Afrin, Assistant Director (Geology), GSB

1. Vertebrate Fossils Evidence and $\delta^{18}O$ and $\delta^{13}C$ Records of Pedogenic Soil Carbonates in Red Clay: Implications for Middle Pleistocene Paleoenvironmental Interpretation in the Barind Tract, NW Bangladesh
   Md. Shafiqul Alam
2. Geomorphological Evolution and Present-day Processes in the Rangabali and Surrounding Islands, Meghna Estuary, Bangladesh
   Md. Bazlar Rashid, *Md. Rubel Sheik, Kamrul Ahsan*
3. Signature of Holocene Marine Transgression in Sub-Surface Sediments of Mahananda Floodplain, Western Barind Tract, NW Bengal Basin
   Md. Sultan-Ul-Islam, *Ms. Fahima Ferdousy, Aftab Alam Khan, Ismail Hossain and H M Zakir Hossain*
4. Lithological and Geochemical Characteristics of the Eocene-Miocene Sediments of the Surma Basin, Bangladesh: Understanding the Changes of Depositional Environment and Sediment Sources
   Md. Masidul Haque, *Md. Ashikur Rahman, Ismail Hossain, Khondaker Emamul Haque, Koichi Hoyanagi*

Technical Session 2
Theme 9: Structural Geology and Tectonics of Bengal Basin and Theme 4: Engineering Geology for Development Planning and Urbanization
Venue: Venue-2: 1st Floor, Auditorium, CIRDAP
Date: 03 May, 2025; Time: 12.30 -13.30 hrs.
Chair: Prof. Dr. Md. Bodruddoza Mia, Department of Geology, University of Dhaka
Co-Chair: Mr. Md. Feruj Alam, Deputy Director (Geology), GSB
Rapporteur: Mr. Md. Azahar Hossain, Assistant Director (Geology), GSB

1. Engineering Geological 3D Modelling for Urban Planning-A Case Study of Aftabnagar, Dhaka, Bangladesh
   Sarwat Jabeen, *Nurun Nahar Faruqa, Mohammad Abdul Aziz Patwary, Mohammad Ashraful Kamal*
2. Formation Evaluation Using Geophysical Logs of Saldanadi Well# 1, Bangladesh
   Kamruzzaman, *Md.Upal Shahriar, Md. Masuk-Un-Nabi, Md. Zakir Hossain, AfridaWasima, Md. Tawhidul Aziz, Md. Maniruzzaman Bhuiyan, Md. Shahadat Hossain, Md. Maksudul Islam and Koushik Roy*
3. Understanding of Structural Configuration and Geometry of the Bengal Basin for a Rational Seismic Risk Assessment of Bangladesh
   Mir Fazlul Karim and ***Md. Zillur Rahman***
4. A Tectonic Insight for Seismic Risk Assessment for Disaster Management in Bangladesh
   Mir Fazlul Karim *and Md. Zillur Rahman*

Technical Session 3

Theme 12: Geophysical Applications for Exploration and Development Activities and Theme 4: Engineering Geology for Development Planning and Urbanization

Venue: Venue-3: 1st Floor, Hall Room, CIRDAP
Date: 03 May, 2025; Time: 12.30 -13.30 hrs.
Chair: Prof. Dr. A.S.M. Woobaidullah, Department of Geology, University of Dhaka
Co-Chair: Mohammed Hasan Shahariar, Deputy Director (Geology), GSB
Rapporteur: Mr. Kamruzzaman, Assistant Director (Geophysics), GSB

1. Gravity and Magnetic Investigations in the Highest Positive Gravity Anomaly in Bangladesh at Chapai Nawabganj and Naogaon Districts
   Sultana Nasrin Nury, *Md. Shahjahan and Md. Selim Reza*
2. Seismic Refraction Survey for Configuring the Archaean Basement Complex in Porsha, Patnitala, and Dhamoirhat Upazilas of Naogaon District, Bangladesh
   Md. Selim Reza, *Mohammad Zohir Uddin and Tushar Kanti Roy*
3. Application of Multi-Electrode Electrical Resistivity Tomography Survey to Delineate Aggregate Resources in Lovachara, Kanaighat, Sylhet
   Md. Shahjahan, *Kamruzzaman and Afrida Wasima*
4. Three-Dimensional Shallow Subsurface Lithological Modeling of the Ganges Delta: A Case Study of Khulna City, Bangladesh
   Faruk Hossain, *Nurun Nahar Faruqa, Sara Schade, Mohammad Ashraful Kamal, Md. Mahmood Hossain Khan, Mohammad Feruj Alam, Sarwat Jabeen, Tahera Afrin and Mohammad Khairul Islam*

Technical Session 4

Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation SDGs and Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh

Venue: Venue-1: Auditorium, Ground Floor, CIRDAP
Date: 03 May, 2025; Time: 14.30 - 15.30 hrs.
Chair: Prof. Dr. Md. Badrul Islam, Department of Geology and Mining, University of Rajshahi

Co-Chair: Mr. Md. Faruk Hasan, Deputy Director (Geology), GSB
Rapporteur: Md. Ahsan Habib, Assistant Director (Geology), GSB

1. Primordial Radionuclides in the Trans-boundary River Sediments Across the Dauki Fault Belt, at the North-east Bangladesh: Implication from U-Th Mineralization and Radiological Consequences
   Sudeb Chandra Das, *Mohammad Rajib, Md. Golam Rasul, Mohammad Zafrul Kabir, Farah Deeba, Md. Moniruzzaman, Nafisa Tamannaya Dina, Tumpa Saha*
2. Impacts of Morphology on Environment Induced by Polders in the Southwest Tidal Flat of Bangladesh
   Reshad Md. Ekram, *Md. Shafiqul Alam, Khalil R. Chowdhury*
3. Evaluation of Landsubsidence in a Multi-slicing Coal Seam of the Barapukuria Coal Mine
   Md. Abdul Malek, *Sohail Kabir, Mushfique Ahmed*
4. Assessing Urban Expansion through GIS and Remote Sensing: A Study of Land Use and Land Cover Changes in Gazipur
   Sanzida Akter, *Md Khairul Haque*

Technical Session 5
Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation SDGs
Venue: Venue-2: 1st Floor, Auditorium, CIRDAP
Date: 03 May, 2025; Time: 14.30 - 15.30 hrs.
Chair: Prof. M. Saiful Islam, Department of Geology, University of Dhaka
Co-Chair: Mr. Mohammd Alamgir Kabir, Deputy Director (Geology), GSB
Rapporteur: Ms. Shahida Akter, Assistant Director (Geology), GSB

1. Stressed Environmental Condition and Pollution Monitoring Using Recent Benthic Foraminifera: A study Along the Sandwip Channel Around the Ship Breaking Yard of Chattogram, Bangladesh
   Kazi Munsura Akther, *Syeda Jesmin Haque, Asma Huque and Tanzim Tamanna Afroz*
2. Geo-environmental Degradation of St. Martin's Island, Bangladesh
   Md. Shamsuzzaman
3. Geological and Environmental Impacts of Light Pollution: A Case Study of Rajshahi City Corporation, Bangladesh
   Fatema Akter Mitu, *Safayet Mostofa, Md. Abdur Rahman, Ahmadullah Zaman*
4. The Significance of Considering Hydro-meteorological Risks for Safe Nuclear Power Planning
   Moniruzzaman Md, *Rezaul Karim, Noor Tushar, Nafisa Dina, Saha Tumpa and Asad Hussain*

Technical Session 6
Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation SDGs and Theme 14: Geo-ethics: Geology for the Society and SDGs Theme 8: Blue Economy, Coastal and Marine Geology
Venue: Venue-3: 1st Floor, Hall Room, CIRDAP

Date: 03 May, 2025; Time: 14.30 - 15.30 hrs.
Chair: Prof. Md. Jamal Uddin, Department of Environmental Sciences, Jahangirnagar University
Co-Chair: Mr. Md. Nuruzzaman Sabuj, Deputy Director (Geology), GSB
Rapporteur: Mr. Tushar Kanti Roy, Assistant Director (Geophysics), GSB

1. Impacts of Dredging and Reclamation Project in the IWT Corridor of Bangladesh
   Naeem Muhammed *and Md. Mizanur Rahman*
2. Integrating Geoethics and Interdisciplinary Strategies: Advancing Resilience and Sustainable Development of Bangladesh
   Md. Jahangir Alam
3. Pondering Over Geoscientific Writing and Geoscience Writing
   A. K. M. Khorshed Alam
4. Towards Sustainable Development: The International Laws and Geospatial Techniques in Addressing Transboundary Riverine Pollution in Marine Areas of Bangladesh
   Nahadul Islam, *Md Golam Kibria, Md Khairul Haque, S. M. Imran Bin Yousuf Ornab*

Technical Session 7
Theme 2: Exploration of Mineral Resources and Theme 7: Hydrogeology, Geochemistry and Water Resource Management
Venue: Venue-1: Auditorium, Ground Floor, CIRDAP
Date: 03 May, 2025; Time: 16.00 - 17.00 hrs.
Chair: Dr. Md. Nehal Uddin, Former Director General, GSB
Co-Chair: Ms. Kazi Mansura Akter, Deputy Director (Geology), GSB
Rapporteur: Mr. Md. Al Razi, Assistant Director (Geology), GSB

1. Comparative Analysis of Deep Learning Architectures for Multi-Class Mineral Classification: A Study Using EfficientNet and ResNet Models
   Minhaz Chowdhury, *Shreoshi Roy Shrima, Md Shofiqul Islam*
2. Advancing Multi-Class Mineral Classification with Generative AI: A Study of EfficientNet and ResNet Models
   Minhaz Chowdhury, ***Shreoshi Roy Shrima,*** *Md Shofiqul Islam*
3. Participatory Rural Appraisal (PRA) Approach and Hydrological Investigation for Groundwater Management in Chapainawabganj District
   Md. Jahid Hossain, *Md. Sydur Rahman Khan, M. Aminul Haque and Nur Alam*
4. Heavy Metal Pollution and Spatial Distribution in Surface Water and Sediments of Dhamrai Upazila, Bangladesh
   Shahtaj Karim, *Riyadul Islam, Md. Rashedul Hasan, Shahida Akter and Khaleda Afrin*

Technical Session 8
Theme 3: Energy and Power for Sustainability
Venue: Venue-2: 1st Floor, Auditorium, CIRDAP
Date: 03 May, 2025; Time: 16.00 - 17.00 hrs.
Chair: Abdul Baquee Khan Majlis, Former Deputy Director General, GSB

Co-Chair: Mr. Mohammad Masum, Deputy Director (Geology), GSB
Rapporteur: Mr. Mohammad Omer Faruk Khan, Assistant Director (Geology), GSB

1. AI-Driven Approaches to Coal Gasification: Enhancing Efficiency, Reducing Emissions, and Advancing Sustainable Energy Solutions
   Minhaz Chowdhury, Shreoshi Roy Shrima, ***Md Shofiqul Islam***
2. Provenance and Reservoir Quality of the Hhydrocarbon-B Bearing Neogene Sandstone Reservoirs in the Begumganj Structure, Bengal Basin, Bangladesh
   Padmasree Paul, ***M. Julleh Jalalur Rahman*** *and Abu Sadet Md. Sayem*
3. Enhancing the Energy Transition Through Clean Technologies and Decarbonization Strategies Towards a Sustainable Energy Future of Bangladesh
   Md. Jahangir Alam
4. Harnessing Brown Hydrogen: Pathways to a Sustainable Energy Future for Bangladesh
   Md. Jahangir Alam

Technical Session 9

Theme 6: Climate Change, Issues, Mitigation and Resilient Bangladesh

Venue: Venue-3: 1st Floor, Hall Room, CIRDAP
Date: 03 May, 2025; Time: 16.00 - 17.00 hrs.
Chair: Prof. Dr. M. Shafiqul Alam, Department of Geology and Mining, University of Rajshahi
Co-Chair: Dr. Md. Samsuzzaman, Deputy Director (Geology), GSB
Rapporteur: Ms. Afrida Wasima, Assistant Director (Geophysics), GSB

1. The Effect of Salinity on Aquatic Macrophytes and it's Application Along the Coastal Area of Bangladesh
   Mahfuza Parveen, *S.M. Mahmudur Rahman, Tarek Shahriar*
2. Geospatial Insights into the Impact of Climate Change on Urban Heat Islands and Public Health in Dhaka, Bangladesh
   Maria Moktadira Shuchi, Farjana Begum, ***Md Khairul Haque***
3. Climate Change Influence on the Flash Flood Hazard in Tahirpur Upazila, Sunamganj District, Bangladesh
   Rajib Kumar Saha
4. Flash Flood 2024 in Feni, Noakhali and Lakshipur Districts and Future Action Plan
   Md. Bazlar Rashid, *Md. Rubel Sheik, Mohammad Abdul Aziz Patwary, Mohammad Ashraful Kamal, Md. Kamrul Ahsan, Md. Mizanur Rahman, Md. Shahdat Ali*

Technical Session 10

Theme 7: Hydrogeology, Geochemistry and Water Resource Management

Venue: 3rd Floor, Seminar Room (GSB)
Date: 04 May, 2025; Time: 09.45 - 11.00 hrs.
Chair: Dr. Ratan Kumar Majumder, Chief Geologist, Nuclear Minerals Unit, Bangladesh Atomic Energy Commission, Savar, Dhaka 1349,Bangladesh
Co-Chair: Ms. Shahtaj Karim, Deputy Director (Geology), GSB

Rapporteur: Mr. Md. Nur-Alam, Assistant Director (Geophysics), GSB

1. Estimation of Groundwater Resource and Suitability of GWREC-97 Methodology for Riverside Aquifers: A Case Study
   Md. Masuk-Un-Nabi, *Khairul Bashar, Mazeda Islam, Farhana Kabir and Md. Mizanur Rahman Sarker*
2. Analyzing Piezometric Level Trends and Management Gaps: A Case Study in Jahangirnagar University
   Sakibul Islam, *Mazeda Islam, Md. Mizanur Rahman Sarker and Imrul Kayes*
3. Hydrochemistry of Arsenic Contaminated Groundwater in Southeastern Bangladesh: Implication for Arsenic Mobilization
   A.H.M. Selim Reza, *Harue Masuda, Nozomu Hiarai, Atsunao Marui, Masahiko Ono*
4. Mapping Potential Zones for Groundwater Recharge in Cumilla District, Bangladesh: An Integrated Approach using AHP, Fuzzy-AHP, and GIS
   Md. Mahedi Hasan, ***Md. Ibrahim Adham,*** *Iftekharul Islam, Muqit Ajmain Shahriyar, Arani Mitra Adri, Obaida Urme*
5. Groundwater Quality in the Barind Tract and Floodplain Regions of Naogaon District, Bangladesh: A Hydrogeochemical and GIS Perspective
   MT. Sharmin Aktar, Khondaker Emamul Haque, Md. Moniruzzaman and ***Shamim***

Technical Session 11

Theme 7: Hydrogeology, Geochemistry and Water Resource Management

Venue: 3rd Floor, Conference Room (GSB)
Date: 04 May, 2025; Time: 09.45 - 11.00 hrs.
Chair: Prof. Dr. A. H. M. Selim Reza, Department of Geology and Mining, University of Rajshahi
Co-Chair: Mr. Mohammad Zohir Uddin, Deputy Director (Geophysics), GSB
Rapporteur: Mr. Md. Harun Or Rashid, Assistant Director (Geology), GSB

1. Isotopic and Hydrogeochemical Assessment of the Central Deltaic Zone in Bangladesh: Intergrating Source, Water Quality and Health Risk Indices
   Md Moniruzzaman, *Hafizur Rahman Tanim, Ratan Kumar Majumder*
2. Groundwater Source, Water Quality, and Health Risk Assessment in the Jamuna Floodplain, Bangladesh: An Isotopic and Hydrogeochemical Approach
   Hafiz Al- Asad, *Md Moniruzzaman*
3. Hydrochemical Evolution and Groundwater Quality of the Aquifer System in Jahangirnagar University Campus and Its Surrounding Area
   Mazeda Islam, *Shara Dil Afroz Sithy, Md. Mizanur Rahman Sarker, Md. Abdul Quaiyum Bhuiyan, Badhan Saha, Md. Sabuj Mia and Md. Ferdous Alam*
4. Deciphering Coastal Hydrostratigraphy Through Integrated Resistivity Survey and Geophysical Logging: Towards a Sustainable Fresh Aquifer for Drinking Water Supply in Noakhali Town, Bangladesh
   Md. Shahjahan *and ASM Woohaidullah*

Technical Session 12

Theme 4: Engineering Geology for Development Planning and Urbanization

Venue: 1st floor, Seminar Room (GSB)

Date: 04 May, 2025; Time: 09.45 - 11.00 hrs.

Chair: Prof. Dr. A.T.M. Shakhawat Hossain, Department of Geological Sciences, Jahangirnagar University

Co-Chair: Mr. Md. Ashraf Hossen, Deputy Director (Geology), GSB

Rapporteur: Mr. Md. Al Razi, Assistant Director (Geology), GSB

1. Shear Wave Velocity Determination in Gopalganj Municipality and Surrounding Areas by Combined Analysis of Downhole Seismic and Multichannel Surface Wave Data

   Md. Mahmood Hossain Khan, Mohammad Khairul Islam, Mohammad Feruj Alam, Sarwat Jabeen, Faruk Hossain, Tahera Afrin, ***Mohammad Ashraful Kamal*** *and Nurun Nahar Faruqa*
2. Sustainable Planning and Management of Hilly Terrain in the Kutupalong Rohingya Camp Area, Ukhiya, Cox's Bazar, Bangladesh: A Geotechnical Data Analysis and Soil Property Investigation

   Khan, PA, Hossain, ATMS, Sayem, HM, Haque, ***ME, Khatun,*** *M, Imam, MH, Jafrin, SJ, Dutta, T, Bakali, R*
3. Stabilization of Low Strength Soil Using Fly Ash and Cement

   Md. Asmaul Islam, *Hossain Md. Sayem and Nousat Ara Maghla*
4. Geotechnical Properties of Clayey Soil Stabilized with Rice Husk and Cement

   Nousat Ara Maghla, ***Hossain Md. Sayem,*** *Mahmuda Khatun and Md. Asmaul Islam*
5. Geotechnical Analysis of Sandy Soil from the Dupi Tila Formation: Implications for Engineering Applications in Sylhet, Bangladesh

   Maliha Anzuman*, Md. Shofiqul Islam, Md. Ashraf Hossain, Ummae Habiba Sultana*

Technical Session 13

Theme 8: Blue Economy, Coastal and Marine Geology

Venue: 3rd Floor, Seminar Room (GSB)

Date: 04 May, 2025; Time: 11.30 - 12.30 hrs.

Chair: Dr. A.K.M. Khorshed Alam, Former Director General, GSB

Co-Chair: Mr. Md. Rubel Sheikh, Assistant Director (Geology), GSB

Rapporteur: Mr. Md. Abdur Razzaque, Assistant Director (Geology), GSB

1. Organic Matter Source and Paleoclimate Variability of Multicore Sediments from the Andaman Sea Off Myanmar

   H. M. Zakir Hossain
2. Grain Size Distribution and Characterisation of Sedimentary Processes of Cox's Bazar Beach, Bangladesh: Implications for Understanding Morphology and Coastal Dynamics

   Md. Masidul Haque, *Mozammal Haque, Koichi Hoyanagi*
3. Evaluation of Trace and Rare-earth Elements in Core Sediments from the Sundarbans

Coastal Area of Bangladesh

Md. Aminul Islam, *H. M. Zakir Hossain, Anas Al Hossain, Zhifei Liu, Mingyang Yu, Razia Sultana, Umme Asrafi Ananna, Sabit Hossain*

Technical Session 14

Theme 10: Stratigraphy and Biostratigraphy

Venue: 3rd Floor, Conference Room (GSB)

Date: 04 May, 2025; Time: 11.30 - 12.30 hrs.

Chair: Prof. Dr. Md. Anwar Hossain Bhuiyan, Department of Geology, University of Dhaka

Co-Chair: Dr. Md. Ahosan Habib, Deputy Director (Geology), GSB

Rapporteur: Ms. Khaleda Afrin, Assistant Director (Geology), GSB

1. Facies and Architectural Element Analysis of the Exposed Oligocene Succession in and Around Jaintiapur, Surma Basin, Northeastern Bangladesh

   Md. Rasel Sarker, *Md. Abdur Rahman, Shanto Mia*
2. Paleoenvironments of the Oligocene Renji Formation, Bengal Basin, Bangladesh: Implications from Lithofacies and Biofacies Aspects

   Md. Sultan-Ul-Islam, *Mrinal Kanti Roy and K M Rajibul Hasan*
3. Distribution of Ostracoda in the Sediments of the Southeastern Coast of Bay of Bengal, Bangladesh-Implications for Microenvironment

   Md. Harun or Rashid, *Kazi Masnura Akhter, Syeda Jesmin Huque, Sabina Yeasmin, Arif Porag and Tanzim Tamanna Afroz*
4. Paleoenvironmental Reconstruction and Petroleum Generation Analysis Using Palynological and Diatomaceous Evidence from Reservoir Rocks

   Syeda Jesmin Haque, *Kazi Munsura Akther, and Asma Huque*

Technical Session 15

Theme 11: Petrology and Mineralogy and Theme 2: Exploration of Mineral Resources

Venue: 1st floor, Seminar Room (GSB)

Date: 04 May, 2025; Time: 11.30 - 12.30 hrs.

Chair: Prof. Dr. Khondokar Emamul Haque, Department of Geology and Mining, University of Rajshahi

Co-Chair: Ms. Sarwat Jabeen, Deputy Director (Geology), GSB

Rapporteur: Ms. Sabina Yesmin, Assistant Director (Geology), GSB

1. Gem-quality Minerals Investigation from Placer Gravel Deposits in Panchagarh District, Bangladesh: Implications of Potential Sources and Links to Pleistocene Glaciations

   Ismail Hossain, *Iftekharul Islam, Anna Karanina and Mozammal Haque*
2. Integrated Evaluations of the Changing Subsurface Lithology in the Surrounding of Rajshahi City Corporation and Adjoining Padma River Bar Sediments: Constraint to Chemical, Mineralogical and Radiological Characteristics

   Anna Karanina, *Ismail Hossain, Iftekharul Islam, Md. Moniruzzaman, Pradip Kumar Biswas*

3. Provenance and Tectonic Implications of the Oligocene Barail Group Sandstones from the Sylhet Trough, Bengal Basin: Constraints from Petrography and Major Element Geochemistry
   Sunjukta Mohinta, *Abu Sadat Md. Sayem, Rashed Abdullah, Md. Sha Alam*
4. Geochemical Prospecting of for Lithium in the River Sands of Dharla, in Kurigram District, of Bangladesh
   Mohammad Omer Faruk Khan, *Md. Ali Akbar, Dr. Md. Ahosan Habib, Md. Sohel Rana, Riyadul Islam, Md. Rashedul Hasan*

Technical Session 16
Theme 12: Geophysical Applications for Exploration and Development Activities and Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation SDGs
Venue: 3rd Floor, Seminar Room (GSB)
Date: 04 May, 2025; Time: 14.30 - 15.30 hrs.
Chair: Prof. Dr. Delwar Hossain, Department of Geological Sciences, Jahangirnagar University
Co-Chair: Mr. Md. Shahjahan , Deputy Director (Geophysics), GSB
Rapporteur: Ms. Masuk-un-Nabi, Assistant Director (Geophysics), GSB

1. Application of Geo-electrical Resistivity Survey and Bore Log Data for the Delineation of Hydrogeological Condition of Tala Upazila, Satkhira District
   Nahian Islam Nirjhar, *ASM Woobaidullah*
2. Subsurface Characterization of Purbachal Town, Dhaka for Seismically Hazardous Zone (Micro zonation) Identification
   Syed Nazrul Islam *and Tanzim Tamanna Afroz*
3. Review of the Geophysical Explorations Activities of GSB in the North-Western Part of Bangladesh
   Sultana Nasrin Nury, *Nazmun Nahar, Tushar Kanti Roy and Sirajum Munira*
4. GIS Approaches for Mapping Drought-Prone Areas: A Comparison of Logistic Regression, Weight of Evidence, Frequency Ratio Methods
   Ahmadullah Zaman, *Fauzia Khoshnobish, Md Nahid Ferdous, Mohammad Ismail Hossain*

Technical Session 17
Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh and Theme 4: Engineering Geology for Development Planning and Urbanization
Venue: 3rd Floor, Conference Room (GSB)
Date: 04 May, 2025; Time: 14.30 - 15.30 hrs.
Chair: Prof. Dr. Md. Mahfuzul Haque, Department of Geological Sciences, Jahangirnagar University
Co-Chair: Mr. Md. Nazwanul Haque, Deputy Director (Geology), GSB
Rapporteur: Mr. Md. Jahangir Alam, Assistant Director (Geology), GSB

1. Development of Vertical Offshore Reference Frame (VORF) for Precise Geospatial Analysis in Maritime Areas of Bangladesh
   Haider Jahan Khan Emon

2. UAV Application and Satellite Image Analysis in Placer Mineral Exploration at Coastal Deposits of Cox's Bazar, Bangladesh
   Md. Golam Rasul, Ratan Kumar Majumder, Mohammad Zafrul Kabir, Farhana Islam, Farah Deeba, ***Mohammad Rajib,*** *Md. Masud Karim, Md. Moniruzzaman Sumon, K M Jalal Uddin Rumi, Sanjib Karmaker, Md. Moniruzzaman Monir, Rahnuma Siddique, Md. Fahad Hossain, Nafisa Tamannaya Dina, Sudeb Chandra Das, Tumpa Saha*
3. Assessing Ground Subsidence Risk in Dhaka City and Its Surrounding Areas, Bangladesh: Insights from Multi-Temporal InSAR Technique
   Rintu Roy *and R. S. Chatterjee*

Technical Session 18

Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh

Venue: 1st floor, Seminar Room (GSB)
Date: 04 May, 2025; Time: 16.30 - 15.30 hrs.
Chair: Dr. Reshad Md. Ekram Ali, Former Director General, GSB
Co-Chair: Mr. Md. Sohel Rana, Deputy Director (Geology), GSB
Rapporteur: Ms. Tanzim Tamanna Afroz, Assistant Director (Geology), GSB

1. Characteristics of River Morphology and Bottom Topography Around the Padma Multipurpose Bridge Site
   Konika Sultana Kona *and Md. Mahfuzul Haque*
2. Ground Subsidence Study of Faridpur Town and Surrounding Area Using RADAR InSAR for Sustainable Spatial Urban Planning and Development
   Md. Nazwanul Haque, *Rintu Roy, Mohammad Ashraful Kamal*
3. Development of Land Use Suitability Map of Faridpur Town area for Spatial Urban Development Planning Using GIS and Multi-Criteria Analysis of Geo-factors
   Mohammad Ashraful Kamal, *Sarwat Jabeen, Nurun Nahar Faruqa, Md. Mahmood Hossain Khan, Mohammad Feruj Alam, Md Nazwanul Haque, Rintu Roy, Tahera Afrin, Mohammad Khairul Islam, Andreas Gunther, Werner Buchert*
4. Detection of Spatio-Temporal Changes in the Jamuna River at Sonatola Upazila, Bogura District
   Md Nazwanul Haque, *Syed Nazrul Islam, Shawon Talukder, Rintu Roy*

Closing Session

Venue: GSB
Date: 04 May, 2025; Time: 16.00 -18.00 hrs.

