Tsingy de Bemaraha Strict Nature Reserve

2020 Conservation Outlook Assessment

SITE INFORMATION

Country: Madagascar
Inscribed in: 1990
Criteria: (vii) (x)

Tsingy de Bemaraha Strict Nature Reserve comprises karstic landscapes and limestone uplands cut into impressive 'tsingy' peaks and a 'forest' of limestone needles, the spectacular canyon of the Manambolo river, rolling hills and high peaks. The undisturbed forests, lakes and mangrove swamps are the habitat for rare and endangered lemurs and birds. © UNESCO

SUMMARY

2020 Conservation Outlook

Finalised on 01 Dec 2020

GOOD WITH SOME CONCERNS

Overall, the strategic approach to conserving biodiversity and enhancing the value of natural resources in the Tsingy de Bemaraha complex (National Park and Integral Natural Reserve) is adequate and appropriate. The sources of pressures and threats are in decline and the peripheral areas of the protected area are better valued by the local communities with the technical and financial support of Madagascar National Parks. The World Heritage site is composed of two appropriately managed, legally recognised protected areas and, by virtue of its impenetrable karst landscapes, is largely immune to anthropogenic pressures over much of its area. Threats include logging, subsistence hunting, agricultural encroachment and fire, but these are restricted to the forest edge, and no commercial extraction is known apart from the reptile trade. The site is appreciated by local communities, regional authorities, conservationists and tourists, and the recent description of numerous new mammal, bird, reptile and amphibian species serves to underscore its World Heritage status.

FULL ASSESSMENT

Description of values

Values

World Heritage values

▶ Rich endemic flora **Criterion:(x)**

The vegetation of the Bemaraha Plateau is dominated by western dry forest (Moat & Smith, 2007), one of the most threatened biomes in Madagascar (Ganzhorn et al., 2001). The flora of the dry forest is typically tropophilous, characterised by the genera Dalbergia, Commiphora and Hildegardia; xerophytic scrub made up of succulents grows on exposed rocks, and the more mesic conditions in canyons support a dense subhumid forest (ANGAP, 2003; Rasoloarison & Paquier, 2003). At least 583 plant species representing 102 families have been recorded (Rabarison, 2000; Schatz, 2001). Although endemism data are not available for the property, nationally 84% of vascular plants are endemic (Callmander et al., 2011). Threatened species include Khaya madagascariensis (EN), Phylloxylon perrieri (EN), Dalbergia humbertii (EN), D. baronii (VU) and Delonix regia (LC) (ANGAP, 2003).

▶ Rare and endemic birds **Criterion:(x)**

The avifauna of the property is rich, with at least 94 recorded species (Rasoloarison & Paquier, 2003; Raherilalao & Wilmé, 2008). These include members of the endemic family Bernieridae, the near endemic families Vangidae and Leptosomatidae, and the endemic subfamilies Couinae and Philepittinae. Threatened species include Madagascar fish-eagle (Haliaeetus vociferoides, CR), Madagascar pond-heron (Ardeola idae, EN), Madagascar heron (Ardea humbloti, EN), Madagascar teal (Anas bernieri, EN), Madagascar marsh-harrier (Circus macrosceles, EN) and Madagascar grebe (Tachybaptus pelzelnii, VU) (ANGAP, 2003; UNEP-WCMC, 2011); all but the latter, however, are wetland species and at best occasional visitors to the Manambolo River in the south of the property. Madagascar's newest bird species, the Tsingy wood-rail (Mentocrex beankaensis, NT), was described in 2011 and is restricted to the Bemaraha and Beanka massifs (Goodman et al., 2011).

