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RESEARCH ARTICLE

Crisis in the wetlands: Combined stresses in a changing climate – Experience from Tanzania

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Climate variability and change has led to multifaceted stresses and compounded socio-environmental problems. Using the example of Simiyu wetlands in Tanzania, this article analyses the complexity and inter-connectedness of climate-related mal-adaptation and coping strategies and their implications. Various study methods were used, including consultative meetings, stakeholders workshops, a literature review, household questionnaires and land use cover and change analysis. Reactive coping and adaptation strategies have resulted in increased risks to livelihoods and the environment. Responses to climate variability and change in the study are complex, leading to amplified chain reactions. Extreme weather events, particularly droughts, have led people and herds of livestock to migrate into the wetlands. Environmental degradation is alarming. More than 42 per cent of natural vegetation in the study area has been wiped out in a span of 15 years. As a result, poor people whose livelihoods derive from the wetlands have suffered. The present institutional arrangements have failed to integrate the community's coping and adaptation strategies into wetlands management. Emerging conflicts among wetland users are intensifying environmental and community risks. This article emphasizes that, in a changing climate, wetlands need to be managed through flexible institutional and management frameworks that cross sectoral boundaries and involve all affected parties.

Keywords: adaptation; climate change and variability; livelihoods; risk reduction; wetland management

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1. Introduction

Wetland ecosystems and wetland bond livelihoods are facing an unprecedented situation in a variable and changing climate (Haslett, Cundy, Davies, Powell, & Croudance, 2003; O'Reilly, Alin, Plisnier, Cohen, & McKnee, 2003; Wolters, Bakker, Bertness, Jefferies, & Moller, 2005). Wetlands are increasingly becoming islands of hope for communities affected by persistent extreme droughts to cope and adapt (UNEP, 2002; Gaston, Blackburn, & Goldewijk, 2003; Jenkins, 2003; Scharlemann, Green, & Balmford, 2004; Sala, 2005). According to the Ramsar Convention definition, 'wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres'. In addition, wetlands may incorporate riparian and coastal zones adjacent to islands or bodies of marine water deeper than 6 m (Ramsar Bureu, 2003).

It is widely reported that wetlands are among the most important ecosystems of the world (e.g. Mitch & Gosselink, 2000; Darwall, Smith, Lowe, & Vié, 2005; MEA, 2005; Reid et al., 2005). Wetlands are often biodiversity 'hotspots' (Reid et al., 2005). They are described as 'the kidneys of the landscape' because they are the downstream receivers and purifiers of water and wastes, and as 'biological supermarkets' because they support extensive food chains and rich biodiversity (Mitch & Gosselink, 2000). They also provide numerous goods and services that contribute to human well-being (Mitch & Gosselink, 2000; MEA, 2005; Yanda, Majule, & Mwakaje, 2005). Even without climate change and variability, wetlands are important sources of livelihoods for local communities. It is therefore clear that in a changing climate, wetlands will become more important as they are reservoirs of water and biodiversity that are crucial for human well-being.

The Simiyu wetlands of Tanzania are the basis of the livelihood of the surrounding communities and thus are of high socio-economic and ecological value (Tumbo, 2007). Apart from wetland farming, different livelihood activities are practiced within the wetland. These include fishing, grazing and harvesting of wetland vegetation for domestic wood-use, medicine, food, fibre and commercial purposes. Studies indicate that these activities contribute significantly to food security and poverty reduction for residents of the wetlands in general and for the poorest of the poor in particular (Yanda et al., 2005; MEA, 2005; Hamisi, 2007; Stern, 2007; Kasthala et al., 2008). Climate change will negatively impact the wetlands and complicate the situation of already poverty-stricken communities

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adjacent to the wetlands (e.g. MEA, 2005; Mock, 2005; Mooney, Cropper, & Reid, 2005; Stern, 2007).

The Simiyu wetlands are threatened by the changing climate. The area faces persistent and extreme drought at the regional scale (Tumbo, 2007). Since the 1990s, the Simiyu wetlands and surrounding areas have been affected by prolonged and frequent hydro-meteorological drought (Tumbo, 2007). Studies indicate that small increases in the variability of precipitation regimes will significantly impact wetland plants and animals (Keddy, 2000) that, in turn, may cause biodiversity loss (Bauder, 2005). It has also been shown that climate change and variability lead to changes in patterns of land use (ICRAF, 2000; Lockwood, Worboys, & Kothari, 2006). Changing land-use patterns and increased wetlands resource use will place additional pressure on wetland ecosystems already stressed by the changing climate.

