2. Cities can capitalize on ocean resources to address global climate change

Yokohama council's strategy of focusing on ocean resources highlights its unique and innovative approach to promoting environmental sustainability. The Blue Carbon Project is promoting decarbonization whilst creating jobs and demonstrates reverence for the ocean's value to humanity. In an interview by Alpatent with Japan's Blue Carbon Project Company,[20] Mr. Keiji Yoshikawa, Alpatent's director, stated that: "The attention attracted by blue carbon reflects its ability to alleviate global warming. CO_2 is easily soluble in water and 2.5 billion tons of CO_2 are dissolved in the ocean every year. Forests, on the other hand, absorb only 1.9 billion tons of CO_2 every year worldwide. So more CO_2 is actually absorbed by the ocean than the land. Global warming, mainly the result of GHG, has been a major problem for a long time. Blue carbon can be understood as CO_2 absorption by the ocean, and is very important for mitigating global warming". According to Mr. Yoshikawa, the high hopes for blue carbon reflect the current energy supply structure. At present, the world relies mainly on thermal power generation using fossil fuels such as oil and coal. This burning of fossil fuels releases large amounts of CO_2 into the atmosphere every year. Replacement of thermal power generation via vigorous development of solar and wind energy would reduce CO_2 emissions. However, in both financial and technological terms, the transition to renewable energy is difficult to achieve quickly. Nonetheless, reducing global CO_2 emissions remains an urgent need and this is one reason the world is pinning its hopes on the ocean's ability to absorb CO_2. As an island country surrounded by oceans, Japan in particular is emphasizing using blue carbon towards their goal of achieving carbon neutrality by 2050.

3. Promote coordination on blue carbon and green carbon projects to ensure a green, low-carbon transition[21]

While global forest coverage exceeds 30 percent, this only applies to the earth's land area and where over 70 percent of the planet is covered by ocean, blue resources have significant potential to help drive sustainable development which can be tapped in particular by coastal cities. In recent years, excessive deforestation and forest resource degradation has reduced the carbon sequestration capacity while desertification has also degraded the carbon sequestration efficiency of other terrestrial vegetation. Despite the ocean's significant size, blue carbon is facing huge challenges due to rapid urbanization and anthropogenic damage and pollution, especially island reefs close to shores, and to important plant species such as mangroves. If the terrestrial environment can be improved – particularly forest coverage and quality – and grassland resources can be expanded, the terrestrial ecological environment will be restored and improved. This will in turn endow the water flowing from land into the ocean with increased nutrition, expanding the ocean's microbial content and improving the health of seagrass and algae. Blue carbon will then naturally increase. At the same time, dead seagrass and algae can be converted into fertilizer and used for soil enrichment on land. Therefore, if the natural environments of both ocean and land can be protected, a low carbon world can surely be created.[20]

Dar es Salaam, Tanzania: Community-Driven Flood Resilience in Dar es Salaam's Informal Settlements[22]

Case background

As a commercial port city on the Indian Ocean, Dar es Salaam is considered to be one of the fastest growing cities globally with a projected 10.79 million inhabitants by 2030.[23] Where the Msimbazi River runs through the city and due to its lowland coastal orientation, it is especially prone to flood events as shown in Figure 4.12; however, such instances have been made more

20 Alpatent. URL: https://weibo.com/ttarticle/p/show?id=2309404787931176108654 (Accessed: 14/08/2022).

21 Carbon Neutral Cities Alliance. URL: https://naturebasedclimate.solutions/resource-database/yokohama-urban-blue-carbon (Accessed: 13/08/2022).

