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Intersecting geo-hazard dynamics with tourism prospects on the mount Elgon biosphere in Uganda

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ABSTRACT

The highland ecosystems in tropical Africa continue to grapple with the increasing intensity and occurrence of geohazards associated with the interplay of changing ecological, climatic conditions and anthropogenic conditions. The situation particularly on the volcanics of mountain Elgon is projected to heighten if no viable interventions are implemented to ameliorate the burden imposed by these phenomena. In this study, we investigated the sensitivity of the mountain Elgon ecosystem to a series of geo-hazards and their trajectories with a spatial lens with a view of providing alternative approaches for effective conservation and resilience. The study is premised on desktop review and meta-analysis of existing data and information pertaining to an array of geohazards. We collected and collated information from 113 studies spanning a period from 1981 to 2022, constituting an inventory that informed our analysis. The data was subjected to cross tabulation and descriptive statistical analysis. The results reveal a diversity of up to 15 geohazards which are prevalent and perpetual particularly on the Ugandan side of mountain Elgon. This finding underpins a high exposure of the mountain Elgon population, livelihood assets to multiple environmental stressors and ultimately disasters. The most significant environmental stressors are land degradation (27%)>, landslide (20%)>, climate change (11%) and land use and land cover change. The mountain Elgon districts of Bududda and Manafwa are currently considered hotspots for geohazards notably landslides and degradative processes, due their location on the critical slope gradients thresholds >30%. A time series analysis strongly associates landslide occurrence with enhanced "dark tourism" tourism on mountain Elgon. Moreover, these districts have an abundance of existing and potential tourism resources which can enhance ecosystem integrity and avert disastrous geohazards. Therefore, harnessing and optimizing green tourism assets might reduce land use pressures that often accelerate geohazards on the mountain Elgon slopes.

1. Introduction

Mountain ecosystems are renowned to contain high biological diversity, often of global relevance making them important biodiversity hotspots, centers of crop diversity and essential territories for local food security, well-being and cultural identity. Mountainous areas are often regarded as highly sensitive in the world [1,2]. However, due to extensive land use changes, as a result of natural and anthropogenic processes, these landscapes are often modified as the local communities' clear natural vegetation for agricultural land leading to the loss of land cover, with serious environmental implications [3–6]. The change in land use has been recognized as one of the key factors exacerbating the occurrence of rainfall triggered landslides [7,8]. The more densely populated an area is, the greater the potential disaster event in human terms can be [9,10]. A small landslide or minor earthquake in a densely populated area captures more attention, whereas a much greater event

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in a remote, scarcely populated area can occur without notice due to the death fatalities attributed and demolition of property [11].

Although mountain regions are often viewed as disaster prone areas, they are also important tourism destinations since they offer opportunities for scenic viewing and sports activities including mountaineering, hiking, biking as well as a rich cultural heritage [12]. Given the often remote and rugged location of mountain landscapes, outdoor recreation and tourism can provide an opportunity to aid economic diversification, generating employment and income for local residents [13,14], potentially reducing over reliance on tilling land for agrarian livelihoods. However, because tourism in mountain regions is highly dependent on natural resources and attractions, which are very sensitive to climatic changes, it is imperative, that if tourism practices are to be sustainable, human induced drivers of disasters such as population growth, urbanization, infrastructure development, and especially environmental degradation are mitigated [1].

The nexus between climate change, landslides and tourism in mountainous landscapes is a tightly interlinked, but seldom studied. Climate change directly or indirectly progressively degrades vital natural assets, thereby undermining nature based tourism, as increasingly evident in the East African highlands. Climate-induced disasters, particularly landslides, have become more frequent across many regions of the world and are associated with approximately 1.3 million deaths and 1.4 billion injuries between 1998 and 2017 [15,16]. Rising temperatures and altered precipitation regimes driven by climate change, accelerate vegetation degradation, weaken ecosystem resilience and constrain both adaptation and mitigation capacities. In fragile highland environments, the loss or degradation of vegetation cover significantly increases slope instability, making landslide hazards increasingly inevitable. Conversely, intact vegetation cover and thriving biosphere reserves provide critical ecosystem services, including slope stabilization, hydrological regulation and climate buffering, which are essential for mitigating global environmental change and advancing sustainable development objectives [3,17].

Studies [18,19] reveal that disasters have increased the risk for tourists participating in activities such as climbing and mountaineering and have the potential to damage and destroy important tourism infrastructure such as trails, climbing boards, bird viewing platforms and access roads. This not only affects the tourism investment and activities but also the livelihoods of the local community. Moreover, it was further noted that communities living in mountain landscapes particularly within developing countries, face barriers that limit their ability to cope with climatic impacts due to lower incomes and restricted opportunities to diversify local livelihoods [20]. Thus, tourism activities related to ecotourism with low environmental impact and climate-sensitive but with high social impacts are considered key when developing tourism activities along mountain regions. However, the occurrence of disasters also presents opportunities for harnessing “Dark Tourism”. Dark tourism refers to tourism associated with visiting sites of disaster, tragedy and deprivation [21]. In this regard, dark tourism activities may actually contribute to tourism product diversification, thereby transforming disaster situations risks into economic opportunities for affected local people to harness. On the other hand, maximizing the tourism potential linked to the mountain Elgon biosphere reserve could also be an alternative avenue to reduce human pressure of exploiting ecologically sensitive sites thereby mitigating hazards that often culminate into disasters.

While geohazards on the mountain Elgon biosphere reserve have been considerably studied [22,23], dismal attention has been paid to examining the nexus between geohazards and tourism. This knowledge gap persists to-date yet substantial evidence indicates that current physical and socio-economic conditions on the mountain Elgon biosphere are intensifying the disaster risk. Climate projections indicate an increase in rainfall depth of approximately 20%, a key trigger of landslides in upstream areas and flooding in downstream segments. Concurrently, an annual population growth rate exceeding 3% on the mountain Elgon biosphere is amplifying pressure on ecologically sensitive slopes accelerating land degradation and slope instability. Against this backdrop, the overarching issue addressed by the study is “how can a tourism-centered approach contribute to disaster resilience in the mountain Elgon biosphere reserve? Thus, the study explores the intersection between evolving geo-hazard dynamics and tourism prospects as a pathway for strengthening local resilience to recurrent geo-hazards on the mountain Elgon biosphere reserve. The specific objectives of the study were; (1) to characterize the temporal diversity and relative significance of geohazards prevalent on the mountain Elgon biosphere reserve (2) to examine the nexus between geohazard occurrence and disaster tourism (3) to explore the potential of tourism in building disaster resilience on the mountain Elgon biosphere reserve.

2. Tourism and geohazards in Uganda's fragile biosphere reserve

Several studies on the mountain Elgon biosphere [24–26] highlight challenges in the area's conservation. The scholars attribute this to the increasing need for livelihoods and land for agriculture, increase degradation and cascade landslide risks [1]. Although there has been limited discussions on tourism centered approaches to landslide hazards in the biosphere, scholars such as [27] have advocated for integration of local community tourism programs in livelihoods endeavors. This follows a realization that well planned tourism could enhance socio-ecological resilience of the local people as is the case with geoparks that have transformed the communities in Samoa [28]. Furthermore, a study by Jafar et al. [29] highlighted post-disaster tourism boom that fueled ecotourism growth, shown by the rise in homestays, their expansion, increased entrepreneur income, and better local job opportunities due to the Panataran Kedamaian River alteration by the earthquake in Kampung Melangkap, Malaysia.

Uganda is committed to building community resilience to geohazards as evidenced by the 2010 National Policy for Disaster Preparedness and Management (Office of the Prime minister (OPM), 2010). While the policy emphasizes disaster risk reduction and preparedness, it does not specify tourism development among strategies. However, it acknowledges the importance of community involvement, although it doesn't stipulate guidelines for empowering local communities in disaster resilience. It identifies the need for adequate funding for disaster management but does not specify how resources will be allocated to support preparedness and resilience building activities. We advocate for enhance community tourism in disaster resilience since it fits well with the overall policy goals. Tourism enhances community resilience through economic diversification and this is envisaged under Uganda's Tourism Policy of 2013, which envisions tourism as a key vehicle for poverty eradication. In addition, the 2040 Vision further recognizes tourism as one of the main catalytic potentials for sustainable development in Uganda since there is a variety of flora, fauna and beautiful sceneries including the rugged terrain smeared with landslide scars on these hills.

According to Nakileza and Nedala [30], landslide scars are consistently increasing in the mountain Elgon Biosphere especially in the community belts providing many challenges to the existing tourism potentials. And yet there is hardly a study that discusses the nexus of geo-tourism and the need to embrace tourism centered approaches to mitigate the increasing geo-hazards in the biosphere. Only a few studies by [31,32] have highlighted need for secondary utilization of the landslide scars for community resilience but these do not mention tourism as an approach. However, Nakileza [31] reported that the reuse of landslide scars for crop cultivation faces secondary land sliding within the scars. This implies a need for more sustainable and socio-ecological centered approaches to mitigate landslide hazards. There is no study to the best of our knowledge that has focused on the interaction between geohazards and tourism dynamics on the mountain Elgon biosphere reserve, a gap which we sought to address. We focused the study on the intersectionality of tourism and geohazards on the mountain Elgon

biospheres in the country through answering the following research questions (1) What is the nature and trend of geohazards on mountain Elgon Biosphere? (2) How are the potential tourism sites on mountain Elgon biosphere utilized? (3) What are the local tourism centered resilience strategies to the prevalent geohazards on the mountain Elgon Biosphere?

