

**BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI
O.A. No. 462/2018**

In the matter of:

D. V. Girish

... Applicant

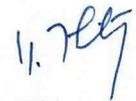
Versus

Union of India & Ors.

... Respondents

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G. Thirumurthy
Scientist-E

Central Pollution Control Board
Parivesh Bhawan, East Arjun Nagar
Delhi-110032

Dated: 07.04.2022

Place: Delhi

**BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI
O.A. No. 462/2018**

In the matter of:

D. V. Girish

...Applicant

Versus

Union of India & Ors.

... Respondents

Compliance Affidavit on Behalf of Central Pollution Control Board in compliance to the order dated 19.03.2020 of Hon'ble NGT, Principal Bench.

I, G. Thirumurthy, S/o Shri C. Ganapathy, aged about 50 years, working as Scientist 'E', Central Pollution Control Board (CPCB), Parivesh Bhawan, East Arjun Nagar Delhi-110032 do hereby solemnly affirm and declare as under:

1. That I, in the capacity of Scientist 'E' am fully conversant with the facts and details of the study conducted and competent to swear this affidavit.
2. That the Hon'ble National Green Tribunal (NGT) vide its order dated 19th March, 2020 in O.A. No. 462 / 2018 in the matter of D. V. Girish Vs Union of India & Ors. directed that "the CPCB may coordinate with the concerned authorities, including the State Administration, for undertaking carrying capacity assessment of at least one Eco-Sensitive area in the State, which may be thereafter replicated for all Eco-Sensitive area in next three months". A copy of the Hon'ble NGT order dated 19.03.2020 is annexed as **Annexure-I**.
3. That, the Eco-Sensitive Zones (ESZs) or Ecologically Fragile Areas (EFAs) are areas around Protected Areas, National Parks and Wildlife Sanctuaries in India, notified by the Ministry of Environment, Forests and Climate Change (MoEF&CC) to create "shock absorbers" to the protected areas by regulating and managing the activities around such areas. These zones are indispensable for a nation as they preserve biologically and ecologically rich areas and potentially valuable and unique natural resources that would be difficult to replace once annihilated. The ecosystem is quite delicate around these areas and needs to be protected against human intervention. They are of immense importance to

human society as they are ecologically and economically important, maintain ecological stability and preserve the rarity of the ecosystems they harbor.

4. That, Carrying Capacity assessment is a tool to determine the growth limits that an area can accommodate without violating environmental capacity goals. As the assignment was time bound (3 months), out of 106 National Parks in the Country, Sanjay Gandhi National Park (SGNP), Mumbai was identified for undertaking Carrying Capacity Assessment, considering the advantages for immediately initiating study i.e. where the secondary data was available. A copy of the Assessment Report of Environmental Carrying Capacity of Eco – Sensitive Zone: Sanjay Gandhi National Park, Mumbai, Maharashtra is annexed as **Annexure-II**.

5. That, Sanjay Gandhi National Park was notified by MoEF&CC vide S.O. 3645 (E) dated 05.12.2016. The Eco-Sensitive Zone is spread over an area of 59.456 sq.km to an extent of 100 meters to 4 kilometers from the boundary of Sanjay Gandhi National Park. Accordingly, CPCB conducted a study through CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur to assess Environmental Carrying Capacity (ECC) of Eco-Sensitive Zone of Sanjay Gandhi National Park (SGNP), Mumbai.

6. That, the study was divided into two parts:

a. Demarcation of the study area, collecting basic details from remote sensing and literature such as areal extent, geographical features, flora and fauna, and tourist activities prevailing.

b. Carrying Capacity Assessment with selected methodologies by considering air, water, habitat, biodiversity, land, noise, and tourism as the crucial elements affecting Sanjay Gandhi National Park by using fuzzy comprehensive evaluation method based on secondary data available.

