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# THE ROLE OF SOCIO-ECONOMIC INDICATORS FOR THE ASSESSMENT OF WASTEWATER REUSE IN THE MEDITERRANEAN REGION

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## INTRODUCTION

Water use in the Mediterranean region has the typical property of being based on scarce water resources. Considering the fact that most of the Mediterranean countries have arid or semi-arid climate conditions, current water resources in this region cannot be simply wasted. Non conventional water use, and in particular wastewater reuse is considered as an opportunity for water saving in the region. As in the most Mediterranean countries, the highest portion of the water resources is allocated to the agriculture, mainly being for irrigation, wastewater could relieve as a substitute for freshwater in irrigation, water resources for potable water and other priority uses of water.

In this sense reuse of wastewater can contribute not only to decrease the impacts of water scarcity, but also to increase social and economic development in the Mediterranean countries. This means that wastewater reuse could be an important brick to sustainable development in the region.

However, sustainability and success of wastewater reuse depends highly on a sound implementation and management of reuse schemes. Poor planning and management might bring not only high health and environmental risks, but also undesired economic and social results.

In a sustainable perspective, wastewater reuse has to respect all three dimensions of sustainability, namely ecological, social and economic dimension. Therefore an assessment based on sound indicators for all three dimensions is needed.

The paper will give an overview about the employment of socio-economic indicators for the assessment of wastewater reuse practices in the Mediterranean region.

## BRIEF BACKGROUND

A substantial problem for water resources management in the Mediterranean countries is the allocation of scarce water resources among the competing sectors of industry, agriculture and domestic use. Moreover, increasing demand for and depleting supply of freshwater resources indicates a further severity of this problem. This situation calls for the use of non conventional water resources in order to overcome the challenge of disparity between the water supply and demand and to employ sustainable water saving options.

The total supply of water resources is distributed among the domestic, industrial and agricultural demand for water. It is stated for many of the Mediterranean countries that the main demand for water comes from the agricultural side (Papadopoulos, 1997). This economic sector also creates the major part of GDP and therefore social welfare in the Mediterranean region. Furthermore, the economic and social development caused an increase in the demand of freshwater for domestic, industrial and agricultural sectors.

It should be added that increased domestic and industrial demand implies more wastewater, which should be handled appropriately in order to conserve the water resources. Having the major driving force as water scarcity, wastewater reuse is considered as a major tool for water saving (Helmer and Hespanhol, 1997, Kretschmer *et al.*, 2002, Davis and Hirji, 2003).

Wastewater from the domestic and industrial use can be the main non conventional water resource especially in the countries where water demand for these two sectors is high. The basic usage of wastewater in agricultural production would be for irrigation purposes. This has been practised in the Mediterranean region for a long time. However, mostly wastewater reuse was practised without planning and with potential high environmental and socio-economic risk.

Although reuse of wastewater has a high positive potential to environmental relief and social and economic development, obviously there is also the danger of the opposite effects if the reuse schemes are not properly planned and managed. For instance, as a primary disadvantage, the demand for wastewater is usually only during the growing season whereas its production is continuous, which might cause high environmental and health hazard risk if the water is not treated and stored adequately (Kretschmer *et al.*, 2002). Therefore the treatment and storage of wastewater should be made accordingly to prevent both hazardous cases and high costs of storage.

The major environmental risks from wastewater occur through the contamination of water with chemical substances and pathogens, due to poor treatment and/or inadequate managing guidelines. The level of impact depends on the degree of purification, the method and the location of reuse and it can be observed in the form of pollution in the soil, groundwater or surface water (Papadopoulos, 1997, Kretschmer *et al.*, 2002). It may cause also soil quality problems in the long run such as accumulation of salts and heavy metals in the soil. Furthermore it results in increased exposure of farmers, consumers and neighbouring communities to infectious diseases (Hussain *et al.*, 2001). Water quality criteria and treatment standards are determined as the tools of assessing and monitoring the ecological impacts of wastewater reuse. Many Mediterranean countries are active in this field for many years within the framework of the WHO initiative for improving water resource quality (Papadopoulos, 1997, Bazza, 2003, FAO and WHO, 2003). However, this does not mean that the countries follow an integrative approach for wastewater management but only on the microbiological safety of water. The emphasis made on the microbiological safety is justified by the fact that more than half of the world population use water, which contains pathogenic organisms (Davis and Hirji, 2003).