3. Methodology

3.1. Location and setting of the study area

The study was conducted on the Ugandan side of Mount Elgon, which includes the Mount Elgon Biosphere Reserve. Mount Elgon is an extinct, transboundary Miocene volcano in eastern Uganda, covering approximately 4203 km2 (Fig. 1). The biosphere reserve spans nine Ugandan districts including Mbale, Bududa, Sironko, Bulambuli, Kapchorwa, Kween, Bukwo, Manafwa, and Namisindwa which were purposively selected for this study and they represent low, mid and high elevation zones with diverse land uses. These districts are prone to landslide triggered disasters. Elevation across the study area ranges from 1200 m to 4231 m above sea level, with predominantly moderate to steep slopes and sharp side valleys (see Table 1). The major soil types include acrisols, nitisols, vertisols, leptosols, and andisols [33].

The landscape was selected for the study because it posits both potentials as well as challenges with respect to insitu and exsitu socio-ecological reliance. Mountain Elgon is a key landscape moderating the climate, controlling the local and regional hydrology and influencing the regional biogeochemistry. It has a great potential to sequester carbon contributing to the global emission reduction envisaged under the Paris Agreement. However, it's also a fragile ecosystem owing to the steep topography, sensitive volcanic soils [34] coupled with extensive human activities and increasing population pressure all of which combine to make the region increasingly susceptible to climate variation [35].

Table 1
Topographic and population of the selected districts by 2024.

District	Altitude	Slope gradient	Population		Decadal change (%)
			2014	2024	
Manafwa	1415	18.9	353,825	186,917	−47
Bududa	2763	41.3	210,173	268,970	28
Bulambuli	2624	18.3	174,508	235,391	35
Kween	2688	38.6	93,667	129,277	38
Bukwo	2715	38.9	89,356	114,396	28
Namisindwa	1929	30.8	NEY	257,346	
Kapchorwa	2507	36.5	105,186	133,621	27
Sironko	2702	31.4	242,422	298,363	23
Mbale	1718	36.6	488,966	290,356	−41

Note: NEY = Not Established Yet. Source of population data is Uganda Bureau of Statistics (UBOS, 2014; 2024), while elevation and slope is SRTM DEM of 30 m resolution.

The area experiences higher annual rainfall amounts ranging from 1200 to 1800 mm per annum depending on the slope orientation and altitude. The southern and western slopes (1500–2000 mm/yr) receive more rainfall than at the eastern and northern slopes (1000–1500 mm/yr) (Kitutu, 2010). The rainfall distribution for the area generally depicts a bimodal structure. Using the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) dataset, we derived total seasonal rainfall patterns for a period of 35 years (1990–2024) which is depicted in Fig. 2. CHIRPS data has widely [35,37,38] been used including in Uganda to successfully derive rainfall information.

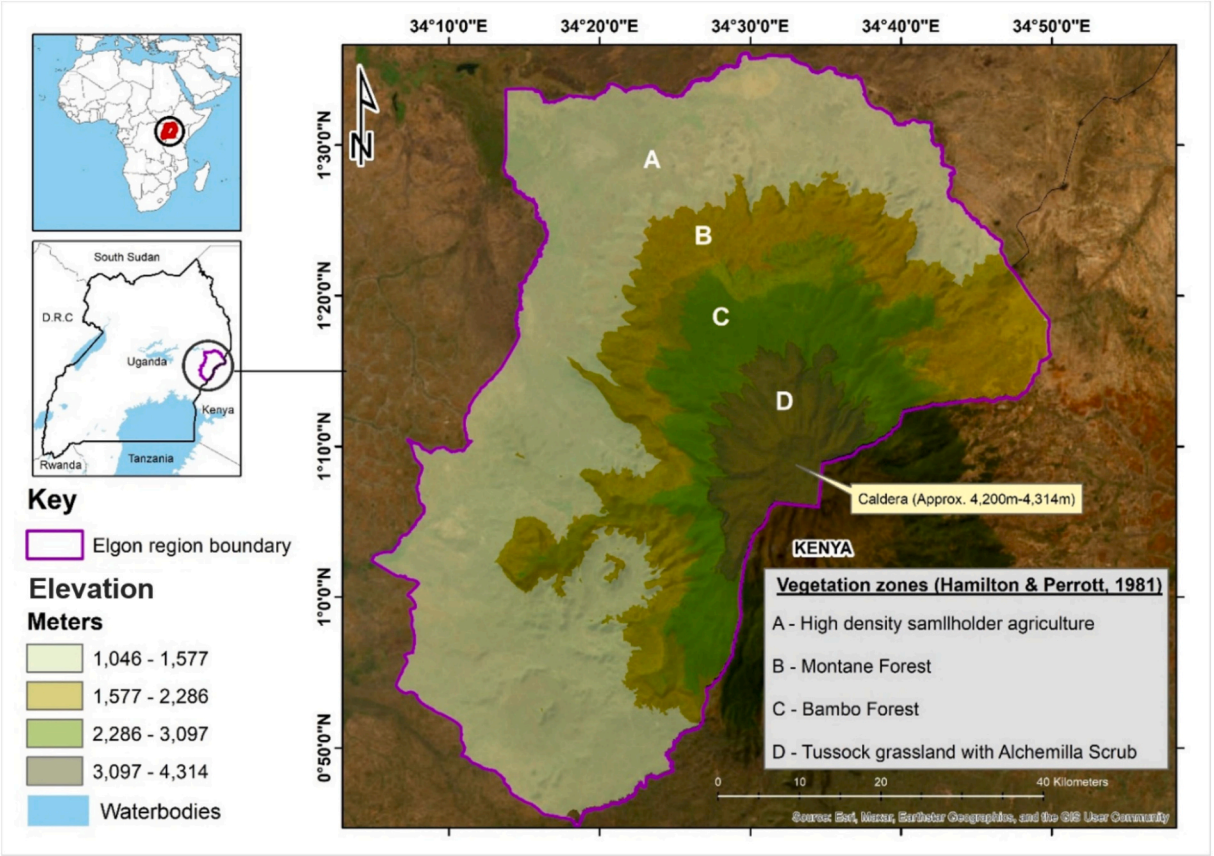

Fig. 1. Location of mountain Elgon biosphere reserve with an indication of vegetation variation with altitude. Vegetational zone (A) High density smallholder Agriculture (1500 m–2000 m); (B) Montane and (C) Bombo Forests (2000 m–3800 m); (D) Tussock grassland with Alchemilla scrub (3800 m–4000 m) Classification by Hamilton and Perrott [36].

