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Viti Levu Flood- Risk Zonation From An Urban Planning Perspective

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***Abstract*—We face an urban future. Global trends show that 6 out of 10 people will be living in urban areas by 2030.This connotes that the bulk of our problems would be concentrated within towns and cities. Apparently, this also means that urban planners' roles become increasingly imperative in our quest to make our cities sustainable and resilient. As a Small Island Developing State (SIDS), our peculiar vulnerabilities are well documented within the Program for Action for Sustainable Development (UN, 1994). These vulnerabilities compounded with impacts of global warming, climate change, sea level rise and weather extremes, are perfect recipes and catalysts for disasters if the business-as-usual (sectoral and reactive) means to development and resource planning, management and governance is allowed to continue. Viti Levu, as host to 12 of Fiji's 15 towns (inclusive of the 2 cities) is especially vulnerable to flooding. All these urban centres together with 90% of Fiji's total infrastructure are coastally located on low-lying flood-risk zones.**

While it may be difficult to reduce the occurrence of natural hazards such as floods, it is however possible to identify and map the risk areas or zones, and accordingly employ measures to minimize its impacts.

Keywords—Flood hazard; GIS; Urban Planning; Disaster risk; Vulnerabilities

I. INTRODUCTION

Flood Hazard Zonation is an important urban planning strategy to disaster risk reduction, and is an area in which Fiji is tremendously lagging in. There is a clear disconnect between physical planning and disaster risk management in the country, and to continue on this path is to be ignorant to the apparent manifestations of wicked issues such as inefficient land use patterns, high infrastructural and societal exposure and vulnerabilities, and so forth. These would (continue to) cause socio- economic impacts to the country.

The potential of urban planning as a profession to creating that desired sustainable and resilient community is still being grossly underestimated and utilized. It is hoped that this paper would effectively bring about the necessary awareness to be able to effect tangible changes. We live in an urbanizing world and current trends show that we also have an urban future. Six out of ten people in the world are projected to be in urban areas by [1]. Considering this fact, it is indubitable that cities will have a major role to play in the sustainable development of a country, as most of our resources, investments, and people would be sited in these areas.

Essentially, this also means that a majority of our challenges would be concentrated within urban centers. In times of disasters, urban areas would concentrate most damages and losses primarily attributed to a combination of factors such as poor quality informal settlements and spontaneous urbanization, which occurs in hazardous and marginal areas such as floodplains, coastlines or zones of higher seismic risk [2].

These challenges are compounded by occurrences of natural hazards and externalities of global warming, climate change, weather extremes, sea-level rise and climate variability. The global concern for the increasing complexity of disasters and their overall impacts on society has apparently led to the UN definition of '*disasters'* outlining the vulnerability and fragility of the built environment.

This paper, firstly, seeks to highlight the (immense) potential and relevance of urban planning in effectively addressing disaster risk reduction (DRR) in Fiji, using relevant case studies from around the world to support the argument. This is especially relevant for Fiji, where the role and potential of urban planning in DRR is, for the large part, simply ignored.

Secondly, in line with the above, a Flood Zonation Map is produced, using a scientifically proven GIS method of mapping (the Analytical Hierarchical Process (AHP)), to demarcate the flood-risk zones of Viti Levu into 'low', 'moderate', and 'high' classes.

This is a first step to highlighting the current and future exposure and vulnerabilities of communities in the country. Identifying the high-risk areas for flood hazards in Fiji is one of the powerful ways to reduce the impacts of future floods.

Mapping of identified flood hazard zones would be beneficial to urban planners, risk managers, and even civil defense and emergency officers for carrying out pre-, during, and post-disaster recovery planning and management.

It is hoped that the outcome of this paper would provide useful lessons for policy consideration for the Fiji Islands; more particularly in recognizing the imperative role of urban planning in creating resilient

and sustainable communities and so as to be able to consider the field and profession as a national priority field in strategic planning matters.

II. METHODOLOGY

Research Question 1: How and Why is urban planning relevant to DRR and in creating the desired resilient and sustainable community?

Answering this first research question entailed a comprehensive desktop analysis of selected case studies from around the world, usingscientific-basedpeer-reviewed literatures to depict the imperativeness and relevance of urban planning in DRR. Specific examples were on countries where urban planning has helped create sustainable communities and enhanced DRR initiatives.

Research Question 2: Why is a Flood Zonation Map important for Fiji, and what are its future implications in light of the DRR discourse?

Geospatial technology, specifically the ESRI ArcMap 10.5.1 was used to produce the desired map that employed an Analytical Hierarchical Process method to assess the flood hazard zones or areas of susceptibilities. Here, the authors employed

6 parameters: 1) rainfall intensity, 2) river density, 3) slope, 4) elevation, 5) soil permeability, and 6) land use, to produce the final product which was a flood hazard zonation map of the Sukhothai Province in Thailand [3].

