Water Resource Management in Larisa: A "Tragedy of the Commons?"

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Abstract The commons are natural or man-made resources that due to non-excludability and subtractability face serious risks of overexploitation, mismanagement, or even destruction, the so-called "tragedy of the commons". Groundwater is a typical example of such a resource. Drawing on the framework developed by the 2009 Nobel laureate Elinor Ostrom, this research explores issues of collective management of groundwater using Larissa area, one of the most important agricultural areas of Greece, as a case study. More specifically, the paper assesses empirically the possibility of user-based management of groundwater used for irrigation purposes. This is done through a survey which explores, *inter alia*, the views of local stakeholders on the intensity of the water problem, the irrigation practices, and the existence of trust-based social relations between the farmers, which are seen as essential for the development of successful, long-enduring, user-based governance solutions. The research finds that farmers are rather reserved toward the possibility of groundwater self-management, which may be due to lack of trust both among them and toward the other players in the field. On these grounds, it seems that the most appropriate solution would be to create an independent coordinative body with multiple responsibilities and powers.

Keywords Groundwater · Common pool resources · Tragedy of the commons · Larisa

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1 Introduction

The common pool resource (CPRs), or simply commons, is a special category of natural or man-made resources characterized by non-excludability, meaning that it is too difficult (i.e., too costly) to exclude someone from using them, and subtractability, meaning that use by someone reduces the level of the resource available to others. These features of commons enable rational individuals (acting in their immediate self-interest) to use as much of the resource as they like, without taking full responsibility for their actions. As a result, the resource is gradually depleted and eventually led to degradation and destruction, a situation known as the "tragedy of the commons" (Hardin 1968; Feeny et al. 1990).

The reasons behind the "tragedy" are twofold. On the one hand, there is the economic rational behavior of the users (which seek to maximize their individual immediate benefit, disregarding the social/collective long-term costs of their actions), and on the other hand, there is a lack of a proper institutional structure for the sustainable "governance" of the CPRs, that is a framework which enables property rights on the resource to be properly defined, allocated, and enforced to all actors. On these grounds, possible solutions to the commons' tragedy could be to infuse stewardship ethic among users[1] and to enhance moral and altruistic behavior toward sustainability (Barclay 2004), and/or, as Hardin (1968) and others (e.g., Libecap 2009) have argued, to attribute clearly defined property rights, either to individuals (privatization) or to the state (nationalization), giving the owner the incentives and authority to enforce the sustainability of the resource.

However, the 2009 Nobel laureate in economics, Elinor Ostrom, has revisited Hardin's work and drawing on a number of empirical studies across the world demonstrated that communities can successfully manage commons even in the absence of private property rights and a strong regulatory authority. In particular, Ostrom (1990, 1992, 1999, 2000, 2008, 2010, as well as Stern et al. 2002 and Dietz et al. 2003) made clear that local users are able to overcome collective action problems and to develop indigenous, self-organized, and long-enduring institutions for the sustainable management of the CPRs. These institutions are particularly social arrangements (rules, norms, routines, customs, etc.) which define and allocate rights and obligations among users and provide the mechanisms for policing and enforcing them.

Combining field and experimental research on the commons, Ostrom (1990, 2006, as well as Ostrom et al. 1999) and other scholars (Wade 1987, 1988; Baland and Platteau 1996; Agrawal 2001, 2003) identified a number of characteristics that are common to all successful management structures. These can be organized under five headings (Briasouli 2003). The first group of elements regards the

[1] In its modern conception, stewardship ethic refers to the "responsible use (including conservation) of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant answerability to society" (Worrell and Appleby 2000: 269).

resource itself; resources of smaller sizes with definable boundaries, for example, can be preserved much more easily. A second group concerns the characteristics of the user community; small and homogeneous populations with a thick social network[2] based on trust, with experience in self-regulation and with social values promoting conservation (e.g., stewardship ethic), do better. The third group of conditions has to do with users' dependence on the resource; there must be a perceptible threat of resource depletion, and the community (current and future generations) should depend to a high degree on the resource for its living. The fourth group refers to the governance structure, that is, the institutional arrangements that should be developed to manage the CPR; locally emerged, user-based, simple rules with simple, internal, and low-cost policing and enforcement procedures are preferable. Finally, the last group concerns the external environment; clear and supportive state regulations (with formal incentives and sanctions) and accommodating and collaborative local/regional authorities do help to a great extent.

Groundwater constitutes a typical example of CPRs (Easter et al. 1997; Theesfeld 2010). It is subject to rivalry in consumption, in the sense that there is a specific amount available (finite in the case of non-renewable, e.g., fossil groundwater), which must be shared over a variety of users/uses and geographical areas. In addition, the change of the climate of the planet, with the rise of the world temperatures and the reduction of the annual rainfalls, and the increase of the environmental degradation and the water demand (for agricultural, industrial, and residential uses) have made groundwater a valuable resource in scarcity (Mariolakos 2007). In this sense, academics (Starr 1991; Klare 2001; Bolton 2010), journalists (de Villiers 2003; Annin 2006; Solomon 2011), technocrats (Serageldin 2009), and politicians[3] alike have called into attention that disputes over freshwater would be the source of conflicts and wars in the near future (Mostert 2003). So, the "tragedy" might be even worse.

Drawing on the analytical framework of commons developed by Ostrom, this research explores issues of collective management of the groundwater resource using Larissa area, one of the most important agricultural areas of Greece, as a case study. In particular, the paper explores empirically the possibility of user-based management of groundwater used for irrigation purposes. This is done through a survey which sets out the views of local stakeholders on the intensity of the water problem (in terms of both quantity and quality), the irrigation practices and degree of dependence of the local farmers on the resource, and the existence of trust-based social relations between the users, which, as mentioned, are seen as essential for the development of successful, long-enduring, community-organized governance solutions.

