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Analyzing Stakeholder Perceptions of Water Ecosystem Services to Enhance Resilience in the Middle Drâa Valley, Southern Morocco

Imane Mahjoubi ^{1,*} , Lisa Bossenbroek ^{1,2,*} , Elisabeth Berger ^{1,*} and Oliver Frör ^{1,*}
¹ iES Landau, Institute for Environmental Sciences, University of Koblenz-Landau, 76829 Landau, Germany

² CRESC—Centre de Recherches et d'Études sur les Sociétés Contemporaines Rabat, Rabat 10020, Morocco

* Correspondence: imahjoubi@uni-landau.de (I.M.); bossenbroek@uni-landau.de (L.B.); berger@uni-landau.de (E.B.); froer@uni-landau.de (O.F.)

Abstract: Freshwater ecosystems deliver an extensive range of ecosystem services (ESs), which are the benefits people obtain from their interaction with nature. Increasing pressure on water resources threatens the sustainable supply of water-related ecosystem services, especially in arid regions, as is the case for the Drâa Valley located in southern Morocco. With the long-term objective of contributing to a sustainable supply of important ecosystem services in the Drâa Valley, this paper analyzes stakeholder perceptions of water-related ecosystem services (WESs). To assess the different perceptions of WES, 35 semi-structured interviews were conducted with the inhabitants of three oases in the middle Drâa Valley, as well as 12 other interviews with key government officials. Based on our interviews, we reflect on two of the policy-relevant generic principles proposed by the Stockholm Resilience Centre for enhancing the resilience of WESs. Our results reveal similarities in perceptions of WES among stakeholder groups regarding provisioning services but marked differences regarding regulating and cultural services. The analysis suggests that these differences stem from stakeholders' different roles and activities in the area. In addition, socio-demographic, biophysical, and spatial aspects also shape how WESs are perceived in the area. Learning about similarities in WES perceptions can help build common ground among stakeholders. The recognition of differences can also assist the balancing of the different needs and interests of these groups. ESs perception assessment can contribute to strengthened stakeholder knowledge of the categories of ESs and provide a common ground for participating in ES-related decision making, hence enhancing resilience in social–ecological systems.

Keywords: water ecosystem services; social–ecological systems; resilience; perceptions; learning; participation; Morocco



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1. Introduction

Freshwater ecosystems deliver an extensive range of ecosystem services (ESs) [1,2]. ESs can be defined as the benefits people obtain from their interaction with nature [3–6]. These services underpin human wellbeing, which is founded upon the basic requirements needed to lead a good life (e.g., water, food, spiritual inspiration) [7,8]. However, many anthropogenic activities degrade ecosystems, with negative consequences for their capacity to deliver ES [7,9,10]. One major challenge of the 21st century is to ensure an adequate and reliable flow of essential services from freshwater ecosystems to meet the needs of human populations; this can be particularly difficult in arid regions where precipitation is low and often irregular.

Since ESs emerge from people's interaction with nature, several approaches have been developed to conceptualize and analyze ecosystems and social systems as closely linked social–ecological systems (SEs) or human–environment systems (HESs) [11]. Biggs et al. [12] propose seven generic principles for enhancing the resilience of ESs in SEs that

either relate to the properties of the system to be managed or to the system of governance. This approach defines “ESs resilience” as the capacity of SESs to reliably sustain a desired set of ESs [12]. The Stockholm Resilience Centre helped clarify the large and growing work on SESs resilience by identifying key underlying principles for building ESs resilience and real-world applications of these principles [13]. These seven policy-generic principles are designed to inform the practical governance and management of SESs at local, regional and global scales [14]. They include: (P1) maintain diversity and redundancy; (P2) manage connectivity; (P3) manage slow variables and feedbacks. Principles that relate to key properties of the governance system are: (P4) foster an understanding of SESs as complex adaptive systems; (P5) encourage learning and experimentation; (P6) broaden participation; (P7) promote polycentric governance systems [13,15].

The Drâa River basin in southern Morocco is among the world’s ten most arid river basins [16]. It can be viewed as a SES that faces several challenges that jeopardize sustainable water-related ecosystem services (WESs) supply. The Middle Drâa Valley (MDV) is an important part of the basin, where approximately 225,000 inhabitants depend on rainfed and irrigation agriculture in oases for their livelihoods [16,17]. Recent analyses suggest that this type of agriculture may not be feasible in the near future due to dropping groundwater levels and water salinization [18,19]. These events have generated a growing need for sustainable water governance in the MDV. However, questions arise regarding which ESs are essential and for what, to whom and how they should be prioritized and sustained.

ESs are likely to be valued differently by different stakeholders: a management strategy based on a single set of stakeholder perceptions may be unacceptable to other stakeholders [20]. Experience has shown that conflicts can occur when values arising from different stakeholder groups are not properly understood [21–23]. To better comprehend the different existing values, attitudes and meanings that underlie the demand and use of ESs, several scholars have assessed the ESs perceptions of the different stakeholders [24]. According to Sagie et al. [25], such methods promote an understanding of the importance that local populations place on ESs. Furthermore, insights into people’s perceptions of ESs and management options inform discussions on how to proceed when faced with tradeoffs among ESs [26]. This discussion also relates to two of the generic social–ecological system governance principles proposed by Biggs et al. [12]: learning and experimentation (P5) and broadened participation (P6).

With the long-term objective of contributing to a sustainable supply of essential WESs in the Drâa social–ecological system, the present study aims to: (i) identify WESs and the associated perceptions among local inhabitants in three MDV oases, and the governmental actors involved in decisions on water resources in the area; (ii) understand the differences in WESs perceptions amongst the two stakeholder groups; (iii) identify trends surrounding WESs perceptions, which ESs matter the most and to whom, and how the contribution to social well-being occurs. Finally, (iv) we want to reflect on two of the policy-relevant generic principles for enhancing the resilience of ESs in social–ecological systems based on our empirical observations in the Drâa River basin.

The paper is structured as follows. Section 2 describes the main natural and social features of the study area and explains the methods used for data gathering, organization, and analysis. Section 3 presents the results of the ESs perception assessment and services identification among stakeholder groups. In Section 4, we discuss our main findings against the background of our main research objectives. Finally, Section 5 concludes by reflecting upon the role of ESs perception assessment in contributing to a sustainable supply of important ESs in the Drâa Valley.

