Overview of Technologies for Climate Change Adaptation related to the Water Resources Sector

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Presentation outline

• Introduction (impacts and adaptation)
• Applications of modern technologies in Climate Change (CC) impacts assessments
• Examples of CC adaptation technologies for water resources sector
• Final remarks and recommendations
Climate change impacts on Water Resources in ESCWA region

- Change of precipitation rates, in time and space, particularly on the scale of individual river basins.
- Variability of surface runoff and flow regimes in the rivers.
- Occurrence of extreme events of flooding and drought cycles.
- Deterioration of water quality in the rivers and in coastal areas due to seawater rise and intrusion in groundwater storages.
- Socio-economic impacts as low water in the rivers and droughts would have severe consequences on most sectors such as agriculture, energy and drinking water intakes.

Adaptation to CC

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001).
Adaptation technologies

- Most adaptation measures involve the use of technology which include not only infrastructure and equipment but also knowledge and practices.
- Adaptation technologies can be defined as “the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the impacts of climate change” (UNFCCC, 2005)

Applications of modern technologies in Climate Change impacts assessments

- Climate change simulation and modelling (climate models)
- Impact assessment of CC on water resources and related sectors (model applications, use of GIS and remote sensing, etc.)
- Data and information management (databases)
Climate Change Simulations

- General Circulation Models (GCM’s)
- Downscaling process
- Regional Climate models (RCM’s)

Source: IPCC AR4 (WG1)
Figure 11.1. Models output (change in temperature and precipitation). The top panel shows projections for the period covering December, January and February, while the bottom panel shows projections for the period covering April, July and August.

Figure 11.5. Temperature and precipitation changes over Europe from the MID-A1B simulations. Top row: Annual mean, DJF and JJA temperature change between 1980–1999 and 2080–2099, averaged over 21 models. Models row shows the top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation.
Exposed population to the negative impacts of 5m SLR.
(Dasgupta et al., 2007)

Vulnerability Index for Nile Delta - Egypt

Medany et al., 2009
• Adaptation Measures technologies can be classified as:
  – Hard technologies (e.g. new constructions, different types of equipments, seawalls and drip irrigation techniques, etc.)
  – Soft technologies (e.g. more concerned with management options, knowledge, know-how, organizational capacity, etc.)
  – A combination of both e.g. Early warning systems that combine hard technologies such as measuring devices and information technology and soft technologies like strengthening awareness and promoting evacuation.

### Examples of CC Adaptation Technologies for Water Resources

<table>
<thead>
<tr>
<th>Vulnerable Water management</th>
<th>Adaptation at supply side</th>
<th>Adaptation at Demand Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal water supplies</td>
<td>• Increase reservoir capacity</td>
<td>• Use Grey water</td>
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<td></td>
<td>• Desalinize</td>
<td>• Improve water efficiency</td>
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<tr>
<td></td>
<td>• Inter-basin transfer</td>
<td>• Reduce leakages</td>
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<td></td>
<td>• Rain harvest</td>
<td>• Conserve</td>
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<td></td>
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<td>• Use economic instruments</td>
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<td></td>
<td></td>
<td>• Enforce water legislations</td>
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<tr>
<td>Pollution protection (Degradation of Water Quality)</td>
<td>• Enhance treatment works</td>
<td>• Reduce effluent volume of waste</td>
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<td></td>
<td>• Reuse and reclaim</td>
<td>• Promote alternatives to chemicals</td>
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<tr>
<td></td>
<td>• Upgrade water protection</td>
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<tr>
<td>Irrigation systems</td>
<td>• Improve soil conservation</td>
<td>• Use drought tolerant crops.</td>
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<tr>
<td>• Rain fed</td>
<td>• Supplement from other sources as needed</td>
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<tr>
<td>• Irrigated</td>
<td>• Develop bio-saline agriculture technology</td>
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<tr>
<td></td>
<td>• Improve tilling practices.</td>
<td>• Increase irrigation efficiency</td>
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<td></td>
<td>• Harvest rainwater</td>
<td>• Empower local water users associations</td>
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<tr>
<td></td>
<td>• Reuse adequately treated domestic wastewater</td>
<td>• Activate economic instruments</td>
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<tr>
<td>Flood Management</td>
<td>• Build reservoirs and levees</td>
<td>• Upgrade flood warnings</td>
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<tr>
<td></td>
<td>• Protect and restore wetlands</td>
<td>• Reduce floodplain development</td>
</tr>
</tbody>
</table>
### Type of various technologies for water resources adaptation measures - Traditional, High and Modern – (UNFCCC, 2009)