Changes in land-use patterns are becoming evident in the Simiyu wetlands. In addition, there is an influx of people from surrounding areas affected by extreme drought. Land and other resources in the wetlands have a limited capacity to accommodate the increasing demand. The increased number of wetland users is likely to exceed the wetland-carrying capacity.

The current management structure of the wetland is rigid, sectorally based and lacks participation. There is a general shortage of resources and as such the management regime is ineffective. The general objective of this article is to assess the wetland-based adaptation and coping practices of the communities affected by climate change and variability in Simiyu wetlands and the surrounding region, as well as the role of management regimes in sustaining wetlands and livelihoods in the changing climate. The article, first, assesses the combined effect of direct and indirect climatic and non-climatic stressors on the Simiyu wetlands and, second, assesses the role of management regimes in ensuring sustainable wetlands and associated livelihoods.

This study area was selected for two main reasons. First, the wetlands are surrounded by areas that face extreme climatic variability, and people in those areas cope with the problem by migrating into wetlands. Second, communities living in the wetland also face the problem of drought and they respond by expanding agricultural activities and patterns of wetlands resource-use not exhibited in the past.

2. Literature review

There is a large body of literature on the role of wetland ecosystems in biodiversity conservation and on their role in supporting livelihoods (MEA, 2005); therefore there is increasing evidence and understanding of the vulnerability of wetland-related livelihoods in a varying and changing climate (Leary, McCarthy, Canziani, Dokken, & White, 2006; Tumbo, 2007). Where there is a shortage of experience and knowledge of the complexity and implications of wetland-related adaptation and coping strategies in response to climate change and variability (Adger et al., 2007), there is also limited knowledge of the role of management processes in regulating such circumstances.

Wetlands goods and services have been found to be important, particularly to the poorest people living near wetlands in rural areas (Masiyandima, McCartney, & van Koppen, 2004; Yanda et al., 2005). These people are highly dependent on wetland ecosystem services and are directly harmed by their degradation (MEA, 2005). For example, people living near wetlands in Cambodia obtain about 60–80 per cent of their total animal protein from wetland fish (Schuyt & Brander, 2004) and the Mekong wetlands are the basis of food security and nutrition for a wide area (Friend, 2007). Wetland-related fisheries also make an important contribution to rural incomes (Schuyt & Brander, 2004; FAO, 2005; Kangalawe & Liwenga, 2005).

Studies from Africa indicate that wetlands contribute in diverse ways to the livelihoods of many millions of people (Neiland & Béné, 2003; McCartney & van Koppen, 2004). According to Mwendera (2003), Ntfonjeni wetlands in the northeast of Swaziland make a significant contribution to both food security and household income. In addition, all households use natural resources from these wetlands. Other benefits obtained from wetlands include livestock grazing and watering (Mwakaje & Sokoni, 2003), the use of wood and non-wood plant products (Roggeri, 1999) and agriculture (Majule & Mwalyosi, 2005). Reports from Zambia by Masiyandima et al. (2004) indicate that wetland natural resources are important for the daily livelihoods of rural communities.

Experience from other parts of Tanzania indicate that overutilization of wetlands may lead to environmental degradation and disruption of ecosystems from which it would be difficult to recover (Majule & Mwalyosi, 2005; Majule, 2007). Because of the major contribution the Simiyu wetlands make to the surrounding community's well-being, such a disruption will have considerable real and potential risks. These challenges show that the management of the wetlands is very complex and requires highly dynamic and responsive management practices.

3. Methodology

3.1. *Study area*

The Simiyu wetlands are found in Magu district, Mwanza region, Tanzania. They are located between 33°23′30″ and 33°28′50″ east and between 2°30′33″ and 2°35′00″ south. The wetlands are mainly fed by Simiyu River, which covers a catchment area of 11,219 km^2 partly located in Magu district, and discharges into Lake Victoria

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through Magu bay in Speke gulf (NEMC, 1998). The Simiyu wetlands are bordered by four villages, namely Bubinza village to the east, Nyalikungu and Ilungu to the south and Bugabu village to the west. The southeastern part of the basin overlaps the Serengeti National Park. The Simiyu basin has a warm tropical savannah climate with daily temperatures varying between 15 and 30°C throughout the year, and an annual average rainfall of 700–1000 mm.

