Diverse stakeholder perspectives and ecosystem services ranking: Application of the Q-methodology to Hawane Dam and Nature Reserve in Eswatini

Linda Siphiwo Mahlalela[a],*, Damien Jourdain[a,b,c], Eric Dada Mungatana[a], Thomas Hedemark Lundhede[a,d,e]

[a]Centre for Environmental Economics and Policy in Africa, Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, South Africa
[b]CIRAD, UMR G-EAU, Hatfield 0028, South Africa
[c]G-EAU, Univ Montpellier, AgroParisTech, CIRAD, IRD, IRSTEA, Montpellier SupAgro, Montpellier, France
[d]Centre for Macroecology, Evolution and Climate, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark
[e]Department of Food and Resource Economics, Faculty of Science, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark

*Corresponding author at: University of Pretoria, Private Bag X20, Hatfield 0028, Pretoria, South Africa. Email: linda.mahlalela@up.ac.za

Abstract

This paper uses the Q methodology to identify and analyze the diverse perspectives different stakeholders held about Hawane Dam and Nature Reserve (HDNR) wetland ecosystem services (ESS), to guide conservation management actions. Using 72 representative stakeholders to sort 40 statements describing ESS into a predefined distribution and a by-person factor analysis, the results show that stakeholders held three distinct perspectives that we labelled "water users", "conservationists", and "traditional users". There emerged consensus across stakeholders about the relatively high importance of the wetland purification and regulating functions, and the relative low importance of the recreation function. Farmers with relatively fewer livestock and households closer to HDNR ranked a mixture of extractive, cultural and regulation services relatively higher, while urban households ranked extractive water uses that go beyond the more traditional uses higher. Finally, water uses for household and farming activities emerged as non-controversial services, since they were ranked as very important by at least two groups and neutral by the third. The paper concludes by showing how the results contribute to conservation management and reducing problem "wickedness" (or improved problem definition).

Keywords: Ecosystem services; Factor analysis; Hawane Dam and Nature Reserve; Q methodology

1. Introduction

Wetlands are complex ecosystems that present several challenges for public agencies tasked with their sustainable utilization and management. These challenges include information and market failures (Turner, 1991; Euliss et al., 2008), policy intervention failures (Turner, 1991; Vélez et al., 2018), poorly defined tenure and ownership structures (Adger and Luttrell, 2000), and management of power dynamics (Reed et al., 2018). Concurrently, lack of adequate information on the full suite of ecosystem services (ESS) they provide, and lack of understanding of wetland processes and function (e.g., see Euliss et al., 2008; De Groot et al., 2018) may lead stakeholders as private agents and collectives, to make poorly informed choices about their use. Policy-intervention failures follow from lack of or poorly enforced wetland policies (Turner, 1991; Vélez et al., 2018). For example, fragmentation across different government levels or departments, which could manifest in lack of institutional coordination and public participation, can lead to adverse wetland outcomes (Byomkesh et al., 2009). Moreover, public agencies often lack adequate funding, trained personnel and resources, which limits their ability for effective public engagement in wetland management (Dugan, 1990; Ostrovskaya et al., 2013). Since wetlands are prone to continuous changes in time and space due to human interventions and climate change (Pavlikakis and Tsihrintzis, 2000), their boundaries are often obscured leading to unclear land tenure and ownership structures (Adger and Luttrell, 2000).

Policymakers have responded to these complex wetland management challenges using several approaches (DeFries and Nagendra, 2017), such as multisector decision-making, decision-making across boundaries, natural capital accounting, and multistakeholder engagements. Multisector decision-making approaches have been used to encourage national level spatial planning and multilevel governance (Nagendra and Ostrom, 2012; Burton et al., 2017), resulting in governance systems that recognize the importance of user communities. Decision-making across administrative boundaries has shown to be useful where ecological processes transcend administrative boundaries (Dore and Lebel, 2010; Chester, 2015). Examples are water governance in river basin programs (Dore and Lebel, 2010) and wetland governance in conservation programs (Joshi and Bhandari, 2016). Adaptive wetland management has been used to address uncertainties arising from complex wetland dynamics (Balint et al., 2011). Natural capital accounting and incorporating ESS in markets have been used to address market failures (Guerry et al., 2015). Government bodies have established management plans and structures for sensitive wetlands, but many of these encounter implementation problems (Vélez et al., 2018) often leading to conflicts between authorities and users, between different types of users, and sometimes between the different authorities in charge of different aspects of the wetlands. Power dynamics imply that some stakeholders have control or influence over the behavior of others in ecosystems management (Berbés-Blázquez et al., 2016). As embedded in institutions (formal and informal) and governance systems, power dynamics mediate the use, access, and distribution of ESS hence are central to the way individuals value ESS (Díaz et al., 2015; Berbés-Blázquez et al., 2016).

A major constraint to sustainable wetlands management is that users and public decision-makers often have differing perceptions about how they function, and often disagree on the relative importance of their different ESS i.e., the tangible and intangible benefits people obtain from ecosystems, broadly classified into provisioning, regulatory and maintenance, and cultural and recreational services (Millennium Ecosystem Assessment, 2005; Haines-Young and Potschin, 2010). It may thus be helpful for policy analysis to distinguish between the variety of stakeholders, who may express divergent values, perspectives, and worldviews about wetlands. Another layer of complexity stems from the multiplicity of government players and agencies, each with limited and potentially conflicting agendas regarding wetlands management. Traditional processes which rely on government experts, top-down legislation, or litigation of rights and responsibilities may thus fail to change resource use trends (Innes and Booher, 2018). Given this complexity, it is increasingly evident that maintaining or restoring wetland ESS requires the commitment and collaboration of all stakeholders, in particular of the different authorities, landowners and ESS users (Davenport et al., 2010). Programs and policies aimed at increasing wetlands stewardship and promoting collaborative partnerships must therefore address this multiplicity of perceptions (Davenport et al., 2010).

Wicked problems are the social or policy issues that are often complex, difficult to define and difficult to solve (Rittel and Webber, 1973). Following from the wicked problems literature (Rittel and Webber, 1973; Conklin, 2006; DeFries and Nagendra, 2017; Kumlien and Coughlan, 2018; Carter, 2019), stakeholder involvement is imperative in designing long term solutions to wetland management challenges (Camillus, 2008). A better understanding of the different stakeholder perspectives contributes to reducing ecosystem management's wickedness (Head, 2008; Rissman and Carpenter, 2015; Head and Xiang, 2016; DeFries and Nagendra, 2017; Mason et al., 2018). As mentioned by Rissman and Carpenter (2015), "*Ecosystem management decisions that may seem to be a simple matter of setting scientific limits on resource use frequently fail because of the political process of decision-making, differing values and norms, and power imbalances*". Camillus (2008) added, "*the aim should be to create a shared understanding of the problem and foster a joint commitment to possible ways of resolving it. Not everyone will agree on what the problem is, but stakeholders should be able to understand one another positions well enough to discuss different interpretations of the problem and work together to tackle it*". Points of consensus and controversy among stakeholders regarding wetlands management must thus be identified to facilitate negotiation when the need to address trade-offs between diverse ESS arises (Clare et al., 2013; Armatas et al., 2017).