▶ Rare and endemic reptiles and amphibians **Criterion:(x)**

The Bemaraha Plateau displays extraordinary rates of local endemism amongst its reptiles and amphibians, and represents an important centre of endemism for these groups (Glaw et al., 2009). Of the minimum 63 reptile species recorded (ANGAP, 2003; Raselimanana, 2008; Bora et al., 2010), 58 are endemic to Madagascar and 17 (27%) appear to be endemic to the massif (e.g. Schimmenti & Jesu, 1996; Puente et al., 2005; Glaw et al., 2007; Köhler et al., 2007; Glaw et al., 2009). The 19 species of amphibian recorded represent the highest species richness of any site in the dry regions of Madagascar (Bora et al., 2010), and six of these species (some not yet described) appear to be endemic to the Bemaraha Plateau (Crottini et al., 2011). Several further candidate species of reptiles and amphibians await description (Bora et al., 2010; Gardner et al., 2011) and are probably also locally endemic. Threatened species include Madagascar big-headed turtle (Erymnochelys madagascariensis, CR), gecko sp. (Paroedura tanjaka, EN), leaf-tailed gecko spp. (Uroplatus guentheri, EN; Uroplatus ebenaui, VU), chameleon sp. (Brookesia exarmata, EN), Antsingy leaf chameleon (B. perarmata, EN), chameleon sp. (Furcifer nicosiai, EN), snake spp. (Phisalixella variabilis, EN; Lycodryas citrinus, VU), splendid skink (Amphiglossus splendidus, VU) and Madagascar coastal skink (Madascincus intermedius, LC).

▶ Rare and endemic mammals **Criterion:(x)**

At least 42 species of mammal have been recorded within the property, of which 35 are endemic to Madagascar. Eleven species of lemur occur, representing five endemic families (Mittermeier et al., 2010; UNEP-WCMC, 2011); these include Van der Decken's sifaka (Propithecus deckenii, EN) and the locally endemic Bemaraha woolly lemur (Avahi cleesei, EN). The eleven species of small mammal that occur

(Soarimalala, 2008; Soarimalala & Goodman, 2011) include Microgale grandidieri (described in 2009, LC), Tsingy tuft-tailed rat (Eliurus antsingy, described in 2001, DD) and lowland red forest rat (Nesomys lambertoni, EN); all three are locally endemic to a small area of northwestern Madagascar, although not the property. Two species of carnivore in the endemic family Eupleridae have been recorded (Rasoloarison & Paquier, 2003), as well as 18 species of bat (Goodman et al., 2005; Kofoky et al., 2007; Goodman, 2011).

▶ **Unique and spectacular geomorphological features** **Criterion:(vii)**

The 250 km long Bemaraha Plateau, composed of mid-Jurassic (approximately 200 mya) limestone of marine origin (Du Puy and Moat 1996), is heavily eroded into a karst landscape characterized by networks of deep crevasses, underground rivers and caves, separated by spectacular pinnacles of limestone, up to 100 m high, forming a “forest of sharp stones” (World Heritage Committee, 2012). It forms a unique, spectacular landscape of outstanding beauty (World Heritage Committee, 2012).

Assessment information

Threats

Current Threats **High Threat**

The Tsingy is afforded strong natural protection by its impenetrable nature and isolation. Although local and migrant communities encroach on the property and exert pressures including village and agricultural encroachment, selective logging, livestock grazing in forests, subsistence hunting, collection of non-timber forest products and, in particular, the renewal of pasture fires, all these threats are currently localised and currently present little threat to the integrity of the property. This assumption is however made in the absence of monitoring of the impacts and a defendable understanding of short to medium trends. With the exception of two reptile species, it presumed that there is no or minor trade in other natural resources from the property, ie the impact are confined to a local scale. Again, in the absence of monitoring and investigative research this position remains an assumption. Forest clearing in low-lying areas for agriculture is, however, a significant and growing threat to the integrity of the site. This impact results in the loss of habitat (including both forest and wetland) and the loss of the species that comprise these habitats and hence the ecological integrity of the Site is progressively being eroded. Notwithstanding these impacts, the loss of ecosystem services is also a growing concern.

▶ **Invasive Non-Native/ Alien Species** **Data Deficient**
(Invasive plants) Outside site

The introduced tree Ziziphus mauritianus (mokonazy locally) forms thick, monocultural stands in the Melaky region but does not appear to invade intact forest.

▶ **Other** **Data Deficient**
(Commercial reptile collection) Inside site, extent of threat not known
Outside site

The gecko Uroplatus henkeli and, in particular, the highly sought-after dwarf chameleon Brookesia perarmata were both formerly collected illegally from within the property (Ramilison & Rabibisoa, 1998), but trade in the latter declined following its listing in Appendix I of CITES in 2002 (Carpenter & Robson, 2005). Collection apparently continues but at unknown rates (Rasoloarison & Paquier, 2003). Robinson et al (2018), however, have investigated the value of CITES-listed reptiles and amphibians that are exported from Madagascar, and highlight the importance of the (predominantly illicit trade) to livelihoods of impoverished people. The authors also emphasise that the dependence of people on illicit trade, in the absence of other opportunities or a formalisation of the trade, is highly likely to have significant consequences for conservation. As numbers of target species are reduced outside of the Park, it is highly likely the Park will experience a concomitant increase in pressure. The same may be argued for poverty abutting the Park. Some individual of Crocodylus niloticus had been hunted and collected in Bemaraha such as Manambolo, Mijamoa, Beboka and Miharàna rivers (IUCN Consultation,

2020).