7. That, owing to the limited literature, data availability, selected methodologies, the calculations and findings with respect to Carrying Capacity of Tourism, Water environment, Noise and Air environment show that some of the environmental attributes are within the permissible limits of carrying capacity while some have exhausted the limits. The main findings are:

- Utilization Ratio (UR) of available water resources in Sanjay Gandhi National Park is 59.87%, which is less than the reference value of 100%.
- The total calculated footfall, in terms of tourists, shows that it is in a critical stage and has exceeded the maximum footfall possible and can affect the wildlife and its carrying capacity.
- The noise level in these areas are exceeding the Noise Limits prescribed for Silence Zone during Day and Night time.
- The Utilization Ratio for air pollutants shows that some of the air pollutants (NO₂, and Particulate Matters) are exceeding the prescribed National Ambient Air Quality Standards.
- The Normalized Difference Vegetation Index values indicates that the vegetation covers of Sanjay Gandhi National Park increased over the years.
- Land Use Land Cover (LULC) map classification area for Sanjay Gandhi National Park from 1978-2020 shows a positive increase in forestland.
- The Mangroves cover and water bodies areas, in the Sanjay Gandhi National Park and buffer area (analyzed through remote sensing data) are decreasing year by year.
- Human settlements are continuously increasing including in buffer area of National Park threatening environmental balance.
- Land Surface Temperature maps of Sanjay Gandhi National Park shows that the surface temperature has increased in 2020 (24-34°C) as compared to 2000 (17.93 °C).
- The values of Aerosol Optical Dispersion (AOD) and indicate higher air pollution level due to anthropogenic activities, which is also confirmed by available ground data.
- The analysis of Sanjay Gandhi National Park indicates limited land stress which should be maintained for ecological balance.

8. That, based on the findings of the study, it is concluded and recommended that:

- a) Construction activity within the premises of the Sanjay Gandhi National Park (SGNP) should be discouraged as it will affect the fragile ecosystem of the area and will also put pressure on other environmental attributes such as water, air and noise which will affect the overall environmental carrying capacity.
- b) The utilization ratio calculations for air pollutants except SO₂ are exceeding the National Standards. Suitable measures to curb the impacts of air and noise pollution in the area should be employed to preserve the floral and faunal biodiversity.
- c) The slope factors of the area show a reduced stress on land which should be maintained by avoiding construction activities in the area.

Further, the evaluation of the Environmental Carrying Capacity of Sanjay Gandhi National Park, Mumbai using Fuzzy Analytic Hierarchy Process and considering the ecological parameters selected on a time scale shows that the ecological pressure is increasing in the area in terms of pollution and increasing temperature. Hence seeing the temporal variation, the following further conclusions are made:

- d) The ecological resilience factors like Land Cover which can be improved, should be done on priority.
 - e) The ecological pressure inducing factors such as air pollution needs to be minimized by controlling the particulate matter.
 - f) The State Government shall ensure the implementation of all the measures mentioned in Notification of Sanjay Gandhi National Park dated 05.12.2016.
9. To summarize, the Environmental Carrying Capacity for Sanjay Gandhi National Park has deteriorated considerably, and efforts should be made ahead of time to ensure that the present Carrying capacity is protected and improved upon.
 10. Further, to undertake carrying capacity of Eco-Sensitive Area in all the State/UTs, the Hon'ble NGT order in O.A no. 462/2018 dated 17.03.2021 directed that "*such exercise may be got conducted by concerned State/ UT to be coordinated by a Joint Committee comprising state PCB, Secretary/ Director Environment and Chief Wildlife Warden*". In order to comply and conducting such similar studies in the remaining 105 National Parks

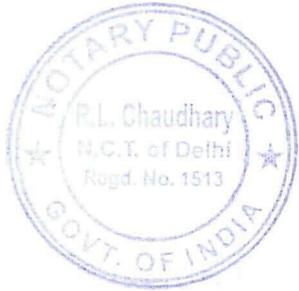
by the Joint Committee of concerned States / UTs may follow the template prepared for carrying out Environmental Carrying Capacity Study based on the present study.

Secondly, the Chief Wildlife Warden shall ensure the group of activities listed i.e. Prohibited, Restricted with Safe Guards, and Permissible as per the Guidelines for Declaration of Eco – Sensitive Zones around the National Parks and Wildlife Sanctuaries of Ministry of Environment, Forest & Climate Change (MoEF&CC).