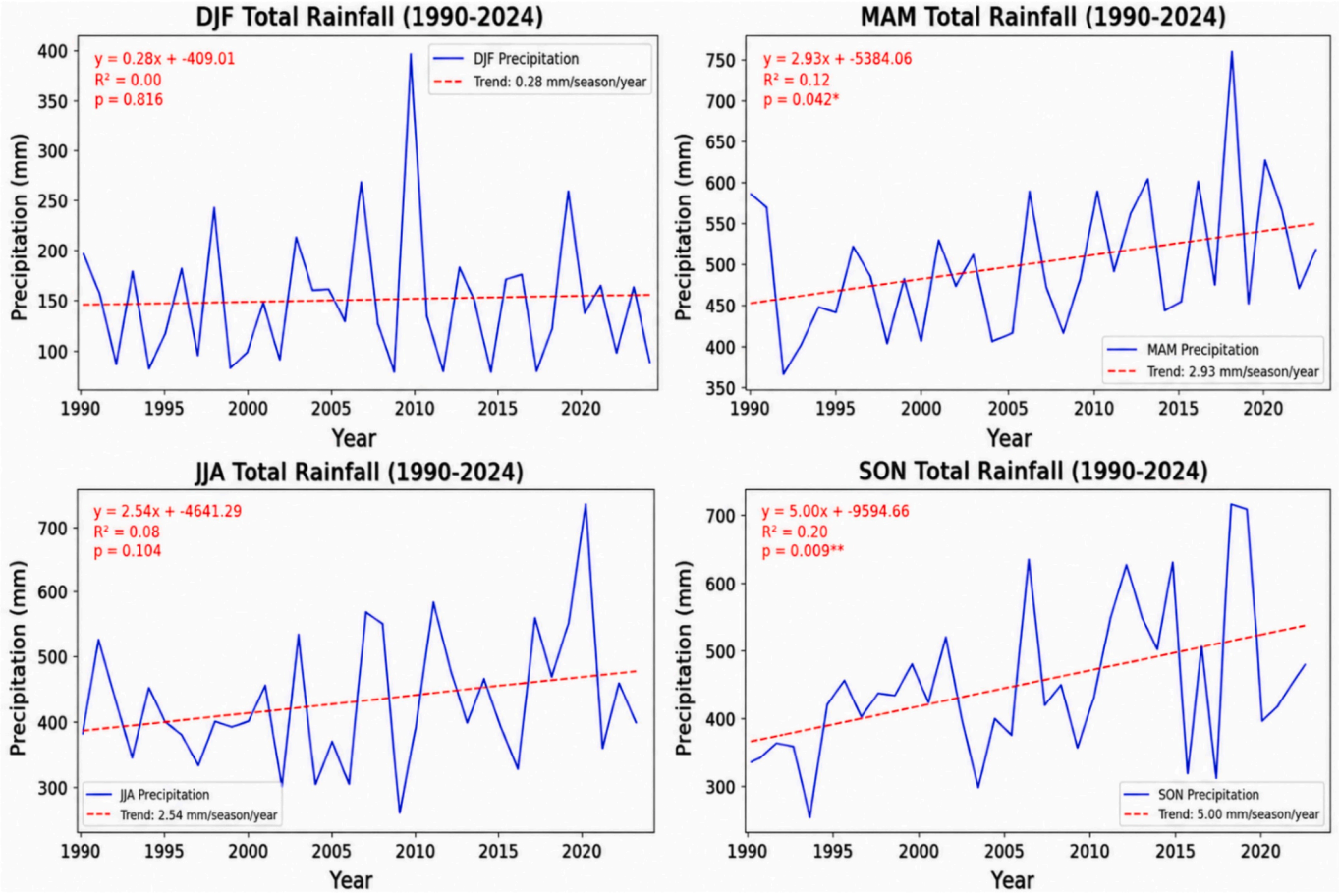

Fig. 2. Average total seasonal rainfall pattern for mountain Elgon biosphere reserve derived from CHIRPS data accessed on 11th February 2026 (https://www.chc.ucsb.edu/data/chirps).

The CHIRPS dataset provides high-resolution, long-term rainfall estimates by combining satellite and ground-station data, making it ideal for data-scarce regions like mountain Elgon [39]. The monthly rainfall data allow analysis of extreme and cumulative rainfall events and how these could relate with occurrence of geo-hazards especially landslides. The area's seasonal rainfall trends indicated statistically significant increases during the MAM ($p = 0.042$) and SON ($p = 0.009$) seasons, with SON exhibiting the strongest positive trend (+5.0 mm/yr). In contrast, DJF and JJA show weak and statistically insignificant trends, despite pronounced interannual variability. Notable extreme rainfall anomalies occurred around 2010 (DJF), 2018–2019 (MAM), 2020 (JJA), and 2019–2020 (SON). This points to the observed tendency of intensification of the occurrence of geo-hazards including landslide and flooding in the catchment. This also reflects what Akello et al., (2025) reported about the study area where over 90% of 210 damaging landslides are caused by heavy rainfall on mountain Elgon. As shown in Table 1, population dynamics across the mountain Elgon biosphere reserve districts varied considerably. Between 2014 and 2024, Manafwa and Mbale districts experienced substantial declines of 47% (−166,908) and 41% (−198,610), respectively, primarily due to administrative restructuring: the creation of Namisindwa District from Manafwa in 2017 reallocated a portion of Manafwa's population, reducing its reported population to 186,917 by 2024, while the establishment of Mbale City in 2021 led to the reclassification of urban populations, lowering Mbale District's population to 290,356. But still these new creations are as a result of increasing population that require more decentralized service delivery. In contrast, other districts recorded growth, with Bulambuli (35%), Kween (38%), Bududa (28%), Bukwo (28%), Kapchorwa (27%), and Sironko (23%) adding between 25,040 and 60,883 people, reflecting natural population growth and internal migration in areas unaffected by boundary changes.

The newly established Namisindwa District reported a population of 257,346 in 2024; its absence from the 2014 baseline reflects its creation in 2017, making direct decadal comparisons for this district inapplicable. The abundant rainfall, fertile soil and access to park's environmental income and services have made this area one of the most populated places. Current population is about 1.6 million people and growing at 3.4% per year [40]. The agricultural land is intensively cultivated with mixed crops including coffee, bananas, Irish potatoes, maize, wheat, beans etc. The only land that is expected not to be cultivated is land under protection (e.g., the National Park and Forest reserves). The area is drained by a dense network of streams and major rivers such as Manafwa, Sironko, Simu and Sipi. Furthermore, the area frequently suffers from soil erosion, landslides and flash floods that occasionally induce earth undercutting thus causing mud and debris flows [30].

The mountain is endowed with a closed canopy tropical hardwood, bamboo and heath moorlands high in endemic flora (forest eco-system) hosting some seventy-six threatened species of global conservation value [40] and a diversity of tourism resources (Fig. 3). In terms of conservation, the mountain biosphere comprises of Mount Elgon National Park (MENP), which is Uganda's second highest mountain with the world's second largest mountain caldera measuring 80 km wide, making it a unique touristic hiking destination in the world. The park has a great value as a water catchment area for the eastern region of the country. The park receives large amounts of rainfall, which is of critical importance to its vegetation and the surrounding farming communities. In addition, the park hosts some large mammals including monkeys

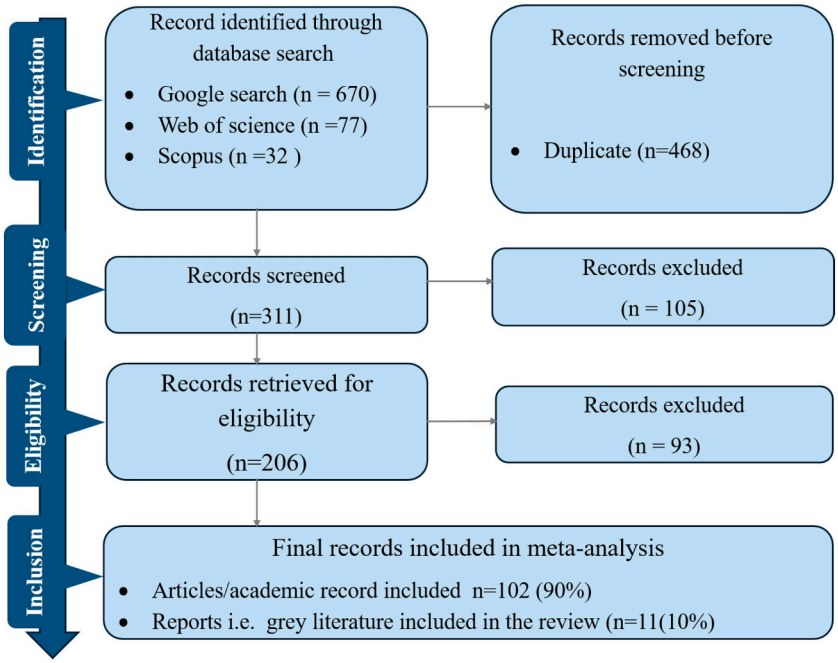

Fig. 3. Steps followed during the meta-analysis based on the PRISMA guidelines.

(Black and White Colobus, Blue and the De Brazza's) leopards, elephants, bush pigs, waterbuck, and duikers. MENP supports a diversity of bird species normally associated with tropical mountain massifs and the resultant range of habitats. There are some restricted-range birds found only in MENP which include; Jackson's Francolin, Moorland Francolin, Moustached Green Tinker bird, Blackcollared Apalis and Hunter's Apalis (Uganda Wildlife Authority (UWA), 2022). Although the mountain Elgon biosphere reserve is prone to geohazards, it in fact, has abundance of natural resources for regional tourism development and livelihoods enhancement to attain socio-economic development (as indicated in SDG 1) in line with Uganda's vision 2040 and the Africa vision 2060.

3.2. Research methods

3.2.1. Secondary data

The study relied on gathering, compilation and anslysis of a suite of several document from various secondary sources to yield quantitative data and qualitative information at the heart of the objectives of the study as detailed below

3.2.1.1. Document collection and review. The systematic document review for the study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [41] and is illustrated in Fig. 3. The search strategy was designed to capture both peer-reviewed and grey literature addressing geo-hazard dynamics and tourism prospects within the Mount Elgon Biosphere in Uganda. Three major academic databases Google Scholar, and Scopus were selected. This allowed a broad multidisciplinary coverage and index literature relevant to geography, environmental science, conservation, and tourism studies. The search was conducted in between September and November 2022 to allow refinement of keywords.

A structured combination of keywords and Boolean operators (AND, OR) was used during the search strategy especially in scopus. Core geographic identifiers such as “Mount Elgon” and “Uganda” (See table in appendix ii) were combined with thematic terms for the study including geo-hazards, environmental change, and tourism systems. Relevant concepts for the study i.e. landslide, soil erosion, environmental degradation, deforestation, floods, conflict, climate change, conservation, and tourism were included. Searches were limited to literature published before November 2022.

3.2.1.2. Screening criteria. All retrieved records were exported into Mendeley reference management database where duplicates were removed. Titles and study objectives were first screened for relevance to mountain Elgon biosphere reserve and assessed against predefined inclusion criteria: (i) focus on Mount Elgon, (ii) geo-hazards, environmental change, conservation, or tourism, and (iii) in Uganda. Grey literature including institutional and project reports was incorporated since applied environmental research may be published outside conventional academic journals and through traditional publication method. We believe that the final database therefore reflected a balance between scholarly sources and policy-relevant documentation.

