Sinharaja Forest Reserve

2020 Conservation Outlook Assessment

SITE INFORMATION

Country: Sri Lanka
Inscribed in: 1988
Criteria: (ix) (x)

Located in south-west Sri Lanka, Sinharaja is the country's last viable area of primary tropical rainforest. More than 60% of the trees are endemic and many of them are considered rare. There is much endemic wildlife, especially birds, but the reserve is also home to over 50% of Sri Lanka's endemic species of mammals and butterflies, as well as many kinds of insects, reptiles and rare amphibians. © UNESCO

SUMMARY

2020 Conservation Outlook

Finalised on 02 Dec 2020

The value of Sinharaja as a natural World Heritage site continues to be recognized by the discovery of several endemic species of plants and animals since the declaration of this forest as a World Heritage in 1988. Some of the recent discoveries include several species of herpetofauna that are restricted ('point endemic species') to the eastern region of Sinharaja. These findings are a result of well-planned systematic research work carried out in Sinharaja over the past three decades. The site is an icon of biodiversity conservation in Sri Lanka, which has led to a considerable increase in conservation awareness among the general public. However, existing conservation issues such as encroachment of forest due to agricultural expansion (e.g. tea plantations), human dwellings, unsustainable tourism developments, fragmentation due to road construction, spread of invasive species and illegal collection of rare and endemic species for international trade, could seriously compromise the conservation of the World Heritage site in the future.

The management authority needs to take immediate steps to implement a plan of action to address threats and fill management gaps. It is expected that some of these concerns can be addressed through two recently initiated projects - National REDD+ Investment Framework and Action Plan (NRIFAP) and the World Bank funded Ecosystem Conservation and Management Plan (ESCAMP).

With the implementation of the ESCAMP project, a 'Sinharaja Management system' has been instituted at the Ministry of Environment by the Forest Department to address all issues related to its sustainable management. Nine peripheral forests of Sinharaja WHS have been clustered together and gazetted as the 'Sinharaja Rain Forest Complex'.

Private sector plantation companies, mainly Finlays and Dilmah Conservation, have agreed to release some of their tea plantations to establish biological corridors linking Sinharaja with Walankanda - Delwala forest reserves (Finlays, 2019; Dilmah Conservation, 2019; Hapugastenna Plantations Ltd., 2020).
FULL ASSESSMENT

Description of values

Values

World Heritage values

► Rare, threatened and endemic invertebrate species  
Criterion:(x)

The endemic invertebrates in Sinharaja include nine species of butterflies and 12 species of land snails (Bambaradeniya et al., 2003). An endemic tree-climbing crab (Ceylonthelphusa scensor) was discovered in Sinharaja during the mid 1990’s (Ng, 1995). A new odonate species was discovered in the buffer zone of the forest in 2009 (van der Poorten, 2009). A study on species richness of ants in a 0.6 ha research plot in Sinharaja has documented 100 species, including the endemic and relict ant Aneuretus simoni (Gunawardena et al., 2012).

► Rare, threatened and endemic mammals  
Criterion:(x)

75% of the mammal species (15 of 20) endemic to Sri Lanka occur in Sinharaja (Bambaradeniya et al., 2003; Rajeev and Vidanapathirana, 2012). A small mammal species new to science (Sinharaja Shrew - Crocidura hikmiya) was discovered in the Sinharaja World Heritage site in 2007 (Meegaskumbura et al., 2007). This species is listed as Globally Endangered (EN) by IUCN.

► Rare, threatened and endemic birds  
Criterion:(x)

Over 150 species of birds have been recorded in Sinharaja. A majority of the bird species endemic to Sri Lanka (33 species) occur in Sinharaja (> 30 species) (Bambaradeniya et al., 2006). An owl species new to science (Serendib Scops Owl – Otus thilohoffmanni) was discovered in the Sinharaja World Heritage site in 2004 (Warakagoda and Rasmussen, 2004). This species is listed as Globally Endangered (EN) by IUCN.

► Rare, threatened and endemic reptiles  
Criterion:(x)

A new canopy-dwelling species of colubrid snake (Dendrelaphis sinharajensis sp. nov.) was recently discovered in the Sinharaja World Heritage site, as well as a new species of the endemic scincid lizard (genus Lankascincus) (Wickramasinghe, 2016; Wickramasinghe, 2020). At present, a total of 36 reptile species have been identified in southern and eastern parts of the Sinharaja Forest Reserve of which 19 are endemic to Sri Lanka. Among them there are 5 vulnerable species, 4 endangered species and 5 critically endangered species recorded (Samarawickrama et al., 2019).

► Rare, threatened and endemic freshwater fish  
Criterion:(x)

Of the 19 species of freshwater fish inhabiting the streams and rivers in Sinharaja, 50% are endemic (Bambaradeniya et al., 2006).

► Endemic Pteridophytes  
Criterion:(x)

63 species of pteridophytes have been recorded in 0.36 ha of randomly placed sample plots in a single hill in Sinharaja, which includes 15 endemic species (Ranil et al., 2007). A new tree fern species (Cyathea srilankensis) was discovered in Sinharaja in 2010 (Ranil et al., 2010).

