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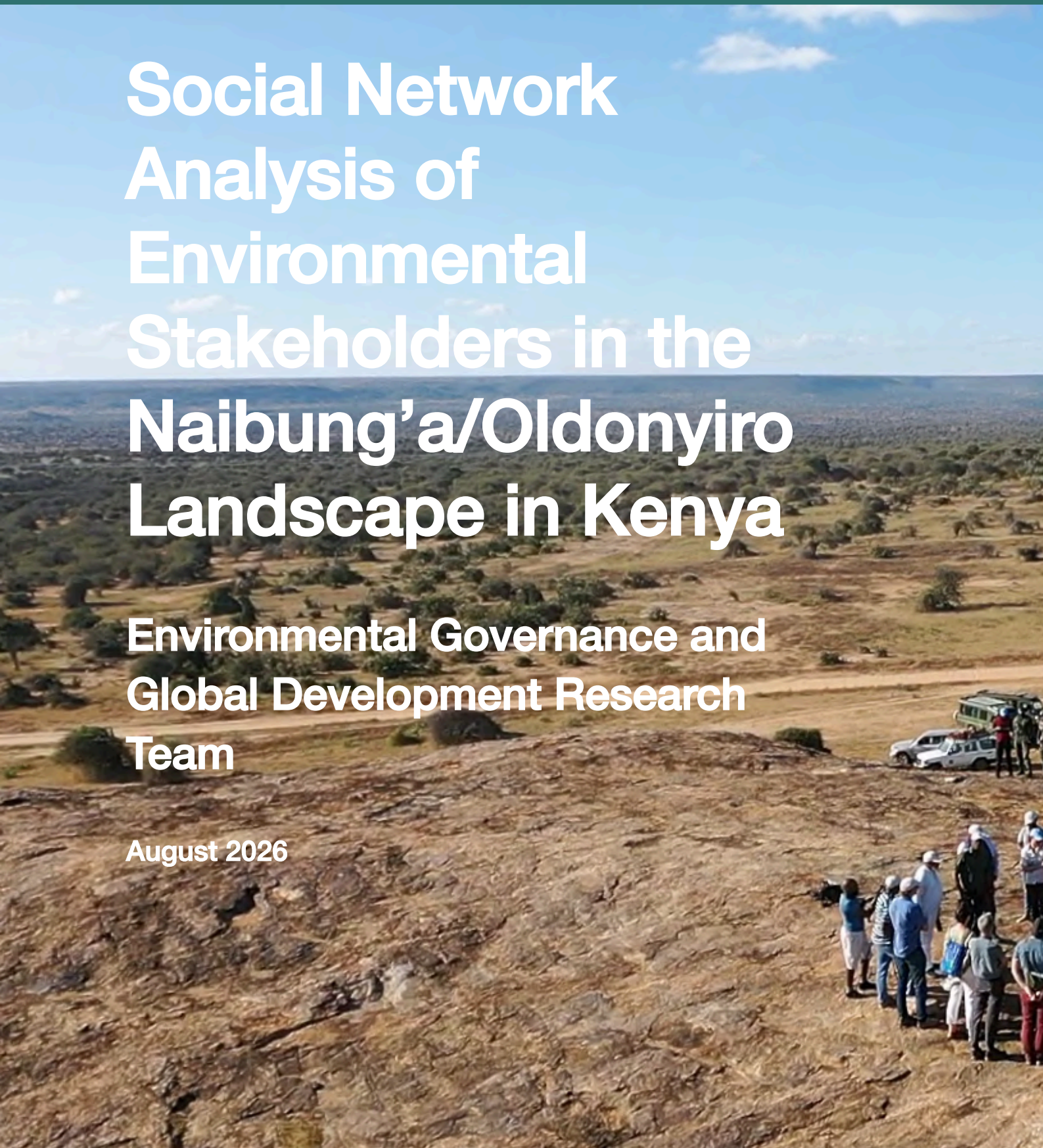

Social Network Analysis of Environmental Stakeholders in the Naibung'a/Oldonyiro Landscape in Kenya

Environmental Governance and Global Development Research Team

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Cover photo: © Photo of visit to Wyss Academy in Kenya, 2024, by James Mwamisi.

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Executive Summary

This report presents a social network analysis of environmental-related stakeholders in the Naibung'a/Oldonyiro landscape in northern Kenya, conducted by the Environmental Governance and Global Development Research Team at the Wyss Academy for Nature (WA) in collaboration with the WA Hub East Africa (EAF). The analysis aims to improve our understanding of relationships among diverse stakeholders in order to identify entry points for more effective and inclusive governance that generates co-benefits for both nature and people.

The analysis draws on data from 53 semi-structured interviews conducted in October and November 2025 with representatives of 17 distinct stakeholder groups, including pastoralists, NGOs, governmental bodies, and other service providers. The data was analysed using descriptive and inferential techniques, such as social network modelling. The findings reveal several important patterns in the Naibung'a/Oldonyiro social network:

- the network is relatively dense, but connections between diverse stakeholder groups tend to represent less frequent employment- or business-related interactions;
- we identify three communities in the network roughly organised along different levels of governance in the landscape;
- stakeholders who directly work with natural resources, such as small-scale farmers, pastoralists, and resource user groups emerge as central nodes in the network;
- stakeholders in the network seek to connect with the ones they perceive as more important for environmental governance.

The findings highlight that the Naibung'a/Oldonyiro social network is a decentralized and resilient network. They highlight opportunities to enhance network cohesion, reciprocity, and trust where it is needed, while ensuring local stakeholders can be the drivers of positive governance changes that promote nature–people co-benefits. Importantly, the WA Hub EAF has already begun to improve stakeholder engagement towards promoting systemic network transformations in the landscape.

Introduction

The WA operates in northern Kenya to advance systemic and innovative changes that promote environmental protection and advance economic livelihoods. Within the Naibung'a/Oldonyiro landscape the Hub EAF collaborates with national, county-level, and local partners to support the development of resilient rangeland systems, where healthy, connected ecosystems sustain pastoralist livelihoods alongside thriving wildlife populations. [1]

Mapping stakeholders and analysing their relationships provides critical insights into the formal and informal structures that shape natural resource governance in a landscape. [2] This study seeks to deepen understanding of stakeholder interactions across the Naibung'a/Oldonyiro landscape and to identify potential entry points for governance interventions that can strengthen collaboration, enhance stakeholder engagement, and improve project outcomes. The analysis offers strategic insights by illuminating the diverse roles, positions, and influence of different actors within the social network. These insights can inform more effective strategies for coordination of actions and the diffusion of information across the landscape.

This report is divided into three parts. The first part introduces the Naibung'a/Oldonyiro landscape and the methods and data collection process. The second part presents descriptive and inferential patterns on the stakeholder network, drawing on social network analysis techniques. Finally, the report concludes with recommendations from this study.

[1] The landscape also represents the first "Solutionscape" established by the WA.

[2] Please note that this is a short report. More detailed information about the methods, questionnaires, metrics, and findings can be found in the handbook on "Using Social Network Analysis to Investigate Local Stakeholder Dynamics" (Michel et. al 2026). Previous publicly available reports also investigate the network in Switzerland (see Bärtschi et al. 2026), Peru (see Borasino et al. 2025) and Laos (see Kommadam et al. 2025).

Study Area, Data, and Methods

Naibung'a/Oldonyiro Landscape

The Naibung'a/Oldonyiro landscape is located in northern Kenya, in the upper Ewaso Ng'iro River basin. While Naibung'a falls in Laikipia County, Oldonyiro is in Isiolo County (Figure 1). This landscape forms an ecologically connected rangeland system extending across the northern slopes of Mount Kenya, linking highland forest ecosystems with the arid and semi-arid pastoral rangelands of northern Kenya. The region plays an important role in supporting both pastoral livelihoods and wildlife movements, functioning as a critical ecological corridor between Mount Kenya, the Laikipia plateau, and the Samburu–Isiolo rangelands. [3]

Ecologically, the region is characterised by arid and semi-arid climatic conditions, with mean annual rainfall generally ranging between 300 and 700 mm, though rainfall distribution is highly variable both spatially and temporally. Rainfall typically occurs in bimodal patterns, with long rains between March and May and short rains between October and December [4]. The elevation varies significantly, ranging from approximately 900 m above sea level in the lower rangelands of Isiolo and Samburu to over 2,000 m on the Laikipia plateau, creating considerable ecological heterogeneity [5]. The landscape comprises diverse vegetation types including Acacia bushland, savannah grasslands, and scattered woodlands, but has experienced substantial vegetation changes driven by climate, overgrazing, fire suppression, and megaherbivores [6]. The

[3]For more information on the multiple land uses in the Ewaso Ngíro River Ecosystem, please refer to Georgiadis et al. (2007) and Mureithi et al. (2019).

