Climate & Development Knowledge Network

FUTURE CLIMATE FOR AFRICA

# POLICY BRIEF

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## Key messages

- Africa requires substantial investment in port infrastructure in the coming decades, to meet the demands of fast-growing maritime trade.
- Port infrastructure is designed for a lifetime of many decades and may be operational in a future climate that will be significantly different to the historical climate used for planning and design.
- Ports are highly vulnerable to climate-related impacts. Their location in often dynamic coastal environments places them at risk from storm surges, extreme waves, high winds and extreme rainfall.
- A close dialogue is needed between climate scientists and the port industry to translate awareness of climate risks into practical actions to reduce those risks.

**About FCFA**

Future Climate for Africa (FCFA), is a new five-year international research programme jointly funded by the UK's Department for International Development (DFID) and the Natural Environment Research Council (NERC). The Programme will support research to better understand climate variability and change across sub-Saharan Africa. More information is available at http://www.nerc.ac.uk/research/funded/programmes/fcfa/ The programme will focus on advancing scientific knowledge, understanding and prediction of African climate variability and change on 5 to 40 year timescales, together with support for better integration of science into longer-term decision making. CDKN is responsible for coordinating the FCFA scoping phase – an 18 month exercise uses six case studies in sub-Saharan Africa to evaluate the needs of science users in the context of the capabilities and limitations of current science. This brief is the fifth in the series.

# The use of climate services for long lived port infrastructure

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## Introduction

**Long-lived infrastructure is inherently exposed to climate risks through its longevity, irreversibility and high initial capital cost.[1] Major transport infrastructure is often designed for a lifetime measured in many decades and may be operational in a future climate that will be significantly different to the historical climate commonly used for planning and design. Figure 1 illustrates this concept by mapping the life spans of different types of major infrastructure built in 2010 onto future temperature projections over the coming century. It shows both a change in climate from historical conditions, and increasing uncertainty as emissions scenarios diverge.**

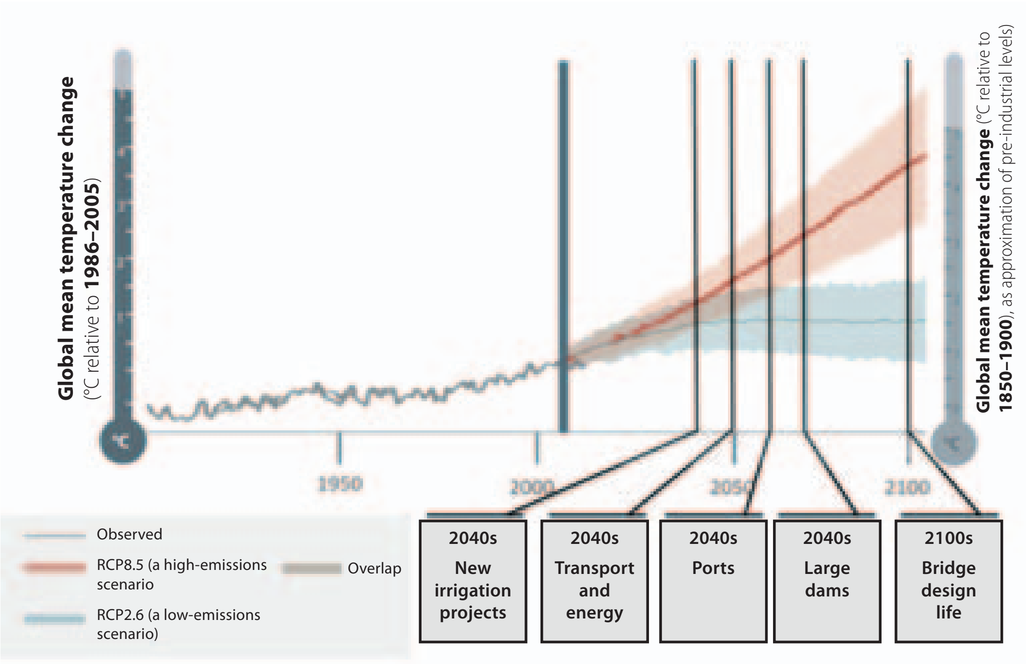
**This policy brief focuses on port infrastructure in sub-Saharan Africa. It investigates the climate change risks, the use of climate services in decision-making and makes recommendations for actions to enhance the resilience of port infrastructure. It summarises a more comprehensive paper[5] prepared to support the scoping phase of the Future Climate for Africa (FCFA) programme for the ports sector.**