► Rare and endemic plant species  
Criterion:(x)

Protecting the last viable remnant of Sri Lanka’s tropical lowland rainforest, Sinharaja is home to at least 139 endemic plant species within two main types of forest: remnants of Dipterocarpus in the valleys and on the lower slopes, and secondary forest and scrub where the original forest cover has been removed. Sixteen of the endemic plant species within the site are considered rare, including endemic palms.
Loxococcus rupicola and Atalantia rotundifolia (World Heritage Committee, 2014). Among the Dipterocarpaceae – trees dominating the forest canopy in Sinhraj, endemism is greater than 90% (Gunatilleke and Gunatilleke, 1980; Gunatilleke et al., 1995).

▶ Rare and endemic Orchids

About 80 orchid species have been recorded in Sinhraj, of which 32 species are endemic (Rajeev and Vidanapathirana, 2012). In the last years, a new species in the family Orchidaceae (Gastrodia gunatillekeorum) was found in the lowland rainforest of Sinhraj (Bandara et al., 2020).

▶ Rare, threatened and endemic amphibians

The eastern corner of Sinhraj (e.g., Morningside area) is considered as a hotspot for endemic amphibians. This small area harbors 10 Pseudophilautus species of which 5 are Critically Endangered (Ps. procax, Ps. papillosus, Ps. lunatus, Ps. simba and Ps. limbus), 4 are Endangered (Ps. poppiae, Ps. ocularis, Ps. auratus and Ps. decoris) and 1 is Data Deficient (Ps. regius).

▶ The largest and relatively undisturbed remnant of Sri Lanka’s tropical lowland rain forest

Sinhraj Forest Reserve is the largest relatively undisturbed remnant of Sri Lanka's tropical lowland rainforest; over 60% of the trees are endemic and many of these are rare; and there are 21 endemic bird species as well as a number of rare insects, reptiles and amphibians. The site's flora is a relic of Gondwanaland and provides an important component to our scientific understanding of continental drift and an outstanding site for the study of the processes of biological evolution (World Heritage Committee, 2014).

Assessment information

Threats

Current Threats

Sinhraj is currently facing many conservation issues that can be broadly classified under habitat destruction/degradation, over-exploitation of species, and spread of invasive alien species. Specific actions are needed to address these existing threats.

▶ Hunting and trapping

(Poaching )

Illegal poaching of wild animals such as sambar, mouse deer and wild boar is reported in Sinhraj. Set up of noose traps is a major conservation issue to the small population of endangered leopards in Sinhraj (Bambaradeniya et al., 2006; Chamikara, 2013; Rajeev and Vidanapathirana, 2012).

▶ Tourism/ Recreation Areas

(Expansion of tourist hotels and guest houses )

Several tourist hotels and guest houses have been constructed around Sinhraj over the past decade, leading to adverse issues such as garbage, storm water runoff, pollution of waterways, forest clearance, and disturbance to wildlife (Chamikara, 2013; Rajeev and Vidanapathirana, 2012). Increased visitation during peak seasons is also driving this fragile ecosystem beyond its carrying capacity especially on the two most popular routes through Kudawa and Pitadeniya entry points (IUCN Consultation, 2020).
IUCN World Heritage Outlook: https://worldheritageoutlook.iucn.org/
Sinharaja Forest Reserve - 2020 Conservation Outlook Assessment

► Crops
(Encroachment of forest and its buffer zone areas for tea and cardamom cultivation.)

Encroachment of forest for tea and cardamom cultivation is a major issue in the northern areas of Sinharaja, resulting in the loss of valuable habitats (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatilleke, 2011; Chamikara, 2013; Samarawickrama et al., 2019).

► Utility / Service Lines
(Power lines)

Power lines associated with mini hydro power stations have led to forest clearance in strips (Chamikara, 2013; Rajeev and Vidanapathirana, 2012).

► Logging/ Wood Harvesting
(Illegal logging)

Illegal logging has previously been reported, especially in the northern region (Bambaradeniya et al., 2006; Chamikara, 2013; Rajeev and Vidanapathirana, 2012).

► Fire/ Fire Suppression
(Deliberate fires set off by villages)

Deliberate forest fires created by villagers for illegal hunting and/or clearance of forest have been observed in the north-eastern area of Sinharaja, which is a hotspot for endemic and threatened herpetofauna (Surasinghe, 2007).

► Mining/ Quarrying
(Illegal gem mining in forest and its buffer zone areas, (including in streams and rivers))

Illegal gem mining is being carried out by organized gangs in a discrete manner inside the forest, leading to habitat degradation of forest and stream/river habitats (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatilleke, 2011; Chamikara, 2013).

