Effects of changes in climate and land cover on Tanzanian nature-based tourism in national parks:

How are tourist attractions affected?

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Chapter 1

General Introduction

Tourism, tourist attractions and environmental change

1.1 Background

Tourism is growing rapidly worldwide and its fastest-growing segment is nature-based tourism (NBT) (Kuenzi & McNeely, 2008), which typically involves experiencing wildlife biodiversity and enjoying natural environments (Eagles, 2001; Naidoo & Adamowicz, 2005). NBT can take many different forms, including trekking in mountains and engaging in wildlife safaris.

Tanzania is a prime destination for NBT in Sub-Saharan Africa. The country attracted 1.2 million international tourists in 2016, up from 0.6 million in 2006 (World Bank, 2016). In 2016, international tourism contributed 13% to GDP, 12% to employment and 21% to export earnings (WTTC, 2017). Half of the international tourists engage in NBT (Mgonja et al., 2015) and this makes NBT an important economic sector in Tanzania.

Tanzanian NBT largely depends on attractions that are supported by natural environments and that include mega-fauna, wildlife migration in Serengeti and snow on Mount Kilimanjaro (Kilungu et al., 2014; Tanzania Tourism Sector Survey, 2017). An attraction is a physical, environmental or cultural feature that meets a specific tourist's desire to travel to a specific destination (Leiper, 1979; Gunn & Var, 2002). A destination is a geographic area with political or administrative boundaries that provides tourists with a range of attractions for a memorable experience (Manente, 2008; Bornhorst et al., 2010; United Nations, 2010). Without developed attractions, NBT and its destinations would not exist (Yale, 1991). This means that the continued growth of NBT in Tanzania depends on the quality of natural environments and its attractions. My thesis considers Tanzanian national parks, game reserves, nature reserves and the Ngorongoro Conservation Area all as NBT destinations, while wildlife, plants and snow are major nature-based tourist attractions.

NBT is highly sensitive to environmental change due to close connections of its attractions with climate and other environmental factors (Simpson et al., 2008). As such, any environmental change that affects attractions, also directly or indirectly affects NBT. The direct impacts include conditions that limit some tourism activities. These may include extreme weather events that limit tourists to participate in specific activities or to reach specific attractions (Scott et al., 2007). The indirect impacts change tourists' perceptions of the affected attractions and may deter tourists from visiting specific destinations. They include changing wildlife distribution or migration patterns, shifts in species range, changes in productivity and loss of wildlife and snow.

Although both the direct and indirect impacts can potentially benefit tourism, the adverse impacts are likely to outweigh these benefits. This is also the case in Tanzania. Convincing evidence shows that loss of wildlife and alteration of wildebeest migration in the Serengeti-Mara is strongly linked to (1) rainfall variability and persistent drought (Ogutu et al., 2008; Ogutu et al., 2011; Ogutu et al., 2012), (2) substantial long-term changes in Serengeti's land cover since the early 1970s (Sinclair, 1995; Homewood et al., 2001; Estes et al., 2012) and 3) a substantial decrease in the dry-season Mara River flow since 1972 (Gereta et al., 2009). The perennial Mara River provides drinking water for the wildebeest migration in the critical dry season and the river's dynamics trigger the large aggregation of wildlife that attracts tourists in the main tourism season from July through September. The large losses of Mount Kilimanjaro snow cover since 1912 (Hemp, 2005; Thompson et al., 2009; Cullen et al., 2013) have reduced the mountain's attractiveness. All these impacts are projected to intensify as climate change accelerates.

The impacts of environmental change increasingly threaten the attractions that NBT in Tanzania depends on (Park et al., 2016; Kilungu et al., 2017; Kilungu et al., 2019). Nevertheless, many of these impacts are ignored and their implications for individual attractions and Tanzanian NBT as a whole are not yet determined. This limits the country's ability to adapt. The next section briefly summarizes the major forms of environmental change and their impacts on Tanzanian NBT.

1.1.1 Environmental impacts threatening Tanzanian nature-based tourism

Over a quarter of Tanzania's land area is protected for conservation and NBT (World Bank, 2010; Bayliss et al., 2014; World Bank, 2016), but this does not make the country's attractions immune to the impacts of environmental change. On the contrary: the impacts are widespread. They include human settlements in wildlife migratory corridors and water extraction, illegal harvests of wild products (i.e. poaching and wildflower collection), climate change, variability and extreme weather events and changes in land cover. Next, I briefly explain how each of these impacts affects tourist attractions and NBT.

1.1.1.1 Settlements in wildlife corridors

A wildlife corridor is an area of land used by wild animal species to move seasonally from one area to another in search of basic requirements, such as water and food (Caro et al., 2009). Wildlife corridors are rapidly vanishing (Caro et al., 2009; Jones et al., 2012), thereby isolating protected areas and threatening wildlife species with population losses and even extinction. The reasons for the vanishing of wildlife corridors are complex, but human settlements and agriculture activities are major factors (Jones et al., 2009). Conversion of wildlife corridors and dispersal areas into agriculture substantially declined the migratory wildebeest population across Tanzania and Kenya (Estes, 2009; Ogutu et al., 2012). Hardest hit in Tanzania are the wildlife corridors connecting the protected areas in the northern tourist circuit comprising Serengeti, Kilimanjaro, Tarangire, Lake Manyara, Arusha, Mkomazi National Parks and Ngorongoro Conservation Area (Kaswamila, 2009).

1.1.1.2 Water extraction

Another alarming threat to the attractions of NBT is the extraction of water from rivers passing through protected areas, to be used as drinking water in settlements, for irrigated agriculture or for hydropower. Decreasing water flows in rivers will likely degrade the habitats for wildlife with negative impacts on wildlife biodiversity and associated tourism activities. Stommel et al. (2016) showed that the hippopotamus population in Ruaha National Park declined due to the decreasing water flow in the Great Ruaha River. This decrease is associated with upstream catchment degradation for settlements and agriculture. Channing et al. (2006) associated the extinction (in the wild) of the Kihansi Spray Toad with the reduced flow in the Kihansi River due to the recent hydropower dam construction. The population of lesser flamingos (Phoeniconaias minor) in Lake Natron, which is a key attraction in East Africa's Soda Lakes, is threatened by a proposed soda-ash-extraction factory and a multi-purpose dam that will be built on the Ewaso Ngiro River (Nonga et al., 2011). Conservation and tourism in the Selous Game Reserve will also likely be damaged by a huge hydropower plant planned for the Stiegler's Gorge (WWF, 2017). The implications of these changes for tourist numbers and tourism revenue are unknown.

1.1.1.3 Illegal harvests of wild products

Illegal harvesting within protected areas (including poaching, logging and collecting wildflowers) increasingly threatens NBT. These activities fuel the loss of wildlife and change characteristic landscape features. Poaching, both for subsistence and commercial demand, drastically reduces the number of wildlife populations and thus the number of tourist attractions (Kideghesho, 2016). Elephant poaching, for example, has made Tanzania along with Kenya, Uganda, Malaysia, Vietnam, the Philippines, Thailand and China part of "the gang of eight" in the 2013 CITES Conference of the Parties in Bangkok (Kideghesho, 2016; WILDAID/AWF, 2016), but how this affected tourism is unknown. Moreover, illegal harvesting of wildflowers causes the loss of floristic attractions. Orchid tubers are the key attraction in Kitulo National Park, which is also known as 'the Serengeti of flowers', and their illegal harvests threatens tourism in this park (Davenport & Ndangalasi, 2003). Such illegal harvesting has drawn less attention than illegal poaching of big game, partly because of the incomplete identification and classification of floristic resources and their poorly documented importance as tourism attractions.

1.1.1.4 Climate change, variability and extreme weather events

The climate of Tanzania has historically already been diverse and highly variable (Munishi et al., 2009; Munishi et al., 2010; FCFA, 2017). Climate change will further intensify climatic variability and increase mean temperatures. Projections from climate models (e.g. GCMs) show that the mean daily temperature in Tanzania could rise by 3°C to 5°C by 2075 (Agrawala et al., 2003). In general, changes in climate and its variability are increasingly threatening NBT by limiting some tourism activities and affecting attractions, such as changing wildlife migration patterns and reducing snow availability (Scott, 2006; Scott et al., 2008; van der Veeken et al., 2016; Kilungu et al., 2017). Changes in climate, climate variability and extreme weather events aggravate other environmental impacts. For instance, reduced rainfall coupled with high temperature increased fire incidences and forests loss in Mount Kilimanjaro National Park (Hemp, 2005; Hemp, 2009). Climate change modifies tourist attractions by changing their types, quality and distribution and eventually this affects how tourists perceive them (Scott et al., 2007; Kilungu et al., 2017; Kilungu et al., 2019). Several analyses (NAPA, 2007; TMA, 2007; Munishi et al., 2010; Yanda et al., 2015; FCFA, 2017) show that rainfall is decreasing and becoming more erratic and less predictable in Tanzania. Erratic rainfall and changing rainfall patterns (including droughts, floods and seasonal shifts) limit wildlife's food availability and quality. Extreme food scarcity during droughts has often been associated with a massive die-off of large numbers of grazing ungulates and some bird species in Tanzania (NAPA, 2007; Dublin & Ogutu, 2015). For instance, the severe drought of 1993-1994 killed almost half of all buffaloes (Metzger et al., 2010) and a quarter of the 1.5 million wildebeest (Mduma et al., 1999) in Serengeti National Park. Likewise, the 1999-2000 drought, which was also extreme and widespread, killed 1500 buffaloes in the Ngorongoro Crater (Estes et al., 2006). The consequences of these and other forms of environmental change for NBT remain under-researched.

1.1.1.5 Land-cover change

The Tanzanian diversity of land cover is the basis for the uniqueness and diversity of its tourist attractions. Land cover refers to the physical characteristics of the land surface and is characterised by the distribution of vegetation, crops, water, bare soil and other physical features, including those created solely by human activities (e.g. settlements) (Rawat & Kumar, 2015).

In Tanzania, the rate of land-cover change, in particular the conversion of forests to grasslands, is high (URT, 2014). Each year Tanzania loses 400,000ha of forest cover (URT, 2014) and this contributes to a drastic loss of wildlife. Extinction of large mammals is substantial and directly related to land-cover change (Newmark, 1996; Homewood et al., 2001; Kinnaird et al., 2003; Ceballos et al., 2010; Estes et al., 2012). Changes in land cover are already a major research theme in conservation biology (Fazey et al., 2005; Fischer & Lindenmayer, 2007; Ceballos et al., 2010; Nyamasyo & Kahima, 2014; Rastandeh et al., 2018), but one that is insufficiently covered from a tourism perspective.

Land-cover changes are typically the complex result of a range of interrelated factors and developments. For instance, decreasing snow cover on Mount Kilimanjaro is linked to multiple factors that include illegal logging and deforestation, climate-driven forest fires, reduced rainfall and increased temperature (Hemp, 2005; Hemp, 2009; Thompson et al., 2009). The extinction of wildlife in Tanzanian National Parks is linked to changes in vegetation cover and poaching (Newmak et al., 1991; Newmark, 1996; Kideghesho, 2016). The conversion of the Kenyan Mau Forest Reserve to croplands changed the Mara River flows and its riparian vegetation and, in turn, affected wildlife in the Serengeti National Park (Gereta et al., 2003). Because of its complex causality, land-cover change (including changes in snow cover) has been widely used as a high-level indicator of environmental change (Thompson et al., 2009).

1.2 Problem statement and justifications

Tourism is thus pivotal for Tanzanian GDP and supports a large contribution to local incomes and livelihoods. This contribution is in jeopardy because the attractions that tourism depends on are highly threatened by the impacts of environmental change. NBT in Tanzania should, therefore, adapt to the impact of environmental change for sustainable growth.

For effective adaptation, the NBT sector and policy makers in Tanzania need assessments of the impacts of environmental change on NBT. The knowledge for such an assessment is, however, inadequate. This is evidenced in four knowledge gaps.

First, tourists visit Tanzania to experience attractions, but the information on the type of attractions that they prefer, is lacking, even though wildlife tourism has existed since the 1600s when Arabs and Europeans travelled across the East African Great Lakes area searching for wildlife trophies and beautiful landscapes. Most contemporary studies focus on the number of tourist arrivals in economic and market analyses (Cater, 1987; Curry, 1990; Gössling, 2001; Wade et al., 2001; Kweka et al., 2003; Lindsey et al., 2007), characteristics of tourism (Salazar, 2009) and governance issues linked to the stimulation of tourist arrivals (Chachage, 1999) but less on the impacts of environmental change.

Second, in fact, some types of attractions are more important than others. Yet, information on the relative importance of each attraction for tourism is poorly assessed. This is partly because existing studies (e.g. Eagles & Wade, 2006; Kaltenborn et al., 2011) coarsely define attractions with homogenous categories such as ‘wildlife’ with no further details to species or type. This category is not informative for a comprehensive impact assessment, because ‘wildlife’ is a highly heterogeneous term.

The term 'wildlife' generally refers to undomesticated animal species (e.g. mammals, birds, lizards, amphibians and fish). Clear information on what type or species of wildlife a tourist is attracted to, is lacking. Moreover, tourist attractions are not only limited to 'wildlife' but also to plants and other physical attractions, such as rocks, waterfall and snow piles in tropical climates. These specifics must be clear for impacts assessment as coarsely defined attractions probably lead to unsustainable conservation and eventually severe damage to unidentified attractions.

Third, tourist attractions are situated within environments, but how exactly do environments give rise to attractions is unknown. Attractions emerge from and are connected to specific characteristic environments (e.g. vegetation types, microclimates, soil types and water types). This link must be clear as each attraction is unique and reacts to environmental change differently. Their response depends on their resilience and adaptive capacity. Tanzanian tourism studies, however, have focused mainly on the characteristics of visitors or their perceptions (e.g. Okello & Yerian, 2009; MNRT, 2015) with little attention to the attractions' environmental characteristic (including, for example, species abundances and land cover). This suggests the lack of approaches to link individual attractions with their supporting environments and delays assessing impacts.

Fourth, although many studies (e.g. Ogutu et al., 2008; Thompson et al., 2009; Ogutu et al., 2012; Sinclair et al., 2015) assess the impacts of environmental change on wildlife biodiversity and snow, the assessments are not fully integrated to determine the effect on individual attractions and Tanzanian NBT as a whole. NBT and its attractions are affected by environmental change but no detailed assessment exists to a park level in Tanzania. In fact, such detailed assessments are scarce for African tourism destinations in general (Scott et al., 2008). Information regarding the links between tourists and attractions, and between attractions and environments is lacking.

The resulting knowledge gaps limit assessing the effects of environmental change on NBT. Information to fill these knowledge gaps is vital to support informed policy decisions and actions to better manage Tanzanian NBT destinations. This knowledge can also provide valuable input for decision-making in land-use planning, infrastructure development and marketing strategies for tourism. Impact assessment for NBT is thus timely and useful.

To produce such assessments, one needs to know or conceptualise how NBT is connected to environmental change. This requires integration of all available knowledge. Integration of past and recent trends in climate and land-cover data, and existing knowledge that relates environmental change and NBT, is important. The required knowledge is conceptualised in four steps. First, tourists come to visit attractions. Thus, a comprehensive information on the types of attractions they prefer and tourists' visitation patterns over time is needed. This information helps to understand the country's past and contemporary NBT, provides insights on how tourists' motives and preferences changed in response to environmental change. Such kind of information forms a basis to understand why current trends of environmental change add more challenges on tourism management and the need for science-based adaptation strategies despite the fact that the Tanzanian NBT sector had changed in the past. Second, some (types of) attractions are more important than others. A detailed assessment on the relative importance of each attraction for tourism is thus needed. This assessment is likely informative for tourism planners and policy makers for effective tourism product diversification and helps to adapt the tourism sector to the current rate of environmental change. Third, attractions are situated in environments. Information on attractions' uniqueness, diversity and uneven distribution within a national park linked with their environments is required. This link helps to understand their attractiveness.

Fourth, information on attractions' environmental change tolerance or thresholds is required. This knowledge would be used to understand how these attractions are (will be) affected by environmental change.

Moreover, impact assessments need to inform tourism-policy processes. Nevertheless, the tourism sector has long taken climate and environmental change for granted (Scott et al., 2005; Tervo, 2008; Tervo-Kankare et al., 2018) and this has hindered the mainstreaming of climate and environmental change adaptation in tourism management, planning and policies, particularly in Africa (UNWTO/UNEP, 2008; Hoogendoorn & Fitchett, 2018). Thus, the rationale for impact assessment in my thesis relates to at least three on-going policy processes. First, most Tanzanian National Parks are reviewing or about to review their general management plans and may take on-board the impacts of environmental change, particularly changes in climate and land-cover. Second, Tanzania is working on an update of its almost twenty-year-old tourism policy (Melubo, 2017) and should pay more attention to the effects of environmental change. Third, in April 2018 Tanzania ratified the Paris Climate Agreement, which not only covers mitigation but also adaptation. The Agreement's Paragraph 7.9 states, "each Party shall, as appropriate, engage in adaptation planning processes and the implementation of actions, including the development of management plans, policies and/or contributions." Tourism-specific adaptation plans and diversification of tourism products to match with the current rate of environmental change may be part of Tanzania's efforts. My thesis could inform the relevant tourism stakeholders and provide useful information to support the government's tourism planning efforts.

1.3 Objective and research questions

My thesis' main objective is to identify the relevant tourist attractions in the Serengeti and Kilimanjaro National Parks and assess how they are affected by environmental change. To achieve this objective, my main research question (RQ) is: **'What are the effects of environmental change on nature-based tourism in Tanzania?** Specifically, my thesis assesses land-cover and climate-change effects on tourist attractions. Changes in land cover (including snow) and climate are integrative indicators of environmental change and thus I use them to study changes in attractions because attractions emerge from and are connected with land cover (i.e. environments).

In my main RQ, 'effects' can be both positive and negative (while impacts are generally negative). Positive effects create opportunities, while negative ones are threats or risks. The main RQ is broken down into four RQs that guide my analysis:

RQ1. What drove the history of nature-based tourism in Tanzania?

RQ2. How can tourist attractions be described to support environmental impact assessments in Tanzanian National Parks?

RQ3. What are the effects of climate and land-cover change on tourist attractions in Mount Kilimanjaro National Park?

RQ4. What are the effects of climate and land-cover change on tourist attractions in Serengeti National Park?

These four RQs are logically addressed in the four chapters of this thesis and comprehensively assess the effects of environmental change on Tanzanian NBT tourism destinations, in particular national parks (see Figure 1.1). Foremost, Figure 1.1 shows that RQ1 provides the historical tourism-environmental literature to gain insights of environmental problems that most tourism destinations in Tanzanian face and briefly discusses how environmental change affects attractions and NBT as a whole (Chapter 2). RQ1 also profiles tourists' visitation patterns, their motives of visit and preferred attractions over time to understand the state-of-the-art of tourism in Tanzania. To address RQ2, I took diverse land-cover types as attractions' supporting environment in a national park landscape. Then, I developed the eco-parcel approach to categorise tourist attractions in details (i.e. wildlife types and species, plants and physical attractions), assess the relative importance of each attraction for tourism and link each attraction with its supporting environments. This assessment resulted into categorising attractions in discrete landscape patches (i.e. eco-parcels) within different land-cover types based on their characteristic environments (Chapter 3). I use high altitude (i.e. Mount Kilimanjaro National Park) and low altitude (i.e. Serengeti National Parks) tourism destinations as case studies to obtain a representative overview of the Tanzanian national parks. I also created a spatial link between tourists and attractions, and between attractions and environments. The links make impacts assessment localised to individual attractions based on attractions' prevailing environmental conditions (Chapters 4 and 5). I used changes in climate and land cover to assess the effects of environmental change on key tourist attractions in KINAPA (RQ3) and SENAPA (RQ4). Knowledge integrations within my RQs allow science-based interpretation of the effects for the Tanzanian NBT sector (Chapter 6). My assessment should provide insights to develop proactive tourism adaptation and management plans to avoid adverse impacts that would aggravate in the future and substantially affect the Tanzanian NBT sector.

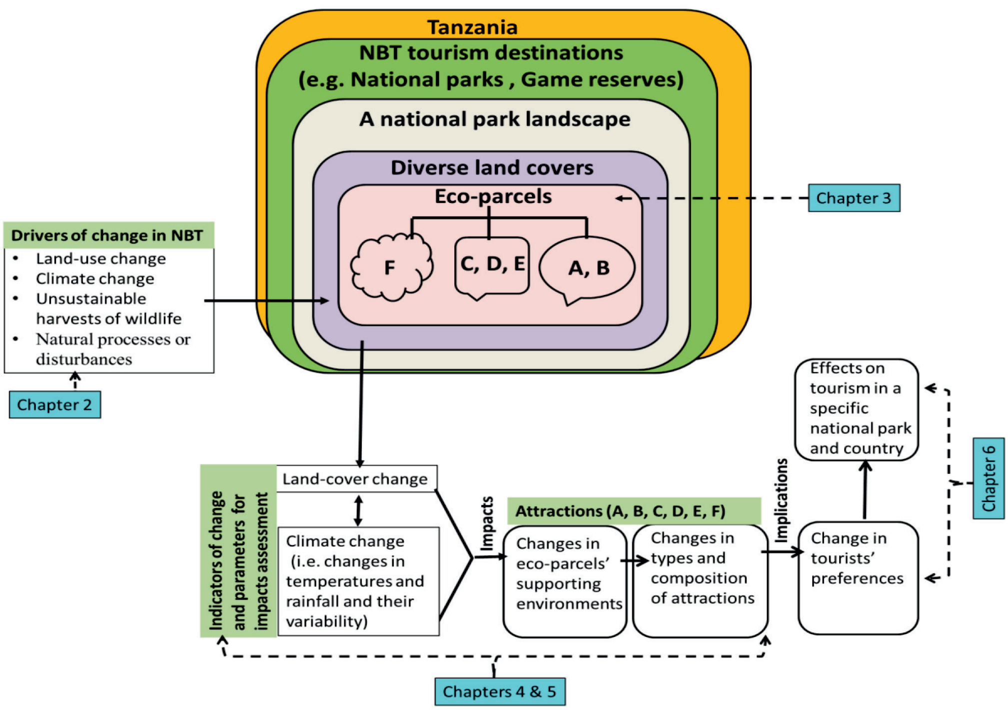

Figure 1.1 The conceptual framework and structure of my thesis. Bold arrows indicate impacts. Dotted arrows indicate my assessments

1.4 Case studies

I studied the Serengeti and Kilimanjaro National Parks because of their importance in tourism and their unique land covers and biodiversity. They provide major attractions for national and international tourists. Of the sixteen Tanzanian National Parks (Figure 1.2), the Serengeti and Kilimanjaro receive about half of all tourist visits and they generate about 85% of NBT's income. This income suffices to manage all Tanzanian National Parks (World Bank, 2015). Both Parks are also UNESCO world heritage sites and they respectively represent the main Tanzanian lowland and highland tourism destinations. The two parks contain highly climate-sensitive tourist attractions (e.g. snow and wildlife migration). Moreover, the two parks were the first national parks in Tanzania and much literature is available for their historical evolution and changes in land-cover and wildlife populations. In my thesis, this literature is combined with the analysis of recent climate change and tourism knowledge to provide relevant input for tourism planning.

The Kilimanjaro and Serengeti National Parks will directly benefit from my impacts assessment as their managers are currently updating their general management plans. Thus, the methodology, findings and recommendations of my thesis are practically timely and likely highly valued.

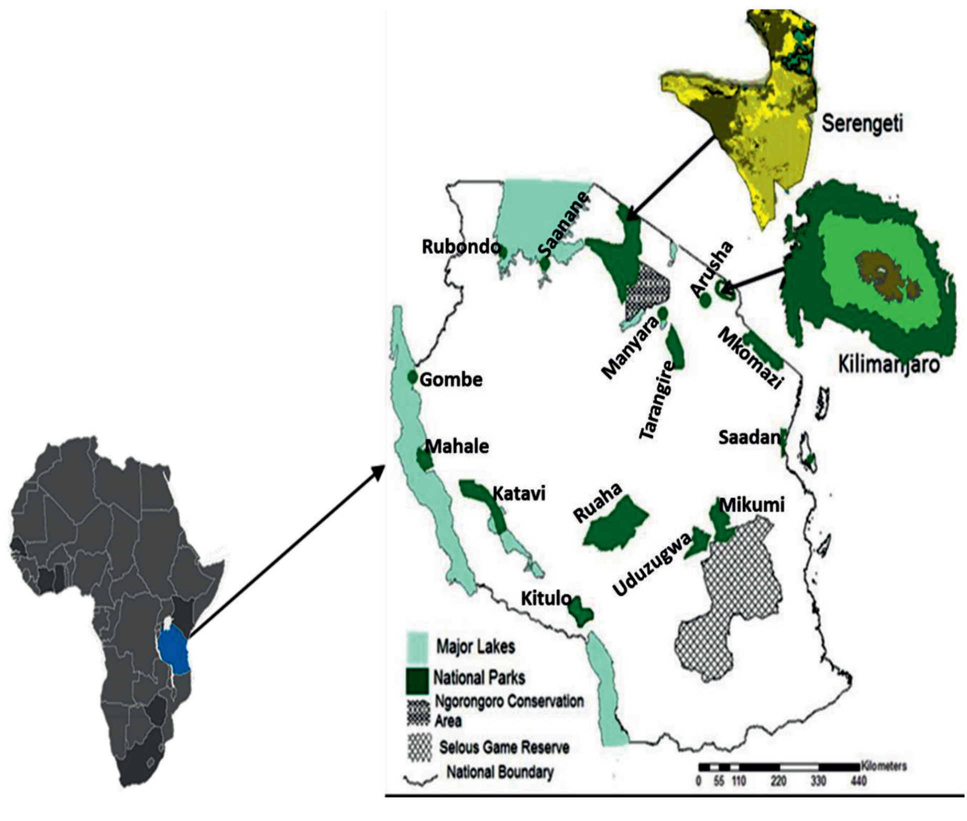

Figure 1.2 Map of Tanzania (inset) showing the National Parks and especially the Serengeti and Kilimanjaro national parks.

1.5 Methods

To assess the effects of environmental change on tourist attractions and, in turn, on NBT, my thesis integrates knowledge across different disciplines including social sciences (i.e. tourism: tourist attractions and tourists' preferences and motives), climatology (i.e. temperature and rainfall), ecology (vegetation and wildlife population dynamics, and wildlife behaviour) and environmental sciences (e.g. changes in land cover and land use). Due to its multidisciplinary character, my thesis uses several approaches to address the four RQs.

RQ1 is addressed through a literature review to understand factors that made NBT the contemporary form of tourism, and national parks the main NBT destinations in Tanzania. Few approaches that describe tourist attractions and that support a comprehensive impact assessment in Tanzanian National Parks, were available. I therefore developed a concept referred to as 'eco-parcel' and included it in my impact assessment to address RQ2. RQ3 is addressed using a hazard-activity pairs' approach, while the final question (RQ4) is addressed through an inferential statistics approach. Next, I briefly explain how each approach has been applied.

1.5.1 Literature review

To answer RQ1, Chapter 1 reviews the literature to understand the historical roots of contemporary Tanzanian NBT. To provide a systematic and detailed analysis, I compare the motives and preferences of the tourists who visited Tanzania in the colonial period (i.e. from the 1880s to 1960s) with those who visited after independence (i.e. since 1961). For these periods, I integrate knowledge from various fields, including tourism's economic contribution (e.g. Cater, 1987; Curry, 1990; Gössling, 2001; Wade et al., 2001; Kweka et al., 2003; Lindsey et al., 2007), the characteristic of tourism (e.g. Chambua, 2007; Salazar, 2009), governance issues related to stimulating tourist arrivals in Tanzania (Chachage, 1999), and the impacts of environmental change on tourism (e.g. Gössling et al., 2006). Based on these studies and information from unpublished sources and key informants, I synthesize the reasons why motives and preferences of tourists who visited Tanzania, changed and why the main tourism activities gradually shifted from exploration and discovery to trophy hunting, to the current NBT. I highlight the impacts of environmental change, including changes in climate, habitat destruction and unsustainable hunting, on tourist attractions and their implications for tourist motives, management of protected areas and Tanzanian NBT.

1.5.2 Development and application of a new eco-parcel concept and approach

Assessing the environmental-change threats to Tanzanian NBT is central to my thesis. However, the lack of adequate approaches to connect attractions to their common characteristic environments limits such assessments. Chapter 3 develops an integrative tourism-resource assessment approach to fill this gap and address RQ2. The approach is based on the following line of reasoning: Tourists are attracted to specific patches with unique attractions and not just to the whole park area (Figure 1.1). This means that attractions emerge from and are connected to specific environments. That is, to enable impact assessment for individual attractions, the link between attractions and their supporting environments should be defined. After all, changes in the characteristic environments of those patches affect individual attractions in parks and finally, adverse changes in attractions affect tourists' interest in visiting a specific national park.

The approach, called 'eco-parcel approach' consists of three steps: 1) the identification and geo-referencing of individual attractions; 2) the rating of attractions; and 3) the allocation of attractions to specific land patches. Information from tourists, literature, key informants and field visits is combined into a list of key geo-referenced attractions (Step 1). Tourists are subsequently asked to rate these attractions (Step 2). Rating individual attractions helps to understand the merit of each attraction when it is threatened, lost or gained. Next, using GIS techniques, attractions are associated with discrete landscape patches (eco-parcels) and their characteristic environments (e.g. vegetation types, microclimates, soil and rock types, snow or hydrology). This delineation distinguishes attractions supported by similar environments from those supported by different environments and from the wider surroundings.

The eco-parcel approach connects the societal notion of 'tourist attraction' to the environmental notion of a 'landscape patch'. This connection makes the approach meaningful to both stakeholders in the tourism sector and environmental scientists. In Chapters 4 and 5, I apply the eco-parcel concept to the Kilimanjaro and Serengeti National Parks. For those parks, detailed information about the supporting environmental conditions is not available, so that I use land-cover as an approximation. Land-cover change indicates environmental change including snow cover and biodiversity. The obvious integration within eco-parcel approach makes the impacts assessment meaningful to a range of stakeholders in the tourism sector and scientists.

1.5.3 Hazard-activity pairs

To address RQ3, Chapter 4 uses a hazard-activity pairs approach to assess the effects of climate and land-cover change on tourism in Mount Kilimanjaro National Park. This approach was first proposed by Moreno and Becken (2009) to structure the analysis of the complex interactions between environmental change and tourism for particular destinations. They concentrated on the links between one relevant aspect of climate change (the hazard) and one important tourism activity at a time, rather than considering all aspects of environmental change and all tourism activities simultaneously. Afterwards, they integrated these partial analyses into a vulnerability profile for the destination as a whole. Although not focusing on vulnerability, my thesis follows their example to establish hazard-activity pairs.

Chapter 4 uses the hazard-activity pairs approach to systematically structure the hazards associated with recent changes on climate trends and land cover and assess their likely effects on trekking on Mount Kilimanjaro. The first hazard-activity pair combines rainfall and trekkers' comfort. The second pair relates the intensity of rainfall events to landslides and rock-fall risks. The third hazard-activity pair pertains to the relationship between temperature and altitude sickness. The fourth hazard-activity pair relates land-cover change to the quality of the actual tourist attractions during trekking. To interpret the impacts of climate and land-cover change on trekking experience, I integrated several data sets and used additional information from the literature and key informants. I combined observed statistical trends of monthly rainfall and temperature covering a period between 1973 and 2013, tourist visits data (2000-2013), land-cover data (1993 and 2013) and insights from a range of impact studies on Mount Kilimanjaro and other high mountains in East Africa and the rest of the world.

1.5.4 Inferential statistics

To answer RQ4, Chapter 5 uses an inferential statistics approach to assess the impacts of climate change and its variability and changes in land cover on nature-based tourism. In Serengeti, wildebeest migration is the key attraction and tracking them is the main tourism activity (Chapter 3). The wildebeest migration is triggered by rainfall onset and is regulated by the availability of food and drinking water. To interpret the impacts of changes in climate and land cover on Serengeti's tourism, I integrated several data sets and used additional information from the literature. I integrated tourism knowledge, observed statistical trends of monthly rainfall and temperature (covering a period between 1970 and 2010), trends in the number of migrating wildebeest for intervals of 3 to 5 years (1970 – 2010), tourist visits data (2000-2013) and land-cover data (1984 and 2009) with existing impact studies in Serengeti. These studies include Boone et al. (2006) who built the relationship between wildebeests and rainfall, Mduma et al. (1999) who studied wildebeest migration and food availability, and Gereta et al. (2009) who studied the relationship between wildebeest migration and water quality and quantity. The approach also involves key informants interviews (e.g. tourism and ecology park wardens) to ascertain the existing climate-driven tourism impacts.

1.6 The innovations in my research

My thesis is among the first to assess the impact of environmental change on Tanzanian NBT by integrating environmental-data sets (i.e. climate and land cover and wildlife behaviour) with social data sets (e.g. tourist preferences and tourist attractions). As such, it forms a basis for better impacts assessment based on empirical tourism-environment relationships. Data from environmental studies further advance understanding of tourist attractions' dynamics and can guide evidence-based NBT decisions. The tourism-environment literature for the past century that is gathered in my thesis helps to better plan and manage tourism, and to create awareness on how to respond to the impacts of environmental change. With the Kilimanjaro and Serengeti National Parks case studies, my thesis clearly demonstrates how to empirically assess the positive and negative impacts, while most prior studies only provided speculative information on possible negative impacts. My thesis contributes to the increasing body of scientific approaches to assess impacts on individual attractions for diverse and specific destinations based on their prevailing environmental conditions.

My thesis connects the realm of environmental change with the realm of the tourist experience by developing the new eco-parcel approach that people from both realms can relate to. In prior studies, conservationists and tourists viewed nature differently and separate disciplines studied the impacts of climate change, land-use change, ecosystems and environmental dynamics and tourism in mostly non-comparable ways. My eco-parcel approach innovatively integrates these disciplines to understand the impacts of environmental change from a tourism perspective. This approach connects the societal notion of 'tourist attraction' to the environmental notion of a 'landscape patch'. The identification and evaluation of attractions is done from a tourist perspective, whereas the landscape patches that give rise to these attractions, are defined from a physical and ecological perspective. The eco-parcel approach likely provides a better basis to assess the impacts of environmental change on tourism and keeps park managers and tourism planners aware of the opportunities and threats associated with these impacts.

My thesis nourishes the public discourse on the benefits of tourism for conservation by making the links between environments and tourism explicit, and can thus inform land-use policies, park management, marketing strategies through the exploration of spatial and temporal shifts in the availability of tourist attractions.

My thesis also identifies adverse and beneficial effects, discusses the options for mitigating the negative effects and encourages stakeholders in the tourism sector to capitalize on the positive effects.

Finally, my thesis contributes to the growing body of literature on environmental change and climate change impacts on tourism in Africa. The literature should remind the tourism sector of its dependence on climate and environmental resources, and of its vulnerability to environmental change. The observed rapid loss of Mount Kilimanjaro's snow, montane forests attractions and changing the wildlife migration patterns in Serengeti are powerful signals.

1.7 Outline of the thesis

This introduction (Chapter 1) and the synthesis (Chapter 6) of my thesis are written to frame the four core chapters (i.e. Chapters 2 to 5). The relationship between the chapters is summarised in Figure 1.1.

Chapter 2 provides the historical background of Tanzanian NBT and answers RQ1. To address RQ2, Chapter 3 develops a generic approach (i.e. the eco-parcel approach) that facilitates assessments of the impacts of environmental change on tourist attractions and NBT by identifying and rating individual attractions and linking each attraction to its supporting environment of landscape patches (eco-parcels).

Chapters 4 and 5 apply the eco-parcel concept and approach developed in Chapter 3. Chapter 4 answers RQ3 by assessing the effects of climate and land-cover change on tourist attractions in Mount Kilimanjaro National Park. Chapter 5 answers RQ4 by assessing the effects of rainfall variability and land-cover change on the Serengeti's key attraction: wildebeest migration.

Chapter 6 concludes my thesis by synthesizing the results, discussing the lessons learnt and management implications and reflecting on the main RQ.

Chapter 2

What drove the history of nature-based tourism in Tanzania?

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Abstract

Tanzania is currently one of the world's most visited countries for nature-based tourism, in particular wildlife tourism, but its main destinations are at risk from changes in climate and local land-use. The consequences of these changes on tourism demand are, however, unclear. Despite a century of Tanzania's experience with wildlife tourism, the trends in Tanzania's wildlife tourism demand are poorly understood. Insights into past, current and future tourist's motivations and preferences are thus vitally important to successfully manage wildlife safari tourist destinations and tourism. This paper aims to profile and explain the developments in tourist motivations and preferences since the early 19^{th} century. Changes in motivation and preferences and the consequent wildlife resource utilization are analysed. Our paper recapitulates a century of wildlife resources governance and use. Wildlife resource uses in Tanzanian protected areas vary historically from exploration and discovery, ivory collection, hunting for trophies, safaris and nature conservation. These different purposes in different periods are summarised in an annotated map of the evolution and distribution of Tanzanian tourist destinations. The results are relevant for spatial planning and wildlife conservation in relation to tourism. The tourism literature gathered in this chapter provides building blocks to develop exploratory scenarios to help Tanzanian wildlife tourism to cope with the current climate and land-use change risks.

Keywords: Tanzania, tourist destinations and wildlife tourism.

