

Article

External Benefits of Irrigation in Mountain Areas: Stakeholder Perceptions and Water Policy Implications

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Abstract: Irrigation contributes to land and ecosystem degradation, especially in intensive farming areas. However, in marginal areas, long-established irrigation systems also supply agroecosystem services. This study aimed to identify and prioritize the external benefits provided by irrigation in extensive grazing farms in an Italian alpine region (Aosta Valley, NW Italy). Three local stakeholder groups (land irrigation consortia members, non-farmer users of the irrigation water service, and non-user citizens) engaged in focus group discussions. The transcriptions were analyzed with an integrated subjective and computer-assisted approach. The main result of the study showed that a convergence of stakeholder opinions led to prioritization of the same four benefits, i.e., hydro-geological and land maintenance, traditional agricultural landscape conservation, biodiversity conservation, and leisure recreational activities provision. Incorporating this information into decision-making processes is relevant in marginal mountain areas, especially in light of the implementation of the water pricing policy laid down in the EU Water Framework Directive. To this end, the economic value of the external benefits should be considered along with the recovery costs for water services. Such information is essential to balance the environmental costs of irrigation and to compare the resource cost of alternative water uses.

Keywords: agroecosystem services; alpine areas; extensive livestock farming; stakeholder participation; focus group; water resources; water framework directive



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1. Introduction

Land irrigation water is a key agricultural production factor throughout Europe; its relevance is significantly higher in Southern Europe than in Northern Europe [1]. Different water requirements depend on different climate conditions and crop types, e.g., horticulture needs more water than cereals and grown crops need more water than those just planted [2]. In Europe, irrigated lands represent 6% of the total utilized agricultural area (UAA) while lands able to be irrigated account for 10% of UAA. In Southern Europe (France, Greece, Italy, Malta, Portugal, Spain) the irrigated area represents 12% of UAA, whereas in Northern Europe it comprises only 2% [3].

Irrigation is known to contribute to land and ecosystem degradation by altering the quantity and quality of water in aquatic and terrestrial systems, especially in intensive farming areas [4,5]. The expansion of irrigation over the last century has altered the hydrologic cycle and impacted global climate [6,7]. In fact, recent decreases in water availability have directly affected agricultural productivity and indirectly affected ecosystem services provisioning [8].

Alternatively, the perspective that long-established irrigation systems provide flows of agroecosystem services for biodiversity, wildlife habitats, landscape aesthetics, and more [1] in some areas has prompted investigation in to how proper water management affects other subjects and social welfare. Those who have analyzed proper irrigation water management have all spoken of its multi-faceted complexity: (i) Boelee [9] encouraged

stakeholders to manage water based on the needs of food security, farmer livelihood, and ecosystem conservation; (ii) Falkenmark et al. [4] recognized the multiplicity of water uses; (iii) Alcon et al. [10] discussed major contributions of irrigation water as not only for land productivity, but also for food security, rural livelihood, and agroecosystem services provision; (iv) Natali and Branca [11] reviewed the positive externalities from irrigated agriculture. This point-of-view is particularly poignant for agricultural activities in mountain areas, where the highest potential to generate such flows of positive externalities is due to their environmental qualities and low-intensity farming systems [12]. Specifically, most farms in the mountain areas of Southern Europe are small in size and the availability of irrigation water is critical to their economic viability. Irrigation of alpine meadows and pastures is part of the history of agriculture. In fact, there is evidence that in pre-industrial times it had a significant impact on rural community land management that affected visual and ecological aspects [13].

The aim of this study was to identify the external benefits provided by irrigation in a mountain region taken as a case study. External benefits are related to the provision of positive externalities. They occur when production processes increase the welfare of a third party [14]. Usually, external effects are not intended, but rather are incidental outcomes of production decisions [15]. They are fully- or partially-unpriced, hence providers are not or not adequately compensated, and the market fails [16].

The analysis was carried out in the Aosta Valley Region, an almost entirely-mountainous region located in northwestern Italy classified by the European Union as ‘rural area with development problems’ (Directive 75/268/EEC, art. 3 (3) and Regulation (EC) 1257/99, art. 18). The regional territory is constrained by natural and environmental factors; therefore, it is considered as being a disadvantaged area for agriculture. More than 96% of the regional UAA is devoted to extensive grazing and about 28% of its meadows and pastures are irrigated [17]. Traditionally, much of the irrigation in Aosta Valley was managed with gravity-fed systems, where water is transported from surface sources via small ditches called *rus* that flood or furrow agricultural lands with irrigation water. Irrigation water services are managed by 176 regional land improvement consortia, with a total of 2833 members [18]. In the region, such consortia are in charge also of natural resource conservation and water regulation, hence we refer to them as “water consortia” going forward.

