Knowledge Triangle Platform for Water-Energy-Food Nexus

EU funded project between European and Egyptian Universities
Helmy Abouleish

- Managing Director of the SEKEM initiative that works for sustainable development in Egypt since 1977
- Under his stewardship, the SEKEM Initiative received the “Right Livelihood Award 2003”
- Member of the Schwab Foundation for Outstanding Social Entrepreneurs since 2004
- Founder and co-founder of various organizations including: The Egyptian National Competitiveness Council (ENCC), the International Association for Partnership (IAP), the Egyptian Biodynamic Association (EBDA), the Centre for Organic Agriculture in Egypt (COAE), SEKEM Development Foundation (SDF).
- Helmy Abouleish is a passionate advocate of sustainable agriculture and sustainable development.
Tempus – TriNex project

Rasha El-Kholy

• Prof. Dr. Rasha El-Kholy has 19 years experience working in the field of water resources management and environmental protection. She has managed many foreign funded research projects as well as national programs in the field of water Engineering.

• Rasha Elkholy is currently the Dean of faculty of Engineering at Heliopolis University for Sustainable Development. She has more than 10 years experience developing specialized post graduate training programs and under graduate academic curricula as well as supervising M.Sc. Students.

• She also serves as a short term consultant for the United Nations - Food and Agriculture Organization (FAO) and highly involved with international organizations.

• Prof. El-Kholy has published several scientific research papers in international scientific journals in addition to some chapters in international books. She is an active member in many international associations annealing scientific research to serve humanity's well-being and protect the environment.
Gabriele Cassetti

- Member of UNESCO Chair in “Energy for Sustainable Development” at Politecnico di Milano
- Contract professor in the course ‘Energy for Sustainable Development’ at Como Campus.
- PhD in “Energetic and Nuclear Science and Technology” on advanced exergy analysis and environmental impact of energy systems.
- Collaborator of the Rector’s Delegate to Cooperation and Development.
Hani Sewilam

- Professor of Sustainable Development and Water Resources Management
- Director of the UNESCO Chair for Climate Change and Water Resources Management
- Academic Director of the Engineering Hydrology at the RWTH Aachen University in Germany
- Coordinator for the Capacity Building Initiative of the United Nations Water
- Director Center for Sustainable Development at the American University in Cairo
- Researcher at the National Water Research Center in Egypt
- Advisor and Member of the Board of several Universities and International Organizations
Global Water Situation

Total amount of water:
1.4 billion cubic kilometer (km³)

Freshwater sources:
35 Mio km³ => 3%

24 Mio km³ is inaccessible as frozen in ice caps and glaciers

0.77% => 11 Mio km³ as groundwater, surface water and in plants and atmosphere
The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015.
More than **1 billion people lack access** to clean drinking water

**Half the hospital beds in the world** are occupied by patients with easily prevented water-borne disease

**Half the people in the world** do not have **sanitation systems** as good as those in Ancient Rome
One-Third of MDGs depends on Water

The United Nations Secretary-General's Advisory Board on Water & Sanitation
River Nile

1. Burundi,
2. Congo,
3. Egypt,
4. Eritrea,
5. Ethiopia,
6. Kenya,
7. Rwanda,
8. South Sudan,
9. Sudan,
10. Tanzania, and
11. Uganda.

Tempus
The Falkenmark Indicator

m³ / [a x capita]

- Absolute Scarcity
- water Scarcity
- water stress
- sufficiente water supply

(Falkenmark 1989)
Virtual Water

TriNex
Knowledge-Triple Platform
for the Water-Energy-Food Nexus

VIRTUAL WATER

4500 litres of water for one steak (300g) of Beef
Agriculture
Know ledge - Triangle Platform for the Water - Energy - Food Nexus

TriNex
Between 1976 and 1994, Egypt lost an average of 8000 ha of agricultural land yearly.
The blue water footprint refers to consumption of blue water resources (surface and groundwater) along the supply chain of a product.

The green water footprint refers to consumption of green water resources (rainwater insofar as it does not become run-off).

The grey water footprint refers to pollution and is defined as the volume of freshwater that is required to assimilate the load of pollutants given natural background concentrations and existing ambient water quality standards.
EGYPT: Population Growth & Per Capita Land Allocation
1897-2050

Population Growth (Million)

Per Capita Agriculture Land Allocation (Fed)
Egypt is facing a crucial energy problem. **Natural gas consumption nearly doubled over the last decades** and reached 1.6 trillion cubic feet in 2010. Total **petroleum consumption has risen by about one-third** over the same time period.
Research: Desertec

Sketch of a possible infrastructure for sustainable power supply to Europe and the Mediterranean.
Renewable Energy + Desalination
Food security and sustainable agriculture

