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Evaluation, potential and actual threats to the Outstanding Universal Values of the World Heritage Gunung Mulu and Gunung Buda National Parks, Sarawak, Malaysia

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(Deceased) [1]

Abstract: All Totally Protected Areas especially in the Tropics are under threat, some serious and some minor. This includes threats to the biodiversity and to geoscientific values. The potential and actual threats to the Gunung Mulu and Buda National Parks are examined, along with potential ways of threat elimination and mitigation, considering the aspirations of the local community. Potential and actual threats are defined. Some threats relate to areas outside of the National Park boundaries that are not designated as parts of areas of Outstanding Universal Value (OUV) within the terms of the World Heritage documentation. Nevertheless, such threats retain a high relevance because they are within the immediate vicinity and potentially their influence can affect the OUVs of the Parks directly. A means of evaluation of specifications to protect the Outstanding Universal Values is examined.

Keywords: Management plans; Totally Protected Areas; Partially Protected Areas; human threats; natural threats; mitigation strategies.

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Introduction

This report references a list of Outstanding Universal Values (OUVs) compiled and published by Gill (2022). Potentially, all totally protected areas (TPAs) remain vulnerable to threats, both natural and related to anthropogenic activities. The primary objective of identifying a TPA is to support conservation of its biodiversity and the fundamental features contributing to the underlying physical environment. Despite their official classification as TPAs, the Gunung Mulu National Park (GMNP) and Gunung Buda National Park (GBNP) are not protected totally; they are only partially protected areas (PPAs).

In areas containing karst terrain and caves the values tend to be high due to the complex nature of the environment along with local community aspirations (Gill, 2021). There is a distinct difference between a potential threat that has not occurred or is unlikely to occur but needs to be considered, and an actual threat that has occurred in the past.

The first stage is to list the OUVs. In order to eliminate and mitigate the threats, a proactive Management Plan is essential in which the threats are listed, and an explanation of their severity given with a proactive approach rather than a reactive approach to their limitation. In the case of the GMNP four Management Plans have been published (Anderson, *et al.,* 1982; Sarawak National Parks and Wildlife Department, 1993; Mandis Roberts, 2000; EY Consultancy, 2022). For the GBNP, only one has been published (Gill, 2018).

This is the most complex and difficult section of any Management Plan as it must be of hands-on practical value where implementation is possible to achieve. This has not always been the case in Management Plans for GMNP as evaluation and yearly auditing of recommendations, referred to as specifications, has not taken place. Ultimately the Management Plan is of little use as specific items are not implemented if there are no means to do so. The Integrated Development Management Plan: GMNP, 2000 to 2020 (Mandis Roberts, 2000) specified that independent evaluation was required but then went on to say that this could be implemented by the Forest Department Sarawak (FDS); however, this was never carried out. Many Management Plans are not adequately consulted and remain in a bookcase. Yearly evaluation and auditing are therefore paramount, from an independent source such as a private consultancy company and not by any government department or non-government department (NGO). This is the only viable means of ensuring that specifications are met and recommendations are carried out. Where an area has been designated as a World Heritage Area, the Outstanding Universal Values are the main factors leading to nomination and therefore some means must be in place to protect the OUVs and evaluate the specifications (Gill, 1999).

Two sets of major threats must be considered: human threats and natural threats. Human threats can be resolved or, in many cases, partly resolved with a mitigation strategy. Natural threats are problematical, but require constant monitoring, with aid available to communities or individuals in emergency situations.

