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## Introduction to a “Complicated Story”: The Role of Wastewater Reuse to Alleviate the Water Problems of Palestine

“Karmaşık bir Hikaye” için Giriş: Filistin’in Su Problemlerini Hafifletme Konusunda Atıksuyun Yeniden Kullanımının Rolü

**Gül ÖZEROL**

### Özet

*Ortadoğu’da su havzalar, ülkeler ve sektörler arasında değişen ölçülerde rekabet ve çatışma ile ilişkilendirilen kıt bir kaynak olarak karakterize edilmektedir. Dünyanın diğer kurak ve yarı-kurak bölgeleri gibi, Ortadoğu’da da atıksu, deniz suyu ve yağmur suyu gibi geleneksel olmayan su kaynakları artan bir biçimde öne çıkarılmaktadır. Bu durum, ilave su arzı yaratma ve su kullanıcı sektörler üzerindeki artan baskıyı hafifletme konusunda geleneksel olmayan su kaynaklarına atfedilen büyük potansiyel ile açıklanabilir. Ancak geleneksel olmayan su kaynaklarının farklı sosyal, kültürel ve ekonomik koşullarda benimsenmelerini etkileyen riskler ve kısıtlar olduğu da bilinmektedir.*

*Filistin, Ortadoğu ülkeleri içinde su sorunlarını en yoğun biçimde yaşayan ülkeler arasında olup bu sorunlar İsrail ile olan çatışma sebebiyle daha da şiddetlenmektedir. Bu çalışma, Filistin’de geleneksel olmayan su kaynaklarından yararlanılması konusundaki mevcut durumu alternatiflerden biri olan arıtılmış atıksuyun yeniden kullanımı üzerine odaklanarak incelemektedir. Daha iyi politikalar ve uygulamalar için farklı kademelerde ve boyutlarda kapasite artırımı gereksinimlerini işaret eden bir stratejik yaklaşımın gerekliliği sonucuna varılmıştır. Atıksuyun yeniden kullanımı konusundaki başlıca kaygıları içine alan böyle bir yaklaşım için yerel, ulusal ve bölgesel kademelerde ve izleme ve değerlendirme konusunda kapasite artırımı için gelişme alanları ortaya konulmuştur.*

To generate water from non-conventional resources, specialised processes are applied such as desalination of seawater and brackish water; collection and treatment of wastewater; harvest of rainwater; capture of agricultural drainage water and extraction of saline groundwater”.

### Abstract

*Water in the Middle East is characterised as a scarce resource that is associated with varying degrees of competition and conflict among its users in basins, countries, and sectors. Like the other arid and semi-arid regions of the world, non-conventional water resources such as wastewater, seawater and rainwater are increasingly promoted in the Middle East. This situation can be explained by the great potential attributed to the non-conventional resources to alleviate the water scarcity problem by producing additional water supply and relieving the increasing pressure on water user sectors. It is however also known that non-conventional water resources entail risks and constraints, influencing their adoption in different social, cultural and economic contexts.*

*Palestine is among the Middle Eastern countries that intensively experience water problems, which are exacerbated due to the conflict with Israel. The paper examines the existing situation in Palestine in terms of the utilisation of non-conventional water resources through focusing on one of the options, namely the reuse of treated wastewater. It is concluded that a strategic approach that addresses capacity-building needs in multiple levels and dimensions is essential for better policies and practice. For such an approach that incorporates the major concerns regarding the reuse of wastewater, improvement areas are identified for capacity-building at local, national and regional levels and for monitoring and evaluation.*

**Keywords:** *Water Scarcity, Water Management, Wastewater Management, Non-Conventional Water Resources, Wastewater Reuse, Palestine*

### Introduction

Water in the Middle East is characterised as a scarce resource that is associated with varying degrees of competition and conflict among its users in basins, countries, and sectors. Many rivers and aquifers in the Middle East constitute transboundary basins such as the Jordan, Euphrates and Tigris rivers, and the Upper Jezira/Mesopotamia, Eastern Mediterranean and Syrian Steppe aquifers. The equitable and allocation of the scarce freshwater in these basins constitutes a highly relevant issue in the relations among the countries in those basins.

Domestic, industrial and agricultural sectors are the three major water user sectors that compete for the scarce water resources in every basin. At the global level, agricultural sector is the largest user constituting 70 percent of freshwater withdrawals, whereas this share reaches to 82 percent in the Middle East.<sup>1</sup> Demand for freshwater has been increasing in all the sectors due to population growth, urbanisation and changing lifestyles and food consumption patterns.