2. Materials and Methods

2.1. Study Area

The Middle Drâa Valley (MDV) is a territory of 15,000 km² located in south-eastern Morocco (Figure 1). A belt of six oases extends over 26,000 hectares (ha) along the MDV [17]. The oases vary in the size and number of their inhabitants. Ketaoua is the largest, with

over 7000 ha of farmland, while M'hamid in the far south is the smallest oasis, covering around 2000 ha of farmland [27]. The MDV falls into two provinces of the administrative region of Drâa Tafilalet: Zagora and Ouarzazate. Zagora is the principal city in the MDV, with 40,067 inhabitants [28], whereas Ouarzazate is located in the Upper Drâa and has 71,067 inhabitants [28].

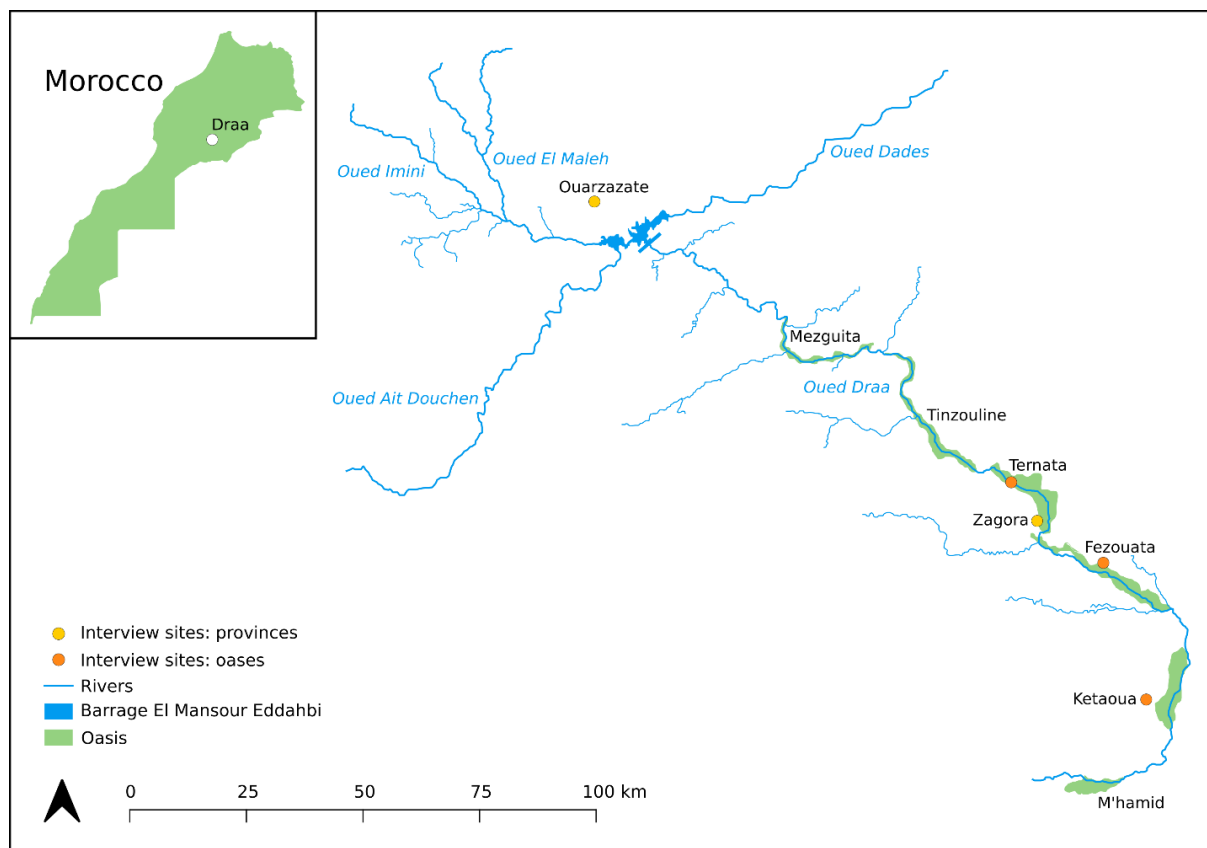


Figure 1. Location of the Middle Drâa Valley in Morocco; sampling locations of interviews with local inhabitants (orange dots) and governmental actors (yellow dots).

Surface water resources in the MDV consist of the Drâa River which flows from El Mansour Eddahbi Dam, which was constructed in 1972, upstream of the valley close to the city of Ouarzazate [29]. The area is characterized by its hot and arid climate, with increasing aridity along a north–south-east direction [30,31]. Average annual rainfall in the region is around 200 mm in the north and 30 mm in the south [19]. Due to its aridity, population, infrastructure and agriculture are concentrated along the river and its oases [27]. The MDV is an irrigation-based area where agriculture is the main economic activity [28,30] on which local inhabitants strongly depend. As a result, 97% of the total exploitable water resources, including surface and groundwater, are used for agriculture [30]. Therefore, the reservoir's key importance is to provide water for agricultural use in the area and to recharge the six oases' alluvial aquifers [32,33]. Released water is directed to the southern oases first, where it is retained in small reservoirs. From there, it is directed through a traditional canal system (*seguia*) onto the fields and allocated according to traditional water rights. In each oasis, water resources are also managed by Water Users' Associations (WUAs) and their federation in the oases, which the government created in the 1990s. WUAs resulted from international debate on the development of participatory irrigation management (PIM) and irrigation management transfer (IMT) in large-scale irrigation systems [34,35]. The objective of the WUAs is to promote farmers' participation in the development, operation and maintenance of irrigation infrastructure and to promote dialogue with regional agriculture organizations [35].

2.2. Semi-Structured Interviews with Stakeholder Groups

To capture the diversity of the perceptions of WESs in the selected study area and to understand these differences in perception, we interviewed local inhabitants of the oases and governmental actors operating in the area.

2.2.1. Local Inhabitants

A total of 35 semi-structured interviews with local inhabitants (Table S1; “S” for supplementary material) were conducted in March and June 2020 and during February 2021. These local inhabitants included 13 respondents from Ternata, nine from Fezouata, and 13 others from Ketaoua oasis. They were selected randomly through “snowballing” (the snowball sampling method consists in asking informants to identify other informants. (see Goodman (1961)) sampling (Figure 1; Table S1). To determine the number of interviews, an indicator of saturation of the given information was used [36]. After the 30th interview, no new perceptions were described. Therefore, 35 interviews were considered enough. The interviews focused on rural household water usage, personal views regarding water-related ESs, and the state in which the WESs are perceived and which factors shaped these perceptions, with potential follow-up questions for clarification purposes. The questions were adapted case-by-case to match the local context and level of understanding or to suit the terminology used in the area when necessary (see Table S2).