List of Posters

Theme 1: Quaternary Geology and Delta Building Processes

1. Unraveling the Geomorphology and Neotectonics of the Mid-Bengal Basin from Fluvial Sediments: A Case Study of Shibalya-Daulatpur Upazila, Manikganj District, Bangladesh
   Md. Jahangir Alam, *Abu Syed Mohd. Faisal and Md. Mizanur Rahman*
2. Volcanic Ash Deposit at Aliarhat, Shibganj Upazila, Bogura District, Bangladesh
   Kamrul Ahsan

Theme 2: Exploration of Mineral Resources

1. Mineralogical and Geochemical Characterization, and Physicochemical Properties of Kaolin from Madhabpur Upazila, Habiganj District, Bangladesh
   Shawon Talukder
2. Concentration of Heavy Minerals and Its Economic Potentiality along the Padma River, Kushtia, Bangladesh
   Fazal M. Mohi Shine

Theme 5: Geo-hazard, Geo-environmental Problems and Mitigation SDGs

1. Hydraulic Characteristics and Bank Erosion Rate of Padma River from Lalpurto Ishwardi, Bangladesh
   Md. Atiqur Rahman, *Md. Naim Ahmed, Md. Raihanul Islam Shakil, Most. Tania Khatun, Younus Ahmed Khan*
2. Statistical Predictive Approach for Bank Erosion of Atrai River from Ahsangonj to Singra, Rajshahi, Bangladesh
   Md. Raihanul Islam Shakil, *Md. Naim Ahmed, Most. Tania Khatun, Md. Atiqur Rahman and, Younus Ahmed Khan*
3. Stability and Cantilever Failure model of Mahananda River of Nawabganj Sadar Upazila, Chapai-Nawabganj
   Most. Tania Khatun, *Md. Raihanul Islam Shakil, Md. Naim Ahmed, Md. Atiqur Rahman and Younus Ahmed Khan*
4. Bed Degradation Model and Empirical Sediment Transport of Jamuna River and its Impact on Embankment Stability from Kazipur to Sirajganj Hard Point, Bangladesh
   Md. Naim Ahmed, *Md. Raihanul Islam Shakil, Most. Tania Khatun, Md. Atiqur Rahman and Younus Ahmed Khan*
5. Application of Sentinel-1 Data for Flood Hazard Monitoring: A Case Study of Sirajganj District, Bangladesh
   Md. Azahar Hossain, *Nanette C. Kingma*
6. Inclusive Disaster Preparedness for Persons with Disabilities in Flood-Prone Areas: Assessing Geomorphological Changes and Vulnerabilities in Rowmari, Kurigram, Bangladesh
   Deepti Sarkar
7. Flood Susceptibility Mapping of Bangladesh under Changing Climate Using IPCC Projections and Machine Learning Techniques
   Md. Walid Hossen Tamim

Theme 7: Hydrogeology, Geochemistry and Water Resource Management

1. Groundwater Quality Assessment of Deep Aquifer and its Impact on Human Health in Dhaka Metropolitan City, Bangladesh
   Shahida Akter, *Anwar Saadat Mohammad Sayem, Md. Rashedul Hasan, Riyadul Islam*
2. Assessment of Groundwater Quality and Its Effect on Human Health in Savar Upazila of Dhaka District, Bangladesh
   Shahida Akter, *Riyadul Islam, Md. Kamal Hossain, Md. Rashedul Hasan*
3. Assessment of Sea Water Intrusion in the Chattogram City: Insights from Hydrogeology and Hydrochemical Analysis
   Md. Aftab Uddin Shawan, *Khairul Bashar and Rashed Abdullah*

Theme 8: Blue Economy, Coastal and Marine Geology

1. Blue Tourism Potentiality in the Khurushkul Area of Cox's Bazar District, Bangladesh
   Md. Shamsuzzaman

Theme 11: Petrology and Mineralogy

1. Textural and Petrographic Characterization, and Distribution of Heavy Minerals in Sand Deposits of the Teesta River, Bangladesh
   Md. Shohanur Rahman Sohan, *Rumana Yeasmin, M. Julleh Jalahar Rahman, Abu Sadat Md. Sayem, Md. Sohel Rana*
2. Petrography and Mineral Chemistry of Padma River Bar Sediments: Implications for Provenance and Petrogenesis
   Nafisa Tabassum, *Ismail Hossain, Pradip Kumar Biswas and Karima Sultana*

Theme 12: Geophysical Applications for Exploration and Development Activities

1. Improving Insights into Petrophysics Using Geophysical Data for the Habiganj Structure, Surma Basin, Bangladesh
   Kamruzzaman, *Delwar Hossain, Mizanur Rahman Sarker, Mahmuda Khatun and Md. Upal Shahriar*
2. 3D Modeling in Geoscience: A Tool for Unveiling Near-Surface Depositional History in Faridpur, Satkhira, Barishal and Khulna Town and Surroundings
   Nurun Nahar Faruqa, *Mohammad Ashraful Kamal, Sarwat Jabeen, Faruk Hossain*

Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh

1. Geospatial Monitoring of Land Cover Transformation in Char Kukri Mukri: Implications for Coastal Sustainability.
   Md. Sayem, *Najia Lamia*
3. Relation Between Development and Land Use Land Cover Changes and Its Impact on Surface Temperature
   Hossain Mohammad Arifeen, *Md. Hossain Al Imran, Tahera Afrin, Asma Huque*

Content

Theme 11: Petrology and Mineralogy

Theme 12: Geophysical Applications for Exploration and Development Activities

Theme 13: Geospatial Analysis, Techniques for Sustainable Development Planning of Bangladesh

Abstract

Vertebrate Fossils Evidence and $\delta^{18}O$ and $\delta^{13}C$ Records of Pedogenic Soil Carbonates in Red Clay: Implications for Middle Pleistocene Paleoenvironmental Interpretation in the Barind Tract, NW Bangladesh

Md. Shafiqul Alam[1]*

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Abstract

Generally, the warm and humid climate of Bangladesh is not suitable for good preservation of fossils. Consequently, it is very difficult to find vertebrate fossils, particularly in older deposits other than the Holocene. Some bones of elephants, cows and buffaloes have been reported only in the Holocene deposits in some parts of Bangladesh. However, two pieces of vertebrate fossils were recorded in Barind Clay deposits of Middle Pleistocene age at a depth of 9 meters in a stream-cut section at Babudanga (24°34′48″N latitude, 88°20′60″E longitude) in the western Barind Tract, NW Bangladesh. The fossil site is located in a high Barind Tract region, approximately 35 meters above mean sea level (AMSL) characterized by a highly dissected, undulating to rolling Pleistocene landmass. These fossils have been identified as a molar tooth of bovid and a part of an antelope antler, marking the first vertebrate fossil records in the Pleistocene deposits in Bangladesh. These fossils were embedded in paleosol horizons within the Barind Clay, associated with pedogenic soil carbonate nodules. It is well known that secondary soil carbonate forms only when the average rainfall does not exceed 750 mm. In contrast to the current average rainfall rate (i.e., >1500 mm/year), this suggests that the climate was significantly drier during soil formation. This arid environment likely created favorable conditions for fossilization, leading to the preservation of these mammal bones in the Middle Pleistocene Barind Clay sediments. Stable oxygen and carbon isotopic analyses were conducted on nine pedogenic carbonate nodules collected from the same horizon where a bovid molar tooth and a piece of antler of antelope were found. The $\delta^{13}C$ (average value +1.23‰) and $\delta^{18}O$ (average value -4.03‰) values indicate remarkably heavier isotopic signatures, supporting the occurrence of drier climatic conditions during the development of the paleosol horizons and fossil preservation. Furthermore, paleo-vegetations based on $\delta^{13}C$ values suggest that C_4 plants (xerophytes, herbs, and shrubs) dominated the vegetation, comprising approximately 90%. Integrated evidence from pedogenic and biogenic features, stable carbon and oxygen isotope analyses, reconstructed paleo-vegetation data, and vertebrate fossil findings robustly indicates the presence of a savanna-like paleoenvironment. This ecosystem likely underwent prolonged dry seasons followed by shorter wet periods during a glacial phase of the Middle Pleistocene in the Barind Tract, northwest Bangladesh.

Keywords: Paleoclimate, Oxygen isotope, Vertebrate fossil

Geomorphological Evolution and Present-Day Processes in Rangabali and Surrounding Islands of the Meghna Estuary, Bangladesh

Md. Bazlar Rashid[1]*, Md. Rubel Sheik[1], Kamrul Ahsan[2]

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Abstract

Based on a geomorphological survey and mapping, this article presents a detailed overview of the landforms and geomorphic processes of the Rangabali and surrounding islands located in the Meghna Estuary mouth, Bangladesh. Large-scale geomorphological study and mapping of the islands allowed the identification of the the remarkable morphodynamic role of the present-day estuary processes, including erosion and accretion processes affecting different islands. The area is mainly used for agriculture and settlement. However, a considerable part is covered by mangrove. It encompasses supratidal deposit, intertidal deposit and beach deposit. The deposits are mainly composed of clayey silt, silt, sandy silt and alternation of sand, silt, clay sediments. Nearly 32.55 km^2 and 151.82 km^2 of land were eroded and accreted, respectively, of different islands from 1977 to 2017 through estuary processes. Erosion occurs mainly along the coastline of the islands. Recently, drainage congestion and waterlogging have also become well-known issues. The findings will be helpful to understand the estuarine islands morphology, its evolution processes, and finally sustainable development activities in connecting with the estuarine islands.

Keywords: Estuarine islands, Geomorphological survey, Sustainable development.

Unraveling the Geomorphology and Neotectonics of the Mid-Bengal Basin from Fluvial Sediments: A Case Study of Shibalya-Daulatpur Upazila, Manikganj District, Bangladesh

Md. Jahangir Alam[1], Abu Syed Mohd. Faisal[1] and Md. Mizanur Rahman[1]

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Abstract

The fluvial sediments transported by the two major rivers, the Ganges (Padma) and Jamuna, have significantly contributed to the formation of the landscape in the central Bengal basin. Subsurface lithostratigraphy reveals that this area was shaped by a paleo-riverine environment, indicating a unique Quaternary history distinct from the nearby Quaternary Tract. To better understand this area, the mappable units of the Morphostratigraphic framework have been categorized into eight units: A) Over bank Deposits: i) Floodplain Deposit ii) Natural Levee Deposit iii) Flood Basin Deposit iv) Crevasse Splay and Splay Deposit B) In-Channel Deposits: i) Channel Bar Deposit ii) Lateral Bar/Point Bar Deposit C) Channel-fill Deposits: i) Meander Scroll Deposit ii) Meander Scar Deposit. This classification has revealed six distinct lithofacies in the subsurface, including three types of sand facies, and clayey silt, silty clay, and various forms of clay (e.g., silty clay, clayey silt, peaty clay, and peat). The uppermost layer of the land is predominantly composed of Holocene fluvial sediments from the Ganges and Brahmaputra, while the underlying strata may reflect influences from the paleo-Teesta, and the Atrai-Gur River systems as well as the paleo-Brahmaputra River system. Noteworthy neotectonic features, such as avulsion, river migration, and fixed river courses have also been documented. For example, the old bed of the Dhaleshwari River appears to have shifted northwest, the Noai River (an active tributary of the Lohajong River) has been abandoned in recent years, and the Dhaleshwari River is actively changing its course toward the southeast, a trend likely to persist. The Ichamati River is almost abandoned and flows seasonally. It is nearly fixed on its flow path. Through examining geological and geotechnical parameters such as consistency (N-Value) and depth-related compactness, significant variations in the lithology of subsurface layers have been identified. In the Shibalaya area, at least two buried peaty layers were located at approximately 20 meters deep, along with a peat layer encountered at around 15 meters. Furthermore, wooden debris and broken wood fragments found at a depth of 30 meters in Chak Mirpur and surrounding areas suggest possible slumping, subsidence, or specific paleoenvironmental conditions. The adaptations in the river courses, combined with new fluvial dynamics and neotectonic activities present valuable insights into the ongoing changes in geomorphology and the evolutionary processes within this region. The sedimentary strata and fluvial facies indicate processes related to climate change, encoded with specific geological signatures. Understanding these aspects can inform sustainable management practices and future research endeavors aimed at preserving the ecological and geological diversity of the Bengal basin.

Keywords: Avulsion, Floodplains, Geomorphology, Lithostratigraphy, Neotectonics.

Volcanic Ash Deposit at Aliarhat, Shibganj Upazila, Bogura District, Bangladesh

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Abstract

Aliarhat is a village of Shibganj Upazila under Bogura District. The area has been divided into two physiographic units-the Karatoya Floodplain and the Barind Tract. The Quaternary deposits of this area are: (1) Abandoned Channel Deposit, (2) Alluvial Terrace Deposit, (3) Natural Levee Deposit, (4) Flood Basin Deposit, (5) Channel Bar Deposit, (6) Barind Floodplain Deposit and (7) Barind Clay Residuum Deposit. Aliarhat village is a flat to very gentle undulating, low, nearly level and poorly drained area. It is almost covered with the Barind Clay Residuum Deposit. A river cut section (Lat. 24°77'00" N and Long. 89°17' 36" E) at Aliarhat area was studied very carefully. This section (73 cm) comprises of strong brown to reddish yellow clay to clayey silt layers. Within this silty clay sequence a distinct lithological materials were found at a depth of 65-72 cm. These sediments are white (10YR 8/1) to gray (10YR 5/1), loose, slightly to strongly acidic, friable, somewhat porous silty loams to silty clay intergrading into a weakly mottled gray, compact and slightly altered. Sands are mainly fine grained, angular to sub-angular in shape. The grain size percentage of the sediment sare: sand 18%, silt 50% and clay 32%. Chemical analysis shows: Na-0.58%, Ca-31.54%, K-0.05%, Mg-7.23%, Pb-22.34, Zn-44.13%, CeO-13.89%, and OC-0.02%. The average percentage of the oxides are: SiO_2 -65.12%, Al_2O_3 -14.25%, Fe_2O_3-4.35%, TiO_2-0.88%, Na_2O-2.54%, K_2O-2.49% , MgO-1.22%, CaO-0.66%, P_2O_5-0.12% and MnO-0.07%. X-ray diffraction analysis result reveals that: quartz, (67-83%), feldspar (6-16%), and illite (5-16%). In clay fraction, the sample contains illite (60-91%), kaolinite (7-13%), quartz (01-05%), feldspar and trace levels of smectite. This highly weathered sediment is devoid of any chlorite minerals. Therefore, it was deduced that the chlorite deposited with the original sediments has been leached out. As a result, this sequence was identified as an eluvial (leached) pedogenic horizon. With this view point, a sample from Aliarhat was analyzed under binocular, polarized and scanning electron microscope. Analytical results revealed that, it contains quartz, plagioclase feldspar, zircon, pyroxene, muscovite, biotite, amphibole, glass shards and other materials. The presence of glass shards indicates that the silty clay layer is a Volcanic Ash Deposit which may compared with the Toba Volcanic Eruption (about 75,000 years ago). Detailed studies of ash beds may help resolve the problems in correlating the Quaternary stratigraphy of this region.

Keywords: Volcanic ash, Volcanic eruption, Toba super-eruption, Pedogenic horizon, Barind Clay Residuum, Quaternary stratigraphy.

Mineralogical and Geochemical Characterization, and Physicochemical Properties of Kaolin from Madhabpur Upazila, Habiganj District, Bangladesh

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Abstract

The kaolin clays of Madhabpur were studied to determine their mineralogical composition and physicochemical properties to evaluate their potential suitability as industrial materials. These clayey materials are not widely used locally as building materials, and limited data exist on their ceramic applications. Ten clay samples from 0.6 to 3.0 m depth were studied in the field to determine their mineralogical (X-ray diffraction), chemical (X-ray fluorescence) and physicochemical (particle size, Atterberg limits, organic matter, pH, moisture content, and bulk density) properties. Mineralogically, kaolinite (30.0–62.0 %) and quartz (19.1–49.8 %) were the most abundant minerals in these raw clay materials. They were associated with illite (18.4-22.4%), phengite (8.6–18.4%), diopsite (0.3 to 4.5) and periclase (1.6 to 21.5). Geochemically, the clayey materials had high silica (SiO_2, 45.27–55.14%) and alumina (Al_2O_3, 23.07–29.96%) contents, with a significant amount of iron oxides (Fe_2O_3, 4.42–10.09%). Other oxides (K_2O, MgO, TiO_2, Na_2O, MnO, CaO and P_2O_5) were in a relatively lower proportion. The high alumina content confirms their kaolinitic nature. Granulometric analysis of the kaolin showed the clay (35–51%) was followed by silt (38–45%) and sand (6–20%). This corresponds to silty clay and silty clay loam according to the Shepard (1954) textural classification diagram. The liquid limit (LL), plastic limit (PL) and plasticity index (PI) of Madhabpur white clays ranged from 48.20%-76.91%, 27.80%-43.53% and 20.40%-42.41%, respectively. Moisture content (10.65-20.45%), organic matter (2.0-5.5%), bulk density (1.32-1.58%) and pH (4.40-5.56%) were measured in the studied clay. The studied kaolin is a good candidate for the production of ceramics and terracotta buildings. The results also showed that the studied kaolin clays have adequate characteristics for ceramics walls, roof tiles, earthenware, and perforated bricks.

Keywords: Kaolin, Madhabpur, Mineralogical, Physicochemical, Geochemical.

Comparative Analysis of Deep Learning Architectures for Multi-Class Mineral Classification: A Study Using EfficientNet and ResNet Models

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Abstract

Accurate mineral classification is critical for various geology, mining, and materials science applications. This study investigates the use of advanced deep learning architectures, such as EfficientNet and ResNet models, for automated mineral classification. Six architectures were evaluated to enhance performance, employing data augmentation and transfer learning (including EfficientNetB0, EfficientNetB7, ResNet50, and ResNet152). The models were assessed based on classification precision, validation accuracy, and F1 scores. Among the tested architectures, EfficientNetB7 and ResNet152 demonstrated superior performance, achieving the highest classification accuracies and robust F1 scores, particularly for complex mineral types like quartz and malachite. EfficientNetB7 recorded the highest macro F1 score of 0.1450, while ResNet152 provided the most balanced performance across all mineral classes. Strategic learning rate reductions and architectural depth were crucial in mitigating overfitting, resulting in high stability and strong generalization capabilities. Despite their strong performance, specific architectures struggled to classify underrepresented mineral classes such as muscovite, indicating class imbalance and feature complexity challenges. The results suggest that deeper architectures, combined with effective transfer learning and optimization strategies, are highly effective for fine-grained mineral classification tasks. This research highlights the potential of deep learning in mineralogy and identifies avenues for future exploration, including class balancing and combining ensemble methods to further enhance model performance.

Keywords: Deep-learning architectures, Mineral classification, Transfer learning, ResNet and EfficientNet models, Data augmentation in geoscience.

Advancing Multi-Class Mineral Classification with Generative AI: A Study of EfficientNet and ResNet Models

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Abstract

This study explores the integration of Generative AI to enhance the accuracy and robustness of multi-class mineral classification. Building on prior research that utilizes deep learning architectures such as EfficientNet and ResNet, this work investigates synthetic data generation to solve challenges including class imbalance and dataset limitations. A Stable Diffusion-based Generative AI model was used to produce high-fidelity synthetic mineral images for seven mineral categories: biotite, bornite, chrysocolla, malachite, muscovite, pyrite, and quartz. These artificially generated images were used to train EfficientNetB7 and ResNet152 models, which were also trained separately on authentic mineral images enhanced with conventional augmentation techniques. The study evaluates the impact of synthetic data on classification performance by analyzing accuracy, macro F1 scores, and model stability across real and artificial datasets. Additionally, metrics such as Fréchet Inception Distance (FID) and Inception Score (IS) were used to assess the quality of the generated images. By systematically comparing CNN performance on synthetic versus real-augmented datasets, this research aims to establish Generative AI as a viable tool for addressing data scarcity in geoscientific applications. The findings suggest that, although synthetic data contributes to improved classification performance, computational limitations restrict the quantity and diversity of the generated images, indicating that further advancements in AI-generated mineral imagery could lead to even better results..

Keywords: Generative AI, Mineral classification, Deep Learning Architectures, Synthetic data generation, Transfer learning, Geoscience applications.

Concentration of Heavy Minerals and Its Economic Potentiality Along the Padma River, Kushtia, Bangladesh

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Abstract

The minerals identified along the Padma River of Kushtia district consist of heavy and other minerals. Heavy minerals composed of biotite, epidote, garnet, hornblende, kyanite, monazite and rutile are from the non-opaque group. Hematite, ilmenite and magnetite belong to the opaque fraction where garnet and magnetite claim the highest positions in the non-opaque and opaque groups, respectively. These heavy minerals carry a wide range of economic importance, but overall, the observed percentage is only 2.99% which is not satisfactory compared to the other potential zones of Bangladesh. The investigation shows that, the majority of the clastic grains were derived mainly from crystalline igneous and metamorphic rocks and a considerable amount may have been contributed through older sedimentary rock within the recent Alluvial deposit. The distribution pattern of heavy minerals reflects that the possible sources lie in the west, northwest and north of the study area.

Keywords: Heavy minerals, River sand, Economic prospect.

Geochemical Prospecting for Lithium in the River Sands of Dharla, Kurigram District, Bangladesh

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Abstract

Lithium (Li) is a crucial element for modern technology, prompting its exploration in various environments. The worldwide demand for lithium is increasing, while its supply is at risk, leading to extensive exploration efforts. Accordingly, the Geological Survey of Bangladesh has initiated a project to identify lithium deposits in the country. This research focuses on geochemical prospecting for lithium in the Dharla River of Kurigram District. The Dharla River, originating from the southern foothills of the Himalayan Mountain Belt, carries sediment primarily composed of sand, which deposits on its bars and banks. A total of 10 samples at a depth of 0.3 m were collected from different bars along the Dharla River and analyzed using inductively coupled plasma mass spectrometry (ICP-MS; NexION 2000) at the Geochemistry and Water Resources Branch of the Geological Survey of Bangladesh. The lithium concentration in bulk sand samples was found to be higher than the crustal average in several instances, with an overall average of 38.1 ppm, significantly exceeding the crustal average of 22 ppm. In certain locations, the lithium concentration is considerably higher than the average, indicating potential prospects for lithium exploration compared to other areas where similar concentrations are considered promising. This is also supported by the enrichment factor (EF), which indicates that the samples are slightly enriched. However, the concentration presented here is based on bulk samples, and it has potential for further enrichment if the sample is refined further. These findings suggest that various refining methods could enhance the lithium concentration. However, further analysis and intensive study of the mineralogy, spatial distribution, environmental aspects, and mining prospects are recommended to fully assess the potential for lithium extraction in the region.

Keywords: Lithium, Dharla River, sand, geochemistry, ICP-MS, spatial distribution.

AI-Driven Approaches to Coal Gasification: Enhancing Efficiency, Reducing Emissions, and Advancing Sustainable Energy Solutions

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Abstract

Coal gasification is a crucial process that converts coal into syngas, a mixture of hydrogen, carbon monoxide, and other gases, which offers a cleaner alternative to traditional coal combustion. With increasing global energy demands and stricter environmental policies, optimizing gasification efficiency and minimizing emissions are critical challenges. This study employs machine learning-based regression models to enhance the predictive accuracy of key operational parameters, such as syngas composition, temperature, pressure, and reaction efficiency. Using advanced regression techniques, including Support Vector Regression (SVR), random forest regression, and deep neural networks (DNN), the proposed approach accurately models complex nonlinear relationships within the gasification process. By leveraging extensive process data, the study provides data-driven insights to optimize operational conditions, reduce carbon emissions, and lower energy consumption. Additionally, AI-driven anomaly detection techniques improve process stability and safety by identifying deviations in system behavior before failures occur. The findings demonstrate the potential of AI in advancing coal gasification technology, paving the way for more sustainable and efficient energy production. This research contributes to bridging the gap between conventional gasification methods and modern AI-powered optimization strategies, threreby aligning with global sustainability goals.

Keywords: Coal gasification, Syngas production, Machine learning, Predictive modeling, Process optimization, Regression analysis, Carbon Emission Reduction, Industrial AI.

Provenance and Reservoir Quality of Hydrocarbon-Bearing Neogene Sandstone Reservoirs in the Begumganj Structure, Bengal Basin, Bangladesh

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Abstract

The quality of a reservoir is essential for developing an effective and economically sustainable exploration and production strategy. This study evaluates the reservoir quality of the Neogene Surma Group within the Begumganj Gas Field (Well-3) in the Hatiya Trough, Bengal Basin, Bangladesh. Wire-line log data, core analysis, petrography, XRD, and SEM were used to evaluate depositional and diagenetic factors affecting the reservoir quality of the Neogene Surma Group. The Surma Group was deposited in a tidal-influenced shallow marine shelf and deltaic environment. Sandstones are classified as lithic subarkosic to lithic arkosic, with primary porosity averaging 8.5% (0%–18%) and secondary porosity at 2.5%. Core permeability ranges from 12–207 mD between depth of 2890–2897 m and 0.08–16 mD (avg. 4 mD) at depths of 3178–3186 m. These sandstones are derived from a recycled orogen source with heavy minerals indicating low-to-medium grade metamorphic provenance. Clay mineralogy reveals that illite is the dominant clay mineral, followed by chlorite, kaolinite, and smectite. Low illite crystallinity and a low chemical weathering index suggest a cold climate with minimal chemical weathering, and physical erosion. Illite and chlorite (~81%) align with Bengal Fan characteristics and sediment input from the Surma-Meghna and Brahmaputra Rivers. Mechanical and ductile grain compaction has significantly reduced primary porosity, with compaction dominating over cementation as revealed by intergranular volume (IGV) analysis. Clay and chlorite cements occur as grain coatings, pore-fillers, and grain linings (rims), while poikilotopic calcite cement severely diminished porosity and permeability. This investigation suggests that the overall reservoir quality is moderate, primarily shaped by the depositional environment (sediment texture, facies, ductile grain supply, and clay content) as well as diagenetic processes, particularly compaction followed by clay and poikilotopic carbonate cementation. These findings will aid in enhancing petroleum production and refining predictive models for discovering new prospects, thus addressing the persistent energy challenges faced in Bangladesh.