To identify the external benefits of irrigation, a participatory approach seemed best to collect the perceptions of local stakeholders and residents who are the primary beneficiaries of the social and environmental benefits of agricultural water use [19,20]. Specifically, our research considered three questions: (i) meadow and pasture external benefits of irrigation, as perceived by local stakeholders; (ii) stakeholder prioritization of identified benefits; (iii) opinions and perceptions on potential conflicts of regional water use. We employed a qualitative approach. Data were collected through focus group discussions and analyzed using subjective and content analysis methods.

Content analysis is an objective technique to provide systematic and quantitative description of texts or other communication contents [21]. Recently, it was employed to investigate water resource management issues in different environments, using semi-structured in-depth interviews with local stakeholders, experts, and key informants to collect data [22–25]. We experimented with this approach using focus groups to enable viewpoint exchange, disagreement, and discussion between participants. Unlike other studies that generically collect information from heterogeneous stakeholder groups [26], we first categorized the stakeholders. As some studies have shown, this allows for greater accuracy in data collection [27,28].

Outcomes of the analysis were used to discuss some policy implications stemming from the recognition of the non-monetary benefits of irrigation in marginal areas. Specifically, how can key external benefits and beneficiaries affected by decisions be incorporated into the main EU water policy. In this regard, the European Commission stresses both the need for protection of water resources and the socio-economic relevance of irrigated agriculture [1]. The European Water Policy is regulated under the 6th Environment

Action Programme (EAP) (1600/2002/EC) and the Water Framework Directive (WFD, 2000/60/EC), aimed at ensuring a sustainable use of water resources. Sustainable management of natural resources (including water) was also one of the three policy objectives of the Common Agricultural Policy (CAP) 2014–2020, alongside viable food production and balanced territorial development. In 2018, the Commission published a proposal for the post-2020 CAP, by including the promotion of sustainable development and the efficient management of natural resources—such as water, soil, and air—among its nine specific objectives.

The study was carried out as part of the Interreg Italy–Switzerland Co-operation Programme ‘Reservaqua’. The general objective is to develop an integrated management strategy for mountain regions to ensure sustainable use and quality protection of alpine water resources.

2. Materials and Methods

A participatory approach was adopted to collect data from regional residents who have a stake in the use of irrigation water and/or who benefit from irrigation water use. The study was conducted in two steps to combine different qualitative techniques such as brainstorming and focus group discussions (Figure 1).

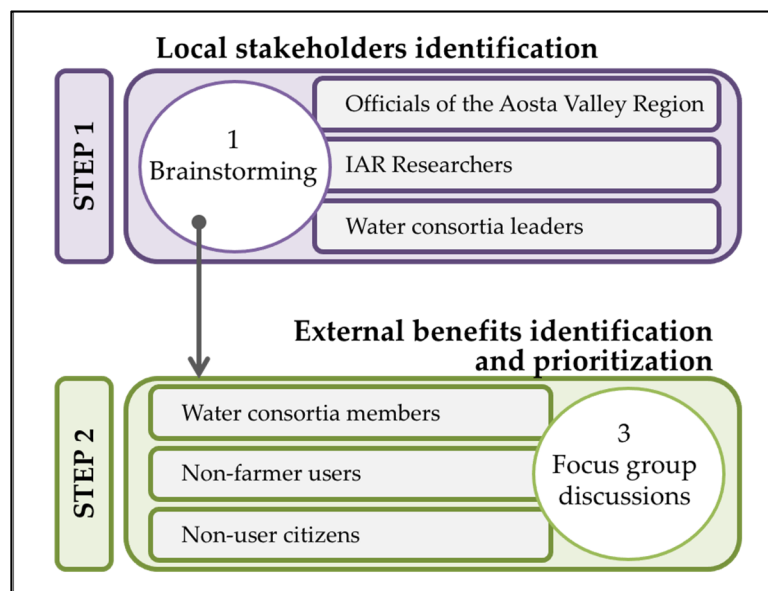


Figure 1. Diagram of methodological approach.