2.2.2. Governmental Actors

Twelve semi-structured interviews were conducted in February 2020 and February 2021 with ten key governmental actors in the water, agriculture and tourism sectors in the MDV (Figure 1). The sample included interviewees from: the Regional Office of Agriculture of Ouarzazate (Office Régional de Mise en Valeur Agricole (ORMVAO)); the Water Basin Agency Drâa-Oued-Noun (Agence du Bassin Hydraulique (ABH)) based in Ouarzazate; the Provincial Delegation of Tourism (Délégation Provinciale de Tourisme (DPT)) situated in Ouarzazate; the Agricultural Subdivision in Zagora (Subdivision Agricole de Zagora—SAZ), which is a “field entity” related to ORMVAO; the National Agency for the Development of the Oasis and Argan Zones (Agence Nationale de Développement des Zones Oasiennes et d’Arganier (ANDZOA)); the desalinization station situated in Zagora which was operating in the drinking water sector as part of the National Office of Water & Electricity (ONEE Zagora). The interviews focused on identifying the benefits derived by the human population of the oases from water resources, the key water management options and strategies implemented in the MDV, and the factors which drive these management options and strategies. The interviews were conducted with several actors who occupied different positions in each of the selected governmental institutions in order to clarify some statements (i.e., directors of institutions, engineers, technicians). Furthermore, documents shared by the actors, which were mentioned during the interviews, were considered to confirm some information.

The interviews were designed to last approximately 45 minutes for local water users and 60–70 minutes for government stakeholders. Each interview was recorded with the informant’s consent. To gain a good understanding of the questions, unfamiliar terms such as “water ecosystem services” were avoided during the interviews. For example, the more colloquial term “benefits from water” was preferred.

2.3. Analysis of the Semi-Structured Interviews

The interviews were transcribed and subject to content analysis using MAXQDA 2020 software [37]. We adopted the ESs categories provided in CICES V4.1 by Haines-Young and Potschin-Young (2012) [38] to assess the different WESs identified. The coding followed the steps suggested by Saldaña (2013) [39]. We combined a deductive approach (codes selected in advance based on our key concepts) with an inductive one (codes as they emerged from the interview texts). Codes established deductively are the main categories of ESs (e.g., provisioning, cultural and regulating services). Specific words and sentences describing

the use of water in certain activities or other benefits derived from water were highlighted to inductively generate subcodes and indicate the different services each of the categories contained (e.g., drinking, irrigation, crops, green spaces, smoothing the arid climate) for each of stakeholder group (See Tables S3 and S4). To capture the diversity of the perceptions of WESs, we calculated the percentage of informants who identified each category of WESs (provisioning, regulating and cultural services) from the overall services assessed [38]. For WESs prioritization, the percentage of respondents who ordered ESs as first, second and third priority for each group of stakeholders was calculated. We assessed the different WESs and analyzed text segments from the interviews with both groups in order to explore the extent to which the ES resilience principles (P5 & P6) had been covered. In particular, we closely looked for information that related to defining the resilience principles and that could support their possible application for the case of the Drâa Valley. Due to the limited sample sizes of the two stakeholder groups and the nature of the research questions, our analysis followed a qualitative approach to identify the trends surrounding ES perceptions and their determinants—this gave rise to new hypotheses.

3. Results

3.1. Water Ecosystem Services (WESs) Perceptions among Stakeholder Groups

3.1.1. Characteristics of Local Inhabitants Interviewed

Despite our random sampling of local inhabitants, more men (23 informants: 66%) than women (12 informants: 34%) were interviewed. This is explained by the low number of women who could be contacted through the snowball sampling method and because women were less willing to participate when asked to be interviewed. Those women interviewed at the level of the oases expressed hesitation and doubt when asked to describe their point of view about how water is supplied to the MDV. Most avoided answering, except for a few interviewees with whom the conversation was open and fluent.

Respondents were between 20 and 68 years old. They were farmers (59% of the respondents), workers (37% of respondents worked in the oases and in cities as housemaids, construction workers or in commerce) or of mixed occupation (4% practise farming together with other occupations). Among the interviewees were members of associations, such as of the water users' associations (10%) and other types of agricultural associations and cooperatives (12%). Students comprised 2% of interviewees.

3.1.2. WES Identification per Categories of Ecosystem Services

During the interviews, we asked the stakeholders to state and describe the benefits derived from the use of water in the MDV. Eleven WESs, including five provisioning services, five cultural services and one regulating service, were identified (Figure 2). Quotes and expressions from the local stakeholders which described the WESs identified are presented in Table S5.

Provisioning Services

Local inhabitants

Four types of provisioning services were identified by all interviewed local inhabitants (Figure 2). Interviewees identified drinking water as an essential source of life. In addition, they considered irrigation water to be vital for the survival of the oases, and crop production to be essential for the economy of the families which depended on farming. Informants explained that dates, wheat, barley, alfalfa and vegetables such as gombos provide an essential source of food and income. Farmers identified dates as constituting one of the most important income-generating crops. Domestic water was also identified by all informants as being used for daily activities such as cooking, cleaning and washing clothes and carpets.