Keywords: Bengal Basin, Clay mineralogy, Diagenesis, Petrography Provenance Reservoir quality.

Enhancing the Energy Transition Through Clean Technologies and Decarbonization Strategies Towards a Sustainable Energy Future of Bangladesh

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Abstract

There is a growing global emphasis on achieving complete decarbonization of the energy system by 2050. Bangladesh, despite contributing only 0.56 percent of global greenhouse gas emissions, is the seventh most vulnerable country to the impacts of climate change. According to the Climate Risk Index 2021, the country lost 11,450 lives and incurred $3.72 billion in economic losses from climate-related events between 2000 and 2019, experiencing 185 extreme weather events (UNOPS, 2023). As natural gas reserves decline, we are increasingly dependent on imported energy sources, such as coal and LNG. According to the IEPMP 2023 the use of coal is expected to increase from the current 6.24% to 30%. To combat climate change effectively and ensure a resilient environment, we must implement clean coal technologies, such as gasification, clean fuel conversion, brown hydrogen, Integrated Coal Gasification Combined Cycle (IGCC) plants, and carbon capture storage (CCS). These technologies can help reduce emissions from coal-fired power plants and facilitate the transition to renewable energy. Bangladesh should embark on a journey toward a more diversified and sustainable energy mix that balances economic development with environmental stewardship alignment with global trends. This is a crucial step in the country's path toward a low-carbon future. For this to happen, authorities and researchers should take integrated initiatives to identify alternative sources, adopt unconventional mining methods and diversifying the energy mix blending. The country's native coal reserve should be reevaluated for diversification e.g. Underground Coal Gasification (UCG), Surficial Coal Gasification, liquefaction and coal conversion to clean fuels (SNG, DME, Brown Hydrogen, etc.). We should explore the potential of renewable sources like Tidal Energy, and micro-hydropower Systems. Modern research focuses on making clean fuels affordable and more reliable. Already hydrogen, syngas, dimethyl ether and ammonia are being popular in addressing the forthcoming challenges of the energy transition. Collaboration among researchers and stakeholders, knowledge-based networks and sustainable initiatives in the energy sector will be essential for overcoming these challenges and fostering a robust policy framework.

Keywords: Brown hydrogen, Clean energy, Clean fuels, Knowledge-based network, sustainable initiatives.

Harnessing Brown Hydrogen: Pathways to a Sustainable Energy Future for Bangladesh

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Abstract

The potential of hydrogen as a clean fuel source offers an exciting opportunity for Bangladesh as it navigates the complexities of energy transition. One of the most promising alternative fuels for a sustainable future is hydrogen (H_2). It is a clean energy source that can aid in the decarbonization of numerous industries, including heavy industries, electricity generation, and transportation. A thorough examination of hydrogen fuel is provided here, including information on its types, manufacturing processes, uses, worldwide developments, difficulties, and potential. With an urgent need to enhance energy security and decrease reliance on fossil fuels, Bangladesh is well-positioned to leverage its abundant natural resources and geographical advantages to develop a hydrogen-based economy. Brown hydrogen could be derived from the coal resources; however, a thorough evaluation of the commercial viability of coal, peat and biomass for hydrogen production remains to be conducted in Bangladesh. Clean hydrogen energy can play a crucial role in decarbonizing various sectors, including transportation, heavy industry, and agriculture. Moreover, building a robust hydrogen infrastructure could stimulate job creation, technology transfer, and local innovation, thereby contributing to sustainable development goals. Nonetheless, significant challenges lie ahead. There is an urgent need for investment in research and development, the establishment of regulatory frameworks, and the creation of public-private partnerships to foster growth in this sector. Additionally, enhancing the technical expertise of the workforce to effectively harness hydrogen technologies should be prioritized. Bangladesh can address its domestic energy challenges while positioning itself as a regional leader in clean fuel production through R&D activities. The conversion technology is becoming more affordable day by day. Due to some unavoidable circumstances, Bangladesh's coal reserve remain almost unexploited; however, we can produce a vast amount of Hydrogen by gasifying the resource for hydrogen generation. Through combined efforts with local and international partners, the transition can significantly contribute to a sustainable energy future, aligning with global decarbonization targets and ensuring energy accessibility for its population. Thus, this transition represents not only an environmental necessity but also a viable pathway for economic resilience and international collaboration in an evolving energy landscape.

Keywords: Clean Energy, Decarbonization, Hydrogen economy, Renewable resources, Sustainable development.

Shear Wave Velocity Determination in Gopalganj Municipality and Surrounding Areas by Combined Analysis of Downhole Seismic and Multichannel Surface Wave Data

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Abstract

An important consideration for evaluating possible seismic amplification of shallow subsurface soils is the local shear wave velocity (Vs) profiles. This study focuses on the assessment of one-dimensional (1D) dynamic soil properties, specifically Vs profiles with layer thickness and depths in the Gopalganj municipality and surrounding areas in Bangladesh. This study uses a variety of shallow seismic techniques, including 10 downhole seismic tests (DST), 12 non-invasive active multichannel analyses of surface waves (MASW), and an equal number of passive microtremor array measurements (MAM). Vertical profiles of the compressional (P) and shear (S) wave velocity-depth functions were effectively provided by DST. Rayleigh wave data is acquired by active MASW and ReMi techniques, which contribute to the calculation of Vs profiles. Both active MASW and ReMi methods were carried out for acquiring Rayleigh wave data in the frequency range $\geq$ 4.9 Hz and $\geq$ 2.6 Hz respectively. Nine multichannel recordings were obtained at sites close to the locations of standard penetration test (SPT) boreholes within the study area. Three additional surveys were conducted at sites of downhole tests where we compared the Vs profiles from both multichannel and DST measurements, along with the SPT-N values. A good correlation was observed among the Vs profiles between these test methods, and a correlation equation from these data was further used in other boreholes to determine the calculated Vs profiles. The generated velocity models show that most parts of the study area have low to very low Vs profiles ranging from 67 m/s to 274 m/s for the top 30 m of soil depth. The range of computed Vs30 values is 160-190 m/s. Based on the Bangladesh National Building Code (BNBC) system, seismic soil classification and spatial distribution maps of Vs30 show that the entire study area belongs to site class 'SC' and 'SD', which is in reasonable conformity with the geomorphological units of the region.

Keywords: Shear wave velocity (Vs), Downhole seismic test (DST), Multichannel Analysis of Surface Waves (MASW), Microtremor array measurement (MAM), Vs30, Seismic site classification.

Sustainable Planning and Management of Hilly Terrain in the Kutupalong Rohingya Camp Area, Ukhiya, Cox's Bazar, Bangladesh: A Geotechnical Data Analysis and Soil Property Investigation

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Abstract

The Kutupalong Rohingya Camp, located in Ukhiya, Cox's Bazar, Bangladesh, is a place of immense significance due to the humanitarian crisis it represents and the challenges it poses. The camp area is situated in the southeastern Chittagong Hill Tracts and geographically challenging region. The rugged terrain presents additional obstacles for infrastructure development, disaster resilience, and sustainable planning. Furthermore, the rapid influx of Rohingya refugees has led to severe overcrowding in the camp area, straining its resources and infrastructure. This has resulted in significant challenges related to housing, sanitation, healthcare, and access to clean water. However, the hilly terrain presents a range of complexities for planning and management that require special attention and strategies to address. In order to handle these complexities, interdisciplinary techniques that take into account disaster risk reduction, urban planning, environmental science, and geotechnical engineering are required. Therefore, the main objectives of this research paper is to enable thorough understanding of soil and terrain conditions, focusing on their implications for sustainable infrastructure development and disaster risk reduction through the collection of comprehensive geotechnical data, and the investigation and analysis of key soil properties.

Keywords: Geohazard, Landslide, Seepage, Sustainable development, Slope management, Slope stability, Sustainable land use planning.

Stabilization of Low Strength Soil Using Fly Ash and Cement

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Abstract

The importance of geotechnical engineering for sustainable development is growing in the face of ever-expanding infrastructure. However, the presence of weak or expansive soil is a serious issue, and stabilizing these soils is essential to prevent structural collapses in areas where the ground is unstable. This study focuses on enhancing the engineering properties of low-strength soils by utilizing fly ash and cement as stabilizing agents. Several samples of collected clayey-silt soil were prepared for laboratory testing with varying percentages of fly ash (5%, 10%, 15% and 20%) and soil with the same percentages of fly ash combined with 2% cement. The results revealed that the specific gravity decreased with increasing fly ash content but increased slightly with the addition of cement. The liquid limit and linear shrinkage decreased with increasing fly ash and further reduced with the addition of 2% cement. Conversely the plastic limit was increased gradually, which led to the reduction in the plasticity index. For example, addition of 10% fly ash with soil decreased specific gravity from 2.62 to 2.54, liquid limit from 47.85% to 42.35% and linear shrinkage from 13.93% to 12.24%. Meanwhile, the plastic limit increased from 19.12% to 23.79%. The direct shear tests result demonstrated that the addition of fly ash and cement improved the soil's cohesion and friction angle significantly. Cohesion gradually increased up to the addition of 15% fly ash addition and then decreased but the friction angle increased gradually. The combination of fly ash and cement yielded even better results, with a mix of 15% fly ash and 2% cement with soil, achieved a cohesion value of 36.36 kPa which was the highest. This indicates that the combined use of fly ash and cement enhances the strength of the soil and contributes to a more sustainable and cost-effective solution for soil stabilization.

Keywords: Cement, Fly ash, Low strength soil, Soil strength, stabilization.

Geotechnical Properties of Clayey Soil Stabilized with Rice Husk and Cement

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Abstract

Over the past several decades, numerous studies have been conducted in search of a cost effective and environmentally sustainable stabilizing additive and most of the time, the researchers have opted for various types of ashes as stabilizers. Rice husk, as a stabilizing element, can be both cost effective and environmentally beneficial due to its local abundance and its ability to strengthen the soil in its original form. This paper investigates the effectiveness of using rice husk as a stabilizing agent in soft clayey soil and aims to develop a solid ground stabilization technique through the positive improvement of the soil's geotechnical properties. In this project, the clayey soil was mixed with varying percentages of rice husk, to be more specific, 5%, 10%, 15% and 20%. Furthermore, these samples were additionally mixed with a fixed 2% cement content and new sample mixtures were tested. For this research to succeed, several tests were conducted, including Moisture Content, Atterberg Limits tests (Liquid Limit, Plastic Limit, Plasticity Index), Linear Shrinkage and Direct Shear test. By dissecting the results, the liquid limit and plastic limit values increased, and the plasticity index value decreased, which, as a result, reclassified the soil as silt rather than clay. Moreover, the decrease in the linear shrinkage value signified the shrink resistance behavior of the altered soil. The direct shear testing has further established the soil's high shear resistance characteristic by demonstrating the increase in cohesion and the angle of internal friction values. Therefore, it can be said that, the modification of the clayey soil with 15% rice husk and with 15% rice husk+2% cement might be feasible, cost effective and environmentally friendly in stabilizing the soil, as these two mixtures indicated the most promising improvements in the soil's geotechnical properties.

Keywords: Cement, Clayey soil, Direct Shear test, Rice husk, Soil stabilization.

Geotechnical Analysis of Sandy Soil from the Dupi Tila Formation: Implications for Engineering Applications in Sylhet, Bangladesh

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Abstract

This study examines the geotechnical properties of sandy soil from the Dupi Tila Formation in the Sylhet region of Bangladesh, which features a complex geological composition. The research aims to understand the formation's behavior under various conditions, tackling challenges in foundation design, groundwater management, and infrastructure development. Significant variations in grain size, gradation, optimum water content (OWC), maximum dry density (MDD), and bearing capacity were noted, all of which are critical for engineering applications. The sieve analysis reveals a range of gradation patterns, from coarser distributions with steep gradients and narrow size ranges to well-graded samples that include a balanced mix of fine and coarse particles. Finer gradations, predominantly consisting of smaller particles, were also observed, highlighting variability in suitability for compaction, permeability, and soil stability. Compaction tests showed MDD values between 15.93 KN/m³ and 18.28 KN/m³, with OWC values ranging from 8.1% to 10.70%. Higher MDD values suggest enhanced compaction behavior, influenced by the soil's texture. California Bearing Ratio (CBR) values ranged from 6.8% to 9%, while ultimate bearing capacities (UBC) varied between 572.68 KPa and 952 KPa. Higher CBR values indicate stronger subgrades, whereas lower values necessitate stabilization measures. These findings highlight the need for site-specific soil stabilization and moisture control to reduce settlement risks and ensure long-term structural stability. Understanding soil variability is crucial for developing effective construction strategies in Sylhet. Integrating these insights into construction and water management practices will promote sustainable regional development. Continuous monitoring is recommended to address changing geotechnical challenges, especially under local climate conditions.

Keywords: Dupi Tila Formation, Sandy soil properties, Geotechnical engineering, Soil compaction and stability, Infrastructure development in the Sylhet region.

Assessing Urban Expansion through GIS and Remote Sensing: A Study of Land Use and Land Cover Changes in Gazipur

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Abstract

The urbanization process has dramatically altered land use and land cover (LULC) in most areas, posing a challenge to sustainable development. This research employs geospatial technology tools, including Geographic Information Systems (GIS) and remote sensing, to assess the LULC changes over the last two decades. The research entails downloading multi-temporal satellite imagery of Landsat 8 (2015) and Landsat 9 (2025) via the USGS Earth Explorer website. Radiometric and atmospheric corrections were conducted for analysis. LULC classification was performed by applying the supervised Maximum Likelihood Classifier (MLC) method using training samples from field observations and high-resolution images. Accuracy was determined using confusion matrices and the kappa coefficient. Change detection was carried out by comparing raster data from 2015 and 2025 using GIS-based polygon analysis. The Normalized Difference Vegetation Index (NDVI) was utilized to assess vegetation health and density changes. The study indicates that there were significant environmental changes from 2015 to 2025. NDVI decreased from 0.47 to 0.32, indicating a substantial reduction in vegetation. Settlement areas increased by 64.32% (120.94 sq. km) and vegetation cover decreased by 17.67% (147.84 sq. km). Water bodies increased by 76.90% and agricultural land increased by 2.00%. The change detection matrix also shows vegetation conversion to settlement and agricultural land, reflecting the impact of urbanisation on the environment. The findings highlight sustainable land management in averting environmental degradation. GIS and remote sensing information enabled this research to produce precise LULC maps, which can be employed to guide urban planning and environmental conservation policy.

Keywords: Change detection, Geographic Information Systems (GIS), Land use and land cover (LULC), Remote sensing, Sustainable urban development, Urban expansion.

Three-Dimensional Shallow Subsurface Lithological Modeling of the Ganges Delta: A Case Study of Khulna City, Bangladesh

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Abstract

Khulna City is situated in southwest Bangladesh on the Ganges tidal plain in the south and the Ganges deltaic plain in the north, both composed of late Holocene alluvium. A shallow subsurface 3D lithological model of the study area has been developed through the "Subsurface Viewer Software." This model is based on the particle size analysis (PSA) of 93 bore log data points and integrates a geological concept for the depositional history of the area. Lithological log descriptions, depth-wise sample photos, and generated coarseness curves of each borehole are analyzed to finalize the model. The dominant sediments are silts, sandy silts, and minor silty sands with varying clay contents. Both the silt and the sand content exhibit bimodal distributions. Sand, silt, and clay percentages are clustered through the K-means clustering method and plotted on a ternary diagram. The analysis reveals a spatially heterogeneous distribution and a strong interlayering pattern. General fining-up trends in the area indicate a depositional energy transition. Eight depositional domains and seven lithological units are identified from different sediment characteristics as well as similarities and dissimilarities of the coarseness curves. Lithological unit boundaries are regionalized through 3D indicator kriging, then modified by isoline modeling to fit the geological concept of the fluvial-deltaic depositional environment. Key findings of the study are the depositional domain, lithological unit, and its characteristics. The findings will assist in identifying a suitable shallow foundation layer, research the paleo-depositional environment, and conduct facies analysis. Additionally, this model would be helpful to the sustainable urban planning process for the urban planner, decision maker, stakeholders, and researcher.

Keywords: 3D Lithological model, K-mean clustering, Coarseness curve, Subsurface viewer software, Depositional domain, 3D kriging.

Engineering Geological 3D Modelling for Urban Planning: A Case Study of Aftabnagar, Dhaka, Bangladesh

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Abstract

Engineering geological 3D modelling integrates geological, geotechnical, and geophysical data to create detailed subsurface models for urban planning. This advanced technique helps planners and engineers visualize, analyse, and predict geological conditions, enabling better decisions in complex urban environments. It provides detailed insights into subsurface features that impact the design, safety, and sustainability of infrastructure. This study applies engineering geological 3D modelling to Aftabnagar, Dhaka, a rapidly urbanizing area with geologically diverse, artificially raised low-lying floodplains. In total, 33 numbers of geotechnical borehole data, with stratigraphic sequences up to 42m depth, and 561 samples were tested for geotechnical properties. All this information is used to create engineering geological modelling for the study area. This model is created using the software 'Sub Surface Viewer MX 7'. Construction is the simplest approach, providing a conceptual or schematic model for this purpose. The General Vertical Section (GVS) containing the principal relationship between the layers known as layer sequence, drawing a network of cross-sections, and defining the layer boundary lines (outcrop and subcrop) from the top layer to the bottom layer are the essential steps for model calculation. Once these components were established, the Triangular Irregular Network (TIN) surfaces of geologic layers (base, sides, and top) were calculated automatically by triangulations. The triangulation is based on 3D points obtained from the cross-sections and the established layer boundaries. Finally, the model is exported as irregular voxels, each with a horizontal size of 2x2 meters, and the voxel boundaries are aligned with the TIN layer depths. The Aftabnagar 3D model shows different layer thicknesses, thickness of Fill (up to 5 m to 20 m), and depth to a good foundation layer (>30 m). Additionally, this model generated model-based calculated maps that show soil types, bearing capacity at various depths, and potential geohazards such as liquefaction. These findings are vital for optimizing land use, improving foundation stability, and reducing risks in infrastructure developments. This study emphasizes the value of 3D modelling as a decision-support tool, improving urban resilience and sustainability. By providing a comprehensive understanding of subsurface conditions, it supports safer and more efficient urban development in rapidly changing environments.

Keywords: Engineering geological 3D model, Depth to hardground, Decision-support tool, Sub Surface Viewer MX 7, Triangular Irregular Network, Voxel model.

Flood Susceptibility Mapping of Bangladesh under Changing Climate Using IPCC Projections and Machine Learning Techniques

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Abstract

Bangladesh, a low-lying deltaic region, is exceptionally vulnerable to floods, a risk further intensified by the impacts of climate change. This study seeks to create a detailed flood susceptibility map for Bangladesh under future climate scenarios, using projections from the Intergovernmental Panel on Climate Change (IPCC) for 2030 and 2050. By employing Representative Concentration Pathways (RCPs) as the basis for climate modeling, the research integrates advanced machine learning techniques, including Random Forest (RF) and Support Vector Machine (SVM), to assess flood susceptibility at a national scale. The analysis considers an extensive range of flood-influencing factors, such as elevation, Normalized Difference Vegetation Index (NDVI), Standardized Precipitation Index (SPI), Topographic Wetness Index (TWI), land use patterns, and proximity to rivers. Synthetic Aperture Radar (SAR) imagery generates historical flood maps, which serve as critical baselines for training and validating the predictive models. Statistical validation metrics, including Receiver Operating Characteristic (ROC) and Area Under the Curve (AUC), are applied to ensure the generated susceptibility maps' reliability and robustness. The resulting flood susceptibility maps provide spatial insights into areas of Bangladesh that are most prone to flooding, offering a clearer understanding of the potential impacts of changing climatic conditions on flood dynamics. From flood susceptibility maps, it has been found that northeastern and particularly areas closer to rivers are most susceptible and level of susceptibility will increase based on projected climatic patterns. These findings are intended to guide policymakers and planners in formulating adaptive strategies to reduce flood risks, enhance resilience, and safeguard vulnerable populations and infrastructure in Bangladesh. This study underscores the urgent need for evidence-based approaches to address the escalating challenges posed by climate-induced flooding.

Keywords: Climate change, Flood susceptibility, Machine learning, RCP projections, SAR imagery, Flood inventory mapping.

Primordial Radionuclides in Trans-boundary River Sediments across the Dauki Fault Belt, North-east Bangladesh: Implication for U-Th Mineralization and Radiological Consequences

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Abstract

River sediments contain primordial radionuclides liberated from rocks through various geological processes which generate several degrees of radioactivity in the natural environments. Periodical field surveys were conducted using portable GF Instruments Gamma Surveyor-II from 2020-2024 in Shari, Jadukata, Chalti, Someshwari, Karnajhora, Chillakhali, Bogai- Rivers flowing across the Dauki fault belt, north-eastern Bangladesh. The aims were to measure natural uranium (ppm), thorium (ppm) and potassium (wt%) concentration as primary steps to search for U-Th mineralization and also to assess the associated radiological consequences in river sediments as supplementary tasks. The average activity concentrations of ^{238}U and ^{232}Th were found to be 60.65±45.47 Bqkg^{-1}, 65.19±57.87 Bqkg^{-1} (x1.7 – 2.2 world average) and ^{40}K was 302.70±195.93 Bqkg^{-1} (lower than world average) in the river sediments as many as 94 sampling points. The results imply for the probable uranium and thorium mineralization in this region indicating the need for detailed exploration. Spatial variations of NORMs were attributed to source rock composition, local geology, weathering, physico-chemical sorting, migration, and drainage pattern, and the variations were depicted in the spatial distribution maps. Multivariate statistical analyses were applied to investigate the sources and relationship among the measured parameters. The analyses revealed that the radioactivity is mainly associated with geogenic sources (predominance of radioactive zircon, monazite) and supported by their positive correlation. Moreover, various radiological indices were calculated to assess the radiation risks. Among the indices, the average values of absorbed dose rate (80.02±50.99ηGyh^{-1}), gamma representative level index (1.26±0.81), excess lifetime cancer risks (3.43x10^{-4}±2.19x10^{-4}) and radiation heat production (9.77±6.68 μWm^{-3}) were found to be higher than their respective recommended worldwide limits. This suggests that the radionuclides produce significant radioactive heat flux and radiation hazards that require regular monitoring to ensure the safety of residents. Finally, the findings will provide a baseline database and assist decision-maker and scientific community to mitigate the radiological hazards for sustainable management of NORMs in the studied areas.

Keywords: Dauki fault belt, Primordial radionuclides, Radioactivity, Transboundary rivers, Uranium-thorium mineralization.

Impacts of Morphology on Environment Induced by Polders in the Southwest Tidal Flat of Bangladesh

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Abstract

The study area lies in the southwest of Bangladesh under greater Khulna- Jessore districts. Here, spatial positions of polders were mostly determined by the position of rivers without considering the morphology of the area and nature of the rivers. Structural interventions during polders construction strongly influenced the morphology mainly due to stress-induced processes that shaped and reshaped the area with time. Remote sensing techniques followed by extensive field observations constitute the main methodological approach of the present research. There is an overlap of geomorphic units like tidal flats, tidal marsh (swamps) and inactive flood plains in different polders. From the history of water logging, it is clear that the overlapping polders, such as 25 and 24 were waterlogged much earlier than the others. Some polders like 1, 3 and 36/1 have very large catchments with inadequate drainage. These polders can be reshaped by segmenting them into sub-polders according to geomorphic units and small catchments to enhance drainage of the area. Rivers are modified by embankments, sluice gates, flash gates, culverts, bridges and closures. Study reveals that among 24 important rivers, at least five are completely silted, three are silted up to 80 to 90 % silted, and the remainder are mostly silting very rapidly. It is obvious that insufficient attention was paid to the underlying geomorphology and land processes that influence the land as well as adjacent rivers during polder construction. As a result, disasters happened, rivers silted, land went under water and people are in significant stress due to harsh environmental conditions. Still, there is scope to reshape polders to avoid overlapping of geomorphic units, splitting big polders, to ensure sustainable water and land management while maintaining the intended benefits of polder system in the area.

Keywords: Coastal morphology, Water logging, Land management.

Evaluation of Land Subsidence in a Multi-Slicing Coal Seam of the Barapukuria Coal Mine

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Abstract

Land subsidence has been a growing concern at the Barapukuria coal mine for nearly two decades, necessitating a detailed horizontal and vertical evaluation of subsidence. Previous studies primarily focused on the horizontal expansion of the subsidence trough and were calculated based on a rudimentary rule of thumb. Through the identification of mining-induced cracks and joints in 37 affected homes close to the mine, the spatial extent of the subsidence trough formed as a result of the intensive coal extraction from the ultra-thick coal seam was empirically evaluated in this study. Findings revealed that the angle of draw for the mine varies between 42° and 60°, with the subsidence effects extending up to 727 meters (average 552 meters) from the panel edge. Subsidence prediction for inclined and deep coal seams has received less attention compared to horizontal seams due to the complexities involved in such mining conditions. However, predicting surface subsidence in multi-slicing panels is more challenging and crucial. To forecast surface subsidence brought on by downward cutting panels in the inclined coal seam at the Barapukuria coal mine, a corresponding profile curve was developed using the geometric data of the operational panels. The measured maximum water depth of 10.5 meters was nearly identical to the maximum calculated subsidence depth of 10.23 meters. The findings show a high degree of agreement between the measured and anticipated values. In order to accurately measure and forecast the growing subsidence trough progression, it is essential to ascertain the mine's geotechnical characteristics, spatial extent and overall expansion, and angle of draw.

