

Title: Ramani Huria and Community Mapping - Towards Free and Open Map Data and Imagery for Dar es Salaam

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Currently, Deogratias Minja is a Community Mapping Analyst working with the World Bank's Global Practice for Transportation in Tanzania, supporting open data and community mapping activities. A town planning professional, having graduated from Ardhi University with B.Sc. Regional Development Planning. Prior to joining the World Bank, he worked with Kinondoni Municipal Council as a town planner, participating in the planning and development of Mabwepande Satellite town towards reducing the congestion of business centers within the Dar es Salaam.

Abstract:

This paper provides a detailed investigation of the in-field experience of using community mapping as a participatory action research tool with communities. It describes two case studies. The first case study examines the environment of Dar es Salaam, through an exposition of community mapping in Tanzania. The second case study investigates how a participatory method can elicit flood inundation areas.

Due to various factors, including rapid urbanization and climate change, Dar es Salaam currently faces the challenge of periodic flooding, this impacting local residents and businesses. This research presents methods for mapping all flood prone areas through engagement of community members. By tapping this local knowledge, it is possible to create flood inundation scenarios and identify flood exposure, using a low-cost participatory process. These in turn lead to realistic natural hazard impact scenarios allowing for improved planning, preparedness, and response activities.

Community mapping has proved to be an inclusive and appropriate tool to elicit and codify the perspectives of communities. Evidence from this research suggests that innovative data collection tools such as Unmanned Aerial Vehicles (UAV), Global Positioning System (GPS) and Field Papers – a tool for annotating maps - the mapping process can successfully engage community members, not just as participants but as key stakeholders in a holistic flood resilience process. This in turn provides opportunities to support facilitators to build risk and disaster management teams to aid in mitigating and responding to flood and other hazard events.

Keywords:

Maps, Community, Participation

Full Paper

Introduction

Dar Es Salaam, Tanzania is the fastest growing city in Africa, with a population of over 5 million people and growing rapidly, in a city originally planned for 300,000 (Calas 2010). This presents a massive challenge for understanding the impact of climate related hazards like flooding due to limited local capacity and semi-periodic flooding (Baker 2011). This situation is made worse due to rapid urbanisation and population growth, most of which is in an uncontrolled manner. As such the urban population, infrastructure and general wellbeing is vulnerable to climate change. In combination this presents a fragile ecosystem with a high rate of poverty and general poor infrastructure that will be severely affected by minute changes to the global climate. Understanding the underlying complex issues necessitates an interdisciplinary approach, spanning the disciplines of environmental science, urban development and geography, among many others. As such, this research paper investigates the nexus of these disciplines in the City of Dar Es Salaam through the method of community mapping, leading to demonstrable flood resilience methods that are currently being applied within Dar es Salaam, providing geospatial capacity within institutions, rationale on why this was necessary and the next steps to create climate resilient growth.

A revolution in the geospatial domain was sparked a decade ago by the convergence of internet based mapping and visualization tools and an explosion in consumers and novice users of cartographic services (Haklay 2008). The innovations driven by the dissemination of the geoweb (geospatial data over the internet) are characterized by greater simplicity and interoperability of services, leading to the emergence of neogeography – the ability to geocode and geotag points of interest, photos, or similar informal datasets onto consumer facing mapping platforms (Turner 2011). Exemplified by the launch of Google Earth and OpenStreetMap in 2004, access to geospatial data has now grown by orders of magnitude. As such, this paper advocates that the traditional domains reserved for high cost, high expertise disciplines such as GIS, Surveying and cartographic and navigation services will continue to exist but are both strengthened by the rise of neogeography as well as transformed or sometimes leapfrogged by it.

Best practices in data hosting and aggregation have moved from building data portals to enabling data platforms – datasets today **should be** compliant with Open Geospatial Consortium (OGC) standards and searchable in regular search browsers to ensure interoperability. The national policies for hosting and serving map data, known as Spatial Data Infrastructures, are also wrestling with tensions between the formal (centralized, authoritative, rigid) and informal (user driven, crowd regulated, Wikipedia style map creation) approaches. Mobile phone companies have become the largest purchasers of geospatial data as they invest heavily in the convergence of mobile and geo (GSMA 2015).

Though, in dense, informal urban areas across the developing world, accessibility to geodata has been severely lacking (Baker 2011). There are numerous factors for this, from national mapping providers lacking capacity to provide the same granularity and resolution of data that their counterpart organizations in developed countries to the lack of financial incentive for commercial mapping providers to operate in these regions. This gap has led to the rise of community mapping projects, such as illustrated by (Hagen 2011) and (Soden 2015) in Kibera, Kenya

and Kathmandu, Nepal respectively that facilitate communities in mapping their own neighborhoods in a participatory process.

