

Evaluation of the impact of anthropogenic activities on sustainable use of medicinal biodiversity in realization of Kenya's vision 2030 agenda for sustainable development

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ABSTRACT

Anthropogenic activities are posing a serious threat to Kenyan medicinal biodiversity and its contribution in the provision of traditional medicines and the potential of getting new drug discoveries. This poses a challenge to the country's achievement of vision 2030 development agenda as envisaged under the health sector. The main objective of the study was to evaluate the effect of anthropogenic factors such as settlement, cultivation, mining and bioprospecting activities on sustainable use of Kenyan medicinal biodiversity in realization of vision 2030 sustainable development agenda. The research article adopted a mixed methods approach including use of desk research and qualitative interview administered to 14 organizations involved in conservation of medicinal biodiversity in the country. Results showed that anthropogenic activities are not carried out in a way that guarantees conservation and sustainable use of medicinal biodiversity because of lack of collaboration, inappropriate legal frameworks and clash of roles occasioned by unclear demarcation of mandate among the organizations meant to safeguard medicinal biodiversity. A strong stakeholder's collaboration is recommended to manage and develop medicinal biodiversity and its sustainable use since it has a great potential to support a robust cultural and social economic development that will lead to realization of the country's 2030 agenda for sustainable development.

Keywords: anthropogenic activities, medicinal biodiversity, sustainable use, sustainable development

INTRODUCTION

Sustainable use of medicinal biodiversity refers to "the use of components of animals, plants and microorganisms with medicinal value in a manner and at a rate that guarantees their long term presence to meet the needs and aspirations of the current and future generations" (convention of biological diversity [CBD], 1992; IPBES, 2019a). Sustainable Development on the other hand is the type of development that satisfies the current needs without compromising the resources needed for future generations and it includes the interdependent aspects of human life in social, economic, and political spheres (Brundtland, 1987; Eisenmenger et al., 2020). Sustainable development is premised on coordinating economic, social and environmental development, so as to balance the intra-generational welfare while maximizing the total welfare of generations (Jin et al., 2020). Medicinal biodiversity which is an ecological resource is foundational to human life and

survival and a cornerstone to their sustainable development (Prakash & Verma 2022). Medicinal biodiversity contributes to human nutrition and well-being which in turn improves their capacity to be more productive and that in turn boosts economic growth thereby contributing to poverty reduction (Carrus et al., 2015). However globally, anthropogenic activities are responsible for the loss of medicinal biodiversity thereby posing a big challenge to conservation of both terrestrial and aquatic biodiversity (Arya, 2021; Chakraborty et al., 2021). While the loss of biodiversity significantly affects human health, it is equally opined to be a considerable threat to the achievement of sustainable development goals (SDGs) (United Nations, 2019a, 2019b). Medicinal biodiversity resources are related to many SDGs such as SDG (NO. 13) climate action and SDG (NO. 15) life on land aim to reduce the impacts of climate change, preventing biodiversity loss and promoting sustainable use of resources. Similarly, prudent utilization of medicinal biodiversity can contribute towards achievement of various SDGs such as SDG (NO. 3) good health

and well-being, SDG (NO. 8) decent work and economic growth, SDG (NO. 1) eradicating poverty and SDG (NO. 2) zero hunger (United Nations, 2015a, 2015b, 2015c, 2015d).

In tandem with the United Nations (UN) Sustainable Development Goals (SDGs), Kenya being one of the UN signatories crafted its 2030 sustainable development agenda and dubbed it “Kenya’s vision 2030” which aims at changing the country into a newly middle income industrialized country that will provide its citizens with a high quality of life by the year 2030 (Kenya Vision 2030 Report, 2007). The vision is premised on three fundamental Pedestals namely: economic pedestal, the social pedestal and the political pedestal supported by what is called the enablers pedestal. To this end, the rich biodiversity in Kenya has a great potential to support the development of a robust cultural and social economic development towards realization of the vision if appropriate institutional and legal framework to curb anthropogenic activities were put in place (NEMA, n.d.).

Biodiversity is a critical source of food, clothing, medicines, shelter and spiritual nourishment to humankind (Ashok, 2016). Medicinal biodiversity has been used since the history of mankind as a source of medicine (Meaza et al., 2015). Globally, medicinal biodiversity is important for human health and well-being and contribute considerably to human livelihoods and development. According to the World Health Organization (WHO), about 40% of existing pharmaceutical drugs have originated from medicinal biodiversity with drugs such as aspirin, quinine, taxol, metformin, and artemisinin serving as novel examples (Chaturvedi et al., 2023). For example, plant-derived natural products have been on record for millennia as an important source for the discovery and development of modern drugs used for the treatment of various communicable and noncommunicable diseases (Newman & Cragg, 2020). Today, plants and fungi medicinal biodiversity are embedded in global healthcare systems as sources of pharmaceuticals (Newman & Cragg, 2020). For instance, of the 185 small molecule drugs approved for cancer (1981-2019), 65% were natural product derived or inspired (Newman & Cragg, 2020). Equally, the hope in getting cure for the rising cases of new incurable diseases such as cancer, HIV/AIDS and COVID-19 lies on medicinal biodiversity from where new therapies may be discovered (Sifuna, 2022).