2.1 Introduction

Inbound tourism in Tanzania performed very strongly over the last three decades. As such, tourist arrivals increased from 0.06 million tourists in 1982 to over 1.1 million in 2012 (i.e. an 18.3-times increase) (Wade, 2001; UNWTO, 2012; Tairo, 2013). In 2006, tourism accounted for 17% of the country's GDP (URT, 2007) and the revenues accrued increased substantially in 2011 (UNWTO, 2012). Meanwhile, a growing number of Tanzanians depends on tourism for their livelihoods either directly or indirectly.

According to few studies (e.g. Curry, 1990; Kweka et al., 2003), scenic landscapes, mega-fauna and other natural environmental features are among Tanzania's main tourist attractions. The biodiversity in protected areas, especially wildlife, account for most of the country's tourist attractions (Kweka et al., 2003). The protected areas, including the famous snow-capped Mount Kilimanjaro, Ngorongoro Crater and the endless plains of the Serengeti, acted as tourist destinations well before the country's independence 1961 and still do today. The defining attractions within these destinations are under pressure from a range of factors, including changes in climate and land cover, biodiversity loss and land grabbing and land-use change. These factors do likely alter the spatial and temporal distribution of the country's key tourist attractions. For instance, herds of animals may change their migratory behaviour, migrating in different seasons or following different routes (Gereta et al., 2009; Ogutu et al., 2012). The snow on Mount Kilimanjaro is projected to disappear within decades (Thompson et al., 2002; Agrawala et al., 2003; Hemp, 2005). The implications of the anticipated changes to wildlife tourist destinations and the Tanzanian nature-based tourism are unknown. The actual implications vary depending on the size and distribution of the protected areas, tourist motives and tourist preferences over time (i.e. supply and demand). This paper does not only consider the actual environmental trends and projections but also trends in tourism demand. Therefore, explicating sufficient insight into motives and preferences of tourists with respect to particular attractions that they like to visit is vital. Beach tourists, for example, are not affected by changing the wildlife migratory patterns. Hence, a detailed history of tourism and tourist destinations in Tanzania helps not only to understand the tourists' motives and preferences, and the consequent changes or shifts in wildlife resources management but also to inform policymakers, tourism managers and other tourism stakeholders on the impacts of environmental change on tourism.

Various studies compile historical information on tourism in Tanzania. However, most of these studies focus mainly on economic and market analysis (Cater, 1987; Curry, 1990; Gössling, 2001; Wade, 2001; Kweka et al., 2003; Lindsey et al., 2007). Such economic analyses only explain the income accrued from tourist expenditures, but do not cover tourist motives and preferences over destinations or even the nature of the destination visited. Salazar (2009), for example, described the general characteristics of Tanzania's tourism, but focused only on a small part of the country 'the Northern Circuit'. Salazar mainly reviewed governance issues and ignored the changing role of tourist destinations in the early 19^{th} century to contemporary periods. At least this could have brought the history on why the Northern Circuit become famous in the country's tourism history. On the other hand, Chachage (1999) focused mainly on the functions of Big International Non-Governmental Organisations (BINGOs), such as IMF and the World Bank in stimulating tourist arrivals since the early 1980s. Wildlife-safari tourist destinations in Tanzania actually already have a history of more than a century and we show, through our analysis that tourist motives and preferences, have changed in this century.

Limited details and analysis are, however, available on the processes behind these changes. Yet, the historical details and analysis are necessary to understand Tanzanian nature-based tourism's current state-of-affairs as well as its coping capacity to manage risks. Information in this paper can, therefore, help to define adaptation possibilities to guarantee a sustainable future for Tanzanian nature-based tourism.

This paper aims to profile international tourist arrivals in Tanzania in terms of their motives and preferred activities. We identify the factors that contribute to the proliferation of protected areas. We also create an annotated map of the tourist destinations distribution in Tanzania. The map details the evolution of each destination covering a period of a century, starting immediately before the colonial era (i.e. early nineteenth century) and ending to date.

One hundred years ago, tourism was not well defined. Meanwhile, although several tourism definitions exist, we adopted the broad definition by UNWTO/UNSTAT (1994) to cater for various tourism motives and preferences over the century. Tourism is defined as those activities deployed by tourists during the course of their journey and their stay in places situated outside their usual environment. For this paper, we considered wildlife discovery, scenic beauty explorations, wildlife hunting (for either trophy or sport), and game viewing as forms of tourism. In addition, we adopted Leiper's (1979) definition of a tourist destination as a location or place, which attract tourists to stay temporarily to conduct tourism activities. In our paper, hunting and game or nature reserves, national parks, wildlife management areas and the Ngorongoro Conservation Area are all tourist destinations while wildlife, plants and non-living objects (e.g. snow, waterfalls, kopjes) are all tourist attractions.

This paper first discusses tourism in the colonial era (Section 2.2) followed by an in-depth discussion of tourism in the post-colonial era (Section 2.3). These discussions show how motives and preferences have changed considerably over time and are then used to annotate a map with the evolution and distribution of Tanzanian wildlife tourists' destinations (Section 2.4). Finally, Section 2.5 concludes on the utility of this comprehensive history and the map of wildlife safari tourists' destinations in Tanzania.

2.2 The colonial period

Long before the advent of European explorers in the second half of the nineteenth century, Arab traders travelled across the African Great Lakes region in search for, among other things, ivory and scenic landscapes. The promise of abundant resources also attracted the attention of European explorers. Famous explorers, such as Mungo Park, David Burton and David Livingstone, travelled across various parts of Africa for explorations and discoveries, and informed their governments. European powers became interested in the region and started colonisation. Britain and Germany divided East Africa among themselves in the 1880s and Tanganyika (now mainland Tanzania) became a German colony. Before the onset of Europeans, Arab sultanate had settled in Unguja and Pemba (since 1964 Zanzibar) in 1698 and stayed for over 190 years (i.e. 1698-1892). In 1890, the Arab Sultanate governance ended with the signing of the Heligoland-Zanzibar Treaty, in which Germany agreed to recognize the British protectorate over the islands of Unguja and Pemba (Chickering et al., undated). In Zanzibar, European governance ended the slave trade. As the slave trade is outside the scope of this historical tourism review, the remaining part of the review focuses on the developments of Tanganyika and its wildlife resources and tourist destinations.

The next section of the historical developments in tourist destinations, therefore, covers tourism developments under German and British rule and ends with tourism during World War II and the subsequent struggle for independence.

2.2.1 German control (1884-1918)

According to MacKenzie (1988), East Africa (i.e. Uganda, Kenya and Tanganyika) was the world's greatest source of Ivory in the German colonial era and ivory exports exceeded those of any other countries. East Africa harboured large groups of elephants and throughout the region, ivory was the vital constituent of pre-colonial government. From an economic point of view, the international attention for the area now known as Tanzania centred on trophy hunting, especially for the ivory trophy trade. This hunting tourism reached its climax when the demand for ivory expanded in response to the growing demand for cutlery, billiard balls and pianos in the United States and Britain.

Ivory, however, was not the only product 'exported' from Tanganyika to the United States and Europe. Animal hides (e.g. lion, leopard, cheetah and crocodile), rhino horns and minerals were also exported. Ivory trade provided European with some insights on abundant nature the region has. After this, traders and explorers returned with stories of landscapes of 'magnificent beauty'. In those days, many Europeans saw Africa as a 'dark continent', 'the world's last great wilderness', 'exotic jungles filled with animals', 'paradise and a place of spectacular beauty' (Adams & McShane, 1996 p. vii). Since only few Europeans had visited Africa, the main sources of information were books and arts. Among the best-known examples of arts are the paintings by the Frenchman Henri Rousseau, who never set foot on the African continent, but his artistic representations of African beautiful landscapes and wildlife were inspired by stories told by explorers and travellers. Rousseau's paintings became a major information source about African wildlife and wilderness (Figure 2.1).

Figure 2.1 Rousseau's imaginary paintings of African wildlife and wilderness (http://www.henrirousseau.org).

After the spread of Rousseaus`s arts, the new era of explorative and discovery tourism started. The German missionary Johannes Rebmann 'discovered' Mount Kilimanjaro and its snow in 1858. Thirty-three years later, Mount Kilimanjaro was protected and in 1910, a National Park was established. The discovery of snow close to the equator attracted many explorers and many publications came out as a result. Among the publications were the "Globus Magazine" and "Brehm's Illustriertes Tierleben" (i.e. Global Magazine and Brehm's illustrated animal life) authored by Alfred Edmund Brehm, both of which appeared in the 1860s. In 1889, a German geographer, Hans Meyer, was the first to reach Kibo, the Mount Kilimanjaro's highest summit (5895m above sea level). His father owned a publishing house, which picked-up on Meyer's adventures and printed a number of magazines and books on Tanzania's natural beauty. These books became famous on the German market. Meyer also founded series of books: 'Allgemeine Länderkunde' (i.e. General geography) and 'Meyers Reisebücher' (i.e. Meyer's travel books), which were used as early tourist-guide books. In 1909, Meyer published a comprehensive two-volume compendium entitled "Das Deutsche Kolonialreich" (i.e. the German Colonial Empire) (CRIA, 2009; Urte Undine Frömming, 2009). This compendium described, among other things, key tourist destinations and attractions within the Germany Empire. Meyer also authored a number of other books, including volumes on the ascent of Kilimanjaro: 'Ostafrikanische Glestcherfahrten' in 1980 (Across the East African Glaciers as translated by E.H.S Calder), 'zum schneedom des Kilima-ndscharo' in 1888 (to the snow dome of Kilimanjaro), 'De Kilima-Ndscharo' in 1900 (the Kilimanjaro) (Stewart, 2004). These publications spread the news about the Tanganyika's attractions within Europe and the world. Thus, Meyer turned out to be highly instrumental in informing the European public about Africa's natural beauty, and in inciting demand for tourism in the region.

In the late 19th century, opposition against the excessive wildlife destruction grew. This condemned massive tourist hunting for elephant trophies and other big game hides (e.g. lion, giraffe and leopard). Thus, calls for preservation measures to promote the survival of the species started to emerge under the influence of natural history studies. The paradigm shifted from tourist hunting for trophy to sport (leisure) hunting tourism, triggering the development of science-informed regulations for wildlife conservation (i.e. the General Wildlife Ordinance of 1896). Non-destructive nature-based tourism activities, such as sightseeing tours and wildlife safaris, were advocated. This, in turn, reinforced and accelerated the establishment and expansion of many protected areas in Tanganyika.

Nevertheless, the condemnation of wildlife hunting, tourism was still considered a lucrative business for the German colonial government. Therefore, strategies to improve tourism earnings were put in place. In the 1890s, leisure and non-destructive tourism become important motives for implementing conservation measures. These measures let into the establishment of hunting/game reserves and sanctuaries. Hermann von Wissman, who was the first Governor of the Moshi and Kilimanjaro districts, introduced stringent conservation measures for Mount Kilimanjaro in 1891. As a result, West Kilimanjaro was declared a game reserve in 1896 (Chachage, 1999). This example was copied all over the country and by 1908, eight reserves were demarcated. From 1910, the German colonial rulers created a series of game reserves (e.g. the Saba River game reserve, which is since 1964 the Ruaha National Park and the Rufiji River now Selous Game Reserve). The number of reserves increased to ten by 1918 to attract especially German tourist expeditions (Mtahiko, 2004). Alongside these efforts, wildlife-marketing activities started. These activities aimed at selling West Kilimanjaro and other demarcated reserves as tourist destinations. In multimedia platforms (.e.g. newspapers and magazines), East African tourist destinations, particularly Tanganyika (by that time Germany East Africa, 1880-1918) and Kenya, were the primary focus.

However, still, at the end of the German empire, the Tanganyika's tourism sector was still in its infancy with low numbers of tourists, mainly explorers and adventurers. German control over tourism resources lasted until World War I in 1918 and the British took over the mandate over tourist destinations.

2.2.2 British control (1918 – 1939)

Tanganyika became a British territory in 1918 following the fall of the German Empire in World War I. This marks the inclusion of Tanganyika in East Africa. In East Africa, Kenya was the central region, but it also included Uganda. Tanganyika by then had become famously known as 'Safari land' due to its natural attractions and wildlife safari tourism (Chachage, 1999). Holidaying tourists started to appear by the 1920s although the country's wildlife was not yet adequately protected. Following in the footsteps of the Germans, the British continued to establish protected areas for tourism purposes. In this era, game viewing tourism in protected areas gained popularity in a period when motorcars and photo camera became popular (i.e. early 20th century). For instance, the 'Big game massacres' and 'Biserk drives' were colonial safari/travel agents specialized in both hunting and leisure tourism safaris in Tanganyika (Dundas, 1924; Reid, 1934). Travel arrangements of Massacres and Biserk were old yet, facilitated the wildlife safaris in Tanganyika. Despite emerging of game viewing tourism, educational and game hunting tourism remained the most lucrative and dominant form of tourism.

Nevertheless, the British extended the number of game reserves from ten to thirteen, still covering only 5% of the land in the early 1920s. The three added game reserves (i.e. the Selous, Ngorongoro, and Serengeti) were confirmed under the Game Preservation Ordinance of 1921. Later, in 1933, the Lake Rukwa and Usambara reserves were added. The extension of these hunting and game reserves coincided with the realisation by the British government that tourism was a potential income generator. Game viewing tours became an increasingly important aspect of wildlife conservation, rivalling or even surpassing sport hunting as a source of government revenues. The change in tourists' preferences from hunting tourism to game viewing forced the re-categorisation of some of the hunting and game reserves into national parks. Hence, the paradigm shift marked the era of national parks creation in Tanganyika.

The era of national parks that were specifically designed for game viewing tourism in Tanganyika, began in 1933. The advocacy of park tourism was a response to the world economic depression of the 1930s (Ouma, 1970), which it sought to counter. To accelerate the growth of wildlife tourism, certified travel organizations were created all over the world. In East Africa, the East African Publicity Association (EAPA) was formed in 1938 (Ouma, 1970). More tourists and hospitality supportive infrastructure, such as airports, roads and accommodations were built. This development focused on Kenya, the Head Quarter of the British territory, where the majority of European settlers resided. In Tanganyika, the poorly developed infrastructure did not match its abundant tourism attractions. What is more, tourists visiting Tanganyika first had to register in Kenya, marking Kenya's superior position in the region's tourism development.

2.2.3 World War II (1939 – 1945) and the struggle for independence (1945 – 1961)

World War II provided Tanganyika with little opportunity to develop its tourism since much of the earnings were committed to territorial protection. Nevertheless, an increasing number of tourists with a 'special interest' in Tanganyika's flora and fauna were recorded (Ofcansky & Rodger, 1997).

Acknowledging the role of tourism as a source of revenue, East African Governors organized a tourism conference in Nairobi in 1947 (Sindiga & Kanunah, 1999). This conference led to the formation of a representative committee of the East African High Commission (EAHC) to oversee tourism and its issues in East Africa. In addition, an interim office of the East African Tourist Travel Association (EATTA) was established in 1949 headquartered in Nairobi. EATTA's aim was to market all tourist attractions in East Africa. EATTA launched various publicity campaigns mainly focused on the region's tourism and its wildlife attractions.

Following these publicity campaigns in the early 1950s, the potential of protected areas as a basis for tourism was widely recognized. For instance, Foran (1950) stated that "all East African territories were fully aware of the necessity for creating national parks and game reserves for the preservation of an immense heritage of fauna and flora, which nature so excessively granted upon these regions." East Africa, in particular, Tanganyika experienced a tourist boom in this period (Ouma, 1970). The growing numbers of tourist arrivals were paralleled by increase in studies of tourism ranging from promotional literature in magazines and journals to penetrating research articles and books. Well-produced guidebooks were developed for East Africa as a whole and for each country (Cox, 1970; Hyma, 1980). In addition, film and photography emerged as important new media. For instance, Grzimek's 1959 film "Serengeti darf nicht sterben" (i.e. Serengeti shall not die) received much attention. The film's aim was to promote the conservation of Serengeti's spectacular wildlife attractions for sustainable use tourism and research. The film became an excellent medium for tourism promotion and indeed stimulated many tourism and conservation activities.

2.3 The Post-colonial period (1961 to date)

In the early 1960s, explorers from Europe, Middle and the Far East already had a long tradition of holidaying in search of exotic features and scenic landscapes but only a few of them reached Tanzania, in small groups and expeditions. It was not until the 1960s that the first ripples of mass tourism began to develop. As argued by Chambua (2007), the expansion of mass tourism from 1960s onwards was an outgrowth of the tourist patterns initiated in the 1940s and 1950s. Mass tourism became a significant sector in Tanzania. Policy changes, changes in tourists' motives and preferences, technological advancement and the diversity of tourism destinations also enhanced tourist arrivals. Unlike in the colonial era, where Kenya was the superior and dominant tourist destination in East Africa, the post-colonial era gave hope to Tanzania to govern its tourist attractions independently as a sovereign state and not as 'common resources' for the East African territory.

With respect to tourism development in the period after independence, four eras can be discerned based on political and technological developments. These include the modernization, the post-Arusha Declaration, the liberalization and the internet-based tourism.

2.3.1 The modernization era (1961-1967)

In the 1960s, tourism expanded in response to increasing demand for certain types of leisure-tourism activities, namely indulgence in fun, food, frolic and exotica (Salazar, 2009). During this time, tourists travelled for the sun, sand and sex (3S' tourism) adventures. The 3S tourism was mostly practised in coastal parts of Tanzania (e.g. Dar es Salaam, Bagamoyo and Zanzibar) and the sex tourism mainly close to wildlife tourist destinations (e.g. the Mto wa Mbu village close to Lake Manyara National Park).

After independence, tourism became a key sector in all development plans. This was encouraged by the rapid growth of international tourist arrivals. The establishment of the Tanzania National Tourist Board (TNTB) in 1962, soon after independence, was a major step ahead to accommodate the increased number of tourist arrivals. The TNTB was structured as an institution to oversee tourism issues in the country and it replaced the EATTA of 1949. The country invested much in the tourism sector, though opportunities for its citizens were restricted, because the sector still hinged on colonial capitalists. Europeans and to a lesser extent Asians dominated the sector. In the mid-1960s, Tanzania created state-owned hospitality enterprises, including hotels and game lodges in major tourist destinations and cities like Dar es Salaam and Arusha.

In the colonial era, Tanzania had only game reserves, but this changed soon after independence. The Serengeti was the first national park gazetted. This park caters for the changing tourist demand from game hunting to game viewing. The number of national parks rose to seven in 1970 and sixteen in 2013. Creation of more national parks was in line with the country's policy to conserve its biological resources for different purposes, including tourism. Tanzania was ready to protect her potential tourist attractions in collaboration with international organizations. In this context, the Tanzanian first president, Mwalimu J.K. Nyerere, stated that:

> *"The survival of our wildlife is a matter of grave concern to all of us in Africa. These wild creatures in wild places are not only important as a source of wonder and inspiration; they are also an integral part of our natural resources and our future livelihood and well-being. We solemnly declare that we will do everything in our power to make sure that our children's grandchildren will be able to enjoy this rich precious inheritance."* (extract from his speech for the symposium on the Conservation of Nature and Natural Resources, September 1961).

Later in 1967, this statement became the Arusha declaration (Azimio la Arusha in Kiswahili). The declaration drove Tanzania to establish and conserve many national parks for the next generations to enjoy the wildlife attractions. .The above statement, "we declare…" indicates that soon after independence natural attractions (i.e. wildlife) should contribute to the country's economy.

The economic contribution of wildlife tourism soon after independence transformed Mwalimu Nyerere's notion to run the sector without depending much on the Westerners as it was in the colonial era. The expansion of the hospitality sector, the acquisition of the ministerial position for tourism in 1964 (i.e. the Ministry of Information and Tourism), and later the creation of the Tanzania National Tourist Board (TNTB) obviously drove Tanzania to abandon the East African base of tourism during the 1960s. The TNTB was established in 1962 to replace the EATTA of 1949 and opened offices in London. The offices were fully equipped to oversee the international promotion of Tanzania's tourist attractions. According to Chambua (2007), during the 1967-1968, lodges were constructed and expanded at the Ngorongoro Crater, Serengeti and Mikumi National Parks, Mafia Island and Dar es Salaam city. The Tanzania wildlife safaris limited was established. The Arusha Declaration, which was enacted on February 5 in 1967, hinged on socialism and self-reliance, which marked a new era of African Socialism as well as a new era of tourism development in Tanzania. Despite poor tourist arrivals' data recording system, these developments indeed improved tourist arrivals.

2.3.2 The Post Arusha Declaration (1967-1985)

The importance of developing national parks for people living around them was strongly echoed in the Arusha Declaration. This declaration led to massive efforts in marketing the tourism and hospitality sector. Tourist statistics recording systems, hotel constructions and other infrastructures were improved. The number of tourist arrivals substantially increased between 1968 and 1973. Tourism was extremely profitable in these years, and hotels and sales of game hunting licence contributed a lot to the export earnings (Shivji, 1975; Chachage, 2003; Chambua, 2007). Wildlife safari tourism further expanded in the 1970s. In mid-1970s, tourism had become the seventh important foreign exchange earner in Tanzania (Green, 1979).

Tourist numbers continued to grow until 1973 after which Tanzania started to experience decreases in tourist arrivals (Figure 2.2). This decrease was associated with the self-reliance policy of African socialism and the Arusha Declaration. Many of the associated policies and regulations weakened the tourism and hospitality sector, although this was not their original intention. During this period, the government ran the tourism and hospitality sector. The involved government officials performed extremely poorly due to their incompetence on tourism and hospitality issues. This was worsened by a number of factors, such as the lack of specialized personnel in the tourism-related sector, the state monopoly in the banking system, the over-night ban of all hunting and photographic safaris and the subsequent closure of all business including state-owned wildlife safaris in the country in 1973 (Herne, 1999; Wade, 2001; Salazar, 2009). The declining tourism development was considered inhumane and demoralizing by tourism entrepreneurs and tourists. The situation was further degraded by the official disintegration of the East African Community and the sudden closure of the Tanzania-Kenya border in 1977. This resulted in a drastic fall of tourist arrivals two years later in 1979-1980 (Figure 2.2). The fall clearly indicated that majority of tourists in Tanzania crossed from Kenya to Tanzania especially to the northern circuit: the Arusha, Manyara, Tarangire, Kilimanjaro and Serengeti National Parks and the Ngorongoro Conservation Area. The Idi Amin war, the war between Tanzania and Uganda in 1978 and 1979 also contributed to the fall in tourist arrivals soon after the declaration.

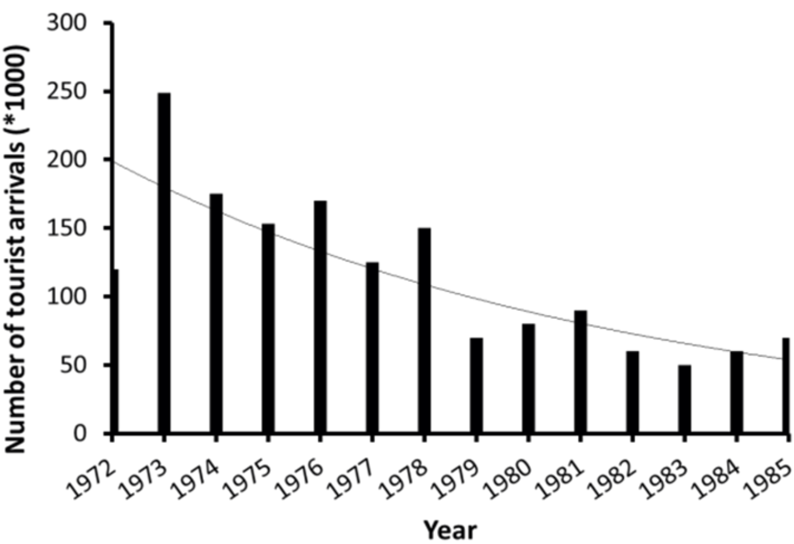

Figure 2.2 Tourist arrivals from 1972 to 1985 in Tanzania (Wade et al., 2001).

The worst tourism performance in Tanzania was from 1979-1983 (Figure 2.2) when the country recorded the lowest numbers of tourist arrivals since its independence. A new wave of international environmental conservation policies in the 1980s imposed by several big non-governmental organisations (BINGOs), aggravated the situation. Chachage (1999) argues that these policies prohibited mass tourism and favoured environmental friendly tourism activities, such as eco-tourism. Unlike mass tourism, where travel costs were reduced through sheer numbers, environmental friendly tourism encouraged to travel in small groups to avoid environmental damage. This also increased travel costs and consequently resulted in fewer tourist arrivals. Apart from the prohibition of mass tourism, the BINGOs imposed conditions, such as collaboration of government and private sectors to run the tourism sector. These conditions meant that the government had the obligation to ensure the stability for private sector entrepreneurs and possible foreign capitalists. The BINGOs' conditions were defined strategically to favour the countries where tourist originated and thus, they controlled the tourism markets. The conditions were seen as a 'cold sanction or war' resulting into the strong political dynamics (i.e. change in policies) that contributed to reducing tourist arrivals in Tanzania.

2.3.3 Liberalization (1985-2000)

After the so-called 'cold war' of tourism that persisted for almost five years (i.e. from 1979 to 1983), tourism increased again in the mid-1980s due to new economic liberalization policies. The new liberal policies, such as cheap and fair travels were introduced. The policies led into lowering travel costs so tourists travelled more easily. The new liberalization policies together with the removal of trade restrictions that forced developing countries to open up their economy for imports from the developed world, triggered the growth of tourism (Kulindwa et al., 2001; Luvanga, 2003; Chambua, 2007). Many foreign tour companies were able to open offices in Tanzania, especially in Moshi and Arusha. This marked the development of tourism in the Northern Circuit (Arusha, Kilimanjaro and Manyara regions). Re-opening of Tanzania-Kenya border in 1984 also resulted in an exponential increase in numbers of tourist arrivals (Figure 2.3). Tourism gradually turned into a well-endowed and multinational, well-financed and technologically advanced sector soon after the mid-1980s.

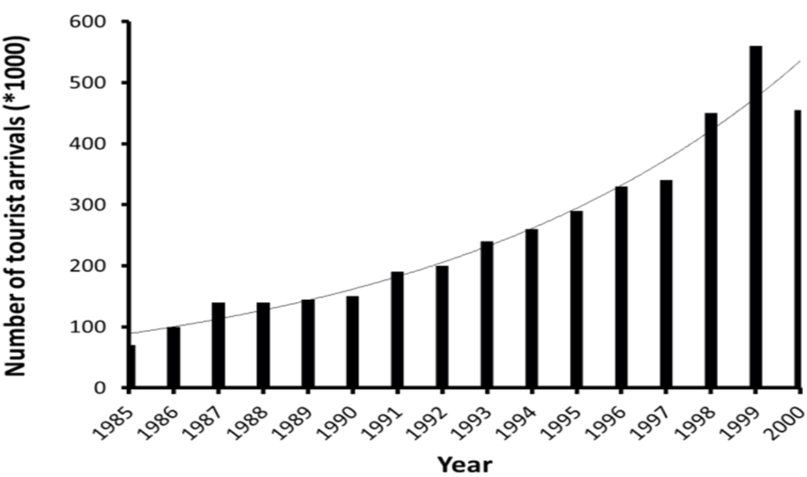

Figure 2.3 Tourist arrivals from 1985 to 2000 in Tanzania (Wade et al., 2001; UNWTO, 2011).

Massive privatization of state-owned tourism assets in the liberalization era allowed the private sector to run much of the tourism sector. The private sectors consist mainly of elite and foreign interests, a situation suggesting a return to the colonial period, where few Europeans owned the sector. This can be seen from the new liberalization policies introduced by the IMF and the World Bank in the 1980s. The policies were meant to again put Tanzanian attractions in the hands of international ownership. This is also evidenced in the on-going move to elevate the status of the country's protected areas by establishing world heritage sites, man and biosphere reserves. For instance, in recent years, the Ngorongoro Conservation Area (1979), the Serengeti National Park (1981), Selous Game Reserve (1982) and the Kilimanjaro National park (1987) have been added to the list of World Heritage Sites. Many other protected areas have been crowned as biosphere reserves or nature reserves. The massive change in international politics over natural attractions resembles the colonial history where Western countries had much control of African wildlife tourist attractions (c.f. German and British era). Now, the elevated status of these destinations contributes into an increasing number of tourist arrivals. However, caution must be taken as the future of these destinations could be threatened if any global environmental change may scale back their status.

National policy reshuffles or adjustments and enactment of the wildlife policy of 1998 (revised in 2007) and tourism policy of 1999 (under revision in 2018) also consider hunting tourism as a viable economic and sustainable use of wildlife. Tourist hunting is still widely practised in several game reserves, game controlled areas and open areas. Other factors contributed to the Tanzanian tourism development in this era were the development of an integrated tourism master plan in 1996 (revised in 1999). This plan focused on improving, developing and refurbishing existing tourist attractions and facilities to attract more tourists (MNRT, 2002). The first national tourism policy of 1999, among other things, stipulated the role of tourism in the country, stimulated tourism investment and encouraged public-private partnerships. The policy insists on low density or environmentally friendly tourism that contributes to the national economy but simultaneously conserves the environment. On another extreme, communication infrastructure development, such as telecommunication, road networks and other infrastructures in various tourist destinations led to a sharp increase in tourist arrivals from 1985 (Figure 2.3). This change marks substantial developments in the tourism sector. However, in 1999/2000 the country experienced a sharp drop of tourist arrivals. This drop was associated with the terrorist bombing of US embassy offices in Tanzania and Kenya on August 7, 1998.

2.3.4 Internet-based tourism (2000-to present)

A phenomenon that has fundamentally changed tourism in the first years of the 21st centuries is the internet. The internet provides a fundamentally different economic environment for doing tourism business. Rayman-Bacchus and Molina (2001) regard internet as a key differentiator in the tourism sector, communication facilitator, a way to access global tourism information at a negligible cost. Internet is shaping the provision of tourism services even in developing countries, in Tanzania particularly. Internet technologies are complementing rather than undermining the role of personal travel. From the turn of the century, the reliance on the internet and websites for promotion of tourism and tourist attractions have grown. In December 1999, for example, 4.1% of the world population had access to the internet worldwide, a leap from 0.4% in 1995 (Internet World Stats, 2012)[1].

1 Internet World Statistics. (2012). Internet growth statistics-today's road to e-commerce and global trade internet technology reports, Accessed in December 12, 2013, from http://www.internetworldstats.com/emarketing.htm

This is equivalent to a 1% increase of annual internet usage. In December 2013, 39% of the world population had used internet, whereas, 77% of the users were the developed world inhabitants versus 31% in the developing world (International Telecommunication Union, 2013).

Seeking to understand the development of internet-based or electronic-tourism services in Tanzania, we need to appreciate some of the antecedent conditions, such as the socio-economic movements and technological developments within the tourism sector. One is the increasing political and economic integration of large regions of the world (e.g. Europe, America and Asia). At the same time, citizens of modern societies, who demand tourism services in developing countries are attaching ever greater importance to leisure, travel and tourism (Claval, 2002). Integrating particular leisure interests with individual work schedule has often-increased mobility of people in search of new tourist attractions to suit their desires. Implicated in these movements, is the harnessing of information and communications technology in general to bring about faster and more widespread communication and greater information dissemination, lower transaction costs, the realization of electronic commerce (i.e. electronic momentary transactions with credit cards and electronic money transfers) and increased scope for meeting and promoting individual preferences.

Technological developments in the banking sector have opened up new modes of doing business in tourism sector. Today's tourists can use E-banking services to purchase tourism services for destinations of their choice, while still in their country of origin. This strongly differs from the 1980s, where tourists had to travel with cash to various destinations. The majority of travellers probably considered the cash-based modes of transaction unsafe, making risk-averse tourists not to travel to less 'secured' destinations. The introduction of mobile money transfer system in Tanzania is a major driver in the rapid growth of the tourism sector. These mobile money transfer systems (e.g. Vodacom: M-Pesa, Airtel: Airtel-Money, Zantel: Eazy-Pesa and Tigo: Tigo-Pesa) allow for rapid transactions. These systems allow even local Tanzanians who have no access to a bank to purchase tourism services using their mobile phones.

Unlike a century ago when marketing was done through simple analogy approaches (c.f. Rousseau's imaginary paintings), in the 21st century, Tanzanian tourism hinges on the use of internet approach. Tourism authorities in the county like the Tanzania National Parks Authority (TANAPA), the Ministry of Natural Resources and Tourism (MNRT), the Ngorongoro Conservation Area Authority (NCAA), the Tanzania Tourist Board (TTB), and local tour operators and travel agents use their websites to market tourist destinations, tourist attractions and hospitality services. Electronic mail (e-mails) and online booking systems for hotel reservations are now prioritised. Further, the expansion of the international airports (i.e. Dar es Salaam and Kilimanjaro), reduced bureaucracy at the airports and immigration authorities and improved border-crossings processes increased tourist arrivals in Tanzania over the last decade (Figure 2.4).

2.4 Evolution, distribution and the management of wildlife safari tourist destinations in Tanzania since the 19th century

Wildlife tourism and its associated destinations and management have evolved in different patterns over the past century. Uneven distribution of wildlife influenced the distribution of tourist destinations the country has today. The uniqueness of tourist attractions increases inbound tourists, because tourists can attain their varied motives and preferences.

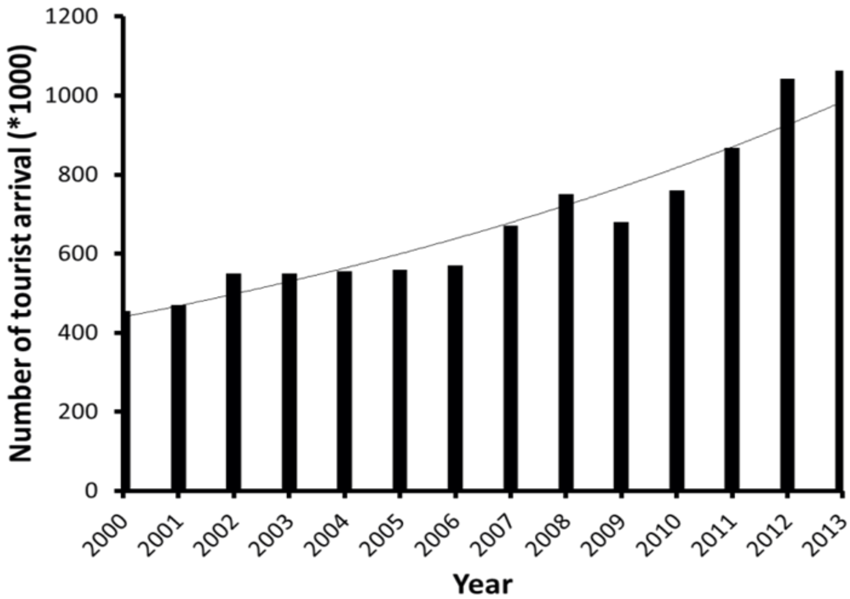

Figure 2.4 Tourist arrivals from 2000 to 2013 in Tanzania (UNWTO, 2011; Tairo, 2013).

As a result, the governance systems that Tanzania have gone through since the early 1800s have contributed to change in tourists' motives for visiting the country, as well as preferences over the demanded attractions and destinations. Before and soon after colonization, the country's wildlife resources were not subjected to any policy or law. The resulting '*common resources*' or '*Shamba la Bibi'* as it is referred to in Tanzania indicates an early tragedy of the commons' that resulted in depleting wildlife through unregulated hunting. For instance, fifty lions were shot in a single year by Stewart Edward White, a Brit visited Serengeti in 1920 (Herne, 1999). Such unregulated hunting depleted lions and the British colonial government made a partial game reserve of just 3.2km^2 around the Seronera area in 1921 to especially conserve this wildlife. Additionally, the Serengeti became a full game reserve in 1929. These actions were the basis for the Serengeti National Park establishment in 1951 and other national parks.

The establishment of national parks as the main nature-based tourist destinations in the country hinges on the wealth of the country's wildlife resource potential for tourism. The historical governance issues (i.e. policies, regulations and laws) that kept on changing the status of protected to suit both tourists' motives, preferences and country's economic benefits, are presented in a spatial distribution map. According to Braat (2013), maps are arguably the best communication tools to initiate discussions on conservation decisions, such as priority areas or relevant policy interventions. Thus, the potential of this map in managing Tanzanian tourist destinations under the current rate of environmental change including climate and land-cover change should not be undermined. The map narrates historical development (i.e. time and space) of the seventeen national parks, the Selous game reserve, and the Ngorongoro Conservation Area in an annotated map (Figure 2.5). The map was created using historical information on the individual protected areas, running from the pre-colonial era to the contemporary era. Some information used to create this map were from studies reviewed for this paper and other sources (e.g. Wikipedia).

Using ArcGIS, we created the spatial distribution of all protected areas in Tanzania. The narrative text boxes for each protected area were added using Adobe Illustrator software. In Tanzania, the national park is the highest rank of non-consumptive use of nature-based tourist destinations. The review reveals that all national parks evolved from either game reserves or forest reserves. While game reserves evolved from open game controlled areas.