Footnote 1:
This Issue of Cave and Karst Science is unusual in that it contains a contribution by an author who, sadly, is no longer with us. Prior to his untimely death, in Mira, Sarawak, on 09 January 2024, Dave Gill had three manuscript submissions awaiting approval. Of these, at the author's request, the current Report (Evaluation, potential and actual threats to the Outstanding Universal Values of the World Heritage Gunung Mulu and Buda National Parks, Sarawak, Malaysia) *had been "on the back burner", so that precedence could be given to other material that he was developing. Nevertheless, review of this text prior to his death confirmed that it needed only cosmetic Editorial tidying. A year having passed, it now seems appropriate that it should be published. Essentially, its content remains as submitted, but with editorial intervention to improve presentation of tabular information and to conform to "house style". Inevitably, some reported information and situations might have changed in the meantime; there is also potential for overlooked minor duplication or ambiguity within the edited text. If any such issues are noticed, hopefully they will neither undermine nor devalue the author's aspirations, intentions and sincerity.*

Problems associated with mitigation of potential and actual threats

Human threats

For the above to be, legislations are required for the conservation of TPAs. In the case of Sarawak, this is via the National Parks and Nature Reserve Ordinance and the Wildlife Protection Ordinance 1998 and any subsequent amendments (Laws of Sarawak, 1998). In World Heritage terms this is under the heading of integrity. For Sarawak these are excellent legislation documents, but enforcement of the law has relied on the Forest Department Sarawak (FDS) and the Sarawak Forestry Corporation (SFC). With the establishment of the SFC all national parks open to the public became their responsibility, however, this has recently been amended in 2022; all TPAs are now under the jurisdiction of SFC, including those classed as Wilderness Areas and closed to the public. Laws are normally enforced by the Police Department with major crimes judged in a court of law by an independent judge with no ties to any political party or ethnicity.

A problem arises regarding enforcement of the laws of conservation in many areas of Southeast Asia where they are not considered to be serious criminal offences. The major issue is the human threat presented by the local communities, where the forest and its biota are regarded as a resource to be exploited. Thus, mitigation needs to take this into account and some means must be developed whereby the local communities regard conservation as a priority (Brodie and Giordano, 2013, Brodie, *et al.* 2014). It needs to be recognized that only with support from the local communities can conservation be achieved successfully by means of tourism. The main reason behind this system of management is that the local communities become totally involved as a part of the TPA, with financial incentives arising from employment related to tourism, maintenance, management, and entrepreneurial activities, along with the benefits of awareness programmes (Amin, 2014; Liam and Gill, 1999; Gill, 2021).

The local community has privileges granted for GMNP and GBNP, as outlined in the Sarawak Government Gazette, which allows them to hunt and gather produce within a certain prescribed area; this is often abused (Sarawak Government Gazette, 1974; 2000; 2011; 2011; 2012). The Penan based at Batu Bungan are situated in a difficult position, being surrounded on three sides by the GMNP boundary and on the fourth side by land claimed by the Berawan. Due to a dramatic increase in the Penan population, the result has been encroachment into the GMNP Extension No 1. This is regarded as a severe threat to the OUVs. Relocation of the Penan is the ultimate answer but considering that development has been undertaken, with a school and a clinic, this is not a viable option. Much objection would take place from NGOs.

A Management Agent has been appointed by the Sarawak State Government for the GMNP but staff working for the Management Agent do not have a warrant to arrest, whilst Park Rangers employed by the SFC do, but are reluctant to do so because they consider it essential to keep on good terms with the local population, among whom they live – which is understandable. Proof of guilt is not easy to establish and, if arrested, the person needs to appear in front of a court headed by a Justice of the Peace. Without substantial proof, the case is dismissed. The major contribution from Park Rangers is to engage in awareness programs rather than antagonizing the local population by arresting poachers. This is approach is practiced with limited success.

A severe threat is the risk of infections being transmitted from wild animals to humans. HIV infection came from a type of chimpanzee in Central Africa (Sharp and Hahn, 2011). To date the related human death toll is estimated at 36 million. The chimpanzee version of the virus is called *simian immunodeficiency virus*. Coronaviruses are known to circulate in mammals and birds, and scientists have already suggested that virus "nCoV-2019" came originally from bats or pangolins. Some research suggests that severe acute respiratory syndrome (SARS) was transmitted to humans via bats and civet cats (Alluwaimi *et al*., 2020). Doubts in the scientific community have arisen because there is little substantial scientific evidence that Coronavirus was transmitted to humans from wild animals, and for a while it was widely assumed as more likely that the virus escaped from a Chinese laboratory, but currently this "hypothesis" retains little scientific support (see BBC, 2023, for a summary). There is no doubt that wild animals carry pathogens and that some have been transmitted to humans, with lethal results.

