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Peer-reviewed author version

Janssens de Bisthoven, Luc; VANHOVE, Maarten; Rochette, Anne-Julie; HUGE, Jean & Brendonck, Luc (2022) Stakeholder Analysis on Ecosystem Services of Lake Manyara Sub-basin (Tanzania): How to Overcome Confounding Factors. In: ENVIRONMENTAL MANAGEMENT,.

DOI: 10.1007/s00267-021-01466-x
Handle: http://hdl.handle.net/1942/34068

Second submission: manuscript FINAL, after minor revision (15 March 2021)

+Environmental Management+

Special Issue: Incorporating Ecosystem Services into Water Resource Management

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Stakeholder analysis on ecosystem services of Lake Manyara sub-basin (Tanzania): how to overcome confounding factors

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Abstract

Ecosystem services are a telling concept to discuss the integrated management of natural resources, such as integrated water and soil, with non-academic stakeholders. Stakeholders have different perceptions regarding the management of various ecosystem services, which is challenging when aiming to develop and foster sustainable ecosystem management. We performed a stakeholder analysis as part of a social-ecological study in preparation of a decision support system for integrated water management within the Lake Manyara sub-basin (LMSB), Tanzania. The area includes a National Park and UNESCO Biosphere Reserve. A group discussion listed 26 stakeholders, categorized according to sector, influence, and interest. The stakeholders were grouped into six functional categories: local Non Governmental Organisations (NGOs), other civil society groups, Belgian and international NGOs, authorities, academics associated to international donors and the private sector. We empirically identified advantages, shortcomings and associated risks when performing a stakeholder analysis with an interest-influence matrix. Confounding factors may include e.g., the omission of important stakeholders, a different understanding of 'influence' and 'interest', or the omission of fragile groups. Instead of 'low' or 'high' interest and influence, we propose the terms 'supportive', 'potentially supportive', 'unsupportive', 'not interested', 'low or no influence' and 'antagonistic'. Further, we consider stakeholders who directly extract resources from the social-ecological system (SES) as a separate category, because of their direct dependence and impact on the SES. This improved stakeholder analysis framework for developing decision support systems in water basins can contribute to better analysis, understanding and management of aquatic social-ecological systems in general.

Key words: Biosphere Reserve- stakeholder analysis- decision support system- integrated water management – group discussion

Introduction

Effective and fair environmental management requires the inclusion of relevant stakeholders, or groups who have a "stake" in the ecosystems under scrutiny. Stakeholders can provide information about changes that have occurred in an ecosystem (Martins et al., 2018), identify problems and suggest alternative solutions (Wilson et al., 2006) and engage in social learning. In the absence of stakeholder analysis, particularly powerful and well-connected stakeholders can have a greater influence on decision-making outcomes than more marginalised groups; a problem that is especially acute in development projects (Chambers, 1997; Reed et al., 2009). Stakeholder analysis has been enriched by the development of participatory methods for project design and planning, for example, through participatory rural appraisal (PRA), action research, social forestry, and land-use planning (Grimble and Wellard, 1997; Mukherjee et al. 2018).

Stakeholder knowledge is key to identify conservation purposes, to inform management and to understand human behaviour and motivations in the context of conservation, especially when complex behaviour is involved (Cepić and Nunan, 2017). Finally, stakeholder involvement is a prerequisite for socially robust knowledge that suits complex sustainability challenges (Cornell et al. 2013). Some type of stakeholder analysis (SA) is therefore recommended for purposes of scoping opinions and knowledge, developing strategy and action plans, management plans, environmental impact assessments or decision support systems, or for increasing local communities' ownership of resource management and use. The seminal review by Reed et al. (2009) developed a typology of SA methods and their strengths and weaknesses. Typically, SA will identify and categorize stakeholders, and their mutual relationships. The categorization of stakeholders according to their "interest" and their "influence" or "power" is a central element in SA analysis. SA can be applied in the first place to identify and describe stakeholders in a particular setting, such as a social-ecological system (SES) (Donaldson and Preston, 1995; Ostrom, 2007). But beyond the descriptive SA, SA can also be instrumental, normative or a combination of those (Reed et al., 2009). SA becomes normative when it is used to legitimate certain policies or decisions through the involvement of key actors. SA is seen as instrumental when its purpose is to help stakeholders understand certain issues, adapt certain behaviours, technologies, or other possible solutions, hence rather at operational or management levels. Moreover, the clustering of stakeholders, based on similarities in specific stakeholder characteristics, such as their roles, degrees of power, or their management objectives, may also assist management decisions, as it can differentiate more clearly between those who make the decisions and those who are affected by the decisions made, and in what way and to what degree (Grimble and Wellard, 1997). A variety of methods have been developed for such differentiation and categorisation,

including ‘interest-influence matrices’, ‘stakeholder-led categorisation’, and ‘Q-methodology’ (Reed et al., 2009, Hugé et al., 2018).

Like other rangeland ecosystems in Tanzania, the Lake Manyara region in Northern Tanzania is of high conservation value, but subject to a myriad of anthropogenic pressures putting pressures on biodiversity (Kideghesho et al. 2013). We therefore consider it a suitable model system to analyse the role of stakeholders in matters of conservation and ecosystem services (ES). Janssens de Bisthoven et al. (2020) collected opinion and perceived trends about ES in group discussions and interviews during a social-ecological assessment of Lake Manyara sub-basin (LMSB) and compared these with relevant literature. Within the group discussions, they used tools to facilitate brainstorming such as the problem tree analysis (Zimmermann et al., 2008), Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis, participatory mapping (Corbett and Rambaldi, 2009) or the prioritization of ES. These approaches have similar components to the Toolkit for Ecosystem Service Site-Based Assessment (TESSA) (Peh et al., 2013). Prior to these collective exercises, a routine SA was performed in plenary, consisting of (1) identifying stakeholders and (2) categorizing them according to their ‘interest’ and ‘influence’. These results served as an implicit basis but were not presented nor elaborated on in Janssens de Bisthoven et al. (2020), as that study was more ES-oriented than actor-oriented. The present study intends to explicitly draw lessons learned from this particular SA and, as a benchmark, match them to insights developed in the literature. We will especially focus on the interest-influence matrix approach, by developing a critical appraisal in an empirical way. From the perspective of our roles, being project holders (of a competitive research project on underpinning decision support systems for LMSB), scientists and development practitioners, we analyse possible confounding factors of SA and we propose fine-tuning elements to make SA more performant (i.e. with less ambivalent implicit understanding by all actors of what influence and interest mean) in the field of management of aquatic ecosystems in particular, and social-ecological systems more generally.