► Renewable Energy
(Mini-hydropower development projects)

The construction of dams, weirs and ponds largely affects the hydrology and ecology of the streams and rivers they impounded (Bambaradeniya et al., 2006; Chamikara, 2013). These projects lead to i) alterations of the river flow, volume and velocity, ii) changes in the sediment transport and river channel processes, which increases erosion downstream of the dam, and iii) blocks the migration routes for many fish species (Geosrilanka, 2016; Rodrigo, 2016a, b; Rainforest protectors of Sri Lanka, 2019). Concerns have been particularly raised regarding the construction of the Koskulana mini-hydropower plant within the buffer zone of Sinharaja. Due to the low flow, the plant would only generate a very small amount of energy (0.6MW), but cause irreversible impacts on soil erosion, the ecosystem and its many endemic freshwater species (EJAtlas, 2017). No Environmental Impact Assessment has been undertaken and there has been accusations of bribes (Daily Mirror, 2016).

► Housing/ Urban Areas
(Construction of dwellings and village expansion)

Expansion of villages is evident in the northern part of Sinharaja, resulting in the clearance of forest in the buffer zone as well as in the interior areas (Chamikara, 2013; Rajeev and Vidanapathirana, 2012).
Sinharaja has seen a gradual loss of forest cover and degradation of habitats due to conversion of forest into agricultural land (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatileke, 2011; Chamikara, 2013; Samarawickrama et al. 2019). The forests are facing many threats, however, among them issues of bio piracy, loss of forest genetic resources, illegal forest utilisation practices, illegal forest encroachments and logging are major issues (Samarawickrama, 2019).

Some species of woody plants (e.g. Sweitenia macrophylla, Alstonia macrophylla) that were introduced to Sinharaja for reforestation purposes are now spreading in an invasive manner in some areas of the forest. Herbaceous invasive alien plants, such as Wedelia trilobata, Clidemia hirta and Lanatana camara, have also established thick covers along disturbed areas (e.g. trails) in the forest (Bambaradeniya et al., 2006). In the eastern lower montane sector, Psidium cattleianum (strawberry guava) is spreading in the Morningside and Hadapanella areas, which are currently outside the Sinharaja World Heritage site boundary, but the potential of its invasion into the site is high. Similarly, there is a likelihood of Tibouchina and Clusia rosea spreading in the eastern part.

Agrochemical usage for pests and weed management is common in the tea plantations around Sinharaja, leading to the pollution of streams due to agrochemical runoff (Bambaradeniya et al., 2006; Surasinghe, 2007; Chamikara, 2013; Rajiv and Vidanapathirana, 2012).

Wildlife smuggling and illegal collection of living plant and animal species from Sinharaja (e.g. freshwater fish, reptiles, molluscs, scorpions, butterflies and other insects, orchids, Sri Lankan agarwood etc.) for commercial trade is a high threat to rare and endemic species (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatileke, 2011; Chamikara, 2013; Rodrigo, 2019c; Samarawickrama, 2019; Masakorala, 2020). In recent times, there has been a wave of illegal extraction of Gyrinops walla trees, which are valued for their fungus-mediated resin known as ‘SL Agarwood’ (Subasinghe and Hettiarachchi, 2015; IUCN Consultation, 2017; Subasinghe, 2017).

According to a TRAFFIC report (Rodrigo, 2019a), a survey of pet markets has revealed sudden spikes of Sri Lankan lizards into the European markets. The majority (58 percent) of the Sri Lankan lizards in the market are identified as having been bred in captivity, however, many of the specimens on sale are adults rather than juveniles — indicating they were likely caught from the wild. Smugglers target egg-bearing female lizards; the rationale is that, soon after capture, the female will lay the eggs and they will hatch, thus bearing baby lizards that are, technically at least, born in captivity (Rodrigo, 2019a). Regardless of regulations, bioprospecting, biopiracy, biological resource and wildlife smuggling has become a significant issue. Authorities have so far failed to control these activities in this site, and they need to be addressed through both national and international laws to preserve species and ecosystems (Kumara, 2016; Masakorala, 2020).

A number of proposed or ongoing road construction projects pose a threat the the site. There is ongoing construction in the northern area, including a road from Lankagama to Neluwa, despite resistance from
local environmental groups (Ranawana, 2020), which may result in fragmentation of forest, and destruction of habitats (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatileke, 2011; Chamikara, 2013). A public road in the north-eastern sector of Sinharaja's buffer zone, connecting the village of Illimbekanda with Suriyakanda, was temporarily suspended in 2019 after ministerial intervention due to strong public opposition (IUCN, 2019).

Another already existing access road to Sinharaja from the north-western entrance at Kudawa was being widened and paved with inter-locking cement bricks with funding from the Ecosystem Conservation and Management Project funded by the World Bank (ESCAMP, 2019). This project has been subject to criticisms by environmentalists and local communities, and has been temporarily suspended due to public protests after obtaining several independent reports (Gunatileke and Dela, 2019; IUCN, 2019; WB Inspection Panel Report, 2020).

**Erosion and Siltation/ Deposition**

*(Soil erosion and siltation of rivers/streams evident in areas encroached/illegally cleared)*

Low Threat

Inside site, localised(<5%)

Outside site

Illegal road construction activities and clearance of land for tea cultivation has led to soil erosion and siltation of streams in Sinharaja, affecting many rare and endemic species (Bambaradeniya et al., 2006; Rajiv and Vidanapathirana, 2012).