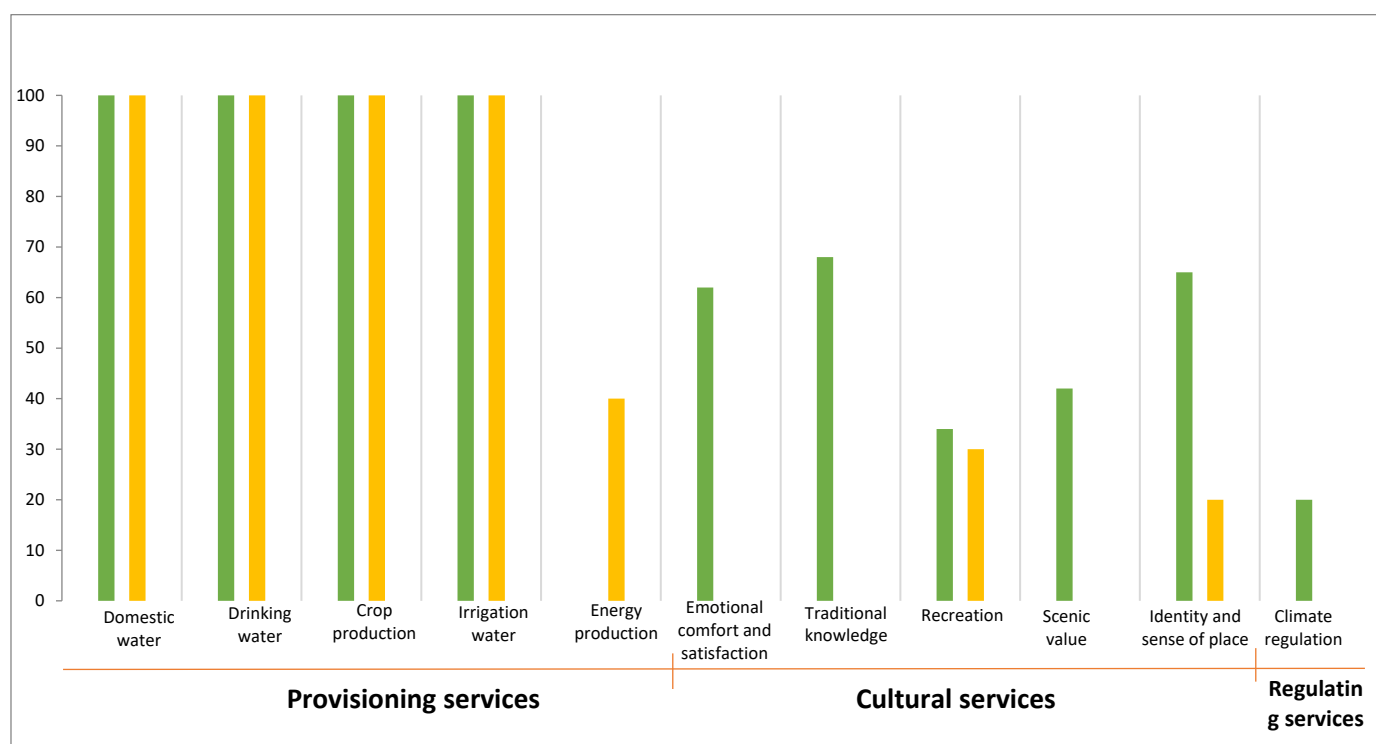


Figure 2. Percentage of local inhabitants (green bars) and governmental actors (yellow bars) identifying the various water ecosystem services (WESs).

Governmental actors

The same four provisioning services were also identified by all governmental stakeholders interviewed; in addition, six of these named energy production as an ES (Figure 2). Specifically, they stated: “It is an area that begins with a large dam, whose purpose is primarily the supply of drinking water as well as irrigation water for the valley of Drâa”. All participants identified crop production as a direct output of water used for irrigation. Respondents from ORMVAO, SAZ and ANDZOA identified date production as the principal and most valuable agricultural production in the area economically, given their high demand in local and national markets; furthermore, they added that such production also boosts the activity of a number of agrarian cooperatives and associations (e.g., economic interest groups—*Groupement d'intérêt économique*), as expressed by an interviewee: “Agriculture is among the main pillars and I can tell you that it is the engine of the economy of Drâa”. Energy production, however, was mentioned only by five participants from ABH, ANDZOA, ORMVAO and SAZ (40%).

Cultural Services

Local inhabitants

Among local inhabitants, the survey results indicate that the presence of water inside the oases facilitates a broad range of cultural services. Of the overall cultural services assessed (Figure 2), 65% of informants perceived a sense of place and an identity from the water resources supplied to the oases. Most inhabitants referred to such a sense when referring to irrigation and crop production. They perceived water as preserving their local lifestyle as farmers and their identity as local inhabitants of the oases. Palm trees especially represented the identity of the area for them. In addition, 68% of the informants claimed that knowledge of how water should be distributed among the local population, which represents traditional and customary rules, is acquired through water. Moreover, the interviews reveal that the different institutions that shape and organize the social dynamics around water also exist in the traditional use of this water. A farmer stated: “The Nouba (turn) system we use to distribute water has existed for almost 400 years now. We started

learning about it when we were young. We were part of the water distribution process and helped maintain the canals at a very young age. We therefore understand well how the system functions and we still use it". Some 62% of the respondents expressed feeling emotional comfort and satisfaction in receiving water and using it for irrigation. Scenic beauty was perceived by 42% of the informants, of whom 34% explained that water flow in the oases provides green spaces and vegetation; these, for the local population, provide opportunities for recreation such as picnics and river walks.

Governmental actors

According to five respondents from DPT, ORMVAO and ANDZOA (30%), water resources provide recreational opportunities for local inhabitants and visitors from other areas. In addition, they stressed that the vegetation growing in the oases, such as palm trees, almond trees, is a source of recreation. For these stakeholders, date production constitutes an essential component of the region's recreation, tourism and nationally significant beauty. Furthermore, palm trees and their fruit were considered by respondents from ANDZOA and ORMVAO (20%) as essential sources of identity for the area and its population; one informant expressed: "I say that the characteristic of the oasis is the date palm." The same 20% claimed that water is critical for the existence of the oases and the provision of a sense of belonging for their inhabitants.

Regulating Services

Only one regulating service, climate regulation, was mentioned, and only by local inhabitants. Seven informants (20% of the local inhabitants sampled) mentioned that water flow—precisely, surface water—provides a favorable climate for living. The informants explained that climate regulation was provided by essential vegetation, such as palm trees, which promotes a cooling microclimate. Respondents referred to this service as "... providing a cool atmosphere ...", "... refreshing the arid weather ..." and "The water helps to smooth the aridity of the weather a little bit."

3.1.3. WESs Prioritization among Stakeholder Groups

When asked to put in order of priority the WESs, both stakeholder groups assigned the highest priorities to drinking water, irrigation water and crop production, and domestic use (Figures 3 and 4). However, the priorities assigned by local inhabitants were more heterogeneous than those by governmental actors.

In particular, while 17% of local inhabitants ranked domestic water as the first priority, governmental actors consistently ranked domestic water as third. Moreover, while 11% of local inhabitants ordered drinking water as third priority, 70% of governmental actors ranked it as first. Local inhabitants who ordered drinking water as first priority included men and women engaged in occupations unrelated to farming (e.g., construction workers, housemaids, commerce in the oases, students). In addition, local inhabitants ranking irrigation water and crop production as second priority included mainly participants who practised farming-related activities (e.g., farmers, cooperative members, WUA members, households practicing subsistence farming or consuming crops from local markets, agricultural laborers). During the interviews, both stakeholder groups explained that they prioritized the services from the most to the least essential. Governmental actors stressed that they considered the most-important criterion to be the existence of people in the Drâa; therefore, they focused on what was indispensable for the population and prioritized what contributed the most to the incomes of the majority of the inhabitants of the valley.