In spite of sound plans for the conservation management of Hawane Dam and Nature Reserve (HDNR) in Eswatini, there is growing evidence that wetland degradation continues unabated (Ramsar, 2016). Transformation of grasslands into agricultural fields and livestock overgrazing, commonly attributed to neighboring stakeholders, is affecting the ecology. Lack of proper solid waste management systems in Mbabane City is resulting in effluent discharge into the wetland (Ramsar, 2016). Wetlands resources in communal areas are often over-exploited (Ramsar National Working Group, 2015), with subsistence hunting and terrestrial animal collection being particularly significant (Ramsar, 2016). Developments continue to contribute to wetland degradation: for instance, human settlements have increased over the past 20 years with at least two roads built (Ramsar, 2016). Fertilizer use in adjacent cultivated areas continues to degrade wetland ecology (Chonguiça and Brett, 2003; Ramsar, 2016). Considering the multiple stakeholders with varying interests in the ESS supplied by HDNR, its management represents a classic example of a "wicked" problem. While some hard biophysical data on the health of HDNR wetland exists (Ramsar, 2016), stakeholder perspectives on its different ESS lacks, in as much as we would expect its neighbors to rank extractive ESS relatively higher.

Informed by this gap, this study recruited stakeholders from the local media, research institutions, government institutions and parastatals, local businesses, recreational users, leisure companies, leisure resorts and neighboring households, and analyzed their perspectives on the ESS they receive from HDNR using the Q methodology. This is a semi-qualitative method which is generally employed to identify subjective perceptions held across diverse stakeholder groups on a certain subject (Watts and Stenner, 2005, Watts and Stenner, 2012). It is increasingly recognized as a valuable tool for analyzing perspectives held by individuals within stakeholder groups (e.g., Cuppen et al., 2010), and has been used to study "wicked" problem applications in the environmental sphere (e.g., Curry et al., 2013; Lehrer and Sneegas, 2018), including preference elicitation in health economics (Baker et al., 2006) and ESS ranking in environmental economics (e.g., Armatas et al., 2014; Bredin et al., 2015; Sy et al., 2018; Jensen, 2019). In contrast to open discussions, focus groups or deliberation techniques, Q methodology assessments are conducted through individual interviews, where all opinions are inventoried and analyzed to identify groups of similar views. The Q method is thus relatively transparent and systematic than open discussions based methods, where group and discussion dynamics may bias the information collected (Sy et al., 2018).

This study was thus designed to investigate how stakeholders rank the ESS provided by HDNR by initially using factor analysis to extract distinct latent views, before identifying consensus and uncontroversial views. The rest of this paper is presented as follows. Section 2 provides the methodology (study area, data collection and analysis). Section 3 presents the results, followed by the discussions in Section 4, and conclusions and recommendations in Section 5.

2. Methodology

2.1. Study area

Hawane Dam and Nature Reserve (HDNR) (26°12′48″S, 31°05′12″E) lies in the Hhohho region of Eswatini (Fig. 1). HDNR (Ramsar site 2121) was gazetted as a nature reserve in 1978 to protect the marshland along the Mbuluzi, one of the main rivers in Eswatini. Following construction of the dam in 1988, the nature reserve was extended to accord better resource protection. HDNR hosts a variety of water birds, and supports a small but critical population of the endemic and regionally endangered plant species, Swati red-hot poker (*Kniphofia gracilis*) (Ramsar, 2016). The current protected area covers 232 ha. HDNR is the only water supply security system for Mbabane, Eswatini's capital.

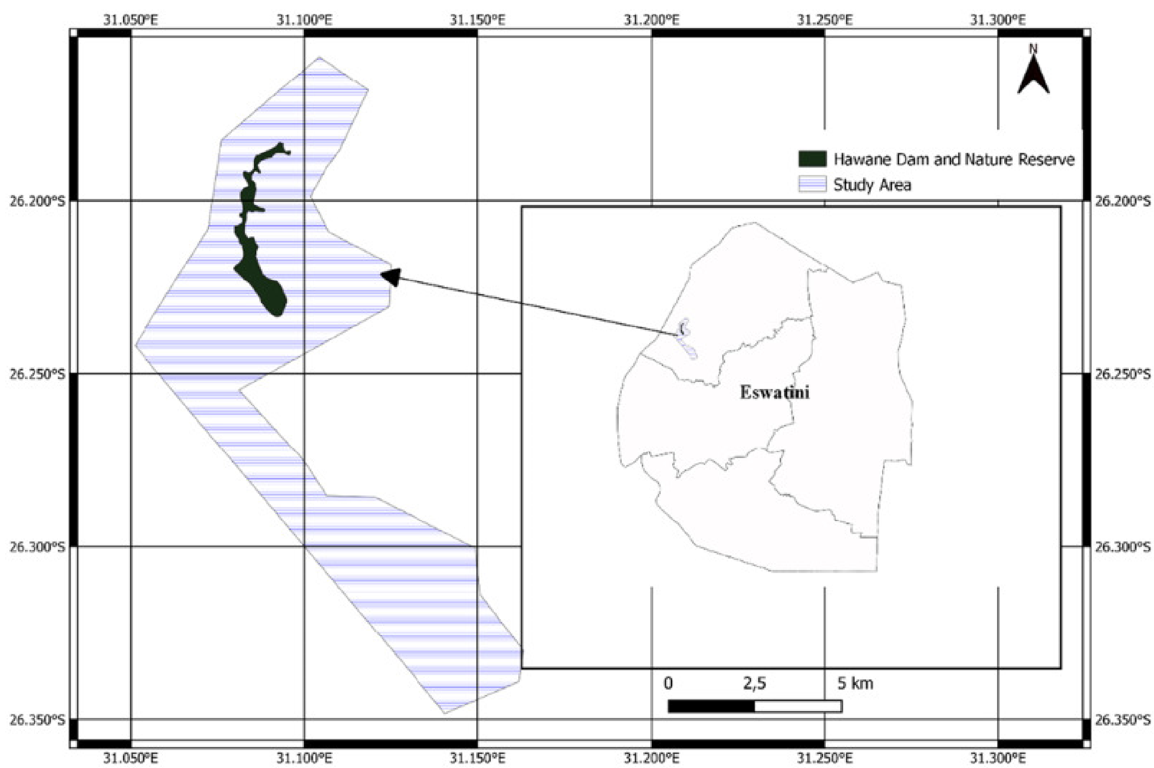

Fig. 1. Study area and HDNR in Eswatini.

Several stakeholders impact or are impacted by management decisions at HDNR (see Appendix A). Adjacent households and those from Mbabane City depend on HDNR for domestic water supply (either piped or directly collected from the wetland). Local businesses, landowners, and adjacent households to the HDNR catchment graze livestock and extract resources like fibre, soapstone, and fish. Recreationists, and resort/leisure companies use HDNR as an input in the production of recreation and cultural experiences (e.g., landscape beauty, aesthetic values, and bird watching). The Tourism and Environmental Affairs Ministry prioritizes recreation and business, the Ministry of Natural Resources and Energy prioritizes water supply, the Ministry of Agriculture prioritizes food security, the Ministry of Tinkhundla Administration prioritizes public administration, while the Eswatini National Trust Commission, Malolotja Nature Reserve, Eswatini Environment Authority, and NGOs prioritize biodiversity and ESS protection. The Malkerns Research Station generates data that informs management decisions. Finally, the local media drives public opinion and politics on wetland use, conservation, and management.