22 This case was co-authored by the UN-Habitat experts and the team of Dr. Chen Haiyun from Tongji University.

23 Population Division of the Department of Economic and Social Affairs of the United Nations. World Urbanization Prospects (2018).

frequent with rapid urbanization where 70 percent of its inhabitants live in informal settlements.[24] Issues such as clogged drainage channels due to inadequate solid waste management, a lack of outflow points to natural drainage areas, unplanned construction of housing, poor sanitation infrastructure, and reduced municipal capacity to issue flood warnings and evacuate communities, all amplify flood risk further exacerbating impacts to some of Dar es Salaam's most marginalized inhabitants. Critically, climate change and rapid urbanization are only exacerbating these issues. In April 2014, three consecutive days of torrential rainfall caused extensive flooding across the city causing 19 fatalities and displacing 20,000 people from their homes.[25] During intense rainfall events, many roads become impassable in these informal settlements whilst deep mud makes even short school walks virtually impossible and schools are forced to halt their operations. This affects the lives of thousands of people, hitting the urban poor the hardest through infrastructural damage and loss of livelihoods; highlighting the fundamental socio-environmental inequalities in the city.

Where flood-induced losses to human and economic capital are compounded by a lack of adequate infrastructure planning, this has in turn slowed the development of Dar es Salaam. Accordingly, it has reduced opportunities for its most marginalized inhabitants to find a way out of poverty, and has served as a major barrier where the city is transitioning into a regional commercial hub. The generation of effective urban disaster risk and response strategies has been a pivotal area of development for the city to embed environmental resilience into its vulnerable neighbourhoods and enhance the urban quality of those local communities. Despite being a key tool for informed decision-making and flood prevention, high-quality mapping is still lacking in developing countries including Tanzania as many local companies lack sufficient incentives to gather quality data. Maps that are produced remotely are often inaccurate, outdated, or do not contain sufficient data for urban decision-makers to plan in the event of disaster. Access to detailed, up-to-date maps is vital to improve disaster planning and response in urban flood zones, and to increase the adaptive capacity of Dar es Salaam

Source: Thomas Reuters Foundation - (photo by Kizito Makoye). URL: https://news. trust. org/item/20170104070454-rd34w (2017) (Accessed 16/08/2022)

Figure 4.12 Informal settlements along Dar es Salaam's Msimbazi River flooded after intense rainfall

24 National Bureau of Statistics (2013).

25 Reliefweb. URL: http://reliefweb. int/disaster/fl-2014-000053-tza (2014) (Accessed: 26/08/2022).

council and its local community in the face of shocks and stressors.

Following a request from Tanzania's Commission of Science and Technology (COSTECH) in 2011 to better address issues of flooding, the World Bank confirmed their support for the community-based mapping innovation Dar Ramani Huria (open mapping) in Dar es Salaam with funding from the Department for International Development. From July 2015, the Tanzanian Red Cross partnered with the World Bank through the Zuia Mafuriko (prevent flooding) project bringing a range of partners on board. With a common vision, they aimed to mobilize local communities to collectively map the city's vulnerable neighbourhoods to minimize flood impact in the most at-risk locations, enhance local knowledge and understanding on flooding and natural disasters, and inform evidence-based city and institutional planning. The municipality mandated the minimization of natural disaster risk, ensuring authorities and communities were equipped with the necessary tools and mechanisms to respond.

Implementation process

1. Establishing partnerships and roles: Dar Ramani Huria and Zuia Mafuriko

The primary management of Dar Ramani Huria was conducted through the Humanitarian OpenStreetMap Team (HOT) with support from OpenMap Tanzania, a local organization. The Tanzanian Red Cross led the Zuia Mafuriko project which enabled the integration of a network of partners and knowledge transfer across sectors with technical support and funding secured from the American Red Cross and Danish Red Cross. Students from Ardhi and Dar es Salaam Universities were also instrumental in training community members during fieldwork operations whilst local government officers from Dar es Salaam city council were also closely engaged as were COSTECH; the Global Facility for Disaster Reduction and Recovery; the Red Cross Red Crescent Climate Centre; the Tanzania Meteorological Agency; Buni Innovation Hub, Deltares (an independent water knowledge institute); and Digital Globe (a geospatial information provider).