Thirdly, the concerned department of State Government and State Pollution Control Board shall ensure the implementation of all the measures / regulations in respect of environmental pollution due to discharge of effluents, air pollution, noise pollution, solid waste & bio-medical waste management, vehicular traffic, establishment of industries, list of permitted activities etc. as mentioned / specified in the respective Notification of National Park.

PRAYER

11. That, in the above facts and circumstances, the deponent humbly prays to the Hon'ble National Green Tribunal to take on record the report on Assessment of Environmental Carrying Capacity of Eco – Sensitive Zone: Sanjay Gandhi National Park, Mumbai, Maharashtra.



VERIFICATION

It is verified that the content of this reply affidavit which is based on official record and information available in the office are true and correct. Nothing has been concealed therein.

Verified on this dayof 2022 at New Delhi.

ATTESTED
R.L. Chaudhary
NOTARY PUBLIC
GOVT. OF INDIA
7 APR 2022

5

5

G. Thirumurthy
DEPONENT

जी. तिरुमूर्ति/G. Thirumurthy
वैज्ञानिक "ई" / Scientist "E" pcp
प्रभारी – अनुसंधान एवं विकास प्रभाग/Divisional Head PCB
केंद्रीय प्रदूषण नियंत्रण बोर्ड
Central Pollution Control Board
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार
M/o Env't. Forest & Climate Change, Govt. of India
परिवेश भवन, पूर्वी अर्जुन नगर, दिल्ली-110 032
Parivesh Bhawan, East Arjun Nagar, Delhi-110032

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Parivesh Bhawan, East Arjun Nagar, Delhi-110032

Item No. 02 &03

Court No. 1

**BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI**

Original Application No. 462/2018

(Earlier O.A. No. 11/2018 (SZ))

WITH

Original Application No. 76/2015 (SZ)

D. V. Girish

Applicant(s)

Versus

Union of India & Ors.

Respondent(s)

With

D. V. Girish

Applicant(s)

Versus

The Member Secretary, National Tiger
Conservation Authority, MOEF & Ors.

Respondent(s)

Date of hearing: 19.03.2020

CORAM:

**HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SHEO KUMAR SINGH, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER**

ORDER

1. The issue for consideration is undertaking of carrying capacity assessment of eco-sensitive zones to give effect to the principle of 'Sustainable Development'. This Tribunal issued directions on 30.07.2018 to the Ministry of Urban Development and the MoEF&CC and the corresponding authorities in all the States. Thereafter on 03.04.2019, the Tribunal considered the affidavit filed by the MoEF&CC dated 27.03.2019 and observed:

"3. The MoEF & CC had filed an affidavit dated 27.03.2019 and submitted that they are taking steps to study the matter and also getting views from the States and the concerned Department but the exercise could not be completed and they require 6 months more time for this

purpose. The order was passed in the month of July, 2018. Nearly more than eight months lapsed after the order but nothing fruitful has been done by them and MoEF & CC has not taken seriousness about the issue as considered by the Tribunal.

4. *On going through the affidavit, it is seen that no substantive work has been done for preparing the report as directed by this Tribunal. Considering this aspect, we feel that some time can be granted but same cannot be as requested by them.*
5. *We feel that 3 months time can be granted and they are directed to file a report regarding progress of the study taken by them on monthly basis by Email and if the Tribunal is satisfied with work done by them and if they require further time that can be considered after expiry of 3 months fixed by this Tribunal. Reports shall be filed to this Tribunal through email at ngt.filing@gmail.com."*

2. Thereafter on 25.09.2019 on further consideration, the Tribunal observed:

"10. In the meantime the MoEF & CC and Ministry of Urban Development may complete the study and prepare national policy as to how this will have regulated as directed by this Tribunal as per order in O.A. No. 462/2018 dated 30.07.2018.

