Climate resilient and inclusive urban WASH in Melanesian Pacific:

Participatory GIS to support planning for WASH in underserved settlements

Participatory workshop report

May 2024

International WaterCentre

Griffith UNIVERSITY Queensland, Australia

USP THE UNIVERSITY OF THE SOUTH PACIFIC

UPNG

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Water For Women

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1) Introduction

Informal urban settlements often lack planned water supply and sanitation systems, rendering them vulnerable to hazards, particularly those induced by wet weather events exacerbated by climate change. The spontaneous development in these areas typically results in a dearth of documented information concerning crucial infrastructure and hazard-prone zones within the settlement.

Previous research conducted in informal urban settlements in Suva, Fiji, by the International Water Centre (IWC) revealed that the water and sanitation systems of two settlements were highly susceptible to the impacts of wet weather events driven by climate change, indicating low resilience. However, there is a lack of documented spatial information on hazard-prone areas and their intersection with impacts on water and sanitation systems.

To address this gap in knowledge, a Participatory mapping using Geographic Information Systems (P-GIS) activity was performed. The goal of this activity is to gather and compile local knowledge regarding the effects of wet weather events through community engagement. This process involves identifying challenges, barriers, and opportunities to enhance the resilience of water and sanitation systems, thus providing valuable insights for urban planning and response strategies. This report delineates the activities undertaken, detailing the methods employed, key findings, and future research directions.

2) Methods

The P-GIS activity was divided into four steps, each with specific goals (*Figure 1*). The P-GIS activity was conducted in Muslim League and Veidogo settlements, in Suva, Fiji (*Figure 2*).

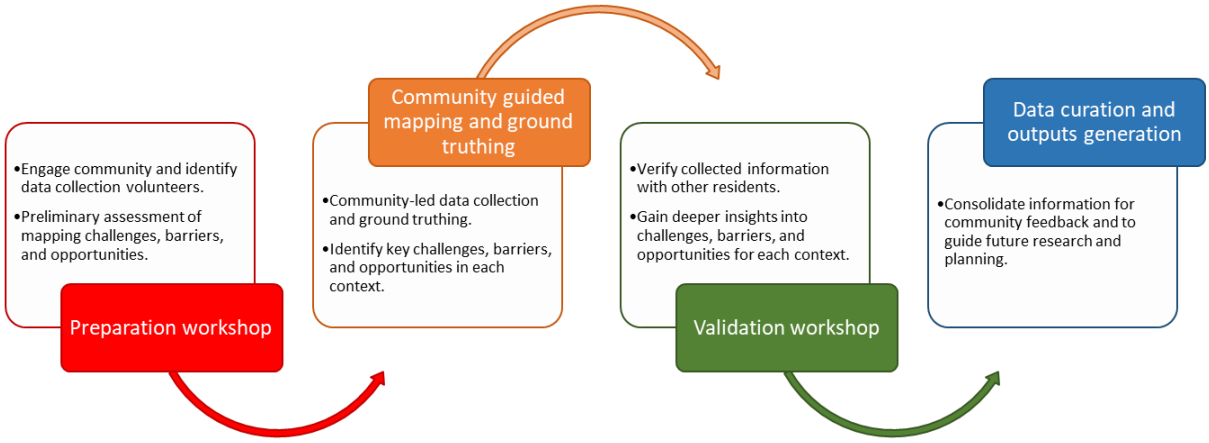


Figure 1 - P-GIS activity methodology: activities and specific goals of each step.

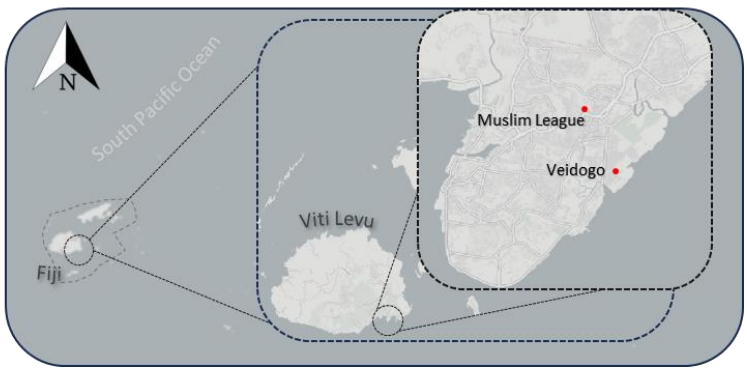


Figure 2 - Informal urban settlements where the P-GIS activity was conducted.