In step one, a brainstorming session was set to identify irrigation water management practices adopted in the region, the stakeholders involved in the use of irrigation water and/or those accruing the external benefits of meadow and pasture irrigation. Brainstorming is a methodology to foster creative thinking through a process of generating group ideas and problem-solving activities [29,30]. The meeting was held in December 2019 and involved nine participants: two officials of the Aosta Valley Region in charge of regional rural development policies, four researchers of the Regional Agricultural Institute (IAR—Institut Agricole Régional, a regional professional training, research and experimentation institute in the agricultural field), and three water consortia leaders. The discussion allowed differentiation of three local stakeholder types: water consortia members (farmers), non-farmer users of the irrigation water service, and non-user citizens. Non-farmer users are citizens and hobbyists who use irrigation water to irrigate their private lawns and gardens, without commercial purposes.

In step two, the three types of stakeholders took part in a focus group, where participants were asked to discuss the research topic from their perspective with the group, and to share personal opinions and experiences [31,32]. The main objective of the discussion was

to identify the social and environmental benefits provided by the irrigation of meadows and pastures as perceived by the participants, and to prioritize them. Besides, the alternative uses of water were discussed to highlight any competing or conflicting uses of the resource.

Participants were selected by purposeful sampling, a non-random sampling technique that utilizes identified purposes and criteria to select particular samples. The basic principle is to select participants based on their relevance to the research questions under evaluation [33]. To this end, participants were recruited by local partners of the Reservaqua project, i.e., by the regional administration and the Regional Agricultural Institute. The selection criteria were developed to include various ages and places of residence. Non-user citizens are those with less knowledge of water management technical issues. However, they were selected from among long-time residents, who are very familiar with the area, local natural resources, and local environmental problems. Tourists and second-home owners were excluded. As for the number of participants, the literature suggests six to eight persons per focus group and not to exceed 12 participants [34,35]. Smaller groups of three or four participants are also acceptable when the group shares specialized knowledge or experience [36]. The number of participants involved in the survey was between six and nine.

Water consortia members, non-farmer users, and non-user citizens met in July 2020, July 2021, and September 2020 respectively. Table 1 summarizes the number of participants and the specific questions discussed in each group.

Table 1. Number of focus group participants and questions discussed (marked by an X).

	Water Consortia Members	Non-Farmer Users	Non-User Citizens
Number of participants	8	7	6
Q1—Does irrigation water use positively impacts the territory and/or on the local community? If yes, how?	X	X	X
Q2—Can you rank those benefits on a scale from most important to least important?		X	X
Q3—Besides irrigation use, what are the other water uses in the region? Are there conflicts between alternative water uses and the relevant stakeholders?	X	X	

Each session lasted about two hours and was audio recorded. Transcriptions of the audio recordings were analyzed using a subjective scissor-and-sort technique integrated with a computer-assisted approach [37,38]. With the subjective analysis we identified and classified the major topics and issues discussed over the three focus groups with question Q1, and analyzed question Q2 and Q3. Results from the subjective analysis were validated through a computer-assisted analysis, carried out using QDA Miner software, a qualitative and mixed method analysis tool [39]. We used the software to assign transcription passages to codes that reflect concepts and issues of interest and to analyze code similarities and frequencies with the coding frequency statistical tool [40]. In particular, this approach was used to compare responses across different types of stakeholders and to establish a priority among the external benefits discussed, using the transcription of research question Q1.

3. Results

3.1. External Benefits of Irrigation

The subjective analysis of the focus group transcriptions allowed identification of the relevant sections to question Q1 and grouping of the major topics discussed. The external benefits identified by the participants spanned both general environmental and social aspects as well as very fine features of water management. Four types of benefits were mentioned by all stakeholder groups: hydro-geological and land maintenance, conservation

of the traditional agricultural landscape, conservation of biodiversity, and provision of leisure activities and recreational opportunities (tourism).

Steep-slopes and natural constraints make difficult the management of agricultural land in the Aosta Valley Region. Irrigation networks and water infrastructures require a continuous effort for their routine maintenance. All stakeholders recognized that constant monitoring of the territory and routine maintenance by farmers contribute to prevent hydrogeological instability, reducing risks and damage caused by natural disasters, such as floods, landslides, and debris flows. Stakeholders also stated that agronomic management activities associated with irrigation in mountain pastures preserve the functionality of the soils.