[4]For more information about climatic conditions of the Ewaso Ng'iro Ecosystem, please refer to M'mboroki et al. (2018) and Lelenguyah et al. (2024).

[5]For more information about the geomorphology of the Ewaso Ng'iro Ecosystem, please refer to Didier et al. (2011).

[6]For more information about the vegetation conditions of the study area, please refer to Unks et al. (2025) and Georgiadis et al. (2007).

area is interspersed with seasonal rivers and dryland wetlands that provide important grazing and wildlife habitats. Human-induced degradation of these resources has adverse implications on the landscape for both ecology and local communities.

Historically, land tenure across much of the region was organised under communal property regimes, particularly through group ranches established in the post-independence period to formalise collective land ownership among pastoral communities. Over time, however, many group ranches collapsed or were subdivided, leading to a gradual transition toward mixed land tenure systems comprising community land, subdivided private holdings, and formally titled properties. Consequently, the contemporary landscape reflects a complex mosaic of registered and unregistered community lands alongside privately owned parcels [7].

In Laikipia, land tenure dynamics have been more heterogeneous. In addition to pastoral group ranches, Laikipia was historically characterised by large-scale private livestock ranches established during the colonial period by settler farmers. Following political and economic changes in the late twentieth century and well into the early 2000s, many of these ranches diversified their land uses, giving rise to a landscape now dominated by private livestock ranches and private wildlife conservancies, many of which integrate livestock production with wildlife conservation and tourism enterprises. This coexistence of pastoral lands, commercial ranches, and conservation areas produced one of the most complex land governance systems in Kenya's rangelands [8]. Livelihoods across the broader Naibung'a/Oldonyiro landscape remain diverse but are predominantly centred on pastoralism, which continues to play a central role in local economies, food systems, and cultural identity. At the same time, the region has emerged as an important conservation landscape, hosting a growing network of community and private conservancies that seek to reconcile biodiversity conservation with pastoral livelihoods and tourism-based economies [9].

Despite its ecological significance and economic potential, the region faces multiple and interrelated challenges. Recurring droughts, intensified by climate variability, periodically disrupt pastoral production systems and increase livelihood vulnerability [10].

[7]For more information about land tenure transformation in Laikipiaand Isiolo, please refer to Lesorogol (2003), Pas et al.(2023), Galaty (2016) and Gravesen (2020).

[8]For more information on land tenure complexities in Laikipia, please refer to Fox (2018), Galaty (2016) and Gravesen (2020).

[9]For more information on the dynamics in private conservancies in Laikipia, please refer to Yurco (2017).

[10]For more information on patterns and effects of droughts and climate vulnerability in northern Kenya, please refer to Mati (2023) and Kirimi (2013).

In addition, inter-community conflicts, often linked to competition over grazing land and water resources, remain a persistent feature of the region's socio-political landscape [11]. Land tenure transformations—particularly the expansion of privately titled land—have also contributed to habitat fragmentation and the obstruction of wildlife migratory corridors, threatening ecological connectivity across the wider northern Kenya landscape [12]. Historically, northern Kenya has experienced political and economic marginalisation, often remaining at the periphery of state-led development initiatives. This has contributed to the emergence of a landscape in which non-governmental organizations (NGOs) and international NGOs play a significant role in providing infrastructure, conservation programmes, and livelihood support [13]. Local place-based organisations, including community-based organisations and collective groupings, have emerged as important drivers of change, often working alongside NGOs and international organisations to shape development processes in the landscape. Since 2013, the devolution of government functions in Kenya has led to the establishment of county governments, which have become key actors in the landscape. These county governments have since expanded the range of stakeholders involved, actively influencing development trajectories in the area.

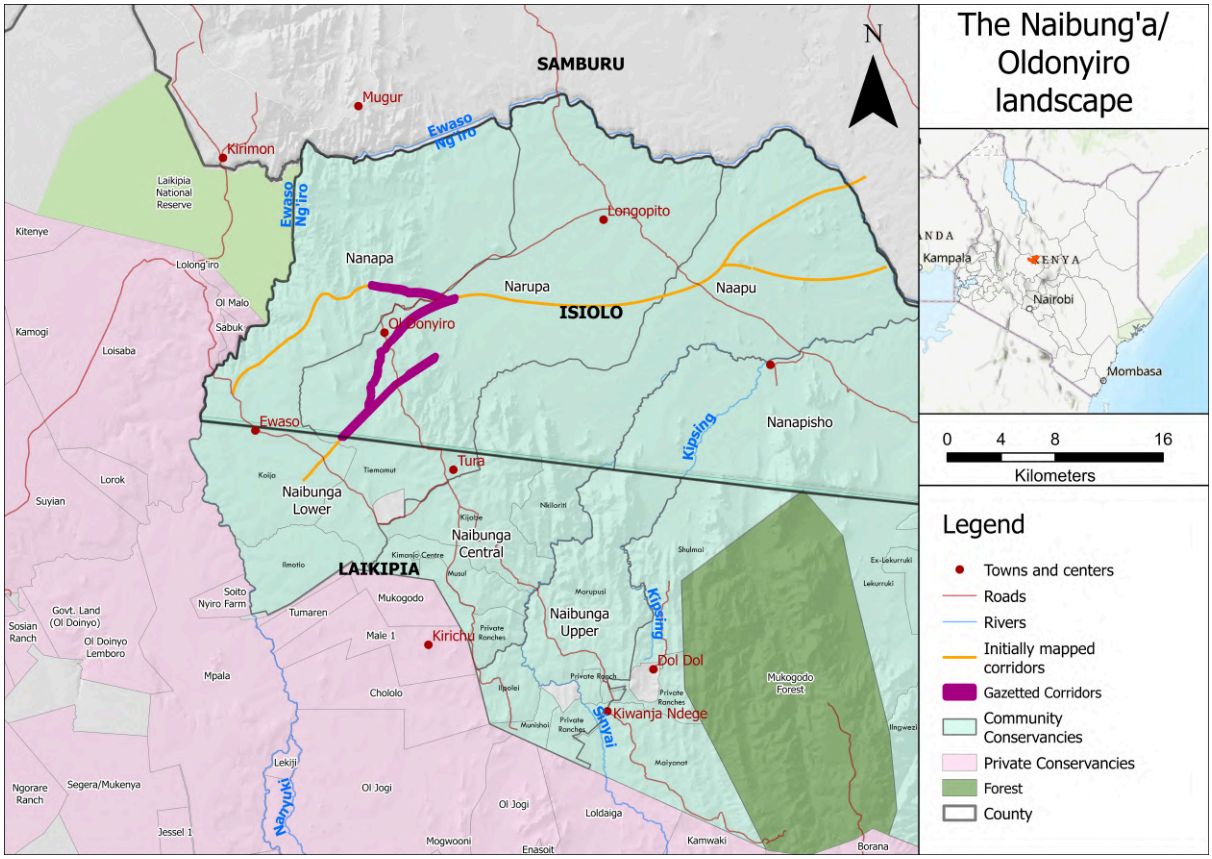
The Naibung'a/Oldonyiro landscape is a primary focus of the WA. In this landscape, the WA collaborates with a range of partners and local stakeholders to address the systemic challenges of dryland ecosystems, with the aim of fostering more resilient livelihoods and healthier landscapes. Key initiatives include land restoration through semicircular bunds, the promotion of nature-positive enterprises, and the strengthening of inclusive and robust governance systems.