Materials and Methods

General context

In the framework of interuniversity cooperation projects between scientists from Belgium, Tanzania, Zimbabwe, the United Kingdom and South Africa, two participative workshops (WS) were held to better understand the perceptions of stakeholders concerning the ES in the Lake Manyara Sub-Basin (LMSB), Tanzania. The aim was to identify ideas or building blocks for the elaboration of a future decision support system for Integrated Water Management of LMSB. Seventeen stakeholders were

present in the 2015 workshop, and 18 during the 2016 workshop, representing NGOs, pastoralists' and farmers' networks, national conservation agencies, local and international universities, and authorities (local districts and water management). The choice of invited stakeholders was based on the appreciation by the local Tanzanian scientists and the Belgian NGO 'Trias' in Arusha working with local civil society. We tried to have a representative sample of stakeholders with a wide range of interest and influence on the management of the LMSB, its costs and benefits, also with the support of grey litterature. Although we used the same procedures of invitation for both workshops, we did not manage to get the same group of people, which was mainly due to individual agendas. Not intentionally, WS1 was composed of stakeholders with more influence and a higher level of formal education, compared to WS2. We accepted it as an opportunity to have a more diverse sample of stakeholders when combining both WS. Stakeholders were working in group discussions (*sensu* Payne and Payne, 2004) and their stated points of interest ranged from small scale farming, land use planning and rights, to pastoralism, water management, and biodiversity conservation. Plenary, group and individual exercises were conducted during the two workshops; key features of these workshops are summarized in Table 1.

Table 1: Overview of the activities conducted during the two stakeholders' workshops regarding the management of Lake Manyara sub-basin, Tanzania, in 2015 and 2016. For each exercise, we specify whether it was organized as an individual, sub-groups or plenary exercise (n refers to the number of stakeholders, present).

2015 workshop (n=17)	2016 workshop (n=18)
• Stakeholder analysis (SA) (individual and plenary) • Problem/solution tree around the central problem of sedimentation and shrinking of Lake Manyara (individual and plenary) • Community mapping of the area (sub-groups) • SWOT analysis concerning the need for a decision support system for integrated water management (plenary)	• Summary of the 2015 workshop • Ecosystem services prioritization and trends (individual) • Detailed description of priority ecosystem services (sub-groups) • Mapping of priority ecosystem services (sub-groups)

The results of these two workshops (WS) were complemented with interviews and published in Janssens de Bisthoven et al. (2020). In the present study, we focus mainly on WS 2015 (WS1) and its SA and SWOT. We however will refer to the 2016 WS (WS2) as well, since it is strongly linked, partially composed of the same actors and part of the same comprehensive social-ecological assessment of LMSB. The WS2 participants were informed about the findings of WS1, hence creating a continuum between both WS. Since WS2 contained enough stakeholders who also participated in WS1, sufficient

agreement remained on the results of WS1. In Table 2 are listed all stakeholders which were listed during WS1 and which of those were present at WS1 and/or WS2.

Stakeholder analysis

The participants of the 2015 WS were asked to use individual cards to cite all possible stakeholders involved in the current use of the sub-basin, and their possible interest and role in a future decision support system for integrated water management. Using the classical stakeholder analysis framework, this list of stakeholders was subsequently classified during a plenary session into four categories: 1/ high interest, high influence, 2/high interest, low influence, 3/ low interest, high influence, 4/ low interest, low influence. These results were used to construct an interest-influence matrix: the X-axis gives the range from low to high interest, and the Y-axis from low to high influence. For ease of understanding and direct description of the stakeholders, we included these data directly in the right columns of Table 2 (reading these columns is equivalent to reading the interest-influence matrix data). We identified *a posteriori* several qualities and shortcomings of the influence-interest matrix according to a number of empirically defined criteria linked to the SA of WS 2015, the lessons learned from the 2016 WS, and we conducted a risk assessment for potential confounding factors.

Results

During the 2015 WS, participants were asked to list stakeholders and their main activities in the LMSB. Twenty-six stakeholders were listed during the workshop and categorized by collective consensus during the plenary session according to their function, influence, and interest in a future decision support system for the LMSB (Table 2). This consensus was reached by proposing an option by the moderators on their own knowledge base and then entering into a dialogue with the participants to reach convergence. The stakeholders identified can be grouped into 6 categories: local NGOs (2), other civil society associations and groups (informal groups, as opposed to accredited local NGOs of category 1) (6), Belgian or international NGOs (3), authorities (8), project-related academics associated to donors, and private sector (5). Based on insights from the research team, and drawn from the workshops, several qualities and shortcomings of the SA as applied in LMSB, were identified as possible confounding factors and their associated risks (Table 3).

Table 2. List of stakeholders identified during the 2015 workshop, categorised according to sector, interest and influence, related to the Lake Manyara sub-basin. WS=workshop. The categorization of the stakeholders is expressed with a colour code according to their score (high-medium-low) for the criteria 'interest' and 'influence'. These columns contain the same data as an interest-influence matrix. The second column indicates the presence of the stakeholders at the 2015 (WS1) and 2016 (WS2) workshops.

Nr.	Presence WS1 or WS 2	Functional categories	Stakeholders	Sector / Activity	Interest	Influence
1	1,2	**1-Local NGO**	Ujamaa Community Resource Team (UCRT)	Land use, pastoralists	high	low
2	1,2		MVIWATA (National networks of Farmers' groups in Tanzania)	Smallholder farmers	high	low
3	1	**2-Associations, groups**	Water research association group	Water user association	high	medium
4	no		Catholic relief services	Karatu, Endabash area	low	low
5	no		Mto wa Mbu cultural tourism programme	Walking around villages (Manyara and Tarangire ecosystems, homesteads, dancing, cooking….)	medium	low
6	2		Pastoralists	Land use, land rights, land protection	high	low
7	2		Farmers	Mto wa Mbu: Smallholder (no large companies): rice, banana, maize, beans, vegetables, fruits, sugar cane	high	low
8	no		Informal groups Fishermen	Seasonal and professional immigrants from all over the country, even Malawi. Fishing	high	low
9	1,2	**3-Belgian NGO**	Trias	Sustainable natural resources, small scale farmers, pastoralists, human wildlife conflicts, land tenure	high	medium
10	1	**4-International-NGOs**	African Wildlife Foundation	Restoration, rehabilitation outside national park in catchment, assisting communities in good practices (forestry, beekeeping, anti-erosion), in partnership/parallel with the Tanzania National Parks (TANAPA)	high	low
11	no		NGO World Vision	Supporting community, land use plans in villages, environmental programmes (trees, bees…) together with pastoralists, broader than African Wildlife Foundation which is more wildlife focused.	medium	low