2.1) Preparation workshop

The P-GIS activity commenced with a Preparation workshop involving the community. The research team at USP coordinated with community leaders to arrange a 2 to 3-hour session. These sessions (*Figure 3*) were designed to assess community interest and availability for the activity, and to conduct a preliminary assessment using maps and coloured markers/stickers to facilitate subsequent field data collection.

Figure 3 - Introduction of the P-GIS activity for community members of Muslim League, Suva, Fiji.

The Preparation workshop for both Muslim League and Veidogo settlements saw a diverse representation of residents, including children, adults, and elder leaders (*Figure 4* and *Figure 5*). The number of participants varied from 5 to 15 individuals. Participants were divided into groups and provided with maps of the settlement. They were tasked with mapping hazard-prone areas, key landmarks/infrastructure related to water and sanitation systems, and areas previously or currently affected, impacting water and sanitation systems.

Figure 4 - Group activities during the Preparation workshop in Muslim League, Suva, Fiji.

Figure 5 - Group activities during the Preparation workshop in Muslim League, Suva, Fiji.

The activity resulted in the identification of community members interested in support the activity and in preliminary maps indicating areas of interest to be mapped and ground truth by the activity (*Figure 6*).

Figure 6 - Preliminary maps produced during the Preparation workshop in Muslim League (left) and Veidogo (right).

<u>2.2) Community guided mapping and ground truthing</u>

Based on the preliminary assessment conducted during the preparation workshop, a field day activity was devised to map and ground truth the points identified earlier. In each settlement, USP and IWC researchers conducted a survey of the entire area, guided by community volunteers who highlighted points of interest and provided additional insights (Figure 7). Equipped with maps from the preparation workshop and tablets for data collection, researchers gathered spatial data, including metadata pertaining to each point. Residents from specific areas were directly engaged to gather local information around their households.

Figure 7 - Photos of the field work conducted in Veidigo (top row) and in Muslim League (middle and bottom rows), in Suva, Fiji.

Data collection utilized survey CTO forms on tablets connected to the internet. Points were categorized as ground truthing hazards, mapping critical infrastructure, or identifying points of damage affecting WASH services. Metadata for each point included details such as flooding height, type of infrastructure (e.g., gang water meters, critical points for WASH services, communal gathering points), and the extent of damage impacting WASH services. Visual documentation of

areas was captured on tablets. Additionally, qualitative data concerning impacts, challenges, and potential solutions were recorded from conversations with residents. In total, approximately 105 points were mapped, and a list of around 30 key challenges, barriers, and opportunities was compiled across both Muslim League and Veidogo settlements. Spatial data processing was conducted using the software the free software QGIS version 3.36.

2.3) Validation workshop

Following data collection, a validation workshop was organized for each informal urban settlement (Figure 8). During these workshops, preliminary maps and identified key challenges, barriers, and opportunities to enhance the resilience of water and sanitation systems were presented to community members. This included individuals who did not attend the initial fieldwork session. The purpose was to validate and supplement, as needed, the information collected. Based on discussions during the validation workshops, additional fieldwork was undertaken on-demand to consolidate the P-GIS data collection and validation processes.

Figure 8 - Photos of the validation workshop in Veidogo (left) and Muslim League (right), with maps produced after the data collection and preliminary workshop stages.

2.4) Data curation and outputs generation and communication to the community

The concluding step of the P-GIS activity involved curating the validated data and generating two main outputs: maps and a list of areas for further exploration. This list encompasses challenges, barriers, and opportunities aimed at enhancing the resilience of water and sanitation systems within the informal urban settlements.

3) Results

The results are presented by settlement and include the produced map and a list of the key identified challenges, barriers, and opportunities.

3.1) Muslim League

3.1.1) Challenges

- **Flooding**
  - Flooding near creeks and rivers damages elevated pipes, mirroring house elevations.
  - Flooding depths exceeding 2 meters dislodge raised pipes, necessitating repairs.
  - Limited accessible bridge during flooding forces residents to stay home.
  - Increased mosquito presence during floods.
  - Reports of leptospirosis cases and diarrhea illnesses post-flooding.
  - Heavy rain cause landslides, flooding, and damage structures.
  - Children miss school due to flooding risks and bus accessibility.
  - Increased cost and difficulty in obtaining food and drinking water during flooding.