Figure 1: **The Naibung'a/Oldonyiro landscape** (Source: Wisdom Kipkemboi)

[11] For more information on conflicts in region, please refer to Bond 2014, Wanjiku 2023, Greiner 2013, Oxford Analytica (2021) and Schilling and Werland (2023).

[12] For impacts of land subdivision on habitat fragmentation in northern Kenya, please refer to Galvin et al. (2008) and Reid et al. (2004).

[13] For more information on marginalisation of northern and non-state actors' engagement, please refer to Schetter et al. (2022) and Donovan (2015).



Social network analysis and environmental governance

Social network analysis examines the relationships between social units, representing various types of connections between them. Examples of such connections include friendships or the exchange of knowledge. These connections can have distinct characteristics, such as being directed (i.e., having a clear origin and target) or undirected, and take different values reflecting the strength, intensity, or frequency of interactions between social units. In network terminology, social units are commonly referred to as “nodes” and connections are called “edges”. Nodes are graphically represented by points and edges by lines. The structure of social networks varies depending on the nature of the nodes and the characteristics of the edges between them. [14]

[14] For an introduction to social network analysis and an overview of various perspectives, methods, and applications, please refer to Scott and Carrington (2011).

Environmental governance requires collaboration among various stakeholders. [15] Stakeholders are embedded in and interact with the ecological systems they rely on or manage. [16] Examining how they connect to each other and to the ecological systems in place provides a better understanding of their role in local governance of natural resources. [17] Various network attributes, such as the strength of the edges connecting nodes, the characteristics of the nodes themselves, and their position within the network, influence local environmental governance processes and decision-making. Insights derived from social network analysis can therefore inform interventions aimed at mitigating resource conflicts, reducing the marginalisation of stakeholders, and ensuring that local governance dynamics reflect diverse interests. [18] While stronger connections, for example, can be beneficial for addressing complex tasks, they may also hinder innovation within networks. In contrast, weak ties may be less effective in building trust but play an important role in connecting otherwise disconnected groups. Understanding this balance helps identify where collaboration should be strengthened and where new connections should be encouraged.

Figure 2 illustrates how different network properties help us understand environmental governance dynamics. [19] Network A represents a cohesive collaborative network comprising numerous collaborative ties between actors engaged in coastal-zone management in Sweden. The differences in centrality between the actors with the most connections and those with an average number of connections are relatively small, and the closed triangular structure is a common building block in this network (e.g., two friends of a common friend also tend to be friends). Network B represents a centralized collaborative network from a United Nations Educational, Scientific, and Cultural

[15]For more information on the resilience of social-ecological networks, please refer to Janssen et al. (2006). For more information on how social-ecological systems are formed, change, and persist, see Folke et al. (2010).

[16]For more information on social networks in the context of natural resource governance, please refer to Bodin (2009).

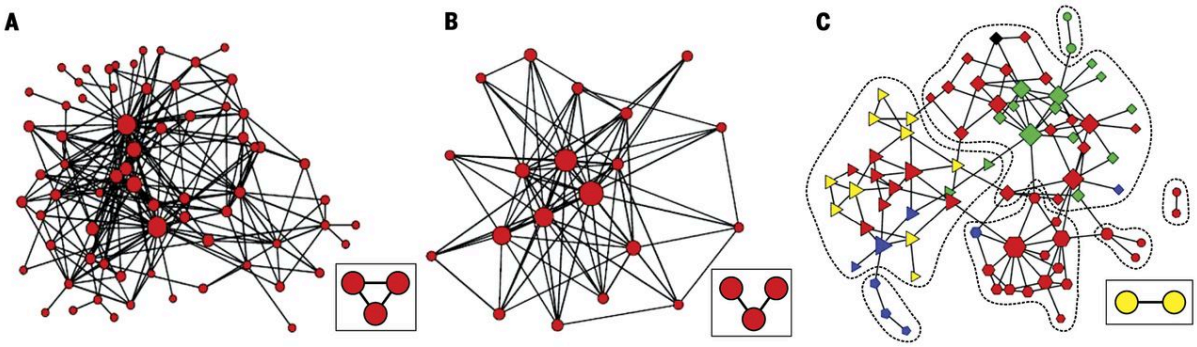
[17]For more information on how network structures can foster collaboration on environmental governance, please refer to Bodin (2017).

[18]For more on this please refer to Prell, Hubacek, and Reed (2016).

[19]For more on network properties, please refer to Bodin (2017).

Organization biosphere reserve in Canada, where the differences in centrality between the actors with the most connections and those with an average number of connections differ substantially. The open triangular structure is a common building block in this network (e.g., an actor connects two unconnected actors). Network C represents a more compartmentalized collaborative network of small-scale fishermen in East Africa. The colours represent fishermen using different fishing gear (traps, nets, etc.), and the dotted lines enclose different identified communities (e.g., subgroup membership also designated by symbol shape). The subgroups partly coincide with gear type.

Figure 2: Different structural characteristics of networks (Source: Bodin 2017).



Data collection

The data collection process for networks can be complex and time-consuming but careful planning and testing help ensure that the data collected is reliable and provides valuable insights into the stakeholder network and its interactions in the study area. The data collection underlying this report took place in three steps.

- Step 1: Stakeholder selection

We relied on suggestions of the Hub EAF team to obtain an initial list of stakeholders relevant in the Naibung'a/Oldonyiro landscape. The list was then used to identify 17 stakeholder groups of interest for the Wyss Academy Hub EAF. Specific representatives from each stakeholder group were then pre-selected, taking into account the heterogeneity of the groups, to form the interview sample. This means that representatives of diverse stakeholder groups with a large presence in the region (e.g., private sector, pastoralists and NGOs/CBOs) are more strongly represented in the pre-selected sample than representatives of more homogeneous groups (e.g., community conservancies and national government).

- Step 2: Questionnaire development

Social network data was collected through an in-person, semi-structured survey. The questionnaire included network-related questions (e.g., common contacts and frequency of interactions), as well as open-ended questions on local environmental issues and stakeholder perceptions. [20]

- Step 3: Interview logistics and training

Enumerators were recruited from the landscape. The enumerators were supervised by the field manager, who coordinated and oversaw the data collection process. Enumerators underwent a comprehensive training covering how to build trust with respondents, accurately formulate questions, and record responses. The training also included an overview of the methods and relevant ethical guidelines.

Fieldwork took place between October and November 2025. On average, each interview lasted approximately 30 minutes. Table 1 provides an overview of the stakeholder groups, their composition, and the number of interview respondents per group. Regular check-ins with enumerators were conducted during data collection to ensure quality and consistency. In total, 53 interviews were conducted. The data collected were subsequently transcribed and cleaned.

Table 1: List of stakeholders interviewed.

[20] The research and questionnaires were reviewed and approved by National Commission for Science, Technology and Innovation of Kenya.

Stakeholder Group	Number of interviews
Associations	2
Community Conservancies	3
Cooperatives	2
County Government	5
International Organizations	3
Largescale Farmers	1
NGOs and CBOs in Kenya	6
National Government	3
Pastoralist	4
Politicians	2
Private Conservancies	3
Private Sector	6
Researchers	3
Resource user groups	1
Self-help groups	4
Smallscale Farmers	3
Traditional Leaders	2

Analysis

The subsequent analysis focuses on stakeholder groups (e.g., governmental bodies) instead of individual actors. [21] Since this aggregation could introduce unforeseen biases, we normalize attribute values, such as frequency of contact to make comparisons across stakeholder groups more meaningful. [22] The analysis relies on descriptive measures, such as different types of node centrality or edge strength and is therefore exploratory and not causal.

The data collected is not exhaustive and likely misses stakeholders and relations in the network. It captures a snapshot of the network at a single point in time. Although the network aggregation by groups makes the results less sensitive to the number of

[21] The aggregation by stakeholder group also facilitates the visualization and descriptive analysis of the network. This does not assume these groups are monolithic, rather that they are a partial and abstract representation of the relations of a certain stakeholder group at a point in time.