In Kenya, medicinal biodiversity contributes to our economy, our health and well-being and it enriches our lives (NEMA, 2011). The use of medicinal biodiversity for the management of various diseases is an important part of the Kenya’s cultural diversity and traditions. Medicinal biodiversity is the cornerstone of traditional medical practice in Kenya (MEWNR, 2015). Eighty percent of the Kenya’s citizenry relies on traditional remedies mainly derived from plant biodiversity due to their accessibility, affordability, effectiveness and cultural acceptability (MEWNR, 2015, MOH, n.d). The practice has been highly embraced largely because many rural areas have few health care facilities offering modern health care with health care personnel far below the WHO’s internationally recommended ratio of the population; with most of these facilities and workforce being not only poorly distributed, but also largely concentrated mainly in urban areas (Government of Kenya [GOK], 2020; Mulaki & Muchiri, 2019; World Bank Group, 2018, 2020; World Bank

Group and GOK, 2018). Further, Gakuya et al. (2020) observed that owing to its social, economic and cultural significance, traditional medicine is a concept that resonates well with many inhabitants of developing countries such as Kenya.

Biological diversity and by extension medicinal biodiversity is one of the fundamental assets for the achievement of vision 2030. Medicinal biodiversity serves as the ingredients of most of the traditional medicine which delivers the basic health care to almost 80% of the Kenyan population. Further, medicinal biodiversity will contribute significantly to the achievement of universal health care (UHC) envisaged in the Kenya’s vision 2030 in the health sector and anchored under the social pillar. On the economic pillar, biodiversity is earmarked to support industrial growth and development by providing raw materials in biodiscovery/bioprospecting projects. Medicinal biodiversity over millennia has been one of the principal sources of conventional therapy discoveries based on their ethno botanic information while on the enabler’s pillar, the government of Kenya has given commitment to convert the indigenous traditional knowledge of medicinal biodiversity into indigenous technology and safeguard it through patenting using applicable intellectual property laws to benefit traditional knowledge owners. However, and sadly, the huge contribution of medicinal biodiversity to the attainment of the country’s sustainable development agenda is faced with many problems and challenges on their sustainable use with most medicinal biodiversity facing extinction or severe genetic loss (IPBES, 2019b). Among them are the anthropogenic activities which are clearing biodiversity at an alarming rate thus interfering with the health functioning of the ecosystem whose benefits if left to disappear would be costly to replace (Millenium Ecosystem Assessment, 2005). Human activities are increasingly putting pressure to biodiversity a move that has not only resulted to environmental degradation but also environmental depletion. In Kenya, report by the Republic of Kenya (2003) pointed out that settlement and cultivation activities affected terrestrial habitats which in turn affected terrestrial animal and plant biodiversity. Interventions to tackle biodiversity loss were however put in place ranging from environmental policies and legislation, community involvement, national biodiversity assessment and documentation, sustainable management and conservation of biodiversity including fair and equitable benefit sharing (Lusweti, 2011). Kenya’s plant biodiversity is made up roughly 7,000 species (MEWNR, 2015) and by the year 2020, a total of 122 species were threatened with extinction according to data extracted from the IBAT (2020) country profile of Kenya. Further, 1.6% of plants assessed and occurring in Kenya are critically endangered according to the international union for conservation of nature (IUCN) Red List (2020) of threatened species. Similarly, animal biodiversity especially for mammal species richness in Kenya ranges between 390 to 405 (IBAT, 2020; MEWNR, 2015; Musila et al., 2019; IUCN Red List, 2020). Of the mammal species found in Kenya, 41 are threatened (IBAT, 2020), while 91 species are experiencing declines in their global populations (IUCN Red List, 2020).

However, an assessment done from 1993 to 2020 using the IUCN Red List index on over 400 official protected areas in Kenya which include forest reserves, terrestrial and marine

national parks and reserves as well as community conserved areas showed a continued decline in species abundance (Kenya National Biodiversity Threat Assessment Report, 2021). According to Goudie (2013), the natural environment and by extension medicinal biodiversity has been significantly affected by anthropogenic activities. Further, the recent reported rising carbon dioxide level in the atmosphere by scientists is being associated with human activities (Prakash, 2017, 2021). The challenge, therefore, would be to strike the delicate balance between the sustainable utilization of biodiversity and its conservation.

METHODS

The research article adopted a mixed methods approach including use of desk-research, qualitative interviews targeting 14 key informants administered through interview guide in the 14 entities involved in conservation of medicinal biodiversity in the country. These were Government Line Ministries and Departments, lead agencies and organizations involved with biodiversity conservation and regulation activities. 69 quantitative questionnaires were also administered in the 14 organizations to enhance the qualitative findings from desk-research and interview sessions as well as for the collection of documentary information. Desk-research was implemented through a search of literature on anthropogenic factors and sustainable use in indexes such as Scopus, Web of Science, PubMed, Education Resources Information Center, Directory of Open Access Journals, JSTOR, and ScienceDirect. The results of literature have been used to enrich the literature review sections and discussions of the study. The anthropogenic factors variable was measured using four indicators including

- (1) settlement,
- (2) cultivation,
- (3) mining activities, and
- (4) bioprospecting activities.

