Smart and Sustainable Port-Cities

Overview
Coastal Cities in the WIO are dealing with profound levels of urban coastal development, mega projects, and population growth. The economic benefits associated with development need to be weighed against the impact on coastal ecosystems, capacity for climate change adaptation and mitigation, waste management and socio-spatial impact. The mini-symposium presents a regional analysis on smart cities and the outcomes of port development on land-use land cover change in port-cities from a multi-disciplinary perspective.

The session is divided into two segments aimed at showcasing the research outcomes of the smart port-cities research projects and their contribution to local municipalities, port authorities and stakeholders. The smart port-cities segment (Bandari Bora) provides an assessment of LULC in Mombasa and Durban. It provides insight into the socio-spatial impacts experienced in Mombasa due to ongoing mega-projects and the persistent impacts in Durban residential areas due to transport and logistics operations increasing. It concludes with a presentation on the role of machine learning and decision support systems for port-cities. The smart cities segment (Miji Bora) analyses institutional and technological innovation in cities, and how machine learning and events such as hackathons can contribute towards identifying integrated solutions to coastal city challenges. A photo story on the impacts of the April floods in Durban ends off the mini symposium.

Target participants
Target participants include, but is not restricted to, scientific researchers, policy makers, marine scientists, city planners, postgraduate students and engineering professionals who are interested in plastic waste management.

Outputs
- Review Paper based on all the talks:
  - Establish current state of knowledge on coastal cities issues and port planning in the WIO region
  - Review gaps that persist and positive outcomes following 4 years of implementation smart-port cities projects in the region
  - Identify priority actions for future follow-up in future research
- Time Frame: Completed in January 2023
### Structure of talks

#### Panel discussion

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Interaction of Port development to City Inhabitants: Measuring the Socio-spatial Scale of Mombasa

Authors

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Background

Coastal cities are experiencing the highest migration resulting in increasing coastal urban populations. Mombasa port-city recorded a stark increase in its population, shown in the census conducted in 2019 compared to the last census conducted in 2009. Mombasa derives its economic revenue from transport, port operations on the city side, tourism and fast moving consumer goods. Hence, a substantial percentage of the population is from outside the county, living and working full time, or commuting daily from Kwale county on the ferry or Likoni walking bridge. The migrating and indigenous population view Mombasa as a city of opportunity and a better life. The county government has embarked on various planning and policy initiatives to improve quality of life, provide basic services, and economic opportunities. Ongoing projects derived from the JICA master plan, and special economic zone (Donga Kunda) will propel Mombasa’s economic status once they are completed. These plans support the continuing port development, and operating standard gauge railway line.

Infrastructure development has pros and cons, which have an impact on the socio-spatial arrangements in the city. Considering the infrastructure developments that are ongoing in Mombasa the study seeks to understand and reveal the social implications. Hence the objective is to evaluate the impacts of port development and operations on urban socio-ecology, socio-economy and socio-spatial arrangements in the city.

Methods

A household survey of Mombasa was administered using a data collection mobile application in November 2021. The geographic areas covered were within a 5km radius of the port. It must be noted that the port is linear stretching along the island from the Likoni bridge north towards the airport. Neighbourhoods such Chaani, Chamgamwe, Makande and Ganjoni were part of the 426 Households surveyed. Data was collected using the GeoODK mobile application. GPS coordinates and photographs of the landscape were taken from outside the households to assess the land-use and infrastructure development. The survey themes were: respondent and household demographics, livelihood strategy (especially those with a connection to the port), transport use, and life/living conditions in Mombasa.

Results

The key findings in the household survey show that 70% of the people living in the sampled areas are not originally from Mombasa but from neighbouring counties. Their livelihoods depend on the port i.e their customers are port employees, they work in the transporting cargo (truck drivers), derive casual work at the port. There are mixed responses in relation to infrastructure in the city and how they are benefiting. From an environmental and health perspective they complained about dust (new roads and routes under construction hence less
tar roads), chemicals in the air affecting their eyes and the bad smell. Economically, their livelihoods have been highly affected by the implementation and operation of the Mombasa Standard Gauge Railway (SGR). The SGR was implemented to alleviate port congestion and truck congestion by moving containers from ship to railway to the container freight station in Nairobi. From Nairobi containers are picked up and taken to their respective destinations in the city/country or one of the seven landlocked countries dependent on Mombasa port for importing and exporting goods.