[22] We normalize values by keeping the average value for their attributes (e.g., frequency of contact) multiplied by the number of edges recorded (i.e., dependent on interview number) divided by the median number of interviews (3) to facilitate visualization. If, for example, edges are duplicated (i.e., multiple stakeholders within a stakeholder group share the same edge with another group), we keep the average value for their attributes (e.g., frequency of contact) multiplied by the number of edges recorded divided by three.

stakeholders interviewed per group, it limits, for example, what can be said about how changes in the network composition (e.g., the entry or exit of specific stakeholders) influence network dynamics. [23]

We employ exponential random graph models (ERGM) to systematically investigate the structure of the Naibung'a/Oldonyiro social network. [24] ERGM is a flexible network modelling technique for cross-sectional network data (i.e., data collected at one point in time) that assumes that the observed network structure can be explained by a set of sufficient statistics. The dependent variable in ERGMs is the network structure (e.g., the presence or absence of edges between nodes), while the independent variables are the node or edge covariates (exogenous) and network effects capture the (endogenous) structures that influence the formation of edges.

[23] Answering questions related to how edges may change over time for specific stakeholders might require a different research design, data collection, and hypotheses. Future studies should move beyond the initial overview presented in this report and provide more specific insights into how changes in the composition of stakeholders and changes in their connections influence local governance dynamics.

[24] There are different ways to model networks; for more information, please refer to Block et al. (2019).

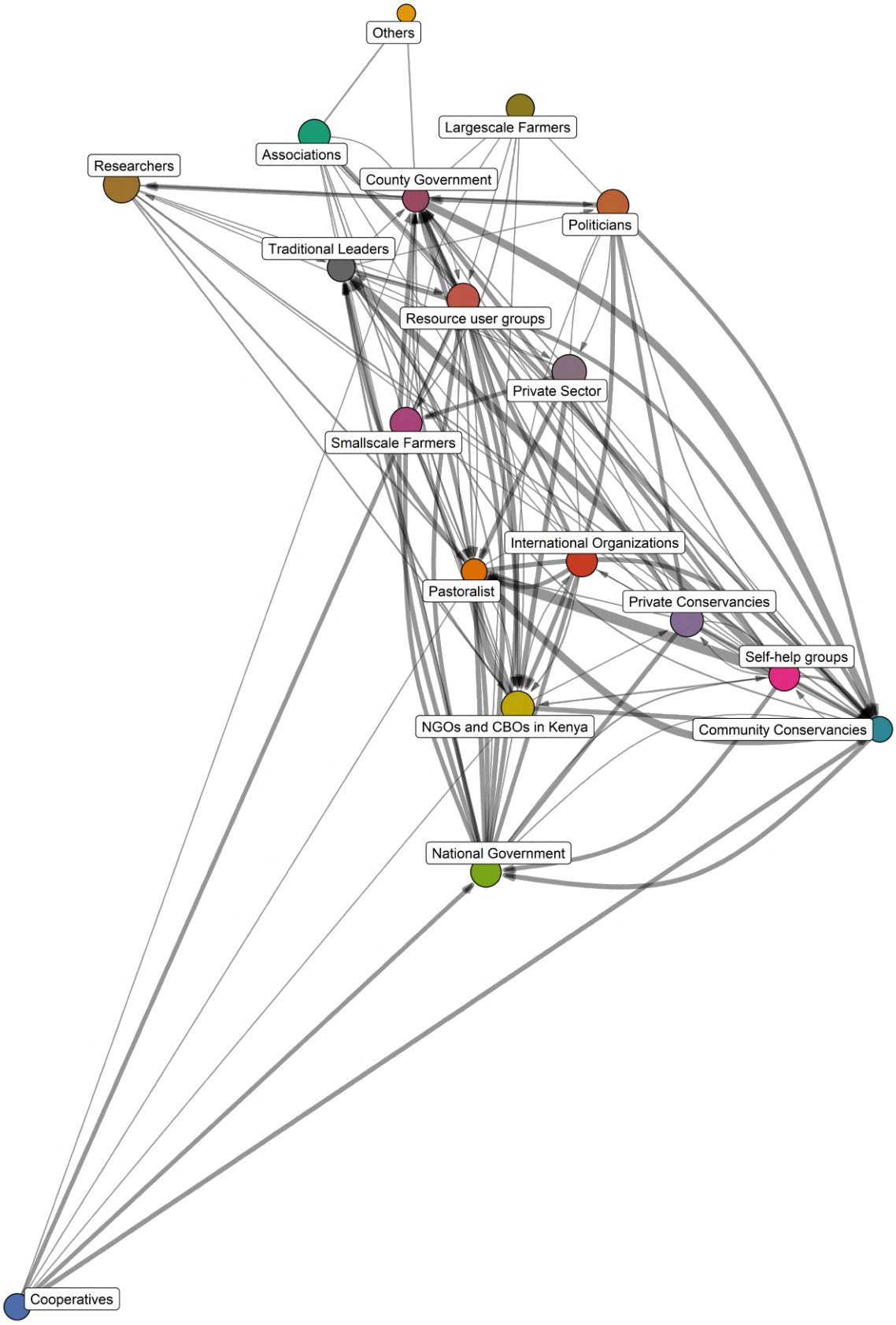
Findings

Communities and centrality in the Naibung'a/Oldonyiro social network

The Naibung'a/Oldonyiro social network is relatively dense (i.e., the proportion of observed edges among all possible edges), with many connections between different stakeholder groups in the network (Figure 3). [25] However, this overall connectedness masks important structural inequalities in how ties are distributed across the network. Connectivity is not evenly distributed across stakeholder groups. Actors such as pastoralists, community conservancies, county government, and NGOs and CBOs, for example, receive a higher number of ties than others.

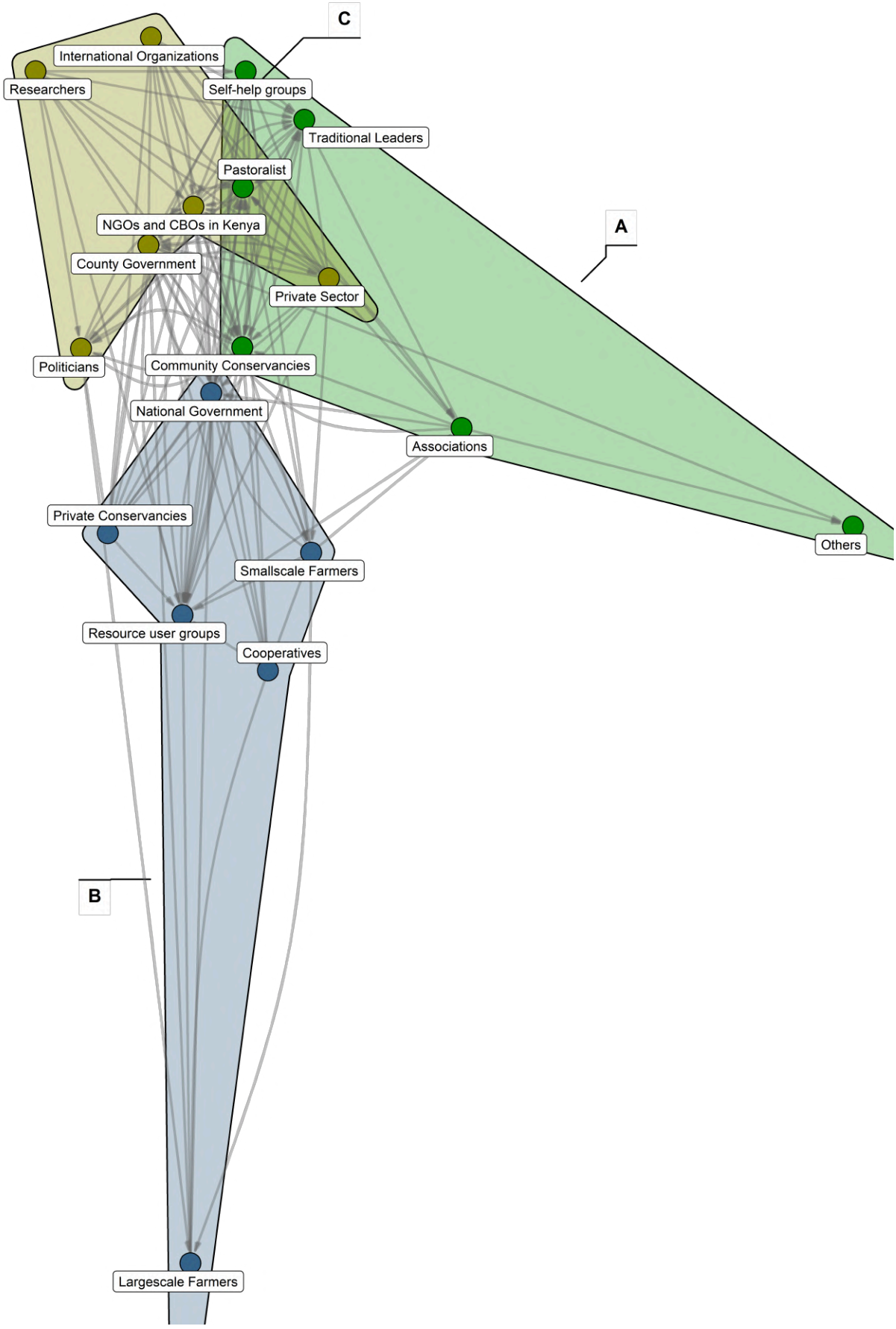
Figure 3: **Naibung'a/Oldonyiro network by stakeholder group**. Node colours represent stakeholder groups. Nodes are sized by number of edges received. Edges are sized according to the (normalized) frequency of interactions. Arrows indicate the source and target of edges.

