Conference Paper

Farmers' Attitudes Toward Recycled Water Use in Irrigated Agriculture

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Abstract

This study aims to investigate whether farmers are willing to use recycled water for irrigation purposes. It attempts to analyze the attitudinal, socio-demographics and environmental factors that affect a potential user's acceptance for wastewater reuse. A primary research designed in order to elicit farmers' preferences and a statistical analysis applied to analyze the relationships among the variables influence their attitudes. The results were obtained from data collected through 302 questionnaires that were answered by the farmers in Nestos catchment, Greece. The research findings might usefully assist policy-makers and planners in the implementation of strategy in water management sector. Farmers' awareness about the recycling water and their level of acceptance to use it might constitute incoming parameters, on which the decisions in agriculture water planning could be based. Moreover, the identification of factors influencing stakeholders' acceptance provide the underpinnings for success in any recycling project.

Keywords: public perceptions, behavior analysis, water recycling, integrated water resources management, agriculture water management

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1. Introduction

Water is a vital resource, for ecological, economic and social reasons, but overexploitation and irrational use have made it an insufficient resource. Moreover, climate change is expected to adversely affect further the water quality and availability for supply, as well as the functioning of aquatic ecosystems [9, 13]. Among the feedback solutions have been proposed to address water scarcity, is the use of recycling water. It has

been recognized as an encouraging solution to cope with the problem of water scarcity around the globe [6]. Recycling water makes a new water supply source available [6], while it entails using the same resource for as much benefit as possible [14].

Although it has been adopted in many sectors, particularly promising is regarded the use of it in agriculture, for irrigation purpose. It is known that agriculture is the sector affected more than any other by water scarcity. At the same time it constitutes the largest consumer worldwide, as it accounts for 90% of consumption [4]. In Greece, it is estimated that 83% of the water demand per year is used for crop irrigation [11].

So, the need for more efficient use of irrigation water is imperative due to the increasing environmental concern and the competition with other uses (urban, industrial, energy) [2]. In this direction, wastewater reclamation for agriculture mitigates: (i) the demand for fresh water, (ii) the application of fertilizers, (iii) the discharge of pollutants into surface waters and (iv) the pressure on water stressed bodies. Apart from the aforementioned, water recycling may be used to restore the previous characteristics of the natural water bodies' ecological status [12].

However, successful implementation of any recycling project depends on its acceptance of potential users. So, this study tries to look into public perceptions and acceptance of water reclamation for irrigation purpose. Moreover, it attempts to investigate the potential factors influence public perceptions of using recycled water and how these factors determine farmers' process of decision-making.

2. Study Area

Nestos catchment is located in north eastern part of Greece and extends to prefectures of Kavala, Drama and Xanthi (Figure 1). It is a transboundary river basin between Bulgaria and Greece. The total area of the catchment is around 5,750 km^2, with about 60% lying in Bulgarian and the rest in the territory of Greece. The population of the Greek part of the catchment in 2011 reached up to 35,543 inhabitants. The greater part of Nestos river basin is mountainous and semi-mountainous, while the Delta of Nestos River is considered to be as an extremely fertile and productive agricultural area. This feature of Nestos catchment leads to the fact that, a relatively high percentage of its population is partly or fully employed in agriculture. More specifically, 26.23% (2,551 people) of the total workforce in the Delta region belongs to the primary sector of economy. Thereby, agriculture played a decisive role to the total Gross Domestic Product (GDP) produced in the region. The main products of the primary sector produced

in the Nestos cultivated fields are corn, wheat, rice, vegetables, tree crops, as well as asparagus and kiwis.

Figure 1: Map of Greece (research area is highlighted).

As would be expected, the intensive agricultural activities in the area have an influence on the water quality and quantity of the region. Extensive use of fertilizers and overexploitation of groundwater for irrigation purpose, have caused water quantity and quality problems [5, 10].

3. Material and Methods

This study was based on data collected from answers to a fully structured questionnaire. The questionnaire was developed in discrete sessions. It contains some questions about the irrigation and cultivation practices that respondents apply. Others questions then followed, such as the environmental profile of the respondents and their familiarity with the environmental degradation of water in the studied area. Subsequently, participants asked if they knew about the meaning and the current state of recycled water. The interview context continued with an information section, clarified the meaning of recycled water. This section was essential in order to be sure that participants had some basic knowledge for the good that they were asked. The ecological

and economic benefits of wastewater recycling, as well as the potential risks arising from its use, explained to respondents. Special emphasis was given in the fact that reclaimed wastewater might reduce the need for fertilizers, because of its nutrients content.

After being informed, interviewees were asked 'If you had available recycled water, would you use it water for your crops irrigation?' They could select one option on the Likert's scale 5 points: 'Definitely no', 'Probably no', 'Neutral', 'Probably yes', 'Definitely yes'. The next question raised in this section was 'If you had available both fresh and recycled water, which would you choose?' There were three options offered in this question, fresh water, recycled water and the option 'I do not know/answer'. Finally, some personal and general socio-economic characteristics of respondents were asked, such as gender, age, income and education level.

