INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

Name of the Student : **Vijay Meena**
Roll Number : **196104117**
Programme of Study : Ph.D.

Thesis Title: **Assessment of heavy metals, their dispersion characteristics and composite-based remediation approaches in the Brahmaputra River System**

Name of Thesis Supervisor(s) : **Prof. ARUP KUMAR SARMA & (Late) Prof. CHANDAN MAHANTA**

Thesis Submitted to the Academic Division : **CIVIL ENGINEERING**

Date of completion of Thesis Viva-Voce Exam : **22/05/2026**

Key words for description of Thesis Work : **Brahmaputra, River, Heavy Metal, Sustainability, Enrichment Factor**

SHORT ABSTRACT

The Brahmaputra River is a major transboundary river system originating in the Tibetan Plateau and flowing through China, India, and Bangladesh before joining the Ganga–Meghna system. It plays a significant role in the economic development and environmental sustainability of the Assam region, particularly Guwahati. However, rapid industrialization, anthropogenic activities, and increased river navigation have raised concerns regarding water and sediment quality. Heavy metals are of particular concern due to their persistence, toxicity, and tendency to accumulate in aquatic environments, posing risks to ecosystems and human health. This study focuses on the assessment and management of eight heavy metals—Cu, Zn, Fe, Mn, Ni, Co, Cr, Pb, and Cd—in the Brahmaputra River system. Since these metals strongly bind with sediments and can be remobilized under changing environmental conditions, understanding their occurrence, transport, and remediation is crucial for sustainable river basin management. Existing heavy metal removal methods, including chemical precipitation, ion exchange, and membrane filtration, often suffer from high operational costs and secondary pollution, highlighting the need for sustainable alternatives. The first component of this study examined the feasibility of dredging operations for inland navigation by assessing heavy metal contamination in river sediments. Sediment samples were collected from 42 locations along an approximately 600 km stretch of the Brahmaputra River, divided into Reach 1 and Reach 2, at depths of 0, 50, and 100 cm. Contamination indices, including the Enrichment Factor (EF), indicated significant spatial variation in metal enrichment. Reach 2 exhibited higher contamination levels due to anthropogenic activities such as industrial effluents, oil refineries, and domestic runoff, whereas Reach 1 showed relatively lower contamination and was considered suitable for dredging. Multivariate statistical analysis further confirmed common anthropogenic sources of pollution. The second phase investigated temporal variations in water quality and associated health risks during and after the COVID-19 lockdown period. Heavy metal concentrations during the lockdown remained below detectable limits, indicating substantial improvements in water quality due to reduced human activities. However, post-lockdown samples showed elevated concentrations of Ni, Cd, Pb, and Cr beyond permissible limits. The Heavy Metal Pollution Index classified water quality as low-to-medium polluted during the lockdown and critically polluted after restrictions were lifted. Health risk assessment indicated increased risks, particularly among children and teenagers. To understand contaminant transport mechanisms, longitudinal dispersion coefficients were estimated through tracer experiments using a physical hydraulic model developed at NEHARI. Empirical relationships based on hydraulic parameters demonstrated improved applicability for braided rivers. Finally, a rice husk-derived nanocellulose-bentonite (RNC-BENT) composite adsorbent was developed for heavy metal removal, showing high adsorption capacity, regeneration capability, and reusability. Overall, this study provides an integrated framework for contamination assessment, pollutant transport analysis, and sustainable remediation of the Brahmaputra River system.