**Avalanches/ Landslides**

*(Landslides due to illegal clearing in hilly areas)*

Low Threat

Inside site, localised(<5%)

Outside site

Several landslides have been observed in the Pitadeniya area at the southern border, which has been subject to illegal clearance. Landslides have also been documented at the northern border of Sinharaja (Bambaradeniya et al., 2006; Chamikara, 2013).

**Tourism/ visitors/ recreation**

*(Over-visititation resulting in erosion along certain forest trails)*

Low Threat

Inside site, localised(<5%)

Outside site

The Mulavella hill trail has been heavily eroded due to over visitation, and similar effects are present along the Sinhagala trail. Some of the hotels and guest houses in and around Sinharaja have also established additional trails without the consent of the Forest Department (Bambaradeniya et al., 2003, 2006; Rajeev and Vidanapathirana, 2012).

**Other Activities**

*(Translocation attempts of the two remaining wild elephants from Sinharaja to another area)*

Low Threat

Inside site, scattered(5-15%)

Outside site

Only two elephants remain within the site and these are among the last of the wet zone mountain elephants in Sri Lanka. Should these remaining two be translocated due to pressure to abate human wildlife conflict, the last of this particular population would be extirpated (Daily FT, 2018). However, environmental groups have campaigned against the translocation (newsfirst, 2018), which has also been shown to be an ineffective method to reduce conflict. Instead, a new radio tracking system has been developed to establish an early warning system in order to reduce conflict between these elephants and local communities without translocating them from the site (Rodrigo, 2020).

**Potential Threats**

*Data Deficient*

Data to evaluate the impacts of potential threats highlighted, such as climate change, is insufficient. The population expansion in surrounding villages needs to be investigated as a matter of priority.
**Habitat Shifting/ Alteration, Droughts, Temperature extremes**

*(Climate change related issues, including extreme weather events)*

The eastern region of Sinharaja is a hotspot for herpetofauna, including representatives of the amphibian genus Pseudophilatus. The entire Sinharaja area, especially the cooler eastern region provides a gradual gradient for animals to disperse, in the wake of climate change (Meegaskumbura et al., 2012). Therefore, future studies should monitor the climate of this region, to gather baseline data. A study by Mutuwatta and Liyanage (2013) on projected changes in climate boundaries in 2050, has shown that the ever-wet climate in the eastern Sinharaja area is predicted to change to intermediate seasonally dry climate by 2050, leading to habitat shifting and possible extinctions of endangered species. However, future studies are needed to monitor the climate of this region, and to gather baseline data.

**Other Activities**

*(Population increase in surrounding villages)*

Expansion of village populations is evident mainly at the northern border of Sinharaja, leading to an increased pressure on land resources (Chamikara, 2013; Rajeev and Vidanapathirana, 2012).

**Utility / Service Lines**

*(Construction of communication towers)*

Several communication towers have already been established on hilltops bordering Sinharaja, resulting in adverse impacts on natural habitats due to construction of access roads, as well as loss of aesthetic value (Rajeev and Vidanapathirana, 2012).

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**Overall assessment of threats**

Illegal encroachment has led to the loss and reduction of forest cover. Other activities such as illegal gem mining, deliberate fires, hydropower development and road construction have resulted in habitat degradation. Illegal hunting and logging have also been reported and documented by conservation groups. Increased visitation and development of tourism infrastructure are impacting negatively on forest and freshwater ecosystems. Overuse of agrochemicals in tea plantations bordering the forest can lead to the pollution of streams and rivers and associated aquatic biodiversity. Exotic plants introduced for forest restoration purposes, e.g. mahogany (Sweitenia macrophylla) and spread of invasive alien plants such as Alstonia macrophylla, Clidemia hirta and Wedelia trilobata can cause adverse impacts on the native flora and ecology of Sinharaja.

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**Protection and management**

**Assessing Protection and Management**

**Management system**

The management of the Sinharaja forest is vested with the Forest Department, which operates two main offices in the northern and southern areas. However, gaps in the management system are evident when considering the current threats in Sinharaja (Gunatillake, 2011; Chamikara, 2013; Rajeev and Vidanapathirana, 2012; Bambaradeniya et al., 2006).

**Effectiveness of management system**

At present, overall management of Sinharaja is unsatisfactory. It is important that management plans...
for Sinharaja are updated on a regular basis, in order to implement actions to address new conservation issues (Gunatillake, 2011; Chamikara, 2013; Rajeev and Vidanapathirana, 2012; Bambaradeniya et al., 2006). Management plans for Sinharaja World Heritage site were updated and included in the National REDD+ Investment Framework and Action Plan (NRIFAP) and also in the World Bank funded Ecosystem Conservation and Management Plan (ESCAMP), which were implemented starting in 2017/18 for five years with funding pledged (ESCAMP, 2016; NRIFAP, 2017).

In December 2019, a Ministerial level committee with five sub-committees was appointed to address all issues pertaining to the efficient management of World Heritage sites in Sri Lanka.

