TREATED WASTEWATER REUSE IN THE WEST BANK: PROSPECTS, CHALLENGES AND CONSTRAINTS

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Importance of agriculture in WB

- Contribution in GDP:
  - 30% in 1960’s
  - 5.3% in 2010

- Contribution to labor force:
  - 43% in 1960’s
  - 13% in the last 10 years
Value of Agricultural Production in Palestine

Animal Production: 39%
Rainfed Agriculture: 22%
Irrigated Agriculture: 39%
Land availability

- One third of WB lands is suitable for agricultural cultivation
- Only 11% is suitable for irrigated agriculture (610,000 dunums)
- Only 130,000 dunums are irrigated
- Limitation of water supplies
Water supply and water use

- **Groundwater:** natural recharge 648 mcm/a to three main aquifer basins

**Use:**
- **Domestic sector:** 96 mcm/a
- **Agriculture:** dropped from 90-100 mcm/a to about 60-70 mcm/a recently
- **Diversion to domestic sector, drying up of springs**
Future perspectives

- Increase demands for fresh water
- Less fresh water will be available for agriculture
- Only high cash crops could afford expensive water prices
- More production of treated wastewater
- TWW reuse is a valid option for agricultural water
Status of wastewater systems

- Population in about 500 villages, towns and cities in the WB.
- Only 16 towns and cities with collection systems
- Only one treatment plant is running and effectively treating wastewater.
- Many ongoing studies and projects for collection and treatment of wastewater.
TWW Reuse

- Currently minor reuse activities at Al-Bireh WWTP within a greenhouse.
- Most of that water dumped in an open valley due to the location of the plant.
- Untreated WW which get mixed with fresh water from springs is being used in agriculture in the northern WB
Palestinian Standards and Regulations for TWW Reuse

- Palestine Standards Institute:
  - PSI 742-2003
  - PSI 34-2012

- Ministry of agriculture:
  - Requires from farmers a reuse permit
  - Issues reuse permits
  - Reuse to be in accordance with PSI
  - Requirements on the farm level
## Typical Quality of Raw Wastewater

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>500–600 mg/l</td>
</tr>
<tr>
<td>COD</td>
<td>900–1000 mg/l</td>
</tr>
<tr>
<td>TN</td>
<td>150–200 mg/l</td>
</tr>
<tr>
<td>TP</td>
<td>200–220 mg/l</td>
</tr>
<tr>
<td>TDS</td>
<td>1500–2000 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>7.3 to 8.1</td>
</tr>
</tbody>
</table>
Classification of Treated Wastewater Quality

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>High quality</td>
<td>BOD5 20 mg/l at most, TSS 30 mg/l, NO3-N 20 mg/l, at most and Feacal coliforms at most 200 per 100 ml</td>
</tr>
<tr>
<td>Grade B</td>
<td>Good quality</td>
<td>BOD5 20 mg/l at most, TSS 30 mg/l, NO3-N 20 mg/l, at most and Feacal coliforms at most 1000 per 100 ml</td>
</tr>
<tr>
<td>Grade C</td>
<td>Average quality</td>
<td>BOD5 40 mg/l at most, TSS 50 mg/l, NO3-N 30 mg/l, at most and Feacal coliforms at most 1000 per 100 ml</td>
</tr>
<tr>
<td>Grade D</td>
<td>Low quality</td>
<td>BOD5 60 mg/l at most, TSS 90 mg/l, NO3-N 40 mg/l, at most and Feacal coliforms at most 1000 per 100 ml</td>
</tr>
<tr>
<td>Crop/use</td>
<td>Low quality (D)</td>
<td>Medium quality (C)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Gardens, sports fields, parks</td>
<td>Not allowed</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Groundwater recharge by infiltration, discharge into seas at least 500 m in sea, Green fodders.</td>
<td>Not allowed</td>
<td>0</td>
</tr>
<tr>
<td>Crops for seeds, Dry fodders, Forests not used as parks, industrial crops and grains</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Corn</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Citrus irrigated without drip</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Citrus irrigated by drip irrigation, Nuts (almonds, walnuts, pistachios, pine nuts), Stone fruits (peaches, cherries, apricots), Apples, tropical fruits (mangos, coco), Grapes, Cactus, Palms, Olives, Ornamentals,</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Not allowed</td>
<td>Not allowed</td>
</tr>
</tbody>
</table>
Potential crops for reuse

- Fodder crops
- Tropical fruits
- Stone fruits
- Grapes and nuts
Potential amounts and areas for reuse

- Potential volumes:
  - Domestic use 96 mcm/a now to 200 mcm/a in 30 years
  - TWW volumes 100-150 mcm/a in 30 years
  - Nearly double the existing amount of water currently used in agriculture
  - Reuse could double the irrigated area
Operational problems - supply vs demand
Farmers acceptance to reuse
Characteristics of farmers and farms

- Average cultivated area 14 dunums/family
- Family size: 6-8
- 3 agricultural workers per family
- 45% of interviewed farmers have education beyond high school
Characteristics of farmers and farms

- 83% own the land they cultivate
- Income from agriculture is less than 50% of total for more than 75% of those interviewed
- No prior knowledge of TWW reuse
- More than 77% never heard of reuse standards
- 80-90% believed TWW is technically possible and willing to do it
Farmers concerns about reuse

- Safety of reuse activities
- Marketing Risks
- Willing to reuse crops produced by TWW reuse
- Willing to pay 0.15 to 0.25 $/CM for TWW compared to 0.5 $/CM for fresh water
- Significant impacts of public awareness
Preferences of crops

- 70% preferred fruit trees
- Supplementary irrigation of olives
- 20% fodders
- Apparently more education is needed on the economy of different crops and options
- Need to look more into the standards
Conclusions

- Need to address farmers concerns in adopting standards and regulation- participotry approach.
- Relax standards at initial stages
- Involvement of community in planning for TWW projects, locations of plants of high concerns
- Need to address master planning and zoning areas in towns and cities
Conclusions and recommendations

- Addressing initial extra costs at farm level when TWW is utilized
- Include storage and irrigation infrastructure in the design
- Public awareness and public involvement at all stages of projects.