The region is traditionally characterized by grazed pastures and grassland for forage production that, in addition to the production role, increase the aesthetic value of the territory. In the opinion of all participants, irrigation contributes to the maintenance of these typical landscape traits. In particular, green meadows and grazing cows are landscape features much appreciated by tourists, especially in the summer season when visitors reach these areas for hiking and outings. Stakeholders recognized the role of irrigation in biodiversity conservation. In their perception, open-air irrigation canals ensure the conservation of wetlands and enrich the biodiversity of typical permanent meadows.

Specific groups discussed other benefits. Both water consortia members and non-user citizens mentioned the role of irrigation for the maintenance of economic and social vitality of disadvantaged areas. In mountain areas, a viable agricultural sector prevents depopulation and its negative consequences, such as the loss of typical local products and land maintenance. Water consortia members also emphasized land stewardship activities provided by irrigation water users. Through a traditional and well-established practice called *corvée*, farmers associated with the consortia volunteer their labor to maintain the irrigation water networks, ensuring at the same time a territorial monitoring service.

Consortia members pointed out that provision of irrigation services guarantee professional jobs that manage the entire water cycle from the source to the users, and has the potential to create new professional roles to increase water service efficiency and coordinate *corvée* activities. In their opinion, irrigation services also preserve water quality through systematic resource monitoring and adoption of filtering systems to maintain overall water chemical and ecological quality. Moreover, water-supply infrastructures (such as open-air irrigation canals, tanks, and duct systems) are important for fire-fighting, especially in mountain areas difficult to reach by emergency vehicles.

Non-user citizens identified some specific benefits not mentioned by other stakeholders. Specifically, they named hydroelectric power production as a secondary consortia activity capable of bringing local economic/employment benefits and artificial recharge of groundwater reserves.

3.2. Prioritization of the External Benefits

Non-farmer users and non-user citizens were directly asked to rank the above-named benefits from most to least important (question Q2). Even if the categories of benefits were shared among respondents, each stakeholder group developed their own criteria to classify them. Non-farmer users prioritized their top five benefits and non-user citizens identified and ranked three groups, consisting of two to three items equal in importance to them (Figure 2).

Non-farmer users ranked benefits according to the magnitude of their spatial effects and the number of beneficiaries involved. In the top position, they ranked biodiversity conservation. In their opinion, its positive effects go beyond the region to non-users who also benefit from it. In other words, they recognized the existence value of biodiversity as prevalent. Hydro-geological and land maintenance and traditional landscape conservation follow, as they mainly affect regional territory land stability and local resident use values. Benefits affecting specific sectors, such as tourism or agriculture, were placed at the bottom of the ranking.

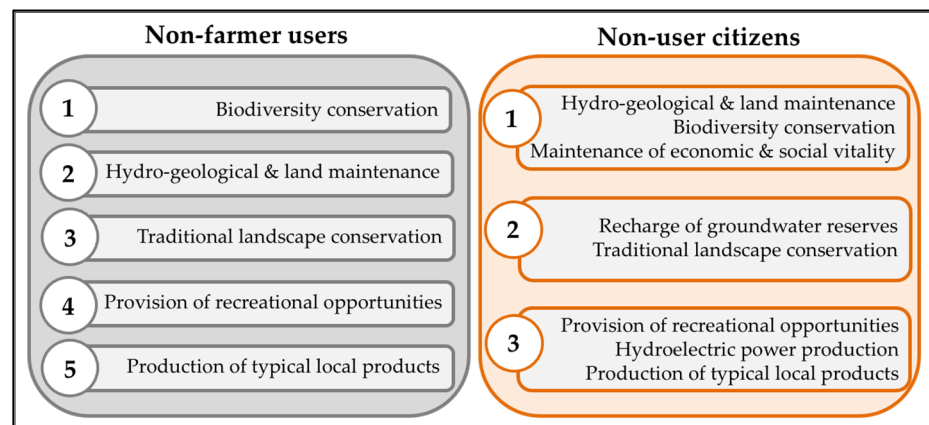


Figure 2. Benefits ranked based on question Q2.

Non-user citizens gave more importance to the effects of irrigation on local community well-being. The first group of benefits includes those, both environmental and economic, that are essential to ensuring a good quality of life for regional residents. The second group refers to environmental benefits having minor impacts on local community short-term livelihood. As with non-farmer users, benefits affecting specific economic sectors followed. There are several similarities between the two rankings, in particular land maintenance and biodiversity conservation rank high in both.

