

A GIS-BASED FRAMEWORK FOR SAFE AND SUSTAINABLE INFRASTRUCTURE DEVELOPMENT

ABSTRACT

The Indian infrastructure sector, contributing 7.16% to the national GDP, is constrained by a significant spatial-intelligence gap. Approximately 86% of infrastructure projects experience cost and time overruns due to unforeseen ground conditions and inadequately mapped underground utilities. Although strategic initiatives such as PM Gati Shakti have strengthened geospatial planning at the national level, a critical gap persists at the project level, where operational decisions often lack timely and reliable geospatial information. This research addresses that gap by developing an integrated GIS Application Framework designed to function as a dynamic operational enabler throughout the project lifecycle.

The methodology progresses from macro-level terrain assessment to micro-level subsurface utility management. In the landslide-prone region of Joshimath, a Multi-Influencing Factor technique was applied to develop a Site Suitability Composite Index, achieving 85% predictive accuracy and providing a reliable safety benchmark for geologically fragile environments. Further analysis of the NH-146B highway corridor, using multi-temporal satellite imagery from 2017 to 2025, revealed a 59% increase in built-up area and a 27% reduction in forest cover. This geospatial signature of land-use transformation highlights the need to incorporate mandatory geospatial monitoring into policy frameworks such as the RFCTLARR Act, 2013.

To address the operational challenge of underground utility mapping, the research developed an AI-assisted Ground-Penetrating Radar system integrated with RTK-enabled DGPS for centimetre-level positioning. The system achieved 95% accuracy and 94% recall, thereby reducing human subjectivity in radargram interpretation. The framework culminated in the development of an open-source Web-GIS platform using GeoServer, PostGIS, and OpenLayers. The platform democratizes access to spatial intelligence by providing stakeholders with a centralized, browser-based single source of truth.

By enabling real-time visualization, spatial analysis, and project-level decision support without requiring specialized technical expertise, the proposed framework offers a comprehensive blueprint for delivering safer, more sustainable, and geologically resilient infrastructure in alignment with national development objectives.

Keywords: *Infrastructure Project Management, GIS Application Framework, Site Suitability Analysis, LULC Dynamics, Subsurface Utility Mapping, Open-Source Web-GIS.*