Conclusion

Mombasa is an important gateway port-city with road and rail links to land locked container handling facilities and countries relying on the port for their imports and exports. Infrastructure development in the past 10 years has changed socio-spatial planning and had an impact on livelihoods. The dominant infrastructure development projects affecting residents in the household survey are roads, the SGR and housing. The outcomes of the study are being communicated with county and port authority, with the aim of creating a strategic framework of engagements to port development processes. The outputs will inform the county decision makers on the current impacts from port activities to the city.
Evaluating port development on sustainable port-city land-use development; case study of Mombasa port-city

Authors:

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Background

Past approaches to port-city planning have focused on the port and the city as two separate entities instead of them being an interlinked system. The port and the city make up the port-city system through the various urban linkages in the socio-spatial, economic, environmental and governance spheres of the port-city region. Globally, ports have over the years been undertaking projects to increase their cargo handling capacity with little regard to sustainability over the years. These activities are majorly large-scale infrastructure projects characterized by the construction of new port facilities and terminals as well as dredging operations.

In the Western Indian Ocean (WIO) region, such developments often happen within the context of limited land within and around the port and the general port-city region. ‘Artificial land’ is thus created by port authorities through sea reclamation to host the port developments. Alternatively urban land uses including public land are converted for port related activities. Hence the permeability or porosity of port land uses presented a challenge to sustainable port-city development. The spatial extent of such porosity is especially prevalent where governance systems involving port and city authorities are less coherent leading to fragmented land-use patterns within the port city.

In the port-city of Mombasa, such actions bring about the dominance of port related land use to other land uses. Subsequently open and green spaces, conservation areas, fishing grounds and residential areas were converted to port related land uses over time.

Port related land uses tend to be predatory in nature and would penetrate the urban fabric of the port city leading to competition in land use. This causes an imbalance in sustainable port-city development. Examples include where port facilities would be established in residential areas leading to the mixing of passenger and freight traffic, thus increasing traffic congestion within the port city. The increased traffic congestion is a contributor to Nitrogen Oxide and other pollutants. The proliferation of the port related land uses within the city also results in greater urban heat island effects within the port city as they tend to be made of impervious surfaces that tend to exhibit a high level of heat reflection.

When port development is coupled with such effects it creates unsustainable city development that does not meet the SDGs (Sustainable Development Goals) and, in particular, goal 11.

Study Objectives

1. To investigate the inter-connection of port development and city development over-time.
2. To interrogate performance of port development in Mombasa on land use.
3. To propose measures that could be adopted in port development which would promote sustainable development.

**Description of the Problem**

In regard to port-cities in the WIO region more so Mombasa port-city, city development was historically linked to port development. Past city development plans outlined areas for port expansion as well as designated land uses within the city. In the mid-2000s the Kenya Ports Authority (KPA) embarked on increasing its cargo handling capacity leading to a shift from this position.

Over time the KPA and government agencies built new berths, container handling terminals, dredged the Kilindini channel and developed freight corridors during this period. In order to accommodate the increased cargo volumes, the port sought to create new port lands through sea reclamation. Additionally, the reclaimed areas were still unable to handle the high volumes of cargo, forcing the KPA to license private cargo handling enterprises. These private players operated as CFSs (Container Freight Stations) and ECTs (Empty Container Terminals). Mombasa has limited land capacity and is currently the smallest county in Kenya.

As a result of this unilateral policy direction by the KPA; public lands, open and green spaces and the coastal shoreline were altered. The port city of Mombasa thus began to see fragmented land use patterns, loss of open spaces, degradation of the shoreline, and the loss of fish landing sites.

**Methods**

Desktop surveys, context analysis of available literature and archival records were perused to establish the inter-connection of port and city development over time. Mapping of port development, facilities as well as port related enterprises was conducted using participatory approaches and remote sensing to evaluate port performance in the port-city. In addition, social surveys were carried out carried out among households and commercial areas to inform on the desired outcomes as envisioned by the port-city residents.