Currently, Tanzania has seventeen national parks. The Tanzania National Parks Authority (TANAPA) manages the sixteen national parks while Zanzibar manages the Jozani Chwaka, the only national park in Zanzibar (Figure 2.5). The Ngorongoro Conservation Area Authority manages the Ngorongoro Conservation Area (NCA). The NCA is managed as a multiple land use where conservation, tourism and Maasai pastoralists live together harmoniously. Game reserve where hunting tourism is permitted is another type of tourist destination. Game reserves have been purposely located adjacent to national parks to control wildlife population carrying capacity within national parks and at the same time to diversify tourism economic benefits through trophy hunting. The Selous Game Reserve is both the most famous tourist hunting game reserve in the world and the oldest and largest in African. The Selous is a special game reserve in the sense that both hunting and nature-based tourism are allowed in designated areas. In Selous, only hunting was allowed during the colonial era. In recent years, however, a special area designated for nature-based tourism was created within the Selous to capture the changing tourists' motives and preferences.

In the past decades until now, conservation and wildlife resources utilization in Tanzania are managed under the hierarchy of authorities. The Ministry of Natural Resources and Tourism, which oversees the conservation of wildlife resources and tourism, is responsible for developing and implementing wildlife and tourism policies. The Tanzania Tourist Body and the Tanzania Hotel Corporations are specifically responsible for actual tourism and hospitality publicity issues respectively. The spatial complexity of wildlife resources, the complicated and varied tourists' preferences led the government to delegate its conservation and utilization power to four authorities or divisions namely: the forest division, the wildlife division, the Tanzania National Parks Authority and the Ngorongoro Conservation Area Authority (Figure 2.6). This complex policy and management structure deal with tourism and their ever-changing tourists' motives and preferences.

2.5 Conclusion

Nature-based tourism, especially wildlife tourism and its associated tourism destinations in Tanzania has been developed over more than one hundred years. Over this period, tourism destinations have changed status from common resources to protected resources. Soon after independence, most of game reserves and/or forest reserves were categorised to national parks to parallel the changing tourists' demands and motives. While the country praised the economic contribution of tourism to the GDP from its onset, all economic interpretations started in the 1970s. These studies only associate increase and decrease in the number of tourists with supply and demand model, where price determined the destinations to visit.

Our paper concludes that tourist motives and preferences more strongly determine the destinations than price and hence, influence the demand and supply of tourism activities. For instance, a change from hunting motives of the late 1890s to sightseeing tourism in the 1930s and the demand for environmental friendly tourism in the 1970s as opposed to low-cost mass tourism in the 1960s.

The contemporary nature-based tourism did not come overnight but were influenced by historic governance issues. Moreover, the current nature-based tourism strategies are clearly rooted in the colonial era. The primary purposes of wildlife conservation in the colonial era were initially for hunting until the 1960s. However, ten years later the paradigm shifted to nature-based tourism to especially environmental friendly tourism segment. This shift was also the main reason for Tanzania's abandonment of mass tourism in the 1960s and encouraged environmentally friendly tourism since in 1970s to date.

The geographic variations of the country resulted in a unique and spatially distributed pattern of protected areas. This distributes high number tourist arrivals to a large area, a situation that reduces adverse environmental impacts, and this caters for varied tourists' preferences (e.g. hunting, sightseeing, trekking and diving).

The profiled role of technological advancements, such as internet and multimedia platforms in the modern tourism sector should not overlook tourism developments. Our analysis elucidates that, apart from road infrastructures and the hospitality sector development, books and multimedia platforms played a major role in conserving tourist attractions and selling wildlife attractions of the country. Despite internet development, much of the information on the historical evolution of protected areas is poorly documented or only available in incompatible formats. The time-series of each protected area on a map format makes the history of tourism in Tanzania more assessable. Although not shown on the map, changes in wildlife use, land use, conservation policies affect the Tanzanian tourism destinations differently. Population increase, economic developments and climate change will likely make land scarcer for conservation and tourism. In turn, this will also increase trade-off between conservation and other economic uses. This will increase the necessity to understand the outlook of Tanzanian nature-based tourism under the current rate of environmental change to better manage its tourism destinations. Our detailed historic evolution and distribution of tourism destinations in a single map provided in this paper is thus an important management tool for development. This history ever collated in the country can form part of explorative scenario development. The scenario can guide the country's tourism sector to cope with the current dynamics in climate, land-cover and land-use risks.

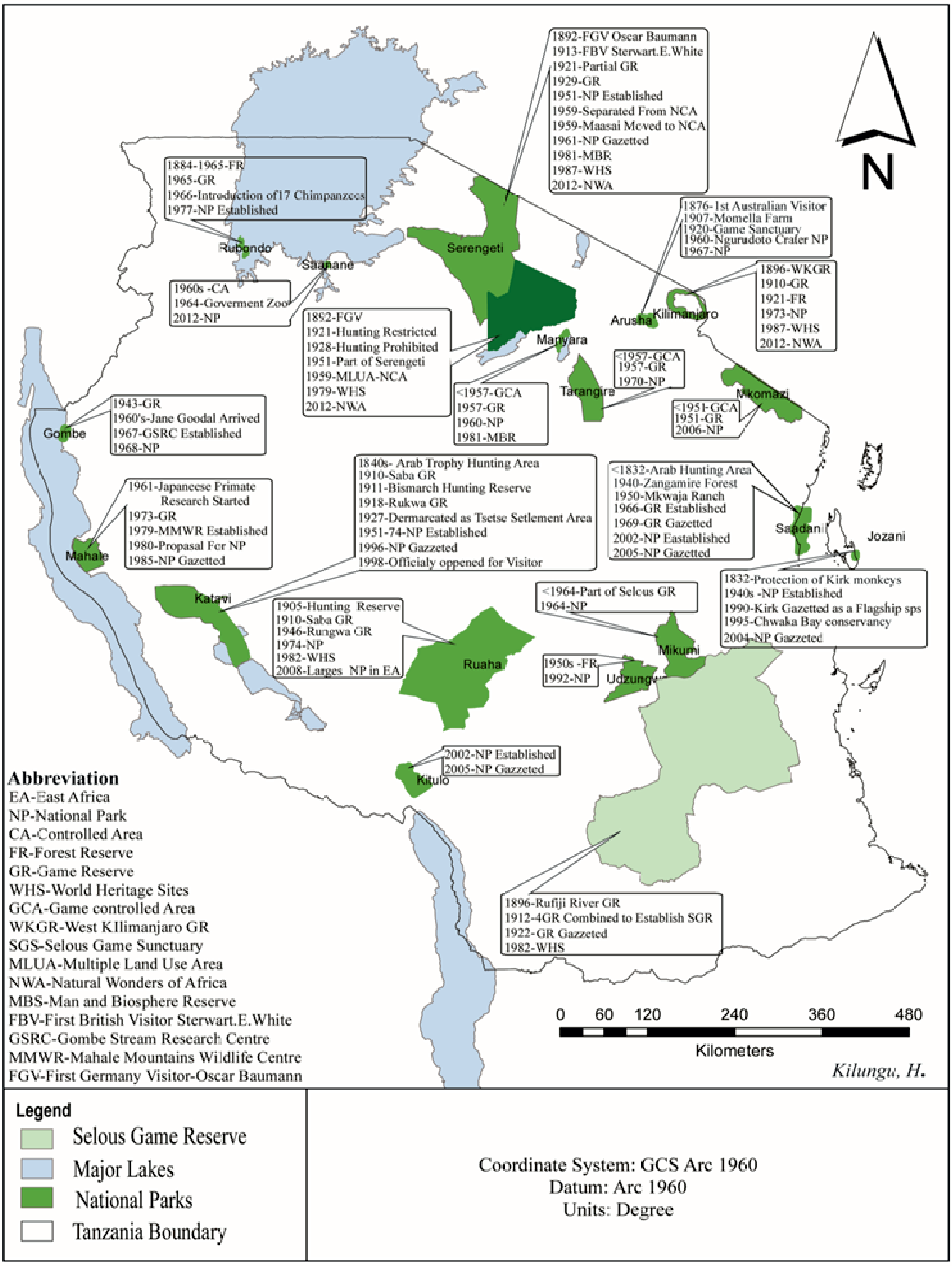

Figure 2.5 Evolution and distribution of wildlife tourist destinations in Tanzania since the 19th century.

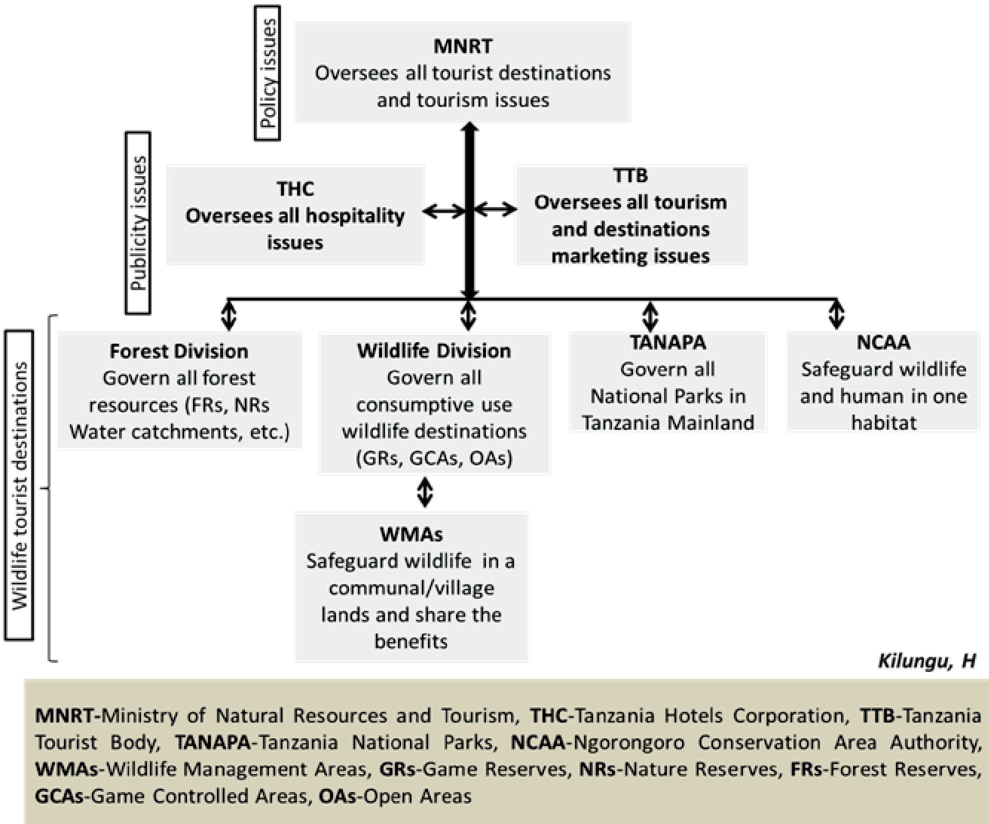

Figure 2.6 A simplified representation of wildlife resource governance in Tanzania soon after independence in 1961.

Chapter 3

How can tourist attractions be described to support environmental impacts assessment in Tanzanian National Parks?

Submitted as:

Kilungu. H., Leemans. R, Munishi, P.K.T. and Amelung, B. How can tourist attractions be described to support environmental impacts assessment in Tanzanian National Parks? Journal of Tourism Geography.

Abstract

Tanzanian Nature-Based Tourism (NBT) is vulnerable to environmental change due to its close connection to natural environments and climate. Unfortunately, no targeted approaches exist to determine the specific environmental-change impacts on NBT's diverse attractions. We develop the eco-parcel approach, which overcomes this limitation. Its three steps include (1) identifying and rating tourist attractions (i.e. wildlife, plants and non-living objects), (2) linking each attraction to discrete land-cover types (e.g. vegetation, soil, water and rock outcrops) and describing their characteristic environments, and (3) assessing the importance of each attraction for tourism based on tourists' preferences. We show how this approach can be operationalized for the Tanzanian Serengeti and Kilimanjaro National Parks. Our key finding is that attractions emerge from and are connected to specific environments that define their attractiveness. Connecting individual attractions with their specific environments allows to accurately assess likely losses or gains of attractions when these characteristic environments change. Tourism-specific assessments of environmental change impacts can support the development of more effective adaptation strategies.

Keywords: Eco-parcel approach, environmental change, Kilimanjaro, Tanzania, tourism and Serengeti.

3.1 Introduction

Over one million international tourists visit Tanzania annually (Tanzania Tourism Sector Survey, 2017), of which ninety percent visit national parks to partake in wildlife safaris and other forms of nature-based tourism (NBT) (TANAPA, 2018). Tanzania's national parks thus form the pillar of the country's tourism industry. These parks are under increasing stress from tourism, infrastructure development and environmental change (Thompson et al., 2009; Holdo et al., 2011; Kioko et al., 2015; Sinclair et al., 2015). These stresses affect wildlife composition and distribution, land cover and the quality of natural areas in general and have a substantial impact on tourist satisfaction (Eagles & Wade, 2006; Okello & Yerian, 2009; Kaltenborn et al., 2011).

The parks' changing environments thus pose a clear challenge to Tanzanian NBT (Öhman et al., 1999; Agrawala et al., 2003; Ogutu et al., 2008). This challenge has, however, not been adequately explored, although government documents have emphasised the need to do so (URT, 2012; TANAPA, 2018). Dedicated environmental-change impact assessments for tourism should evaluate the effects of environmental change (including changes in land use, land cover and climate) on tourist attractions and inform tourism stakeholders, so that they can start adapting to these changes. Such assessments require that the relevant tourist attractions, their relative importance for tourists and their links to environmental properties are well-defined. These requirements are currently not met. Tourist attractions in the national parks are very coarsely defined. To group attractions, coarse categories such as 'wildlife' are used without further detail to species or type. In this case, the term 'wildlife' becomes too homogenous for environmental assessment for tourism purposes. In addition, little is known on how tourist attractions are rooted in the environmental properties of the national parks in which they occur. Finally, the locations of these attractions occur within national parks are poorly mapped (Kilungu et al., 2014).

Few, if any, tourism impacts studies in East Africa addressed all three knowledge gaps simultaneously. In a study of three main national parks in Kenya, for example, Nyamwange (2016) found that the El Niño flash floods left most of the roads impassable and forced the flamingos to flee from Lake Nakuru due to increased water level. Nonetheless, Nyamwange (2016) did not present quantitative data that indicated how many tourists failed to reach specific attractions in these parks or how the disappeared flamingos affected the number of tourists.

Assessments of environmental-change impacts would benefit from improving and connecting the three knowledge gaps simultaneously. Arthur et al. (1977) already made a similar point forty years ago; "*Measures of landscape quality should be systematically related to physical, biological and social features of the environment so that accurate predictions of the implications of environmental change can be made"*. Since then, progress has been made on various fronts. The consensus approach was developed to evaluate the scenic quality of natural environments, resulting in overall evaluations of larger areas or ecosystems (e.g. Priskin, 2001). Based on field work or the analysis of aerial photographs, a team of experts appraises areas of outstanding beauty, working towards such consensus. Its focus on evaluating larger landscapes makes the consensus approach suitable for informing policies globally or nationally but less appropriate for local and park applications. In addition, this expert-based approach is not rooted in tourist perceptions and preferences.

Descriptive approaches were developed to evaluate the scenic quality of environmental components (e.g. landforms and vegetation patterns). Based on field work, analysis of aerial photographs and topographic maps, an individual expert or a team of experts qualify the scenic quality of each component (Scott & Canter, 1997; Daniel & Meitner, 2001). This approach relies on spatial data and complex mathematical algorithms (such as addition, subtractions and multiplications) to compare and qualify the scenic quality of landscape components (The James Hutton Institute, 2010). The descriptive approach has been criticized for the way attractions are arbitrarily identified and scored by experts. Although experts may claim that it is their duty to guide public perceptions in choosing what is attractive (France & Briggs, 2017), their knowledge should not complement tourists' opinions. The approach also lacks empirical research to justify the inclusion of landscape components as determinants of scenic quality. These limitations make the descriptive approach less appropriate for park applications. Each attraction needs a detailed description of how it is connected with the environment because its response to environmental change differs in a different locality.

The recent increase in public interest in conserving attractive landscapes has resulted in the development and/or application of public-preference approaches (see Jacobsen, 2007; Chaminuka et al., 2012; León et al., 2015; Mueller et al., 2017). The essence of the preference-based approaches is the judgment of the total landscape. Experts identify attractions, formulate questions about the attractions and qualify the attractiveness by respondents' opinions. In most cases, the approaches use visual stimuli (e.g. photographs, video clips, maps) accompanied by questionnaires for the respondents to qualify attractions therein. Neither the visual stimuli nor the questionnaires are structured to capture the attractions' supporting characteristic environments. As a result, preferences' approaches have been criticized by the way attractiveness is measured. This is generally done based on the 'whole area's environment' and not for a specific attraction. For instance, Philemon (2015) concludes that the attractiveness of Tanzanian tourism destinations is based on tourists' preferences for the northern, southern, western, coastal and Zanzibar regions. This is coarse to specify attractions. Wang et al. (2016) assess the attractiveness of four different landscape types (i.e. urban, urban green space, farm and forest) using only ten (aerial) photographs. Although preference approaches are straightforward and require relatively little time and equipment, coarse attractions' category and poor description of attractions' characteristic environments make them less appropriate for comprehensive impact assessments as a standalone approach.

The importance of obtaining attractions' characteristic environments (e.g. temperature, moisture, soil type, water quality and land-cover types) and location from remotely located tourism destinations necessitates the use of remote sensing and Geographic Information Systems (GIS). Remote sensing utilizes satellite, airborne and drone to collect environmental information about attractions without any physical contact. Its utility in scenic quality assessments will then need a field visit to verify attractions' actual geographic locations and other descriptions (e.g. types, behaviour, populations) to evaluate the accuracy of data. GIS is a computer-based tool to analyse, manipulate and integrate remote sensing information. The remote sensing and GIS techniques are gaining popularity in assessing landscape scenic qualities (see Lee et al., 1999; Agnes et al., 2016). GIS manipulates and links each attractions' environmental data to a particular location and organizes such data in spatial layers that can be combined with other data sets. This computer and expert-based approach is not rooted in tourist perceptions and preferences. This limits its use as a standalone approach.

In conclusion, the consensus, descriptive, preferences and GIS approaches do not simultaneously create a link between tourists and individual attractions, and between attractions and environment in order to support environmental-change impact assessments. This link is needed. These approaches assess too large areas and landscapes instead of specific attractions. These landscapes are rated by experts, not tourists. Moreover, Vanderheyden and Schmitz (2017) argue that reaching consensus among experts is challenging and expensive. Our paper takes up the challenge to devise an approach that links tourists and attractions, and attractions to local environmental features and that is generic, cost-effective and meaningful to both tourists and environmental experts.

We introduce such a new and integrated approach: the ecological parcel or 'eco-parcel' approach. We define the eco-parcel concept, elaborate its use as an integrated impact-assessment approach and apply this approach to Tanzania's two most frequently visited national parks: Serengeti National Park (SENAPA) and Kilimanjaro National Park (KINAPA). The three leading research questions are:

1. What are the characteristics and relevance of the eco-parcel concept?
2. What are the key features and steps in the eco-parcel approach?
3. What are the eco-parcels in Serengeti and Kilimanjaro National Parks?

Together, SENAPA and KINAPA harbour a wide variety of attractions, ranging from tropical snow to wildlife migration. Moreover, tourism in both parks is likely vulnerable to environmental change (including changes in land use, land cover and climate). Park management would, therefore, benefit from environmental impact assessments that are tailored to tourism.

This paper is organised as follows. Section 3.2 introduces the eco-parcel concept and approach, presents the methods and steps to make it operational and introduces the case studies of KINAPA and SENAPA. Section 3.3 presents the findings of applying the eco-parcel approach in these two national parks. Section 3.4 discusses the study's implications for Tanzania and the merits of the eco-parcel approach in general. Section 3.5 concludes.

3.2. The eco-parcel concept and approach

3.2.1 The characteristics and relevance of the eco-parcel concept

The rationale of the eco-parcel concept and approach is to connect the societal notion of 'tourist attraction' to the environmental notion of a 'landscape patch' and to be a generic and cost-effective approach. These aspects make the eco-parcel concept and approach meaningful to tourism stakeholders and scientists. The term 'eco-parcel' originates from landscape ecology. From an ecological view, 'eco' mean environment and a parcel is a relatively homogenous patch that differs from its wider environment (Forman & Godron, 1981). From a tourism perspective and in my thesis, the term eco-parcel refers to a landscape patch with distinct physical and ecological features where one or multiple attractions occur, and whose supporting environmental properties can be determined. In the eco-parcel concept, attractions occur in higher abundances in specific discrete landscape patches (i.e. eco-parcels) and not everywhere in a tourism destination. These eco-parcels are the attractions' most suitable habitats or locations. From ecology, suitable habitats are discrete landscape patches where 'species' can potentially or do occur (Delong & Gibson, 2011).

In my thesis, ‘species’ represents tourist attractions. Because of the attractions’ high abundance in eco-parcels, tourists are especially attracted to specific eco-parcels and not just a ‘whole’ national park area. The eco-parcel concept thus defines attractions based on the characteristic environments that are most suitable for an attraction’s existence and not otherwise.

Patches are also the basic units to understand landscape dynamics as they are connected with their adjacent wider environment through energy and material flows (Forman & Godron, 1981). Changes in the wider environments also affect attractions within patches. The eco-parcel concept hinges on this background and it aims to determine the attractions’ supporting environments to better localise and quantify environemntal impact on individual attractions.

The eco-parcel approach that we use in this study is based on three premises: (1) It is the tourists’ prerogative to define what the attractions are and how attractive they are, (2) information about the attractions’ precise geographic locations is vital, and (3) information about attractions’ characteristic environmental properties is essential. Tourist attractions are therefore identified and evaluated from a tourism perspective and acknowledge the social prerogative to attach sense to them. To ensure this, tourists identify and rate attractions. To ensure compatibility with environmental-science terminology and practice, eco-parcels are georeferenced and their physical and ecological features are described. This firmly connects them with available environmental information.

The next sections first describes the generic eco-parcel approach (Section 3.2.2), followed by the approach’s implementation for the KINAPA and SENAPA case study areas (Section 3.2.3).

3.2.2 Defining the eco-parcel approach

The key features within an eco-parcel are unique attraction(s), a definite landscape patch and distinct characteristic environments. The eco-parcel approach consists of three simple steps. Steps 1 and 2 build a spatial database of tourist attractions. The first step identifies attractions by creating a list of key attractions in a specific tourism destination and rates these attractions based on tourists’ preferences. Step 2 identifies eco-parcels by mapping the individual tourist attractions and delineating attractions’ landscape patches according to their common environmental properties (e.g. vegetation types, microclimates, soil and rock types, snow and hydrology) so as to distinguish individual eco-parcels from their surroundings. Step 3 determines the importance of individual eco-parcels indirectly based on these individual ratings obtained in Step 1. Each of the steps is described in more detail below.

Step 1: Identifying and rating tourist attractions

In this Step, the key attractions are identified directly by asking tourists and park experts, such as wardens and tour guides. But, solely relying on personal information will probably marginalise some attractions that are rarely visited by tourists and their guides. Thus, several other sources, such as academic, policy and professional literature, photo-sharing websites (e.g. Flickr) and field observations should be used to reveal important additional information and tourist data (e.g. visitor levels, stated preferences and motives for visiting the area). Tourists are then asked to rate attractions to verify their relative importance for tourism.

Step 2: Linking attractions with their environments

For each attraction that is identified in Step 1, its location is geo-referenced and its landscape patch is described. These descriptions can be the attractions' distinguishing environmental conditions (e.g. found in water only or in a specific vegetation type) and relevant behaviour and timing (e.g. migration). All georeferenced attractions are used to create spatial layers to overlay with a land-cover map of the study area in GIS. Land-cover types here represent the wider environmental properties supporting attractions. In GIS, attractions are classified in discrete landscape patches based on their common characteristics (i.e. types, locations, distinguishing environments and relevant behaviour and timing). Each discrete landscape patch is an eco-parcel and is delineated to differentiate it from other eco-parcels and with its wider environment. Each of the geo-referenced and well-described landscape patch is added to the eco-parcel database in GIS. Naming eco-parcels helps their identification within a tourism destination.

Step 3: Analysing the importance of each eco-parcel for tourism

This step assesses how important each eco-parcel is for tourism. This is achieved by using the ratings given for individual attractions in Step 1. The importance of an eco-parcel with a single attraction is represented by the rating of that attraction. The importance of eco-parcels with multiple attractions with varied ratings (e.g. extremely important, medium important or less important), their importance is represented by the highest ratings. Multiple attractions, which are important within an eco-parcel strengthens the value of that eco-parcel for tourism. Eco-parcels with diverse attractions are probably more resilient to the impacts of environmental change than single-attraction eco-parcels. This means when one attraction is lost from eco-parcels with diverse attractions, it can still have value for tourism.

3.2.3 Method

3.2.3.1 The study area descriptions

The eco-parcel approach was applied to the Kilimanjaro and Serengeti National Parks, in Tanzania. Kilimanjaro National Park (KINAPA) is located 330km South of the Equator between 2°45'– 3°25'S and 37°00'– 37°43'E, while Serengeti National Park (SENAPA) is located 349km to the West of Mount Kilimanjaro, between 2019'S and 34034'E. The two parks are ecologically very different. SENAPA (14,763km^2) represents lowland ecosystems, with an altitude from 920m to 1850m above sea level (ASL). Its main ecosystems are extensive savannah grasslands, woodlands, kopjes (rock outcrops), lakes and riparian riverbanks. KINAPA (1688km^2) represents highland ecosystems, with an altitude from 1800m to 5985m ASL. KINAPA is composed of arctic, alpine desert, heath/moorlands and montane forests ecosystems. The extents of SENAPA and KINAPA together cover one-third of Tanzania's sixteen national parks (Figure 1.2). Yet they receive about half of all tourist visits and account for about 85% of the total annual revenue accrued from the Tanzanian National Parks (World Bank, 2015). SENAPA and KINAPA are UNESCO-world heritage sites.

3.2.3.2 Applying the eco-parcel approach to SENAPA and KINAPA

To operationalize the eco-parcel approach, the three-step outlined in Section 3.2.2 was applied to the SENAPA and KINAPA cases as follows;

Step 1: Identification and rating of tourist attractions

The main information source used to create a gross list of attractions in SENAPA and KINAPA was a 60-day field trip (30-days to each park). In KINAPA, we conducted a field survey in February 2013, while in SENAPA we did this in March 2013. The field survey included interviews and direct field observations. Interviews with tourism park wardens and tour guides were performed in each park. Tourism park wardens provided a general list of attractions. Tour guides, who often escort tourists to parks, complemented this list. With direct field observations, we followed tourists and recorded what attractions they viewed.

Other information sources were of limited use. A large majority of tourists to SENAPA (92%) and KINAPA (96%) were first-time visitors, whose knowledge was largely limited to those attractions showcased on international media sources (e.g. snow, wildebeest migration and the so-called big five). Written documentation about specific tourist attractions in Tanzania's national parks was also very scarce. Kaltenborn et al. (2011) and Eagles and Wade (2006), for example, only identified few undifferentiated attractions, such as 'wildlife' in SENAPA. Photo-sharing websites proved to be an impractical source because information on the locality where the photos were taken, was generally lacking.

To rate individual attractions, tourists were invited to participate in questionnaires at the exit gates of the respective parks. We used this survey to capitalize on the tourists' experiences with an overview of the existing attractions. Only tourists of 14 years or older were approached. Each tourist was briefed on the purpose of the study and asked to rate his or her preferences on the list of attractions provided. The list included individual types of attractions and a group of attractions. The accompanying question was: "Now you were in this park, what was/were your main attraction(s)? Note: you may give the same rate to different attractions" We used a 5-point Likert score rating scale, ranging from 1 (extremely important), 2 (very important), 3 (medium important), 4 (less important) to 5 (least important). 806 completed checklists were collected (306 in KINAPA and 500 in SENAPA).

We analysed the surveys statistically to determine tourists' preferences for each attraction and group of attractions using the Statistical Package for Social Sciences (SPSS). In SPSS, the Likert scores are presented as mean scores ranging from 1 to 5. Low number of mean score and high preference's frequency (i.e. number of tourists that preferred an attraction) were used to indicate the importance of a specific attraction or a group of attractions.

Step 2: Linking attractions to their local environments

To identify and define eco-parcels in KINAPA and SENAPA, each identified attraction was geo-referenced and its landscape patch's characteristic environments were described. Descriptions of attractions' characteristic environments were based on our knowledge and experiences with the two parks, and the knowledge from experienced tour guides and park wardens.

Important elements in the descriptions were the attractions' uniqueness (e.g highest point on the mountain), their patches' uniqueness (e.g. snow piles, hydrology and floral diversity), their supporting characteristic environments (e.g. water, forest and grasslands) and relevant wildlife behaviour (e.g. migration). For the wildebeest migration, we further described the exact locations based on the known migration calendar.

A hand-held Global Positioning System (GPS) was used to geo-reference all attractions. Wildlife species were georeferenced in the surroundings where they were sighted most or in their known suitable habitats. Based on the GPS data, we created a spatial layer of all attractions in each park. We overlaid the spatial layer of attractions with land-cover maps of the respective park. Landsat 7 images were used to derive land-cover maps and ArcGIS-ArcMap-version 10 for the spatial analysis. In SENAPA, the major land covers were savannah grasslands, woodlands, forest, water bodies (i.e. lakes, rivers and dams) and Kopjes. In KINAPA, the major land-cover types were defined by altitude and they were snow (from 5001m to 5895m ASL), gravel/boulders of the alpine desert (from 4001m to 5000m ASL), heathlands and moorlands (from 2801m to 4000m ASL) and the montane forests (from 1800m to 2800m ASL).

On the overlaid layers, attractions were classified in discrete landscape patches based on their types, locations, common characteristics environments and relevant behaviour and timing. Each discrete landscape patch is an eco-parcel. We identified similar eco-parcels across the parks' landscapes. Similar eco-parcels are those with alike attractions that are located in similar location (i.e. surrounding pixels on the Landsat images) and supported by similar characteristic environments.

We only used the coordinates of attractions within eco-parcels and their qualitative descriptions. Therefore, delineating the exact physical boundaries of each eco-parcel (e.g. hippo pools in SENAPA or the Shira plateau in KINAPA) was difficult. Moreover, the Landsat images used to create the land-cover maps were coarse (i.e. 30m pixel resolution) while determining the eco-parcels' distinguishing environments, that described in Tables 3.2 and 3.3 need a higher resolution images that are capable of characterising fine details. To obtain more detail, we used land-cover types as a wider environmental description to define the general supporting environmental properties of eco-parcels as shown in Tables 3.2 and 3.3. The discrete distribution of eco-parcels shown on the map overlay (Figures 3.1 and 3.2), suggests that eco-parcels are connected to specific land covers that characterize the different KINAPA and SENAPA landscapes.

To delineate eco-parcels from their wider environment, we used the 'add polygon' edit tool on ArcMap-GIS10.2. At a scale of 1: 10,000, we created a polygon around each eco-parcel. Steven and Clark (1990, p. 76) argue that a scale between 1: 10,000 and 1: 25,000 shows high-resolution features. Our scale thus captures the fine details of eco-parcels' environmental properties described in Tables 3.2 and 3.3. Within this scale, we delineated several types of eco-parcels in KINAPA and SENAPA. For easy identification, we named all types of eco-parcels after their key attraction(s) or their intrinsic scenery. The results are presented in maps in Figures 3.1 and 3.2.

Step 3: Analysing the importance of each eco-parcels for tourism

The importance of each eco-parcel for tourism is determined indirectly by using the ratings of individual attractions and a group of attractions from Step 1. The resulting importance values for eco-parcels in SENAPA and KINAPA are determined by the ratings of individual attractions within them.

The James Hutton Institute (2010) argues that the scenic quality of a whole landscape can be estimated by aggregating the values of individual landscape components. The importance value of eco-parcels with a single attraction is represented by the rating of that attraction. The importance value of eco-parcels with multiple attractions of varied ratings (e.g. extremely, medium or less important) is represented by the maximum vulue of ratings of those attractions. Eco-parcels with multiple attractions are more resilient to the impacts of environmental change than single-attraction eco-parcels. Here, we slighly modify the James Hutton Institute's concept because we did not want to marginalise the importance of each attraction by aggregating or averaging all rating. The results for this analysis are presented in Tables 3.4 and 3.5.

3.3 Findings

Section 3.3.1 briefly describes the types of tourist attractions that were identified in Kilimanjaro and Serengeti National Parks (Table 3.1), while Section 3.3.2 shows the spatial distribution of eco-parcels and their key attractions. Section 3.3.4 presents how important each eco-parcel is for tourism.

3.3.1 Key attractions in Serengeti and Kilimanjaro National Parks

In SENAPA, the key attractions were wildlife migration, high concentrations of wildlife other than migrating wildebeests, big cats, kopjes, big birds, hippos, flamingos and hills of unique shapes. In KINAPA, the key attractions were the Uhuru peak (mountain's high altitude), huge snow piles in tropics, plants (e.g. groundsels, protea and flowers), wildlife (e.g. Black-and-White Colobus monkeys, elephants and birds), waterfalls and uniquely shaped rocks.

3.3.2 Linking attractions to their local environments

The attractions in Table 3.1 were classified in nine eco-parcel types based on their supporting characteristic environments (Table 3.2 and Figure 3.1). These eco-parcels had unique attractions that could be exclusively linked to specific land cover in time and space (except for migrating wildebeests in Serengeti, which were linked to multiple land covers in different periods due to their migratory behaviour). The findings in this section show that, although KINAPA and SENAPA each cover an extensive area, tourist attractions only occur in specific patches. These results indicate that not the whole national park's area is important for tourism.

Table 3.2 and Figure 3.1 illustrate the nine types of eco-parcels (named in capitals) defined by their key tourist attractions and supporting environments in SENAPA. These eco-parcels include the Mara riparian (NORTHERN MIGRATION) eco-parcels in the northern and short-grass (SOUTHERN MIGRATION) eco-parcels in the southern Serengeti, short-grassed (SIMBA) eco-parcels, KOPJES eco-parcels, water pool (POOL) eco-parcels, sparse bushy eco-parcels (OSTRICH), Grumeti forest eco-parcels (GRUMETI'S MBEGA), closed woodlands eco-parcels (TEMBO) and woody (LOVEBIRD) eco-parcels.

The key supporting characteristic environments for the NORTHERN MIGRATION eco-parcels is the perennial Mara-River flow while short grasses support the SOUTHERN MIGRATION eco-parcels. The key attraction in these eco-parcels is wildebeest migration. The SOUTHERN MIGRATION eco-parcels provide nutritious grass for calves and lactating mothers between December and May, while the NORTHERN MIGRATION eco-parcels provide feeding grounds and drinking water during the critical dry season of June through September.

Apart from migrating wildebeests, the SOUTHERN eco-parcel also supports a high concentration of other wildlife species. In the SIMBA eco-parcels, for example, the key supporting environmental characteristic is short grasslands and the key attractions are big cats (i.e. lions, cheetah and leopards). The SIMBA eco-parcels are sparsely distributed in grasslands to patches of very short and medium grass height that provide the required wider hunting view for the cats. The OSTRICH eco-parcels are supported by bush/grasslands and the key attractions are big birds, such as ostriches, bustards and secretary birds.

Table 3.1 Key tourist attractions in Serengeti and Kilimanjaro National Parks.

SN	Key attractions in Serengeti National park	Key attractions in Kilimanjaro National Park
1	Wildlife migration	Mountains' high Altitude (i.e. Kibo summit/Uhuru peak)
2	High concentration of game other than wildebeests, and wilderness (endless plains)	Snow piles of about 50m high in tropics
3	Big cats (lions, cheetah and leopards)	Rocks of unique shapes (i.e. Zebra rocks, church-like rock, mushroom-like rocks and rock pinnacles)
4	White flowers	Barranco wall and lava tower,
5	Big birds such as ostriches, bustards and secretary birds	Groundsels (giant senecio and lobelia)
6	Kopjes, and its special wildlife association (e.g. big cats, klipspringers and rock hyraxes)	Maundi Crater
7	Maasai paintings and the gong rock (sound stone)	Helichrysum flowers (e.g. Everlasting flowers, stoebes, underground waterfall and Protea flowers
8	Pancake-like rocks	Climatic experiences, forest flowers (e.g. fireball lily, red-hot poker and impatiens kilimanjarii)
9	White rocks	Birdlife (e.g. Hartlaub's turaco and Raucous silvery-cheeked hornbill)
10	Black rocks	Wildlife (e.g. Elephants, Black and White Colobus monkeys, tree hyrax, grey and Abbot's duiker and elands)
11	Hippos and crocodiles,	Numerous waterfalls
12	Flamingoes, cranes and other water birds	
13	Black and White Colobus monkeys	
14	Birdlife (e.g. Nubian woodpecker, Fischer's and Yellow-collared lovebird, Grey-headed Kingfisher, Rufous-tailed Weaver, Superb stalling, Lilac-breasted roller and Rüppell's vulture)	
15	Big games such as giraffes, elands, buffaloes, elephants and Zebras	
16	Attractive hills (e.g. Dwarf Mt. Kilimanjaro and Buttock mountain)	

In addition, KOPJES is an eco-parcel type that is discretely distributed from the southern to the northern part of the SENAPA. The key attractions are the kopjes themselves and special wildlife (e.g. klipspringers, rock hyraxes and agama lizards) confined in kopjes. The supporting environmental characteristics are bush, trees and rocks that keep the immediate environment moist. This situation makes KOPJES eco-parcels different from the adjacent endless grasslands. In the POOLS eco-parcels, the key supporting environmental properties were stagnant or slow moving water along the main river channels (i.e. Mara, Grumeti, Simiyu or Mbalageti), dams and lakeshores of the inland lakes (i.e. lakes Magadi and Ndutu), while the key attractions here are hippos, crocodiles and water birds (e.g. flamingos and other water-dependent birds). The GRUMETI'S MBEGA eco-parcels are found to the western part of SENAPA. A semi-deciduous closed forest and the Grumeti River support these eco-parcels, which are the only locations where tourists can observe Black-and-White Colobus monkeys (Colobus guereza). The TEMBO eco-parcels are found in closed woodlands and the key attractions are large aggregation of big ungulates, such as elephants, giraffes, elands and buffaloes. Although birds are found in many land covers, the LOVEBIRD eco-parcels in patches of open woodlands harbour abundant and unique bird species. Thus, bird watching is mostly done in these specific eco-parcels and not in the whole woodlands area.