- **Landslide**
  - Prone areas threaten downstream housing.

- **River contamination**
  - Sewage disposal upstream leads to foul odours and public health risk.
    - Recurrent sewer pump failures is pumping station nearby to settlement result in overflow to streams.
    - Damage to sewer lines causes direct sewage disposal into the river.
  - River pollution due to rubbish accumulation.
  - Some households discharge toilet waste directly into the river.
  - Animals carry diseases between homes despite resident caution.

- **Water supply system vulnerabilities**
  - Main water pipes damaged, resulting in intermittent supply to higher areas.
  - Concentration of meters at settlement boundaries leads to extensive, shared connections and difficulty accessing meters.
  - Houses uphill reliant on downhill water meters experience low daytime water pressure.
  - High number of leaks and cracks in household connections, increasing the risk of cross-contamination.

3.1.2) Barriers

- **Land tenure**
  - Limited accessibility for Water Authority Fiji (WAF) repairs.
  - Land ownership disputes affecting water access and allocation of water meters.

- **Limited resources**
  - Insufficient resources for settlement-wide accessibility improvements.
  - Costly and complex water meter relocations (reports of costing 300-400 FJD)

- **Human behaviour**
  - Slippery terrain drive people to walk barefoot, increasing contamination risk.
  - Disengagement of portion of the community due to past experiences, lack of ownership, and temporary mindset.
  - Inadequate waste disposal behaviour within the community.

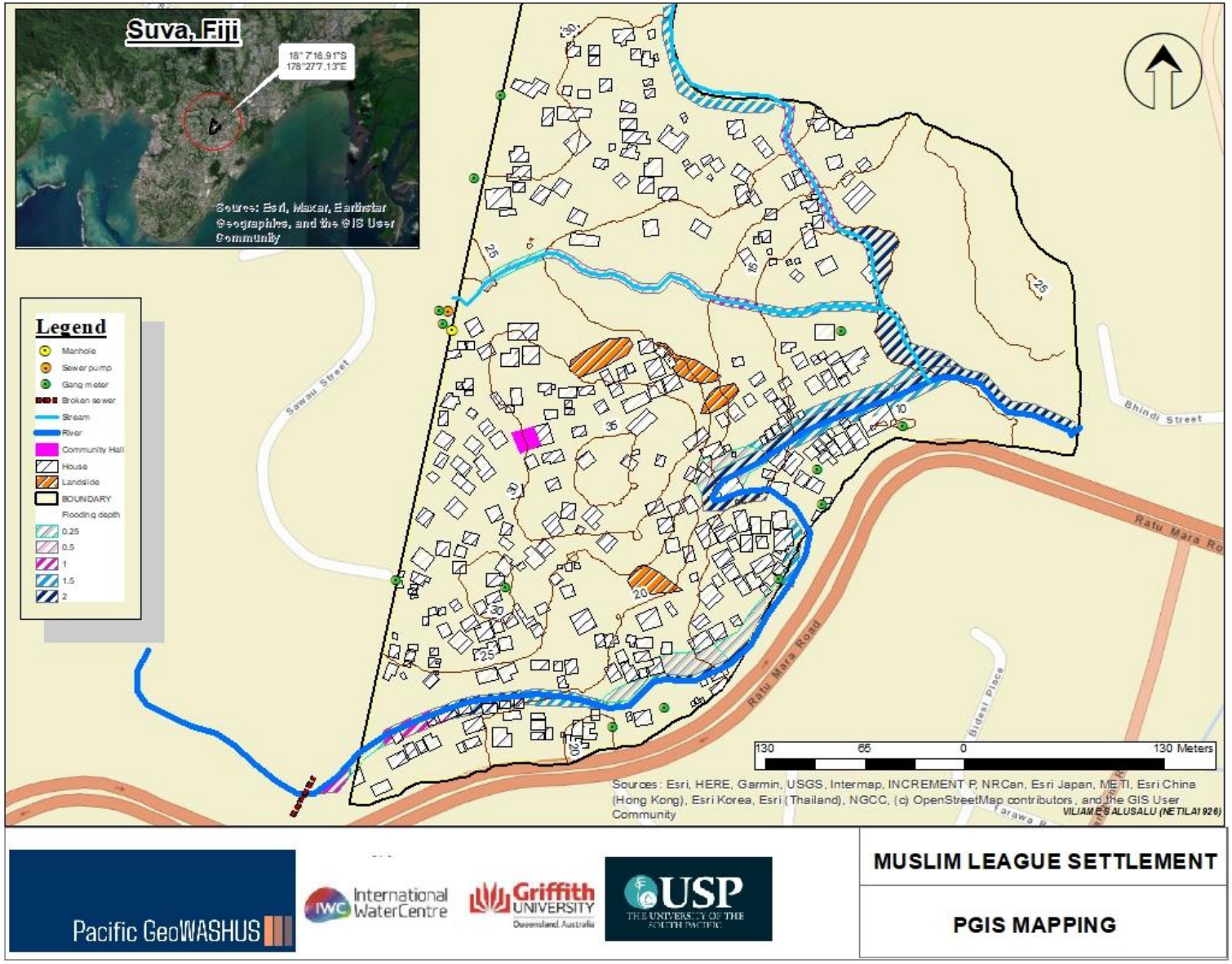
- **Inadequate planning of common areas**
  - Inadequate drainage increases mosquito breeding sites.
  - Low pressure due to shared water connections.