The multiplicity of stakeholders with competing interests presents a management challenge that is not easily formulated and could potentially precipitate into conflicts between households and public authorities, and even among public authorities. Such complexity justifies research that identifies consensus among stakeholder groups on priority ESS and dominant worldviews. Identifying consensus can potentially contribute to managing and reducing “wickedness” of problems. Once stakeholders agree on priority ESS, they can engage in transparent discussions and jointly define urgent problems and proposed solutions. Divergent dominant worldviews present an opportunity for stakeholders to engage in honest negotiations where some compromises and perhaps some agreements could be reached on priority ESS, conservation initiatives and sustainable livelihoods through inclusive management. A study of this nature could also contribute to the government's strategic goal of effective and equitable conservation management of ecologically representative and well-connected protected areas of particular importance for biodiversity and ESS by 2022 (Swaziland Environment Authority, 2014).

2.2. Data collection

The process of data collection followed a standard four-step Q methodology procedure which involves developing the concourse, selecting statements that respondents will sort out or the Q-set, selecting respondents to participate in the study or the P-set, interviews where respondents in the P-set sorted out the Q-set into Q-sorts, and finally exit interviews (Watts and Stenner, 2012).

A comprehensive list of all possible statements (i.e. the concourse) relevant to ESS was formulated from literature reviews (e.g., Millennium Ecosystem Assessment, 2005; Boyd and Banzhaf, 2007; Haines-Young and Potschin, 2010; TEEB, 2010; Armatas et al., 2014), expert consultations and focus groups which included local households living adjacent to HDNR and Mbabane residents. This approach resulted in a concourse of 46 statements. Following pretesting of the concourse on nine respondents, we further reduced it to the final Q-set of 40 statements shown in Table 1.

Table 1. Definitions of ecosystem services related to HDNR.

ID[a]	Ecosystem service	Statement	Type[b]
1	Purifying water	Hawane wetland purifies water naturally, resulting in clean water.	R
2	Aquatic habitat	The remaining water in Hawane wetland and its streams help to create and maintain healthy aquatic (water) habitats.	R
3	Conservation of threatened plants and animal species	Hawane wetland supports different important and threatened plants (e.g. Swati red hot poker 'licacalatikoloshi') and animals (e.g. Southern Bald Ibis 'inkondla') of international importance.	R
4	Gradual discharge of stored water (water regulation)	Hawane wetland and its underground water base (wells, boreholes, etc) naturally regulate water released into streams, rivers, and Hawane dam, providing gradual flow of water throughout the year.	R
5	Natural flood control	The storage of water in Hawane wetland and its underground water base (wells, boreholes, etc) provides natural flood control, which avoids flooding damage costs.	R
6	Carbon sequestration	Hawane wetland removes large quantities of toxic gases that cause increase in temperatures and lung diseases, from the atmosphere and store them.	R
7	Nutrient cycling and sediment transport	Hawane wetland water cycle nutrients and transport sediments thus maintain healthy and diverse aquatic habitats.	R
8	Pollination	Hawane wetland plants support the distribution, abundance, and effectiveness of pollinators e.g., bees.	R
9	Erosion control	Vegetation cover plays an important role in soil retention and prevalence of landslides.	R
10	Regulation of human diseases	Hawane wetland regulates disease vectors or agents, such as mosquitos.	R
11	Waste treatment	Hawane wetland can help filter out and decompose organic waste seepage from pit latrines.	R
12	Biological control	Hawane wetland regulates crop and livestock pests and diseases.	R
13	Air quality maintenance	Hawane wetland both releases chemicals to and extract/absorb chemicals from the atmosphere resulting in clean air.	R
14	Fibre	Hawane wetland provides indigenous wetland plant species that are used to make craft products like mats, thatching ropes, and brooms, e.g., 'likhwane', 'inchoboza' etc.	P
15	Food	Hawane wetland provides food from hunted or collected snails, grasshoppers, fish, and birds, etc.	P
16	Medicinal plants	Hawane wetland is a habitat for medicinal plants.	P
17	Household/municipal water	Hawane wetland surface water and groundwater is used for drinking, washing, and other in-house uses.	P
18	Hydropower	Hawane wetland water can be used to generate hydropower or electricity.	P
19	Commercial irrigation	Hawane wetland surface water and groundwater is used to irrigate commercial crops, which could include hay, sugar beets, corn, grain, and beans.	P
20	Personal irrigation	Hawane wetland surface water and groundwater can be used to fill private ponds, and irrigate gardens and lawns.	P
21	Water for livestock	Hawane wetland water is used for livestock drinking.	P
22	Manufacturing and industrial	Hawane wetland surface water and groundwater can be used for manufacturing and industrial purposes.	P
23	Mining of soapstone	Hawane wetland is used for the mining of soapstone.	P
24	Fighting fires	Hawane wetland water can be used for extinguishing forest fires and related fire outbreaks.	P

25	Supporting commercial land-based recreation	Hawane wetland water facilitates land-based recreational activities like boating.	C
26	Fishing	Hawane dam, ponds, and streams are used for the harvesting/catching of fish for personal consumption.	C
27	Dam/reservoir hunting	Hawane dam/reservoir throughout the study area provides opportunities for hunting waterfowl (water/wetland birds) from the water in a boat.	C
28	Land-based hunting	Hawane wetland provides habitat for game and, as a result, it can be used for land-based hunting.	C
29	Dam/reservoir recreation	The rivers/streams flowing in and out of the Hawane wetland can be used for both water and scenic recreational activities like rafting, kayaking/canoeing, and bird watching.	C
30	Commercial wetland-based recreation	Water rafting trips and guided fishing trips are two examples of commercial wetland-based recreation I can pay for when provided by Hawane wetland.	C
31	Recreation/leisure activities done near wetland	The experience of wildlife viewing and hiking could be done in close proximity to Hawane wetland together with reflective recreational activities like introspective thoughts.	C
32	Physically and mentally challenging recreation	Hawane wetland provides opportunities for physically and mentally challenging recreational opportunities.	C
33	Education, management and science	Hawane wetland water habitats and processes are studied with the goal of improving both management and knowledge of natural and social sciences, which include ecology, history, agriculture, and economics.	C
34	Knowledge systems	Hawane wetland contributes to the sharing, preservation, and collection of indigenous knowledge which improves human-ecosystem (wetland) relationships.	C
35	Swati spiritual values	Hawane wetland has a special meaning to emaSwati, and can be used for spiritual and religious purposes, like the use of 'Imphepho' – Africa's Sacred Herb. (African Sage).	C
36	Swati cultural values	Hawane wetland has a special meaning to emaSwati, and can be used for ceremonial purposes, e.g., reeds used for the reed dance 'Umhlanga'	C
37	Preserving landscapes	The water flowing and grasslands (including fibre) from the wetland are used to support healthy agricultural communities and working farms and ranches.	R
38	Preserving livelihoods through income generation	The wetland resources like fibre (for making mats, brooms etc) and soapstone (for making sculptures) presents an alternative source of livelihood.	P
39	Inspirational values	Hawane wetland provides inspiration and enjoyment, for example, the scenic wetland provides the motivation for an artist's work like carving sculptures using soapstone from the wetland.	C
40	Aesthetic values	Hawane wetland provides enjoyment from the beauty of the landscape and the sound of birds.	C

[a]The numbers assigned to the ecosystem services are random nominal and only used for identifying the statements.
[b]The ecosystem services were classified *ex-post* into (P) provisioning, (R) regulatory & maintenance, and (C) cultural & recreational.