In KINAPA, we identified eight types of eco-parcels as named in capitals. The eco-parcels are restricted to specific environmental characteristics defined by land-cover types and altitude (Table 3.3 and Figure 3.2). Starting from the mountaintop (from 5001m to 5895m ASL), we defined the SUMMIT eco-parcel whereby the Uhuru peak and snow piles of about 50m high were the key attractions. The snow piles are firmly supported by snow cover and very cold microclimates. The ROCKY eco-parcels are supported by patches of gravel, rocks or bare soils of the alpine desert (from 4000m to 5000m ASL). In these ROCKY eco-parcels, rocks of unique shapes, including zebra stripes rocks, church-like rock and mushroom-like rocks were the key attractions. The GROUNDSELS, GOD's GARDEN and MAUNDI CRATER eco-parcels are supported by heath or moorland vegetation cover (2800m to 4000m ASL). The GROUNDSEL eco-parcels are attractive because of their groundsel plant species (i.e. giant senecio and lobelia) and the underground waterfall. The key supporting environmental characteristics are swampy environmental conditions.

The GOD's GARDEN eco-parcels occur in the Shira plateau, which is the only flat area on the mountain, and in some other patches along the heathlands or moorlands vegetation. The key attractions are the plateau itself and its attractive flowers of the genus Helichrysum (e.g. everlasting and stoebes) and Protea species (c.f. Figure 3.2). The MONTANE GARDEN, KILIMANJARO ZOO and WATERFALL eco-parcels are supported by the montane forests, which start at the main entrance gates of the park (from 1800m to 2800m ASL). The key attractions in the MONTANE GARDEN eco-parcels are rainforest flowers, various bird species and ancient huge trees, some of which are medicinal species. THE KILIMANJARO ZOO is the only eco-parcel in KINAPA where tourists have a high chance to encounter big game, such as elephants, elands, giraffes and Black-and-White Colobus monkeys. The WATERFALL eco-parcel is characterized by the river that falls at a high crest and the key attraction is the waterfall and many amphibious species.

Table 3.2 Main eco-parcels, their distinguishing characteristic environments, key attractions and main supporting environmental properties in SENAPA.

SN	**Main eco-parcel**	**Description(s) of distinguishing characteristic environments**	**Key attraction(s)**	**Main supporting Environmental properties (i.e. Main land-cover type)**
1	NORTHERN MIGRATION	Spots of Mara River riparian covered with patches of wooded grasslands running adjacent to water the Mara river meander	Great wildlife migration between August and September	Wooded grasslands
2	SOUTHERN MIGRATION	Short grasses mixed with bushes and solitary acacia umbrella in the endless plains White flowers	Great wildlife migration between February and May High concentration of games other than wildebeests in the endless plains	Grasslands
3	SIMBA	Very short grasses mixed with tall grasses	Big cats (lions, cheetah and leopards)	Grasslands
4	OSTRICH	Bushes mixed with short grasses	Big birds (e.g. ostriches, bustards and secretary birds)	Grasslands
5	KOPJES Simba, Moru Massai and Klipspringer	Granite and genesis rock outcrops sometime covered with bushes	Kopjes Special wildlife (e.g. klipspringers and rock hyraxes), Maasai paintings and Gong Rock (sound stone), black rocks and white rocks and pancake rocks	Bushes/ Rocks
6	POOL Hippo pools Lake shore	Slow moving or stagnant water in pools of the main river channels or lake shores and dams	Hippos and Crocodiles and Water birds (e.g. flamingos, cranes)	Water (e.g. main river channels, lakes shores and dams)
7	GRUMETI'S MBEGA	Closed canopy riparian forest Semi-deciduous species Sparse grass in the understory	Black-and-White Colobus monkeys	Forest (Grumeti)
8	TEMBO	Closed woodlands	Big games such as giraffes, elands, buffaloes, elephants Attractive hills (e.g. dwarf Kilimanjaro and buttock like hill)	Woodlands
9	LOVEBIRDS	Space acacia and banalities trees Bushy Large Kigelia/sausage trees	Birds species (e.g.fischer's and Yellow-collared lovebird, Rufous-tailed weaver, Superb starling and Lilac-breasted roller)	Woodlands

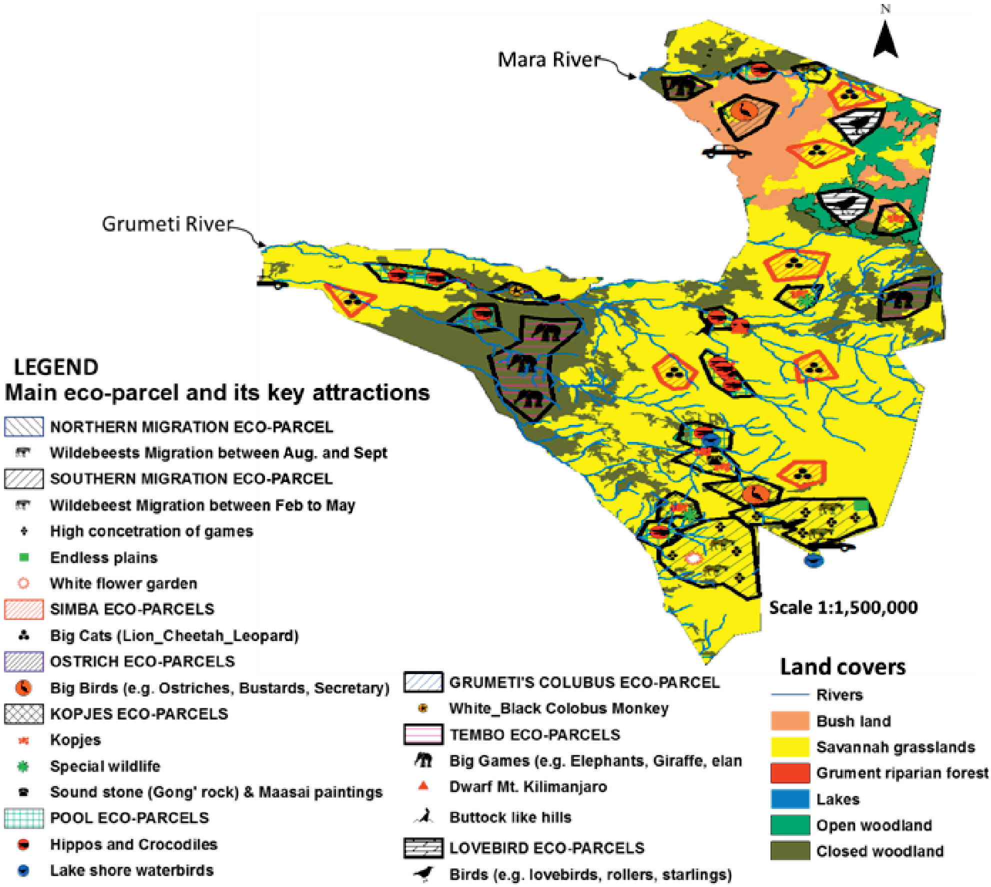

Figure 3.1 Distribution of the main eco-parcels and their key attractions in SENAPA.

3.3.3 The importance of each eco-parcel for tourism based on tourists' preferences on attractions

Tourists' ratings of the different attractions within each national park varied strongly. Consequently, the importance of different eco-parcel for tourism in these parks also varied.

In SENAPA, the most important eco-parcels are the NORTHERN and SOUTHERN migration patterns followed by SIMBA and KOPJES (Table 3.4). The attractions in these eco-parcels are rated as 'important' or higher by the majority (>50%) of tourists. The analysis of the relative importance of all attractions in each eco-parcel based on tourists' preferences revealed useful insights. 69% of all interviewed tourists (N=500) considered wildebeest migration as an extremely important attraction. The NORTHERN and the SOUTHERN migration eco-parcels are the most important landscape patches (mean score of 1.4) for tourism because of wildebeest migrations. Nonetheless, not every tourist perceived wildebeest migration as that important. 20% considered migration as a very important attraction, while 12% considered it only important for Serengeti's tourism. The significance of the SOUTHERN eco-parcels not only relies on the presence of wildebeest migration between December and May but also on the high concentrations of other wildlife species all-year round.

About 58% of all tourists considered the high concentrations of wildlife a very important attraction while 20% and 21% considered this attraction as important and extremely important respectively.

Table 3.3 Main eco-parcels, their distinguishing characteristic environments, key attractions and main supporting environmental properties in KINAPA

SN	Main eco-parcel	Description (distinguishing characteristics environments)	key attraction(s)	key supporting environmental properties (i.e. main land-cover type and altitude zone)
1	SUMMIT	The highest point on the mountain	Kibo summit/Uhuru peak (Highest peak 5985m ASL on Africa)	Volcanic soil and rocks (5895m ASL)
		Snow cover	Snow piles of about 50m high	Snow 5001-5985m ASL
2	ROCKY	Patches of unique rock outcrops of various shapes	Zebra stripes rocks, church-like rock, rock pinnacles, lava tower, Barranco wall, turtle-like rocks and mushroom-like rocks.	Gravel/rocks (Alpine desert zone) 4001-5000m ASL
3	GROUNDSEL	The only tallest trees in the surroundings High altitude swamps	Giant senecio of about 3m high and lobelia of about 5m high Underground waterfall	Heath/moorland vegetation 2801-4000m ASL
4	MAUNDI CRATER	A deep and wide crater covered with tussock grass boarded by Erica trees at its ream The ream, the highest point to view lake Chala	Crater Point to view lake Chala	Heath/moorland vegetation 2801-4000m ASL
5	GOD'S GARDEN	Shira plateau: the only flat area on the mountain. Spots of Helichrysum, Stoebes and protea tree flowers	Helichrysum flowers (i.e. everlasting flowers+ stoebes) Underground waterfall Protea flowers	Heath/moorland vegetation 2801-4000m ASL
6	MONTANE GARDEN	Tall trees with open patches of grass understory	Forest flowers (e.g. fireball lily, red-hot poker, impatiens kilimanjarii) Birdlife (e.g. Hartlaub's turaco and raucous silvery-cheeked hornbill)	Montane forest vegetation 1800-2800m ASL
7	KILIMANJARO ZOO	Wildlife encounters (e.g. Elephants, Black and White Colobus monkeys, tree hyrax, grey and Abbot's duiker, elands)	Montane forest vegetation 1800-2800m ASL	-Wildlife encounters (e.g. Elephants, Black and White Colobus monkeys, tree hyrax, grey and Abbot's duiker, elands)
8	WATERFALL	Waterfalls Amphibians	Montane forest vegetation 1800-2800m ASL	Water

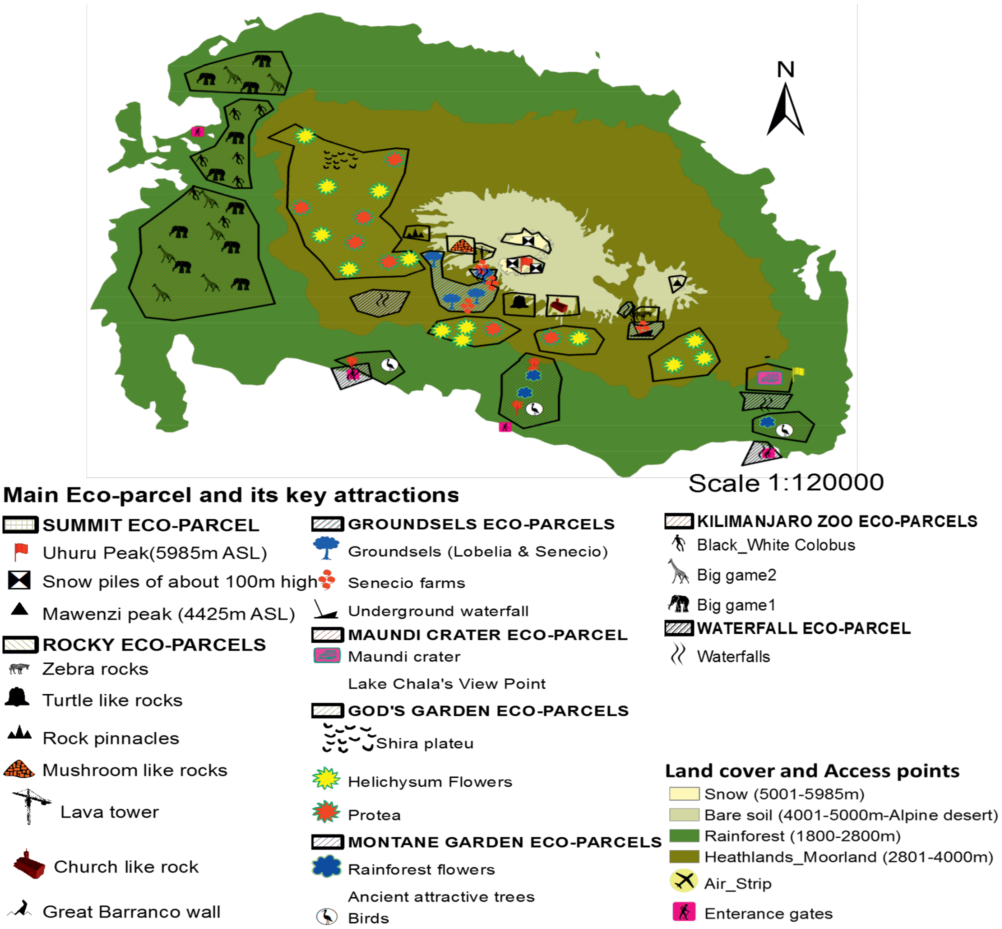

Figure 3.2 Distribution of key eco-parcels and their attractions in KINAPA

The third most important eco-parcel is SIMBA. The SIMBA eco-parcels harbour big cats (lion, leopard and cheetah). Despite lions being the king of the animals, only 39% of 484 tourists considered big cats an 'extremely important' attraction and 37% considered it very important. In the list of important eco-parcels, KOPJES should not be underrated. 71% of all tourists considered kopjes and its special wildlife as an extremely important attraction with a mean importance rating of 1.4. The POOLS eco-parcels are less important for tourism because only 59% considered hippos and crocodiles, and flamingos as extremely important, while 36% considered them as very important. The OSTRICH eco-parcels are important for few tourists, because relatively few tourists (14% of 500) considered big birds as a key attraction. Of these few tourists, 67% considered big birds as extremely important, while 18% considered them as very important. While also few tourists listed Black-and-White Colobus monkey (23%), big game (4%)and other birds (29%) in the woodlands as their attractions, some indicated them as extremely important attractions (c.f. Table 3.4). We considered those eco-parcels containing attractions that are preferred by few tourists, as a special interest eco-parcels for a small group of tourists.

Our findings in Table 3.4 imply that savannah grasslands and Kopjes are the most important land cover for tourism in SENAPA. They harbour many eco-parcels that contain the most preferred attractions.

In KINAPA, the SUMMIT eco-parcel is the most important for tourism (Table 3.5) because it is where the highest point in Africa (i.e. Uhuru peak 5985m ASL) and snow piles of about 50m high in the tropics are located. 84% interviewed tourists considered the Mountain's high-altitude as the most important attraction. Snow piles were the second most important attraction in this eco-parcel (mean score is 2.2; i.e. very important). However, the tourists' preferences over the snow piles strongly varied. Most (i.e. 38%) tourists considered snow very important, while 31% considered snow as extremely important and 16% very important. To find 11% and 5% of tourists who respectively consider snow as somewhat and least important attraction, is surprising and contrary to conclusions in the literature (Mafuru et al., 2009; Minja, 2014) that all tourists are mainly attracted by snow in the tropics. Other important eco-parcels were the KILIMANJARO ZOO, MONTANE GARDEN AND WATERFALL in the montane forests. In the MONTANE GARDEN eco-parcel, 30% tourists considered climatic experiences, rainforest flowers and birds as very important attractions, while 19% considered the same attractions as extremely important attraction. The KILIMANJARO ZOO eco-parcel in the western part of KINAPA is considered important (mean score is 3.0) because 27% of all tourists considered big game encounters a very important attraction. The MAUNDI CRATER, GROUNDSELS AND GOD'S GARDEN are other important eco-parcels in the heathland vegetation (from 2800 to 4000m ASL). 32% of all tourists considered MAUNDI CRATER very important attraction (mean score is 2.7). The GROUNDSELS eco-parcels harbour the giant scenesio and lobelia, and 14% of tourists considered groundsels as a very important attraction. ROCKY eco-parcels were only considered important by 23% of all tourists. As such, the ROCKY eco-parcels were the least important (mean score is 3.6) eco-parcels for tourism in KINAPA.

Based on the tourists' preferences on key attractions found in all eco-parcels, snow is the most important land cover for tourism in KINAPA (Table 3.5), followed by montane forests and heathlands and lastly the alpine deserts. The importance of these land covers hinges on the uniqueness of attractions therein.

Table 3.4 Important eco-parcels for tourism in SENAPA based on tourist preferences over individual attractions (N =500)

SN	Main eco-parcel	Description(s) (distinguishing characteristic environments)	Key attractions	Main supporting environmental properties (i.e. main land-cover type)	Designation of important eco-parcel based on 'main attraction' Counts* (% of tourists who preferred an attraction out of 500)	Variations (%) in tourists' preferences over attractions: Importance Extremely	Very	Medium	Quite	Least	SD	***Likert scores (Mean score (Important eco-parcel for tourism)
1	NORTHERN MIGRATION	Spots of Mara River riparian covered with patches of wooded grasslands running adjacent to water the Mara river meander	Great wildlife migration	Wooded grasslands	500(100%)	68.8%	19.8%	11.8%	0.0%	0.0%	0.7	1.4
2	SOUTHERN MIGRATION	Short grasses mixed with bushes and solitary acacia umbrella in the endless plains with some patches of white flowers	Great wildlife migration -High concentration of games other than wildebeests in the endless plains	Grasslands	489(98%)	20.9%	57.7%	19.8%	1.8%	0.4%	0.7	2.0
3	SIMBA	Very short grasses mixed with tall grasses	Big cats (lions, cheetah and leopards)	Grasslands	484(97%)	39.3%	36.8%	22.7%	0.2%	1.0%	0.8	1.9
4	OSTRICH	Bushes mixed with short grasses	Big birds (e.g. ostriches, bustards and secretary birds)	Grasslands	72(14%)	66.7%	18.1%	6.9%	4.2%	4.2%	0.8	1.6
5	KOPJES -Simba, -Moru -Massai and -Klipspringer	Granite and genesis rock outcrops sometime covered with bushes	-Kopjes -Special wildlife (e.g. klipspringers and rock hyraxes), -Maasai paintings and Gong Rock (sound stone), black rocks and white rocks and pancake rocks	Bushes/ Rocks	367(73%)	71.1%	17.7%	10.9%	0.3%	0.0%	0.7	1.4
6	POOL -Hippo pools -Lake shore	Slow moving or stagnant water in pools of the main river channels or lake shores and dams	-Hippos, Crocodiles and water birds (e.g. flamingos, cranes)	Water (e.g. Main river cannels, lakes shores and dams)	256(51%)	59.0%	35.9%	4.7%	0.4%	0.0%	0.7	1.4

SN	Main eco-parcel	Description(s) (distinguishing characteristic environments)	Key attractions	Main supporting environmental properties (i.e. main land-cover type)	Designation of important eco-parcel based on 'main attraction'	Variations (%) in tourists' preferences over attractions					SD	***Likert scores (Mean score (Important eco-parcel for tourism)
					Counts* (% of tourists who preferred an attraction out of 500)	Importance						
						Extremely	Very	Medium	Quite	Least		
7	GRUMETI'S MBEGA	Closed canopy of the semi-deciduous riparian forest	Black-and-White Colobus monkeys	Forest (Grumeti)	115(23%)	68.7%	16.5%	9.6%	4.3%	0.9%	0.7	1.5
8	TEMBO	Closed woodlands	-Big games such as giraffes, elands, buffaloes, elephants, -Attractive hills (e.g. dwarf Kilimanjaro and buttock like hill)	Woodlands	19(4%)	42.1%	26.3%	15.8%	15.8%	0.0%	1.1	2.1
9	LOVEBIRDS	Space acacia and banalities trees Large Kigelia/sausage trees	Birds species (e.g. Nubian woodpecker, fischer's and Yellow-collared lovebird, Grey-headed kingfisher, Rufous-tailed weaver, Superb starling, Lilac-breasted roller, Rüppell's vulture	Woodlands	147(29%)	58.5%	17.7%	19.7%	3.4%	0.7%	0.9	1.7

*Counts= number of tourists who chose the attractions out of the total number of tourists (N=500)
***Likert score or Mean score: 1 is extremely important, 2 is very important, 3 is medium important, 4 is less important and 5 is least important
SD stands for Standard Deviation

Table 3.5 Important eco-parcels for tourism in KINAPA based on tourist preferences over individual attractions (N = 306)

SN	Eco-parcel	Description(s) (distinguishing characteristic environments)	Key attraction(s)	Key supporting environmental properties (i.e. main land-cover type and altitude zone)	Designation as 'main attraction'	Variations (%) in tourists' preferences over an individual or a group of attractions within the eco-parcel (the importance of attractions for tourism)					SD	*** Likert scores (Mean Score (Importance of eco-parcel for tourism)
					Counts* (% of tourists who preferred an attraction out of 306)	Importance						
						Extremely	Very	Medium	Quite	Least		
1	SUMMIT	The highest point on the mountain Mawenzi summit Snow cover	Kibo summit/Uhuru peak (the highest peak (5985m ASL) on African)	Volcanic soil and rocks (5895m ASL)	301(98%)	84%	6%	5%	3%	2%	0.9	1.4
			Snow piles of about 50m high	Snow 5001-5985m ASL	243(79%)	31%	38%	16%	11%	5%	1.1	2.2
2	ROCKY -Zebra -Church -Pinnacle -Tower -Wall and -Mushroom	Unique rock outcrops of various shapes	Zebra striped rocks, church-like rock, rock pinnacles, lava tower, Barranco wall, turtle-like rocks and mushroom-like rocks.	Gravel/rocks (Alpine desert zone) 4001-5000m ASL	118(38%)	7%	12%	23%	27%	31%	1.2	3.6
3	GROUNDSELS	The only tallest trees in the surroundings that occur in swamps	Giant senecio of about 3m high and lobelia of about 5m Senecio farm Underground waterfall	Heath/moorland vegetation 2801-4000m ASL	157(51%)	4%	14%	17%	26%	39%	1.2	3.8
4	MAUNDI CRATER	A deep and wide crater covered with tussock grass boarded by Erica trees at its ream The highest point to view lake Chala	Crater Point to view lake Chala	Heath/moorland vegetation 2801-4000m ASL	219(72%)	15%	32%	28%	17%	9%	1.2	2.7
5	GOD'S GARDEN	Shira plateau: the only flat area on the mountain. Spots of Helichrysum, and protea tree flower	-Plateau itself -Helichrysum flowers (i.e. everlasting flowers and stoebes) -Protea flowers	Heath/moorland vegetation 2801-4000m ASL	14(5%)	71%	7%	21%	0%	0%	1.2	1.5

SN	Eco-parcel	Description(s) (distinguishing characteristic environments)	Key attraction(s)	Key supporting environmental properties (i.e. main land-cover type and altitude zone)	Designation as 'main attraction'	Variations (%) in tourists' preferences over an individual or a group of attractions within the eco-parcel (the importance of attractions for tourism)					SD	*** Likert scores (Mean Score (Importance of eco-parcel for tourism)
					Counts* (% of tourists who preferred an attraction out of 306)	Importance						
						Extremely	Very	Medium	Quite	Least		
6	MONTANE GARDEN	Tall trees with open patches of grass understory	-Attractive forest flowers (e.g. fireball lily, red-hot poker, impatiens kilimanjarii) -Birdlife (e.g. Hartlaub's turaco and raucous silvery-cheeked hornbill)	Montane forest vegetation 1800-2800m ASL	237(76%)	19%	30%	28%	13%	11%	1.2	2.6
7	KILIMANJARO ZOO	The closed canopy of very tall trees	-Wildlife encounters (e.g. Elephants, Black and White Colobus monkeys, tree hyrax, grey and Abbot's duiker, elands)	Montane forest vegetation 1800-2800m ASL	170(56%)	11%	25%	27%	22%	15%	1.2	3.0
8	WATERFALLS	Waterfall of about 10-100m crest and water pools underneath	Waterfalls	Montane forest vegetation 1800-2800m ASL	145(47%)	6%	15%	17%	28%	34%	1.2	3.7

*Counts= number of tourists who chose the attractions out of the total number of tourists (N=306)
**Likert scores or Mean score: 1 is extremely important, 2 is very important, 3 is medium important, 4 is less important and 5 is least important
SD stands for Standard Deviation

3.4 Implications

These results indicate that the eco-parcel concept and approach likely provide a useful start to assess the possible impacts of environmental change on NBT. The three steps in the eco-parcel approach help to focus on the essential attractions and their supporting environments, and not only on the park as a whole, and spatial and temporal links between attractions. Before applying the eco-parcel approach in SENAPA and KINAPA, we expected low tourists' ratings for most attractions and high ratings for wildebeests migration and snow because wildebeests migration and snow are well-documented in the media, books (e.g. Serengeti Shall not Die, the Snows of Kilimanjaro) and publications (e.g.Hemingway, 1974; Hemp, 2005; Holdo et al., 2011; Sinclair et al., 2015). We found, however, high ratings for other identified attractions, such as big cats and kopjes in SENAPA: high altitude, wildlife and flowers in KINAPA (cf. Tables 3.4 and 3.5). These findings imply that the full range of attractions should be taken into consideration when determining the impacts of environmental change or synergies and trade-off between tourism's and nature conservation interests. Our detailed spatial approach can also be used to determine attractions at risk that have high tourism potential but that are simultaneously marginalised in traditional assessments. For example, kopjes deserve special conservation attention because 71% of interviewed tourists considered kopjes and their special wildlife as extremely important attractions for tourism in SENAPA. Unfortunately, no serious conservation measures for Kopjes are planned despite that its wildlife communities are currently threatened (Trager & Mistry, 2003).

Moreover, the information that is collected while applying the eco-parcel approach is likely to keep park managers and tourism stakeholders updated on the impacts of the ongoing environmental change on attractions. Specifically, the assessment of the relative importance of each attraction can be used to inform on the consequences of attractions that are disappearing. In KINAPA, for example, our findings showed the high-altitude Uhuru peak is actually the most important attraction followed by snow. The detailed assessment about attractions is informative to tourism stakeholders, especially now when tourism in KINAPA is anticipated to collapse due to continued rapid snowmelt (see Minja, 2014). As we have shown, classification of attractions into easily understood categories allow each attraction to be considered based on its merits in the planning and decision-making process.

Our eco-parcel approach has several advantages. UNWTO/UNEP (2008) argues that assessing the impacts of environmental change on NBT is difficult given the diversity of environmental conditions, compared to, for example, ski tourism (relying principally on snow conditions) or coastal tourism (relying mainly on beach, sun and water conditions). As we have shown, the eco-parcel approach can well handle such diversity and explicitly link individual attractions to their environmental conditions and thus also to environmental change. When the supporting environmental characteristics of individual attractions are known, changes in those conditions are a proxy to assess possible changes in those attractions. With limited information on wildlife's environmental requirements, an eco-parcel can help to inform wildlife and tourism mangers. For instance, changes in grassland vegetation, which is the supporting environment for wildebeest migration, can be used to project the shifts in wildebeest migration tourism and adapt the timing of tourists that want to observe this phenomenon. Mureithi (2017)[2] suggests, for example, that the ongoing increase in water levels of Lake Nakuru threatens flamingo-based tourism, but the findings did not indicate the spatial and temporal variation. Such details can be quickly identified by applying the eco-parcel approach to these changed conditions.

2 Mureithi, F. (2017, Sept. 20, 2017). Flamingoes flee as Lake Nakuru water level rises, *Business Daily*. Accessed on May 23, 2018

Although the eco-parcel approach is now static in time, but returning changes (e.g. migration, breeding and flowering) can be included in the future to improve the assessments. Meanwhile, we temporally distributed individual attractions to specific locations. Nevertheless, the inclusion of spatial and temporal description on the NORTHERN and SOUTHERN wildebeest migration eco-parcels proves the capacity of the approach to handling multiple (future) environmental data.

Furthermore, the eco-parcel approach not only allows to estimate changes in the distribution of specific attractions, but it also informs about the impact of losing attractions when environmental factors change. Such estimate is possible as each attraction type is connected to specific environmental conditions. In SENAPA, for example, rapid changes in grasslands and water-bodies can be more acute for tourism than changes of similar magnitude in woodlands. This is because grasslands and water-bodies harbour the majority of highly preferred attractions. Likewise, in KINAPA, many attractive flowers, waterfalls and wildlife occur in the heathlands and montane forests. This means that changes in these landscapes can have negative effects on trekking tourism experience. The recently published report (Climb Kilimanjaro Guide, 2015)[3] shows that the average-summit success rate across all climbers and routes is only 65%. A trekking journey takes about six days (Karinen et al., 2008) with one full day devoted to finally reaching the summit. This means that tourists spend five days to acclimatise to the weather and altitudes, while enjoying the attractions in heathlands and montane forests.

The eco-parcel approach is simple and cost effective, and can be applied to a range of tourism destinations. The eco-parcel approach obtains data from readily available sources, such as park experts (e.g. park wardens), tour guides and tourists or visitors. Other approaches depend on costly teams of experts and sophisticated data sets, such as aerial photographs (Priskin, 2001). Low-cost approaches are useful given that most authorities, especially in the Global South, do not have the resources to fund costly approaches for planning purposes. Furthermore, the eco-parcel approach identifies and classifies all range of attractions within a tourism destination and verifies the merit of each attraction for tourism by using on-site tourists' preferences and not observer's preferences or experts. Lastly, our eco-parcel approach creates maps and the related spatial databases of tourist attractions within a GIS. These systems simplify data storage, retrieval, analyses and integration with other land-use planning data sets. Data integration within the eco-parcel facilitates to estimate changes in local tourism resources over time. The eco-parcel approach is thus a generic and cost-efficient approach, but it gives an effective geographic overview.

Limitation of the study

To assess the impacts of environmental change on nature-based tourism, the attractions' supporting characteristic environments (i.e. climates, vegetation types, soil types and hydrology) should be known and changes therein should be projected. Nonetheless, the supporting environmental properties of many attractions that we identified in KINAPA and SENAPA were poorly known. Complex interconnections within attractions and between attractions and their supporting environments make the delineation of the actual characteristic environments that support individual attractions very difficult. However, the use of land-cover types as attractions' supporting environment simplifies this somewhat.

3 Climb Kilimanjaro Guide. (2018). Kilimanjaro success rate – How many people reach the summit? Retrieved December 08, from https://www.climbkilimanjaroguide.com/kilimanjaro-success-rate/

Another limitation of our eco-parcel approach is its static character. The eco-parcels are currently located in one specific place. Some attractions, however, shift locations throughout the year and manifest themselves according to a regular seasonal pattern of occurrence (e.g. wildebeest migration). Such sequence of attractive events within a major attraction is difficult to capture in the single localized eco-parcel that we used. However, creating a series of spatial and temporal linked eco-parcels throughout a year would be relatively easy. Such series adds a seasonality dimension into the eco-parcel approach, which would further enhance its value for tourism assessments.

Future research

An obvious avenue for further research would be to apply the eco-parcel concept to assess further the effects of future environmental change on tourism in SENAPA and KINAPA. We only demonstrated the utility of the concept for these parks' contemporary environmental conditions. Such kind of future impact assessment likely improves tourism planning in these parks. The application of the eco-parcel approach in KINAPA and KINAPA is timely. This is because many trade-offs (maybe synergies) are emerging when more tourism products, infrastructure (e.g. the public road through SENAPA and the luxury picnic site on the Shira plateau in KINAPA) etc. are developed, and climate-change impacts are mitigated or adapted to. Moreover, applying the eco-parcel approach for other tourism destinations is desirable.

Changes in land cover and climate are a major indicator of environmental change. These can be used to approximate the impacts of environmental change. In the future, however, detailed environmental requirements for each attractions, ideally, including temperature and moisture requirements or thresholds and water quality and quantity should be incorporated. This improvement into tourism-resources assessment would help, for example, in tourism and climate change scenarios.

3.5 Conclusion

Linking attractions with their supporting environments (habitats) is needed to support environmental-change impact assessments for NBT. The eco-parcel approach better characterizes tourist attractions in their environmental context and thus supports such impact assessments. The use of land-cover type as a proxy to characterize environmental properties firmly connects attractions with their environments. Application of the eco-parcel approach to Kilimanjaro and Serengeti National Parks shows that attractions are diverse and unevenly distributed, and occur in discrete landscape patches that are strongly linked to specific land-cover types and climates. The link between attractions and land cover and between attractions and climate allows using (future) changes in land cover and climate to approximate their threat to an attraction. In other words, the eco-parcel approach allows to better localize the impacts assessment to individual attractions and it provides essential information to a range of tourism stakeholders.

The eco-parcel approach is thus an innovative new impact assessment approach for NBT. It combines and maps multiple data layers of an attraction (e.g. its type, its importance for tourism and location and its supporting environments), preferably in a GIS. Such advanced integration illustrates the eco-parcel approach's potential to quantitatively assess the impacts of enviroenmntal change on tourist attractions and to improve local tourism planning and management in NBT destinations.

Chapter 4

What are the effects of climate and land-cover on tourist attractions in Kilimanjaro National Park?

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Chapter 4
Mount Kilimanjaro's tourism under environmental change

Abstract

This study explores the effects of observed changes in rainfall, temperature and land cover on the physical and sightseeing aspects of trekking in Kilimanjaro National Park. The impact analysis is organised around hazard-activity pairs approach, combinations of environmental change aspects (such as higher temperatures and rainfall) and tourism activities (such as trekking and sightseeing). The results suggest that higher temperatures and reduced rainfall have lowered the risks of landslides, rock fall and mountain sickness, improving physical trekking conditions. Changes in land cover have affected sightseeing: there now are more flowers and groundsels to admire and less wildlife, waterfalls and snow. In the short term, the disappearing snow may give rise to 'last chance tourism', increasing visitation, but eventually, the loss of snow and forest cover will likely decrease the number of tourists. The paper concludes that effective management of the attractions in the expanding heathlands is the most promising option to limit the losses.

Keywords: Attractions, climate, Kilimanjaro, land cover, last chance tourism and tourism.

4.1 Introduction

Mount Kilimanjaro is the highest mountain in Africa, rising 5895 metres above sea level (m ASL). The ancient volcano with three peaks (Shira, Mawenzi, and Kibo) is an iconic tourism feature in Tanzania and one of the UNESCO world heritage sites in Tanzania. The snow-capped Kibo peak, rare plants and animals, and favourable microclimates have attracted tourists to Mount Kilimanjaro since its 'discovery' in 1889 by Western explorers. Kilimanjaro National Park (KINAPA) is the second biggest earner of Tanzania's national park system after Serengeti National Park. KINAPA manages the part of Mount Kilimanjaro above 1800m ASL.

According to the most recent visitor statistics available, the total number of KINAPA visitors reached almost 60,000 in 2013 (https://web.archive.org/web/20151220102029/ and http://www.tanzaniaparks.com/corporate_information.html), close to a threefold increase since 2000. Trekking is the key tourism activity, performed by adventure tourists who aim to reach the summit. Day-trip visitors, in contrast, are mostly drawn to attractions at lower altitudes (park warden M. Mombo, personal communication, February 2013). Traditionally, the majority (78%) of visits made by both adventure tourists and day-trip visitors occur in two distinct seasons: June to October and December to February. These timeframes coincide with the summer and Christmas holidays in the major source markets. They also coincide with the traditional dry seasons.

As a nature-based tourism destination, Mount Kilimanjaro is dependent on favourable environmental and climatological conditions. Over the past decades, climate change has started to affect Mount Kilimanjaro. Higher temperatures and changes in precipitation patterns have been reported (Hemp, 2005; Hemp, 2009; Appelhans et al., 2015). These climatic changes, in combination with other forms of environmental change, have reduced Mount Kilimanjaro's snow cover (Thompson et al., 2002; Thompson et al., 2009), increased the incidence of wildfire (Hemp, 2005) and altered vegetation patterns (Hemp, 2006, 2009).

Climate change and its induced effects are likely to have substantial implications for trekking and other forms of tourism, but these implications have so far remained under-researched. Our literature study revealed only one dedicated study. Minja (2014) analysed local people's perceptions of tourism's vulnerability to climate variability and change on Mount Kilimanjaro. Using survey and key informant methods, he found that local people perceived increased temperature, decreased annual rainfall, dry riverbeds, water shortage, increased frequency of forest fire, and decreased snowfall as key threats to the mountain's tourist attractions, including its snow, forests, waterfalls, springs and wildlife. No resource-based assessment exists for Mount Kilimanjaro. In fact, such assessments are scarce for African destinations in general (Scott et al., 2008).

