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Review article

Anthropogenic and natural factors influencing African World Heritage sites

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ABSTRACT

The article presents anthropogenic and natural factors influencing African World Heritage sites. The analysis was based on the data contained in the Conservation Outlook Assessments for 2020, including all sites on the African continent where natural values are protected, i.e., both natural (38) and mixed sites – natural and cultural (6). The assessment of current and potential threats and effectiveness of protection and management included 57 items, each of which was analyzed concerning all African properties. The results show that the African World Heritage sites are subject to various pressures from human activity and natural factors. The most common current threat is hunting and trapping, found in 33 sites. The spread of invasive (alien) species in 21 areas is second. Common threats (reported in 15-17 sites) include livestock farming and grazing, logging and wood collecting, fires, tourism, mining, and crops. The most frequently mentioned potential threats are mining, oil/gas exploration, construction of dams, and various effects of climate change – droughts, flooding, temperature extremes, and habitat shifting. The effectiveness of protection and management is not satisfactory. There are serious concerns related to law enforcement, sustainable finance, staff capacity, training, and development. Some concerns are directed to monitoring, tourism and visitation management, boundaries, and effectiveness of the management system. Results of a review show that, of all natural and mixed World Heritage sites in Africa for three areas, the conservation outlook is assessed as good, 15 – good with some concerns, 14 – significant concerns, and 12 – critical. In 2020, as many as 11 "in danger" sites were listed in Africa. At that time, there were 17 sites around the World in danger, i.e. as many as 70% of them were in Africa.

KEY WORDS: World Heritage, human impact, threats, management, nature protection, Africa

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1. Introduction

Sites distinguished by 'Outstanding Universal Value' (OUV) constitute the common good of humanity and are successively entered on the World Heritage List. According to the UNESCO Convention of 1972, the World's Cultural and Natural Heritage is to present all world regions' cultural diversity and natural richness. The States Parties to the Convention are to ensure the protection of these sites against destruction and to create conditions for their preservation as unchanged as possible for future generations. The requirement for entering a site on the World Heritage List is meeting one or more cultural and/or natural criteria that make it unique on a global scale. These sites must conform to the authenticity and integrity requirements set out in the Operational Guidelines. The first 12 places were entered on the list in 1978. Currently (2022), there are 1,154 sites in 167 countries: 897 cultural, 218 natural, and 39 mixed cultural and natural sites.

Natural World Heritage sites include intact landscapes/seascapes and are the most significant protected areas on Earth. For this reason, they are monitored for nature conservation. The International Union for Conservation of Nature (IUCN) prepares the World Heritage Outlook every three years, starting in 2014, next in 2017, and 2020. Importantly, all sites are monitored at the same time. Assessments prepared for each natural

World Heritage site are available online at worldheritageoutlook.iucn.org.

The Conservation Outlook Assessments for 2020 provide the overall results for 252 natural sites existing this year (213 natural and 39 mixed – natural and cultural). The results indicate that for 63% of sites, the conservation outlook is either 'good' or 'good with some concerns', while for 30%, the perspective is with 'significant concern', and for 7% of it is assessed as 'critical' (OSIPOVA ET AL., 2020).

According to each of the three outlooks to date, on a global scale, the most common threat to Natural World Heritage sites is climate change. In 2020 it was assessed as a high or a very high threat in 1/3 of sites. The second common threat is alien invasive species, followed by threats from human activities: tourism visitation, hunting, fishing, fires, and livestock grazing (OSIPOVA ET AL., 2020). In regions, however, there are significant differences in the main threats to natural sites; for example, in South America, it is livestock grazing; in Africa, Asia, and Mesoamerica – hunting and fishing; in the Arab States – solid waste.

This article presents anthropogenic and natural factors influencing African World Heritage sites. The analysis covered sites on the African continent (excluding islands). Therefore, no reference was made to the division The World Heritage Committee used, dividing the world into five geographic zones, in which North Africa is included in the zone of Arab states.

2. Methods

The analysis was based on the data contained in the Conservation Outlook Assessments for 2020 (www.worldheritageoutlook.iucn.org), including all sites on the African continent where natural values are protected, i.e., both natural and mixed sites – natural and cultural. The state of values, conservation, and management assessment included 57 items, each of which was analyzed concerning all African sites. Thus, a general overview of the conservation status of African World Heritage sites, including especially its weakest points, was obtained.

The World Heritage Outlook is prepared every three years and is global, applying the same criteria for each site. Numerous experts assess whether a site will retain its World Heritage values by taking into account the following: the current and potential threats to values, the effectiveness of protection and management, and the current state and trend of values (OSIPOVA ET AL., 2020) (Table 1) Based on the assessment of the listed elements, the overall conservation outlook is formulated, and the site is assigned one of four rating categories – good, good with some concerns, significant concern, and critical (Table 2). A site is categorized as 'data deficient' if there is no available data.

Table 1. Assessment of the conservation of the World Heritage sites

Assessment element	Rating category			
Current and potential threats	Very low threat	Low threat	High threat	Very high threat
Effectiveness of protection and management	Highly effective	Mostly effective	Some concern	Serious concern
Current state of values	Good	Good with some concerns	Significant concern	Critical
Trend of values	Improving	Stable		Detoriorating

Table 2. Rating categories for Conservation Outlook Assessments (Source: Osipova et al., 2020)

Rating category	Description
Good	The site's values are in good condition and are likely to be maintained for the foreseeable future, provided that current conservation measures are maintained
Good with some concerns	While some concerns exist, with minor additional conservation measures the site's values are likely to be essentially maintained in the long term
Significant concern	The site's values are threatened and/or are showing signs of deterioration. Significant additional conservation measures are needed to maintain and/or restore values over the medium to long term
Critical	The site's values are severely threatened and/or deteriorating. Immediate large-scale additional conservation measures are needed to maintain and/or restore the site's values over the short to medium term, or the values may be lost

3. Results

There are 130 sites on the World Heritage List on the African continent, of which 38 are natural sites, and six are mixed – natural and cultural (Fig. 1). The natural values are therefore protected in 44 sites. They cover an area of almost 490 thousand square kilometers. These sites are located in 30 countries, the most (5) are in the Democratic Republic of the Congo and South Africa, four are in Tanzania, three are in Kenya, and three are in Côte d'Ivoire. Almost half of the sites (21) are located in just five countries. The oldest site is the Semien National Park in Ethiopia, established in 1978, and the youngest is the Barberton Makhonjwa Mountains, existing since 2018 in South Africa. The largest site – Aïr and Ténéré Natural Reserve in Niger, covers an area of over 77 thousand square kilometers, while the least, i.e., Mosi-oa-Tunya on the border of Zambia and Zimbabwe – is less than 69 square kilometers.

Four of the 10 Outstanding Universal Value criteria refer to natural values: VII – outstanding natural beauty and exceptional phenomena; VIII – geoheritage; IX criteria, and X are linked to biodiversity, i.e., ecosystems and species. African World Heritage sites meet all four natural criteria but in different proportions (Table 3, Fig. 2). Most of them, as many as 33, complete criterion X, meaning they are valuable in terms of biodiversity and the presence of endangered species of flora and fauna. The smallest number of sites, only 8, meet criterion VIII regarding the history of the Earth, its geology, or geomorphology. As many as 27 sites meet criterion VII regarding the area's exceptional beauty, and criterion IX, relating to valuable ecosystems, has been assigned to 24 sites. Some sites meet only one natural criterion (e.g. Wadi al-Hitan in Egypt, Vredefort Dome in South Africa), and some meet all four criteria (Lake Turkana National Parks in Kenya, Ngorongoro Conservation Area in Tanzania, and Namib Sand Sea in Namibia).

