Climate Change: Impacts, Adaptations and Policy-Making Process: Palestine as a Case Study

By

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Rising Temperatures, Rising Tensions. The project was implemented by the International Institute for Sustainable Development (IISD).

GLOWA-Jordan River Project:

EQA/UNDP Climate Change Adaptation Strategy for the Occupied Palestinian Territory (2009)
According to the IPCC *Fourth Assessment Report* (2007), the Mediterranean region is forecast to receive a mean warming over this century of 2.2°C-5.1°C (Scenario A1B).

Precipitation is forecast to decrease by 10% by 2020 and 20% by 2020, with an increase in drought periods. A Japanese/Tel Aviv University climate change analysis forecasts a 82-98% decrease in the Jordan River flow by 2100.

In its draft *Climate Change Adaptation Programme* (2008) the Israeli Ministry of the Environment predicts the sea level in the Mediterranean to increase by 0.5 metres in 2050 and 1 metre by 2100.
Analysis of the Climate Change Situation in Palestine
“sustainable development can reduce vulnerability to climate change” (IPCC 2007 in UNDP 2008)

WHAT IS ‘VULNERABILITY’?

CLIMATE VULNERABILITY

Climate Vulnerability = Biophysical Vulnerability + Social Vulnerability

GEO-4 (UNEP 2007)
**Biophysical Vulnerability** = “the degree to which a [physical] system is… unable to cope with, adverse effects of climate change” IPCC

\[
\text{(Physical) RISK} = \text{HAZARD} \times \text{VULNERABILITY} \\
\quad (\text{climate}) \times (\text{exposure})
\]

**Social Vulnerability** = 
measure of a society to adapt to hazards

\[
\text{(Social) VULNERABILITY} = \text{RISK} - \text{ADAPTATION} \\
\quad (i.e. \text{the residual impact after adaptation measures implemented})
\]
Adaptive Capacity → ability to develop *long-term* options

Coping range → ability to generate *short-term* solutions

Adapted from Vincent (2004).
(Physical) RISK = HAZARD × VULNERABILITY
(climate) × (exposure)

Shelter for Sudanese refugees in Chad, 2004

Harsh climate + High exposure

→ High Physical Risk

High Risk + High coping mech., but Low Adaptation

→ High Social Vulnerability

(Social) VULNERABILITY = RISK – ADAPTATION
(Physical) \( \text{RISK} = \text{HAZARD} \times \text{VULNERABILITY} \)

\( \text{(climate)} \times \text{(exposure)} \)

\[ \text{Shelter for American citizens, California USA} \]

\[ \text{But…} \]

\[ \text{Relatively Low \textit{Climate} Vulnerability} \]

\[ \text{High Risk} \]

\[ \text{+ Many Coping Mech.,} \]

\[ \text{+ High Adaptive Capacity} \]

\[ \text{(e.g.insurance)} \]

\[ \text{⇒ Low Social Vulnerability} \]

\[ \text{(Social) \text{ VULNERABILITY} = \text{RISK} - \text{ADAPTATION}} \]
(Physical) RISK = HAZARD x VULNERABILITY
(climate) x (exposure)

Refugees from Palestine, 1948

Harsh climate
+ High exposure

→ High Physical Risk

High Risk
+ High coping mech.,
but Low Adaptation

→ High Social Vulnerability

(Social) VULNERABILITY = RISK – ADAPTATION
= the *political* component of vulnerability.

Are national adaptation plans applied evenly?

Does ‘political cover’ extend selectively to some communities?

How does the *marginalisation* of a community or people affect their ability to adapt?

Financial mobility?