Each selected record was assessed against a set of predefined screening questions seen in Table 2 to guide its inclusion or exclusion. The questions were operationalized as binary (Yes/No) indicators to minimize subjectivity during screening but also maintain consistency between the three author who analyzed the documents. Included studies

Table 2
A set of predefined screening questions. Each selected record was assessed based on the following questions. Only literature that has the following was considered for meta-analysis.

No	Criterion question	Returned score (Yes or No)
1	Does the study clearly mention that it was conducted in the region of Mount Elgon, Uganda?	–
2	Were there clear research questions/research objectives?	–
3	Were these research questions/objectives relevant to the study themes?	–
4	Does the study mention a clear research design, including design, approach, methods, type of data, and analysis?	–
5	Does the study indicate whether it is a journal article or report, or a working paper?	–
6	Does it have a clear and precise title and abstract visible with details relevant to the study?	–
7	Does it clearly indicate the temporal scale? When was it conducted?	–

that scored 1 = Yes for the seven questions provided a sufficient methodological and contextual detail to support synthesis of geo-hazard and tourism dynamics. While those that received a "No" response on one or more screening questions were excluded.

3.2.1.3. Meta-analysis. Details of the selected literature were entered into a Microsoft Excel database to facilitate systematic extraction of metadata. These details included serial number, name of the authors, title of publication, year of publication, major findings, conclusion and recommendations, research design, temporal scale, thematic focus and type of study. We also captured the spatial scale in detail (i.e. catchment, district, subcounty or entire Mount Elgon biosphere). The compiled metadata repository was subsequently exported to the Statistical Package for the Social Sciences (SPSS) for analysis, where frequencies and percentages were generated.

3.2.2. Field data collection and analysis procedures

After meta-analysis, we then conducted field visits to the landscape. With the help of tourism officers in the three selected districts of Manafwa, Bududa and Kapchorwa, a total of Twenty-six (26) participants were selected to participate in key informant interviews either through face-to-face interviews or via on-line interviews using key informant and focus group discussion guides provided as appendix ii. We selected the three districts that are more prone and have received several incidences of landslides on mountain Elgon, but which also harbor great potential for tourism development. Regarding the sample, it was deemed sufficient for qualitative data gathering and analysis as supported by literature [42,43]. In particular, a set of four environment officers, three natural resources officers, three tourism officials and three community development workers, three commercial officials, three disaster focal persons, two officials from Uganda Wildlife Authority. In addition, we also engaged four members representing the private sector from the community including prominent coffee farmers and tourist activists. Among the key informants, four were female officials including the commercial officer, senior environment officer, disaster focal persons, and tourism officers from the study districts. These were purposively selected due to rich expertise and knowledge in geo-hazard risks and their direct engagements in the tourism resources conservation, disaster preparedness and risk reduction measures within the Mt. Elgon biosphere. Some of them had activities and programs championing the tourism activities that lessen community vulnerability to disasters in the Elgon biosphere.

We also held two Focus Group Discussions (FGDs) with community members who have previously experienced or been victims of geo-hazards. One group composed of six female participants and the second comprised of six male participants. The participants included prominent community members who resided in geo-hazard hotspot areas, those leading community-based touristic sites. In many rural areas, traditional gender roles cause discomfort among women during mixed-gender discussions, particularly when men dominated the conversation. This dynamic often results in women feeling less engaged, as they may have feared judgment or backlash for sharing their opinions. Gender-power imbalances frequently caused women to remain silent in mixed-sex groups due to cultural norms that discouraged open expression in front of men [44]. We therefore conducted two FGDs with single-sex participants, especially when discussing critical issues such as land use for tourism and landslide hazard mitigation. Such environments encouraged female participation and ensured their voices rich narratives that helped us assess the intersectionality of geo-hazards and tourism.

We then used content and thematic analysis plans for the qualitative data obtained from the key informant interviews and focused group discussions. Through content and thematic analysis, we generated major responses to the study questions and also derived some quantitative results such as the number of tourism resource potentials and their levels of development.

4. Results

4.1. A meta-analysis of environmental risk studies on mountain Elgon biosphere 1981–2022

A meta-analysis conducted on the existing literature on the mountain Elgon biosphere revealed that the highest number of studies have focused on conservation (27), followed by landslides (20%), soil degradation (13%) and climate change (11%) (see Fig. 4). The least researched themes included agroforestry and policy frameworks, among others. Majority of the publications analyzed included surveys 53% (60) with those that applied modelling at 19% (21) and experimental with 11%.

Mountain Elgon biosphere reserve experiences the highest number of disasters linked to geohazards in Uganda. It is particularly vulnerable to mass movements due to a compendium of both preparatory and triggering causal factors. The study results reveal a diversity of up to 14 thematic areas emerging from the literature on Mt. Elgon ecosystem as presented in Fig. 4. These include landslides, rock falling, mudslides/flood, Pests and disease infestation, prolonged drought among others. Interviews with the Natural Resources Officer, Bududa district, indicate that the high dense population inhabiting mountain Elgon is exposed to multiple environmental stressors. The most significant processes as established from our analysis are land degradation (27%), landslide hazards (20%), climate change (11%), land use and land cover change (10%). The analysis reveals an increasing trend in these processes as illustrated in Fig. 4. Interactions with the Natural Resources Officer further revealed that whenever disasters happen, they are associated with much destruction that range from loss of human life and agricultural produce since the fertile soils are washed away in the process among others.

> "…In this biosphere, there is a big challenge of encroachment but also degradation of the environment. Degradation is majorly due to land tiling. People need food to eat and earn a living. Unfortunately, they trigger landslides, rock falls and to make matters worse, these people are hesitant to live in these high-risk areas [said Key informant in the district Natural resources official, 2023].

Overall, there has been a big rise in the publications between 2014 and 2020 in Elgon region, especially those calling for conservation of the biosphere as depicted in the solid green curve in Fig. 5.

Using the Sendai framework for Disaster Risk Reduction, occurrences of the effects of disasters in the selected districts were analyzed (Table 3). According to the Sendai framework for Disaster Risk Reduction (2018) disaster normally leads to loss of human lives, injuries, destruction of homes, loss of cattle and road destruction. The study established that disasters mainly occurred in Bushika, Bulacheke, Bukalasi, Namesti, Mayoka, Maboro Sub counties in Bududa district. The narrations by the sampled respondents indicate that these are old problems in this area and have caused destruction of property and loss or injury to human life. Interviews with the district natural resources and environment officer revealed that the worst event was in 2010 when over 350 lives were lost in the mudflow and debris slides in Nametsi area located Bududa district caused by massive movement of fertile soils downslope, destroying farmlands, household properties as well as displacement of people.

With respect to spatiality, Bududda and Manafwa districts distinguish themselves as hotspots for geo-hazards and degradative processes on Mt. Elgon. A geospatial analysis reveals that the terrain in these districts in terms of critical slope gradients (>30%), is significantly more fragile (see Fig. 6). A temporal analysis indicated an increasing occurrence of geo-hazards probably due to land use and land cover conversion together with increasing variability and change in climatic conditions.

On the mountain Elgon biosphere, disasters majorly happen in the middle and upper altitudinal elevations. The middle belt has the higher frequency of occurrence compared to the upper belt except for the

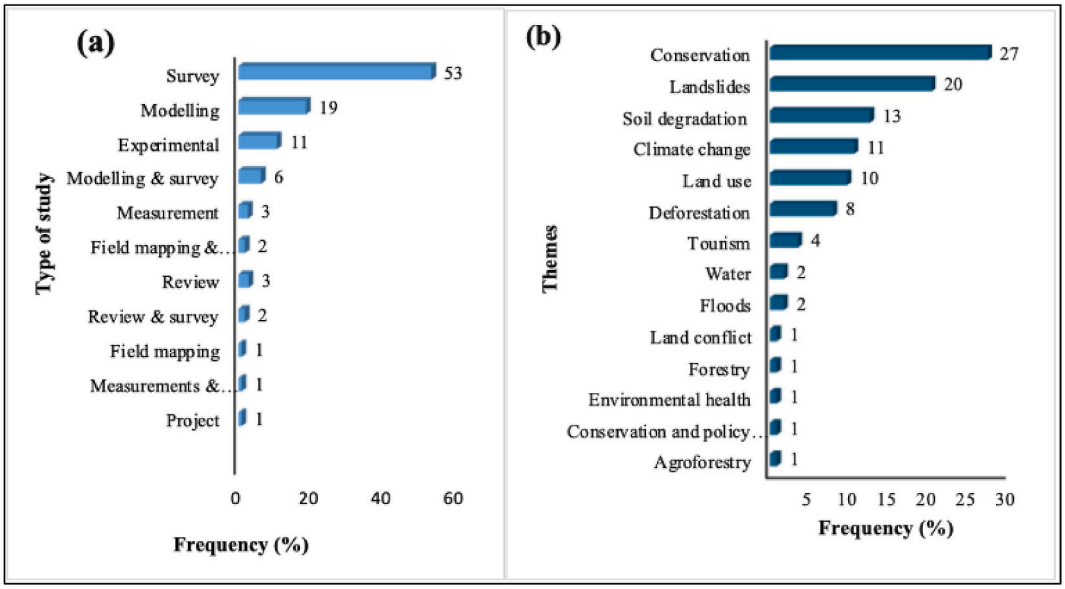

Fig. 4. (a) type of studies revealed in the review and (b) themes that guided the literature review. Majority of the studies employed survey and focused on conservation aspects.

wildlife protected area under the administration of the Uganda Wildlife Authority (UWA). Interviews with UWA staff revealed that rarely do they experience disasters in the areas under their administration. The Conservation Area Manager (CAM) particularly noted that they have so far only recorded one landslide that rolled down slopes but did not have a significant impact due to the vegetation cover along its rolling path. However, the Warden Tourism noted that although Mt. Elgon is endowed with exceptionally high diversity of animals and plants of renowned global importance and tourism value, it is also vulnerable to climate change attributed to the poor land use practices by the neighboring communities that have a potential to negatively impact the ecosystem resources that form the tourism base in the area.

