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# Stakeholders' attitude towards the reuse of treated wastewater for irrigation in Mediterranean agriculture

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ABSTRACT

Reuse of treated wastewater could provide a key solution to address sustainable water resources management in agriculture. However, the success of this practice depends on public acceptance and involvement, which require careful assessement and evaluation. In order to promote treated wastewater reuse in a Mediterranean context, in the present work the opinion of key stakeholders was analyzed by eliciting and structuring their attitudes and willingness towards the reuse of treated wastewater. Results demonstrated a high level of acceptance of wastewater reuse among the Apulian stakeholders, Southeastern region of Italy, both farmers and citzens/consumers, respectively 59 and 87%. Central to the discussion is that the majority of farmers does not always choose to use treated wastewater but is willing to exploit its benefits occasionally. The negative attitude of some stakeholders towards wastewater stemmed from the health risks related to chemical toxic substances as well as to diseases. Results from the consultation process highlighted that no change in water quality can be expected without infrastructure investments and wastewater management changes, which are slow in coming due to the lack of institutional awareness about the complexity of the problem. The importance of informing the public about the reuse aspects through a formalized mechanism, as improved communication and awareness campaigns, was confirmed in the study by the consultation process' results. Such process made also clear the importance to integrate any measure of enhancement of wastewater reuse as a major part within a more comprehensive water management policy.

## 1. Introduction

Water resources management in semi-arid areas calls for solutions able to provide responses to the decrease of available resources as effect of, among others, climate change (Vergine et al., 2015) and to ensure the sustainability of water uses, mainly in agriculture (D'Agostino et al., 2014). In this perspective, reuse of treated wastewater is recognized as a key component for its ability to satisfy the increasing demand while mitigating environmental pollution (Qadir et al., 2010; Navarro et al., 2015). However, the worldwide amount of treated wastewater reuse is still very small (less than 1%) compared to the total withdrawal of water (World Bank, 2007). In Mediterranean countries like Greece, Italy and Spain, where water scarcity is more severe the reuse is between 5% and 12% while in Europe, an average of 2.4% of the total treated wastewater is reused.

Although wastewater treatment technologies are available, many countries have experienced public resistance to the adoption of new water projects (Dolnicar et al., 2010 and 2011; Hurlimann and Dolnicar, 2010). A number of large-scale wastewater reuse schemes were realized but never became operative due to public opposition (Hartling, 2001). Acceptance by the public is indeed crucial to locate, finance, develop and operate any wastewater treatment plant while public participation is essential to meet the particular needs, channel local knowledge to improve the design of the project, and build vital institutional trust (Garcia and Pargament, 2015). When addressing the issue of public acceptance towards wastewater treatment and reuse, analysis should also include investigation around the attitude towards the environment and the concern of the public for the future generations (Kontogianni et al., 2003). Scientists and water managers agree that positive community attitude regarding this alternative source is critical (Gatto D'Andrea et al., 2015; Hurlimann and McKay, 2007; Kiriaki and Tsagarakis, 2013) and, accordingly, informing the public

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about the treatment process and the resulting quality of water, becomes a success promoter for any reuse policy (Friedler and Lahav, 2006).

Previous studies (Robinson et al., 2005; Dolnicar et al., 2011; Ben Brahim-Neji et al., 2014) have concluded that education, followed by age and knowledge about the reuse, have been the most significant factors influencing the level of acceptance; to a lesser extent, income and gender. Also, reuse acceptance strongly depends on the potential use of treated wastewater: Rock et al. (2009) reported that 70% of the surveyed public in California favoured the reuse for non-edible crops, washing roads, fighting fires, cooling power plants and irrigating sport fields compared to 40% for feeding livestock, recharging groundwater and irrigating vegetable crops. Kaercher et al. (2003) described the disgust factor as an element generating a negative attitude towards wastewater reuse. Other studies (Higgins et al., 2002; Mankad and Tapsuwan, 2011; Buyukkamaci and Alkan, 2013; Ross et al., 2014) pointed out that major farmers' concerns are related to perceived health risks mainly due to toxic substances and diseases.

Most social analysis regarding the reuse stresses the feasibility of influencing the social attitude through two factors: risk perception and trust. In the US, public informative campaigns on the human health risks have successfully worked out to determine public acceptance (O'Connor et al., 2008). Thus, understanding the risks perceived by the public and its degree of knowledge about treated wastewater, becomes the starting point of any water management plan.

Change in thinking cannot be acquired unless a large and disperse group of stakeholders is involved, since no individual has the capacity to implement any measures required for sustainable wastewater reuse. These challenges suggest that social learning is an important goal to facilitate stakeholders' involvement (Hartley, 2006; Collins and Ison, 2009).