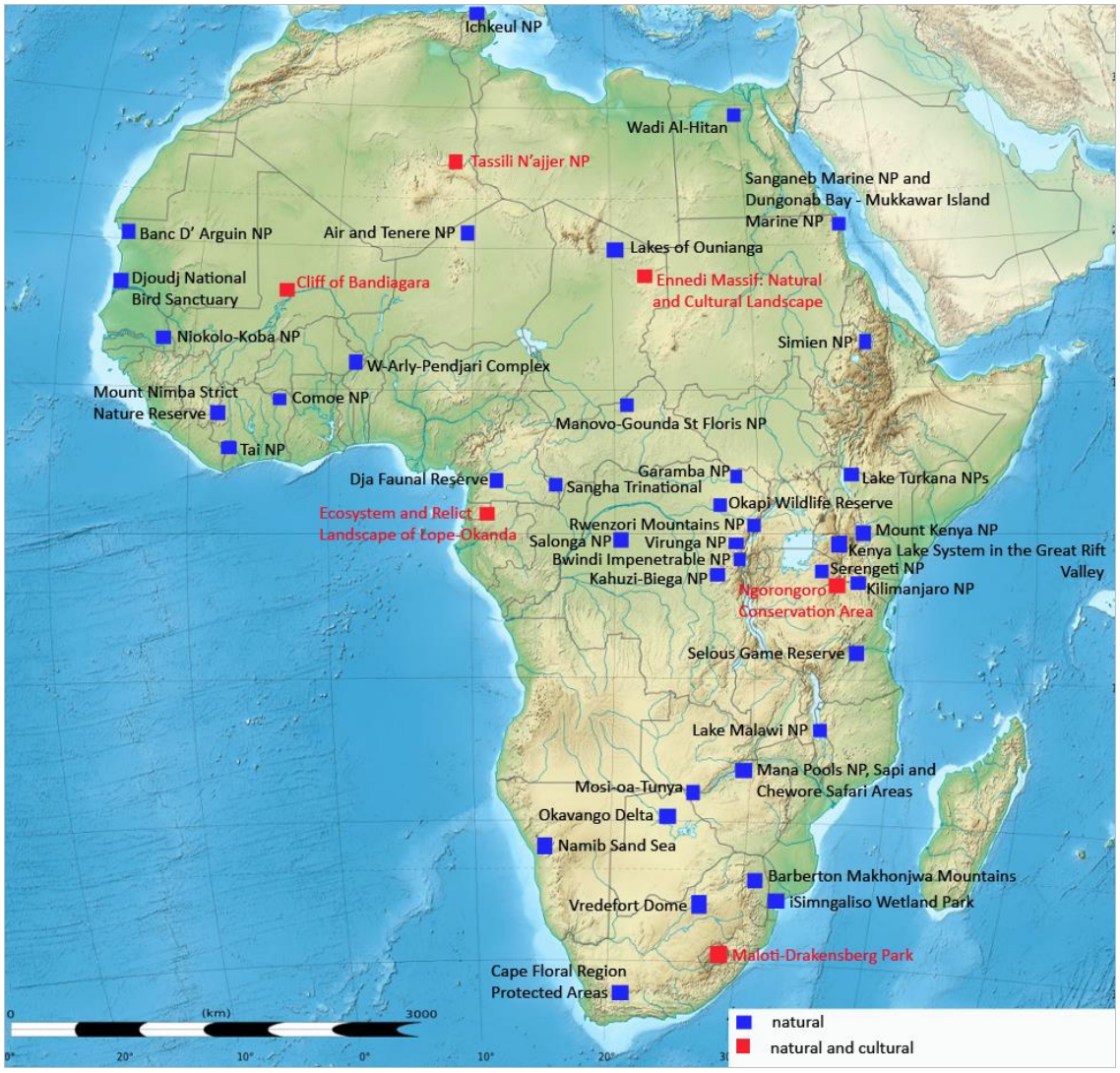


Fig. 1. Natural and mixed (cultural and natural) World Heritage sites in Africa (abbreviation NP – National Park)

Table 3. Natural and mixed World Heritage sites in Africa according to criteria of Outstanding Universal Value

Criteria of Outstanding Universal Value			Number of sites in Africa
Criterion	Full description	Short description	
VII	Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	Exceptional beauty and phenomena	27
VIII	Be outstanding examples representing major stages of Earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features	Geoheritage (Earth's history; geology)	8
IX	Be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;	Ecological processes (biodiversity; ecosystems)	24
X	Contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation	Species and habitats	33



A B C D

Fig. 2. Examples of World Heritage sites in Africa according to criteria of Outstanding Universal Value
A – Criterion VI: Mosi-oa-Tunya/Victoria Falls, Zambia/Zimbabwe; B – Criterion VIII: Namib Sand Sea, Namibia; C – Criterion IX: Okavango Delta, Botswana; D – Criterion X: Cape Floral Region Protected Areas, South Africa (*Photos R. Dulias*)

3.1. Threats

The analysis shows that the values of World Heritage sites in Africa are subject to various pressures from human activity and natural factors. More than 40 factors have been identified that adversely affect these sites. They are listed in Table 4 according to the threat groups defined by IUCN. These are, therefore, threats related to construction, mining, energy, transport, agriculture, or other use of biological resources, moreover, disruptions resulting from military operations, tourism development, water management, as well as various types of environmental pollution, modification of ecosystems, or the spread of alien species of flora and fauna. A separate group comprises threats related to geological phenomena and climate change. In addition, social threats were taken into account.

The most common current threat is hunting and trapping, found in 33 sites. The spread of invasive (alien) species in 21 areas is second. Common threats (reported in 15–17 sites) include livestock farming and grazing (17), logging and wood collecting (17), wildfires (17), tourism/ visitors/ recreation (17), mining (16), and crops (15).

The most frequently mentioned potential threats are mining/quarrying (13 sites), oil/gas exploration (13), and construction of dams (12), with very high and high threats for 8, 10, and 8 sites, respectively (Table 4). In addition, potential threats are anticipated through various effects of climate change – droughts (6 sites), flooding (6), temperature extremes (8), and habitat shifting (8). Potential threats are water pollution can occur in 7 sites, and construction and expansion of roads in 6 sites.

Table 4. Current (C) and potential (P) threats in natural and mixed World Heritage sites in Africa

Threats		Number of sites with current (C) and potential (P) threats*											
		Total		Very high threat		High threat		Low threat		Very low threat		Data deficient	
		C	P	C	P	C	P	C	P	C	P	C	P
Land development	Housing/urban areas	7	2	–	–	5	2	2	–	–	–	–	–
	Commercial/industrial areas	2	3	–	–	1	1	–	2	1	–	–	–
	Tourism/recreation areas	11	4	–	1	4	3	5	–	1	–	1	–
Minning and energy	Oil/gas exploration/development	1	13	1	3	–	7	–	1	–	–	–	2
	Mining/quarrying	16	13	1	1	5	7	8	4	1	1	1	–
	Renewable energy	3	3	1	–	1	2	–	–	–	–	1	1
Transport and service lines	Roads/railroads	13	6	–	1	5	2	6	3	–	–	2	–
	Utility/service lines	3	–	1	–	–	–	1	–	1	–	–	–
	Shipping lanes,	2	1	–	–	–	–	1	1	1	–	–	–
	Flight paths	2	2	1	1	–	1	1	–	–	–	–	1
Agriculture and aquaculture	Crops	15	5	–	–	6	3	7	1	2	1	–	–
	Forestry/wood production	5	–	–	–	3	–	2	–	–	–	–	–
	Livestock farming/grazing	17	1	2	–	6	1	7	–	–	–	2	–
	Marine/freshwater aquaculture	3	1	–	–	1	–	–	–	2	–	–	1
Biological resource use	Hunting and trapping	33	1	11	–	8	–	9	1	1	–	4	–
	Logging/wood harvesting	17	2	1	–	8	1	6	1	1	–	1	–
	Collection of non-timber forest products	4	–	–	–	1	–	2	–	1	–	–	–
	Fishing/arvesting aquatic resources	11	2	2	–	4	–	3	2	1	–	1	–
	Other biological resource use	5	–	1	–	2	–	1	–	–	–	1	–
Human intrusion/ interference	Tourism/visitors/recreation	17	5	1	1	8	1	6	2	2	1	–	–
	War, civil unrest/military exer	9	3	5	–	1	2	3	1	–	–	–	–
	Other activities	6	3	1	1	4	1	–	1	1	–	–	–
Ecosystem modifications	Fire/fire suppression	17	1	3	–	6	–	7	1	1	–	–	–
	Dams/water management or use	8	12	3	4	2	4	2	4	–	–	1	–
	Other ecosystem modifications	9	1	1	–	6	–	2	1	–	–	–	–
Invasive species	Invasive non-native/alien species	21	3	1	1	9	1	5	–	2	1	4	–
	Problematic native species	4	–	–	–	2	–	1	–	–	–	1	–
Pollution	Water pollution	9	7	1	1	6	3	1	2	1	1	–	–
	Household sewage/urban waste water	5	1	–	–	3	1	2	–	–	–	–	–
	Industrial/military effluents	2	2	–	1	2	1	–	–	–	–	–	–
	Agricultural effluents	2	4	–	–	2	2	–	1	–	1	–	–
	Solid waste	3	2	–	–	2	1	1	1	–	–	–	–
	Air pollution	2	4	–	1	2	2	–	–	–	–	–	1
Geological events/ phenomena	Volcanic activity	1	–	–	–	–	–	1	–	–	–	–	–
	Erosion and siltation/deposition	7	–	2	–	1	–	3	–	1	–	–	–
Climate changes and extreme weather conditions	Habitat shifting/alteration	7	8	2	–	4	5	–	–	–	–	1	3
	Droughts, desertification	4	6	1	–	1	3	–	1	–	–	2	2
	Temperature extremes	8	8	2	–	4	6	1	1	–		1	1
	Storms/flooding	2	6	1		–		–		–		1	
Social/cultural changes	Changes in traditional ways of life and knowledge systems that result in negative impact	1	–	–	–	1	–	–	–	–	–	–	–
	Identity/social cohesion/changes in local population and community that result in negative impact	4	2	1		2	1	–	1	1	–	–	–
Other	Other	9	7	–	–	4	2	3	2	–	1	2	2

