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Exploring treated wastewater issues related to agriculture in Europe, employing a quantitative SWOT analysis

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Abstract

SuWaNu is a research project funded within the EU Commission FP7 framework where one of the objectives is to identify impediments and factors of success for sustainable water treatment and nutrient reuse options. For this purpose several European regional clusters have been framed (in Bulgaria, Germany, Greece, Malta and Spain) while, through a quantitative SWOT analysis, have been identified and quantified the strengths, weaknesses, opportunities and threats of the treated wastewater sector focusing on the economical regional aspects, on research innovation potential and on market exploitation and penetration. The analysis of the contributions of the different clusters included in the SuWaNu project has provided a detailed description of the reclaimed water sector in the European agriculture. After the analysis of more than 200 strengths, opportunities, weaknesses and threats provided by the partners of the project, this study includes a complete description of the use of reclaimed water in the European agriculture. These findings have been used as the fundamental cognition for the development of a joint action plan and several other business plans in the selected regions. A brief discussion on empirical modelling and results, especially regarding the Greek case study, is shown in this paper. A more detailed discussion can be found in the SuWaNu project report, available through the website (http://www.suwanu.eu).

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1. Introduction

Some short term questions that this paper aims to explore are: (a) how can wastewater treatment and reuse be encouraged amongst farmers? (b) what methods would be used to collect tariffs from farmers? (c) determination of the farmers' willingness-to-pay for treated wastewater, (d) who would distribute the wastewater? (e) farmers' acceptance of public-private partnerships (PPPs), (f) how will cluster networks play a role in this? Additionally, this paper attempts to reveal the heterogeneity of farmers in rural areas. Who is really using the treated wastewater? Is it the farmer or other members of the rural areas? Can rural areas be seen as a homogenous space or do different types of treated wastewater users exist? On the other hand a very important long term objective of this paper is to conclude and design policy measures and recommendations targeted on the answers to these questions to strengthen the work of policy makers and stakeholders in general.

2. Study area

The region of West Macedonia is situated in north-western Greece, bordering with the regions of Central Macedonia (east), Thessaly (south), Epirus (west), and bounded to the north at the international borders of Greece with the FYROM (Bitola region) and Albania (Korçë County). Although it covers a total surface of 9,451 km^2 (3,649 sq mi) (7.2% of country's total), it has a total population of 283,689 inhabitants (2.6% of the country's total), thus it is a low-density populated region (30 per km^2, as compared to the country's 79.7 relevant figure). This is mainly due to the mountainous nature of the region, as 82% of the total surface are mountainous and semi-mountainous areas. This is also reflected in the population distribution, as a majority of the population (56%) lives in rural areas. The capital of the region is Kozani with 53,880 inhabitants. Other main towns are Ptolemaida (37,289), Grevena (17,610), Florina (19,985) and Kastoria (16,958). The Region of West Macedonia consists of four Prefectures: Florina, Grevena, Kasoria and Kozani (Figure 1).

Fig. 1. Position of the Region of West Macedonia in Greek state

Florina is a market town with an economy dominated by agriculture, forestry, summer and winter tourism, cross-border trading and the sale of local produce such as grain, grapes, and vegetables including Florina peppers. It also

has textile mills and is known for locally manufactured leather handicrafts. The most notable industrial activity is the very large Ptolemaia-Florina lignite mine. Its university changed in 2002 from being a branch of the Aristotle University of Thessaloniki, to a part of the University of Western Macedonia. After 2004, four departments that previously belonged to the Aristotle University reinforced its potential. Besides, there is also a Technological Education Institute in Florina offering higher education agricultural studies. Florina has 8 radio stations, 2 daily political newspapers, 4 weekly ones, one women's press and two newspapers on sports. During the 1950s and 1960s, the area lost much of its population to emigration, both to Athens and Thessaloniki as well as US, Canada, Australia and Germany. Following Greece's EU membership and the economic upturn, many from Germany returned.