After the Q-set development, 72 representative respondents from the stakeholder groups were purposively selected for the Q-sorting, based on their interest in HDNR and existing power dynamics (see Appendix A). More than half of the respondents came from households adjacent to HDNR and Mbabane City. We conducted one-on-one interviews without monetary compensation. Each participant completed a Q-sorting exercise and an exit interview. In the Q-sorting exercise, participants ranked 40 cards across the x-axis of a Q-board (see Fig. 2).

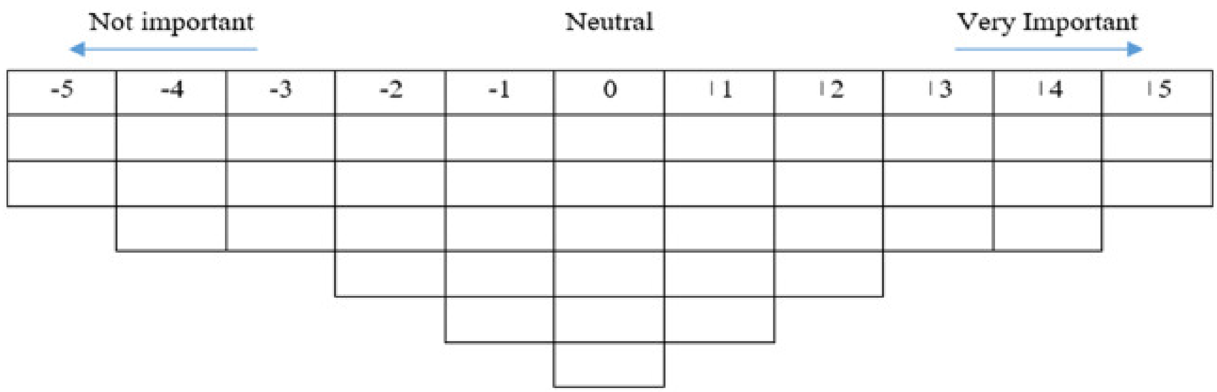

Fig. 2. Q-board.

The Q-board represents a predefined quasi normal distribution (McKeown and Thomas, 1988; Watts and Stenner, 2005, Watts and Stenner, 2012; McKeown and Thomas, 2013), while the 40 cards represent the 40 statements identified on the Q-set (Table 1). After introducing the research objectives, participants were asked to read statements presented on the 40 cards carefully, and then sort the cards into three stacks reflecting how they rank the statements as “important”, “neutral”, or “not important”. Then participants were requested to rank order the three stacks into the Q-board slots, which was 11-point quasi-normal (forced-choice) distribution on a Q-board ranging from −5 (not important at all) to +5 (extremely important) (see Fig. 2). Thereafter, exit interviews were conducted, these were informal discussions designed to understand interviewee rankings and collect socio-demographic information. Finally, we coded the Q-sorts and recorded them in a results matrix.

2.3. Data analysis

The Q methodology uses factor analysis to correlate the entire responses of individuals who participated in the Q-sorting (Zabala and Pascual, 2016). In the current application, highly correlated Q-sorts show stakeholders with a similar view on the ranking of wetland ESS. The statistical approach proceeds from factor extraction, through factor rotation, to generating factor scores, and finally to determining the distinguishing and consensus statements, which are then used to explain the different viewpoints and make recommendations to policymakers.

We chose the principal component analysis (PCA) among other feasible factor extraction methods, a procedure that minimizes information loss while reducing dimensionality and increasing the interpretability of the dataset (Jolliffe and Cadima, 2016). The variance accounted for by the factors (first and successive) was maximized by the unrotated (PCA) output. This often leads to several items substantially loading on more than one factor. To obtain a solution in which each item loads on one factor strongly and on the others weakly, factor rotation was conducted. We tested a number of rotation methods in terms of how meaningful the resulting interpretation was and ended using the oblimin rotation.

For the purpose of selecting a feasible number of factors, three commonly used criteria in Q methodology and factor analyses were used: the parallel analysis (Horn, 1965), the minimum number of significant Q-sorts, and Humpfrey's rule. The parallel analysis compares the model-computed eigenvalues, with those obtained using a random dataset using the same number of observations and variables as the original data, to identify the point where the additional components are mostly random noise. Following Brown (1980), a Q-sort was deemed significantly loaded on a factor at $p < 0.01$ if its loading was greater than $2.58/\sqrt{S} = 0.408$, where $S = 40$ is the number of statements or the Q-set and 2.58 corresponds the 99.5% threshold of a normal distribution (Brown, 1980). The Humphrey's rule states that a factor is significant if the cross-product of its two highest loadings, ignoring the sign, exceeds twice the standard error (Brown, 1980). We extracted and inspected two to four factor solutions to reach a final decision regarding the number of extracted factors that were meaningful.

After the rotation, in each factor we selected representative Q-sorts. To allocate a Q-sort to a factor, also described as flagging the Q-sorts, we used the communality (h^2) concept, which is the amount of variance that a completed Q-sort shares with other respondents' completed Q-sorts (Brown and Perkins, 2019), and calculated as the summation of squared loadings in each row. Q-sorts with high communalities load on the same factor. We used a pre-flagging algorithm in the Q-sorts selection to only flag clear-cut cases, defined as cases that load on only one factor. A Q-sort with a loading a on a factor is pre-flagged if its loading is significant at $p < 0.05$, and if $a^2 > h^2/2$, i.e. over half of the common variance is explained by the factor.

In order to test the internal replicability of a Q study, Fairweather (2002) suggests analyzing sub-samples of responses and interpreting the results relative to those of the entire sample, since some of the recovered viewpoints may be less robust relative to others. More recently, Zabala and Pascual (2016) systematized this suggestion using a bootstrapping procedure that allows obtaining new measures of internal variability. In our case, we used the package *qmethod* developed for the R software (Zabala, 2014) for the bootstrapping.

Zabala and Pascual (2016) highlight two types of variability in the results. First, some respondents get flagged on different factors when using different sub-samples, while others are always flagged on the same factors making them better definers of a factor. In this application, we used the frequency with which a Q-sort was flagged in the bootstrap to screen-out the most ambiguous respondents. Next, within a factor, the ranking of a statement may vary with the different subsamples. Therefore, some statements have a more stable relation with the factor than others. The standard deviation of the scores allows identification of statements that are ranked significantly differently across factors, and gives a better understanding of the reliability of a statement in defining a factor.

To interpret Q sorts related to a factor, we created factor scores denoting how a weighted average group member arranged his/her statements (Watts and Stenner, 2005, Watts and Stenner, 2012; Yarar and Orth, 2018). Factor scores are centered on Z-scores of each statement.[1] Since all Z-scores have identical standard deviations (one) and means (zero), they enable direct comparisons of the same statements across various factors. As statements were sorted into a quasi-normal distribution, we reproduced initial Q-sorts format by selecting the item with the highest Z-score and assign it a value of +5, next highest Z-score assign a value of +4, etc. Even though marginal errors were introduced by the rounded factor scores and the arbitrary grouping, factor scores are generally ideal for interpretation, as they follow the original data collection format. Qualitative interpretation is based on the analysis of these factor scores, and determining consensus and distinguishing statements used to explain the different viewpoints and make recommendations to policymakers.