Using the random sampling method a total of 321 face-to-face interviews took place in public places, from November 2016 to April 2017 in the region of Nestos Delta. From them, 302 were retained for further analysis, while 19 questionnaires were left out. The self-reported demographic characteristics of the sample are summarized in Table 1.

Table 1: Frequencies and percentages of membership in demographic groups for the sample.

Variable	Frequency	Percentage
Gender		
Female	43	14,2
Male	259	85,8
Age		
20–29	7	2,3
30–39	47	15,6
40–49	58	19,2
50–59	78	25,8
60–69	80	26,5
70–79	29	9,6
> 80	3	1,0
Education level		
Illiterate	11	3,6
Primary and Secondary school	187	61,9
High school	52	17,2
Associate degree	19	6,3
University	33	11,0

As it arises from Table 1, farmers involved in the survey were mainly middle-aged and elderly men, namely the typical agricultural population of Greece. It is, also, obvious from the results that most of them completed primary schooling (109 participants out of 302).

4. Results

Results show that a high proportion (65.6%) of the farmers expressed ignorance about the wastewater reuse in irrigation agriculture. When participants were asked, after the explanatory section, if they would accept wastewater reuse for crops irrigation about 64.2% in total were positive ('Probably yes' or 'Definitely yes'). As shown in Figure 2, 25.5% of participants believe that they would use definitely recycled water in the future, while 38.7% of farmers regard it as a probable option. Moreover, significant percent of the sample (13.2%) assessed as 'Somewhat improbable' to adopt the recycled water, followed by 11.9 percent of the respondents who reject such a possibility. Finally, about 10.6 percent of the farmers select the option of neutrality.

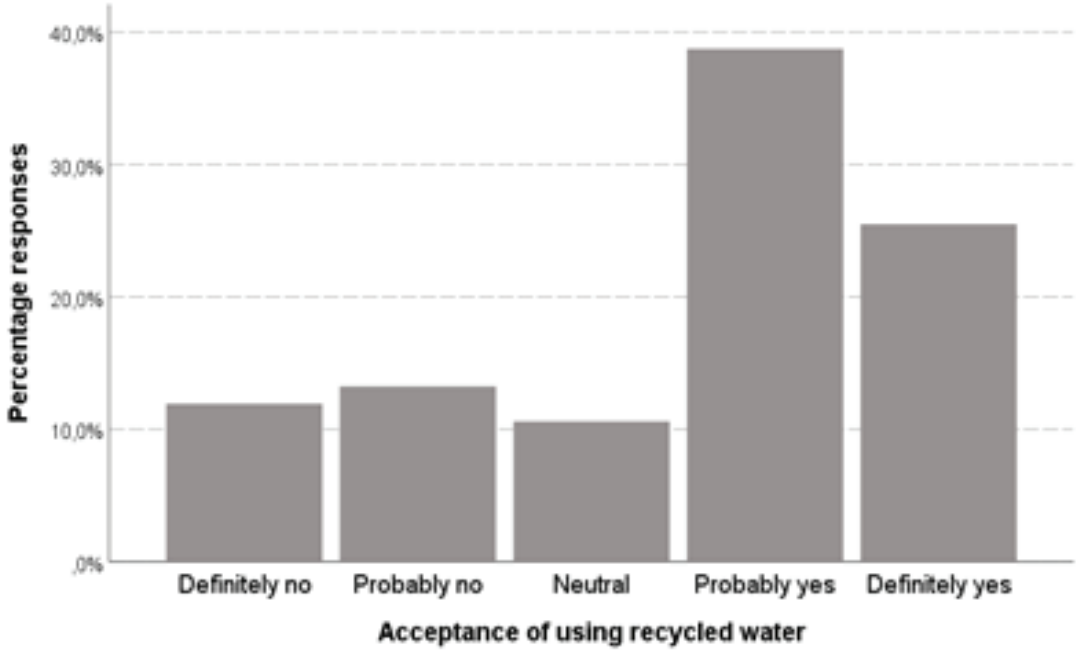

Figure 2: The percentages of responses to the acceptance of use question.

From the statistical analysis arises a correlation between the demographic characteristics examined (age, gender, educational level) and the acceptance of respondents to adopt wastewater in their cultivations. Specifically, a one-way ANOVA explored statistical significance between the education level and the acceptability of recycled

water. The interaction between these two factors approached significance, F(6,295) = 4.43, $p < 0.0001$. Another demographic factor influences the implementation of recycled water for farmers is their age. Namely, younger participants express higher levels of acceptance (Pearson correlation coefficient $r = -0,21$). As it is usually found in this type of studies, age has a notable influence on respondents' attitude. So, the greatest opposition to water reuse schemes would be from older people [1, 7]. Moreover, women tend to be more supportive of water reuse, as statistical analysis shows that females (Mean = 3,77, S.D. = 1,171) are more positive toward adopting recycled water than males (Mean = 3,49, S.D. = 1,342).