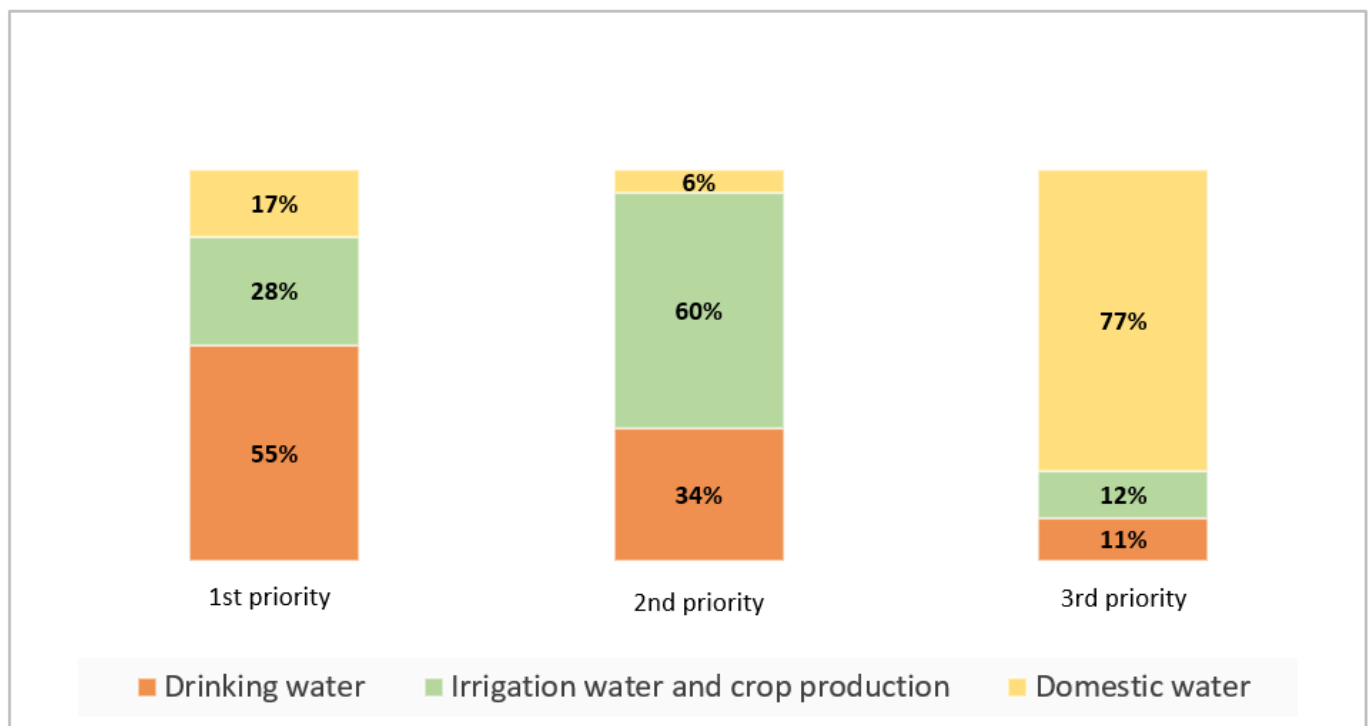


Figure 3. WESs ordered by local inhabitants (in percentage) as first, second and third priority.

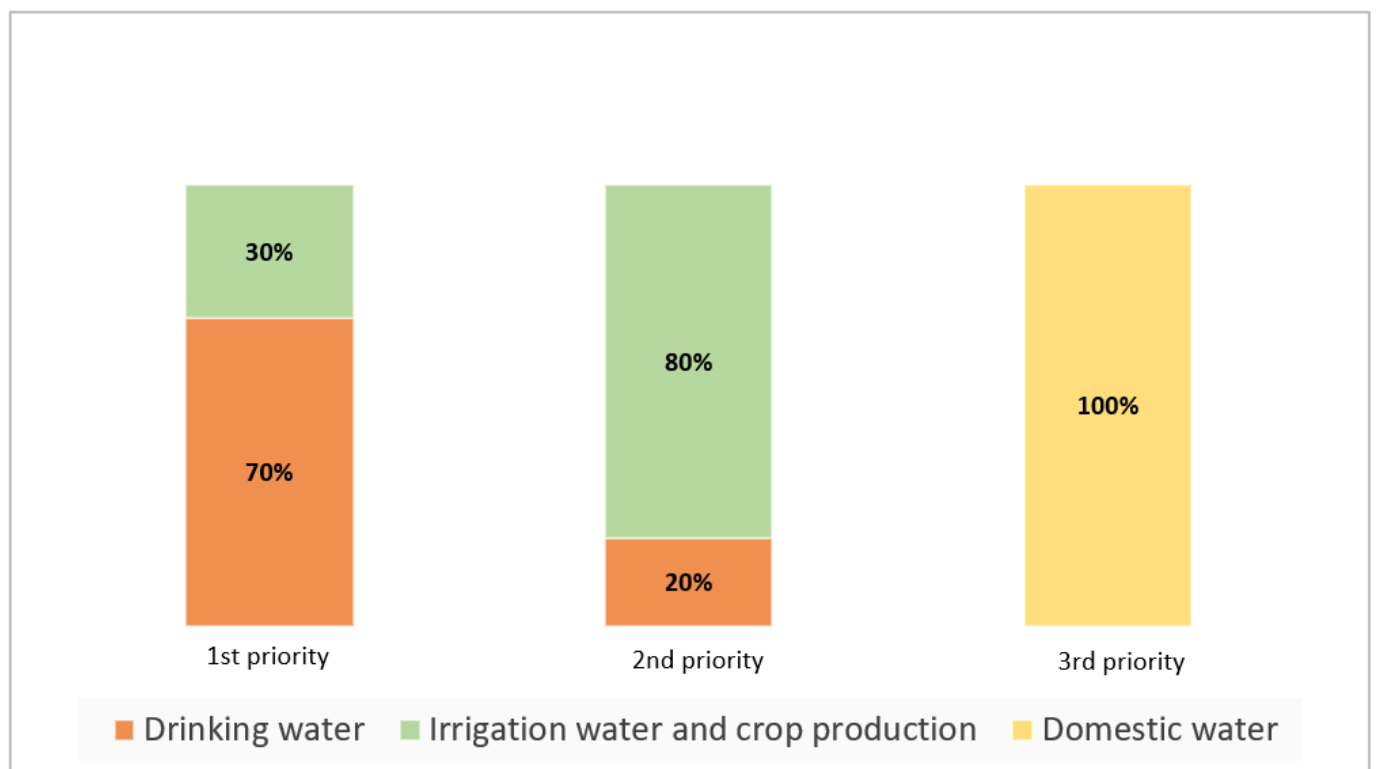


Figure 4. WESs ordered by governmental actors (in percentage) as first, second and third priority.