To facilitate the identification of the consensus statement we used two visual aids. First, we created Venn diagrams of the most salient ESS so we could quickly identify consensus statements in the overlapping areas. Second, as suggested in Zabala and Pascual (2016), we plotted the mean and the standard deviation (represented as error bars) of the bootstrapped z-scores on the different factors. The plot allows distinguishing consensual (overlapping bars) and nonconsensual (non-overlapping bars) views about the services among the groups of stakeholders. To discuss the relative importance of the broad types of ESS (see Table 1), we computed the salience attributed by the factors to the three categories of ESS. Salience is defined as the mean of the absolute values of Z scores in each category. It also allows for comparisons across categories of ESS, and provides a way to validate each type of ESS inclusion in the study, as low salience themes are less important for interviewed stakeholders. In addition to the salience, we computed a mean *Z*-score per category.

3. Results

Upon applying the Humpfrey Rule and parallel analysis on our initial 72 Q-sorts, the PCA extracted three factors. We thus ran a bootstrapped Q-factor analysis with the three factors, an oblimin rotation, and 3000 resamplings. The results showed that 16 Q-sorts had a flagging frequency lower than 0.5 on all the three factors, implying that they yielded ambiguous information, and we thus excluded them from further analysis. Appendix B presents results from the rotation and selection of active Q-sorts following analysis on the remaining 56 Q-sorts.

The first factor summarized 27 Q-sorts and captured 18% of the variance, and based on the statements defining the factor, we labelled it ‘water users’. The second factor summarized 20 Q-sorts and captured 14% of the variance, and we labelled it ‘conservationists’. The third factor summarized eight Q-sorts and captured 9% of the variance, and we labelled it ‘traditional users’. One Q-sort, a stakeholder from the Tourism Ministry, was not used in the analysis as it was loading equally between two factors.

The correlations between factors 1 and 2 was 0.34, 1 and 3 was 0.32, and 2 and 3 was 0.35, all below the threshold value of $2.58/\sqrt{40} = 0.41$ required to ascertain significance at $p < 0.01$ (Brown, 1980). These correlations suggest that the three factors represented distinct viewpoints. We depict the weighted average Q-sorts for factor 1 in Fig. 3, factor 2 in Fig. 4, and factor 3 in Fig. 5. We also present a more detailed table with weighted average factor scores and Z-scores in Appendix C.

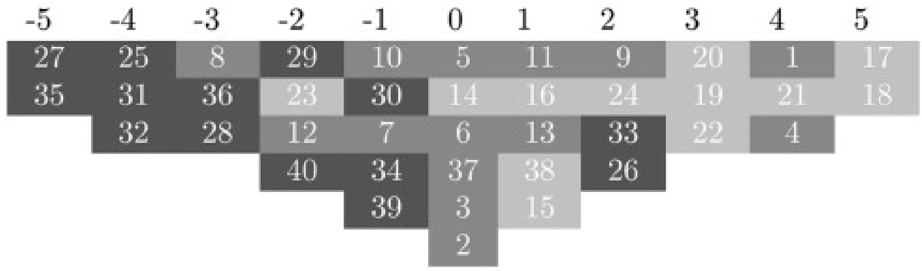

Fig. 3. Average weighted Q-sort of factor 1. The numbers are statement numbers as in Table 1. Background colours indicate ecosystem services category: i) light grey = provisioning services, ii) medium grey = regulation and maintenance services, and iii) dark grey = cultural and recreational services.

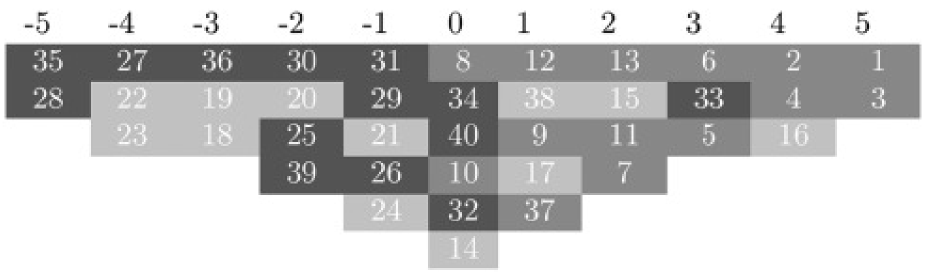

Fig. 4. Average weighted Q-sort of factor 2.

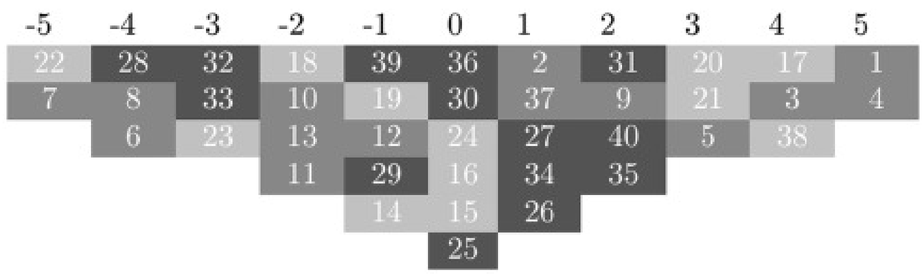

Fig. 5. Weighted-Average Q-sort of factor 3.

3.1. Distinct latent views (factors) about the importance of wetland ecosystem services

The information between brackets in the factor descriptions below refer to the statements in Table 1 numbered from #01 to #40, with the normalized ranks assigned to them ranging from −5 (not important at all) to +5 (extremely important).

3.1.1. Factor 1: water users: "wetland supports direct consumptive uses of water"

Stakeholders with the above viewpoint gave high priority to major wetland provisioning services (Fig. 3): household/municipal water supply (#17: +5), hydropower generation (#18: +5), water for livestock use (#21: +4), commercial uses (#19: +3), commercial and personal irrigation (#19: +3; #20: +3), and manufacturing or industrial uses (#22: +3). Two wetland regulatory services were also given high priority: water purification (#1: +4) and water flow regulation (#4: +4). While water purification is a regulatory service, it also contributes directly to generating clean water for main consumptive uses, especially for households, irrigation and livestock. This leads us to conclude that this combination of services is coherent: stakeholders perceive wetlands as important because they provide clean water for major consumptive uses.

The group ranked wetland provisioning services that are not directly related to water use at the center of the distribution indicating a degree of indifference towards them (food: #15: +1; medicinal plants: #16: +1; income generation #38: +1; fibre #14: 0). Hunting, classified as a provisioning service (#27: −5; #28: −3) and soapstone mining (an illegal activity), were rated as unimportant (#23: −2).

In contrast, this group ranked most of the wetland cultural and recreational services (spiritual values #35: −5; recreation related statements #25: −4; #31: −4; #32: −4; cultural values #36: −3; reservoir recreation #29: −2; aesthetics: #40: −2) as unimportant. Hunting, classified as a recreation activity, was rated as unimportant (#27: −5; #28: −3).

Finally, the group classified most of the regulation and maintenance services at the center of the distribution. This is particularly the case for carbon sequestration (#6: 0), natural flood control (#5: 0), and conservation of threatened plant and animal species (#3: 0).

Similar to Sy et al. (2018) we noticed that negative scores were occasionally used to express rejection yet they are generally presented as relatively "not important". For example, stakeholders in group 1 and 2 chose #35: −5 to express their strong rejection for spiritual values, i.e. a stakeholder in group 1 in the exit interview said, "I do not believe in water or wetland spiritual values as it conflicts with my … faith".