3.2. *Sample design and sampling procedures*

The four villages that surround the Simiyu wetlands were selected for this study. The village inhabitants' livelihoods depend on the wetland resources. People in the surrounding areas affected by extreme climatic variability migrate to these villages. This selection of villages was important, because it enabled comparison on the basis of population pressure and environmental stress. Selection of sample households was done on a sub-village basis. A stratified random sampling procedure was employed, based on locally perceived categories wealth. Other criteria included specific resource-user groups (such as medicinal plant dealers, fishermen, mat makers, house builders, fish processors and sellers, fish transporters), as well as male- and female-led households. Another important thing for the survey to capture was the views of both residents and immigrant communities. In the household survey a total of 104 households responded to a detailed structured questionnaire.

3.3. *Primary data collection*

A number of primary data were collected during the survey. These included the types of resources collected from the wetland, collection frequency, amount collected and value of the products collected. Other questions captured information on land ownership, crop production, market values of the crops and socio-economic characteristics of the population. Other instruments for collecting primary data included a checklist of questions to different village departments, Participatory Rural Appraisal (village and hamlet general meeting), key informant (elderly inhabitants) interviews, focus group discussions and observation.

3.4. *Secondary data collection*

The focus was on data and information on wetland resource trends over time, and on livelihood adaptation and coping strategies. A detailed assessment of the implications of these strategies was carried out, and the institutional arrangements for wetland management were examined. Data were also captured on the status of the wetland resources and their trends over time. Sources of data included archival information and district reports on resource harvesting, resource inventories and socio-cultural and economic information.

3.5. *Remote sensing and GIS work*

A remote sensing and Geographical Information System (GIS) method was used to derive thematic maps of land cover and land use in the Simiyu wetlands. The timeframe for the analysis was between 1991 and 2006 (for reasons as explained below). The image processing and GIS software used were Erdas Imagine 9.1, ArcGIS 9.2 and Idrisi 32. Erdas Imagine was used in image pre-processing and processing and ArcGIS was used in data reclassification and in laying out land use and land cover maps. Idrisi was used to run the cross-tabulation change analysis technique and composing the resulting change maps.

The spatial approach of land use/land cover change analysis was done to evaluate threats to the wetland ecosystem integrity. Three key questions guided this analysis: first, what are the contemporary land cover and land use characteristics in the flood plain, and what do these imply? Second, what has been the pattern of change of land cover and land use since the 1990s? And finally, what do these changes mean for the sustainability of the wetlands? A major factor that guided the choice of the period 1991–2006 for the analysis was that it was the only period for which remotely sensed satellite imagery was available. The main area of focus for this study was the core wetland, which covers an area of about 237 km^2. The trends in land cover/use change in the area were compared with ground truthing results to check the integrity of the results.

4. Results and discussion

This section highlights the importance of wetlands to the communities and the threats they face in a changing climate. The results of the responses of both resident and migrant communities are considered. In addition, the results of land use/cover change analysis and the current wetland management mechanism will also be presented.

4.1. *Respondent profiles*

A total of 104 respondents were interviewed from the four villages that surround the Simiyu wetlands. The respondents were representatives of all socio-economic classes in the study area (see Table 1). There are substantial numbers of immigrants in the Simiyu wetlands (27 per cent). The rate of in-migration to the wetlands, as reported by the respondents, seems to have increased in the last decade, due to persistent drought in surrounding areas. Reported reasons for immigration, in order of importance, include opportunities to attain farming land, grazing rights, fishing and fish business opportunities, and general

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Table 1. Classification of communities in the study area according to wealth, age, education level and residential status

Community features	Wealth groups			Age structure			Education		Residency	
Profiles	Rich	Intermediate	Poor	Young (<18 years)	Middle (18–55 years)	Elders (55 years or above)	Non-formal education	Primary education	Secondary education	Residents	Immigrants
(%)	13	30	57	48	35	17	28	69	3	73	27

Source: Field Survey (2009).

businesses. Most of the respondents are either poor or somewhat less so (with an intermediate income). The wealth classification was based on issues such as whether one possessed livestock or not, the value of respondents' annual harvest and also possession (or not) of fishing tools. The poor respondents did not possess either livestock or fishing equipment. They normally work as hired labour, and in most cases they face serious food shortages and are mostly dependent on wetland resources for their livelihoods. Education levels in the area are very low. Most of the respondents (97 per cent) had only either non-formal or primary education, a statistic that has important implications for the selection of coping and adaptation strategies.