Review

The Power of Maps - Power of the Community

Cartography, the art of creating maps is a term imbued with power. Hartley (1989) eloquently summarised the relationship between power and cartography as thus:

“Power is exercised with cartography. Monarchs, ministers, state institutions, the Church, have all initiated programs of mapping for their own ends. In modern Western society maps quickly became crucial to the maintenance of state power to its boundaries, to its commerce, to its internal administration, to control of populations, and to its military strength. Mapping soon became the business of the state: cartography is early nationalised. The state guards its knowledge carefully: maps have been universally censored, kept secret and falsified... A mapless society, though we may take the map for granted, would now be politically unimaginable. All this is power with the help of maps. It is an external power, often centralised and exercised bureaucratically, imposed from above, and manifest in particular acts or phases of deliberate policy.” (p12)

Alas, for much of the global south, maps are non-existent with traditional agencies and institutions deficient in their production and provision as discussed in (Baker 2011). *A new method is required to bridge this gap for such an important artefact.* Community mapping could be a resolution to this, and has been used to much discussion in Kibera, Kenya through the Map Kibera project (Hagen 2011).

Hagen (2009) discusses that while Kibera is “...one of the most heavily studied informal settlements in the world... Publicly available information about Kibera is minimal” (p41). Formal maps were inaccessible, so by using OpenStreetMap, Kibera was mapped using consumer grade GPS tools by the community of Kibera. What was mapped was the choice of the mapper: “The mappers were allowed to choose what features were most important to collect, and agreed to try for every single water point, toilet, clinic, pharmacy, school, church, mosque, and NGO office, plus anything else at their discretion. They painstakingly uploaded the data using the Java OpenStreetMap editing software, overcoming a substantial lack of computer experience. Some signed up for their first email account” (p42). The data were then made freely available on OSM. These maps were in theory accessible not just to those community members in Kibera, but also to the wider world. Though there is an extent to which online maps are accessible in technologically challenging environments such as Kibera, with limitations of access to technology and/or internet. In Kibera, these maps had the effect of facilitating and strengthening community interactions and discussion around community driven media and journalism, as investigated by Ekdale (2014) and other situations, such as public service delivery and security.

However, lacking from the analysis of Hagen (2011) and Ekdale (2014) is method of community mapping, instead investigating the phenomena from a social angle, where the result revolves around the participatory aspect of

community mapping, whereas this paper argues: *the data produced from community mapping is also a very valuable resource to be harnessed.*

Community mapping as a term has its roots in Parker (2006), who defines it as “a map, produced collaboratively by residents of a particular locale, often featuring local knowledge and resources” (p470). Elwood (2006) describes how GIS and community participation can work in developing plans in a neighbourhood of Minneapolis, Minnesota, USA; Perkins (2007) examines the mapping of parishes in rural England; Perkins (2008) looks at the community mapping of golf courses; Amsden (2005) look at how the youth in Vancouver can be engaged to create maps.

These instances are indicative that a majority of literature focuses on developed nation instances of community mapping, though some research exists in the global south. While Parker (2006) investigates how Community Mapping is “a response to conventional, elitist cartography, comprising an alternative, egalitarian counter-culture”, there is scant research on *how* this is achieved in the global south, as it refers to areas in developed nations.

The emergence of community mapping aligns with the definition of Volunteered Geographic Information (Goodchild 2007), where non-experts can volunteer and create geographic information. In the instance of community mapping in the global south, such as in Tandale, and in both VGI and Neogeography, the key factor in VGI is the volunteer geographer, as opposed to the expert cartographers and production of maps as discussed previously by Harley (1989); Peluso (1995).

Case Study One: Dar es Salaam: Bay of Peace?

This case study examines Dar es Salaam, from a geographic perspective. Dar es Salaam is already highly vulnerable to climatic variability, which is expected to increase as climate continues to change. The most frequent hazard concern to Dar es Salaam is heavy rainfall. A combination of poor drainage, unplanned construction challenges within public infrastructure, the addition of heavy rainfall and subsequent flooding, causes major economic and social loss, including death (Floodlist 2015). For the 75% of Dar’s population living in informal settlements, poor water and sanitation provision multiplies this threat with risk to diseases such as malaria, cholera, and dysentery, alongside periodic annual flooding, as seen in Figure 1.