2. Community mapping for urban risk exposure: Dar Ramani Huria 1.0

Initiated in March 2015, Dar Ramani Huria 1.0 was launched following a workshop with COSTECH marking the first phase of the project in which mapping work was facilitated across Dar es Salaam's most flood-prone wards. Critically, this sought to enhance knowledge at institutional and community levels on flood hazards, vulnerability and exposure – the three components of the risk framework – whilst promoting sustainable water resource management. The World Bank contracted HOT to facilitate work, partnering with 165 students from Ardhi and Dar es Salaam Universities who carried out mapping operations through industrial placements. In parallel, the Tanzanian Meteorological Agency led forecasting work with the Red Cross Red Crescent Climate Centre to identify localized rainfall forecasts to integrate into forecast based financing mechanisms. The Dar Ramani Huria team introduced themselves to local ward officers explaining the project, and sent introductory letters to sub-ward officials to initiate local cooperation after which they were introduced to Wajumbe local leaders (operating at the most granular administrative level). To begin mapping, students first collected information on paper obtaining the GPS locations of buildings, rubbish collection points, drains and other important features, from which data was then uploaded onto OpenStreetMap (OSM) – a collaborative web-based platform working to create a free and open-source map of the entire world. OSM facilitated digitization of the data and generation of highly accurate flood maps, although some issues did arise in corroborating mapping where GPS locations were taken incorrectly. Never-the-less, this first phase of the project showed authorities and local community members the power of mapping as a key tool to integrate into urban disaster planning efforts providing flood extent information to advise urban disaster risk decision-making and flood mitigation strategies. The generation of printed maps also helped local community members to establish new waste management initiatives to unblock drains and educate residents on the detrimental impact of littering.

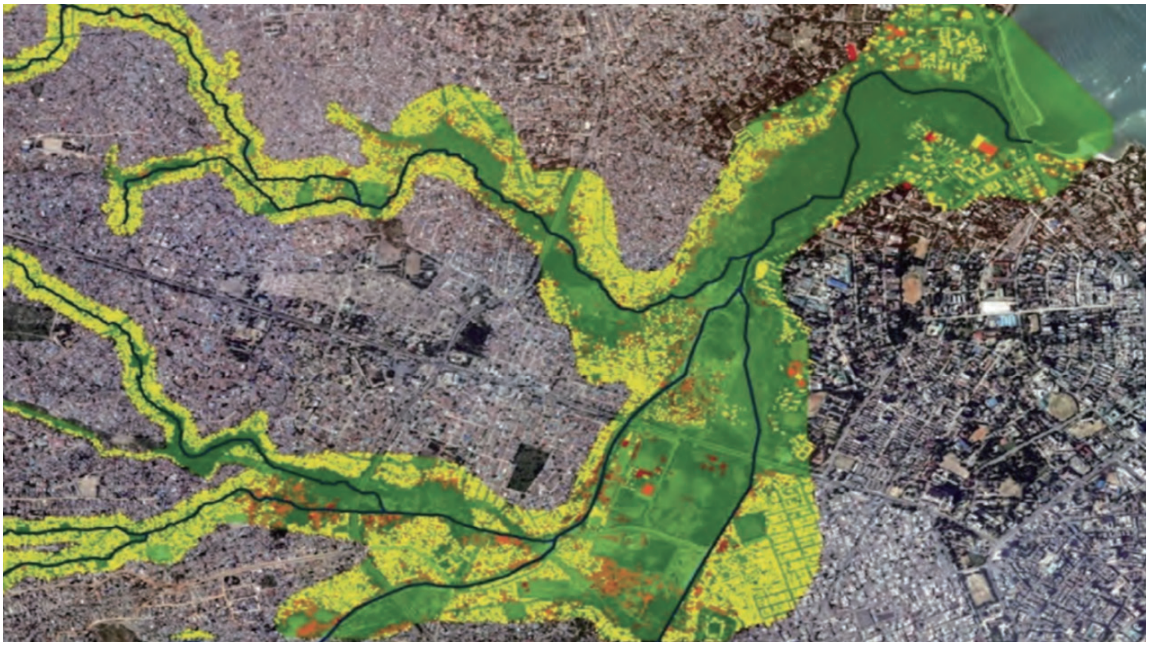
3.Developing flood early warning and response plans