4.2. *The importance of wetlands to resident communities of the Simiyu wetlands*

Communities in the Simiyu wetlands engage in a range of livelihood activities. Crop production and livestock farming are the major land-use activities. The wetlands provide the conditions to cultivate a wide range of crops (see Table 2). About 85 per cent of households are engaged in either crop farming and/or livestock keeping. Crop production is carried out on both a large and a small scale, and hand-hoes are the main tool for land preparation. The natural fertility and high water retention capacity of the wetlands mean that there is a relatively high potential for supporting crops and consequently the demand for land is high.

Simiyu wetlands comprise a multitude of resources. Some of the key wetland resources are presented below, including fisheries, wetland vegetation and wetland agriculture. Fish availability and price plays a big role in reducing food insecurity in Simiyu wetlands. Average income from fishing ranges from USD700 to USD3,000 per year. Certainly, for many poor households engaged in full-time, seasonal or occasional small-scale fishing activities, such contributions are crucial for food security.

Papyrus (*Cyperus papyrus* L.) is a valuable wetland plant for local communities, and is used for a range of purposes. The shoots are rhizomes harvested for fuel wood, due to severe shortage of alternative sources of fuel wood around the Simiyu wetlands. It is also used for mat making, construction and fencing. The dead and partially decaying shoots of papyrus, which float in water, are collected for medicinal purposes and used mainly to treat pregnant women. About 33 per cent of respondents from the Simiyu wetlands use papyrus as medicine. The reeds are also used for making house doors, beds, roofing and small huts. The shoots are used mainly for making roofs and walls. In some cases, the shoots are woven and used as windows and doors. Most of the local traditional fishing tools are also made of reeds. About 54 per cent of the respondents' house roofs

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Table 2. Percentage of households engaged in selected livelihood activities in the Simiyu wetlands, and yearly income from those activities in USD per year

Activities	Crop production/ha					Grazing	Fishing	Vegetables (food)	Fibres (reeds, papyrus)
	Maize	Chicken peas	Water melon	Paddy	Tomatoes				
Households (%)	39	41	5	17	13	56	34	42	59
Average income per household per year, in USD	2,400	3,100	2,100	300	3,000	NA	2,700	1,000	3,900

Source: Field Survey (2009).

are made of reeds and thatches. The wetlands are also covered by *Sesbania sesban* (L.) Merrill (*Sesbania*) and giant reeds (*Phragmites australis (Cav.) Trin. ex. Steud.*), which are used in making floats and canoes and mats, respectively.

4.3. *Livelihood adaptation and coping strategies of the resident communities*

In this article, 'resident communities' means those communities that have lived in the four villages surrounding the Simiyu wetlands prior to the 1990s. Increasing climate variability and extremes in the wetlands has led to crop failures as well as lower productivity of livestock (Odada, Olago, & Ochola, 2006; Tumbo, 2007). Different farming practices have emerged, such as increased land clearance and farming closer to the lake and river banks. These community responses are likely to compromise the wetland integrity. The experiences from other parts of Tanzania indicate that overutilization of wetlands leads to environmental degradation and disruption of ecosystems (Majule & Mwalyosi, 2005; Majule, 2007). Because of the substantial contribution that the Simiyu wetlands make to the well-being of the surrounding community, such a disruption presents a considerable risk to people's livelihoods.

Changes have been manifested in other wetland activities as well as in farming practices. Recent years have seen large-scale production of papyrus for commercial purposes (e.g. local furniture making). This has emerged as a livelihood adaptation to reduce risks from the increasing trend of crop failure. On average, a household could make 6–15 mats in a week, which were sold at USD0.5 per mat at the time of the study.

