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RESEARCH ARTICLE

Managing resources through stakeholder networks: collaborative water governance for Lake Naivasha basin, Kenya

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ABSTRACT

Stakeholder analysis and social network analysis were used to analyze stakeholders' social and structural characteristics based on their interests, influence and interactions in Lake Naivasha basin, Kenya. Even though the Kenyan government and its agencies seem to command higher influence and interest in water resource management, the presence of influential and central stakeholders from non-government sectors plays a key role in strengthening partnership in a governance environment with multiple sectors, complex issues and competing interests. Interactions in the basin are guided by stakeholders' interest and sphere of influence, which have both promoted participation in implementing a collaborative water governance framework.

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Collaborative water governance; stakeholder analysis; social networks; Lake Naivasha basin; Kenya

Introduction

Collaborative natural resources governance, particularly for water resources, has recently gained prominence and promotion as a flexible and sustainable approach to dealing with complex dynamics and uncertainties associated with resources (Ananda & Proctor, 2013; De Boer, Kruijf, Özerol, & Bressers, 2016; Fish, Ioris, & Watson, 2010). Governance is broadly defined as "a partnership in which government agencies, local communities and resource users, non-governmental organizations and other stakeholders negotiate, as appropriate to each context, the authority and responsibility for the management of a specific area or set of resources" IUCN (1996). It therefore represents a shift from a government-driven, hierarchical and command-and-control model to a model that encompasses a network paradigm where stakeholders share in the management, rights and responsibility for the resource (Marín & Berkes, 2010). This shift reflects the recognition of the importance and influence of diverse stakeholders – individuals, groups and organizations – to devise and implement efficient,

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equitable and sustainable solutions in resources management (Brugha & Varvasovszky, 2000; Duram & Brown, 1999).

Collaborative water governance combines *collaboration*, which involves cooperation to achieve goals of efficiency, equity and sustainability in water resources, and *governance*, which is made up of forces, systems and mechanisms consisting of elements that exist inside and outside government institutions and work together to achieve particular outcomes (De Boer, Vinke-de Kruijf, & Özerol, 2013; Driessen, Dieperink, Laerhoven, Runhaar, & Vermeulen, 2012). Governance takes place at multiple scales and levels and involves multiple stakeholders. This study borrows from Bressers et al. (2013) and defines a water governance system as "the context that guides and organizes the actions and interactions of the stakeholders involved in the management of water resources". Engagement of stakeholders in collaborative water governance has the advantage of reducing enforcement costs, enhancing sharing of knowledge and promoting systematic learning between the stakeholders, all which are important for promoting effectiveness and legitimacy (Adger, Brown, & Tompkins, 2006; Brisbois & de Loë, 2016).

The interaction of stakeholders in collaborative water governance often leads to social networks (Folke, Hahn, Olsson, & Norberg, 2005). Such interactive networks are normally dictated by the diversity of stakeholders' interests and influence, and have often proved to be more effective than formal institutions in shaping regulatory output and ensuring compliance (Berkes, 2002; Scholz & Wang, 2006). The networks have proved to facilitate development, availability and diffusion of knowledge and information; mobilizing and availing of resources; and management and resolution of conflicts (Crona & Bodin, 2006; Hahn, Olsson, Folke, & Johansson, 2006; Newman & Dale, 2007; Provan & Kenis, 2007).

Success in collaborative water governance therefore depends on a fundamental understanding of the stakeholders, their social processes and interaction networks (Crona & Hubacek, 2010; Marín & Berkes, 2010). At a water basin level, there has however been limited analysis of the social dimension and relations among the stakeholders in terms of their varying positions, interests, authorities and level of participation. Without an adequate understanding of stakeholders and their spheres of influence, interests and interactions, collaborative water management arrangements may yield dismal results or become a chaotic situation, even with good intentions (Grimble & Wellard, 1997).

Lake Naivasha basin, Kenya, is a significant resource due to its social and economic importance, including for horticultural production, geothermal power generation and tourism (Becht, Odada, & Higgins, 2006; Mulatu, van Oel, & van der Veen, 2015; Van Oel et al., 2013; Willy, Zhunusova, & Holm-Müller, 2014). The scramble to derive economic benefits among the competing users and uses on one hand, and the desire to protect the basin from degradation and ensure its sustainability on the other, have led to the coexistence of multiple stakeholders (Enniskillen, 2002; Otiang'a-Owiti & Oswe, 2007; Pegram, 2011). Using stakeholder analysis (SA), this article identifies and analyzes those with a stake in water resource management in the basin, based on their interest and influence. Further, the study assesses the interaction and networks of the stakeholders using social network analysis (SNA). Both SA and SNA have proved to be powerful tools in natural resource policy analysis and development, particularly in systems characterized by the challenges of multiple stakeholders, multiple objectives and multiple interests, as is the Lake Naivasha basin (Grimble & Wellard, 1997; Yang, 2014)

Institutional structure for stakeholder participation in water governance in Kenya

The Water Act of 2002 defines the management, use, conservation and control of water resources in Kenya (GoK, 2002). The act emphasizes the principles of decentralization and subsidiarity in the management of the country's water resources. To this effect, the act has created an institutional framework that promotes public–private–people (civil society) partnerships. This is a people-oriented approach in which the community and water resource users, in partnership with the public and private sectors, participate in water resource management through planning, decision making and implementation. This framework has resulted in complex interactions characterized by trade-offs and interdependencies between stakeholders and sectors operating at various levels and scales of water resource management.

The governance set-up derived from the act has been adopted and implemented in the Lake Naivasha basin. The basin has a multiplicity of stakeholders representing diverse ethnic, geographic, economic, socio-political and environmental groups with unique vested interests and varying spheres of influence. Whatever level they operate at and whatever their focus issues, these stakeholders have been important in making, implementing and changing the 'rules of the game', which are the codes of conduct through which the institutions engage and operate in water resource management in the basin.