Biovision Alexandria Conference 2014
Tuesday, 8th April, 2014

Helmy Abouleish
Managing Director – SEKEM Group
Global Challenges

- Population Growth
- Climate Change
- Environmental degradation
- Resource scarcity
- Food security
Food consumption increases

Figure 3 World demand for cereals, 1974, 1997, and 2020

Global Challenges

• 800 mio new consumers in the global middle class expected till 2020
• Growing and shifting demand for „high value“ food (meat, fish, dairy, fruits and vegetables)
• Resource intensive production of „high value“ food
  – Adds to raising food prices
  – Food will be larger share of total consumer expenditure
  – Incentives shift from imported to cheaper, seasonal local consumption

Source: Deloitte – Consumer 2020: Reading the signs
Figure 3: The ecological footprint of food

<table>
<thead>
<tr>
<th>Food</th>
<th>Water footprint (litres)</th>
<th>Emissions (Kg CO2e)</th>
<th>Land use (m²)</th>
<th>Grain (for feed) (kg)</th>
<th>Calories (Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>15,500</td>
<td>16</td>
<td>7.9</td>
<td>6</td>
<td>2470</td>
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<tr>
<td>Chicken</td>
<td>3,900</td>
<td>4.6</td>
<td>6.4</td>
<td>1.8</td>
<td>1650</td>
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<tr>
<td>Eggs</td>
<td>3,333</td>
<td>5.5</td>
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<td>Milk</td>
<td>1,000</td>
<td>10.6</td>
<td>9.8</td>
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<td>610</td>
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<tr>
<td>Wheat</td>
<td>1,300</td>
<td>0.8</td>
<td>1.5</td>
<td></td>
<td>3400</td>
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<tr>
<td>Rice</td>
<td>3,400</td>
<td></td>
<td></td>
<td></td>
<td>1300</td>
</tr>
</tbody>
</table>

1 Kg Water footprint (litres)

Emissions (Kg CO2e)

Land use (m²)

Grain (for feed) (kg)

Calories (Kcal)

Assumes an average egg weighs 60g, and the density of milk is 1kg per litre.

Based on production in England and Wales.

Based on production in England and Wales, assumes all production is on land of an equal grade.

Sustainable Agriculture is the only solution!

- Long term yield increase
- True cost of organic products are increasingly cheaper in the future
- Closed nutrient cycles + local production & consumption
  - Decouples energy prices and commodity prices
- Improved climate change adaptation
- Promotes climate change mitigation
- Only way to stop the loss of arable land
The new paradigm of sustainable agriculture!
Egypt Water Dilemma & Interventions

Biovision Alexandria Conference 2014
Tuesday, 8th April, 2014

Rasha Elkholy
Dean, Faculty of Engineering – Heliopolis University
The annual per capita share of water resources is dramatically reduced from more than 2500 m$^3$ at the year 1950 to less than 850 m$^3$ at the year 2010, and is further projected to fall to about 500 m$^3$/cap/yr by year 2050.
Demand on Water Resources

- Drinking water actual requirements = 9 BCM
- Groundwater provides 17% of the latter
- 97% of urban population, and 70% of rural population of Egypt relies on piped water supply.
- 52% of urban populations, and 11% of rural population have full sanitation services
Agriculture accounts for 82% of the total demand for freshwater.

Evaporation losses from the 31,000 Km-long water conveyance network is estimated at about 3.0 BCM/yr.
• Waste water: **full potable water network while partial sanitation network**

• Agriculture drainage with fertilizers & pesticides polluting surface and GW

• Nile River: mostly good except from industry points as well as in Rosetta and Damietta branches in addition to sewage, and agriculture pollutants

• Main canals: WQ is moderate except: Fayoum with organic pollutants
  Elsalam, Bahr Moeas, el bahr el Abbasy, and El- Mahmodeia

• Agriculture drains: high pollution from sewage in village without services - Winter is better than summer

• GW: Most wells in Nile delta and Valley are suitable for drinking and irrigation. Some pollution in the new reclaimed lands within Nile Delta. with Heavy metals violating limits in deep GW and need treatments
Crop Requirements

Total (milion Cubic Meters)

Summer Crops WR
Total WR = 26.5 bcm

Winter Crops WR
Total WR = 14.8 bcm

- **Wheat**: Production: 7.2 million tons & Import: 7.9 million tons
- **Maize**: Production: 7.4 million tons & Import: 5.3 million tons
- **Rice**: Production: 5.5 million tons with 105.5% self-sufficiency

Tempus
Interventions
(Water Strategy Pillars)

1. Water resources Development
   (Invest in desalination of sea water & brackish GW, cooperation with NB countries, Increase GW rational use, rain & Flash Flood harvesting, better management of the shallow GW in the Nile Valley)

2. Improve the rational use of the current WR
   (Increase Water Use Efficiency, Ag. land protection & improve fertility and productivity, Improve infra-structures & water distribution structures based on actual needs, Improve water availability for all purposes)