The effects of global warming and flooding present widespread and increasing problems. The GMNP and surrounding area experienced four major floods in 2022, causing extensive damage to homes and to the Mulu park headquarters. The flood level increases year on year. Recent severe flooding could be due to changing climatic conditions, or to more-rapid runoff triggered by deforestation, but without doubt an increase in the sedimentation loads of the rivers has contributed to severe backing up within natural drainage systems. Annual flooding and backing up of the Melinau River in the GMNP are for the most part caused by the Tutoh River when in high flow. Runoff rainwater from tributaries has increased in recent years due to logging and palm oil operations causing increased sedimentation loads. As the Melinau River is little more than 20 metres above sea level, any rise in sea level due to global warming will have a notable effect, with a corresponding increase in flood events. Some backing-up does occur on the Medalam River GBNP because of the high flow of the Limbang River. Annual flooding is a normal and a natural process, being an integral part of the general biological processes of riparian and peat swamp forest dynamics, but the recent trends do indicate manmade operations and global warming are increasing the severity and frequency. This is considered as a severe actual threat to the OUVs.

Plans for a direct road link to the GMNP from the closest major city of Miri are being implemented and are planned to be completed within five years. This road will go only as far as Long Iman and Kuala Melinau. Accessing the GMNP at this point will involve crossing the Tutoh River by barge. The planned intention is that this road should not be used by tourists, but act only as an access road for fuel supplies and services, because the airport is the main gateway to Mulu, ensuring its continued remoteness. Use of the road as a tourist entry point could seriously jeopardize the carrying capacity of the GMNP, which has been calculated as no more than 35,000 visitors per year. Mass tourism for the Park would not be recommended. This is regarded as a severe potential threat to the OUVs (DayakDaily, 2021).

The oil-palm estate bordering GMNP Extension No.1 along the Tutoh River has now been cancelled due to objections from the local community, State Government decision, and threats to the OUVs. There is some indication that this area may be included as an extension to the Park boundary, which would be advantageous. The introduction of a palm-oil estate or logging operations would have a significant detrimental effect upon the feeding area for bats and swiftlets. This is regarded as a potential severe threat to the OUVs (Hanafiah, *et al*., 2021; Donald, R, 2022).

As there is no provision in the Laws of Sarawak for buffer zones or biosphere reserves to be established, recommendations would be that no logging or palm oil estates should be established with a 25-kilometre zone around the boundaries of the two parks in order to safeguard the OUVs and provide a continued feeding ground for bats and swiftlets, which are an integral part of the biodiversity, especially with respect to the caves.

Plans for the construction of a hydroelectric dam scheme along the Tutoh River have been cancelled, because such a development would affect the World Heritage values adversely, thus impacting the integrity of Extension No.2 to the GMNP. If the project was to go ahead, it would be regarded as a severe potential threat (Economic Times, 2008; International Rivers, 2008).

Natural threats

Rainfall figures presently remain stable. Severe El Niño and La Niña effects can have serious consequences, with forest fires and changes in fruiting periods of certain tree species, which affect the distribution and density of fruit-eating fauna. Manmade forest fires are common throughout Sarawak during the rice planting period. Occasional natural forest fires, generally caused by lightning strikes on the karst mountains, have been known to occur during the dry season. These have destroyed substantial areas of vegetation on Gunung Api, Gunung Benarat, and Gunung Buda. Natural regeneration of vegetation on mountainous karst areas takes a considerable period. One such area of damage related to a naturally occurring forest fire was identified on Gunung Api and was calculated to date back several hundred years. As the word 'api' means fire in Bahasa Malay, such fires are presumed to be a common occurrence. The study of past climatic conditions over previous glacial periods is ongoing, and should be encouraged because the caves preserve invaluable climatic records.