**Results**

The high levels of porosity of port-related land uses within the port-city results in high levels of pollution in the port city. This leads to a negative correlation between port development and sustainable port city development. The expansion of the port through sea reclamation for instance led to the loss of the Kwaskembu fish landing site in Jomvu leading to the disruption of livelihoods to the local fishermen. It was also submitted that the 75% of the CFSs and ECTs within the Mombasa port-city island were former public spaces dealing as open spaces, transport facilities or the coastal shoreline. This occurrence gave rise to fragmented land use patterns within the port-city of Mombasa. The CFSs and ECTs handled approx. 400,000 TEUs (Twenty Foot Equivalent). Consequently, this brought about traffic congestion due to increased freight traffic which had direct links to greenhouse gas emissions, noise pollution and urban heat island effect in Mombasa. Sea reclamation on the other hand reduced the fish stock in the ocean and the degradation of the shoreline.

**Conclusion**

Port-city development needs an integrated approach by the port and city authorities especially with regards to the location of port related land uses in order to promote sustainable development in the WIO port regions.
Understanding the macro and micro determinants of a sustainable port cities and decision support using a machine learning model.

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Background
The Port-City is characterized by the interaction between the port and the city. Thus, its very definition is derived from the degree of intimacy or conflict that the two entities have established over the years. Over the decades, ports have been both peculiar and generic places: made of the same constitutive elements, they combine their language with the urban one, making port cities universal categories, mirrors of each other. According to Moretti, over the twentieth century, the city-port relationship has evolved, making it ever more contentious when it comes to defining its nature and metabolism (Moretti, 2021a).

Ports are significant nodes in the countries. As the nexus of the global economy, ports have played a key role in allowing and enabling flows of information, goods, resources, and people inside those countries, between countries, and across seas and oceans (OCDE, 2014). Ports have typically been positioned in urban areas and have played an essential part in the consolidation and growth of many port cities, not only economically but also culturally, intellectually, and socially (Bandarin and van Oers, 2012). Cities, on the other hand, serve as spatial carriers, laying the groundwork for port growth (Akhavan, 2017).

Many cities throughout the world have developed a close relationship with their port since they owe their origins to the location of their port. Traditionally, a city's economic activity was tied to its port, which served as a source of employment and commercial linkages with the global markets. While port operations have improved, they also pose challenges for the communities in which they are located, for example, local air pollution from ships or inland transportation, traffic and congestion, and the colocation of hazardous or polluting industrial sites near ports. These issues interact with related urban dynamics and have an impact on urban planning, well-being, and other areas. On the other hand, as urbanization processes have accelerated, the city's population has increased, and the city's size has become greater and larger, putting more pressure on the environment.

Although port-city interaction and sustainability are becoming increasingly essential, prospering regional economy and facilitating international shipping trade, problems of their mismatch and incoordination have also been aroused. Thus, research on their relationship is necessary to generate profound enlightenment on how to achieve healthy and benign development for ports and cities. This paper aims to decouple and analyse the linkages between ports and cities to build a machine learning model based on these linkages/indicators, which can foster sustainable development of port cities.

Problem statement
It is without a doubt that ports and cities have one of the most complex and intriguing relationships. Over the years, studies of economies, markets and businesses have largely ignored the environment, treating it as an externality. Similarly, small to large-scale models of climate and the environment do not factor in the dynamics of human interactions, markets, and
economies. Given that neither port nor city is democratic, it will be beneficial to model their interaction while also being cognizant of the dynamics of both environments. As Moretti also emphasizes, “port city interaction extends into a field with variable depth in which conditions, functions, uses, artefacts, and destinies all persist, and It would be beneficial to include them in a single vision capable of working with the synergies of the differences by transforming them into added value” instead of externalities (Moretti, 2021b).

The modelling frameworks that would integrate all these interacting domains with some degree of usefulness have yet to be developed. This research is aimed at solving this gap by integrating network analysis, gravity models, and spatial interaction models in a single machine learning model that can take any indicator and aggregate it into a function of other indicators.

**Objectives**

The overall objective of this research is to model how port and city interact to understand how this interaction affects the port city ecosystem. Firstly, we investigate the linkages between the port and the surrounding urban tissue. Secondly, we evaluate the causal relationships for sustainable port-city indicators through an iterative process.