▶ **Identity/social cohesion/ changes in local population and community that result in negative impact**

(Social changes)

Data Deficient
Inside site, extent of threat not known
Outside site

Rasoloarison and Paquier (2003) suggest that local communities are “real allies” in the conservation of the Tsingy because of the area’s important cultural heritage value, but that the arrival of migrants who don’t share these values has started to “modify this balance”.

Poverty of and limited benefits arising from the Park to neighbouring communities may become an increasing concern. This is particularly relevant when an imbalance of natural resources develops between the Park and abutting communal areas. The corollary being that Parks ‘associated with positive socioeconomic outcomes were more likely to report positive conservation outcomes’ (Oldekop et al 2015; Morelli et al 2019).

▶ **Other Biological Resource Use**

(Non-Timber Forest Products)

Data Deficient
Inside site, extent of threat not known
Outside site

There is “considerable collection pressure” for honey and tubers from adjacent communities (Fanarena, 1999), but this pressure is probably localised and restricted by the impenetrable nature of much of the property.

See subsistence hunting below

▶ **Hunting and trapping**

(Subsistence hunting)

Data Deficient
Inside site, extent of threat not known
Outside site

There has been and is a traditional dependence of communities on wildlife as a source of protein (see for example Manjoazy et al 2017, Rizzolo et al 2016, Barrett and Ratsimbazafy 2009) and traditional medicine. Lemurs such as Eulemur rufus, Cheirogaleus medius and Lepilemur randrianasoloi are hunted and trapped in the site and Dioscorea oviala, Dioscorea soso, Aponogeton fenestralis are collected by adjacent communities (Ausilio, 1993; Rabarison, 2000), but impact is limited to areas near villages (IUCN, 1990). Lemur trapping necessitates the clearing of small areas of forest, totalling 1.2 ha in 2001 (ANGAP, 2003). The turtle Erymnochelys madagascariensis (CR) is collected for food from the Manambolo River (ANGAP, 2003). Notwithstanding the literature cited above and the general literature focussing on poaching/bushmeat trade and medicine in Madagascar (see for example Mildenstein et al 2016), there is little to no recent documentation (and consequently little is known of the occurrence and extent of) this this activity (and its impacts) in and around the site. With the potential increase of poverty and reduction in the availability of wildlife resources outside the site and beyond, there is likely to be a concomitant increased poaching pressure within the site (Merson et al 2019). In the absence of monitoring data, this threat may be greater than the previously documented 'low'. A cautious and risk averse approach is advised and hence a 'moderate risk' should be assumed.

▶ **Livestock Farming / Grazing**

(Fire clearance for livestock grazing)

High Threat
Inside site, localised(<5%)
Outside site

Fires are set annually to renew pastures for cattle, but only on the fringes of the World Heritage area (IUCN, 1990; IUCN Consultation, 2012). Cattle also graze in much of the accessible forest and may reduce regeneration locally (IUCN, 1990). Forest clearing located in areas of low wetland for agriculture is a significant ecological challenge affecting both the loss of the individuals of the different species concerned and the related ecosystem services.

Fires (and associated grazing) has been identified as a threat to reptiles occurring in and around the site, for example the nocturnal gecko of the Paroedura genus (Köhler et al 2019), dwarf chameleons (Brookesia spp.) (Randrianantoandro et al 2008). This threat is affected through either a direct impact or indirectly through a change in habitat. Fires and associated grazing also threaten the site's flora as was

recorded by Rakotoarisoa and Grace (2017).