This study further revealed that the primary drivers of disasters in the Mt. Elgon ecosystem include limited land availability for cultivation and settlement, restricted livelihood opportunities, and population growth. These factors have led to increased land clearing for agriculture, cultivation on steep mountain slopes thereby weakening soil structures and making them prone to erosion—and deforestation due to the demand for domestic fuel. Additionally, ecological modifications through encroachment and habitat destruction are threatening the sustainable conservation of biodiversity resources, including both fauna and flora. Continued, unregulated extraction of natural resources, such as bamboo shoots (*Phyllostachys edulis*), has altered the aesthetic appeal of certain tourism sites and left soil surfaces exposed, increasing the likelihood of erosion during heavy rains.

4.2. Tourism resource potentials in the Mt. Elgon biosphere reserve

Mount Elgon is the oldest and largest solitary volcanic mountain in East Africa as depicted in Fig. 1. It is the eighth highest mountain in Africa and has the largest base area of any freestanding volcano in the world. The landscape is endowed with exceptionally high diversity of fauna and flora of renowned global importance.

The upper parts of the area were declared a World Heritage site and a Transboundary Biosphere Reserve by the United Nations Education, Cultural and Scientific Organization (UNESCO) in 2003 [46]. The different tourism resources in the transboundary biosphere reserve include, but are not limited to Mt. Elgon national park, caves, craters and calderas, forests, culture and heritage sites, among others (see Fig. 7).

The study used levels of visitation based on the visitation books; report from Uganda Wild Life Authority (UWA), levels of development, and conservation guided by expert judgment and existing resource management strategies to analyze the tourism resource potentials for tourism-based development in the Mt. Elgon biosphere reserve (See appendix i). Under the levels of visitation to the tourism resource, considerations were on the number of visitors to the site. A criterion of low, moderate and high was developed by researchers based on expert opinion of the respondents from the field ranging from 'Low – Less than 5 visitors per day, Moderate 6-10 and high 10+ per day'. Regarding the level of development, the study focused on the tourism supporting facilities as well as their ability to facilitate the tourist experience. This is symbolized by, 'X representing no development', 'XX representing underdeveloped' and 'XXX representing developed'. Regarding natural resources, the interest was on the level of conservation or protection. This also focused on whether there are plans, regulations or policies to manage the resources (thus a Yes and No to refer to lack of a resource management strategy was applied). The analyses were validated by expert opinions, interviews held with local leaders as well as field observations.

4.3. Community resilience to disasters through tourism

For many years, local communities in the Mt. Elgon region have continuously depended on nature's provision to meet their livelihood needs. As noted in Sub Section 3.1 poor land use practices have rendered the soil surface bare accelerating the frequency and intensity of disasters particularly during the heavy downpour. Therefore, there is urgent need for an alternative livelihood resource strategy that would strengthen their livelihood resilience capacity. During stakeholder engagements, there was consensus that tourism can be promoted as alternative livelihoods means to reduce the future occurrence of disaster. This is based on the realization of the enormous tourism potential in the region. Although the local communities had mixed views on the potential and the effectiveness of tourism as an approach to lessen disaster occurrence, the technical officers at the districts dominantly agreed about its effectiveness. The mixed responses with the local communities could be attributed to their lack of understanding of how tourism can provide alternative livelihood sources while minimizing further occurrence of disaster in the area. During a focus group discussion with women, it was revealed that occurrence of disaster creates fear of food insecurities at home. They added that in most cases, financial decisions are dominated by men since majority are male headed households. Therefore, if eco-

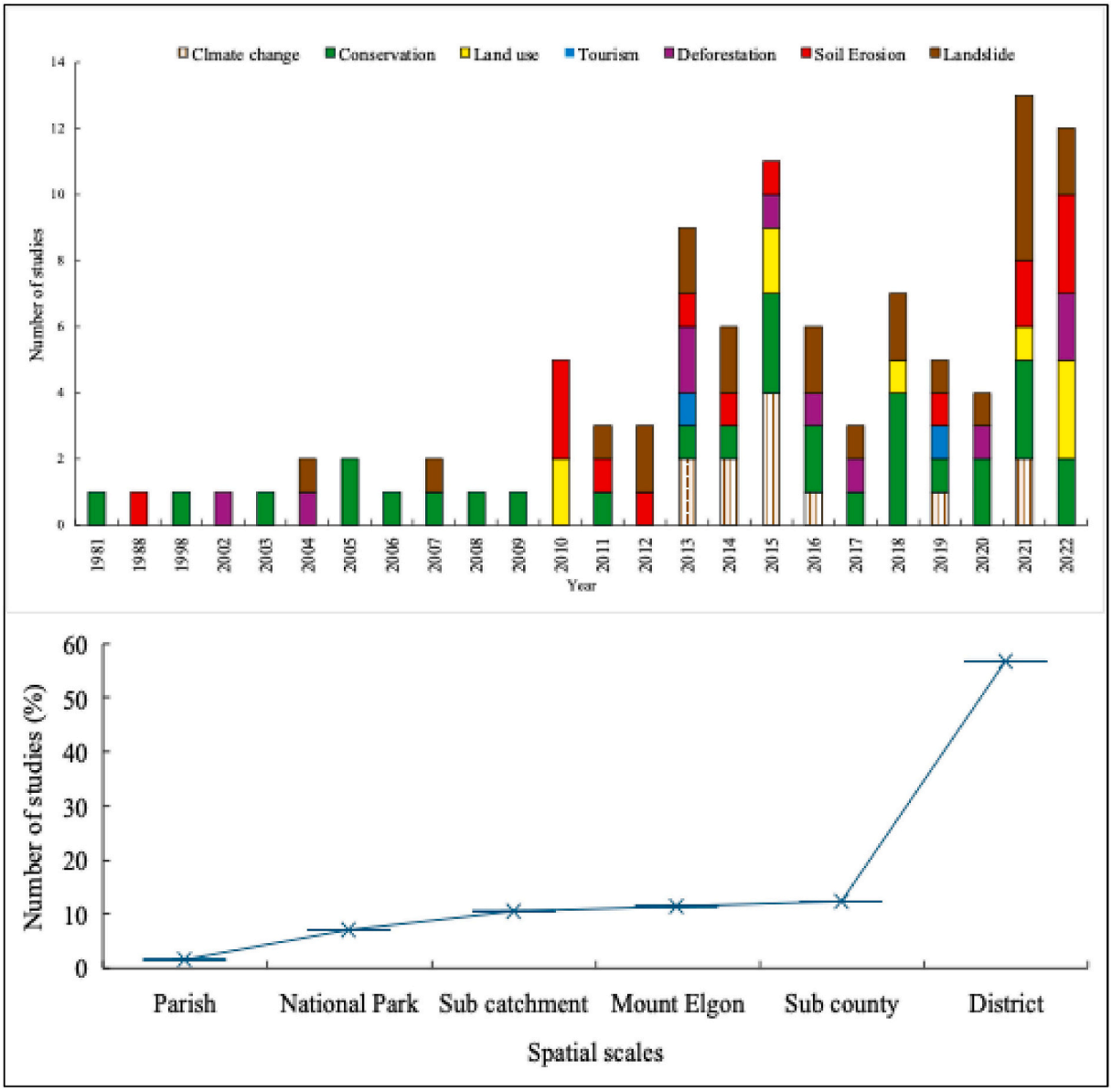

Fig. 5. Temporal trend of studies across the seven major themes of the study (top) and the spatial scale for the reviewed studies (down). Conservation related studies increased steadily up to 2019, while those focused on landslides and climate change rose markedly around 2010 and 2012. Most of the studies (57%) were scoped to the district level. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3
Effects of geohazards for the period:1933–2020.

District	Units used	Bududa	Bulambuli	Kapchorwa	Kween	Manafwa	Mbale	Sironko
Deaths of human beings	Number	2393	199	114		2	229	85
Injured people	Number	62	2	189			1022	119
Missing people	Number	950	17				14	
Houses Destroyed	Number	583	2708	107		85	584	4465
Houses Damaged	Number		327			274	1214	761
Education centers destroyed	Number	47		7		15	39	101
Hospitals destroyed	Number	1					2	
Damages in crops	Ha	4793	42,124			1053	1132	17,571
Lost Cattle	Number	8		2			1	98
Roads	Mts	4080		13		7		

Source: UNDRR, 2020) (https://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=uga [Date of access, 20th January 2024].

tourism is promoted in their crop gardens, it may result in scarcity in some households.