According to All Media Communications (2013), agriculture and livestock are the most dynamic primary branches of the sector, the fisheries, the exploitation of forests and the mines are involved with 30% in the Gross National Product (GNP) of Law and designate as prime farming county. Key products: soft and hard wheat, barley, rye, corn, beans (excellent quality), sugar beet, alfalfa, potatoes, strawberries, grapes (from which the name origin of superior quality wines Amyntaio), cauliflower, leeks, cabbage, tomatoes, onions and peppers, apples, pears, chestnuts, walnuts, etc. Furthermore, the county produced high quality meat and dairy products in thousands of tons. The main catch of the six ponds are koi carp, white fish, Tsironi, eels, mullet, sheatfish, pike and platikes. Good is the annual production from the exploitation of forests are divided into public ToR 43%, EU 39% and 13% private. The forest products are mainly broadleaf timber and firewood trade.

3. Material and Methods

The methodological framework employed in this study designed in order to measure, in a scientific manner, the potential and pitfalls of treated wastewater reuse on European (and especially on Greek) agriculture. In particular this paper employees a quantitatively Delphi method using expert's values in a scale from 0 (strongly disagree) to 9 (strongly agree). Empirical analysis is based on a questionnaire: a) administered using e-mail, b) conducted, during January and March 2014 and c) addressed to 25 experts of treated wastewater. This focus group mainly comprised of key stakeholders in Greece (academics, policy directors, staff scientists and farmers engaged wastewater research).

The Delphi method mainly developed by Dalkey and Helmer (1963) is a widely used and accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts within certain topic areas (Hsu and Sandford, 2007). Researchers have applied the Delphi method to a wide variety of situations as a tool for expert problem solving. However, in the literature no papers can be found applying the Delphi method in treated wastewater reuse issues.

Thus, the contribution of this paper is twofold: a) from a methodological point of view this paper offers a research framework to quantify treated wastewater reuse impacts, and b) from a practical point of view this papers estimates the potential and pitfalls of treated wastewater reuse on Greek agriculture, in order to avoid even higher future costs due to mismanagement of water resources and agriculture. The following Figure 2 presents the general organization framework of the Delphi technique.

According to the literature (Taylor and Judd, 1989; Markou et al., 2014), and in order to achieve the aim of the paper we employ a research plan consisting of a three-step strategy. First, to identify factors that will answer the research question and the problem definition. The second step involves quantitatively evaluating the identified factors. This is more objective and should provide more confidence and solid directions for the third step: repeating the data collection until the satisfaction of the consensus condition which was declared by the researchers.