Particularly in low-income countries, the agricultural sector also creates a major part of national income and therefore social welfare. However, the growing competition among the water user sectors works against the agricultural sector, since water productivity in agriculture remains low with slow improvements, while the domestic sector demands the best quality water available.<sup>2</sup> This implies that in order to meet the growing food, fibre and fodder demand of increasing global population, the agricultural sec-

tor has to improve water productivity by producing 'more crops per drop' or using alternative or complementary water resources.

In many arid and semi-arid countries that face increasing water scarcity, conventional water resources<sup>3</sup> are insufficient to meet the growing demand. As a result, non-conventional water resources such as seawater, brackish water, wastewater, agricultural drainage and rainwater are developed to complement conventional freshwater resources. To generate water from non-conventional resources, specialised processes are applied such as desalination of seawater and brackish water; collection and treatment of wastewater; harvest of rainwater; capture of agricultural drainage water and extraction of saline groundwater.<sup>4</sup>

Non-conventional water resources can be used for potable and non-potable purposes that both increase water supply. Marginal-quality water resources such as wastewater, agricultural drainage water and saline groundwater contain impurities at levels higher than in freshwater, such as salts, metals and organic compounds.<sup>5</sup> Due to the environmental and public health risks of these constituents, marginal quality water resources are mostly suitable for non-potable uses, mainly including industrial and agricultural uses, and limited domestic uses such as toilet flushing. Desalinated waters, on the other hand, can also be suitable as potable water, as long as the quality and public health standards are met.

Like the other arid and semi-arid regions of the world, non-conventional water resources are increasingly promoted in the Middle East. Palestine is among the Middle Eastern countries that intensively experience water problems and consider resorting to non-conventional water resources. This paper elaborates on the water problem of Palestine by analysing the potential of non-conventional water resources for solving the water problems through focusing on one of the options, namely the reuse of treated wastewater. The outline of the paper is as follows: Section 2 gives an overview of the existing situation of water sectors in Palestine. Section 3 outlines

the benefits, costs and risks of wastewater reuse. Finally in section 4, the potential of wastewater reuse as a non-conventional water resource is investigated and improvement areas regarding the wastewater reuse policies and practices in Palestine are identified.

### **Water and Palestine: "A Complicated Story"<sup>6</sup>**

Palestine is among the most challenged countries in the world when it comes to water resources availability and accessibility. Per capita daily water consumption is around 77 litres in the West Bank,<sup>7</sup> and around 98 litres in the Gaza Strip,<sup>8</sup> both lower than 100 litres, the minimum level of "optimal access to water" as recommended by the World Health Organisation<sup>9</sup>.

All the freshwater sources of Palestine are trans-boundary waters. On the one hand, the surface water from the Jordan River is shared among Lebanon, Syria, Jordan and Israel, while Palestine cannot use the Jordan River waters as a riparian since 1967. On the other hand, groundwater resources from the aquifers, the West Bank Aquifer System and the Coastal Aquifer, are shared with Israel that controls the water and exploits around 89 percent, leaving 11 percent to Palestine.<sup>10</sup> Thus the only practically available freshwater water resource of Palestine is limited to groundwater that is threatened by problems such as over-pumping, saltwater intrusion and fertilizer infiltration.<sup>11</sup> The unsustainable use of groundwater is an urgent problem in the Gaza Strip. Annually 169 million cubic meters of water are consumed from the Coastal Aquifer, which substantially surpasses the renewable groundwater feeding into the basin that is estimated at 55 million cubic meters.<sup>12</sup>

Several drivers can exacerbate the water scarcity problem of Palestine. These include population growth (lower water availability per capita), urbanisation (higher water demand per capita), and more importantly climate change. The semi-arid to arid climate of the region implies that precipitation levels are low and evaporation is high. Projections of climate change indicate that precipitation will decrease, whereas temperatures



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will increase.<sup>13</sup> Decreased precipitation implies lower groundwater recharge, and thus worsened water scarcity, which will increase the existing competition among the water user sectors.

