Opportunities for Woody Crop Production Using Treated Wastewater in Egypt

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Egypt & Nile River Basin
Nile River Basin Land Cover

Land Cover and Use Variables

- Percent Forest Cover: 2.0
- Percent Dryland Area: 36.8

Source: http://www.nilebasin.org
Nile Waters

- Nile River provides ~97% of Egypt’s freshwater, of which >80% is utilized for agriculture.
- Egypt’s share of Nile waters is allocated to international treaty obligations (Sudan 1959); fixed at 55.5 billion m$^3$ annually.
- Egypt will not be able to meet increasing freshwater demand & has been developing wastewater reuse strategies.

Wastewater Volume (billion m$^3$)
- 5.5 billion m$^3$ in 2017.
- 10% of freshwater.
Primary Pollution Sources

- Industrial wastes
- Pesticides
- Fertilizers
- Pharmaceuticals
- Field crop wastes
- Acid rain
- Untreated sewage wastes

Source: Prof. Nabil Kandil, Soils, Water, & Environment Research Institute, Agricultural Research Center, El-Giza, Egypt
Sewage Water History

- Historically, both treated & untreated sewage water was simply pumped into the sea or main drains, disposed of in the desert or allowed to seep into the ground.
  - Environmental pollution & human health hazards

- Today, treated effluent generated from sewage treatment plants in cities are used in forest plantations in the desert & bordering areas.

Source: Prof. Nabil Kandil, Soils, Water, & Environment Research Institute, Agricultural Research Center, El-Giza, Egypt
Environmental Parameters

1. pH, EC, cations, anions, SAR
2. NO$_3$- N, NH$_4$-N, NO$_2$-N, total N
3. Zn, Fe, Mn, Cu, B, P, Ca, Mg
4. Th, Si, Pb, Cd, Mo, Cr, Se, As, Co, Ni
5. Petroleum hydrocarbons
6. Phenolic compounds
7. Hormones
8. Pesticides residue
   - Organic: Aldrin, Dieldrin, Lindane, Endrin, Malathion
   - Inorganic: Fl, Cl, As, P, Hg
9. Pathogenic indicators
   - Total coliform, Feacal coliforms, *Salmonella*, *Shigella*
10. COD
11. BOD
12. DO
13. Total suspended & dissolved solids

Source: Prof. Nabil Kandil, Soils, Water, & Environment Research Institute, Agricultural Research Center, El-Giza, Egypt
Water Conservation Strategies

- Cooperate internationally (10 African countries of Nile basin)
- Improve irrigation capacity
- Reuse agricultural drainage water
- Increase capacity of water management
- Maintain renewable ground water aquifer in Nile Basin & Delta
- Desalinate sea water
- Build capacity via integrated water resources management
- Exercise precaution during fishing & Navigation
- Reuse treated sewage water

Source: Prof. Nabil Kandil, Soils, Water, & Environment Research Institute, Agricultural Research Center, El-Giza, Egypt
Action Steps

- **Monitor sewage water quality**
  (e.g., salinity, heavy metals, pathogenic indicators, public health hazards)

- **Characterize soil properties**
  (i.e., chemical, physical, hydrological)

- **Cultivate:**
  - Trees in the desert as windbreaks & green belts
  - Artificial forests in selected demonstration fields
  - Fiber crops for industrial purposes (e.g., flax, jute)
  - Oil crops (e.g., *Jojoba*, *Jatropha*)

Source: Prof. Nabil Kandil, Soils, Water, & Environment Research Institute, Agricultural Research Center, El-Giza, Egypt
USAID is an independent agency that provides economic, development & humanitarian assistance around the world in support of the foreign policy goals of the United States.

USAID promotes peace & stability in 100 developing countries by:
- providing emergency humanitarian assistance,
- fostering economic growth,
- protecting human health, &
- enhancing democracy.