Figure 1 Effects of Flooding in Dar es Salaam April 2015

Other physical factors that contribute to flooding in those settlements include flat topography, lack of storm-water drainage system, poor solid waste management leading to blockage of natural drainage systems, building in hazardous areas, unregulated housing and infrastructure development. Ultimately, the lack of maps and the geospatial data that underpins their creation prevents data driven decisions for flood prevention and preparedness. Community mapping is starting to bridge this gap.

Initiating Community Mapping in Dar es Salaam

In Tanzania community mapping was used from August 2011 to map and collect geographical information about Tandale, Dar Es Salaam, an informal or 'slum' neighbourhood as part of a knowledge exchange with Map Kibera (World Bank 2011) with a view to identifying sanitation and logistics needs. Eighteen community members assisted by twenty-five masters students from Ardhi University's School of Urban and Regional Planning participated in the mapping and were facilitated by an instructor to catalyse the process and advise on OpenStreetMap (OSM) methodology and editing. Mappers were combined into six groups, each for the six sub wards, and used GPS coordinates to points of local interest in their local vicinity, thus drawing substantial local knowledge.



Figure 2 Community Forum in Tandale

To start the mapping, community forums with community and local administrators and leaders were held in communal areas to update on progress (as seen in Figure 2), with physical paper maps being distributed. This aided with ensuring the map came from the *demos* of the community, allowing it to comment and share thoughts then incorporating community views into the map: by democratising the cartography the map can organically grow and incorporate features relevant for the community.



Figure 3 Community mapping for drainage system in Msasani bonde la mpunga

The second phase of community mapping consists of the mapping itself: the community teams using tools such as GPS' to annotating maps in the field as seen in Figure 3 above. This is an iterative process, until the community is fully mapped.



Figure 4 Before and after progress over the 2011 mapping effort

Figure 4 illustrates the potential for change, showing the temporal change of geodata in for Tandale over the 2011 mapping campaign, over 3 weeks. Based upon this mapping, at the request of communities, local and national government a consortium to support a larger community mapping program, under the name “Ramani Huria” – Swahili for Open Mapping – was formed. From this point, the main motivation of this paper and research question is *how can participatory techniques inform community flood resilience?* This question, two cases studies are presented: one regarding the social methodology of community mapping, the other discussing the technical elements of community mapping.

Ramani Huria: Towards Open Maps for Dar es Salaam

From 2014, community mapping has continued in Dar es Salaam, under the Ramani Huria project. Ramani Huria is a consortium of Commission for Science and Technology (COSTECH), Local Government at the ward level and

Municipal Councils which together participate on the mapping process, subsequently using the result in community and government decision making.

By way of example, let us first consider the evolution of community maps in Dar es Salaam under Ramani Huria. Figure 5 and Figure 6 respectively show the location of Manzese in the central urban area of Dar es Salaam before and after Ramani Huria's mapping. The detail of the map is evident: roads (main roads, secondary and tertiary roads), footpaths, drains, buildings, places of worship, schools and many other features are now mapped and openly available. While this is far from complete, this evidences a clear improvement upon map data prior to June 2015. This can be also contrasted with the areas surrounding Manzese, whereas Ramani Tandale was purely focused on the administrative boundary of Tandale, as such Ramani Huria is a much more expansive mapping campaign, which as of early 2016 has mapped over 1.3 million people in Dar es Salaam.



Figure 5 Manzese in OpenStreetMap after mapping



Figure 6 Manzese in Openstreetmap in 01/06/2015, before mapping

This method allows community members to map residential areas, roads, streams, floodplains, general land use and other relevant features. This data collection helps lay the foundations for resilience and response capabilities to areas that were previously off the map. Additionally, by directly engaging with local community groups, this also raises awareness of the need for flood prevention and risk reduction at a neighbourhood level.

Ultimately, this allows for a basemap that provides the foundation to investigate the causes of flooding more thoroughly. For example, some communities, like Tandale and Manzese are in basins, during high intensity flood events, some rainfall can cause severe localised flooding. Though, if the provision of drainage was improved on higher ground, it would suggest that localised flooding would be lessened, if not mitigated. Traditional techniques of hydrological modelling identify flood inundation areas, however, as the proceeding case study argues, this is also possible using a combination of the basemaps, created by community mapping and participatory community action.

Case Study Two: Participatory Techniques for Flood Inundation Mapping

This case study builds upon the method presented in the previous case study, in using the community created base map to support a further participatory mapping method that elicits community knowledge, identifying flood prone neighbourhoods and their historical inundation extents.