▶ **Tourism/ visitors/ recreation**

(Tourism impacts)

Very Low Threat
Inside site, localised(<5%)
Outside site

There are few bats in caves visited by tourists, though it is not clear whether this relationship is causal (Kofoky et al., 2007). Some infrastructure (e.g. bridges) can detract from the wilderness aesthetic of the site (pers. obs.). However, tourism is spatially concentrated due to the impenetrable nature of the Tsingy, and any impacts are therefore highly localised (IUCN Consultation, 2012). Further, the number of visitors is limited by the distance and poor accessibility of the property from the nearest city/commercial airport.

▶ **Roads/ Railroads**

(Established road)

Data Deficient
Inside site, extent of threat not known
Outside site

American oil prospectors blasted a seismographic trail through the Tsingy in 1984, facilitating access into previously inaccessible areas (IUCN, 1990, Rasoloarison & Paquier, 2003), and thus contributing to other threats.

It is well documented that in general, existing and new roads increase the risk of poaching, collection of wildlife, habitat transformation people (etc) by increasing the ease of access to the site (Pinto et al., 2020). Roads also pose a direct threat to wildlife by way of road kills (e.g. Alamgir, 2017).

▶ **Fire/ Fire Suppression**

(Fire)

High Threat
Inside site, extent of threat not known
Outside site

Fires are set within the property in June-October, before the rainy season, to stimulate the growth of new grass, and to clear trails for people. The Tsingy is naturally resistant to fires, however (Rasoloarison & Paquier, 2003). Pasture fires may be impossible to eradicate given the cultural importance of cattle, but do little damage to Outstanding Universal Value areas and occur only on the periphery of the property (IUCN Consultation, 2012).

Fires (and associated grazing) has been identified as a threat to reptiles occurring in and around the site, for example the nocturnal gecko of the Paroedura genus (Köhler et al 2019), dwarf chameleons (Brookesia spp.) (Randrianantoandro et al 2008). This threat is effected through either a direct impact or indirectly through a change in habitat. Fires and associated grazing also threaten the sites flora as was recorded by Rakotoarisoa and Grace (2017).

▶ **Housing/ Urban Areas**

(Village establishment)

Data Deficient
Inside site, extent of threat not known
Outside site

Several villages have been illegally established in the eastern portion of the Integral Nature Reserve with extensive areas of rice paddies (IUCN, 1990; Rasoloarison & Paquier, 2003; Thorsell & Sigaty, 2001). Threat is highly localised and no recent data exist. It is however recognised that the encroachment of people onto and into the Site markedly increases the risk of illicit collection of both flora and fauna from the park (see for example Mildenstein et al 2017 and Merson et al 2019). Likewise this encroachment increases the need for roads and associated impacts.

▶ **Crops**

(Agricultural encroachment)

High Threat
Inside site, extent of threat not known
Outside site

Although rice paddies are mentioned by Rasoloarison and Paquier (2003), agricultural encroachment is not listed as a threat in the site management plan (ANGAP, 2003). The drainage of lakes and marshes for rice cultivation in peripheral and contiguous areas of the Tsingy de Bemaraha Protected Area influences water flow, and the need for arable land may increase pressure for water.

▶ **Collection of non-timber forest products (NTFPs)** — **Data Deficient**
(Collection of commercial plants)
Inside site, extent of threat not known
Outside site

Some plant species in CITES List predominantly illicit trade: Euphorbia viguieri, Kalanchoe gastonis-bonnieri, Adenia firingalavensis, Cyphostemma laza, Cissus rhodotricha, Pachypodium lamerei, Pachypodium rutenbergianum, Hildegardia erythrosiphon, Delonix spp., etc. had been collected (IUCN Consultation, 2020).

Potential Threats

Data Deficient

Although natural gas exists under the property, the combined National Park and World Heritage statuses will probably prevent its extraction at least in the short term. A change in the political policy and/or an increased need for gas fuel may render this Site vulnerable to mining - as has been seen elsewhere. The impacts of climate change remain unknown.

▶ **Habitat Shifting/ Alteration, Droughts, Desertification** — **Data Deficient**
(Habitat shifting)
Inside site, extent of threat not known

The impacts of climate change on the distribution of habitats and species require study, but the Bemaraha Plateau has served as a climatic refugium in the past (Goodman et al., 2008).

▶ **Droughts, Storms/Flooding** — **Data Deficient**
(Changes to rainfall patterns)
Inside site, extent of threat not known

The impacts of climate change on the distribution and intensity of precipitation require study.