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[2] That is a network of strong personal relationships and social interactions between members of a community (individuals, groups, or organizations).

[3] In response to the water supply threat posed by an Ethiopian dam, Egyptian President Mohamed Morsi declared in a television speech to his people on June 10, 2013: "Egypt's water security cannot be violated at all. As president of the state, I confirm to you that all options are open" (BBC News 2013).

The paper is structured as follows. The following section assesses the formal regulatory framework that prescribes (ground) water use in Greece, whereas the next one moves to outline the condition of water resources in Thessaly, which is the region where Larisa is located. Section four presents the analysis and results of the case study, and section five concludes the chapter.

2 The Legal Framework of Water Management in Greece

As discussed, facilitative to sustainable CPR management is the provision of a formal institutional (legal) framework that clearly and credibly defines (property) rights and responsibilities and enforces compliance with those involved, providing incentives for proper consumption, management, and conservation of the resource.

As far as Greece is concerned, until three decades ago, there was a serious lack of legal provisions regarding the protection and management of the water resources.[4] Despite the several efforts to overcome problems and to provide a comprehensive institutional framework that deals with these issues,[5] the legal instruments available by the mid-1980s were multiple in number, limited in scope, and piecemeal in character, with weak policing and enforcement mechanisms and poor control and implementation powers (Kampa 2007; Kampa and Bressers 2008).

The Framework Laws 1650/1986, for the "Protection of the Environment," and 1739/1987, for the "Management of Water Resources," constituted the first serious attempts for the provision of an integrated legal frame able to support sustainable water management in Greece. Although they were only partially implemented,[6] mainly due to public sector inability to put into effect some of their provisions (CSEH 2003; Kampa 2007), the 16-year experience that they endowed to all relevant parties provided a valuable background for the transposition of Water Framework Directive 2000/60/EC into the Greek national legal context—see below (NTUA 2008).

The Water Framework Directive (WFD) provided a wider frame for European Union (EU) member states in the field of water policy in order to achieve good qualitative and quantitative status of all water bodies by 2015. To do so, it established a number of common objectives, principles, definitions, and measures for

[4] In practice, there were no restrictions in the abstraction of groundwater to both private and public users (Kampa 2007).

[5] Such as the Civil Code of 1940, the Law 481/1943 on the management and administration of waters used for irrigation (complemented with further acts in 1948, 1949, 1952, 1957), the Law 1988/1952 on wells, the Decree 3881/1958 on land reclamation works, the Code 420/1970 for the protection of the aquatic ecosystem, and the New Constitution of 1975 (which introduced environmental protection as an obligation).

[6] As a result of their weak implementation, water management continued in a piecemeal and opportunistic manner throughout the 1990s (Kampa 2007). In practice, this meant that water users could abstract, at their will, uncontrolled, large amounts of water with the tolerance of the local authorities (Delithanasi 2004).

the sustainable management of the water resources throughout EU and prescribed the steps that member states need to follow in order to reach the common goal, taking in due account not only environmental but economic and social considerations as well. Interestingly, in contrast to past mentality, the WFD has, *inter alia*, urged states to encourage the participation of all interested parties in the water management process (Article 14) and recommended the establishment of economic instruments to ensure incentive pricing to water savings and full cost recovery based on the polluter pays principle (Article 9).

Despite the shortcomings of the WFD (see *inter alia* Kallis and Butler 2001; Baltas and Mimikou 2006), Greece has been relatively prompt to incorporate it into the national legal context through the adoption of the 3199/2003 "Water Protection and Management" Framework Law (Kanakoudis and Tsitsifli 2010). This Law introduced most of the new definitions and notions of the Directive and determined the competent authorities and the analytical procedures that they should follow for each individual issue, but did not go through a number of important provisions specified by the WFD (left to be regulated in future time). This partial harmonization with the Directive brought Greece in front of the European Court of Justice for a couple of times (in 2006, 2008, 2011), giving rise to the 51/2007 Presidential Decree, which literally transposed (word by word) all the provisions left out from the Framework Law. This delay in transposition, however, has brought further delays to a number of implementation actions (Sofios et al. 2008), posing a serious threat to the overall process. In addition, the recent financial crisis that afflicted the country with the hard austerity measures that imposed to local bodies has put into question the financial feasibility and necessity of the program and made its requirements to be somewhat neglected (Kalampouka et al. 2011). This, nevertheless, brought new impetus to bottom-up user-based initiatives, aiming to the sustainable governance of the water resource.

3 The Characteristics of Water Resources in the Region

The Thessaly Water District (WD)[7] virtually coincides with the corresponding regional territory incorporating almost the whole prefecture of Larisa and large parts of the prefectures of Magnesia, Trikala, and Karditsa (see Fig. 1). Its total area is 13,136 km^2 (with population, as measured in 2011, of 746,714 residents), which is divided into three sections: the eastern costal and mountainous area with Mediterranean climate, the central flat area with continental climate, and the western mountainous area with mountainous climate (Baltas and Mimikou 2006). The Thessaly WD comprises the basins of Pineios River (and its tributaries) and the

[7] The 3199/2003 Framework Law adopted the existing division of Greece into 14 WDs (already defined by the 1739/1987). A WD is considered to be the entity of all runoff basins of as similar as possible hydrological–hydrogeological conditions, which constitute the regional level in the field of water management (NTUA 2008).

Fig. 1 The 14 WD in Greece (*source* NTUA 2008)

lake of Karla as well as two self-contained aquifers, the western and the eastern, covering 4,520 km^2, or 35 % of the region's area. The average annual temperature ranges from 16 to 17 °C (WMC 2005). The rainy season lasts from October to January and the dry one from July and August, giving an average annual precipitation of about 678 mm, which is one of the lowest in the country (WMC 2005). This provides a first indication of the water condition that the area exhibits.