In addition, familiarization with the meaning of recycled water has a significant positive impact on farmers' level of support for the scenario. Respondents who are informed about it, state higher probability of using recycled water. Knowledge constitutes a factor identified previously as being associated with higher levels of public acceptance of recycled water [3].

Finally, results from further analysis did yield an effect of environmental concern, as attitudes toward the environment may also play a crucial role in stakeholders' acceptance. In particular, participants express a significant level of concern about water protection, display higher acceptability of recycled water (Pearson correlation coefficient $r = 0,242$). This confirms previous survey finding according to which, farmers with greater environmental concern adopt a relatively positive stance toward proposed environmental amelioration measures [8].

5. Conclusion

This article contributes to the literature through exploring farmers' preferences with regard to the contingent use of recycled water, for irrigation purposes. The data collected show that farmers in Nestos catchment have, in principle, a positive perception of water reuse in cultivations. As it arises, stakeholder's acceptance of recycled water may be correlated with socio-demographics characteristics, environmental concern and the familiarization level with this kind of water. Generally, the social research into public perceptions and conditions shape stakeholders' participation in any water management project, are recognized as the cornerstone of success for the introduction of any alternative proposal.

The research findings might usefully assist policy planners in the implementation of strategy in water management sector. Farmers' acceptance to use it might constitute

an incoming parameter, on which decisions in agriculture water planning can be based in the future.

References

[1] Alcon, F., Martin-Ortega, J., Berbel, J., de Miguel, M.D. (2012). Environmental benefits of reclaimed water: an economic assessment in the context of the Water Framework Directive. *Water Policy*, vol. 14, pp. 148–159. doi:10.2166/wp. 2011.001.

[2] Chen, W.Y., Hua, J., 2015. Citizens' distrust of government and their protest responses in a contingent valuation study of urban heritage trees in Guangzhou, China. *Journal Environmental Management,* vol. 155, pp. 40–48.

[3] Dolnicar, S., Hurlimann, A., Grun, B. (2011). What affects public acceptance of recycled and desalinated water? Water Research, vol. 45, pp. 933–943.

[4] Food and Agriculture Organization of the United Nations (FAO). (2012). Coping with Water Scarcity: an Action Framework for Agriculture and Food Security. FAO Water Reports. Rome, Italy.

[5] Ganoulis, J., Skoulikaris, H., Monget, J.M. (2008). Involving stakeholders in trans-boundary water resources management: the Mesta/Nestos 'HELP' basin. *Water SA*, vol. 34, pp. 461–467

[6] Garcia, X., Pargament, D. (2015). Reusing wastewater to cope with water scarcity: Economic, social and environmental considerations for decision-making. *Resources, Conservation and Recycling*, vol. 101, pp. 154–166.

[7] McKay, J., Hurlimann, A. (2003). Attitudes to reclaimed water for domestic use: Part 1. Age. *Journal of the Australian Water Association,* vol. 30, no. 5, pp. 45–49.

[8] Lazaridou, D., Michailidis, A., Trigkas, M. (2018). Socio-economic factors influencing farmers' willingness to undertake environmental responsibility. *Environmental Science and Pollution Research*. doi:10.1007/s1135.

[9] Meyer, J., Sale, M., Mulholland, P., Poff, N. (1999). Impacts of climate change on aquatic ecosystem functioning and health. *Journal of the American Water Resources Association*, vol. 35, no. 6, pp. 1373–1386.

[10] Pedreira, R., Kallioras, A., Pliakas, F., Gkiougkis, I., Schuth, C. (2015). Groundwater vulnerability assessment of a coastal aquifer system at River Nestos eastern Delta, Greece. *Environmental Earth Science*, vol. 73, pp. 6387–6415.

[11] Pedrero, F., Kalavrouziotis, I., Alarcón, J.J., Koukoulakis, P., Asano, T. (2010). Use of treated municipal wastewater in irrigated agriculture—Review of some practices in Spain and Greece. *Agriculture Water Management,* vol. 97, pp. 1233–1241.

[12] Plumlee, M.H., Gurr, C.J., Reinhard, M. (2012). Recycled water for stream flow augmentation benefits, challenges, and the presence of wastewater-derived organic compounds. *Science of the Total Environment*, vol. 438, pp. 541–548.

[13] Sowers, J., Vengosh, A., Weinthal, E. (2011). Climate change water resources, and the politics of adaptation in the Middle East and North Africa. *Climatic Change*, vol. 104, pp. 599–627.

[14] Wiek, A., Larson, K.L. (2012). Water, people, and sustainability—a systems framework for analyzing and assessing water governance regimes. *Water Resource Management*, vol. 26, pp. 3153–3171.