Investigating port cities' interactions will involve multi-faceted data ranging from socio-economic, economic, infrastructure, satellite images, and environmental data. These datasets will be gathered from various sources, while others like land-use intensity and functional land use will be generated from satellite images.

Before data analysis, a thorough data cleaning exercise will be conducted on all the datasets; Some of the analyses conducted include network analyses to identify the centrality of the key nodes in the city. Path analytics and community analytics to determine the predictors in the casual port city ecosystem. Remote sensing spectral analyses was used to characterise functional land-use and intensity.

**Results**

i. Weighted threshold grid of port influence
ii. A machine learning model for decision support
iii. A casual network of port city linkages and determinants

**Conclusion**

The proposed model will have a variety of applications that will shape the future development and policy formulation that, in the long run, will support the sustainable development of port cities. For instance, with the proposed tool, one can formulate a solution that optimizes green space, promotes a blue economy, and also provide space for port expansion.
Augmenting or subverting sustainable growth outcomes: External funding, policies, and community agendas in coastal cities in emerging economies.

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Abstract

The implementation of policies to achieve sustainable cities in emerging economies is frequently hindered by potential trade-offs between priorities for the provision of basic services, political interests, and economic outcomes. The manner in which these inform policy approaches remains clouded within the melee of multiple agendas, such as bottom-up, community-led, top-down and international agreements. In addition, the role of targeted, but narrowly defined international aid funding, in altering the policy trajectory anticipated by city policies/plans, especially towards major projects, is significant. These extra-jurisdictional influences and the interventionistic nature of external partners can/do shape the form and function of the cities. However, ways in which these conflict with, or synergize policy actions towards achieving sustainable growth outcomes are rarely explored.

This paper examines ways in which external funding for major projects in the coastal city of Mombasa influences the existing policy intents and benchmarks the funding objectives with sustainability outcomes. The paper integrates multiple lines of evidence gathered through an eclectic mix of qualitative techniques, namely; stakeholder interviews, document analysis, and observations.

The paper finds that the justification for external funding is foregrounded on economic outcomes with environmental and social impacts pushed to the background. Much of the international funding received by the city in the last 10 years did not align with the predetermined vision and city plans outlined as outlined in various documents. This points to a tendency to treat projects in isolation of existing policy contexts and priorities. There was no evidence to suggest that the implementation of the externally funded capital works took into consideration co-design approaches to enhance local governance capacity.

The implication for cities in emerging economies is that there is a need to strike a balance between being open to external influences and remaining faithful to predetermined policies. Whether or not economic transformation is viewed as a key driver of social development, projects should be rigorously benchmarked against existing policies, and the effects on those they are designed for.
Coastal cities are already experiencing negative impacts of climate change hence attracting more attention to mainstreaming climate change mitigation and adaptation actions in sectors that emit greenhouse gases (GHGs). The transport sector is key to the development and economic growth in coastal cities. Growth in the sector has significantly contributed to climate change due to over-reliance on fossil fuels for combustion emitting Greenhouse gases into the atmosphere. Contrary, Climate change hazards such as sea-level rise, heavy rains, storms, flooding, and high temperatures have disproportionately affected the transport infrastructure leading to short and long-term risks in transport operations. For sustainable coastal city development, knowledge of the nature of transport infrastructure and the impacts of climate change is vital for appropriate interventions. This paper takes a deep cut at GHG emissions from the transport sector in Mombasa city through a review of transport status, challenges, interventions, and case studies globally, at regional and local levels, and examines key policy levers for change and consideration of governance issues around them. The research used stakeholders' engagement methods through key informant interviews, and dialogue with key stakeholders from the energy and transport sector. The study established gaps such as the conspicuous lack of standards for accessing GHG emission in the Transport Sector, lack of capacity to do GHG assessment, lack of monitoring of stationary heavy commercial vehicles around the port area, and lack of infrastructure for non-Motorized means of Transport (NMT) and alternative sources of energy for transport stakeholders willing to switch from fossil fuel sources. The study recommends that three-wheelers and fourteen seater vehicles to be prioritized for assessment, assessment of the ambient air quality for Mombasa and GHG emission from public service vehicles, a ban on the usage of fuel engine three-wheelers for more than three years and adoption of Bus Rapid Transits, electric engine three-wheelers in Mombasa City, need for well-demarcated walking and cycling zones to promote NMT, intense capacity building on climate change impacts to city residents and investment in infrastructure as a key to enable regulatory authorities to measure exhaust emission.
Stakeholder placement in Institutional re-alignment to transition to sustainable coastal cities