## Trends in African port development

With approximately 80% of world merchandise trade carried by ships, maritime transport remains by far the most common mode of international freight transport. It is the backbone of international trade, offering the most economical and reliable way to move goods over long distances. In the African context, maritime transport represents the link between the African continent and global markets. For example, the Port of Durban serves the economy of not only South Africa but also provides a vital link for landlocked countries in Southern Africa including Botswana, Lesotho, Malawi, Swaziland, Zambia and Zimbabwe.[6]

Since the mid-1990s, the volume of both general cargo and containerised cargo passing through African public ports has trebled.[7] At the global level, the Organisation for Economic Co-operation and Development (OECD) projects a quadrupling of container traffic by 2030,[8] implying the need for substantial investment in port infrastructure

**Figure 1. Indicative timescales of a range of infrastructure planning activities compared with timescales for climate change**




*Source: Adapted from IPCC (2014)[2] with selected infrastructure lifetimes from Stafford Smith et al. (2011)[3] and UNCTAD (1985)[4]. Note that infrastructure lifetimes are indicative and will vary considerably in practice.*

over the coming decades. Research by Mundy and Penfold[9] found that new national port plans, which emphasise the development of physical infrastructure as well as institutional and regulatory reform, were being undertaken in 50% of the 31 African countries in the study.

This infrastructure development will include new deep-water ports, expansion of existing ports and the rehabilitation of port infrastructure. It will be both long-lived and subject to a range of climate risks such as storm surges, extreme waves and sea level rise. African ports are among those projected to see the greatest increase in exposure to coastal flood hazard over the coming century. Hanson and Nicholls[10] estimate that Conakry, Douala, Lagos, Luanda and Mogadishu are in the top 10 port cities worldwide with expected increases in asset exposure to coastal flood risk from 2005 to 2070. These projections highlight the pace of African urbanisation and development, as well as the urgent need for management of climate risks in these port cities over the coming decades.

## Climate risks to port infrastructure

Ports are highly vulnerable to climate-related impacts.[11] Their location in often dynamic coastal environments places them at risk from storm surges, extreme waves, high winds and extreme rainfall. Ports' standard asset management procedures involve managing climate risks such as the impacts of wave damage on structures and the effects of sedimentation, scour and drainage, among other risk factors.[12] Climate change will alter the levels of risk, consequently changing the maintenance requirements in existing ports and the levels of risk that should be considered during the planning of new ports. Sea level rise brings slow-onset change, which will incrementally increase the impacts of existing hazards on ports over the coming century.[13]

Climate hazards result in immediate impacts on port infrastructure and operations such as damage to assets, operational delays and health and safety risks to staff. These in turn have secondary economic, social and environmental consequences. Operational delays due to severe weather or closure of facilities can have serious financial implications for ports and those who depend on their operation. The social consequences of port delays and closures will be felt by those employed directly or indirectly through the trade and commerce system, which relies on port services.

Table 1 summarises direct climate impacts on ports and how climate

**Table 1. Summary of climate hazards to port assets (synthesised from NCCOE [2004] and Stenek et al. [2011])[14,15] and generalised climate change projections extracted from IPCC (2013)[16] and CDKN (2012)[17]**