4.4. *Livelihood adaptation and copying strategies of the immigrant communities*

For the purpose of this article the immigrant community refers to the community that has moved into the four villages surrounding Simiyu wetlands between 1990 and 2006. Due to extreme droughts in areas surrounding Simiyu wetlands, the area has become a refuge for diverse wildlife species and people with or without herds of livestock. Apart from water and pasture for livestock they are also searching for wetland plots to farm. Increasing immigration is affecting wetland ecosystem goods and services, and community livelihoods, and is intensifying resource-use conflicts (Mwita, 2004). Giving numbers, Odada et al. (2006) report a high degree of movement of fishermen between fishing villages, and residents between the rural areas for economic reasons (although numbers are not reported).

Furthermore, in-migration to the wetlands, especially among youth, has been partly linked to production of

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crops with guaranteed and lucrative markets (e.g. water melon and tomatoes). Currently, tomato production among the immigrants has become a major source of income, instead of providing only subsistence level returns. About 75 per cent of the immigrant households grow tomatoes, with an average area of 0.2 acre per household.

The Simiyu wetlands provide adequate and permanent water and pastures for livestock production. This study, as Tables 1 and 2 indicate, gives evidence of a substantial in-migration of agro-pastoralists to the Simiyu wetlands in search of land for cultivation and grazing. Agro-pastoralists from surrounding drought-devastated areas are migrating to Simiyu both permanently and seasonally. About 38.4 per cent of livestock keepers in all the surveyed villages are immigrants. As expected, grazing is particularly intense in the wetlands during the dry years and seasons. Results indicate that only about 50 per cent of livestock keepers come from outside the resident communities of the four villages in the wetland (see Table 3).

This kind of grazing is generally uncontrolled, and creates conflicts between crop farmers and livestock keepers.

4.5. *Land use/cover change analysis*

The results of the GIS remote sensing analysis indicate that there is a significant decline of natural vegetation cover from 1,914 to 1,286 km^2 (about 33 per cent) during the period 1991–2006 (see Table 4). This is mainly due to expansion of croplands, which grew by about 168 per cent during the same period, from nearly 455 to 1,218 km^2. If the loss of natural vegetation proceeds at the present rate, in less than 30 years all natural vegetation in Simiyu wetlands will be wiped out. However, the bulk of the cropland expansion took place over a period of just 6 years, which means that the rate of loss will be even higher and, at that rate, there would be a complete loss of natural vegetation in less than 15 years from 2006. Reduction in the size of water bodies is another alarming finding. Between 1991 and 2006, the land covered by water was reduced by 149 km^2. This is consistent with the observed loss in natural vegetation, which is important to maintain the key wetland characteristics (Figure 2).

The pattern of fragmentation of the land as well as in cover and use has also been transformed. In 1991, crop cultivation was fragmented and dispersed within the flood plain, and the natural vegetation cover was continuous. At present, the croplands have increased and show continuous cover, whereas the natural vegetation as of 2006 shows a very high level of fragmentation. On the other hand, it was revealed that the aerial coverage of rivers and swamps declined from nearly 5 km^2 to under 2 km^2. Most likely, swamps have declined and been replaced by new farmland. The lake coverage also declined by nearly 2 km^2, from over 50 km^2 to about 48 km^2 (see Figure 1). These changes are attributed to increased human activity in the wetlands. The literature and experience suggest that crop cultivation and building, which involve the removal of vegetation, cause the waterline to recede (Mwanukuzi, 2002).

Table 3. Grazing intensity in the Simiyu wetlands

Grazing intensity (%)	Residents	Immigrants
Mean grazing intensity	62.4	38.4
Dry season	50.2	49.8
Wet season	71	29
Dry year	38.6	62.4
Wet year	69.3	30.7

Source: Field Survey (2009).

5. Discussion

The situation in the Simiyu wetlands is complex and dynamic. Wetland size and location depend on Simiyu River and its flood plain and water level fluctuations in Lake Victoria. With an increase in climate variability and extremes, locations for different wetland-related activities have also changed over time. For example, in 1961 which was an extreme flood year, the lake levels increased and this led to an increase in the wetland area. In 1974 there was an extreme drought, during which people cultivated potatoes in wetland areas and even on the river bank to cope with the severe food insecurity resulting from drought. A similar situation occurred in 1984 and 1994/95. In 1996/97 came more floods, and almost all farming plots were swallowed by water. Since 2000, extreme climatic events, especially droughts, have increased in frequency and magnitude. Due to the consistent droughts

Table 4. Changes in land use/cover by class between 1991 and 2006 in the Simiyu wetlands

	Vegetation	Farms	Bare land	Built environment	Water bodies
1991 (km^2)	1,914	455	3,625	72	1,827
2006 (km^2)	1,286	1,218	3,592	93	1,678
Change in land use/cover (km^2)	628	763	33	21	149
Change in land use/cover (%)	33	168	0.9	29	8.2

Source: Field Survey (2009).