12	1	**5-Authority**	Monduli district	Administration planning land aspects & natural resources	high	medium to	high
13	1,2		TANAPA (Tanzania National Parks)	National conservation: conservation of Lake Manyara and associated biodiversity, improving livelihoods of surrounding communities in support of conservation	high	medium to	high
14	1,2		Internal Drainage Basin Water Board	Water management and allocation, abstraction from boreholes, furrows (irrigation)	medium (WS 2) to	high (WS 1)	high
15	1,2		Karatu, Mbulu, Monduli, Babati , Kondoa, Simanjiro, Arusha districts	Forestry, land & natural resources, mining + other departments such as community development, water, health, connection with ministry	high	medium to	high
16	no		Regional commissioners Manyara and Arusha, Dodoma (level above the district-1 commissioner per region)	Centralise the districts	medium to	high	high
17	no		Town of Mto wa Mbu, district wards (3)	Residents, consumers and sellers on local markets.	medium to	high	low
18	no		National Environment Council (NEC)	Water use, set national goals and objectives and determine policies and priorities for the protection of the environment	medium to	high	medium to	high
19	no		Ngorongoro conservation Area Authority NCAA	Springs, forest water catchment, multiple land use (go inside the crater for salt licking)	medium		low
20	1,2	**6-Academics and donors**	Five Universities	Project-related: Nelson Mandela – African Institute of Science and Technology, KU Leuven, University of Zimbabwe, University of the Western Cape, Plymouth University	high	low
21	1,2		Royal Belgian Institute of Natural Sciences	Project-related research institute	high	low
22	no	**7-Private, business**	Hunting companies	Hunting for trophies, future plan to be more committed to conservation, outside national park (95% of issues is outside)	low	low
23	no		Tour operators	Tourists within and outside the NP.	medium	low to	medium

24	no		Large scale farmers, plantations	Large scale: rice, sugar cane, maize, beans	low	medium to	high
25	no		Middlemen (lorries)	Trade in fish	low	low to	medium
26	no		Lodges	Tourism, water use	medium to	high	medium

Table 3. Confounding factors identified for the stakeholder analysis approach used in Lake Manyara sub-basin (LMSB), with their associated qualities, shortcomings, and risk assessment

Confounding factor	Qualities and shortcomings at the LMSB assessment	Risk assessment per confounding factor and consequences
Who is physically present or absent during the WS?	Of the ca. 30 listed stakeholders, 17-18 were present at WS 1 and/or 2. Of these, 5 international stakeholders were project-related and hence also part of the moderation panel. This means that the remaining 12 local stakeholders represent ca. 1/2 of identified stakeholders. Noteworthily absent was the business sector. Indeed, the WSs were dominated by actors from civil society, authorities, and academics. We expect the participants to be aware of civil society and official (authorities) stakeholders, but less aware of private sector stakeholders, not present at the WSs. Hence participants may tend to focus more on their own judgements (=self-assessment) and could possibly influence the discussions in their favour. A strong gender imbalance was observed, especially in the first workshop (3 women and 14 men in WS1, 5 women and 13 men in WS2).	**Variable attendance to consecutive workshops:** LOW RISK: The risk of missing out information in one workshop is compensated by the organisation of another workshop (even when this second WS did not include a stakeholder analysis) and the partial overlap of participants between both WS needs to be acknowledged but can be an enrichment for the scoping of knowledge. The WS2 participants were informed about the findings of WS1.
		Self-assessment & stakeholder subjectivity: LOW RISK: Stakeholder analysis is per definition subjective. A diverse composition of the focus groups or group discussions is necessary to have a diversity of opinions. Possible biases can be rectified by the facilitators. Key measures to lower these risks: (1) to ensure the group composition covers a sufficiently large range of interests and influence; and (2) to moderate the WS in such a way that all stakeholders feel confident enough to have the opportunity to express themselves. It is the responsibility of the moderator, not to influence the discussion and to make sure everybody has a voice.
		Gender imbalance: LOW to MEDIUM RISK: The replacement of 4 to 5 men by women in both workshops would have created a better gender balance. However, it remains unknown if this would have influenced the outcomes of the workshop. Additional surveys and video sequences were added to the workshops, with a

		special effort to listen to women from grassroot organisations. This additional information had the potential to compensate for eventual gaps due to the gender imbalance. When it comes to the role of men and women when harnessing or benefiting from ES, we estimate that the risk of scoping biased information would be higher.
Who is listed or not listed during the stakeholder analysis?	The participative listing of stakeholders can be biased by the stakeholders present at the WS. Not listed during the WS 1 exercise were e.g., the Members of Parliament and ministers with high decision powers, and potentially medium to high level of interest, as well as other international donors.	**False positives** RISK NIHIL. Inclusion of stakeholders who have nothing to do with the Social Eological System (SES) concerned is minimal, given the expert knowledge within the group discussions.
		False negatives MEDIUM RISK: forgetting some important players in the stakeholder analysis might bias the needs for a future decision support system of the SES. In the case of the LMSB, some members of government or international NGOs were not mentioned, probably seen as 'too far' from the stakes of the SES.
Clusters and level of detail	The outcome of such participative exercise is dependent on the level of knowledge of the participants and reveals the focus of the participants as stakeholders. The functional categories are arbitrarily chosen to structure the data. However, the number of stakeholders per category is dependent on the level of detail. Some stakeholders are given by their name (e.g., project-related), while others are just described by their generic activity (e.g., tour operators including several companies).	**Variable level of detail** LOW RISK: whether a stakeholder analysis will generate 25 or 35 listed stakeholders is very much dependent on the level of detail: are the groups listed in a generic way or with their specific names (=more stakeholders)? The level of detail during the stakeholder analysis can generate a certain risk of missing out important information about stakeholders put into the same generic group but having different 'stakes' (interest & influence). The facilitators and the participants should be made aware of that to mitigate this risk and can maybe