Keywords: Multi-slicing, Profile function, Spatial expansion, Subsidence prediction, Ultra-thick seam.

Geo-environmental Degradation of St. Martin's Island, Bangladesh

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Abstract

St. Martin's Island is the only offshore coralline island in Bangladesh. Its unique location, remarkable sea views, natural resources, and rich biodiversity have contributed to the rapid growth of the tourism industry in the area. However, both natural and human activities have led to the deterioration of the island's natural landscape and biodiversity. This study utilizes historical and topographic maps, satellite images, and aerial photographs, employing remote sensing and GIS techniques, along with field investigations and laboratory analyses to assess the situation. The island has a flat topography, with an average elevation ranging from 2.5 to 3.6 meters above mean sea level. The surficial deposits consist of Holocene alluvium sediments that vary in thickness from 0.15 to 3.7 meters. Beneath these deposits are Pleistocene St. Martin's limestone and Upper to Middle Miocene Tipam shale and sandstone layers. The major geo-environmental hazards in the area include coastal erosion and deposition, coral destruction, underwater solid waste, unplanned tourism, overfishing, deforestation, freshwater deficiency, decline of turtles, cyclone and tidal surge and oil pollution. The north-western and southern parts of the island have been experiencing severe erosion for the past 35 years. During this period, the island has lost approximately 0.18 km^2 of land, which equivalent to a rate of 0.006 km^2 per year. The temperature of the sea surface is about 29°C, whereas sea bed ranges from 27°C to 28°C. The dissolved oxygen levels vary between 3.5 and 5.5 mg/L, and the pH values range from 8.1 to 8.5. Total dissolved solids fluctuate between 0.10 and 3.56 ppm, with an average salinity of about 33‰. The concentration of heavy metals in the bottom sediment surrounding the island is quite high, particularly for Cd (0.08 to 0.1 mg/L), Zn (0.03 to 0.08 mg/L), Pb (0.4 to 0.5 mg/L) and Cr (0.07 to 0.08 mg/L), which indicate significant pollution in the marine environment. Additionally, unplanned tourism contributes to environmental degradation and poses a threat to the marine ecosystem. Therefore, it is essential to take necessary actions to protect both the natural environment and the marine ecosystem of the island.

Keywords: Marine geology, Geo-hazards, Coral, Sustainable development.

GIS Approaches for Mapping Drought-Prone Areas: A Comparison of Logistic Regression, Weight of Evidence, Frequency Ratio Methods

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Abstract

Drought is a severe natural hazard caused by prolonged precipitation deficits. Understanding its spatial distribution is crucial for mitigation. Various methods, including satellite imagery and historical records, have been used to study drought's spatial and temporal patterns. However, drought is typically recognized based on climatic factors. Drought indices are numerical tools that quantify drought severity by integrating data from one or more indicators. This study evaluates three GIS-based models- Logistic Regression (LR), Weight of Evidence (WoE), and Frequency Ratio (FR) for drought susceptibility mapping in the Barind region of Bangladesh. Additionally, ensemble models combining WoE-LR and FR-LR were also assessed. LR provides a probabilistic framework for predicting drought-prone areas. WoE enhances reliability by considering spatial correlations. FR offers a simple statistical approach for identifying vulnerable areas. Ensemble models improve prediction accuracy by combining these strengths. The dataset was divided into 70% for training and 30% for validation. Twelve drought-conditioning factors were used: temperature, precipitation, humidity, soil moisture, land use/land cover, normalized difference vegetation index, normalized difference moisture index, normalized difference water index, normalized burning ratio, land surface temperature, groundwater level, and digital elevation model. Model validation was conducted using the area under the curve (AUC) method. The results showed that the WoE-LR ensemble achieved the highest prediction accuracy (92.56%), outperforming standalone models. Among individual methods, LR performed best. These findings highlight the potential of ensemble techniques for improving drought susceptibility mapping.

Keywords: Drought, GIS, Logistic regression (LR), Frequency ratio (FR), Weight of evidence (WoE), Remote sensing.

Geological and Environmental Impacts of Light Pollution: A Case Study of Rajshahi City Corporation, Bangladesh

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Abstract

Light pollution has emerged as a critical environmental issue, particularly in rapidly urbanizing regions, where excessive and misdirected artificial lighting disrupts ecological processes, alters geological conditions, and degrades urban environmental quality. This study provides a comprehensive evaluation of the extent, intensity, and implications of light pollution in Rajshahi City Corporation through a multidisciplinary approach that combines remote sensing, field surveys, and photometric measurements. To analyze long-term trends in light pollution, multi-temporal nighttime satellite imagery from 1992 to 2024 was used, incorporating data from DMSP/OLS (1992–2013) and VIIRS DNB (2013-2024). A harmonization process involving inter-calibration and cross-normalization techniques was applied to ensure consistent temporal analysis across the datasets. Ground-based surveys were conducted to assess public perceptions, environmental impacts, and potential strategies for mitigating light pollution. Sky Quality Meters (SQMs) were employed to measure sky brightness, providing validation for satellite-derived illumination data. The findings indicate a marked increase in nighttime illumination over the study period, with the most significant rise occurring after 2013, coinciding with rapid urbanization and infrastructural development. High-intensity illumination zones, particularly in urban areas, exhibited sky brightness values exceeding 19 mag/arcsec^2, suggesting severe interference from artificial light. Ecological effects include disruptions to avian migration patterns and a decline in insect populations, while geological consequences involve altered soil thermal regimes and increased temperature variability in areas with consistently high luminance. These results highlight the urgent need for sustainable lighting practices to mitigate the adverse effects of light pollution. Proposed measures, such as the use of directional lighting, adaptive dimming technologies, and strict regulatory measured and guidelines, are essential for minimizing environmental degradation. This study contributes valuable insights into the spatial and temporal dynamics of light pollution, offering evidence to guide urban planning and policy development for sustainability in Rajshahi City Corporation.

Keywords: DMSP/OLS, Geographic Information System (GIS), Multi-temporal nighttime light, Questionnaire-based, Remote sensing, Urbanization, VIIRS DNB data.

Hydraulic Characteristics and Bank Erosion Rate of Padma River from Lalpur to Ishwardi, Bangladesh

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Abstract

The hydraulic characteristics and related bank erosion of the Padma River at Lalpur and Ishwardi Upazilas of Rajshahi District have been studied. The statistical correlation between the hydraulic characteristics and erosion rate was analysed and established. Nurullahpur is the the most severely affected area. The other area has little or no erosion. The erosion in Nurullahpur along the river Padma has been posing a threat to the protection of the embankment. The embankment erosion or failure at this area is occurring due to strong water current, the presence of crack, toe erosion and significant rise of water level at the Padma River. The embankment slope was not well protected and it remained vulnerable to erosion. The total amount of land loss due to the erosion in the area was about 35 square km during the last 20 years.

Keywords: Padma River, Bank erosion, Hydraulic characteristics.

Statistical Predictive Approach for Bank Erosion of the Atrai River from Ahsangonj to Singra, Rajshahi, Bangladesh

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Abstract

The present research deals with the statistical predictive regression analysis to predict bank erosion of Atrai river from Ahsangonj to Singra in greater Rajshahi area. Field investigation in the area have been done to collect the data about near bank velocity, boundary shear stresses, bank soil properties and sediment supply near the bank and these were used as the input parameters in logarithmic transformation approaches of regression models to predict the rate of the bank erosion in the study area. The bank erosion rate was used as the dependent variable whereas all the input parameters were used as independent variable in the analysis. Islamgati, Nandigram and Pachupur have been found most affected areas with high rate of bank erosion. The calculated rate of erosion in these areas ranges from 10 to a maximum of 100 m/sec. Bhangajangal and Jormollika are the less affected areas. The bank erosion from Ahsangonj to Singra is occurring due to strong water current, the presence of crack, toe erosion at the Atrai River. The present study suggests necessary protection measures in the area of high erosion rate to protect the land and home establishments in the area.

Keywords: Atrai River, Regression model, Bank erosion, Accretion, Preventing measure, Arc GIS.

Stability and Cantilever Failure Model of Mahananda River of Nawabganj Sadar Upazila, Chapai-Nawabganj

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Abstract

Riverbank erosion poses a significant threat to both the environment and human settlements along riverine areas. The failure at the cantilever at the different places of the bank of Mohananda River has been modeled and the factors of safety against these failures were computed. The computed factor of safety ranges from 1.22 to 1.00, where the cantilever with factor of safety close to unity were identified as failed and those with factor of safety above the unity seems stable. This study examines the impact of such riverbank failures on local land-use of Nawabganj Sadar Upazila of Bangladesh using field surveys and historical records and evaluates the extent and patterns of erosion. The study underscores the urgent need for comprehensive river management strategies, including erosion control measures to mitigate the adverse effects of riverbank erosion.

Keywords: Mahananda River, Bank erosion, Cantilever, Factor of safety.

Bed Degradation Model and Empirical Sediment Transport of Jamuna River and its Impact on Embankment Stability from Kazipur to Sirajganj Hard Point, Bangladesh

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Abstract

Jamuna River is characterized by its extremely dynamic and unstable alluvial channels. This 240 km long braided river is located in the lowest reach of the Brahmaputra River in Bangladesh. The bed degradation and empirical sediment transport characteristics of Jamuna River and its impact on embankment stability have been studied. The total accretion was 151 km^2 and an erosion was150 km^2 during the period from 1995 to 2024. Study revealed that the discharge and heavy sediment load during floods cause the Jamuna River to be extremely unstable, and it consistently migrates laterally. This tendency of lateral channel migration, results in erosion of the river banks which causes severe problem to the people living in the floodplain of the river Jamuna. This particular study was carried out using the satellite imagery of the last decade as well as some old historical images to show the pattern and extent of channel migration and bank erosion of the Jamuna River. A comprehensive analysis was carried out in this study using the state of the Arc GIS technology to identify the vulnerable reaches of the river in respect of bank erosion. Noticeable bank shifting of the river bank in the west-ward direction has been identified during the period from 1995 to 2024. This study suggests proper measures to protect the soil underneath the embankment.

Keywords: Jamuna River, Bed degradation, Empirical sediment transport, Bank erosion.

Application of Sentinel-1 Data for Flood Hazard Monitoring: A Case Study of Sirajganj District, Bangladesh

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Abstract

Sirajganj District is highly vulnerable to riverine flood. The district was most severely affected by the severe flood of 2017. Heavy precipitation and water discharge from upstream caused significant damage in the study area. Floods damaged the agricultural/croplands and infrastructure of the area. Five Upazilas (administrative units) were affected by the floods that caused the damage partially or entirely. The main focus of the study was to prepare the inundated area by the floods of 2017 by the processing of Synthetic Aperture Radar (SAR) Sentinel-1 remote sensing data from European Space Agency (ESA). The primary criteria for selecting the dates was high resolution and cloud-free images. The downloaded Sentinel-1 images were processed in SNAP software for accurate analysis. In August, most of the lowlands, wetlands and some char islands were inundated since the confluence of rain and upstream water. With decreasing the precipitation rate along with the scorching sunshine, the evaporation rate increased. Thus, in September, the inundated area started to decrease. On 15 September 2017, the flood area percentage was 11.85% of the total flooded area. The resulting maps showed that the largest flooded and also agricultural damaged period was on 31 July and 22 August in the Year of 2017. The devastating flood occurred on 24 August, covering an area of 112,485.4 hectares (16.4% of the total flooded area), and it caused about 30,374.8 hectares of damaged cultivable lands of the entire study area. The benefits of using the space borne Synthetic Aperture Radar (SAR) have been harnessed in this study. The outcomes of the study might help the monitoring of flood vulnerabilities as well as flood preparation.

Keywords: Synthetic Aperture Radar (SAR), Sentinel-1, Flood map, Agricultural damage.

Stressed Environmental Condition and Pollution Monitoring Using Recent Benthic Foraminifera: A Study Along the Sandwip Channel Around the Ship-Breaking Yard of Chattogram, Bangladesh

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Abstract

The marine ecosystem is under severe threat worldwide due to coastal pollution, and the ship-breaking yards are now one of the major contributors to this issue. To effectively manage this problem, strong pollution control and environmental management strategies along with comprehensive and affordable monitoring methods are required. Benthic foraminifera study can be a comprehensive and low-cost effective tool to monitor the health of coastal ecosystems. The study area spans approximately 50 km along the Sandwip channel, specifically around the Sitakunda ship-breaking yard of Chattogram. About 15 subsurface sediment samples were collected from the intertidal zone using a Piston Auger sampler to depths ranging from 1 to 10 cm. The prepared samples were observed under a stereo binocular microscope (Leica-S9i) and the shell compositions were analyzed using scanning electron microscope (SEM) through eZAFsmert Quant by energy-dispersive spectroscopy (EDS). From the 654 shell, a total of 12 species of foraminifera belonging to 12 genera and 5 orders were identified. The dominant species were Elphidium excavatum and Ammonia tepida, with relative abundances of 55% and 35%, respectively. Other species included Haynesina germanica (5%), Nonionella turgida (2%), others (3%). The low diversity index of foraminifera ranges from 0.8696 to 1.213, suggesting that the ecosystem is experiencing moderate to high levels of stress in the Sandwip channel. The dominance value ranges between 0.42 and 0.75, and belongs to low to moderate class. The FORAM index (FI) ranges from 1 to 1.5, indicating low diversity and highlighting the presence of environmental conditions that favor stress-tolerant species. Several morphological abnormalities were observed in the shells, including abnormal growth in chambers, distorted chamber arrangements and reduced chamber sizes, which suggests long-term environmental stress along the coast. Therefore, it can be used for monitoring the environmental health of coastal ecosystems. To conserve the coastal ecosystem, it is necessary to combine this bio-indicator along with various pollution evaluation indices to analyze the pollution levels in any coastal ecosystem.

Keywords: Benthic foraminifera, Sandwip channel, Pollution Evaluation Index, Bio-indicator, Ship breaking yard, EDS, SEM.

Inclusive Disaster Preparedness for Persons with Disabilities in Flood-Prone Areas: Assessing Geomorphological Changes and Vulnerabilities in Rowmari, Kurigram, Bangladesh

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Abstract

This study investigates inclusive disaster preparedness for persons with disabilities in flood-prone areas, with a focus on assessing geomorphological changes and vulnerabilities in Rowmari, Kurigram, Bangladesh. Located along the Brahmaputra River, Rowmari is characterized by a dynamic geomorphological landscape, including riverbank erosion, sediment deposition, and shifting floodplains, which exacerbate flood risks and unpredictability. The region's low-lying topography and proximity to the river make it highly susceptible to annual flooding, as illustrated by the flood inundation map developed for this study. These geomorphological processes disproportionately impact persons with disabilities, who face heightened vulnerabilities due to limited access to disaster management resources and infrastructure. Using a mixed-methods approach, the study integrates surveys, focus group discussions, and interviews with persons with disabilities, local authorities, and community members to evaluate the inclusivity of disaster preparedness measures. Findings reveal significant gaps in awareness, accessibility, and institutional support. Many persons with disabilities and their families lack knowledge of disaster preparedness plans and early warning systems, while shelters and evacuation routes often remain inaccessible due to physical barriers and insufficient assistive resources. Furthermore, persons with disabilities are frequently excluded from disaster planning and decision-making processes, resulting in overlooked needs and inadequate support systems. The study highlights the urgent need for tailored interventions that incorporate geomorphological insights to enhance inclusivity in disaster preparedness. Key recommendations include developing accessible early warning systems, improving the physical accessibility of shelters and evacuation routes, strengthening the capacity of local disaster management committees, and promoting the active participation of persons with disabilities in preparedness planning. By addressing these gaps and integrating geomorphological considerations into disaster risk reduction strategies, policymakers and practitioners can build more resilient and inclusive communities in flood-prone regions. This research provides a critical foundation for designing targeted interventions to support persons with disabilities in disaster preparedness and response, ultimately contributing to more equitable and geomorphologically informed disaster risk reduction strategies in Bangladesh.

Keywords: Geomorphology, Disaster management, Disaster risk reduction.

The Significance of Considering Hydro-Meteorological Risks for Safe Nuclear Power Planning

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Abstract

Selecting a safe site is the prerequisite for establishing any nuclear installation for the protection of public and environment for possible radiological consequences. Climatic hazards such as floods and droughts can affect the efficiency of nuclear reactors. River bank erosion also may cause significant destruction, including dam failures. To ensure the nuclear and radiological safety it is mandatory to fulfill the regulatory requirements of the country and recommended International Atomic Energy Agency (IAEA) guidelines while conducting the Nuclear Power Plant (NPP) siting, operation and maintenance. Bangladesh has entered into the nuclear power program through the implementation of Rooppur Nuclear Power Plant which is expected to operate by 2026. Bangladesh Atomic Energy Commission (BAEC) is implementing this project aiming to reduce the escalating power demand of the country. Bangladesh also is looking for several nuclear installations in near future such as second NPP, high power research reactor and thereby near surface disposal of low and intermediate waste (LILW). BAEC has been entrusted to conduct research and development activities for suitable site selection for those installations considering the safety guidelines by IAEA and Bangladesh Atomic Energy Regulatory Authority (BAERA). Therefore, monitoring hydro-meteorological hazards such as flood and drought for the targeted site is of primary importance and should be implemented for nuclear and radiological safety. However, BAEC has yet not established that kind of Research and Development capacity for those hazard monitoring and response. Therefore, the primary objective of this study will be climate change prediction and vulnerabilities of RNPP site due to hydro-meteorological hazards such as floods and droughts by using historical data and real time climate data i.e. hydrometric, storm, precipitation, temperature, soil and vegetation data; and their response identification as mitigation approach for the safety of nuclear installations.

Keywords: Climate hazards, Drought, Flood, Nuclear power plant.

Impacts of Dredging and Reclamation Project in the IWT Corridor of Bangladesh

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Abstract

Water resources management in Bangladesh faces immense challenges for resolving many diverse problems and issues. The most critical of these are alternating floods and water scarcities during the wet and the dry seasons. Bangladesh receives a large amount of water during monsoon causing regular seasonal flood in its low elevated areas and during dry irrigation season, scarcity of water threats time-bound irrigation in many areas that leads to extensive use of groundwater. The importance of groundwater irrigation increased with the introduction of HYV (High Yield Variety) seeds in late 1960s to meet the food demand of the growing population. To protect the population from water-borne diseases, millions of hand tubewells (HTWs) have been installed in the shallow aquifers (<100m depth) that is mostly affected by arsenic contamination. The decline in the groundwater table in many areas is due to overexploitation for irrigation abstraction in rural areas and extensive domestic and industrial use in cities like Dhaka. High rates of pumping from shallow aquifers may result in widespread saltwater intrusion in coastal areas, and the degradation of water quality. Since the early 1990's, deep tubewells (DTWs) have been installed (100-250 m depth) in an attempt to find safe groundwater for drinking water supplies. However, the wells often contain high concentrations of iron, manganese and chloride. Estimation of the availability of water and preparation of water budget and water allocation plans for different uses down to union (administrative area consisting of few villages) level need to be formulated. Strengthening appropriate monitoring organizations for tracking groundwater recharge, surface and groundwater interaction, and changes in water quality is important. Due to arsenic contamination in shallow groundwater and salinity at different depth levels, deep fresh water aquifers may serve as sustainable options for safe drinking water, however, more use of surface water mainly for irrigation and industrial use may reduce the stress on groundwater resources. The lack of appropriate methods and research for groundwater resources assessment is considered to be a significant gap in present water resource management. Sustainable development and management of groundwater can be done with a clear understanding of the groundwater system, its geology, hydrogeology, the subsurface flow and the response of the system considering seasonal, tidal and pumping stresses. As such, investigation of the aquifer systems, understanding of formation behavior, regular monitoring and assessment of groundwater storage and quality are important considering adoption of appropriate and sustainable strategy to ensure food security, healthy society and safe water supply of the country.

Keywords: Dredging, Reclamation, Impacts, Geo-hazard.

The Effect of Salinity on Aquatic Macrophytes and Its Application Along the Coastal Area of Bangladesh

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Abstract

Bangladesh is a low-lying country situated beside the Bay of Bengal, with a long coastline. Around 32% area of Bangladesh's area is considered a coastal region, consisting of 19 districts that accommodates more than 35 million people. Salinity is one of the major reasons for the degradation of water quality along the coastal belt of Bangladesh. The key reasons behind the increase of salinity are sea level rise due to climate change and human intervention. Along the coastal belt of Bangladesh, Koyra Upazila is one of the salinity affected areas, where people are living in very vulnerable situations. The objectives of the present study are- to analyse the physico-chemical parameters specially salinity of saline and freshwater water sources in Koyra Upazila, and to check the adaptability of submerged macrophyte (Egeria densa) under different salinity conditions. Both fieldwork and laboratory-based work were conducted for the study. Three different salinity concentrations (0 ppt, 5 ppt, 10 ppt) were selected for the laboratory experiment on the basis of field work. E. densa survived in 5 ppt saline water and the total weight, shoot length of the treated plants has increased. This means, plants not only survived in 5 ppt saline water but also their growth rate has increased sufficiently. Root began to form at 5 ppt saline water. The total chlorophyll and carotenoids concentrations also increased under 5 ppt salinity. This research provides an understanding of the threshold limit of submerged macrophytes E. densa under different salinity concentrations. It will also help to understand the habitat preferences of submerged macrophytes under different saline environments and can eventually be used as an ecosystem management tool along the coastal area of Bangladesh.

Keywords: Submerged macrophyte, Salinity, Coastal area, E. densa, Climate change.

Climate Change Influence on the Flash Flood Hazard in Tahirpur Upazila, Sunamganj District, Bangladesh

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Abstract

Bangladesh has been experiencing shifts in precipitation patterns, leading to more frequent and intense rainfall events. The northeastern Haor Basin is particularly vulnerable to flash floods due to heavy rainfall and runoff from the Meghalayan Hills in India. Major flash floods occurred in 2007, 2014, 2016, 2017, 2019, and 2022. Despite these changes, no effective measures have been implemented to mitigate future risks. Tahirpur Upazila, located in Sunamganj District, is characterized by a densely populated, compact, and unplanned area, yet it holds significant potential as a growth center. This study aimed to assess flood susceptibility using a Geographic Information System (GIS) technology, local geological data, historical rainfall records, and flood data. A flood hazard map was created, and a spatial database was compiled with information on topography (slope, elevation, watershed), drainage, water extent, soil permeability, geology, land type, and flood inundation. The analysis identified flooded zones and classified flood hazards into high, medium, and low categories. The results indicated that 47% of Tahirpur's northern area is susceptible to severe flash floods. Generally, no flooding occurs in the northeastern highland areas. However, flooding depths, ranging from 1.83 m to over 3.05 m were observed in the middle and southwestern areas of Tahirpur Upazila. During each monsoon, low-lying areas of Tahirpur are the first to be inundated, and increased rainfall leads to greater inundation depths. These findings can aid policymakers, development agencies, and urban planners in creating effective preparedness guidelines to prevent property damage and safeguard assets in Tahirpur Upazila.

Keywords: Flash flood, Geology, GIS, Monsoon, Precipitation.

Geospatial Insights into the Impact of Climate Change on Urban Heat Islands and Public Health in Dhaka, Bangladesh

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Abstract

Excessive temperatures and random changes in temperature patterns are evidence of climate change, primarily driven by rapid urbanization, modernization, industrialization, etc. Bangladesh is a casualty of the climate crisis where the capital city Dhaka has been regarded as Urban Heat Island (UHI). The study scrutinizes the impact of UHIs on public health in Dhaka, adopting GIS and remote sensing systems. Land Surface Temperature (LST) and Land Use/Land Cover (LULC) were processed using GIS tools and the Normalized Difference Vegetation Index (NDVI) to assess vegetative cover. Rapid urbanization has intensified UHIs effects, resulting in elevated surface temperatures that pose significant health risks, especially during extreme heat events. A substantial temperature difference exists between green spaces next to urban areas and densely built-up communities. The recorded NDVI value was drastically changed from -0.3145 to -0.1346, mean LST fluctuated from 25°C in 2014 to 27°C in 2024, and urban heat island anomaly reached its maximum level in 2014 then grew steadily until 2024 where it surpassed 6.14 degrees Celsius. Besides, the analysis of correlation between UHI and NDVI shows weak negative correlation over the last decade. It clearly determines the reduction of vegetation in Dhaka which impacts climate change and public health vulnerabilities, including a higher incidence of heat-related illnesses such as heat stroke, anxiety, dehydration and cardiovascular diseases, especially among vulnerable populations. The research contributes to urban climatology and public health by offering a spatially detailed framework for assessing and managing UHI and climate change impacts. Future investigations should incorporate finer-resolution data and consider socioeconomic variables to improve the accuracy of predictive health risk models in urban environments, fostering more comprehensive heat-mitigation strategies.

Keywords: Urban heat islands (UHIs), Geospatial analysis, Land Surface Temperature (LST), Land Use/Land Cover (LULC), Normalized Difference Vegetation Index (NDVI), Climate change health impact.

Flash Flood 2024 in Feni, Noakhali and Lakshmipur Districts and Future Action Plan

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Abstract

The southeastern part of Bangladesh and eastern Indian states suffered with heavy rainfall during the third week of August 2024. As a result, several trans-boundary rivers and tributaries failed to accommodate the enormous volume of water and caused devastating floods in the eastern part of Bangladesh. The most affected areas are Noakhali, Feni, Lakshmipur, Comilla, Brahmanbaria, Khagrachhari, Cox's Bazar, Chattogram, Habiganj, and Moulvibazar districts. This study was conducted in the severely affected coastal districts Feni, Noakhali and Lakshmipur based on field investigation, public opinion of the affected areas and available literature. The floods were extremely accelerated by the careless opening of the Dumbor Barrage gate in Tripura State, India, which significantly flooded Bangladesh. In Feni district, the water level rapidly rose ~ 1-1.5 m within a few hours (2-5 hours), which was horrible, and the people had no time to escape from this devastating flash flood. Similarly, the water level in Noakhali and Lakshmipur districts also rose ~ 1-1.5 m, but at a comparatively slower rate (it took a few hours to 24 hours). The impact was severe, ~ 3.7 million people affected, 41 people died, and 237,672 shelters were damaged. The economic loss was about $547.691 million. Advance information sharing regarding the opening of the barrage gate could have minimized these enormous losses. An integrated basin management policy and trans-boundary approach are essential for the sustainable management of the future terrible floods in this region.