A severe tropical storm in 1994 destroyed a considerable portion of Karangas forest in the GMNP. The area is now in the process of natural regeneration.

Seismic activity

Whereas Borneo is regarded as being tectonically stable, it lies within the Sundaland Block (Sunda Plate), which is seismically active and, tectonically, one of the most complex regions on Earth. The plate is surrounded by active convergent plate boundaries and recent Global Positioning System data indicate that Borneo is rotating slowly in a clockwise sense. In 2015 a magnitude six earthquake in Sabah led to 18 fatalities and caused severe damage, estimated at 2.84 million US$.

Known major faults in Sarawak appear to be relatively inactive, because no major tremors have been recorded in their vicinity. For example, the Mulu Fault appears to be tectonically stable apart from showing related thermal activity. Currently active sulphur-rich thermal springs are known on the true right bank of the Melinau River and the true left bank of the Terikan. Both appear to be associated with the Mulu Fault, but other than being linked potentially to the hot springs, no seismic activity has been reported. At the time of writing, a report of a hot spring on the upstream Assam River in the GBNP has not been substantiated.

Whereas landslides occur in the parks, on steep slopes that display potentially susceptible geological conditions, they are not normally triggered by seismic activity (Day, 1980).

In summary, threats from seismic activity appear to be low, whereas the effects of flooding are severe. Help with removal of sediment deposit buildups and compensation payments to affected local communities are recommended.

Lists of threats to the key features of World Heritage Outstanding Universal Values

Potentially, all items within the Outstanding Universal Values are threatened to some degree, but appropriate legislation and efficient management can reduce the potential severity of the threats. Some of the items and criteria listed in tables 1 to 4 apply to areas outside of the National Park boundaries, but the related assessments are valid and relevant.

- The threats are presented within the categories: ***None***; ***Low***; ***Moderate; High;*** or ***Severe***;
- Potential threats are marked "**P**";
- Actual threats are marked as "**A**".

Criterion (vii): *to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.*

As presented in Table 1: the two National Parks fulfil criteria representative of areas of exceptional natural beauty.

Criterion (viii)*: to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features*

As presented in Table 2: the two National Parks fulfil the criteria of areas that include outstanding examples representing major stages of the Earth's history.

Criterion aspects	Threat Level	Actual (A) or potential (P) threat	Notes
Natural beauty	Low	P	Global warming will have a detrimental effect on aspects of the natural beauty.
Active recreation	High	A	Hunting within the tourist areas creates potential dangers for tourists, especially because shotguns are commonly used.
Tropical karst	Moderate	A	Wildfires, currently with few effective means of extinguishing them.
Caves	High	A	Some damage to floor deposits by Adventure Caving tourists vecause the designated cave trails are not always adhered to. Some pollution occurs due to deterioration of composite floor plank walks in caves that are developed for tourist visits. Deterioration of rotting timber plank walks. Illegal bird-nest collecting with associated reduction in swiftlet populations, toiletry, litter, graffiti and damage to floor deposits and cave fauna. The possible introduction into Sarawak of histoplasmosis and White Nose Syndrome from clothing and equipment used by cave explorers and scientists; all such items should be disinfected before use (Guemas *et al.,* 2020; Magnino *et al.,* 2021).
Bats in Deer Cave	Severe	P	Use of pesticides and fertilisers within palm-oil estates and logging areas surrounding the parks leads to a reduction of feeding areas and to poisons entering the food chain (Hall, 1996; Lundberg *et al.,* 2022).
Guides	Low	P	Training in rescue techniques and Adventure Caving designated trails. Recruited from local communities and trained in conservation and health and safety.
Trekking [Pinnacles of Gunung Api and the Summit Trail]	Low	P	Tourists are led by professional park guides and safety equipment is installed on climbs.
Cultural significance	Low	P	Archaeological sites are in remote locations, kept confidential, and not visited by tourists.
Visitor facilities and Management Plans	Moderate	A	Unsustainable development has taken place using timber. Visitor impact assessment and environment assessment are within the scope of the Management agreement and must be included in Management Plans.

