Practical solutions for adaptation in land use planning, water and coastal zones

*How to make better informed anticipatory decisions*

Ad Jeuken
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Aim today

Identify major gaps and challenges for adaptation due to existing regulatory, land-use planning, financial and market incentives; and options that you have devised to overcome these challenges.

IEG identifies already some of these major challenges
Some best practices from Deltares’ experience

- Use of an adaptive planning approach stimulating robust and flexible solutions
- Connect long term options to short term decisions.
- Objective driven analysis considering multiple options in reaching it (decrease water shortage vs. build a dam)
- Use of learning-, decision- and design tools to engage with stakeholders
- Flexibility in approaches from heavy data and model dependent to using expert knowledge
1. Analyse objectives, vulnerabilities & opportunities using scenarios

2. Identify actions and assess efficacy, sell-by date of actions

3. Develop and evaluate adaptation pathways and map

4. Design of an adaptive plan, inc. preferred pathways and triggers

5. Implement the plan

6. Monitor

Development of Adaptive Plans

reassessment, if needed

actions

1. Objectives, vulnerabilities, scenarios

- Setting the scope, priorities, main objectives
- What are key vulnerabilities of your ‘system’: sectors, critical infrastructure, assets, management
- By what key external uncertain developments is this vulnerability influenced the most
- When will this lead to a need to take action?

TOOLS: Risk/Vulnerability maps, scenarios, adaptation tipping points
Spatial distribution of vulnerabilities

Hazard × Adverse consequences

De Bruijn et al., 2009
Adaptation Tipping Point & Use by date of policy action

A stress test: How much (climate) change can we cope with? When do start to achieve missing our objectives?

Kwadijk, J.C.J. et al 2010 WIRES Climate Change DOI: 10.1002/wcc.64, Haasnoot et al 2012 Climatic Change
Example ATP, Rhine Meuse Estuary

Note: Red bullets indicate endpoints of a strategy, blue arrows indicate the strategy can cope with higher sea levels. The climate scenarios used in the Netherlands are marked with dotted lines.

Source: Jeukern et al., 2010.

EEA, 2013
2,3 define and assess options for adaptation

- Explore options for adaptation (spatial, structural, instrumental or public versus private, grey versus green)

- Do they reflect different societal perspectives?

- What is the efficiency of the individual options?

- Do they include or exclude each other?

- (economic) evaluation of pathways

TOOLS: adaptation pathways, economic evaluation methods, delta ateliers
Adaptation pathways describe a sequence of policy actions or investments in institutions and infrastructure over time to achieve a set of pre-specified objectives under uncertain changing conditions,

An adaptation pathways map shows different possible sequences of investment decisions. A scorecard helps to evaluate the decisions.

Costs and benefits of pathways

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Costs</th>
<th>Benefits</th>
<th>Co-benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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Pathways that are not necessary in low-end scenario

- **Decision node**
- **Transfer station to new policy action**
- **Policy action effective**
- **Adaptation Tipping Point of a policy action (Terminal)**
Example: Adaptation Pathways

How to keep a river navigable in a changing environment that may result in lower water levels in the river?

- **Small ships**
- **Medium ships**
- **Small dredging**
- **Large dredging**

**Scorecard for Pathways**

<table>
<thead>
<tr>
<th>Path actions</th>
<th>Costs</th>
<th>Target effects</th>
<th>Side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+++</td>
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- **Transfer station to new adaptation action**
- **Adaptation Tipping Point of a policy action (Terminal)**
- **Policy action effective in all scenarios**
- **Policy action not effective in worst scenario**
Adaptation pathways for the Yom river – after floods 2011
Flooding problems at Sukothai district
Hydrograph for the three characteristic years at the location Y.14
### Screening of measures and plans

<table>
<thead>
<tr>
<th>(R): Reduction of peak flows</th>
<th>(D): Diversion of peak flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Reservoir development in Upper of Middle reach of Yom river (1 or 2 large scale reservoir(s))</td>
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<tr>
<td>- Optimized operation of multipurpose reservoirs for flood mitigation</td>
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<tr>
<td>- Reservoir development in tributaries of Yom river (medium scale reservoirs in various tributaries)</td>
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<tr>
<td>- Watershed management and conservation measures, including reforestation</td>
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<tr>
<td>- Flood retention: diversion of river flow to adjacent retention areas (monkey cheeks)</td>
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<tr>
<td>- Diversion of peak flows (to Nan river)</td>
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<tr>
<td>- Flood Bypass around Sukhothai area</td>
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<thead>
<tr>
<th>(P): Improvement protection against floods</th>
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<tbody>
<tr>
<td>- Raising and reinforcement of embankments</td>
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<tr>
<td>- Dredging of river to increase the discharge capacity</td>
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<thead>
<tr>
<th>(M): Mitigation of impacts of floods</th>
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<tbody>
<tr>
<td>- Development of flood forecasting and early warning system</td>
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<tr>
<td>- Flood response and disaster recovery plan, including awareness raising</td>
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<thead>
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<th>(V): Reduction of vulnerability for floods</th>
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<tr>
<td>- Adaptation of current land use</td>
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<tr>
<td>- Land use regulation to reduce flood vulnerability of new developments</td>
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</table>
Combining different measures