3.2. Factors Shaping Perceptions of WESs: Some Emerging Trends

3.2.1. Local Inhabitants

Place of Residence

Interviewees indicated that their place of residence—which varied geographically among the oases—might determine their perceptions of WESs. For instance, variables such as the proximity to the El Mansour Eddahbi Dam (Figure 1) and the distance from the river were volunteered as influencers of provisioning and cultural service perceptions in the oases. Residents in Ternata (28% of respondents), located upstream of Fezouata and Ketaoua, claimed to perceive more provisioning services than other oases. Due to its proximity to the dam, Ternata is among the first oases to benefit from water releases through aquifer recharge, in comparison to Fezouata and Ketaoua. Furthermore, respondents in Ternata and Ketaoua explained that living farther away from the Drâa River made it difficult for the water flowing in the canals to reach the villages located deep inside the oases.

Water Quality and Quantity

Interviewees from the three oases indicated that the water's perceived quantity and quality factored highly in determining perceptions of provisioning, culture and regulating WESs. Respondents claimed that they tended to select water usage by looking at its quantity. Thus, the less volume of water they received, the fewer benefits were perceived. Non-farming respondents prioritized usage other than agriculture, such as drinking water for livestock or households. Furthermore, by looking at water quality (e.g., degree of saltiness, acidity, sweetness, pollution, etc.) we observed that farmers tended to select crops best-suited to the quality of available water (surface or groundwater). For example, farmers in Fezouata and Ketaoua (62% of the respondents) preferred to use surface water released from the dam over the very salty groundwater to irrigate their crops (such as alfalfa, vegetables and cereals). However, in Ternata, farmers (37% of the respondents) depended more on groundwater, as they perceived the river water to be polluted. All respondents who identified scenic beauty associated the beauty of the landscape, its vegetation and air quality with the quantity of water flowing in the river. Respondents thought that farming in the oases could only continue with a sufficient quantity and quality of water.

3.2.2. Governmental Actors

Interviews with governmental stakeholders highlighted how management strategies and policies shape their perceptions of WESs. The main focus of all interviewees was dam construction policy. Two respondents from the Water Basin Agency (ABH), which manages dams and other infrastructure in the Drâa region, claimed that meeting the water needs of the local populations, the survival of the region, and protection from floods were the essential drivers behind the construction of the MDV dams. When referring to the projects and activities of the different institutions, the majority of respondents tended to refer to the supply of water-provisioning services (e.g., agriculture, water for irrigation, etc.). In addition, most respondents stated that the different strategies and development policies implemented to manage water in the area promote agriculture as an important sector of the region's food and income security.

3.3. The Perceived State of WESs and of Local Institutions in Providing WESs to Local Inhabitants

3.3.1. The Perceived State of WESs

Local inhabitants shared similar perceptions on the state of WESs. The majority claimed a negative perception of the irrigation water supplied to the MDV. Of this group, 66% identified declining water quantity as a prime concern for the future conditions of the MDV. Residents in Ketaoua (37% of the sample) identified increasing salinity levels and declining palm tree vegetation as a key concern. All of the oases' inhabitants interviewed claimed to perceive some essential crops as being of poor quality—for example, date fruits during the last five years. For 60% of the respondents, sense of place and identity, and scenic beauty stood out as being perceived negatively compared to ten years ago; they

were referring to the reduced water flow in the oases and existing and newly constructed water infrastructure along the Drâa River. In this sense, Ketaoua's residents referred to the presence of a deviation dam, built at the beginning of the oasis, from which they received water through cement canals; these preventing the natural river flow and the recharge of their aquifers. Similar results were found from farmers from Fezouata and Ketaoua concerning traditional knowledge in the oases. Participants from these two oases noticed a decrease in farming among the younger population and even a loss of skills linked to water scarcity (e.g., young individuals abandoning a field left by their parents). According to the same group, the number of people willing to occupy a position in traditional water management institutions within the oases has decreased. Moreover, due to less available water, older people tend to farm less, which reduces the transfer of knowledge. For Ketaoua's residents, this can also be explained by the fact that only a minority of young people are still interested in farming. The majority of respondents from Ternata, Fezouata and Ketaoua perceived that the supply of drinking water was in a significantly better state than previous years because it is now provided by a diversity of entities such as the National Office for Drinking Water (*Office national de l'eau Potable* (ONEP)), communes, local associations and collective actions inside within oases. However, most respondents also perceived that many families in the MDV still struggled with drinking-water availability.

3.3.2. The Role of Local Institutions in WESs Provision

The local inhabitants interviewed indicated the important role of several local institutions in surface water allocation, including the water user's associations (WUAs) and the *jem'âa* (the Arabic word for "meeting"). It refers to an assembly, usually of elders and notables or an "informal" socio-political framework, that allows members of a rural community, often a village or a group of villages, to meet and discuss issues related to the organization of collective assets, such as rangelands, the mosque and water hydraulic equipment (Rachik, 2001)). In particular, demands for material for irrigation canal maintenance or small water infrastructure construction are all made through the WUAs, according to farmers. Interviewees from Ketaoua also explained that individuals in managerial roles, particularly "the *ailam*" (an individual responsible in the community for overseeing water distribution), are capable of adjusting the traditional system (the "clock system", also referred to as water turns, used to distribute water according to traditional water rights held by each water user). Such managers are responsible, depending on the amount of water available, for everyone receiving his/her share of the water released. Further, respondents who occupy presidency positions in the WUAs stated that they usually report water issues and concerns directly to governmental organizations (e.g., ORMVAO, ABH) or to other local institutions or authorities such as provinces, communes or *cercles* (intermediate administrative units of the local authorities). However, respondents highlighted that some WUAs were non-functioning due to tensions between different ethnic groups who occupied key roles in the associations. Moreover, some respondents indicated the difficulty of approaching the right actors for specific water issues at the provincial and commune levels (e.g., well-digging permits and land-property issues).