Source: http://www.usaid.gov
USAID Assistance

- Technical assistance & capacity building
- Training & scholarships
- Food aid & disaster relief
- Infrastructure construction
- Small-enterprise loans
- Budget support
- Enterprise funds
- Credit guarantees

Source: http://www.usaid.gov
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Source: http://www.usaid.gov

- Livelihood & Income from the Environment – Integrated Water Resources Management Project
- USAID Cairo / Egyptian Ministry of Water Resources & Irrigation
  - Provide technical assistance, training, commodities, & small grants to support decentralization of water management
  - Increase water use efficiency & productivity

Source: http://egypt.usaid.gov
1. Decentralized Management of Water Resources
   Formation of Integrated Water Management Districts (IWMD)
   Formation of Branch Canal Water User Associations
   Equitable Allocation of Water Resources

2. Stakeholder Engagement in Water Resources Management
   Improved Maintenance & Upgrading of Water Management Equipment
   Environmental Services for Improving Water Quality Management
   Improved Wastewater Reuse Practices

3. Capacity Building for MWRI Staff
   Graduate Degree Training for MWRI staff
Egyptian government has developed & approved guidelines for the reuse of treated wastewater for agricultural purposes.

These guidelines represent the legal foundation for farmers to begin cultivating with irrigated wastewater.
<table>
<thead>
<tr>
<th>Grade</th>
<th>Agricultural Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1-1: Plants and trees grown for greenery at tourist villages and hotels.</td>
<td>Grass, Saint Augustine grass, cactaceous plants, ornamental palm trees, climbing plants, fencing bushes and trees, wood trees and shade trees.</td>
</tr>
<tr>
<td>G1-2: Plants and trees grown for greenery inside residential areas at the new cities.</td>
<td>Grass, Saint Augustine grass, cactaceous plants, ornamental palm trees, climbing plants, fencing bushes and trees, wood trees and shade trees.</td>
</tr>
<tr>
<td>G1-3: Fodder/Feed Crops</td>
<td>Sorghum, rye.</td>
</tr>
<tr>
<td>G2-4: Nursery Plants</td>
<td>Nursery plants of wood trees, ornamental plants and fruit trees.</td>
</tr>
<tr>
<td>G2-5: Roses &amp; Cut Flowers</td>
<td>Local rose, ekaie rose, onions (e.g. stadiolus)</td>
</tr>
<tr>
<td>G2-6: Fiber Crops</td>
<td>Flax, lute, hibiscus, jute</td>
</tr>
<tr>
<td>G2-7: Mulberry for the production of silk</td>
<td>Japanese mulberry</td>
</tr>
<tr>
<td>C</td>
<td>Industrial Oil Crops</td>
</tr>
<tr>
<td>G3-2: Wood Trees:</td>
<td>Kasha, camohor and other wood trees.</td>
</tr>
</tbody>
</table>
Wastewater Treatment Plants in Egypt
Establishment of Man-made Forests

28 Total; 21 Irrigated with Treated Sewage Water

Ismailia
Luxor (2)
Aswan (4)
Menofia
Dakahlia
Qena
Sohag (2)
North Sinai
South Sinai
Asyout
Giza
Red Sea
New valley (4)

Source: Egyptian Ministry of Agriculture & Land Reclamation
Dispose of treated wastewater & produce product with economic value

Evaluate the feasibility of scaling up afforestation efforts throughout Egypt

- 67,200 ha available

LIFE – IWRM (II) Project
(2008 – present)
Mission Objectives

1. Identify tree species suitable for afforestation based on local soil characteristics, water quality, & water quantity
2. Define the benefits & consequences of using these species
3. Provide recommendations for irrigation based on potential tree species & local conditions
4. Identify strategies to maximize the potential of afforestation efforts with regard to: improving water quality, maximizing resource production, increasing biodiversity, & limiting commercial inputs
5. Identify potential long-term impacts on the natural resource base from afforestation & strategies to mitigate these impacts
Three Species Classes

- **Pulpwood & sawnwood**
  
  *Pinus, Eucalyptus, Populus* (spp)

- **High-value**
  
  *Khaya ivorensis* (mahogany),
  
  *Tectona grandis* (teak)

- **Pulpwood**
  
  *Gmelina arborea* (beechwood)
Khaya ivorensis

Shoot borer? (Hypsipyla robusta)

14 yrs
Populus spp.

Irrigation vs Crop Requirements

Ismailia, Egypt

Pacific Northwest, USA

Midwest, USA
Great Potential

- Irrigation water is available
- Land is available
- Trees will grow, despite conditions
- Proper management, guidance
Questions?

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