Recent years have seen a surge of scientific publications on the impacts of climate change and tourism in Africa. A large share of these studies, however, are general literature reviews, whose coverage ranges from the whole of Africa (e.g. Sifolo & Henama, 2017; Hoogendoorn & Fitchett, 2018), to Sub-Saharan Africa (e.g. Preston-Whyte & Watson, 2005; Mutana, 2016; Pandy, 2017) and to the individual country of South Africa (e.g. Rogerson, 2016; Amusan & Olutola, 2017; Fitchett et al., 2017; Pandy, 2017; van de Bank & van de Bank, 2018). These studies reveal that the dearth of empirical studies that Scott et al. (2008) observed ten years ago still persists, and repeat the urgent call for such studies in Africa. The impacts of climate change on tourism are site-specific (Hoogendoorn & Fitchett, 2018) and destinations require site-specific studies to inform adaptation.

Recently, a few empirical and site-specific studies have been published, notably the study on Botswana's Okavango Delta by Hambira et al. (2013), the study on the desert town of Uis, Namibia by Tervo-Kankare et al. (2018), and the studies by Dube and Nhamo on the Zambian (2018b) and Zimbabwean (2018a) sides of the Victoria Falls and the study in the Serengeti National Park in Tanzania by Kilungu et al. (2017). Whereas the first two of these studies are based on tourism stakeholders' perceptions, the latter three explore the implications for tourism of observed climatic trends. Our paper follows a similar research-based approach; the first application to a mountainous destination in Africa.

Resource-based assessments do exist for mountainous destinations in North America, Europe and Asia. Pederson et al. (2006), for example, report how climate-induced glacier retreat threatens the sustainability of tourism in Montana's Glacier National Park in Montana. Serquet and Rebetez (2011) show that summer heat waves in the European Alps have resulted in more visitor nights. With respect to the Himalayas in Asia, Moore and Semple (2009) found that increases in temperature have improved trekking condition on Mount Everest while Nepal (2011) and Nyaupane and Chhetri (2009) conclude that nature-based tourism in the Himalayas is threatened by more climate-induced avalanches, debris flows and glacial lake outburst floods.

Impact assessments typically make a distinction between direct and indirect effects. Direct effects influence tourist activities. They interfere with the timing and duration of tourism activities or influence the quality of tourism experiences (Scott et al., 2007). A hiking experience in warm and sunny conditions, for example, is qualitatively different from one in cold, rainy or extremely hot conditions. Indirect effects influence tourist attractions. They include changes in mountain landscapes, snow cover and wildlife biodiversity (Beniston & Fox, 2013).

Tourism activities vary widely in terms of their climatic and environmental requirements and they respond to environmental change in very different ways. Careful activity-by-activity assessments are therefore required. Systematically connecting the wide range of climate-change impacts to specific tourism activities is a formidable challenge. In the context of coastal tourism, Moreno and Becken (2009) developed a vulnerability framework based on hazard-activity pairs. From mapping the vulnerability of key hazard-activity pairs, a relatively complete assessment of a destination's overall vulnerability can be put together. Our study identifies the hazard-activity pairs that are most relevant for trekking; Mount Kilimanjaro's main tourism activity. The aim of this study is to make a first-order assessment of the effects on tourism of the recent climate and land-cover changes observed on Mount Kilimanjaro.

The study has two objectives: 1) to assess the effects of observed changes in rainfall and temperature on trekking conditions in Mount Kilimanjaro and 2) to assess the effects of observed changes in land-cover on the extent and distribution of tourist attractions for sightseeing. Future projections of change are not considered in the analysis, but an outlook of what continued changes in climate and land cover may bring is given in the discussion section.

The study relates to at least three policy processes that are currently ongoing in Tanzania. First, in April 2018 Tanzania ratified the 2015 Paris Climate Agreement, which not only covers mitigation but also adaptation. Paragraph 7.9 of the agreement states that, "each Party shall, as appropriate, engage in adaptation planning processes and the implementation of actions, including the development or enhancement of relevant plans, policies and/or contributions."

Tourism-specific adaptation plans may be part of Tanzania's efforts. Second, Tanzania is working on an update of its almost twenty year old tourism policy (Melubo, 2017), and may pay attention to the effects of environmental change. Third, KINAPA is reviewing its general management plan (current version: 2005-2015) and may account for the impacts of environmental change on tourist visitation.

This paper is organised as follows. Section 4.1.1 introduces the major tourism activities on Mount Kilimanjaro including their specific physical and environmental requirements. Section 4.2 outlines the methods and data used to determine climatic and environmental change. Section 4.3 presents the developments in the climate and environmental change indicators relevant for trekking and sightseeing, and discusses their implications for tourism. Section 4.4 reflects on the study's approach and findings and puts these findings in a broader context. The final section concludes.

4.1.1 Mount Kilimanjaro's key tourism activities and their environmental requirements

Trekking, the key tourism activity on Mount Kilimanjaro, has two main aspects: 1) the physical challenge of reaching the summit and 2) sightseeing along the way. Both aspects are described in more detail below, highlighting their dependence on the mountain's physical conditions and aesthetic features.

Reaching the mountain's summit is the primary goal for most tourists. A range of environmental factors makes it a challenging endeavour: supposedly, almost half of the trekkers never reach the summit (https://www.climbkilimanjaroguide.com/kilimanjaro-success-rate/). On the lower parts of Mount Kilimanjaro, trekkers often have to endure rainfall. The mountain receives more rain than other high east African mountains (Hemp, 2006). Apart from being a nuisance in its own right, heavy rainfall makes surfaces slippery, reduces visibility and can cause landslides and rock fall (de Freitas, 2003; Kanungo & Sharma, 2014; Owen & Slaymaker, 2014). Landslides are already occurring after short bursts of intense precipitation. In 1970, a downpour of 100mm in less than 3-hours caused landslides in the Uluguru Mountains, a few hundred kilometres to the South of Kilimanjaro (Temple & Rapp, 1972). On Mount Kilimanjaro itself, twenty people were killed in 2009 by a landslide that occurred after four days of heavy rain (CNN, 2009). Landslides are a challenge for mountain tourism development in the whole of East Africa, but few studies have so far been devoted to the issue. Jacobs et al. (2016) and Komu (2017) reported on the increasing incidence of landslides in the Rwenzori Mountains in Uganda and on Mount Kenya in Kenya respectively, but did not discuss the implications for tourism.

Annual precipitation on Mount Kilimanjaro increases upslope, reaches its maximum in the mid-montane forest zone, located between 1800m and 2400m ASL on the southern slope, and gradually decreases again at higher elevations (Hemp, 2005). Most precipitation occurs in two distinct rain seasons: the long rains from March to May, and the short rains from October to November. The short rains are less intense than the long rains (Chan et al., 2008) and are also less predictable. In some years, there is no rain at all in October and November.

Nearer to the summit, extreme cold and altitude sickness take their toll. Mount Kilimanjaro's summit is at 5895m ASL, and most climbers reach it at night, when temperatures can be as low as -20°C (Hemp, 2005). The combination of high altitude and low temperature creates conditions of low barometric pressure, which limits oxygen uptake in the lungs. Consequently, the ability to perform work (e.g. walking or trekking) diminishes greatly (Grocott et al., 2009).

Altitude sickness is a major source of unsuccessful summiting on Mount Kilimanjaro (Karinen et al., 2008; Eigenberger et al., 2014; Lawrence & Reid, 2016). According to Karinen et al. (2008), trekkers on Mount Kilimanjaro start to experience the first symptoms of altitude sickness at an altitude of around 2700m ASL. At altitudes above 3700m ASL, some trekkers suffer potentially fatal forms of altitude sickness, namely High Altitude Pulmonary Oedema and High Altitude Cerebral Oedema.

A trekking journey on Mount Kilimanjaro takes about six days (Lawrence & Reid, 2016). Only one of these days is devoted to finally reaching the summit, which leaves plenty of time for sightseeing. The peaks and snow of Kilimanjaro are the most famous sights, but there are more. Kilungu et al. (2018) made an inventory of attractions and their evaluation by tourists in Serengeti National Park and Kilimanjaro National Park (KINAPA). For KINAPA, 306 tourists completed a survey on the park's attractions and their importance. Respondents were asked to rate the importance of each of the listed attractions and to indicate KINAPA's main attraction. Importance was denoted on a discrete scale ranging from 1 (extremely important) to 5 (least important).

According to the study by Kilungu et al., each altitudinal zone has its own unique type of attractions, brought about by elevation-based differences in temperature and precipitation. Tourist attractions change from plants and animals in the montane forests (between 1800m and 3000m ASL) and heathlands (between 3000m and 4000m ASL) to rocks in the alpine desert (between 4000m and 5000m ASL) and snow in the arctic zone (higher than 5000m ASL). The Kilungu study suggests that the Kibo summit/Uhuru peak is the most important attraction in KINAPA, with a mean importance rating of 1.4. The second most important attraction is snow with a mean importance rating of 2.2. The wildlife, forest flowers and waterfalls of the montane forest are in third place (mean rating of 3.0), followed by the flowers and giant groundsels (i.e. senecio and lobelia plant species) of the heathland (mean rating of 3.3) and the rocks and other abiotic attractions of the alpine desert (mean rating of 3.6). Table 4.1 gives an overview of the results.

Interestingly, all vegetation zones, except for the alpine desert, were considered to be home to 'main attractions' by three quarters or more of respondents. Fewer respondents, albeit a sizeable minority, considered the inanimate attractions of the alpine desert zone 'main attractions'. In summary, on their way up, trekkers first pass through two zones of considerable interest (montane forest and heathland) and one zone of more limited importance, after which they reach the two main attractions: snow and the mountain peak.

The overview shows that temperature and precipitation influence the trekkers' experience in all stages of the climb. Temperature and precipitation patterns are changing because of climate change, affecting trekking tourism on Mount Kilimanjaro in at least three main ways. 1) changes in rainfall patterns affect the trekking conditions on the lower parts of the mountain; 2) changes in temperature affect the trekking conditions near the summit; and 3) changes in temperature and precipitation alter the distribution of the various land-cover types (i.e. snow and vegetation zones) and the tourist attractions associated with them. Environmental change is likely to impact trekking tourism via each of these three ways. This paper assesses the impacts that occurred over the past few decades. The following section presents the methods used.

Table 4.1 Attractions on Mount Kilimanjaro organised by land-cover zone and their importance as perceived by tourists. Source: Kilungu et al. (2018)

Location of tourist attraction based on land cover/altitude zone	Description of attractions in each zone	Designation as 'main attraction'		Importance of attraction	
		Count*	Percent	Mean score**	Std. Deviation
Snow/ice and gravel (>5000m)	the Kibo summit/Uhuru peak (i.e. Mountains' high altitude)	301	98%	1.4	0.9
	Snow	242	79%	2.2	1.1
Alpine desert zone (4001-5000m)	Zebra rocks, Great Barranco wall, lava tower, turtle-like rocks, mushroom-like rocks, church-like rock and rock pinnacles	117	38%	3.6	1.2
Heath/moorland (3001-4000m)	Patches of groundsels (i.e. giant senecio and lobelia trees), flowers of the genus Helichrysum (e.g. everlasting and stoebes), protea, Maundi crater and underground waterfall	233	76%	3.3	1.0
Montane forest (1800-3000m)	Wildlife, waterfalls, forest flowers (e.g. red-hot pokers, fireball lilies and wilderness) etc.	264	86%	3.0	1.0

Total number of respondents (N=306)
*Count is the Number of respondents who indicated this was the/a main attraction
**Likert rating or Mean score based on scale: 1 extremely important: 2 very important: 3 medium important: 4 less important: 5-least important

4.2 Methods and data

Our study approaches the effects of environmental change on tourism from an environmental suitability perspective. It concentrates on the environmental side rather than the tourism side of the topic, because of the very limited availability of tourism statistics. The only available dataset, provided by KINAPA, contains monthly visitor numbers for the 2000-2013.

The main links between environmental change and trekking tourism that were described in Section 4.1.1 are interpreted as hazard-activity pairs. Hazard-activity pairs were proposed by Moreno and Becken (2009) as a way to structure the analysis of the often complex interactions between climate change and tourism in a particular destination. Rather than considering all aspects of climate change and all tourism activities at the same time, they concentrated on the links between one relevant aspect of climate change (the hazard) and one important tourism activity at a time. Afterwards, these partial analyses were integrated into a vulnerability profile for the destination as a whole.

This paper uses the hazard-activity approach to structure our analysis of the interactions between environmental change and tourism activities on Mount Kilimanjaro. Four pairs: three related to the physical aspects of trekking and one related to sightseeing in the various land-cover zones.

The first pair combines rainfall and trekkers' comfort. Trekkers' comfort is assumed to decrease linearly with rainfall amounts. The observed trend in annual rainfall for Tanzania were available at a resolution of ~5km for 1981-201 6 (FCFA, 2017). Complementary to this source, rainfall trends were estimated from local weather station data, using linear regression. In addition, monthly trends were estimated in view of the strong seasonality in visitation patterns.

Annual and monthly data from the weather station at Kilimanjaro International Airport (KIA; 896m ASL), covering the 40-year period between 1973 and 2013, were purchased from the Tanzania Meteorological Agency. The KIA weather station is located outside KINAPA. Additional data were obtained from the Nyati weather station, located within KINAPA at 3250m altitude. This dataset covers a shorter period: from 2000 to 2013. No other datasets were available to sample the heterogeneity of rainfall patterns within the park.

Hazard-activity pair two represents the relationship between the intensity of rainfall events and the risk of landslides and rock-fall. Exploring the intensity of rainfall events and the frequency of intense rainfall events requires very high-resolution precipitation data. This kind of data is not available for KINAPA. Instead, monthly data were used as very rough proxy data, under the assumption that rainfall intensity and the frequency of intense rainfall are positively correlated with rainfall totals. The same data were used as for the rainfall-comfort pair.

Hazard-activity pair three pertains to the relationship between temperature, air pressure and altitude disease. To explore this hazard-activity pair, the trend in temperature at the top of Mount Kilimanjaro over the past decades is estimated. Observed weather data for Kilimanjaro's mountaintop are limited to two years of daily measurements by an automatic weather station in 2000 and 2001, which had been temporarily placed there in the context of a research project. These data provide a reference point but not a trend. That is not a problem, however, since we do have time-series data on temperature at the mountain's foot, yielding information on temperature change. This is a good estimate for temperature change at the mountaintop, given the rather stable temperature gradient between a mountain's foot and top. Monthly temperature data were obtained from the KIA station, located at the foot of the mountain, for 1973-2013. The trends obtained from these weather station data were compared with those reported in FCFA (2017); this is a useful check, since temperature is generally much less variable in time and space than rainfall.

Hazard-activity pair four relates to the effects of climate change on the quality of the attractions tourists pass while trekking. The quality of an attraction is understood here as the importance tourists attach to it, in this case according to a study by Kilungu et al. (2018). Attractions on Mount Kilimanjaro are uniquely connected to specific land-cover zones, with some land-cover zones harbouring more important attractions than other zones. In this study, we assume that the sightseeing attractiveness of the mountain as a whole depends on the distribution of the total mountain area over the various land-cover types (e.g. snow, heathlands and montane forest). Our analysis consists of tracking the shares of Mount Kilimanjaro's mountain area that each of the land-cover types occupies over time. The land-cover maps needed for this analysis were derived from Landsat TM7 satellite images, which are available free of charge from www.glovis.usgs.gov. The Landsat images were transformed into land-cover maps using the Normalised Difference Vegetation Index (NDVI), following Pettorelli et al. (2005) and Zurlini et al. (2006). Images were selected based on three criteria. First, the level of cloud cover on the images had to be limited to allow processing. Second, the period covered by the set of images had to be at least a decade to allow detection of slow changes. Third, all images had to be taken in the same season of the year to avoid interference of inter-seasonal changes. The final selection contained three images, which were taken in February 1993, February 2000 and February 2013.

4.3 Results

FCFA's climate policy brief for Tanzania (FCFA, 2017) clearly shows that rainfall amounts for the Mount Kilimanjaro region (around 1500mm per year) are among the highest in the country. The report indicates slight to moderate reductions of up to 6mm/year in rainfall for the Kilimanjaro region in the 1981-2016 period. The KINAPA and KIA weather station data reveal that annual rainfall on and near Mount Kilimanjaro is highly variable (see Figure 4.1). For both stations, trends in annual rainfall are negative, albeit not significant at the 95% confidence level.

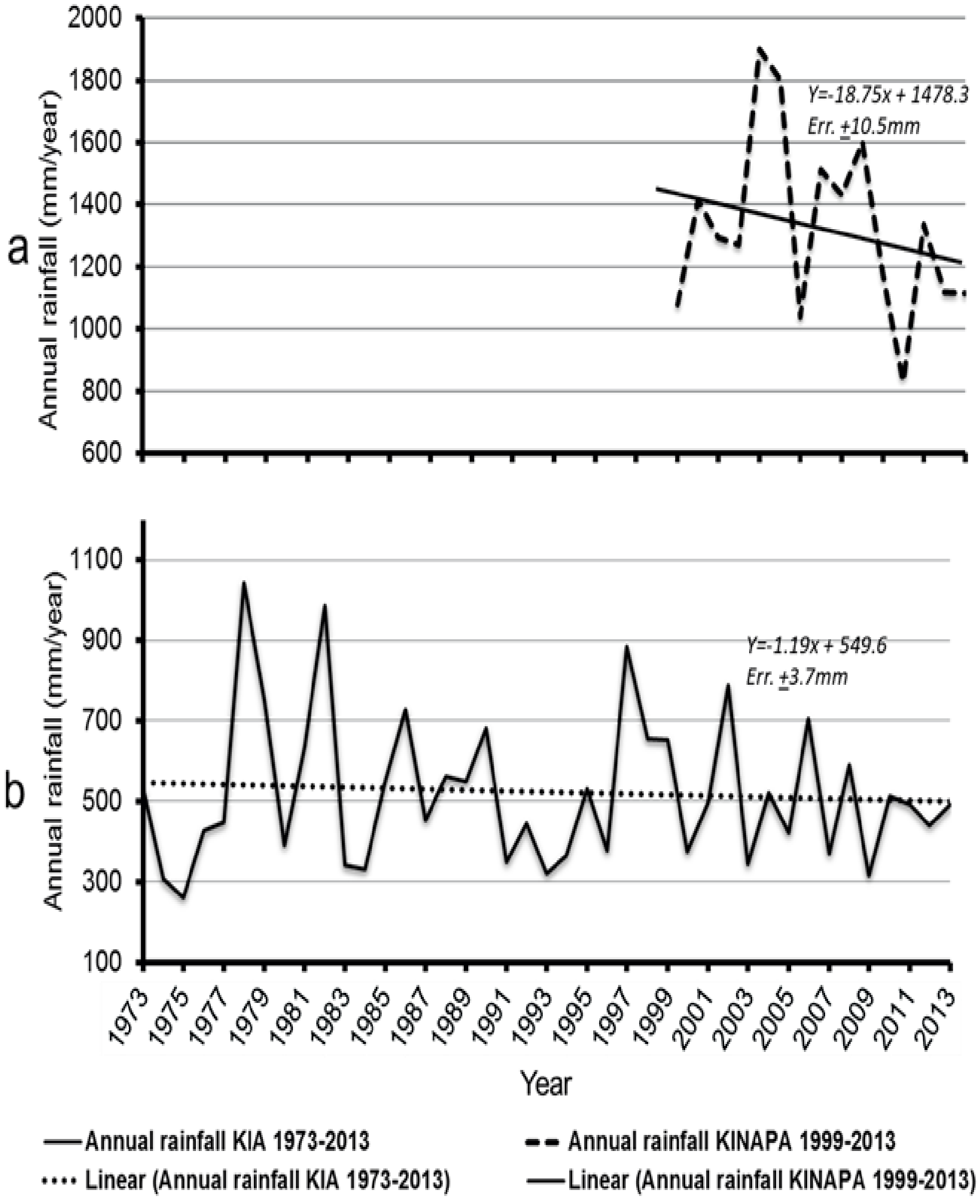

Figure 4.1 Annual rainfall totals and trends for (a) KINAPAand (b)KIA from 1973 to 2013.

On a monthly level, significant changes in rainfall seasonality were found for March and April. March's share in annual rainfall increased by 15±1.4 percent points, at the expense of April that lost 14±1.6 percent points (see Figure 4.2). This shift signals an earlier start of the long rains season. No significant trend was detected for the rainfall shares of the other months. The earlier onset of the rainy season has had no discernible impact on the tourism seasonality pattern. This pattern remained fairly stable between 2000 and 2013, with considerable inter-annual variability. June appears to be gaining importance at the expense of August, but the data series is too short to conclude if this is a significant trend.

In view of the decreasing trends in annual precipitation, general climbing conditions are likely to have improved. The risk of landslides may have decreased as well, under the assumption that the general decrease in precipitation has corresponded to a decrease in heavy precipitation. The analysis suggests that March and April have been subject to most changes, with climbing conditions in March deteriorating and conditions in April improving.

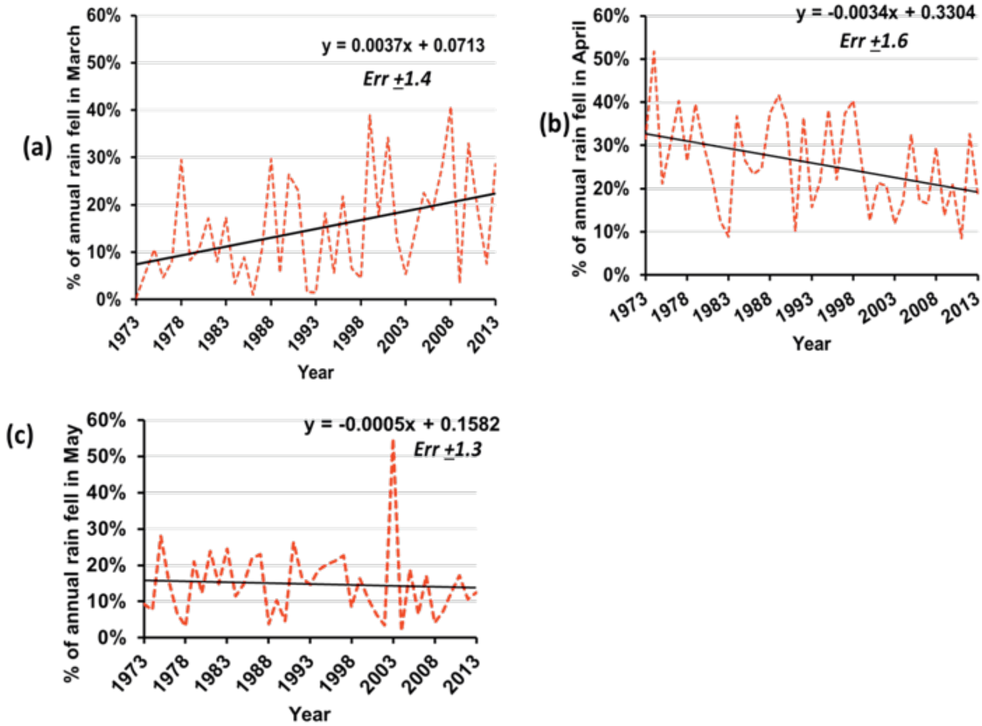

Figure 4.2 Shares in annual rainfall totals at KIA. Trend for March (a), April (b) and May (c) 1973 to 2013.

In 2000 and 2001, the temporary weather station at the mountaintop registered an annual mean temperature of -7.1°C, with daily temperature fluctuating slightly around that mean and never exceeding -2°C (Thompson et al., 2002). At the foot of the mountain, as represented by the KIA weather station, the annual temperature increased by 1.3±0.6°C (p-value <0.05) between 1973 and 2013 (see Figure 4.3). Taking the annual mean temperature of the year 2000, measured at -7.1°C, as a reference point, the observed temperature change at the foot of the mountain corresponds to a temperature change at the top from an estimated -8.0°C in 1973 to an estimated -6.7°C in 2013.

This temperature change translates into an increase in barometric pressure of around 200Pa, which, at the mountaintop, is equivalent to a descent of around 28m. Whereas this change seems small, in a study for Mount Everest a similar change in pressure (from 200Pa to 300Pa) was found to be physiologically relevant for climbers (Moore & Semple, 2009). Besides affecting the risk of altitude sickness, the increasing temperatures at higher altitudes also cause permafrost soils to thaw. This can destabilize infrastructure, such as climbing trails, airstrips and campsites and increase the risk of landslides and rock fall.

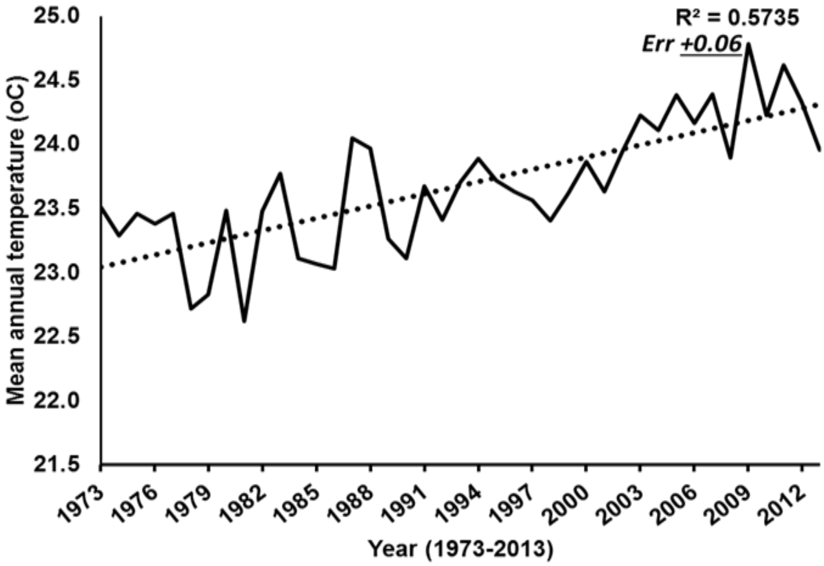

Figure 4.3 Mean annual temperature at KIA from 1973 to 2013.

At the start of our study period in 1993, changes in land-cover were already well underway, in particular with respect to forests (see Hemp, 2005) and ice cover (see Thompson et al., 2002; Thompson et al., 2009; Cullen et al., 2013). In 1912, ice cover on Mount Kilimanjaro amounted to 11.40km^2, of which only 3.8 remained in 1993 and 1.76km^2 in 2011 (Cullen et al., 2013) and we assumed a negligible change between 2011 and 2013. That is, ice lost 2.04km^2, 54% of its 1993 area. Our study indicates that between 1993 and 2013, land cover patterns on Mount Kilimanjaro showed substantial further change (see Table 4.2). Montane forest lost 169.5km^2, 15% of the initial area. The area of alpine desert increased by 9.5km^2 (8%) and that of heathland by 166.1km^2 (38%). The analysis further suggests that most of this change occurred prior to 2000. Afterwards, the rate of change levelled off; the trend in ice cover even reversed.

Figure 4.4 shows how the changes in land-cover played out spatially. The alpine desert expanded upslope as a result of snow melt, but also downslope into areas previously home to heathland vegetation. In its turn, heathland vegetation shifted further downslope, in particular towards the Shira plateau in the West and northeast. Replacing montane forest cover, heathlands now occur under 3000m. The possible reasons for these changes are discussed in the discussion section.

The downslope shift of heathland vegetation has resulted in the presence at lower altitudes of flowers with substantial tourism potential, such as Helichrysum. Changes are particularly noticeable at the Shira plateau.

The plateau, which offers good views of the snow on top of Mount Kilimanjaro and Mount Meru, was largely covered by Erica bush (Beck et al., 1983), but is now being colonized by Helichrysum and other flowering species. The area is within easy reach of day visitors.

The loss of montane forest has likely increased pressure on wildlife species, including those of tourism potential. Prior studies (e.g. Newmak et al., 1991; Agrawala et al., 2003) associate change in forests with loss of wildlife. Grey duikers and Elands have become endangered, while Black Rhinos are now extinct (Newmak et al., 1991; Agrawala et al., 2003). Local residents report that Black-and-White Colobus monkeys, which were previously spotted year-round, are now only seen in specific seasons and that the spatial distribution of many bird species has changed (Minja, 2014). The abundance and diversity of forest flowers have probably also diminished.

Table 4.2 Land-cover change in Kilimanjaro National Park between 1993 and 2000/2013

Land cover	Area (sq. km)	Land cover change			
	1993	1993-2000		1993-2013	
		Area change	Percentage	Area change	Percentage
Snow/ice (5001-5895m ASL)	3.8 as per Cullen et al, 2013			-2.0	-54%
Boulders/sand -alpine desert (4001-5000m ASL)	128.1	+9.5	+7%	+10.6	+8%
Heathland/moorland vegetation (3001-4000m ASL)	431.7	+118.6	+27%	+166.1	+38%
Montane forest vegetation (1800-3000m ASL)	1096.7	-120.5	-11%	-169.5	-15%
Total	1668.0	0	0	0	0
Cullen et al, 2013 reported 1.76 square kilometres remained in 2011. We assumed a negligible change between 2011 and 2013.					

4.4 Discussion

This paper's main purpose is to draw attention to the main impacts of observed environmental change on trekking in Kilimanjaro National Park, also in view of the projected acceleration of climate change and other forms of environmental change. The results suggest that the indirect impacts of environmental change have likely had a much bigger impact on tourism in KINAPA than the direct impacts. Since the 1970s, sightseeing opportunities have changed substantially as a result of land-cover change supporting key attractions. The land-cover changes reported here resonate with those reported by other authors, such as Hemp (2005; 2006, 2009) and Newmak et al. (1991).

Snow, which is KINAPA's second most important attraction, lost most of its coverage and may even disappear completely in the near future (Thompson et al., 2009; Thompson, 2010; Helama, 2015). Simultaneously, large areas of montane forests, which are home to attractions, such as wildlife, flowers and waterfalls, have given way to heathlands, radically changing the vegetation and wildlife.

The transformation from forest to heathlands is remarkable, since it represents a downward shift in vegetation, whereas climate change is typically associated with upward shifts. Deforestation and a change in the wildfire regime have been put forward as explanations (Hemp, 2005; Hemp, 2009). Drier and warmer conditions have made Erica trees, which dominate the cloud forest at the high end of the montane forest belt, more susceptible to fire. Fire caused the loss of nearly one-third of the forest cover between 1906 and 1976 (Hemp, 2009), 300 hectares of Erica forest between 2001 and 2004 (Madoffe & Munishi, 2005; URT, 2013), and 40 hectares in 2014 alone (Jenman East Africa, 2013). The Erica forests are replaced by Erica bush, a pioneering species characteristic of the heathlands that thrives in the new conditions. Erica bush, however, is also susceptible to wildfire. At higher altitudes, it is in its turn replaced by Helichrysum, the heathlands' climax vegetation. Assuming that the usual uphill shift in vegetation is still taking place, the Erica forest is actually squeezed between the uphill expansion of the lower montane forest and the downslope expansion of Erica bush. The precarious position of the Erica forest will further deteriorate as climate change continues. The developments within the montane forests and their implications for tourist attractions are an important topic for further study.

The reported slowdown of land-cover change after 2000 may be related to the introduction by the Kilimanjaro regional administration of stringent bylaws in 2000 to control cutting trees. The bylaws control tree cut and forest harvests. In addition, illegal logging is limited to occasional incidents (ecologist warden, E. Kikoti, personal communication, February 2017).

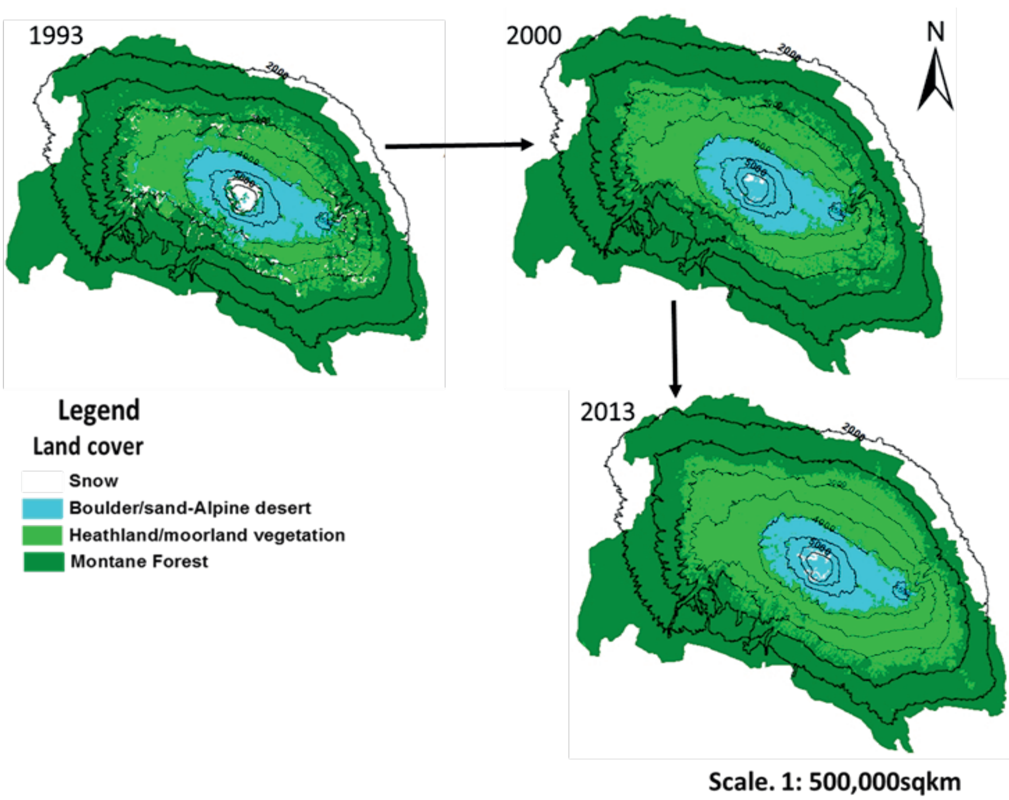

Figure 4.4 Land-cover in Kilimanjaro National Park in February 1993, February 2000 and February 2013. Data source: Landsat TM7, www.glovis.usgs.gov

Our findings on the loss of snow cover confirm earlier studies, such as Thompson et al. (2009) and Cullen et al. (2013). Snowless Mount Kilimanjaro will very likely be less attractive to tourists, given the position of snow as the mountain's second-most important attraction after the mountain's high altitude. Therefore, the long-term impacts of snow loss will be negative. In the short term, however, as long as snow is melting but has not completely vanished, visitor numbers may actually increase through a phenomenon called 'last-chance tourism'. Last-chance tourism refers to visits to destinations or attractions that are expected to disappear (Lemelin et al., 2011).

The direct impacts of environmental change, those affecting trekking conditions, are less clear. Mean temperature has gone up by an estimated 1.3+0.6°C. The downward trend in our annual precipitation was not significant at the 95% level, which may be due to the limited time series. Based on a much longer dataset (1911-2004) for two stations located at 1430m altitude on Mount Kilimanjaro's southern slope, Hemp (2009) also reported a decrease in annual rainfall. In contrast to ours, Hemp's results were statistically significant. For Tanzania as a whole, Future Climate for Africa (FCFA, 2017) reports a negative trend in rainfall, albeit not a statistically significant one because of the large inter-annual variability in rainfall. A combination of higher temperatures and less precipitation creates more favourable climbing conditions on the lower parts of the mountain. Higher up on the mountain, the temperature increase may have caused permafrost to melt and destabilised trails and infrastructure. The same temperature increase has likely reduced the risk of altitude sickness, albeit to a limited extent. Air pressure increased by 200Pa, which is equivalent to a descent of just 28m. This may seem a marginal effect, but Moore and Semple (2009) found similar increases in pressure (200Pa -300Pa) to be of physiological relevance for climbers on Mount Everest, as it increased the maximum oxygen consumption at the summit by 10%. The effects on Mount Kilimanjaro are likely to be noticeable as well, albeit smaller than on Mount Everest, given the difference in altitude between the mountains.

Due to a general lack of data, both on the environmental and on the tourism side, many assumptions had to be made, with varying effects on the reliability and plausibility of the results. To start with, the strong spatial and temporal variation in temperatures and rainfall amounts on Mount Kilimanjaro could not be adequately captured, since climate data were available from only a few weather stations, and for relatively limited periods of time. To compensate for the lack of a long series of temperature data at the summit, we used the few years of available data to create a reference point and combined this with the temperature trend, observed at the mountain foot. This method yields reasonably accurate results as long as the temperature at the top shows little inter-annual variability and the temperature gradient between the foot and top of the mountain is stable, both of which conditions are met. Daily or hourly data are required to analyse the high-intensity rains that can trigger landslides and rock fall, but monthly data were the best available. Our suggestion that the risk of landslides and rock fall may have diminished because of decreasing rainfall totals is therefore the most speculative of our study. FCFA (2017), for example, point in the opposite direction, projecting an increase in rainfall intensity on rainy days, despite a general reduction in rainfall. Our analysis of land-cover change was based on freely available satellite images. The limited number of images studied were enough to draw some general conclusions about long-term changes, but insufficient to deliver insights on developments in the rate of change. In addition, the limited number of land-cover categories identified may hide dynamics within each of the categories, as in the case of the Erica forest being squeezed from two sides in the montane forest area. Future impact assessments would greatly benefit from more, longer and higher-resolution datasets of climate and environmental change.