Appendix D presents the group's composition and selected characteristics. It is mostly composed of urban households who rarely visit the HDNR, and some farming households living in the vicinity or inside HDNR. Relative to the average household in Eswatini, these farming households tend to have more cattle, which could possibly explain the importance of the "water for livestock" attribute to this group. Further analysis showed that these farming households had lower factor loadings relative to urban households, meaning that they carry less weight in computing the average ranking. This suggests that this first factor (or point of view) is mainly representative of urban households who focus on the water related provisioning services provided by HDNR, and to a second extent, farmers in the vicinity or inside HDNR who rely on it for their livestock.

3.1.2. Factor 2: the conservationists: "wetlands as a natural regulator"

Stakeholders with this perspective gave high priority to major regulation and maintenance services (Fig. 4): water purification (#1: +5), conservation of threatened species (#3: +5), aquatic habitat (#2: +4), gradual discharge of water (#4: +4), natural flood control (#5: +3), and carbon sequestration (#6: +3). One provisioning service, medicinal plants (#16: +4) was also ranked as important.

The current group i.e. "the conservationists" ranked provisioning services differently from the "water users" group in two ways. First, they did not consider some of the commercial and business water uses as important, including commercial irrigation (#19: −3), hydropower generation (#18: −3), manufacturing and industrial uses (#22: −4). Second, they were indifferent to individual wetland uses such as fibre (#14: 0), water for livestock (#21: −1), fishing (#26: −1), and personal irrigation (#20: −2). They however agreed with the first group that extractive uses like soapstone mining (#23: −4), dam/reservoir and land-based hunting

(#27: −4; #28: −5) were not important. This group also ranked cultural services like spiritual values (#35: −5), cultural values (#36: −3), and inspirational values (#39: −2) as not important. The group is indifferent to most recreational services (#29: −1; #31: −1), and they ranked commercial land-based recreation (#25: −2) even less.

Appendix D presents the group's composition and selected characteristics. It is mainly composed of civil servants working in the different government ministries, research stations, or environmental institutions. Some farming households were also represented in this group, but relative to the first group, they had fewer cattle and smaller farm sizes. As such, they are likely to be less dependent on water provisioning ESS from HDNR. The farming households also carried less weight in defining the factor, as shown by their lower factor loadings. Overall, this second group is more focused on the regulation and maintenance services delivered by HDNR.

3.1.3. Factor 3: the traditional users: "find a balance between private uses and conservation"

Stakeholders in this group held a more balanced view about the services rendered by the HDNR wetlands (Fig. 5). First, they rank major regulation and maintenance services as very important: water purification (#1: +5), gradual discharge of stored water (#4: +5), conservation of threatened species (#3: +4), and natural flood control (#5: +3).

They also rank provisioning services as equally important: household/municipal water (#17: +4), income generation (#38: +4), personal irrigation (#20: +3), water for livestock (#21: +3), and to a lesser extent fishing (#26: +1) and reservoir hunting (#27: +1). In contrast, they rank the more commercial or industrial wetland uses low: manufacturing and industrial water (#22: −5); hydropower generation (#18: −2); soapstone mining (#23: −3); and commercial irrigation (#19: −1). While not seeing them as the most important, they valued cultural services higher than the other two groups: spiritual values (#35: +2), aesthetic values (#40: +2). Finally, they rank key supporting services as low: carbon sequestration (#6: - 4); pollination (#8: - 4); nutrient cycling and sediment transport (#7: −5).

Appendix D presents the group's composition and selected characteristics. It was a relatively smaller group composed mainly of farming households. The presence of a person working at the Ministry of Tourism and Environmental Affairs, and a recreational user may explain the higher rankings given to cultural values.

While the analysis above allows characterization of stakeholder viewpoints, we proceeded to use the mean Z-scores and salience to investigate whether stakeholder rankings of the ESS groups in Table 1 vary by viewpoint (Table 2).

Table 2. Salience and mean scores per type of ecosystem services.

Type of ecosystem service	**Salience**			**Mean Z-Score**		
Empty Cell	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
Provisioning	0.95	0.842	0.858	0.814	−0.346	0.0016
Regulation & maintenance	0.518	0.879	1.12	0.124	0.871	0.114
Cultural & recreational	0.959	0.781	0.526	−0.822	−0.575	−0.116

The mean *Z*-scores for Factor 1 (Table 2) suggest that on average, "water users" expressed strong positive views about provisioning services (0.814) and strong negative views about cultural and recreation services (−0.822). They were however more neutral about regulation and maintenance services (0.124). The salience scores of 0.95 (provisioning services) and 0.959 (cultural & recreation services) suggest high intensity of expressed views. Similarly, with a mean Z-score of 0.871 for the regulation and maintenance services, the "conservationists" (Factor 2) expressed strong positive views with high intensity (salience score of 1.21). The mean Z-scores for the provisioning services (−0.346) and cultural & recreation services (−0.575) suggest that "conservationists" did not view them as important. Finally, the low mean Z-scores of the "traditional users" (Factor 3) across the three ESS groups reflect their more balanced views. In the following section, we further interrogate the variation in ESS rankings by stakeholder groups observed in Table 2.

3.2. Consensus and un-controversial views about ecosystem services ranking

The Venn diagrams in Fig. 6 synthesize information about the most salient ESS, defined as those ranked with an absolute factor score of three and above by at least one stakeholder group, with Fig. 7, Fig. 8 showing the associated standard deviations and mean z-scores. Non-overlapping bars in the later figures suggest significantly distinct views about a given service.

Fig. 6, Fig. 7, Fig. 8 generally show that contrast between "water users" and "conservationists" was quite strong, since many services viewed as most important by "water users" were on the contrary viewed as least important by "conservationists". "Traditional users" shared many views with both "water users" and "conservationists". With "water users", they shared the view that water extraction for municipalities, personal irrigation and livestock was quite important. With "conservationists", they shared the view that conservation of threatened species and flood control were quite important, while industrial uses and soapstone mining were not important. Despite these contrasts, the three groups agreed on the importance of water purification and natural water flows regulation (important regulation services), and the very little importance of land-based hunting (it should not be derived from the wetlands).

Finally, water supply to municipalities, livestock and personal irrigation emerged as a less polarizing service across the groups, since "water users" (Factor 1) and "traditionalist" (Factor 3) ranked them as very important, while "conservationists" (Factor 3) as neutral. The emergence of consensual and non-polarizing services could serve as a starting point for stakeholder involvement in wetland management.

4. Discussion

Our results suggest three contrasted worldviews regarding the relative importance of the ESS provided by HDNR. Despite the apparent contrasted views, stakeholders uniformly recognized two important regulation functions: water purification and water flows regulation. This indicates that the sustainable maintenance of these services ought to be given priority and visibility when designing strategies to incentivize behavioral change in stakeholder practices and uses of wetland resources. In particular, research and communication about the possible relationship between current wetland uses and their capacity to sustainably provide these functions should be prioritized. An important research question would then be the extent to which encroachment into natural areas would reduce the wetland capacity to naturally provide these regulatory services from land that stakeholders will eventually occupy. This would require quantitative research on the value of the different ESS, given that