Computer-assisted analysis was employed to support the subjective analysis of Q1 with measurable indicators and to validate the stated priorities from Q2. In particular, we used this approach to prioritize the external benefits and compare responses across the three stakeholder types. We grouped the external benefits identified by subjective analysis with question Q1 into 12 categories: land maintenance, landscape, biodiversity, recreation-tourism, typical production, economic vitality, new jobs, water quality, *corvée*, fire-fighting, hydroelectric and groundwater reserves. Using QDA Miner, each transcribed Q1 text portion was assigned to one of the 12 thematic categories (codes). The software used two key counts, number of words used (Figure 3a) and number of discussion participants (Figure 3b)—as proxy indicators of the extent to which each benefit category was fully discussed among respondents and how widely it was shared among respondents, respectively (the output data provided by the software are reported in Appendix A).

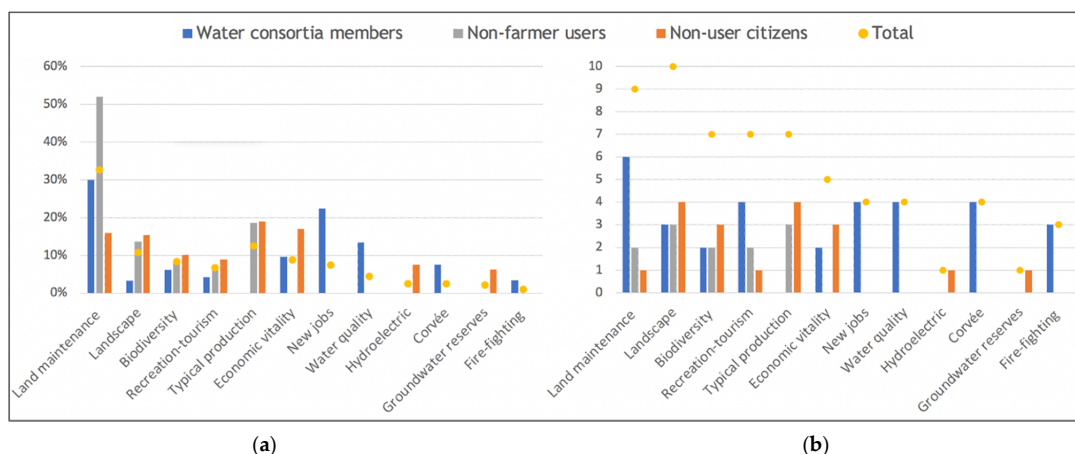


Figure 3. Discussion topics compared across different stakeholder types: (a) Spoken words on each topic (%); (b) participants involved in the discussion (n).

The measurable indicators confirmed the shared preferences found in the subjective analysis; the same four external benefits were highlighted in all three groups. A relatively sizeable word count (33%) centered on the importance of irrigation for hydro-geological

and land maintenance. It was boosted by non-farmer users who devoted more than half of their count of words to this issue. As for the breadth of participant discussions, no topic rose to the level of being discussed by 50% of the 21 participants. The most widely discussed topics were traditional landscape conservation and land maintenance (10 and 9 participants, respectively).

The analysis also confirmed different perceptions across different types of stakeholders. Consortia members discussed a wider variety of benefits than other stakeholders (followed by non-user citizens), including technical issues related to irrigation water management (new jobs, water quality, *corvée*, and fire-fighting). Non-user citizens were concerned for socioeconomic and environmental issues not mentioned by other groups, such as energy and groundwater reserves.

Based on these results, the benefits were grouped and ranked using three criteria: (i) number of focus groups in which the benefits had been discussed; (ii) quartile of positioning based on spoken word percentages; (iii) number of participants involved in the discussion of that benefit (Table 2).

Table 2. Group of benefits ranked based on the selected criteria for question Q1.