		suggest general categorizations of stakeholders after the first listing by the WS participants.
Who has interest in what?	A difficulty with this type of analysis is the definition of the focus of interest: is it the development of an Integrated Water Management Plan (IWMP), its implementation or its impact? Also, the level of interest is maybe present, but not fully elaborated due to a lack of awareness and knowledge. So, the level of interest is often more 'potential' than real. Further, 'interest' can be facultative (tourist having interest in conservation) or 'existential' (pastoralist needs grass).	**Unclear definition of interest** MEDIUM to HIGH The 'interest' can be identified as a positive attitude towards the need of an IWMP, but also as 'having an interest' or an 'existential stake' in an IWMP which takes their corporate/sectoral interests into consideration (e.g., crops, livestock, tourism). Therefore, the term 'interest' can be ambivalent or 'bi-directional' (positive or negative) and was subject to discussions in the group discussions.
Who has influence in what?	Sometimes, the 'influence' was not clear, depending on the lobbying power of the concerned stakeholder, often unknown or intentionally unexpressed because of its sensitivity among the WS participants, creating socially desirable answers. This is reflected in Table 2, were sometimes several scores were assigned to the same stakeholder.	**Unclear definition of influence** HIGH The WS participants were all highly interested but had relatively little decision power or 'influence' (most are low or medium), a bit more during WS1 than during WS2, the latter being more grass-root based. Here the term 'influence' can be interpreted as potential official decision power or potential lobbying power on the decision makers and creates an ambivalence of interpretation and power attribution.

SWOT analysis

A collective exercise in the 2015 WS consisted of listing the criteria "strengths-weaknesses-opportunities-threats" (SWOT) identified in plenary session by the group discussion concerning the development of a decision support system for integrated water management of the LMSB Social Ecological System (Table 4). The SWOT was reached in consensus after several rounds of dialogue for each of the criteria. Analysis of the SWOT reveals that of the 25 issues listed by the group discussion, 11 issues are rather related to stakeholders' relationships and 14 issues are rather linked to the sustainable use or management of ES (Table 5).

Confounding factors

From previous listings and analyses (Tables 1-5), we identified several confounding factors when considering SA with interest-influence matrix or biplot of stakeholders. They are summarized in a conceptual biplot of interest against influence (Fig. 1): the participating stakeholders at the focus group or workshop are themselves stakeholders of the socio-ecological system under consideration. There is hence an element of subjectivity and bias towards the participants, who reflect about their own interest and influence and list other stakeholders who might be relevant for the central question, in this case, the opportunity to elaborate a decision support system for integrated water management. The gender ratio of the participants might have influenced the discussions as well, though we could not uncover in what way. Fact is that workshops in Africa are often numerically dominated by men, and in our study, this was unfortunately no exception. Calhoun et al. (2016) pleaded in that respect to better acknowledge the voice of women in fisheries management. Further, we consider the possibility that some important stakeholders were not present at the WS, which could be a missed opportunity to have their opinions 'live' during the WS. We symbolize this with the dark triangles in Fig. 1, representing potentially important stakeholders with high influence and interest (upper triangle, e.g., members of parliament), and potentially important stakeholders with high interest but no influence (lower triangle, the so-called fragile groups, such as e.g., the indigenous groups and local communities, women groups, youth...). Moreover, it is theoretically possible that the SA 'forgot' to list some pertinent stakeholders (false negative, error type II), or it is possible that the SA listed stakeholders who are not relevant (false positive, error type I). And finally, the two axes (interest and influence) might be subjected to debate as to their exact significance, as it is collectively understood during the SA at the WS.

Table 4. SWOT analysis concerning the development of a decision support system for integrated water management of the Lake Manyara sub-basin.

SWOT criteria	**Issues identified**
Strengths	1. Increased sustainability (long term benefits, no overexploitation of natural resources). 2. Involvement of communities and gender equity. 3. Integrated natural resources management (linked to socio-economic aspects). Increased demand leads to increased prices. 4. Nelson Mandela – African Institute of Science and Technology (NM-AIST): already lots of plans but questionable sustainability. 5. Pastoralists: livestock keeping contributing to conservation of wildlife corridors. Cultural bomas, jobs in lodges, revenue from tourism, also for Maasai. 6. Farmers: most people who live here (town of Mto wa Mbu) are not natives, they come here to do business (e.g., selling bananas, cassava, eggs, etc.). This means that the availability of water is crucial. When the lake basin is depleted, most of the people will flee, because they will lose their sources of income. 7. TANAPA (Tanzania National Parks): filling gaps of missing information, scientific data (siltation, water budget), modelling, different scenarios. We can use this info to provide decision makers with clear scientific language. Research is considered important for policy: politicians want scientific information but under the form of understandable graphs and schemes. Output of the project within which the workshop took place, should be a policy brief. 8. Restoration of water sources, implementation of legal practices (Decision Support System) and stimulation (operational monitoring). Attempts to mitigate erosion, demonstration plots can be helpful. 9. Districts: community awareness, improvement of Lake Manyara basin protection, benefits for the people, info on species biodiversity of Lake Manyara (fish species). 10. NGO Trias provides clarity about what is sustainable use, efficiency of water use. 11. Universities: problems presented here are not unique to Tanzania: institutional, policy implementation, water allocation, human wildlife conflicts, good models. This is a case study. Awareness raising amongst students, capacity building, because the financial support is limited, raise awareness in the North is very important. Joint effort with NM-AIST is a strength that will provide bigger buy-in with the authorities. Common context analysis by Belgian actors supports this kind of synergies.

Weaknesses	12. Lack of involvement of stakeholders who have a lot of influence (tourism not represented, big farmers, plantations) e.g., water source with small scale farmers in conflict with pipe from large farmers. Communication goes through districts. Mutual interests with tourism are there. 13. The research can only provide data e.g., how much of the water reaches the lake. But the government should act. 14. Trust in academicians (stakeholders) from the North is often a problem.
Opportunities	15. Generation of ideas and plans for extension projects and policy makers, decision makers, the seeds for further decisions. 16. Coming up with assessment of needs, questions. 17. Building up trust in academicians, expertise. 18. Making baseline data available, mobilize it for decision support. 19. Making clear that the different stakeholders are working towards the same goals, enhance cooperation between stakeholders.
Threats	20. Putting finger on the wounds, without good implementation of results and discussions it could enhance tension between stakeholders (e.g., big farmers gain from this project?). 21. Polarizing, creating division (e.g., big scale farming creates jobs, food security...). Clear boundary setting and proper communication are needed. 22. Lack of communication from universities in an accessible way, lack of feedback, lack of cooperation. Ivory tower, lack of trust. 23. Climate change is out of control of local people. 24. Lack of implementation of advice given by the project, gap between policy-laws-compliance. 25. More water, so more cattle possible, threat of perverse effects or negative feedback loops.