Table 1*:*
Criterion (vii) [see text]: the two National Parks fulfil criteria representative of areas of exceptional natural beauty.

Criterion aspects	Threat level	Actual (A) or potential (P) threat	Notes
Geology	None	—	Parks are protected under the Ordinances (Waltham and Webb, 1982).
Geomorphology and hydrology	Moderate	**A**	Removal of trees along the riverbanks and Penan farms, no efficient fresh water, waste disposal and sewage systems causing high levels of pollution of the Melinau River GMNP (Friederich,1980; Waltham and Brook, 1980).
Alluviums	Low	**A**	Storm damage.
Predictions for the future	Severe	**A**	The weather conditions remain stable except for flooding periods along the Melinau River GMNP, which are on the increase in severity. This is due to heavy siltation of the major rivers causing backing up to occur. There is a possibility of diversion of the Melinau drainage system from the Melinau Gorge area towards the Medalam and Limbang rivers due to rapid sediment deposition. This is especially relevant to enhanced understanding of the effects of increased climatic variability under conditions of global warming.
Karst	Low	**A**	Forest fires do happen due to the dry conditions associated with the vegetation on karst.
Caves	High	**A**	Bird-nest collecting, including related graffiti. The bats, swiftlets, guano and atmospheric condition created in the caves due to the cave wildlife, has greatly affected the development of the caves over millions of years. Illegal bird-nest collecting over a period of 10 years (2000 to 2010) resulted in the loss of millions of swiftlets, thus reducing the buildup of guano and directly effecting cave development (Smart and Willis, 1982; Allen, 2010; McFarlane and Lundberg, 2018; McFarlane and Lundberg, 2021).
Caves with pathways and lighting	Low	**A**	Guided by Park Guides, little pollution, low radon and carbon dioxide levels. Some pollution due to plank-walk deterioration of timber and composite material.
Sarawak Chamber	Low	**P**	Open for adventure tourists with qualified Park Guides and equipment.
Api Chamber	None	—	Remotely situated in the Whiterock section of the Clearwater Cave System and is the eighth largest known chamber in the world by volume. Only accessible to cave explorers and scientists.
Cave geomorphology	Low	**A**	Cave sediment damaged by illegal bird-nest collectors (Farrant *et al,* 1995; Farrant *et al,* 2008).
Palaeomagnetic dating	None	—	—
Notches along the cave walls	None	—	—
Cave pinnacles	None	—	Situated in remote caves not visited by tourists.
Straw stalactites	Low	**P**	The longest recorded in the world at 9.13m in a remote location (Boothroyd, 2017).
Cave formations	Low	**P**	Covers all types, including mineral deposits in guano, helictites, needle gypsum, anthodite with selenite and aragonite. Crystal-tree formations have been found, which appear to be unique. Damage from bird-nest collectors.
Biological processes	None	—	—
Phytokarst	None	—	—
Archaeological cave sites	Low	**P**	Remote locations not visited by tourists (Datin, 1990).
Carbon sequestration and storage	Low	**P**	Global warming.

Table 2*:*
Criterion (viii) [see text]: the two National Parks fulfil the criteria of areas that include outstanding examples representing major stages of the Earth's history.

Criterion aspects	Threat level	Actual (A) or potential (P) threat	Notes
Cave invertebrates	Moderate	A	Damage caused by bird-nest collectors (Chapman, 1980 and 1982).
Cave food ecology	Moderate	A	Litter and toiletries left by bird-nest collectors.
Cave fauna diversity	Moderate	A	Damage caused by bird-nest collectors. The habitats for cave fauna rely on guano deposits that could be contaminated via pesticides introduced into the feeding areas for bats and swiftlets from palm-oil estates located outside the park boundaries.
Evolution of troglobites	None	—	(Barr, 1968).

Table 3*:*
Criterion (ix) [see text]: the two National Parks fulfil criteria indicative of an outstanding example representing aspects of ongoing ecological and biological processes in the evolution of terrestrial habitats..