11. The Joint Secretary, MoEF & CC was present today. He explained that a draft template has been prepared for circulation and they need to consult the Ministry of Urban Development for approval of the same and thereafter it will be circulated among the States, then final guidelines will be issued. They are directed to submit a further report on this aspect before the next date of hearing."

3. In pursuance of the above, an affidavit has been filed by the MoEF&CC on 31.01.2020 as follows:

"5. The draft guidelines/template prepared by the Ministry was circulated to G.B Pant National Institute of Himalayan Environment & Sustainable Development, Almora, Uttarakhand, Ministry of Housing Affairs, Town & Country Planner, Town & Country Planning Organization (TCPO), New Delhi and School of Planning and Architecture, New Delhi. Based on the comments received on the template, a meeting was held on 25th November, 2019 in the Ministry of Environment, Forest and Climate Change, wherein the officials from the above

organizations were present. During the meeting all components/parameters of draft template assessing Carrying Capacity of Town/Hill Station were discussed. Accordingly, the structure of the template was finalized.

6. *The G.B Pant National Institute of Himalayan Environment & Sustainable Development, Almora, Uttarakhand has submitted a report, which was examined in the Ministry and finalized. A copy of guidelines has been circulated to all State Governments and UTs.”*

4. In view of the above, further steps need to be taken in the matter. It should be possible to undertake carrying capacity of at least one eco-sensitive area in every State/UT in the first instance within three months. The CPCB may coordinate with the concerned authorities, including the State Administration, for undertaking carrying capacity assessment of at least one eco-sensitive area in the State, which may be thereafter replicated for all the eco-sensitive areas in next three months. The CPCB is at liberty to associate any individual/organization for the purpose and utilize compensation funds available with for this purpose.
5. Let a further report in the matter be filed before the next date by email at judicial-ngt@gov.in.
6. A copy of this order be sent by email to CPCB.

List for further consideration on 14.10.2020.

Adarsh Kumar Goel, CP

Sheo Kumar Singh, JM

Dr. Nagin Nanda, EM

March 19, 2020
Original Application No.462/2018
with Original Application No. 76/2015
AK

**Assessment of Environmental Carrying Capacity of Eco –
Sensitive Zone: Sanjay Gandhi National Park,
Mumbai, Maharashtra**

[In the matter O.A. No. 462/2018 of Hon'ble NGT]



Central Pollution Control Board
(Ministry of Environment, Forest & Climate Change, Govt. of India)
Parivesh Bhawan, East Arjun Nagar, Delhi-110032

March, 2022

Executive Summary

The Hon'ble National Green Tribunal (NGT) vide its order dated 19th March, 2020 in O.A. No. 462 / 2018 in the matter of D. V. Girish Vs Union of India & Ors directed that "the CPCB may coordinate with the concerned authorities, including the State Administration, for undertaking carrying capacity assessment of at least one Eco-Sensitive area in the State, which may be thereafter replicated for all Eco-Sensitive area in next three months".

Eco-Sensitive Zones (ESZs) or Ecologically Fragile Areas (EFAs) are areas around Protected Areas, National Parks and Wildlife Sanctuaries in India, notified by the Ministry of Environment, Forests and Climate Change (MoEF&CC) to create "shock absorbers" to the protected areas by regulating and managing the activities around such areas. These zones are indispensable for a nation as they preserve biologically and ecologically rich areas and potentially valuable and unique natural resources that would be difficult to replace once annihilated. The ecosystem is quite delicate around these areas and needs to be protected against human intervention. They are of immense importance to human society as they are ecologically and economically important, maintain ecological stability and preserve the rarity of the ecosystems they harbour.

Carrying capacity assessment is a tool to determine the growth limits that an area can accommodate without violating environmental capacity goals. As the assignment is time bound (3 months), out of 106 National Parks in the Country, Sanjay Gandhi National Park (SGNP), Mumbai was identified for undertaking carrying capacity assessment, considering the advantages for immediately initiating study i.e. where the secondary data was available. The Eco-Sensitive Zone is spread over an area of 59.456 sq.km to an extent of 100 meters to 4 kilometers from the boundary of Sanjay Gandhi National Park. Sanjay Gandhi National Park was notified by MoEF&CC vide S.O. 3645 (E) dated 05.12.2016. Accordingly, CPCB conducted a study through CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur to assess Environmental Carrying Capacity (ECC) of Eco-Sensitive Zone of Sanjay Gandhi National Park (SGNP), Mumbai.