Extended to an area of 14,000 km^2 (about 11 % of the whole country), the Thessaly region incorporates the highly fertile plain of Larisa, providing 14.2 % of the national agricultural product (40 % of cotton) and making it one of the most important agricultural areas of Greece. Agriculture is the main consumer of Thessaly's water resources (87 % of the total demand). The 2,500 km^2 of irrigated farmland requires about 1,550 million m^3 of water annually, whereas the sustainable supply is about 750 million m^3 (or which the 550 are groundwater) (Goumas 2006). This gives an annual deficit of roughly 800 million m^3 of water (see Fig. 2), which is usually extracted through illegal borewells (count to be more than 30,000, according to some estimates, see Lialios 2011) depleting the groundwater resource and leading to 'tragedy.'

The dropping levels of the water table of the eastern aquifer, where our case study is located, provide another indication of the extent of the problem (see Fig. 3). As can be seen, from 1985 onward, there is a steady decrease of the groundwater level, apart from the years 2002–2003, when the area has experienced frequent and heavy rainfalls (Goumas 2012). In addition to the quantitative depletion of the resource, there is also qualitative deterioration, which comes from two main sources (Polyzos et al. 2006; Goumas 2012). First is saltwater intrusion (since the area is close to the coast and there is a hydraulic connection between

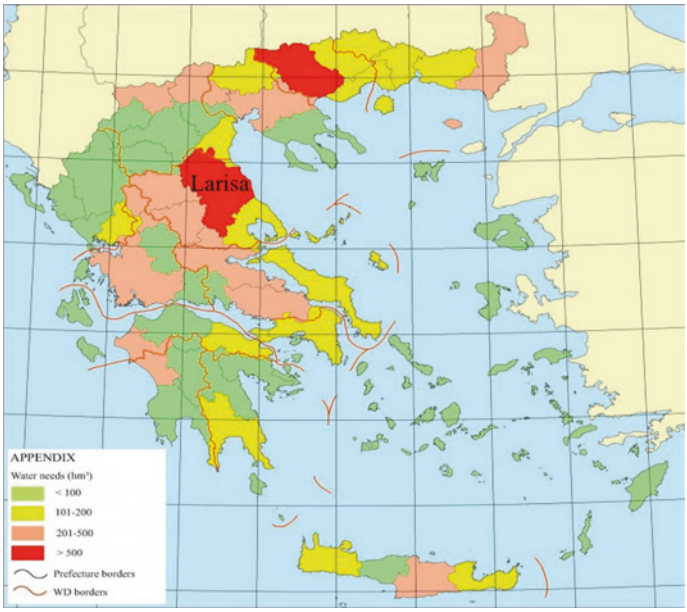

Fig. 2 Water deficit per prefecture (*source* NTUA 2008)

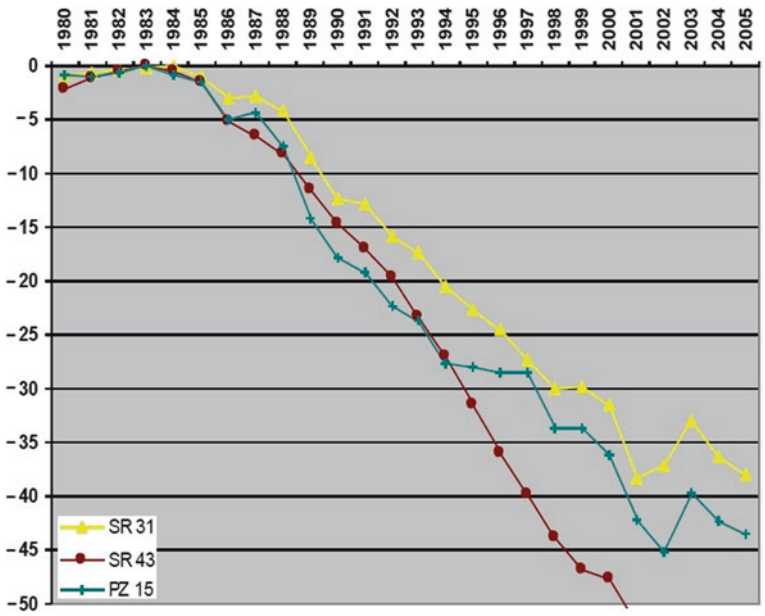

Fig. 3 Water table levels, eastern aquifer of Thessaly WD (*source* Goumas 2012)

the two bodies), and second is nitrate pollution due to crop overfertilization (as a result of lack of both proper education of the farmers and supervision by the regulatory authorities) both of which cause contamination to the groundwater, with catastrophic consequences for the agriculture and the economy of the area.

4 Is the Tragedy of the Commons Unavoidable?

4.1 Research Concept and Methodology

Previous sections made evident the extent of the groundwater degradation in Larisa (mainly due to illegal water extraction) leading to a tragedy of the commons and the deficiencies of the formal–legal framework to deal effectively with all these issues (at least up to the present point). The current section investigates the possibility of developing some bottom-up, user-based initiatives toward the sustainable management of the CPR. This is done through a questionnaire survey which explored the views and attitudes of local stakeholders on a number of relevant issues, such as the condition of the resource and the factors that affect this, the degree of dependence of the local farmers on the resource, the strength of social relations of users and the level of trust (among farmers and between farmers and other players), the willingness to contribute financially toward the maintenance of the resource ("willingness to pay"), and the institutional arrangements which are necessary toward sustainability.