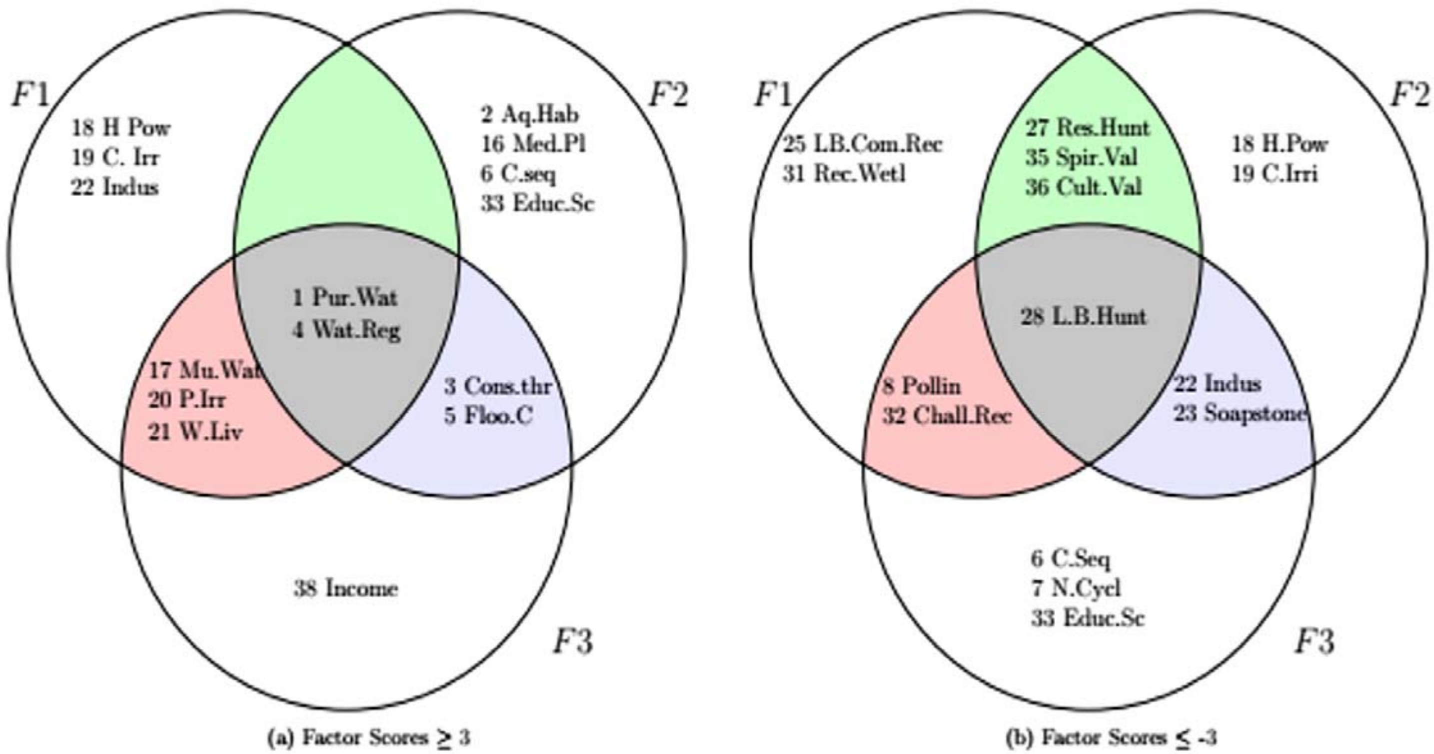

Fig. 6. Venn diagrams of the most salient ecosystem services: (a) highest ranked, and (b) lowest ranked.

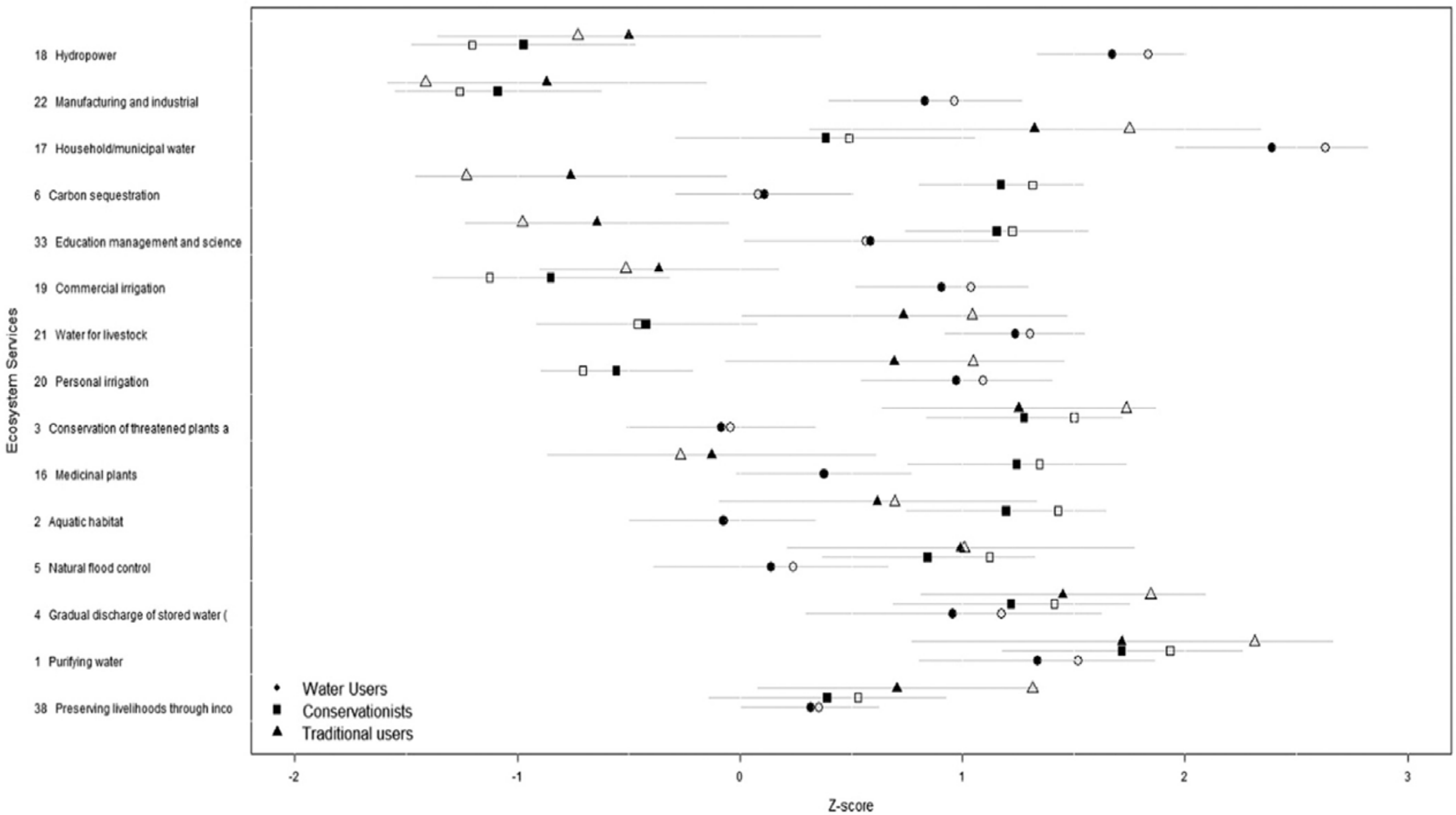

Fig. 7. Distinguishing ecosystem services – Ranking ≥ 3 on at least one factor ("Empty symbol": Z-score under the standard Q-factor analysis (no-bootstrap), "Filled symbol": Mean of the 3000 bootstrap Z-scores, "Error bars": Standard deviations of the 3000 bootstrap Z-scores).