Ranking	Group of Benefits	Criteria
1	Landscape Land maintenance	Benefits: (i) mentioned in all 3 focus groups; (ii) included in the fourth quartile for spoken words; (iii) discussed by more than 8 people
2	Biodiversity Typical production Economic vitality	Benefits: (i) mentioned at least in 2 focus groups; (ii) included in the fourth or third quartile for spoken words; (iii) discussed by more than 5 people
3	Recreation-tourism New jobs Water quality	Benefits: (i) mentioned at least in 1 focus group, (ii) included in the fourth, third or second quartile for spoken words; (iii) discussed for more than 2 people
4	Hydroelectric <i>Corvée</i> Groundwater reserves Fire-fighting	All remaining benefits

The computer-based prioritization from the discussion of Q1 differs slightly from the rank order of benefits stated explicitly with Q2. The ranking from content analysis of question Q1 is objectively based on the attention and effort dedicated by the participants for each topic. The discussion of the benefit order originated from Q2 brought forward by differing opinions among participants within each of the focus groups. As a result of a heated debate, the final ranking reflected the mediation between respondent points of view, mainly driven by the most determined ones, rather than a collective idea. Nevertheless, land maintenance and landscape and biodiversity conservation were placed at the top of all rankings.

3.3. Alternative Water Use

Consortia leaders and non-farmer users discussed other uses of water (Q3). Although few alternative uses were identified, participants considered those uses as competitors to water irrigation. In the case of drinking water, participants recognized potable water as a legal priority over other uses and considered it a fully-justified essential function. Hydroelectric energy production was named as another alternative use of water and participants varied in their view of it. Among non-farmer users, some participants considered hydropower generation as a benefit for the region, while others identified it as a competing water use. Specifically, competition arises when both irrigation and energy generation are simultaneously required that then results in a reduced water flow rate for agricultural

purposes. Despite these divergent opinions, the entire group of non-farmer users agreed that water for hydroelectric purposes is necessary to transition to a sustainable energy source, which makes it increasingly important for the future of the region. Consortia members were unanimously concerned by what they perceived as private high-production hydropower plant inefficient water use that reduces irrigation water availability.

4. Discussion

This section discusses the qualitative analysis of the priority benefits identified. For each, we highlight stakeholder perceptions and opinions endorsed by scientific literature and those not supported by research findings. Second, we present some policy implications stemming from the recognition of such benefits.

4.1. Stakeholder Perceptions

Natural resource management is complex because natural systems are often characterized by competing users and uses, issues that cut across social, economic, administrative, and political units, unclear property rights, and market prices that do not reflect their full value [41]. The brainstorming session in which participants discussed the regional irrigation system, illuminated the existence of three distinct stakeholder groups and roles. Stakeholders may also be categorized according to the degree to which each is involved with or affected by water resource use [42,43]. Farmers and non-farmer users are primary stakeholders. Along with external benefits, they each receive direct private benefits—farmers from higher farm productivity and profitability and non-farmer users from product self-consumption and the utility associated with well-kept gardens. Non-user citizens represent secondary stakeholders, who consume local agricultural products and receive external social and environmental benefits.

Farmers access irrigation services as members of the water consortia. Membership is mandatory for landowners located within the territory of the consortia, and members are eligible for election to consortia management bodies (Regional Law no. 3/2001). For this reason, we involved water consortia members (most of whom are farmers) in the focus group discussions. Compared to other stakeholders, they command a legitimacy as dominant powerbrokers to manage the resource [44]. They affect water management decisions and actions as they are essential to irrigation service planning and provisioning.

Although the influences and technical skills differ among the three stakeholder types, all focus participants recognized and prioritized the same key irrigation benefits. Those benefits relate to activities to maintain extensive livestock farming in the region that involve grazing and herd management [45], agronomic forage management [46,47], and irrigation network management [48]. Some benefits are closely linked. Historic landscape shaped by traditional livestock farming activities represents one of the most-appreciated attractions and inspirations for summer recreation and tourism. The traditional practice of *corvées* performed by the members of water consortia is one activity that contributes to land monitoring and natural hazard protection. Land economic vitality and the conservation of typical local products demand livestock farms remain profitable. The dairy product from these farms is Fontina, a protected designation of origin (PDO) cheese. Some authors confirm the link between most of the external benefits discussed by the stakeholders and traditional agricultural practices (see Vidaller and Dutoit, and Palomo-Campesino et al. [49,50] for a review), mountain farming [51–53], and irrigation activities [5,10,11,13].