The study was divided into two parts,

a) Demarcation of the study area, collecting basic details from remote sensing and

literature such as areal extent, geographical features, flora and fauna, and tourist activities prevailing.

- b) Carrying capacity assessment with selected methodologies by considering air, water, habitat, biodiversity, land, noise, and tourism as the crucial elements affecting Sanjay Gandhi National Park by using fuzzy comprehensive evaluation method based on secondary data available.

Owing to the limited literature, data availability, selected methodologies, the calculations and findings with respect to Carrying Capacity of Tourism, Water environment, Noise and Air environment show that some of the environmental attributes are within the permissible limits of carrying capacity while some have exhausted the limits. The main findings are:

- ❖ Utilization Ratio (UR) of available water resources in Sanjay Gandhi National Park is 59.87%, which is less than the reference value of 100%.
- ❖ The total calculated footfall, in terms of tourists, shows that it is in a critical stage and has exceeded the maximum footfall possible and can affect the wildlife and its carrying capacity.
- ❖ The noise level in these areas are exceeding the Noise Limits prescribed for Silence Zone during Day and Night time.
- ❖ The Utilization Ratio for air pollutants shows that some of the air pollutants (NO₂, and Particulate Matters) are exceeding the prescribed National Ambient Air Quality Standards
- ❖ The Normalized Difference Vegetation Index values indicates that the vegetation covers of Sanjay Gandhi National Park increased over the years
- ❖ Land Use Land Cover (LULC) map classification area for Sanjay Gandhi National Park from 1978-2020 shows a positive increase in forestland.
- ❖ The Mangroves cover and water bodies areas, in the Sanjay Gandhi National Park and buffer area (analyzed through remote sensing data) are decreasing year by year.
- ❖ Human settlements is continuously increasing including in buffer area of National Park threatening environmental balance.
- ❖ Land Surface Temperature maps of Sanjay Gandhi National Park shows that the surface temperature has increased in 2020 (24-34°C) as compared to 2000 (17.93 °C).
- ❖ The values of Aerosol Optical Dispersion (AOD) and indicate higher air pollution level

due to anthropogenic activities, which is also confirmed by available ground data.

- ❖ The analysis of Sanjay Gandhi National Park indicates limited land stress which should be maintained for ecological balance.

Based on the findings of the study, it is concluded and recommended that,

- (1) Construction activity within the premises of the Sanjay Gandhi National Park (SGNP) should be discouraged as it will affect the fragile ecosystem of the area and will also put pressure on other environmental attributes such as water, air and noise which will affect the overall environmental carrying capacity.
- (2) The utilization ratio calculations for air pollutants except SO₂ are already beyond the safe limits. Suitable measures to curb the impacts of air and noise pollution in the area should be employed at the earliest to preserve the floral and faunal biodiversity.
- (3) The slope factors of the area show a reduced stress on land which should be maintained by avoiding construction activities in the area.

Further, the evaluation of the Environmental Carrying Capacity of Sanjay Gandhi National Park, Mumbai using Fuzzy Analytic Hierarchy Process and considering the ecological parameters selected on a time scale shows that the ecological pressure is increasing in the area in terms of pollution and increasing temperature. Hence seeing the temporal variation, the following conclusions are made:

- ❖ The ecological resilience factors like Land Cover which can be improved, should be done on priority.
- ❖ The ecological pressure inducing factors such as air pollution needs to be minimized by controlling the particulate matter.
- ❖ The State Government shall ensure the implementation of all the measures mentioned in Notification of Sanjay Gandhi National Park dated 05.12.2016

To summarize, the Environmental Carrying Capacity for Sanjay Gandhi National Park has deteriorated considerably, and efforts should be made ahead of time to ensure that the present

Carrying capacity is protected and improved upon.