Lake Naivasha basin: location, management challenges, and stakeholder interests

Lake Naivasha basin, Kenya, is a 3400 km^2 closed basin composed of four sub-catchments: the River Gilgil, River Malewa, River Karati and Lake Naivasha (Figure 1). The lake is of international importance, having been declared a Ramsar site in 1995, and is thus protected under the International Convention on Wetlands (Ramsar, 2011). It has also been designated an Important Bird Area by BirdLife International. The basin has immense socio-economic and conservational benefits, which hinge on tourism, geothermal energy, subsistence farming, ranches, fisheries and a flourishing floricultural and horticultural industry (van Oel et al., 2012).

The tourism sector in Naivasha is estimated to have a value of about KES 600 million per year, with the attraction sites being centred around Aberdare National Park and the lake region, including Hell's Gate and Longonot National Parks and several sanctuaries. The area under irrigation is estimated at 4,450 ha and is dominated by flower production, which contributes over 70% of Kenyan flower exports (earning about USD 400 million in foreign exchange per year). The floriculture industry contributes about USD 180 million to the basin's local economy. The Ol Karia geothermal power plant, also located in the basin, has a potential of 162 MW and generates about 15% of Kenya's electric power.

The increased economic production has resulted in immigration of people from different regions, introducing an ethnic dimension in the use and management of water in the basin. The basin has a fast-growing population of about 650,000 people (Kenya National Bureau of Statistics, 2009), which has contributed to unplanned human settlements. The rapid economic activities and population growth have led to increased

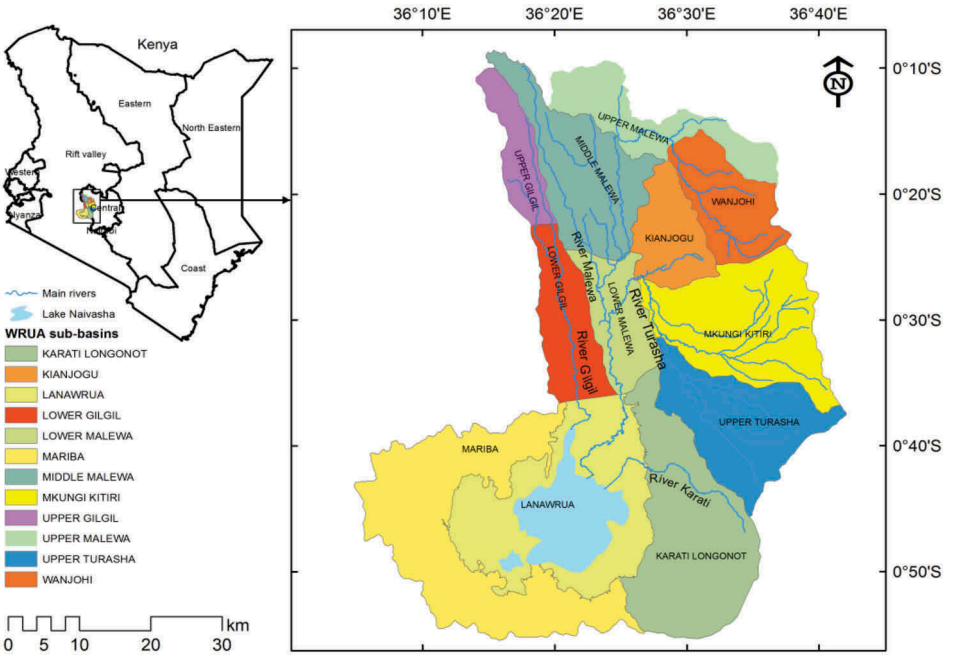

Figure 1. Study area: a map of Lake Naivasha basin showing its hydrology and local water resource management units.

demands for environmental resources (water and land) and substantial degradation (soil erosion; increased siltation and nutrient enrichment) (Van Oel et al., 2013). Further, land-use changes have had an effect on the water balance, putting the ecosystem under increased pressure (Otiang'a-Owiti & Oswe, 2007). This pressure and the need to protect the ecosystem have resulted in conflicts of interest between stakeholder groups, including landowners, water users and conservation organizations. The above factors threaten the future sustainability of the lake and its waters. Efforts by stakeholders to address these challenges have evolved into a complex governance situation that needs to be understood for purposes of policy strengthening, for sustainable basin management as well as for knowledge and provision of lessons.

Although public participation in natural resources management in Kenya has developed only recently (Avramoski, 2004), Lake Naivasha basin stakeholders have a long tradition of championing their complex interests with respect to the need to use, conserve and ensure the future sustainability of the basin (Becht, Odada, & Higgins, 2006). The oldest formal stakeholder engagement in the basin's resource management can be traced back to 1929, when landowners adjacent to the lake formed the Lake Naivasha Riparian Owners Association to resolve conflicts over the use of water resources and land around the lake (Enniskillen, 2002). The association has since changed its name to Lake Naivasha Riparian Association (LNRA) and has evolved into a more inclusive community-based organization by accommodating membership of non-riparians and other stakeholder categories. With changing times and increased resource needs, more stakeholders have emerged, with some forming groups for more collective operation in the basin, e.g. Lake Naivasha Growers Group representing

commercial flower farms, Lake Naivasha Tourism Group, Naivasha Plot Owners Association, etc. On the other hand, several water management projects, through the support of the donor community, are active in the basin: the World Wide Fund for Nature (WWF), in partnership with CARE-Kenya and the Water Resources Management Authority (WRMA), has been implementing a programme on Equitable Payment for Watershed Services; the Water Stewardship Project by Deutsche Gesellschaft für Internationale Zusammenarbeit (GiZ), in collaboration with Imarisha Naivasha and WRMA, supports Water Resource Users Associations (WRUAs) to carry out riparian conservation and infrastructure project activities in the basin. Further, the Water Governance Centre, with the support of the Embassy of the Kingdom of the Netherlands, is involved in executing an integrated water resource action plan that brings together public- and private-sector actors in sustainable water resources management for people, businesses and nature in the Lake Naivasha basin.

