# UNIVERSITY *of York*

This is a repository copy of *Prospects of scenario planning for Kenya's protected ecosystems: An example of Mount Marsabit*.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/158941/

Version: Published Version

## Article:

White Rose
university consortium
Universities of Leeds, Sheffield & York

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

# Prospects of scenario planning for Kenya's protected ecosystems: An example of Mount Marsabit

Caroline Achieng Ouko [a,*], Richard Mulwa [a], Robert Kibugi [b], Jessica P.R. Thorn [c,d], Nicholas Oguge [a]

[a] University of Nairobi, Centre for Advanced Studies in Environmental Law and Policy, P.O. Box 30197-00100, Nairobi, Kenya
[b] University of Nairobi, School of Law, P.O. Box 30197-00100, Nairobi, Kenya
[c] University of York, York Institute of Tropical Ecology, Department of Environment and Geography, UK
[d] University of Cape Town, African Climate and Development Initiative, South Africa

## ARTICLE INFO

## ABSTRACT

Place-based scenario planning can systematically explore and anticipate future uncertainties regarding interactions between human and the environment. However, to date, few studies explicitly link scenarios at different social-ecological scales, particularly, for forests and Protected Areas (PA) in Eastern Africa. To address this gap, we developed scenario narratives to illuminate how divergent futures may unfold and what opportunities exist to improve future management of Mount Marsabit forest PA in northern Kenya. This ecosystem is under unprecedented degradation, and with use by multiple stakeholders, exhibits a complex governance arrangement. We compared local participants' perspectives on change with predetermined global scenarios from the literature. Thirty-six key informant interviews were conducted to identify drivers of change and potential impacts. Twenty-six participants partook the scenario development process (SDP), from which four divergent but plausible exploratory scenarios were generated namely: a) land use conflicts resolution in the context of traditional governance systems b) strategic advisory group-led governance of Mt. Marsabit PA c) community-led governance of Mt. Marsabit PA, and d) addressing climate change and drought effects in forest through policy development and community inclusion. Results were then compared with themes from global scenario group archetypes. Local stakeholders, as in the global archetypes, emphasized social values, market forces, and policy reform as major influencers in determining the future (2070) of Mt. Marsabit forest PA. However, stakeholders were less concerned with institutional breakdown, an important theme from the global scenario's perspectives. Our findings offer a new approach to analyzing similarities and differences between scenarios' narratives and local perspectives, and contributes to the growing body of place-based scenario studies.

## 1. Introduction

Ecosystem management and governance across the developing world is facing an increasingly unpredictable and dynamic future (Verburg et al., 2015). These challenges span across scales, from institutional linkages, land use land cover changes and socio-economic issues, to national and international development policies (Bennett et al., 2015). Ecosystems degradation can be attributed to, among others, man-made actions (Millennium Ecosystem Assessment, 2005a; Neugarten et al., 2018), ineffective policy outcomes (Díaz et al., 2015), biased decision making, a lack of implementation of the policies, multi-scale interactions, and non-linear dynamics of social-ecological systems (SES) (Sanderson et al., 2014). Governance scenarios of SES have the potential to engage relevant groups to envision plausible options considering future pathways and uncertainties (Carpenter et al., 2006). Scenarios can be instrumental in identifying themes and driving forces from stakeholders to construct future decisions using socio-economic, landscape and climate lenses rather than projections (Wardropper et al., 2016). As scenarios become more prominent, their influence on society through changes in stakeholders' interests, knowledge, risk perception and beliefs increase in importance (Verburg et al., 2015; Wardropper et al., 2016; van Notten et al., 2003). The geographic location of Mt. Marsabit forest PA as an oasis within an arid area and the ongoing policy and legislative framework changes offer a great opportunity to examine future changes (Muhati et al., 2018). However, few studies explicitly link scenarios at different social-ecological scales (van Notten et al., 2003; Western et al., 2009; Carpenter et al., 2006; Zurek and Henrichs, 2007).

Scenario development allows different perspectives across levels. Since SES includes societal (human) and ecological (biophysical) subsystems in mutual interaction, complexity, uncertainty and change are inherent challenges to its management (Pearson et al., 2017). These problems often involve social, economic and ecological crises at different scales (Oldekop

et al., 2019). The complexity could be attributed to different interest groups (e.g., public, private, government, community and individuals) vying for their agendas to be considered in decision-making (Zafra-calvo and Garmendia, 2019). Effective and equitable management of SES require analysis at multiple levels of governance, interconnections and the different values and perspectives across levels.

Participatory Scenario Planning in environmental research enables management choices, strategic planning, and decision-making to be better structured for stakeholders (Oteros-Rozas et al., 2015). It allows for exploration of dynamics due to its adaptability and flexibility (Bennett et al., 2017). Scenarios are "plausible descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces", such as changes in markets or social values (Millennium Ecosystem Assessment, 2005a). Scenarios development therefore have the potential to engage relevant stakeholders in envisioning plausible futures and considering pathways for decision making under uncertainty (Carpenter et al., 2006). By engaging stakeholders, scenarios can assemble conflicting opinions and different worldviews (Carpenter et al., 2006), and help build a shared understanding of alternative interventions and their nature-human impacts (Carpenter et al., 2006). Collaborative management of protected areas such as Natura 2000 offers valuable lessons on the importance of network approach to PA governance (Nita et al., 2018). Actual collaborative relationships between stakeholders can address social-ecological issues and ensure sustainability (Nita et al., 2018).

In Kenya, there are a number of institutions responsible for planning and managing protected areas. Governance of Mt. Marsabit Forest Ecosystem is multifaceted with multiplicity of stakeholders with diverse interests and relations. The government agencies and ministries work is supported by other organizations including civil society organizations, foreign aid donors, community-based organizations, non-governmental organizations and the private sector. These are involved in policy formulation, decision-making and developing and implementing site specific plans. Mt. Marsabit forest PA, as a multi-use landscape under different regulatory regimes, also involves different stakeholders with challenges for inclusive governance that encourages the active participation of local communities (Ouko et al., 2018). Two national agencies, Kenya Wildlife Service (KWS) and Kenya Forest Service (KFS), hold key positions in its conservation and management. Despite conservation efforts, forest degradation has been accelerating over time (Ouko et al., 2018).

Mt. Marsabit Forest PA, our case study, is an important and vital ecosystem for a large landscape in northern Kenya. The area is under anthropogenic threat from land use change; climate change; increase in population; and unsustainable use of the ecosystem goods and services which are ultimately leading to degradation (Muhati et al., 2018; Ouko et al., 2018). The overall aim of the study was to identify alternative options of sustainable governance policies and strategies, in the face of interacting local and global driving forces of social-ecological change, and critical future uncertainties. To examine multiple stakeholder perspectives and influences of plausible future, we incorporated participatory scenario planning with themes from global scenario archetypes to help broaden the range of change narratives (Carpenter et al., 2006) and understand the system dynamics (Metzger et al., 2010). Results show the four local perspectives from this study had similarities to the ones from a study by (Muhati et al., 2018) which described four scenarios, that is, tragedy of the commons; collapse; winning backspace; and the desired scenario. Common themes of change, such as "business as usual, value shift and technological innovation" influence scenario development at different scales (Wardropper et al., 2016).