Two groups of people have been surveyed. The first is local farmers (i.e., the users) from the area of Platykampos (a municipality located at about 10 km southeast of Larisa city), and the second is "informed technocrats," i.e., high-ranked public officials, scientists, and experts, who are involved in water management issues (affiliated to the regional authority, the local authorities, the Local Organization of Land Reclamation—TOEB, the local universities, the local branch of the Geotechnical Chamber of Greece, and the Geoponic Association of Larisa). Survey questions were pretested in a pilot study enabling fine-tuning of the instrument and improvement of its clarity. The final questionnaire consists of six parts containing 35 questions of all types: measurement, dichotomous, ordinal, as well as Likert-scale and semantic-differential ones scaled from 0 (denoting strong disagreement, negative opinion, etc.) to 10 (denoting strong agreement, positive opinion, etc.). The first part informs the respondent on the purpose of the research and ensures the anonymity of participation. The second part records views regarding the adequacy and quality of the groundwater (at present and in the near future) and the factors that affect its condition. The third part contains questions about the farming practices, their water consumption, and the willingness to pay for water conservation.[8] The fourth part assesses which institutional arrangements are conducive to sustainable water management. The final part of the questionnaire gathers information about the respondents, such as age, gender, and education.

[8] This part was included only in the questionnaire distributed to the farmers.

Table 1 Composition of respondents

			N	M	SD	Mdn	Percentiles		
							25	50	75
Group	Farmers	81.10 %	133						
	Technocrats	18.90 %	31						
Gender	Male	86.60 %	142						
	Female	13.40 %	22						
Age	<30	1.20 %	164	49.7	11.1	50	41	50	58
	30–50	51.80 %							
	>50	47.00 %							
Education	Primary or less	15.20 %	164	3	1.2	3	2	3	4
	Secondary	17.10 %							
	Post-secondary	33.50 %							
	Tertiary(university)	20.70 %							
	Postgraduate	13.40 %							

The survey was held during the first quarter of 2010. Questionnaires were distributed in person by the members of the research team and asked to be completed on the spot.[9] In order to increase the response rate and quality, participants were given the choice of having the questions read to them and responses recorded by the researcher, or, should they wish, to complete them on their own time and be picked up in a week. Questionnaires were collected, validated, and then coded and analyzed to generate a number of statistics illustrating the respondents' views on the issues raised. Data analyses were conducted with SPSS release 19.0. Since none of the developed variables satisfied the Shapiro–Wilk test for normality, non-parametric analysis was employed. Thus, correlations were assessed using the Spearman's rho correlation coefficient.

4.2 Response Rate and Composition of Respondents

A total of 250 distributed questionnaires yielded 164 properly completed responses (a response rate of about 66 %). The respondents were principally men (86.6 %), reflecting male dominance in both the agricultural sector (89.5 %) and high-ranked officer positions (74.2 %) (see Table 1). The 30–50 age bracket was the main group (51.8 %), followed by those over 50 (47 %) and those below 30 (1.2 %). The average age of the sample was about 50 years. Farmers comprised the majority of the sample (81.1 %). Most respondents (36.4 %) have completed post-secondary studies (33.5 %), followed by those holding a university degree (20.7 %), which are mainly technocrats. 81.2 % of the farmers had acquired only compulsory education.

[9] It should be noted that due to difficulties in defining with precision the statistical population, the choice of the sample was made by simple random sampling.

4.3 The Condition of Groundwater

When asked to assess the adequacy of groundwater for irrigation purposes, respondents almost unanimously acknowledged the problem (see Table 2). The majority of the sample (31.1 %) replied that there is a water shortage (scored 2, on a scale of 0: shortage to 10: abundance) and the average score was 2.6 (see Table 2). Similar, if not gloomier, was their response regarding the situation over the next decade. More than 75 % of the people said that ceteris paribus, the resource will diminish, whereas most respondents (28 %) gave the lowest score—zero (average score 1.3). Interestingly, a 3 % of the sample replied that there will be some increase in the groundwater reserves, all of which were farmers. In line was the next question, asking whether the resource faces a tragedy condition. Over 80 % of the respondents agreed that the amount of water extracted is not replenished, whereas more than 50 % gave the highest scores (indicating the severity of the problem).

Turning to the factors that held responsible for this situation, out of the five put forward: climate change, agricultural consumption, non-agricultural consumption, wasteful use, and bad management (by official authorities), the last scored higher (mean value of 7.6, with more than 25 % of the respondents giving the highest score), followed by climate change (mean 6.3) and by agricultural consumption and wasteful use (both scored 6.1). When asked to assess the percentage of illegally extracted water, technocrats indicated on average that this should be 32.1 % of that totally consumed, whereas the respective figure given by the farmers was 19.8 %. Similarly, technocrats deemed that 27.9 % of the farmers extract water illegally, while farmers provided a much lower figure (16.3 %).

What becomes evident from the above is that farmers (as well as technocrats) are fully aware of the intensity and causes of the groundwater problem in their area. This is good news, because realization of the problem constitutes the first step toward its solution.

4.4 Irrigation Practices and Attitudes

As regards to irrigation practices, the vast majority of the farmers (76.7 %) admit that they use as much water as there is available, with aim to maximize crop production. After all, they confess, even if they do not do so, someone else will. Of the rest 23.3 % who care for water conservation, 22.5 % do this due to concerns of water availability in the future, and only a 0.8 % act on purely altruistic motives (i.e., for water to be available to the others). Overall, using economics jargon, it becomes evident that economic rationality (utility maximization) drives to a large extent farmers' behavior, which, due to non-excludability of the groundwater resource, gives rise to a free-rider situation.