| Climate hazard | Impact of climate hazard on ports | Influence of climate change on impact | Summary of Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) projections for Africa (IPCC, 2013) |
|---|---|---|---|
| Extreme waves / storm surge | • Damage to major structures (for example, quay walls, jetties, breakwaters)<br>• Damage to port super-structure (cranes, buildings, land-based transport)<br>• Damage to floating assets, vessels and cargo<br>• Operational delays in berthing and handling<br>• Disruption to ancillary services (power, water) and off-port transport networks<br>• Risk to life<br>• Release of pollutants | Sea level rise could increase the potential for flooding during storm surge events.<br><br>Changing storm intensity could increase extreme wave conditions. | **Sea level rise** between 17 cm and 38 cm is expected by the 2050s and 26 cm to 82 cm by the 2090s (includes emission scenario uncertainty). Africa is broadly consistent with global projections.<br><br>Increased incidence and/or magnitude of **extreme high sea level** is likely in the early part of the 21st century and very likely by the later part of the 21st century. This increase will primarily be the result of an increase in mean sea level (high confidence), with extreme return periods decreasing (i.e. more frequent extremes) by at least an order of magnitude in some regions by the end of the 21st century. There is low confidence in region-specific projections of storminess and associated storm surges.<br><br>General trend towards decreasing frequency of **tropical cyclones** but increasing intensity. However, confidence is low in regional projections. |
| Long-term wave and current controlling sediment and coastal morphology | • Damage to assets and limited navigation resulting from sedimentation and scour around port structure and channels | Changing waves and current patterns could increase sedimentation and scour. | Quantitative estimates require detailed local hydrodynamic modelling studies to provide estimates of how changes in sea levels and wind climates affect sediment and coastal morphology. |
| Extreme rainfall resulting in river floods and low flows | • Damage to assets and limited navigation resulting from high sediment loads and scour around port structure and channels<br>• Low flows limiting navigation in inland ports | Changing extreme rainfall conditions could increase sediment loads from river systems. | Increased **average run-off** projected across East Africa, reductions in average run-off across Southern Africa. Confidence in projections are variable across Africa. General trend towards increasing **intensity of storm rainfall** across the continent, although the trend is more pronounced in East Africa than North Africa, for example. |
| Extreme rainfall resulting in surface water flooding of ports | • Damage to port super-structure (cranes, buildings, land-based transport)<br>• Damage to cargo<br>• Operational delays in berthing and handling<br>• Risk to life<br>• Release of pollutants | Changes in rainfall intensity could increase the risk of surface water flooding. | General trend towards increasing **intensity of storm rainfall** across the continent, although the trend is more pronounced in East Africa than North Africa, for example. |
| High winds | • Damage to port super-structure (cranes, buildings, land based transport)<br>• Damage to vessels and floating assets<br>• Operational delays in berthing and handling<br>• Risk to life | Changes in storm wind intensity could increase risk. | It is likely (medium confidence) that **annual mean significant wave heights** will increase in the Southern Ocean as a result of enhanced wind speeds. Southern Ocean-generated swells are likely to affect heights, periods and directions of waves in adjacent basins. In general, there is low confidence in region-specific projections due to the low confidence in tropical and extra-tropical storm projections, and to the challenge of down-scaling future wind states from coarse resolution climate models. |

change may influence these impacts over time.

## Current status of climate change in port planning and decision-making

Climate change adds a new dimension to the management of risks. Prior to the consideration of climate change, climate was generally assumed to vary around consistent long- term averages for planning and operational purposes. This assumption is no longer valid, and long-term changes in climate will change the risks to ports. Decision-making processes must adapt to ensure ports can maintain their services in a changing climate. This will require consideration of climate change and better use of climate services (see box) in decision-making processes to support planning of long-lived port infrastructure. The enabling environment needed for the uptake of climate services for risk management has been assessed by examining the overall awareness of climate change issues, the policy and regulatory frameworks for port planning, and the design of long-lived port infrastructure using existing literature. This section provides summary findings for each of these areas.

### Awareness and perception of climate change issues

- The industry is aware of climate change as an issue but translation into practical action in port planning is more limited.
- Responsibility for climate change issues can lie with a number of different stakeholders involved in port management, including departments of environmental planning, the chief engineer and the port director.
- Short planning horizons for ports (relative to climate change) are a barrier to the consideration of climate change in planning.
- African port associations could provide valuable entry points to raise awareness on climate change issues, although the extent of current awareness among these organisations is not known.

### Policy and regulatory frameworks for port planning

- Ports are typically publically owned and operated in Africa; transport ministries and port authorities lead the development of infrastructure and are not independently regulated.
- Port master plans are a key entry point for influencing the inclusion of climate change in long-term planning, but little evidence is available on the extent to which climate change is considered.

### Integrating climate change into port design

- Design guidance often incorporates sea level rise projections, but projected changes in other variables such as storminess, rainfall and temperature are rarely considered.
- A number of different design manuals are used across Africa, depending on the port developer involved and consulting engineers used.
- Uncertainty in climate change projections is a barrier to their incorporation in deterministic design approaches, which typically involve the use of additional design allowances to accommodate uncertainty.