The Water Act has led to more structured government participation in the basin's water resource management. Water is managed by a complex web of ministries and multiple national, regional (county), local and cross-jurisdictional agencies. Some of the notable institutions include: WRMA, which has the overall mandate to conserve, manage and regulate use of water resources; Kenya Wildlife Services, as the custodian of Lake Naivasha Ramsar Site on behalf of the government; Imarisha Naivasha, a programme which provides a forum for coordination of management activities and collective engagement by the stakeholders involved in the conservation of the lake and its catchment; the National Environment Management Authority (NEMA); and several water-sector ministries and departments. The government's promotion of the principle of subsidiarity has led to the formation of 12 WRUAs in the basin. The WRUAs represent local water users and riparian landowners who work together under formal and voluntary arrangements to promote conflict resolution and cooperative sharing, management and conservation water commons in the basin.

Despite the many stakeholders in the basin, their involvement in water resources management has been poorly studied, with only limited attempts to identify key stakeholders and analyze their relationships and arrangements (Becht et al., 2006; Billgren & Holmén, 2008). Yet the performance of water governance and institutional initiatives is influenced by stakeholders and the nature and extent of the relationships between them.

Methods

Analysis techniques

This study used SA and SNA. Both techniques have been used together in several studies due to their ability to complement each other (e.g. Lienert, Schnetzer, & Ingold, 2013; Prell, Hubacek, & Reed, 2009; Reed, 2008; Yang, 2014). These studies show the integral role which can be played by the two methods in decision making by providing an analysis of those with stakes in a given resource. As a study method, SA has been applied to gain an understanding of multi-stakeholder dynamics in participatory resource management systems through identification of stakeholders in particular aspects of the system, and prioritizing their involvement in decisions on aspects of the system (Grimble & Wellard,

1997). In assessing stakeholders' influence and interest, the method classifies stakeholders into four categories based on their relative influence and interest (Reed et al., 2009). Thus, our study classified stakeholders in the basin into Players, Subjects, Crowd, and Context Setters. Players are those with high interest and high influence and thus have an essential role in water resources management (Grimble & Wellard, 1997; Reed et al., 2009). Subjects have high interest but low influence and are usually central to the process of participation, even though they may lack the ability to produce an impact (Reed et al., 2009). To overcome their weak influence, stakeholders in this group sometimes form groupings or alliances. Context Setters are those with low interest but high influence. Even with their low interest, which makes them not the main target for engagement, this category cannot be ignored (Reed et al., 2009). Crowd are those with little interest and limited influence. The extent of their engagement with other stakeholders therefore also tends to be limited.

Even though SA has become an integral part of participatory water resources management initiatives, it has occasionally been seen as subjective and wanting in analytical quality due to its qualitative nature (Lienert et al., 2013; Prell et al., 2009). As a way of addressing this weakness, SNA was also used in this study.

SNA is a quantitative technique (Bodin & Crona, 2009; Lienert et al., 2013). It employs network algorithms and a combination of ethnographic work and field observation to capture stakeholders' social relations (Hellmann & Staudigl, 2014; Robins, 2013). Numbers are used to represent the presence or absence of a tie, and stakeholders are linked by one or more ties. Results are displayed graphically and consist of points (or nodes) to represent stakeholders and lines (or edges) to represent ties or relations (Prell et al., 2009). In specific terms, SNA does not just analyze individual stakeholder attributes but also examines stakeholders' relations; the position of the stakeholders in the network; and the structure of the relations and how they feed into the overall network pattern (Scott, 2000; Wasserman & Faust, 1994). Information from SNA can be useful in strengthening policy to ensure that there is no marginalization of key groups and in identifying conflicts between stakeholders (Reed et al., 2009).

The SNA measures analyzed in this study are strength of ties, centrality and homophily. Strength of ties is a measure of frequency of interaction between the stakeholders, while centrality measures interconnectedness and importance and is useful in determining how stakeholders can use their position/location in the network. Stakeholders occupying central positions are assumed to wield influence over others in the network and are in a position to access valuable information (Burt, 2004; Degenne & Forsé, 1999). Apart from their importance in playing a bridging role, central stakeholders tend to have and exercise more power (Burt, 2001; Hanneman & Riddle, 2005). Three centrality indicators – degree, betweenness and eigenvector – were analyzed. For degree centrality, having more ties means you are more important, while betweenness centrality assumes that being in between many other actors is what makes an actor central. Eigenvector centrality, on the other hand, is based on the inequality among the stakeholders' connections and considers that the more important stakeholders are those connected to the more influential ones.

Homophily is the tendency to relate with stakeholders of similar characteristics. It is assumed that stakeholders having some similarity will tend to be attracted to each other and consequently will choose to interact with each other (Prell et al., 2009; Skvoretz & Fararo, 1992). This however may lead to new information flowing only among the similar few, to the

exclusion of dissimilar stakeholders (Granovetter, 1973). Having only like-minded stakeholders can also limit diversity of knowledge due to unwillingness to accommodate the views of dissimilar others (Bodin & Crona, 2009; Prell et al., 2009). We used density and E-I (external-internal) index to measure homophily among the groups/categories.

Data collection and analysis

Document reviews, participatory methods and interviews were used for data collection following the typology developed by Reed et al. (2009). Stakeholders were (1) identified and (2) categorized; (3) data on their influence and interest were collected and analyzed; and (4) the relationship between groups/institutions in the stakeholder network was investigated.

Following the work of Knoke, Pappi, Broadbent, and Tsujinaka (1996), the definition of stakeholders was limited to formal, organized groups sharing a common interest or stake. The initial conventional stakeholders were identified from an inventory obtained from the Lake Naivasha Basin Integrated Management Plan 2012–2022. The plan has a list of over 100 stakeholders, which was scrutinized to select only stakeholders currently participating in the management of the basin. Such scrutiny was guided by the criterion that a stakeholder is either directly or indirectly influencing water management, water sources or water flows in the basin (Falkenmark, 2003). To the resultant list, snowball sampling was applied to identify other groups who were regarded as stakeholders by the already identified respondents. This eventually resulted in a 'refined list' of stakeholders involved in water resources management in the basin. Due to the diversity and heterogeneity of the stakeholders, they needed to be categorized based on attributes representing different characteristics in the population. The stakeholders were thus categorized based on sectors, functional roles and type of resource use. The 12 WRUAs in the basin were also divided into two groups: LaNaWRUA (Lake Naivasha Water Resources Users Association, i.e. water users around the lake), whose members are individual water abstractors, irrigators, pastoralists, commercial users, tourist operators and water service providers; and upper-catchment WRUAs (the other 11 WRUAs), who are mostly small-scale commercial farmers.