On the contrary, science findings at times diverge from stakeholder perceptions of the effects of irrigation on plant diversity. All stakeholders associated the greenness of irrigated meadows and pastures with higher biodiversity. However, scientific evidence does not validate this common belief. In fact, species selection due to irrigation and fertilizing irrigation has actually reduced grassland ecosystem biodiversity in mountain areas [54–56]. Actually, research conducted in the region shows a link between extensive grazing with local livestock breeds, soil conservation, and plant diversity [45,57]; however, these positive effects on biodiversity do not depend on irrigation. Another science-based fact did not

arise in the focus group discussion. Only one participant mentioned the effects of irrigation on the conservation of faunal biodiversity, whereas a large body of literature highlights the habitat functions provided to insects, birds, amphibians, and reptiles by structures associated with irrigation (e.g., traditional ditch systems) (see Leibundgut and Kohn [58] for a review). The divergent views between scientists and stakeholders on biodiversity confirms that social learning is fundamental to sustainably manage natural resources provided that there is an information exchange to integrate stakeholder perceptions and opinions with technical information and expertise [59–61].

As for the quality of these findings, they could be refined by expanding the number of focus group discussions. Engaging different types of stakeholders helped to expand the range of different interest and views, although the small number of focus groups may have limited the analysis of conflicting positions discussed in Q2 and Q3. As for the priority external benefits that emerged in Q1, the convergence of opinions in all groups suggests that saturation (i.e., the point at which gathering more information reveals no new important issues) may have been achieved [62].

Identification of the multiple benefits of irrigation is the first step for evidence-based management of irrigation water. Nevertheless, sound decision-making requires additional information. From an economic standpoint, such benefits are positive externalities or public goods without market price. For cost-benefit analysis and trade-off evaluation between alternative uses of the resource, their economic value should be estimated in monetary terms [4,63]. Further analysis would be needed, using the outcomes of this study to inform which principal external benefits need to be included in the estimates [64].

4.2. Policy Implications

In 2000, European member states were provided a pan-EU water policy with two goals—to achieve a good ecological and chemical status for all ground and surface water bodies, and to promote long-term protection and sustainable use of available water resources [65]. The WFD recognized the complexity of water resource management by calling for a public participatory process and overcoming of the usual command-and-control approach to design efficient water policies [66]. The directive requires interested groups and the public-at-large to be actively involved in sustainable water management decisions [61]. To the best of our knowledge, few studies have tested this approach in Europe [61,67,68], and only Ricart and Clarimont [59] analyzed the perceptions and preferences for irrigation use and management in a mountain area. Evidence from the Aosta Valley Region provides insight into the stakeholder groups to be involved in making decisions that affect the irrigation service and related external benefit provisioning in agriculturally-disadvantaged areas. A regional peculiarity is the presence of non-farmer users of irrigation water. Currently, these private actors have a demand for irrigation water, yet do not compete with farmers. However, the need for negotiation may arise if the effects of climate change make water scarcer. Therefore, any approach to decision-making should integrate the roles of all users and the interactions between them.

The WFD introduced water pricing as an economic instrument to achieve the efficient use of water resources. The directive calls for a pricing policy based on the ‘polluter-pays’ principle to recover the total costs of water services, including environmental and resource costs (WFD, article 9). Environmental costs are the costs water users impose on ecosystems and other users through damaged or negatively-impacted aquatic environments [69]. Results showed that irrigating Aosta Valley meadows and pastures produces a wide range of social and environmental external benefits, some of which are prioritized by all stakeholders. This evidence contributes to the discussion of opportunities and constraints of WFD implementation [66,70]. Marginal and less-favorable lands in danger of depopulation (e.g., mountain areas) are in crucial need of conservation of agricultural activities to provide private as well as external benefits to their communities. Therefore, pricing policy design should consider the monetary value of such external benefits along with the external costs for the use of irrigation water. Other authors have emphasized that external benefits give

rise to a socially-derived demand for water and to a need to internalize environmental amenities via water allocation policies [71].

Resource costs refer to foregone opportunities of alternative water uses from exploitation or depletion of the resource beyond its natural rate of recovery or recharge [69]. In economic terms, forgone benefit of the alternative use is the opportunity cost for the current use of the resource. In Aosta Valley, hydropower generation is the main alternative water use versus irrigation that requires decision-making among competing users. Resource costs arise if the use of water for hydropower generates a higher economic value than current or future use of water for irrigation. This justifies the transfer from agricultural to hydroelectric use if the allocation process increases the net social benefits for the community. Again, the economic value of external benefits is necessary information for decision-making, as comparisons between alternative uses are only correct if they include estimates of the monetary value of both private and external benefits from irrigation.