**Boundaries**

Discrepancies related to boundary demarcation has led to illegal encroachments around Sinharaja (Gunatillake, 2011; Chamikara, 2013; Rajeev and Vidanapathirana, 2012). Progress has already been made to survey the boundaries and maps have been prepared based on topographical coordinates recorded using GPS technology covering the entire Sinharaja ecosystem across the Rathnapura, Matara, Galle as well as Kalutara districts. Acquisition of forested lands belonging to the private sector and Land Reforming Commission within the boundary of Sinharaja Ecosystem has also commenced (Sri Lanka Forest Department, 2018; IUCN Consultation, 2020).

Boundary demarcations have been completed for most parts and all forest reserves have been gazetted together with the Sinharaja World Heritage site as ‘Sinharaja Rainforest Complex’ (the Gazette signed by the Minister of Environment is now with the Legal Draftsman for final editing) (Rodrigo, 2019b; Cooray, 2019).

**Integration into regional and national planning systems**

Concerted efforts and actions to protect Sinharaja should be well integrated into local development plans to avoid adverse impacts related to development (Gunatillake, 2011; Chamikara, 2013; Rajeev and Vidanapathirana, 2012), although this is not always the case (Daily Mirror, 2016). However, with the co-operation of the private sector tea plantations, two important biological corridors are being established connecting Sinharaja forest with Walankanda and Delwala forest reserves (Finlays and Dilmah Conservation Projects) (Finlays 2019; Dilmah Conservation, 2019).

**Relationships with local people**

The Forest Department has maintained good relationships with local people through the implementation of collaborative programmes with “Sinharaja Sumithuro” - a local community-based organization. There is a great public respect and awareness of the values of the rainforest, especially among local people (IUCN Consultation, 2020).

**Legal framework**

Implementation of the existing legal framework to address serious conservation issues at Sinharaja is poor (Chamikara, 2013; Rajeev and Vidanapathirana, 2012). In order to reduce further fragmentation and land use change, the Forest Department has gazetted several forests along with Sinharaja World Heritage site, as ‘Sinharaja Rain Forest Complex’, thus almost quadrupling its original size (Rodrigo, 2019b).

**Law enforcement**

The buffer zone and adjoining forests in Sinharaja are currently facing major issues related to illegal encroachment and vegetation clearance due to poor protection/poor enforcement of law and management (Chamikara, 2013; Rajeev and Vidanapathirana, 2012).

**Implementation of Committee decisions and recommendations**

The Committee decision 17COMX recognized the fact that there are many incremental threats to the site, but the Committee noted that a Management Plan to address these had been completed. It was further noted that continued monitoring of the site should be implemented as a priority activity of the Plan. The committee decision specifically mentioned the need to monitor forest encroachment, but the
management authority has not been able to address the issue of illegal encroachments in a satisfactory manner.

**Sustainable use**  
Some Concern

Previously, there has been inadequate data to verify aspects related to sustainable use. However, a new publication evaluating the present status of Sinharaja World Heritage site, through an assessment of the discrepancy between conservation laws and their implementation through management plans, is proposing recommendations for sustainable management of the buffer zone that would balance contemporary development threats while defending the conservation status granted by UNESCO via natural World Heritage sites and Biosphere Reserves (EFL, 2018).

**Sustainable finance**  
Some Concern

Financing conservation of Sinharaja has been improved recently through ESCAMP and NRIFAP projects (ESCAMP, 2016; NRIFAP, 2017).

**Staff capacity, training, and development**  
Mostly Effective

The Forest Department staff stationed in Sinharaja, and members of the ‘Sinharaja Sumithrayo’, regularly participate in various training programmes from the universities, research institutions, the IUCN Country office and NGOs in Sri Lanka.

A training program on forest landscape restoration was conducted for all field level forest officers of the Forest Department in February 2016 in collaboration with the University of Peradeniya and the Sri Lanka Forestry Institute.

**Education and interpretation programs**  
Highly Effective

Sinharaja has been well integrated into the school curriculum and university degree programmes. The management authority as well as several NGOs conduct education and awareness programmes on Sinharaja (Bambaradeniya et al., 2006). Several national and international training programmes are being conducted in and around Sinharaja. A 3-day field training programme for junior field officers of the Forest Department was conducted on forest landscape restoration at Sinharaja in 2016.

The Overseas School of Colombo regularly takes students to Sinharaja on field courses (Lockwood, 2019). The Sri Lanka Program for Forest Conservation (SLPFC), a Yale-based project, launched a postgraduate fellowship program in 2017 that provides practical and professional development experience in tropical forest conservation based in Sinharaja, mostly on village-forest interactions and their sustainability values (SLPFC, 2016).

**Tourism and visitation management**  
Mostly Effective

There is a visitor center at the Kudawa entrance in the north. The IUCN Sri Lanka office has produced a general guide to the biodiversity of Sinharaja, including trail guides (Bambaradeniya et al., 2006). Several other NGOs/individuals have published guides on Sinharaja. Both positive and negative impacts of tourism in Sinharaja have been examined, in particular in estimating visitor pressure during peak visitation periods and recommendations have been made to alleviate the visitor pressure in order to not move beyond carrying capacity at peak times (Liyanage et al., 2018). A nature based tourism plan for the Sinharaja Forest Complex has also been prepared under the ESCAMP Project. This plan provides a comprehensive set of strategic objectives and subsequent actions for developing tourism (ESCAMP, 2018).