Data on influence and interest were obtained from stakeholder workshops. The workshops were organized by WRMA-Naivasha and facilitated by the project Earth Observation and Integrated Assessment (EOIA) Approach to the Governance of Lake Naivasha, Kenya. From each of the groups formed in the categorization process (see result in Table 1), three stakeholders were purposively sampled based on the nature and extent of their engagement in the basin. It is this group of sampled stakeholders who were involved in a workshop, where they were expected to state the main interests of the stakeholders and to quantify their presumed influence and interest in water resource management in the basin. The quantification was done using a five-point semantic differential response scale ranging from very low influence/interest (1) to very high influence/interest (5). To get these data, the sampled stakeholders were presented with the following questions on each of the stakeholders in the refined list: (1) What is/are the main interest(s) of stakeholder X? (2) Based on your knowledge of stakeholder X's engagement in the basin's water resources management, how would you rate/quantify X's level of influence/interest on a scale of 1–5?

Table 1. Stakeholders in Lake Naivasha basin and their categories/groups.

A. Government agencies/authorities	***D. International NGOs/Agencies***
1 WRMA sub-regional office, Naivasha	27 World Wide Fund for Nature (WWF)
2 WRMA regional office, Nakuru	28 CARE Kenya
3 WRMA national office, Nairobi	29 International Union for Conservation of Nature
4 Imarisha Naivasha	30 World Vision
5 Kenya Wildlife Services	31 GiZ
6 National Environment Management Authority	32 United States Agency for International Development
7 Kenya Forestry Services	33 Netherlands Development Organization (SNV)
8 Catchment Area Advisory Committee	34 Wetlands International
9 Water Services Trust Fund (WSTF)	35 Nature Kenya
B. Government ministries/departments	***E. Local NGOs and community-based organizations***
10 Ministry of Environment, Water and Natural Resources- Nairobi	36 Lake Naivasha Riparian Association
11 Department of Water, Naivasha	37 Lake Naivasha Community Conservation and Development Organization
12 Department of Environment, Naivasha	38 Naivasha Watershed Conservation and Management Programme
13 Department of Agriculture, Naivasha	39 Resource Conflict Institute
14 Department of Livestock- Naivasha	40 Water and Sanitation for the Urban Poor
15 Department of Fisheries, Naivasha	41 Naivasha Civil Society Organizations Forum
16 Ministry of Devolution and Planning, Naivasha	42 Kinangop Birds Conservation Centre
17 Ministry of Lands, Naivasha	
18 Department of Tourism, Naivasha	***Local resource user groups***
19 Ministry of Health, Naivasha	43 Pastoralist community
20 Nakuru County/Governor's Office	44 Fishing community
	45 Upper Catchment Water Resource Users Associations
C. Business sector	46 Lake Naivasha Water Resources Users Association
21 Lake Naivasha Growers Group	47 Community Forest Associations
22 Naivasha Tourism Group	48 Lake Naivasha Basin Umbrella WRUA
23 KenGen Ltd	
24 Water Service Providers (e.g. NAWASCO)	***Universities and research institutions***
25 Kenya Flower Council	49 ITC, University of Twente
26 Naivasha Plot Owners Association	50 Leicester University
	51 University of Western Ontario
	52 Egerton University
	53 University of Nairobi
	54 Kenya Forest Research Institute
	55 Kenya Agricultural Research Institute
	56 Kenya Marine Fisheries Research Institute
	57 Kenya Wildlife Services Training Institute

The level of interest of the stakeholders was guided by Krott (2005): "Interests are based on action orientation, adhered to by individuals or groups, and they designate the benefits the individual or group can receive from certain object." Since interest cannot be determined directly, the way a stakeholder behaves and what he does in relation to water resources management in the basin were therefore used as indicators of their level of interest. Influence, on the other hand, was determined based on (1) statutory role in water resource management; (2) extent of resources committed in water resource management; (3) length of involvement in water resources management in the basin; and (4) existing rights to the resource within the basin.

We further interviewed the stakeholders on the 'refined list' to acquire quantitative data used to analyze their interactions and networks. Interaction in this case was defined as direct links through information exchange and knowledge transfer or provision of tangible resources related to water resources management in the basin. The stakeholders were asked to mark: (1) who they are interacting with; and (2) frequency

of interaction, for which responses were captured in a coded interaction scale: 0, no interaction; 1, interacts once a year; 2, quarterly; 3, monthly; 4, weekly; 5, daily.

SPSS was used to draw a bivariate scatterplot for the SA matrix, and box-and-whisker plots to capture the mean and distribution of interests and influences of stakeholders in each category. UCInet was used to analyze data on network statistical measures of strength of ties, centralities and homophily, while the network graphs were created with NetDraw (Borgatti, Everett, & Freeman, 2002). An assumption was made that the stakeholders in the basin had the objective of achieving effective resource management, and therefore the focus of this study was on positive interactions. Further, this study focused on symmetric networks, where for every stakeholder *i* that reported interaction with stakeholder *j*, stakeholder *j* also reported interaction with stakeholder *i*. The reciprocity also applies to the frequency of interaction, so that if *i* interacted weekly with *j*, *j* was also expected to interact weekly with *i*.