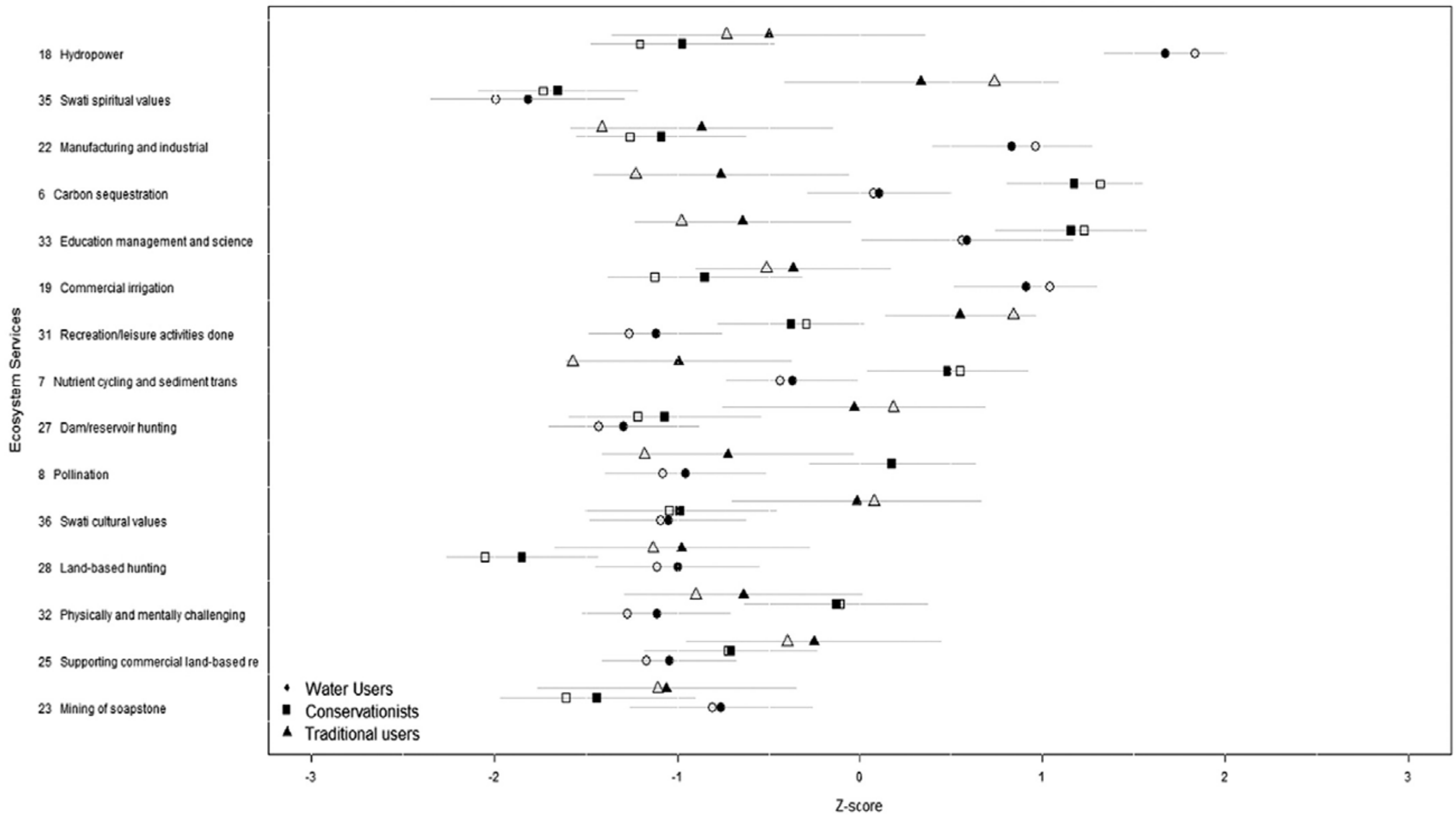

Fig. 8. Distinguishing ecosystem services – Ranking ≤ −3 on at least one factor ("Empty symbol": Z-score under the standard Q-factor analysis (no-bootstrap), "Filled symbol": Mean of the 3000 bootstrap Z-scores, "Error bars": Standard deviations of the 3000 bootstrap Z-scores).

such results could capture the attention of public decision-makers and stakeholders on the trade-offs involved: how would wetland benefits and their distribution change with land use practice changes?

Second, farmers with relatively fewer livestock and households closer to HDNR tended to have a more balanced view about the different wetland ESS, given that they ranked a mixture of extractive, cultural and regulation services relatively higher. This suggests that proximity gives them better appreciation of the different ESS, and the potential trade-offs in the event of wetland degradation. Contrary to our prior expectations, neighboring households may be better resource stewards because they are more often confronted with the need to balance protection and extractive uses, implying that they may be willing to seek solutions that improve the *status quo*. They may thus readily embrace research-based guidance on natural resources management. Our notion of a balance view must thus be qualified and substantiated with research, building on theory of the commons and community-based natural resource management.

Third, urban households ranked extractive water uses that go beyond the more traditional uses relatively higher. As such, the urbanites are probably part of that population that is less *"cognizant of biodiversity and ecosystems, their value and the steps they can take to conserve and use these sustainably"* (GOS-SEA, 2016). If government wants to achieve its stated goal, it should probably focus more attention on the urban population to sensitize them about the benefits they extract from wetlands, and the role they could play in their sustainability.

Fourth, conservation policy must work with stakeholders to promote land based practices that support delivery of non-controversial ESS like water supply to municipalities, livestock and irrigation. This must be accompanied by informed discussions on extraction levels that do not compromise wetland capacity to deliver regulatory services.

Beyond natural resources management, we reiterate that the controversial and non-controversial worldviews present all stakeholders with an opportunity to understand each other's positions, openly discuss challenges and how they could be solved (e.g., see Camillus, 2008; Clare et al., 2013; Armatas et al., 2017). We concur with Sy et al. (2018) that studies of this kind facilitate stakeholder engagement and participation in decision making, thus contribute to making management challenges "less wicked". It is finally important to assess the utility of contrasted worldviews to management in the socio-cultural context. Power dynamics in Eswatini have historically molded the institutional context shaped by traditions, norms, habits, and various types of knowledge. In pursuing environmental sustainability and social justice, power relationships must be uncovered, transformed and managed to give equal opportunities to all stakeholders in influencing outcomes (Reed et al., 2018).

5. Concluding remarks

The Q methodology as applied in this paper attempts to provide a more systematic analysis of the complexity that emerges when public agencies base the design of wetlands management policies on diverse stakeholder perspectives. Although diversity provides a challenge for policymaking, it is our view that having a better comprehension of what the diversity is about, and its implications for the resource and stakeholders is a first step in improved policymaking. The emergent distinct viewpoints could help initiate and facilitate fruitful discussions, commitment, and future collaboration across stakeholders. In the absence of such consensus, society will struggle to mitigate wetland loss and deterioration. The distinct and consensus viewpoints could also serve as the starting point for future wetland valuation research designed to quantitatively deal with trade-offs in managing wetlands. For example, studies of this kind could inform the attributes for a choice experiment that seeks to assess whether society is better off with a greater proportion of HDNR converted to farmland. Following acknowledged limitations of the Q method viz. small samples and conditional on the number of statements (Watts and Stenner, 2012; Jensen, 2019), and the fact that it does not analyze power dynamics (Sy et al., 2018), it is advisable to view it as a compliment to other approaches used to address wetland management challenges (e.g., multi-stakeholder engagements, multisector decision-making, natural capital accounting, and decision-making across boundaries) for the benefit of present and future generations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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