Community Led Inundation Models

- Traditional techniques are very expensive.
Inundation modelling is the application of computational models to determine the extent of flooding due to a wide range of processes which cost time and money. Flooding is a significant low land hazard threatening communities that requires mitigation planning. However, processes that contribute to inundation vary widely. They include long term rain season, annual climate variability, and short term meteorological events. Furthermore, their effects can vary significantly across an ecosystem due to the local topography.
- Eliciting community knowledge is a cost effective method, but also allows for a much finer granularity of information to be collected.

Our experience suggest that more work is needed to improve the use of mapping techniques with community members who have had less access to high education and who may not be socially or culturally oriented to using maps to describe and depict their experiences in their lived environment. When communities carry out surveys of their own area in to details, build an accurate knowledge of what their community actually looks like, in a way that keeps that information within the community, it not only puts them in a stronger position to represent themselves with local and national governments or NGOs, but the process itself can skill and build capacity within the community. That enables the community to establish for itself what problems it faces, and to begin to look for and implement solutions

- Method of community created open data.

Method used is participatory technique of seating down with the subward officer and street leaders. With the using of maps each member had time to trace (demarcate) the coverage of inundation areas within the subward on the map by using a pencil, rubber. Scanned and digitization of the areas marked as prone area i done through the JOSM and finally uploaded to the OpenStreetMap. Therefore the data will be available online and can be used to run the InaSAFE analysis for infrastructure vulnerability.



