Improving Cadastral Accuracy for Disaster Management: The Role of Segment Anything Model (SAM) in Digitizing Historical Cadastral Maps

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SUMMARY

Cadastral maps, which detail land ownership, boundaries, and values, are crucial for effective disaster response and recovery efforts. Up-to-date cadastral information is essential for disaster risk management as it facilitates efficient resource allocation, improves response planning, ensures accurate damage assessment, and provides legal and administrative clarity. It also supports informed decision-making and better environmental and risk management. In Nepal, where disasters occur frequently, precise and current cadastral data are vital. Given the challenges associated with updating cadastral mapping, there is a pressing need to digitize existing maps to establish an up-to-date cadastral database. The initial cadastral survey, completed in 1995 A.D., provided analog cadastral maps for all of Nepal but excluded densely populated areas such as village blocks and public lands. As demand grew for accurate and easily accessible land records, the Department of Land Information and Archive (DoLIA) was established in 2000 A.D. to implement a Land Information System (LIS) aimed at efficient land management. DoLIA began archiving cadastral records and developing software systems for acquiring spatial data from hard copies of cadastral sheets through digitization and their attribute data as well.

Despite these advancements, significant challenges persist in the scanning and digitization of old maps, including susceptibility to human errors, variability in interpretation and digitization skills among personnel, and inconsistencies in data quality. The digitization process remains time-consuming and error-prone due to differing skill levels and interpretations among individuals working on different map sections, resulting in edge problems and data inconsistencies. Additionally, not all personnel are proficient in digital technology, further complicating the digitization efforts. A notable research gap exists in the efficient and accurate digitization of these maps using automated methods. Open-source AI models, such as the Segment Anything Model (SAM), present promising solutions. This study evaluates SAM's feasibility and effectiveness in

automatically segmenting land parcel boundaries from scanned maps into GIS databases. It assesses SAM's performance across various map scales (1:500, 1:1250, 1:2500), maps scanned with varying resolutions (DPI), and geographic regions (Terai and mountainous areas with varying parcel sizes). Specifically, the research focuses on evaluating SAM's efficacy across different scales and data scanning quality, assessing its performance with parcels of diverse sizes, and comparing the geolocation accuracy of SAM-segmented parcels with manually digitized ones in terms of parcel area and vertex coordinates.

The findings of this study could demonstrate SAM's advantages over traditional segmentation algorithms, showcasing its potential to streamline cadastral digitization processes, reduce human errors, and enhance the accuracy of Nepal's cadastral databases. This improvement in cadastral data accuracy will, in turn, support more effective disaster response and recovery efforts. SAM's integration into Geographic Information Systems (GIS) for enhanced analysis and visualization further underscores its potential as a practical solution for large-scale cadastral and disaster response projects.