## 2. Study area and methods

### 2.1. Study area

Mt. Marsabit landscape is a unique social-ecological system, with an extensive upland forest on an extinct Holocene shield volcano in an arid setting (Bussmann, 2002). It is of vital importance for biodiversity conservation, and supports livelihoods for communities living in its surroundings. The forest (2° 19' N, 37° 59' E), located in Marsabit County in northern Kenya, occupies an area of 400 km² (Fig. 1). Marsabit National Park, gazetted in 1948, is a critical wildlife habitat for endemic and migrating species, including elephants, buffaloes and gazelles. Historically, elephants are believed to have moved within the larger ecosystem that Mt. Marsabit comprises, and this includes Mt. Nyiru, Matthews, Losai, Ndotos, and Bure Marmar ranges (Bussmann, 2002). However, today, most corridors have been blocked by human activities. Vegetation ranges from evergreen forest semi-deciduous bushland, deciduous shrubland, to perennial grassland (Cuni-Sanchez et al., 2017). In addition to biodiversity benefits, it is also important economically through tourism activities which provide revenue to surrounding communities. More importantly, being a watershed, it is a source of water for a vast area that encompasses the Chalbi Desert to the west, the Milgis Basin to the south, and the Shura plains to the east (Maina and Imwati, 2015).

The population in Marsabit County grew from 96,216 in 1979 to 291,166 inhabitants in 2009 (a 200% increase) (Republic of Kenya, 2014). Such growth has been accompanied by increased rapid urbanization, and associated pressure on natural resources over-extraction of ecosystem goods, forest conversion, and overgrazing (Camarillo, 2002; CICES, 2013; IPBES, 2015; Millennium Ecosystem Assessment, 2005b). These conditions are likely to be exacerbated by climate change (Muhati et al., 2018). A multiplicity of actors in managing the PA, inadequate community participation, and a lack of a coherent legal framework for natural resource management at the county level compound these drivers (Fig. 2) of ecosystem degradation (Ouko et al., 2018). These factors provide justification as to why Mt. Marsabit is an important yet understudied area. This area is representative of other regions undergoing rapid change.

### 2.2. Methods

The mixed method study design combined a review of the literature, land cover change mapping, key informant interviews and two Participatory Scenario Planning workshops, with outputs compared to predetermined global scenarios. First, we reviewed published and grey literature relating to forest ecosystem governance in Mt. Marsabit forest and how this has changed over time. This included the Mt. Marsabit forest PA management plan, the legislative framework at County and National government levels, peer reviewed literature on Mt. Marsabit and surrounding landscape among others.

Second, land cover maps were generated using LandSat imagery data as follows; for (years, 2000 (21/02), 2010 (19/08) and 2015 (05/01)). The algorithm used to classify the data into five classes followed supervised image classification approach. A random forest model, trained in R Studio using samples collected during household surveys, was used as the technique for grouping similar pixels (Ouko et al., 2018). A significant model with overall accuracy of 0.97 at *p-value 0.05* was obtained and used to classify the images. The overall change in forest cover between 2000 and 2015 was also calculated.

Third, key informant interviews (n = 36) were conducted in May 2017, exploring historic drivers environmental change, risks, governance of and community participation in forest management, decision making processes, social-ecological values, and envisioned governance processes of land use transformations. Interviews enabled a deeper understanding of the land use changes and the status of the ecosystem services. Participants were selected using snowball purposive sampling, to ensure they were aware of the governance status of Mt. Marsabit forest PA (Camarillo, 2002). The stakeholders gave information on the status of the PA focusing on issues they could recall in the past (1980, 1990), and the more recent past (2000, 2010, 2015). Years were chosen to reflect legislative, political changes. That is, in the 1980s there was one party rule, while in the 1990s, there was a multi-party democracy. In 2000s, there was a coalition government. In 2010, a new constitution was instated, and in 2015, the government was devolved. In devolution system, the existing power balance was reconfigured by sharing power and responsibilities between the national
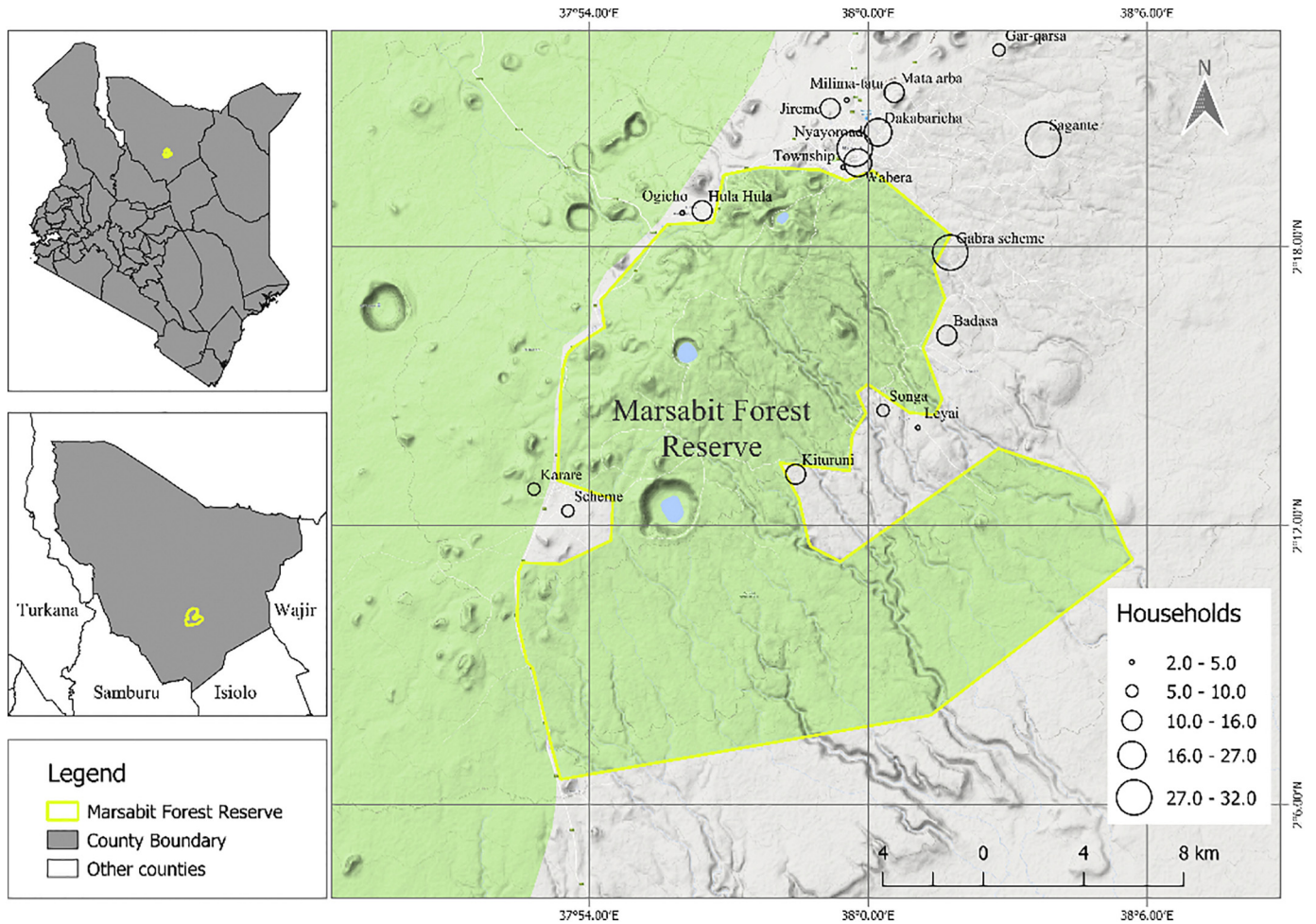
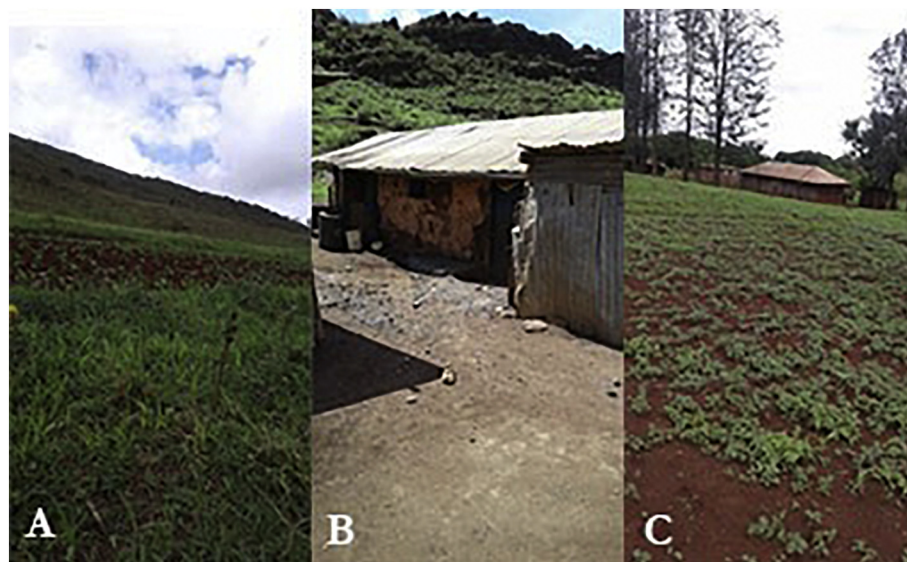**Fig. 1.** Location of Mt. Marsabit Forest Ecosystem in northern Kenya.