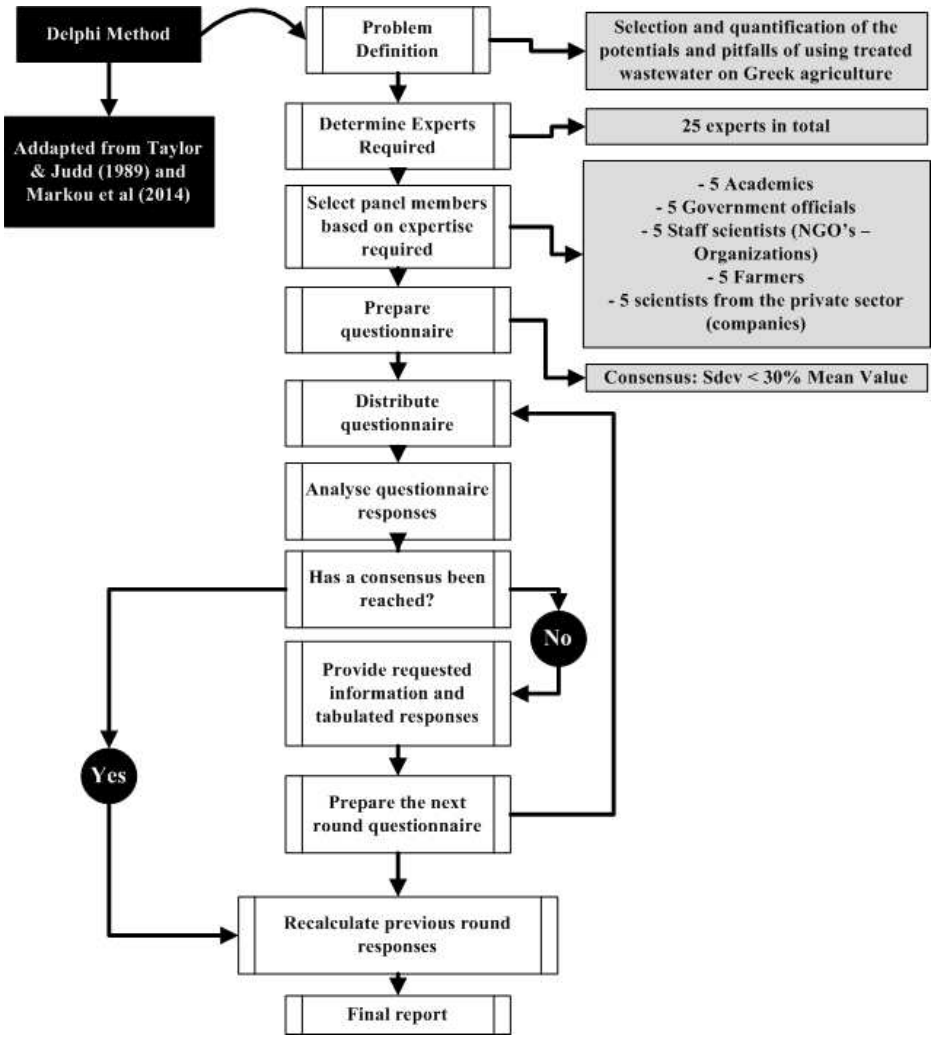

Fig. 2. Delphi process systemization

4. Selection of the Delphi Methodology

Actually, a traditional survey could be used to gather input from a group of experts or stakeholders concerning treated wastewater reuse impacts. However, a Delphi method, and especially a quantitatively Delphi method, has been judged to be a stronger methodology for a rigorous query of experts for the following reasons (Okoli and Pawlowski, 2004):

- A quantitatively Delphi study answers the complex study question more properly for the reason that this compound concern requires deep knowledge and practical experience from people who understand *in extenso* the different economic, environmental, agronomical, social and political issues.
- A quantitatively Delphi study does not require the experts to meet physically.
- A quantitatively Delphi study requires a limited number of experts.
- A quantitatively Delphi study allows a deeper understanding of the complex research question mainly due to its flexibility to follow-up interviews.

- A quantitatively Delphi study serves the dual purpose of ranking the treated wastewater reuse impacts according to their importance and having them evaluated using Likert-type scale values.

5. Procedure for selecting experts

Following the guidelines of Delbecq et al. (1975), Okoli and Pawlowski (2004) and Markou et al. (2014) in this study a multiple-step procedure has been employed in order to identify, categorize, rank and select the 25 experts for the Delphi methodology (Figure 3).