The above finding is also supported by the next question which explores whether farmers would be willing to slim down their water extraction levels as part of a program for the maintenance of the resource. Interestingly, 29.3 % of the

Table 2 Perceptions on the condition of groundwater

		0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)	N	M	SD	Mdn	Percentiles		
																	25	50	75
Groundwater condition	Water adequacy (0: shortage, 10: abundance)	10.4	20.7	31.1	18.3	5.5	3.0	3.7	1.8	4.3	1.2	0	164	2.6	2.0	2	1	2	3
	Quantity in next decade (0: deteriorate, 10: improve)	28.0	23.2	25.6	7.9	7.9	4.3	0.6	1.8	0.3	0.3	0.0	164	1.3	1.6	1	0	1	2
	"Tragedy of the commons" (0: disagree, 10: agree)	3.7	0.6	2.4	1.2	3.7	3.7	3.7	11.0	18.3	23	28.7	164	7.8	2.5	9	7	9	10
Factors affecting groundwater (0: not important, 10: very important)	Climate change	2.4	3	6.7	5.5	3.7	11.6	14.6	18.3	14.6	3.0	16.5	164	6.3	2.6	7	5	7	8
	Agricultural consumption	5.5	1.2	3.7	4.3	7.9	13.4	12.2	19.5	17.1	6.7	8.5	164	6.1	2.6	7	5	7	8
	Non-agricultural consumption.	3.0	9.8	8.5	25.0	14.0	17.1	14.6	3.7	1.8	0.6	1.8	164	4.0	2.0	4	3	4	5
	Wasteful use	7.9	1.8	4.3	6.1	7.9	10.4	8.5	15.2	15.9	8.5	13.4	164	6.1	3.0	7	4	7	8
	Bad management	1.2	0.6	1.8	1.2	3.7	11.0	8.5	10.4	17.1	18.9	25.6	164	7.6	2.3	8	6	8	10

Table 3 Willingness to pay (€)

0	1–100	101–500	501–1,000	1,001–2,000	>2,000	N	M	SD	Mdn	Percentiles		
										25	50	75
36.8 %	9.8 %	24.8 %	17.3 %	10.5 %	0.8 %	133	474.8	598.1	200	0	200	1,000

respondents have a rather non-positive stance, and of the rest 70.7 % who agrees to do so, most (39.8 %) seem willing only if sound economic incentives are given, whereas the others (20.3 %) if there would be additional measures for compliance by all farmers.[10]

4.5 Willingness to Pay

Given the above findings, the gloomy condition of the groundwater resource, and the provisions of the WFD for water service cost recovery through pricing policies, the next question is of particular interest. It is set as follows: "assuming that under current conditions the groundwater reserves will be run out in 10 years, what amount of money are you willing to pay on an annual basis in order successful corrective measures to be taken?". Table 3 presents the results. As can be seen, 36.8 % of the respondents were not willing to provide any financial support, on the basis (as subsequent conversations with the farmers revealed) that the water is a public good and the onus is on the state to ensure its adequate provision and maintenance. The amount of money that the rest of the farmers (63.2 %) were willing to contribute varied substantially, ranging from €50 to €3,000, with the mean value of €474.8.

4.6 Groundwater as Commons

The current section explores the need for, previous experience of, and willingness of the stakeholders to be engaged in some form of bottom-up, user-based initiatives toward the sustainable management of the groundwater. The specific issues examined are the degree of user dependence on the resource, the preferred allocation of ownership rights on groundwater, the kind of institutional arrangements regarded as conducive to sustainable management, the strength of trust-based social relations among users, and their past experience and willingness to cooperate with each other toward the aforementioned end.

Three questions were set to assess the degree of user dependence on groundwater and on agriculture in general. First, farmers were asked to estimate the change in their crop production capacity and resulted income if there was no groundwater

[10] These figures indicate that farmers were generally skeptical of the success of such an endeavor, especially given the acute economic conditions of the country and its population.

available. Though replies were varied considerably, on average, a 71.1 % reduction in production and a 67.9 % reduction in incomes were reported. The second question explored whether farmers would consider changing their occupation. Though 26.4 % of respondents were rather negative, the majority (46.7 %) were quite positive (and the rest 23.3 % were indecisive) (see Table 4). To assess the long-term intergenerational dependence, farmers were next asked whether they believe their offsprings would take over their family business. The results were overwhelming: 57.2 % of respondents deemed that their children will not continue farming, 20.4 % was not sure, and 22.6 % thought that rather they will. Overall, it became evident that although farmers and their families depend highly on groundwater for their living, this situation could be rather impermanent and short-termed. On these grounds, it is doubtful whether they would be willing to engage themselves and invest in long-standing relations regarding the management and maintenance of the resource.

The above findings explain relatively well the assignment of property rights that stakeholders seems to prefer, which is examined by the next question. In particular, respondents were asked to choose who should have the ownership of groundwater in order for sustainability to be achieved; should this be the central or local government (i.e., nationalization), a specialized management organization, formal associations/cooperatives of farmers, all farmers collectively, each farmer individually, private investors (i.e., privatization), or none of the above? The group of farmers showed a degree of divergence. Not unexpectedly (on the basis of the low trust among farmers—see below—and the low intergenerational commitment to farming and to self-governance of the resource), almost half of the respondents (49.1 %) opted for the specialized management organization, 20.5 % upheld the central state, 13.7 % argued that ownership should be split between farmers, and only 11.0 % endorsed a form of user-based ownership (i.e., 5.5 % voted for farmer associations and 5.5 % for collective ownership). Interestingly, a tiny 1.7 % chose privatization (i.e., ownership given to private investors) as the preferable solution. Perhaps, equally interesting was the outcome of the technocrats' group. Only two options were selected: the specialized management organization (getting the high 71.0 % of votes) and the central state, indicating that neither privatization nor any form of community ownership was deemed capable to ensure proper use and longevity of the resource.[11]

Next, respondents were asked to assess a number of institutional arrangements in terms of their significance for sustainable management (see Table 5). With the mean value of 8.0, first scored "rule enforcement," which, as seen, is the major deficiency of the Greek institutional framework. Next came the "specification of rules for use," the "specification of sanctions for violations," and the "monitoring of rule compliance" (with mean scores of 7.8). Last were placed arrangements

[11] Although further investigation is required, we could argue at this point that such a stance might be due to lack of confidence toward farmers' capacity for self-organization, fueled by relevant previous experience (e.g., the limited success of agricultural cooperatives in Greece—see, *inter alia*, Iliopoulos and Valentinov 2012).