Table 5. Summary of the SWOT (Table 4) in terms of number of issues related rather to stakeholder relations or rather to ES. The numbers in brackets refer to the items listed in Table 4.

SWOT category	# issues related to stakeholder relations	# issues related to ES
S	4 (2,5,6,9)	7 (1,3,4,7,8,10,11)
W	2 (12,14)	1 (13)
O	2 (17,19)	3 (15, 16, 18)
T	3 (20,21,22)	3 (23,24,25)
Total	11	14

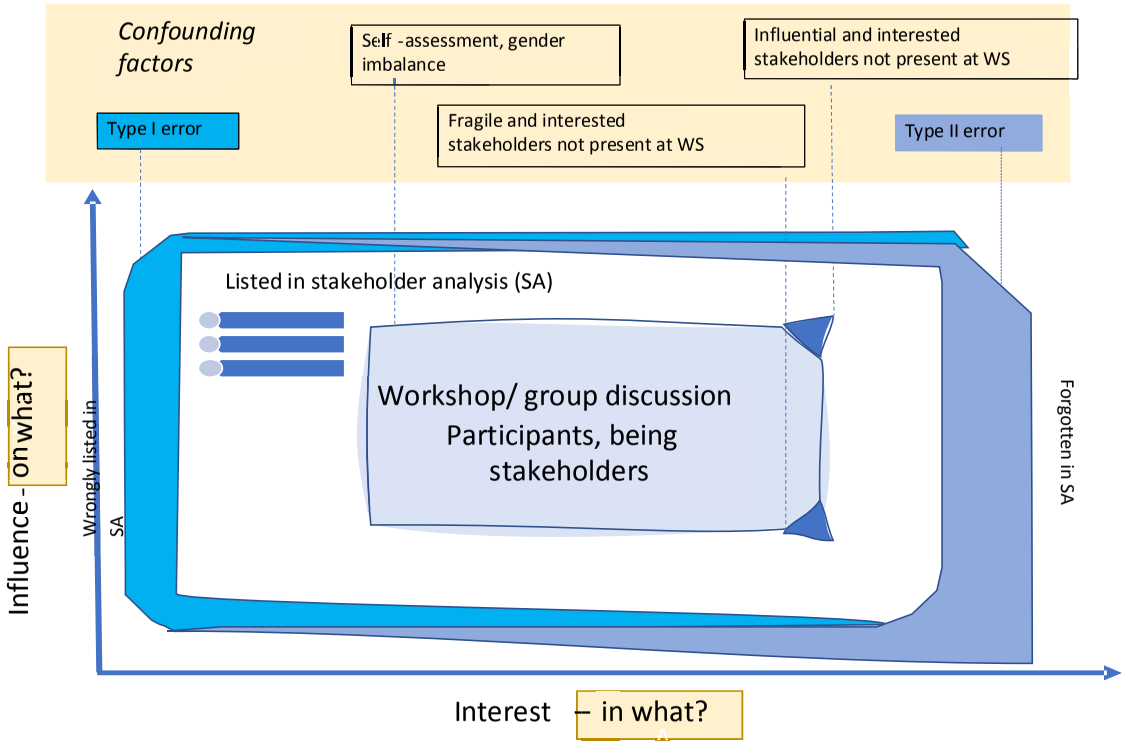

Fig. 1: Link between the classical interest-influence biplot of stakeholders and possible confounding factors: false positives (wrongly listed irrelevant stakeholders, type I error), false negatives (forgotten pertinent stakeholders, type II error), self-assessment & gender imbalance, lack of important stakeholders in WS (dark triangles), unclear definitions of 'interest' and

‘influence’. The polygons represent the surface where stakeholders can be plotted as a function of their ‘interest’ and their ‘influence’, from low to high. The scheme does not answer the question about what kind of interest or influence is meant.

Discussion

The conceptual ambivalence of 'interest' and 'influence'

The confounding factors listed in Table 3 were empirically derived from the discussions during the workshop, which focused on the integrated management of water as a key ES. In terms of the stakeholder assessment there was some confusion as to what exactly defined 'interest' and 'influence' in terms of 'getting' and 'giving' water. The village communities have a lot at stake, hence a high 'existential' interest as their livelihoods depend on the whole system (Wynants et al., 2019). Some listed stakeholders like fishermen were however not present at the WS (high interest, low political influence but high influence on the lake, lower triangle in Fig. 1), but the participants agreed that fishermen, even when only temporarily based in the area, have interest in, and influence the biotic system as they come fishing whether the season for fishing is open or not (illegally). The conservation authority, Tanzania National Parks (TANAPA), would have a lot of influence in the National Park as it can decide who enters and who does not. Using natural resources was seen by the participants as 'influence', which is interesting, since in classical SA, 'influence' rather tackles power relations (Reed et al. 2009).

Local farmers do not have much power, hence no so-called formal, institutionalized 'influence', although they have high stakes, high 'existential' needs, hence 'interest'. Further, participants mentioned that lodges and hotels have a high influence as the community complains that they use all the water, and this causes conflict. Here again, influence is interpreted as 'direct impact on the ecology' of the area, not actually on the governance, management of the area.

Smallholder farmers reported that they were invited to parliament, but still their influence stays rather limited. They reported that they cannot act without consulting the districts. But these have different interests. Different district authorities were categorized in different sectors within the interest-influence matrix. For instance, the district of the town of Mto wa Mbu has a lot to contribute and to benefit. They are the primary beneficiaries. They can make the local people participate so they are influential. The group discussions highlighted the mutual relationships between stakeholders, one of the pillars of SA according to Reed et al. (2009) and Raum (2018).

The bigger plantations can have a negative influence on the water balance. Their interests are high, but they are not of the same nature as other 'interests', as they could be 'antagonistic' in terms of impact on the SES. The place of the tourist lodges and the private tourism-linked sector caused a lot of discussion and disagreement. Do they have a positive or negative influence? What about the

conflict with communities? The fact that pastoralists burnt down a lodge shows the high conflict potential in the area.