**Fig. 2.** Images illustrating settlement and cropping as drivers of degradation in the Mt. Marsabit forest PA in Kenya (November 2017). A & C Small scale farmlands showing crops adjacent to the PA. B showing settlement adjacent to the PA (Photos by Caroline Ouko).

government and 47 county governments. In addition to the political and regulatory considerations, there were also other conditions such as climate variations. The participation was voluntary, and interviews were conducted in English and Swahili where necessary, averaging one hour at the place of formal employment after booking prior appointments over the phone (Ouko et al., 2018).

Two Participatory Scenario Planning workshops were held in November 2017. The aim of the workshops was to develop diverse, plausible scenarios of governance policies and strategies to be adopted in Mt. Marsabit PA. Expert knowledge from organizational leaders was used to identify interacting local and global drivers of change of ecosystem degradation, their interdependencies, and provide foresight to future trends in the face of critical uncertainties. To push the stories into more provocative territory, workshop participants drew from a myriad of sources of inspiration, including the Millennium Ecosystem Assessment, science fiction, as well as national and international news stories. Four narratives were produced in each workshop, and results from key informant interviews were incorporated into the narratives. Participants (n = 26) included individuals and organizations involved in forest management or have direct or indirect interests in forest resources of Mt. Marsabit. Institutions ranged from county and national government, to research organizations, non-governmental organizations, and community members, working across scales and sectors (Table 1). We ensured that the 26 participants had not participated in the key informant interviews.

Workshops followed six sequential steps in Participatory Scenario Planning. First, researchers elaborated on the background theory of PSP. Second, researchers presented a synopsis of Marsabit Forest Ecosystem Management Plan, with the following objectives: institutional collaboration; ecosystem restoration and management; community involvement; ecotourism opportunities; and security. This step was important to establish consensus among the stakeholders of the baseline conservation situation, and associated mitigation plans. Third, highlights of the results of the key informant interviews regarding historical trends were presented and discussed. Fourth, based on this information, drivers of change in Mt. Marsabit forest were identified. For ease of understanding, the questions posed to participants (Fig. 3) were: What factors form the focal system of the forest? What will drive change (in the future up to 2070)? What does this imply for the governance of the PA? Fifth, stakeholders created a set of scenario logics using qualitative narratives of possibilities (that is, what? how? where?) tailored to the context of Mt. Marsabit forest, and identified critical governance action points. Finally, when the groups completed deliberations, the scenario narratives were branded, and presented back to the larger group consistency and plausibility appraisal.

We then compared local perceptions of change with predetermined global scenarios. While many global scenarios exist (Munya et al., 2015; Oroda, 2011; CIDP, 2013), we utilized the Global Scenario Group (GSG) scenarios, because they are credible, consistent and represent over 20 years of data synthesis of more than 150 scenarios (Hunt et al., 2012). They proposed three scenario archetypes with two themes each. The interdisciplinary global scenario group (GSG) proposed different themes at global scale (Hunt et al., 2012). The conventional archetype had

**Table 1**
List showing institutions where workshop participants represented.

| Institution |
| --- |
| Kenya Wildlife Service |
| Kenya Forest Service |
| National Environment Management Authority |
| Water Resources Management Authority |
| County Government departments (Environment and Water; Lands; Agriculture; Culture services) |
| Northern Rangeland Trust (NRT) |
| Conservancy representatives (songa, shurr and Jaldesa conservancies) |
| Non-governmental organization (NGOs) Food for the Hungry |
| Ministry of Agriculture, Fisheries and Livestock |
| Community Forest Associations (CFA) |



**Fig. 3.** Image illustrating participatory scenario development workshop (November 2017). A) Cross-section showing participants listening to proceedings during the workshop. (Photos by Caroline Ouko).

a) markets whereby actors' advance growth, liberalization and privatization; and b) policy in which government action drives sustainable development. The great transitions archetype had a) social value change promoting broad-based SES; and b) Localism in which local self-reliance in rule making and economic growth drives further change. The barbarization archetype had a) inequity whereby authoritarian rule divides the haves and have-nots; and b) collapse in which conflict creates institutional collapse, which drives further change (Hunt et al., 2012). Finally, we used the six themes (that is, markets, policy, social values, localism, inequality, and collapse) to represent pathways of change in global scenario archetypes (Table 2).