Data are also lacking on the tourism side. Records of monthly visitor numbers for most parks in Tanzania, including KINAPA, do not go back further than the year 2000 (also see, Mitchell et al., 2009; Kilungu et al., 2017). Before 2000, the parks' tourist visits were not properly documented. In 2005, TANAPA decided to gather and digitise these data from 2000 onwards (park warden M. Mombo, Personal communication, February, 2013) This dataset sufficed to establish a clear link between the seasonality patterns in rainfall and visitation, with visitation peaks in the dry seasons. However, shifts in visitation, as a result of shifts in rainfall, could not be established. Longer datasets with daily resolution are needed for that. Information about the spatial patterns of tourism behaviour is also scarce. Our study compensated for this knowledge gap by using survey data about tourists' preferences for the various sightseeing attractions on Mount Kilimanjaro. Spatial data on tourists' whereabouts would, however, help to complement this self-reported data, in particular if it was a product of continuous monitoring programme.

Our study has important implications for management and policy. In the short term, park managers should account for potential last-chance tourism to Kilimanjaro. They should, however, be aware that almost by definition any increase in visitor numbers associated with last-chance tourism is temporary, in particular if Kilimanjaro were to be completely snowless by 2020 as has been projected (Thompson et al., 2009; Helama, 2015). Making structural investments to accommodate this temporary growth may not be warranted. A more structural change that park managers can try to capitalize on is the increased attractiveness of the Shira plateau. They can do so by providing facilities, such as picnic sites and campsites. Such facilities are likely to be of particular interest for day visitors and domestic tourists and can thus help to diversify the park's visitor profile. This insight is a good example of the study's broad scope that goes beyond the traditional focus on the ice cap and reaching the summit. For many visitors, sightseeing in the various landscapes, either as part of a mountain climbing expedition or as part of a daytrip, is an important aspect of visiting Mount Kilimanjaro. Just like snow and ice, sightseeing attractions are tourism resources that merit monitoring and management.

Mountain tourism destinations are highly susceptible to the impacts of climate change (Beniston, 2003). Our study shows that Kilimanjaro is no exception. It is increasingly important for mountain tourism-destination managers to understand their susceptibility to climate change and to devise appropriate adaptation strategies to warrant sustainable tourism. Nevertheless, KINAPA's current general management plan (2005 2015) does not yet identify climate change as an issue of concern. KINAPA's new 10-year general management plan, which is currently being developed, provides an excellent opportunity to introduce climate and environmental change as major drivers of change. The general management plans of other parks are being revised or replaced as well, and our study can inform those plans by showing the variety of ways in which climate and environmental change can affect nature-based tourism.

The policy relevance of our study extends beyond Tanzania's park system. Tanzania is currently revising its tourism policy (current version dated 1999) and is committed to developing adaptation plans as part of the 2015 Paris Agreement. Our study draws attention to the importance of climate and environmental change for tourism, and the importance of tourism for adaptation. The tourism sector has long taken climate and weather for granted (Scott et al., 2005; Tervo, 2008), which has hindered the mainstreaming of climate change adaptation in tourism management, planning and policy, particularly in Africa (UNWTO/UNEP, 2008; Hoogendoorn & Fitchett, 2018).

Our study adds to the growing body of literature on climate change impacts on tourism in Africa that reminds the sector of its dependence on climate and environmental resources, and of its vulnerability to environmental change. Mount Kilimanjaro's rapid loss of snow is a powerful signal.

Similarly, our study reminds the adaptation community of the relevance of tourism. This is particularly important now that Tanzania has committed to developing adaptation plans as part of the 2015 Paris Agreement. Tourism is a major economic sector in Tanzania, accounting for 13% of Tanzania's GDP, compared to 29% for both agriculture and industry (https://www.indexmundi.com/tanzania/gdp_composition_by_sector.html)[4]. Tourism in Tanzania is primarily nature-based and thus susceptible to environmental change, as our study on Mount Kilimanjaro shows. Whereas climate change impact assessments and adaptation plans have been produced for sectors, such as agriculture (FAO, 2015) and forestry (FAO, 2009; Hall, 2009), no such assessments and plans exist for tourism. Our study responds to the call for tourism-focused studies and policies (see e.g. Hoogendoorn & Fitchett, 2018) and adds further urgency to it.

Tanzania may come to experience tension between adaptation and mitigation policies with respect to tourism. Its adaptation policies may be directed at projecting the tourism sector as a key economic sector and an important source of foreign currency. Most tourists, however, are foreigners, most of whom arrive in Tanzania after long-haul flights. Aviation is tourism's largest and most problematic source of greenhouse gas emissions and, in the absence of viable technological solutions in the short and medium term, may face restrictions and/or much higher fuel prices in the not-so-distant future (Peeters & Eijgelaar, 2014). Restrictions and higher prices are likely to have the largest impact on long-haul tourist flows, thus potentially hurting destinations that depend on such flows, such as Tanzania. The study by Peeters and Eijgelaar (2014), however, suggests that for most countries, the negative impacts will be limited, as long-haul visitors will be replaced in part by short-haul visitors from neighbouring countries. In this case, Tanzania should also advocate its domestic tourism.

4.5 Conclusion

This study is a first-order assessment of the changes in climate and land-cover on Mount Kilimanjaro over the past 20 to 40 years and the impacts thereof on trekking and tourist attractions. The study's primary focus is on trekking, the dominant tourism activity on Mount Kilimanjaro. Trekking has two main aspects: the physical performance of climbing and sightseeing. Change in rainfall at lower altitudes, temperature change at high altitudes and land-cover change were identified as the aspects of environmental change that are most relevant for trekking and sightseeing.

Land-cover change has arguably had the largest impact on tourism. The montane forests, which is home to Black-and-White Colobus monkeys, birds and other animals appreciated by tourists, became 166km^2 (15%) smaller in the past two decades. The area of heathlands, which is known for its many attractive flowers and giant groundsels, increased by almost the same amount (170km^2, 38%) and now covers most of the Shira plateau. Since the Shira plateau is within the reach of day visitors, this development provides an opportunity for market diversification. Increased use by day visitors and domestic tourists, however, probably requires a higher standard of facilities than is currently provided. The most alarming development has been the loss of snow cover. Mount Kilimanjaro's snow-cap, one of the mountain's main attractions, lost half of its extent in the last two decades.

4 https://www.indexmundi.com/tanzania/gdp_composition_by_sector.html . Tanzania GDP-Composition by sector. Accessed on Septermber 12, 2018

Ironically, in the short run, this rapid decline is likely to add to the mountain's appeal through an increase in 'last-chance tourism': tourism to disappearing destinations. Park managers should be aware that this positive effect on visitor numbers will likely be short-lived. In the long-run, the absence of snow will make the mountain less attractive. This effect can be partly mitigated by carefully managing the mountain's forest cover and maintaining and further developing attractions in the expanding heathlands.

Reaching the top of Mount Kilimanjaro has probably become somewhat easier over the past 40 years. Mean temperature at the mountaintop increased by 1.3±0.6°C, which resulted in an estimated 200Pa rise in barometric pressure, making breathing easier and reducing the risk of altitude disease. Although an increase of 200Pa is equivalent to a descent of just 28m, previous studies suggest that such change has physiological significance. With respect to rainfall, trekking conditions at lower altitudes appear to have remained largely unchanged over the past 40 years. The downward trend in annual rainfall, though not statistically significant at the 95% confidence level, confirmed the results of earlier studies. Our study did reveal a statistically significant backward shift in rainfall from April to March, signalling an earlier start of the short rains period. The relevance of this shift for tourism is limited, however, as March and April belong to the low season. This study found substantial impacts of environmental change on tourism in Kilimanjaro National Park, and the acceleration in climate change suggests that more is yet to come. Adequate anticipation and adaptation by park managers require detailed assessments. More complete and extensive datasets on tourist arrivals, attractions, temperature, rainfall, and land-cover are a pre-requisite.

Our assessment coincides with the revision of KINAPA's general management plan, the revision of Tanzania's tourism policy, and the development of adaptation policies in response to the 2015 Paris Agreement on climate change that Tanzania signed earlier in 2018. The current versions of the general management plan (2005-2015) and the tourism policy (1999) do not yet identify climate change and environmental change as major factors. Current adaptation plans do not yet identify tourism as an important sector. Our study emphasises the need to acknowledge and act on the strong links between the phenomena of environmental change and tourism.

Chapter 5

What are the effects of climate and land-cover change on tourist attractions in Serengeti National Park?

Published as:

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Abstract

Serengeti National Park is famed for its wildlife migration tourism for decades. The park contributes substantially to country's revenue and is a major employment arena that is based on tourism activities. Wildlife migration is the major tourist attraction in Serengeti and climate-dependent. There is a growing concern that climate has changed significantly with potential influence on wildlife migration. However, the knowledge of the consequences of climate-change on Serengeti's tourism are poorly known. This paper analyses the consequences of rainfall and temperature variability and change, and associated land-cover changes on major tourist attractions and tourism over the past four decades. The results show that natural climate is an important factor shaping tourism seasonality and tourist attractions in Serengeti. Key impacts of increasing rainfall and temperature variability, and associated land-cover change include disruption of tourism seasonality, wildebeest migration patterns, and reduced diversity of tourist attractions. Both negatively affect tourism by reducing the park's attractiveness. Adapting tourism to climate-change impacts requires active and integrated management approaches that improve the park's attractiveness. The results can be used to develop climate-change adaptation strategies and inform conservation and tourism planning.

Keywords: Climate change, Serengeti, tourist attractions and tourism.

5.1 Introduction

Nature-based tourism (NBT) in Tanzania is largely conducted in national parks. Serengeti is the keystone national park in Tanzania and one of the most famous world heritage sites. The land-cover diversity and the vast endless savannah plains in the Park host the last remaining wildlife migration of about 1.3 million wildebeests (Sinclair et al., 2015). The park contributes one-third of all income earned by the Tanzania National Parks (Eagles & Wade, 2006) and provides a significant employment opportunities for Tanzanians (Melamari, 1996). NBT in Serengeti National Park (SENAPA) is thus very important in Tanzania.

The rainfall patterns in Serengeti are very variable and its wildlife species are generally well-adapted to these variations. A quarter of its main tourist attraction (i.e. wildebeest migration) is triggered by rainfall (Boone et al., 2006; Musiega et al., 2006) and two-third being driven by rain-fed food availability (Mduma et al., 1999; Boone et al., 2006) and drinking water (Walonski & Gereta, 2001; Strauch, 2013). The significance of rainfall variations in Serengeti's tourism is powerful and should not be undermined.

The timing, amount and duration of both short and long rains are fundamental determinants of the diversity of major tourist attractions and day-to-day tourism activities in Serengeti. The normal rainfall seasons (i.e. March to May and October to December) in the southern Serengeti provide a conducive growth environment for short grass that contains high nutritional content required for both calves and lactating wildebeests (Walonski et al., 1999; Walonski & Gereta, 2001). As a result, each year wildebeests give birth synchronously with almost half a million calves being born between February and March in the southern short grasslands (Estes, 1976). The synchronised breeding results to large aggregations of wildlife that form a significant attraction to tourists. In case the synchronised breeding coincides with drought or shifted rainfall seasons, the survival rate for both calves and lactating mothers is reduced (Estes, 1976), consequently the likeliness of tourists observing large wildlife aggregations is less guaranteed. For instance, during the 1962 severe drought, approximately 500,000 calves died (Talbot & Talbot, 1963; Estes, 1976). This change probably had affected tourism although studies to attest this are inadequate.

Between the 1900s and 1970s, a series of droughts of different magnitudes have occurred in the Serengeti's ecosystem with a minimum return period of ten years. One large El Niño-related flooding occurred in 1962 (FAO, 2010). Due to these extreme climatic events and associated diseases (e.g. rinderpest), the migrating wildebeest population dropped to 200,000 in the 1950s and the migration stopped due to few individuals and fragmented wildebeests' population. Migration resumed in the post-1960s (Mduma et al., 1999). Recently, a severe drought caused the wildebeest population in the Kenyan Amboseli ecosystem (a similar ecosystem to Serengeti) to collapse by more than 85% (FAO, 2010; MEMR, 2012). In 2010, its population numbered only 3,000 animals out of over 15,000 animals a year before (Ogutu et al., 2011; MEMR, 2012; Ogutu et al., 2013). These climatic and/or weather events affected the perceived attractiveness and, in turn, tourism. In the pre-1980s, most severe events with a long return period allowed ecosystems to recover, adapt and build resilience. However, recent studies (Hastenrath, 1984; Hemp, 2005; IPCC, 2007a; Hemp, 2009; Munishi et al., 2009; Munishi et al., 2010) show that since the 1980s, droughts have become intermittent and the rate of rainfall and temperature variations has exceeded those of the past 100 years. The increased variability likely has changed the return period of extreme climatic events in SENAPA and likely affected tourism seasonality and natural land-cover diversity that supports tourism.

Climate change indirectly affects NBT by impacting the physical resources that define the nature and quality of natural environments (i.e. land-covers) on which tourism depends (Scott, 2006). Land cover heterogeneity and diverse landscape patches in SENAPA harbour a variety of tourist attractions and provide a range of habitats and food for large aggregations of wildebeest migration. Any changes in the properties of land covers could negatively affect tourism by reducing this wildlife diversity and thus its perceived attractiveness. According to Turpie and Siegfried (1996) and Sandra et al. (2005) changes in land cover is the major factor that reduce the diversity of tourist attractions and diminish the attractiveness of most protected areas in South Africa. Savannah grasslands, which are the major vegetation cover in SENAPA and a pillar of its tourist attractions, are also highly sensitive to short-term rainfall variations and highly vulnerable to long-term changes (Vanacker et al., 2005). Changes in grasslands and other vegetation covers are the key drivers of wildlife habitats modification and loss (Balmford et al., 2001; Brooks et al., 2002; Duerksen & Snyder, 2005). The ecological consequences of changes in vegetation cover are well studied in SENAPA (Trager & Mistry, 2003; Sinclair et al., 2007; Sharam et al., 2009) in contrast to tourism management.

In summary, climate is a powerful driver of wildlife migrations and likely a driver of tourism in SENAPA. Thus, understanding the relationship between climate and tourism and consequences of climate change on tourism becomes a pressing issue to tourism planning and informing policy. In recent decades, however, there is a growing concern that climate change threatens wildlife migrations in the East Africa (NAPA, 2007; Ogutu et al., 2011; 2012; 2013). The increased frequency and severity of droughts and floods that is expected to occur will modify vegetation growth and hence wildlife's food availability and populations (IPCC, 2012). Serengeti is no exceptional. The changes are expected to affect the Serengeti's attractiveness and tourism, though the consequences of climate change on Serengeti's tourism are poorly studied. Addressing this knowledge gap is becoming more important as the economic significance of tourism is growing and the impacts of climate change on tourism are becoming more apparent.

The main objective of this paper is, therefore, to analyse the consequences of the long-term climate variability and change and associated land-cover change for major tourist attractions in SENAPA. Specifically, the paper addresses two major questions. 1) What are the relationships between rainfall, tourist visits and tourist attractions? 2) How have contemporary climate change and variability affected tourist attractions? To answer these two questions, the paper (1) assessed the relationship between rainfall variations and tourist visits and wildebeest migration. (2) Analysed the impacts of rainfall and temperature variability and change on this relationship and (3) assessed the impacts of climate-driven land-cover change and its consequences on tourist attractions and tourism for the past 40-year period (i.e. from 1970 to 2010). The results of these analyses were innovatively combined to suggest possible adaptation and mitigation measures for (future) tourism in SENAPA. This paper strongly builds on the relationship between wildebeests and rainfall that was developed by Boone et al. (2006).

The next section (Section 5.2) provides a brief description of the methods; the case study, data used and analyses. Then, results are briefly presented in Section 5.3 followed by detailed discussions on the consequences of recent climatic trends and land-cover change on major tourist attractions and tourism (Section 5.4). The conclusion (Section 5.5) highlights on the necessary adaptation measures to reduce adverse impacts of climate change on tourism in SENAPA and calls for active management that considers an integrated approach to changes in climate and land cover.

5.2 Materials and method

5.2.1 Description of the paper site

The focus of this paper is the Serengeti National Park (SENAPA), which covers almost fifty percent of the major Serengeti-Mara Ecosystem. The park is largely operating under a `*closed managed system model*`, which means that almost ninety percent of its ecosystem is legally protected and surrounded by other protected ecosystems (Figure 5.1). This model assumes that changes in land covers are largely driven by climate-related changes and variability. The park boundaries lie between 34°0'E to 36°0'E and 1°15'S to 3°30'S and stretches over Northern Tanzania and Southern Kenya. As a result, the park's attractions are unique as it falls in the Somali-Masai centre of plants and animal endemism (White, 1983). Its location between Lake Victoria in the West and Lake Eyasi in the South strongly influences wetness and, in turn, wildlife's food availability and this makes the wildlife-based tourism reliable in dry seasons. The Great Rift Valley to the East and the Ngorongoro Crater to the South enhance the plant and animal diversity, and in turn, this makes Serengeti the most attractive park in Africa. The plant and animal diversity is also contributed by altitude variation between 920m and 1,850m above sea level and mean annual temperatures that vary between 15°C and 25°C and annual rainfall that varies from 450mm lee-wards of the Ngorongoro highlands to 1,050mm closer to Lake Victoria's shores (Schaller, 1972; McNaughton, 1979; Sinclair, 1979; McNaughton, 1983; Sinclair et al., 2000). Rainfall is strongly seasonal and occurs in two distinct rain seasons: a long rainy season from March, April and May (MAM) and a shorter rainy season in October, November and December (OND). The slight seasonal rainfall variation between North and South enhances the cyclical annual wildlife migration of 1.3 million wildebeests and other wildlife. The weather stations in Figure 5.1 represent the nearest stations where we acquired quality and historical climate data (1970-2010) for climate analysis. The weather stations are owned by Tanzania Meteorological agency and include; Mugumu, representing the northwest zone, Seronera, representing the central zone, Ngorongoro Crater, representing the southern zone and Loliondo, representing the eastern zone of SENAPA.

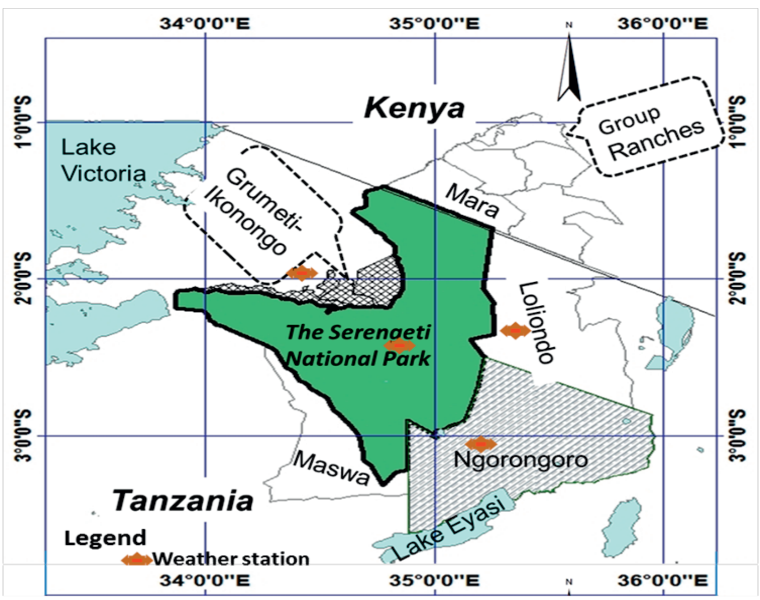

Figure 5.1 A map of the Serengeti-Mara Ecosystem indicating the Serengeti National Park as enclosed by other protected areas and weather stations used

5.2.2 Data collection and analyses

Climate and tourist arrivals data

To assess the relationship between rainfall seasonal variations, tourism seasonality and wildebeest migration calendar, the study used monthly rainfall and tourist vistation (i.e. number of peson visit) data the year 2000-2010 and wildebeest migration calendar as influenced by rainfall based on Boone et al. (2006). The paper used the EXCEL to calculate the correlation coefficient (r) to assess the strength of the relationship between rainfall and tourist visitations whereby -1 indicates a strong negative and +1 a strong positive relationship.

Furthermore, this paper assesses how long-term rainfall variability and change threatens the major tourist attractions and tourism. To achieve this, the study used rainfall data (i.e. 1970-2010) to analyse the rainfall trend in various zones in SENAPA. The statistical significant test (p-value) was used only as an indicator to determine the climate trends but not taken into greater considerations because monthly rainfall anomalies were seen to have greater influences that masked the long-term trends. In addition, the study assessed the trends for different climatic seasons that correlate with tourism visitation patterns to understand the influences of rainfall on wildebeest migration and, in turn, tourism. The seasons were; the long-rain season (i.e. MAM), the dry season (June, July, August and September, JJAS), the short-rain season (i.e. OND) and the transition dry season (January and February, JF).

The analysis of seasonal rainfall patterns aimed to assess how variability and change affect tourist attractions and day-to-day tourism activities. Increasing rainfall totals indicates food availability, consequently concentration of large aggregations of wildlife migration that in turn influencing the focus of tourism in these areas. Rainfall decrease indicates food scarcity and that migrating wildebeests will be scattered searching for food and drinking water. In this case, tourism will be chaotic because locating large aggregations of wildebeest will be difficult. In addition, we compared the amount of rainfall received in peak months to see if seasonal shifts exist and integrate it into the migration calendar stability to explain its implications on the wildebeest-migration viewing tourism.

Apart from rainfall assessments, temperature data were subjected to trend analyses to assess the warming trends and explain its impacts on the Serengeti's tourism. The mean monthly temperature variations were used to compare traditional comfort temperature (normal temperature in the 1970s) used for the wildlife-safari drives in the 1970s and 2000s. Then, the results of annual rainfall and temperature trends were superimposed on wildebeest population trend. The aim was to assess how rainfall and temperature variability and change have influenced the main tourist attraction (i.e. migrating wildebeests) in SENAPA.

Environmental and other qualitative data

We used Landsat TM7 and Enhanced Thematic Mapper plus (ETM+) images to assess land-cover change as an indicator of changes in food and the perceived attractiveness. Change detection techniques in ArcGIS were performed to assess land-cover changes. The paper applied the Normalised Difference Vegetation Index (NDVI) to assess the amount of land-cover change (Pettorelli et al., 2005; Zurlini et al., 2006). The resulting land-cover maps of 1984, 1995 and 2009 were used to indicate changes in suitable areas for migrating wildebeests. Images used for this analysis were for July 1984, July 1995 and October 2009.

The periods experienced severe droughts (see FAO, 2010) and can represent possible future climate-change impacts. The images were freely acquired from GLOVIS, the USGS Global Visualization Viewer (www.glovis.usgs.gov/). Wildebeest-migration population data for 1971 to 2010 were acquired through prior communications with Hopecraft and Sinclair, who are among the authors in Sinclair et al. (2015). Series of actual droughts to correlate with rainfall extremes were extracted from various literature reviewed in this paper.

The information collected during field observation and personal interviews with key informants from the Serengeti park authority (i.e. tourism and ecology wardens, hotel managers and hot-air balloon-safari managers) in March-April 2013 hinted the consequences of already felt climate-change impacts on tourism, conservation and coping strategies.

5.3 Results

5.3.1 Relationship between climate, tourism and tourist attractions

Our results indicate that tourist visits in SENAPA are marked in two distinct seasons with low rainfall. High number of tourists' visits (high tourism seasons) occur in dry season months of June through September and low number of tourists' visits occurs in rainy season months of March through May (Figure 5.2). The results demonstrate that natural factor; in particular, rainfall is an important factor shaping tourism seasonality in SENAPA although institutional factors like summer and the End of the Year holidays in the tourists' country of origin likely plays a role. The climate-tourism dependence was also proven by a strong negative correlation coefficient (r = -0.8) between rainfall and tourist visitations patterns. Integrating rainfall-tourism relationship with the known wildebeest migration calendar gives insights that Serengeti's tourism is time and location based. That is, in December through February, tourism is mainly conducted in the southen-central Serengeti (i.e. Seronera and Lake Ndutu and Magadi areas) and this coincides with synchronous wildebeest breeding. June through September tourism occurs in the northwest along the Mara River where wildebeests feed in dry season (Figure 5.2).

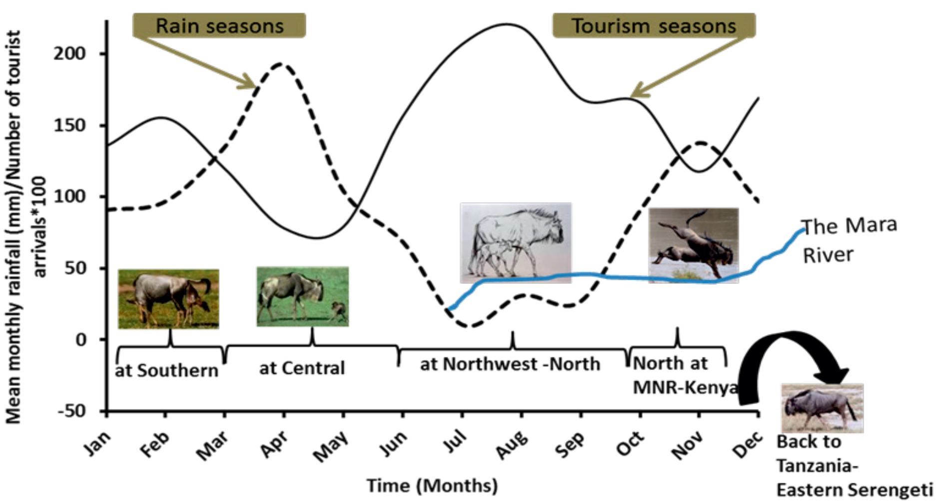

Figure 5.2 The relationship between rainfalls, tourism seasons and wildebeest migration in SENAPA from January to December. Small photos represent the location of migrating wildebeest in a year.

5.3.2 Consequences of climate change and variability on major tourist attractions

Rainfall in SENAPA has become highly variable though long-term trend shows no significant change ($p>0.05$). Lack of such trend does not mean no impacts rather highlights high climate variability in a short-term (i.e. monthly). Some months received unusual heavy rains (i.e. climate anomalies) that masked the trend. As a result, the 1983 and 1993 are seen as wet years for both southern and central Serengeti besides being the drought years in the literature (Figure 5.5). Despite the lack of a significant annual rainfall trend, the amount of rainfall received in various seasons either in the northern or southern zones has changed significantly (Figure 5.3). In the northwest and eastern Serengeti, the amount of rainfall received in the short-rain season (i.e. OND) increased by 8% and decreased by 5% in the south-central Serengeti.

In transition dry season (i.e. JF), no substantial change shown either in the North or South. The long-rains season (i.e. MAM) decreased by 5% in the northwest-eastern and increased by 6% in the southern-central zones. In dry season (i.e. JJAS), rainfall in both zones decreased by 3% (Figure 5.3). These variability and change have resulted in a substantial decrease in rainfall during peak months of April or November in the 1970s making them non-peak months in the 2000s. Contrary to this, March or May for long rains and December or January for short rains receive more rains relative to the 1970s (Table 5.1).

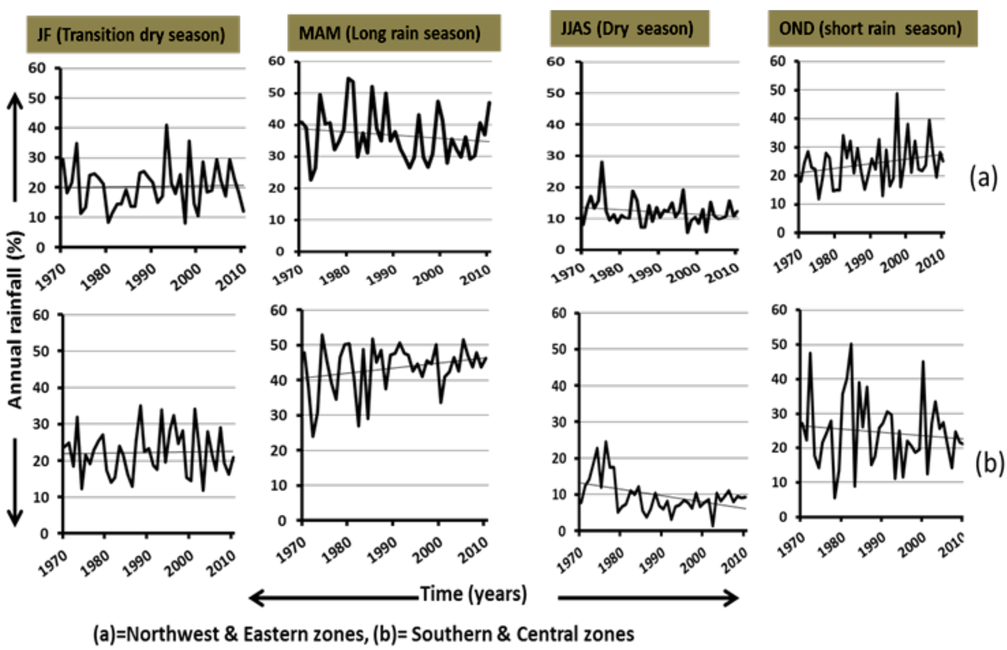

Figure 5.3 Changes in rainfall received for various rain seasons from 1970 to 2010 in the SENAPA

Table 5.1 Rainfall seasonal variability and peak shifts in SENAPA from 1970 to 2010

Amount of rainfall (%) falling in long, short and transition dry season										
		Long rain season (MAM)			Dry season JJAS	Short season (OND)		NDJ	Transition dry season JF	
Zone	Time	Mar	Apr	May		Oct	Nov	Dec	Jan	Feb
Northwest	1970s	8	27	13		6	11	10	9	13
	2000s	13	18	22		8	10	11	10	6
Eastern	1970s	18	24	12		3	7	9	12	10
	2000s	15	17	10		4	12	14	13	13
Southern	1970s	14	24	8		5	10	12	11	10
	2000s	16	18	15		3	5	15	14	11
central	1970s	8	16	9		6	8	9	10	12
	2000s	18	15	10		4	14	10	12	9

Blue circles =peak months, **red arrows** =decrease in rainfall in peak months in 1970s, **blue arrows** =increase in rainfall in non peak months in 2000s
Rainfall in non-peak months in 2000s are increasing at the expense of decreasing rainfall in peak months in 1970s. No specific peaks in 2000s as in 1970s . This study refer the situation as less predictability of rainfall seasons, prolonged dry season and droughtness in Serengeti

If the results in Figures 5.2 and 5.3 and Table 5.1 are suggestive and rainfall is the cue for wildebeests' migration and driver of the Serengeti's attractiveness, its implications of for tourism management will be substantive. The results can have both positive and negative impacts in different parts within SENAPA. Positively, the results imply a high possibility of migration to stay less or not going further to the North and then to Masai Mara National Reserve in Kenya or arrive early to the eastern Serengeti because of the increased OND rainfall in the eastern Serengeti. In turn, this will likely improves tourism in the eastern zone. Negatively, wildebeest migration likely to arrive early in the central Serengeti and delay further going to the northwest. This may arise due to increased MAM rains in central and deceased MAM rains in the northwest. This situation likely to delay the synchronized breeding and, in turn, this negatively affects the December to February tourism in the Southern zone and improves tourism in the central zone.

In addition, the high tourism season (i.e. JJAS) largely conducted in northwest along the Mara River is likely to be chaotic. The decreased rainfall reduces the Mara River flow and, in turn, this decreases the riparian forage. This may result into migrating wildebeest to roam randomly searching for forage and water. The SENAPA tourism officials also acknowledged that for quite sometimes now migration arrives to the central Serengeti early than expected and delays going further to the West and North.

This situation makes wildlife tourism in the Serengeti and Mara National Reserve a chaotic experience. For instance, in 2012 the migration did not go to Mara National Reserve in Kenya and, in turn, this affected tourism in Kenya (Ihucha, 2012).

Apart from rainfall, moderate warm temperature (i.e. 15-25^{o}C) is an ideal weather condition for outdoor recreation activities. Nonetheless, our results indicate that SENAPA has warmed by 0.8^{o}C (i.e. approximately 0.2^{o}C per decade) over the past 40 years (Figure 5.5c). The Figure further illustrates that warming has accelerated since the 1980s when temperatures have ranged well above the average (i.e. 23.1^{o}C). The year 1999 was the coldest year in Serengeti since 1978. The overall mean monthly minimum and maximum temperatures that ranged between 17.5^{o}C and 28.1^{o}C in the 1970s have shifted to 18.3^{o}C and 28.7^{o}C in the 2000s (Figure 5.4). The daily temperatures in this season sometimes exceed 30^{o}C.

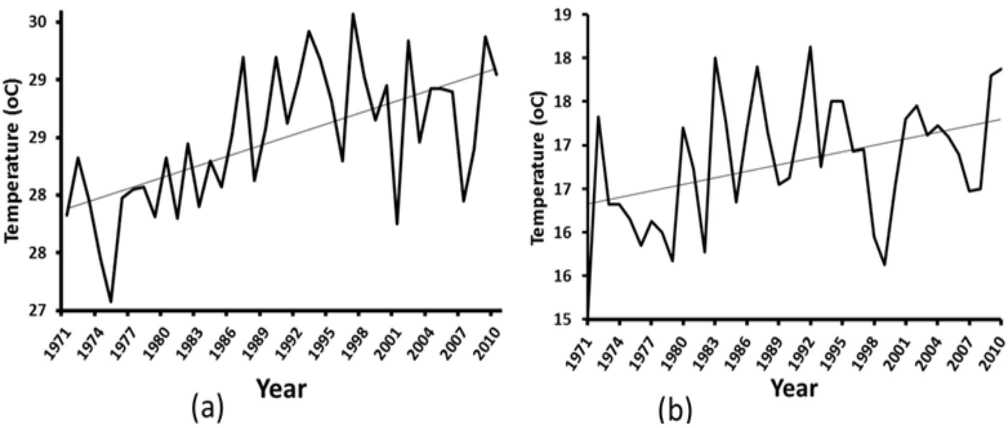

Figure 5.4. Temperature trends in high tourism season: (a) Maximum and (b) Minimum temperature.

Since the 1990s, drought frequencies have increased and become more intermittent (Figure 5.5). Consequently, wildebeest population drop substantially soon after drought and recover afterwards when rainfall increases (Figure 5.5c). In a severe drought, such as the 1993 and 1999, migrating wildebeest population took a longer to recover. Apart from drought, El Niño flooding seems as well destructive, but wildebeest population recovers sooner that in the severe drought event. The population of wildebeests now stabilises in 1.3 million individuals and this seems to be its ecological carrying capacity. However, if the observed drought frequencies continue, fewer wildebeest individuals should be expected. This situation threatens the future of tourism in SENAPA.

5.3.3 Consequences of land-cover changes on tourist attractions in SENAPA

Apart from climates, wildebeest's migration relies heavily on grasses for their forages. In times of scant grasses, they usually subsist on forage from trees and shrubs. When they cannot find suitable forage, they migrate long distances in search for forages. The shown drought and increased temperature have changed the land cover and thus the forage for wildebeests.

Savannah grasslands that almost cover half of the SENAPA, has increased by 21% at the expense of 87% loss of woodlands and 30% loss of riparian forests. The inland lakes (i.e. Ndutu and Magadi) shrunk by 14% over the past 40 years (Table 5.2 and Figure 5.6). These results suggest that wildebeests population likely to increase due to plenty grasslands to feed on. However, increased savannah grasslands signals that the park is becoming more homogeneous, a situation that threatens the diversity of tourist attractions for which the park is famed for. In the short-run, increasing grasslands might have positive effects on tourism as wildebeest population will increase. Nevertheless, in the long-run, the number of wildebeests might drop rapidly due to forage shortage since no alternative forage. The natural vegetation in SENAPA is replaced by short-lived grass while trees and other long-lived plants, which are used as a substitute feed in critical dry seasons, are being eliminated. In addition, the shrunk lakes indicate that wildlife drinking water is becoming a pressing issue.