4. Discussion

4.1. WES Perception Assessment among Stakeholder Groups

4.1.1. Identification of the WESs

This study revealed that stakeholder groups recognized both the direct and indirect WESs provided by the local ecosystems, as reported in other studies [40–42]. All informants from both stakeholder groups perceived direct or provisioning services (e.g., crop production, irrigation, drinking and domestic water) to a greater degree than indirect services, as reported previously [41–43]. In a subsistence economy based on the primary sector, particularly in developing countries, it is understandable that provisioning services are more valued than other services, as they are fundamental for the livelihood of local people [42,44]. Therefore, as noted by Guerbois and Fritz [45], provisioning services were

also more frequently perceived and prioritized among local inhabitants of the MDV oases and governmental actors than other categories. One important difference between the groups, however, regards the energy produced by the dam: it was not mentioned once by local inhabitants. This may be due to a lack of local awareness of hydropower production and whether they are benefiting from it. This specific point requires further research. Furthermore, several studies have emphasized the perception of indirect services by rural residents [41,43]. Similarly, in the present research, local inhabitants showed an appreciation of cultural services such as sense of place, identity and scenic beauty as benefits derived from water, probably because water resources play an important role in maintaining their lifestyle and preserving the oases' ecosystems. Given the droughts the area suffers from, cultural characteristics seem to come more to the fore. The lack of farming opportunities pushes people out of agriculture to pursue livelihoods elsewhere, with a consequent loss of identity. As Berger et al. [34] concluded, access to water is essential to fulfilling one's identity as a farmer and local inhabitant. The fact that governmental actors referred less to cultural services can be explained by the scope of the different governmental agencies and the approach each of them adopts. In regard to regulating services, climate regulation was the only service mentioned—only by seven respondents, all local inhabitants and associated with the water supplied to the MDV. This illustrates that, as found by Zhang et al. [46], local residents still have relatively low awareness of existing regulating services. Finally, as per Silvano et al. [47], we also found that local inhabitants possess ecological knowledge of the importance of water for the environment and for oasis ecosystem services, such as the maintenance of good air quality, the regulation of the microclimate of the oases through vegetation such as palm trees, and the reduction of aridity.

4.1.2. Factors Shaping Perceptions of WESs: Emergent Trends

This analysis highlighted that the current policies, responsibilities and plans of governmental institutions contributed to shaping WESs perceptions among governmental actors. However, our study also revealed trends related to gender (see also [48–50]), occupation, source of income, place of residence, and water quality and quantity surrounding ESs perceptions amongst local inhabitants. In recent years, various studies have revealed that perceptions of ecosystems as sources of particular services can vary among respondents as a result of a complex set of factors [42,43,51,52]. Our analysis highlighted that men and women in the oases perceived and experienced cultural ecosystem services differently. Men derived a sense of identity, of belonging and emotional comfort from their farming activities, their lifestyle as farmers and their interaction with water (e.g., irrigating the land, turning on the pumps or clearing the canals). Female informants mainly linked cultural services to their domestic activities in the riverscape (e.g., cleaning clothes and carpets, harvesting activities, feeding the herd and domestic work). Although these activities occur in the same environment (i.e., in the oases), the gendered labor division and the limited participation of women in formal farming and irrigation organizations may contribute to the fact that they have different perceptions. Our analysis further revealed that WESs perceptions also partly relate to respondents' occupation and source of income. In particular, respondents who derived income from farming perceived more provisioning services: water for irrigation and crop diversity (e.g., dates, cereals, vegetables, etc.). Furthermore, individuals with local sources of income perceived more cultural services and experienced the beauty of the area in its different seasons compared to individuals working for long periods outside the oases. Place of residence appears to influence rural people's perceptions of ecosystem services. As reported in previous studies [20,42], as well as contextually depending on the needs, choices, and values of the people, ESs are also related to place and tend to vary in geographical space within a landscape. Spatial differences within a landscape can lead to changes in the flows of ecosystem services and the reallocation of the benefits accrued from this landscape [20]. Among the various spatial variables that might be related to place of residence and which might influence the perceived ecosystem services in the MDV oases, we identified proximity to the El Mansour Eddahbi Dam: oasis inhabitants closer to the

dam perceiving more water. Fagerholm [42] also noted that distance from respondents' homes to the landscape elements that provide ESs was an important indicator of the spatial pattern shaping people's perceptions of these services; this was represented in our study by distance from the Drâa River. Our results stress that access to water in terms of quantity and quality has a significant role in determining people's perceptions of WESs. Changes in the availability or quality of water and the above-mentioned spatial variables may affect their well-being, limit their benefits and make agriculture and the enjoyment of the riverscape difficult. Therefore, decision-makers' consideration of these variables is required for a better-informed surface water allocation in the MDV oases; this requires further research.

4.2. *Contrasting WESs Perceptions: Which WES Matters the Most to Whom?*

Our findings hint at similarities and differences in perceptions of WESs among local inhabitants and governmental actors (Figure 2). The similarities are mainly related to identifying and prioritizing similar provisioning services, whereas the differences are mainly related to energy production as well as regulating and cultural services identification. The differences point to the interaction of the stakeholders with the local ecosystem and the ecosystem knowledge they hold. This interaction may determine the ability of stakeholders to identify indirect ESs, as reported previously [41,51,53]. This difference also hints at the different role each stakeholder plays in the area (local beneficiary or manager of the WES or institutional actors). For instance, local inhabitants identified the services most closely linked to their livelihoods, their subsistence and main source of income, and considered provisioning, cultural and regulating services essential to their wellbeing. On the other hand, governmental actors mostly identified water provisioning services; this is in line with the actions and drivers of water management in the area. Furthermore, the differences in WESs perceptions between both stakeholder groups were reflected during the interviews, and the process of assessing these perceptions was different for local inhabitants and governmental actors. In particular, local stakeholders spontaneously attached different intangible values and senses to the ESs and narrowed the answers using descriptions of the ecosystem elements (see Table S5). In contrast, governmental actors described ESs and their purposes more formally and from the perspective of their specific sector. Perceptions of WESs can vary across stakeholder groups but they can also vary within each group. Different ESs perceptions indicate an opportunity for stakeholder groups to interact in one system and to learn which ESs matters to other stakeholder groups and to members of the same group. They can then adjust their management or consumption actions to maintain these services. At the same time, as we will discuss later, similarities in WESs perceptions can also contribute to a common ground of understanding amongst stakeholders to discuss the availability long-term and sustainability of WESs.

4.3. *Relevance and Possible Application of the WESs Perception Assessment*

In this final section, we reflect on two policy-related generic principles—learning (P5) and broader participation (P6)—for enhancing the resilience of ESs in social–ecological systems as proposed by Biggs et al. (2012) [12]. Based on our interviews conducted in the Drâa River basin, our objective is to show how ESs perception assessment can be used to inform the learning process and promote the participation of stakeholders in real-world settings, as well as deriving recommendations for Drâa Valley water resource management. As far as we are aware, the contribution of ESs perception assessment to enhance their resilience has not been extensively analyzed before. Furthermore, compared to ESs studies conducted in the Drâa River basin (e.g., [54–56]), our study includes cultural services and emphasizes the importance of their consideration in decision making.

