WASTEWATER MANAGEMENT AND REUSE: MOTIVATIONS, CHALLENGES AND OPPORTUNITIES IN DEVELOPING COUNTRIES

BY

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Outline

- Water Scarcity
- Wastewater Reuse Linkages
- Wastewater Reuse in most Arab Countries
- Challenges of Wastewater reuse
  - Technological
  - Economic
  - Political Factors
  - Regulatory and Institutional Aspects
  - Social Aspects and Risk Factors
- Planning for Wastewater Reuse
Water Scarcity

Population Increase

Increased Per capita Consumption

Intense Utilization of Non-Conventional Sources of Water

Increased Water Management Challenges

Water Scarcity

Climate Change

Technological Development And Economic Growth
Wastewater Reuse Linkages

- Climate Change Adaptation Measure
- Food Security Tool
- Reduce Environmental Impacts of Discharging Untreated Wastewater
- Alternative Water Supply
- IWRM

Wastewater Reuse
Generally, Tunisia (WRI* = 12.7), Jordan (WRI = 27.8) and the GCC countries are the leaders in the wastewater reclamation and reuse.

<table>
<thead>
<tr>
<th>Country</th>
<th>Type of Reuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>Agriculture (direct forage and trees, indirect vegetables)</td>
</tr>
<tr>
<td>Jordan</td>
<td>Agriculture (direct forage and trees, indirect vegetables), Grey water reuse</td>
</tr>
<tr>
<td>Lebanon</td>
<td>Agriculture (limited)</td>
</tr>
<tr>
<td>Morocco</td>
<td>Research and Pilot</td>
</tr>
<tr>
<td>West bank</td>
<td>Agriculture and Grey Water reuse</td>
</tr>
<tr>
<td>Syria</td>
<td>Agriculture – all crops</td>
</tr>
<tr>
<td>Tunisia</td>
<td>Irrigation of green areas, Agriculture, Wetlands</td>
</tr>
<tr>
<td>Yemen</td>
<td>Agriculture – all crops</td>
</tr>
<tr>
<td>UAE</td>
<td>Green space irrigation</td>
</tr>
</tbody>
</table>

* Wastewater Reuse Index (WRI) which quantifies the total amount of wastewater being reused as percentage of the total generation of wastewater (MWI, 1991; ONAS, 2001; Abu Madi and Alsaeed, 2009)
# Wastewater Reuse in most Arab Countries

<table>
<thead>
<tr>
<th>Country Ref: 1-13</th>
<th>Degree of Treatment</th>
<th>Treatment Techniques Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>P, S</td>
<td>AS, OD, TF, and WSP</td>
</tr>
<tr>
<td>Jordan</td>
<td>S</td>
<td>AS, TF, WSP, EA, and anaerobic sludge digesters</td>
</tr>
<tr>
<td>Morocco</td>
<td>P, S, T</td>
<td>Natural lagoons, AL, TF, AS, and WSP</td>
</tr>
<tr>
<td>Lebanon</td>
<td>P, S</td>
<td>Settling tanks and AS</td>
</tr>
<tr>
<td>Syria</td>
<td>S</td>
<td>AS, Wet Land, Oxidation ponds, and AL</td>
</tr>
<tr>
<td>Tunisia</td>
<td>S</td>
<td>AS, OD, WSP, AL, and TF</td>
</tr>
<tr>
<td>Yemen</td>
<td>S</td>
<td>WSP, settling/Imhoff tanks (predominant), AS, TF, and EA</td>
</tr>
<tr>
<td>UAE</td>
<td>S, T</td>
<td>AS and SF</td>
</tr>
<tr>
<td>Kuwait</td>
<td>T, A</td>
<td>AS, OD, SF, DF, UF, and RO</td>
</tr>
<tr>
<td>Algeria</td>
<td>S</td>
<td>AS, WSP, AL, SF, reed bed sewage treatment, and garden filter</td>
</tr>
<tr>
<td>Bahrain</td>
<td>S, T</td>
<td>AS, SF, RBC, AL</td>
</tr>
<tr>
<td>Oman</td>
<td>S, T</td>
<td>AS, WSP, RBC</td>
</tr>
<tr>
<td>KSA</td>
<td>S, T</td>
<td>AS, WSP, TF</td>
</tr>
<tr>
<td>Sudan</td>
<td>S</td>
<td>WSP, AS</td>
</tr>
</tbody>
</table>