**Monitoring**  
Some Concern

Monitoring of conservation issues in Sinharaja is inadequate (Gunatillake, 2011; Chamikara, 2013).

**Research**  
Highly Effective

The Center for Tropical Forest Science - Forest Global Earth Observatory (CTFS-ForestGEO) is a global network of forest research plots and scientists dedicated to the study of tropical and temperate forest function and diversity. A 25 ha Forest Dynamics Plot is part of the CTFS-ForestGEO network and a
restoration ecology programme (Ashton et al., 2014a, b; CTFS-ForestGEO). This plot was surveyed for the fifth time during 2018 and 2019 and has been featuring in a number of international publications on inter-site comparisons and trend analyses (CTFS-ForestGEO).

Sinharaja is a crucial global centre for forest ecological and biogeographical research, owing to the fact that it contains the best remaining example of the lowland forest that evolved on the Indian island in the late Cretaceous era, as it separated from Madagascar and moved north-east along the East-African coast (IUCN Consultation, 2020).

## Overall assessment of protection and management

**Some Concern**

Enforcement of legislation to conserve Sinharaja needs significant improvement to address serious conservation issues, halt further fragmentation and avoid adverse impacts from infrastructure and hydropower development. The boundary of the existing World Heritage site needs to be clearly defined, and options to expand the extent of the site to conserve remaining primary rainforest patches in the adjoining areas need to be considered. It is expected that some of these concerns can be addressed through two recently initiated projects - National REDD+ Investment Framework and Action Plan (NRIFAP, 2017) and the World Bank funded Ecosystem Conservation and Management Plan (ESCAMP, 2017a, 2017b). A long-term research plot has been successfully established to document the temporal and spatial dynamics of the ecology of Sinharaja, including its fauna and flora. Several national and local NGOs have carried out successful education and interpretation programs within Sinharaja World Heritage site, leading to raising general awareness about Sinharaja at the national level.

### Assessment of the effectiveness of protection and management in addressing threats outside the site

The buffer zone and adjoining forests in Sinharaja are currently facing major issues related to illegal encroachment and vegetation clearance due to poor protection/poor enforcement of law and management (Chamikara, 2013; Rajeev and Vidanapathirana, 2012). Although some measures are taken, such as the development of i) the ‘Sinharaja Rain Forest Complex’, ii) a ministerial committee to address the issues of natural World Heritage sites including Sinharaja, and iii) a project proposal for management of Sinharaja (ESCAMP, 2018), some concerns still remain.

### Best practice examples

- A Forest Dynamics Plot (500m x 500m) established in 1993 to study the temporal and spatial dynamics in a tropical rainforest, and species richness and diversity of fauna and flora;
- Restoration of tropical rainforest using Pinus as a nurse crop;
- Empowerment of local community based organizations (the network of ‘Sinharaja Sumithrayo’) in Sinharaja.

A model ecotourism resort - ‘The Rainforest Ecolodge’ established in the SE perimeter of Sinharaja WHS in Enselwatta Estate in Deniyaya has been awarded several international green awards for ecotourism hotels (Abstract presented at ATBC -AP 2019 by Rainforest Ecolodge (Pvt.) Ltd.).

## State and trend of values

### Assessing the current state and trend of values

**World Heritage values**

### Rare, threatened and endemic invertebrate species

**High Concern**

Studies have found that overall topographical changes, and the associated shifts in vegetation structure...
at ground level from valley bottom to ridge top, can significantly alter ant species composition (Gunawardene, 2012). Another threat to endemic invertebrate species is the illegal trade and wildlife smuggling. In February 2019, five people were caught possessing a large variety of animal and plant species from Sinharaja, including butterflies and their cocoons, beetles, spiders and their eggs, grasshoppers and scorpions (Masakorala, 2020).

Although further studies to gather data to assess the status of endemic invertebrates are needed, there is some ongoing progress. A series of books including pocket/field guides on butterflies, dragonflies, damselflies and spiders of Sri Lanka, as well as maps of their habitats and distribution within Sri Lanka have been published, some with corporate sponsorship. The National Red List 2012 of Sri Lanka provides the taxonomy and conservation status of most invertebrate species (MOE, 2012).

Rare, threatened and endemic mammals

Research indicates adverse impacts on the ecology and distribution of endemic small mammals in Sinharaja due to logging activities carried out prior to the inscription of the site as a World Heritage (Wijesinghe and de Brooke, 2005). However, these areas have recovered well over the past two decades, providing stable conditions to endemic mammals.

Rare, threatened and endemic birds

Observations carried out by the Ceylon Birds Club (CBS) and the Field Ornithology Group (FOG) indicates that the populations of endemic avifauna in Sinharaja are stable.