## 3. Results

### 3.1. Socio-ecological changes in the landscape

The study shows that land use and land cover has been changing negatively over the years at different rates (Fig. 4). The highest rate of change was visible from year 2000 to 2010.

Table 3 shows bare land has changed negatively from approximately 24% in 2000 to 37% in 2015, while wetlands from 0.04% in 2000 to 0.1% in 2015. The forest cover change analysis shows most change has been from forest cover to grasslands (9.16 sq. km) as shown in Table 3.

Ecological changes were also influenced by socio-economic dynamics including; population increase, livestock production, crop production, urban settlement, rural settlement, physical infrastructure, conservation measures among others. The numbers and distribution of people and their livestock have increased over the years with profound influence on the study area and the pattern of land use within it (Fig. 5).

The numbers and distribution of people and their livestock have increased over the years with profound influence on the study area and the pattern of land use within it. The implications of population expansion and changes to the future of the PA is clear (Table 4).

Livestock and human population increase influences forest change. There is high likelihood of forest cover decreasing when population and livestock number increases.

This substantial increase in population can be attributed, on the one hand, to new births being higher than deaths, and on the other hand, to immigration from Ethiopia due to unrest and proximity. Devolution is another factor contributing to migration, as it incites Kenyans to migrate towards the counties (Munya et al., 2015). The population increase led to more water and food demand, and thus a need of land for agricultural expansion.

**Table 2**
Global Scenario Group archetypes, themes and social visions. (Adapted from (Hunt et al., 2012)).

| Scenario archetype | Scenario variant | Change themes | Archetypal social visions |
|---|---|---|---|
| **'Conventional world'** currently dominant driving forces; that is, the economy and Government shapes social- ecological conditions | Market forces<br>Policy reform | Markets<br>Policy | A world that evolves gradually, shaped by dominant driving forces<br>A world that is influenced by a strong policy push for sustainability |
| **'Great transitions'** novel value systems and approaches' to development and decision making emerge | New sustainability paradigm<br>Eco-Communalism | Social values<br><br>Localism | A world where new human values and new approaches to development emerge |
| **'Barbarization'** Society succumbs to fragmentation, collapse, and institutional failure | Fortress world<br>Breakdown | Inequality<br>Collapse | A world that succumbs to fragmentation, environmental collapse and institutional failure |
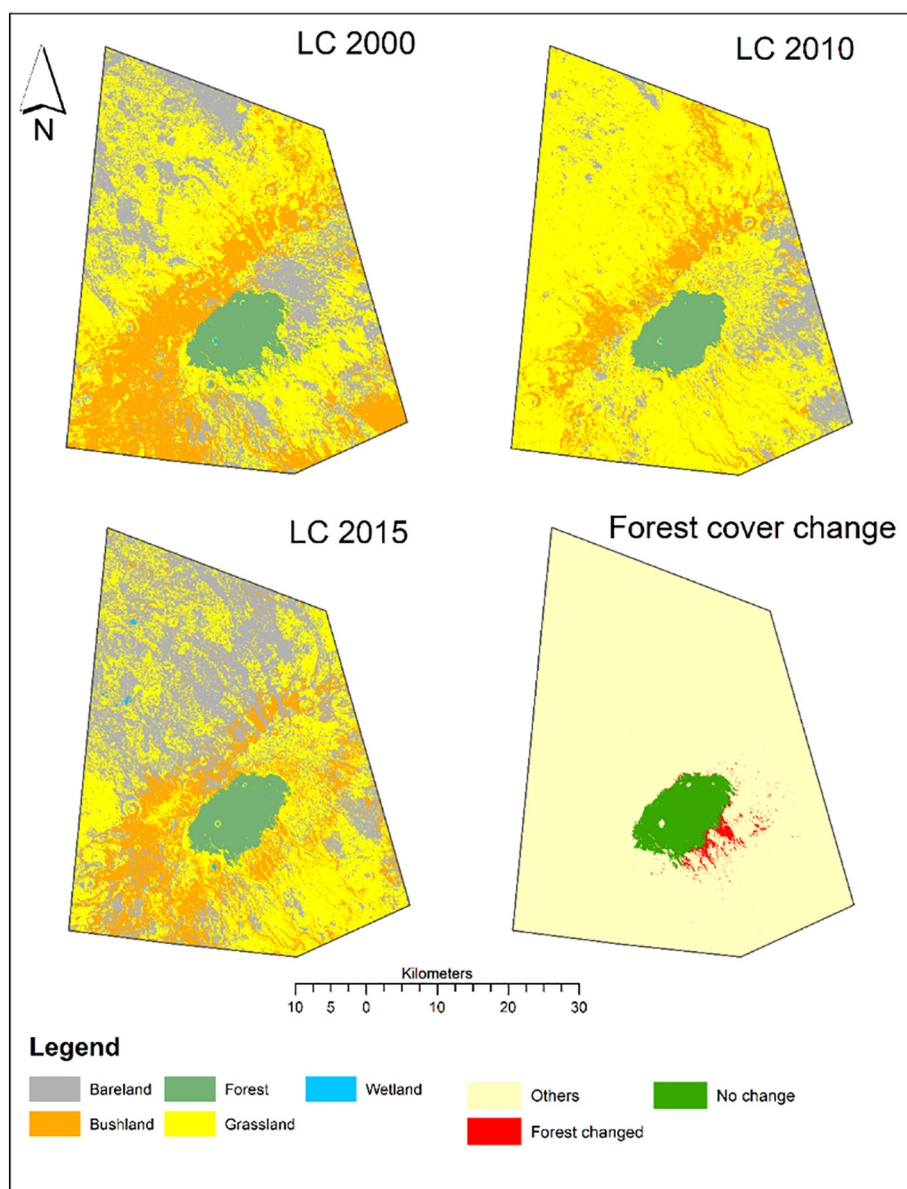


**Fig. 4.** Land cover maps showing different land use and land cover changes.

There are increasingly small-scale agricultural activities spreading in the area, leading to increased land fragmentation and sedentarization. The rising population and increasing spread of settlements has also led to a decline in forest cover, loss of wildlife habitat, decrease in biodiversity, and insufficient supply of spring and well water (Hunt et al., 2012; Munya et al., 2015).