Criterion (ix): *to 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;*
As presented in Table 3: the two National Parks fulfil criteria indicative of an outstanding example representing aspects of ongoing ecological and biological processes in the evolution of terrestrial habitats.

Criterion (x): *to 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.*
As presented in Table 4: the two National Parks also contain significant natural habitats that satisfy criteria applicable to areas considered suitable for *in-situ* conservation.

Proactive approach to potential and actual threats and non-conformity to conservation and World Heritage values

Information and comments presented in Table 5 include categories that are not classified as of Outstanding Universal Value, but which remain as important components of World Heritage general values.

The potential and actual threats to the conservation of the National Parks, and their associated non-conformity values are as presented in Table 5, which differs slightly from Tables 1 to 4 by restricting the perceived threat levels only to the four categories listed below:

Low; Moderate; High; and Severe.

Shading of cells within Table 5 corresponds to appropriate parts of the colour-scheme employed in Tables 1 to 4.

Criterion aspects	Threat level	Actual (A) or potential (P) threat	Notes
Flora	Severe	A	Collecting by members of the local communities and others of Sarawak's protected plant species. This includes the felling of Agarwood trees, known in Sarawak as Gharu (Family Thymelaeaceae, *Aquilaria* sp.), in search of a black resin that is a by-product of infection by a mould (*Phialophora parasitica*). In the GMNP, trees are felled indiscriminately in the search for this highly valued product that, at the time of writing, has a weight for weight value greater than those of gold and platinum, reputedly fetching 100 to 250 US$ per gram. Estimated **world** value of the trade (also at the time of writing) is reputed to reach 6 to 8 billion US$ per year. The GMNP has one *Aquilaria* species recorded (*A macrocarpa* Baill.), which has an IUCN Red List classification of Vulnerable (VU), and is known to be felled by members of local communities as well as Indonesian operators. Another three *Aquilaria* species, *A beccariana* Tiegh, *A malaccensis* Lam and *A microcarpa* Baill. are on the Sarawak Protected Plant list. Cultivation of planted *Aquilaria* forests is underway in Sarawak, and should be encouraged, to reduce the illegal operations currently taking place in both the GMNP and the GBNP. Further research might add to the number of *Aquilaria* species recorded in the GMNP and the GBNP (Anderson and Chai, 1982; Kanazawa, 2016).
Endemic species of flora	Low	A	Illegal collecting of plants by members of the local communities, for sale to the public, has been recorded. (See also "Plants", below).
Fungi	None	—	—
Varied and diverse fauna	Moderate	A	Hunting by members of the local communities.
Summary of mammals	Severe	A	Hunting of protected species, including Critically Endangered pangolins, by members of the local communities. There is an additional severe danger of infections being transmitted to humans via wild animals.
Invertebrates	None	—	—
Plants	Low	A	Collection and sale of endemic species (as for "endemic species of flora", above).
Borneo endemic mammals	Low	A	Hunting by the local communities.
Bats	High	P	Degradation of feeding areas from logging and palm-oil operations outside the Park boundaries (McArthur, 2012; McArthur and Khan, 2021).
Reptiles	Low	A	Hunting by the local communities.
Amphibians	Low	A	Hunting by the Penan community.
Birds	Moderate	A	Hunting by members of the local communities. Sale of songbirds and sales of hornbill casques have been reported in the GMNP (Lepage, 2022).
Fish	Moderate	A	High levels of fishing in the rivers by members of the local communities (Cramphorn, 1982).
Endemic invertebrates including cave fauna	Low	A	Bird-nest collecting.
60% of all known species recorded in Borneo	Low	P	Global warming could have long-term detrimental effects on all Park species.
Exotic alien species	None	—	Introduction of such species is prohibited under the National Parks and Nature Reserve Ordinance, 1998.
IUCN Red Listed species	Severe	A	Hunting and collecting pressures, and global warming.
Summary endemic species	Low	P	—