Keywords: Flash Flood, Rainfall, Water logging, Drainage congestion.

Participatory Rural Appraisal (PRA) Approach and Hydrological Investigation for Groundwater Management in Chapainawabganj District

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Abstract

Water resources have become an increasingly serious concern in Bangladesh, despite the country having numerous rivers. This study aims to assess the current status of water resources through a combination of Hydrological Investigation and Participatory Rural Appraisal (PRA) approaches. The research covered 45 unions across 5 upazilas in Chapainawabganj District. In PRA, local communities at the union level participated in detailed interviews, providing valuable insights into the existing water resources. The hydrological investigation focused on both surface and groundwater resources, using physical data analysis. The area contains 5,184 surface water bodies, comprising 4,944 ponds and 240 beels. For the PRA, data was collected from both primary and secondary sources. For the hydrological investigation, hydro-meteorological data-such as rainfall, evaporation, temperature, relative humidity, and sunshine hours- were collected. Rainfall data for 1985-2022 were collected. The depth of the groundwater table in the area varies between 3.0 and 27.5 m annually. The estimated groundwater recharge ranges from 193 to 727 mm per year across the unions. The transmissivity values range from 89 to 4,648 m^2/day, while the storage coefficient for the first aquifer varies between 0.0000748 and 0.1781. The study identified different levels of water scarcity across the district: 11 unions fall under very low scarcity, no union faces low scarcity, 14 unions face moderate scarcity, 10 unions experience high scarcity, and 10 unions suffer from very high scarcity. In terms of water stress, it is found that 1 union in Chapainawabganj Sadar, 5 unions in Gomostapur, and 4 unions in Nachol fall under very high-water stress zone. Additionally, 3 unions in Chapainawabganj Sadar, 3 in Gomostapur, and 4 in Shibganj are categorized as high-water stress zone. The current groundwater abstraction practice, particularly in Nachol and Gomostapur upazilas, is alarming, with significant drops in groundwater levels due to over-extraction for agricultural purposes. To ensure sustainable water resources for future generations, it is essential to reduce groundwater usage. Implementing the conjunctive use of groundwater and surface water, re-excavating potential beels and ponds to greater depths, promoting crop diversification, and enhancing surface water storage during the monsoon season are crucial measures for improving water resource management in the district.

Keywords: Recharge, Participatory Rural Appraisal, Water stress, Groundwater level.

Estimation of Groundwater Resource and Suitability of GWREC-97 Methodology for Riverside Aquifers: A Case Study

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Abstract

The study deals with the estimation of groundwater resource of four riverside upazilas of Sirajganj District, Bangladesh for the period of 2011-2015 by applying the methodology proposed by Groundwater Resource Estimation Committee-1997 (GWREC-97) while addressing the limitations of this methodology for riverside aquifers. Groundwater recharge is estimated seasonally, considering components such as rainfall, irrigation return flow, and seepage from canals, tanks and ponds. Rainfall is the main source of groundwater recharge. The study estimates that the replenishable groundwater resource is approximately 554 Mm^3, where groundwater recharge through rainfall is 341 Mm^3 and recharge from other sources is about 213 Mm^3. The calculated annual draft is estimatedabout 618.5 Mm^3, where the draft for irrigation is about 591.5 Mm^3 and the draft for domestic and industrial purposes is nearly 27 Mm^3. The net annual availability of groundwater (after deducing natural discharge) is about 498.8 Mm^3. The stage of groundwater development is about 126%, which indicates that the annual draft is higher than the availability of groundwater. But with this over extraction of groundwater, there is no indication of depletion and no remarkable change in the long-term trend of groundwater level for the last sixteen (2000-2015) years. The GWREC-97 method does not take into account horizontal recharge from the river and vertical recharge from river flooding while estimating resources and this could be considered as a limitation of this method. These two recharge processes cause massive influx of groundwater to the aquifers adjacent to the mighty Jamuna River. That's why the fluctuation of groundwater level does not increase significantly even though large scale abstraction of groundwater. This study indicates that the principle, GWREC-97 adopted for groundwater resource estimation may reasonably be suitable for the aquifers which are not hydraulically connected with adjacent rivers but not where the aquifers are hydraulically well connected with the adjacent river.

Keywords: Groundwater development, Groundwater draft, Replenishable groundwater resource, Resource estimation.

Analyzing Piezometric Level Trends and Management Gaps: A Case Study in Jahangirnagar University

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Abstract

The Jahangirnagar University (JU) campus solely depends on the groundwater abstracted from the Plio-Pleistocene fluvio-deltaic sands of the Dupi Tila Formation. The increasing number of populations (about 20000 people) on the campus is causing enormous pressure on the groundwater. This study aims to understand the campus's current piezometric level (PL) and identify the groundwater management gaps to create a sustainable water management plan that can help reduce the current piezometric level declining trend. PL variability has been analyzed using descriptive analysis such as mean and correlation coefficient. The trend of PL has been estimated using Mann-Kendall test and Sen's slope estimator to determine the depth to PL increase or decrease on the campus. The Auto Regressive Integrated Moving Average (ARIMA) model has been used to forecast the linear principle of PL time series data. The amount of water wastage due to overflows from the outlets of each building on the campus has been measured. The measured depth to PL among the 5 piezometers varies from 21.65 m to 29.60 m (April 2023 to October 2024). The deepest depth to PL is observed in the northeastern boundary (29.60 m) and the shallowest level is observed in the central part (21.65 m) where the depth of the piezometers is 60 m. The rate of PL decline is very fast, and it is around 2.4 m per year. The forecast analysis for the next 2 years showed that the depth to PL will continue to increase at the rate of 1 m per year. At the same time, around 35% of the total abstracted water gets wasted due to overflow from the different outlets and inefficiencies in the water distribution system over one year. The total abstraction is 5.05 MLD while the total water demand determined using the population data is around 3.30 MLD. It indicates around 1.57 MLD gets wasted as a system loss. The authority should take steps to improve the current water management system of the campus and the over-extraction should be minimized by matching abstraction rates to demand.

Keywords: Dupi Tila aquifer, Forecast modeling, Over-exploitation, Water wastage.

Hydrochemistry of Arsenic Contaminated Groundwater in Southeastern Bangladesh: Implication for Arsenic Mobilization

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Abstract

A total of 122 groundwater samples were collected from different depths in the arsenic hot spot area of Bangladesh for geochemical analyses. Major cations (Ca^{2+}, Mg^{2+}, K^{+}, Si, NH_4^{+} and Na^{+}) and trace elements (As, Fe, Mn, Cu, Sr, Mo, Ce, Nd, Eu, and Pb) in groundwater were analyzed using ICP-MS and major anions (Cl^{-}, Br^{-}, F^{-}, PO_4^{3-}, SO_4^{2-}, and NO_3^{-}) were analyzed by Ion Chromatography. Bicarbonate in groundwater samples was analyzed by titration method. The piper diagram and a positive correlation between Na^{+} and HCO_3^{-} indicate that the groundwater type is Na-HCO_3, which suggests a cation exchange processes is involved in the study area. Na shows strong correlation with Cl which further implies that remnants of connate seawater are present in the aquifer. As, Fe and Mn concentration in groundwater of south eastern part (Chandpur District) ranges from 114 to 716.23 µg/l, 1.30 to 25.04 mg/l, and 22.30 to 1488.11 µg/l, respectively, exceeding WHO permissible limits for drinking water. TOC in groundwater ranges from 1.2 to 12.30 mg/l. High As, Fe, Mn and HN4 along with low SO_4^{2-} and NO_3^{-}, and high TOC levels suggest that the aquifer is in highly reduced condition which favors the arsenic release into groundwater. The positive correlation between As and NH_4^{+} indicates that NH_4^{+} released from fertilizer or from the decay of organic matter (as evidenced by positive correlation between HCO_3^{-} and NH_4^{+}) may contribute to arsenic mobilization from sediment into groundwater, although the reductive dissolution of FeOOH (highest value of Fe is 25 mg/l) and MnOOH under reducing condition facilitated by anaerobic bacteria is identified as the primary mechanism of arsenic release in Bangladesh's alluvial aquifers. The relationship between δD and $\delta^{18}O$ suggests a meteoric origin for groundwater, indicating modern recharge processes. PO_4^{3-} and F^{-} show a strong correlation, suggesting a common source, likely anthropogenic. The negative correlation between Ca^{2+} and PO_4^{3-} also demonstrates that PO_4^{3-} comes from fertilizer rather than a natural geogenic source but it appears to play a significant role in As mobilization in groundwater as there is a strong correlation exist between As and PO_4.

Keywords: Arsenic, FeOOH, Groundwater, South-eastern part, Chandpur, Bangladesh.

Groundwater Quality Assessment of Deep Aquifer and its Impact on Human Health in Dhaka Metropolitan City, Bangladesh

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Abstract

The effects of groundwater on human health have gained significant attention, highlighting the importance of sustainable and safe water practices. A study has been conducted to assess the groundwater quality and its impact on the residents of Dhaka City. This research involved a geochemical analysis of thirty-five (n=35) groundwater samples sourced from deep tube wells. The evaluation aimed to determine the suitability of the groundwater for domestic use, understand the potential human health risks, and promote public awareness within the city. Physicochemical parameters measured in the field indicate that the water is slightly acidic to nearly neutral (avg. pH 6.91) with low turbidity (avg. 1.31 NTU), and the environment ranges from reducing to oxidizing (ORP -77.4 to 153 mV). Geochemical analysis by ICP-OES (Varian 710-ES) suggests that the average concentrations (mg/L) of the analyzed elements were Cl (20.46), Fe (0.38), Cd (0.002), Pb (0.004), Zn (0.11), F (7.86), As (0.00). Cl and Zn deficiency has been observed in chemical analysis of water samples. The F distribution map of the aquifer indicates that approximately two-thirds of the investigated area has excess F, while about one-fourth of the area is deficient in it. This imbalance could have serious negative impacts on human health, particularly affecting teeth and bones. Chemical analyses of Fe, Pb, Cd, Zn, F, Cl and As of the water sample suggest that all the elements are within permissible limits except Zn and Fe, and there is no As in the water. According to the water quality index, 40% of the samples are classified as excellent and 60% good for drinking purposes. Considering the overpopulation and improper distribution of people in the area, over-pumping of aquifers, unplanned urbanization, and industrialization may lead to worsening the water quality and geo-environment.

Keywords: Groundwater quality, Geochemical analysis, Human health, Geo-environment.

Assessment of Groundwater Quality and Its Effect on Human Health in Savar Upazila of Dhaka District, Bangladesh

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Abstract

The study was designed to predict the water quality in different areas of rapidly urbanized and industrialized Savar Upazila. The study area lies on the southwestern part of Madhupur Tract, an uplifted Pleistocene Terrace in the central part of Bengal Basin. The area is underlain by the Plio-Pleistocene light yellowish-brown alluvial fine to coarse-grained sands of Dupi Tila Formation which forms the main aquifer in the region. Twenty-seven (n=27) groundwater samples were systematically collected from shallow/deep tube wells (22 to 138 m depth) already installed in different parts of the explored area and analyzed for various hydrochemical parameters following standard protocol. Physicochemical parameters of groundwater samples measured in the field indicate that the water is found to be almost neutral in nature (avg. pH 7.05) with low TDS (avg. 120.21 mg/L) and arsenic-free and residing in an oxidizing environment (avg. ORP 64.04 mV). Geochemical analysis by ICP-OES (Varian 710-ES) suggests that the average concentrations (mg/L) of the analyzed elements were HCO_3 (135.37), SO_4 (6.63), NO_3 (7.30), Cl (8.48), Na (14.73), Ca (28.22), Mg (12), K (1.31), Fe (0.34). The values of other trace metals (As, Mn, Cd, Cu, Pb, Ni, Cr, and Co) were also determined in collected water samples but mostly present in very low concentrations. The obtained results indicate that water type of the designated area is mainly $Ca(HCO_3)_2$ type. In a comparison of the detected hydrochemical attributes with WHO (2011) and Bangladesh (The Environmental Conservation Rules, 2023) guidelines values for drinking water purposes, all the measured values of the analyzed samples are within the permissible limit. The majority of the samples (90.59%) belong to the excellent class and below one-tenth of the samples (7.41%) belong to the good for drinking class according to the water quality index. Low K intake can cause K deficiency or hypokalemia. Cl and Na deficiency has been observed in the chemical analysis of water samples. Though current groundwater quality poses no threat to human health, due to excessive industrialization and urbanization, and subsequent increased abstraction of groundwater through unscientific installation of deep and shallow tube wells at different depths can lead to loss of water quality and damage to the underground environment, especially if the water level drops excessively, arsenic can enter from the surrounding floodplain areas.

Keywords: Aquifer, Groundwater quality, Hydrochemistry, Public health.

Lithological and Geochemical Characteristics of the Eocene-Miocene Sediments of the Surma Basin, Bangladesh: Understanding the Changes in Depositional Environment and Sediment Sources

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Abstract

Eocene to Miocene sediments in the Sylhet Trough were examined to present an overview of the sedimentary provenance, depositional environment, and tectonic setting. Lithological characteristics, elemental analyser mass spectrometer for geochemical proxies of organic matter (OM) in sediments, and X-ray fluorescence (XRF) for elemental analysis of clastic sediment were studied. A dynamic depositional environment is shown by lithology and geochemical proxies including TOC (0.02–2.68%), T/N (0.15–26.34), T/S (0.23–7.74), and $\delta^{13}C$ (-26.50‰–23.42‰). The sediments exhibit moderate to high maturity, as shown by the CIA (62.2–89.7%), ICV (0.32–1.16), and K_2O/Na_2O ratios (1.36–7.50). The MFW and A–CN–K diagrams demonstrate that the sediments predominantly originated from felsic to mafic sources and exhibit an intense weathering trend. Tectonic provenance discrimination diagrams show that sediment deposited is mostly influenced by collisions, implying an active to passive continental margin. The analyses reveal that Sylhet Limestone was deposited in a stable shelf environment, and Kopili Shale represented a shelf-to-deltaic depositional setting, where OM predominantly originated from adjacent land sources. Due to a sinking basin next to a rising Himalaya during 34–21 Ma, sediment of the Barail Sandstone was rapidly deposited in a deltaic to fluvial depositional environment. The ongoing collision of the Eurasian and Indian Plate-driven uplift of the Himalayas increased the South Asian Monsoon during 21–5 Ma. Bhuban, Boka Bil, and Tipam Sandstone Formation were deposited in continental shelves to deltaic, estuarine to marine, and fluvial depositional settings, respectively, while Girujan Clay was deposited on the floodplain in response to tectonic loading and flexure of the basin floor. The study contributes to the broader understanding of the geological evolution of the Bengal Basin, emphasising the complex interplay between tectonics, sea level influences, and sedimentation processes.

Keywords: Lithology, Geochemical proxies, Elemental geochemistry, Organic matter, Bengal Basin.

Mapping Potential Zones for Groundwater Recharge in Cumilla District, Bangladesh: An Integrated Approach Using AHP, Fuzzy-AHP, and GIS

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Abstract

Groundwater is the most significant source of freshwater for humanity. This study utilizes Geographic Information System (GIS) technology to conduct a qualitative assessment of groundwater recharge potential in the Cumilla District, Bangladesh. By integrating nine key factors, such as elevation, slope, drainage density, land use and land cover (LULC), the normalized difference vegetation index (NDVI), the normalized difference water index (NDWI), precipitation, soil type and permeability, a comprehensive groundwater recharge potential zoning (GWRPZ) map is generated through weighted overlay analysis. For this analysis, the Analytic Hierarchy Process (AHP) and Fuzzy-AHP methodologies were applied to assign weights to determine the relative significance of these parameters in affecting groundwater recharge. Based on the AHP and Fuzzy-AHP models, the GWRPZs were classified as low, moderate and high. The study identifies most of the zones with moderate to highest potential, characterized by gentle slopes, low drainage density, a high vegetation index, an elevated water index, low soil permeability, and abundant precipitation within the research area. According to the AHP and Fuzzy-AHP model, 58.10% and 55.23% of the final GWRPZs were classified as moderate potential, 1.27% and 1.07% as low potential and, 40.62 and 43.69% as high potential, respectively. The integration of GIS technology and the comprehensive evaluation of groundwater recharge potential provide ciritcal information on decision-making and strategic planning for the utilization of water resources. The research findings are also important for water management authorities as they offer invaluable perspectives for the sustainable management of groundwater resources in this region.

Keywords: Analytical Hierarchy Process (AHP), Cumilla, Bangladesh, Fuzzy-AHP, Geographical Information System (GIS), Groundwater recharge potential.

Groundwater Quality in the Barind Tract and Floodplain Regions of Naogaon District, Bangladesh: A Hydrogeochemical and GIS Perspective

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Abstract

Hydrogeochemical analysis of groundwater aquifers in Naogaon district (Mohadebpur and Badalgachi Upazilas) of Bangladesh has been carried out to assess the water quality. Physiographically the study area consists of mainly Floodplain and Barind Tract region. A total of 21 water samples (Floodplain12 and Barind Tract-9) were collected from the study area. Among the physiochemical and chemical parameters, the pH (avg. 7.2), DO (avg. 1.45), EC (avg. 375.57), TDS (avg. 151.32), Na^+ (avg. 20.14), K^+ (avg. 2.30), Ca^{2+} (avg. 24.83), Mg^{2+} (avg. 11.25), HCO_3^- (avg. 199.38), SO_4^{2-} (avg. 9.40), and Cl^- (avg. 19.15) in all samples are within the WHO-2022 guidelines while NO_3^- (avg. 1.07, 5%) NO_2^- (avg. 3.63, 90%), Fe (avg. 2.06, 100%), Mn (avg. 0.27, 85%), are exceeded that standard value. This result represents that the Floodplain groundwater are more vulnerable than Barind Tract. The concentration sequences of major cations and major anions are $K^+<Mg^{2+}<Na^+<Ca^{2+}$ and anions are $NO_2^-<NO_3^-<SO_4^{2-}<Cl^-<HCO_3^-$ respectively. All samples are mainly of Ca-Mg-HCO_3 type water. The hydrogeochemical results suggest that the weathering of rock-forming minerals as well as secondary contributions from anthropogenic sources are mainly controlling the groundwater composition. The water quality index (WQI) (avg. 93.27) revealed that Floodplain groundwater is comparatively more unsuitable for drinking purposes than the Barind Tract water. The USSL diagram, Wilcox diagram, %Na (avg. 30.10), SAR (avg. 0.86), RSBC (avg. -1.49), MH (avg. 41.29), TH (avg. 6.43), KR (avg. 0.44), and PI (avg. 53.85) suggest that all groundwater samples are suitable for irrigation purposes. Therefore, the water of Barind Tract region has no problem with the quality while the Floodplain aquifer is recharged with anthropogenic contaminants. This study implies that the subsurface hydrogeological environment should be carefully managed for the sustainable development of the groundwater resources for the future generations.

Keywords: Hydrogeochemical, Floodplain, Barind Tract, Rock Weathering, WQI.

Isotopic and Hydrogeochemical Assessment of the Central Deltaic Zone in Bangladesh: Intergrating Source, Water Quality and Health Risk Indices

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Abstract

Environmental isotopes (δ^2H and $\delta^{18}O$) and hydrogeochemical (anion, cation and trace elements) techniques are being assessed for identifying groundwater in Bangladesh's central deltaic zone (Faridpur, Madaripur and Magura), with an emphasis on groundwater source, quality, and health risk. A total of 30 groundwater samples were collected from various locations within the study area, where the water is mainly Ca-HCO_3^- to Na-HCO_3^- types. Diverse water chemistry is observed in shallow (enrichment of nitrate, arsenic and total iron) and deep aquifers (high chloride, bicarbonate and total dissolved solid). The δ^2H and $\delta^{18}O$ of shallow aquifer samples are plotted below the GWML and LMWL, indicating that rainwater infiltrated shallow (Holocene) aquifers with contaminated plumes (NO_2 and NO_3) leaching through the recharge source. Deep aquifer samples are found alongside the GWML and LMWL, implying that ancient or paleosaline (Pleistocene age) water was entrapped during deltaic development. Most metalloids, and metals (As, Cr, Fe, Ni, Pb, and Mn) and NO_2^- exceed the WHO-2011 and BD acceptable limit from shallow groundwater. According to the Integrated Water Quality Index (IWQI), groundwater from the shallow aquifer is unsuitable for drinking, whereas water from the deep aquifer is appropriate with a borderline saline taste. The non-carcinogenic and carcinogenic health risk indexes for shallow and intermediate aquifers exceed the allowed limit for adults and children. To protect human health and ecosystems, effective measures must be implemented for sustainable water resourses development and management.

Keywords: Hydrogeochemistry, Isotopic techniques, metalloids, and metals, Health Risk Assessment, Integrated Water Quality Index.

Groundwater Source, Water Quality, and Health Risk Assessment in the Jamuna Floodplain, Bangladesh: An Isotopic and Hydrogeochemical Approach

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Abstract

This study investigated groundwater sources, water quality, and associated health risks in the Jamuna Floodplain region of Bangladesh using isotopic and geochemical methods. Geologically, the study area is of the Holocene Formation. A total of 35 groundwater samples were collected from various locations within the study area, comprising 21 shallow samples, 7 intermediate samples, and 7 deep samples. The analysis focused on identifying the sources of groundwater, assessing the water quality, and evaluating potential health risks. The water types are mainly Ca-HCO_3^- to Na-HCO_3^-. The isotopic composition ($\delta^{18}O‰$ and $\delta^{2}H‰$) indicates that the shallow and intermediate aquifers have recently replenished from precipitation, but a thick layer of clay has prevented any replenishment of the deep Holocene aquifer. During recharge, various anthropogenic and industrial contaminants like As, Cr, Fe, Mn, and Pb enter the shallow and intermediate aquifer and deteriorate the quality of groundwater. HPI, HEI, and C_d showed higher contamination extent in shallow and intermediate aquifers. The Integrated Water Quality Index (IWQI) showed the water from shallow and intermediate aquifers is unsuitable while the deep aquifer is suitable for drinking. The non-carcinogenic and carcinogenic health risks index surpasses the permissible limit for both adult and children for shallow and intermediate aquifers. Tackling these challenges calls for effective management strategies. This includes proper waste disposal, sustainable farming methods, and continuous water quality monitoring to protect human health and ecosystems.

Keywords: Geochemical analysis, Health Risk Assessment, Holocene aquifer, Isotopic analysis, IWQI.

Assessment of Seawater Intrusion in the Chattogram City: Insights from Hydrogeology and Hydrochemical Analysis

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Abstract

The port city Chattogram, one of the commercial and industrial cities in Bangladesh, relies heavily on groundwater abstraction from the sub-surface aquifer for the domestic and industrial use. However, the knowledge on aquifer distribution, groundwater quality, and sea water intrusion in Chattogram is limited. Therefore, this research has been carried out to assess the current condition of the hydrogeological and hydrochemical aspects of the aquifer system, to identify salinity distribution and water quality of coastal aquifers, and to map areas vulnerable to sea water intrusion. Based on the geological, geomorphological and hydrogeological observations, the aquifer system in the city can be divided in three broad zones -(a) Quaternary (coastal) aquifer system, (b) Tertiary aquifer system, and (c) Active channel aquifer system. Cross-sections based on borehole information show that the hydro-stratigraphic units are laterally continuous (except offset by reverse faults), although their depth and thickness vary moderately (20-180 m). Based on the aquifer-aquitard relationship, the aquifers of the area are dominantly confined to semi-confined. The TDS and Chloride content of the Quaternary aquifer is much higher compared to the Tertiary aquifers. The TDS varies from 423 to 3539 ppm (median 1143 ppm) in the Quaternary coastal aquifer. But in the Tertiary aquifer TDS ranges from 119 to 187 ppm (median 158 ppm). Similarly, the Cl^- content varies from 65.86 to 3816.25 mg/L (median 204.12 mg/L) in the Quaternary coastal aquifer. But in the Tertiary aquifer, Cl^- content varies from 2.18 to 26.58 mg/L (median 3.55 mg/L). These results indicate that seawater intrusion has already occurred in the Quaternary aquifer system. However, no evidence for sea water intrusion has been found for the Tertiary aquifer system. These observations on seawater intrusion are vital for future planning and sustainable management of groundwater resources in Chattogram city.

Keywords: Aquifer system, Chattogram city, Hydrochemical analysis, Sea water intrusion.

Hydrochemical Evolution and Groundwater Quality of the Aquifer System in Jahangirnagar University Campus and Its Surrounding Area

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Abstract

Around 20,000 people are living on the Jahangirnagar University (JU) campus and are almost exclusively dependent on groundwater for drinking and domestic purposes. This research deals with the aquifer geometry, hydrochemistry, hydrochemical processes, water quality, and interaction between groundwater and surface water. Hydrochemical evolution and water quality have been inferred from water chemistry, bivariate plots, correlation of major ions, graphical plots and stable isotopes analysis. There are several lakes on the JU campus; a component of recharge as well. The piezometric level (PL) is declining over time. Two hydrostratigraphic units were identified within the the explored depth: the Upper Aquitard and the Upper Dupi Tila Aquifer (UDA). The UDA is very productive and has the potential for groundwater development. The pH of UDA is slightly acidic to neutral in nature. The TDS of groundwater indicates fresh water and is suitable for drinking. The EC indicates low mineralization of all waters. The order of cation and anion dominance in the UDA is $Na^{+}>Ca^{2+}>Mg^{2+}>K^{+}$ and $HCO_3^{-}>Cl^{-}>SO_4^{2-}>NO_3^{-}$, respectively. The waters are mostly Ca/Mg-HCO3 type. The overall groundwater quality is good and mostly within the ranges of drinking water standards both for Bangladesh and WHO. The aluminosilicates weathering is the dominant process controlling the major ions concentration. The stable isotopes show three distinct groups. The groundwaters of Group 1 and 2 are mainly recharged from local precipitation and few samples from Group 2 show relatively more depletion representing variable composition of rainfall. The median d-excess values indicate that the local rainfall is the main source of groundwater. All the surface waters in Group 3 are isotopically enriched due to the evaporation effect. The different isotopic values of groundwater and lake/pond water indicate that there is no direct hydraulic connectivity between them. Therefore, development of a management plan is important for the sustainable supply of groundwater in the JU campus and its adjacent areas.