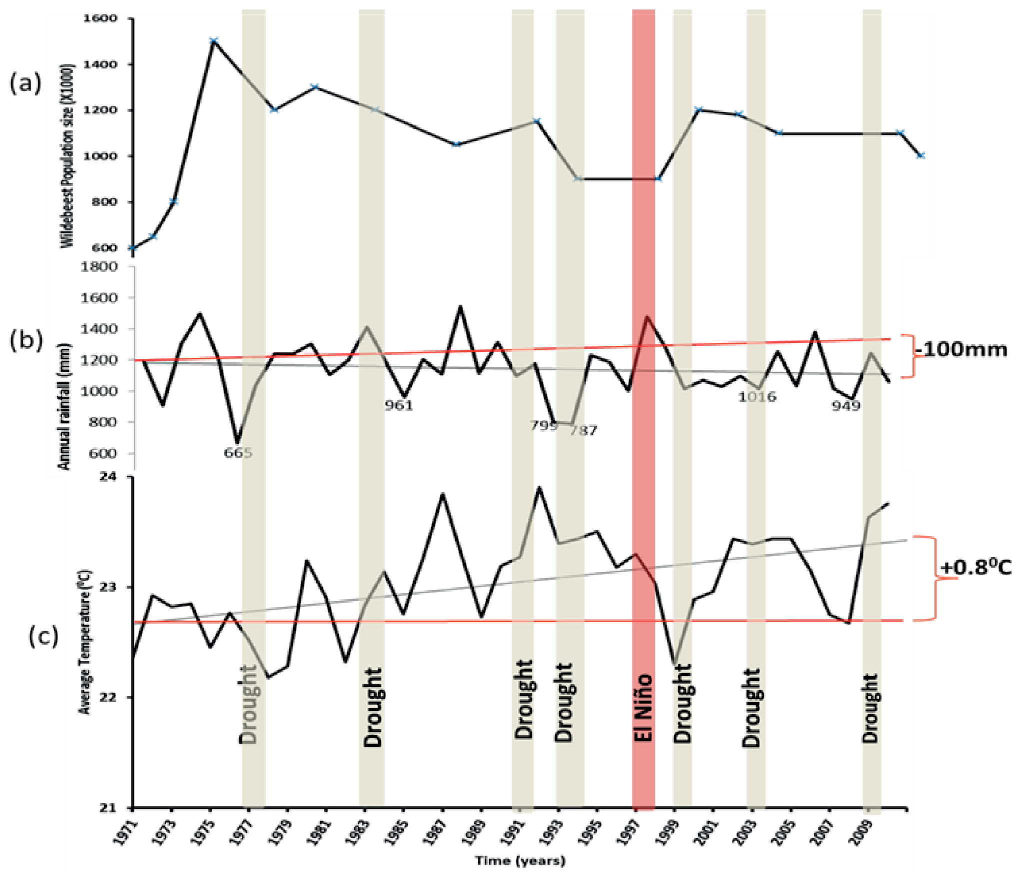

Figure 5.5 Wildebeest population dynamics as influenced by climate variability and change from 1970 to 2010: (a) Wildebeest population dynamics, (b) annual rainfall trend and (c) temperature trend in relation to drought frequency (Wildebeest data source: Mduma et al., 1999: Sinclair et al., 2007, Sinclair et al., 2015).

Table 5.2 Changes in land cover within SENAPA from 1970 to 2010.

Cover types	**Area (square km)**			**Overall cover change (%)**
	1984	1995	2009	(1984~2009)
Grasslands	8194.6	8062.5	9915.4	21
Open woodlands	2099.2	2843.4	272.9	-87
Forests	53.9	55.0	37.8	-30
Lakes	3.7	3.2	3.1	-14
Thickets	2424.2	2439.8	2181.8	-10
Bush land/shrubs	1987.3	1359.2	2351.9	1
Total area SENAPA	14763	14763	14763	

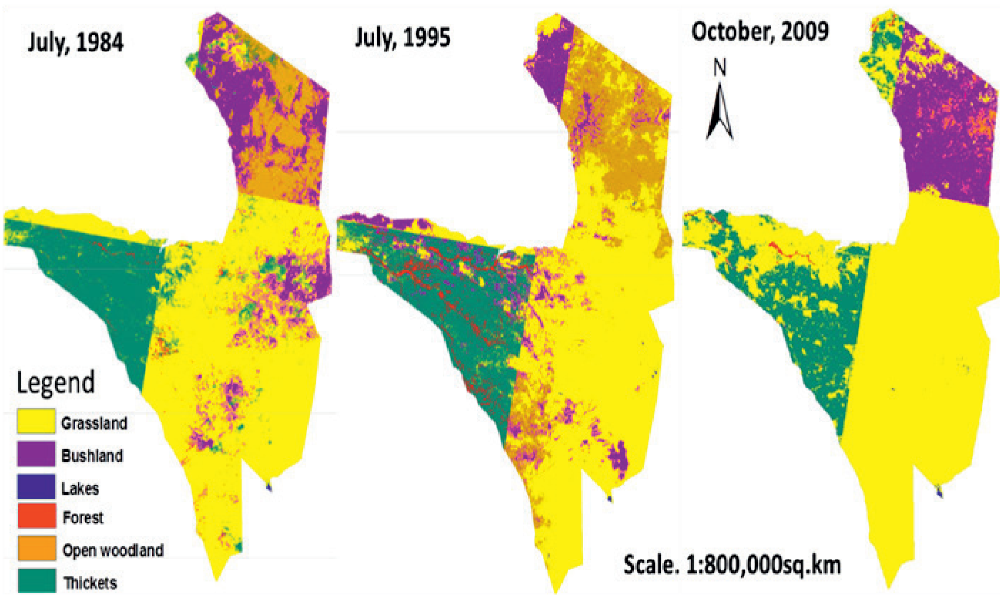

Figure 5.6 Changes in land-cover for the Serengeti National Park from 1970 to 2010.

5.4 Discussion

In this paper, the climate-tourism relationship and consequences of climate change on tourism in Serengeti National Park have been explored. The findings indicate that climate, tourist visits and wildebeest migration as the key attractions are closely connected. As such, the major tourism activity is largely migration viewing termed as 'wildlife migration chasing tourism' in this paper. This tourism activity is largely conducted during dry months. This tourism activity has already been affected by the shown rainfall seasonal variability and change, increased temperature by 0.8^{o}C and drastic changes in land covers.

Tourism in Serengeti is about time (i.e. perfect time to see the migration) and place (where are the migration). Time is the central importance, especially as tourism is generally defined in terms of time (i.e. tourism seasonality). Diverse tourism activities are severely constrained by time availability (Dietvorst & Ashworth, 1995). Patterns of tourist visits to many protected areas are typically seasonal, with peak periods occurring in relatively narrow windows of time (Baum & Lundtorp, 2001; Hadwen et al., 2008). Despite the fact that institutional factors (i.e. holidays and income) especially for international tourists have substantial influence in determining tourism seasonality (de Freitas, 2003; Keller et al., 2005; Hadwen et al., 2011), we argue that the role of climate and/or weather and ecological processes, such as animal migration and plant forewing in influencing tourism seasonality in natural areas should not be undermined.

Accommodation bookings in SENAPA are based on time (i.e. traditional wildebeest migration calendar) and locations of the accommodation facilities (e.g. along the migration routes or close to a hippo pool). In other word, the later may seem like 'view the great migration at your hotel window'. In fact, when migration is in the southern or central Serengeti, accommodations in these zones are fully booked and vice when the migration moves to the North, East or West parts of the park. The shown changes and variability in rainfall seasons have made timing of the migration chasing tourism sometimes unreliable and chaotic (Kimaro and Kihwele, park wardens, personal communication, March 2013). Tourists book the accommodations when they expect to see the migration at a particular time only to find that the migration is delayed or changed the patterns due to rainfall variability or change. As a result, tourists have to drive far to view the wildebeest migration. This situation brings discomfort to tourists and adds cost in terms of money and time. The delays and changes in migration patterns are the major climate-tourism challenge that the park has to adapt and deal with. At the moment, this challenge may be seen as a less concern. However, in future decades, this may results to either abandon some accommodation facilities as owners cannot offer what they promised to tourists or increase the accommodation cost to cater for unnecessary disturbances that may rise due to delays or changes in migrations patterns. If this happens, either tourism in Serengeti likely to be expensive or tourists and other tourism stakeholders may opt for other destinations. The economic impacts of these options are overwhelming as the park contributes substantially to TANAPA's income and the country at large (Melamari, 1996; Eagles & Wade, 2006).

Furthermore, our findings show that the Serengeti National Park has warmed about 0.2^{o}C, above the observed 0.6^{o}C global mean temperature rise over the last three decades (Hulme et al., 2001; Hansen et al., 2006). Mean monthly temperature in high tourism season (i.e. June through September) has increased while the daily temperature sometimes reaches above 30^{o}C, which will be expected in lower coastal regions. This rise likely interferes with traditional comfort temperature (~15^{o}C to 25^{o}C) adapted for the outdoor recreation. According to Maddison (2001), the maximum daytime temperature for tourism activities should ideally be close to 30ºC while Lise and Tol (2002) estimate the optimal minimum daily temperature to be around 21ºC. Understanding the effects of temperature variability and change is important for tourism in Serengeti although Abegg et al. (1998) argue that the effects of temperature change and variability in global tourism have been taken for granted because of their supposed long-term stability. The observed temperature change in our paper likely is a powerful signal to in mainstreaming climate change in tourism planning. Temperature comfortability (i.e. thermal comfort) is one of the key tourism climatic indexes that may drive tourists either to choose or not to choose a destination (Amelung & Viner, 2006) or guarantee a certain tourism activity to be performed.

Moreover, large aggregations of wildlife migration, which is the major attractions in Serengeti, have been decreasing due to extreme temperatures and rainfall, and increased drought frequencies and persistence. Our results support few studies (e.g. (Ogutu et al., 2008; Ogutu et al., 2012) that climate change is happening and affects the Serengeti ecosystem that defines its tourism. Our results differ with TMA (2007), Munishi et al. (2009) and Munishi et al. (2010) that areas with bimodal rainfall patterns like SENAPA will experience increased rainfall of 5-45%. So far, our results indicate no significant change. However, our results concur with others studies (Hulme et al., 2001; Michael, 2006; IPCC, 2007b) that under intermediate warming Eastern Africa, which Serengeti is a part will experience an increase of 5-20% from December to February. All these changes aggravate the situation and affect the large aggregation of wildebeest migration that tourists go for. Wildebeest migration and other iconic wildlife, such as buffaloes and 'resident' wildebeests have been starving to death due to drought and thirst. In 1993, for example, almost half of the wildebeest population and two-thirds of buffaloes starved to death due to drought (Mduma et al., 1999; Gereta et al., 2003; Sinclair et al., 2007) while in 2010, almost 10,000 wildebeest drowned to death in Mara River (Farouky, 2007).

Droughts and floods have made the wildebeests population never resume 1.5 million individuals reached in 1977 (see Mduma et al., 1999). Although droughts in Serengeti are common, in the post-1980s they are more destructive as frequencies have increased and likely no adequate time for the ecosystem to adjust, adapt and build resiliencies. The massive losses in wildlife have major consequences in tourism and conservation as we have discussed in our paper. If wildebeest's population in SENAPA decreases to a point of no migration and end up revoking the World Heritage Site status, this will negatively affect tourism. The wildebeest migration is used as a competitive advantage and self-tourism marketing strategy. In not only Serengeti, but droughts have also been a major driver, which changes the attractiveness of most national parks and other protected areas by removing tourism flagship species. For instance, in just two weeks, severe drought killed 60-80 hippos in Masai-Mara National Reserve in 2006 (Bogonko & Lee, 2006) and left the 'attractive pools' as a 'graveyard' filled up with rotting hippo carcases.

Apart from rainfall as a trigger for wildebeest migration, land cover heterogeneity is the basis for diverse tourist attractions in SENAPA. The presence of a large proportion of grasslands has contributed to the long-term existence of large aggregation of migrating wildlife, which in other parts of the world, has become extinct. Large and diverse grasslands nourished by rainfall variations provide adequate food all-year round for migrating wildebeest, the important tourist attraction in Serengeti. The current changes in land cover bring much uncertainty for wildebeest migration tourism in Serengeti. In the 1990s, Sinclair (1995) noticed that more than thirty percent of Serengeti's vegetation cover vegetation has substantially changed. Twenty years later, our study suggests that more than seventy percent of the Serengeti's land-cover have changed. The change suggests that there are less virgin vegetation cover remained in the park. If this is the case, the impacts of such drastic change on the Serengeti's attractions and tourism are numerous. Wildebeest's population will either continue to increase, as food (i.e. increased grass) is not a limiting factor or decrease due to habitat loss and/or fragmentations (Mduma et al., 1999; Ogutu et al., 2012).

Increased grasslands suggest drier conditions, which means less forage and, in turn, this possibly decreases the wildebeest population. These changes might have positive effects now for tourism as wildebeest population increases. In the long run, however, the number of wildebeest night drop rapidly due to food shortage.

Short-lived grasses are replacing trees and other woody plants, which are used as substitute feed in critical dry seasons. Wildebeest rely heavily on grasses for forage. However, in times of scant grass, they usually subsist on forage from trees and shrubs. When they cannot find suitable forage, they migrate long distances to search for food. Changes in land cover will not only affect wildebeest migration but also other tourism flagship species. Between 1966 and 2006, the Serengeti ecosystem has suffered drastic losses of 6 to 16 species of fruit bird eaters due to 70-80% loss of the Grumeti riparian forests (Sharam et al., 2009). If the loss of bird species is cumulatively added to 30% loss of Grumeti's forests shown in our paper, the impacts on tourism, especially bird watching will be extensive. The Grumeti riparian forests not only serve as bird watchers paradise but also the only area where few Black-and-White Colobus monkeys' population exist and a refugee for migrating wildebeests in critical dry season.

Climate change is affecting tourism in Serengeti. To overcome the climate-related impacts and improve the wildebeest-migration viewing experience, hot air balloons safari was introduced. However, for the last ten years, flying schedules have been cancelled more often due to unfavourable weather conditions (Gereta, Hot air-balloon safari manager, personal communication, March 2013). Moreover, mobile camping accommodations were introduced to match with changing wildebeests' migration patterns and/or delays at least for tourists to track the wildebeest migration with little hassle (Kimaro and Kihwele, park wardens, personal communication, March 2013). The introduced copying and/or adaptation measures seem like the best alternatives to overcome the current situation. But our paper considers them as temporary coping and adaptation strategies to transitions in NBT as a result of changes in tourist attractions in response to climate change. Not only in the Serengeti, but also in the world tourism seasons are expected to shift as tourist attractions react to climate change and other environmental change (Amelung et al., 2007). For Serengeti, all weathered roads, given the black cotton soil type that causes slippery and stuck mud and assurance of permanent drinking water and forage for wildlife likely to be the best coping and adaptation options to take the park though this transition period. Other adaptation measures would include reducing human-induced impacts and avoid activities that would block the migration route and avoid wild fires.

Limitations of the study

This paper used short-term tourist arrivals data that were available. The data did not indicate the types of activities a tourist participated. As a result, all tourists were assumed interested in viewing wildebeest migrations. Availability of long-term tourist arrivals' data linked with activities that a tourist undertaken in a particular time and place would improve the future studies of this nature. Despite the lack of long-term tourist arrivals data, this short-term data provided insights that tourism in the Serengeti National Park is highly seasonal and climate change is the major threat.

5.5 Conclusion

Climate, tourist attractions (i.e. wildebeest migration) and tourist visits are closely connected in Serengeti National Park. The observed rainfall variability and change, and increasing temperatures have likely directly affected tourism seasonality and indirectly influenced natural attractiveness of the park by changing the tourism flagship species and natural landscape. The substantial land-cover change from heterogeneous towards more homogenous (i.e. increasing grasslands at the expense of other land covers) threatens the diversity of tourist attractions that the park is famed for. Although, our paper shows no severe impacts have been observed yet (i.e. migration still occurs in Serengeti) and only day-to-day tourism activities (e.g. delay of the migration or changes in migration patterns) are affected, we argue that the future of Serengeti's tourism is uncertain.

Decreasing rainfall and increasing temperatures that have increased drought frequencies and accelerated the rate of land-cover change will severely affect wildlife food availability, habitats and drinking water. These changes have a potential to influence the distribution of wildlife and, in turn, this affects tourism. Natural factors such as climate, wildlife and land cover diversity can, in principle, establish and maintain tourism in Serengeti National Park. However, if strategies for managing these factors are not adequate, the park will gradually lose its touristic appeal, despite the increasing number of tourist visits annually. Adapting tourism to climate-change impacts requires active and integrated management approaches that improve the park's attractiveness. Thus, the climate-tourism insights provided in this paper are of significant importance for tourism planning to maintain the Serengeti's natural attractiveness and day-to-day tourism activities of which climate change has of recent become a threat.

Chapter 6

Synthesis, reflection and conclusions

6.1 Background

The Tanzanian tourism policy (1999, p. 22 Section 5.13) states that *"The government will ensure that the development of tourism is based on careful assessment of carrying capacities of tourism products and ensure enhancement and improvement of special environmental features in order that tourism development do not conflict with indigenous forests, beaches, mountains and other important vegetation."*

This statement clearly acknowledges the importance of nature and environments for Tanzanian nature-based tourism (NBT). This statement shows that Tanzania is ready to incoprate current environemental impact assessments to ensure the sustaibaility of its tourism sector. In this thesis, the term 'nature' refers to all wildlife, plants, habitats, ecosystems and physical landscapes. The physical landscapes provide environments or habitats that determine the conditions that species live in and interact with, for example, other species, water, soil and climate and weather. Changes in the environment, such as changes in climate, land cover and land use, affect tourist attractions.

Considering the complex and dynamic environmental problems that Tanzania faces, my thesis aims to assess the impacts of environmental change on tourist attractions in Tanzanian National Parks to support policy decisions and actions to better manage individual attractions and NBT. Specifically, it assesses how tourist attractions react to changes in climate and land cover and their associated impacts. The assessment is conducted in the most visited Tanzanian National Parks: Serengeti (SENAPA) and Mount Kilimanjaro (KINAPA). Both parks are also UNESCO world heritage sites and they respectively represent the main Tanzanian lowland and highland destinations. These two parks also contain highly climate-sensitive tourist attractions (e.g. snow and wildlife migration). The main research question (RQ) of my thesis is: **'What are the effects of environmental change on nature-based tourism in Tanzania?**' This RQ is broken down into four RQs that guide my analysis:

- RQ1. What drove the history of nature-based tourism in Tanzania?
- RQ2. How can tourist attractions be described to support environmental impacts assessment in Tanzanian National Parks?
- RQ3. What are the effects of climate and land-cover change on tourist attractions in Mount Kilimanjaro National Park?
- RQ4. What are the effects of climate and land-cover change on tourist attractions in Serengeti National Park?

Figure 1.1 presents the conceptual framework of my thesis. This framework describes the connections between my RQs and knowledge inputs. Specifically, my research assessed the impacts of environmental change on tourist attractions based on the two major changes: land-cover change and climate change and variability. Land-cover change approximates environmental-change impacts, including indirectly climate change. Changes in rainfall directly triggers wildebeest migration and forage availability in the Serengeti, and limit trekking Mount Kilimanjaro all-year-round.

This synthesis chapter is organised as follows. Section 6.2 provides key findings of my four RQs and discusses some key results, whereas Section 6.3 reflects on the methodology and its data needs. I discuss the implications of my research to manage tourist attractions sustainably under environmental change in Section 6.4. Section 6.5 concludes that although environmental change has been negatively affecting tourist attractions in Tanzania for over a century, it also opens new tourism opportunities. Section 6.6 provides insights for future research to better understand the impacts of environmental change on other NBT destinations, mitigate impacts and sustainably invest in the opportunities while working towards adapting the Tanzanian NBT sector to future environmental change.

6.2 Findings for each RQs

6.2.1 The drivers of change on nature-based tourism in Tanzania (RQ1)

To address RQ1, I reviewed the literature on the evolution of the demanded tourist attractions and the history of Tanzanian NBT since the 1880s to date. First, the drivers that contributed to changing the types and distribution of the demanded tourist attractions in Tanzania were identified. These drivers included unsustainable harvesting of wildlife resources (i.e. poaching, logging, etc.); changes in land-use patterns to cater for agriculture expansion, settlements and industrial developments; and climate change and variability. Second, I elaborated on how changes in tourist attractions coupled with environmental impact awareness and law enforcement affected the motives and tourism activities of tourists that visited Tanzania, and the management of tourism destinations over time.

The four key findings were:

1. Wildlife resource uses in Tanzanian protected areas varied historically from exploration and discovery, ivory collection, hunting for trophies to safaris and nature conservation;
2. Over the past century, NBT and its attractions have been poorly defined although several wildlife-related tourism activities were conducted in Tanzania since the 1600s when Arab and Europeans travelled across the African Great Lakes region in search for, among other things, ivory and scenic landscapes;
3. Tourists' motivations and preferences for visiting different tourist destinations in Tanzania have changed substantially over the past century; and
4. Although other factors, such as economic gains, political interests and tourists' motives contributed to the contemporary NBT and proliferation of its tourist destinations in Tanzania, environmental impacts on attractions (e.g. habitat destruction, excessive hunting and potential species extinction, and climate change) played a main role.

These findings are in line with previous studies (Curry, 1990; Chachage, 1999; Wade et al., 2001; Salazar, 2009) that concluded that the Tanzanian NBT and its destinations have evolved over time. My findings deviate from Kweka et al. (2003) and Dwyer et al. (2000) who stated that price is the main motive of tourist visits. I argue that tourist attractions more strongly determine the main motives and influence preferences on which destinations tourists should visit than price, and, hence, influence the demand and supply of tourism services. For instance, the change from hunting tourism in the late 1890s to sightseeing tourism in the 1930s and environmentally friendly tourism in 1970s as opposed to low-cost mass tourism in the 1960s.

The changes in tourists' motives prompted the evolution of the different destinations in Tanzania. As such, the upgrade of most protected areas to national parks were brought about by increasing awareness of the impacts of environmental change on attractions (i.e. species extinction and reduced landscape beauty) among tourists, park managers and governments. The paradigm shift shows that the sustainability of NBT in Tanzania is contingent to addressing and adapting the sector to impact of environmental change. I therefore argue that, while Tanzania focus on improving tourism services (e.g. accommodation and roads) in protected areas, should also consider that without quality environments (attractions), NBT and its destinations would not exist even if accessibility, accommodation and amenity (the other 3As) are provided.

6.2.2 Describing tourist attractions to support environmental-change impact assessments in Tanzanian National Parks: the eco-parcel approach (RQ2)

To address RQ2, I identified and classified nature-based tourist attractions in detailed and unambiguous categories that support comprehensive and localised environmental impact assessments in Tanzanian National Parks using the Serengeti and Kilimanjaro National Parks as case studies. A newly developed tourism-resources assessment approach referred to as the 'eco-parcel approach' supported this assessment.

The three key findings were:

1. Attractions emerged from and are connected to specific characteristic environments. This means that different characteristic environments support the attractiveness of each attractions. This implies that the impact of environmental change on attractions should not be generalised to all attractions even if they occur is same tourism destination;
2. Some type of attractions are more important than others. This finding helps to understand the effect of losing or gaining of specific attraction based on its merit on tourism. For instance, snow on Mount Kilimanjaro and wildebeest migration in Serengeti National Park were thought as the 'main' attractions but through the eco-parcel approach, other equally important attractions were identified. This includes attractions, such as kopjes and big cats in Serengeti, Uhuru peak and Black-and-White Colobus monkeys on Mount Kilimanjaro; and
3. The types of attractions within each eco-parcel defined the value of discrete landscape patches for tourism. An eco-parcel is a landscape patch with distinct physical features on which one or multiple attractions occur and whose supporting environmental properties are known.

The findings from my new eco-parcel approach are among the innovations in my research because they resulted from environmental-change impact assessments undertaken from a tourism perspective. The traditional assessments use an ecological perspective. Wildlife and plants occur in their habitats (i.e. characteristic environments) and thus a loss and/or change in species' habitats would mean a loss or threat to a specific species. For instance, Falcucci et al. (2007) conclude that loss of vegetation cover affects wildlife biodiversity. My findings demonstrate that if the supporting characteristic environments for individual attractions are known, then information about changes in those environments can help to assess the possible threat to an attraction. Chapters 4 and 5 reported on impact assessments based on the eco-parcel approach.

As Chapter 4 showed, loss of the montane forests in KINAPA means a threat to Black-and-White Colobus monkeys (a forest tourist attraction) because this species occurs only in these forests, while an increase in grassland abundance in SENAPA was interpreted as one of the reasons for high numbers of migrating wildebeest in Chapter 5.

The eco-parcel approach can in principle be used to address the impact of future environmental change on NBT. The spatial link between tourist attractions and their environments allow integration of current tourist attractions' data with future environmental conditions.

6.2.3 The effects of climate and land-cover change on tourist attractions in Mount Kilimanjaro National Park (RQ 3)

To address RQ3, I assessed the impacts of climate change and variability and land cover on trekking conditions and tourist attractions in KINAPA. Trekking is the major tourism activity in KINAPA. Yet, almost half of the trekkers never reach Mount Kilimanjaro's summit due to a range of environmental factors. Apart from physical trekking, existence of attractions, both biological (attractive species) and physical (snow, waterfall and scenic rocks), enhance the trekking experience. These attractions make Mount Kilimanjaro a prime NBT destination for non-trekkers.

The two key findings were:

1. On Mount Kilimanjaro's summit, the mean annual temperature increased by 1.3^{o}C between 1973 and 2013 while at the lower part of the Mountain the long rains have probably shifted from May towards March (cf. Figure 4.4). This also extends the traditional dry period in the high tourism season (June to September). The 1.3^{o}C temperature rise at the mountain top translates into a 200Pa increase in barometric pressure. Even though this pressure increase may seem small, Moore and Semple (2009) found similar increases in pressure (from 200Pa to 300Pa) to be of physiological relevance for trekkers on Mount Everest. Increased pressure elevates/improves the maximum oxygen uptake in the lungs. This lowers altitude-sickness risks; and
2. Land cover has changed substantially between 1993 and 2013. Snow lost 54% of its 1993 extent. Montane forest lost 169.5km^2 (i.e. 15% of the initial area). The area of alpine desert increased by 9.5km^2 (8%) and that of heathland by 166.1km^2 (38%). From a tourism perspective, the implications of these changes are twofold. First, warmer temperatures and reduced rainfall create better trekking conditions and, second, changes in land cover likely diminish the mountains' attractions and undermine trekking experience. Trekkers and day-trip visitors are highly fascinated by the unique wild montane forest animals and heathlands plants (flowers and groundsels) and snow at the summit.

6.2.4 The effects of climate and land-cover change on tourist attractions in Serengeti National Park (RQ4)

To address RQ4, I assessed the impact of changes in climate and land cover on main tourist attractions in SENAPA. Tourism in SENAPA largely depends on viewing wildebeest migration between December and March in the southern-central Serengeti and between June and September in north-western Serengeti. Rainfall triggers wildebeest-migration patterns and regulates the quality of drinking water and food availability.

The four key findings were:

1. Trends in annual rainfall were negative, albeit not significant at the 95% confidence level. However, on a monthly basis, significant changes in rainfall seasonality occurred in the northern and southern parts of the park for March, April and May (MAM) and October, November and December (OND) (cf. Figure 5.3). MAM rainfall decreased by 5% in the northwest and increased by 6% in the south-central Serengeti. OND rainfall increased by 8% in the northwest and decreased by 5% in the south-central Serengeti. The decreasing OND rains in the south-central Serengeti suggest a delayed arrival of wildebeest migration in the southern Serengeti. Moreover, a delayed OND rainfall onset can thwart synchronised breeding. Both of these changes affect the sighting of wildebeest migration in the December-February tourism season. Tourism Park Wardens acknowledged the delays on arrivals of wildebeest migration and thwarts of synchronised breeding and their effects on tourism in the December-March season in the southern-central Serengeti (G. Kimaro, personal communication, March 2013);

2. Increasing MAM rainfall in the south-central Serengeti delays the arrival of wildebeest migration in the north-western Serengeti and, in turn, this affects tourism in the northern part of the park, which is mainly conducted between June and September. Less predictable rainfall seasons between North and South distorted the wildebeest-migration patterns and made wildebeest-migration tourism in Serengeti unreliable and chaotic;

3. Serengeti has warmed by 0.8°C (i.e. approximately 0.2°C per decade) over the past 40 years. In the high tourism season (i.e. June through September), mean minimum and maximum temperatures range between 18°C and 29°C. The 0.8°C increase in temperature is likely to change the ideal warm temperatures (i.e. between 15°C and 25°C before the 1970s) suitable for the outdoor-recreation activity; and

4. Savannah grasslands that covered almost half of the SENAPA before the 1970s, increased by 21% at the expense of woodlands (87% loss) and riparian forests (30% loss). Surface water (i.e. Lake Ndutu and Magadi) shrunk by 14% over the past 40 years. On the one hand, increasing savannah grasslands suggests that the park is becoming more homogeneous and this probably limited the diversity of wildlife attractions for which the park is famous. On the other hand, increasing grasslands cover suggests increased forage for the migrating wildebeest. In turn, this suggests a high possibility of sighting wildebeest migration in Serengeti all-year-round. The decreased woodlands cover suggests limited alternative forage during the critical dry season. This is likely threatening the future of the Serengeti's attractions.

Trends in increasing temperatures and changes in vegetation cover presented in Chapters 4 and 5 resonate with previous studies on Kilimanjaro (c.f. Hemp, 2005; Duane et al., 2008; Hemp, 2009; Appelhans et al., 2015) and Serengeti (Norton-Griffiths et al., 2008).

6.3 Reflection on the methodology and its data needs

To address the four RQs, I integrate knowledge across different disciplines, especially tourism studies (i.e. tourist attractions, motives and preferences), climatology (i.e. climate, climate change and weather variability) and environmental sciences and ecology (e.g. changes in land cover, wildlife-population dynamics and wildlife behaviour).

Due to the multidisciplinary character of my research, I used several methods. RQ1 is addressed through a literature review to understand the relationship between nature, tourism, climate with changing environments and tourist motives and preferences. Addressing RQ2 requires an approach to describe tourist attractions to support a comprehensive impact assessment in Tanzanian National Parks. I, therefore, developed the eco-parcel concept and turned it into an assessment approach. In RQ3, I use the hazard-activity pairs approach to assess the impacts of environmental change on trekking on Mount Kilimanjaro. RQ4 is addressed through an inferential statistics approach to explain the impacts of the recent climatic trends on wildebeest migration tourism in Serengeti National Park. Next, I briefly explain the use of each approach, its data needs and challenges.

6.3.1 The literature review

The Tanzanian NBT has changed over time. Several drivers have contributed to this change. However, detailed information to explain the implications of these drivers to the contemporary Tanzanian NBT is limited. Literature review approach is used to delineate what is known and what is unknown about the research problem I address. In my thesis, the approach shows inadequate assessments that attempt to build a relationship between tourism and environmental change. For a comprehensive environmental-tourism review, I first need to profile the drivers that changed Tanzanian NBT and its destinations over the past century. Then, I need a dataset containing detailed historical trends of (1) tourists' motives and preferences of visiting Tanzania; (2) types of tourist attractions demanded; and (3) drivers that led to changes in the status and or proliferation of protected areas. This information was highly fragmented, yet needed.

Collating all this literature as part of my thesis was too ambitious but a prerequisite for my thesis. I systematically collated this literature from various sources including published and unpublished materials, key informants and my interpretation based on my sixteen years' experience with environment and tourism. I started my literature review with economic studies, which are well covered in the country because of the potential of tourism to national income and livelihood. Then, I reviewed few studies that cover tourism market segments and international politics on tourist arrivals due to the complex governance process that the country has passed. Finally, I reviewed and synthesized (few) recent developments on tourism and environmental change in Tanzania.

Economic and market analysis (e.g. Cater, 1987; Curry, 1990; Gössling, 2001; Wade et al., 2001; Kweka et al., 2003; Lindsey et al., 2007; Kazururu, 2014) studies only explain the income accrued from tourist expenditures but do not cover the motives and tourist preferences over destinations nor the attractions visited. Nonetheless, from these studies, I extracted the number of tourist arrivals in Tanzania, understood that tourist arrivals increased over time and tourism is an important economic sector in Tanzania. Thus, NBT needs to adapt to the impact of environmental change as agriculture and energy sectors do. Furthermore, the literature on tourism-market segment and governance (see Salazar, 2009) described the general characteristics of tourism in Tanzania but focused only on a small part of the country: the Northern Circuit. From Salaza's study, I learned that 'wildlife' abundance were the main attractions that drove tourists' motive to visit Tanzania and preference for the Northern Circuit tourism destinations. Moreover, the literature on international politics (see Chachage, 1999) provided insights on the functions of big International Non-Governmental Organisations, like the IMF and World Bank on stimulation of tourist arrivals soon after a fall in the 1970s due to the self-reliance policy of 1967 and ignore the role of the natural environments (attractions).

From Chachage's study, awareness on the impacts of unsustainable harvests of wild products and wildlife habitat destruction were among the factors that led to changes in tourists' motives of visiting Tanzania and proliferation of protected areas. The review of how climate change affects tourism in Zanzibar (Gössling et al., 2006) provides insights that environmental change is a threat to NBT in Tanzania. Nevertheless, the study considers only a few climatic indices, such as temperature and rainfall, and ignores the impacts on other attractions, such snow loss on Mount Kilimanjaro and changing wildebeest migration in Serengeti.

Although my comprehensive literature review shows that environmental change drove the history of the Tanzanian NBT over time, inadequate environmental data and poorly defined attractions were challenging my impact assessments. I filled this knowledge gap in Section 6.3.2 as I developed the more integrative tourism-resource impacts-assessment approach in Chapter 3.

6.3.2 The eco-parcel approach

To perform a comprehensive impact assessment, a new detailed dataset is needed. I developed the eco-parcel approach to provide the required dataset. This dataset includes a detailed classification of all types of attractions (e.g. wildlife to species, plants and non-living objects), their geographic locations and preferred environmental conditions including climate and weather, behaviour for wildlife species and touristic value for individual attractions. Collecting all these data as part of my research was too ambitious but vital for a future comprehensive impacts assessment. Few studies, however, exist that classify tourist attractions to such detail in Tanzanian National Parks (not even in Serengeti and Kilimanjaro National Parks, which are the most visited and researched parks in Africa). The existing studies (e.g. Eagles & Wade, 2006; Kaltenborn et al., 2011) coarsely defined attractions with homogenous categories such as 'wildlife'. Wildlife represents a group of undomesticated animal species that all react to environmental-change impacts differently depending on their resilience and adaptive capacity. In addition, Tanzanian attractions are not only wildlife but also plants and landscapes. My review therefore concluded that coarsely and ambiguously defined attractions do not support environmental-impacts assessment and may even lead to unsustainable conservation and eventually severe damage to unidentified attractions. Thus, I integrated field-collected data with the existing literature to acquire the data set needed for my thesis.

Quantifying characteristic environments for individual attractions is data intensive. I therefore used simpler descriptive approaches to prove the concept. The approach called eco-parcel consists of three steps: 1) the identification and geo-referencing of individual attractions; 2) the rating of attractions; and 3) the allocation of attractions to specific land patches. Information from tourists, literature, key informants and field visits is combined into a list of key geo-referenced attractions. Each georeferenced attraction and its well-described patch is an eco-parcel. These eco-parcels are the discrete suitable-habitats and/or geographic areas where individual attractions occur in high abundance. This high-resolution information about individual attractions is a prerequisite to detailed impact assessment. Each attraction reacts differently to environmental change and its loss or gain will differently affect tourists' motives and preferences to visit a specific tourism destination. Delineating the exact boundary between each eco-parcel and its surroundings is thus essential. This is difficult and it depends on the type of spatial base-map (representative of the surrounding environment) that is used to overlay with the layer of eco-parcels. In this thesis, only qualitative descriptions of the eco-parcel's distinctive features and the geo-coordinates of the attractions were available.

These details are suitable for physical identification of eco-parcels but not for further spatial analysis, especially when overlaid with land-cover maps derived from coarse resolution Landsat imagery (30-metre spatial resolution). Perhaps, 1 to 5-meter resolution imagery would have served the high-resolution requirement.

Acquiring these high-resolution images was too expensive (e.g. a 1m resolution imagery from Digital Globe cost $7000) while the increase in accuracy between the Digital Globe images and the free Landsat images is less than 10% (Fisher et al., 2018). Opting for high-resolution imagery will limit the wider application of the eco-parcel approach in developing countries where only limited budgets for such assessments are available. Instead, I overlaid the spatial layer of the eco-parcels with the Landsat land-cover map. Next, I used the 'add polygon' edit tool on ArcMap-GIS10.2 (for steps see, USA-EPA, 2018, p. 36) at a zooming scale of 1:10,000 to delineate the boundary of each eco-parcel from its wider environment (c.f. Figures 3.2 and 3.3). At this scale, I assumed that eco-parcels' detailed environmental characteristics are well captured.

I use tourists' preferences over individual attractions to indirectly estimate the importance of each eco-parcels. The value of eco-parcels determines the importance of discrete landscape patches for tourism. Some (types) attractions are more important than other. The eco-parcel approach makes this classification clear and allows tourists to attach variable importance to them.

The capacity of the eco-parcel approach to create a link between tourists and attractions, and between attractions and environment allows the approach to be used to localise impact assessment on individual attractions in time and space. This makes the eco-parcel a meaningful approach to both tourists and environmental experts unlike in the expert-based consensus and descriptive approaches.

6.3.3 The hazard-activity pair's approach

A hazard-activity pair is an approach to link key tourism activities or attractions with the environmental changes that pose the greatest threat to them. This approach needs long-term tourist visitation data, climate data (in particular, rainfall and temperature data), key tourism activities and their climatic or weather requirements, and a list of already encountered climate-related impacts for inference. The hazard-activity pairs approach was first developed by Moreno and Becken (2009) to assess climate-change vulnerability to coastal tourism. They interpreted cyclones as a hazard to swimming and relaxing on the beach (activity). Increased water temperature coral bleaching was interpreted as a hazard to snorkelling and diving (activity). Although not focusing on vulnerability, I use their experience to establish hazard-activity pairs to address RQ3.

The hazard-activity pairs in this thesis were interpreted based on changes in annual rainfall for Tanzania at a resolution of ~5km for 1981 -2016 (FCFA, 2017) and observed changes in land-cover between 1993 and 2013. The land-cover changes reported here resonate with those reported by other authors (e.g. Hemp, 2005; Hemp, 2006, 2009). Climate on Mount Kilimanjaro is highly varied between the foothill and mountaintop, and is influenced by El Niño and La Niña. Thus, integrating national and case study climate dataset gives a comprehensive overview. Complementary to FCFA's (2017) source and in the absence of long-term climate data on or near the mountaintop, rainfall and temperature trends were estimated from local weather station data, using linear regression. In addition, monthly trends were estimated in view of the strong seasonality in tourists' visitation patterns.