Results

Stakeholder identification and classification

The identification process led to 57 stakeholders with representation from public, private and civil society sectors. The identified stakeholders were categorized into seven groups (Table 1), with government ministries/departments having the highest number of stakeholders due to the inclusion of multi-level vertical interactions at national, regional and local levels. It was necessary to separate government agencies/authorities (Group A) from government ministries/departments (Group B), even though both are government units, due to the former category being composed of institutions formed with more specific mandates and focus on resource management. A notable stakeholder category was the academic and research institutions. These institutions have been engaged over the years in research focused on identifying the challenges in the basin and trying to come up with strategies to overcome the challenges.

Stakeholder analysis: the interaction of interests and influence

The data on stakeholders' perceived influence and interest were used to develop the influence–interest scatterplot in Figure 2. Values from 0 to 2.5 were considered low interest/influence, and those from 2.5 to 5, high interest/influence.

As shown in the figure, the majority of stakeholders (52.6%) were in the Crowd, with low interest and low influence. There were a total of 10 Key Players (high influence, high interest) – five government agencies/authorities, one government ministry, one from the business sector, one international NGO, and two local resource users groups. The interests of the Key Players are captured in Table 2, and since the majority of them are government units, their functions are more in regulation, coordination, formulation and implementation of policies/strategies.

The basin has five Context Setters (high influence, low interest), notably NEMA, three government ministries/departments and the Nakuru County Office. NEMA is the principal government authority charged with the supervision and coordination of all matters relating to the environment, as well as implementation of all policies relating to the environment. Such an important mandate gives NEMA greater influence in the management of the basin

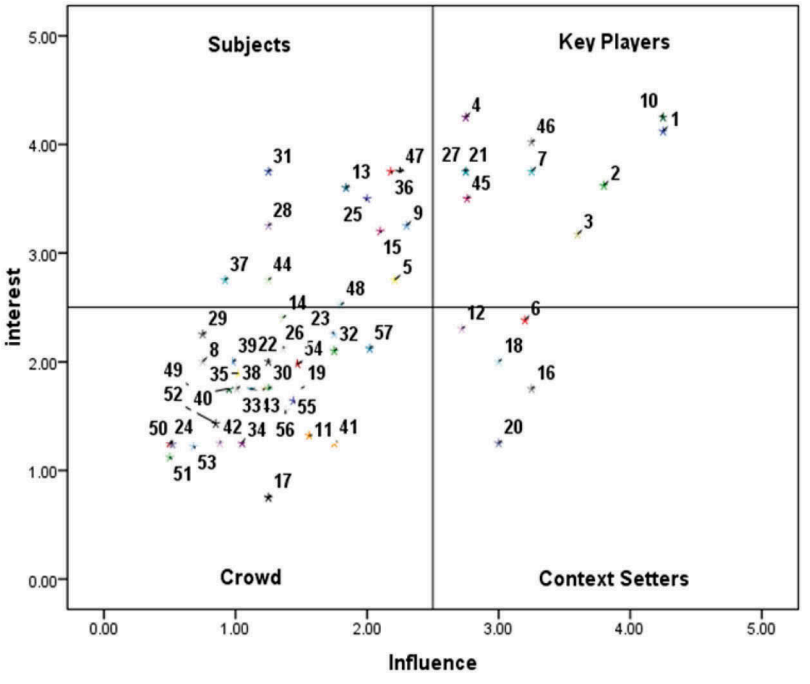

Figure 2. Perceived mean influence and interest of stakeholders in Lake Naivasha basin. Scale from 0 (stakeholder has no influence/interest) to 5 (stakeholder has very high influence/interest).

Table 2. Main interests of the key players.

ID	Name of stakeholder	Main interests in Lake Naivasha basin
1	WRMA sub-regional office, Naivasha	-Better regulation and management of water resources -Improved conservation and sustainable use of water -Efficient allocation and use of water resources
2	WRMA regional office, Nakuru	-Improved and sustainable management of water resources and catchment
3	WRMA head office, Nairobi	-Sustainable development and management of water resources
4	Imarisha Naivasha	-A multi-stakeholder approach to sustainable resource management -Compliance with the laws governing water resources
7	Kenya Forestry Services	-Conservation and sustainable management of forests as catchment for water resources for environmental stability and social-economic development
10	Ministry of Environment, Water and Natural Resources	-Funding for resource management -Control over resources
21	Lake Naivasha Growers Group	-Increased production and income from water use -Sustainability of water resources
27	World Wide Fund for Nature	-Sustainable management of water resources -Improvement in livelihood of local resource users -Empowerment of local water resource users
45	Upper-catchment WRUAs	-Benefits from resource use -Sustainability of water resources
46	Lake Naivasha Water Resources Users Association	-Benefits from resource use -Sustainability of water resources

and its waters. The low interest is explained by the fact that the authority's operations are minimal due to low capacity as the basin continues to experience environmental and water quality degradation. The adoption of a devolved government system in Kenya in the new constitution in 2010 led to the creation of 47 county governments. The Nakuru County

government is responsible for managing the water resources and catchment within its boundary, including Lake Naivasha basin. The responsibility and authority from the constitution therefore gives the county government considerable influence. However, though it was formed in 2013, the county government still lacks the necessary structures and strategies for water resources management. Further, attempts by the county government to acquire control of the political action space and economic gains has led to a debate as to whether water resources management should follow administrative boundaries or should still be managed under hydrological boundaries, as currently done under WRMA.

A linear regression was conducted between stakeholders' interest and their spheres of influence in the basin's water resource management. A positive value of 0.64 (significant at the .05 level) was realized, showing that those stakeholders with high influence are also most likely to have high interest in the basin.

Data on stakeholders' influence and interest were used to produce box-and-whisker plots to capture the mean and distribution of the stakeholders in each category.

As shown in Figure 3, the government agencies/authorities, government ministries/departments and resource users had the highest mean influence on the basin's water resources management. This is understandable since the government units have the regulatory power and authority which they exercise in managing the basin. On the other hand, research institutions, local NGOs and international NGOs had the lowest mean influence. A notable extreme was the Naivasha Civil Society Organizations Forum (41). As an umbrella body for civil society organizations, the forum derives its relatively high influence from its members and its ability to represent the interests of the many local resource users. However, the forum's influence on water resource management is minimal compared to other stakeholders in other categories, probably due to the diversity of its engagements (thus reducing its focus). On the other hand, the WWF (27) was an outlier in the plot due to its high influence compared to the other international NGOs. The fund has been actively involved in the basin for over 15 years, focusing on catchment protection and resource users' livelihood.