Keywords: Seismo-tectonic, Earthquake, Peak Ground Acceleration.

Deciphering Coastal Hydrostratigraphy Through Integrated Resistivity Survey and Geophysical Logging: Towards a Sustainable Fresh Aquifer for Drinking Water Supply in Noakhali Town, Bangladesh

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Abstract

Noakhali, a coastal town near the estuary of the Bay of Bengal in southern Bangladesh, faces significant challenges in securing potable water due to arsenic contamination and salinity in shallow aquifers. The incidental discovery and frequent omission of freshwater-bearing zones at greater depths during tube well drilling prompted the local water supply authority to initiate a systematic aquifer mapping survey. A Vertical Electrical Sounding (VES) survey, comprising 16 VES with AB/2 separation of 800 meters, was conducted in and around Noakhali town to delineate suitable fresh aquifers for the town's water supply. The results indicated the absence of a viable freshwater aquifer in the southern vicinity and within the town itself; however, a promising freshwater aquifer was identified approximately 5 kilometers north of the town, in the Ekhlaspur area. This aquifer lies beneath a protective clay layer, underlying the near-surface brackish and arsenic-contaminated zones. The freshwater-saline water interface has also been delineated. Four observation tube wells, drilled to a depth of 285 meters, were used to verify the VES results. Geophysical logging comprising of gamma, caliper, long and short normal resistivity, spontaneous potential (SP), and temperature logs was conducted in these drill holes to characterize the subsurface layers. The geophysical logging data agree with the VES findings and provided a comprehensive hydrostratigraphic profile of the area, revealing three distinct layers: (i) an upper brackish (iron and arsenic contaminated) zone, about 160 meters thick; (ii) a natural clay aquitard approximately 30 meters thick; and (iii) a freshwater aquifer exceeding 150 meters in thickness. The base of the freshwater zone was not encountered within the logged depth of 285 meters; however, VES curves of the area suggested the presence of a low-resistivity zone, indicative of saline water, beneath the fresh aquifer. The middle freshwater aquifer, protected by a natural clay layer, has been identified as a sustainable source for the town's drinking water supply. This assessment was validated through the implementation of production deep tube wells tapping the middle aquifer and subsequent monitoring of water quality with constant rate pumping test for seven days. The study underscores the effectiveness of integrating resistivity surveys and geophysical logging techniques in exploring fresh aquifers in the coastal regions of Bangladesh. Additionally, it provides valuable insights into the regional hydrostratigraphy, which could aid in identifying potable groundwater sources in other coastal areas.

Keywords: Resistivity survey, Coastal aquifer, Hydrostratigraphy, Noakhali, Ekhlaspur.

Heavy Metal Pollution and Spatial Distribution in Surface Water and Sediments of Dhamrai Upazila, Bangladesh

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Abstract

Rapid industrial growth is transforming Dhamrai Upazila into a suburban hub near the capital Dhaka, though development remains predominantly unplanned. Industrial effluents are discharged into the Banshi, Gazikhali, and Dhaleswari Rivers, raising concerns about contamination particularly heavy metals. This study examines spatial distribution and pollution assessment of heavy metals (Cr, Mn, Fe, Co, Ni, Cu, Cd, Pb, As, Al) in surface water and sediments using Potential ecological risk index (RI), geo-accumulation index (Igeo), contamination factor (CF), and pollution load index (PLI). Seven surface water samples and corresponding sediment samples (15 cm and 60 cm depths) were collected from upstream to downstream locations and analyzed using inductively coupled plasma mass spectrometer (ICP-MS). The mean heavy metal concentrations followed a decreasing order of Fe>Mn>Cu>As>Ni>Pb>Cr>Cd in water and Mn>As>Cr>Cu>Pb>Ni>Co>Al>Fe>Cd in sediments. RI in surface water displayed considerable risk to very high risk while Igeo showed moderate to extreme contamination. CF indicated moderate to very high contamination while PLI values also suggested polluted condition. In sediments, Igeo values exhibited uncontaminated to extremely contaminated levels (As, Pb, Cd, Cu), whereas CF indicated moderate to very high contamination (As, Pb, Cd, Cu) at 15 cm. PLI indicated pollution in sediments at both depths. All pollution indices exhibit lower contamination levels at 60 cm depth. Increased amount of Al, Fe, Mn both in surface water and sediments suggested geogenic sources and rest of the metals (Cr, Co, Ni, Cu, Cd, Pb, As) represents pollution due to anthropogenic activities. These findings highlight the need for targeted pollution control like industrial effluent and agricultural runoff treatment, waste water management, community awareness, policy implementation, integrated river basin management (IRBM) in Dhamrai Upazila.

Keywords: Contamination factor, Geo-accumulation index, Heavy metal, Pollution load index, Potential ecological risk index, Anthropogenic contamination.

Organic Matter Source and Paleoclimate Variability of Multicore Sediments from the Andaman Sea off Myanmar

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Abstract

The distribution, source, and redox change of sedimentary organic matter in the Andaman Sea off Myanmar is significant for understanding its biogeochemical cycle. The total organic carbon (TOC) and total nitrogen (TN) concentrations in the multi-core sediment samples varied from 0.61 to 1.18 wt.% (average 0.87 wt.%) and 0.07 to 0.17 wt.% (average 0.13 wt.%), respectively, with high TOC in the clay-rich sediments indicating that hydrodynamic sorting readily controlled TOC abundances. The bulk TOC/TN ratio ranges from 5.51 to 11.92 (average 7.89), indicating high inputs from planktonic organic matter and substantial amounts of terrestrial organic matter. The $\delta^{13}C_{org}$ and $\delta^{15}N_{tot}$ values for the sediment cores ranged from –8.34‰ to –20.3‰ and +3.65‰ to +6.53‰, respectively, suggesting that organic matter in the sediments originated from planktonic sources, with significant contributions from a mixture of terrestrial and aquatic sources and seagrasses. n-alkane distributions, characterized chiefly by C_{16} to C_{35}, with odd-over-even predominance after C_{25}, suggesting a diverse origin of organic matter. The high content of odd long-chain n-alkanes from C_{27} to C_{33}, with high peaks at C_{29} and C_{31}, identified in the samples, reflects a terrigenous origin of organic matter (e.g., shrubs, woody, or herbaceous plants). Average chain length (ACL), carbon preference index (CPI), aquatic proxy (P_{aq}), and terrestrial wax (P_{wax}) ratio values indicate that high input of organic matter from non-emergent aquatic macrophytes followed by grasses and herbs. High ACL with low P_{aq} values and $\delta^{13}C_{org}$ excursions in the down-core sediment samples could suggest initially cold and dry climates existed and steadily shifted to warm and humid climatic conditions.

Keywords: Organic matter, TOC/TN ratio, Stable isotopes, Biomarkers, Sediment, Andaman Sea off Myanmar.

Grain Size Distribution and Characterisation of Sedimentary Processes of Cox's Bazar Beach, Bangladesh: Implications for Understanding Morphology and Coastal Dynamics

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Abstract

The study investigates the mode of transportation, depositional environment, and sedimentation process by examining grain size and heavy minerals (HM) in sediment. Eighty surficial beach samples were collected from Kakra to the north, Inani, and Teknaf to the south along Cox's Bazar Beach to characterise the sediment. Fine to medium-grained (1.76–2.54 φ), well to moderately well-sorted (0.34–1.23 φ), nearly symmetrical (-0.10–0.03), mesokurtic (0.93–1.28) sand, show the uniformity of grain sizes. The bivariant plot of the grain size parameters, linear and multivariant discriminant functions, and C-M diagram reveal that the sediments deposited in an aeolian, shallow agitated, turbidity-influenced beach environment. The sand has higher concentrations of HM in the swash zone (4.9–19.1%), followed by the surf zone (3.5–12.3%), backshore (2.2–12%), and dune (2.5–6.2%). The spatial distribution of grain parameters expressed that moderately well-sorted medium-grained sand was deposited in the swash zone, while well-sorted to very well-sorted fine-grained sand was found towards land. Waves with strongly asymmetric ocean currents carry sediment from offshore in a turbulent manner, causing coarser sand and a higher proportion of HM deposits in the swash zone and finer back to the ocean. In contrast, the wind carries sediments landward, forming dunes. The oblique approach of waves along the coast formed longshore currents, which influenced sediment movement and led to a decreasing grain size from south to north. Overall, this research enhances understanding of factors influencing modern beach development along the Bengal Basin coast, providing valuable insights for coastal sedimentation and management.

Keywords: Grain size, Discriminant function, Heavy minerals, Coastal current, Sediment transport, Depositional process.

Towards Sustainable Development: The International Laws and Geospatial Techniques in Addressing Transboundary Rivering Pollution in Marine Areas of Bangladesh

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Abstract

Bangladesh, with its vast and vulnerable marine ecosystem, faces critical challenges from transboundary waste dumping, which threatens marine biodiversity and the livelihoods of coastal communities. Addressing this issue through the implementation of geospatial techniques and international legal frameworks can significantly promote the attainment of the Sustainable Development Goals (SDGs). This research explores the intersection of international law and geospatial techniques in addressing the critical issue of transboundary waste dumping in the marine area of Bangladesh, with a focus on achieving sustainable development. This research integrates geospatial techniques, such as GIS and remote sensing, with international legal frameworks to support environmental monitoring and enhance the regulation of hazardous waste dumping in marine areas. The methodology involves a comprehensive review of relevant international treaties, such as the London Convention, Basel Convention, UNCLOS and other agreements combined with the application of geospatial techniques like GIS and remote sensing to track waste movement and assess its impact on marine ecosystems. High-resolution satellite imagery from sources like Landsat provides critical data for monitoring and analyzing hazardous waste dumping in marine areas. Data integration and mapping uses GIS platforms for base maps, spatial data layers, and visualizations, incorporating techniques such as data fusion and image processing. Specific geospatial parameters and indices, including SST (Sea Surface Temperature, Chlorophyll-a Concentration) and the Turbidity Index, will be employed for comprehensive analysis. The expected outcome suggests that integrating legal measures and geospatial technology can significantly enhance the detection, prevention, and management of transboundary waste dumping, thereby protecting marine biodiversity and promoting the sustainable use of marine resources. The conclusion demonstrates that robust international cooperation and cutting-edge geospatial tools are essential for effective environmental governance and for meeting Sustainable Development Goal 14, which emphasizes life below water. This integrated approach ensures environmental protection and supports the socio-economic well-being of coastal communities in Bangladesh.

Keywords: Geospatial, International Law, Marine area, Sustainable development, Transboundary, Waste dumping.

Blue Tourism Potentiality in and Around the Khurushkul Area of Cox's Bazar District, Bangladesh

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Abstract

Bangladesh is a coastal country with extensive marine and coastal areas. The surrounding area of the Khuruskul is a significant and attractive beauty spot located near Cox's Bazar town. Blue-tourism is one of the nine priority sectors of the Blue Economy in Bangladesh and is expected to become the largest component of the overall ocean economy by 2030. This sector has the potential to be a major source of foreign exchange and sustainable tourism can help create new jobs and alleviate poverty. According to the World Bank, 25% of Bangladesh's maritime economy is derived from blue tourism. Geomorphologically, the area comprises mainly of Tertiary hillocks and coastal plains. Geologically, the area can be divided into 16 distinct map units. The study of the coastline of the area from 1931 to 2024 indicates that the total land accretion is about 3 sq. km, while erosion is estimated at approximately 0.4 sq. km. The sub-surface geological characteristics and engineering properties of soils the area reveals that the area is geologically more stable and very suitable for blue-tourism development. The Khuruskul area is an another fascinating beauty spot near Cox's Bazar, which is changing the map of the region's prosperity for economy. This area boasts several unique attractions, including favorable geological conditions, sufficient depth in the Maheshkhali Channel for cruises, and suitable anchorage for tourist ships. Additional highlights include the Rakhayinpara and Monupara climate refugee shelters, a local fried fish village, small ethnic communities, rich marine biodiversity, extensive salt fields, mangrove forests, the meandering Bakkhali River, various types of fishing boats, and the crystal-clear blue waters of the Maheshkhali Channel. Moreover, the area is home to flocks of birds, a Buddhist temple, and the nearby Sonadia and Moheshkhali islands, all set against the beautiful backdrop of the Bay of Bengal. This area offers a wide range of tourism activities, including cruises, visits to sites of maritime heritage and culture, sailing and boating, fishing, coastal wildlife watching, sunbathing, and exploring seaside islands and beach clubs or bars. Additionally, visitors can enjoy coastal walks, water sports such as jet skiing, surfing, sailboarding, parasailing, and sea angling, as well as scuba diving, snorkeling, swimming, bird watching, and exploring coastal natural reserves. These activities have the potential to open up new avenues for tourism, create jobs, and reduce poverty, making them significant sources of tourism revenue in Bangladesh. The immense potential for tourism and development in this region promises to transform the lifestyles of communities in and around Cox's Bazar town.

Keywords: Blue Economy, Tourism, Sustainable Development.

Evaluation of Trace and Rare-Earth Elements in Core Sediments from the Sundarbans Coastal Area of Bangladesh

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Abstract

This research investigates the geochemical characteristics of trace elements and rare-earth elements (REEs) in long-core sediment samples (n = 25; depth = 100 m) using ICP-AES/MS from the Sundarbans mangrove forest in Bangladesh to evaluate the source, depositional environment, and tectonics. Vertical variation of the core sediment showed LREE/HREE ratios ranging from 6.82 to 9.14, and Σ REE values varied from 101.97 to 186.31 ppm (mean 139.66 ppm). Positive Ce anomalies (4.16 to 4.40) and strong negative Eu anomalies (0.19 to 0.35) consistently suggest oxidative depositional conditions, plagioclase depletion, and highly differentiated precursor rocks. The ratios of REE/UCC and YREE/PASS exhibit a systematic fractionation pattern, with HREE enrichment (Eu, Gd, Tb; REE/UCC>1; YREE/PASS>1) and LREE depletion (La, Ce, Pr, Nd, Sm; REE/UCC<1; YREE/PASS<1) values suggest their derivation from felsic sources. A strong positive correlation between HREEs and LREEs exists (r = 0.93) in the core sections based on Pearson correlation analysis, with correlation coefficients decreasing gradually with depth. Th and ΣREE have strong positive correlations (r = 0.93), indicating consistent sedimentary input; U and ΣREE show significant redox variations. A negative correlation between Ti and ΣREE indicates various depositional controls. High-energy depositional environments are marked by grain size distributions that show fine sand textures (81.56 to 222.30 μm) with very well-sorted sediments. Th–Sc–Zr/10 and La–Th–Sc ternary diagrams and Eu enrichment and Dy, Ho depletion confirm mixed provenance from active (Himalayan Orogeny) and passive (Indian Craton) continental margins with contributions from weathered felsic and intermediate orogen sources, hydrothermal processes, mechanical sorting, and sediment recycling, offering critical insights into sedimentary processes.

Keywords: Core sediments; REEs; Tectonic; Felsic sources; Oxidative conditions.

Formation Evaluation Using Geophysical Logs of Saldanadi Well# 1, Bangladesh

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Abstracts

Formation evaluation involves analyzing geophysical data along the wellbore depth to determine a formation's potential for hydrocarbon production, utilizing core data, well logs, and production data. This research focused on Saldanadi Well #1, using petrophysical parameters from wireline logs to assess lithology, mineralogy, porosity, permeability, fluid saturation, and the movable hydrocarbon index. Techlog software (2015) was used to calculate petrophysical properties, identify reservoir intervals, and summarize key metrics such as shale volume, porosity, water saturation, and hydrocarbon pore thickness. Lithology and mineralogy were determined through neutron-density log cross-plots. Two reservoirs were identified at depths of 2170–2213 m and 2405–2429 m, exhibiting fair to high permeability (0.3–10.0 mD, 0.1–24.0 mD) and good porosity (16.9% and 17.6%). The result highlighted that shale and clay minerals (e.g., illite), negatively impacted permeability. Although porosity and permeability plots displayed variability, they confirmed reservoir permeability. The Saldanadi Gas Field's total Gas Initially in Place (GIIP) is estimated at 116.5 BCF, with a recoverable reserve of 81.5 BCF. The moveable hydrocarbon index (0.2–0.5) indicates the field's economic viability.

Keywords: Geophysical logs, Hydrocarbon, Reservoir, Saldanadi Gas Field, well #1.

Understanding of Structural Configuration and Geometry of the Bengal Basin for a Rational Seismic Risk Assessment of Bangladesh

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Abstract

The Bengal Basin, situated across Bangladesh and part of India, is formed of complex geological structures during converging collision of the Indian and Eurasian plates. The geologic-setting, active fault system and complex geometry make the region vulnerable to earthquakes. For seismic risk assessment we investigated structural and geometrical configuration of the basin and associated regional tectonics. The basin is characterized by distinct tectonic boundaries and inner elements consisting of central deep basin, fold and thrust belts and major fault systems to the east, which collectively accomplish a decisive tectonic stress condition by accommodating thick sedimentary deposits. It is formed during the subduction of the Indian Plate beneath the Burmese Plate, resulting in a significant foreland basin due to a complex tectonic convergent collision to moderate seismic activity along the interpolate tectonic boundary. For a rational and comparative seismic risk assessment, available geometric and geodynamic data are used. This analysis indicates that the seismicity is influenced by the motion of Indian Plate, the geometry of neighboring accretionary prism and activities along the Myanmar and Sunda Arc System. There is a theoretical hypothesis for great earthquakes (magnitude > 8) to occur at any time from a blind megathrust associated with presumed décollements (fossilized) located below 5-9 km depth under massive vertical load. We used a P- Wave velocity anomaly model and shear wave splitting measurements from published sources to locate the Indian Plate subduction and configure the geometry. Due to an irrational hypothesis, the seismic risk assessment of Bangladesh remained with baffling uncertainties. We presented a detailed structural analysis for a rational seismic risk assessment for Bangladesh. Considering the geometrical configurations, Bangladesh can be divided into three tectonic divisions: The Stable Shelf, The Bengal Foredeep and The Sylhet-Tripura-Chittagong Folded Belt. These divisions have their unique seismogenic characteristics.

Keywords: Bengal Basin, Subduction, Tectonic, Arc.

A Tectonic Insight for Seismic Risk Assessment for Disaster Management in Bangladesh

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Abstract

Bangladesh is the most densely populated country and rapidly expanding its urban and industrial infrastructures. This growth and tectonic location intensify the country's vulnerability to earthquake damage and necessitate an effective disaster management system and preparedness. We present a rational understanding of possible locations of seismogenic tectonic structures that can generate damaging earthquakes. We mapped the major exposed and subterranean tectonic structures of Bangladesh which are crucial for causing strong tremors and determining the potential seismic source structures. Geologically Bangladesh encompasses major parts of Bengal Basin at the convergence of several tectonic plates, namely the Indian Plate, Eurasian Plate and Myanmar Platelet. We determined the resulting multifaceted stress-strain progression in the environs of intraplate seismic source domains in a complex setting of inter-plate boundary conditions. This tectonic setting of the Bengal Basin in association with subducting thrust faults along the Indo-Myanmar Ranges make earthquake prediction difficult. We also identified several mega-structures by regional remote sensing. This indicates a potential seismogenic structure located beyond the eastern borders of the country. Extensive fieldwork and published data analysis were conducted for identifying relationships among the tectonic boundaries, geomorphic terrain, and engineering ground consistency. The distribution of seismic epicenters is very closely related to the tectonic motion, seismic stratigraphy, and crustal configuration of the Bengal Basin. Based on seismic and ground response criteria, we divided Bangladesh into four geotechnical provinces: 1) Bengal Foredeep, 2) Deeper Basin (including Surma Basin), 3) Coastal plain including Troughs and Islands; and 4) Eastern and North-Eastern Fold Belt. The geological and engineering characteristics of the composite material of these geotechnical provinces will aid delineating rational geo-structural design criteria for sustainable development and earthquake hazard assessment for effective seismic risk reduction, disaster management-plans and implementation. This study concludes that the eastern and north-eastern Fold Belt province is capable of moderate to strong earthquakes.

Keywords: Bengal Basin, Tectonic, Seismic risk, Disaster management.

Facies and Architectural Element Analysis of the Exposed Oligocene Succession in and around Jaintiapur, Surma Basin, Northeastern Bangladesh

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Abstract

In northeastern Bangladesh (Jaintiapur, Sylhet), the Surma Basin's Oligocene sedimentary succession/sequence marks a turning point in the geological evolution of the area. Despite its economic importance, little is known about the depositional condition of this sequence because of the limited exposure of outcrops. This research offers a comprehensive sedimentological characteristic of the siliciclastic strata in the region, based on in-depth field observation. Prominent high-order erosional surfaces and nine different lithofacies were found and thoroughly examined. Two primary architectural components of the observed lithofacies were Overbank Fines and Channel Elements. The distribution and characteristics of these materials were predominantly influenced by delta plain and fluvial processes. The channel elements are notable for having a high channel-to-overbank ratio, which is a sign of a high amalgamation system tract accumulating in a high-energetic fluvial setup with frequent avulsion episodes, migration, unconfined channels, and little aggradation of the overbank (floodplain) deposits. These findings not only enhances the understanding of the basin's geological framework but also emphasizes the significant role of deltaic and fluvial processes during the Oligocene.

Keywords: Architectural elements, depositional environments, depositional model, sedimentary facies, Oligocene succession, Surma Basin.

Paleoenvironments of the Oligocene Renji Formation, Bengal Basin, Bangladesh: Implications from Lithofacies and Biofacies Aspects

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Abstract

A detailed study of architectural elements and facies of an exposed section (45 x 8.35 m) of the Oligocene Renji Formation of Barail Group in Sylhet Trough, Bengal Basin has been done to interpret its paleoenvironments of deposition. All together three major architectural elements like channel (CH), bar (LA, DA, LS) and tidal flat (TF) and thirteen sub-elements having first to fifth-order bounding surfaces have been recognized in the sequence. A broad spectrum of facies like St, S_p, S_{ph}, S_{ph}, S_h, S_l, S_r, S_{rm}, S_{cb}, S_w, S_f, F_{sl}, F_l and F_m within these architectural elements has also been identified. The facies form multistoried fining upward sequences that belong to two distinctive genetic facies associations. The sandstone facies association (SFA) is related to stronger flow and tide in the channels and creeks whereas, heterolithic facies association (HFA) or tidalite is related to weaker flow and tide in channels, creeks, interdistributary bays and floodplain. Both the associations SFA and HFA show bi-polar, bi-directional paleocurrent patterns with dominant direction of SSW and NNW-SSE respectively. Sedimentological aspects strongly suggest a deposition of the formation in subtidal, intertidal and even supra tidal sub-environments under tide dominated coastal paleogeographic setting along the northern margin of the Barail paleocoastal zone. Water depth during deposition of the associations SFA and HFA was 0.07-10 m and 0.01-0.164 m respectively with an overall decrease towards the top of the sequence. Abundance of palynomorphs of the family like Palmaepollenites and Palmidites and abundance of pteridophytic spores of family Parkeriaceae and Polypodiaceae suggests a deposition under warm and humid coastal swampy environments with abundant mangrove forest like the present Sundarban area (Saha, 2003). Biological remains like burrows, bioturbations, trace fossils and leaf impressions of mangrove vegetation also support the same views.

Keywords: Barail Group, Architectural elements, Depositional environments

Distribution of Ostracoda in the Sediments of the Southeastern Coast of Bay of Bengal, Bangladesh: Implications for Microenvironment

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Abstract

Ostracods are calcareous microscopic bivalved crustacean organisms. This study provides a new insight by employing recent ostracods as an ecological indicator and its applications, especially for the indication of water quality status at the southeastern part of the Bay of Bengal. Such study could also contribute to developing a good ostracod-based proxy for paleoclimate research. A total of 39 sediment samples were collected from the southeastern part of the Bay of Bengal, specifically from the beach area of Cox's Bazar and along the Maheshkhali Channel. These samples were collected by using a piston auger, which reached depths of about 0.3 meter. The analysis of ostracod distribution in the study area indicates that the species are particularly abundant along the beach area, especially in the inner shelf environment. In total, 63 ostracod shells from 13 samples were identified most of them belonging to 8 families: Cytheruridae, Cytherellidae, Trachyleberididae, Cytheridae, Cytherideidae, Brachycytheridae, and Bythocyprididae. A comparative sedimentological analysis was conducted by calculating the ratio of carapaces to open valves in the study area. The study indicates that areas with a higher abundance of open valves may have tended to lower sedimentation rates compared to areas dominated by carapace accumulation, probably under normal oxygenated environmental conditions. These findings may facilitate our understanding of the sedimentary environment and marine biodiversity in the study area while offering practical applications in coastal environmental monitoring, fisheries management and climate change adaptation.

Keywords: Bay of Bengal, Ostracod, Microenvironment, Sedimentation.

Paleoenvironmental Reconstruction and Petroleum Generation Analysis Using Palynological and Diatomaceous Evidence from Reservoir Rocks

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Abstract

This study aims to reconstruct the paleoenvironmental condition of the reservoir rock by studying the taxonomy and ecology of palynomorphs and diatoms; and analyzing the petroleum maturation of the palynomorphs by emphasizing biological paleothermometers, of Shahbazpur well 2 (SBZ), Bhola, Bangladesh. Seven sediment samples from various depths were prepared using standard methodologies for microscopic observation under transmitted and fluorescence light. Taxonomic identification based on morphological characterization, ecological assessments were performed, and paleoenvironmental analysis was conducted using POLPAL software. Hydrocarbon Maturation stages were analyzed using the thermal alteration index (TAI) under transmitted light and wavelength values (in nm) against different colors under fluorescence light. The ecological information of identified 43 species from different depths of the well indicates a fresh to brackish water marshy-estuarine environment, transitioning to a tidal flat, mangrove swamp, and terrestrial floodplain under humid climatic conditions. Evidence of grazing mammals at depths of 2593.21 m to 2593.23 m and 2591.95 m to 2591.98 m, along with high herbaceous plant production at 2591.52 m to 2591.55 m, influenced by monsoon rains, suggests a dynamic environment. Paleoenvironmental reconstruction points to a shallow marine to fluvial-deltaic system with shoreline regression and emerging mangrove swamps. Hydrocarbon maturation analysis revealed that most palynomorphs are in the "immature to mature the main phase of liquid petroleum generation", with a temperature range of 60 °C to 100 °C, capable of producing both oil and gas. Using the Thermal Alteration Index (TAI) and fluorescence microscopy, thermal maturity assessments indicated a range from early dry gas to wet gas and condensate stages, corresponding to diagenesis to katagenesis stages. The variation in maturation suggests uneven temperature and pressure across the strata. The thermal maturity analysis of most miospores suggests that the strata function as a local hydrocarbon generation source. The findings highlight the potential of reservoir rocks for local hydrocarbon generation and provide a basis for improving resource identification techniques.