Annual and monthly data from weather station at Kilimanjaro International Airport (KIA; 896m ASL), covering the 40-years period (i.e. from 1973 to 2013) were purchased from the Tanzania Meteorological Agency. The KIA weather station is located outside KINAPA, which is relatively far away. This distance could have limited detailed extrapolations. Nonetheless, this was not the case. I used a well-established knowledge about the temperature gradient (i.e. lapse rate approach) on mountains to fill this gap. With the lapse rate approach, temperature is known to decrease with altitude at a fairly uniform rate of 6.5°C km-1 (Barry & Chorley, 2009). Prior studies on temperature change on Mount Kilimanjaro (Thompson et al., 2002; Hemp, 2006; Duane et al., 2008; Appelhans et al., 2015) have used this lapse rate approach with KIA data and produced authentic results. Therefore, I adopted the same approach to obtain temperature trend on the summit. Complemented to this, additional data were obtained from the Nyati weather station, located within KINAPA at 3250m altitude. This dataset proves that up to this altitude, high rainfall amount is a challenge for trekkers.

Moreno and Becken (2009) engaged experts and other stakeholders to reach consensus on hazard vis-a-vis tourism activities due to the large range of tourism activities and infrastructure along the coasts. However, as trekking is the only tourism activity on Mount Kilimanjaro, few experts or stakeholders are involved and little infrastructure is needed. Tourists are thus the only directly affected stakeholders. A good approach would have been to ask tourists about how climate change affects their trekking experience, but Chapter 3 shows that 96% of tourists who visited KINAPA, were first-time visitors. Arguably, repeat visitors do not experience the impacts of climate change. In addition, studies that relate climate-change impacts with trekking experiences on Mount Kilimanjaro do not exist. My research is, therefore, the first to apply the hazard-activity pairs approach on mountainous tourism destinations thus should be taken as a baseline study. The hazard-activity pairs approach provides pertinent information that can assist in tourism management, planning and policy formulation.

6.3.4 The inferential statistics approach

Assessing the impact of environmental change on wildebeest migration tourism requires detailed data. These include long-term data on daily numbers of tourist visits, daily rainfall amount, daily minimum and maximum temperatures, land-cover extent (including food availability) and numbers of migrating wildebeest and incidents of severe droughts. The majority of these data were not readily available and, when available, they were incomplete. I used the available data for monthly rainfall and temperature covering the period between 1970 and 2010, the numbers of migrating wildebeests for an interval of three to five years. Available tourist visits data were for fourteen years (2000-2013). Such data were unfortunately unsuitable for a correlation analysis. Even if some of these data correlate, environmental impacts take a long time to be realised. The time lagging between environmental impact and its resultant effect on attractions and short-term tourist arrivals data would have limited our impact assessment. Nonetheless, the inferential statistics approach plays a key role to relate observed climate-change impacts with the observed trends in climate and land-cover change.

An inferential statistics approach is used to make judgments on the probability of causal relationships between observed changes through statistical analysis. The plausibility of the inferential approach is constrained by the lack of long-term literature studies. This was, however, not a limiting factor for my research. Serengeti is a well-researched tourism destination in Africa due to its global ecological and tourism importance.

The impact assessments in Serengeti gained popularity after the Grzimek's (1959) movie 'Serengeti shall not die'. Unfortunately, since then, the observed environmental change impacts have inadequately been integrated and interpreted for tourism. My study is likely the first to integrate environmental impact on tourism in this park and thus makes a vital contribution to research on tourism management. I related trends in the observed temperature and rainfall with incidences of droughts and deaths of migrating wildebeests to explain its impact on tourism in Serengeti.

6.4 Implications for the sustainable management of tourist attractions under environmental change

The knowledge gathered in my thesis can make a substantial contribution to inform policy and create awareness at international, regional, national, local and park levels. My thesis is timely especially now that Tanzania has pledged a 'low-carbon tourism' policy upon ratifying the 2015 Paris Agreement in 2018 (UNFCC, 2015). This Agreement states "each Party shall, as appropriate, engage in adaptation planning processes and the implementation of actions, including the development of management plans, policies and/or contributions". The contributions of my research towards achieving this policy strategy are manifold. The study broadens the scope of knowledge on the impact of environmental change, particularly changes in climate and land cover on NBT. Quantifying these impacts from a tourism perspective is a new research area with potential contribution to the tourism sector. The discussed climate impacts associated with a 1.3°C increase in temperature on snow loss on Mount Kilimanjaro and the impact of changing rainfall and its variability on wildebeest-migration tourism in Serengeti are likely to prompt environmental-tourism policy discussions. My research can thus provide timely policy-relevant information as Tanzania is currently revising its tourism policy (Melubo, 2017) and general management plans for most National Parks. Tourism-specific adaptation plans and diversification of tourism products to match with the current rate of environmental change may thus be part of Tanzania's efforts.

Increasing temperatures have also policy implications for high-risk tourism destinations, such as Mounts Kilimanjaro, Meru and Ol Donyo Lengai (active volcano), and Mounts Kenya and Rwenzori. Increasing temperature is associated with permafrost melt, landslides and rock-fall on mountainous areas (Gruber & Haeberl, 2007). The rapid freezing and thawing of permafrost can initiate rock-falls and/or landslides (Owen & Slaymaker, 2014). Rock-fall and/or landslide reduce trekker's comfort and safety as discussed in Chapter 4. Climate-tourism knowledge provided by my research is vital to prompt evidence-based policies or management strategies for early-warning actions on mountainous tourism destinations. My research advise closing the high-risk routes or camps during high fluctuation of extreme cold or hot weather conditions to minimize risks associated with rock-fall and/or landslide.

In SENAPA, the observed changes in rainfall between North and South have shown to distort the wildebeest migration pattern and the effects are manifesting in tourism. This distortion brings inconveniences among tourists and accommodation providers. Tourists book their accommodations based on the well-known timing of wildebeest migration and locations of the migration route. When wildebeest migration delays or changes its patterns, it inconveniences tourists and accommodation providers. This inconvenience will probably force tourists and other stakeholders to opt for other destinations. This change thus calls for short and long-term management adjustments. In the short-term, the park may opt for mobile camps to cater for immediate demands resulting from the distortion of wildebeest migration patterns because of changes in rainfall season between the northern and southern Serengeti.

In the long-term, the management must promote activates that decelerate changes in vegetation cover and avoid activities that will further distort the wildebeest migration pattern, such as the proposed road through the Serengeti National Park (Dobson et al., 2010; Holdo et al., 2011; Fyumagwa et al., 2013). In addition, SENAPA should work to extend its western part so that migrating wildebeest could access permanent water from Lake Victoria to cater for the 14% loss of its water sources within the park. Adapting the Serengeti's tourism to the observed impacts is needed because the park contributes substantially to the Tanzanian tourism sector and employs the majority of Tanzanians.

Apart from climate change, changes in land cover and its associated impacts adversely affect Tanzanian tourist attractions and in turn NBT, but also bring opportunities that call for short and long-term tourism management adjustments. In the short-term, snow loss on Mount Kilimanjaro may actually increase the number of tourists to the park through a phenomenon called 'last-chance tourism'. Last-chance tourism refers to visits to destinations or attractions that are expected to disappear (Lemelin et al., 2011). Increased numbers of tourists will require KINAPA to recruit more staff but also implement strategies to avoid additional stress on the ecosystem. The increasing number of tourist visits calls for an increase in temporary tourism infrastructure including accommodation facilities in Kilimanjaro region. In the long-term, the impacts of snow loss will likely be negative. Snow is the second-most important attraction after the Uhuru peak (mountain's high altitude). Its loss is, therefore, likely to reduce the number of tourists. Reduced number of tourist visits in KINAPA has high consequences. KINAPA and SENAPA contribute about 85% of total income accrued by the Tanzania National Parks (World Bank, 2015). Thus, KINAPA has a substantial contribution to the national gross domestic product. To maintain its economic contribution, KINAPA can advocate adaptation activities that decelerate the rate of snow loss. Furthermore, exapsion of heathlands to lower altitude calls KINAPA to capitalize on the increased floristic attractiveness of the Shira plateau by providing facilities, such as picnic sites and campsites. Such facilities are likely to be of particular interest for day visitors and domestic tourists and can thus help to diversify the park's visitor profile. The Tanzanian National Climate-Change Strategy (2012) proposes diversification of tourist attractions as among the strategic interventions to increase the resilience of the tourism sector to environmental change.

'Wildlife' is the key tourist attractions for NBT but not the only one. Using coarse and homogenous categories, such as 'wildlife' are likely to undermine our understanding of the actual impact of environmental change on individual attractions. This eventually limits sustainable management of attractions under the era of rapid environmental change. My detailed and unambiguous classification of tourist attractions in this thesis shows that attractions are numerous within the parks. I argue each attraction to be considered based on its merit for tourism.

The detailed knowledge about attractions, their behaviour and supporting environment is indispensable for park managers to device appropriate management activities and adaptation strategies. That is, for example, to restore the vanishing montane forest for the Black-and-White Colobus monkeys and to avoid fire on heathlands for floristic attractions. Having this in mind, understanding the characteristic environment supporting individual attractions is vital to tailor management activities to address specific impacts. To achieve this, the eco-parcel approach connects each attraction with its common characteristic environment. In other words, attractions are connected to their most suitable 'habitats'. A suitable habitat is a landscape patch that a species can potentially or does occupy in high abundance (Delong & Gibson, 2011).

Changes in suitable habitats approximate changes in specific attractions. Focusing on suitable habitat makes environmental impacts assessment localised and meaningful to a range of stakeholders in the tourism sector and natural and social scientists.

Furthermore, the pioneering research that is presented in my thesis not only assessed the impacts of environmental change on tourist attractions by using land-cover and climate change for the first time but also brings new methods and mindsets to NBT research. Identifying the whole range of attractions both living organisms and non-living objects, rating individual attractions based on tourists' preferences, geo-referencing each attraction and classifying attractions in landscape patches based on their suitable characteristic environment provide valuable detailed knowledge on the temporal and spatial data for impact assessment in NBT sector. The new eco-parcel approach provides a platform to study the consequences of changing environmental properties on attractions in different perspectives or interest of stakeholders. Right from the beginning, the eco-parcel approach involves tourists, park managers and tour guides to identify attractions and only tourist to value attractions. The involvement of an array of tourism stakeholders thus supports their decision-making process. This approach encourages tourists, tourism managers, and conservationists to view nature not only as attractions but also as part of the functioning ecosystem. The eco-parcel approach thus bridges tourism and the environment.

The eco-parcel approach improves impact assessment from a tourism perspective by using available data, reducing costs and enhancing dissemination of findings. Most impact assessments in different tourism destinations are not integrated to feature on tourism. The eco-parcel approach is thus a generic and cost-effective approach to provide an outlook of NBT in SENAPA, KINAPA and other destinations. The implications of using land-cover change to approximate the impacts of environmental change are manifold. Connecting each attraction with a specific land-cover type allows determining if an attraction is likely gaining or losing prominence. Land-cover change and particularly the responses of vegetation to climate change, are expected to be rapid (Allen & Breshears, 1998). Consequently, the loss of attractions is also expected to parallel such rapid changes. This implies that reversing the rate at which attractions disappear would involve reducing the rate at which changes in land cover occur. This argument calls for policy reforms to reduce the rate at which forests are lost in Tanzania (see URT, 2014). This is possible because Tanzania pledges to protect natural environments potential for tourism (see Tanzania Tourism Policy, 1999, p. 22 Section 5.13) and tourism is the second economic sector that contributes substantially to Tanzanian GDP, livelihood and foreign exchange.

My thesis draws attention to the critical issues of climate and environmental change and the importance of adaptation strategies for tourism. The tourism sector has long taken climate change and weather for granted (Scott et al., 2005; Tervo, 2008; Tervo-Kankare et al., 2018) and this has hindered the mainstreaming of climate change adaptation in tourism management, planning and policies, particularly in Africa (UNWTO/UNEP, 2008; Hoogendoorn & Fitchett, 2018).

6.5 Conclusions

My thesis assesses the effects of environmental change on NBT in Tanzania. I discovered that, although the NBT sector has adapted to new conditions over the past, coping with the current environmental-change impacts is more challenging for tourism management. Nevertheless, evidence-based environmental-change impact assessments in my thesis provide insights that help to overcome these challenges.

The review of tourism-environmental literature since the 1880s indicates that the meaning of NBT in Tanzania changed dramatically over time. It all started as a discovery and exploration, to trophy hunting and sport, to experience and to finally, wildlife and NBT. I also found out that awareness on the effect of environmental change (e.g. unsustainable hunting and habitat destruction) on attractions contributed to the different meaning on NBT over time. The different meaning of NBT changed how to manage tourism attractions.

'Wildlife' was the key attraction. Nonetheless, I argue that the term 'wildlife', which refers to undomesticated animals species of mammals, birds, reptiles and fish, is too inaccurate to understand the impact of environmental change on individual attractions. For a comprehensive impact assessment, attractions must be classified into unambiguous category because each attraction reacts to environmental change differently. Tourists and key tourism stakeholders hinted out that tourist attractions are numerous and not only include 'wildlife' but species of wildlife, plants and other physical attractions, such as kopjes, snow and waterfalls. The relative importance of each attraction for tourism varies in time and space. With these findings, I argue that coarsely defined attractions may lead to unsustainable conservation and eventually severe damage to unidentified attractions.

My research also established that changes in climate and land cover are the main environmental impacts that threaten contemporary NBT in Tanzania. Nevertheless, law enforcements have been unable to resolve these impacts and science-based assessment is thus the solution. Most tourism destinations' land covers are heavily affected by human activities that decreased the number of wildlife and reduced the natural landscape beauty. Many tourism destinations have become isolated areas with clear boundaries. This isolation leaves little room for expansion, few corridors for wildlife movements and confines wildlife habitats. Consequently, over the last century, tourism destinations changed from common resources to either game reserves and/or forest reserves, and finally to nature reserves and national parks to adapt the effect of environmental change on attractions. In addition to these adaptation strategies, I consider impact assessment on individual attractions is important for informing tourism planners and park managers. This is because increasing the extent or upgrading tourism destinations will likely be impossible due to competition with local people's needs.

To assess the impacts, I developed the three-step approach refered to as the eco-parcel. Specifically, the eco-parcel approach uses changing climate and land cover to approximate the impacts of environemntal change. The eco-parcel appraoch, first identifies all attractions and assess the relative importance of individual attractions for tourism and then links each attraction to its supporting charactrisic environments. Connection between environment and tourism makes the eco-parcel a generic approach that can in principle be applied in many different destinations.

The application of the eco-parcel approach demonstrate that the approach can be applied to help tourism stakeholders to identify (i) impacts to adapt to, (ii) opportunities to invest in and (iii) threats to proactively mitigate before they cause irreversible change. In my research, the most alarming impacts have been the loss of snow cover on Mount Kilimanjaro and spatial and temporal changes in wildebeest-migration patterns in the Serengeti. Mount Kilimanjaro's snow-cap, which is the mountain's main attraction, lost more than half of its extent in the last two decades. Ironically, in the short run, this rapid decline is likely to add to the mountain's appeal through an increase in 'last-chance tourism' (i.e. tourism to disappearing destinations).

The montane forests that is home to Black-and-White Colobus monkeys, birds and other animals, which are appreciated by tourists, decreased by 15% in the past two decades. The area of heathlands that are known for their many attractive flowers and giant groundsels, increased by 38% and currently covers most of the Shira plateau. As these changes resonate with previous studies (c.f. Hemp, 2005; Hemp, 2006, 2009; Thompson et al., 2009; Cullen et al., 2013) and the Shira plateau is within the reach of day visitors, the expansion of heathlands' floristic attractions provides an opportunity for tourism product diversification on Mount Kilimanjaro. Increased use by day visitors and domestic tourists, however, will require improved short-term tourist facilities but these can profitably be developed.

In the Serengeti National Park, wildebeest migration, which is the key tourist attraction, is threatened by changes in climate, which are already observed between the northern and southern parts of the park. As wildebeest migration is triggered by rainfall (c.f. Boone et al., 2006), these observed changes make fullfilling the tourists'expectations to experience the migration less reliable. Consequently, this unreliability will probably force tourists and other stakeholders to opt for other destinations. For the time being, I argue that park managers should opt for mobile camps to satisfy tourists. They should also avoid activities that further distort the wildebeest migration patterns and ensure alternative water sources to cater for the observed 14% decrease in the extent of surface water.

In line with the above findings, although my annual rainfall trends analysis and FCFA (2017) show no significant trends, the monthly analysis does shows trends and further assessments on land-cover change show substantial impacts on individual attractions. With these findings, I argue that statistical tests (i.e. p-values) should not be the only criterion to invalidate research hypotheses in environmental impacts studies as some statistically none-significant variables indicate adverse real-life impacts. Impact assessments on individual attractions or tourism activities are vital as each will react differently to environmental change depending on its resilience or adaptive capacity. My approaches have made environmental-change impact assessment possible and localised to individual attractions or tourism activities. The eco-parcel approach (c.f. Chapter 3) shows that both attractive animals and plants emerge from and are spatially connected to specific land covers. Any change in such land cover also changes the composition and distribution of attractions attached to that land-cover type. The link between individual attractions and their supporting environments thus makes the environmental impact assessments more localised in specific land-cover types. This type of specialised assessment is relevant for specific NBT destinations. Tailoring impact assessment to specific localities is now especially necessary because many trade-offs are being made to develop more tourism products or other economic or livelihood projects. My eco-parcel approach helps to quantify the impact of development projects on tourist destinations. Spatial and computerised data storage within the eco-parcel approach allows retrieval and integration with other land-use plans.

My thesis contributes to the 2015 Paris Climate-Change Agreement's plea for adaptation. The Tanzanian NBT should adapt to the impacts of environmental change by diversifying tourism attractions and activities. I suggest short-term and long-term management adjustments and actions that can be part of the governments' efforts to such adaptation processes. Moreover, my findings call the tourism policy strategy from 1999 (under revision) to consider climate change as a threat and put effective adaption strategies to minimise the adverse effects on existing and future attractions.

Adaptation strategies for snow loss on Mount Kilimanjaro and distortion of migrating wildebeest in SENAPA should be an example of many attractions at risk. Finally, my thesis prompts to mainstream the impacts of environmental change on attractions in parks' management plans. KINAPA and SENAPA are immediately to benefit with my thesis because they are currently reviewing their general management plans.

My thesis draws attention to the critical issues of climate and environmental change and the importance of adaptation strategies for tourism. Although my research does not solve all the environmental challenges that Tanzanian NBT faces, it provides pertinent information that can assist the NBT sector to cope with the current impacts of changing environments on attractions. My research process and methods innovate tourism-resources and environmental-impact assessments and provide insights on how to proactively address the impacts of environmental change on Tanzanian National Parks, which are the main nature-based tourism destinations.

6.6 Future research outlook

My research provides a comprehensive review of the factors that contribute to contemporary Tanzanian NBT and better characterises attractions to support environmental-change impact assessments. Moreover, my thesis assesses the impacts of environmental change on individual attractions and NBT in SENAPA and KINAPA. My observed changes in climate and land cover and their impacts on the key tourist attractions and tourism activities in SENAPA and KINAPA are thus building blocks to understand the (future) effects of climate change. The interrelationship between climate change and tourism seasons (i.e. tourism timing) is, however, still a research gap. Short-term (i.e. ten years) tourist arrival data limited this analysis. Addressing it would certinly benefit tourism planners and park managers in Tanzania and wider Africa. Tourism's timing is largely determined by socio-economic factors that are driven by market forces elsewhere (e.g. USA and Europe) but should also consider the destinations' prevailing environmental conditions in space and time.

My findings that were based on the eco-parcel approach can form a basis to develop scenarios of plausible future changes in tourism under the impacts of climate and land-cover change. My assessments on tourist preferences on snow and wildebeest migration, and the results of snow loss and distorted wildebeest migration patterns call for a what if scenario to inform their consequences before they cause irreversible change. Scenario studies will help to adapt the Tanzanian NBT sector to the impacts of environmental change. Scenario studies that consider one environmental impact with one tourism activity or attraction at a time, are vital to bridge the knowledge gap between scientists, tourists, policymakers and society while they also provide an outlook on the Tanzanian NBT based on projected rates of environmental change.

Lastly, my impacts assessment bridges researchers, tourists, policy-makers and society. The impacts of environmental change on NBT are probaby wider spread but yet poorly assessed and communicated in most destinations in Africa. The IPCC Africa reports of 2007 and 2014 acknowledge this research gap (see, Boko et al., 2007; IPCC, 2014). Consequently, tourism stakeholders have limited opportunities to adapt to such impacts. The successful operaliolisation of the eco-parcel approach for low altitude (based on Serengeti National Park) and high altitude (based on Kilimanjaro National Park) NBT destinations prove that the approach is generic. The eco-parcel can be applied to other parks in Tanzania and Africa to provide an outlook for NBT under environmental change.

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Summary

The impacts of environmental change are generally recognised as the major threats to humans and biodiversity. With respect to nature-based tourism (NBT), the impact of environmental change not only changes the types and distributions of tourist attractions but also interfere with tourists' comfort and safety. In Tanzania, some environment impact assessments are available, but these do cover neither NBT nor specific attractions and destinations. A major knowledge gap is that tourist attractions are poorly defined in coarse categories, such as 'wildlife', without details on types or species, and knowledge on how individual attractions are rooted in the environmental properties in which they occur. This knowledge gap is primarily related to the current lack of approaches to link individual attractions with their supporting environments (i.e. microclimate, soil, water and vegetation types and hydrology).

My thesis fills this knowledge gap as it assesses how tourist attractions react to climate and land-cover change for the key Tanzanian NBT destinations: Serengeti and Kilimanjaro National Parks. To achieve this, Chapter 2 reviews and synthesizes the major factors that drove the Tanzanian NBT since the 19th century. This review provides the state-of-the-art information on the Tanzanian contemporary NBT and its destinations.

Subsequently, I developed a tourism-resource assessment approach referred to as the 'eco-parcel' approach (Chapter 3). The eco-parcel approach is a three-step approach that classifies tourist attractions in fine categories and firmly links individual attractions with their supporting environments of discrete landscape patches. Each well-described discrete landscape patch is an eco-parcel. An eco-parcel is a landscape patch with distinct physical features on which one or multiple attractions occur and whose supporting environmental properties are known. I applied the eco-parcel approach in Serengeti National Park (SENAPA) and Kilimanjaro National Park (KINAPA) to identify all attractions in details. 'Wildlife' is now classified into types and species. In addition, plants and physical features are as well identified as key attractions for NBT. The eco-parcel approach uses land-cover type as a proxy to link attractions with their supporting environment so that land-cover change would be an approximate of environmental change. I use this link to assess the impacts of environmental change on individual tourist attractions and tourism in KINAPA and SENAPA (Chapters 4 and 5).

Chapter 4 assesses the impacts of climate and land-cover change on the physical and sightseeing aspects of trekking in KINAPA for the past forty years. Trekking is the main tourism activity in KINAPA and sightseeing is an add-on to the experience. In this Chapter, I use a hazard-activity pairs approach to link trekking with the impacts of environmental change, especially changes in climate and land cover. Hazard-activity pairs' is an approach to structure the analysis of the complex interactions between environmental change and tourism for particular destinations. Chapter 5 assesses the implications of climate and land-cover change on the key tourist attractions and tourism in SENAPA for the past forty years. I focus on wildebeest migration as the key tourist attraction although important attractions in SENAPA are many (cf. Chapter 3). In this chapter, I use the inferential statistics approach to make judgments on the probability of causal relationships between happened environmental impacts and observed changes on attractions through climate and land-cover statistical analysis. In Chapters 4 and 5, an increase in a specific land-cover type suggests an increase in types and distribution of attractions supported therein. Land cover is a basis for wildlife and plant to breed and grow. An adverse change in land-cover types is, therefore, an indicative threat to tourist attractions.

Chapter 2 shows that environmental change is a root cause for the substantial changes in tourist attractions and, in turn, motives and preferences of tourists visiting Tanzania. As such, tourism activities changed from trophy hunting to mass tourism and finally, to environmental friendly tourism. These trends changed the management of tourism destinations from open areas and game reserves (mainly for hunting) or forest reserves (forest products) to national parks (mainly for experience tourism) to minimise the impacts and conserve wildlife.

Chapter 3 concludes that, first; wildlife is not the only key attractions for NBT contrary to what is well-known. Attractions are diverse and the relative importance of each attraction for tourism varies widely. For instance, wildebeest migration and snow are indeed the key attractions but not the only important attractions in SENAPA's and KINAPA's tourism respectively. I found, however, high ratings for other identified attractions, such as big cats and kopjes in SENAPA, and high altitude, wildlife and flowers in KINAPA. These findings imply that assessing the relative importance of each attraction adds value in environmental-change impacts assessment from a tourism perspective. These details are likely to lead into the conservation of attractions at risk that have high tourism potential but are simultaneously marginalised in traditional and coarse assessments. Second, attractions emerge from and are connected to specific characteristic environments. This means that these characteristic environments regulate the attractiveness (e.g. breeding, migration or flowering) of many attractions. The spatial link between individual attractions and land-cover types enables the eco-parcel approach to localise the impacts assessment to individual attractions in time and space. The magnitude of environmental impacts on attractions, however, varies depending on their capacity to adapt, behaviour, sensitivity and resiliency.

Chapter 4 shows that both, climate change and variability and land-cover change have positive and negative impacts on Mount Kilimanjaro's tourism. Trekking is its key tourism activity and it needs conducive weather and preferably dry weather conditions and other attractions to enhance the trekking experience. Consequently, trekking Mount Kilimanjaro is mostly done during the dry months of June and September to avoid the long-rain period of March through May. The results indicate that mean annual temperature increased by 1.3^{o}C ($p< 0.05$) between 1973 and 2013 and no significant trend for annual rainfall. Rainfall's seasonality, however, did change with backward shift from May to March. This change extends the favourable trekking conditions. Moreover, land-cover changed substantially. This change has had substantial impacts on the extent and distribution of tourist attractions and, in turn, trekking experience. Heathlands that are known to attract tourists because of their flowers and giant groundsels, have increased by 38% and currently covers most of the Shira plateau. The montane forests that are also known to attract tourists because of their rich attractions including, Black-and-White Colobus monkey, birds and other wildlife species and high-crest waterfalls, have decreased by 15% in the past two decades. Snow cover, which is the mountain's second most attraction, lost more than 50% of its extent in the last two decades.

As these changes resonate with previous studies, in the short-term, the rapid decline in snow is likely to add to the mountain's appeal through an increase in 'last chance tourism' (i.e. tourism in disappearing destinations). Warmer temperatures and reduced rainfall create better trekking conditions. In the long-term, however, the loss of snow and the montane forest cover will likely decrease the number of tourists. With this knowledge, I argue that climate and land-cover change should be considered more systematically and interactively to device appropriate management practices to adapt the Tanzanian NBT sector to current and future impacts.

In Chapter 5, the key findings are that since the 1970s climate and land cover have changed significantly with potential influence on wildlife migration tourism and tourist comfort in SENAPA. Temperature has warmed by 0.8^{o}C (i.e. approximately .0.2^{o}C per decade). Mean monthly minimum and maximum temperature during the high tourism season (June to September) shifted from 17.5^{o}C and 28.1^{o}C in the 1970s to 18.3^{o}C and 28.7^{o}C in the 2000s. As a result, daily temperatures during high tourism season sometimes exceed 30^{o}C. This rise likely interferes with comfort temperature (~21^{o}C to 30^{o}C) adapted for outdoor tourism activities. Rainfall totals have become highly variable despite long-term data showing no significant change. The rainfall amount received in different zones within the park varied substantially. In the northwest and eastern Serengeti, the amount of annual rainfall received in the short-rain season of October through December increased by 8%, while in the south-central Serengeti rainfall decreased by 4%. In the long rain season of March through May, the rainfall decreased by 5% in the northwest-eastern and increased by 6% in the southern-central zone. Furthermore, savannah grasslands, which form the main food for wildebeest migration, increased by 21% between 1970 and 2010. Woodlands and the riparian forests, which are the alternative food during the critical dry season, decreased by 87% and by 30% respectively. The surface water (i.e. lakes Ndutu and Magadi) shrank by 14%.

As these changes resonate with previous studies, the implications of these results in SENAPA's tourism include disruption of wildebeest migration patterns and timing. The disruption makes fulfilling tourists' expectations to see wildebeest migration tourism to experience a challenge. Wildebeest-migration tourism is largely conducted between December and March in the southern-central Serengeti when the wildlife synchronously breeds and between June and September in northern Serengeti when the migration aggregates along the Mara River and ready to migrate to the Masai Mara in Kenya. The findings in Chapter 5 imply that this calendar is slowly changing and affects tourism. Personal communication in 2013 with park ecologist and tourism wardens acknowledge that the odds of delayed migration in the southern and northern Serengeti have increased and sometimes make tourism a chaotic experience. In the future, the likeness for tourists to visit Serengeti only to find no migration is increasing. Strategies to adapt tourism to the impacts of climate and land-cover change require active and integrated management approaches to improve or maintain the park's attractiveness. The results in Chapters 4 and 5 can be used to develop climate and land-cover change adaptation strategies to inform tourism planning.

The pioneering environmental-change impact assessments presented in my thesis bring new methods and mindset to NBT researches. This assessment is timely and indispensable. Very few studies exist that quantify the implications of environmental change on the Tanzanian NBT. My research potentially makes a substantial contribution to science and society. A detailed temporal and spatial link between tourists and attractions, and between attractions and their supporting environments provides a platform to assess the impacts of weather or climate change and land-cover change on individual tourist attractions. Chapters 4 and 5 demonstrate that the eco-parcel approach developed in Chapter 3 supports impacts assessment and allows the inclusion of tourists' and other stakeholders' perspectives or interests to support their decision-making process.

My research, therefore, presents the eco-parcel approach as a generic tourism-resources assessment approach that can be used to study the impacts of environmental change on attractions in any tourism destination. The eco-parcel approach is timely. It provides NBT and recreation sectors with reliable spatial and temporal tourist attractions information to support impacts assessment.

The spatial link between individual attractions with their characteristics environments not only allows to assessing changes in the distribution of attractions but also determine the attractions likely to be lost or gained when environment changes. With the ongoing rapid rate of forest loss and snow melting, the odds of complete loss of key attractions increase. I, therefore, argue that the impacts of environmental change on individual attractions and, in turn, NBT should not be ignored.

Because attractions emerge from and are connected to specific environments, the integration of remote sensing in data collection and GIS-data analysis tool within the eco-parcel approach to determine changes on attraction is not an option. In fact, the majority of tourism destinations in developing countries are located in remote areas that are either difficult to access or poorly equipped with weather stations. As such, to acquire long-term environmental data including climate and types of attractions is difficult. This situation presents a challenge in addressing the impacts of environmental change on NBT in Africa's tourism destinations. The IPCC 2014 and 2007 Africa reports acknowledge this knowledge gap. The use of land-cover within the eco-parcel approach makes a substantial contribution to tourism researches. Land-cover data are often freely acquired from satellites. Thus, the link between attractions and specific land-cover types makes the eco-parcel approach a model and a cost-effective approach to assessing the impacts of environmental change on NBT. The eco-parcel approach is the key contribution to the scientific arena

My thesis informs the importance of the NBT sector to adapt to the impacts of environmental change. The tourism sector has long taken climate and environmental change for granted. This has hindered the mainstreaming of climate and environmental change adaptation in tourism management, planning and policies, particularly in Africa. My thesis is, therefore, timely to inform at least the three on-going policy processes. First, most Tanzanian National Parks are reviewing or about to review their general management plans and information provided in my thesis particularly the discussed impacts and implications of changing climate and land cover on tourist attractions is a valuable input. Second, Tanzania is reviewing its almost twenty-year-old tourism policy from 1999 and my research argues that the new policy should pay serious attention to the effects of environmental change. Third, in April 2018 Tanzania ratified the 2015 Paris Climate Agreement, which not only covers mitigation but also adaptation. The discussion in my thesis about the tourism-specific adaptation plans and diversification of tourism products to match with the current rate of environmental change may be taken as part of Tanzania's adaptation efforts.

In conclusion, my thesis quantified the impacts of environmental change on tourist attractions by using empirical environmental data (i.e. climate and land-cover) and societal data (i.e. tourist visits and preferences). Although I acknowledge that my research alone will not solve all the environmental problems that Tanzanian NBT face, my research process and methods bring innovations in tourism-resources and environmental impact assessments. In addition, my research also provides insights on how to (1) identify the impacts, (2) proactively address the impacts on individual attractions and (3) identify opportunities to invest and adapt. This knowledge is indispensable to informing decisions and actions to better manage individual attractions and the Tanzanian NBT under the current rate of environmental change.

About the Author

Halima Kilungu Hassan was born in Tanzanian Kilimanjaro region, where Africa's highest snow-capped mountain and her PhD case study is found. Halima was privileged to travel to different parts of the world with spectacular landscapes, full of wildlife and magnificent human-made attractions. This includes the Great Wall and the Forbidden Temple in China, the Table Mountain and the Cape of Good Hope in South Africa, the Sonoran Mountain in the United States, the Old Trafford in the UK, the North Sea at Oostende beach in Belgium, the tulip gardens 'Keukenhof' and De Hoge Veluwe National Park in the Netherlands and the Andes Mountains in Bolivia.

Halima pursued her BSc in wildlife management in 2004 at the Sokoine University of Agriculture (SUA) in Morogoro, Tanzania. She then tutored students at the Open University of Tanzania before she got her MSc in Integrated Water Resources Management (IWRM) at the University of Dar es Salaam in 2008.

Her frequent visits to major Tanzanian tourism destinations helped her to discover diverse tourist attractions that are highly threatened by environmental-change impacts. Her focus on linking attractions and their supporting environments limited her contribution to the policy discussions on how the tourism sector should adapt to these changing environments. This knowledge gap determined Halima's career passion to understand the impacts of environmental change on natural environments and improve their management and resilience. She starts to address this gap by first studying the contribution of wetland ecosystems to household income and food security in her bachelor thesis. Since wetlands were considered as 'wastelands' but occupy a quarter of the Tanzanian land, Halima's thesis provided input to several government documents, such as the national strategy for growth and poverty reduction (MKUKUTA in Kiswahili), and the property and business formalisation program (MKURABITA in Kiswahili). She specialized in environmental impact assessment during her MSc studies and wrote her dissertation on water allocation to sustain aquatic ecosystems. She again pinpointed the importance of wetlands ecosystems to society.

Always having a career passion on how environmental systems (e.g. ecosystems and climate change) affect social systems (i.e. livelihood, tourist attractions and preferences) and taking an opportunity of inadequate academic staffs with integrated environmental and tourism knowledge in Tanzania, Halima starts her PhD in 2012 to fill this gap. Through her PhD thesis, she shows society and decision makers that nature-based tourism is increasingly threatened by the impact of environmental change but also these changes bring new attractions and opportunities to invest. She developed an innovative and generic tourism-resources assessment approach and she referred it to as the 'eco-parcel' approach. This new eco-parcel approach enables scientists to localize impacts assessment on individual tourist attractions and empowers tourism managers to plan appropriate adaptation measures for each attraction.

Halima participates in several international projects, such as the 'Speciation Clock' and the Sustainable Development Goals: Knowledge for synergistic action 'R4D'. Halima works with the Open University of Tanzania and can be contacted via: *kilunguh@yahoo.com or halima.kilungu@out.ac.tz* .

Selected publications

Kilungu, H., Leemans, R., Munishi, P. K. T., Nicholls, S., & Amelung, B (2019). Forty years of climate and land-cover change and its effects on tourism resources in Kilimanjaro National Park. *Tourism Planning & Development* 16, 235-253

Kilungu, H., Leemans, R., Munishi, P. K. T., & Amelung, B (2017). Climate change threatens major tourist attractions and tourism in Serengeti National Park, Tanzania. In: W. Leal Filho, S. Belay, J. Kalangu, W. Menas, P. Munishi & K. Musiyiwa (Eds.), *Climate change adaptation in Africa: Fostering resilience and capacity to adapt* (pp. 375-392). Cham: Springer.

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- Scientific writing (2016)

Other PhD and Advanced MSc Courses

- Tourism and Sustainable development, Wageningen University (2012)

External training at a foreign research institute

- Workshop on 'Resilient pasts and sustainable futures? The social-ecological dynamics of East African landscapes ',Worldwide Universities Network (2012)
- Regional training of trainer's course on Ecosystem functions and Integrated Water Resources Management, SADC and EAC, held in Harare, Zimbabwe (2013)
- Workshop 'Africa Rising: Mobilising Biodiversity Data for Sustainable Development', SANBI, GBIF, UNEP-WCMC and USAID (2015)

Management and Didactic Skills Training

- Developing the MSc. degree curriculum of Southern Africa Regional Universities Association (SARUA) in 'Climate Change and Sustainable Development' (2015-2017)

Oral Presentations

- *The future of eco-based tourist destinations in Tanzania under climate change.* International Training on Tourism, Wellbeing and Ecosystem Services (TObeWELL), 4-6 November 2013, Warsaw, Poland
- Climate change threatens major tourist attractions and tourism in the Serengeti National Park, Tanzania. World Symposium on Climate Change Adaption -WSCCA, 2-6 September 2015, Manchester, United Kingdom

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