3.1.3) Opportunities

- **Community organization**
  - Organized committee aims to improve accessibility and water situations.
  - Residents collect funds for stronger bridges during floods.
  - Community initiatives to keep children away from creeks during floods.
  - Positive outcomes from community engagement with local municipality.
    - Installation of barriers and white goods collection as requested by the community.

- **Human behaviour**
  - Some residents already practice water treatment after flooding.
  - Voluntarily support from residents in repairing broken water connections.

- **Water supply resilience**
  - Proposed solutions given by the community include relocating water meters and increasing their numbers.


Suva, Fiji
18° 7'16.91"S
178°27'7.13"E
Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Legend
Manhole
Sewer pump
Gang meter
Broken sewer
Stream
River
Community Hall
House
Landslide
BOUNDARY
Flooding depth
0.25
0.5
1
1.5
2
Sawau Street
Bhindi Street
Ratu Mara Road
Bidesi Place
130
65
0
130 Meters
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
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PGIS MAPPING

3.2) Veidogo

3.2.1) Challenges

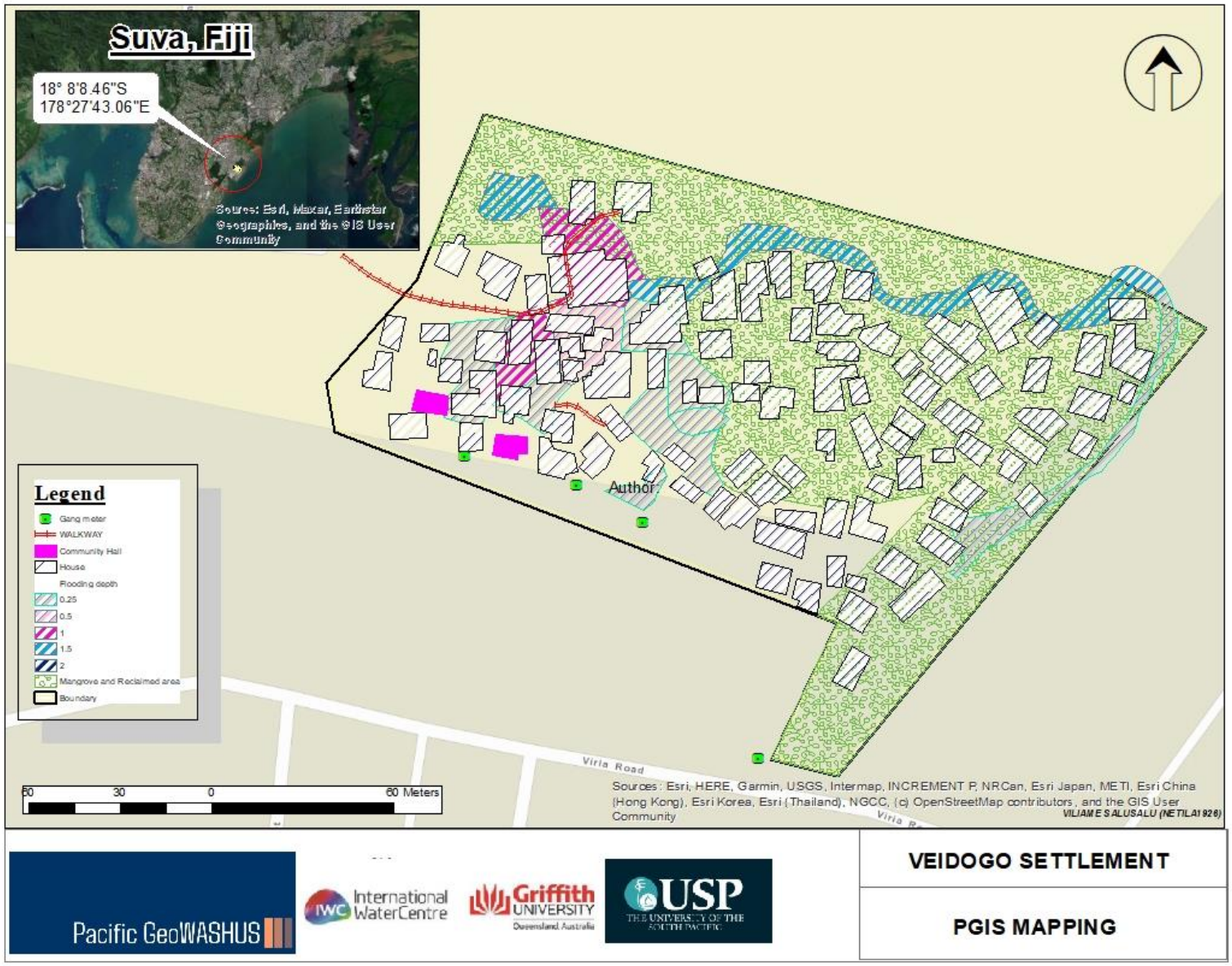
- **Flooding and wet weather events**
  - King tides and heavy rainfall affects walkways adjacent to houses.
  - Most houses are elevated, but walkways pose risks to residents.
  - Flooding can reach overhead heights, requiring unconventional navigation methods.
  - Recurrent flooding during prolonged rainfall events, occurring more frequently.
  - Temporary relocation during cyclones, with evacuations lasting up to two weeks.
  - High mosquito and bed bug presence during the rainy season.
  - School absenteeism during flooding.
  - Flooding increases risk of contamination in some areas of the settlement, particularly for young people.

3.2.2) Barriers

- **Human behaviour**
  - Lack of widespread urgency to improve resilience due to varying impacts and limited water supply disruptions.
  - Perceived benefit of flooding in washing way rubbish from settlement to the sea