In Apulia region, Southeastern region of Italy, where no permanent surface water bodies exist and most of the agricultural activities are managed with a water deficit strategy, agricultural wastewater reuse could represent a primary source of water. However, the reuse practice is penalized by the lack of knowledge and evaluation of the people's opinion, awareness, concerns and confidence in the wastewater treatment and reuse system as a whole. The ensemble of these components make Apulia a suitable laboratory to elaborate a regional water resources management strategy that, starting from the analysis and knowledge of stakeholders' attitude, promotes the reuse of treated wastewater in agriculture.

## 2. Material and method

To assess the social acceptance of treated wastewater reuse in Apulia, a two-step method was implemented and included both a survey and a consultation phase.

In the first step, two main groups of stakeholders – farmers and citizens/consumers – were surveyed through two questionnaires of 25 close-ended questions addressing 6 main topics: 1. water scarcity in Apulia (causes, solutions and major users of water); 2. awareness and knowledge about wastewater treatment and reuse (regional regulation, water quality parameters, managing entities and control bodies, etc.); 3. acceptance level for different wastewater reuse applications (including irrigation, potable use, industrial use, etc.); 4. level of trust in governance and administration; 5. fear factors and perceived benefits regarding treated wastewater reuse; 6. willingness to pay for treated wastewater.

Additionally, questions regarding farm structure (farm size and land use) and questions related to personal information (age, educational level, profession, environmental association membership) were included in the farmers' and the consumers/citizens' questionnaires, respectively.

A 3-point scale of importance (1 = not at all important; 2 = important and 3 = very important) was used to measure farmers' and consumers' opinions. Thus, the higher the score the higher the level of importance that interviewees give to a specific answer option. Unanswered questions were discarded from the description of results and also not considered for statistical anylsis.

**Table 1**
Comparison between farmers' sample and farm distribution by land use. Source: ISTAT (2015).

| | Farms | Sample |
|---|---|---|
| Fields crops and horticulture | 26.8 | 32.8 |
| Permanent crops | 68.4 | 60.2 |
| Mixed crops | 4.7 | 7 |

Farmers' questionnaire was randomly distributed to 183 Apulian farmers: 7% mixed farms, 33% cereals and horticultural farms, and 60% permanent crops (grapes, olives, etc.) both in specialized or mixed production. The sample is representative of regional farms distribution by type of farming (ISTAT, 2015) as evidenced in Table 1.

Consumers' questionnaires were filled out by 297 families, that can be considered representative of the regional population aged from 35 to 64 years (ISTAT, 2015). The representativeness of the sample is given by the similarity of our sample with respect to the official statistics of population in Apulia in 2010 as shown in Table 2.

Collected data were processed by descriptive and frequency analysis and Pearson's coefficient, $r$, was used to evaluate the correlation between all the variables in order to select those to be included within the regression analysis.Variables with correlation index $r$ ranging from $-0.5$ to $+0.5$ were inserted in a linear regression model and computed with IBM-SPSS®. This model was used to interpret the relationship, expressed by the activation coefficient B, between the dependent variable, the level of acceptance of the reuse of treated wastewater (which varies between 0 and 2 for farmers and 0–4 for citizens/consumers), and the series of chosen independent variables. By using the backward method, independent variables with the lower level of probability to influence the coefficient of determination $R^2$ were excluded in a step by step iteration to assess the goodness of the model.

In the second phase, a driven process of stakeholders' consultation was organized in order to define common objectives and intervention strategies for increasing the reuse of wastewater in agriculture. The most interested and active stakeholders were involved.

Two methods were used to structure stakeholders' perception and to lead the debate among them: the qualitative Delphi technique (Dalkey and Helmer, 1963; Nowack et al., 2011; Alcon et al., 2014) and the semi-qualitative cognitive mapping (Kosko, 1993; Giordano et al., 2005; Khadra et al., 2011). The former is a social research technique whose aim is to structure communication between a group of stakeholders who can provide valuable contributions on the topic under discussion, based on their experience and knowledge (Landeta, 2006). In the present work, different input contributions of participating stakeholders were grouped in clusters of similar ideas. Collected ideas were afterwards used to build the cognitive map (CM) in order to identify which were, according to the stakeholders' opinion, the main issues to be addressed and the most important actions to be implemented to increase the reuse of treated wastewater in agriculture. Components of the CM were represented as boxes and relationships as arrows, indicating the way in which one idea may lead to or have implication for another. The CM allowed formalizing the understanding of

**Table 2**
Comparison between citizens' sample and population distribution by age class. Source: ISTAT (2015).

| | Population | Sample |
|---|---|---|
| Age 35–44 | 34 | 32.3 |
| Age 45–54 | 36.1 | 36.4 |
| Age 55–64 | 29.9 | 31.3 |