## Recommendations

Recommendations for enhancing the climate resilience of long-lived port infrastructure include a broad range of actions from awareness and perception, to adjustment of decision-making processes and tools. Given the relative scarcity of information on the processes and tools used by African ports for decision-making, further research and engagement with the industry is a central recommendation. This will be core to building an evidence base to steer further practical actions. Building on existing stakeholder networks and on the body of existing research will be important to maximise the value of future research.

At the broadest level, Becker et al. note: "On a global scale, most ports are in the beginning stages of considering adaptation to climate change. There is an opportunity for the scientific community to engage with this sector to create the knowledge base needed to understand and improve the resilience and efficiency in the coming century".[19]

### What are Climate Services?[18]

Climate services involve the production, translation, transfer and use of climate knowledge and information in decision-making and policy and planning. Climate services ensure that the best available climate science is effectively communicated with agriculture, water, health and other sectors, to develop and evaluate mitigation and adaptation strategies. Easily accessible, timely and decision-relevant scientific information can help society to cope with current climate variability and limit the economic and social damage caused by climate-related disasters. Climate services also allow society to build resilience to future change and take advantage of opportunities provided by favourable conditions. Effective climate services require established technical capacities and active communication and exchange between information producers, translators and user communities.

### Recommendations on awareness and perception of climate change

1. **A close dialogue between the climate science community and ports industry is required to align demand and supply of climate services.** The port industry is generally aware of climate change as an issue, but translation of this awareness into practical application is limited. There is a need for a close working relationship between industry practitioners and climate change specialists to develop appropriate information products and tools to integrate these into existing decision-making practices. This should build on existing industry forums, such as the World Meteorological Organization climate services platform, and relevant industry associations, such as the World Ports Climate Initiative, to open a dialogue between industry stakeholders and climate scientists.

2. **Awareness raising and knowledge sharing on good practice in adapting to climate change and the economics of adaptation is required.** Much theoretical work has been completed on the potential impacts of climate change on ports. A major challenge arises in turning this theory into practical application at the port level. Potential actions include research into the economics of adapting ports to climate change. This could include the costs and benefits of over-designing infrastructure for an uncertain future climate, and the economics of maintaining flexibility in infrastructure. Case studies of good practice that pragmatically incorporate climate change risks and uncertainties into planning processes should be developed and shared across the industry.

### Recommendations on policy and regulatory frameworks for port development

3. **Undertaking further research on the institutional environment for decision-making will be important** to understand how decisions around long-lived infrastructure are made and the extent of incentives and policies to support the management of climate change risks. There is little Africa-specific information on the policies, legislation, regulation and other guidance that supports decision-making processes and the extent to which they foster climate resilience. Studies are generally limited to Europe and North America. A comprehensive policy mapping for the African ports sector that assesses the extent to which the policy environment supports climate resilience would be a useful contribution to the knowledge base.

4. **Reviewing port master plans and planning guidelines for African ports will help understand how climate change is considered in planning processes.** Port master plans are a key entry point to understanding the decision-making process for planning long-lived infrastructure at ports. Potential activities could include:
   - reviewing master plans to understand the extent to which climate risks and climate change are included in planning
   - identifying examples of good practice in master planning both in Africa and globally
   - developing case studies and transferrable knowledge and tools to target the improvement of African port master plans when they are due for revision.

### Recommendations for design guidance

5. **Infrastructure designers require clear and simple guidance on projected changes in climate-related variables that influence their designs.** Engaging stakeholders, including experts in coastal structure design, coastal scientists and climate scientists, will identify those variables for which designers would require guidance on climate change when planning new infrastructure. Following this, developing simple projections that quantify the range of changes in relevant variables would be helpful for planners and designers. This should include uncertainty ranges and guidance on incorporating climate change uncertainty in decision-making.

6. **Although not strictly related to long-term climate change, the effective management of existing climate hazards as they affect operational activities can offset changes in climate.** This includes effective forecasting of hazards and implementation of operational protocols to manage risk. This paper has not assessed the extent to which ports make use of climate services for these purposes, hence it is not possible to make detailed recommendations. A general recommendation would be an international review on the use of, and benefits accrued from, hazard warning for port operations. This should include an assessment of the barriers to successful implementation for hazard warning, especially in the context of African ports. It should provide recommendation on best practices and knowledge transfer within the industry, as well on as climate services that should be developed to support improvements in hazard warning where needs are identified.

## Endnotes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