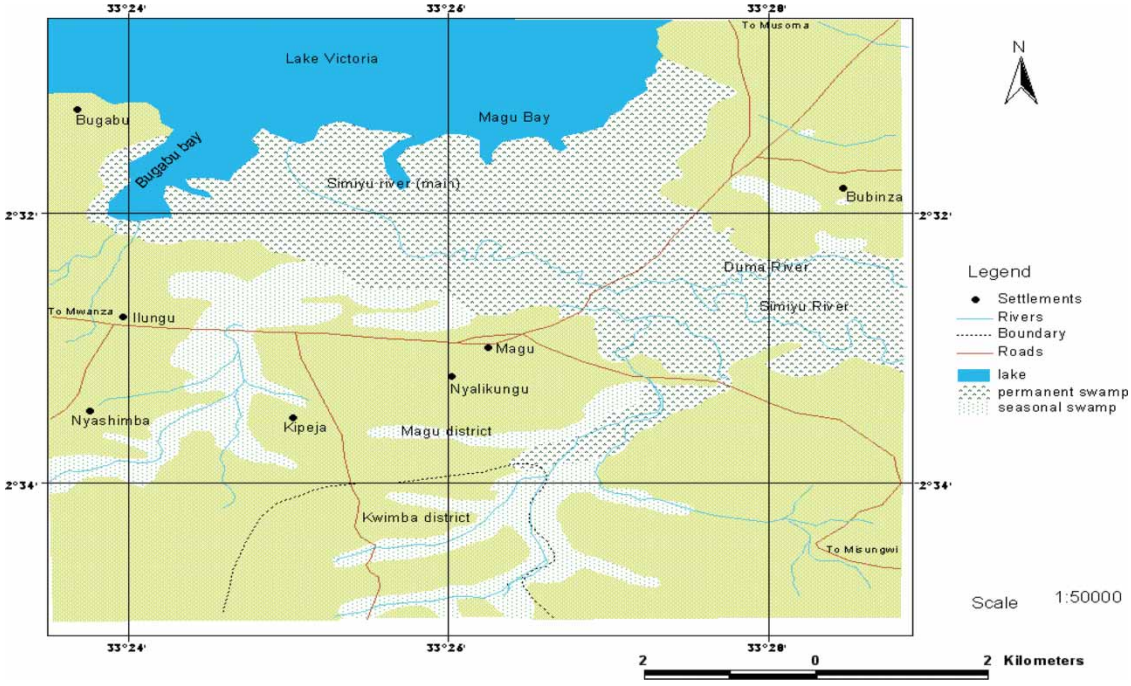


Figure 1. Study area (Simiyu wetland and surrounding areas).