3. Protection of Public Health and Environment
   (Prevention and combating the WR pollution, treating polluted water from different activities, pollution control & considering the water suitability for its specific usage purposes)

4. Provide suitable environment for planning
   (Improve WR planning & provide required finance & improve cooperation and coordination in the water sector, decrease population growth rate)
Research & Development
(Opportunities)

- Renewable energy technology for water resources development
- Solar Pumping technology & remote connectivity
- Desalination technology with cheap energy resources
- RS Management Technology for different WR
- Canals water distribution remote management & technology (SCADA systems)
- O&M research & new technologies for all WR
- Rain & Flash flood harvesting research & technology
- Treatment technology
Energy Challenge in DCs

1.3 billions no access to electricity

2.6 billions rely on biomass for domestic usage

Source: WEO 2012, IEA
Energy and Development

Possible options according to the **IEA forecast**: 50-250 kWh per year per capita

- Improve access to the **national electric grid**
- Foster **distributed generation**

Which strategies?
Access to electricity in Egypt

<table>
<thead>
<tr>
<th>Country</th>
<th>Electrification Rate (%) 2005</th>
<th>Electrification Rate (%) 2010</th>
<th>Rural Electrification Rate (%) 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>98.1</td>
<td>99.3</td>
<td>97.9</td>
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<tr>
<td>Bahrain</td>
<td>99.0</td>
<td>99.4</td>
<td>94.7</td>
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<td>Egypt</td>
<td>98.0</td>
<td>99.6</td>
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<tr>
<td>Iran</td>
<td>97.3</td>
<td>98.4</td>
<td></td>
</tr>
<tr>
<td>Iraq</td>
<td>15.0</td>
<td>98.0</td>
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<tr>
<td>Kuwait</td>
<td>100.0</td>
<td>100.0</td>
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<tr>
<td>Libya</td>
<td>97.0</td>
<td>99.8</td>
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<tr>
<td>Oman</td>
<td>95.5</td>
<td>98.0</td>
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<tr>
<td>Qatar</td>
<td>70.5</td>
<td>98.7</td>
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<td>Saudi Arabia</td>
<td>96.7</td>
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<td>Syria</td>
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<td>92.7</td>
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<tr>
<td>UAE</td>
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<td>Yemen</td>
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<td>Israel</td>
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<td>Jordan</td>
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<td>99.4</td>
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<td>Lebanon</td>
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<td>Morocco</td>
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<td>Palestinian Territories</td>
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<tr>
<td>Tunisia</td>
<td>98.9</td>
<td>99.5</td>
<td></td>
</tr>
</tbody>
</table>

Source: MENA RSR 2013, REN21

Source: IEA2013
Clean Energy Technologies

1. Renewable energies

Recent progress:
Investment fell by 11% in 2012 from 2011 due to tougher financing conditions, policy uncertainty and falling technology costs. Solar PV capacity still grew by 42% and wind by 19% compared with 2011 cumulative levels.

Key conditions:
- Ongoing subsidies
- Reforms to facilitate grid integration
- R&D in emerging technologies, such as concentrating solar panel, ocean and enhanced geothermal.

Source: WEO 2013, IEA

2. Biofuels

Recent progress:
New investments was 50% lower in 2012 than in 2011, as a result of overcapacity, and a review of biofuels support policies and higher feedstock prices.

Key conditions:
- A longer-term policy framework to build investor confidence.
- R&D to improve costs and efficiency, and to develop sustainable feedstocks.
- Development and application of internationally agreed sustainability criteria and standards.

3. Energy Efficiency

Recent progress:
Evidence of renewed focus from governments, with many major energy countries announcing new measures.

Key conditions:
- Policy action to remove barriers obstructing the implementation of energy efficiency measures that are economically viable.
Desalination plant (Trapani, Italy)

Characteristics:
- 4 units MED-TVC 4 x 9.000 m³/giorno
- 2 Heaters (40 MWt) - 54 t/h of saturated vapor 45 bar and 260°C
- 4 sea pumps 4 x 2.100 m³/h

Mineralization Unit
- 2 storages 2 x 13.000 m³
- Thermal Power required: 73,9 MWt
- Electric Power required: 4,1 MWₑ
Objective 1 – TriNex aims to develop a national Water-Energy-Food strategy and collaboration platform for researchers and decision makers.

Objective 2 – Develop a Water-Energy-Food training program for officials from different ministers and raising the awareness of policy makers.

Objective 3 – Training junior researchers on interdisciplinary water-energy-food research and offering PhD Summer Schools.

Objective 4 – Developing a web-based knowledge-sharing system to enable all the stakeholders (universities, research centers, ministers, NGOs) to share knowledge and exchange experience.
TriNex Partners

RWTH Aachen University

Politecnico di Milano

TU Graz

SEKEM

The American University in Cairo

Cairo University

Alexandria University