[25] The network density of the Naibung'a/Oldonyiro network is 0.386 while the network transitivity is 0.726. Please note that network density could be a feature of how the data was collected or other types of sampling bias. We account for this by focusing the analysis on the broader groups and weighting the edges by both the number of interviews per group and frequency of contact.


Others
Largescale Farmers
Associations
Researchers
County Government
Politicians
Traditional Leaders
Resource user groups
Private Sector
Smallscale Farmers
International Organizations
Pastoralist
Private Conservancies
Self-help groups
NGOs and CBOs in Kenya
Community Conservancies
National Government
Cooperatives

Interactions are structured around partially segmented groups of stakeholders who engage more frequently within their respective clusters than across the broader network (Figure 4). Using optimal modularity, a standard community-detection algorithm, to detect network communities (i.e., densely connected subgroups of nodes), we identify three communities within the Naibung'a/Oldonyiro social network. While strong internal connectivity within each community can enhance efficiency, limited linkages between them may constrain information flow and hinder collaboration.

Figure 4: **Communities in the Naibung'a/Oldonyiro network** . Node and hull colours represent different communities in the network.

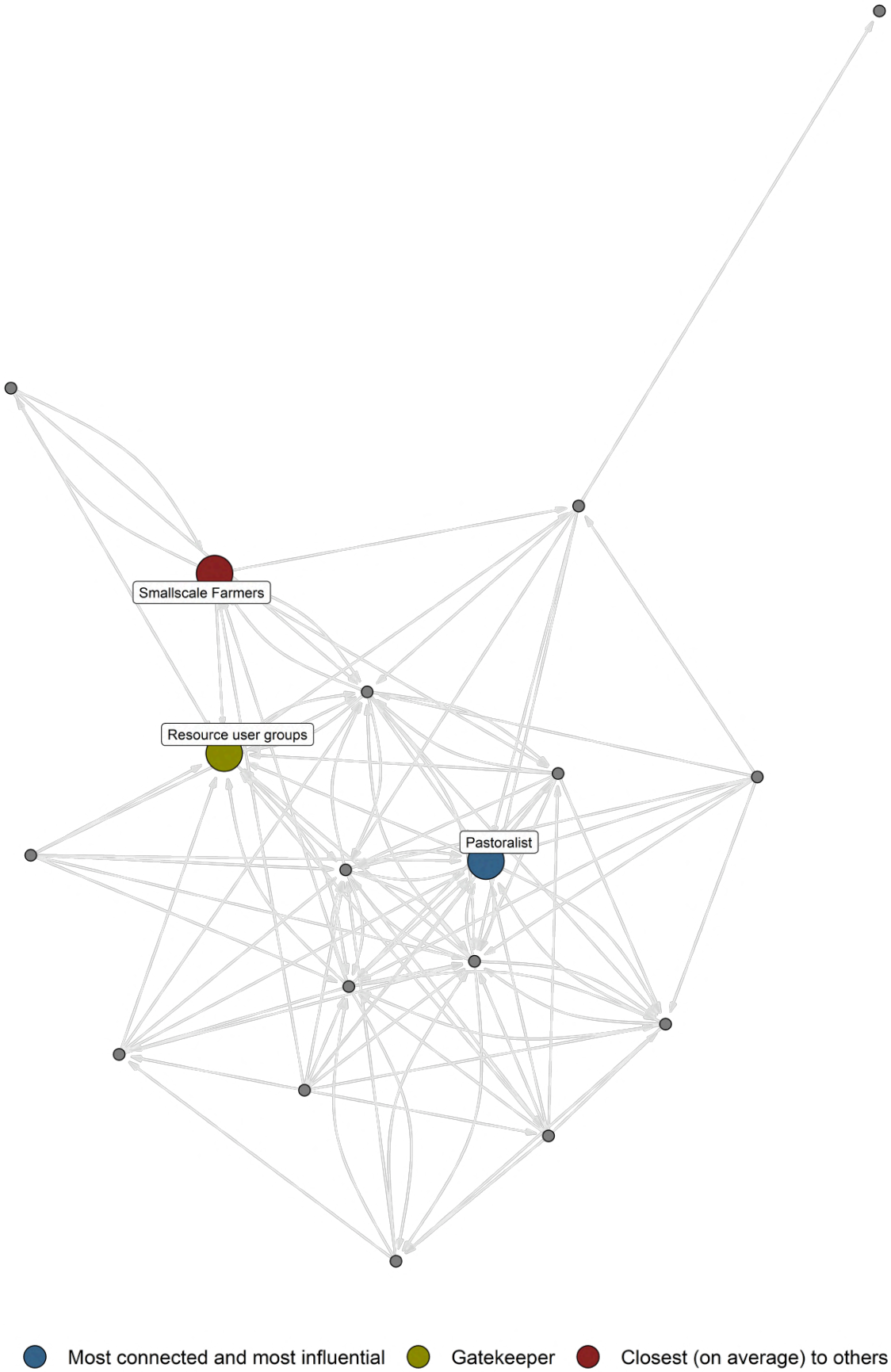

C
International Organizations
Researchers
Self-help groups
Traditional Leaders
Pastoralist
NGOs and CBOs in Kenya
County Government
Private Sector
A
Politicians
Community Conservancies
National Government
Associations
Private Conservancies
Others
Smallscale Farmers
Resource user groups
Cooperatives
B
Largescale Farmers

These communities appear organised along institutional scales, reflecting different levels and modes of governance within the landscape. Community A, for example, appears to comprise stakeholders, such as traditional leaders, pastoralists, community conservancies, self-help groups, and associations, that interact on a place-based level. These locally embedded interactions support locally coordinated approaches to landscape governance. In contrast, Community B seems to constitute a more state-centred cluster of stakeholders, primarily coordinated through formal institutional arrangements, reflecting more formalised interactions shaped by regulatory frameworks and state-led coordination mechanisms. Alternatively, Community C appears to represent a cluster of regional and intermediary stakeholders, including county government, researchers, politicians, NGOs and CBOs, international organisations, and private sector stakeholders. This cluster likely reflects a governance space oriented towards coordination and policy mediation across levels.

Specific stakeholders can influence network dynamics based on their structural position (e.g., centrality). Degree centrality indicates which groups maintain the most connections with others. Closeness centrality reflects which groups are, on average, closest to all other stakeholders. Betweenness centrality identifies stakeholder groups that act as gatekeepers by connecting otherwise separate parts of the network. Finally, eigenvector centrality captures influence derived from being connected to other highly central stakeholders. [26] Figure 5 compares different types of node centrality in the Naibung'a/Oldonyiro social network.