Based on the discussions during the workshops, it appears that low or high 'interest' and 'influence' can have different meanings for different stakeholders. This makes the debate only richer. However, a more fine-tuned approach would facilitate a thorough understanding of the factors and actors in a SES (Table 6), bringing less ambivalence and more clarity. Moreover, scientists also are motivated by their own 'interests', governed by their research agenda and some development outcomes linked to their funding agency (Table 6). As funders, knowledge brokers, co-organizers and co-moderators of the workshops, they have multiple roles and might inadvertently or on purpose influence the discussion dynamics, which refers to the confounding factor "self-assessment" in Fig. 1. Duncan et al. (2020) identified under-explored aspects of brokering expertise, such as the multiple dimensions of brokering, transdisciplinary skills and expertise, uncertainty management and knowledge translation practices. Interestingly, they found that scientists were building boundaries between science and policy to foster credibility and legitimacy for themselves as scientists and the knowledge they were brokering. We estimate this as being part of the game (or difficult to avoid), but active acknowledging these underlying processes would help establish clear boundaries of what can be expected from such workshops.

If 'interest' can be shaped from potentially supportive to supportive, it shows that 'interest' can be a choice. That can be true for some – e.g. "I can decide to care about Lake Manyara as a global citizen". But for many local farmers and pastoralists, 'interest' is not a choice, there is just no plan B, it is a so-called 'existential' interest. They need the lake, the land etc. Interest could be fine-tuned as a continuum of voluntary/non-voluntary interest. If influential actors (e.g., the government) realize that their stakes (their interests) are higher now, does that mean these interests are the same as the farmers'? Probably not. Pushing some influential (= powerful) actors to have stronger stakes in an area is not always desirable, especially when it comes at a higher cost to e.g. biodiversity (e.g. mass tourism or intensive agriculture). What would be desirable in the framework of developing a decision support system, is to involve influential actors (e.g. water authorities) with a genuine interest for the less influential ones who depend on ecosystem services for their existence (the local farmers, the pastoralists). Benevolent powerful actors, acting for the interests of the powerless is a desirable category. That is however an emancipatory thought and is a highly normative wish or reflection, as part of the SA process. Another consideration is the fact that stakeholders are 'potentially supportive' because of lack of knowledge or awareness, and with some efforts of awareness raising and information, can become more or fully 'supportive'. Hence, instead of 'low' or 'high' interest, we propose the terms 'supportive', 'potentially supportive', 'not interested' and 'antagonistic' (Table 6).

Analogically, instead of 'low' or 'high' influence, we propose 'supportive', 'unsupportive', 'low or no influence' with their decision power and lobbying power, and this at three levels: policy and governance, management and local. Further, the SA on LMSB highlighted the fact that we needed to take the group of stakeholders directly extracting resources from the SES separately. These stakeholders have a high 'existential' interest in the LMSB and are 'influential' on the ecology of the area, although politically they have low or no influence. They might have a supportive or an antagonistic attitude (Table 6). Our typology, explained in Table 6, can be an additional fine-tuning of the classical interest-influence matrix. The typology is descriptive rather than normative, as the typology needs additional testing and fine-tuning in the field. The fact that the classical interest-influence matrix tends to categorize stakeholders in four compartments (low vs high interest, low vs high influence) refrains from assigning stakeholders to different categories at the same time. This approach, however, might be a simplification of the reality as stakeholders' positions in the matrix quadrants are not static. Stakeholders, for example, can initially be indifferent or potentially supportive, but become supportive with the help of awareness campaigns, action research or education. For instance, pastoralists can be made aware of solutions to co-exist with wildlife (e.g., the use of living fences) and to benefit from eco-tourism schemes. In the classical matrix these stakeholders would be plotted at the boundary between low and high interest. Further, our framework offers the possibility to fine-tune the type of influence attributed to certain groups of stakeholders. Our new framework therefore offers a template to better describe the real meaning of 'interest' and 'influence'.

In his UK study on forest ES, Rau (2018) defined 'influence' of the stakeholders as the ability to affect the provisioning of forest ES either directly through their use and/or management activity, or indirectly through policy and/or regulation. In his definition we can identify the bidirectionality of the possible influence (be it negative or positive), as well as the different levels of influence, be it direct (management and use) and indirect (policy and regulation). One elegant way to understand what is meant with 'interest or influence of stakeholders', is to ask about the possible reasons for interest or influence in a specific ecosystem service (Rau, 2018). For instance, in the case of Rau's study (2018), the Royal Society for the Protection of Birds (RSPB) has a medium to high interest in forest ES because of (1) it is mainly interested in biodiversity and (2) also other ES, partly to access public funds for management and conservation activities. Further, the RSPB has high influence, because it has a large membership, is wealthy and has a large land ownership (= another reason). By listing 19 stakeholders having some level of interest and influence in forest ES in the UK, Rau (2018) identified 34 reasons, why stakeholders might be interested, and 42 ways (how?) of having some sort of influence. Reed et al. (2009) identified strengths and weaknesses inherent to interest-influence matrices: they can be

used to prioritise stakeholders for inclusion and renders power dynamics more explicit (strengths). On the other hand, prioritisation may marginalise certain groups; and it assumes that stakeholder categories based on interest–influence are relevant (it can be seen as a possible weakness). A more in-depth analysis from the perspective of the social psychology literature of the significance of 'interest' and 'influence' is referred to in Reed et al. (2009) but is beyond the scope of present study.

Table 6. Typology for fine-tuning 'interest' and 'influence' based on the stakeholder analysis in Lake Manyara sub-basin (LMSB). Note that stakeholders may belong to several categories at the same time. This scheme is proposed as additional fine-tuning to the classical low-high interest-influence matrix used in SA.

<table>
<tr><th>Interest</th><th>Influence</th></tr>
<tr><td rowspan="2">'Supportive' (voluntary or existential): has genuine interest in environmental protection, the development of a Decision Support System (DSS) and IWMP and needs to be kept informed and involved. E.g., interest to receive or provide training, education & awareness. Is interested because can be affected by a DSS in a positive way: more income, need to optimize sustainable livelihoods activities, multiplicator, best practices, or because can enjoy the protected ES (e.g., tourism).
Example from our study:
- voluntary: tourists, scientists
- existential: some farmers and pastoralists</td><td>'Supportive': has positive decision power concerning (in the case of LMSB) (1) water allocation, (2) land use, (3) benefit redistribution at
• policy & governance level
• management level
• local level
Example from our study:
- district wards
- TANAPA rangers
- local NGOs</td></tr>
<tr><td>'Unsupportive': has antagonistic decision power concerning (in the case of LMSB) (1) water allocation, (2) land use, (3) benefit redistribution at
• policy & governance level
• management level
• local level
Example from our study:
- some decision makers or ES users having vested interests</td></tr>
<tr><td rowspan="2">'Potentially supportive': could be made more aware and interested because of their influence but lack of interest or ignorance. E.g., interest to receive training, education & awareness and to be empowered on rights. This category can switch to the supportive category by awareness, education, information.
Example from our study:
- local communities, villagers</td><td>Supportive: 'has lobbying power' at
• policy & governance level
• management level
• local level, rallying/activist/ campaigning
Example from our study:
- Tourism industry in Arusha
- International NGOs
- The involved scientists from North and South have also their own interests, such as a research agenda, coupled with some desired development outcomes which are linked to the funding agency.</td></tr>
<tr><td>Unsupportive: 'has lobbying power' at
• policy & governance level'
• management level'
• local level, rallying/activist/ campaigning
Example from our study:
- Politicians with vested interests</td></tr>
<tr><td>'Not interested': Does not feel concerned by the issue at stake.
Example from our study:
- some politicians, people not living in the area, not depending on the ES.</td><td>No or small influence: has a fragile position, no influence socially and politically, this group includes marginalised populations, hunter-gatherers, indigenous people and communities or women and youth groups. Their influence in terms of 'lobbying power' might increase with the strengthening or empowering in a rights-based approach by external dedicated actors. Their culture, world view, traditional knowledge, way of life or role in society are often threatened and often overseen.
Example from our study:</td></tr>
</table>

