Green Water Assessment in the Arab Region
An Approach to Virtual Water Evaluation

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Annual Renewable Water Resources in the Arab Region (m³/cap/year)
Virtual Water

- It is the water ‘embodied’ in a product in a virtual sense.
- It refers to the water (blue & Green) needed for the production of the product.
- Virtual water trade value ($/m³) = unit crop trade value ($/kg) / crop water requirement (m³/kg)
Blue Water

- It is the surface water or groundwater that is abstracted manually for the purpose of development or production (e.g. water in lakes, rivers, and groundwater)
Green Water

- It is the beneficial green cover abstractions portion of the renewable water resources which comes from atmospheric water directly consumed by rainfed agriculture, natural pasture, and forests.
Water Resources in the 10 Nile Countries

1660 BCM/year annual precipitation on the Nile Basin.

7000 BCM/year annual precipitation on the Nile Basin Countries.

Egypt’s Use from the Nile is 55.5 BCM/year.
Per Capita Share of Renewable Water Resources & Green Cover

Water for Irrigated Land
Compared to Rain-Fed & Irrigated Land

Irrigation Water Use 2000 (MCM/Year)
Cultivated Area (1000 acre)
Irrigated Area (1000 acre)

Egypt
Syria
Morocco
Greece
France

92% Rain-Fed
100% Irrigated
- France: cultivated area:
  80 million acres, 8% is irrigated

- Egypt: cultivated area:
  8 million acres, 100% is irrigated

- France: freshwater outflow to Mediterranean: 50 Km³/year

- Egypt: total renewable freshwater: 55.5 Km³/year
### Some Quoted Virtual Water Content

**Hong Yang, 2006**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Country</th>
<th>Virtual Water Content (m$^3$/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>USA</td>
<td>1.30</td>
</tr>
<tr>
<td></td>
<td>Morocco</td>
<td>4.14</td>
</tr>
<tr>
<td></td>
<td>Algeria</td>
<td>7.22</td>
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<tr>
<td>Maize</td>
<td>France</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>USA</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>Mexico</td>
<td>1.34</td>
</tr>
</tbody>
</table>

- Is this Really the True **Virtual Water Needed**?
- Or is this Only **Blue Water Requirements**?
- Is **Green Water Consumption** Ignored?
- Is the **Irrigation Efficiency** Factor considered and how?
- Is the **leaching Factor** in Rainfed Agriculture Areas included?
- Is the **Reuse** of Water (Agriculture Drainage) considered?
Food Import Dependency in Egypt

- Cereal
- Oil
- Sugar
- Vegetables
- Fruits

Import / Total Supply %
Trade Barriers & Market Competition
(Vegetables & Fruits Exports in Egypt)

(Hong Yang, 2006)
Trade Barriers & International Competition

(Egyptian Cotton Production and Export)

(Hong Yang, 2006)
Assessment of Green Water

- Natural pasture, forests, and rainfed agriculture land coverage are extracted from the DCW, WRI and FAO reports.
- Data were compiled in CEDARE (WRIS).
- Estimates for the beneficiary abstraction for rainfed crops, pasture, and forests are derived from the reference value of irrigated agriculture with each country (utilizing the figures for the total irrigated agriculture area, total irrigated agricultural abstraction, and number of crop rotations per year for the same land).
The reference value is then multiplied by a conversion factor which accounts for:

- effective rainfall periods per year
- precipitation distributions per land use
- irrigated crops are subject to water availability throughout the full year
- rain-fed crops and vegetations are subject to water availability during the rainy season only
Water requirements for the nearest irrigated crop land use in the same country is calculated as the ratio between irrigation abstractions and the area for the corresponding land use ($R$).

Actual ET by crops / (Supplied water - Leachate Requirements) = $\alpha$

where $\alpha$ is a function of the prevailing aridity and the plant cover (an average value of 0.7 may be assumed for crops in temperate to arid regions).

Rainy period for the Natural vegetation land use is then identified (say 3 months, i.e. (0.25) year)

Vegetation abstractions = Area of Vegetation $\times$ ($R$) $\times$ (0.7) $\times$ (0.25)
Seven prevailing land uses are considered for the entire Arab Region. These are: Irrigated crops, Rain-fed crops, Natural pasture, Forests, Desert, Rocks and lava, and Swamps.
Land Use in the Arab Region
Simplified Land Use in the Arab Region
Land Use in the Arab Region

Land Uses for the Arab Region

- Irrigated Crops: 87%
- Rainfed Crops: 7%
- Forests: 3%
- Natural Pasture: 2%
- Desert: 1%
Land Use in the Arab Region

- Irrigated Cropland: 1%
- Total Natural Vegetation Land: 12%
- Desert Area: 87%

Web: www.cedare.org
E-mail: water@cedare.org
Precipitation by Land Type
Water Use by Different Land Uses in the Arab Region
Green Water in the Arab Region

- Rainfed Crops Abstraction
- Natural Forest Abstraction
- Natural Pasture Abstraction
Blue & Green Water for Food Production

- Irrigated Crops Abstraction (Blue Water)
- Rainfed Crops Abstraction (Green Water)
Blue & Green Water Use in Arab Region (for Green Cover)
Blue & Green Water Use in Arab Region
(for Green Cover)

- Irrigated Crops Abstraction (Blue Water)
- Rainfed Crops Abstraction (Green Water)
- Natural Forest Abstraction (Green Water)
- Natural Pasture (Green Water)
Blue & Green Water Use in Arab Region  
(for Green Cover)
Blue & Green Water for all Sectors

Blue/Green Water Abstraction for the Arab Region

- Irrigation: 254,474, 58%
- Domestic: 162,106, 37%
- Industrial: 8,809, 2%
- Natural ET (Green Water): 11,726, 3%
Blue & Green Water for Food in Arab Region

- Irrigated Crops Abstraction: 168.73
- Rainfed Crops Abstraction: 43.69
Virtual Water in the Arab Region

Virtual Water in Local Produced Food: 212.42
Imported Virtual Water: 292.1
Exported Virtual Water: 57.08
Conclusions & Recommendations

- Green water should be an integral element that should be included in assessing virtual water, and renewable water resources.
- The same exercise should be done on other regions (especially Large cereal exporters).
- Virtual Water Trade is naturally taking place in the Arab Region and will continue, but it is difficult to put national policies that is based on Virtual Water Trade.
- Trade barriers, international market competition, subsidies, price distortions, and free cropping pattern policies, hinders implementing virtual water trade policies.
- Exporter of goods is not always the importer of strategic food commodities which is also a constraint to food security policies.