Figure 5: **Central stakeholder groups in the Naibung'a/Oldonyiro network**. Node colours represent different types of network centrality. Central nodes are labelled and displayed at a larger size to facilitate visualization.

[26] For an overview of how different centrality metrics can influence governance dynamics, please refer to Prell et al. (2016).


Smallscale Farmers
Resource user groups
Pastoralist
Most connected and most influential
Gatekeeper
Closest (on average) to others

The network centrality patterns reveal differentiated roles among stakeholder groups with important implications for landscape governance, particularly in relation to accessibility, brokerage, and the flow of information and knowledge. Small-scale farmers, for example, exhibit the highest closeness centrality. This indicates that they can reach other stakeholders through relatively short paths, making them well positioned to spread information and knowledge. Their structural position enhances their potential to facilitate rapid communication across the network.

Pastoralists, instead, exhibit the highest degree and eigenvector centrality, emerging as both the most connected and most influential stakeholders in the network. Their high degree centrality indicates that they maintain a large number of relationships with other stakeholder groups, reflecting their deep embeddedness within local governance systems. Pastoral livelihoods depend on interactions with multiple actors for grazing access, livestock markets, and resource management. To carry out these activities, pastoralists connect to other influential stakeholders, allowing them to play a critical role in the coordination of collective action and to shape local governance processes.

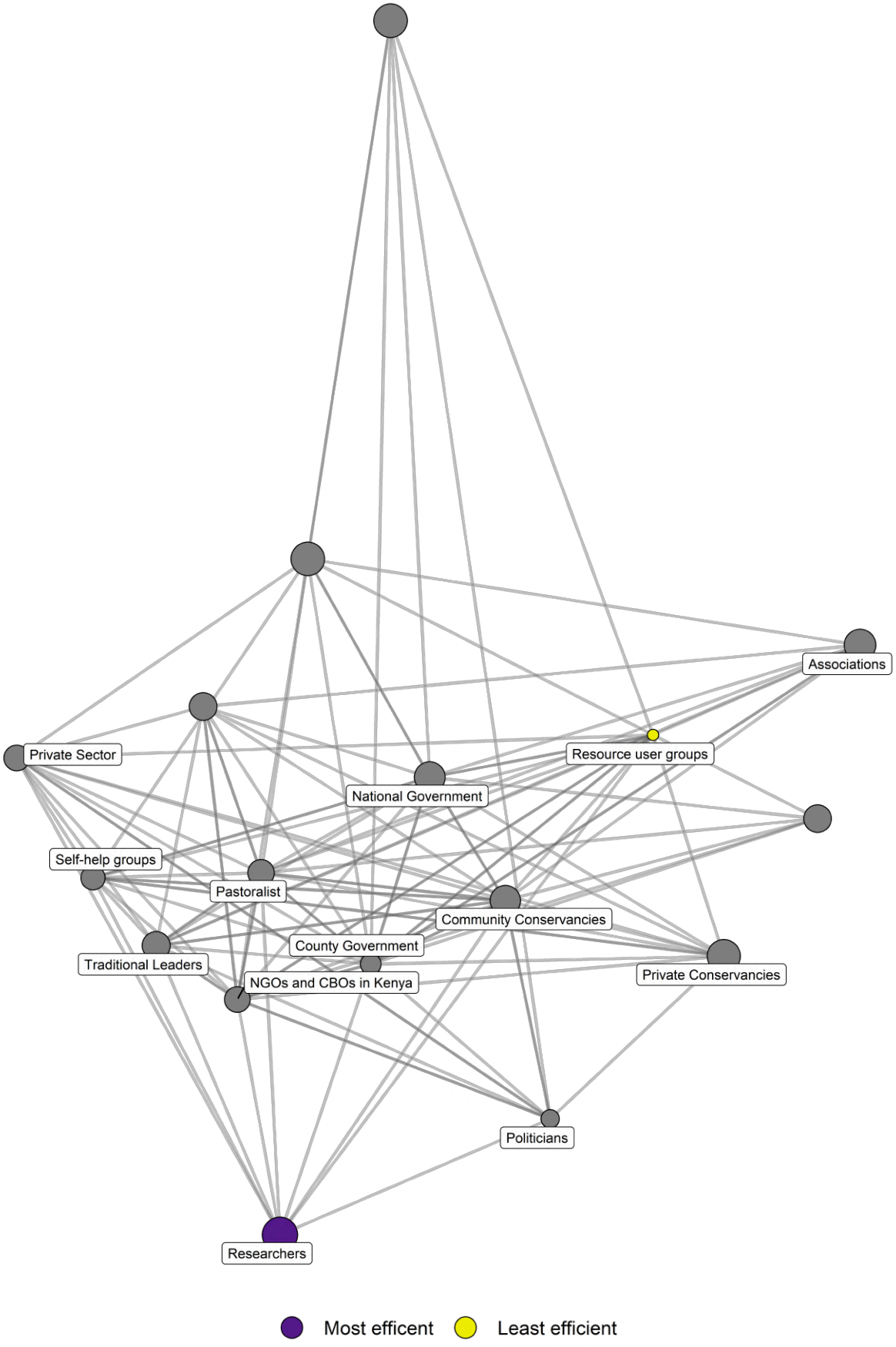
Furthermore, resource user groups display the highest betweenness centrality and emerge as gatekeepers in the network located along many of the shortest paths connecting otherwise disconnected actors. They play a central role in facilitating communication and mediating interactions. Resource user groups, such as Water Resource Users Associations and Community Land Management Committees, can serve as institutional linkages between local communities and formal state structures responsible for land-use planning and resource management.

Efficiency, in social network analysis, measures how efficiently information or resources are exchanged among a node's immediate neighbors, specifically when that node is removed. It indicates that the neighbours of a node are well-connected to each other, forming a dense, cohesive group. Unlike centrality measures, local efficiency does not take into account what happens in distant parts of the network; it highlights nodes that are embedded within highly interconnected groups and serve as "local integrators". [27] Figure 6 highlights most and least efficient nodes in the Naibung'a/Oldonyiro social network. The stakeholder category "researchers" exhibits the highest local efficiency, indicating that they are embedded within a dense and cohesive network group. This suggests that stakeholders connected to researchers are also well-connected among

[27] Local efficiency of a node is calculated by removing it and computing the distances (shortest path lengths) between its neighbours through the rest of the network.

themselves, enabling relatively smooth circulation of information even when they are absent.

Figure 6: **Node local efficiency in Naibung'a/Oldonyiro network**. Node colours represent most and least efficient actors in the network.


Associations
Private Sector
Resource user groups
National Government
Self-help groups
Pastoralist
Community Conservancies
County Government
Traditional Leaders
NGOs and CBOs in Kenya
Private Conservancies
Politicians
Researchers
Most efficent
Least efficient