On the other hand, as the agricultural production constitutes the main component of the economy and social structures in many Mediterranean countries, wastewater reuse may enable an improvement of productivity in this sector and an increase in range of products. This would be an important contribution to social and economic development of the countries in the Mediterranean region. However, it seems that these impacts are not considered yet adequately.

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 ecological, social and economic concerns, but more to consider a systemic perspective of the sustainability impacts. Following benefits of using the wastewater as a non conventional water resource are addressed (Papadopoulos, 1997, Hussain *et al.*, 2001, Kretschmer *et al.*, 2002, Al-Dadah, 2003):

- water conservation by using the freshwater resources more efficiently,
- positive environmental impact through the prevention of direct emission of wastewater to the environment,
- economic contribution by using the same water several times,
- reduced costs for sanitary disposal of municipal wastewater,
- increased soil quality agricultural yields through the use of wastewater nutrients for agricultural products,
- reduced need for artificial fertilizers, hence reduced fertilizer costs,
- additional income through its use in other enterprises such as aquaculture.

In addition to the ecological aspect, the social and economic aspects of wastewater reuse are considered as the main concerns related with the issue. For instance, the property values in the vicinity of the reuse location might decrease (Hussain *et al.*, 2001). Furthermore the acceptance for the reuse and the costs of treating the wastewater and transporting it to the reuse location should be taken into account and handled appropriately. Such concerns during the planning and implementation can assure the social and economic viability of the wastewater reuse practices (Davis and Hirji, 2003).

It is suggested that, the assessment of social and economic impacts of wastewater reuse, but also the adequacy of management and planning schemes, can be made by using relevant socio-economic

indicator. An appropriate approach can be the investigation of the current socio-economic indicators that are used to assess the sustainability of the water use (Winograd *et al.* 1999, Bahiigwa *et al.*, 2001, Davis and Hirji, 2003, Rodrigues, 2003). This paper will review the current use of such indicators in the Mediterranean region.

## **MATERIALS AND METHODS**

The investigation of the role of socioeconomic indicators for wastewater reuse had to deal with several expected and also unexpected problems.

Due to budget restrictions it was not possible to do a full-fledged field research. Therefore it was planned to do an investigation of project reports and evaluation reports of already implemented wastewater reuse projects regarding the use of indicators for their assessment.

Unfortunately, it became clear very soon that it is very difficult to get such direct information of established projects. This might be probably because these reports are not published to a broader public, but aiming more to inform the project partners and the funding organisation.

Due to these constraints, our research had to be limited to a secondary analysis of existing case studies about wastewater reuse in the Mediterranean countries.

To get a broader perspective of water related issues in the region and its assessment, we did as a first step an internet research for case studies dealing with themes like water scarcity, water use for agricultural irrigation and wastewater reuse on a global level. The aim was to get a first impression to the indicators used for the evaluation in these fields. Out of the found case studies those were selected, which are relevant to the aim of this investigation. From these selected case studies the indicators, which were used to assess the projects, were extracted. Then the indicators were sorted according to the target field of water management (water use, water reuse, water scarcity, etc.) and the dimension of sustainable development (ecological, social and economic). In addition to the first internet search, a literature review in accessible libraries was done.

In the second step, we concentrated on the Mediterranean region with the purpose of determining which indicators are used in the region for the evaluation and the assessment of wastewater reuse.

The resulting sets of indicators was analysed in terms of their meaningfulness to address the problem at stake. The selection of appropriate indicators requires the identification of the problem and the establishment of objectives so that the indicators can reflect and benefit from the problem definition and the objectives (Winograd *et al.*, 1999). The problem about wastewater reuse was identified above as the assessment of social and economic impacts of wastewater reuse on the sustainability of water management in the Mediterranean region. This means that it was intended to evaluate only socio-economic indicators. However, we realized that it was not possible to concentrate only on socio-economic indicators. Following this, we broadened the scope also to ecological indicators where it was necessary and appropriate.

In addition and parallel to the evaluation of case studies of implemented water management projects, a literature review was made for the wastewater reuse related scientific literature to give the framework for this overview and the evaluation of indicators.