**P: Primary, S: Secondary, T: Tertiary, A: Advanced**

Wastewater Reuse in most Arab Countries

### Categories of Arab Countries According to Reuse Standards Status (ref: 5, 7, 13, 14)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1</strong></td>
<td>Includes Arab countries that adopt low-risk WHO and FAO based on low technology and low cost, such as Bahrain, Jordan, and Morocco have adopted fully or partially WHO and FAO guidelines (Loutfy 2010; WHO 2006; WHO 2005; &amp; Choukr-Allah 2010).</td>
</tr>
<tr>
<td><strong>Category 2</strong></td>
<td>Includes Arab countries that adopt stringent reuse guidelines based on high technology and high cost similar to California reuse quality standards, for example Kuwait, Oman, KSA, and UAE (Choukr-Allah 2010 &amp; WHO 2005).</td>
</tr>
<tr>
<td><strong>Category 3</strong></td>
<td>Includes Arab countries that have their own country specific national public health laws to regulate reuse practices, such as Egypt and Syria.</td>
</tr>
<tr>
<td><strong>Category 4</strong></td>
<td>Includes Arab countries that have no specific standards for wastewater reuse, such as Lebanon, Palestine, Iraq, and Yemen.</td>
</tr>
</tbody>
</table>
## Wastewater Reuse in most Arab Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Safety Control</th>
<th>Risk Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>Monitoring is limited and no corrective measures are known</td>
<td>No risk management system</td>
</tr>
<tr>
<td>Jordan</td>
<td>The Food and Drug Administration is responsible for sampling, analysis and evaluation under the Crop Monitoring Program for Fresh Fruits and Vegetables Produced in the Jordan Valley</td>
<td>Many organizations have a stake in the quality control of wastewater effluent with overlapping responsibilities</td>
</tr>
<tr>
<td>Lebanon</td>
<td>No monitoring system or safety control system due to the lack of WWTP</td>
<td>No risk management system</td>
</tr>
<tr>
<td>Morocco</td>
<td>There is a general quality control of water resources but nothing specific for wastewater reuse</td>
<td>No risk management system</td>
</tr>
<tr>
<td>Syria</td>
<td>Irrigation water is monitored but no corrective measures are taken in case of pollution</td>
<td>No risk management system</td>
</tr>
<tr>
<td>Tunisia</td>
<td>WWTP effluent is monitored but enforcement and corrective measures are limited</td>
<td>No risk management system</td>
</tr>
<tr>
<td>Yemen</td>
<td>Some quality parameters for WWTP effluent are monitored but due to the lack of funds corrective measures are impossible</td>
<td>No risk management system</td>
</tr>
<tr>
<td>UAE</td>
<td>Abu Dhabi frequently monitors the effluent quality as water is distributed for green space irrigation purposes. No information on the other Emirates</td>
<td>No information available about risk management systems</td>
</tr>
</tbody>
</table>
Unfortunately, in many countries that are already using or start using treated wastewater, the monitoring and evaluation programs are not well developed.

Ignoring monitoring evaluation parameters or performing monitoring not regularly and properly could result in serious negative impacts on health, water quality and environmental and ecological sustainability.
# Wastewater Reuse in most Arab Countries

## Income Level of Arab Countries

<table>
<thead>
<tr>
<th>Level</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Bahrain, KSA, UAE, Oman, Kuwait, and Qatar</td>
</tr>
<tr>
<td>Upper Middle</td>
<td>Algeria, Jordan, Iraq, Tunisia, Libya, and Lebanon</td>
</tr>
<tr>
<td>Lower Middle</td>
<td>Egypt, Syria, Morocco, Palestine, Yemen, Sudan, Mauritania, and Djibouti</td>
</tr>
<tr>
<td>Low</td>
<td>Somalia, Comoros</td>
</tr>
</tbody>
</table>

Challenges of Wastewater Reuse

Technological:

- The problems related to wastewater treatment and reuse cannot be solved simply by constructing treatment plants.
- These plants must also be operational and effective.
- The uncritical adoption of international criteria for design of wastewater treatment plants and ignorance of the local conditions could result in wasted capital.
Challenges of Wastewater Reuse

**Technological:**

- Wastewater treatment plants in many Arab counties do not operate satisfactorily.
- Might be attributed to the lack of adequately trained staff with the technical skills to operate these plants, as well as the lack of an adequate budget for plant maintenance and operation.
Challenges of Wastewater Reuse

**Economic**

- Often, the high cost of wastewater treatment and management is a major impediment towards implementing such projects.
- The additional treatment of wastewater beyond secondary treatment for reuse and the installation of reclaimed water distribution systems can be costly.
- The economic considerations are necessary because, when other sources of water are available at a cheaper price, it may not be worthwhile to reuse wastewater.
Challenges of Wastewater Reuse

Political Factors and Regulatory and Institutional Aspects

- The lack of political commitment and of a national policy and/or strategy to support wastewater treatment and reuse are main constraints in most Arab countries.
- The most advanced technology should be supported by the appropriate institutions and enforced legislation to ensure maximum efficiency.