The qualitative data was obtained through interview guides that were self-administered to 14 key informants from the three line ministries and 11 organizations concerned with biodiversity and biological resources in Kenya. These were staff in the level of directors and other top leaderships as instructed by the visited directors. The variables considered included anthropogenic factors, medicinal biodiversity and sustainable use of medicinal biodiversity.

Quantitative data was obtained using structured questionnaires that were administered to six employees each from the 14 entities comprising of the three line ministries; Ministry of Environment, Climate Change and Forestry, Ministry of Health and Ministry of Sports, Culture and Heritage, and the 11 organizations which included the lead agencies and research Institutions in the country's biodiversity and biological resources management were: Kenya Forestry Service, Kenya Wildlife Service, National Museums of Kenya, National Environmental Management Authority, Kenya Industrial Property Institute, Kenya Plant Health Inspectorate Services, Pharmacy and Poisons Board, Kenya Forestry Research Institute, Kenya Agricultural and Livestock Research

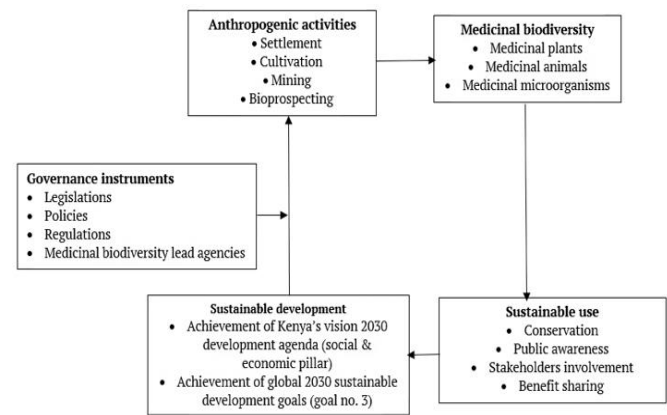


Figure 1. Conceptual framework of anthropogenic factors, medicinal biodiversity, sustainable use, and sustainable development (Source: Authors' own elaboration, © Micheni Ndi Kiraithe)

Institute, Kenya Medical Research Institute and the Universities. The total target respondents from the 14 entities were 84. These were technical personnel at the level of head of department. However, the researcher obtained 73 questionnaires of which four had serious omissions and were therefore not included in the analysis thereby leaving a total of 69 questionnaires for analysis.

The measurement of the indicators was an assessment of the extent to which respondents agreed that the anthropogenic practices had impact on the four agenda of achieving conservation, utilization, acquisition and commercialization of medicinal biodiversity in the country. The variable medicinal biodiversity was measured using three indicators namely the sustainability of the medicinal plants, medicinal animals and medicinal microorganisms. Sustainable use of the medicinal biodiversity was measured through assessment of the impact of the measures put in place in relation to how they had: increased awareness, supports to local users, saved biodiversity, grown more biodiversity and supports conservation.

The collected data, which were ratings for respondents of stated questions for each indicator was in ordinal scale, adopting a 5-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neutral/not sure, 4 = agree, and 5 = strongly agree. The measurement of the variable was through arithmetic mean of the average of mean ratings for each of the indicators for each variable. The quantitative data was analyzed using the test of relationships undertaken through factor analysis according to Chatterjee and Hadi (2006) and Costello and Osborne (2005) respectively, while the qualitative data was analyzed through content analysis of the interview narrations. **Figure 1** shows conceptual framework of anthropogenic factors, medicinal biodiversity, sustainable use and sustainable development.

RESULTS

The results section is based on both the qualitative interview of the 14 key informants in the 14 institutions

involved in management of medicinal biodiversity in Kenya and also the quantitative data from the 69 questionnaires.

Qualitative Interview

The interview on key informants in the organizations specified in the methodology was carried out. The results in **Table 1** shows the summary of findings from the

transcriptions. The respondents provided essential insights into the issues of anthropogenic factors and medicinal biodiversity in Kenya.

Based on the findings, it can be concluded that there are several organizations mandated to safeguard medicinal biodiversity. However, they have not done enough to ensure medicinal animals, plants and microorganisms are available

Table 1. Summary from transcriptions (Source: Research Data Analysis, 2024)