Using the mapping and historical precipitation data, the Tanzanian Red Cross subsequently developed disaster preparedness and response plans for 3 of Dar es Salaam's municipalities (Ilala, Kinondoni and Temeke)

and 10 of the most flood-prone wards, cooperating with trained Community Disaster Preparedness and Response Teams. The plans set out critical early actions, preparedness, coordination and response strategies for disasters. Maps were combined with InaSAFe, a free software programme that enables users to run real-life natural disaster scenarios for improved response/planning. The Dar es Salaam Urban Forum was also established as a quarterly meeting enhancing coordination between relevant actors and bolstering long-term resilience planning. Collaboration between the World Bank (focusing on flood risk/community mapping and modelling) and the American Red Cross/ Danish Red Cross (funding community organization, flood preparedness/response planning) was essential, as well as direct engagement with local communities to ensure equitable resource allocation and gain local knowledge. Through the partnership, community mapping covered approximately 1.3 million inhabitants, 750,000 buildings and 2,000 km of road across the city enabling the production of a suite of flood maps, as shown in Figure 4.13, to aid local government planning. Community mapping and flood plans reached 540,834 individuals and 449 direct beneficiaries.[26]

4. Technological integration to improve data collection quality: Dar Ramani Huria 2.0[27]

In July 2017, Dar Ramani Huria 2.0 expands upon version 1.0 through a more sophisticated approach to data collection combining exposure and flood hazard data to perform disaster risk analysis. This new method integrated smartphone applications to aid comprehensive community mapping, leveraging OpenDataKit (ODK) and OpenMapKit (OMK) – intuitive applications equipped with imagery and forms for direct data collection – which allowed for monitoring field data in real-time and historical data collection tracing to identify any discrepancies. This resulted in a more systematic database stored on a central server, enabling users to access files remotely. Where OMK (an extension of ODK) was used initially, it was realized that data analysis was too complex in a polygon



Source: The World Bank. URL: https://documents1.worldbank.org/curated/en/694491555396781552/pdf/Volume-A-Strategy-and-Management-Framework.pdf (Accessed: 28/06/2022)

Figure 4.13 The flood buffer zone on the lower reaches of Msimbazi River

26 Tanzania Red Cross. URL: https://ctk.climatecentre.org/downloads/modules/training_downloads/A%20Partnership%20with%20Communities%20for%20Flood%20Resilience%20in%20Dar%20es%20Salaam.pdf (2017) (Accessed: 25/06/2022).

27 Dar Ramani Huria. URL: https://ramanihuria.org/en/2018/07/16/community-mapping-for-flood-modelling-2-0/ (2018) (Accessed: 28/06/2022).

format (particularly when developing heat maps where point data was required), so the team then switched to ODK (an open-source mobile data collection platform that replaces paper forms used in survey-based data gathering) which enabled data point collection and survey development to establish flooding trends in the wards.

As a first step, Wajumbe leaders selected individual community members who owned smartphones to install ODK Collect from which they could ensure that survey forms were downloaded from the server and check GPS accuracy (typically less than 4 m). Via a number of questions, ODK guided surveyors through a step-by-step process ensuring a high degree of accuracy. Dar Ramani Huria field teams could then train community members to collect data using ODK, teaching them analytical techniques to ensure a comprehensive assessment of all wards. Trained students also worked with local communities to perform ground surveys adding a range of data layers such as the type/dimension/condition of drainage networks, infrastructure and assets.[28] Field data was visualized according to Mjumbe[29] jurisdictional areas within which survey question coverage could be determined for each cluster.

The team was able to clearly show respondents answers regarding flood history in their area, from which they created new datasets for the reported flood years. Drains were remapped with a more detailed drainage model, placing attention on connectivity. A specialized Dar Ramani Huria team surveyed, cleaned and quality checked the drainage data, producing associated datasets for 20 wards (Buguruni, Hanansifu, Ilala, Kigogo, Kijitonyama, Kinondoni, Magomeni, Makumbusho, Manzese, Mburahati, Mchikichini, Mikocheni, Mkurumula, Msasani, Mwananyamala, Mzimuni, Ndugumbi, Sinza, Tandale and Vingunguti). Ward data was quality checked using Deltares Hydro – OSM quality data assurance model, a toolbox which identifies errors/warnings/missing information and which converts OSM data into individual data layers to use for hydrological and hydraulic modelling, and generates a topologically accurate 1D network.