- Optimized operation of multipurpose reservoirs
- Pha Lat, Nam Ngao and Tao Pun dams (439 MCM)
- Small reservoir development in tributaries of Yom river
- Flood retention in monkey cheeks Thung Khui Thong and Pak Phra (80 MCM)
- Flood retention in monkey cheeks (68 MCM) + diversion Right Yom Gate
- Regulated overflow areas (250 m$^3$/s)
- Flood Bypass (350 m$^3$/s)
- Flood forecasting and recovery
- Land use regulation
- Dredging
- Raising and reinforcement of embankments

**Base case**

- Reservoir development and optimized operation for flood risk
- No-regret measure to reduce flooding probability
- No-regret measures planned to be realised in the year 2021
- No-regret measures to reduce impact of flooding
- Measures to reduce flooding probability

28 mei 2015
Adaptation pathways

Flood Risk management
Multi-objective water resources development
Base case
No-regret measures planned to realise (monkey cheeks, flood bypass, regulated overflow)
No-regret measure to reduce flooding probability (flood retention in monkey cheeks)
Reservoir development and optimized operation for flood risk
Dredging
Raising and reinforcement of embankments (10)

Risk reduction achieved (%)
Suitability map for local scale adaptation

Elevated building
Rain water harvesting potential

Rain Water Harvesting Potential

Legend
- RWH potential
  - High
  - Above average
  - Below average
  - Low
- Populated places
  - Village
  - Town (>10,000)
  - Bobo Dioulasso
  - Ouagadougou
- Rivers and lakes
  - Lakes
  - Perennial
  - Intermittent
- Borders
  - Country
  - Province

(C) Deltares 2010
Can many local solution be alternative for large scale infrastructure?

Many local solutions

Could make a difference
Economic Evaluation of Adaptation Pathways

Net present value (pathway_8)

Expected costs

Expected benefits (avoided damages, co-benefits)

Initial investment_{ActionC}(t=1) + Costs_{ActionC}(t_1...t_x) + Transfer cost (t_x) + Costs_{ActionD}(t_x...T) + Benefits_{ActionC}(t_1...t_x) + Benefits_{ActionD}(t_1...t_x)

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Pathways that are not necessary in low-end scenario
To connect interactively:

- Land use planners - (technical) experts ("knowledge and design")
- Hydraulic objectives - local initiatives
- Those who have Costs with benefits
- Abstract ideas - images/maps
1. Increase the possibilities of economic growth = Opportunities
2. Decrease the threats of climate change = Threats
3. Improve the living conditions = Opportunities

Make a safe, prosperous and more beautiful Beira
## Projection of Future Growth

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<thead>
<tr>
<th></th>
<th>Current</th>
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<th>Projection 2035</th>
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<tr>
<td></td>
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<td>Low scenario</td>
<td>High scenario</td>
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<tr>
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<td></td>
<td></td>
<td>(2.25%)</td>
<td>(4.25%)</td>
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<tr>
<td>Population</td>
<td>443.000</td>
<td>827.000</td>
<td>1.422.000</td>
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<tr>
<td>Residential areas</td>
<td>7.743 ha</td>
<td>11.366 ha</td>
<td>16.991 ha</td>
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<tr>
<td>Industrial area</td>
<td>580 ha</td>
<td>1.375 ha</td>
<td>3.150 ha</td>
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<tr>
<td>Port area (total area)</td>
<td>442</td>
<td>575 ha</td>
<td>1.270 ha</td>
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<tr>
<td>Port area (net area terminals)</td>
<td>78 ha</td>
<td>237 ha</td>
<td>527 ha</td>
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<tr>
<td>Area requirements 2035</td>
<td>8.765 ha</td>
<td>13.320 ha</td>
<td>21.100 ha</td>
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Urban development plan according to stakeholders

Legend
- existing mainroad
- new mainroad
- increased public transport via existing railway
- new railway
- expansion port
- expansion industry
- moving existing residential area
- expansion residential area/cidade satellite
- retention area
- tourism zone
Adaptation Support Toolbox for Urban adaptation

Output:
- ranked list of measures
- 2-3 alternative adaptation packages
- strengthened design & innovation
- design ready for decision making

Blue Green Dream
Adaptation Support Tool
Dynamic Evaluation Tool

to visualize dynamic effect of adaptation measures

http://www.3di.nu/3di-videos/
Creating resilience: a process of dialogue, design & engineering

To conclude

• Use of an adaptive planning approach stimulating robust and flexible solutions
• Connect long term options to short term decisions.
• Objective driven analysis considering multiple options in reaching it
• Use of various learning-, decision- and design tools to engage with stakeholders
• Flexibility in approaches from heavy data and model dependent to using expert knowledge
• The real challenge is in the implementation, but it helps if there is support by key stakeholders and sound information base
3rd Annual Workshop on Decision Making Under Deep Uncertainty

3 & 4 November 2015, Delft, The Netherlands

http://deepuncertainty2015.deltares.nl | Contact: deepuncertainty2015@deltares.nl
Thank you for your attention