The plots for mean interest in Figure 4 show government agencies/authorities having the highest values, followed by resource users, the business sector and international NGOs. Government agencies have high interest in the basin since the Water Act states that "every water resource is vested in the state" (GoK, 2002), and therefore the government and its units have a mandate to manage and protect it on behalf of the citizens. For the resource users, besides relying on the basin for economic gains, the majority of them depend on it for their livelihood. The business sector's high interest is driven by the economic gains, particularly from the horticultural sector, which generates about 10% of Kenya's export revenue and 2.1% of the country's GDP. The business sector is therefore keen to ensure that the basin and its waters are managed in a sustainable way.

A notable outlier is LNRA (36), which, being the oldest association in the basin, has a long-standing interest in the protection and conservation of the riparian region, giving it an edge over the other local NGOs and community-based organizations. Under the new constitution, however, the riparian land belongs to, and should be managed by, the government. This has weakened LNRA's influence and interest, since its role in the basin is no longer clear.

The results from SA indicate that the benefits, services and functions of the ecosystem have much value to the society both directly and indirectly, thus leading to the

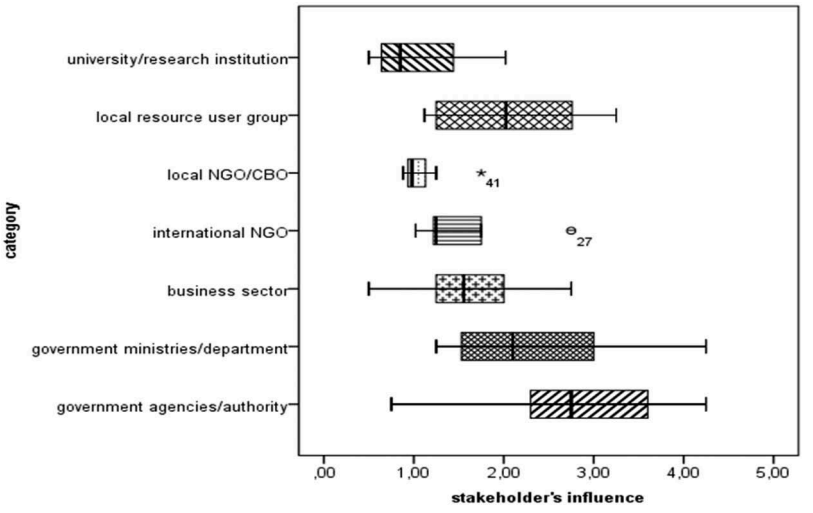

Figure 3. Distribution of mean influence across stakeholder categories.
Note: ⊖ and * indicate the outlier and extreme stakeholders.

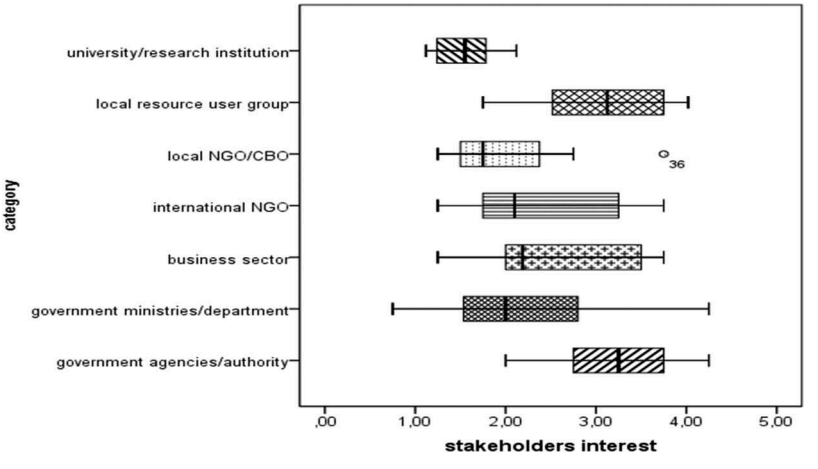

Figure 4. Distribution of mean interest across stakeholder categories.

diversity of interests in the basin. The stakeholders' having influence, and how they exercise the influence, could be used to further their interests and determine the direction and extent of interaction in the basin. It should however be noted that the stakeholders' interests and spheres of influence operate within a dynamic environment and therefore may experience rapid redistribution with changing conditions.

Stakeholder interactions and social network analysis

Using data from stakeholders' interactions, a network graph was drawn with 750 ties (Figure 5). The stakeholders are linked by ties of varying strengths – that is, varying

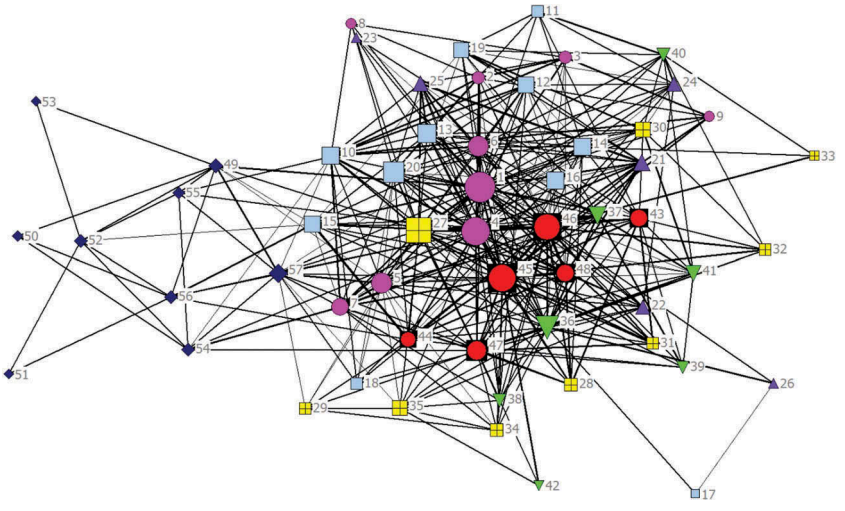

Figure 5. Network diagram showing interaction of stakeholders in Lake Naivasha basin. Density = 0.235; connectedness = 1; network centralization = 26.88%; average distance = 1.942.

frequency of interaction; thicker lines represent higher frequency. The different node shapes and colours represent the seven different categories of stakeholders, while the node sizes are based on the relative degree centrality of the stakeholders (larger nodes represent higher number of ties). Even though only 23.5% of the potential ties in the network are present (density = 0.235), the whole network is cohesively held together, with no isolates separated from the main group.