The key is to have achievable standards and enforced regulations.
Challenges of Wastewater Reuse

Social Aspects and Risk Factors

- The reuse of wastewater, whether direct or indirect, raises public concern as a result of the overall risk perception.
- In general, public health concern is the major issue in any type of reuse of wastewater, be it for irrigation or non-irrigation utilization, especially long term impact of reuse practices.
- Human health risks from wastewater irrigation include farmers’ and consumers’ exposure to pathogens including helminth infections, and secondly, organic and inorganic trace elements.
Challenges of Wastewater Reuse

Social Aspects and Risk Factors

- Although water reuse has been practiced indirectly for decades through the existing water cycle of abstractions and discharges to rivers, the reuse of water does carry potential risks that need to be addressed.

- For instance, pathogens and biological agents that can potentially cause disease and illness may be present in any wastewater that is discharged to a water course and is subsequently reused for water supply.
Challenges of Wastewater Reuse

Social Aspects and Risk Factors

- Despite the limitations of epidemiological investigations, the reuse of wastewater has not been implicated as the cause of major infectious disease outbreaks.
- Emerging contaminants, in particular endocrine disruptors and pharmaceutically active chemicals, are becoming a concern for environment protection and health for indirect potable reuse schemes.
Challenges of Wastewater Reuse

Social Aspects and Risk Factors

- Adverse impacts on environment include alteration of land use, impacts on wetlands and ecosystems, effects on soils, plants and aquifers
  - Unregulated irrigation with wastewater may lead to problems such as deterioration in soil structure which results in poor infiltration, soil salinization, and phytotoxicity
  - Potential environmental impacts from the reuse of wastewater in agriculture may also include groundwater and surface water contamination as well as degradation to natural habitat and ecosystems
The formulation of realistic, economically feasible, safe and socially acceptable set of standards and regulations is very essential.

Codes of practices for sustainable use are also crucial.

Policies accompanied by national strategies for wastewater reuse are preconditions to success.

Many different stakeholders are involved and it is very crucial to allocate responsibilities in both treatment and reuse stages.

Existing water charges must be changed so that they reflect scarcities and wastewater management fees.
Planning for Wastewater Reuse

- While there are many impediments and challenges towards wastewater reuse, these can be overcome by comprehensive planning, risk assessment and policy implementation.
- Establishment of wastewater infrastructure should include a systematic evaluation of all options, beginning with consideration of on-site systems and simple technologies and finally, the centralized treatment option.
## Planning for Wastewater Reuse

### Most Appropriate Technology

- Economically Affordable
- Environmentally Sustainable
- Socially Acceptable

<table>
<thead>
<tr>
<th>Economically Affordable</th>
<th>Environmentally Sustainable</th>
<th>Socially Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>Environmental protection</td>
<td>Public health protection</td>
</tr>
<tr>
<td>Population density</td>
<td>Resources conservation</td>
<td>Government policy and regulations</td>
</tr>
<tr>
<td>Technology Efficiency</td>
<td>Water reuse</td>
<td>Human settlement</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>Nutrient recycling</td>
<td>Planning</td>
</tr>
<tr>
<td>Residuals management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Planning for Wastewater Reuse

- Technologies available are many and well known, but any choice should rely on those not entailing excessive costs and providing the best environmental practice and option.
- Also, reuse site must be located as close as possible to the wastewater treatment and storage facilities.
Planning for Wastewater Reuse

- The choice of an adequate technology should be based on an integrated assessment of the local technical, environmental and social aspects.
- Replication of successful projects is beneficial but the system should be adjusted to meet the local conditions.
- A comprehensive and long term strategy that requires extensive planning and implementation phases is vital for sustainable wastewater management and reuse.
Planning for Wastewater Reuse

- There are a number of technologies for treating wastewater for reuse
- The technologies chosen depend on the intended use
- During the last decades, membrane treatment has been approved as the best available technology for the production of high quality recycled water for indirect potable
- Among the membrane processes used for wastewater treatment, membrane bioreactor (MBR) technology is advancing the most rapidly worldwide
Planning for Wastewater Reuse

- Monitoring (process control and compliance) and evaluation of wastewater use programs and projects is a very critical issue, hence, both are the fundamental bases for setting the proper wastewater use and management strategies.

- Equally important, monitoring programs must provide reliable and timely data.
Planning for Wastewater Reuse

- More participatory approaches: To achieve general acceptance of re-use schemes, it is of fundamental importance to have active public involvement from the planning phase through the full implementation process.

- Health education targeting policy makers, consumers/farmers/end users, local authorities, NGOs, Media can play an important role.
Planning for Wastewater Reuse

- Differentiation between developed and developing countries, rural and urban as well as centralized or decentralized is required.
- Monitoring and evaluation to guarantee quality is essential to protect public health.
- Reshaping our approaches of development, especially in terms of holistic management of water, wastewater and energy is equally important.
The international Organization for Standardization (ISO) established a technical committee for water reuse whose scope is the standardization of water reuse of any kind and for any purpose.

This standardization has potential implications for Arab Countries as it might affect export opportunities and tourism.

It is essential to take an active part in the discussions and formulation of waste reuse standards to reflect the challenges that are mentioned earlier.
References

Thank You for Your Attention