Table 4 Farmer dependence on groundwater

	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)	N	M	SD	Mdn	Percentiles		
																25	50	75
Occupation change	21.1	3.0	2.3	3.8	5.3	12.0	6.0	7.5	9.8	2.3	27.1	133	5.6	3.8	6	2	6	10
Offsprings continue farming	39.8	5.3	8.3	3.8	3.8	12.8	3.8	6.8	3.8	1.5	10.5	133	3.3	3.5	2	0	2	6

Table 5 Institutional arrangement significance

	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)	N	M	SD	Mdn	Percentiles		
	0: Not important						10: Very important									25	50	75
Specification of users	7.0	1.3	5.0	4.4	1.9	7.6	4.4	15.2	19.0	13.9	20.3	158	6.8	3.0	8	5	8	9
Specification of rules for use	3.8	0	2.5	1.3	1.9	7.0	6.3	12.7	12.7	17	34.8	158	7.8	2.6	9	7	9	10
Specification of sanctions for violations	2.5	1.3	0.6	3.2	2.5	7.0	7.6	10.8	14.6	13.9	36	158	7.8	2.5	8.5	6.8	8.5	10
Monitoring of rule compliance	3.8	1.9	1.9	1.9	1.3	5.0	5.7	9.5	20.9	13.3	34.8	158	7.8	2.6	8	7	8	10
Rule enforcement	1.3	0.6	3.8	1.3	2.5	4.4	4.4	10.8	18.4	15.8	36.7	158	8.0	2.4	9	7	9	10
User coordination and conflict management	6.3	0	3.2	2.5	3.2	11.4	10.1	17.1	22.8	6.3	17.1	158	6.7	2.7	7	5	7	8
User participation in management	8.9	0.6	2.5	3.2	1.3	12.7	11.4	12.0	14.6	10.0	22.8	158	6.7	3.0	7	5	7	9

Table 6 Institutional arrangement significance by respondent group

	M (SD)		
	Farmers	Technocrats	Difference
	(a)	(b)	(b − a)
Specification of users	6.7 (3.2)	7.3 (2.0)	0.6
Specification of rules for use	7.5 (2.7)	9.0 (1.0)	1.5
Specification of sanctions for violations	7.7 (2.7)	8.1 (1.6)	0.4
Monitoring of rule compliance	7.5 (2.8)	8.9 (1.4)	1.4
Rule enforcement	7.9 (2.5)	8.5 (1.7)	0.6
User coordination and conflict management	6.6 (2.9)	7.5 (1.2)	0.9
User participation in management	7.0 (3.0)	5.4 (2.5)	−1.6

regarding the "precise specification of users" (6.8), "user coordination and conflict management" (6.7), and "user participation in management" (6.7). It is interesting to note that technocrats, as compared to farmers, valued higher all aforementioned institutional arrangements (see Table 6), apart from the one, the "user participation in management," which not only was placed at the bottom of the rank but also was regarded as having neutral significance.

The next set of two questions attempted to assess the strength of trust-based relations of users (a form of social capital). First, the trusting attitude of farmers was measured using a semantic-differential question with the following contrasting options: "I do not trust someone until there is clear evidence that (s)he can be trusted," indicating low trusting behavior (scored 0), and "I trust someone until there is clear evidence that (s)he cannot be trusted," indicating high trusting behavior (scored 10). Table 7 presents the results making apparent the low degree of trusting that characterizes farmers in Larisa. In particular, 58 % of respondents described themselves as rather reserved and suspicious (interestingly, 36.1 % picked the lowest scope), 13.6 % placed themselves on the middle of the scale, and a low 28.7 % put themselves on the high end of the trusting spectrum. Since interpersonal trust is a relative concept, depending on who it is directed at, the next question tried to assess the degree of trust farmers have on various people/entities: relatives, friends, fellow-villagers, other farmers, farmer associations/cooperatives, technocrats/scientists, specialized bodies, local authorities, and the central state. As Table 7 reveals, friends are the most trustworthy group (mean of 6.6), followed by technocrats (6.5) and relatives (6.0). Respondents were reserved against farmer associations (mean score of 5.6) and specialized bodies (4.9), and they distrusted local authorities (score of 3.8), other farmers (3.7), fellow-villagers (3.5), and the central state, which got the lowest score (3.0).

Finally, it has been examined whether farmers had previous cooperative experience and how willing they would be to cooperate with other farmers toward self-governance of the groundwater as commons. As regards the former, the majority of respondents (69.2 %) reported that they do participate in associations, cooperatives, clubs, etc. Of them, 46.2 % take part in one such organization, 37.4 % in two, and the rest in three or more, with average experience greater than 20 years of involvement. As concerns their attitude toward cooperation for self-governance