Several constraints obstruct the development of water resources that can alleviate the water scarcity problem of Palestine. Infrastructural problems such as the high rates of losses in water networks and the difficulty of extending the water network to rural areas persist in large parts of Palestine.<sup>14</sup> The water losses are mainly attributed to the destroyed infrastructure that has been inherited from the Israeli occupation. Similarly, the difficulty of extending the water networks and developing new water resources is related to Israel's military control over water resources. Israel imposes physical restrictions and obstacles on Palestinians' access to water, and inhibits the development of Palestinian water sector by re-

jecting, cancelling or suspending many water projects and destroying water infrastructure.<sup>15</sup> Several Israeli actors significantly influence the development of the water sector of Palestine. According to the Oslo Interim Agreement from 1995, "*all development of water resources and systems, by either side, shall require the prior approval of the Joint Water Committee*".<sup>16</sup> The approval process of the Joint Water Committee often lengthens and even inhibits the realisation of water development projects, since the committee comprises of an equal number of representatives from each side and all its decisions are to be reached by consensus.<sup>17</sup> Furthermore, the water wells in the West Bank are controlled by *Mekorot*, the Israeli national water company. To reduce the supply deficit, water that is extracted from Palestinian wells by Mekorot is purchased back from Mekorot. The Palestinian Water Authority reports that in 2010 the share of water

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purchased from Mekorot did not exceed 5 percent of the total supply, whereas the share of the purchased resources in the West Bank exceeded the 35 percent.<sup>18</sup> Purchasing water from Mekorot also implies a dependency on Israeli water supplies, which also constitutes a major indication of water ‘insecurity’ in Palestine.

In its strategic plan, the Palestinian Water Authority asserts that “*it is vital for Palestinians to be able to have full access to their water rights as well as be able to develop conventional and non-conventional methods to access more (desalination, water reuse, importing water from outside sources) in order to fulfill the increase in demand.*”<sup>19</sup> Thus, in addition to making efforts towards obtaining water rights, it is crucial that Palestine improves the effectiveness of water management. This paper elaborates on the utilisation of wastewater as a non-conventional water resource that is increasingly considered in Palestine due its potential for contributing to the protection of freshwater and soil resources and the augmentation of water supply.

### **Benefits, Costs and Risks of Wastewater Reuse**

Increased domestic, industrial and agricultural demand implies the generation of higher amounts of wastewater. Four options are possible regarding the handling of this wastewater. It can be 1) released to the environment without treatment 2) released to the environment after treatment but without reuse, 3) reused without treatment and 4) reused after treatment. These four options are associated with different social,

cultural, institutional, technical, economic and environmental objectives that entail often conflicting benefits and costs as well as risks to be managed.

Although the treatment of wastewater serves the major environmental objective of preventing water and soil pollution and protecting public health, the major driving force behind the reuse of wastewater is alleviating water scarcity, making the reuse of wastewater a major non-conventional water resource.<sup>20</sup> The benefits expected from of using wastewater as a non-conventional water resource can be categorised under environmental and socio-economic dimensions. Environmental benefits include water conservation by using the freshwater resources more efficiently; and environmental protection through the prevention of direct emission of wastewater to the environment, whereas the socio-economic benefits are economic contribution by using the same water several times; reduced costs for sanitary disposal of municipal wastewater; increased soil quality and agricultural yields; reduced need and costs for artificial fertilizers; and additional income through use in other enterprises such as aquaculture.<sup>21</sup>

The major socio-economic benefits of wastewater are due to the use of wastewater in irrigated agriculture. Reusing treated or untreated wastewater augments the water supply by substituting or complementing the available water sources. This both contributes to the expansion of irrigated agriculture and enables the reuse of nutrients, which in principle would increase the agricultural production and the resulting agri-

cultural income. In the countries where agricultural production constitutes a major component of national economy, wastewater reuse can enable a productivity improvement in this sector and an increase in the range of agricultural products, both of which are important contributions to social and economic development. Despite these positive benefits, however, negative socio-economic impacts can also be experienced from reusing wastewater. For instance, the property values in the vicinity of the reuse location might decrease.<sup>22</sup> Furthermore, the costs of treating the wastewater and transporting it to the reuse location and the acceptance for different reuse options should be taken into account and handled appropriately. Reflecting these concerns during the planning and implementation of wastewater treatment projects can contribute to the social and economic sustainability of reuse practices.<sup>23</sup>

The sustainability of wastewater reuse practices require a sound planning, implementation and management of reuse projects also due to public health and environmental risks and potential impacts. Uncontrolled use of wastewater for irrigation is the major issue that entails public health and environmental risks.<sup>24</sup> Increased exposure of farmers, consumers and neighbouring communities to infectious diseases constitutes the major health risk factor.<sup>25</sup> The level of environmental impacts depends on the degree of purification, the method and the location of reuse and can be observed in the form of pollution of groundwater or surface water.<sup>26</sup> In the long run, wastewater irrigation can also cause soil quality problems such as accumulation of salts and heavy metals. Proper treatment and monitored use of wastewater can alleviate the negative environmental and public health impacts associated with using wastewater for irrigation.