This method was similarly used to produce the Flood Zonation Map of Viti Levu. 9 parameters were used for our case [4].

III. DISCUSSION AND ANALYSIS

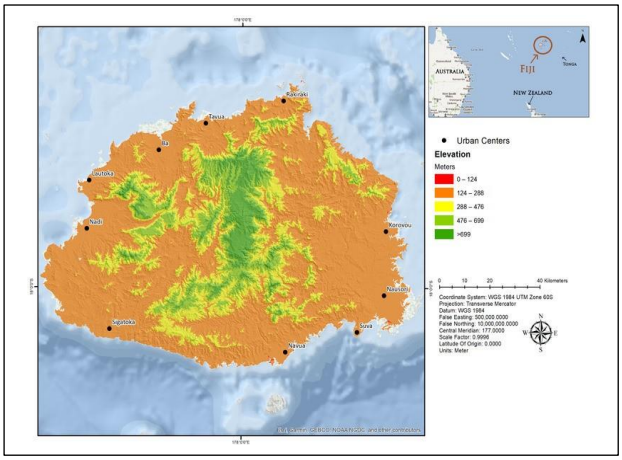

Fig. 1. Elevation

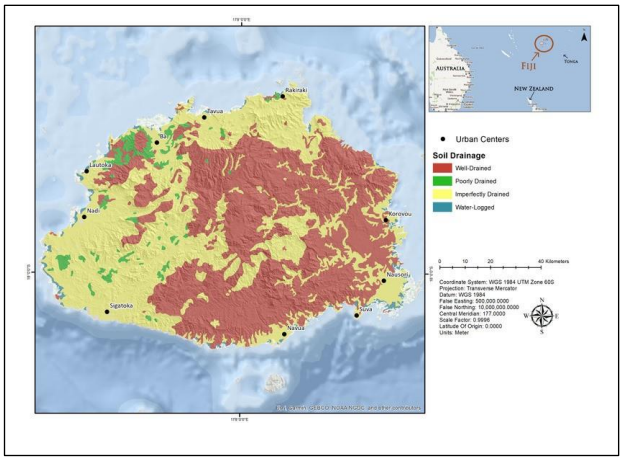

Fig. 2. Soil Drainage

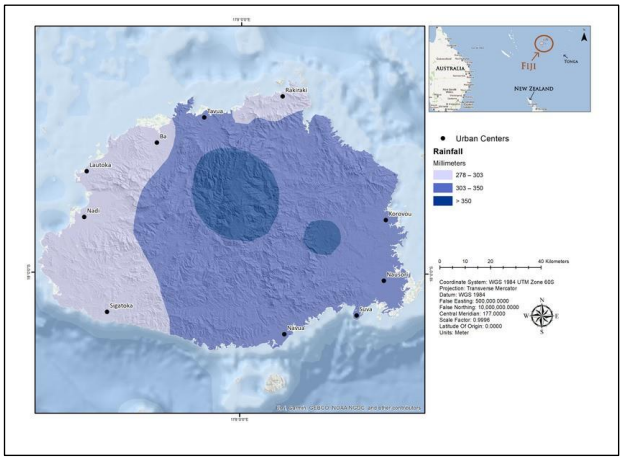

Fig. 3. Rainfall

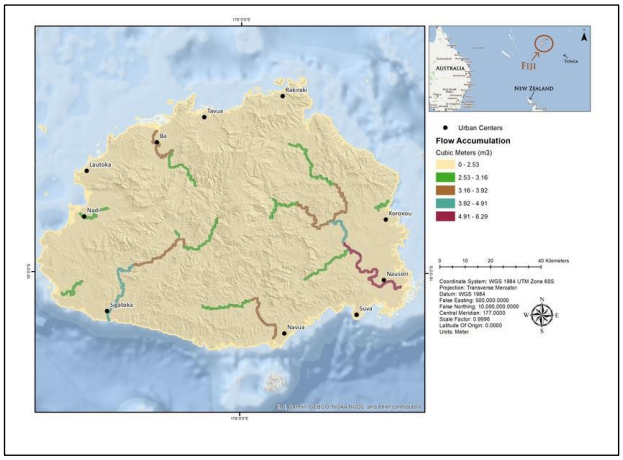

Fig. 4. Flow Accumulation

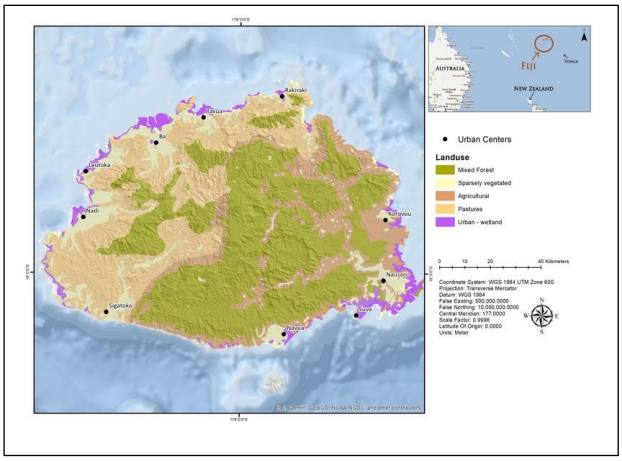

Fig. 5. Landuse

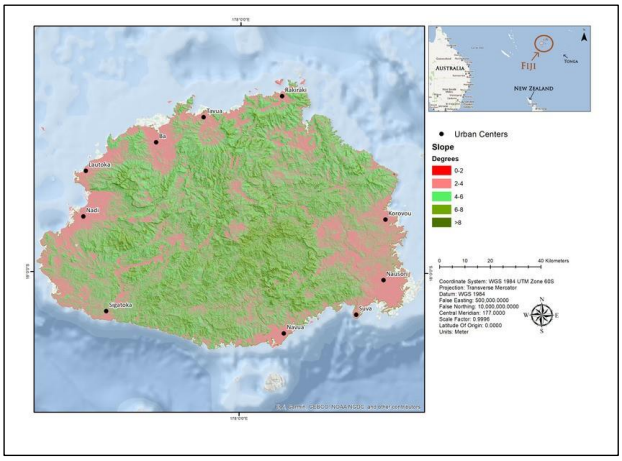

Fig. 6. Slope

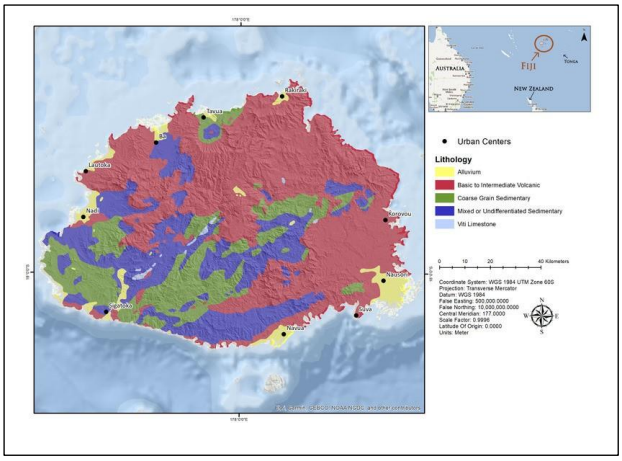

Fig. 7. Lithology

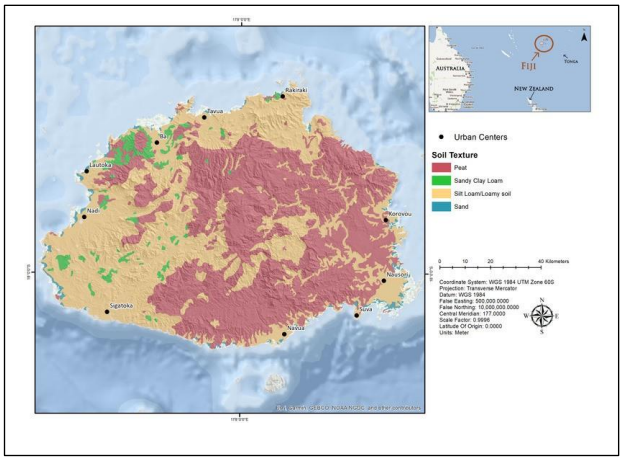

Fig. 8. Soil Texture

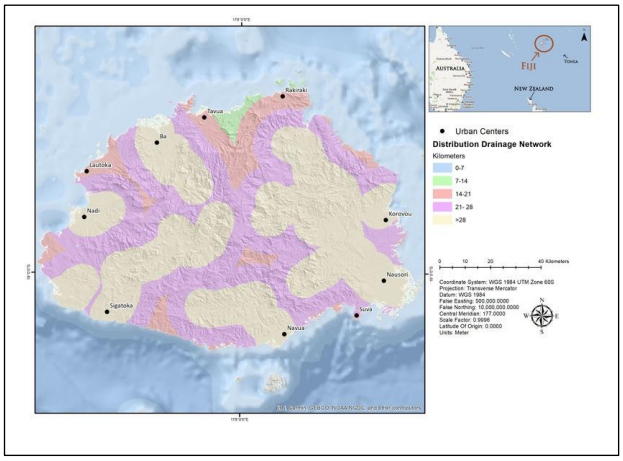

Fig. 9. Distance from Drainage

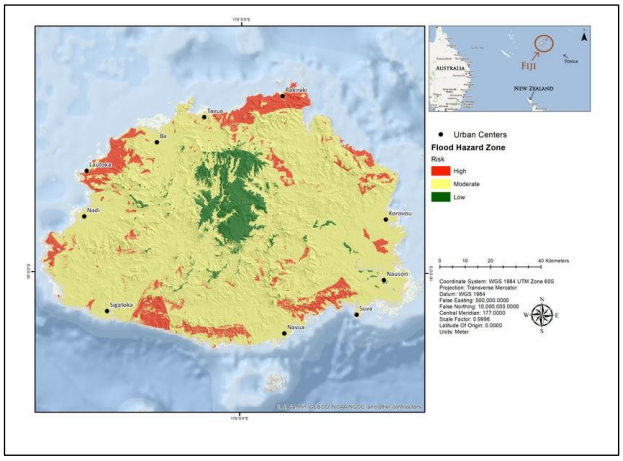

Fig. 10. Flood Hazard Zone

The results above depict that approximately 10% of Viti Levu's landmass is within the high risk zone for flooding, and these are mainly within close proximity of waterways.

Apparently, these seem to be the very areas where our urban centers and developments are concentrated.

Flood Hazard Zones (EHZ)	Area (Sq. km)	Area %
Low	749.8	7.46
Moderate	8275.7	82.3
High	1024.4	10.1

Many of the key built-features are highly exposed and vulnerable due to its proximity to the high flood-risk zone. By overlaying these key infrastructural features on the map above, exposure and impact analysis can be made.

The **Flood-Risk Zonation Map shown in Figure 10** above would surely provide an important baseline information for decision- making purposes.

Flood hazard zonation has been carried out in many countries, but is yet to be done for Fiji (showing a lack in literature and also in the operational sense of it [5-10]

IV. Conclusion

