

## **A Framework for Implementing Participatory GIS For Environmental Conservation of The Muringato Catchment**

Wisdom Kipkemboi<sup>a</sup>, Bartholomew T. Kuria<sup>a</sup>, and David N. Kuria<sup>b</sup>

<sup>a</sup>Remote Sensing Research Group, Institute of Geomatics, GIS and Remote Sensing, Dedan Kimathi University of Technology, Private Bag, Nyeri, 10100, Kenya,

<sup>b</sup>Institute of Geomatics, GIS and Remote Sensing, Dedan Kimathi University of Technology.

E-mail: [kipwizzdom@gmail.com](mailto:kipwizzdom@gmail.com)

### **Abstract**

The recent decades have seen a growing interest in applying Geographic Information Systems (GIS) to community empowerment and policy formulation. This has been made possible through approaches like participatory design, data collection, and effective implementation strategies. The limitations of traditional GIS alienated the local and marginalized communities. This paved the way for the evolution of traditional GIS to participatory GIS (PGIS) which has reshaped the way community engagement is conducted. In environmental conservation, PGIS has been applied in various areas

including mapping naturally occurring harmful species to alert the general public and monitoring river water levels to improve hydrologic forecasts. The Muringato catchment, one of the River catchments within the Greater Tana basin, and is important for the water recharge of the Greater Tana basin, has been faced with numerous environmental challenges. These challenges include deforestation, water abstraction, and riparian encroachment which have reduced the natural resources ability of the catchment to support the growing population. PGIS approach needs to be implemented within the catchment to identify and visualize the location of the incidents for the appropriate agencies to act and thus curb the environmental destruction within the catchment. This research sought to implement a PGIS approach to identify and visualize the environmental incidents within the catchment in near-real-time for its conservation. The approach utilized a mobile crowd mapping platform and a web-GIS platform PGIS tools for effective engagement. The crowd-mapping platform was custom-developed, using Android studio, PHP scripts, and PostgreSQL database, for reporting environmental disturbance incidents within the Muringato catchment. The web-GIS platform was also custom-developed using Django and GeoDjango frameworks and PostgreSQL Database, to visualize the reported incidents data from the crowd mapping platform in near-real-time. With the Government of Kenya enshrining public participation in the constitution of Kenya, 2010, the study hypothesized that implementing PGIS for environmental conservation would stir the Muringato catchment stakeholders to conserve the catchment. These stakeholders included; the Muringato water resource users' association (WRUA), Water Resource Authority (WRA), and Kenya Forest Service (KFS) among others. Because of their local knowledge of the environment including knowledge of the environmental disturbance incidents within the catchment, the Muringato WRUA were targeted to utilize the crowd mapping platform to report the various incidents within the catchment. The other stakeholders, since were involved mainly in policy formulation and implementation for environmental conservation were targeted to utilize the web-GIS platform to monitor the reported incidents by the Muringato WRUA. This ensured collaboration among the various stakeholders who were all interested in the catchment conservation. A total of 85% (18) WRUA members attended the mobile PGIS tool training and fieldwork

sessions, while 71% (15) WRUA members attended the evaluation session conducted 16 weeks after the training session. A total of 53% (16) review responses of the web-GIS platform were received from the 30 sampled stakeholders. 26 users had utilized the crowd mapping platform to report various environmental disturbance incidents within the catchment at the time the evaluation session was being conducted. The incidents included deforestation (25 incidents), dam construction (7 incidents), and soil dumping (2 incidents). Thus, the PGIS tools developed aided the reporting and visualization of the incidents in near-real-time. The near-real-time reporting of the incidents was crucial for environmental conservation stakeholders to make preliminary assessments and draft action plans to curb the incidents. Thus, the use of the PGIS tools aided the implementation of the PGIS approach to the environmental conservation of the Muringato catchment. The framework of implementation could be adopted for the conservation of other river catchments as well.

**Keywords:** Participatory GIS, Environmental conservation, community engagement