Physical mobility?
### Determinants and Indicators of Climate Change, Water and Vulnerability

**Towards a Vulnerability Assessment...**

<table>
<thead>
<tr>
<th>Environmental Hazard (Water-related)</th>
<th>Determinant of Vulnerability</th>
<th>Indicators (related to vulnerability)</th>
<th>Coping Mechanisms</th>
<th>Adaptative Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop in Precipitation</td>
<td>Infrastructure – Water Supply</td>
<td>Network coverage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in Temperature</td>
<td>Infrastructure – Water Storage</td>
<td>Storage capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease in Humidity</td>
<td>Infrastructure – Water Storage, Water Quality</td>
<td>Salinity, Nitrates, Chlorides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extreme Weather Event (Heat Wave/Cold Snap)</td>
<td>Quality of Shelter</td>
<td>Roofing material; heating capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rise in Sea-level</td>
<td>Water Quality</td>
<td>Nitrate levels; Coastal erosion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shorter Growing Period</td>
<td>Crop response</td>
<td>Crop yields; crop selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BIOPHYSICAL VULNERABILITY</strong></td>
<td><strong>Dependence on water for livelihood</strong></td>
<td><strong>Source of Household Income</strong></td>
<td></td>
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<tr>
<td></td>
<td>Economic Well-being</td>
<td>GNP per capita</td>
<td></td>
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<td></td>
<td>Interconnectivity - National</td>
<td>Access and Movement Restrictions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interconnectivity - International</td>
<td>Access and Movement Restrictions</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOCIAL VULNERABILITY</strong></td>
<td>Overall Decreased Availability of Water</td>
<td>Quality of technical staff; available budget;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marginalisation within state government</td>
<td>Extent / likelihood of adaption plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marginalisation by external forces [donors, occupiers]</td>
<td>Extent / likelihood of adaption plans</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discuss during focus group discussions

**e.g. What are the links between Livelihood Choices and Water Infrastructure??**
WEST BANK
Palestinians living in **Area C** are the most vulnerable in their subsistence living.

Vulnerable to **elements** (in plastic tents), **seasons** (drought, frost), **violence** (from settlers) and **expulsion** (from IDF).
West Bank: Jordan River Valley

Problems that are related to water availability

Drastic drop in rainfall

Main canal for Al-Auja Spring
1. Reducing accessibility to water sources through denial of travel to the Jordan River

2. Reducing the quantity of water through indiscriminate destruction of water infrastructure such as pipes, cisterns and wells

2. Israeli Practices

- Denial of permission to construct water and sanitation infrastructure like deep wells
- Supplying water to settlements
Damaged agricultural wells
West Bank – CLIMATE VULNERABILITY

(Physical) \( RISK = HAZARD \times VULNERABILITY \)
(climate) \( \times \) (exposure)

Drop in precipitation
+ Livelihoods dependent on irrigated agriculture

→ High Physical Risk

High Risk
+ Low coping mech.,
+ Low Adaptation

→ High Social Vulnerability

(Social) \( VULNERABILITY = RISK - ADAPTATION \)
Jericho - Biophysical Vulnerability

Unplanted fields near Fasa’el (May 2007)

[Ziad… more on jericho]

Zubeydat (May 2007)
Rainfed agriculture near Massafer Yatta

Drop in precipitation
+ Livelihoods dependant on irrigated agriculture

→ High Physical Risk

High Risk
+ *High* coping mech., but
Low Adaptation

→ High Social Vulnerability

(Social) VULNERABILITY = RISK – ADAPTATION

(Physical) RISK = HAZARD x VULNERABILITY (climate) x (exposure)
Figure 3.5: Climate Vulnerability Pathways in the West Bank

Risk = higher variability in precipitation
- Increased stormwater floods
- Shorter production period
- Decreased soil quality

Risk (current) = occupation + movement restrictions
- Restrictions on farmers’ movements
- Restrictions on pumping from Oslo II Agreement
- Obstructive permit system for water + wastewater projects of Joint Water Committee
- Limited water availability
- Illegal well-drilling
- Unlicensed connections
- Over-pumping
- Poor development of waste water sector
- Water use by settlers encouraged

LIVELIHOODS reduced
- Land is confiscated
- Land lies unplanted
- Lower stocks of livestock kept
- Lower income from agriculture
- Lower yields
- Increased groundwater contamination
- Increased tensions between communities and/or ministries, aid agencies, water project managers, national authorities