Rare, threatened and endemic reptiles

Similar to amphibians, several new species of tetratop reptiles have been recorded from Sinharaja since its declaration as a World Heritage site. However, further studies are needed to assess the current status of reptiles in Sinharaja.

A recent publication highlights the many threats to reptiles in southern and eastern Sinharaja. Among them are issues of bio piracy, loss of forest genetic resources and wildlife smuggling for trade, illegal forest utilisation practices, hydropower constructions, gem mining, illegal forest encroachments and unsustainable tourism practices (Samarawickrama et al., 2019). Smuggling of the spotted bowfinger gecko (Cyrtodactylus triedra) and other reptiles have become profitable in Kudawa-Sinharaja site and a growing number of bio-pirates venture into the forest to illegally gather the species (Kumara, 2016; Masakorala, 2020).

Rare, threatened and endemic freshwater fish

The diversity and ecology of freshwater fish in the streams of Sinharaja have not been adequately researched. However, the construction of dams and weirs, illegal road construction activities, as well as pollution from agrochemicals are negatively affecting the stream ecology of Sinharaja (Bambaradeniya et al., 2006; Surasinghe, 2007; Rajiv and Vidanapathirana, 2012; Chamikara, 2013).

Endemic Pteridophytes

The site harbours many endemic species of Pteridophytes, and several new species of ferns have also been recorded from the site since its inscription as a World Heritage. However, the current data is insufficient to assess trends related to the ecology of Pteridophytes in Sinharaja.

Rare and endemic plant species

The endemicity among trees species of Sinharaja is high, where in some families (e.g. Dipterocarpaceae) endemism is greater than 90%. Research data on the ecology of tree flora indicates stable conditions (Gunatilleke and Gunatilleke, 1980; Gunatilleke et al., 1995; Gunatilleke et al., 2004). A long-term (over 40 years) growth study across an elevation gradient has been conducted in Sinharaja.
World Heritage site. Dipterocarps and members of Clusiaceae increased in dominance with succession (time), with topography (ridges greater than valleys) and with elevation (lowland < hill < lower montane) (Ediriweera, 2020). However, forest clearance and illegal collection are posing some threats to endemic plant species (Gunatilleke, 2011; Kumara, 2016).

▶ Rare and endemic Orchids

Data Deficient
Trend: Data Deficient

The site harbours many endemic species of orchids, and several new orchid species have also been recorded from the site since its inscription as a World Heritage (Bandara et al., 2020). Current data is insufficient to assess trends related to the ecology of the orchid flora in Sinharaja, however, illegal collection of orchids have been documented (Kumara, 2016).

▶ Rare, threatened and endemic amphibians

High Concern
Trend: Deteriorating

Several new species of amphibians have been discovered from Sinharaja, including point endemics restricted to the eastern Sinharaja region. This area is currently under threat due to many adverse anthropogenic activities, which could threaten the survival of these sensitive species (Meegaskumbura et al., 2012; Surasinghe, 2007). A recent global IUCN Red List assessment of the amphibians of Sri Lanka has highlighted that 72 out of a total of 116 are threatened with extinction, with 20 critically endangered (Rodrigo, 2020b).

▶ The largest and relatively undisturbed remnant of Sri Lanka’s tropical lowland rain forest

Low Concern
Trend: Improving

Research indicates a gradual regeneration of forest in areas subjected to logging in the 1970s, with an increase in primary forest vegetation. However, it is difficult to predict trends for most taxonomical groups, due to inadequate baseline data and continuous monitoring. A CTFS plot network-wide study (including Sinharaja), surveyed over five times since 1995, has shown that the shifts in forest dynamics are already occurring, and the emerging pattern is that global forests are tending toward younger stands with faster turnover as old-growth forest with stable dynamics are dwindling (McDowell et al., 2020).

In addition, forest fires, forest clearance for power lines and encroachment of forest for tea and cardamom cultivation is a concern, especially in the northern areas of Sinharaja, resulting in the loss of forest cover and degradation of habitats (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatilleke, 2011; Rajeev and Vidanapathirana, 2012; Chamikara, 2013; Samarawickrama et al., 2019).

Summary of the Values

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

Low Concern
Trend: Data Deficient

Since the inscription of Sinharaja on the World Heritage list in 1988, many species of plants and animals new to science have been discovered in this site, as a result of a significant increase in research work over the past three decades. However, resent assessments and publications have also highlighted particular concern regarding threats to amphibians (Rodrigo, 2020b) and reptiles (Samarawickrama et al., 2019) within the site. All the same, current data is insufficient to assess trends related to the ecology of many species of flora and fauna in Sinharaja. Forest research indicates a gradual regeneration in areas subjected to logging in the 1970s, with an increase in primary forest vegetation. Although it is difficult to predict trends for most taxonomical groups due to inadequate baseline data and monitoring, some concerns remain regarding the impacts of development, encroachment, forest fires, vegetation clearance and illegal trade on the Sinharaja ecosystem and its species (Bambaradeniya et al., 2006; Surasinghe, 2007; Gunatilleke, 2011; Chamikara, 2013; Kumara, 2016; Samarawickrama et al., 2019; Masakorala, 2020).
Additional information

Benefits

Understanding Benefits

► Access to drinking water

Non commercial: All villages around the Sinharaja forest are dependent on the streams, rivers and groundwater resources sustained by the forest for drinking water and water for their day-to-day uses.