Organization	Sub-variables	Summary of respondents input
Kenya Wildlife Service (KWS) Officer	Settlement	o Governed by Wildlife Act 2013.
		o Have rights to conserve and manage wildlife in both non-protected and protected areas.
	Cultivation	o Settlement near parks and conflict with wildlife reported.
		o Cultivation in protected areas is highly prohibited.
Mining	Herder communities near parks are allowed to graze for peaceful coexistence.	o That has caused incidences of poaching.
		o Mining in protected areas not allowed.
	Occasional breach by miners with quarry near parks	o Interact with the local communities as conservation partners and biodiversity custodians.
		o Rarely work with local communities as traditional knowledge holders especially on medicinal biodiversity.
Bioprospecting	o Engage local communities in microorganisms governance	
	o No close partnerships with non-governmental organizations (NGOs) in microorganisms' governance.	
	o Have partnerships with research institutions, universities and companies.	
Kenya Forestry Service (KFS)	Settlement	o KFS is represented in every sub-county across the country even where there are no forests for the purpose of forest extension service provision.
		o Aim to minimize entry into forests and to engage communities for further afforestation.
		o Human settlement with political backing is a major challenge for Kenyan forests and medicinal biodiversity.
	Cultivation	o Conflict between forestation champions and farming committees is a biggest challenge.
		o Many indigenous plants and medicinal trees destroyed because of people supported by politicians.
Mining	o No partnership with NGOs with activities centered on medicinal plants or interested in medicinal plants	
	o Have KFS branches spread across all counties and sub-counties to support organization's mandate.	
	o No significant influence on mining activities in the country.	
Bioprospecting	o KWS manages protected areas, & a good number of protected areas have dual gazettement necessitating presence of both KWS and KFS but no significant control or influence on bioprospecting activities.	
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Kenya Industrial Property Institute (KIPI)	Settlement	o KIPI was created under the National legislation during the post-colonial period.
		o The institute pursues biodiversity and industrial property rights to safeguard medicinal biodiversity.
	Cultivation	o No known impact or relationships
		o No known influences or impact
Bioprospecting	o Majored in regulating micro-organisms as a component of biodiversity.	
	o Role clash due to uncoordinated stakeholder assignments in the case of KEMRI and KALRO who respondent feels violated the Industrial Property Act (2001) section 29 and Regulation 11.	
	o Medicinal biodiversity use and governance were safeguarded in vision 2030 blueprint under the National Products Industry (NPI) flagship project, which falls under economic and social pillars.	
	o But no known efforts to safeguard biodiversity through appropriate settlement policies.	
Kenya Vision 2030 Delivery Secretariat	Settlement	o Forest cover & declaration of rich biodiversity sites as protected areas as primary policies in Kenya's vision 2030 that guarantees the availability of medicinal biodiversity
		o Reclamation of all wildlife corridors and migratory routes and comprehensive mapping of all land use patterns in Kenya are key projects envisaged in vision 2030 that can help in preserving medicinal biodiversity, but mining policies not tailored to preservation of biodiversity but mostly exploitation.
	Cultivation	o Mining
		o KFS and Kenya Forestry Research Institute (KEFRI) were organizations coordinating medicinal biodiversity programs at the county level.
National Environment Management Authority (NEMA)	Settlement	o Governed by Environmental Management & Coordination Act of 2015 with mandate to regulate, and provide general supervision, coordination and implementation of environmental protection policies.
		o Settlement is possibly a major threat to biodiversity in Kenya.
	Cultivation	o Also adheres to Convention on Wetlands of International importance and the United nations Convention to Combat Desertification (UNCCD) and the United Nations CBD.
		o Mining
Bioprospecting	o NEMA works closely with local communities & all stakeholders, in general to ensure that public enjoys a healthy and clean environment.	
	o Facing the challenge of having few competent biodiversity enforcers, limiting NEMA in ensuring absolute medicinal biodiversity in Kenya.	
	o NEMA adheres to National Biodiversity Strategy Action Plan (NBSAP) which the country has signed and ratified with Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Convention on the Conservation of Migratory species of Wild Animals.	
Settlement	o Focused on identifying 2010 stalled policy on traditional medicine and medicinal plants but had no known influence on settlement.	
	o Cultivation	
Cultivation	o Herbal medicinal plants are part of pursuits yet traditional medicine which encompass microorganisms and medicinal animals are not part of focus.	
	o There were no other existing relevant policies/laws prior to the draft policy and had no significant influence on cultivation policies.	

Table 1 (Continued). Summary from transcriptions (Source: Research Data Analysis, 2024)