Although Mt. Elgon region has been experiencing disasters, the study revealed that areas that are highly conserved for tourism such as the national park have experienced minimal occurrence of disasters. Interviewed respondents could only recall one incident of disaster that had

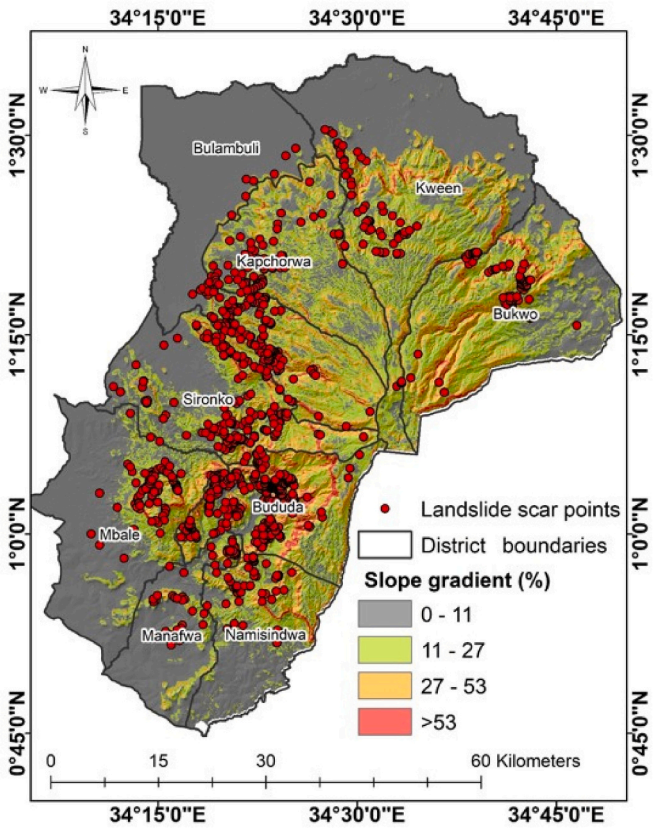

Fig. 6. Distribution of landslide scars across different slope gradients on mountain Elgon biosphere. The hillshade was processed in a GIS environment from the 30 × 30 SRTM DEM obtained from RCMRD in 2022. The Landslide scar points plotted where obtained from field surveys, district records and Broeckx et al., 2018).

occurred with the protected area. This was reaffirmed by the UWA, Conservation Area Manager and Warden Tourism who corroborated that even when it happened, there was less impact. They attributed it to strict adherence to the existing conservation principles and policies that guide their operations. Thus, land use activities that support conservation are vital if the frequency of disasters is to be lessened. Responses from UWA officials and Community-Based Tourism Organisations that derive income from tourism activities observed that if the mountain communities are empowered to take the lead in tourism developments such as agroforestry or agro-tourism the slopes will be saved from being left bare and prone to disasters. However, they need to build their capacity in understanding the forms of tourism. Similarly, the study revealed that areas with coffee farms and or forested areas had experienced none or minimal landslide or flood occurrences.

4.4. *Implication of geohazards on tourism*

Analysis of tourist visit data between 2017 and 2022 indicates a positive temporal association between landslide occurrences and recorded visitor numbers (Fig. 8). Notably, the peak in tourist visits in 2017 (4371 visitors) follows the highest number of landslide events recorded in the preceding year (121 events in 2016). While this pattern suggests that heightened landslide activity may coincide with increased visitation in subsequent periods, this relationship should be interpreted cautiously. The observed increase in visitor numbers may reflect a combination of factors, including post-landslide research and assessment activities, educational field visits, media attention, and other disaster-related engagements, rather than leisure-driven tourism alone. As such, Fig. 7 highlights an indicative association rather than a causal link, underscoring the need for further, detailed investigation into visitor motivations and the nature of post-landslide visitation in the Elgon region.

The established nexus as illustrated in Fig. 8 does not necessarily confirm causality or to conclusively characterize such visitation as dark tourism but the results provide an exploratory indication of an emerging and underexamined interaction between geohazard events and tourism dynamics. These insights pioneer debates on the intersection between geohazards and tourism in the Elgon region and highlights the need for a dedicated, detailed study to systematically monitor post-landslide visitation, disaggregate visitor typologies, and examine motivations over time.

5. Discussion

In line with nature and trend of the studies, the analysis revealed an increasing focus on Elgon biospheres especially in terms of climate change, hazards and conservation research. While studies preceding 2015 concentrated on explaining the diminishing ecosystem through encroachment for livelihood support among the nearby communities, shifts are seen more towards climate variability and change especially in the upper belts covering Bududa and Manafwa districts were experienced.

Attention shifted to aspects of climate variability, climate change and adaptation as well as climate induced hazards such as soil erosion, landslides, floods, water quality and conservation [47]. This shift followed rising incidences of land degradation driven by inhabitants degrading sections of the landscape and encroaching on previously undisturbed areas in search of fertile land to meet livelihoods needs. These pressures resulted into intensified exploitation of forest resources some of which is under formal conservation regimes [48]. Consequently, high levels of conflicts emerged between the Uganda Wildlife Authority (UWA) and the local communities as the agency conducted evictions from areas under formal conservation geared on mountain Elgon geared at lessening the occurrence of disastrous landslides and boosting ecosystem services [49]. The relationship between climate change, ecosystem services and hazards is well established in literature [16,35] and generally points to adverse effects. On the mountain Elgon biosphere reserve, the negative climate change effect often triggering landslides and conflicts is strongly mediated by insitu unsuitable land use practices coupled with exsitu extensification activities that tilt the ecological balance favoring shear stress as opposed to shear strength.

Previous studies [50] on Mt. Elgon were largely centered on extent of land use and cover change and its implication on water, soil erosion, landslides. Vulnerability of ecosystem and population to debris flow and other geo-hazards and health related issues followed in 2021 [51] [51–53]. These studies could have been inspired by the increasing occurrence of disastrous landslide hazards between in 2018 and 2019 such as the killer landslide events such as on 13th October 2018, where more than 34 people were reportedly killed and many went missing due to a landslide in Elgon. From 2021 and onwards, studies on climate risks, community resilience and coping mechanisms to the climate related hazards including agroforestry intensified [26]. This period also reveals studies focused on mapping susceptibility of people with disabilities to landslides, ascertaining their resilience and demystifying their coping mechanisms to landslide hazards [54,55].

Another notable outcome from our analysis is the growing attention given socio-ecological hazard assessment studies. These studies have significantly contributed to unpacking the complex socio-ecological dynamics and vulnerabilities of the region, although literature remains predominantly focused on climate change, conservation and the associated hazards. However, comparatively dismal attention has been paid to exploring the potential role of tourism in enhancing community resilience. This deficit manifests a hazard centric narrative and a consideration of tourism as a secondary factor in the resilience domain on mountain Elgon. These gaps in linkages between tourism, disasters