<table>
<thead>
<tr>
<th>Category</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional/indigenous technology</td>
<td>Water harvesting</td>
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<td>Spate irrigation</td>
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<td></td>
<td>Maintenance and construction of reservoirs and wells</td>
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<td>Gravity irrigation systems</td>
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<tr>
<td>Modern technology</td>
<td>Drip irrigation</td>
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<td>Groundwater recharge of wells</td>
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<td>Wastewater treatment</td>
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<td>Water transfer</td>
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<td>Water quality control</td>
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<tr>
<td>High technology</td>
<td>Desalination</td>
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<td>Early warning flood systems</td>
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<td>Real time flood forecasting using modeling and computer simulation</td>
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</tbody>
</table>

### Modern Irrigation technologies

Increase irrigation efficiency:

- **Drip Irrigation**
- **Sprinkler (Spray) Irrigation**
- **Low-energy spray irrigation**

![Drip Irrigation](image)

(Drip irrigation waters crops efficiently. Credit: Nova Scotia Agriculture and Fisheries)
Regional Land Degradation monitoring System (ACSAD, 2009)

<table>
<thead>
<tr>
<th>Level</th>
<th>Data Sources</th>
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<tbody>
<tr>
<td>Continental to regional level</td>
<td>AVHRR Pathfinder (8 km) data, Large scale climatological, meteorological and bio-physical factors</td>
</tr>
<tr>
<td>Regional to national level</td>
<td>AVHRR (1 km), MODIS, MERIS data, National policies, soil types, vegetation types, large scale management practices</td>
</tr>
<tr>
<td>Local Level</td>
<td>Various high resolution data (Landsat, ASTER, HyMap), Management practices, field history</td>
</tr>
</tbody>
</table>

- NOAA, AVHRR Pathfinder, 8 km Continuous Time Series of 20 years
- NOAA 1 km, Continuous time series of up to 10 years (MERIS, MODIS, …)
- Landsat, ASTER, IRS, 15-30 m, Time Series
1987 Local deforestation? 2000

Landsat TM (5-4-3) sub-scenes from 26.5.87 (left) and 26.5.2000 (right) showing the foothills of the Lebanon Mountains

Regional approach - Lebanon

Technologies for adaptation in coastal zones

- According to the UNFCCC (2006) coastal zones are addressed through three different adaptation strategies:
  - For protection:
    - Hard structures: dykes, sea-walls, tidal barriers and detached breakwaters
    - Soft structures: wetland restoration or creation and beach nourishment and indigenous approaches such as afforestation.
  - For re-treatment:
    - Creating upland buffers, establishing set-back zones and phasing out development in exposed areas.
  - For accommodation:
    - Early warning systems for extreme weather events, new building codes, improving drainage systems and agricultural practices, etc.
Developing a touristic area and reducing currents and possibly future risks due to sea water rise off shore of Alexandria, Egypt (Al-Raey, 2009)

Desalination Technologies

- **Thermal (distillation)**
  - Multi-stage flash (MSF)
  - Multi-effect distillation (MED)
- **Electric (membranes)**
  - Reverse osmosis (RO)
  - Electrodialysis (ED)
- **Other processes** include freezing and solar or wind-driven mechanisms.

![Global Desalination plant capacity by technology, 2008](chart.png)

- RO 53%
- MSF 25%
- MED 8%
- ED 3%
- Other 11%
Diagram of the RO process

Diagram of the Multi-stage flash desalination process
Wastewater Treatment Technologies

• Mechanical
  – Oxidation ditch
  – Extended aeration
  – Sequencing batch reactor
  – Trickling filter solids contact process - SCP

• Aquatic (Lagoon)
  – Free water surface
  – Subsurface flow
  – Sand filter

• Terrestrial
  – Slow-rate
  – Overland flow
  – Rapid infiltration
  – Subsurface infiltration

Final remarks and recommendations

• There is a need to strengthen regional and international cooperation on adaptation technologies.
• Improve access to best available information on the likely impacts of climate change
• Enhance access to financial resources and adequate funding mechanisms for developing countries to improve national and local capacities on adaptation technologies
• Enhance research, development and access to technologies for adaptation taking into account the needs and specificities of the region.