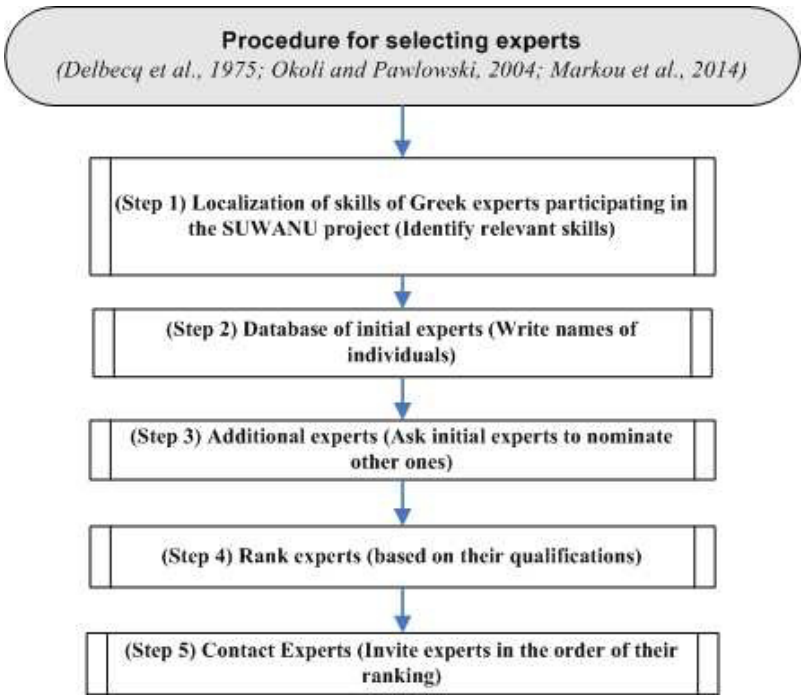

Fig. 3. Selection procedure of experts

6. Data collection and analysis method

The Delphi questionnaire has been administered using e-mail and following a modified version of the procedure for "ranking-type" Delphi studies outlined by Schmidt (1997). This general procedure basically involve three steps: brainstorming for important factors, narrowing down the original list to the most important ones and ranking the list of important factors. The employed modified version involves one more step; evaluating the most important factors using Likert-type scale values. To address the research aim, the first version of the very simple questionnaire asked experts to list at least six important strengths, weaknesses, opportunities and threats of treated wastewater reuse. This creative process was designed to generate a list of treated wastewater reuse impacts, removing identical or similar responses. Then, we sent this list to the heterogeneous group of experts asking them to mention additional impacts from the generated list and to validate that we have correctly interpreted their initial responses and placed them in an appropriate category. In a third stage the experts have been asked to rank the impacts of treated wastewater reuse based on their effects on agricultural activity. Finally, the experts have been asked to state their suppositional Likert-type scale value, where 0=strongly disagree and 9=strongly agree, for each one of these statements. This final step has been repeated five times up to the satisfaction of the consensus condition which is that the standard deviation of the experts' values for each statement does not exceed the 30% of the mean value of the statement. In any failure to

satisfy the consensus condition each expert asked to mention new suppositional value closer to the respective mean value (Figure 4).

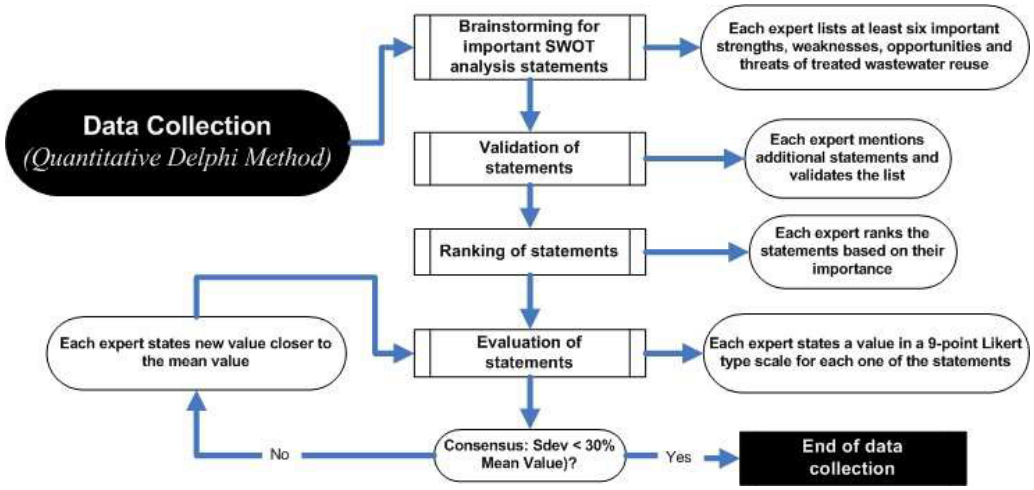

Fig. 4. Data collection process

7. Results

Summarizing from the SWOT analysis of the treated water sector in the study area, the most important generalized dimension of the strengths referred to markets, followed by economic aspects and legislation while technical aspects, health aspects, agriculture and R&T transfer are also considerable (Figure 5).