Risk = reduced precipitation
- Higher tanker water price
- Lower soil moisture
- Lower supply of water from Israel
- Less spring flow
- Increased salinity of ground water (esp in JRV)
- Greater reliance on ground water
- Lower groundwater recharge rates
- Less transboundary freshwater to share
Climate Vulnerability =

**Biophysical** Vulnerability + **Social** Vulnerability

... and the *political* component!
Methodology of Analysis

- **Metrological data**: Temperature, precipitation, relative humidity, sunshine hours and wind speed
- **Historical data**
- **Formulated scenarios**
- **Soil data**: Soil texture, available moisture, infiltration rate and initial soil moisture
- **Crop data**: Length of growing period, crop coefficient, crop yield response factor and root zone
- **CROPWAT**: Computer model
- **Irrigation water requirement (IWR)**
- **Reference evapotranspiration (ETo)**
- **Crop water requirement (CWR)**
Figure 4.5: Evapotranspiration ($ET_o$), Crop Water Requirement (CWR) and Irrigation Water Requirement (IWR) for some of the crops planted at Jericho and Al-Aghwar Governorate crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (1000m$^2$)</th>
<th>$ET_o$, CWR, IWR (mm/period)</th>
<th>Total irrig. req. X 10$^6$ (MCM/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$ET_o$</td>
<td>CWR</td>
</tr>
<tr>
<td>Fruit Trees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bananas</td>
<td>2100</td>
<td>1376.75</td>
<td>1200.85</td>
</tr>
<tr>
<td>Dates</td>
<td>1882</td>
<td>1727.48</td>
<td>1614.39</td>
</tr>
<tr>
<td>Pomegranates</td>
<td>70</td>
<td>1727.48</td>
<td>1073.35</td>
</tr>
<tr>
<td>Grapes</td>
<td>348</td>
<td>1727.48</td>
<td>879.92</td>
</tr>
<tr>
<td>Citrus</td>
<td>1132</td>
<td>1727.48</td>
<td>1171.67</td>
</tr>
<tr>
<td>Olives</td>
<td>85</td>
<td>1727.48</td>
<td>1149.74</td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squash</td>
<td>9180</td>
<td>428.62</td>
<td>387.29</td>
</tr>
<tr>
<td>Corn</td>
<td>6868</td>
<td>266.37</td>
<td>191.73</td>
</tr>
<tr>
<td>Eggplant</td>
<td>4817</td>
<td>460.16</td>
<td>382.77</td>
</tr>
<tr>
<td>Tomato</td>
<td>3468</td>
<td>460.16</td>
<td>382.77</td>
</tr>
<tr>
<td>Green beans</td>
<td>1760</td>
<td>251.46</td>
<td>189.14</td>
</tr>
<tr>
<td>Fababeans</td>
<td>835</td>
<td>369.76</td>
<td>272.21</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>994</td>
<td>266.37</td>
<td>224.24</td>
</tr>
<tr>
<td>Jew's Mallows</td>
<td>782</td>
<td>1727.48</td>
<td>1437.72</td>
</tr>
<tr>
<td>Cabbage</td>
<td>795</td>
<td>266.37</td>
<td>224.24</td>
</tr>
<tr>
<td>Snake Cucumber</td>
<td>586</td>
<td>274.05</td>
<td>244.17</td>
</tr>
<tr>
<td>Pepper</td>
<td>569</td>
<td>319.3</td>
<td>253.96</td>
</tr>
<tr>
<td>chilli pepper</td>
<td>499</td>
<td>319.3</td>
<td>253.96</td>
</tr>
<tr>
<td>Okra</td>
<td>570</td>
<td>753.15</td>
<td>733.04</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>455</td>
<td>388.6</td>
<td>289.98</td>
</tr>
</tbody>
</table>
Figure 4.6: Total Irrigation Water Requirement for Jericho and Al-Aghwar Governorates under different scenarios in MCM/year.