Organization	Sub-variables	Summary of respondents input
Kenya Medical Research Institute (KEMRI)	Mining	<ul style="list-style-type: none"> ○ Mining and Biopiracy in the recent past has posed a real threat to Kenya's biodiversity with threats from international companies seeking the impetus for new drug development. ○ The multiplicity of Institutions mandated with medicinal plants oversight have led to Institutional conflicts often stalling decisions.
	Bioprospecting	<ul style="list-style-type: none"> ○ Department of Culture under the Ministry of Sports, Culture and Heritage is mandated with legislation/regulation of traditional medicine and herbal medicine practice instead of ministry of health. ○ Major concerns with regard to traditional remedy is their safety, suitability and quality. ○ Globalization and civilization is the major threat to traditional remedies.
Kenya Agricultural and Livestock Research Organization (KALRO)	Settlement	<ul style="list-style-type: none"> ○ As per KALRO Act 2013 mandated to conserve food crops, industrial crops, livestock, genetic resources and biotechnology, as well as all forms of biodiversity including medicinal genetic resources. ○ Have established botanic gardens conserving medicinal genetic resources but competition for land for settlements is major challenge.
(KALRO)	Cultivation	<ul style="list-style-type: none"> ○ KALRO engages in promotion of various species among small holder farmers owing to their known medicinal value. ○ Most of the species have remained neglected and underutilized and have mostly been found in the wild.
	Mining	<ul style="list-style-type: none"> ○ KALRO collaborates with the traditional medicine practitioners to identify priority medicinal species that are threatened and need to be conserved so that they are not lost. ○ KALRO has research centers around the country whereby most counties have a KALRO center.
	Bioprospecting	<ul style="list-style-type: none"> ○ Kenya is not doing enough as a country to ensure medicinal food crops /livestock are available for use by both present and future generations. ○ There is a need to partner with communities, herbalists and other practitioners to identify important medicinal species and adopt community gardens to conserve them.
Genetic Resources Conservation Research Scientist (in KALRO)	Settlement	<ul style="list-style-type: none"> ○ Mandated to conserve all forms of biodiversity but at the time of research, they dealt with plant genetic resources only. ○ No readily available land in strategic places due to increasing population and land repossession and compensation are complex marred with politics.
	Cultivation	<ul style="list-style-type: none"> ○ Cultivation is among the big challenge in medicinal biodiversity conservation because most modern day farmers do not know indigenous biodiversity products that are of importance.
	Mining	<ul style="list-style-type: none"> ○ Mining does not affect biodiversity significantly. ○ The researcher interacts with local communities in regard to medicinal biodiversity research, particularly traditional knowledge holders.
Kenya Plant Health Inspectorate Service (KEPHIS)	Bioprospecting	<ul style="list-style-type: none"> ○ Conserves the knowledge for use by future generations through documentation of the medicinal biodiversity as claimed by the local community. ○ Encourages the traditional knowledge holders to pass it along ancestral lineage. ○ They motivate local communities to share their traditional knowledge with the institution freely by embracing the access and benefits sharing concept.
	Settlement	<ul style="list-style-type: none"> ○ Settlement due to population increase a key threat
	Cultivation	<ul style="list-style-type: none"> ○ Cultivation for food and livestock breeding a key challenge
(KEPHIS)	Mining	<ul style="list-style-type: none"> ○ No specific division or section that specifically deals with medicinal plants. ○ KEPHIS only inspects plants and plant products (unprocessed) for Phytosanitary certification.
	Bioprospecting	<ul style="list-style-type: none"> ○ KEPHIS faced challenges while executing their mandate, noting that smuggling of products, limited scientific information, on the products by illegal exporters, unwillingness to disclose scientific names of the plant products during certification as significant challenges. ○ Regarding intellectual property policy, the respondent maintained that KEPHIS is the custodian of plant breeders' rights in Kenya. ○ Faced numeral challenges while coordinating and collaborating with other institutions because of functional and operational clash. ○ Carries out Phytosanitary certification of plant material for export or import and surveillance of pests within the country
	Settlement	<ul style="list-style-type: none"> ○ Population increase necessitates land space for settlement.
Researcher at Kenya Forestry Research Institute (KEFRI)	Cultivation	<ul style="list-style-type: none"> ○ Population growth has increased land use and destroying of key biodiversity.
(KEFRI)	Mining	<ul style="list-style-type: none"> ○ Increased trade both locally and internationally has posed a real threat in conservation of medicinal plants in Kenya. ○ For example, Prunus Africana was declared an endangered species by Convention of International Trade in Endangered Species (CITES) in 1995.
	Bioprospecting	<ul style="list-style-type: none"> ○ Safety and suitable quality are the main inhibitors to the uptake of traditional and herbal remedies in Kenya. ○ In Kenya, traditional and herbal medical practice has recently been converted into a trade where quacks have infiltrated the market. ○ Many traditional herbal medicine men/women hawking what they consider as traditional medicine.

for use by both present and future generations. Confusion amongst the organizations exists as the different entities strive for space in biodiversity conservation.

Clash of responsibilities and operational procedures underpin a lack of appropriate, effective legal framework as enabler, low local stakeholder engagement and co-option as well as lack of or unattractive incentives. As a result, anthropogenic factors such as settlement, cultivation, mining

and bioprospecting activities are posing a threat to sustainable use of medicinal biodiversity. Anthropogenic activities are therefore wiping out biodiversity and interfering with the smooth functioning of healthy ecosystems whose benefits if lost would be costly to reinstate. The goods and services provided by medicinal biodiversity will become increasingly rare and highly sought after if these anthropogenic factors including settlement, cultivation, mining and bioprospecting are not put into check.

Table 2. Anthropogenic factors (Source: Research Data Analysis, 2024)

	SS	Mean	SD
Settlement	69	3.39	0.820
Cultivation	69	3.43	0.780
Mining	69	3.42	0.775
Bioprospecting	69	3.28	0.790

Note. Grand mean = 3.38; SD: Standard deviation; & SS: Sample size

Analysis of Relationships

In addition to the qualitative interview on key informants, a test of effect of anthropogenic factors on sustainable use of medicinal biodiversity and vice versa was implemented using data from questionnaires from 69 respondents after targeting six employees from each of the organizations mandated to manage biodiversity in the country. Those were the 14 organizations which included the three line ministries, and 11 organizations concerned with biodiversity and biological resources in Kenya.

