Conceptual Framework for Conducting a climate change impact analysis and vulnerability assessment for the Arab Region

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Why do we need an integrated assessment approach?

Components of Proposed Conceptual Framework.

Indicator-based Approach.

Final remarks.
The regional climate change projects and simulations for vulnerability and impact assessment of water resources are not well developed in the Arab region.

There is a need to assess vulnerability in view of better understanding of the effects of the CC on sustainable development in the region.

We need to integrate the available climate change modeling methodologies with the vulnerability and impact assessment approaches in a multidisciplinary manner to study impacts on all affected sectors.
The logical flow in the process of developing this framework is be represented by three inter-related components:

- Climate modeling and downscaling.
- Hydrological modeling.
- Assessment of socio-economic and environmental impacts and vulnerability.

All three components are dependent upon access to and availability of reliable data in various sectors.
COMPONENTS OF PROPOSED CONCEPTUAL FRAMEWORK

- Climate Change modeling
- Hydrological modeling and water resources management
- Socio-economic Vulnerability and impact assessment
  - Impacts on water resources
  - Long term scenario development in water policies

Industry
Food security
Agriculture
Human settlement
Poverty & Employment
Health
Biodiversity
A number of simulations need to be carried out (5 are proposed) based on general circulations models (GCM’s) to define appropriate boundary conditions.

The GCM’s are then used to derive a regional climate model (RCM) for regional downscaling at a reasonable resolution (25 or 50 km) using a number of climate projections.

The resolution used will be depending upon the size of the region (the whole Arab region?), area covered by meteorological records and effects on key model outputs (e.g. precipitation rates)
1- Climate Modeling

Climate data
Domain boundary
GCM boundary conditions

RCM Climatic precipitation
Temperature (max, min, mean, etc.)
Evaporation rate
Humidity level
Atmospheric pressure
etc.
The RCM’s outputs such as precipitation and temperature are fed into a hydrological model to predict:

- River runoff
- Groundwater recharge
- Extraction rates
- Water quality parameters
- etc.
2- Hydrological and Water Resources Modeling

A- Hydrological Modelling
- RCM Climatic precipitation
- Temperature (max, min, mean, etc.)
- Evaporation rate
- Humidity level
- Atmospheric pressure etc.

B- Water Management
- Water quality
- Water level
- Water Demand Consumption by sector
- Water balance
- Reservoir level

Stream runoff
- Soil moisture
- Groundwater recharge
- Groundwater level
- Water quality
These impacts need to be identified in order to measure the effects of climate change within a sustainable development context.

This can be done by analyzing impacts and mapping hotspots of affected sub-regions based on key issues of regional concerns.

e.g. agricultural models can be used to estimate vulnerability indicators related to cropping patterns, water distribution and irrigation efficiency.
Other aspects such as human settlement and food security would rely less on formal models and more on experts’ subjective estimates of indicators of vulnerability.

Economic variables are also important to determine vulnerability and the adaptive capacity of communities in terms of services costs, GDP, dependency on agriculture and unemployment.
3- Socio-economic and environmental impacts (cont’d)

Agriculture

Precipitation
Runoff
Temperature
Soil moisture
etc.

Optimum cropping patterns
Crop water duties
Crop yields
Crop sensitivity to climatic changes

GIS analysis and Mapping

Water distribution and Agro-economic models

Vulnerability and impact mapping

Cotton field
Sugar cane
Vulnerability is a function of exposure to hazard, sensitivity to hazard and adaptive capacity (Adger et al. (2004)).