Figure 7 Community Elicitation of Flood Prone Areas



Figure 8 Community demarcation of flood prone neighbourhoods

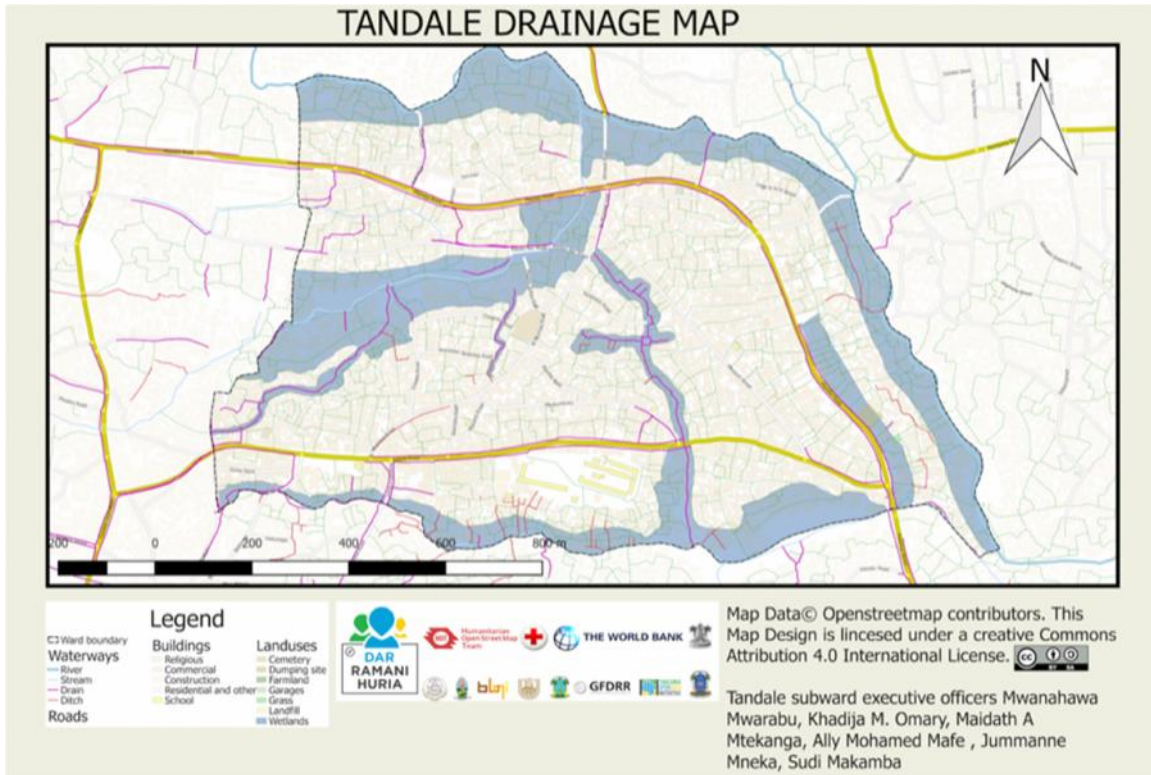


Figure 9 Resulting Community Level Map

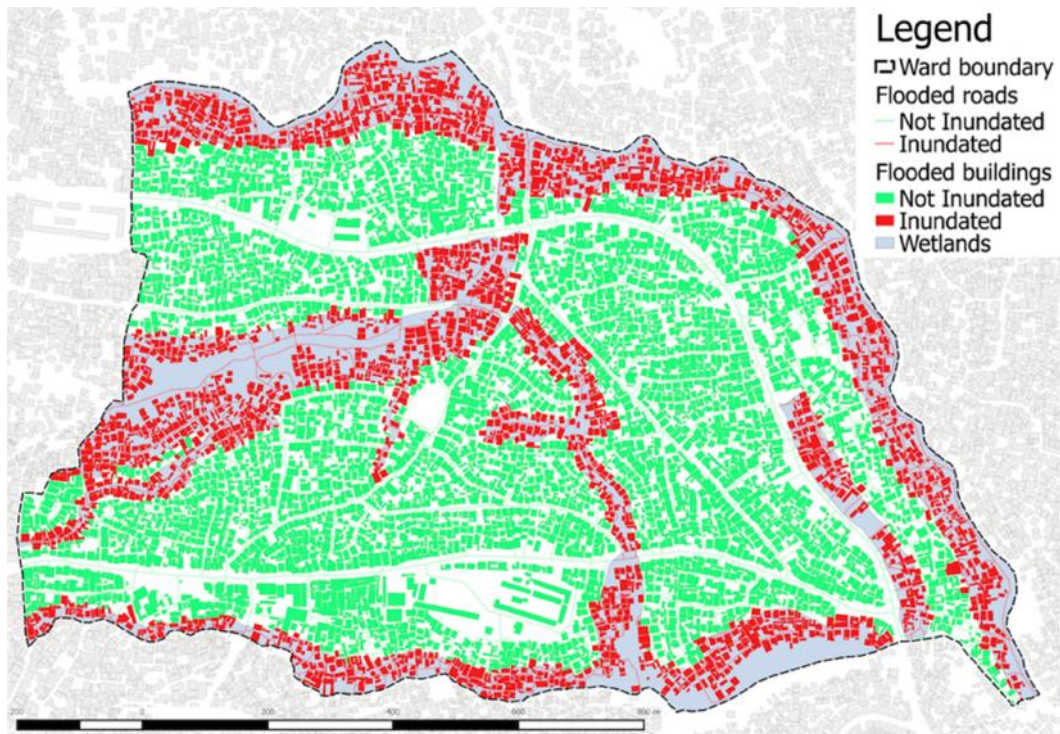


Figure 10 Identification of Infrastructure to Flood Exposure

When the maps are finished, they are combined with other data in InaSAFE, a free software that providing community leaders and flood responders with realistic natural disaster scenarios for better planning and response.

The View from the Skies: Using UAV Sensed Imagery

- Process of using drone imagery
- Supports local and remote mapping
- **Outputs of aerial image orthomosaic and point clouds**

Discussion

- OSM is a standard data mechanism – it makes the data interoperable – comparisons could be made with other countries to assess attainment of SDGs!
- Informal communities can be mapped using participatory techniques, reinforcing Soden (2015)
- Community mapping at scale offers a platform with which to pilot and experiment, such as UAVs.
- The current method means that most data collection is conducted locally. The emergence of international communities such as Missing Maps and other global international communities offer opportunities to collaborate. Offers potential efficiency gains in mapping through division of labour.
- Mapping parties are another form of community forum, albeit convened internationally
- New communities and technology is needed to store data collected by community mapping. OSM deals poorly with ephemeral data – should it though? OSM for point cloud data too.

Summary

By involving community members on using open source tools, the result is highly sophisticated maps of city neighbourhoods, demonstrated in Figure 5. This was done through knowledge sharing whereby the community shares their local knowledge about their areas, and experienced trainers teaching the community skills of making maps by using high-tech data collection tools such as GPS units and Unmanned Aerial Vehicles (UAV), to more commonly available tools mobile phones, computers, pens and paper.

At the heart of community mapping, the intent is to give the local community opportunities to improve the local understanding of their community's geography: creating awareness and a sense of responsibility among the community members to ameliorate and manage their drainage systems through preparedness activities, such as cleaning and maintenance of all drains and ditches before rain seasons. A side effect of this open, participatory process is that data is available for decision makers to make data driven decisions, at neighbourhood, municipal and national levels. This is a valuable addition to the toolkit of these decision makers, demonstrating the power of participatory methods, leaving these methods ready to be applied in new contexts and countries, indicating a bright future ahead for community mapping.

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