Keywords: Palynomorph, Diatom, Paleoenvironment, Hydrocarbon maturation, Reservoir rocks, Biological paleothermometers.

Petrography and Mineral Chemistry of Padma River Bar Sediments: Implications for Provenance and Petrogenesis

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Abstract

Bangladesh is a riverine country, and most of the rivers originated from the Greater Himalaya, which derives about trillion tonnes of sediment over the years. The present investigation deals with grain size distributions, petrography, and the potentiality of heavy minerals in the Padma River bar sediments of Chapainawabganj, Rajshahi, and Rajabari in Bangladesh. The study also explores the mineral chemistry of detrital heavy and light minerals like amphibole, biotite, plagioclase, rutile, zircon, magnetite, etc. The main goal of this study is to ascertain their provenance and petrogenesis. Primarily, the bar sediments are mostly fine-grained and moderately sorted, containing 65% moderate to fine-grained, 20-30% moderate to coarse-grained, and 10-15% fine-grained, suggesting a predominantly fluvial condition. Petrographic data indicate that quartz was the most common detrital, accounting for 78% of the total sediment components, whereas feldspar was the second most prevalent element, followed by lithic fragments and mica accounting for 1.9%, 2.2% and 1.5%, respectively. Based on the QMF diagram, the Padma River sediment, primarily composed of 90% quartz arenite, partly subarkose, and sublitharenite, is derived from a metamorphic origin mixed with a plutonic source. The sediments are mostly composed of non-strained and polycrystalline quartz, indicating a stable cratonic and transitional continental block tectonic setting. The mineral chemistry of biotites shows primarily Fe^{2+} biotites and some Mg-biotites, moreover, low TiO_2 and high Al_2O_3 indicate felsic source rocks derived at shallow crustal depths. Biotite primarily includes annites and siderophyllitic types, which disintegrated from alkaline anorogenic and peraluminous suites. The oxygen fugacity of biotite indicates a mafic source, with a value between -13.1 to -15.8 within 810-930 °C temperature. The amphibole of the bar sediment is mostly edenite, with some magnesiohastingsite types. Andesine makes up 36 to 62% of plagioclase at moderate to low temperatures, indicating intermediate dioritic sources. Geothermometric data also suggest an intermediate origin calculating temperature range of 689-714 °C.

Keywords: Petrogenesis, Provenance, Mineral chemistry, Padma River, Bar sediment, Geothermometer.

Textural and Petrographic Characterization and Distribution of Heavy Minerals in Sand Deposits of the Teesta River, Bangladesh

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Abstract

The Teesta River, originating in the Higher Himalayas, flows through India and Bangladesh, transporting substantial sediment loads to the Brahmaputra-Jamuna River. This study focuses on the sand deposits of the Teesta River, with an emphasis on heavy mineral concentrations within sand bars. Understanding depositional characteristics and heavy mineral concentrations is essential for reconstructing sediment provenance, assessing resource potential, and evaluating environmental changes within the dynamic fluvial system of the Teesta River. Surface and subsurface samples, collected from exposed bars and boreholes up to 30 m depth, were analyzed for textural and mineralogical characteristics. Textural and petrographic analyses were conducted using granulometric (sieve) analysis, heavy mineral separation with bromoform (s.g. 2.9), and thin-section microscopy. The sand deposits are classified into seven lithofacies: Massive Sand (Sm), Trough Cross-Stratified Sand (St), Planar Cross-Stratified Sand (Sp), Ripple Cross-Laminated Sand (Sr), Parallel Laminated Sand (Sh), Massive Clay (Fm), and Laminated Clay (Fl). These facies reflect a fining-upward sequence, with coarser sediments deposited during low-energy dry seasons and finer sediments during flood phases. Textural analysis reveals that the sands are predominantly fine-grained, moderately well-sorted to well-sorted, and positively skewed, suggesting deposition in low to medium-energy environments. The sands, primarily bedload deposits, exhibit transport mechanisms ranging from rolling and suspension to graded suspension. The compositional analysis identifies the sands as Sub-Litharenitic to Feldspathic Litharenitic, with abundant quartz (59.5%), minor lithic grains (10.9%), and feldspars (7.5%), along with significant mica content (10.9%). Heavy mineral analysis indicates an average concentration of 9.8%, dominated by amphibole (41.2%), garnet (17.1%), epidote (13.4%), and opaque minerals (7.2%). The provenance analysis points out that the Teesta River sediments originated from weathering and erosion of mainly sedimentary–metasedimentary recycled sources in tropical humid to sub-humid climatic regions, primarily from the Higher Himalayas, with contributions from the Lesser Himalayan Orogen. These findings enhance our understanding of sediment dynamics, resource potential, and paleoclimatic conditions, supporting sustainable resource management and climate resilience strategies for the Teesta River basin.

Keywords: Heavy mineral, Lithofacies, Paleoclimate, Provenance, Sedimentary processes, Teesta River.

Gem-Quality Minerals Investigation from Placer Gravel Deposits in Panchagarh District, Bangladesh: Implications of Potential Sources and Links to Pleistocene Glaciations

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Abstract

This study presents the findings from an investigation into gems and gem-quality minerals, along with their lithostratigraphy and river gravel deposit study in the Panchagarh District, Bangladesh. It also discusses the main causes and characteristics of depositional landforms and the transportation of sediments. A detailed gravel-rich zoning map was prepared to support the investigations, illustrating the relative abundance of gravels, and tracing possible gemstones, and gem-quality minerals-rich areas. The study area consists of two main lithostratigraphic units: older gravel beds and recent alluvial sediments. The gravel beds are predominantly Type-II outwash deposits, primarily composed of drainage from ice-dammed or subglacial lakes, known as glacial lake outburst floods (GLOFs) linked to Pleistocene glaciation, originating from the Himalayas. The main rock types of the gravels, based on minerals and mineral assemblages, are garnet-biotite-plagioclase gneiss, sillimanite/ kyanite-plagioclase-muscovite gneiss, quartzite, hornblende-plagioclase gneiss, phyllite, migmatite, granite or diorite porphyries, etc. In these rocks, several mineral assemblages are present and these minerals are amphibole, plagioclase, biotite, muscovite, quartz, garnet, sillimanite/kyanite, clinopyroxene etc. Notably, these Type-II outwash deposits contain few gemstones and gem-quality minerals. Additionally, recent river thalwegs in the Mahananda, Korotoya, and Dahuk rivers also show evidence of gem or gem-quality minerals upon preliminary observation. Primarily, several gem polymorphs of silica or quartz have been identified in the study area, including agate, purple grape agate, rose quartz, milk quartz, carnelian (a variety of chalcedony), moss agate, citrine, as well as other gemstone varieties like aventurine, decorative migmatite pieces, epidote, corundum, and spinel. Finally, the primary source of the Type-II outwash (colluvial or alluvial placer deposits) and the gem-quality minerals is the Himalayan orogenic sequence. Overall characteristics of the studied out-wash gravels suggest that most of the rocks in the study area are very similar to the High Himalayan Crystalline Complex in the Sikkim Himalaya of Sikkim-Darjeeling section.

Keywords: Gemstone, Gem-quality minerals, Placer gravel deposits, Glacial lake outburst floods (GLOFs), Type-II outwash, Pleistocene glaciation, Bangladesh.

Integrated Evaluations of the Changing Subsurface Lithology in the Surrounding of Rajshahi City Corporation and Adjoining Padma River Bar Sediments: Constraint to Chemical, Mineralogical and Radiological Characteristics

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Abstract

The current research focuses on the subsurface lithological changes and their mineralogical, geochemical and radiological characteristics evaluation of the Rajshahi City Corporation area with adjacent Padma River bar sediments (no. of samples, n= 20). For the accomplishment of the research, several laboratory analyses, for example–lithofacies analysis, heavy mineral separation, petrography (microscopy) and radiometric analysis (HPGe gamma spectrometry) have been carried out accordingly. Subsurface lithological data (studied borelogs and collected borehole samples; BH=1, from depth 3 m to 80 m) discloses a mixture of clay, sand and gravelly sand facies, representing a dynamic fluvial depositional condition. The petrographic value of the determined subsurface sediments reveals that quartz (47.0–53.3%), K-feldspar (13.0–16.2%), plagioclase (5.8–8.1%) and a considerable amount of mica, amphibole, lithic fragments and some heavy minerals. The mean abundance of heavy minerals is of garnet (avg. 18.1%) as the dominant heavy mineral, with a notable amount of magnetite (avg. 14.4%), ilmenite (avg. 10.0%), hornblende (avg. 9.6%), tourmaline (avg. 3.2%), epidote (avg. 6.5%), rutile (avg. 3.6%), etc. However, bar sediments are rich in zircon, apatite, sillimanite, staurolite etc. but scarce in subsurface sediments. The findings also reveal that bar sediments show high SiO_2 and Al_2O_3 variations (59.24–73.44 wt.%, 10.39–15.25 wt%) indicate quartz and aluminosilicate dominance and primarily depicts sediment types such as- arkose, lithic arkose, sub-arkose and litharenite deriving from the tectonically active mountain belts, transitional continental and recycled orogenic set up. The CIA, ICV and PIA values show a low degree of maturity, weak or limited chemical weathering intensity in source areas and derived from felsic to intermediate rock provenance. The radiochemical indices of bar sediments from the Padma River show slightly elevated values of Ra_{eq}, H_{ex}, H_{in}, D, I_γ, and AUI are 229.5 $Bqkg^{-1}$, 0.62, 0.79, 103.44, 1.64 and 1.73, respectively, which are mostly within safe radiological limits. The risk assessment results reflect that the NORMs in the measured samples currently do not pose any threat to human health. Thus, the information may help to perform more stringent environmental monitoring programs in the eco-environmental system by the relevant regulatory authorities.

Keywords: Lithology, Petrography, Heavy minerals, Radiochemical Indices, HPGe Gamma Spectrometry.

Provenance and Tectonic Implications of the Oligocene Barail Group Sandstones from the Sylhet Trough, Bengal Basin: Constraints from Petrography and Major Element Geochemistry

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Abstract

The origin and tectonic context of Oligocene sediments in the Bengal Basin remain poorly understood. This study examines the framework mineralogy and major element geochemistry of the Barail Group sandstones from the Sylhet Trough to shed light on the provenance and tectonic evolution during the Oligocene. Modal analysis ($Q_{83}F_7L_{10}$) and geochemical data classify the sandstones as sublitharenite to subarkose, with some samples displaying Fe-enrichment. The heavy mineral assemblage predominantly consists of opaque minerals, followed by ultrastable minerals (zircon, tourmaline, and rutile). The sub-angular to sub-rounded sand grains and their moderately mature composition suggests deposition close to the source area. Provenance discrimination diagrams highlight contributions from felsic igneous, sedimentary/metasedimentary, and low-grade metamorphic sources, with detritus primarily originating from the Indian craton and proto-Himalayan region. The petrographic and geochemical evidence suggests moderate to intense chemical weathering, low-relief landscape, and sub-humid to humid climate in the source area. Tectonic analyses reveal that the Bengal Basin transitioned from a predominantly passive margin to an active tectonic margin setting during the Oligocene. These findings enhance our understanding of the depositional environment, provenance, and tectonic evolution of the Bengal Basin during the Early history of the Himalayan uplift.

Keywords: Geochemistry, Petrography, Provenance, Tectonic setting, Bengal Basin.

Improving Insights in Petrophysics Using Geophysical Data for the Habiganj Structure, Surma Basin, Bangladesh

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Abstract

The Habiganj gas field is one of the largest gas fields in Bangladesh, however, very few analyses have been conducted on it. A study based on gravity and magnetic data of the Habiganj Gas Field, and its adjoining areas has been carried out to delineate the structure and infer the general geology of the region. This study primarily encompasses formation evaluation and determination of petrophysical parameters of the gas-bearing zones in Habiganj Well No. 11 (HB #11). As a result of detailed interpretation of various wireline logs of this well and using the cross-plots of logs, it is evident that there are two hydrocarbon (HC) bearing zones in this field. The computed averages of shale volume, porosity, permeability, and gas and water saturation have been used to determine the reservoir interval pay zone, net thickness, gross thickness, net-to-gross ratio, bulk volume of water, pore thickness, and hydrocarbon pore thickness.

Keywords: Fluid contacts, Geophysical data, Habiganj gas field, HB #11, Hydrocarbon, Reservoir.

3D Modeling in Geoscience: A Tool for Unveiling Near-Surface Depositional History in Faridpur, Satkhira, Barishal and Khulna Town and Surroundings

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Abstract

3D modeling in geoscience is a powerful tool for visualizing complex surface and subsurface features, geological sequences, enhancing the understanding of the sedimentation process and the geotechnical properties of sediments. Near-reality 3D representations can be created to study subsurface conditions by integrating geological, geotechnical, and geospatial data. Four 3D geological models were developed for four different cities Faridpur, Satkhira, Barishal and Khulna towns and surroundings, focusing on engineering geological study for spatial urban development planning. These areas, characterized by complex fluvial-deltaic systems, provide insights into subsurface structures and sediment dynamics. A geostatistical approach using 3D indicator kriging was employed to generate litho-depositional models. Each layer is assigned to sediment cluster IDs for a second round of unit-wise 3D indicator kriging. Statistical analysis of geotechnical data such as sand, silt, and clay percentages, SPT-N values, litho-coarseness curves, core photographs, and geomorphological features serves as the primary data for the study. Using Subsurface Viewer software, a 3D lithological 100x100x0.50-meter voxel model was created to visualize sedimentary sequence changes, identify sediment-type clusters, and track depositional stages from younger to older sediments. Thickness maps with color gradients of the models illustrate sediment accumulation (green) and low deposition (yellow to red). The lithological analysis, which includes these thickness maps, revealed distinct depositional patterns. In Faridpur, there is a dominance of sandy sediments, suggesting the presence of high-energy flow systems; In Satkhira, the trend of increasingly coarser sediments toward greater depths, reflecting a mixed depositional environment; in Barishal clayey silt sediment replaces sandy silt, indicating lower deposition energy conditions; and abundance of sandy silt at greater depths in Khulna, highlighting sediment transport variability in deltaic systems. This modeling technique enables geoscientists, and decision-makers, including those without a geoscience background, to effectively assess geospatial data. Moreover, it assists geoscientists in exploring subsurface conditions related to groundwater quality, pollution, and predicting paleo-floods, etc.

Keywords: 3D indicator kriging, Geostatistical approach, GeoUPAC, Litho-coarseness curves, Core photographs, Voxel models, Subsurface viewer software.

Gravity and Magnetic Investigations in the Highest Positive Gravity Anomaly in Bangladesh at Chapai Nawabganj and Naogaon Districts

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Abstract

The Bouguer gravity anomaly value of Bangladesh ranges between -179 and +11 mGal throughout the country and the most positive anomaly values are found in Nachole, Gomastapur, Niamatpur and Porsha areas of Chapai Nawabganj and Naogaon Districts. Tectonically, this area is part of the Rangpur Platform and assumed as an eastward extension of Malda gravity high from West Bengal. To delineate the subsurface geological features, significant local anomalies and to suggest prospective areas for future exploration, land-based regional scale gravity and magnetic surveys were carried out by GSB in January 2019 in this area. Data were collected covering an area of about 300 sq. km from 203 observation points at about 1 to 1.5 km intervals in a square grid sampling pattern. The acquired data were subsequently processed digitally, and relevant corrections were applied to achieve Bouguer gravity and magnetic anomalies. A polynomial fitting technique was used to separate the residual anomalies to obtain the near-surface anomalies. Analysis of the slope percentage of the residual gravity and magnetic anomaly values was done to enhance the linearity of the subsurface features. Seven profiles were drawn from gravity and magnetic data to get a view of probable subsurface structural settings. Processed gravity and magnetic data were qualitatively interpreted to delineate the subsurface structures. In general, half-elliptical, dome-shaped east to west stretched, high regional gravity values are observed in the middle part of the survey area, which dips towards both the north and south directions. Total regional gravity relief is 21 mGal with a minimum value of -4.64 mGal and a maximum of +16.44 mGal. Magnetic anomaly relief of the surveyed area is 693 gamma, which ranges between +246 gammas to -447 gammas. The residual gravity anomaly shows waves with high and low values trending north-south directions and multiple closures of high and low values. Residual magnetic anomalies decipher local positive and negative magnetic areas with a few wide areas of negative anomaly in the central and in the northern parts four prominent and discrete negative magnetic anomalies are found where gravity values are high. Shapes of these anomalies are closed circular to elliptical and indicate the probable presence of different mineralization within the basement.

Keywords: Gravity, Magnetic, Chapai Nawabganj, Naogaon.

Seismic Refraction Survey for Configuring the Archaean Basement Complex in Porsha, Patnitala, and Dhamoirhat Upazilas of Naogaon District, Bangladesh

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Abstract

Previous regional gravity and magnetic surveys identified a significant gravity low closure in the Ronail area, west of Patnitala upazila in Naogaon District, Bangladesh. This anomaly was interpreted as indicative of prospective Gondwana deposits. Based on this information, a seismic refraction survey was conducted to delineate the depth and configuration of the Archaean Basement Complex in the Porsha, Patnitala, and Dhamoirhat upazilas of Naogaon District. A total of 50-line kilometers were surveyed along two profiles: WNW to ESE (Profile1, 30-line kms) and NNW to SSE (Profile 2, 20-line kms). The seismic data were recorded by forward, reverse, and split shootings along each profile. Dynamite was used as the seismic source and the conventional intercept time method was applied for interpretation. The survey identified four distinct velocity zones: 1190–1375 m/s, 1775–2313 m/s, 2331–3102 m/s, and 4100–6476 m/s, corresponding to the Alluvium/Barind Clay Residuum, Upper Dupi Tila, Lower Dupi Tila, and the Archaean Basement Complex, respectively. Correlation with existing drill holes (EDH-16, EDH-18, and EDH-22) confirmed these interpretations. The depths and thicknesses of the layers vary significantly along the seismic profiles. Along Profile 1, from Juthbhabani in Dhamoirhat to Arjunpur Bhabuk in Sapahar upazila, basement depth ranges from 822 m to 1097 m, with a gentle dip towards the west. Along Profile 2, from Halakanda to Bazitpur in Patnitala upazila, basement depth ranges from 413 m to 500 m, dipping southward. These variations suggest the presence of two major NE-SW trending faults near Halakanda in Shihara union and Bazitpur in Patnitala upazila. The Archaean Basement Complex is shallowest near Halakanda in Shihara union and deepest (1097 m) near Khalna in Patnitala upazila. Additionally, low-velocity zones within the high-velocity basement zone were identified, potentially indicating fractures in the Basement Complex. These fractures may be significant for hosting various economically valuable mineral deposits.

Keyword: Gravity and magnetic survey, Gondwana deposits, Seismic refraction, Velocity zone, Archaean Basement Complex.

Application of Multi-Electrode Electrical Resistivity Tomography Survey to Delineate Aggregate Resources in Lovachara, Kanaighat, Sylhet

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Abstract

Construction aggregate resources are in high demand in Bangladesh due to the limited indigenous reserves. The country's predominantly flat alluvial terrain, composed mostly of fine sand, silt, and clay, lacks significant aggregate deposits, except in the vicinity of hilly rivers along the India-Bangladesh border. Here, strong monsoonal currents transport and deposit coarser aggregate materials annually, a process ongoing since the Holocene. The thickness of these deposits varies as the river courses continually shift, with older, coarser deposits often concealed beneath finer sediments due to geological processes. Traditional borelogs to observe the vertical extent of aggregate resource often become unfunctional through larger cobble and boulders. So, an alternate investigation tool is needed. This study highlights the applicability of Electrical Resistivity Tomography (ERT) surveys for delineating aggregate resources in the Lovachara area under Kanaighat Upazila of Sylhet, Bangladesh. The surveys were conducted along the river bed or charlands of the present course and silted-up old courses of the Lovachara River, employing six ERT profiles to investigate subsurface layers from 3 to 43 meters depth. Using a Syscal Pro setup, the surveys employed a 10-channel dipole-dipole array with 13 electrodes spaced at 15-meter intervals. Measurements progressed in 15-meter increments along profiles approximately 500 meters in length. Elevation data extracted from open-source satellite data were integrated into the ERT models to enhance spatial and vertical accuracy. The data were processed and inverted using Res2Dinv software, with optimal inversion parameters defined for the specific geological conditions of Lovachara. The resulting model sections revealed resistivity values ranging from 15 to 900 Ohm-m, with higher resistivity correlating with coarser aggregate layers such as gravel, pebbles, and cobbles, while lower resistivity values indicated finer sediments like sand. A resistivity threshold of 100 Ohm-m was identified as the boundary between sand and 'stone' deposits, providing a basis for resistivity-based characterization of aggregate layers. Geological interpretations of the ERT model sections were validated using borehole data, field observations, and information from local 'stone' workers, enhancing the reliability and robustness of the findings. The results demonstrated distinct lithological units and offered valuable insights into the distribution and quality of aggregate deposits. This research underscores the efficacy of ERT surveys as a cost-effective and environmentally friendly supplement to, and in some cases an alternative to, traditional drilling methods for aggregate resource mapping. Drilling is often impractical in areas with cobble and boulder layers, whereas ERT surveys overcome such limitations. The integration of ERT techniques with ancillary data emphasizes their potential for aggregate resource delineation, contributing to sustainable development initiatives.

Keywords: Aggregate resources, 2D ERT, Lovachara, Dipole-dipole, Inversion.

Application of Geo-Electrical Resistivity Survey and Bore Log Data for the Delineation of Hydrogeological Condition of Tala Upazila, Satkhira District

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Abstract

The rivers have played a significant role in the lives and living of people in Bangladesh. Rivers are highly sensitive to environmental condition. In the study area, like in most parts of the coastal belt, the lack of adequate fresh drinking water is an acute problem. As the surface water is saline almost throughout the year, especially in the dry months when surface water resources are dried up, ground water becomes the only alternative source of fresh water for thousands of people. The water quality of the shallow aquifers in the coastal area is poor due to salinity and arsenic contamination except in some isolated pockets. These pockets are of limited capacity. Previous hydrogeological investigations through exploratory drillings and electric loggings generated scattered information about the water quality in the shallow and deep aquifers in the coastal area. During the wet periods, the recharge of groundwater helps to mitigate this situation to an extent by diluting saline and arsenic concentration in the shallow aquifers. But the deep aquifers, which are not as much affected by the recharge by rainwater, show a more stable condition throughout the year. Eight Vertical Electrical Sounding (VES) surveys were conducted on various locations and test boring is drilled in Tentulia Village of Tala upazilla of Satkhira district. The VES data are of good quality and the interpretation of data, in conjunction with borelog data, suggests that the sequence below the topsoil is composed of clay, silty clay, silty sand and medium to fine sand alterations. The resistivity of the sandy or silty sand layer is primarily controlled by the ground water quality and sand layers showing resistivity of more than 25 Ωm indicate fresh ground water. Water samples collected from the shallow aquifer were analyzed to test multiple parameters such as arsenic, iron, manganese, pH, electrical conductivity, TDS, alkalinity, chloride, and hardness that showed higher concentration of arsenic and iron along with acceptable amount of alkalinity (Bangladesh Environmental Conservation Rules, 2023).

Keywords: Arsenic concentration, Coastal belt, Resistivity survey, Shallow aquifer, Water quality.

Subsurface Characterization of Purbachal Town, Dhaka for Seismically Hazardous Zone (Micro Zonation) Identification

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Abstract

Lithological subsurface characterization is an essential process for understanding the geological setting of an area and properties of the subsurface materials, which is crucial in infrastructural studies, and environmental studies. Dhaka is one of the most rapidly expanding cities in the world. Over the past few decades, the city has grown in every direction without properly considering subsurface information. Ground information plays a vital role in understanding and visualizing the spatial distribution of sub-surface conditions. This study aims to improve understanding of Purbachal Town in Dhaka through subsurface analysis and area zoning with the help of lithologic data and continuous (top and base) subsurface modeling for the target stratigraphic formations. Lithologic data were collected from drilling boreholes by Standard Penetration Test (SPT) at 30 m to 70 m depth below surface. The subsurface lithology helps in predicting how seismic waves will travel through different materials, which is crucial for assessing earthquake hazards and designing earthquake-resistant structures. This study compares and contrasts the features of cross-section-based and borehole-based (3D and 2D) modeling. Subsurface modeling were generated from lithologic cross sections using Rockworks 17 software by lithoblending interpolation algorithm method and ESRI ArcGIS 10.4 for processing spatial analyses. Through 3D modeling, it is possible to evaluate the distribution of rocks and soil, both in space and time. This present research illustrates the results of 2D and 3D surface to subsurface modelling within the boundaries of Purbachal Town of Dhaka city. The results highlight the various subsurface layering distributions, potential hazardous zone distributions, and the direction of future studies. Study analysis reveals that the northwest, southwest, and northeast corners of the Purbachal area are vulnerable to different geological hazards and these areas may not be suitable for construction works. This subsurface characterization may help to reduce construction risk as well as ensure climate-resilient city developmentin the project area. This output might help the local authorities, planners, decision makers and stakeholders to make proper decisions for sustainable urban planning in and around Purbachal area and utilization of the spatial data in infrastructure platform.