Table 4:
Criterion (x) [see text]: the two National Parks also contain significant natural habitats that satisfy criteria applicable to areas considered suitable for in-situ *conservation.*

Potential or actual threat	Category	Description and recommendations
Park management	Low	Professional management team under a Concession Management Agreement has been implemented successfully for the GMNP. A similar system should be implemented for the GBNP.
Visitor satisfaction	Low	Professional guiding policy implemented. Carrying capacity not exceeded and zoning procedure implemented for both parks. The GMNP should be regarded as a remote location with tourist arrivals via air only.
Facilities	Moderate	Many of the facilities especially in the caves are constructed of un-sustainable materials which are detrimental to the conservation principles and the Management Plan. Because the caves have high humidity, timber rots, producing fungi and bacterial growth. Walk-ways in the caves that are open to the public should be constructed of steel and concrete for long term sustainability. The decomposing composite floor planks pollute floor areas beneath the walkway. Surface plank-walks suffer from the same problem.
Management Plan	Moderate	Specifications require a timeframe for implementation, a responsible authority for funding, and priority of implementation. Specifications should be audited independently every year. Independent auditors should not be from a Government Department or a non-government organisation (NGO), but from a private consultancy company, registered in Malaysia, with proven expertise in park management.
Community stakeholders	High	There should be community involvement in the Park management, alongside associated benefits, and suitable awareness programs should be available for community participation.
Conservation and enforcement	Severe	Sarawak Forestry Corporation Park Rangers should carry out regular enforcement duties and provide continued awareness programs, especially in schools.
Poaching	Severe	No arrests or prosecutions have been recorded, so the value of current “deterrents” is zero. Penan are classified as settled, their privileges should revert to being the same as those of the Berawan, as per the Sarawak Government Gazettement Proclamation. The privileges should be reviewed, and withdrawn within the World Heritage Area, because the present level of hunting presents a direct threat to tourists. There is also a severe danger of infections being transmitted to humans via wild animals.
Boundary encroachment logging operations and palm oil plantations	Moderate	Illegal logging operations have occurred. Palm-oil plantations and logging operations should be distanced beyond 25 kilometres from the boundaries of the parks, so as not to prejudice the feeding areas of bats and cave swiftlets by use of pesticides and fertilisers.
Boundary maintenance and marking, buffer zones	High	Kampung Committee representaties could be employed by the Sarawak Forestry Corporation to carry out some boundary maintenance duties. Buffer zones and biosphere reserves should be considered as amendments to the National Parks and Nature Reserve Ordinance.
Waste disposal Gunung Mulu National Park	Severe	The present system in the GMNP, is detrimental to World Heritage Values. Pollution of the Melinau River, and poor waste tip management might eventually lead to spread of severe contagious diseases such as Leptospirosis and Cholera. Much waste material is deposited in the river.
Utilities, electricity supply Gunung Mulu National Park	High	Atmospheric and noise pollution. Concepts of carbon-free electricity supply along with electrically operated outboard engines is a long-term aim. Completion of the Mulu SESCO overhead supply is urgently required, to supply all dwellings, resort, park, school, clinic, etc. Electrical supply for the recommended visitor centre at the Gunung Mulu National Park can be installed via the existing overhead supply line along the proposed 12km road or more solar power could be utilized.
Utilities, clean water supply and sewage Gunung Mulu National Park	High	With a 24-hour electrical supply, a water treatment plant is planned with supplies to all the area’s dwellings. Drinking water is presently polluted. A sewerage system to be introduced as pollution of the Melinau River in the Gunung Mulu National Park is high.
Proposed township Gunung Mulu National Park	High	Not required, because this plan will attract more residents from outside the area, which will be detrimental to the conservation values of the World Heritage Area and the combined two parks.
Population increases	High	Further settlement of people from outside the local community should be discouraged because further problems of illegal activities will escalate to uncontrollable levels. It is important that the local community keeps just in pace with employment opportunity. As the population has increased to more than 800, employment has not kept pace with rising numbers. Problems with waste and sewage management will increase the already critical situation. The Penan population in the Gunung Mulu National Park, has risen within 40 years from 20 persons to 600.
Road leading directly to the parks	High	For the Gunung Mulu National Park, the road system should go only as far as Long Iman, Long Terawan and Kuala Melinau. This road should not be used for tourist traffic but only for supplies and the local community because the remote location is a major attraction for visitors and also a major factor for World Heritage values. For Gunung Buda National Park, the existing logging road through the park could be upgraded as far as a possible Visitor Centre.
Climate change and flooding	Severe	Rainfall figures to be monitored monthly. Sea level rise will seriously effect flooding as the Melinau River is only 20 meters above sea level. Under normal conditions flooding occurs once per year. In 2022 four floods have been recorded with ever increasing levels. High sedimentation of the rivers causing backing up of flood water is the primary cause. Assistance given to the local community in a clean-up of sediment within their homes and compensation for losses related to flooding.
Seismic activity	Low	Subject to yearly monitoring from the Geological Department, Sarawak.
Health and safety	High	Careless driving along the road at the Gunung Mulu National Park has led to accidents. Eventually, speeding river traffic will inevitably lead to a serious collision with tourist traffic, resulting in severe injury or death(s). Such river traffic also produces large waves, which damage or destroy local community pontoons along the riverbanks. Introduction of White Nose Syndrome and histoplasmosis into Sarawak must be avoided, by strict enforcement of rules relating to disinfection of all caving equipment. Help and compensation should be available to residents faced with loss of earnings related to there being zero tourists during a pandemic.