*For five sites, the same threat was assessed in two different aspects. The table includes the rating with the higher level of risk.

3.2. Effectiveness of protection and management

An essential element of the site assessment is the effectiveness of protection and management. Fifteen actions/matters are assessed each on a four-level scale – highly effective, mostly effective, some concern, and serious concern (Table 5). The result of this assessment for natural and mixed World Heritage sites in Africa is not satisfactory. There are serious concerns related to law enforcement, sustainable finance, staff capacity, training, and development. Some concerns are

directed to monitoring, tourism and visitation management, boundaries, and effectiveness of the management system. Protection and management of 23% of sites are of serious concern. The most (6) 'highly effective' rating concerns conducted research. It is significant that in the overall assessment, no site received the highest grade for the effectiveness of protection and management. However, it is also worth noting that in 17 areas, relationships with local people were rated mostly effective.

Table 5. Effectiveness of protection and management in natural and mixed World Heritage sites in Africa

Assessment element	Number of sites				
	Serious concern	Some concern	Mostly effective	Highly effective	Data deficient
Management system	9	18	13	4	–
Effectiveness of management system	9	21	9	4	1
Boundaries	6	22	13	3	–
Integration into regional and national planning systems	8	16	14	3	3
Relationships with local people	8	17	17	1	1
Legal framework	7	19	16	2	–
Law enforcement	10	20	10	–	4
Implementation of Committee decisions and recommendations	7	17	15	1	4
Sustainable use	6	19	6	4	9
Sustainable finance	12	19	10	1	2
Staff capacity, training, and development	11	15	13	1	4
Education and interpretation programs	5	19	14	1	5
Tourism and visitation management	6	21	13	1	3
Monitoring	5	23	10	3	3
Research	3	18	14	6	3
Overall assessment of protection and management inside the site	10	23	11	–	–
Assessment of the effectiveness of protection and management in addressing threats outside the site	14	21	6	–	3

3.3. Current state and trend of values

The current state of natural and mixed World Heritage sites in Africa is unsatisfactory. Only eight sites scored good, and the assessment of low concern was formulated for 11 areas, while as many as 20 sites were assessed as a high concern and five – critical in terms of the state of values.

The deteriorating trend was found in as many as 16 sites, half of which refer to sites not in danger status, which is worrying. For five areas, the trend was found to be improving; one of these ratings relates to the site in danger, namely Garamba NP. A stable trend was found for 18 sites. Data for five areas were insufficient to determine the trend, including the in danger Virunga NP (Democratic Republic of the Congo – DRC) and the newly established Barberton Makhonjwa Mountains.

3.4. Conservation outlook

Results of a review show that, of all natural and mixed World Heritage sites in Africa for three areas, the conservation outlook is assessed as good (Namib Sand Sea, Lakes of Ounianga in Chad, Wadi al-Hitan), 15 – good with some concerns, 14 – significant concerns, and 12 – critical. It means that 59% of sites are classified as critical or significant concerns.

In 2020, as many as 11 'in danger' sites were listed in Africa, constituting a quarter of the total number of World Heritage sites on this continent (Table 6). At that time, there were 17 sites around the world in danger, i.e. as many as 70% of them were in Africa. All five sites were in danger in the DRC (Salonga NP was removed from this list in 2021). As of 2020 (the year of the report), Garamba NP was the longest on the in danger list – 33 years (1984-1992; 1996-), and seven sites were on this list from 23 to 29 years, two of them for over 95% of the time from being entered on the UNESCO list (Okapi Wildlife Reserve in DRC and Aïr and Ténéré Natural Reserves). Except for Mount Nimba Strict Natural Reserve (Côte d'Ivoire, Guinea) and Lake Turkana NPs, these are extensive sites ranging from several hundred thousand to several million hectares, mainly in tropical forests. These sites cover an area of almost 220,000 square kilometers (45% of the total area of World Heritage sites in Africa), which impacts the effectiveness of conservation and management.

Table 6. African World Heritage in Danger in 2020

Site	Country/Countries	Inscription	
		List of World Heritage	List of World Heritage in Danger
Virunga National Park	Democratic Republic of the Congo	1979	1994 -
Garamba National Park	Democratic Republic of the Congo	1980	1984-1992; 1996 -
Kahuzi-Biega National Park	Democratic Republic of the Congo	1980	1997 -
Mount Nimba Strict Natural Reserve	Guinea, Côte d'Ivoire	1981	1992 -
Niokolo-Koba National Park	Senegal	1981	2007 -
Selous Game Reserve	Tanzania	1982	2014 -
Salonga National Park*	Democratic Republic of the Congo	1984	1998 -
Manovo-Gounda Strict Nature Reserve	Central African Republic	1988	1997 -
Aïr and Ténéré Natural Reserves	Niger	1991	1992 -
Okapi Wildlife Reserve	Democratic Republic of the Congo	1996	1997 -
Lake Turkana National Parks	Kenya	1997	2018 -

*Removed from the list of World Heritage in Danger in 2021

4. Discussion

4.1. Land development

Land development high threats are found in eight sites, including the two smallest in Africa – Mosi-oa Tunya/Victoria Falls (69 km^2) and Lake Malawi NP (94 km^2). Since the Mosi-oa Tunya was included in the World Heritage List, the population of the neighboring city of Livingstone (Zambia) has doubled to over 135,000 (2015) (https://www.city-facts.com/livingstone-zambia). The property has numerous tourist facilities – hotels, restaurants, visitor centers, camps, and others (Liu & Mwanza, 2014). There are controversial plans to expand the infrastructure inside the site and in the buffer zone (a tethered balloon, a Ferris wheel, 5-star hotel). In the town of Victoria Falls (Zimbabwe), construction began on a large shopping and entertainment center near the property.

Within the Lake Malawi NP are five villages enclaves, whose predominantly fishing population has grown from 5,400 in 1977 to over 25,000 in 2018 (State Party of Malawi, 2020). Due to population growth, the encroachment of houses within the park boundaries is reported in some places. Numerous tourist facilities are developed at the largest enclave village, Chembe. The high density of tourist facilities along the beach may result in deterioration of water quality, as shown by the results of the research by Tyner et al. (2018) in other areas close to the park, namely extremely high fecal coliform counts in nearshore water.

Kenya Lake System in the Great Rift Valley has no permanent residents, but it is located close to the rapidly growing city of Nakuru. Increased housing developments are recorded in the buffer zone of the property. One of the areas has already lost its protected status (Ututu) as it has been divided into plots and sold (State Party of Kenya, 2019).

Around Simien NP, there are around 30 villages with an estimated population of about 30,000, while inside the park, more than 3,200 people live in over 580 households (Conservation Outlook, 2020). Voluntary resettlement within the site was carried out, but due to livelihood problems, part of the population re-graze cattle in the protected area (Tessema et al., 2012).

The population displacement also occurred in the Ngorongoro CA. In 1974, 8,700 Maasai were evicted, and no permanent residents were on the site, but grazing of about 300,000 cattle continued. Contemporary housing and commercial areas in Ngorongoro CA are perceived negatively for aesthetic reasons. Due to non-compliance with building guidelines, modern houses and housing estates are created that stand in a visual dissonance with the natural landscape (UNESCO/ICOMOS/IUCN, 2012).