## **EVALUATION OF CASE STUDIES**

The review of the relevant literature on the development and use of the sustainability indicators for the Mediterranean region demonstrates that there are only a few case studies or projects in this field. Within this context, the Blue Plan is an innovative program that, among others, aims at developing indicators for sustainable development. It is a joined program of the Mediterranean Commission on Sustainable Development (MCSA), the European Commission, United Nation Environmental Programme and Mediterranean Action Plan for fostering Sustainable Development in the Mediterranean. Established on the basis of the UN-CSD indicator set, a set of 130 indicators were

developed for the coastal zones of the Mediterranean region in which water related indicators have a prominent position<sup>3</sup>. The following table shows the indicators related with water.

Table 1. Water related indicators for the Mediterranean region

No	Indicator	Related Issues
13	Access to safe drinking water	Public health
35	Global quality of coastal waters	Pollution and coastal water
50	Use of agricultural pesticides	Agriculture and pollution of
51	Use of fertilisers per hectare of agricultural land	water and soils
52	Share of irrigated agricultural land	Agriculture and water
53	Agriculture water demand per irrigated area	
57	Water use efficiency for irrigation	
54	“Arable land” per capita	Agriculture and population
84	Exploitation index of renewable resources	
85	Non-sustainable water production index	
86	Share of distributed water not conform to quality standards	Freshwater and wastewater
87	Water global quality index	
89	Existence of economic tools to recover the water cost in various sectors	
90	Drinking water use efficiency	
41	Wastewater treatment rate before sea release for coastal agglomerations over 100 000 inhabitants	Urbanisation and wastewater
63	Industrial releases into water	Industry and wastewater
88	Share of collected and treated wastewater by the public sewerage system	Wastewater treatment
91	Share of Industrial wastewater treated on site	Industry and wastewater treatment

Source: Blue Plan, 2002

There are several indicators in the above list, which can be utilised to assess the sustainability of wastewater reuse. However, even though there is a section for freshwater and wastewater, there are several wastewater indicators that are spread in various sections of the list under different themes. This situation indicates the absence of an integrated approach for assessing the sustainability of wastewater reuse. Considering the fact that wastewater is used in different sectors including industrial, agricultural and domestic use, the assessment can be more integrated by putting the wastewater related indicators together in a single category. It would also be reasonable to collect all the indicators related with water resources in a separate category, including those about conventional and non-conventional water resources. Hence, their mutual interactions, which result from the fact that they are the components of water cycle, are not excluded from consideration. Such an approach can also be useful in ensuring a systemic perspective of water sustainability.

Another relevant study is the list of sustainability indicators developed for Malta by SI-MO (Sustainability Indicators - Malta Observatory), which is a research centre established within the content of the MED-ERMIS (Mediterranean Environmental Reporting Monitoring and Information System) Project. The total list consists of indicators for different themes including water<sup>4</sup>. Different sets of indicators for freshwater, sea water and wastewater were developed. The indicator sets of Blue Plan, the EU, OECD and UN were examined and mainly based on the Blue Plan list, the following indicators were categorised considering their suitability for Malta:

<sup>3</sup> The list of indicators along with their definitions are available at URL: [www.planbleu.org/pdf/Glossary.pdf](http://www.planbleu.org/pdf/Glossary.pdf)

<sup>4</sup> The MCSD list of indicators for sustainable development, Sustainability Indicators - Malta Observatory, Available at URL: <http://home.um.edu.mt/islands/indicators.htm>

Table 2. Water indicators for Malta

Freshwater Indicators	Sea Water Indicators	Wastewater Indicators
Groundwater abstraction	Eutrophication	Water treated/water collected
Exploitation index of renewable resources	Fishing pressure	Share of industrial waste water treated on site
Non-sustainable water production index	Development along shore	
Share of distributed water not conform to quality standards	Discharges of heavy metals	
Water global quality index	Oil pollution at coast and at sea	
Existence of economic tools to recover the water cost in various sectors	Global quality of coastal waters	
Drinking water use efficiency	Coastal waters quality in some main "hot spots"	
Domestic consumption of water per capita		
Density of hydrological networks		

Source: Portelli, 2001

It can be observed from the above table that the wastewater indicators are limited to the ratio of treated water to the collected water and the share of wastewater treated on site. On the one hand, the comprehensiveness of these two indicators might be justified by the country specific characteristics of Malta, which also implies the production of an entirely different set of indicators for a country that is not an island and has rivers and lakes, etc. Given the fact that a comprehensive set of water indicators is an asset for each country, such a list is a major step in assessing the sustainability of water. On the other hand, as we stated above, putting the water related indicators in separate categories might cause the exclusion of mutual interactions among the water resources.