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ASSESSMENT OF ENVIRONMENTAL CARRYING CAPACITY OF ECO – SENSITIVE ZONE: SANJAY GANDHI NATIONAL PARK, MUMBAI, MAHARASHTRA

1.0 INTRODUCTION

The Hon'ble National Green Tribunal (NGT) vide its order dated 19th March, 2020 in O.A. No. 462 / 2018 in the matter of D. V. Girish Vs Union of India & Ors directed that "the CPCB may coordinate with the concerned authorities, including the State Administration, for undertaking carrying capacity assessment of at least one Eco-Sensitive area in the State, which may be thereafter replicated for all Eco-Sensitive area in next three months".

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. "An Ecological Sensitive Area (ESA) is a bio-climatic unit (as demarcated by entire landscapes) wherein human impacts have locally caused irreversible changes in the structure of biological communities (as evident in number/ composition of species and their relative abundances) and their natural habitats." All the Identified area around Protected Area and wildlife corridors to be declared as Eco-Sensitive Zones (ESZs) or Ecologically Fragile Areas (EFAs) under E(P)Act, 1986.

Eco-Sensitive Zones (ESZs) or Ecologically Fragile Areas (EFAs) are areas around Protected Areas, National Parks and Wildlife Sanctuaries in India, notified by the Ministry of Environment, Forests and Climate Change (MoEF&CC) to create "shock absorbers" to the protected areas by regulating and managing the activities around such areas. These zones are indispensable for a nation as they preserve biologically and ecologically rich areas and potentially valuable and unique natural resources that would be difficult to replace once annihilated. The ecosystem is quite delicate around these areas and needs to be protected against human intervention. They are of immense importance to human society as they are ecologically and economically important, maintain ecological stability and preserve the rarity of the ecosystems they harbour.

Carrying capacity assessment is a tool to determine the growth limits that an area can accommodate without violating environmental capacity goals. As the assignment is time

bound (3 months), Sanjay Gandhi National Park (SGNP), Mumbai was identified for undertaking carrying capacity assessment, considering the advantages for immediately initiating study i.e. where the secondary data was available. The Eco-Sensitive Zone is spread over an area of 59.456 sq.km to an extent of 100 meters to 4 kilometers from the boundary of Sanjay Gandhi National Park. Sanjay Gandhi National Park was notified by MoEF&CC vide S.O. 3645 (E) dated 05.12.2016, the copy of the Notification is provided as **Appendix I**. Accordingly, CPCB entrusted the study to CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur to assess Environmental Carrying Capacity (ECC) of Eco-Sensitive Zone of Sanjay Gandhi National Park (SGNP), Mumbai.

There are 106 existing national parks in India covering an area of 44,372.42 km², which is 1.35% of the geographical area of the country as per National Wildlife Database, Dec. 2021. In addition to the above 75 National Parks covering an area of 16,608 km² are proposed in the Protected Area Network Report (Rodgers & Panwar, 1988). The network of parks will go up 181 after full implementation of the above report. The details of the National Parks are given as **Annexure 1A & 1B**.

Out of 106 National Parks in the country, six national parks within the state of Maharashtra, Sanjay Gandhi National Park (SGNP), which was previously known as Krishnagiri Upawan and later as Borivali National park, is an alluringly protected green desert which is located around 25 km north of Mumbai city and 8 km from the shores of Arabian Sea [1]. It lies between 72° 53' & 72° 50' East longitude and 19° 88' & 19° 21' North latitude [1]. Geographically, the southern boundary of the park is shaped by the Shore of Vihar Lake, the eastern by the townships of Bhandup, Mulund, and Thane, and the western by Goregaon, Malad, Kandivali, and Borivali suburbs of Mumbai. The northern boundary expands past Bassein creek and incorporates the Nagla forest block [1]. The park has a total area of 103.09 km², of which the recreational sector alone takes up 5.06 km². SGNP is one of the foremost highly visited national parks within the country. The important tourist spots of SGNP include the Krishnagiri Upawan sector, which comprises the recreation zone and over 2000 years old Buddhist caves popularly known as Kanheri caves [1].