5. Generating high-quality data maps

By combining digital applications with locally available tools, Dar Ramani Huria successfully generated high-quality data maps as shown in Figure 4.14.[27] This data then fed into maps highlighting inundation and flood extent, drainage connectivity, rubbish points, community assets and community vulnerability and exposure. Additional activities such as soil sampling and the development of elevation tools to improve flood forecasting models were also undertaken. These later helped to inform municipal agencies and communities to better prepare for floods understanding water flow routes, channel widths and capacities, the location of businesses/assets and critical facilities (e.g. schools, hospitals, shelters, etc.). Dar Ramani Huria has since worked on new solutions, deploying drones which can be used in cloudy conditions. This has made it simpler to map different features, monitor infrastructure and river basins leading to quicker flood response times. Where over 1,000 students and 300 community members were involved, they acquired invaluable knowledge across a suite of open mapping tools, enhancing their technical skills and awareness on data. The project has developed stronger, more prepared communities, cultivating a greater desire for data-driven urban policies and decisions.

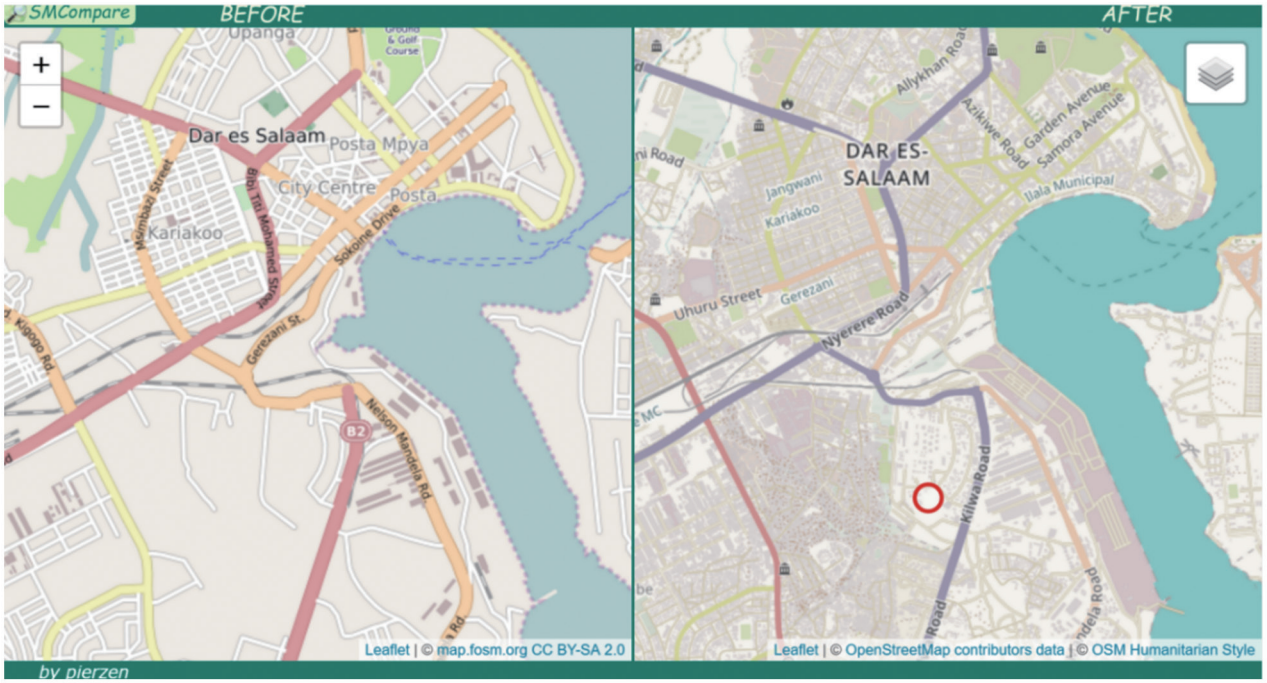
Reference experiences

1. Assess socio-environmental inequalities in urban disaster risk and prioritize those at most risk in resilience building measures

The case of Dar es Salaam has made the intrinsic vulnerability that poorer, marginalized urban communities are faced with in regard to natural disaster risk visible. A combination of poor infrastructure, reduced adaptive capacity (e.g. a lack of early warning systems/awareness and mitigation components) and geographic susceptibility to flood events in Dar

28 Winsemius. H. URL: https://medium.com/@h.c.winsemius/using-community-mapping-for-flood-modelling-c04976d3e982 (2017) (Accessed: 29/06/2022).