Table 5*: Potential and actual threats (related to a proactive approach to potential and actual threats and non-conformity to conservation and World Heritage values).*

Sarawak State Government and SFC	Management Agency	Initiative	Remarks
Independent evaluation	Independent evaluation	Human threats	As listed above
Independent evaluation	Independent evaluation	Boundaries. Biosphere reserves and buffer zones	As listed above. Biosphere Reserves and Buffer Zones require amendments to National Parks and Nature Reserve Ordinance.
Independent evaluation	Independent evaluation	Natural threats, Climate change, Annual rainfall Seismic activity	Monitoring as listed above
Independent evaluation	Independent evaluation	Threats and non-conformity to Outstanding Universal Values, conservation and general World Heritage values.	As listed above

Table 6: *Strategic performance.*

Strategic performance, strategy protection and conservation, health and safety, planning, funding, and responsible agency

A highly generalized overview, including some of the roles of the Sarawak State Government, the Sarawak Forestry Corporation, and such management agencies as are involved is provided in Table 6.

Conclusion

Both actual threats and potential threats to the OUVs of the GMNP and the GBNP are generally considered as low, but there are ways to mitigate the threats.

The protection of the wild animal populations cannot be over emphasised; too many times in television documentaries, so-called conservationist presenters are seen handling wild animals. As the name suggests,wild animals are "wild"! They should be left so, and handled only if absolutely necessary, and even then only if wearing protective gloves. Study based upon photographs and film/video is perfectly acceptable.

There is scientific proof that wild animals carry pathogens, exposure to which can be harmful and, in some cases, potentially fatal to humans. Considering the above statement, there are three possible long-term strategies to help achieve the objective of conserving the OUVs.

- Education in schools as part of the curriculum, from an early age into adulthood, stressing the priority of the conservation values of maintaining wildlife and of preserving a cover of native vegetation to provide essential habitats. The strategy should also include emphasizing the dangers of climatic change related to global warming. Locally organized awareness programmes should form a vital part of any such educational strategy.
- Promotion of tourist activities, from the proceeds of which appropriate financial benefits are passed on to the local communities.
- Domestic livestock farming based upon approved methods, and located within appropriately recognized areas, should be subsidized. If introduced in a sensitive and achievable fashion, such a strategy should reduce the needs for factions within the local communities to resort to exploiting the endemic biota by poaching or to collect potentially irreplaceable natural resources from protected areas.

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