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Cities have become a focal point for production, exchange and consumption, and urbanisation is characterised by mass consumption with the fastest urban population growth. The larger coastal populations exacerbate the already growing social-economic and environmental problems associated with pressures of housing quality, air pollution, water and sanitation and climate change. Coastal cities. Yet in the case of Mombasa, its island nature has limited the city in terms of space to sequence these transitions. Furthermore, the current adaptation initiatives are either small in scale, opportunistic in nature or accidental in their application. To facilitate learning, co-generation, and co-creation of knowledge among policy makers, urban researchers, and other stakeholders, a key component is stakeholder engagement in project activities.

First, we identified the key issues of interest to the County Government of Mombasa (CGM) and set these as our thematic areas of focus. Stakeholder prioritised the key drivers of urban form as being Solid Waste management, Water and Sanitation, Energy and Transport, Sea level rise. Next, we adapted a dialectic mix of methodologies to define stakeholders, identify individuals/groups of stakeholders matched with respective urban issues. We used Stakeholder Analysis (SA) applying power/interest matrix to determine the variables affecting stakeholders’ relative influence and interest. This activity facilitated the project in identifying potential partners with shared vision to enable mutual understanding, and to evaluate the potential of shared learning and discourse on present and future areas of cooperation in the city.

The stakeholders identified cut across global, regional, national, and local level stakeholders and were either primary or secondary stakeholders in respect to the project’s issues of concern. They also clarified who the key duty bearers were and their responsibilities and influence in relation to the key issues of concern. Stakeholders have a high interest and influence on a particular thematic area for example solid waste management or water and sanitation but lacked interest or capacity to influence other key issues. Networks of partners form a basis for genuine outreach and create synergies among actors in the city to share experiences, achievements, research outputs and governance efforts for the purpose of charting a unique path towards an environmentally and socially, economically sustainable and Smart City. The Stakeholders have developed the Mombasa Smart and Sustainable City Forum (MSCF) within this action research study. The purposes is to influence institutional matters by hosting a series of physical meetings, webinars, dialogues, workshops and learning based exchanges cutting across the priority thematic areas.

The Mombasa Climate Change Policy formally envisages the establishment of a multistakeholder forum bringing together city stakeholders and repositions county departments to improve engagement and integrate climate considerations in the plans and activities. The continuous engagements between stakeholders and key county government departments would position cities on the right trajectory to transition to low carbon economy. This however would
require a strong and deliberate network of partnership to support sustained information exchange.

Durban underwater. A photo essay of the April 11th & 12th April 2022

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On 11th and 12th April 2022 Durban received 1/3 of its annual rainfall over the course of one evening. This rainfall was preceded by two days of hard rains, so all ground space was saturated, and on Tuesday 12th there was massive flooding in KwaZulu-Natal, particularly within Durban. Over 450 people lost their lives with over R 17 billion (Rands) damage estimated and over 40,000 people displaced. Two key impacts from the rainfall were land slips through developments and riverine flooding. Because of the geology of the region, land slips are to be expected, but actions to stabilise slopes as best as possible are being mooted. Much of the damage from flooding was due to culvert blockages, as trees, alien invasive vegetation, solid waste and silt blocked river flow causing changes in direction of said flow, usually through developments. Preventative solutions, like Durban’s Transformative River Management Programme, are now being planned for city-wide implementation. One good news story has emerged of the City’s Forecast Early Warning System being paired with a local network in one of the worst affected informal settlements, Quarry Road West, where no fatalities due to flooding were recorded, despite the loss of over 450 dwellings. A photo assay of the flooding causes of damage and solutions offered is put forward for discussion at WIOMSA, as a precursor to a peer-to-peer learning exchange being planned for June 2022.