Economic and governance approaches have been studied to achieve efficient and socially acceptable water allocation solutions. Tilmant et al. [72] modeled an economic mechanism to compensate farmers who have forgone some (or all) of their private benefits to increase the availability of water for hydropower plants. Crook [73] analyzed the consultation process that led communes and irrigation consortia to ratify long-term conventions for ceding water to hydropower companies in a mountainous Swiss canton. The governance arrangement protects water provisioning, optimizes the use of the resource, maintains the economic benefits supplied by the hydropower companies to the territory, and simultaneously improves water security where irrigation is economically feasible. For stakeholders in the Aosta Valley Region, the issue is controversial; they prefer a small-scale solution. Water consortia members cited the poor economic benefits to local communities and territories provided by current large electric power company management teams. They suggested that smaller plants directly managed by water consortia are able to allocate water resources deftly among different uses following seasonal needs and shortages. Furthermore, local consortia believe that they are capable of managing water resources more efficiently than private hydropower managers by reducing water waste and maximizing economic benefits for the region, which secures additional income for land improvement investment and job creation.

5. Conclusions

Following the European Commission recommendation for public participation and social learning in the design of land use and natural resource management policies [65], this study opened a space for the principal stakeholders in an Italian alpine region to discuss the external benefits of irrigation water services.

In particular, the study allowed local stakeholders to be categorized, described their priority benefits, and identified water uses competing with irrigation. Farmers, non-farmer users of irrigation water, and non-user citizens unanimously prioritized four categories of key benefits. Three of them (hydro-geological and land maintenance, conservation of the traditional landscape, and provision recreational opportunities) closely relate to irrigation of meadows and pastures in traditional livestock farming. Biodiversity conservation turned out to be a controversial item, due to agronomic considerations about the actual effects of irrigation on plant biodiversity in grassland ecosystems. As for the alternative water uses, hydropower generation was indicated as the major competitor to irrigation.

The benefits recognized as priorities are regulating, supporting, and cultural agroecosystem services without market price. Their differentiation provides policymakers with new information on the effects of irrigation water management and pricing decisions and on the trade-offs among policy actions affecting their provision. Incorporating this information into decision-making processes is essential in marginal mountain areas, where the balance between maintenance of agricultural practices and actions to optimize the use of environmental resources should be carefully considered.

Previous research to estimate irrigation water costs under different scenarios in the Aosta Valley raises concerns for implementation of cost recovery principles for water services laid down in the WFD [74]. Farmers in the Region may not be able or willing to pay increased operating expenses. Indeed, introduction of a water pricing policy, as defined by the directive, may hasten declines in current traditional farming practices and produce negative effects on the provision of the related external benefits. Efficient resource use should be incentivized in all European regions, but any economic analysis to define water recovery costs should include area-specific spatial analysis of the provision of external benefits of irrigation. Different environments and types of agricultural systems, as well as lands with differing degrees of economic marginalization have various requirements.

Operationally, internalizing the monetary value of external benefits to make decisions in cost-benefit analysis requires further research. The outcomes of this study can inform economic evaluation. External benefits identified as priorities should be valued in commensurable monetary units and aggregated over the affected stakeholders. Such estimations are essential to balance the environmental costs of irrigation and to estimate the net social benefits of alternative water uses in mountain areas.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Appendix A

Table A1. Spoken words on each topic (%).

	Water Consortia Members	Non-Farmer Users	Non-User Citizens	Total
Land maintenance	30.0	52.0	16.0	32.7
Landscape	3.3	13.6	15.4	10.8
Biodiversity	6.2	8.8	10.2	8.4
Recreation-tourism	4.2	7.0	8.9	6.7
Typical production		18.6	18.9	12.5
Economic vitality	9.6		17.0	8.9
New jobs	22.4			7.5
Water quality	13.4			4.5
Hydroelectric			6.3	2.1
<i>Corvée</i>	7.5			2.5
Groundwater reserves			7.6	2.5
Fire-fighting	3.4			1.1

Table A2. Participants involved in the discussion (n).

	Water Consortia Members	Non-Farmer Users	Non-User Citizens	Total
Land maintenance	6	1	2	9
Landscape	3	4	3	10
Biodiversity	2	3	2	7
Recreation-tourism	4	1	2	7
Typical production		4	3	7
Economic vitality	2	3		5
New jobs	4			4
Water quality	4			4
Hydroelectric		1		1
Corvée	4			4
Groundwater reserves		1		1
Fire-fighting	3			3

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