Climate Risk and Adaptation Case Study
Ports: Muelles el Bosque (MEB)
Cartagena, Colombia

Amanda Rycerz
Climate Risk Analyst,
Acclimatise Group Limited

Surface Transportation
System Resilience to
Climate Change and
Extreme Weather Events
9/16/2015
Company overview

• Acclimatise Group is a specialist consulting, digital application and communications company providing world-class expertise in climate change adaptation and climate resilience with contracts in nearly 60 countries.

• We work for the public and private sectors in developed and developing countries.

• Offices in USA, UK, Barbados, France and India
## Some of our clients

<table>
<thead>
<tr>
<th>Development partners</th>
<th>Major corporates</th>
<th>Financial services</th>
<th>National governments</th>
<th>Regional / local govts &amp; others</th>
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- ADB
- DFID
- IDB
- CCCA
- EU
- USAID
- IFC
- European Bank
- CDKN
- vai
- ADB
- giz
- CDKN

- shell
- bhp billiton
- Eskom
- Rio Tinto Alcan
- Rio Tinto

- Barclays
- RAILPEN Investments
- CARBON DISCLOSURE PROJECT
- USS
- Marks & Spencer

- National Centers for Environmental Information
- Foreign and Commonwealth Office
- GOVERNMENT OF KENYA
- Environment Agency
- DEFENCE ESTATES

- London
- COMMISSION DE L'OCEAN INDIEN
- ECC
- GCC
- USA

- OXFAM
- CIFOR
MEB Study Partners

• Managed and funded by IFC under its Climate Risk and Adaptation Program

• Supported by staff and owners of Terminal Marítimo Muelles del Bosque de Cartagena (now COMPAS)

• Undertaken by Acclimatise with WorleyParsons, University of Oxford and Synergy Global
MEB objectives

- **Identify** and **assess** climate change **risks** and **opportunities** for MEB
- Provide assessments for MEB specifically, as well as risks and opportunities to ports in general worldwide
  - Where possible quantify risks in physical or financial terms
  - Some risks assessed qualitatively (ex. environmental, social performance)
- **Identify** and **evaluate** adaptation options
  - Financially optimal? Environmentally sustainable? Societal benefit?
  - Other stakeholder involvement? (City of Cartagena, regional/national government)
  - Timing of adaptation investments and adaptive approach

![Graph showing projected baseline without climate change, residual impacts of climate change after adaptation, future impacts with climate change after adaptation, and gross benefit of adaptation. The graph spans from 1990 to 2080, with time on the x-axis and value on the y-axis.](image)
Methodology

• A combination of site visit, desk-based analyses and modelling
• Local data (MEB, government, academia, other experts, etc.), scientific literature, climate model outputs
• Understand how current climatic conditions affect MEB’s value chain
• Project future changes in climate-related risks and opportunities, based on wide range of climate change scenarios
• Evaluate net present value (NPV) of adaptation options and test sensitivity for range of discount rates
<table>
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<tr>
<th>Area</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
<td>Demand, trade levels and patterns</td>
<td>Supply and demand for products traded through ports will be influenced by climate change</td>
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<tr>
<td>Navigation, shipping and berthing</td>
<td>Navigation depths can be affected by sea level rise and changing river runoff</td>
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<tr>
<td>Goods handling and storage</td>
<td>Wind speed increase, heavier rainfall and higher storminess can affect ship (un)loading</td>
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<td><strong>Vehicle movements inside ports</strong></td>
<td>Increased risk of coastal or surface flooding</td>
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<td>Infrastructure, building and equipment damage</td>
<td>Sea level rise can exacerbate coastal erosion and under-scouring</td>
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<tr>
<td>Inland transport beyond ports</td>
<td>Reliability of inland transportation can be disrupted by storminess and rainfall extremes leading to landslides</td>
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<td>External stakeholders</td>
<td>Climate change will influence the behaviour or expectations of port stakeholders, such as insurers</td>
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<td>Social performance</td>
<td>Occupational hazards due to extreme weather conditions can increase</td>
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<tr>
<td>Environmental performance</td>
<td>Risk of water, land and air pollution can increase, for instance due to flooding overwhelming drainage and pollution control systems</td>
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MEB in context