In the Serengeti NP (Tanzania), tourism infrastructure and facilities are concentrated in a relatively small area in the central part of the park. There are lodges, permanent tented camps, campsites, rest houses, and a youth hostel. In addition, the tourist infrastructure in the Western Corridor is being expanded. It is worrying that some new investments occur in the middle of the migration route in important wildlife areas. Permanent tented camps from the Mara River bank have recently been transferred because of limiting free access by migrating herds that cross the river en mass during the dry season (Conservation Outlook, 2020). Considerable pressure on the ecosystem exerts the infrastructure required to maintain the tourism demand (e.g., toilets, food, waste, road maintenance).

The tourism pressure is growing in Mana Pools NP – Sapi and Chewore Safari Areas in Zimbabwe.

Two of the six new tourist facilities were located in the Wilderness zone, which stripped the area of this status. Close to the floodplain core area, at least ten camps with their exclusion areas have been established. New camps are also allocated at pans; despite their seasonal character, they can potentially disturb wildlife (CONSERVATION OUTLOOK, 2020).

There are no industrial areas in African World Heritage sites. An evaporative saltworks on the Dungonab Bay-Mukkawa NP (jointly protected with Sanganeb Marine NP) in Sudan, but o limited impact on the site values.

4.2. Minning

Mining activity is conducted in over a dozen sites. Besides geomorphological and hydrological changes, mining is associated with felling trees, agriculture, and hunting for the mining camps. In six sites, mining activity is a very high or high threat. Artisanal and semi-industrial illegal mining of diamonds and coltan occurs in the Okapi Wildlife Reserve and the peripheral zones. In 2019, 57 mines were observed, of which 30 active mines have been closed by eco guards (CONSERVATION OUTLOOK, 2020).

In Kahuzi-Biéga NP (DRC), there are very rich natural resources. In 2000, the gold and coltan rush began, fueled by its high price in world markets. From 10 to 15,000 miners came to the park, and dozens of mines arose. In 2011, there were over 900 mining sites (HOLLESTELLE ET AL., 2012). Since 2017 no legal mining concessions have been active, but illegal mining continues. Patrols subsequently dismantled mining digging holes. Illegal mining of diamonds is conducted at the Manovo-Gounda Strict Nature Reserve in the Central African Republic (CAR).

North-east of Comoé NP (Côte d'Ivoire), a gold-panning tradition has been going on for generations. This activity has expanded considerably for some time and is secretly encroaching inside the park. The main threat from mining is the potential contamination of watercourses within the limits of the property (CONSERVATION OUTLOOK, 2020).

In Niokolo-Koba NP (Senegal), a basalt quarry is operating, which should be closed by 2022. A few years ago, gold mining began at the site's eastern border. Monitoring surface and groundwater quality around the mine shows general compliance with drinking water standards and rare exceedances of the limit values (CONSERVATION OUTLOOK, 2020).

In Selous Game Reserve (Tanzania), the WORLD HERITAGE COMMITTEE (2012), in an 'exceptional and unique manner,' approved the excision of ca. 40,000 ha from the property to facilitate uranium mining. Due to low uranium prices, mining has become uneconomical, but the mining threat continues.

Lake Malawi NP is the only African World Heritage site currently highly endangered by oil exploration. The oil concession covers the entire property. Lake Malawi is essentially a closed system with a flushing time of more than 600 years, so any oil spilled in the lake will pollute it (CONSERVATION OUTLOOK, 2020). Oil drilling anywhere in the lake represents a significant threat to the unique assemblage of endemic fish species and associated evolutionary processes (VERHEYEN ET AL., 2016).

4.3. Transport and service lines

Each year, an average of 5 elephants and buffaloes are killed by a train crash in the Ecosystem and relict Cultural Landscape of Lopé-Okanda in Gabon. The excessive speed of cars, buses, and trucks on the main road passing through the center of Ngorongoro CA, also poses a risk of animal accidents. The main (unpaved) road in the Simien NP runs through critical wildlife habitat in the middle of the park – it will not be decommissioned after building a new road outside the park (CONSERVATION OUTLOOK, 2020). In Ennedi Massif: Natural and Cultural Landscape in Chad, the influence of common off-road driving on the vegetation and landscape of this site is noticeable. The rapid road development in Sangha Trinantional (Cameroon, DRC, CAR) has made available an area of the site for illegal hunting and fast transport of bushmeat to outlets.

A very high threat for birds is a high-voltage power transmission line 500 m from the southern shore of Lake Elmenteita in the Kenya Lake System in the Great Rift Valley (SMALLIE & VIRANI, 2010). 50-meter high pylons are a physical hazard for about 4 million flying birds, mainly flamingos, and pelicans. At the same property, there is a very high risk of collisions between birds and planes on the existing bird flight corridor between the Rift Valley lakes (a planned expansion of the military airstrip in Nakuru).

Shipping lanes do not pose a significant threat to the nature of African World Heritage sites.

4.4. Agriculture and aquaculture

Crops. Agriculture is reported for 15 sites, and for several of them, it was considered a high threat to the values of properties. In long and narrow Virunga NP, about two-thirds of its borders are under pressure from illegal agriculture. Crops' encroachment into the park interrupts the connectivity between the uniquely diverse habitat

types. Given that approximately 1,000 km^2 of the park area remains under illegal occupation, the above problem is difficult to solve (CONSERVATION OUTLOOK, 2020).

Around the villages that exist within the boundaries of the Okapi Wildlife Reserve, 27 agricultural zones have been established, but some have excessive forest clearance under crops due to increased migration to these villages. Agricultural activity has been spotted inside the Manovo-Gounda Strict Nature Reservee, but it is relatively small. On the contrary, in Simien NP, agriculture pressure is extensive due to high population growth and dominant subsistence agriculture. Thousands of households near the park run the crop-livestock farming system using park resources as a grazing area. Under cultivation are some 1,200 hectares inside the park. The law permits crop cultivation on steep slopes of up to 60-degree slope gradients; therefore, erosion commonly occurs (CONSERVATION OUTLOOK, 2020). In W-Arly-Pendjari Complex (Benin, Niger, Burkina Faso), cotton, millet, and sorghum are cultivated in the site's immediate vicinity and pose a risk of fire or cutting of non-wood materials.

Forestry/wood production. Deforestation was recorded in five sites, and it was considered a high threat in three. In Lake Malawi NP, fuelwood harvesting and regular burning contributed to clear denudation of the hills on the property. Harvesting large trees for use in smoking fish has the largest share of forest degradation (RANTALA ET AL., 2004). In Ecosystem and Relict Cultural Landscape Lopé-Okanda, three decades ago, forest concessions were granted in reserve, currently only in the buffer zone (CONSERVATION OUTLOOK, 2020). In iSimangaliso Wetland Park (South Africa), new forestry licenses have been discontinued.

Livestock farming/grazing. In W-Arly-Pendjari Complex, the illegal grazing of hundreds of thousands of cattle occurs during the dry season (TCHÈGOUN ET AL., 2018). However, this pressure is gradually diminishing, thanks to the creation of pastoral areas and corridors on the outskirts of the property. Around the Serengeti NP human population growing rapidly, which led to changes in land use (VELDHUIS ET AL., 2019). In some areas, the field fenced with wire, which resulted in the collapse of the Loita-Mara wildebeest migration from 140,000 animals in the mid-1990s to under 10,000 now (OGUTU ET AL., 2016). It is unknown what the consequences of constructing a new electrified fence (35 km and in plans extend for the next 35 km) are in an area used by the wildebeest and zebra migration.

In Manovo-Gounda Strict Nature Reserve, at least 280,000 domestic animals graze, which is several times more than wild animals. Shepherds from CAR, Chad, and Sudan reside in the property area, often armed. Niokolo-Koba NP is also exposed to intense grazing to meet the needs of the large population in its vicinity. Overgrazing outside and inside Maloti-Drakensberg Park (Lesotho, South Africa) on high-altitude grassland results in the loss of some grass species.