### 3.2. Local perspective of Mt. Marsabit future scenarios

Local stakeholders described four future plausible scenarios and perceived direct and indirect drivers of change in uncertain futures of Mt. Marsabit as tabulated below. In order to manage the drivers, they suggested governance action points (Table 5).

**Table 3**

Areas and percentage cover of different land cover types in Mt. Marsabit forest PA.

| Land cover class | 2000 | | 2010 | | 2015 | |
|---|---|---|---|---|---|---|
| | Area (sq. km) | % Cover | Area (sq. km) | % Cover | Area (sq. km) | % Cover |
| Bareland | 501.71 | 24.40 | 229.04 | 11.14 | 751.07 | 36.53 |
| Bushland | 512.39 | 24.92 | 247.78 | 12.05 | 362.12 | 17.61 |
| Forest | 123.94 | 6.03 | 107.83 | 5.25 | 109.98 | 5.35 |
| Grassland | 917.03 | 44.60 | 1470.92 | 71.55 | 830.6 | 40.40 |
| Wetland | 0.86 | 0.04 | 0.35 | 0.02 | 2.15 | 0.10 |

The local stakeholders elaborated four scenarios based on plausible futures. These scenarios were as follows:

### 3.2.1. Land use conflicts resolution in the context of traditional governance systems

In the first local scenario which stakeholders developed for 2070, negative impacts are associated with climate change and land use change. Climate change is worse than expected and society is unprepared, leaving the ecosystem vulnerable. The society focuses on mere survival. Climate change also leads to land use conflict, leading to an increase in inter-ethnic tension without conservation and restoration efforts. This is because livestock incursions persist, and the relationships between Mt. Marsabit PA management authorities and community deteriorate. With persistent

**Table 4**

Results of logistic regression model analysis.

| Coefficients | Estimate | S.E. | z value | Pr(>|z|) |
|---|---|---|---|---|
| Intercept | −1.00 | 3.26 | −3.09 | 0.002 |
| Population density | 3.23 | 2.30 | 1.41 | 0.16 |
| Livestock numbers | 2.32 | 7.55 | 3.07 | 0.002 |

conflict, agricultural production is expected to reduce and a reduced welfare of the surrounding community by 2070. Therefore, human wildlife conflict leads to a surge in compensation claims which will be unsustainable by 2070. Land use change exerting pressure in the PA and population increase, will eventually lead to a crisis. Traditional governance structures for forest management exist, but not fully utilized. The council of elders (called Abagatha, Rendille, and Gabra) hold the ability to mitigate potential land use conflict that result in ecosystem degradation. This is compounded by a policy and institutional regime that is exclusionary in nature. The community is left alienated as they are not involved in decision-making and ecosystem management.

### 3.2.2. Strategic advisory group-led governance of Mt. Marsabit PA

Stakeholders developed a second local scenario where all the actors in the PA were proactive. The national leaders invest heavily in technology in response to environmental crises, creating a highly engineered
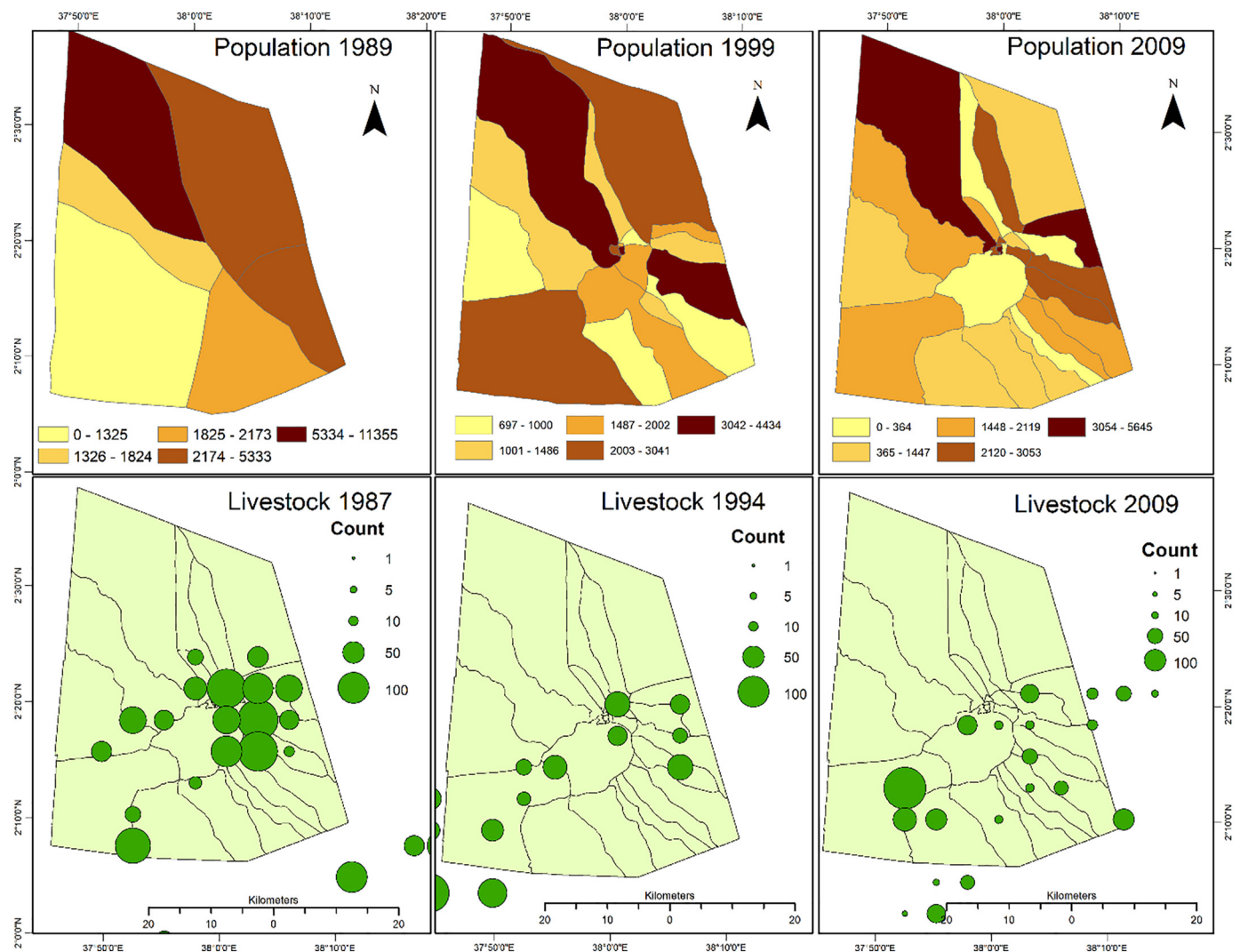


**Fig. 5.** Maps showing population growth and livestock numbers over the years (Source of livestock population data department of resource surveys and remote sensing (DRSRS).