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>T+1</th>
<th>T+2</th>
<th>T+3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-20%</td>
<td>21.05</td>
<td>21.63</td>
<td>22.23</td>
<td>22.83</td>
</tr>
<tr>
<td>P-10%</td>
<td>20.24</td>
<td>20.82</td>
<td>21.42</td>
<td>22.01</td>
</tr>
<tr>
<td>P</td>
<td>19.95</td>
<td>20.53</td>
<td>21.12</td>
<td>21.71</td>
</tr>
<tr>
<td>P+10%</td>
<td>19.66</td>
<td>20.24</td>
<td>20.83</td>
<td>21.42</td>
</tr>
<tr>
<td>P+20%</td>
<td>19.38</td>
<td>19.96</td>
<td>20.54</td>
<td>21.13</td>
</tr>
</tbody>
</table>

Source: Abu-Jamous (2009)
Nearly ALL Palestinians in Gaza are highly vulnerable in their subsistence living:

Vulnerable to:

- the **elements** (heating),
- **seasons** (drought, shorter growing seasons),
- **violence** (internally, and from IDF)
- **expulsion/home demolition** (from IDF); and
- (mainly) – the **economy** (even remittances are slowing).
(Physical) \( \text{RISK} = \text{HAZARD} \times \text{VULNERABILITY} \)

\( \text{climate} \times \text{exposure} \)

Sea-level rise (Harsh climate)

+ Houses near shore (?)

\( \Rightarrow \text{Med } \text{-High Risk} \)

\( \Rightarrow + \text{ Even worse water quality} \)
Figure 4.4: The disruptive and destructive impacts of a flash flood in the Gaza Strip, following 36-hours of heavy precipitation on 27-29 October 2008 (Source: UNDP/PAPP).
GAZA – SOCIAL VULNERABILITY

(Social) VULNERABILITY = RISK – ADAPTATION

High Risk

+ 

Low Coping and Adaptative Capacity

→ High Risk
GAZA – SOCIAL VULNERABILITY

(Social) VULNERABILITY = RISK – ADAPTATION

before

27 March 2007

(Very) High Risk + (Very) Low Adaptative Capacity

→ Extreme Risk
GAZA – SOCIAL VULNERABILITY

GAZA AS A WHOLE is socially vulnerable to environmental hazards

Gaza is under siege; Lifelines extend near, but not to it...

Coping mechanisms abound; BUT...

…long-term adaptation is foreclosed by politics.
Example of Potential Findings

- e.g. Tel Aviv
- e.g. Fesa’el
Adapting to Vulnerability – Adaptive Capacity

Rainwater Harvesting – Wadi Terracing
Adapting to Vulnerability – Coping Mechanisms
<table>
<thead>
<tr>
<th>Consequences for food and water and security</th>
<th>Agricultural and water-sector adaptation</th>
<th>Category^1</th>
<th>Scale^2</th>
<th>Adaptive capacity^3</th>
<th>Technical feasibility^3</th>
<th>Potential cost^3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risks</strong></td>
<td></td>
<td></td>
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<tr>
<td>1. <strong>Crop area changes due to decreases in optimal farming conditions</strong></td>
<td></td>
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<tr>
<td><strong>Main climatic causes of risk:</strong></td>
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<tr>
<td>Changes in monthly precipitation distribution</td>
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<tr>
<td>Increased temperatures in critical periods</td>
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<tr>
<td>Increased erosion</td>
<td></td>
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<tr>
<td>Loss of soil water retention capacity</td>
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<tr>
<td>Farming optimal conditions altered resulting in increased risk to rural income</td>
<td>Rural livelihood diversification</td>
<td>M</td>
<td>N</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Strengthen capacity of agricultural extension services</td>
<td>M</td>
<td>N</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Irrigation of highest value crops</td>
<td>I</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Changing cultivation practices</td>
<td>M</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>H</td>
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<tr>
<td></td>
<td>Increased irrigation of main crops</td>
<td>M</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Switching to drought-resistant alternative crops</td>
<td>T</td>
<td>R</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Loss of indigenous species</td>
<td>Introducing drought-resilient varieties of indigenous crops</td>
<td>T</td>
<td>R</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Soils deterioration due to land use changes</td>
<td>Precision agriculture: improve soil and crop management</td>
<td>M</td>
<td>R</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>
### 2. Decreased crop and livestock productivity