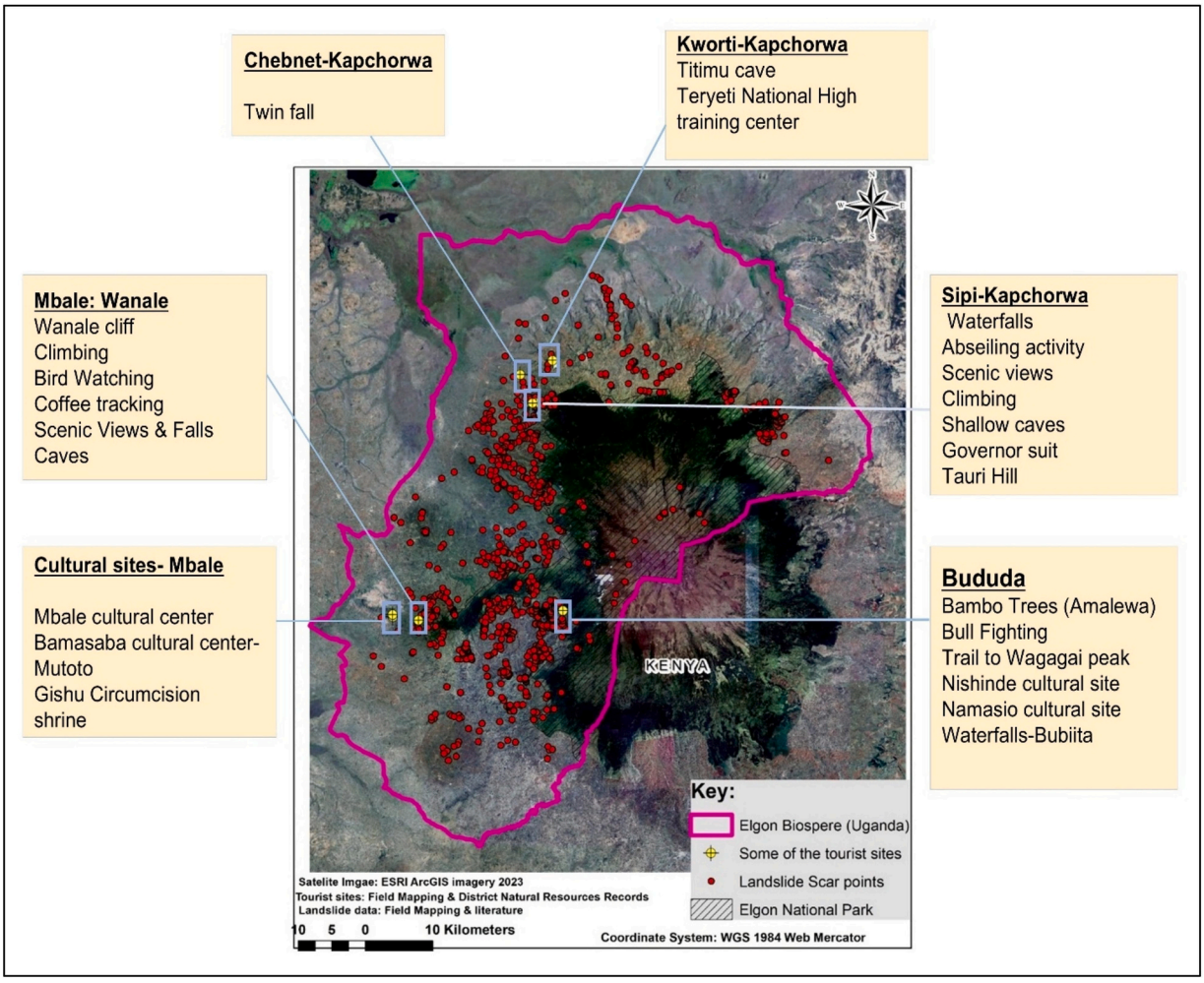

Fig. 7. Spatial distribution of potential tourism resources on the mountain Elgon Biosphere. Potential tourism sites were mapped during the detailed field surveys in the study area. The base satellite imagery was sourced through online ArcGIS from Esri imagery of 2023. The tourist sites were generated through field surveys and district local government records. The landslide inventory in the study was sourced from Broeckx et al. [45].

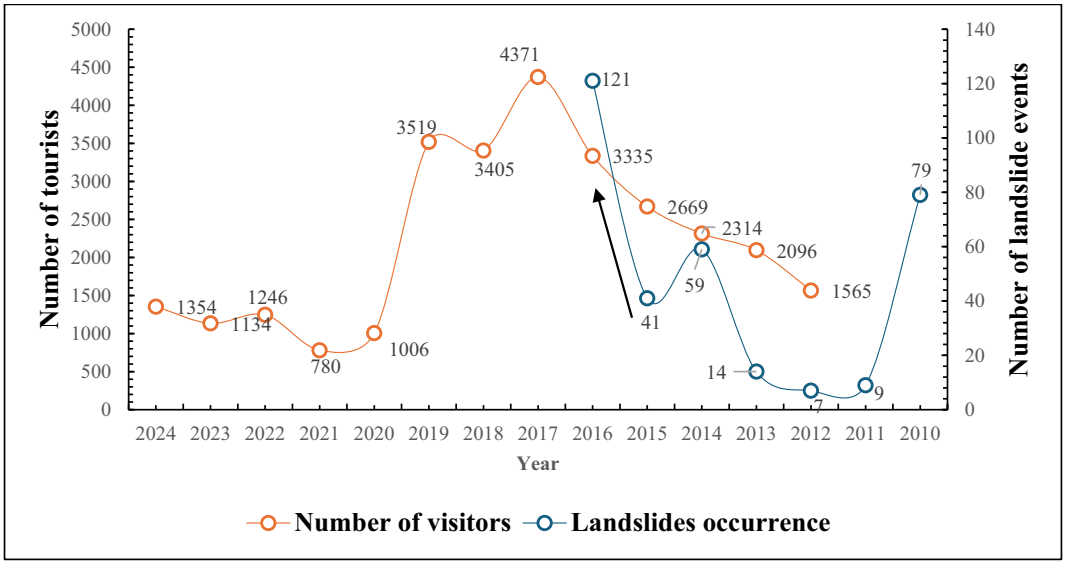

Fig. 8. Trend of landslide events and tourist visits in MENP (Landslide data was sourced from Broeckx et al., (2018); Number of tourism visitors (MENP administrative records & MTWA, (2024).

and resilience deficits are not only limited to mountain Elgon and have also been observed elsewhere as noted by Zhang et al. [56]. Yet

sustainable tourism can simultaneously promote conservation and provide alternative livelihoods options [57,58], thereby reducing the pressures that drive environmental degradation. Our study explored this underexamined dimension in the context of mountain Elgon and offers new insights into how balancing conservation objectives can be balanced with the socio-economic needs of the local communities.

Studies such as Ratemo and Bamutaze [59] and Bamutaze [23] identified landslide hotspots on Mt. Elgon as being predominantly located on steep, medium, and low-lying slopes, with agricultural land, housing, and infrastructure as the major elements at risk jeopardizing people's livelihood. The fertile soils and high rainfall in the region, as noted by Opedes et al. [60] had attracted a dense population, leading to increased pressure on land and other resources, which in turn contributed to slope instability. Studies including Bista [61] and Nga et al. [62] further highlighted the high vulnerability of communities to landslides to be linked to income dependency ratios, driven by the total number of dependents and levels of education among households. Although, interventions including relocation, landslide scar rehabilitation, among others, the area consistently grapples with climate induced hazards claiming lives annually [31,32].

Based on the nature and trend of studies in the mountain Elgon biosphere, we strongly advocate for promotion of tourism development in the disaster hotspot areas especially Bududa, Manafwa, Sironko among other high-risk areas. It is well known that revenue from tourism can be reinvested to enforce implementation of biodiversity laws obviating encroachment on sensitive sites where geohazards and often triggered [63–65]. In the context of Mt. Elgon ecosystem, there is evidence of lesser chances of geo-hazards occurrences within the strictly protected areas compared to areas inhabited by humans [60]. Moreover, during the survey, it was revealed by key informants that promotion of ecotourism, agri-tourism (including fruit growing and coffee tourism), bird watching, and mountain biking could potentially mitigate disaster risks while enhancing environmental conservation in the region. Agri-tourism, particularly, which combines agricultural activities with tourism, offered an alternative livelihood by reducing the need for over-tilling land for food and income, thereby minimizing soil erosion. Agri-tourism practices such as fruit growing contributed to soil stabilization, reducing the risk of landslides by binding the soil together [66,67]. The potential for regulated bamboo shoot extraction to support food tourism presented another opportunity to diversify income sources while promoting environmental conservation. As can be noted practicing agri-tourism offered opportunities to enhancing social-ecological resilience and sustainable livelihoods practices around the Mt. Elgon ecosystems. Scaling this prospect requires a shift the from traditional unsustainable agricultural practices to tourism-based activities coupled with enhancing local capacity to scope with disturbances that trigger geo-hazards [68].

Studies elsewhere have shown that community-based tourism can effectively build resilience to geo-hazards. For instance, Tsai [27] found that tourism played a key role in enhancing socio-ecological resilience in Taiwan. Similarly, studies [69,70] have highlighted how the establishment of a Geopark significantly improved the livelihoods of communities in Samoa. Jafar et al., [29] also discussed how a post-disaster tourism boom in Kampung Melangkap, Malaysia, following an earthquake led to the growth of ecotourism. This was evidenced by the rise in homestays, increased income for local entrepreneurs, and better job opportunities after the Panataran Kedamaian River Landform Changes to form.

Uganda is committed to building community resilience to geo-hazards as evidenced through the policy frameworks exemplified by the National Policy for Disaster Preparedness and Management, 2010 (Office of the Prime minister (OPM), 2010), which underscores aspects of disaster risk reduction and preparedness. But this policy gives dismal attention to tourism development as a key strategy and action area for disaster resilience. We thus argue for community tourism for propelling disaster resilience on the mountain Elgon biosphere reserve which aligns strongly with Uganda's tourism policy, 2013.

6. Conclusion

We investigated the nature and trend of geohazards, utilization of potential tourism sites and the local tourism centered resilience strategies to the prevalent geohazards on the mountain Elgon Biosphere. It can be concluded that (1) Geohazards are increasing in frequency and intensity on the mountain Elgon biosphere reserve with landslide and floods emerging as the most significant spatially (2) Huge tourism potential exists on the mountain Elgon biosphere reserve which can be harnessed for disaster risk management, but local communities have capacity deficits to develop tourism enterprises as alternative livelihood sources to agriculture (3) a bidirectional interaction between geohazards and tourism exists. A well-managed and optimized tourism can incentivize improved ecosystem management reducing risk to landslide disasters. On sites where conservation and tourism are practiced on the mountain Elgon biosphere, landslide geohazards are minimal (4) A positive temporal association between landslide occurrence and visitor numbers indicative of dark tourism was established but causality couldn't be ascertained on the basis of the data at our disposal. Accordingly, the study recommends (a) strengthening of the protection of the biosphere reserve based on zonation to reduce the pressure on the most fragile and sensitive sites (b) Tourism centered disaster resilience needs to get more prominence in the policy domain and government programming. The transformative potential of tourism in disaster resilience on the mountain Elgon biosphere could be realized through financial incentives for restoration of degraded areas (c) building local capacities is essential for tourism based disaster resilience. It is worth noting that this was largely an exploratory study substantially hinged on secondary data, which has limitations. The cause-effect relationship between tourists and landslide occurrence couldn't be inferentially determined to establish causation due to data limitations and our results remain indicative. Nevertheless, our study gives crucial insights on this hitherto unexplored issue.