In Lake Turkana NP, the grazing pressures from domestic livestock occur mainly within Sibiloi NP. Over-grazing results in trampling vegetation, loss of grasslands, and increased woody vegetation. It also negatively affects shoreline nesting habitats for birds and crocodiles (CONSERVATION OUTLOOK, 2020). Grazing adversely affects the small Kenya Lake System in the Great Rift Valley. Domestic animals graze along the lakeshore, increasing erosion rates, run-off, and siltation. In addition, the capacity of rangelands has decreased significantly due to the exceptionally high lake water levels, so over-grazing is a significant threat to the valuables of the site.

Freshwater aquaculture. Two non-indigenous species of Oreochromis (*O. niloticus* and *O. leucostictus*) are farmed on fish farms in ponds connected with Lake Malawi by the Ruhuhu River. There are well-founded concerns that their introduction into the lake is a matter of time (GENNER ET AL., 2013). Farming of common carp (*Cyprinus carpio*) has been banned.

4.5. Biological resource use

Hunting and trapping (poaching). Hunting are the most common threats in African World Heritage sites. It applies to as many as 33 areas (75%), including very high and high threats, occurring in 11 and 8 sites, respectively. This practice occurs mainly in large parks, in politically unstable regions affected by military conflicts, and in areas of illegal mining. It is also facilitated by transport accessibility. The most challenging situation is in the DRC, where poaching occur in all five properties.

In Kahuzi-Biéga NP, the hunting problem began to increase with the influx of Rwandan refugees in 1994 and rebels in 1997; it took immense proportions during the gold and coltan rush of the early 2000s. The demand for meat from thousands of miners has led to the mass killing of animals. In just four years, the highland sector of the property lost more than 95% of its elephant population and about 50% of its gorilla population (YAMAGIWA, 2003). Research by PLUMPTRE ET AL. (2016) indicate that in the lowland sector, from

1994-2015, Grauer's gorilla numbers declined by 87%.

War, military conflicts, and illegal mining also underlie hunting in Okapi Wildlife Reserve in the pristine Ituri Forest. From 1995–2006, the population of elephants declined by nearly fifty percent, i.e., by approximately 3,300 animals; it was estimated that at least 23 tons of ivory were taken out of the reserve and its surroundings (BEYERS ET AL., 2011). The most important species is the okapi – a forest giraffe that has decreased from around 5,000 in 1986 to about 3,000 in 2008. The hunting intensity of the bushmeat trade increased after the renovation of the RN4 national road, which made access to the reserve easier.

Significant declines in all wildlife populations are reported for Garamba NP (DRC). The number of elephants has decreased by approximately 20,000 since 1976 (BEYERS ET AL., 2011). The population of Kordofan giraffe has declined by more than 85%, from 350 individuals recorded inside the park in 1976 to 45 in 2017 (D'HAEN ET AL., 2019).

Commercial poaching to supply bushmeat markets also includes elephants, hippopotamus, Buffalo, chimpanzees, l'Hoest's monkey, okapi, Ruwenzori duiker, and other animals in Virunga NP. For example, since the 1990s, the hippopotamus population has been reduced by 95% (CONSERVATION OUTLOOK, 2020).

Both forest and savanna elephants, very common in the Salonga NP (DRC), were reduced to approximately 2,000 individuals in 2003 due to poaching (IUCN & UNESCO, 2007). This practice decreased significantly thanks to the preventive measures taken, and the park was removed from the in danger list in 2021.

Aviation research has established that in the Manovo-Gounda Strict Natural Reserve in CAR, the large mammal population decreased by 75% in just five years (2005-2010) (IUCN & UNESCO, 2019). Due to the hunting of savannah elephants by armed groups of poachers (local and foreign – Chad, Sudan), the animal is on the verge of extinction. Also, in the Selous Game Reserve, the numbers of the African elephant, as well as the critically endangered black rhino, dramatically dropped in the 1980s, when prospecting for oil began, and roads were made to hitherto inaccessible parts of the reserve (BORNER & SEVERRE, 1986; KIDEGHESHO, 2016).

Ivory poaching continues to be intense in and around the Sangha Trinational (UNESCO, 2019), Niokolo-Koba NP (Senegal), and Dja Faunal Reserve (Cameroon), where the number of forest elephants decreased from 420 in 2015 up to 219 individuals in 2018 (BRUCE ET AL., 2018). In Mount Nimba Strict Nature Reserve, poaching is a very high threat, especially concerning black duiker, water chevrotain, royal antelope, olive colobus, or Diana monkey (BENE ET AL., 2013). In Taï NP (Côte d'Ivoire), most catches are focused on duikers and monkeys, but fish, otters, water turtles, and other reptiles are also caught (CONSERVATION OUTLOOK, 2020). Railroads and roads at the Ecosystem and Relict Cultural Landscape of Lopé-Okanda site facilitate elephant poaching for ivory, buffalos, gorillas, chimpanzees, and duikers. Hacking has decreased in recent years thanks to the remedial measures taken (CONSERVATION OUTLOOK, 2020). In Mana Pools NP and Sapi and Chewore Safari Areas, poaching of black rhinos drove the species to local extinction between 1984 and 1994. in others, Global Conservation and Bushlife Conservancy has made very good progress in countering poaching (https://globalconservation.org)/news/conservation-win-over-last-year-no-elephants-poached-mana-pools- /).

A very high threat of hunting and trapping occurs in Aïr and Ténéré Natural Reserves, which is facilitated by its large area and difficulties in patrolling. Poachers often travel on motorcycles; their prey is North African ostriches, adaxas, dama and dorcas gazelles, Berber sheep, and Nubian and Arab bustards. Cheetahs have become very rare (CONSERVATION OUTLOOK, 2020).

Poaching persists in iSimangaliso Wetland Park, especially among rhinos. At the same time, in Lake Malawi NP, the mammalian fauna, except vervet monkeys and baboons, has been drastically reduced (CHAFOTA ET AL., 2005). In Lake Turkana, NPs crocodiles and turtles are threatened as they become entangled in nets and drown, Grevy's zebra may no longer be present, and the Northern topi population is approaching 'vulnerable' or 'near threatened' status (CONSERVATION OUTLOOK, 2020).

It follows from the above that hunting and trapping threaten various animals, especially mammals – elephants, gorillas, rhinoceros, buffaloes, and others. Poaching occurs primarily in the following biogeographical provinces: Congo Rainforest (5 sites), West African Woodland/Savanna (5), Miombo Woodland/Savanna (2), Guinea Rainforest (2), and Central African Highlands (2).

Logging/wood harvesting. In as many as 17 sites, illegal logging/wood harvesting is a threat to their values, including site threat is very high in one and high in eight. Mount Nimba Strict Nature Reserve is the worst situation. As a result of the progressive loss of forest in the buffer zone of this site (slash-and-burn agriculture, cocoa plantations), it is becoming more and more isolated, and its ecological functions are endangered. In Mount

Kenya NP, illegal logging increased by 3.5 fold in the last several years, and charcoal production by 74% (Conservation Outlook, 2020). The pressure on the forest in Kilimanjaro NP (Tanzania) is also high. An aerial survey in 2001 found about 8,000 smallscale logging sites, which means that logging for valuable timber species is common at the mountain (Hemp, 2006). Most lower montane forests are destroyed by this illegal activity, including *Garcinia tanzaniensis*, the tallest trees of Africa (*Entandrophragma excelsum*), and Camphor (*Ocotea usambarensis*) (Hemp et al., 2017). In another mountain park, Virunga NP, under intense pressure from commercial charcoal making, there are especially slow-growing unique *Sclerophyllous* forests, which also threaten chimpanzee populations and the endemic l'Hoest's monkey. Tropical forests in Kahuzi-Biéga NP are affected by logging, especially in the Nindja ecological corridor where illegal farms arise. According to the UNESCO report (2009) continuum of primary habitat types from low altitude to high altitude has been completely severed. Simien NP has very high pressure, especially on the tree heather forests and *Hypericum thickets*.

Some logging companies in the buffer zone of Sangha Trinational use practices threatening biodiversity – creating gaps in the canopy and unsustainable extraction of large trees, e.g., Mahogany (Conservation Outlook, 2020). The example of Dja Faunal Reserve shows that even minor logging impacts biodiversity due to the fragmentation of forest habitats (Betti, 2004). In Aïr and Ténéré Natural Reserves, a lot of wood is harvested each year, especially since gold panning was started.