**Main climatic causes of risk:**
- Changes in monthly precipitation distribution
- Increased temperatures in critical periods (heat stress)
- Loss of soil water retention capacity

| Crop productivity decrease | Change in cropping and grazing patterns for productivity gains | M | R | M | M | L
|---------------------------|------------------------------------------------------------|---|---|---|---|---
|                           | Increased input of agro-chemicals                          | M | R | H | H | H
|                           | Increased irrigation of main crops                         | I | R | H | H | H
| Land abandonment          | Adaptive land use planning                                 | M | N | H | M | M
|                           | Rural livelihood diversification                           | M | N | H | M | M

### 3. Increased risk of floods

**Main climatic causes of risk:**
- Increase of extreme events frequency
- Loss of soil water retention capacity

| Increased expenditure in emergency and remediation actions | Develop contingency plans | M | N | H | H | L
|-----------------------------------------------------------|---------------------------|---|---|---|---|---
|                                                           | Enhance flood plain management | M | N | M | M | M
| Flash flood frequency and intensity increase             | Increase rainfall interception capacity (local-level) | M | R/U | H | H | L
|                                                           | Reduce grazing pressures to protect against soil erosion from flash flooding | M | R | M | M | M
4. Increased risk of drought and water scarcity

Main climatic causes of risk:
Decreased annual and/or seasonal precipitation
Increase in the frequency of extreme conditions (droughts and heat waves)

<table>
<thead>
<tr>
<th>Conflicts among water users due to drought and water scarcity</th>
<th>Set clear water use priorities</th>
<th>Increase water use efficiency</th>
<th>Increase rainfall interception capacity (sector-level)</th>
<th>Increase water re-use</th>
<th>Awareness-raising on water conservation techniques</th>
<th>Improve field drainage and soil absorption capacity</th>
<th>Altering crop rotations for more tolerance to heat/drought</th>
<th>Local use of treated wastewater for agriculture</th>
<th>Development of new water sources including desalination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>N</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
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<tr>
<td>Water supply reduced</td>
<td>M</td>
<td>N</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
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</tr>
</tbody>
</table>
## 5. Increased irrigation requirements

### Main climatic causes of risk:
- Increased average and extreme temperature
- Increase of drought and heat stress conditions frequency
- Decreased precipitation

<table>
<thead>
<tr>
<th>Water availability decrease</th>
<th>Invest in irrigation equipment that collects rain water</th>
<th>T</th>
<th>R</th>
<th>H</th>
<th>H</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic olive oil production</td>
<td>T</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Invest in water saving devices like trickle irrigation</td>
<td>T</td>
<td>R</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Irrigation during the night</td>
<td>M</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Increased water harvesting</td>
<td>I</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Desalination of sea water and brackish water for agriculture</td>
<td>I</td>
<td>N</td>
<td>H</td>
<td>M</td>
<td>H</td>
</tr>
</tbody>
</table>

## 6. Increased risks to public health from reduced drinking water quality (DWQ)

### Main climatic causes of risk:
- Decreased precipitation
- Decreased groundwater recharge rates
- Saline intrusion (Gaza)

<table>
<thead>
<tr>
<th>Drinking water quality decrease</th>
<th>Review national DWQ management system to incorporate climate risks</th>
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<tr>
<td></td>
<td>Increase water quality monitoring</td>
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<td>Identify minimum household water security requirements</td>
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</tbody>
</table>

| Groundwater contamination       | Reduce over-pumping                                              | I | R | M | H | M |
|                                 | Reduce use of untreated wastewater in agriculture                | I | U | M | H | H |
|                                 | Increase wastewater treatment                                    | I | U | M | H | H |
Adaptation Integration into Policy and Planning