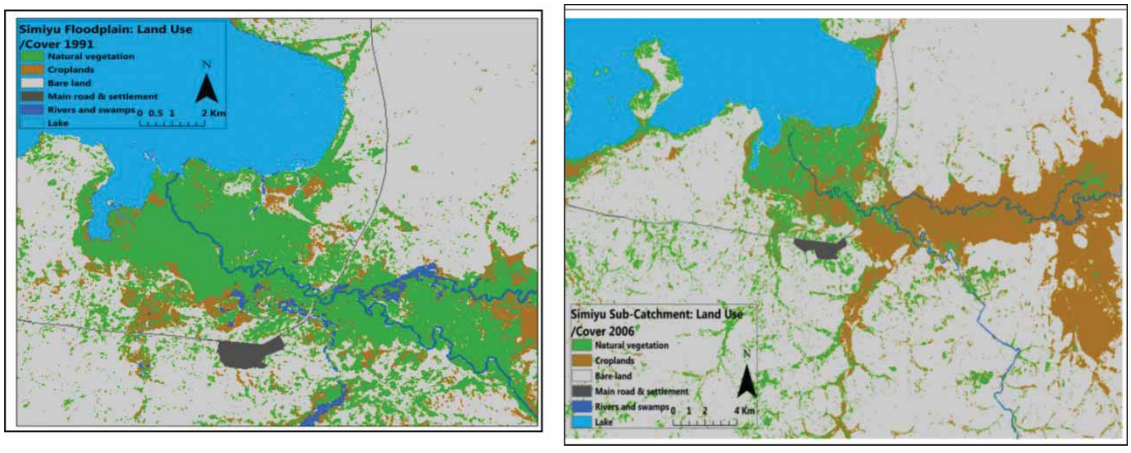


Figure 2. Land use/cover change patterns in Simiyu wetland from 1991 (left) to 2006 (right).

the lake level has recorded a steady decrease, a trend that is leaving more land open for human activity, which further threatens the wetlands.

The natural land cover is declining. In the past, farmlands were distributed in localities near homesteads, and the homesteads were located in the drier lands adjacent to the wetlands. At present, however, farms have relocated to the wetter areas in the flood plains. This indicates that the change in the water content of the soil is a greater driver of action than distance from homestead. Relocation is one of the key adaptive mechanisms by which farmers adjust to the pattern of climate and environmental change in sub-Saharan Africa (Sitari, 2005). The increased intensity of farming and grazing compromises the ecosystem balance in the flood plains because much of the natural vegetation is being replaced. The destruction of natural vegetation and establishment of farms are known to deplete the amount of water content in the soil, and push the lake waterline away from the land (Mwanukuzi, 2002), a fact that might explain the decline in the lake area coverage (see Table 4).

Most people living in the area adjacent to the plain cultivate in the valleys and floors of the Simiyu wetlands. These activities are the single greatest threat to the natural vegetation of the area. Intensive cultivation is also causing moisture stress in the soils, and people are forced

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to encroach further into the core wetland areas. The water level in Lake Victoria fluctuates, and when the lake level rises, people cultivating on the edge are forced to move further inland. They come head-to-head with those who are moving their farming activities downstream. The wetland has thus become a conflict hotspot. These conflicts are likely to continue and intensify as a result of increasing pressures from the changing climate.

5.1. *Proposed changes to wetland management*

The current institutional arrangements for management of the Simiyu wetlands and other wetlands in Tanzania do not take into account climate change and intensification issues. Most of the decisions on access to and use of the wetland resources are taken at the district and higher levels (regional and national). Such decisions are also sector-based and not integrated. Although the minstries dealing with fisheries (Ministry of Livestock and Fisheries Development), land (Ministry of Land and Human Habitat Development), wildlife (Wildlife Division) and forestry (Forestry Division) all operate under the Ministry of Natural Resources, they operate independently and without cooperation.

Existing management arrangements do not recognize local institutions. Recent devolution and legislation to enable community-based resource management have been based on the recognition of the potential of local institutions, while at the same time calling into question the efficacy of state institutions to manage on their own without community institutions (Lockwood et al., 2006). Districts and other sectrol authorities thus need to recognize the legitimacy of traditional and/or local systems with their related structures and rules.

The current institutional arrangement is not flexible enough to allow integration of community adaptation strategies into wetland management, which is required if risks to the environment and livelihoods are to be reduced. Top-down approaches outweigh bottom-up approaches for managing and conserving wetlands, which has led to serious conflicts among the stakeholders which intensify environmental and community risks. Findings also indicate that, despite the presence of a somewhat conducive policy environment in wetland management which advocates stakeholder participation, particularly at the grassroots, this is only understood and practiced in a limited way at the ground level.

During focus group discussions and interviews with key informants, it was evident that local people have an understanding of major threats to the wetlands. They are aware of the costs and benefits of most traditional practices, such as papyrus harvesting and cultivation on the edge of the wetlands. They emphasized that sustainable benefits would accrue only as a result of the wise use of wetland resources, and serious and damaging costs will result as a consequence of misuse of the same resources. It is crucial to capitalize on this understanding as a starting point for designing an integrative, comprehensive and flexible wetland management mechanism. The Adaptive Management Framework (AMF) (Lockwood et al., 2006) is seen as an important institutional arrangement for the management of the Simiyu and other wetlands in Tanzania in a changing climate.