  - Perceived benefit of transitioning from pit to flush toilets as solution to sanitation problem
- **Land tenure**
  - Concerns raised regarding reclaimed land hindering water flow to the sea.

3.2.1) Opportunities

- **Water supply resilience**
  - Well-protected underground pipelines.
- **Sanitation**
  - Transition from pit to flush toilets in some households reduces public health risk in some cases.
- **Flooding**
  - Suggestions to raise walkways and widen river mouths to improve drainage.
  - Community organization to collect funds and build new walkways.
  - Identification of areas unsuitable for children's play during wet weather due to contamination risks.


Suva, Fiji
18° 8'8.46"S
178°27'43.06"E
Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Legend
Gang meter
WALKWAY
Community Hall
House
Flooding depth
0.25
0.5
1
1.5
2
Mangrove and Reclaimed area
Boundary
Author
Virla Road
60 30 0 60 Meters
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
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4) Conclusions and future research

This activity effectively demonstrates the significance of community-based initiatives in addressing data gaps essential for proper planning of water and sanitation services in informal urban settlements. The P-GIS activity carried out in Muslim League and Veidogo settlements successfully pinpointed key challenges, barriers, and factors, while spatially correlating them with specific settlement areas to facilitate informed planning aimed at enhancing the resilience of water and sanitation systems.

While the P-GIS activity aids in mapping such areas, future research should focus on further elaborating on the identified key challenges, barriers, and factors for each settlement. This could be achieved through the integration of additional research methods such as focus groups and semi-structured interviews, primarily for qualitative insights. Furthermore, integrating other sources of spatial data such as satellite imagery and outputs of global models for flooding, based on digital elevation models, should be considered where applicable to enrich the analysis and planning process.