	- Poor communities, women & youth groups & associations, hunter-gatherers (Hadza, South-West of LMSB)
'**Antagonistic'**: has vested interests which are antagonistic to the intended changes. The 'interest' resides in wanting to have a say to resist intended changes, avoid losing actual income or switching to other economic activities. The degree of antagonism can be gradual and can switch to become supportive. **Example from our study:** - Farmers in intensive agriculture, some politicians	**Has influence on natural resources**: these groups of stakeholders live from ES in a direct way, by extracting water, fish, medicinal plants, wildlife, wood etc, or having beehives favouring pollinating. Their economic activities have an impact on the SES, be it negative or sustainable. Their interests can cover the whole range, from supportive to antagonistic. **Example from our study:** Bee-keepers, traditional medicine men/women

Who has a voice?

As stated by Reed et al. (2009) and Raum (2018), "Stakeholder analysis enables the systematic identification of stakeholders, the assessment and comparison of their particular sets of interests, roles and powers, and the consideration and investigation of the relationships between them, including alliances, collaborations, and inherent conflicts". However, many questions need to be addressed in this debate, about representation, legitimacy, power and 'who is in and why', and who defines these issues (Reed et al., 2009; see also Schut et al. 2015 for the importance of power imbalances and unequal representation between stakeholder categories in integrated analysis of agricultural challenges).

These questions very much reflect our practitioner's empirical experience in this social-ecological assessment of LMSB. As Brugha and Varvasovsky (2000) stated, stakeholder analysis is very much about understanding "relevant actors", their behaviour, interests, agendas, and influence on decision-making processes. This is important to scope the feasibility of future policy options in a transparent way for all involved. Possible drawbacks of participatory stakeholder analysis are well described by Reed et al. (2009) and recognised in the present study, which guided us to identify the main confounding factors. In some cases, hidden agendas or covert interests may also skew the analysis (ODA, 1995), sometimes questioning the legitimacy based on categorisations (Reed et al., 2009). For example, Bardosh et al. (2014), in a case study on the zoonotic tapeworm *Taenia solium* in Laos, caution against using ethnographic participatory approaches in a purely instrumental way, to deliver messages perceived as scientifically correct. Rather, they should lead to a choice and implementation of policies that is adapted to the local bio-social context. Other potential problems include the perceived lack of knowledge, skills, or resources to conduct stakeholder analysis, concerns over what the analysis will reveal, fears that the analyses may be destabilising or manipulative, and ethical concerns about representing the views of other people (Fraser and Hubacek, 2007). The presence of

Western scientists as funders, knowledge brokers, co-organizers and co-moderators may also have a huge influence on the group dynamics of such workshops. The whole group (North and South) is confronted with ingrained and often unconscious attitudes which were shaped by decades of colonialism and donor-beneficiary power balances (see Verran, 2002). This is a relevant subject in another debate, which is beyond the scope of the present study. Identifying the usual suspects may generate a danger that this may lead to the under-representation or even omission of marginalised or powerless groups (Calton and Kurland, 1996; Grimble and Chan, 1995) (see also confounding factors in Fig. 1, omission of important players, false positives, and negatives).

Listing the stakeholders: who is in and how?

As pointed out by Rau (2018), most studies that include stakeholders in ecosystem services research, do so at the local level only (e.g., Asah et al., 2012). In the case of the LMSB study, we expect that scale or distance of stakeholders to the provisioning of ES, might affect the level of interest. For example, Hartter and Goldman (2011) reported for a Ugandan forest park that an additional couple of kilometres distance from the protected area can cause substantial differences in benefits or harm experienced by stakeholders. We observed that the authorities of the town of Arusha, heavily dependent on the multi-million tourism industry in the Northern tourist circuits of Tanzania, might be highly interested, although not involved in the two workshops and not really mentioned in the SA, nor present at the WS (false negative, type II error). There is a real risk that some stakeholders may be accidently or not intentionally omitted (for agenda or logistic reasons) and therefore not all relevant stakeholders of the phenomenon may be identified (Clarkson, 1995) or present in the discussions, which is a false negative or type II error (Fig. 1). There is a risk of overlooking stakeholders who act as long-distance or indirect drivers of change, as is the case for e.g., international consumers of Nile perch from Lake Victoria (Van Asselen et al., 2013). In the LMSB case both WS did not include Arusha town, high level politicians, the tourism industry (dependent on wildlife viewing inside and outside the national park) and the commercial farmers (extraction of irrigation water from tributaries of Lake Manyara and pollution by pesticides), even though all have relatively high stakes in the ES of LMSB. On the other hand, it is often not possible to include all stakeholders and a line must be drawn at some point, based on well-founded criteria established by the research analyst (Clarke and Clegg, 1998). These may include for example, geographical criteria like the boundary of a protected area or demographic criteria such as nationality or age, depending on the focus of the analysis In this respect, the concept of 'servicesheds' (i.e. spatial unit that can provide the same benefits of ES to the same people) as described by Tallis et al. (2015) offers an interesting spatial tool to motivate conservation

efforts for stakeholders with different socio-economic interests. Also, such SA should rely on the collective intelligence of all participants to arrive at a comprehensive analysis or understanding of the SES under scrutiny.

Who is interested in what, and has influence on what?