**Table 5**
Drivers and Governance action points.

| Driver of change | Governance considerations |
|---|---|
| Community participation | Effective engagement process of the community with the guiding principle of using adequate information to guide engagement. |
|  | Creating awareness on importance of the forest ecosystem through public barazas (meetings), local medias -training of the community-based institutions e.g. environment management committees (EMC), community forest associations (CFA), and conservancies. |
|  | Policy formation and development - to be given legal backing on the role of CFA, EMC and the conservancy committees. |
|  | Integration of traditional resource management model in the policy management plan. |
|  | Harmonize communities on the natural resource use through elders and community-based institutions. |
| Institutional coherence/policy alignment/lack of devolved government's ownership | There is need to promote coordinated governance to drive this scenario, the need to establish accountable institutional mechanisms and to unify decision making, lead to the recommendation of a single management platform. This platform would coordinate and promote cooperation among stakeholders. |
|  | The group called this unified management platform a strategic advisory committee. The County government would lead this platform. |
|  | All stakeholders identified in the study to be included into this platform |
|  | The mandate of this platform should be backed by legislation passed by the County government |
|  | The advisory platform should be guided by a long-term management plan and backed by a budget for forest management and implementation of the plan |
| Land use conflict/use of traditional governance system in ecosystem governance | Incorporation of the traditional norms, customs and values in governance of the eco system. This is an effective means to guarantee community support in conservation. |
|  | Contested land use delineation that results to improved habitats/improved community PA relationships based on trust, provision of viable alternatives for community livelihood, optimal service provision and a mutual understanding of shared benefits of conservation. |
| Climate change, drought and political goodwill | Importance of checks and balances to hold politicians accountable in managing the Mt. Marsabit Forest ecosystem (MFE). These will ensure that politicians work to promote rather than discourage ecosystem conservation |
|  | A governance scenario the improves community perceptions towards conservation would lead to an improve the community's capacity to hold political elite accountable. |
|  | The multi-sectoral approach to conservation is not coordinated well. |

landscape. Social media, global positioning systems (GPS) and digital software are used to manage data in forest landscapes. The state introduces communities to the use of innovative, energy saving alternatives and climate smart technologies. In this scenario, with every actor perusing an individual role irrespective of complementary actions by other actors,

degradation is expected to persist. The lack of a unified approach to mitigating human impact to the eco-system is critical uncertainty in managing the ecosystem to the future. The multiplicity of actors ultimately does not put the community at the forefront of ecosystem management, causing alienation, uncertainty and few conservation incentives. A lack of unified decision-making exposes the ecosystem to individual benevolence as opposed to conservation being vested in institutional structures and systems. The rapid development of technology is funded by national, state, local government (Policy) and private companies (Markets). The ecosystem is managed by multiple stakeholders, each formed under a separate legal framework. Each actor works disjointedly without all the relevant complementarities, resulting in an institutional conflict/impasse. For example, the forest PA is dual gazetted, leading to conflict and mistrust between KFS and KWS.

### 3.2.3. Community-led governance of Mt. Marsabit PA

In this scenario, looming environmental crises incite a global movement to adopt sustainable values and behaviors by 2070. In the face of rising temperatures and unpredictable rainfall patterns, the possibility of land grabbing and community conflict increased. When the community is excluded from forest conservation management, the present situation of forest degradation is exacerbated with land acquisition. Over-extraction of forest products, including charcoal, fuel wood, forest fires, illegal logging for timber and building material, tree species used during cultural events to persist will be accelerated, threatening wildlife and forest biodiversity. Land use change occurs with forest fires, uncontrolled grazing and resource use conflicts.

### 3.2.4. Addressing climate change and drought effects in forest through policy development and community inclusion

In this scenario, climate change is worse than expected and the forest ecosystem faces a crisis. Persistent climate change through prolonged occurrence of drought ultimately puts pressure on the ecosystem as the community ultimately relies on the forest reserve for dry season grazing. Fostering political good-will in forest conservation was identified as uncertainty in the future of governing the forest ecosystem. Community perception and involvement in preserving the forests was uncertain. A multi-sectoral approach to conservation leads to a high risk of degazzettement of the forest, land grabbing, and water catchment destruction. This pressure presented by climate change is expected to lead to reduced percentage of forest cover and mass, as well as disruption or extinction of some species, such as sandal wood. Government-led change results in a national reorganization of ecosystem management with focus at lower levels (forest scale).

From literature, the four scenarios elaborated by the global scenario group were as follows:

1. Abandonment and renewal

In this scenario, climate change is worse than expected and society is unprepared and unable to deal with environmental disasters. By 2070, some of the people abandon the place and there are a few people when the state of the environment is undesirable. The people who remain behind focus mainly on survival.

2. Accelerated innovation

Technology use is to achieve sustainable social-ecological systems and adapt to climate -related disasters. By 2070, the focus on technology does not translate to ecological integrity but solutions to emerging issues is use of innovative technologies.

3. Connected communities

Sustainability and community involvement are central to governance of the ecosystems. All decisions are oriented towards the well-being of the community. Climate change adaptation is acceptable but the conditions are altered.

4. Nested ecosystems

There is an environmental crisis due to climate change and to curb the crisis, the authorities regulate most aspects of the environment. By 2070, the adaptive processes are small and the crisis is not adequately addressed.

*3.3. Linking local perspectives to global archetypes*

There are synergies between local stakeholder perspectives and the global archetypes. Comparing the four scenarios as shown below:

1. Land use conflicts resolution in the context of traditional governance systems, representing Abandonment and renewal

This scenario is closely related to the global archetype of the fortress world (Barbarization scenario) as there is an Abandonment and Renewal phase. The Collapse theme characterizes the Abandonment phase. An environmental disaster occurs as a result of failure to adapt social and governmental institutions to the governance of the changing ecosystem. The second phase, Renewal, depicts fragmented, self-sufficient, and highly dense living settlements aligned with the Localism theme. Governance is small scale and decentralized, and many communities are completely dependent on the forest ecosystem.

2. Strategic advisory group-led governance of Mt. Marsabit PA, representing Accelerated innovation

This scenario most closely related to the global archetype of the market forces (conventional scenario) and the Markets theme because "natural processes are valued economically and controlled by market mechanisms," and people are drawn to the forest ecosystem for jobs, as "entrepreneurs and businesses base their headquarters here".

3. Community-led governance of Mt. Marsabit PA, representing Connected communities

Here, this scenario aligns with the global archetype of Eco-Communalism (great transition scenario) and Social Values theme, as "the younger generations embrace community building and sustainability through grassroots action to get their voices heard and included in ecosystem governance. This values shift has also happened at a global scale." Global youth, disenchanted by political gridlock and dismayed by climate change impacts, organize effectively to create a sustainable, values-driven society referred to as the Great Transition. By 2070, "connectivity, community, and environmental sustainability" are the new norm.