The AMF approach is integrated and challenges the traditional reactive approach to dealing with uncertainty in resource management (Lockwood et al., 2006). AMF is especially suitable for making management decisions under uncertainty. The approach is flexible, encouraging public input and monitors the results of actions for the purpose of adjusting plans and trying new or revised approaches (Lockwood et al., 2006). It is inclusive in terms of the precise goals of climate change policy and the means used to achieve them. By definition, the approach seeks to apply a variety of policy treatments to a problem. As such, it could be used to pursue a range of policy goals in the areas of both mitigation and adaptation in the wetlands and wetland-related activities. The approach is also flexible enough to include policy measures and interventions that address climate issues indirectly.

While many of the pressures and drivers of ecosystem changes are linked to climate, a few of the management and conservation planning, projects/programmes and policies are explicitly linked to climatic change (Lockwood et al., 2006). Climate change issues are excluded from effective resource management policies. The AMF takes on board both climate and non-climate factors. Given the dynamic nature of the Simiyu River wetlands, a flexible framework such as the AMF could be crucial.

The theory of the AMF also implies that, depending on the impact generated, there is a continual reworking process of the institutional arrangements to either liberate or constrain human behaviour towards management of natural resources (Lockwood et al., 2006). In natural resource management, institutions that are better integrated in terms of traditional, socio-cultural traits and incentives, and a given moral and political legitimacy at the local level, are also more stable and enduring (Lockwood et al., 2006). This might include, in the Simiyu case, institutions that cover traditional leadership, different types of clans or households, as well different resource user groups (e.g. fishers, agro-pastoralists, peasants, craft products users, etc.).

Institutions made up of traditional chiefs, councillors and clanheads are socio-culturally accepted/respected, morally and politically supported and legitimate, self-enforced and promote social cohesion. This is contrary to the way in which governmental departments, civic rules, norms and regulations function. Previously, traditional chiefs played a significant role in keeping communities together. Even outsiders were obliged to respect and pay

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allegiance to the institutional arrangements at the village level. Today in Simiyu, land grabbing and unlawful expansion of farms in the wetlands is increasing. In such situations a transparent and flexible mechanism linking the government authorities and traditional leaders would be in a better position to control the unlawful practices. This would be more effective than leaving it to government officers based at the district headquarters who rarely visit the wetland due to management constraints, such as lack of resources.

There is potential for existing traditional institutions to operate in harmony with external institutions (Kajembe & Kessy, 2000). However, in recognition of different resource endowments within communities and overlaps of interest groups (often with conflicting and competing interests) the government must reserve the right to intervene where required in conflicts at the local level to protect marginalized groups and provide a forum for conflict resolution.

6. Conclusion and recommendations

Wetlands provide essential resources to sustain local economies, communities and livelihoods in Tanzania. However, the current institutional arrangement does not support adaptive management of the wetlands. Adaptive management requires the involvement of a range of different institutions and stakeholders. Only when the wide array of wetland benefits is fully understood and appreciated by wetland communities as well as other stakeholders, wetlands will be managed better. Approaches for managing wetlands and regulation of access and use have in the past focused on only a few resources (e.g. fisheries, wildlife and land). This narrow approach has led to unsustainable exploitation, which is threatening the ecological integrity of ecosystems and thereby the wetlands' potential to support sustainable development and their function as resources for fighting poverty (MEA, 2005).

The hub for sustainable management of wetlands in a changing climate would be an integrated institutional arrangement that considers both the state and traditional institutions. Evidence shows that traditional institutions are still stronger relative to government institutions, even without receiving state support (ICRAF, 2000; Kibwage, Onyango, & Bakamwesiga, 2008). Traditional institutions still have the best potential to mobilize for natural resource management, including wetland management. This is evident from the values they espouse, and the esteem with which local people hold the institutions and their leaders. Therefore local communities should be empowered to participate in shaping their own destiny through management of environment and resources according to their needs and vision for the future. These insights call for flexible approaches that take on board all the changes and affected parties. This is especially important given that human demands on ecosystems will continue to grow in the coming decades. Furthermore, integrated institutional management is crucial for enhancing the sustainability of wetlands. These considerations would contribute towards meeting development goals at the national and international levels.

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