CRediT authorship contribution statement

Yazidhi Bamutaze: Writing – review & editing, Writing – original draft, Project administration, Funding acquisition, Formal analysis, Conceptualization. **Francis Mugizi:** Writing – review & editing, Validation, Investigation. **Amos Ochieng:** Writing – review & editing, Formal analysis. **Yeeko Kisira:** Writing – review & editing, Methodology, Data curation. **Mary Kerubo Nyasimi:** Writing – review & editing, Visualization, Methodology. **Samuel Partey:** Writing – review & editing, Resources, Conceptualization.

Ethical statement

The research received approval from the Research Ethics Committee (REC) of the College of Agricultural and Environmental Sciences, Makerere University.

Declaration of competing interest

Authors declare no conflict of interest.

Acknowledgement

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research team to the concerned district offices, private tourism centers, tourist activists, and community members leading the eco-tourism in the area.

Appendix A. Appendices

A.1. Appendix i: Tourism resource potentials for tourism based development in the mountain Elgon biosphere reserve

Location	Category	Status			
		Levels of visitation	Levels development	Conservation status	Existing Resource Management strategy (Yes or No)
Mbale	**Natural**				
	Caves – Kanka Cave	Low	**X**	High	Yes
	Mt. Elgon National Park (wildlife, waterfall, caldera etc)	High	**XXX**	High	Yes
	Ridges - Bulegeni and Butandinga Cliffs/Ridges	Low		Low	No
	Rivers – R.Shande and R. Nabuyonga	Low	**X**	Low	No
	Bufumbo and Wanale Forest reserves	Low	**X**	Moderate	Yes
	Culture and Heritage				
	Mutoto Circumcision (Imbalu) ground	**Low**	**X**	Low	Yes
	Semei Kakungulu Tombs	**Low**	**X**	Moderate	No
	Facilities				
	Mbale Golf Club/Ground	Low	**XX**	Moderate	Yes
	Mbale Cricket Ground	Low	**XX**	Moderate	Yes
	Mbale City Stadium	Low	**XX**	Low	No
	Hotels and Restaurants	Moderate	**XX**	NA	Yes
Sironko	**Natural**				
	Water falls - Sisiyi falls	Low	**X**	Moderate	No
	The gorge where Sisiyi falls	Low	X	Moderate	No
	R. Sisiyi	Low	X	Moderate	No
Kapchorwa	**Natural**				
	Sipi Falls	Moderate	X	High	No
	Mt. Elgon	Moderate	XXX	High	Yes
	The landscape	Low	X	Low	No
	Culture and Heritage				
	Cultural rites	Low	X	NA	No
	Agro tourism	Low	X	NA	No
	Culinary	Low	X	NA	No
	Facilities				
	The higher altitude sports center	Not yet in use	XX	NA	NA
	Hotels and Restaurants	Low	XX	NA	NA
Bududa	**Natural**				
	Mt. Elgon National Park	Low	XXX	High	Yes
	Culture and Heritage				
	Cultural Sites such as Nashua (litosi) and Nalufutu located at Bunamubi parish	Low	X	Low	No
	Facilities				
	Hotels	Low	X	Low	No
Manafwa	**Natural**				
	Mt. Elgon NP	Moderate	XXX	High	Yes
	Mt. Elgon	Moderate	XX	High	Yes
	Culture and Heritage e.g. Imbalu dance	Low	X	Low	No
	Caves, Cliffs and Ridges	Moderate	X	High	Yes
	Lakes such as Caldera, Lubola	Moderate	X	High	Yes
	Experiential tourism e.g. food cuisine i.e. malewa	Low	X	Low	Yes and No
	The Bukusu Prayer Mountain located in Lubola village	Low	X	Low	No
	Scenic viewing activity, Hill climbing	Low	X	Moderate	No
	Birds-over 10 species of birds, Monkeys, Snakes, Baboons, Tree species-over 130 tree species in Bushula Organic farm	Low	X	High	No
	Religious tourism e.g. History of the "Dini-Ya Musambwa" religion	Low	X	Low	No
	Agri-tourism e.g. Coffee tours	Low	X	Low	No
	Facilities				
	Hotels and Restaurants	Moderate	X	NA	No
Namisindwa	**Nature**				
	Caves such as Namagabwe and Namisindwa cave located in Bupoto Sub-County	Low	X	Low	No
	Namatali Falls.	Low	X	Low	No
	Culture and Heritage				
	The Lwandubi Inemba Site located in Namabya Sub- County	Low	X	Low	No
Bulambuli	**Natural**				
	Falls such Kagyere and Sisyu in Simu Sub-County	Low	X	Low	No
	Caves such as the Zebubu and Nakoko Caves.	Low	X	Low	No
	The Biritanyi Gorge	Low	X	Low	No
	Culture and heritage				
	The Lishengelo (Kamashengelo) found in Bugambi Sub-County	Low	X	Low	No

Key: Levels of visitation (low = Less than 5 visitors per day, moderate = 6–10 per day and high =10+ per day); Level of development (X = no development, XX = under developed and XXX = developed)
Source: Field data collection and records at District Local Government.

Appendix B. Appendix ii: Showing the search strings used for systematic document review

Study Theme	Example Search Strings (Boolean Combinations)	Purpose/Explanation
Climate Change	("Mount Elgon" AND Uganda AND "climate change") OR ("climate variability" AND "Mount Elgon")	Captured studies on changing climate patterns influencing hazards and tourism.
Conservation	("Mount Elgon" AND conservation) OR ("protected area management" AND "Mount Elgon Biosphere")	Retrieved literature on biodiversity protection, biosphere management, and ecosystem governance.
Tourism	("Mount Elgon" AND tourism) OR ("ecotourism" AND Uganda AND "Mount Elgon")	Focused on tourism development, visitor activities, and livelihood opportunities linked to the biosphere.
Landslides	("Mount Elgon" AND landslide*) OR ("mass movement" AND eastern Uganda AND Elgon)	Included hazard-specific studies, risk assessments, and disaster impacts.
Floods	("Mount Elgon" AND flood*) OR ("river flooding" AND eastern Uganda AND hazards)	Targeted hydrological hazard research relevant to communities and tourism infrastructure.
Deforestation	("Mount Elgon" AND deforestation) OR ("forest cover change" AND Uganda AND Elgon)	Addressed land-cover change drivers influencing environmental degradation and hazard risk.
Conflicts	("Mount Elgon" AND conflict*) OR ("resource conflict" AND conservation AND Uganda)	Captured human–environment conflicts, including park–community tensions.
Environmental Degradation	("Mount Elgon" AND degradation) OR ("environmental degradation" AND eastern Uganda AND biosphere)	Included studies linking human activities to ecosystem decline.
Soil Erosion	("Mount Elgon" AND "soil erosion") OR ("land degradation" AND slope AND Elgon)	Focused on geomorphological processes affecting agriculture and hazard exposure.
Core Geographic Filter	("Mount Elgon" OR "Mount Elgon Biosphere") AND Uganda	Ensured all retrieved studies were geographically relevant to the study area.

B.1. Appendix iii: Tools

(a) Key informant interview

1. How would you describe the main geohazards affecting the Mountain Elgon Biosphere? Do you observe any changes or trends in these hazards over the last 10 years or more?
2. What are the key tourism sites that you are aware of in your district/mount Elgon Biosphere? How are these sites currently being used by tourists and local communities? What are some of the unique cultural practices, heritage, etc. that exist in the region?
3. What other tourism resource potentials are in the Mt. Elgon Biosphere reserve? Which of these resources have been developed for tourism? And which of the resources above are still underdeveloped?
4. On a scale of 1–3, rate the development and utilization of the different sites mentioned, where 1 means no development, 2- underdeveloped and 3 = developed?
5. Are existing plans, regulation or policies to manage the resources? Would you rate the conservation status of tourist attractions you have in this district? If yes, what challenges exist in implementing these regulations to promote tourism in these areas?
6. Are there ways through which local communities or authorities responding to geohazards in relation to tourism?if yes, could mention some sites where tourism is being promoted to reduce pressure on land?
7. Do you think there is a possibility of landslides/disaster occurrence attracting tourists? Are there any local initiatives that integrate tourism and hazard resilience? How best can such opportunities be boosted? In your opinion, what strategies could strengthen tourism while minimizing geohazard risks?
8. What are the hindrances to developing tourism-based resources in the region?
9. What are the challenges for utilizing environmental resources for tourism in the Mt. Elgon BR for tourism development?

(b) Focus group discussion guide

1. Which natural hazards have affected your community in the Mountain Elgon area in the last 10 year or more such as landslides, floods etc.?
2. How frequently do these hazards occur, and what impact do they have on your livelihoods?
3. How does your community respond to hazards while engaging in tourism-related activities?
4. Are there community initiatives or practices that help reduce risks or enhance tourism? What additional support is needed to improve safety and tourism potential?
5. Are there any local tourism sites you know or visit? Do you see tourism promotion reducing disasters in the area? If yes how? What benefits or challenges has tourism brought to your community?
6. What are the hindrances to developing tourism-based resources in the region?
7. What are the challenges for utilizing environmental resources for tourism in Mt. Elgon BR for tourism development?

Data availability

Data shall be made available on request from the Corresponding author.

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