Table 2 shows the descriptive statistics for the indicators of the anthropogenic factors. The results show that the mean of the ratings for each of the variables was above 3.0 and below 4.0 while the grand mean was 3.38. It means that the respondents agreed with the questions regarding the extent to which each of the activities related to settlement, cultivation, mining and bioprospecting had influenced medicinal biodiversity conservation. The ratings did not differ significantly as shown by the low (all below 1.0) standard deviations for the various anthropogenic factors.

The results in **Table 3** shows the descriptive statistics for the indicators for the sustainable use of medicinal biodiversity. The mean of the factors was used to measure sustainable use of medicinal biodiversity. The results show that the mean of the ratings for the indicators lie between 2.0 and 3.0 which means that the respondents were neutral on whether the anthropogenic factors had influenced medicinal biodiversity. However, the mean rating can be rounded off to 3.0 but the results are self-explanatory that the respondents were somewhat conservative in rating those issues. The standard deviations were below 1.0 which imply no major dispersion of the respondent's opinions from mean rating.

Table 3. Sustainable use of medicinal biodiversity indicators (Source: Research Data Analysis, 2024)

	SS	Mean	SD
Identification of biodiversity	69	2.88	0.62
Save and grows biodiversity initiatives	69	2.71	0.80
Preservation of medicinal animals	69	2.81	0.74
Preservation of medicinal microorganisms	69	2.78	0.71
Increased awareness	69	2.88	0.67
Sustainable use	69	2.94	0.62

Note. Grand mean = 2.84; SD: Standard deviation; & SS: Sample size

Relationship Between Sustainable Use and Anthropogenic Factors

The study analyzed the interplay between sustainable use of medicinal biodiversity and anthropogenic factors and vice versa. The results for the test of the relationship between sustainable use of medicinal biodiversity and anthropogenic factors such as settlement, cultivation, mining and bioprospecting showed a negative relationship with the coefficient corresponding to sustainable use variable of -0.207 with a significant value equal to 0.072 as shown in **Table 4**. That implies that the initiatives of the organizations mandated to manage medicinal biodiversity by ensuring positive impact to identification of medicinal biodiversity, conservation and growing medicinal biodiversity initiatives, preservation of medicinal animals, preservation of medicinal microorganisms, increased awareness and sustainable use of biodiversity can reduce the adverse effects of settlement, cultivation, mining and bioprospecting.

DISCUSSION OF FINDINGS

The study established the relationship between sustainable use of medicinal biodiversity and anthropogenic factors such as settlement, cultivation, mining and bioprospecting activities in Kenya. The results established a negative relationship between sustainable use and anthropogenic factors since coefficient was -0.207 and was significant at 0.1 significant level because corresponding significant value was 0.072. These results compare favorably with those of Scheffers et al. (2016) which reported direct drivers affecting land and sea changes being human activities dominated by settlement,

Table 4. Sustainable use of medicinal biodiversity and anthropogenic factors (Source: Research Data Analysis, 2024)

Model summary						
Model	R	R square	Adjusted R square	Standard error of the estimate		
1	.218 ^a	.048	.033	.26617		
^a Predictors: (constant), sustainable use						
ANOVA ^a						
Model	Sum of squares	df	Mean square	F	Sig.	
1	Regression	.237	1	.237	3.350	.072 ^b
	Residual	4.747	67	.071		
	Total	4.984	68			
^a Dependent variable: In anthropogenic factors & ^b Predictors: (constant), sustainable use						
Coefficients ^a						
Model	Unstandardized coefficients		Standardized coefficients		T	Sig.
	B	Standard error	Beta			
1	(Constant)	3.223	.327		9.846	.000
	Sustainable use	-.207	.113	-.218	-1.830	.072
^a Dependent variable: In anthropogenic factors						

direct exploitation of natural resources ranking second, followed by pollution and climate change being reported as a recent and accelerating driver that is causing widespread biodiversity loss. Similarly, the results agree somehow with those of IPBES (2019a) that reported climate change, habitat change, exploitation, pollution and invasive alien species to have been recognized as the most important and widespread direct anthropogenic causes of biodiversity change. In line with our results, Appiah et al. (2019) reported agricultural expansion, drought, overharvesting and bush fires as the main threat to medicinal biodiversity in Ghana while in Ethiopia, Uganda, Indonesia and Cameroon, settlement activities, agricultural expansion and climate change have been cited as major threats to the sustainable management of medicinal plants (Affandi & Batubara, 2019; Ssenku et al., 2022). The study findings are also in agreement with those of Lal et al. (2023) and Roy et al. (2022) which established that natural and anthropogenic factors including settlement, agricultural expansion and climate change threatens medicinal plants.

Based on the study results therefore, emphasis on sustainable use of medicinal biodiversity can reduce anthropogenic factors. That is consistent with the findings of Dey et al. (2021) who observed that emphasis on sustainable use of medicinal biodiversity can sensitize users of biodiversity to be more responsible in use. Emphasis on sustainable use can benefit medicinal biodiversity anthropogenic practices that increase keen interest and knowledge on conservation of medicinal biodiversity and other related resources. Moreover, Purwanto (2021) concurs that the culture of sustainable management of biodiversity can be developed through enhancement of local knowledge on use of biodiversity products in technology and art.