▶ **Habitat Shifting/ Alteration, Droughts, Desertification, Temperature extremes** — **Data Deficient**
(Temperature changes)
Inside site, extent of threat not known

The impacts of climate change on temperature require study.

▶ **Oil/ Gas exploration/development** — **Data Deficient**
(Oil and gas)
Inside site, extent of threat not known
Outside site

There are natural gas deposits under the property, but the concession holder Madagascar Oil is staying away from the site, respecting the 2.5 km protective zone (IUCN Consultation, 2012). Large tar sand finds elsewhere in the Melaky region may transform the regional economy and demographics with unknown impacts on the property.

▶ **Other Activities** — **High Threat**
(Selective logging of native tree species)
Inside site, extent of threat not known
Outside site

The demand for timber for construction and fuel is accelerating with the growing population both inside and outside of the Site. Furthermore, the decreasing availability of suitable timber within the surrounding landscape (as a result of unsustainable use) is highly likely to result in increased pressure on the Site.

Overall assessment of threats

High Threat

The Tsingy is afforded strong natural protection by its impenetrable nature and isolation. Although local and migrant communities encroach on the property and exert pressures including village and agricultural encroachment, selective logging, livestock grazing in forests, subsistence hunting, the collection of non-timber forest products and, in particular, the renewal of pasture fires, all these threats are highly localised and present little threat to the integrity of the property. With the exception of two reptile species, no natural resources from the property are known to be traded

beyond the local scale. Recent data are lacking for all threats, which require careful monitoring. Natural gas extraction and climate change represent potential future threats. The drainage of lakes and marshes for rice cultivation in peripheral and contiguous areas of the Tsingy de Bemaraha Protected Area influences water flow, and the need for arable land may increase pressure for water.

Protection and management

Assessing Protection and Management

▶ **Management system** — **Mostly Effective**

An appropriate and adequate management plan exists, incorporating analyses of conservation targets and threats, as well as conservation strategies and a monitoring plan (ANGAP, 2003). The management plan was updated in 2012 (Madagascar National Parks, 2013).

▶ **Effectiveness of management system** — **Some Concern**

Management is not sufficiently effective at preventing entry and illicit resource use by adjacent communities (Rasoloarison & Paquier, 2003), but impacts are small and localised. Collaborative management of the property between the park manager and local communities in a participatory manner would enhance the success of protection, particularly through involvement in ecotourism and ecological monitoring.

▶ **Boundaries** — **Serious Concern**

Although the World Heritage Committee (2011) notes clarifications of the site's boundaries, there appears to remain much confusion about the area and status of the World Heritage site. The site is known as Tsingy de Bemaraha Strict Nature Reserve (SNR) and is said to have an area of 152,000 ha (IUCN, 1990; UNEP-WCMC, 2011). The southern half of the site, however, has the status of National Park (NP), while the northern half remained an SNR. The area of the two components is given as 72,340 ha for the NP and 85,370 ha for the SNR (ANGAP, 2003; UNEP-WCMC, 2011; MNP, 2012) for a contradictory total of 157,710 ha). While the website of Madagascar National Parks (accessed on 17 July 2014) continues to refer to the northern half of the site as a Strict Nature Reserve, the status of the northern half was changed to that of National Park by Decree no. 498-2011 of 6 September 2011 (IUCN Consultation, 2017) – the name of the site should reflect this change. The boundaries of the NP are clear and marked, although those of the SNR were not clear in 2003 (ANGAP, 2003).

There is a need to improve the peripheral management strategy for conservation areas and natural resource development, taking into account the concerns, capacity and skills of local communities.

▶ **Integration into regional and national planning systems** — **Mostly Effective**

The Melaky region is committed to the protected area (IUCN Consultation, 2012), but it is not clear whether the property is integrated into the regional development plan. The site is managed as part of a network under a national plan (PlanGRAP) but this has not been updated since 2001. Protected area management and expansion (although not the property specifically) was integrated into the Madagascar Action Plan (MAP, Government of Madagascar, 2007), but the MAP has not been retained as a guiding development framework since the political crisis in 2009.

▶ **Relationships with local people** — **Mostly Effective**

The local population is generally supportive of the site owing to the revenues generated through tourism and shared with communities as well as other related economic opportunities. Tourism was also a major reason why the main road into the region was upgraded, allowing local people to take advantage of it. Local people are involved in management of the site, including surveillance, and there is a general

sense of pride in it being a World Heritage site (IUCN Consultation, 2012).