Strength of ties

Strong ties are often characterized by more frequent interaction and communication (Prell et al., 2009). A network of 'strong ties' was derived by recoding the stakeholder relations and focusing on those occurring at least monthly (Figure 6). The isolated strong ties represent only 27% of the total interactions in the network.

Even though Figure 6 still shows evidence of interaction, the recoded network has a low connectedness index of 0.466 (fragmentation = 0.534), with almost one-third of the stakeholders being isolates (as shown by a total of 15 unconnected stakeholders on the left side of Figure 6) and the majority being on the periphery. The low connectedness may imply that an attempt to concentrate only on the strong ties may lead to the network breaking apart due to exclusion of some important, though weakly linked, stakeholders. This brings to fore the important role of 'weak ties' in bridging the network (Granovetter, 1973).The drop in network density by more than 70% between Figure 5 and Figure 6 further stresses the significance of weak ties in holding the network together.

Measures of centrality

The data on stakeholder interactions being undirected (symmetric), differences between stakeholders were based on the number of connections each had. The mean degree-centrality score was 29.37 (minimum = 2, maximum = 102, SD = 22.28). WRMA,

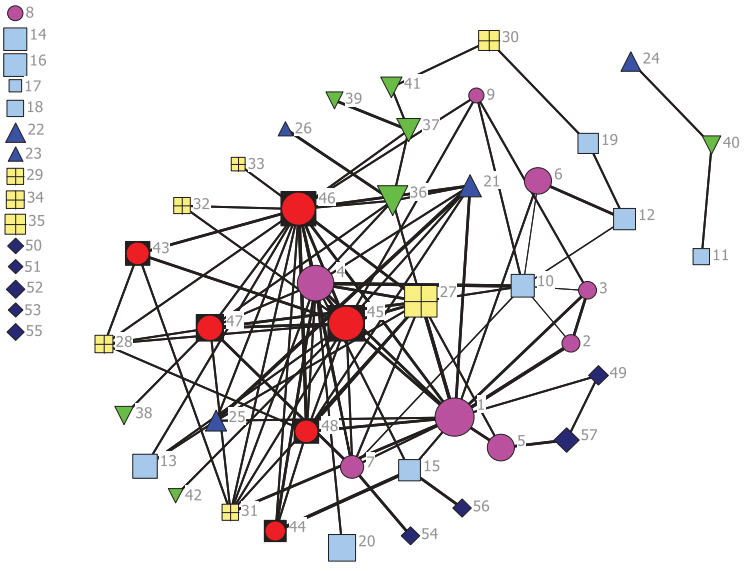

Figure 6. Network diagram of 'strong ties'. Density = 0.063; connectedness = 0.466; network centralization = 19.55%; average distance = 2.548.

LaNaWRUA, Imarisha Naivasha, upper-catchment WRUAs and WWF had the highest degree centrality (in decreasing order). The high degree centrality puts these stakeholders in a strategic position since it creates more opportunities and alternative ways of satisfying needs due to the availability of more choices. Further, they are more likely to be powerful since they are in a position to directly affect the majority of the other stakeholders. This may enable them to access more resources than the other stakeholders.

For betweenness centrality the mean score was 26.386 (minimum = 0, maximum = 179.921, SD = 41.658). The first five stakeholders with high betweenness centrality, in descending order, were WRMA, Imarisha Naivasha, LaNaWRUA, upper-catchment WRUAs, and LNRA. Being between other stakeholders in the network and performing a brokerage role may give these stakeholders the opportunity to control the flow of resources and information.

When linear regression was done between degree centrality and betweenness centrality an r^2 value of 0.748 was realized, indicating that stakeholders with more ties are also likely to have ties between disconnected others. This further stresses the importance and influence of the central actors in any water resources management in the basin.

Eigenvector centrality assumes that central stakeholders should be those connected to those who are central within a given network. The measure therefore takes into consideration stakeholders' direct vis-à-vis indirect connections. In this study, the mean eigenvalue was 0.106, with a minimum of 0.002, maximum of 0.329 and SD of 0.008. WRMA Naivasha, Imarisha Naivasha, LaNaWRUA, upper-catchment WRUAs and WWF had the highest eigenvector scores (in descending order), while the three lowest eigenvector scores were all from universities and research institutions.

To test the difference between the means of the seven categories of stakeholders, a one-way analysis of variance (ANOVA) was conducted on the eigenvector centrality

values. This procedure provides the regular OLS approach to estimating differences in group means. The mean eigenvector centrality of seven categories of stakeholders was A = 0.155; B = 0.091; C = 0.089; D = 0.097; E = 0.095; F = 0.211; G = 0.031; and ANOVA results showed that the difference among these means is highly significant (F = 5.4525, with 6 degrees of freedom, $p < .0005$). The differences in group means account for 40% of the total variance in eigenvector centrality scores among the stakeholders in the basin.

Homophily: within- and between-group interactions

Using density and E-I index, the seven stakeholder categories were analyzed for homophily, as shown in Table 3. Density, in relation to groups, is a mathematical computation of how much closure there is within a particular group, and it ranges between 0 and 1. A low density translates into a sparse interaction network, while a high density translates into network closure. Density of ties within each group was highest among the local resource users groups (0.6), government agencies/authorities (0.28) and research institutions (0.5), while low values were realized in the business sector (0.133), international NGOs/agencies (0.250) and local NGOs and community-based organizations (0.333). There was high density of between-group interactions for all the categories (except universities and research institutions) with local resource users groups.