29 Mjumbe: Singular of Wajumbe.



Source: Dar Ramani Huria. URL: https://ramanihuria.org/en/ (Accessed: 30/06/2022)

Figure 4.14 A comparison of maps of Dar es Salaam before and after the Dar Ramani Huria initiative

es Salaam's informal settlements reinforces the importance of targeting high-risk neighbourhoods within city resilience strategies, areas which accommodate the most socio-economically marginalized dwellers. In line with the SDGs leave no one behind principles, cities and municipal governments must equate socio-environmental justice as a core component to sustainable urbanization to build resilience and prosperity in such vulnerable urban communities.

2. Understand the value of community maps as a key tool to inform urban resilience strategies and strengthen local adaptive capacity to disasters

Within the context of flooding and natural disasters, community mapping can serve as a powerful tool for change to create more environmentally resilient communities. As exemplified through Dar Ramani Huria, the generation of accurate, highly detailed maps can guide municipal governments and urban practitioners to make more informed urban flood mitigation/DRR strategies. Throughout the project, community-based mapping captured key infrastructure and water bodies, helping to strengthen risk identification, raise awareness of climate risk, and build the capacity of institutions and local communities to better withstand flood events. This collaborative approach to mapping helped transfer knowledge to neighbourhood leaders and local community members equipping them with highly valuable skills for mapping, digitizing, and modelling risk. As versatile skills, they are widely applicable to a number of areas and have promoted self-organization within the respective communities and increased the ability of local citizens to diversify their livelihood options and adapt to change whilst also enhancing the capacity of Dar es Salaam council's planning sector to innovate and generate data through community involvement.

3. Build partnerships between urban practitioners and communities that promote the integration of Big Data with local action to build resilience

Where Dar Ramani Huria worked directly with neighbourhood/area leaders and community members, the creation of partnerships was crucial to ensuring Big Data translated into local-level action (see Figure 4.15). The deployment of geocoded data layers developed in tandem with local communities fed into

Source: Reliefweb. URL: https://reliefweb. int/report/united-republic-tanzania/ramani-huria-atlas-flood-resilience-dar-es-salaam (2016) (Accessed: 02/07/2022)

Figure 4.15 Community residents actively participating in the project

more extensive community dialogue, DRR strategies and planning processes. In this respect, Big Data played a catalyzing role in stimulating new cooperation and partnerships, fostering the articulation of mapping efforts among a range of development stakeholders. Urban practitioners should understand the potential of Big Data to build urban environmental resilience and bolster development pathways, building local capacity and driving evidence-based decision making.

4. Ensure that data is accurate, accessible and actionable for its effective use in urban risk management

Where it is essential that data is of high-quality, data vetting through quality assurance mechanisms was essential to gain trust and ensure informed decision-making in the city.[30] Dar Ramani Huria continually tested new technology and methodologies to review data quality, enabling local teams to detect any issues efficiently and ensure the highest-quality of data possible. Capitalizing upon open-source software enabled a cost-effective, flexible approach to data collection in which mapping was made accessible, performed remotely with the aid of GPS devices and smartphone applications. The project provided a robust capacity-building programme for local mappers whereby data could be integrated into OSM allowing for high-quality digitalization and visualization during assessment. Data could also be easily applied to guide strategic disaster planning whereby its combination with additional software (e.g. InaSAFe) generated realistic flood scenario models, whilst direct training in disaster preparation across local communities further increased data actionability. Urban practitioners should therefore prioritize data that is accessible, easy to analyse and effective to integrate into disaster-related decision-making processes.

30 Humanitarian OpenStreetMap Team. URL: https://www.hotosm.org/projects/community-mapping-urban-risk-exposure-in-dar-es-salaam-ramani-huria-extension/ (Accessed: 02/07/2022).