Keywords: Subsurface lithology, 3D modeling, Sustainable urban planning

Review of the Geophysical Explorations Activities of GSB in the North-Western Part of Bangladesh

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Abstract

The geophysical exploration works of Geological Survey of Bangladesh (GSB) for the investigations of economic minerals are mainly concentrated in the northwestern part of Bangladesh. This review-based research summarizes the geophysical exploration activities in the northwestern part of the country up to 2023 and, for the first time, spatial area coverage maps of these geophysical exploration activities have been prepared as planning information to help future geophysical exploration activities. Generally, geophysical exploration begins with the regional scale gravity and magnetic surveys, which are followed by the detailed scale gravity and magnetic survey, seismic refraction or reflection and electrical methods. In GSB, a regional scale airborne magnetic survey with 5 km interval comprised of 61,916 line km was done in 1979-80, covering the whole country except the Chittagong Hill tracts. The study found that after independence, land-based regional gravity and magnetic surveys cover about 8779 sq. km in the north-western part of the country. Out of this, only 1024 sq. km has been covered by the detailed scale survey, seismic surveys cover about 2818 sq. km and the electrical surveys cover about 195 sq. km. For wire line geophysical logging, estimation of total logging length is difficult as different geophysical logging sondes have covered different depths in the same drill hole. From the spatial map, it is observable that significant areas that are identified as prospective on a regional scale are not yet covered by any detailed scale surveys; especially west of Shymnagar, west of Phulbari, north of Dinajpur-Parbatipur and east of Mithapukur need further attention. Identified mafic dyke also deserves exploration for future mineral prospects. It is also necessary to expand the exploration area to the shallow shield (depth 0.5 km) and, after that, expansion is required to spatially cover up to 1.5 km depth.

Keywords: Geophysical exploration, northwestern Bangladesh.

UAV Application and Satellite Image Analysis in Placer Mineral Exploration at Coastal Deposits of Cox's Bazar, Bangladesh

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Abstract

Unmanned Aerial Vehicle (UAV), commonly known as drone, and satellite images were utilized during the physical reassessment of coastal heavy mineral deposits at Cox's Bazar area, southeast Bangladesh. The objective of the assessment survey was to evaluate the conditions of the placer deposits and recommend for future programs aimed at the commercialization of heavy minerals. Existing deposit maps were updated by combining old analog maps with present-day satellite images. Outlines of the existing deposit maps were demarcated from the geological field works. The old-sketched maps were digitized with the help of satellite imageries using Google Maps and Google Earth Pro which was processed by ArcGIS software and then verified with the field survey data. Consequently, aerial images were taken using drones at existing and recent depositional areas to observe the present land use scenario of the areas in a short time. Detailed orthomosaic maps of survey areas were prepared from the aerial photos, which provided a clear pictorial view of the deposits. From these satellite and drone image analyses, land cover areas were calculated for the individual deposits. The physical assessment survey showed significant reduction in heavy mineral reserves from the previous estimation. However, deposits in certain areas appear to be recoverable, which can be considered for future exploration. A recently-developed mineralization zone was found in the foreshore areas along with new areas at offshore islands deemed promising considering the average heavy mineral concentration more than existing deposits. The geospatial techniques confirm that the Cox's Bazar coastal areas are still promising for heavy mineral prospect considering their radioactivity and rare earth element content. However, more detail and systematic survey are needed in order to reassess the old and new mineralization zones and their reserves using advanced drilling technologies, geophysical survey, UAV and satellite image analysis.

Keywords: Physical reassessment, Geospatial techniques, Orthomosaic maps, Heavy minerals, Radioactivity.

Assessing Ground Subsidence Risk in Dhaka City and its Surrounding Areas, Bangladesh: Insights from Multi-Temporal InSAR Technique

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Abstract

Rapid urbanization and industrial growth in Dhaka City have led to extensive groundwater extraction, significantly depleting aquifers. This overexploitation, coupled with soil compaction and the weight of burgeoning infrastructure, has induced substantial land subsidence. This study focuses on spatiotemporal patterns of ground deformation across the metropolitan area and its surroundings, using Differential Interferometric Synthetic Aperture Radar (DInSAR) and Persistent Scatterer Interferometric Synthetic Aperture Radar (PS InSAR) methodologies. This research leverages the PS-InSAR time series by utilizing multiple SAR images (Sentinel-1) acquired over the same area during the period spanning from 2020 to 2023. Analysis of time-series deformation was conducted using 121 Sentinel-1 SAR images and SRTM (30 m resolution) digital elevation model data served as the reference for adjusting the residual phase. The highest rate of subsidence is experienced in reclaimed land, which is composed of loose sand, silt, and clay materials. Many low-lying areas are reclaimed for industrial development and urbanization. Five major PS clusters have been identified as subsiding areas with deformation rates varying from -1 cm/year to ≤ -2.5 cm/year along the radar line of sight (LOS). In some places, the subsidence rate reached up to 50 mm/year. The results have unveiled a significant control on land subsidence by the geomorphology of the study area. Landforms such as natural levees, point bars, back swamps etc., were found to be more susceptible to land subsidence. The substantial subsidence observed in certain areas necessitates proactive measures to mitigate potential damage to critical infrastructure. The high accuracy and reliability of DInSAR and PS-InSAR results provide invaluable insights to the decision-makers, enabling the development of effective strategies for disaster mitigation and sustainable urban planning.

Keywords: DInSAR, PS InSAR, Land Subsidence, Geology, Geomorphology, Disaster.

Relation Between Development and Land Use Land Cover Changes and Its Impact on Surface Temperature

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Abstract

Development and urbanization are inevitable phenomena, especially in rapidly economically advancing countries like Bangladesh and have a substantial impact on changing the surface temperature. The research attempts to find the relationship between land use land cover changes and land surface temperature and the probable reasons for these changes during the period 2000 to 2020 employing GIS and remote sensing techniques with Landsat 5 (TM), 7 (ETM+) and 8 (OLI/TIRS) satellite imagery. The kappa coefficient ranges from 0.80 to 0.90, indicating the satisfactory accuracy of the work. Urbanization increased overwhelmingly in the area, enlarging from 14.77 km^2 in 2000 to 61.32 km^2 in 2020, showing a rise in the study period more than 4 times. The agricultural land was lowered by around 2.5 times during the same period. The overall land surface temperature implies an increasing trend from 22.82 °C to 28.30 °C i.e., approximately an increase of 6 °C in the research period. Hence, policymakers and stakeholders can consider the consequences of the research to realize the current development scenario and rethink their verdicts to make the country suitable and more habitable for future generations.

Keywords: Development, GIS, Remote sensing, Land surface temperature, Land use land cover, Urbanization.

Detection of Spatio-Temporal Changes in the Jamuna River at Sonatola Upazila, Bogura District

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Abstract

The Jamuna River plays an important role in the livelihood and socio-economic activities of the inhabitants of Sonatola Upazila, which is located on its right bank. Riverbank shifting is a common problem in this area. This study evaluates the spatiotemporal variation of the lateral channel shifting over the past 66 years using Remote Sensing and GIS techniques, followed by field verification. Between 1956 and 2022, the Jamuna River has significantly changed its course, shifting from east to west. It is estimated that a total area of 74.29 km^2 was engulfed by the river during this period, with an average rate of 2.31 km^2/year. The most substantial land engulfed occurred between 1990 and 1995. The average rate of shifting in the right bank of the Jamuna River in the upazila is 48.03 meters/year, with a minimum shifting rate of 24.24 meters/year. Morphodynamics analyses from 1956 to 2022 indicate that the old bar, newly accreted bar, and the river's flow path have continuously changed, and sometimes abruptly. The research is expected to have practical implications for stakeholders responsible for river management, including environmental regulators, engineers, and policy-makers. The outcomes of this study can be used to develop effective strategies for mitigating the impact of river movements on infrastructure, property, and human life.

Keywords: Accretion, Erosion, Channel shifting, GIS, Remote sensing.

Characteristics of River Morphology and Bottom Topography Around the Padma Multipurpose Bridge sSite

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Abstract

The Padma Multipurpose Bridge on the Padma River connects the southwestern part of Bangladesh with the capital city, Dhaka. The 6.15-km bridge stretches from Mawa on the left bank to the Jajira on the right bank of the river. The location is very dynamic, as it receives the combined discharge and sedimentation from both the Padma and Jamuna Rivers. The aim of this study is to assess the decadal suface morphological changes around the bridge site using multi-temporal satellite imagery (2000-2023). At the same time, the study aims to identify the bottom topographic characteristics around the bridge site by comparing the cross-section of the year 2000 and 2023. The surface morphological analysis indicates that around the bridge site, the river is very dynamic and lateral bars are formed around both banks. However, the sedimentation is more profound at the right bank. Although surficial morphology detects only bank adjacent lateral bars, the bottom topographic analysis indicates that this part of the river has several submerged bars and the bottom profile more resembles a braided river. The cross-section study indicates that at least four active channels are present around the bridge sites separated by submerged and exposed bars. The analysis suggests that the overall channel depth has reduced in the last two decades, and it is different for each thalweg. The amount of channel depth reduction ranges from 0 to 7 meters. In the year 2023, a new deep channel was observed in the middle of the river, approximately 6 km from the left bank, and it is probably formed due to dredging around the bridge site. In summary, it can be stated that although the Padma River appears to be a meandering river around the bridge site, but its bathymetry suggests that actually it is a multi-threaded channel, separated by submerged bars which is similar to the profile of a braided river.

Keywords: Bottom topography, Change detection, Cross section, Padma River, Padma Multipurpose Bridge, River morphology.

Geospatial Monitoring of Land Cover Transformation in Char Kukri Mukri: Implications for Coastal Sustainability

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Abstract

Geospatial analysis has become very imperative in planning for sustainable development, especially in vulnerable coastal areas like Bangladesh. This study analyzes changes in land use and land cover (LULC) of Char Kukri Mukri, an island in Bhola District on the coast, over the period from 1973 to 2020 using remote sensing and GIS techniques. The research analyzes satellite-derived data in order to classify and quantify changes in three major land cover categories: forest, cropland, and wetland. The results show a rapid expansion of forest cover, dynamic changes in cropland, and a sustained loss of wetlands driven by anthropogenic activities and climate change. This study uses the linear regression model for projecting the trend of LULC up to 2040, revealing possible wetland shrinkage and future land-use changes. The present study has focused on the critical role that geospatial technologies play in assessing long-term environmental changes that could lead to sustainable land management policies. This study does indeed provide very important insights on the drivers of land change by integrating multi-temporal remote sensing data with predictive modeling, hence helping policymakers and stakeholders in the development of strategies for coastal resilience and environmental conservation. The necessary sustainable planning measures to mitigate adverse impacts include afforestation initiatives and wetland protection programs to ensure a balanced land use in the region. This contributes to the wider theme of geospatial analysis and its application in sustainable development planning. Much emphasis is placed on data-driven decision-making for the management of fragile coastal ecosystems, where land change can have substantial impacts on biodiversity, agriculture, and human settlements. This will be very instrumental as a reference for future studies focusing on climate resilience and land-use optimization in Bangladesh and other deltaic environments.

Keywords: LULC, Climate resilience, Sustainable planning

Ground Subsidence Study of Faridpur Town and Surrounding Area Using RADAR InSAR for Sustainable Spatial Urban Planning and Development

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Abstract

Faridpur is an important town in the south-central part of Bangladesh that is expanding rapidly. Geologically, it comprises Recent Floodplain deposits composed of a mixture of unconsolidated, very soft to medium-hard sand, silt and clay sediments. Geomorpohologically, the area is included in Floodplain, Marsh, Natural Levee and Abandoned Channel units. This research work is based on RADAR InSAR image analysis to study the ground subsidence of Faridpur town and surroundings. Persistent Scatterer Interferometry (PSI) methods were used in this ground motion study. The goal of the research is to assess ground subsidence of the study area. A total of 323 ascending and descending Sentinel-1 satellite images from 2014 to 2019 were used for the analysis. Envi SARScape Analytics, Python, and QGIS software were used for image processing, data analysis, and result calculation. The PSI result shows that the ground subsidence ranges from -13.63 mm/year to + 3.98 mm/year, having a mean value of -0.63 mm/year. The negative mean value indicates that the overall trend is slow ground subsidence. Besides, north-eastern and south-western parts are more vulnerable to ground subsidence. These results and geo-information are very important to urban planners, development authorities and decision-makers in ensuring future sustainable infrastructure development and spatial urban planning.

Keywords: Ascending, Descending, Deformation, InSAR, PSI, Sentinel-1.

Development of Land Use Suitability Map of Faridpur Town Area for Spatial Urban Development Planning Using GIS and Multi-Criteria Analysis of Geo-Factors

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Abstract

A Land Use Suitability Map is a type of thematic map used in spatial urban and development planning, civil engineering and environmental management to identify the most suitable locations for infrastructure and sustainable land use management. This study addresses an efficient methodology to create a land use suitability map, combining GIS with Multi-Criteria Analysis (MCA) for optimal infrastructure sites considering multiple geo-factors. Geo-factor maps integrate geospatial data by applying GIS-based weighted overlay analysis to generate suitability scores. A multi-step approach using geomorphic map, 30 m depth SPT-N values, soil geotechnical properties, PS logging, and image analysis data was employed for the calculation of foundation suitability maps. These included parameters such as bearing capacity, local PGA map, seismic soil class, liquefaction, inundation, and subsidence as spatial geodata input. Each geo-factor is normalized to a 0-1 scale for uniform comparison and classified as "high," "moderate," and "low". The maps are combined using a weighted linear approach on a grid cell basis to calculate the Building ground Suitability Index (BSI). Geo-factor weights are assigned using the Analytical Hierarchy Process (AHP), which determines their importance for ground suitability, with parameter class weights ranging from 0 to 1. The study area is characterized by moderate to high foundation suitability and low earthquake hazard in most of the area. However, a significant portion of the area shows high inundation potential and moderate subsidence trends. The resulting map is classified into five suitability classes, I to V, with BSI > 0.8, BSI 0.8 - 0.6, BSI 0.6 - 0.4, BSI 0.4 - 0.2, and BSI < 0.2, respectively. Approximately 44% of the area (Class II) is considered highly suitable for industrial, residential, and commercial uses. Conversely, Class V area is more susceptible to seismic hazards, ground subsidence, and inundation, posing risks for development. Input from other stakeholders can improve MCA and help achieve specific goals. This benefits urban planners, developers, policymakers, researchers, and the public. The study highlights the usefulness of geospatial data-driven decision-making for spatial land use and development planning.

Keywords: Analytical Hierarchy Process (AHP), Building ground Suitability Index (BSI), Geo-factors, Multi-Criteria Analysis (MCA), Land Use Suitability Map.

Development of Vertical Offshore Reference Frame (VORF) for Precise Geospatial Analysis in Maritime Areas of Bangladesh

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Abstract

Seamless integration of hydrographic and topographic datasets is essential for geospatial planning and analysis, especially in coastal and shallow offshore areas. In Bangladesh, the lack of a VORF poses significant challenges to coastal zone management, maritime engineering, hydrographic surveying, and disaster preparedness. Hydrographic and topographic data are collected using different methods and referenced to various vertical datums. While land-based vertical positions are relatively straightforward to define using gravity-based measurements realised by levelling networks related to the MSL measurement at the reference tide gauge, hydrographic measurements are more complex. Vertical positions at sea are often referenced to diverse tidal datums, each with unique applications and relationships. The non-linear relationships among these datums necessitate a unified reference system. VORF is a unified framework, consisting of a set of mathematical models to transform datasets between different tidal datums, establishing their relationship with the reference ellipsoid. However, developing an accurate vertical reference frame is a complex endeavour. This paper underscores the critical requirement of VORF framework in the Bangladesh context. It reviews the established frameworks such as the UK's VORF, USA's VDatum, France's Bathyelli, and Canada's approaches, drawing lessons to suggest a methodology to develop the framework for Bangladesh. The methodology involves the integration of various data sources, including tide gauge observations, offshore tidal observations, hydrodynamic tidal modelling, satellite altimetry, geoid model, and geodetic measurements. It will be necessary to use a combination of gridded surface modelling and geospatial interpolation techniques to develop transformation models between different tidal datums. Additionally, a validation process is to be conducted using ground-truth observations to ensure accuracy and consistency. The primary obstacle to developing this framework lies in effectively modelling and integrating datasets. This paper also evaluates the challenges in developing the VORF model for Bangladesh and possible solutions to mitigate inherent challenges, enabling sustainable development and improved geospatial analysis in Bangladesh's maritime domain.

Keywords: Geospatial analysis, Hydrodynamic modelling, Hydrographic surveying, Satellite altimetry, Tidal datums, VORF.

Pondering Over Geoscientific Writing and Geoscience Writing

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Abstract

Tertiary-Quaternary sedimentary geodiversity constitutes Bangladesh, and provided opportunities for water, food, shelter, and security that have attracted humans for thousands of years. Complex and dynamic tectono-geophysical characteristics, climate change threats, and huge population make the country unique in the world. Geoscientists of the country have been contributing to the development for the nation through their research and actions in discovery, extraction, and management of energy, minerals, and water resources, which are driving forces of civilization and essential for security and survival. Their research findings are communicated to global geoscientists' community through peer reviewed journals, and the importance of geoscientific writings is undeniable. However, over time people's needs changed to food and water security, shelter (urbanization, waste management, coastal zone management) and health safety; people's security; environmental and ecological protection; climate resilience; geohazard mitigation, societal and economic relevance to oceans. In reality, continuous threat and pressure on our geo-resources, ecology and environment from global climate change and its consequences, regional tectono-geophysical dynamics, population growth and their changing mindsets, and pollution make the situation complex. Moreover, with technological advancement new challenges viz. need for critical minerals/rare earth metals, low-carbon and renewable emergy for energy transition, big data and AI, are emerging. For sustainable development geoscientists alone cannot meet these demands and tackle the challenges. People's participation and co-operation from others like social scientists, engineers, policy and decision makers are certainly required. Hence, geological information and knowledge (geo-facts) should be communicated as geoscience writings (geo-communication) to the public and policymakers, beyond professional communities, in an understandable language. Translating geoscientific knowledge for them is crucial. Geo-facts may include the benefits and wise management of geo-resources, human-earth system interactions, anthropogenic disturbance to Earth's processes and consequences, preservation of the natural environment, detrimental impacts of unplanned land use, people's participation in geohazard mitigation, new knowledge to improve the quality of lives and society.

Keywords: Bangladesh, Geoscientific writing, Geoscience writing, Climate change, Sustainable development.

Integrating Geoethics and Interdisciplinary Strategies: Advancing Resilience and Sustainable Development of Bangladesh

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Abstract

To promote resilience and sustainable development in developing countries, it is essential to consider an interdisciplinary approach that thoughtfully integrates the expertise of geologists and other professionals like engineers, economists, urban planners, policymakers, etc. We can address the intricate challenges associated with some national issues like environmental degradation, pollution control, soil erosion, water scarcity, sustaining roads and highways, megastructures, river basin management, mineral exploration etc., by encouraging meaningful collaboration among these professionals and also supporting practices towards the net zero. Engineers build structures with their valuable solutions, while geologists can offer crucial insights into the present earth's processes and materials. The longevity and effectiveness of structures can be enhanced by considering the local geological settings and geo-information. For successful resource management and disaster risk reduction, a comprehensive understanding of geological contexts is very vital. This knowledge can help identify potential impacts on local geo-environments, thereby guiding the implementation of strategies that protect communities and their natural habitats. For mineral economics and energy policy, the knowledge of economics and diplomacy is essential for having an impactful signature. Without an interdisciplinary, holistic approach and cooperating conditions, we cannot overcome the challenges of Climate Change and Energy Transition issues alone. Geologists can date samples and provide insights into floodplain paleo-depositional conditions and strata. By coming together in a cooperative spirit, we can create resilient societies better prepared to navigate the uncertainties of a changing world. Such collaboration not only addresses urgent challenges but also sets a solid foundation for a sustainable, equitable, and prosperous future for all, ultimately enhancing the well-being of developing countries and their inhabitants. For a developing country like Bangladesh, ethical approaches, professional values and good governance are comparably less-practiced. Geoethics and its values should be practiced and addressed in academia, professional organizations, and society to promote cooperation and integration which may result in the inclusive growth of the country.

Keywords: Geoethics, Developing countries, Professionals, Interdisciplinary, Resilience.

Signature of Holocene Marine Transgression in Subsurface Sediments of Mahananda Floodplain, Western Barind Tract, NW Bengal Basin

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Abstract

Lithological, biological, geochemical and isotope studies of Holocene carbonated mud sediments in the Mahananda floodplain in western Barind Tract near Chapai Nawabganj reveal the evidence of Holocene marine transgression in north-westernmost Bengal Basin. Low abundance of foraminifera and ostracods has been identified in the carbonated mud facies in the boreholes BH-1 and BH-2. Gastropods and oogonia of charophyte algae have also been identified at the top of the unit in the borehole BH-1. Foraminifera are characterized as benthic type, dominated by species belonging to genera Ammonia and Elphidium, with only one planktonic species. Eight ostracoda specimens belongs to genera Cypris, Ilyocypris, Keijella, Darwinula sp. Bicornucythere sp. Fabaeformiscandona sp. occur in the borehole BH-1. The foraminiferal assemblage is the characteristic of a high organic, low energy, hyposaline to normal marine and brackish water with influence of freshwater in the coastal lagoon, marsh to tidal flat and mud flat environments. Gastropods and charophyte oogonia with abundant fragmented molluscan shells indicate a shallowing upward trend from coastal brackish (supratidal swampy paleoecology near the coast or bay) to freshwater fluvial environments. All this evidence suggest a deposition of the carbonated mud unit under shallow marine, coastal lagoon, marsh, tidal mudflat and marsh to mixed freshwater environments.

Small negative $\delta^{13}C_{carb}$ (-0.95‰ to -0.56‰ V-PDB) excursions in section BH-2 indicate marginal marine environment, and shifted to positive excursion at the top (BH-1.1, 1.45‰ V-PDB) reflecting a sub-aerial exposure horizon owing to the influence of sea-level fluctuation. The marked negative $\delta^{18}O$ values (-12.92‰ to -11.34‰ V-PDB) suggesting humid climatic conditions prevailed at the bottom part, and gradually shifted to arid conditions as indicated by a subtle increase in $\delta^{18}O$ excursions at the top section (-5.57‰ V-PDB). This also indicates the rise of sea level during the deposition of lower carbonated mud sequence and the dropping of sea level during the deposition of the upper non-carbonated light yellowish gray sands. Considering the marked dominance of genus Ammonia, the high abundance of genus Elphidium and the north-westernmost position of the

study area, it is suggested that the carbonated mudstone facies might have been deposited most probably during a peak phase of the well-established Holocene transgression (such as Ammonia or Flandrian transgression?) in the Bengal Basin, with at least two phases of coastal to marine incursion. About 158 m thick Holocene sedimentary sequence in the boreholes demarcates its accumulation times about 7,600 years at a rate of 2.07 cm/yr following modification of Stanley and Hait (2000) indicating a mid-Holocene sea-level highstand. The thick (158 m) Holocene sedimentary sequences from the study area represent complex paleoenvironmental history. Sediments from the study area indicate an accumulation period of approximately 7600 years, considering the sedimentation rate of 2.07 cm/yr, which has been derived from a modification of the method illustrated by Stanley and Hait (2000). In this case, the method of Stanley and Hait (2000) for calculating approximate mean annual sediment accumulation rates for the Sundarban was not directly used in the present study due to its considerable sediment thickness. Instead, the method of Stanley and Hait (2000) was modified and applied for very thick Holocene sediments of the study area to provide a broader perspective. From incremental rates of annual sedimentation, the rates of sedimentation were calculated to range from 0.13 to 0.14 cm/yr for every 10 m long sections. While it is not an ideal way to calculate the age of sediments, it provides a general idea about the sedimentation rate and its age. Logically, it demands appropriate age dating techniques for accurate determination of the period of deposition. Several sedimentological and other paleobiological evidence suggest consistency with this age. Sarkar et al. (2009) worked on the western part (India) of the GB delta where they found a thick mud unit (max. 25 m) rich in peat deposits, mangrove woods, and marine fossils dated to 10-7 ka in age. The palaeosol has been identified across the GB delta, such as in the Brahmaputra (Zheng et al., 2004), Meghna (Yount et al., 2005), Jamuna (BADC, 1992) and Hoogli (McArthur et al., 2008) floodplains. In the eastern part of the delta, this sequence is overlain by thick (upto 60 m) silty sediments deposited between 11 and 6 ka during the a major transgressive event (Umitsu, 1993; Goodbred and Kuehl, 2000a, b). In the western part (Indian side) the thickness of the Holocene sediments has been found to be significantly lower (15–20 m; Hait et al., 1996; Goodbred and Kuehl, 2000a, b; Stanley and Hait, 2000; Sarkar et al., 2009). Goodbred and Kuehl (2000a) suggested three major Holocene stratigraphic units from the upper delta plain. These are a lower mud unit (max. 25 m, dated) of 10–7 ka age and rich in peats, mangrove woods and marine fossils, a middle fluvial sand-silt unit and an upper silt-mud deposit (max. 15 m). The top two units evidently correspond to the progradational facies following the Early Holocene transgression. While this provides a generalized picture for the GB delta system, the progradation history, particularly in the western part, remains poorly understood (Sarkar et al., 2009). Although the initiation of subaqeous delta clinoform has been suggested at 7.5 ka (Michels et al., 1998), it is not known exactly when progradation started in different parts of the delta. Further, both the palaeosol and upper progradational

units are not uniformly distributed throughout the region and often eroded by single or amalgamated fluvial channel sands of various ages (Stollenwerk et al., 2007). On the basis of C14 dating of biological assemblage Acharyya and Shah (2010) identified the Flandrian Transgression in the Bengal Basin during 10,000–7,000 years BP. Umitsu (1987, 1993) suggested that during 10,000 (or 8000) years BP and 6000 (or 5000) years BP, the sediments of the Khulna city were deposited under a strong marine influence. Rashid et al. (2009) mentioned a highstand of sea-level at Dhaka City around 7570-7430 years BP. These studies also support the transgression event of 7000 years BP, which has been described by Umitsu (1993) (Goodbred and Kuehl, 2000). After a regression around 6500 years BP, a short term transgression was proposed by Islam (2003) during 5850-4580 years BP, which is supported by Rashid et al. (2009). On the basis of the Report on the State of Environment in West Bengal, September, 1998, Ammonia transgression inundated the West Bengal region of the Bengal Basin 80 to 120 km inland from present coastline during 7000-6650 yrs BP. Freshwater bio-assemblage predominates the sediments younger than 5000 years BP. Coastal to brackish marine conditions occurred at Namkhana (West Bengal) during 4000 (+/-) yrs BP. Rashid et al. (2009) stated that at the Dhaka region around 4000 years BP, brackish water replaced by freshwater marshy land. The Holocene relative sea-level signal is characterised by a mid-Holocene sea-level highstand. Even when the nature of Holocene sea-level change is broadly similar in all locations, differences exist in the timing and magnitude of the highstand, and the pattern of the late Holocene sea-level fall.

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