Table 7 Strength of social relations and trust

		0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)	N	M	SD	Mdn	Percentiles		
		0: Not trust								10: Trust							2	5	7
																	5	0	5
Trusting attitude		36.1	5.3	12.8	3.8	2.3	6.8	4.5	9.8	6.8	3.8	8.3	133	3.5	3.6	2	0	2	7
Trust on	Relatives	6.1	1.5	2.3	6.9	6.1	18.3	9.9	16.0	16.0	9.2	7.6	131	6.0	2.6	6	5	6	8
	Friends	2.3	2.3	2.3	6.1	3.8	11.5	14.5	14.5	18.3	13.0	11.5	131	6.6	2.5	7	5	7	8
	Fellow-villagers	14.5	12.2	13.7	11.5	7.6	13.7	12.2	11.5	2.3	0.8	0	131	3.5	2.5	3	1	3	6
	Other farmers	10.7	7.6	17.6	9.9	14.5	18.3	15.3	2.3	0.8	0.8	2.3	131	3.7	2.3	4	2	4	5
	Farmer associations	5.3	3.1	6.1	6.1	11.5	15.3	12.2	12.2	15.3	3.1	9.9	131	5.6	2.7	6	4	6	8
	Technocrats/ scientists	8.4	0.8	0.8	5.3	2.3	13.0	10.7	14.5	19.8	13.7	10.7	131	6.5	2.8	7	5	7	8
	Specialized bodies	11.5	4.6	5.3	6.1	9.9	16.8	12.2	16.0	12.2	2.3	3.1	131	4.9	2.7	5	3	5	7
	Local authorities	13.7	8.4	10.7	16.8	11.5	12.2	10.7	8.4	3.8	2.3	1.5	131	3.8	2.6	4	2	4	6
	Central state	24.4	11.5	11.5	15.3	8.4	9.9	6.9	4.6	4.6	0.8	2.3	131	3.0	2.7	3	1	3	5

of the commons, 59.3 % of the farmers were rather positive to work with farmers they know quite well (whereas 24.1 % were reserved) and 63.9 % were positive to join forces with organized groups (associations, cooperatives, etc.) of farmers (whereas 21.1 % were skeptical), but only 15.9 % were happy to work together with all interested farmers, in contrast to 58.6 % who were unwilling (see Table 8), indicating, one more time, the low level of trust among farmers in general.

4.7 Perceptions, Views, and Stakehold Characteristics

This section explores the degree to which the characteristics of the respondents, i.e., age, gender, education, and position/affiliation (viz. farmers or technocrats), affect their perceptions and attitudes with regard to examined groundwater issues. To do so, the Spearman's rho correlation coefficient is used, which measures the association between characteristics and perceptions/attitudes toward groundwater.[12] Table 9 presents the results of such statistically significant correlations.

As already mentioned, both farmers and technocrats have the same, gloomy perception of the groundwater conditions in Larisa. This does not seem to be affected by the age, gender, or education level of the respondents. As regards the factors that play a role in the depletion of the resource, positive correlations were detected between them and the gender, education level, and position of the respondents. On these grounds, it can be asserted that women, more educated people, and scientists–experts (as compared to men, less educated, and farmers) ascribe higher significance to agricultural and non-agricultural consumption, wasteful use, and poor management, as sources of groundwater degradation.

Turning to the irrigation practices of the farmers, it appears that water usage manners and care for groundwater conservation are not related to the age, gender, or educational differences between the respondents. On these grounds, explanations of both utility maximization or altruistic behavior and water conservation sensitivity of the farmers should be sought on other factors, related, perhaps, to socioeconomic or cultural characteristics. The same seems to be the case for the willingness of the farmers to pay for the groundwater services. On the other hand, farmer willingness to change occupation seems to be negatively related to their education background: The more educated people are more reluctant to change job, indicating probably how conscious and deliberate such decisions have been on their part.

As far as ownership on groundwater is concerned, once again, views are not differentiated by age, gender, or education level of the respondents. However, technocrats seem to draw apart from farmers, favoring allocation of property rights to a specialized management organization and discriminating against ownership by farmers (positive and negative coefficients, respectively).

[12] Correlations were also checked with the Sommer's d coefficient, giving the same results. For reasons of space efficiency, these have not been included in the paper.

Table 8 Attitude toward self-governance of the groundwater as commons

	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)	N	M	SD	Mdn	Percentiles		
Cooperation with	0: No							10: Yes								25	50	75
…farmers I know well	15.8	1.5	3.0	3.8	1.5	9.8	5.3	10.5	12.0	7.5	29.3	133	6.4	3.6	7	4	7	10
…organized farmer groups	15.8	3.0	0	2.3	3.0	3.0	9.0	4.5	14.3	17.3	27.8	133	6.7	3.6	8	5	8	10
…all farmers	35.3	9.8	7.5	6.0	8.3	7.5	9.8	5.3	5.3	1.5	3.8	133	3.0	3.1	2	0	2	6

Table 9 Correlation coefficients between respondent characteristics and groundwater variables (Spearman's rho)

		Age	Gender	Education	Position
Water conditions	Water adequacy	–	–	–	–
	Quantity in next decade	–	–	–	–
	"Tragedy of the commons"	–	–	–	–
Degradation factors	Climate change	–	–	–	–
	Agricultural consumption	–	0.220[a]	0.201[a]	0.388[a]
	Non-agricultural consumption	–	0.194[b]	–	–
	Wasteful use	–	0.244[a]	0.261[a]	0.414[a]
	Bad management	–	–	0.162[b]	0.217[a]
Irrigation practice	Use as much as needed	–	–	–	
	Conserve for future	–	–	–	
	Leave for others	–	–	–	
Willingness to pay		–	–	–	
Farmer dependence	Occupation change	–	–	−0.161[b]	
	Offsprings continue farming	–	–	–	
Property rights	Central state	–	–	–	–
	Local authorities	–	–	–	–
	Specialized management organization	–	–	–	0.173[b]
	Farmer associations/ cooperatives	–	–	–	–
	All farmers collectively	–	–	–	–
	Each farmers individually	–	–	–	−0.170[b]
	Private investors	–	–	–	–
Institutional arrangements	Specification of users	–	–	–	–
	Specification of rules for use	–	–	0.161[b]	0.195[b]
	Specification of sanctions for violations	–	–	–	–
	Monitoring of rule compliance	–	–	–	0.194[b]
	Rule enforcement	–	–	–	–
	User coordination and conflict management	–	–	–	–
	User participation in management	–	–	–	−0.279[a]
Trust	Trusting attitude (general)	–	–	–	
	Relatives	–	–	–	
	Friends	–	−0.216[b]	–	
	Fellow-villagers	–	–	–	
	Other farmers	–	–	–	
	Farmer associations	–	–	–	
	Technocrats/scientists	–	–	–	
	Specialized bodies	–	–	–	
	Local authorities	–	–	–	
	Central state	–	–	–	