Urban planning as a profession, has tremendous potential (but still grossly underestimated and ignored) in addressing DRR issues and helping to create the desired resilient community. This is also a loophole for Fiji, as evidenced by the fact that urban planning is not a priority area for the national government and the lack of good urban governance policies to help create a sustainable and resilient community.

The existing pre-conditions of wicked issues as a result of poor (sectoral and reactive) urban governance are catalysts that would aggravate the impacts of disasters such as floods.

Whilst there tends to be a clear agreement on integration and inclusivity being the way forward to attaining the desired resilient and sustainable community, there is however no clear direction on how it is that this can be effectively achieved – more particularly so for SIDS where sectoral governance is still prevalent. Urban Planning (via its tools and strategies) is well-placed amongst competing fields to take the lead role in *integration* efforts, and pave the way to creating the desired sustainable and resilient community.

DRR can no longer operate in isolation from urban planning, especially for Fiji, as the cost of this "business-as-usual' attitude is sure to increase in response to the increasing intensity and frequency of natural and anthropogenic hazards. Fiji's economy as a SID is already extremely volatile to disaster impacts, and hence the need to take action.

V. Recommendation

Urban planning should be considered a national priority for Fiji. This may require sending citizens abroad to be capacitated within this field, and tailor-make courses in local institutions to reflect and respond to the needs of the nation. Sadly, Fiji lacks – urban planners with only 1 out of the 15 urban centers having a qualified planner. The need for planners is/has been well justified given the country's peculiarities, and existing shortfalls within its urban governance systems.

It is vital for all key stakeholders involved in the construction and development industry to assume responsibility for integrating and mainstreaming DRR activities into the planning, (re)design, construction and operation of the built environment. This also extends to the fact that hazard mapping must be a mandatory (baseline) component for all future planning work.

Community *Resilience* must be a deliberate target added atop of our sustainable development efforts. Being sustainable does not necessarily mean being resilient, but being resilient may fulfill objectives of sustainability. This demarcation must be clearly made, and so understanding how resilience effectively fits in within the context of sustainable development is important in our quest to achieve the ideal community.

Whilsturbanplanningremains disconnected (reactive and sectoral) from other relevant fields in many parts of the world, new and more inclusive and innovative approaches to urban planning, such as integrated and citizen-led collaborative planning is required if urban growth is to contribute to a sustainable and resilient future for all.

Inclusiveness and proactiveness is the way forward for Fiji. This includes mainstreaming of disaster risk into key fields and sectors, most particularly into physical/urban/developmental planning; and also, actively including and engaging citizens and stakeholders throughout the planning and decision-making process.

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