► Commercial wells

Commercial: Several mini-hydropower plants located around Sinharaja are sustained from streams and rivers originating from this forest.

When part of a stream is diverted for power generation, the habitat downstream over a certain distance changes and fish will be affected even though a percentage of water might be allowed to flow freely. With flow changes, the sediment transport, erosion rate and the pH value of water could also change and very sensitive species could become affected. Some fish migrate upstream to breed and when the stream is blocked this movement is disrupted. During the dry season, little or no water is released as environmental flow in to the stream, causing deaths of aquatic biota.

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

2. https://geosrilanka.wordpress.com/2016/06/05_mini-hydro-schemes-threatening-sinharaja/

► Collection of medicinal resources for local use

Medicinal plants are extracted by local communities from buffer zone areas.

► Outdoor recreation and tourism

Sinharaja is a popular ecotourism destination among local and foreign tourists. Unplanned and unauthorized building of tourist lodges near waterways along the perimeter of the forest is affecting negatively on the forest by enhanced pollution of waterways and by some form of cultural pollution, as well.

Increased visitation during peak seasons is driving this fragile ecosystem beyond its carrying capacity especially on the two most popular routes through Kudawa and Pitadeniya entry points.

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


► Importance for research,

Contribution to education

Resource for building knowledge and education: Taxonomic, biogeographical and exploratory research in Sinharaja over the past three decades has contributed to the discovery of many plants and animals
that are new to science and also how this diversity is maintained (LaManna, 2017; Bandara et al., 2020). Research on forest restoration has generated a wealth of knowledge on regeneration of tropical rainforests (Ediriweera et al., 2020).

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

▶ Environmental services,
   Soil stabilisation

Sinharaja contributes to sustain an array of environmental services, including the regulation of local climate, soil conservation, generate and sustain quality freshwater, and sustain natural pollinators.

▶ Collection of timber, e.g. fuelwood

Rattan is extracted from the buffer zone areas for local livelihoods. Collection of medicinal plants as well as those yielding fragrant resins of high value (Gyrinops sp.) is on the increase thus decimating the natural populations in and around Sinharaja World Heritage site.

Factors negatively affecting provision of this benefit:
- Pollution: Impact level - Low, Trend - Increasing
- Overexploitation: Impact level - Very High, Trend - Increasing
- Habitat change: Impact level - Moderate, Trend - Increasing

2. https://doi.org/10.1016/j.indcrop.2015.01.060

Summary of benefits

Sinharaja has immense global value in relation to biodiversity conservation, as it harbors many species of animals and plants that are restricted (point endemics) to this forest. The villages surrounding Sinharaja (22 in total) benefit from an array of environmental services from Sinharaja. Over 10 members of the local village youth (male and female) who had been assisting the researchers in their field studies in Sinharaja over the years have been absorbed by the Forest Department as visitor-guides and this has been a very successful project both for the visitors and the guides. Booster programs to increase the guides' knowledge on Sinharaja and its biota have been conducted by the Forest Department with assistance from researchers.

Projects

Compilation of active conservation projects

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<tr>
<th>№</th>
<th>Organization</th>
<th>Brief description of Active Projects</th>
<th>Website</th>
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<tbody>
<tr>
<td>1</td>
<td>Herpetological Foundation of Sri Lanka (HFS)</td>
<td>Research on new species of amphibians and reptiles in Sinharaja World Heritage site</td>
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<tr>
<td>2</td>
<td>Center for Applied Biodiversity Research and Education (CABRE)</td>
<td>Research on orchids in Sinharaja</td>
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<td>3</td>
<td>Ceylon Bird Club (CBC)</td>
<td>Annual monitoring of avifauna in Sinharaja, including</td>
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<td>4</td>
<td>Field Ornithology Group (FOG)</td>
<td>Mixed-species foraging bird flocks in Sinharaja</td>
<td>University of Colombo</td>
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<td>5</td>
<td>Madhava Meegaskumbura</td>
<td>Monitoring of amphibians in eastern Sinharaja, Morningside (long-term study)</td>
<td>Department of Zoology, University of Peradeniya Web: <a href="http://web.mac.com/madhavameegaskumbura">http://web.mac.com/madhavameegaskumbura</a></td>
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<td>6</td>
<td>University of Uva Wellassa, Badulla, Sri Lanka</td>
<td>Restoration of forest in buffer zones (long-term study initiated in 1990) and Sinharaja Forest Dynamics Plot for monitoring changes in plant diversity over time.</td>
<td><a href="https://forestgeo.si.edu/ediriweera">https://forestgeo.si.edu/ediriweera</a></td>
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<td>Report of the Committee Appointed to Advise the Hon. Minister of Environment on the Proposed Road through the Forest from Illumbakanda to Sooriyakanda with a Potential Threat to Sinharaja Natural World Heritage Site (Sinharaja NWHS)</td>
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