(continued)

Table 9 (continued)

		Age	Gender	Education	Position
Cooperation	With organized farmer groups	–	–	−0.190[b]	
	With farmers known well	–	–	–	
	With all farmers	–	–	–	

[a]Correlation is significant at the 0.01 level (two-tailed)
[b]Correlation is significant at the 0.05 level (two-tailed)
–Correlation is not statistically significant at the above levels

Perceptions regarding the significance of institutional arrangements for the sustainability of the groundwater resource differ according to the education background and position of the respondents. In particular, the more educated people seem to ascribe higher significance on the specification of credible rules for appropriate usage of groundwater. So do technocrats, which in addition set apart from farmers to highlight the importance of monitoring and policing procedures for rule compliance. Moreover, and in accordance with previous findings, technocrats are "significantly" skeptical on whether farmers should have an active role in the management of the groundwater resource (negative correlation coefficient).

A particularly interesting and valuable conclusion that this analysis yields relates to the trust issue: Not only is the lack of trust a characteristic of the farmer community examined, but this seems to be a pervasive phenomenon extending to all ages, sexes, and educational backgrounds.[13] In addition, the negative correlation coefficient between gender and the variable indicating trust to friends affirms other pieces of research (see *inter alia* Chaudhuri et al. 2013) that find women (as compared to men) to show lower levels of trust.

Finally, the schooling level seems to affect also the farmers' attitudes toward cooperation for the self-governance of the resource. In particular, the negative correlation between education and willingness to cooperate with organized groups of farmers implies that the less educated people are more prone to get involved in such relations, compared to the more educated farmers who are significantly reluctant.

5 Conclusions

Groundwater as a typical example of a common pool resource is subject to serious risk of overexploitation, pollution, degradation (in terms of both quantity and quality), and even total destruction (the so-called tragedy of the commons).

[13] Several other pieces of research report similar findings, that is, low and declining levels of social trust in Greece (see *inter alia* Paraskevopoulos 2006; Jones et al. 2008; Roumeliotou and Rontos 2009), offering a number of possible explanations: increasing levels of individualistic mentality and utilitarian political culture, increasing income disparities, strong clientelistic relations, increasing disappointment and distrust to political institutions, and a long tradition of authoritarian statism along with a problematic transition to democracy during the first post-dictatorship period (1974–mid-1990s).

The conventional literature prescribed either privatization or full nationalization of the resource as appropriate solutions to the problem. However, countries may exhibit a number of characteristics (e.g., weak property rights, deficient policing and enforcement mechanisms, rigid and bureaucratic institutions, lack of privatization experience) which preclude successful implementation of such top-down approaches. In turn, as the 2009 Nobel laureate in economics, Elinor Ostrom, has established, the users themselves can develop collective institutional arrangements that provide solutions to the commons problems which are more socially acceptable, more durable and sustainable, and with lower implementation costs.

Drawing on the analytical framework on commons that Ostrom and other scholars have developed, the current paper has examined issues of collective management of the groundwater resource using Larisa area (one of the most important agricultural regions in Greece) as a case study. Issues examined include the overall institutional/legal framework available for groundwater management, the irrigation practices in the area, the condition of Larisa's groundwater (and the perception stakeholders have about it), the institutional and other arrangements that local players deem as significant for the maintenance of the resource, and the capability of farmers to join forces toward the self-governance of commons. A number of emerged points should be highlighted.

First, adverse climate conditions, poor resource management, and overexploitation practices (e.g., illegal water extraction) have over the years depleted and downgraded the groundwater resource of Larisa, putting into great danger the agriculture industry and the whole economy of the region. Second, despite significant legal developments undertaken under the WFD, the existing regulatory framework lags behind in terms of ability to deal effectively with the tragedy condition that the groundwater of the area faces. Third, users (and stakeholders in general) are fully aware of the severity of the problem, but deficient policing and enforcement mechanisms on the part of the state and opportunistic, free-riding behavior on the part of the farmers (fed by the low intergenerational dependence on the resource and the subsequent short-term exploitation horizon) have intensified the condition and precluded the exploration of more innovative solutions to the case. Fourth, an additional and serious obstacle toward the development of community-emerged user-based governance arrangements has been the lack of trust both among farmers and between farmers and the state, both local and central (which in a sense constitutes a social capital deficit), hurting the confidence of technocrats that user participation can indeed be a key element of successful solutions. Fifth, given the reluctance of the farmers to engage themselves and invest in long-standing relations regarding the management and maintenance of the resource, the most pragmatic solution (acknowledged by all parties) would be the development of an independent coordinative body with multiple responsibilities and powers.

Though further research is necessary in order to specify the most acceptable form and structure of such an organization, some hints could be gained from the above findings and conclusions. Given the low trust both among users and between them and the state authorities on the one hand, and the high respect that technocrats enjoy on the other, it should be the latter to take the leading role in

coordinating the whole initiative, bringing together all interested parties in a collaborative and participatory fashion. In such a scheme, state authorities could contribute legal credibility (formalizing successful practices) and, perhaps, financial support, whereas local users would infuse social validation, grassroots reinforcement, and safeguard.

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