Strengthening the Interface between Science and Policy Communities through Inclusive Tools

Expert Group Meeting on the science-policy interface

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Water-Energy-Food Nexus

(Mohtar, Daher, 2012)
Conceptual Framework

Water
- Water Balance
- Gap Identification
  - Agriculture
  - Municipal
  - Industrial

Food
- Consumption
  - %DPC
  - %DPE
  - % IMP
- DPC: Domestically Produced and Consumed
- DPE: Domestically Produced and Exported
- IMP: Imported

Energy
- kl/m³ of water produced for food production → kl/ton
- Technologies and Efficiencies
  - Surface water pumping
  - Ground water pumping
  - Water Treatment
  - Wastewater Treatment
  - Desalination
  - Other
  - Tillage
  - Fertilizer production
  - Harvest
  - Local Transport

Conventional & Non-Conventional Water Resources
- Rainfall
- Surface Water
- Groundwater
- Treated Water
- Treated Waste Water
- Desalinated Water

Reallocation
- Scenario 1: Importing Products
- Scenario 2: Domestic Production
  - Intensify Agriculture
    - Arable Land Availability
    - Open Vs. Protected Ag. Technologies
  - Financial Cost
    - $/ton food

GLOBAL COSTS
- Environmental Costs
- Energy Costs

LOCAL COSTS
- Financial Costs
- Dependency Risks (uncertainty)
- Product + Transport Cost
  - $/ton food
  - CO₂/ton food
  - kl/ton food
  - Virtual water import

Environmental Cost
- Ppm of NOx, SOx...
- Ton CO₂/ton food

Climate
- Amounts of water for irrigation under different climates
- Climate specific crops
- Outdoor vs. Indoor Agriculture

(Daheer, Mohtar)
Tool Structure

- Available food products
- Available water resources
- Available energy resources
- Available countries for import

- Yield/food product for open and protected agriculture (ton/ha)
- Water Requirement/food product for open and protected agriculture (m³/ton)
- Annual rainfall (mm)
- Energy requirements for securing needed water (kJ/m³)
- Energy requirements for local agricultural production (kJ/ha)
- Carbon Footprint respective to different energy sources (ton CO₂/kJ)
- Market price of local and imported products ($/ton)
- Energy requirement for import (kJ/ton food product/country)
- Carbon emission for import (ton CO₂/ton food product/country)

User

Tool

Water (m³)
Land (ha)
Local Energy (kJ)
Local Carbon (ton CO₂)
Financial ($)
Energy IMP (kJ)
Carbon IMP (kJ)

(Daher, Mohtar)
Too Structure

Local Characteristics

Acceptable limits

- Available food products
- Available water resources
- Available energy resources
- Available countries for import

- Yield/food product for open and protected agriculture (ton/ha)
- Water Requirement/food product for open and protected agriculture (m³/ton)
- Annual rainfall (mm)
- Energy requirements for securing needed water (kJ/m³)
- Energy requirements for local agricultural production (kJ/ha)
- Carbon Footprint respective to different energy sources (ton CO₂/kl)
- Market price of local and imported products (S/ton)
- Energy requirement for import (kJ/ton food product/country)
- Carbon emission for import (tonCO₂/ton food product/country)

User → Tool → Policy

%SS₁, %OP AG₁, %Water Sources, %Energy Sources, %IMP Countries₁

Water (m³), Land (ha), Local Energy (kl), Local Carbon (ton CO₂), Financial (S), Energy IMP (kl), Carbon IMP (kl)

Index

WI, LI, EI, CI, FI, IE IMP, IC IMP

Sustainability Index

Importance coefficients (Daher, Mohtar)
## Qatar Case Study

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
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<tbody>
<tr>
<td>WATER (m³)</td>
<td>5,783,797</td>
</tr>
<tr>
<td>LAND (ha)</td>
<td>792</td>
</tr>
<tr>
<td>E1 (kJ)</td>
<td>24,699,706,932</td>
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<tr>
<td>E2 (kJ)</td>
<td>15,000,733,177</td>
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<tr>
<td>C1 (ton CO₂)</td>
<td>3,039,436</td>
</tr>
<tr>
<td>C2 (ton CO₂)</td>
<td>1,089</td>
</tr>
<tr>
<td>F Local (QAR)</td>
<td>48,940,200</td>
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<tr>
<td>F Import (QAR)</td>
<td>3.68E+08</td>
</tr>
<tr>
<td>E IMP (kJ)</td>
<td>1.2117E+12</td>
</tr>
<tr>
<td>C IMP (kJ)</td>
<td>92,987</td>
</tr>
</tbody>
</table>

**Combined self-sufficiency = 15% (2010)**

**Tomato and Cucumber** are partially done in protected agriculture

**Groundwater** is main source for agriculture

**Natural Gas** is main source of energy

**Imports** secured from 15 different countries

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Tomato and Cucumber are partially done in protected agriculture. Groundwater is the main source for agriculture. Natural Gas is the main source of energy. Imports are secured from 15 different countries.
Increase food production by 100% for coming year

Hypothetical Scenario 2010

Percentage change for resources as a result of 50% increase in self-sufficiency per product

<table>
<thead>
<tr>
<th>Resource</th>
<th>% Change</th>
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<tbody>
<tr>
<td>WATER</td>
<td>+411%</td>
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<tr>
<td>LAND</td>
<td>+764%</td>
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<tr>
<td>E1</td>
<td>+411%</td>
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<tr>
<td>E2</td>
<td>+486%</td>
</tr>
<tr>
<td>C1</td>
<td>+411%</td>
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<td>C2</td>
<td>+461%</td>
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<tr>
<td>F Local</td>
<td>+390%</td>
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<tr>
<td>F Import</td>
<td>-60%</td>
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<tr>
<td>E-IMP</td>
<td>-55%</td>
</tr>
<tr>
<td>C-IMP</td>
<td>-55%</td>
</tr>
</tbody>
</table>
Integrative Planning

Two necessary spaces for collaborative and integrative planning

among decision making entities

among decision making entities & science
Recommendations: Science

- **Academia** and current **reward system**

- Train a **new generation of professionals** with the skills needed to manage interactions between scientific experts and those with other kinds of specialized knowledge

- **Effective Science Communication**

- Deploy **tools** for managing and planning resources and risk management strategies
Recommendations: Policy

• **Inclusive discussions.** Make sure scientists and policy makers are in the same room

• **Build institutional capacity** required to implement collective decision making

• **Introduce platforms** to have scientists and policy makers meet

• **Consider non-stationarity** in policy decisions

• Promote **nexus friendly & site specific technology**

• **Develop local capacity** for R&D in sustainability