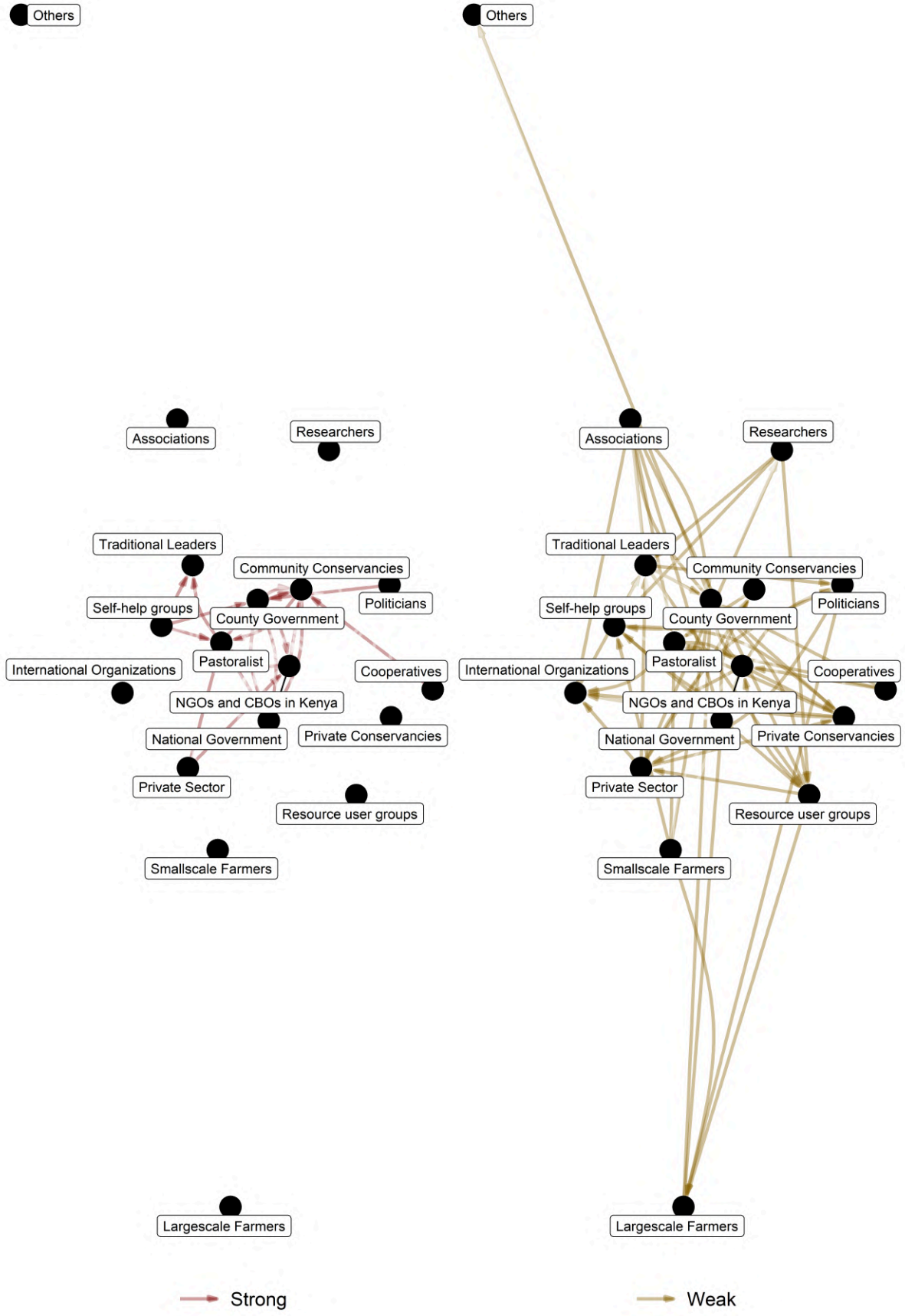
In contrast, resource user groups display the lowest local efficiency, meaning that their neighbours are not well connected. If these actors are removed, their connected stakeholders become more isolated, reducing the efficiency of information flow. This reinforces their role as gatekeepers. While not embedded in cohesive clusters, they are structurally essential for maintaining overall network connectivity.

The strength and types of connections in the Naibung'a/Oldonyiro social network

There are notable asymmetries in the frequency of relationships among stakeholder groups in the Naibung'a/Oldonyiro network (Figure 7). Many actor categories— including associations, resource user groups, researchers, small-scale farmers, international organisations, and large-scale farmers— interact less frequently with others in the network. Despite this, weaker linkages play a critical structural role connecting different parts of the network, facilitating the diffusion of non-redundant information across social, institutional, and geographic boundaries. [28] Alternatively, strong edges can facilitate coordination, trust-building, and sustained interactions. The concentration of strong connections at the core of the network reinforces social norms and provides a potential foundation for collective action in managing common-pool resources within the landscape. However, such tightly connected clusters may limit information exchange and resist proposed network changes.

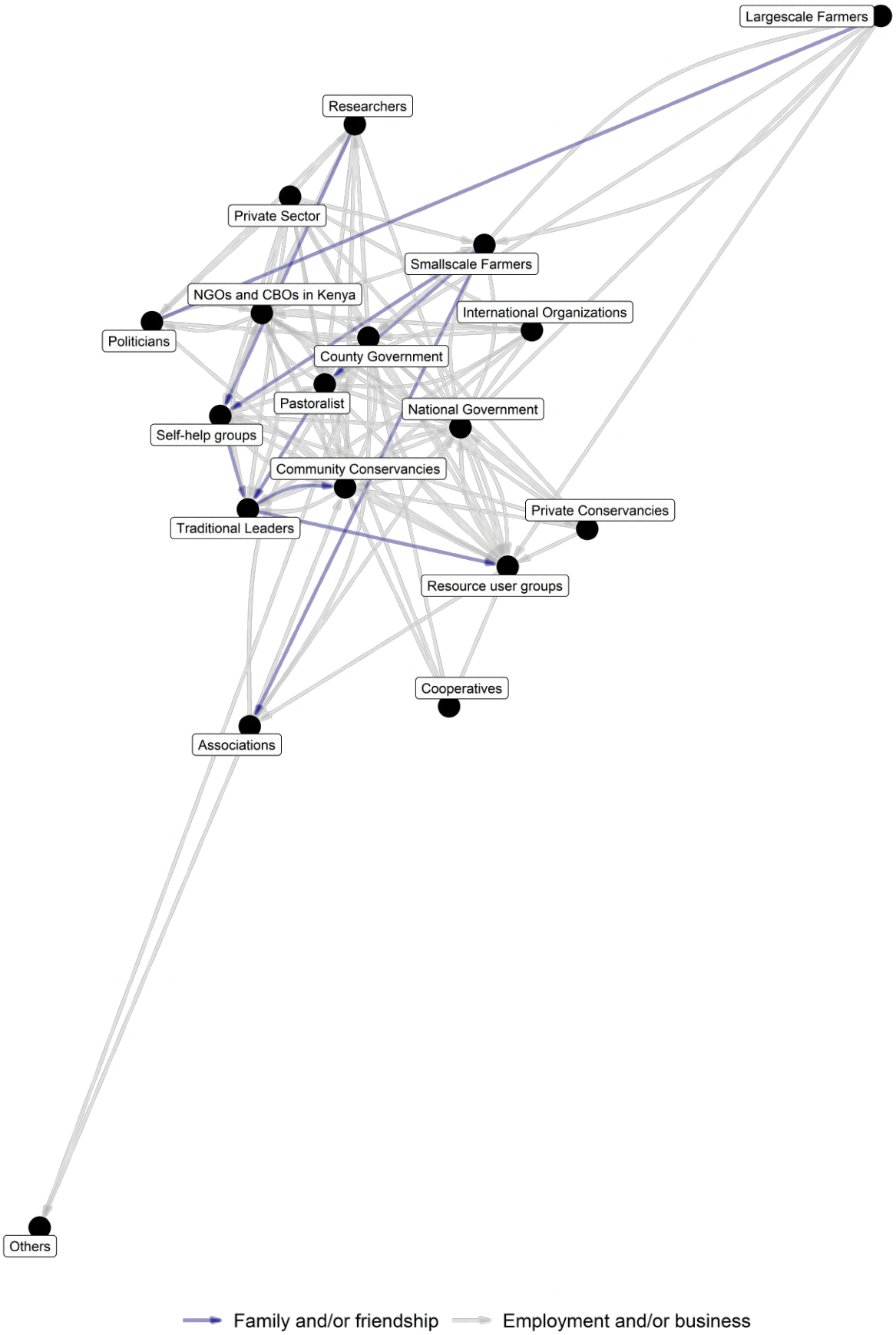
Figure 7: **Comparing the strength of edges in the Naibung'a/Oldonyiro social network** . Strength is defined based on the frequency of interactions. If nodes interact between daily and weekly (on average), edges are recorded as "strong"; if they interact less frequently than once per month, edges are recorded as "weak".

[28] For more information on strength of weak and strong edges, please refer to Granovetter (1973).