- e.g. water related hazards such as floods, rainfall events, droughts, conflicts, water borne epidemics are represented by indicators to measure their intensity, extent and frequency.
- This approach does not aim to conduct a quantitative climate change risk assessment.
- These indicators can be used as tools to assess and monitor adverse conditions and identify vulnerability hotspots for decision makers.
- Indicators of vulnerability and hazards will be represented in geo-referenced (GIS) maps of the Arab region to facilitate overlaying and to conduct spatial analysis between different layers.
## Example of vulnerability indicators

<table>
<thead>
<tr>
<th>Category</th>
<th>Factor</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water resources planning and management</td>
<td>Application of IWRM</td>
<td>Level of application</td>
</tr>
<tr>
<td></td>
<td>Efficiency of water demand management</td>
<td>% cost recovered from water fees</td>
</tr>
<tr>
<td></td>
<td>Water network losses</td>
<td>% water network losses</td>
</tr>
<tr>
<td></td>
<td>Water storage capacity</td>
<td>% water storage to total water resources</td>
</tr>
<tr>
<td></td>
<td>Status of strategic water reserves</td>
<td>% abstraction to total strategic water resources</td>
</tr>
<tr>
<td>Economy</td>
<td>General state of economy</td>
<td>Gross national income</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gross domestic product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gross savings (% of GNI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total reserves (% of total external debt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total debt services (% of GNI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lending interest rate (%)</td>
</tr>
<tr>
<td>Population relative wealth</td>
<td>GNI per capita</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GDP per capita</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unemployment (% of total workforce)</td>
<td></td>
</tr>
<tr>
<td>Poverty</td>
<td>% of population earning less than $1.25 per day</td>
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<tr>
<td>Economic diversification</td>
<td>Value added – industry (% of GDP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Value added – services (% of GDP)</td>
<td></td>
</tr>
<tr>
<td>Energy consumption</td>
<td>Electric power consumption (kWh per capita)</td>
<td></td>
</tr>
<tr>
<td>Energy cost</td>
<td>Diesel fuel price</td>
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</tbody>
</table>
### Example of vulnerability indicators (cont’d)

<table>
<thead>
<tr>
<th>Category</th>
<th>Factor</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demography/socio-economic</td>
<td>Size of population</td>
<td>Total population</td>
</tr>
<tr>
<td></td>
<td>Population growth</td>
<td>Population growth</td>
</tr>
<tr>
<td></td>
<td>Population-female</td>
<td>% female of total population</td>
</tr>
<tr>
<td></td>
<td>Population density</td>
<td>People per km²</td>
</tr>
<tr>
<td></td>
<td>High concentration of people in urban areas</td>
<td>Population in the largest city (% of total population)</td>
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<tr>
<td></td>
<td></td>
<td>Population in urban agglomerations of more than 1 million (% of total population)</td>
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<tr>
<td></td>
<td>Economically dependent population</td>
<td>% of young and old to working-age population</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Dependency on agriculture</td>
<td>% of agricultural land to total</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of workforce in agriculture</td>
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<tr>
<td></td>
<td></td>
<td>% of rural population</td>
</tr>
<tr>
<td></td>
<td>Dependency on rain-fed agriculture</td>
<td>% of rain-fed land</td>
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<tr>
<td></td>
<td>Level of land degradation</td>
<td>% of degraded lands</td>
</tr>
<tr>
<td>Food security</td>
<td>Reliance on single or few crops</td>
<td>% of product of top three strategic crops</td>
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<tr>
<td></td>
<td>Reliance on locally produced food</td>
<td>% Food produced locally</td>
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<tr>
<td></td>
<td>Food productivity</td>
<td>Cereal yield in kg per hectare</td>
</tr>
</tbody>
</table>
Final Remarks:

- Establishment of a **regional knowledge hub** for climate and water resources information in the Arab region as data and models are scattered among various institutions.

- Identification of **socio-economic and environmental indicators** relevant to the vulnerability assessment (use of Arab SD indicators, IPCC database, World Bank database, ...etc.).

- Establishment of a **Regional Climate Modeling Forum of Arab Experts** for review of current climate projections and models and supervising the development of **periodical Climate Change Assessment reports** in the Arab region.

- Implementation of this regional initiative will need **integrated and collaborative efforts** by all actors involved in the formulation of its work plan.