4.3.1. *Learning (P5) amongst Stakeholder Groups*

The assessment of ESs perceptions conducted in this study allows an understanding of how the different actors who interact in the MDV perceive and prioritize ESs similarly or differently. As Biggs et al. [14] concluded in the resilience framework, actors' knowledge

always incomplete in the face of inevitable uncertainty, change and surprises in complex social–ecological systems; thus arises the need for learning. In our case, the learning process could enhance a common dialogue on ESs by bringing the different actors together to discuss the Drâa Valley’s long-term development vision, which is to attain a sustainable supply of ESs as identified by the various stakeholders. Nevertheless, due to greater climatic variations and the increased use of water resources, not all WESs may be supplied in sufficient quantities in the near future. Which WESs to prioritize and what trade-offs might be required may become important themes. Here, as mentioned by López-Rodríguez et al. [57], learning could enhance dialogue and understanding of the ESs approach to support transformative social change in governance practice. In the current example, the learning process is termed “sustainable” or “transdisciplinary” learning, being a tool for facilitating constructive dialogue between groups of actors [58,59]—local inhabitants and governmental actors in our case. For there to be true dialogue and mutual understanding, it is essential to make different kinds of knowledge accessible and understandable for the various participants (see also [60]). Moreover, learning also needs to occur among the different groups of governmental actors and local inhabitants. Both groups have heterogeneous characteristics in terms of interests and priorities, which require better exchange and coordination to improve the local management of ES. We agree that the learning process is effective if it is collaborative [61], which means that scientists, water decision-makers, civil society and local water users must be involved. A long-term vision is also needed, which can withstand the impact of short-term politics and objectives [62]. Power dynamics can influence how learning occurs, who is learning, relationships between learners, what type of learning takes place, and whose knowledge is integrated or discarded [63,64]. In our case, an example would be the powerful and influential role of the provincial authorities in the MDV, which can either help or hinder local knowledge exchange and learning. Furthermore, powerful governmental actors can strongly affect whose knowledge is considered or ignored, leading to the exclusion of some local individuals’ knowledge. Learning and dialogue could enhance the importance of administrators looking beyond sectorial boundaries; this is important for oasis regions considered to be agricultural areas but are also natural ecosystems that help prevent desertification, and have rich biodiversity and local cultures. At this point, the learning principle is subject to questions. How feasible would be the application of a learning process in the MDV? How collaborative need the different stakeholders to be for this process to happen? How much will powerful decision-makers be willing to learn and from whom among local communities? Finally, how can a learning space for this particular group of stakeholders be created, since the WESs of policymakers seem to be much influenced by larger water management plants?

4.3.2. Broader Participation (P6) of Stakeholders in the Management Process

Our results highlighted the existence of different local and traditional institutions (e.g., the WUA, the *jem’âa*, the *ailam*). Interviews with members of traditional institutions revealed their experiential knowledge in managing water resources and other matters inside these communities. These results point to the importance and possibility of local communities actively participating in the management of water together with governmental actors, thus incorporating their knowledge in new management strategies. This may help safeguard existing traditional community knowledge around how water is managed. Moreover, when local communities identify with decisions, they might be more willing to accept them and may be more compliant in their enforcement (see also [64]). As such, the active engagement of local and traditional institutions in dialogue regarding water governance could contribute to the resilience of ESs in the Drâa River basin by including different views and perspectives (farmers, water users, association members, local leaders, etc.) in dealing with disturbances and changes in such a social–ecological system (e.g., droughts) (see also [65]). It is, nevertheless, important to consider power inequalities in participation between stakeholders and among stakeholder groups. Additionally, a more honest assessment of the costs and benefits to individuals of becoming involved in such

processes should also be considered [66]. In considering the MDV case, the participating actors and their motivations for doing so are critical elements which require further research.

5. Conclusions

In this paper, we assessed and analyzed perceptions of WESs among different stakeholders and investigated how they may contribute to sustaining the future supply of these services in the MDV. In particular, we identified WESs and the associated perceptions among local inhabitants and governmental actors in the area, explored which WESs matter to whom the most and why, and discussed different factors that influence perceptions of WESs. One central result of our study is the existence of common ground with regards to the identification and prioritization of WESs: both stakeholder groups prioritized the four most important WESs equally, resulting in provisioning services being considered the highest priority for people's livelihoods in the area. However, we also revealed a marked difference in WESs perceptions among both stakeholder groups regarding regulating and cultural WESs. We explain this difference by the various roles and responsibilities each stakeholder fulfills, their geographical location, and by their current usage, access to, and the state of water resources. Against this background, we reflected on two of the policy-relevant generic principles for enhancing the resilience of ES in social–ecological systems: learning (P5) and participation (P6). Our assessment illustrates how the identification and associated perceptions of WESs amongst different stakeholder groups may open new pathways for joint learning and enhance a dialogue for transformative social change in governance practices. For this to happen, we recommend broader participation, including by traditional and more recent institutions and diverse water users. During such a process, different future scenarios for the development of water resource management in the Drâa Valley could be discussed while envisioning what this means in terms of possible tradeoffs of the different WESs for the various stakeholder groups. Furthermore, information about the perceived state of ESs may also help practitioners and researchers to design management strategies that better address current shortcomings in ESs that are perceived as important yet considered by local inhabitants to be in a mediocre or poor state. In this sense, the ESs framework could be useful in fulfilling the requirements of the resilience principles P5 and P6, in that it constitutes a common and comprehensive system for analyzing sets of benefits that different stakeholder groups perceive from water resources. In addition, it can foster communication about water resources and their various benefits between stakeholder groups for overcoming the inherent tendency of following largely sectoral approaches. Finally, our research points to the need for studies that can convey lessons learned in applying ESs approaches to actual decision-making processes that involve different interests, power relations and politics at different scales of space and time (see also [67]). Such insights, gleaned from experience, would help improve the application of the ESs framework to foster environmental decision-making processes that improve the resilience of ecosystems and people. Having achieved these insights, future research in the Drâa region will now focus on applying suitable environmental economic valuation approaches to generate transparent information on the benefits of the identified ecosystem services to be used by institutions and decision makers related to water management in the area.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/su14084765/s1>--- Table S1: Local inhabitants' sample description; Table S2: Interview guides for stakeholder groups; Table S3: Code system derived from interviews responses of water users using three categories of ecosystem services (MAXQDA Analytics Pro 2020); Table S4: Code system derived from interview responses of governmental actors using three categories of ecosystem services (MAXQDA Analytics Pro 2020); Table S5: Expressions or quotes of ecosystem services identification by local inhabitants.

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