Others
Associations
Researchers
Traditional Leaders
Community Conservancies
Politicians
Self-help groups
County Government
Pastoralist
International Organizations
Cooperatives
NGOs and CBOs in Kenya
National Government
Private Conservancies
Private Sector
Resource user groups
Smallscale Farmers
Largescale Farmers
Strong
Others
Associations
Researchers
Traditional Leaders
Community Conservancies
Politicians
Self-help groups
County Government
Pastoralist
International Organizations
Cooperatives
NGOs and CBOs in Kenya
National Government
Private Conservancies
Private Sector
Resource user groups
Smallscale Farmers
Largescale Farmers
Weak

Besides asymmetries in frequency of interactions, relationships within the Naibung'a/Oldonyiro social network are predominantly professional (Figure 8). This pattern reflects a network structured around functional and transactional relationships, where interactions are driven by the exchange of knowledge, expertise, and organisational mandates rather than social or emotional bonds. While, on the one hand, this structure may reduce risks associated with informal power dynamics and reflect a more formalised and expert-driven system built upon professional norms and institutional linkages, on the other hand, the structure might hinder the development of trust and reciprocity across the network, critical aspects for sustaining long-term collective action in landscape governance.

Figure 8: Types of interactions within the Naibung'a/Oldonyiro network . Edge colours represent different types of ties relating to family or friendship and employment or business. If, for example, edge type is recorded as both family or friendship and employment or business relations, family and/or friendship is maintained.


Largescale Farmers
Researchers
Private Sector
Smallscale Farmers
NGOs and CBOs in Kenya
International Organizations
Politicians
County Government
Pastoralist
National Government
Self-help groups
Community Conservancies
Private Conservancies
Traditional Leaders
Resource user groups
Cooperatives
Associations
Others
Family and/or friendship
Employment and/or business

Modelling the Laikipia–Samburu–Isiolo network

Network modelling techniques are powerful tools to systematically investigate network patterns not visible to the naked eye. [29] Since many of the central stakeholders in the Naibung'a/Oldonyiro network appear to receive many edges, with clusters and strong connections at the center of the network, we hypothesize that:

- *Stakeholders tend to cluster around common connections*. That is, if stakeholder A is connected to stakeholder B, and stakeholder B is connected to stakeholder C, it is likely that stakeholder A also shares a connection with stakeholder C.
- *Stakeholders that receive many edges are more likely to attract new ones, creating a pattern of preferential attachment based on their popularity*. That is, if stakeholder A, B, and C are connected to stakeholder D, it is likely that stakeholder E is also connected to stakeholder D.
- *Stakeholders perceived as more important are more likely to attract edges*. That is, if stakeholder A perceives stakeholder B as an important stakeholder, stakeholder A will be more likely to send an edge to B.

We rely on ERGMs to investigate these hypotheses. In Models 1 to 4 in Table 4, we account for (i) the baseline probability of observing the network based solely on the number of edges, (ii) the tendency of nodes to cluster around common connections, and (iii) how in-degree centrality influences the probability of edge formation, and (iv) how perceived importance influences the likelihood of sending edges. In simple terms, the model estimates which factors make connections between stakeholders more or less likely. Model 1 indicates that the Naibung'a/Oldonyiro social network is not randomly structured (i.e., negative and statistically significant coefficient for edges). Model 2 illustrates that network transitiveness does not help to predict edge formation (i.e., positive but not statistically significant coefficient for transitiveness), which suggests sharing common edges does not necessarily increase the likelihood of clusters of stakeholders being formed in the network. The negative and statistically

[29] Social network modelling can also help projects understand how their interventions change network configurations. As well, modelling can pinpoint ways to improve project reach and efficiency, or the unintended consequences, of interventions.

significant coefficients for in-degree centrality in Model 3 suggest that nodes do not preferentially connect with popular ones that receive a lot of edges. However, perceptions of stakeholder importance positively affect edge formation, as illustrated in Model 4 (i.e., positive and statistically significant coefficient for perceived importance).

Table 4: Modelling the Naibung'a/Oldonyiro network using ERGMs.

	Model 1	Model 2	Model 3	Model 4
Edges	-0.47***	-1.13*	-0.64	-2.38**
	(0.12)	(0.50)	(0.56)	(0.86)
Transitiveness		0.50	0.23	0.27
		(0.38)	(0.43)	(0.43)
In-degree centrality			-4.79***	-4.94***
			(1.03)	(1.07)
Perceived importance				0.53**
				(0.20)
AIC	410.05	410.45	402.00	396.77
BIC	413.77	417.89	413.17	411.66
Log Likelihood	-204.03	-203.22	-198.00	-194.38

Note: Edges are a network effect that refers to the odds of observing the network based on the number of observed edges. Transitiveness is a network effect that refers to the tendency of stakeholders to cluster around shared connections. In-degree centrality is a network effect that refers to how node in-degree centrality influences the probability of edge formation. Perceived importance relates to the main effect of the covariate for out-edges. Each column in the table represents a model. Model 1 accounts for how edges predict the network structure; model 2 includes edges and transitiveness, model 3 includes edges, transitiveness, and in-degree centrality, and model 4 includes edges, transitiveness, in-degree centrality, and perceived importance. Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are statistical metrics to compare different models by balancing goodness of fit and model complexity. Significance: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

The models suggest that in-degree centrality and popularity perceptions help explain edge formation: stakeholders do not necessarily cluster locally or connect to popular stakeholders, rather seek to connect with the ones they perceive as more important for the local environmental governance. Altogether, the models indicate that the Naibung'a/Oldonyiro social network is not necessarily centralized or hierarchical, but rather decentralized - displaying the structural patterns of a resilient network that may withstand changes in composition or connections among stakeholders. [30]

[30] Although helpful, the models could be improved with additional data and the inclusion of other network effects. The relationships on the ground are likely shaped by a broader range of attributes than those captured in the collected data, as the goodness of fit diagnosis illustrates.

Recommendations and Conclusion

The findings indicate that the Naibung'a/Oldonyiro social network is decentralized and displays patterns of resilience. Strong connections between central stakeholders in the network can increase trust and coordination, while the extensive presence of weak connections enhances information diversity and reach. However, the analysis also highlights critical gaps and opportunities for strengthening local governance and promoting nature–people co-benefits.

First, the functioning of the network depends on stakeholders capable of connecting segmented communities. In the absence of these, the network risks fragmentation, which may undermine effective landscape governance. Strengthening connections between stakeholders working at different governance levels and across network communities can boost nature-positive socio-ecological outcomes. For instance, researchers and small-scale farmers belong to different communities but are the most efficient and closest (on average) to others, respectively. Bringing these stakeholders together can not only be an effective way to diffuse important information in the network but also strengthen their role within and outside of their communities and governance levels.

Second, the most central stakeholders in the network, such as pastoralists, small-scale farmers, and resource user groups, directly participate in (and dependent on) the active management of natural resources. While this indicates that the network is strongly grounded in the local socio-ecological realities, it may also reflect their need to maintain strong linkages with regional and national institutions to access resources. This structure can place significant responsibility for environmental governance on local stakeholders with limited capacity and resources. Strengthening the link between local resource-dependent stakeholders and state authorities enables communities to mobilize, drive positive change, and improve their livelihoods.

Third, the role of resource user groups as gatekeepers mediating policy interactions between state actors and different resource users has the potential to enable cross-sectoral and cross-scale coordination. This provides an opportunity to coordinate action and disseminate knowledge across critical sectors in the Naibung'a/Oldonyiro

landscape, such as water, land, and grazing. At the same time, resource user groups have the lowest local efficiency and their removal risks fragmenting the network. It is therefore essential to better integrate and empower not only resource user groups, but also their neighbours in the network to enhance network cohesion, reciprocity, and trust where it is needed.

Fourth, the limited distribution of strong ties beyond core actors may constrain deeper collaboration and sustained interaction needed for collective action to take place across the network. Alongside this, the network is dominated by professional connections that risk privileging formalised, technocratic forms of knowledge over situated, experiential, and locally grounded understandings. This provides a window of opportunity to promote repeated, less formal exchanges between diverse stakeholders such as roundtables to share knowledge and open forums that foster dialogue.

The WA Hub EAF has already initiated actions aligned with several of the recommendations presented in this report by engaging stakeholders, strengthening cross-sector collaboration, and supporting more inclusive governance processes in the Naibung'a/Oldonyiro landscape. As these efforts continue, the social network analysis provides a valuable evidence base for identifying strategic opportunities to reinforce existing partnerships and build new connections. In this way, the report serves not only as an assessment of the current governance network but also as a practical guide for future action.

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