All the impacts associated with the reuse of wastewater should be assessed with an integrated approach taking into account not only the monetary cost and benefits in terms of environmental, social and economic concerns, but more to consider a systemic perspective on sustainability.<sup>27</sup> The assessment of social and economic impacts of wastewater reuse as well as the adequacy of management and planning schemes

can be made by using relevant socio-economic indicators. An appropriate approach can be the investigation of the current socio-economic indicators that are used to assess the sustainability of the water use.<sup>28</sup>

Water quality criteria and treatment standards are the tools to assess and monitor the public health and environmental impacts of wastewater reuse. Various countries are active in monitoring and improving the quality of treated wastewater within the initiative of the World Health Organisation (WHO).<sup>29</sup> In 2006, the WHO issued the third edition of guidelines that set standards and reduction goals for managing environmental and public health risks associated with wastewater use in agriculture as well as measures to achieve human health and environmental health.<sup>30</sup> The resulting criteria for the sustainability of wastewater reuse projects are identified as health; economic feasibility; social impact and public perception; financial feasibility; environmental impact; market feasibility; institutional feasibility; and technical feasibility.

For realising sustainable wastewater reuse policies and projects, it is also essential to incorporate country-specific conditions at the national and local levels and to consider project-specific requirements. The final edition of the WHO guidelines on wastewater aim to adjust the wastewater reuse projects to different national and local contexts, a principle considered essential for project sustainability.<sup>31</sup>

Several studies comprehensively investigate the constraints related with implementing wastewater treatment and reuse policies and projects by addressing, among others, the multi-level and multi-dimensional issues that affect wastewater treatment and reuse. A recent study that reviews the situation in Mediterranean partner countries in the Middle East and North Africa<sup>32</sup> adopts such an approach and categorises the key constraints of wastewater treatment and reuse into eight areas:

*1- Financial constraints:* The investment and operation costs are too high, especially for small- and medium-sized communities.



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- 2- *Standards and regulations* are mostly based either on United States Environmental Protection Agency<sup>33</sup> or on WHO guidelines that sometimes do not respond to scheme- and country-specific needs
- 3- *Monitoring and evaluation*: Due to the lack of personnel and institutions, the monitoring and evaluation programs are irregular, insufficient or not well-developed
- 4- *Institutional set-up and personnel capacity*: Planning, design, implementation, operation and maintenance of wastewater treatment and reuse facilities are usually distributed among many governmental departments, while coordination and cooperation is lacking.
- 5- *Policy and political constraints*: There is a lack of political commitment and of a national policy and/or strategy to support wastewater treatment and reuse.
- 6- *Technical constraints of wastewater treatment*: Responsible authorities lack information on treatment technologies; the transferred treatment technology does not work in practice due to high operation costs and the lack of qualified technical personnel; the infrastructures for treatment and for the conveyance and distribution of the treated effluent is limited.
- 7- *Health impacts and environmental safety of wastewater reuse*: Negative impacts are experienced on water, soil, humans and animals.
- 8- *Public acceptance and awareness regarding wastewater reuse*: Local farmers, civil society and the private sector have limited involvement in policy planning. This reduces partic-

Several drivers can exacerbate the water scarcity problem of Palestine. These include population growth (lower water availability per capita), urbanisation (higher water demand per capita), and more importantly climate change.

ularly the awareness and knowledge of farmers and consumers on health risks, management procedures and economic benefits of reuse and the awareness of consumers.

### The Role of Wastewater in Alleviating the Water Problems of Palestine

Wastewater treatment and reuse can play a significant role in alleviating the water problems of Palestine, both in the West Bank and the Gaza Strip. This is particularly valid for the Gaza Strip since groundwater pumping rate exceeds the replenishment rate of the aquifer and the quality of water continually decreases. The reuse of treated wastewater in irrigation will increase the water supply for agriculture, which consumes the two thirds of groundwater supplies, and the availability of freshwater resources for domestic and industrial uses (Nassar et al., 2009).

The agricultural sector has a similar share at the national level. In 2008, domestic water consumption was recorded as 94 million cubic meters, whereas the consumption of the agricultural sector is estimated as 123 million cubic meters.<sup>34</sup> Thus the share of agricultural sector in total water consumption is around 57 percent. The contribution of agriculture to national income, however, shows a decreasing trend with a 4.9 percent share in 2012.<sup>35</sup> This justifies the argument that the conventional water resources should be diverted from agricultural to domestic use, whereas the reuse of non-conventional water resources like treated wastewater should be emphasised.