▶ Legal framework — Mostly Effective

The property is composed of two protected areas, a Strict Nature Reserve (IUCN category Ia) in the north, and a National Park (IUCN category II) in the south (UNEP-WCMC, 2011); both are governed by national protected areas legislation (Code des Aires Protégées, Government of Madagascar, 2001) which forbids extractive resource use within both categories, but Madagascar National Parks does not have authoritative power to apply the law and relies on state security services.

▶ Law enforcement — Mostly Effective

Enforcement is effective but the involvement of local communities and benefit sharing from the protected area management can be further improved (e.g. in ecotourism).

▶ Implementation of Committee decisions and recommendations — Data Deficient

The property has not been examined by the Committee since 1992.

▶ Sustainable use — Mostly Effective

National legislation governing the protected area (Code des Aires Protégées, Government of Madagascar, 2001) forbids all extractive use of natural resources, but a local-use exemption could be granted under existing legislation. All current resource use is illicit, and any potential for sustainable use by local communities is currently unrealised.

▶ Sustainable finance — Some Concern

As for other protected areas in Madagascar, sustainable funding is a potential problem, but the property makes money through tourism and is considered an exceptional conservation priority, so is likely to be maintained even in periods of constraint for Madagascar National Parks (IUCN Consultation, 2012). The Fondation pour les Aires Protégées et la Biodiversité de Madagascar has been created to ensure sustainable financing of the protected area system, but is not yet fully capitalised.

▶ Staff capacity, training, and development — Mostly Effective

Management capacity was rated as high in 2003 (ANGAP, 2003); the staff are committed and some have a good science background (IUCN Consultation, 2012). A staff training programme has been developed every year by the human resources department of Madagascar National Parks (pers. comm.). Recently a new team of protected area staff has been created to enhance biodiversity conservation and sustainable management of natural resources.

▶ Education and interpretation programs — Highly Effective

The 2003 management plan (ANGAP, 2003) includes strategies for the education of adjacent communities, and park ‘rangers’ have an education role. Following awareness-raising programmes and environmental education for several years, local residents are aware of the importance of the property at a national and international level in terms of its diverse fauna, flora and karst landscape including its ecosystem services.

▶ Tourism and visitation management — Highly Effective

Tourism is well managed and its impacts are highly localised (IUCN Consultation, 2012). Infrastructure (trails, viewpoints, bridges, etc.) is good along well-established circuits, and professional guides are available. Visitor numbers are constrained by the isolation of the property. The community guides appear to be well versed in and are effective in insuring tourist safety.

▶ Monitoring — Some Concern

The management plan for the property (ANGAP, 2003) contains an ecological monitoring plan, but it is not clear whether the plan was implemented and whether monitoring outputs have been used for

adaptive management. Monitoring efforts for the property provide good indicators of faunal and floral species in terms of its biological health and ecological quality.

There is currently an absence of a long term monitoring system that will provide trends over the longer term. This monitoring system need not be complex or arduous and need to be linked to the capacity of staff. In the absence of dedicated capacity to undertake the monitoring required and the generation of records, the monitoring system could be based on 'citizen/tourist' science.

▶ Research — Some Concern

Research appears to have been centred on the description of species. However, research elsewhere in Madagascar is relevant to the site, particularly from a management perspective. In reviewing a sample of the research undertake since the inception of the Park, and particularly since its inscription, research undertaken has included speleology, an inventory of karstic systems, flora and fauna, socio-economic contexts, geographical information systems, anthropology, as well as the description of several new species (e.g. Glaw et al., 2007, 2009; Köhler et al., 2007; Bora et al., 2010; Goodman et al., 2011;).

Since the 2017 Outlook Assessment, published research has been limited in extent, but has included discovery of a new species of nocturnal gecko (Köhler et al., 2019), and an aloe (Rakotoarisoa & Grace, 2017). Furthermore, research outside but applicable to the Site, has focussed on a number of treats to biodiversity, for example: Alamgir et al. (2017) and Pinto et al. (2020) - impacts of road development, Rizzolo et al. (2017) - wildlife poaching, and Jones et al. (2019) - threats to biodiversity.

