Gravel Resource Evaluation and Environmental Implications in the Patgram Area, Lalmonirhat District, Northwest Bangladesh

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Abstract: **This study examines gravel resources and their environmental implications in Patgram Upazila, Lalmonirhat District, located within the Teesta alluvial fan system. Field surveys along approximately 55 km of the Teesta, Dharla, and Saniazan riverbanks reveal gravelly sand and coarse fluvial deposits derived from Himalayan source terrains, reflecting high-energy depositional conditions. Gravel extraction is an important local economic activity; however, it is largely unregulated. Uncontrolled removal has resulted in riverbank erosion, channel modification, lowering of riverbeds and water tables, loss of aquatic habitats, and degradation of adjacent agricultural lands. The natural rate of sediment replenishment is insufficient to offset ongoing extraction. The study recommends sediment budget-based extraction limits, environmental impact assessments, protected buffer zones, and community-based monitoring to ensure sustainable resource management.**

Keywords: ***Teesta Fan, Patgram Upazila, Gravel extraction, Fluvial geomorphology, Environmental impact, Sustainable resource management, Lalmonirhat, Bangladesh.***

Introduction

The Patgram Upazila of Lalmonirhat District lies within the extensive Teesta Fan deposits, which were formed during the Pleistocene to Holocene period by the dynamic fluvial processes of the Teesta River and its tributaries. This region hosts abundant gravel resources that are continuously reworked and redistributed by active river systems. To assess the characteristics and utilization of these materials, a field survey covering approximately 55 km along the Teesta, Dharla, and Saniazan river corridors was conducted. The survey focused on mapping gravel-bearing zones, examining their geological and sedimentological settings, and documenting local extraction techniques. Additionally, the study evaluated how current gravel mining practices influence river morphology, floodplain stability, groundwater conditions, and surrounding agricultural and ecological environments.

Geological and Sedimentological Characteristics

The sedimentary succession in the study area is characterized by fluvial channel-fill deposits in which gravelly sand and coarse sand dominate the lower stratigraphic horizons, gradually fining upward into layers of fine sand, silt, and clay within the overbank floodplain environment. Granulometric and petrographic analyses reveal that the gravel fraction is polymictic in nature, consisting primarily of quartz and quartzite, along with notable proportions of felsic rock fragments. These components suggest a provenance linked to the Himalayan orogenic belt, transported downstream through the Teesta River system. The observed grain-size distribution and sedimentary structures reflect deposition under high-energy hydraulic conditions, typical of proximal alluvial fan settings where rapid sediment supply, steep gradients, and fluctuating discharge contribute to frequent reworking and sorting of coarse clastic materials (Goodbred and Kuehl, 2000).

Gravel Extraction Practices and Socioeconomic Context

Gravel extraction constitutes an important livelihood and economic activity in the Patgram region, supplying essential materials for local construction, road development, and infrastructure projects. The extraction is carried out through both manual labor and mechanized equipment, depending on accessibility and market demand. However, the activity remains largely unregulated, with limited oversight or adherence to environmental management practices. Observations from field surveys, supported by discussions with local communities, reveal that such uncontrolled extraction has triggered notable geomorphic changes along the river corridors. These include progressive riverbank erosion, alteration of natural channel patterns, and a measurable lowering of riverbeds due to excessive sediment removal (Baki and Gan, 2012). Furthermore, the disturbance of sediment balance has led to the

degradation of aquatic habitats, adversely affecting fish populations and riparian biodiversity, and ultimately impacting the ecological stability of the floodplain environment.

Environmental Implications

Satellite imagery and GPS mapping reveal that natural gravel replenishment is insufficient relative to extraction rates. Resulting impacts include:

- Slope instability and floodplain degradation
- Lowering of water tables
- Loss of agricultural productivity
- Habitat fragmentation and biodiversity decline

Additionally, abandoned extraction pits contribute to increased erosion and landscape degradation.

Sustainable Resource Management Recommendations

To ensure long-term availability and environmental integrity, the study recommends:

- Establishing extraction zoning and sediment budget-based quotas
- Implementing Environmental Impact Assessments (EIA)
- Creating buffer zones to protect riparian ecosystems
- Introducing community-based monitoring and government regulation

Conclusion

Sustainable utilization of gravel resources in the Patgram area requires a thoughtful balance between economic development and environmental protection. While gravel extraction plays a vital role in supporting construction activities and local livelihoods, unregulated removal has already begun to alter river dynamics, degrade ecological habitats, and threaten agricultural productivity. Implementing scientifically informed management strategies, such as regulating extraction rates based on sediment budget assessments, designating controlled mining zones, and enforcing systematic environmental impact evaluations, will be essential to prevent long-term geomorphic instability. With appropriate planning, monitoring, and community engagement, Patgram's gravel resources can continue to contribute to regional development while maintaining the natural integrity and hydrological balance of the broader Teesta Fan system. Sustainable governance will therefore ensure both present economic benefits and future environmental security.

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