Fishing/harvesting aquatic resources. In the past, Lake Edward in Virunga NP was one of Africa's most productive lakes for fish. During the wars, illegal fishing increased, and recently we have been dealing with severe overfishing, and volumes and fish sizes dramatically declined. Inland fisheries support livelihoods for over 4.9 million people in this region, so the management of inland fish stocks needs to be improved (Musinguzi et al., 2021). A very high threat constitutes illegal fishing in Lake Malawi NP. 'Mbuna' (the 13 genera of cichlids), which are relatively small, are caught in nets set for other species, so their diversity declines. According to Bell et al. (2012), nearshore fishing results in the capture of spawning and immature fish, including 'chambo' (three species of *Oreochromis*), lowering the productivity of these commercially important species. Overfishing has long been reported for Lake Turkana NPs, but its scale is not determined. Lake fisheries ecology is dependent on the annual Omo seasonal flood. Hydropower plants (Gibe III and Gibe IV) built in the Omo basin changed the annual flooding regime. According to Gownaris et al. (2015), the loss of the seasonal oscillations in lake water level decreases fisheries yield by over two-thirds.

Illegal fishing in rivers is widespread in the Salonga NP, using destructive methods, including dynamite and poison (Conservation Outlook, 2020). Illegal fishing in Zambezi River in Mana Pools NP is carried out with the use of extensive plastic, non-destructible monofilament net, in which crocodiles, in addition to fish, are entrapped.

In the Atlantic waters near Banc D'Arguin NP (Mauritania), international fleets and Moorish fishermen fished artisanal (Campredon & Cuq, 2001). These have increased many times over, but the impact of fishing on the park's ecosystem is undetermined, as is the result of fisheries; over 300 foreign trawlers were 2012 licensed to fish in the waters surrounding the site.

Other biological resource use. In Tassili N'ajer National Park (Algeria), unsustainable is considered the commercial collection of several species for charcoal and medicinal purposes (Conservation Outlook, 2020). The harvesting of non-wood forest products (medicinal plants, fruit, etc.) in the W-Arly-Pendjari Complex is generally done under the control of foresters.

4.6. Human intrusion/interference

Tourism, visitors and recreation. According to the IUCN report, tourism is a very high threat in one site, W-Arly-Pendjari Complex. This negative assessment does not reflect the real impact of tourism on the area's nature because, in this site, the threat was determined jointly for various human intrusion/interferences, among which the activities of terrorist groups (jihadists) are decisive. The insecurity due to the presence of terrorists has even reduced tourism, thus the pressure on its part.

Over three hundred thousand tourists come to Serengeti NP every year. Most of them concentrate on several points, mainly around Seronera. Twenty years of field observations show that wildebeest migrators avoid areas with a large tourist footprint despite their prime grazing conditions. Increased tourist traffic increases road kills and erosion (Conservation Outlook, 2020).

Hiking to Bwindi Impenetrable NP (Uganda) focuses on gorilla sightings. Currently, 19 gorillas are habituated, but their fearlessness in front of humans could potentially threaten them to poachers. Gorillas may also be susceptible to transmission of human disease (Hanes et al., 2018).

Excessive tourism in Kilimanjaro NP results in erosion of paths and water contamination (Wakibara et al., 2009). There are also significant problems with litter and waste and the trampling of vegetation.

The wilderness qualities and aesthetic value of the Mosi-oa-Tunya/Victoria Falls are disrupted by noise from sightseeing helicopter tours (9 in 2007), micro-light aircraft carrying visitors to view the Falls, and sunset party boats operating on the upper river (40 in 2007; newer data not available).

Increased vehicular traffic and operator game drives in Mana Pools NP and Sapi and Chewore Safari Areas threaten the site's wilderness values. There are also reports of disturbance by tourists at African wild dog dens leading to their abandonment.

Other types of tourism threats exist in Sanganeb Marine NP and Dungonab Bay-Mukkawa NP. Large tourist liveaboard vessels cause damage to sensitive coral habitats when they deploy and recover their anchors (Cousteau Society, 2013). Banc D'Arguin NP tourism is poorly developed, and its impact on the environment is limited (Boide et al., 2018). However, weekend excursions result in degraded coastal vegetation and dunes due to non-organized 4x4 traffic and abandoning solid waste. In Simien NP, constructing a new lodge in a critical gelada habitat is a threat. Along with the development of tourist facilities in the vicinity of the camp in Chembe Village in Lake Malawi NP., the area and access road have been very littering, and the quality of nearshore water has deteriorated due to sewage (Tyner et al., 2018).

War, civil unrest, and military exercises. W-Arly-Pendjari Complex has no security due to the presence of jihadists. They attack and even kill forest guards and other officers. Monitoring the property is complicated, and counting wild animals is carried out from the air.

The civil war in the CAR started in 2014, makes it practically impossible to manage the Manovo-Gounda Strict Nature Reserve and protect its values. There are over a dozen armed groups and shepherds in this area, and illegal use of natural resources is ongoing (Conservation Outlook, 2020). Several armed militia groups also influence Okapi Wildlife Reserve; one of them, in 2012, attacked the Reserve headquarters and killed seven people. The patrol station and village looting also happened in the following years.

At least three rebel groups (called M23) occupied the Virunga NP and were involved in illegally exploiting natural resources. During fierce fighting with dissident elements of the Congolese army in 2012, the rebels were stationed in the gorilla sector. Although they were defeated, in 2019, their number in the park was estimated at around 1000–1200 (Conservation Outlook, 2020). The scale of the danger in the park is evidenced by the number of over 180 killed park guards in the years 1996-2020.

A similar situation occurs in Kahuzi-Biéga NP, where illegally armed militia oversees hunting, mining, and farming inside the five sectors of the park. The Congolese army removed the rebels from the other two sectors. Activities of rebel groups still affect animal biodiversity and endemism values.

The security crisis in Mali, which has been going on for more than a decade, is failing to adequately protect the Cliff of Bandiagara. Islamist terrorism and a sharp conflict between the shepherd (Fulani) and agricultural (Dogoni) communities continue. Massacres of the population, the destruction of villages, and the abduction of cattle make the park and its surroundings very dangerous, so tourism has collapsed, and the site's values are deteriorating.

Other activities. The outskirts of Okapi Wildlife Reserve are under a lot of pressure from migrants who have come from overpopulation highlands. They sought land to settle, leading to deforestation, hunting, and inside the property. In Bwindi Impenetrable NP, a source of conflict between park authorities and local farmers is crop damage by wild animals. The poverty and local feelings of injustice become illegal activities inside the reserve (Baker et al., 2013). Destroy crocodile's nesting sites by fishermen who illegally encroach into the waters on the Lake Turkana NPs is reported.

4.7. Ecosystem modifications

Fire. Intentional or accidental fires are a problem in over a dozen sites. In Kilimanjaro NP, as Hemp (2005) reported, wildfires destroyed about 150 km^2 of subalpine cloud forest during the last decades and lowered the upper forest line by over 800 m. Mount Nimba Strict Nature Reserve is also affected by fires from farmers, e.g., charcoal production and poachers, to facilitate hunting, but their frequency has decreased recently (Conservation Outlook, 2020). In another mountain site – Mount Kenya NP, the causes of fires are also anthropogenic – charcoal burners, honey collectors, livestock grazers, and for cultivation purposes (Nyongesa & Vacik, 2018). Although fire is a natural component of the Fynbos Biome in Cape Floral Region Protected Areas, frequent fires are a significant threat because they make it difficult for some plants to reach seeding age. Fire management in this property is complex due to its proximity to urban areas, large pine plantations, and the presence of invasive alien plants (Pooley, 2012; Conservation Outlook, 2020). High fire

frequency of sub-alpine vegetation is recorded in Maloti-Drakensberg Park, which threatens with loss of some plants and animals. Winter and spring fires of high-altitude grasslands (O'Connor, 2008) can touch the integrity of the natural vegetation cover. In turn, in the Cliff of Bandiagara site, frequent fires severely degraded the savannah vegetation, especially near villages. They are also initiated to prevent terrorists from sheltering (Conservation Outlook, 2020). Burning savannah under the pretext of regenerating vegetation for grazing animals is typical in Manovo-Gouna St Floris. In turn, the Lake Malawi NP's terrestrial part is burning annually, influencing, among other things, woodland density and species composition.