Several studies exist that deal with water use and water scarcity in the Mediterranean region. Within the content of the POLAGWAT (relationships between agricultural water use and sectoral policies in the Mediterranean countries) project, Kroll (2002) presented the analysis of agricultural water use in several Mediterranean countries. The consequences of different policies on agricultural water use were also identified with the purpose of developing guidelines for water saving. The analysis was made through the assessment of indicators for agricultural water use, most of which were based on the indicator list of the Blue Plan. With an emphasis on the integrated river basin management, López and Morales (2002) presented the current situation of water demand and use in the Mediterranean region mainly in terms of the implications for water scarcity. They also address key sustainability issues, and the needs and priorities for the integrated river basin management in the Mediterranean region.

There are also several studies from different countries of the Mediterranean region that consider wastewater reuse as an opportunity for water saving. They have different scales and scopes reflecting the specific concerns that they have and hence they are valuable in so far as they serve for the purpose of improving wastewater reuse practices at the local, national or regional level. However they do not have the approach of developing and using sustainability indicators for the assessment of wastewater reuse. Their goal is the analysis of factors that can be considered for a more efficient and effective wastewater reuse or the investigation of the problems and constraints related with wastewater reuse.

The first case that we examine is the analysis of the situation with a socio-economic perspective at the national scale. Al-Dadah (2003) presented the socio-economic aspects of wastewater reuse in Gaza Strip. This analysis is a unique example since it reflects country-specific aspects of the situation at the national level. For instance, the failure of two current wastewater reuse projects in Gaza Strip are attributed to the following reasons: The fear of Israeli control on freshwater resources in Gaza Strip, lack of trained staff, available funds and acceptance of wastewater reuse by the farmers.

Keeping aside the country-specific aspect of Israeli relations, the lack of different resources would be a common reason for many projects in other countries. However it should be noticed that projects in other countries could have problems related with their own country-specific situation. The assessment of wastewater reuse projects should take into account, among others, such characteristic cases in addition to the common regional issues. Al-Dadah (2003) relates the social acceptance of wastewater reuse with two factors, which are assessed through the interviews with the farmers. First one is the possible religious reluctance, which is not observed in this case, and the second one is the acceptance of the farmers to use treated wastewater, which is found to be more than 80%. Al-Dadah (2003) differentiates the financial and economic dimensions of wastewater reuse and introduces the usage of average incremental cost (AIC) per m<sup>3</sup> of treated wastewater as the basis for the financial analysis. It is also suggested to arrange the water and wastewater prices by considering respectively water and wastewater charges based on the AIC to recover the operational and replacement costs. It is suggested that the evaluation of treated wastewater irrigation techniques should consider the following aspects:

- Cost of irrigation,
- Cost of treatment,
- Level of wastewater treatment required,
- Water use efficiency,
- Health risks, and
- Cost of distribution.

Ganoulis (2003) proposed a multi-criteria analysis approach that could be used to evaluate the alternatives for wastewater recycling and reuse in the Mediterranean region. The criteria were categorised under the public health and environmental factors, economic factors and social issues. Public health and environmental factors mainly included water pollution from irrigation and water use efficiency. Economic factors were suggested as the water cost, the initial cost of the irrigation system, maintenance costs and crop profitability. Finally the social issues included the employment of rural labour. The approach of Ganoulis (2003) can be considered as an integrated approach in the sense that it has environmental, economic and social concerns. It enables the comparison of different available alternatives against each other at the local level.

In a recent study (FAO and WHO, 2003), an exploration of wastewater experience was made for the Near East countries, most of which are in the Mediterranean region. An overview of wastewater related projects, which were carried out with the cooperation of the Food and Agricultural Organisation (FAO), is given. Those projects had different objectives such as evaluating the effects of reusing wastewater for agriculture irrigation, assisting the countries to improve water use efficiency for crop production, formulating national wastewater reuse policy and capacity building of the staff working in wastewater relevant institutions. Several country reports are included in the study, which demonstrate both similarities and differences of the countries in terms of the problems and constraints. Problems that are addressed include mainly the economic inefficiency, public health problems, and environmental degradation. These problems are mainly attributed to the lack of standards, regulations, institutional capacity and public awareness. The following constraints are also addressed regarding the wastewater reuse in the Near East region:

- *Policy and Planning*: There are no clear policies and adequate planning, monitoring and control measures.
- *Regulatory Mechanisms*: No standards, suitable regulatory criteria and mechanisms exist. Even if the control and regulation exist, they are generally not enforced.
- *Technical*: Technical capacity is low, particularly at the field level. Most wastewater treatment plants in the region have operational control and maintenance problems. As a result the effluent usually does not comply with the recommended guidelines.
- *Institutional*: Several institutions have responsibility, which is not clearly distributed. There is a lack of cooperation mechanisms among the various authorities involved in the collection, treatment and reuse of wastewater. At present, this aspect is considered as the most critical issue for the countries of the Near East region.