The development of water treatment systems in Palestine has been limited to few large- and small-scale projects implemented without a strategic vision on wastewater management. In cooperation with the Ministry of Agriculture, the Palestinian Water Authority plans to develop and implement a strategy, which focuses, among others, on benefiting from treated wastewater. According to Palestinian Water Authority, “*the inability to rehabilitate and manage the necessary infrastructure needed for wastewater services [...] negatively effect[s] economic and social development in Palestine*” (PWA, 2010). In line with this understanding, Palestinian Water Authority and the international donors and organizations make substantial effort to improve wastewater collection and treatment infrastructure.<sup>36</sup> Construction plans and designs for various wastewater collection systems and treatment plants have been accomplished in the past five years for the main cities and towns of both the West Bank and the Gaza.<sup>37</sup> Unless rejected or delayed by the Joint Water Committee, these projects can be realised in the coming few years and significant amounts of treated wastewater can be produced.

The current practice regarding wastewater is the release of untreated water to the environment and the use of untreated wastewater for irrigation.<sup>38</sup> Even if not reused in irrigation, the treatment of wastewater would contribute to the protection of groundwater resources, since the current practice of releasing the untreated wastewater to the environment causes groundwater pollution through seepage. When utilized in irrigation, treated wastewater can create a

great potential for agricultural development by significantly increasing the amount of water available for irrigated agriculture, while preventing public health risks of using untreated wastewater. These practices have environmental and public health implications that are addressed by relevant governmental authorities, seeing the sustainable management of wastewater a socially and politically relevant issue.

Achieving the benefits expected from wastewater reuse in Palestine requires sound planning, management and monitoring of wastewater reuse schemes. Otherwise treated wastewater reuse might cause serious health problems for the exposed people as well as environmental problems due to the contamination of soil and water resources. It is therefore a priority issue for Palestine to develop and implement a policy approach that reflects the needs and realities of both local, national and regional contexts. As stated in the Strategic Water Sector Plan of the Palestinian Water Authority *“it is more important to focus on wastewater, as it can be used as an additional source of water after being treated. [...] The PWA has begun preparing a clear strategic plan to manage wastewater, in accordance to a vision that ascertains the importance of this water after it has been treated, to be used specifically for irrigation.”*<sup>39</sup>

Focusing on the need for capacity building at different dimensions and levels, four improvement areas are discerned to assess and exploit the potential of wastewater reuse, particularly in irrigation, and to manage the environmental and public health risks:

- *Local capacity:* Awareness raising for the general public (not only for farmers) on technical, environmental, economic and health aspects of wastewater reuse and the facilitation of public participation in the development of guidelines for planning, managing, pricing and monitoring wastewater reuse
- *National capacity:* Establishment of a collaborative institutional structure that involves clear goals and responsibilities for each na-

tional actor of wastewater collection, treatment and reuse processes

- *Regional capacity:* Cooperation with the countries in the Middle East and North Africa region that share similar cultural and social contexts and experience similar water problems.<sup>40</sup>
- *Monitoring and evaluation:* Development of tools for economic, financial and institutional analysis and for assessing social, environmental and public health impacts at multiple levels

Policy changes are necessary in order to realise concrete and sustainable outcomes in each improvement area. These changes include revising the national water legislation, restructuring the water institutions and changing the water pricing strategies, each of which entails socio-economic and geo-political considerations. A crucial ingredient of these policy changes is managing both the demand and supply sides of water and wastewater. Although non-conventional water resources are appropriate options to increase the water supply, defining water scarcity as a merely supply problem and neglecting the demand side will not bring long-term solutions, given that demand is likely to continue increasing, whereas supply side is very limited. It is therefore equally important to manage the demand for non-conventional resources. In this regard, the acceptance of the farmers to use the treated wastewater is crucial, since the farmers are the key actors on the demand side of wastewater reuse in irrigation. According to recent studies, the farmers' awareness on the benefits of reuse of treated wastewater is found to be significantly high both in the West Bank<sup>41</sup> and in the Gaza Strip,<sup>42</sup> whereas they are not yet aware of the guidelines and regulations for wastewater reuse. Pricing treated wastewater is, however, a totally new phenomenon to the farmers and to all other stakeholders, since it has never been practiced in Palestine before. Experiences in these issues remain to be seen until the reuse of treated wastewater becomes a common practice in the coming years or decades.

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