Dams and water management or use. The construction of dams in protected areas is almost always controversial, mainly when conflicts of interest occur. Lake Turkana NPs is influenced by changes due to the almost finished construction of the cascade of five hydropower dams (Gibe I to V) on the Omo in Ethiopia River. So far, this river has provided over 80% of the inflow to Kenya's Lake Turkana; therefore, the use of its waters for hydropower generation, irrigation, and other services significantly impacts the 'Outstanding Universal Value' of the World Heritage site. They include, among others, loss of the all-important annual flood season, reduced freshwater inflow to the lake, and reduced supply of sediments and nutrients (Avery & Tebbs, 2018).

Due to the overlapping of anthropogenic and natural influences, a complicated hydrological situation occurs in the Kenya Lake System in the Great Rift Valley. Throughout the region, small irrigation dams were constructed on rivers flowing into the lakes, and Lake Naivasha's water level was critically lowered for some time (Conservation Outlook, 2020). However, flooding from above-average rainfall contributed to high water levels in all lakes in the Rift, and terrestrial ecological habitats were inundated.

In Serengeti NP, irrigation farming (in Kenya) during a drought withdraws about 80% of the available Mara River water (Kihwele et al., 2021). During a dry period, this river is the only permanent source of surface water in the park; therefore, a significant concern raised the proposals for several dams upstream as there would probably be water and sediment flow changes.

On the Zambian side of the Mosi-oa Tunya/ Victoria Falls, there is a hydroelectric power station that, to operate at total capacity, needs a certain amount of water in the dry season. Climate changes may deepen this seasonal fall in water flow (Killingtveit & Hamududu, 2016).

Negative consequences of damming in Ichkeul NP in Tunisia caused the park to be on the danger list from 1996 to 2006. Reduction of water inflow resulting in salinization and consequent shift in vegetation to halophytes and reduction in waterbird numbers. Declining water levels during dry years threaten aquatic fauna, including the European eel. Situations are improved by periodic increases in rainfall and worsened by the rise in local water demand (Conservation Outlook, 2020).

A very high threat to Selous Game Reserve is the construction of the Julius Nyerere Hydropower in the middle of the property, which will change the site's values (Dye & Barnaby, 2017). Among other things, below the dam, the Rufiji River will lose its characteristic seasonal flow variability and the related changes in the course of the riverbed and the oxbow lake system during the rainy season, which threatens the biodiversity of a large wetland. For nature, Dja Faunal Reserve (Cameroon) high threat is the Mekin Hydroelectric power station on the Dja River.

Other ecosystem modifications. In Lake Turkana NPs, ecosystem modifications that reduce the extent and quality of floodplain vegetation which impact the ecology of aquatic habitats that are essential fish-spawning sites may occur (Conservation Outlook, 2020).

In Kenya Lake System in the Great Rift Valley, three lakes – Nakuru, Bogoria, and Elmenteita are isolated. Still, they are linkages shared in supporting bird populations, above all the lesser flamingo. Already small buffer zones threaten the maintenance of the people of many birds due to the reduction of the land area available to them. Recent rises in lake water levels in all lakes further aggravate this deficit.

Almost two-thirds of the Simien NP area grazed massive numbers of sheep, goats, and other animals by the herders from the vicinity of the park. Thus, it reduces the amount of habitat available for wildlife species (Ethiopian wolf, Wales ibex). As Nievergelt et al. (1998) reports, overgrazing caused an almost complete disappearance of small mammals, mainly rodents.

The increasing population of the Maasai people and their poverty result in competition between domestic animals and wildlife for natural resources in Ngorongoro CA. Human-wildlife conflict aggravates lost livestock by wild predators. In Rwenzori Mountains NP (Uganda), there are only 13 elephants left, probably of only one gender. This population is isolated and has limited movement to and from the property due to the fragmentation of the forest outside of the park by the new roads and the increase in agricultural lands.

In iSimangaliso Wetland Park, critically endangered swamp forest is cut out in two areas for subsistence agriculture. The reasons are sought for the residents' conflict over the property's boundaries. Tobacco farming in peripheries of the Mana Pools NP and Sapi and Chewore Safari Areas resulted in unspecified deforestation, as fuelwood is used for tobacco curing.

4.8. Invasive species

Threats related to invasive non-native/alien species are reported for 21 African World Heritage sites, including very high for one site and high for nine sites. The most serious situation in this respect is Cape Floral Region Protected Areas), where invasive plant species are the most severe threat to the continued existence of the Fynbos ecosystems. Fynbos is a biome with unique adaptive flora to fire and seed dispersal patterns. Meanwhile, species such as *Pinus* spp., *Acacia* spp., *Hakea* spp., and *Eucalyptus* spp. Have invaded large areas of 13 parts of the property, changing the fire regime and characteristics. MOTHAPO & WOSSLER (2011) reported that species that depend on seed dispersal by ants are under threat because the alien Argentine ant could displace the native seed-dispersing species.

Apart from Cape Floral, belonging to the Cape Sclerophyll biogeographical province, the remaining highly endangered sites belong to the West, East, South, or Miombo Woodland / Savanna provinces (7) and the Western Sahel province (2).

In iSimangaliso Wetland Park, the native flora is threatened by several alien invasive plant species, including *Chromolaena odorata*, *Psidium guajava*, *Casuarina equisetifolia*, *Lantana camara*, *Parthenium hysterophorus* (CONSERVATION OUTLOOK, 2020). In turn, in Maloti Drakensberg Park (Lesotho, South Africa), the montane vegetation is vulnerable to invasion by American bramble (*Rubus cuneifolius*) (NDLOVU ET AL., 2018) and, e.g., pine and wattle. An important seed source is forestry plantations outside the park.

In Mosi-oa-Tunya/Victoria Falls, the cliff faces in the Falls and gorges have colonized by spreading aggressively *Lantana camara*, while water hyacinth *Eichhornia crassipes* may be obstructing water channels above the falls. Various measures are taken to prevent the spread of invasive species (CONSTANTINE ET AL., 2022).

The main biological threats to biodiversity in the Ngorongoro CA are invasive alien species such as water fern (*Azolla filiculoides*), black wattle (*Acacia mearnsii*), Eringa (*Melia azedarach*), Lantana (*Lantana camara*), Mexican Poppy (*Argemone mexicana*), Mauritius Thorn (*Caesalpinia decapetala*) and others (FOXCROFT ET AL., 2006). Negatively impacting grazing quality also has to step on grasslands indigenous pioneer species of plants.

In Kenya Lake System in the Great Rift Valley, in the grazing areas for the large mammals in the Lake Nakuru area, invasive plants such as *Solanum incanum*, *Datura stramonium*, and *Lantana camara* (NG'WENO ET AL., 2010) appeared, while grasslands and wetlands in the region of Lake Bogoria are spreading robust and thorny *Prosopis juliflora* (CONSERVATION OUTLOOK, 2020), already listed throughout Kenya's Rift Valley. In the described property, specifically in the fenced area around Lake Nakuru, native species of animals are also a high threat to the habitat. In rising lake level conditions, competing for feed causes severe ecological imbalances, the over-abundant population of buffalo and giraffe.

In Senegal, in Niokolo-Koba NP, the risk is the drying out of joints and their obstruction due to the invasive *Mimosa pigra* plant and the spread of *Lantana camara* in the western part of the park (CONSERVATION OUTLOOK, 2020). In the second Senegalese site – Djoudj National Bird Sanctuary, the threat is *Typha domingensis*, which has spread since the construction of the Diama Dam. It reduces the speed of water flow and has partially contributed to the loss of waterfowl habitat on Lake Lamantin (GUEYE ET AL., 2017). The water macrophytes *Ceratophyllum demersum* and *Najas marina* also contribute to the reduction of the water flow velocity and eutrophication and siltation. The same problem occurs in the buffer zones of the W-Arly-Pendjari Complex, where the water hyacinths *Eichhornia crassipes* and *Typha* contribute to silting.

Three marine invasive non-native species were found in Banc D'Arguin NP – an unidentified red alga, ascidian tunicate (*Botrylloides diegensis*), and the green alga *Caulerpa taxifolia*, which could constitute a severe threat to the local seagrass (CONSERVATION OUTLOOK, 2020).