Although the SA performed within the framework of a social-economic analysis of LMSB proved useful (Janssens de Bisthoven et al. 2020), an ex-post critical appraisal of the tool used (interest-influence matrix) led us to identify a number of confounding factors (Fig. 1). These factors ranged from possible subjective and gender bias of the group discussions, omission of important players from the group and from the listed stakeholders in the SA, to unclear or different understanding of 'interest' and 'influence'. While omission of important players can be resolved by putting more effort into the reflection within SA and the (logistic organisation of) participation in the WS, we felt that the 'classical' interest-influence matrix did not reflect a complex reality. Analyzing these factors and their associated risks (Table 3) guided us in defining a new fine-tuning framework of 'interest' and 'influence' within SA which may offer some relief when considering the confusion raised about 'interest' and 'influence'.

What about the relationships between the stakeholders?

The '4Rs' tool analyses how people relate to one another over natural resource use by splitting stakeholders' roles into the '4Rs': rights, responsibilities, and revenues (benefits), and then assessing the relationship between these roles (Tekwe and Percy, 2001; Salam and Noguchi, 2006). In the present SES-assessment, less explicit attention has been devoted to the underlying relationships between the stakeholders. However, as shown during the lively debates at both workshops, we believe that the categorization of stakeholders according to their influence and role descriptions implicitly included a strong aspect of relationship. The SWOT analysis showed clearly that about half of the issues raised, directly concerned relationships among stakeholders, be it in a collaborative, informative or conflictual way. The data in Table 5 suggest that, when installing a Decision Support System for integrated water management, about half of the issues related to weaknesses, opportunities and threats are related to relationships among stakeholders. For 'strengths', especially issues (e.g., access to water) related to ecosystem services were underlined. This observation accentuates the importance of engaging with stakeholders, especially in the management of natural resources, as ownership of processes by stakeholders is perceived as the key to success. This approach might also reduce the risks of possible weaknesses and threats and increase opportunities.

Among the 11 stakeholder-related statements collected in the SWOT analysis (Table 4), 'strengths' mostly related to community awareness). Concerning possible weaknesses, a lack of good communication or trust between communities and decision makers, academics, and commercial stakeholders is highlighted. Concerning opportunities, trust and joint efforts or cooperation appear as good entry points for opportunities. Concerning possible threats, the same issues emerge, such as bad communication, lack of trust, lack of tangible results in the field resulting from a DSS, lack of feedbacks.

Reed et al. (2009) mention three main methods to investigate the relationships among stakeholders: (1) Actor-linkages, (2) Social Network Analysis; and (3) Knowledge Mapping Analyses. Rau (2018) described the roles of groups of stakeholders as providers, users, and regulators of forest ES, which is an actor-based approach. This comes the closest to our second WS 2016 where we let the stakeholders draw schemes of flows of goods and services from providers to beneficiaries, in combination with our interviews (Janssens de Bisthoven et al., 2020). Obviously, the power or influence of certain stakeholder categories upon others is the very basis of the underlying relationships and of potential conflict resolution. Negotiation among stakeholders about costs and benefits of ES is crucial to address concerns of credibility, saliency, and legitimacy, in order to define alternative scenarios, as explained by Adem Esmail and Gineletti (2017) for watershed management. When working with stakeholders, one has to be aware that different groups derive well-being benefits from different ES (Daw et al., 2011). Daw et al. (2011) plead for disaggregated analysis of stakeholders, especially when dealing with ES related to poverty alleviation. Our SA typology (Table 6) contributes to this disaggregation, by looking in detail who is supportive, has interest or is influential in positive or negative sense.

Approaches to link stakeholders and environmental management can be very diverse. Janssens de Bisthoven et al. (2020) framed the SES into the Driver-Pressure-State-Impact-Response framework, where the ES and the human well-being (inherently linked to stakeholders) were placed within the Impact compartment. Stakeholders with influence on decision making can be part of the Response box, while many other stakeholders will be affected by, or will affect ES (Driver and Pressure compartments). In this case it was more a statement-based approach (both from a literature review and from stakeholders present at the WS and in the surveys) in contrast to the actor-based approach of Rau (2018 In other cases, stakeholders may be analyzed for the costs and benefits they are subject to, linked to changed environmental patterns or management (Cong et al., 2014), or using multi-criteria evaluation for different scenarios in water management or conservation (Rosso et al., 2014, Nyumba et al., 2018, Adem Esmail, 2018). Integrated approaches are increasingly recognised in order to support policy decisions (Ferreti, 2016). Notwithstanding the development of elaborate stakeholder engagement and analysis techniques, Young et al. (2016), stressed that processes need in the first

place to be fair and to instill trust among stakeholders, especially in situations of environmental conflicts. They stated that 'building and maintaining trust with landowners and managers may be central to conserving biodiversity. Such trust-building requires effort and resources, opportunities for appropriate dialogue between stakeholders and a willingness to share power in terms of knowledge and policy implementation, especially when local stakeholders are dependent on and knowledgeable about natural resources.' This clearly is reflected in the SWOT (Tables 4 and 5).

Conclusion

A SA creates a process of reflection amongst the stakeholders, and a sense of knowledge about the issues at stake in such environmental conflict setting. It allows addressing issues which are difficult to address frontally and without the help of external facilitators. The latter may be considered more neutral (but see Denney et al. 2018 on how power relations between researchers, practitioners and stakeholders may have an influence). Thus, stakeholders observe themselves; it is like a self-assessment (Fig. 1). The categorization of stakeholders in 'haves and have nots' concerning 'influence' and 'interest' is helpful, but also may lead to confusion. Influence and interest can be defined in several ways, and hence the results will be biased to what stakeholders believe they understand.

We propose an improvement to the analytical power of categorisation approaches in SA and the use of the interest-influence matrix SA tool by finetuning the typology of involved stakeholders. We suggest fine-tuning with additional criteria based on the level of support, distinguishing between voluntary or existential interest. Any number of stakeholder attributes can be included in this way and the resulting patterns examined and the implications assessed. This improved stakeholder analysis framework for developing DSSs in water basins can contribute to better support the analysis, understanding and management of aquatic social-ecological systems in general.

Acknowledgements

We wish to address a special thanks to all stakeholders present at the two workshops in 2015 and 2016. This work has been co-financed by a North South South Project of VLIR-UOS (financed by the Belgian development Cooperation, DGD), and by the EVAMAB project (Belgian Science Policy BELSPO). Esther Roux (CEBioS) is acknowledged for bibliographical editing. MPMV is supported by the Special Research Fund of Hasselt University (BOF20TT06).

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