The paucity of research, particularly that concentrating on the threats and gaps in management strategies is a concern. There is limited funding available for research, which is compounded by the absence of dedicated research facilities. Finally, potential research within the Site may benefit from an updated list of priority research.

Overall assessment of protection and management — Mostly Effective

The majority of the World Heritage site is naturally protected against threat by its impenetrable nature, and therefore manageemnt requirements are generally low and mostly effective. It is legally protected and enjoys the support of local communities and regional authorities. An appropriate management system exists, although its effectiveness is unknown and the management plan is out of date. Further clarity to the boundaries of the site coulld enhance the management of edge effects and encroachment of agriculture and development noted as threats. Focussed efforts towards monitoring and research would further enable informed management of the site's OUV.

▶ Assessment of the effectiveness of protection and management in addressing threats outside the site — Mostly Effective

Management by Madagascar National Parks is focused within the World Heritage site, with little or no consideration for the wider landscape or region (ANGAP, 2003). While the observation that there are limited regional or local markets in natural resources from the property there is an abiding concern that pressures on the Site are on the increase. This is evident from the growing transformation of the landscape in the areas abutting the Site and the growing illicit trade in rare and endemic animals and possibly plants.

Defining and securing the boundary of the Site is deemed a priority, as is the establishment of a buffer zone which is retained in either a natural state or used in a manner that does not undermine the ecological and geological integrity of the site, as well as retaining the sense of arrival and place for tourists. The latter is important given the increasing dependence of both the Site and communities on the income generated from tourism.

State and trend of values

Assessing the current state and trend of values

World Heritage values

▶ **Rich endemic flora**

Low Concern
Trend:Deteriorating

Although fires burn forest edges each year, most of the vegetation cover is naturally protected by the Tsingy and impacts are minimal (Rasoloarison & Paquier, 2003; IUCN Consultation, 2012).

▶ **Rare and endemic birds**

Low Concern
Trend:Stable

No rare or endemic birds appear particularly threatened within the property, although localised subsistence hunting may affect some species.

▶ **Rare and endemic reptiles and amphibians**

Data Deficient
Trend:Stable

The impact of commercial collection of Brookesia perarmata and Uroplatus henkeli remains unknown, but is likely highly localised (Rasoloarison & Paquier, 2003). Numerous new and locally-endemic species have been recently described (Bora et al., 2010).

▶ **Rare and endemic mammals**

Low Concern
Trend:Stable

Although subsistence harvesting may impact some species, particularly lemurs, its impacts are highly localised (Ausilio, 1993; ANGAP, 2003; IUCN Consultation, 2012).

▶ **Unique and spectacular geomorphological features**

Good
Trend:Stable

There are no pressures known to negatively impact the Tsingy karst itself, apart from the impacts of tourism which are highly localised and well-managed (IUCN Consultation, 2012).

Summary of the Values

▶ **Assessment of the current state and trend of World Heritage values**

Low Concern
Trend: Data Deficient

The values of the World Heritage site are well maintained due to the low levels of threat. The unique geomorphological features are not threatened, while loss of forests and subsistence hunting have only minimal impacts on biodiversity values of the site, due to their localised nature. The impact of tourism is becoming evident by way of litter accumulating in crevices and along the trails. It was also noted that the Ring-tailed Mongoose had habituated to tourists in a manner that suggested that this animal was being actively fed. Finally, there is a a degree of uncertainty as to the dependence, of the above listed values, on a functioning and ecologically secure buffer zones. While this may be of low concern for species with limited ranges within the Site, it may not be so for species that are mobile (e.g. birds) or with ranges the extend beyond the boundary of the Site.

Additional information

Benefits

Understanding Benefits

▶ **Outdoor recreation and tourism,**
Natural beauty and scenery

The World Heritage site is an important tourist destination. Visitor numbers increased by 33% annually between 1992 and 1999 (Rasoloarison & Pacquier, 2003), but no up-to-date data are available.

Factors negatively affecting provision of this benefit :
- Climate change : Impact level - Low, Trend - Continuing
- Pollution : Impact level - Low, Trend - Continuing
- Overexploitation : Trend - Continuing
- Invasive species : Impact level - Low, Trend - Continuing
- Habitat change : Impact level - Moderate, Trend - Increasing

Land-use change within and beyond the boundary of the Site is a growing concern from both an ecological (Site integrity) and sense of place perspective.
As this land-use change progresses, the Site is likely to become more isolated and experience greater pressure.