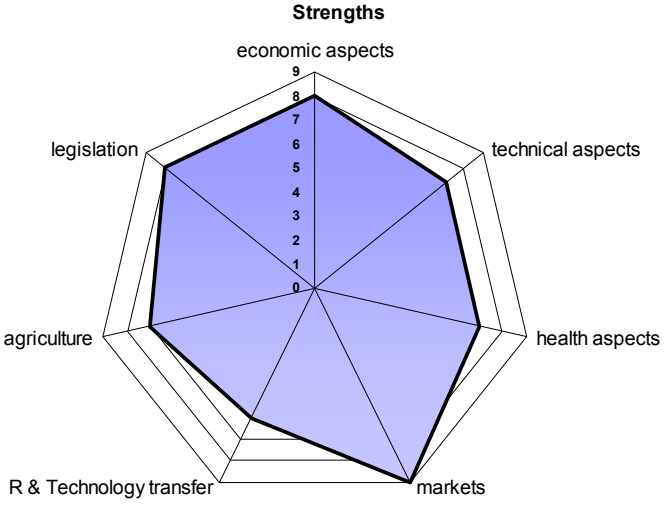

Fig. 5. Strengths of the treated water sector in the study area

Regarding the opportunities (Figure 6), technology transfer is the most important followed by economic aspects, water availability and social aspects. Environmental aspects, agriculture and technical aspects are also notable.

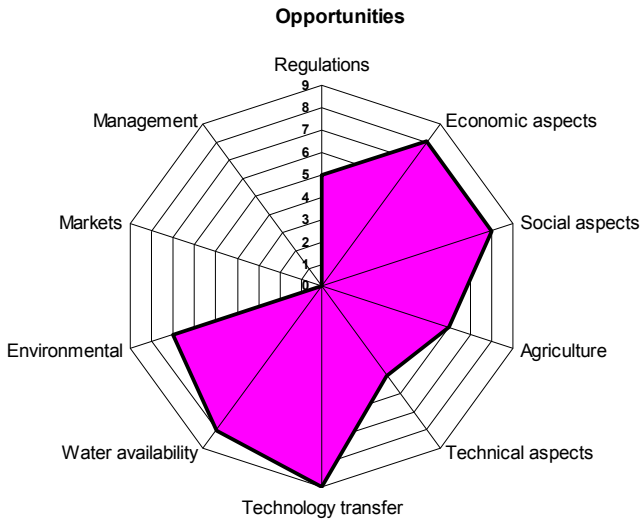

Fig. 6. Opportunities of the treated water sector in the study area

According to the above mentioned generalizations, the most important dimension of the weaknesses of the treated water sector in the study area are the economic aspects followed by technical aspects, markets, technology transfer and management aspects while water availability is also a considerable weakness (Figure 7).