While the study results agree with the past authors, Moyini (2004) and national biodiversity strategy action plan (NBSAP, 2000) points out that Kenyan environmental policies are remedial rather than anticipatory. It appears that there is little effort to enshrine sustainable environment management plan through sustainable use of biodiversity. Similarly, the study results confirms that anthropogenic activities are drivers of environmental degradation and barriers to sustainable development. This is in line with the findings of Qumsiyeh and Abusarhan (2021) which explain that sustainable biodiversity is akin to sustainable environment. Overuse and misuse of biodiversity affects the environment through climate change, occupation and waste management, all resulting to environmental degradation. This is contrary to SDG No. 12 which advocates for sustainable consumption and production patterns and SDG No.15 which advocates for protection, restoration and promotion of sustainable use of biodiversity and ecosystems respectively as enshrined in chapter 15 of agenda 21 of the CBD (1992). Worthy to note that the agenda 21 addresses the global population primary health needs since they are fundamental to the attainment of goals of sustainable development and environmental care.

In Kenya's vision 2030 sustainable development blueprint, medicinal biodiversity is earmarked to support industrial growth and development by providing raw materials in biodiscovery/bioprospecting processes and upon medicinal biodiversity providing these opportunities to the Kenyan citizenry, it will be in line with the UN SDG No. 1 which aims

at ending poverty in all its forms. Similarly, the Government of Kenya's commitment on medicinal biodiversity in attaining its vision 2030 is in line with the UN SDG No. 9 on inclusive and sustainable industrial development. Industries increase productivity, job creation and generate income. Additionally, GOK (2020), through relevant institutions is also working towards legislating a bioprospecting policy for the country. A properly constituted medicinal biodiversity bioprospecting policy will guide the country's bioprospecting activities premised on the community's ethnobotanic knowledge. Medicinal biodiversity over millennia has been one of the principal sources of conventional drug discoveries. However, on the contrary, the results from this study revealed that human settlement and cultivation activities had large effects on conservation, sustainable use, acquisition and commercialization of medicinal biodiversity. The findings of the study concur with those of Mesfin et al. (2013) and Nanyingi et al. (2008) which reported that many medicinal plant biodiversity among the Samburu Community in Kenya and other communities in Northern Ethiopia respectively were declining leading to reduction of traditional herbal medicine due to pressures from human activities such as settlement, cultivation and livestock grazing.

On the enabler's pedestal in vision 2030 sustainable development agenda blueprint, the government of Kenya has given commitment to convert the indigenous traditional knowledge of medicinal biodiversity into indigenous technology and safeguard it through patenting using applicable intellectual property laws to benefit traditional knowledge owners. This commitment would only be actualized if initiatives are put in place to conserve the biodiversity and ensure its sustainable utilization and secondly to document the indigenous traditional knowledge and the associated medicinal biodiversity.

Similarly, on the social pedestal in Kenya's vision 2030 sustainable development agenda blueprint under the health sector, medicinal biodiversity serves as the principal sources of Kenyan traditional medicines which provide the primary health care to almost 80% of the Kenyan population. It is worth noting that traditional medicine as a form of basic health care is used worldwide Kenya included owing to its accessibility, affordability and cultural acceptability. Curbing anthropogenic activities on medicinal biodiversity in Kenya will go a long way in sustaining traditional medicine sources. By virtue of medicinal biodiversity providing free primary health care in Kenya, this will be in line with SDG No. 3 which advocates for good health and well-being. Further, sustainable use of medicinal biodiversity will contribute significantly towards the attainment of UHC also hinged under the social pedestal. UHC as defined by the WHO (2019) is a form of health care where individuals receive affordable health care services. Traditional and complementary medicine which is a component of medicinal biodiversity is extensively used in Kenya by many communities in their basic health care and basic health care is foundational for achieving UHC. These findings are in agreement with (MEWNR, 2015, MOH, n.d) that reckons eighty percent (80%) of the Kenya's citizenry relies on traditional remedies mainly derived from plant biodiversity due to their accessibility, affordability, effectiveness and cultural acceptability. Unfortunately, traditional medicine,

which is a product of medicinal biodiversity, and UHC will be at great risk if environmental degradation as pointed out by the results of this study is not curbed. The environmental degradation as a result of anthropogenic activities if not checked will lead to extinction of medicinal biodiversity which is an important source of traditional medicines and also and the potential of getting new drug discoveries.

Whereas traditional medicine sector in Kenya has the capacity to spur business opportunities and create employment, the future of safeguarding this important natural heritage lies on discovering how to strike the delicate balance between the growing demand for traditional medicine and the sustainable supplies from medicinal biodiversity. It is not enough to heap the burden of reversing biodiversity loss as a result of anthropogenic activities to the conservationists alone. Instead, it should rather be a multimodal approach advocacy involving all stakeholders including ethnomedicine practitioners, natural products researchers and medical physicians who are beneficiaries of the prospective drugs from the medicinal biodiversity under threat to curb the danger of biodiversity loss. This is important since this loss will not only mean loss of traditional medicines provision alone but also the new therapies discoveries, which overall compromises the potential and capacity of conventional therapy to combat the ever-increasing ailments. This will not only kill the dream and aspirations of carrying out biodiscovery and bioprospecting processes as a country but also the dream of achieving meaningful UHC envisaged in the country's 2030 agenda for Sustainable Development.