Pollution is a low concern but not negligible. Here pollution includes littering and pollution emanating (air quality) beyond the bounds of the Site.

▶ **Importance for research**

The advanced knowledge of Tsingy de Bemaraha has made it possible to value the various biological, ecological, biogeographical, paleontological, anthropological and socio-cultural options for the development of the protected area complex of Tsingy de Bemaraha.

Factors negatively affecting provision of this benefit :
- Climate change : Impact level - Moderate, Trend - Continuing
- Pollution : Impact level - Low, Trend - Continuing
- Overexploitation : Impact level - Moderate, Trend - Continuing
- Invasive species : Impact level - Low, Trend - Continuing
- Habitat change : Impact level - High, Trend - Continuing

There are large gaps in the research as a result of the limited research undertaken. Importantly, a priority list of research fields/ projects needs to be generated to guide the efforts of researchers.

▶ **History and tradition,**
Sacred natural sites or landscapes

The Tsingy of Bemaraha are believed to be the tomb sites of the aborigines' ancestors, the 'vazimba' and the final resting place of the souls of the ancestors.

Factors negatively affecting provision of this benefit :
- Climate change : Impact level - Low, Trend - Continuing
- Pollution : Impact level - Low, Trend - Continuing
- Overexploitation : Impact level - Low, Trend - Continuing
- Invasive species : Impact level - Low, Trend - Continuing
- Habitat change : Impact level - High, Trend - Continuing

▶ **Carbon sequestration,**
Soil stabilisation,
Pollination

The estimated 85,000 ha of forests contain unquantified stocks of carbon.

Factors negatively affecting provision of this benefit :

- Climate change : Impact level - Moderate, Trend - Continuing
- Pollution : Impact level - Moderate, Trend - Continuing
- Overexploitation : Impact level - Moderate, Trend - Continuing
- Invasive species : Impact level - Low, Trend - Continuing
- Habitat change : Impact level - High, Trend - Continuing

▶ **Water provision (importance for water quantity and quality)**

The Bemaraha Plateau receives considerable precipitation in the rainy season and regulates the hydrology of the region to its west; this includes the Manambolomaty and Bemamba lake complexes, both of high biodiversity importance, as well as an unquantified extent of rice paddies and feed lakes stocked with fish (Rasoloarison & Pacquier, 2003).

Factors negatively affecting provision of this benefit :
- Climate change : Impact level - Low, Trend - Continuing
- Invasive species : Impact level - Low, Trend - Increasing
- Habitat change : Impact level - Low, Trend - Continuing

The quality and quantity of water provided by the Site may be negatively impacted upon by a variety of factors of which habitat change, climate change and invasive species, are seen to be paramount.

▶ **Direct employment, Tourism-related income, Provision of jobs**

The site contributes to local economy through job provision and tourism-related income opportunities.

▶ **Collection of wild plants and mushrooms**

Presence of honey and wild yams.

Factors negatively affecting provision of this benefit :
- Climate change : Impact level - Low, Trend - Continuing
- Pollution : Impact level - Low, Trend - Continuing
- Overexploitation : Impact level - Low, Trend - Increasing
- Invasive species : Impact level - Low, Trend - Continuing
- Habitat change : Impact level - Moderate, Trend - Increasing

Summary of benefits

The World Heritage site provides hydrological regulation services to the region to its west, including economically and biologically important wetland areas, and contains 85,000 ha of carbon-storing forest. Its ecosystems are of global importance for biodiversity conservation as well as providing the opportunity for knowledge generation and recreation, but its potential for the sustainable provision of forest products has not been realised.

However, the most important benefit of the Site is its contribution to the local and regional economy through tourism. This benefit may be actively enhanced without a concomitant increase in the impact on the protected area.

Projects

Compilation of active conservation projects

№	Organization	Brief description of Active Projects	Website

1	Madagascar National Parks	National NGOs working in protected area networks.
2	WWF	Mangrove conservation project to the west of Tsingy de Bemaraha.
3	Durrell Wildlife Conservation Trust	Bird conservation projects to the west of Tsingy de Bemaraha.
4	Biodiversity Conservation Madagascar	Manages the Beanka new protected area to the north of Tsingy de Bemaraha.

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