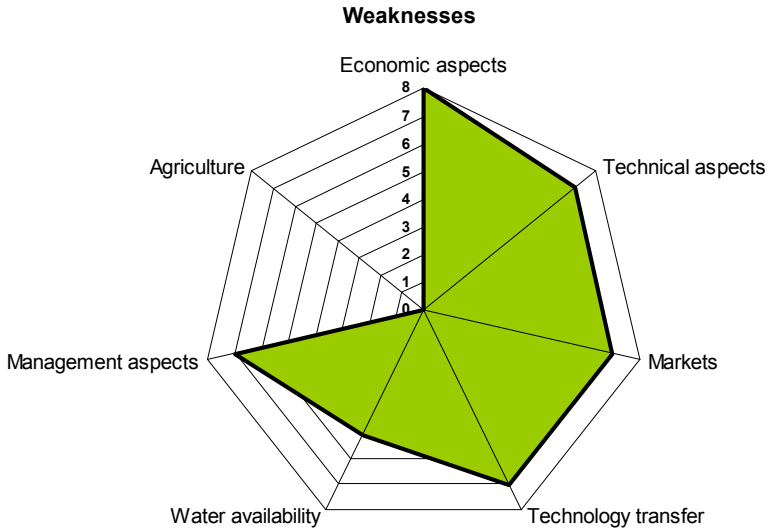

Fig. 7. Weaknesses of the treated water sector in the study area

Finally regarding the threats, technical aspects, social aspects, agriculture and markets are the most considerable dimensions while the regulations, management aspects and environmental aspects (with same weights) are also notable in the Figure 8.

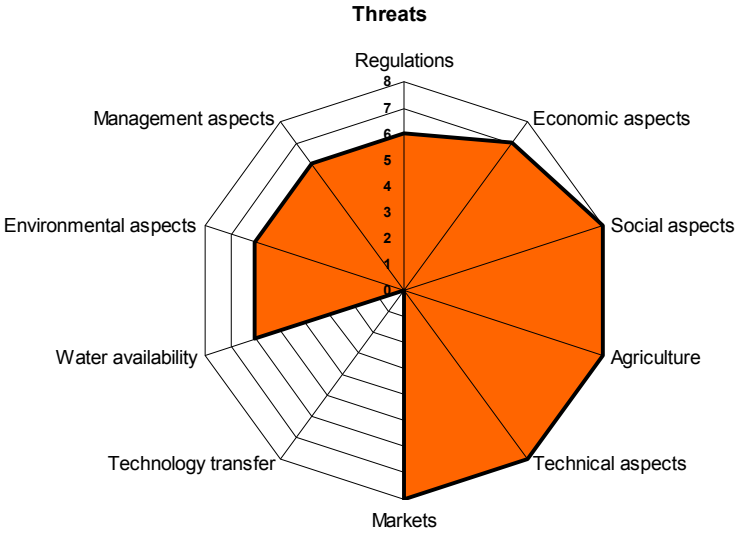

Fig. 8. Threats of the treated water sector in the study area

8. Conclusions

The agricultural sector in the region of West Macedonia could be characterized as rather "traditional". Actually, the applied technology in agriculture is not very innovative and the adoption process of precision agriculture is in a very early stage (Michailidis et al., 2010). On the other hand, the majority of the farms are small family units and many of the heads of the farms are not full time farmers (Michailidis et al., 2012). Regarding the treated water units, the level of innovativeness is also very low and the adopted technology is marginal rather "laggard". The recent economic crisis in Greece combined with the usual lag observed in rural, marginalised and remote areas led to this innovative depreciation with significant impacts on farm productivity and capital efficiency. However, during the very recent years a small scale change has been mentioned in this issue and few of the traditionally employed "soft" technologies gradually began to be replaced by other "harder" ones (Michailidis et al., 2010). This trend, if proven and continue further, could be a good potential for technological change and innovativeness upgrade.

Although the adopted technology gap between the study area and the central European countries is considerable, the most important delay reason in the agricultural development process is the endogenous orientation of the agricultural sector (Chatzitheodoridis et al., 2013). A more inter-regional or international trading of agricultural products could be a desirable improvement offering comparatively greater benefits and increasing the demand and the prices of products. Besides, a small scale reformation of the cultivations towards high value-added products and increased needs for irrigation water could be also necessary and desirable progress.

SuWaNu project combined with a strong and innovative group of experts, recently established in the study area, could offer several future R&D capabilities. Especially, the applied and practical orientation of the local agricultural research institution (Technological Education Institute of West Macedonia) and the strong collaboration between local key scientists and members of the bigger Greek University (Aristotle University of Thessaloniki) point toward a future diffusion of R&D.

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