The E-I index, on the other hand, is important in calculating the relationship between members of a given group and the amount of interaction one has with stakeholders external and internal to one's group. A score of −1.0 in the E-I index means that a stakeholder interacts only with members of its own group, thus indicating homophilous relationships. On the other hand, an index of +1.0 shows that a stakeholder interacts with others external to one's own group, which translates to heterophilous ties.

From the E-I analysis of the whole network, internal ties account for 23% (density = 0.397), while external ties account for 77% (density = 0.210), resulting in a rescaled E-I index of +0.206, which points to heterophilous interactions. At the group level, universities and research institutions (Group G) is the only category whose members have a preponderance of ties within their own group (E-I of −0.161), while stakeholders under government ministries and departments tend towards closure (0.429). The business sector and local resource users had members with the highest tendency towards having ties with others external to the group, compared to internal ties.

Table 3. Measures of homophily in stakeholders' interaction in Lake Naivasha basin.

Density within and between groups							
A	B	C	D	E	F	G	E-I index
0.528	0.364	0.296	0.198	0.270	0.556	0.136	0.537
0.364	0.382	0.227	0.121	0.143	0.364	0.071	0.429
0.296	0.227	0.133	0.074	0.119	0.306	0.000	0.855
0.198	0.121	0.074	0.250	0.222	0.537	0.062	0.633
0.270	0.143	0.119	0.222	0.333	0.571	0.000	0.671
0.556	0.364	0.306	0.537	0.571	0.600	0.056	0.741
0.136	0.071	0.000	0.062	0.000	0.056	0.500	−0.161

Discussion

This study has shown that collaborative management of water resources in Lake Naivasha basin is a complex endeavour due to the multiplicity of stakeholders with diverse social relations and dimensions (Billgren & Holmén, 2008). The dominance of government and its affiliated units in the Key Players and central stakeholders points to the pivotal role of regulation, supervision, planning and coordination still being played by the government in natural resource governance. Adoption of collaborative management and decentralization is meant to encourage participation and links with other non-government players and users. However, that does not translate to complete exclusion of the government and its hierarchies since they still play a role of defining and executing strategies that reflect national priorities and in building an institutional framework that supports them. The results therefore suggest that governance and water resource management initiatives are more likely to succeed if there is active participation and commitment from the government to steer the processes.

The active engagement of local resource users points to the appreciation of decentralization and subsidiarity, where WRUAs are expected to play a more active role in resource management in the basin. Through financial empowerment by WSTF and livelihood-improvement projects supported by international organizations, the resource users have displayed influence and interest as central players in the basin. However, whereas the government has managed to devolve responsibility to the local resource users, this process has not been accompanied by devolution of power to the WRUAs and the capacity to execute the mandates. Most WRUAs have a limited role in decision making and still operate within a top-down framework with imposed government responsibilities (Adger et al., 2006; Steins & Edwards, 1999).

On the other hand, the involvement of stakeholders from local and international private organizations, civil society groups, business-sector partners and research organizations shows that collaborative water governance in the basin is a more inclusive process, with multiple stakeholders from different sectors. This deviates from the popular conceptualization that depicts the governance approach as an arrangement of two parties, where the government shares power with homogeneous resource users (e.g. Adger et al., 2006). The more inclusive participation shown in our findings is supported by the works of Carlsson and Berkes (2005); Marín and Berkes (2010).

The SNA reveals a network that is cohesively held together. However, the weakness of the network is observed in the low level of interaction and association, as reflected by the low density, which could negatively affect the flow of information and mobilization of resources due to limited interactions and accessibility. Further, with more than 70% of the ties being weak, the majority of the interactions are characterized by sporadic communication with low emotional intensity, a fact which could negatively impact collaboration and execution of complex participatory tasks. The high percentage of weak ties could be attributed to weak coordination and lack of institutionalization of the links.

The principle of homophily assumes that 'birds of a feather flock together'; we expect similar stakeholders to have more connections among them (Skvoretz, 2013). But the results of this study, particularly from the E-I index, did not show homophily in the seven stakeholder categories, except for universities and research institutions. Stakeholders in the basin tended to interact more with others outside their group (external ties) than

inside (internal ties). This could be due to the institutional roles played by different stakeholders and the need for collaboration with other stakeholders outside one's group to achieve expected gains or results in water resources management in the basin.

Following the work of Ingold (2014), stakeholders with strong relationships and hence influence (embedded stakeholders) are those who occupy a central position in the network (degree centrality), are located between poorly linked stakeholders (betweenness centrality), and are linked to those who are well linked (eigenvector centrality). Based on these three centrality indices, the most influential stakeholders in the basin are WRMA-Naivasha, Imarisha Naivasha, the WRUAs and WWF. Due to their central positions, these stakeholders have also proved to exploit their interests and spheres of influence and therefore have higher inclusion and greater opportunities to participate in collaborative water resources management in the basin.

Conclusions

Stakeholder analysis and social network analysis of the Lake Naivasha basin is important for improving our understanding of water resources management practices in the basin. This study provides insight into social complexities in the collaborative governance setup. The results point to key/central stakeholders and their engagement based on their position, interactions and representation. Such an analysis, which looks at water governance from a collaborative and network perspective, aims at encouraging collective actions among the stakeholders and consequently better management of water resource in the basin. Even though there may be challenges associated with the engagement of multiple stakeholders in the basin, collaborative governance should be promoted as a necessary process for improving water resource management. Multi-stakeholder processes should therefore be strengthened based on the stakeholders' positions through improved policy and communication strategies. The study underlines the significance of social networks in resource management and shows that stakeholders who know and astutely exploit their interests and sphere of influence are more effective participants in implementing a collaborative water governance framework.

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