- USA is Colombia’s largest trading partner:
  - 26% of imports
  - 35% of exports
- Asian trade also important for Colombia, via ports on Pacific coast
- Cartagena, Caribbean coast
- Sheltered location, south of main tropical storm tracks
Overview of MEB

- First privately owned maritime terminal in Colombia, established in 1992
- Second largest port in Cartagena
- Government concession to develop and manage the port - currently until 2032
- Located in Bay of Cartagena - sheltered natural harbour
- Occupies 10 ha site: Isla del Diablo and adjacent mainland, linked via causeway
- Moves 1% of Colombia’s international trade (by tonnage, 2008)
- Handles containerized cargo, grains, bulk cargo and coke
Observed winds and storminess in Cartagena

• Cartagena is South of the tracks of most tropical cyclones (TCs) in the Caribbean

• Compared to its major competitor ports (Santa Marta, Barranquilla, Buenaventura), Cartagena has highest percentage of calm days (no wind)

• Most common wind direction for Cartagena is northerly or north easterly

• Wind speeds (above 14m/s) occur only about 1% of the time

Observed tracks of TCs over the Caribbean (NASA, 2009). Cartagena is circled in green.
Observed mean sea level rise

- Sea level measured between 1951 - 2000 in Bay of Cartagena (gauge moved in 1993)
- Linear trend of +5.6mm/year
- Includes effects of land subsidence in Cartagena, sinking at rate of 2.7mm/year

Sea level time series for Bay of Cartagena (1951-1993) and linear trend
Future projections: mean sea level rise and storm surges

- IPCC AR4 SLR projections for the end of the century: 0.18 - 0.59m (excluding uncertain dynamical changes to ice sheet flows)
- Other research at the time of the study provided higher estimates of global mean SLR of 0.75 - 1.9m
- This study applied 2 future SLR scenarios:
  - ‘Observed’ scenario: continued observed rate of SLR (+5.6mm/year constant until 2100)
  - ‘Accelerated’ scenario: increasing rate of sea level rise (from 5.6mm/year today to 20mm/year in 2100)
- Assumed no change to storm surge heights in Bay

Mean sea level rise scenarios used in this study
Interruptions to vehicle movements due to seawater flooding of the port

- Lowest area: causeway linking mainland and island sites (0.6m above port plan datum)

- **Causeway projected to flood at highest tides by 2018 and 2015** (observed and accelerated SLR scenarios)

- **Mainland patio and storage warehouses projected to flood at highest tides by 2070 and 2050** (observed and accelerated SLR scenarios)

- **Quays not projected to flood**

Projected flooding (areas in blue) during highest spring tides and highest water level in 2050 in the observed (left) and accelerated (right) scenarios.
Business cost of vehicle movement interruptions

- Flooding greater than 30cm deep causes interruptions to vehicle movements along causeway
- Frequent flooding of more than 30cm expected from 2080 or 2050 onwards (observed and accelerated SLR scenarios)
- If no adaptation is undertaken, loss of revenue projected to be between 3 and 7% of MEB’s annual projected earnings by 2032. From 2060 losses could represent 10% or more of MEB’s annual projected earnings

MEB’s earnings under three scenarios. The costs associated with climate change assume no adaptation
Raising the causeway road to adapt to rising sea levels

- Raising the causeway road height by 60-120cm necessary this century
- **Relatively low cost**: US$180,000 /30cm increase (US$250,000 /day of closure)
- 2 adaptation options: raise once or raise by increments (adaptive management)
- For discount rate >0.2%, adaptive management is economically more efficient
- Adaptive management also allows MEB to adjust adaptation decisions according to the observed rate of SLR

The cost of adaptation investments in causeway to 2100 under the observed sea level rise scenario
At the study launch, Gabriel Echavarría announced an investment of 10m USD to protect against future flood risks, based on the study findings.

“This study will have an important impact on future climate change studies in Colombia, because it is one of the first to analyze how businesses and commerce will be affected by the changing environment in our country”.

“The study has helped us develop our long-term strategic planning and investment priorities, and ... will serve as a model and guide for future efforts in our region”.

— Gabriel Echavarría, President of COMPAS
Thank you!

Please find the full report available on the IFC website: ‘Climate Risk and Business: Ports’

Amanda Rycerz
Climate Risk Analyst
contact: a.rycerz@acclimatise.us