4. Addressing Climate change and drought effects in forest through policy development and community inclusion, representing Nested ecosystems

This scenario aligns most with the global archetype of policy reform (conventional scenario). Change here is most influenced by Policy. The country passes new legislation, creating a new forest PA governance framework, and giving authority to local governments to tailor site specific policies. Management authorities have the power to incentivize or regulate landowners and forest product users in their respective regions "to maintain, improve, and distribute forest resources." The threat posed by climate change has potential to incentivize conservation and result to possible income from carbon credit trading for the community.

## 4. Discussion

Local stakeholders' perceptions of direct and indirect drivers of change in uncertain futures of Mt. Marsabit mirror those represented in commonly used global scenario archetypes. Key drivers of change were associated with markets, policy, and social values. A number of drivers were used to describe change across multiple themes; for instance, technology was conceived as a driver in markets and policy themes, whereas extreme climate change was described as a catalyst across several themes.

Literature shows that there is an increase in use of scenarios of future SES change to help societies grapple with how to fulfill diverse human needs sustainably without compromising ecosystems (Raskin, 2002; Miller et al., 2014). There is need to integrate change themes from scenarios literature with local stakeholder perceptions (Metzger et al., 2010). Results from the global scenarios group, showed overlap and some differences with local stakeholder perspectives, themes from global scenarios archetypes, and the Mt. Marsabit PA scenario narratives.

Social values, economy (markets) and government (policy) were mentioned, by stakeholders as the main drivers of change. However, there was low emphasis on extreme change. According to the GSG, the Great Transitions archetype's themes of social values and localism, are positive as they predict hopeful visions associated with the power of human values and social movements (Raskin, 2002). The stakeholders alluded to similar change, citing communities, social values, and grassroots driven changes. This was mentioned more frequently than themes of change associated with Conventional or Barbarization scenario archetypes which are inequality and collapse. The Mt. Marsabit scenario Connected Communities is primarily driven by the shift of social values. This can be associated with understanding of sustainable change being ethical and concerning responsibility to future generations and nature's worth (Miller et al., 2014). Market forces and policy reforms which are conventional archetype themes, assume the continuation of current trends without significant rupture in values, economies, or politics (Raskin, 2000). Market forces and policy reforms were predominant during discussions and may reflect stakeholders' familiarity with the existing governance status associated with historical attachment and fear to shift to or change to the unknown (Levin et al., 2012).

Inequality and collapse themes associated with the Barbarization archetype, are pessimistic visions of institutional failure and chaos. The PA stakeholders rarely mentioned these types of breakdown narratives when they described what they see as influential determinants of the future. It is difficult to imagine drastic institutional changes. This is can be explained by psychological distance whereby when threats that seem more distant from an individual (that is, occurred in the past, to others people, or in geographically distant places) are less concerning and less likely to come to mind (Liviatan et al., 2008). GSG literature also showed that the inequality and collapse are less common (Hunt et al., 2012). Inequality and collapse narratives have the potential to dissuade pessimists, and can provide provocative contrast to other storylines, creating the most unexpected future outcomes compared to other themes from the other two archetypes (van Notten et al., 2003; Kenter et al., 2016).

Mt. Marsabit PA scenario Land use conflicts resolution in the context of traditional governance systems comparable to the abandonment and renewal depicts societal and institutional collapse, with significant impacts on both social and environmental variables. The type of change associated with particular themes depends on the archetype. For example, global and local markets and governments, can go experience rapid, unexpected changes that may disrupt the SES. This may result in greater changes than the ones associated to the Barbarization themes. Other classifications of scenario narratives could also change the analysis of scenarios' and stakeholders' narratives of change. For example, (Kriegler et al., 2014) classify themes similar to inequality and collapse under a "regional competition/regional markets" category, which is less extreme than the Barbarization archetype.

It is important to include a variety of stakeholders in the participatory scenario development process. This is because, representation by different gender and across major sectoral scales ensures more diversity of opinion regarding how change might occur (Metzger et al., 2010). The potential benefits of expanding beyond common local views include connecting with themes important in other places and times around the world, and suggesting ideas for transformational change that may advance public. The Mt. Marsabit forest PA scenario with the most dramatic and negative social changes, was driven by land use change and low participation in conservation by community members. Ecological and social changes may occur without adequate attention to climate change, pollution, and resource overuse. There is need to strike a balance between social-ecological considerations when developing scenarios (Zafra-calvo and Garmendia, 2019).

It is clear from Kenya's legal framework that there are a number of institutions responsible for planning for and managing protected areas. Most of

these institutions have overlapping mandates. Mt. Marsabit forest ecosystem is governed by government agencies and ministries whose work is supported by other organizations including civil society organizations, foreign aid donors, community-based organizations, non-governmental organizations and the private sector. Issues of legitimacy and accountability are often stressed, and good governance of ecosystems has been interpreted as solving the trilemma characterized by tensions between effectiveness, participation, and legitimacy (Kenter et al., 2016).

Experts suggest that a lot of attention is given to multilevel governance and cross-scale interactions in relation to social-ecological systems and adaptive co-management (Folke et al., 2005). However, it is argued that problem arises when dealing with systems that are not only dynamic, but also relied on by various communities. Environmental assessments such as environmental impact assessment, strategic environmental assessment, social impact assessment and risk impact assessment needs constant proper guidance, better public engagement and evidence-based decision-making (Nita, 2019). Incorporating changes requires resources namely time, manpower and legal frameworks. SEA, EIA and EA powers are relative to activities being undertaken in PAs. For instance, the Marsabit Management plan requires SEA but this has not been done.

## 5. Conclusion

Mt. Marsabit forest PA, like many other multi-use PAs will benefit from developing provocative, but plausible scenarios that emphasize unpredictable shifts and consequences for SES futures. Each of the four scenarios present critical ideas that cannot be ignored. The winning governance scenario is one that builds on all critical strengths of each of the solutions. During the ongoing preparation of county-based policies and legislative framework, this study shows that the planners, scientists and policy makers should ensure that they incorporate local perspectives and established global scenario literature perspectives. This should be through participatory scenario planning to recognize the drivers, plausible futures at multiple scales because the SES is complex and deeper understanding will be holistic and ensure sustainable PA. These results can help identify governance mechanisms and management options that respond to future challenges while understanding the complexity of SES, considering multiscale dynamic, different perspectives, and potential for change.

### Declaration of Competing Interest

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

## References

Bennett, E.M., et al., 2015. Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. Curr. Opin. Environ. Sustain. 14.

Bennett, N.J., et al., 2017. Conservation social science: Understanding and integrating human dimensions to improve conservation. Biol. Conserv. 205, 93–108.