Several recommendations are made addressing the problems at different fields including the policy, environment, health, legislation, institutions, data, technology, education and public awareness. The following information is collected from the 29 countries of the Near East Region so that a regional network on wastewater can be established and the experiences could be shared.

Table 3. Wastewater parameters for the Near East region

Percentage of total population served with piped water supply	
Average per capita water supply demand	
Percentage of total population served by sewage schemes	
Existing average per capita wastewater flow	
Produced wastewater	
Annual quantity of wastewater (no drainage water from agriculture) produced in the country if possible with a break down of domestic, industrial and other	Wastewater production
Number of existing treatment plants and their capacities per day / year	
Treated wastewater: Annual quantity of wastewater which is treated and different degrees of treatment: preliminary, primary, secondary, tertiary and / or advanced	
Annual quantity of treated wastewater in irrigation	Wastewater reuse
Irrigated areas with raw and treated wastewater	
Irrigation methods used with wastewater	
Any report on adverse health and / or environment impacts due to reuse of wastewater and associated with the kind of treatment	Sludge
Annual quantity of sludge produced in the country	
Sludge treatment if any: thickening, stabilization (aerobic/ anaerobic)	
Digestion, (lime) dewatering (dry beds, dry lagoons)	
Ultimate disposal of sludge: land application, incineration	
Composting land filling including any national guidelines for sludge disposal	

Source: FAO and WHO, 2003

The purpose of the proposed regional network is stated as the assessment of the status of wastewater treatment and reuse in the Near East region. It is mentioned that much of the information is missing for many countries in the region. Therefore we should conclude that the use of the information also depends on the data availability in the countries. Once the relevant data is collected, the above mentioned used parameters can also be used as to assess the sustainability of wastewater reuse at the national and regional scale. However it is not clear which methodology is used to develop this set of parameters. Since the establishment of the network is not completed yet, further research and output are expected from this study. A similar regional network is established for the Mediterranean region<sup>5</sup> with the main purpose of improving cooperation and exchange of information between the stakeholders of wastewater reuse in the Mediterranean region.

Papadopoulos (1997) presented an overview of the wastewater reuse for agricultural production in the Near East and North African countries, which constitute a major portion of the south Mediterranean region. The main focus is given to the microbiological quality criteria associated with public health protection. Monitoring and evaluation of the wastewater reuse is suggested to be insufficient for the Near East and North African countries in general. Papadopoulos (1997) also argues that the economic evaluation of irrigation with wastewater possesses two major difficulties. The first difficulty is the valuation of non-financial aspects, e.g., reduction of environmental pollution or health risks, and the second one is the allocation of treatment costs between the producer and the user of wastewater. It is argued that if the above difficulties are handled, the Cost-Benefit Analysis of wastewater reuse in irrigation can be made based on the following elements:

- estimation of least-cost disposal options that meet the environmental and health standards,
- identification of the demand areas for wastewater and the corresponding cost of transportation,
- incremental treatment cost of wastewater,
- price of wastewater, which is generally zero for the countries in the region, since the farmers are enabled to use the wastewater without paying for it.

Based on the review of the previous experiences of the countries in the Near East region, Bazza (2003) identified the major issues for a better management of wastewater. Those issues are categorised under technical, institutional, legal, economic and financial considerations and raising awareness. The level of the treatment technology, which is associated with the problem of high cost of treatment, and the distribution of the treated wastewater are stated as the technical considerations to be made. It is mentioned about the institutional issues that there is a multiplicity of related departments that share the responsibility of wastewater management usually within a complex and