CONCLUSION AND RECOMMENDATION

Settlement activities as established in the findings of this study were found to impact heavily on medicinal biodiversity loss. Settlement leads to habitat loss, overharvesting, fragmentation and degradation of both terrestrial and aquatic ecosystems which all together impacts negatively on medicinal biodiversity and their sustainable use. Protection of habitats will support protected growth of endangered medicinal biodiversity species. Much as the humankind requires resources for their survival and growth, these resources are being cleared unsustainably from the environment with most significant causes of extinctions being human settlement, cultivation, mining and bioprospecting activities. Thus, efforts are needed to reverse the effects or at least to manage the pace at which anthropogenic activities and environmental degradation occurs for the benefit of the present and future generations. Curbing anthropogenic effects will go a long way in implementing the post-2020 global biodiversity framework of the CBD. Based on the foregoing, this study concludes that sustainable utilization of medicinal biodiversity can help in mitigating anthropogenic effects. Insistence on sustainable use of medicinal biodiversity through awareness campaigns, sustainable use solutions, and consciousness to preserve biodiversity for posterity can help to achieve growth of biodiversity and increase support of medicinal biodiversity conservation initiatives by all stakeholders. While the loss of medicinal biodiversity appears to affect significantly human health, it has also been opined to

be a significant threat to the attainment of SDGs which is the blueprint for achieving a better and more sustainable future for all. Sustainable use of medicinal biodiversity by Kenyan communities will not only help the country in realization of its 2030 development agenda but also will be in line with article 2 of the UN CBD and also the UN SDGs. To achieve sustainable use of medicinal biodiversity, it is important for the Lead Agencies mandated with the responsibility of medicinal biodiversity management in Kenya to promote conservation efforts to protect medicinal biodiversity from anthropogenic disturbance and the imminent threat of climate change. This will not only be critical for medicinal biodiversity conservation and sustainable economic development in local communities but also for the entire country. Biodiversity must be conserved in order to prevent the extinction of species and to protect endangered and endemic species. Good medicinal biodiversity cultivation practices, good harvesting techniques, domestication of medicinal biodiversity rather than relying from the wild collections and conservation of protected areas including forests should be adequately taken into account for the sustainable use of medicinal biodiversity resources. For instance, the use of botanic gardens and zoos will go a long way in maintaining the ecosystems to enhance the survival of rare and endangered medicinal biodiversity species as a result of anthropogenic impacts. Further, traditional/cultural medicinal biodiversity management systems such as preservation of sacred groves and documentation of indigenous traditional knowledge systems should be embraced. Moreover, it is also important for the Lead Agencies to design and implement awareness campaigns about the importance of medicinal biodiversity as the foundation for human health and its sustainable utilization as it provides the raw materials for development of traditional and modern medicine which ensures the health improvement of the humankind. Therefore, biodiversity as an ecological capital must be protected for Kenya to achieve its aspirations of 2030 sustainable development agenda (Kenya Vision 2030 Report, 2007). Efforts to minimize anthropogenic effects in the environment are of paramount importance while working out towards achieving sustainable development.

This study therefore recommends the Kenyan medicinal biodiversity regulators, legislators, policy makers and biodiversity lead agencies to consider initiatives that can help to reverse the damages done to medicinal biodiversity through anthropogenic activities since this loss threatens the whole capability of new drug discovery from medicinal biodiversity and also a significant threat to the attainment of SDGs which is a blueprint for achieving a better and more sustainable future for all. Further, medicinal biodiversity could be conserved through deliberate efforts such as promotion of in-situ and ex-situ conservation strategies including the domestication of medicinal biodiversity in farmlands and home gardens to promote their sustainable use and conservation. There should also be a strong collaboration between biodiversity lead agencies and media to increase public awareness and knowledge, boost conservation efforts and manage medicinal biodiversity and its resources sustainably. There is need to review existing policies and legal frameworks to stimulate, develop and support a national biodiversity legal framework to help put in place mechanisms

to approve, appropriate and/or deter inappropriate use of medicinal biodiversity resources to achieve sustainable socio-economic development in line with national goals and aspirations as envisaged in the country's vision 2030.

This study further recommends for a multifaceted approach to ensure sustainable use of medicinal biodiversity is achieved. This is important for speedy remedy to the negative impact caused by the disjointed governance efforts. In a nutshell, there is need to embrace and domesticate the CBD (1992) and the Nagoya protocol principles which emphasizes on the need for conservation of medicinal biodiversity, its sustainable utilization while recognizing the rights of the indigenous people and traditional medicine knowledge holders and the equitable sharing of accrued benefits thereof to the people of Kenya to increase trust and good motive.

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