Bussmann, R.W., 2002. Islands in the desert—forest vegetation of Kenya'S smaller mountains and highland areas (Nyiru, Ndoto, Kulal, Marsabit, Loroghi, Ndare, Mukogodo, Porror, Mathews, Gakoe, Imenti, Ngaia, Nyambeni, Loita, Nguruman, Nairobi). J. East Afr. Nat. Hist. 91 (1), 27–79.

Camarillo, G.C., 2002. Forum: Qualitative Social Research Sozialforschung Review: 1. Words Connecting the World.

Carpenter, S.R., Bennett, E.M., Peterson, G.D., 2006. Scenarios for ecosystem services: an overview. Ecol. Soc. 11 (1), 29.

CICES, 2013. Roy Haines-Young Centre for Environmental Management School of Geography, University of Nottingham Nottingham, NG7 2RD. p. 34.

CIDP, 2013. Marsabit County Integrated Development Plan.

Cuni-Sanchez, A., Pfeifer, M., Marchant, R., Calders, K., Sorensen, C.L., Pompeu, P.V., Lewis, S.L., 2017. New insights on above ground biomass and forest attributes in tropical montane forests. For. Ecol. Manag. 399, 235–246.

Díaz, S., et al., 2015. The IPBES conceptual framework - connecting nature and people. Curr. Opin. Environ. Sustain. 14, 1–16.

Folke, C., Hahn, T., Olsson, P., Norberg, J., 2005. Adaptive governance of social-ecological systems. Annu. Rev. Environ. Resour. 30 (1), 441–473.

Hunt, D.V.L., et al., 2012. Scenario archetypes: converging rather than diverging themes. Sustainability 4 (4), 740–772.

IPBES, et al., 2015. The IPBES conceptual framework - connecting nature and people. Curr. Opin. Environ. Sustain. 14, 1–16.

Kenter, J.O., et al., 2016. Shared values and deliberative valuation: future directions. Ecosyst. Serv. 21, 358–371.

Kriegler, E., et al., 2014. A new scenario framework for climate change research: the concept of shared climate policy assumptions. Clim. Chang. 122 (3), 401–414.

Levin, K., Cashore, B., Bernstein, S., Auld, G., 2012. Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. Policy. Sci. 45 (2), 123–152.

Liviatan, I, Trope, Y., Liberman, N., 2008. Interpersonal similarity as a social distance dimension: implications for perception of others' actions. J. Exp. Soc. Psychol. 44 (5), 1256–1269.

Maina, P.M., Imwati, A.T., 2015. Use of geoinformation technology in assessing nexus between ecosystem changes and wildlife distribution: a case study of Mt. Marsabit forest. Int. J. Sci. Res. 4 (4), 718–724.

Metzger, M.J., Flanagin, A.J., Medders, R.B., 2010. Social and Heuristic Approaches to credibility Evaluation Online. J. Commun. 60 (3), 413–439.

Millennium Ecosystem Assessment, 2005a. MA conceptual framework. Curr. State Trends Assess. 25–36.

Millennium Ecosystem Assessment, 2005b. Ecosystems and human well-being. In: Reid, W.V. (Ed.), Our Hum. Planet - Summ. Decis. Mak.Isl. Press, Wash. DC, pp. 25–36

Miller, T.R., et al., 2014. The future of sustainability science: a solutions-oriented research agenda. Sustain. Sci. 9 (2), 239–246.

Muhati, G.L., Olago, D., Olaka, L., 2018. Participatory scenario development process in addressing potential impacts of anthropogenic activities on the ecosystem services of Mt. Marsabit forest, Kenya. Glob. Ecol. Conserv. 14, e00402.

Munya, A., Hussain, N.H.M., Njuguna, M.B., 2015. Can devolution and rural capacity trigger de-urbanization? Case studies in Kenya and Malaysia respectively. GeoJournal 80 (3), 427–443.

Neugarten, R.A., et al., 2018. Tools for Measuring, Modelling, and Valuing Ecosystem Services. 28.

Nita, A., 2019. Empowering impact assessments knowledge and international research collaboration - a bibliometric analysis of Environmental Impact Assessment Review journal. Environ. Impact Assess. Rev. 78, 106283.

Nita, A., Ciocanea, C.M., Manolache, S., Rozylowicz, L., 2018. A network approach for understanding opportunities and barriers to effective public participation in the management of protected areas. Soc. Netw. Anal. Min. 8 (1), 31.

Oldekop, J.A., Sims, K.R.E., Karna, B.K., Whittingham, M.J., Agrawal, A., 2019. Reductions in deforestation and poverty from decentralized forest management in Nepal. Nat. Sustain. 2 (5), 421–428.

Oroda, A.S., 2011. The Impact of Increased Population and Sedentarization of the Pastoral Communities on Land Cover and the Resources of Mount Marsabit Forest and Surrounding Lands. Kenyatta University.

Oteros-Rozas, E., et al., 2015. Participatory scenario planning in place-based social-ecological research: Insights and experiences from 23 case studies. Ecol. Soc. 20 (4).

Ouko, C., Mulwa, R., Kibugi, R., Owuor, M., Zaehringer, J., Oguge, N., 2018. Community perceptions of ecosystem services and the management of Mt. Marsabit forest in Northern Kenya. Environments 5 (11), 121.

Pearson, T.R.H., Brown, S., Murray, L., Sidman, G., 2017. Greenhouse gas emissions from tropical forest degradation: an underestimated source. Carbon Balance Manag. 12 (1).

Raskin, P.D., 2000. Bending the curve: toward global sustainability. Development 43 (4), 67–74.

Raskin, P., 2002. Great Transition the Promise and Lure of the Times Ahead. Stockholm Environmental Institute, Boston, MA.

Republic of Kenya, 2014. Kenya: Facts and Figures, Kenya National Bureau of Statistics. Gov. Print, Kenya, p. 50.

Sanderson, I. a N., et al., 2014. What is the policy problem? methodological challenges in policy evaluation. Evaluation 30 (4), 1–22.

van Notten, P.W.F., Rotmans, J., van Asselt, M.B.A., Rothman, D.S., 2003. An updated scenario typology. Futures 35 (5), 423–443.

Verburg, P.H., et al., 2015. Land system science and sustainable development of the earth system: a global land project perspective. Anthropocene 12, 29–41.

Wardropper, C.B., Gillon, S., Mase, A.S., McKinney, E.A., Carpenter, S.R., Rissman, A.R., 2016. Local perspectives and global archetypes in scenario development. Ecol. Soc. 21 (2).

Western, D., Russell, S., Cuthill, I., 2009. The Status of Wildlife in Protected areas compared to Non-Protected areas of Kenya. PLoS One 4 (7), e6140.

Zafra-calvo, N., Garmendia, E., 2019. Progress Toward Equitably Managed Protected Areas in Aichi Target 11: A Global Survey. January. .

Zurek, M.B., Henrichs, T., 2007. Linking scenarios across geographical scales in international environmental assessments. Technol. Forecast. Soc. Change 74 (8), 1282–1295.