4.9. Pollution

Water pollution in the analyzed sites comes from known or unspecified sources. In Djoudj National Bird Sanctuary, the waters are excessively contaminated with pesticides applied in rice fields located in the property's buffer zone. In Lake Malawi NP, larger tributaries deliver increased loads of sediment and nutrients from farmland to the lake (HECKY ET AL., 2003), threatening fish abundance and diversity, especially around the Maleri Islands (RUSUWA ET AL., 2006). In iSimangaliso Wetland Park detected high levels of organochlorine pesticides (OCP) in two common fish species,

Mozambique tilapia (*Oreochromis mossambicus*) and African Sharptooth catfish (*Clarias gariepinus*), as well as in Nile crocodiles (*Crocodylus niloticus*) (BUAH-KWOFIE ET AL., 2017). High OCP concentrations in coastal groundwater are probably a source of the pollutants in coral species *Sarcophyton glaucum*, *Sinularia gravis*, and the sponge *Theonella swinhoei* (PORTER ET AL., 2018). Widespread contamination of herbicides in riverine sediments and the St Lucia estuarine environment has also been detected (CONSERVATION OUTLOOK, 2020). No data is available on the source of heavy metal contamination detected in several species of fish from Kosi Lake (arsenic) and found in the soft coral *Sinularia* from Sodwana Bay (nickel) (VAN DER SCHYFF ET AL., 2020). In Kahuzi-Biéga NP, in the low altitude, the fishing practice often uses the insecticide Andrine, which in addition to fish poisoning, causes water pollution (CONSERVATION OUTLOOK, 2020).

Significant water pollution with high cadmium concentrations occurs in the marine waters in Banc D'Arguin NP. Vaal River in Vredefort Dome is reached by contamination from upstream mining activities and poorly treated urban wastewater. Household sewage is also a high threat in iSimangaliso Wetland Park. The quality of groundwater, the lakes, and the estuary is threatened due to boreholes and wastewater discharge into the ground between numerous private holiday establishments built near this park (BATE & TAYLOR, 2019). In Lake Malawi NP, concentrations of fecal coliform bacteria in much of the nearshore water around the property are very high due to seepage from septic tanks and latrines (TYNER ET AL., 2018), especially in nearshore park enclave villages (MADSEN ET AL., 2011). The pollution also results from spillage of boat fuel and oil.

Kenya Lake System in the Great Rift Valley is the most serious water pollution situation. It is related to the development of the large city of Nakuru and other localities. Into Lake Nakuru flow poorly treated wastewater and water from fertilized farmland, which may lead to its eutrophication. Due to poor waste management, garbage, plastics, and sullage are dumped into stormwater drains and released into the lake (CONSERVATION OUTLOOK, 2020).

Solid waste is a major growing problem in Lake Malawi NP, where plastic bags and other plastic litter are along the lake's shores (MAYOMA ET AL., 2019). In Banc D'Arguin NP on the several kilometers coast (between the villages of Teichott and R'Gueiba), there is an open dump, probably plastic fed by ocean currents from the open sea. Moreover, macroplastics come, among others, from the development of the town of Chami and Mamghar (CONSERVATION OUTLOOK, 2020).

Air pollution is not a severe problem and African World Heritage sites. In Lake Malawi NP, locally and temporally, air pollution can be intense during the dry season when biomass burning is widespread. In addition, large amounts of nutrients are transported through the atmosphere into the lake, causing eutrophication (CONSERVATION OUTLOOK, 2020).

4.10. Geological events/phenomena

Volcanic activity is threatened only in one site – Virunga NP. It is low, but each time there is a lava flow, *Sclerophyllous* forests are lost, which are already significantly degraded by illegal charcoal exploitation. The volcanic activity also threatens communities living in the vicinity (NICOLE, 2022).

In Kenya Lake System in the Great Rift Valley, a very high threat constitutes erosion and siltation/ deposition. Deforestation, overgrazing, and expansion of agriculture result in increased soil erosion, run-off, and siltation of lakes (WATENE ET AL., 2021). It provides to raising bed levels and consequently raises lake water levels and flooding the terrestrial buffers around the lakes. Siltation of the Niger River, the floodplains, and wetlands are observed within the W-Arly-Pendjari Complex as a consequence of deforestation and, among other things, cotton cultivation in the periphery of the site.

4.11. Climate changes and extreme weather conditions

Climate changes and extreme weather conditions significantly affect the environment of the ten sites. In the Rwenzori Mountains NP rising temperatures cause the melting of the glaciers and a shift of vegetation zones. The valuable high-altitude Afro-alpine vegetation communities are reducing the acreage, while the area of crops at the park boundary is increasing. Also, changes in the rainfall regimes periodically lead to flooding. In Kilimanjaro NP, rising global temperatures have reduced the surface area of glacial ice by more than 80% and a general shift of vegetation zones; however, like Mount Kenya NP, not necessarily on the higher elevations.

In Banc D'Arguin NP, sea level rise and erosion are modifying the flat and sandy coastlines and impacting marine and terrestrial ecosystems (EL-HACEN ET AL., 2018). Coastal retreat and islet flooding threaten breeding colonies of endemic sub-species. In addition, there has been a reduction in the overall bird population (including migratory birds) by around half a million. Climate change also affects coral reefs protected in the two-piece Sanganeb Marine NP site and Dungonab Bay-

Mukkawar Island Marine NP (Red Sea). Heat stress events result in coral bleaching, and the threat remains high (CONSERVATION OUTLOOK, 2020). In turn, the area of the Cliff of Bandiagara is affected by droughts and desertification, which harms natural and cultivated vegetation. Harmattan, the wind blowing during heat waves, is likely to intensify aeolian soil erosion.

Droughts and desertification also occur at Lake Turkana NPs. The lake is a very vulnerable ecosystem, and its water level has changed frequently in recent decades for climatic and anthropogenic reasons (OJWANG ET AL., 2016). With global warming, the lake's salinity can increase further due to increased evaporation rates due to rising lake water temperature (CONSERVATION OUTLOOK, 2020). However, the recent rise in water levels leaves these forecasts in question.

HERRNEGGER ET AL. (2021) 's research clearly shows the connection between rainfall and changes in lake areas in Kenya Lake System in the Great Rift Valley. The authors write about increases from 21% for Lake Naivasha to 123% for Solai and about fluctuation between the minimum and maximum water level range between 8.53 m and 2.38 m. There is a threat that saline waters of Lake Bogoria can spill into the freshwater of Lake Baringo (CONSERVATION OUTLOOK, 2020). Changes in Lake Nakuru's limnological conditions caused flamingoes to desert the lake, and consequently, the number of tourists has decreased.

4.12. Other

In the expansive Serengeti NP, disease transmission between domestic stock and wildlife is a very high threat. Starting around 1960 population of wildebeest was decimated by a rinderpest outbreak transmitted by cattle. As a result of long-term recovery, the present population has 1.2-1.4 million (HOPCRAFT ET AL., 2015). A rabies outbreak or a canine distemper virus that killed over 1000 lions is also a threat to wild animals (ROELKE-PARKER ET AL., 1996).

There is a constant fire risk at the Kenya Lake System in the Great Rift Valley. It is postulated: fire-breaks, ban on wood burning and collection. To stem abuse in forest decimation, the transport of wood is banned in Kenya. Meanwhile, people living in the neighborhood of Comoé NP are protesting against the destruction of crops by elephant herds. The conflict in this background is serious. In Salonga NP, human pressure (encroachment of park boundaries by villages and settlements) concerns an ecological continuum between the northern and southern parts of the park.

4. Conclusions

The African World Heritage sites are subject to various pressures from human activity and natural factors. The most common current threat is hunting, which occurs mainly in large parks in rainforests and savannas, in politically unstable regions affected by military conflicts, and in areas of illegal mining. It is also facilitated by transport accessibility. Poaching threatens various animals, especially large mammals, whose numbers have dropped dramatically. The spread of invasive (alien) species occurs in nearly half of the sites and poses a severe threat to African flora. Anthropogenic threats include livestock farming and grazing, logging and wood collecting, fires, mining, crops, tourism, and others. Various effects of climate change – droughts, flooding, temperature extremes, and habitat shifting are reported for many properties and are expected to deeply more and more.

Results of a review show that, of all natural and mixed World Heritage sites in Africa (44) for three areas, the conservation outlook is assessed as good, but for 12 as critical. As many as 11 sites are inscribed on the World Heritage in Danger list, accounting for 70% of all such sites worldwide.

Conflicts between nature and humans in Africa have various causes and occur in various socio-economic and political conditions. Generalizing, however, two reasons can be indicated: 1) meeting life's needs by poor rural communities living in overpopulated areas in the vicinity of the property, and 2) the desire for profit pursued by illegal hunting and mining by armed groups.

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