<sup>5</sup> Mediterranean Network on Wastewater Reclamation and Reuse: [www.med-reunet.com](http://www.med-reunet.com)

controversial institutional setting resulting in conflicts among the departments. Such conflicts are mainly on the support of treatment costs and the ownership and allocation of the reclaimed water. Regarding the legal issues, Bazza (2003) argues that some of the enacted laws and standards are too rigid and not suitable for the country conditions, and therefore violation is expected. He suggests that the regulatory framework should be made more adaptive and comprehensive; consider the purpose of reuse, since it affects the measures to be taken to prevent health and environmental risks; and regulate the handling of wastewater, such as the storage of the reclaimed water, recharge of groundwater aquifer, irrigation methods and application rate. As for the economic and financial dimension, Bazza (2003) suggests that economic studies should be carried out such as the cost effectiveness analysis, cost-benefit analysis and financial feasibility. It is also suggested that through the development of financial measures, such as recovering part of investment and operation/maintenance costs through user fees and taxes, the expenses of reuse schemes can be relieved. Finally, Bazza (2003) identifies the lack of awareness as a major issue and suggests that it is necessary to involve the public in the early stages of reuse schemes and to conduct awareness raising activities such as informing the farmers about the health and environmental risks of untreated wastewater and training them on technical aspects of using wastewater.

It can be concluded from the review of the relevant literature that no previous research is undertaken that aims at developing water sustainability indicators for the Mediterranean region and deal in particular with wastewater reuse in the region, even from a socio-economic perspective. It is argued that the development and use of a set of systemic indicators for the assessment of the sustainability of wastewater reuse schemes is crucial for water saving in the Mediterranean region.

## **RESULTS AND DISCUSSION**

Considering the problem of water scarcity in the Mediterranean region, several potential benefits are expected from the wastewater reuse in agricultural irrigation. However it should be noted that the achievement of these benefits requires proper planning and management of wastewater reuse schemes. Otherwise the use of wastewater might cause serious health problems for the people exposed to wastewater and ecological problems due to contamination of both soil and water, hence also high economic costs.

On the one hand, it is a priority issue to investigate the possible ecological impacts of wastewater reuse and to develop and use necessary indicators for monitoring the sustainability of wastewater reuse schemes. On the other hand, this assessment should have an integrated approach that also has economic and social concerns. However, the review of the used literature demonstrates that the assessment of wastewater irrigation schemes is mostly restricted to health and consumer protection and the prevention of environmental risks. The focus is laid on the control of pathogens and chemicals in the treated wastewater and the reduction of the risk resulting from using treated wastewater. Regarding the assessment of environmental impacts, the focus is on the impacts like soil and groundwater contamination with toxic materials or salinity. The economic assessment, and in the same line the social assessment, is normally reduced to a simple analysis of the cost and benefits. Concluding from our literature study, no approach could be found where so called systemic indicators were applied to assess impact of wastewater reuse.

Among the cases that develop and use sustainability indicators for Mediterranean region, none of them deal with the wastewater in an integrated approach. This is mainly due to the fact that current indicators sets are either developed for a general goal of sustainable development, hence they do not focus on wastewater reuse, or they are limited in the number and scope of the wastewater related indicators.

Several studies are reviewed which are about water use and water scarcity and have the geographical scale of Mediterranean region. However it is observed that non-conventional water resources, in particular wastewater reuse is not one of the prominent issues in the analyses made. Furthermore even if they have the emphasis on wastewater reuse, their approach is analysing the current situation of wastewater reuse practices in terms of technological, institutional, economic and social considerations.

The review of the studies, which were made for analysing the wastewater reuse practice in Mediterranean countries, demonstrates several problem areas including mainly the lack of cooperative institutional settings, lack of tools for economic and financial analysis, and lack of awareness on technical, environmental and health related impacts of wastewater reuse. We argue that this problematic situation can be attributed to the absence of common guidelines for adequate managing and planning of wastewater reuse in the Mediterranean region. Therefore the potential of wastewater reuse are not fully used, or even known, and risks could not be prevented adequately. In addition to the current practice of assessing the environmental and health impacts, assessment of the social and economic impacts of wastewater reuse, could also foster the contribution of wastewater reuse on the social and economic development of countries in the Mediterranean region.

Considering the findings of this study, we suggest that further research is necessary to develop and use a set of systemic indicators for the assessment of the sustainability of wastewater reuse in the Mediterranean region. Within this context, a systemic approach to assess planned and installed wastewater reuse schemes is needed. Moreover such a systemic perspective should be developed in a participatory process with a specific focus on the local or regional circumstances.

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