The major sources of water in the park are Tulsi and Vihar lakes. These man-made lakes having a combined catchment area of 25.72 km², are over 100 years old and are a source of drinking water supply to Mumbai city [1]. Along with these lakes, there are streams and

water holes that act as water sources during the monsoon season [2]. The park shows varied terrain qualities from 30 m over sea level to nearly 500 m and exhibits coastal, dry and mixed deciduous and typical Western Ghats plateau habitats. With its seasonal cyclic changes, the SGNP habitat is fascinating at any time of the year. The mean annual temperature is 27° C and over 2000 mm of rainfall is recorded in slightly over 100 days [2]. Due to its proximity to the coast, numerous watercourses, and hilly terrain, the flora too presents a very diverse picture, ranging from dry and moist deciduous to semi-evergreen, open scrub, and halophytes [1]. The studies also reveal that the park is very rich in fauna and has many endangered flora and fauna species. As per Wildlife Institute of India's Bio-geographical classification, SGNP falls in "The Western Ghats Bio-geographic Zone-5 and is considered an Eco-Sensitive Zone.

From literature, it is known that many medium and large-scale chemical and engineering industries are located close to the park boundary, mainly at Malad, Goregaon, Dahisar, and Thane city. Many illicit human activities such as urbanization and encroachment, are hampering the ecological balance of resources in SGNP. Without a doubt, recent researches show that the capacity of the environment to maintain a specific level of movement may as of now have been surpassed in a few zones, and thus, it has become essential to evaluate the carrying capacity of SGNP.

In the preliminary report, the environmental attributes such as air, water, habitat, noise, land, flora, and fauna of SGNP were studied along with tourism activities prevailing there and considered as indicators for the assessment of the Environmental Carrying Capacity (ECC) of SGNP. Carrying capacity is a term that has been used to quantify the impact of socioeconomic human activities and the natural environment. This has been captured through the ability of the environment to support human activities by understanding the relationship that exists.

The estimation of ECC helps in identifying the relation with its effect between the existing environment and the growth oriented human activities. This whole system can be described under two major forces, supporting forces and the pressure forces. The supporting forces can be named as the ecological resilience and pressure forces as ecological pressure. The ecological resilience was studied through soil erosion, land cover and climatic factors while ecological pressure has been captured under air pollution and urban heat island effect. This pressure forces are further described through parameters (or evaluation factors) which has

been elaborated further. In this study, the ECC has been estimated in such a way that the critical parameters affecting environment of Sanjay Gandhi Park has been included. The study uses Fuzzy Analytic Hierarchy Process (FAHP) to estimate the ECC.

1.1 Objectives of the Study

The study's major goal is to perform the carrying capacity assessment of Sanjay Gandhi National Park, Mumbai-Maharashtra. The study is divided into two parts:

Part 1: Demarcation of the study area and collecting basic details from remote sensing and literature such as areal extent, geographical features, flora and fauna, and the tourist activities prevailing there.

Part 2: Carrying capacity assessment with selected methodologies by considering air, water, habitat, biodiversity, land, noise, and tourism as the crucial elements affecting the same of SGNP by using fuzzy comprehensive evaluation method based on secondary data available in the literature.

1.2 Stages of the study

Stage 1: Demarcation of the study area:

The study area is analyzed in detail to ascertain the geographical features, areal extent, and the watersheds available. Remote sensing tools and techniques with the support of literature are used to finalize the study area.

Stage 2: Selection of suitable methodologies:

The carrying capacity assessment of SGNP can be evaluated by sectioning the environment into several components, which include Land, Air, Water, Habitat, Biodiversity along with Noise, and Tourism. Suitable methodologies are selected by exploring recent research articles in the field of environmental and ecological carrying capacity assessment.

Stage 3: Compilation of details:

The basic details for the study area based on selected methodologies are collected and analyzed for carrying capacity assessment.

Stage 4: Preparation of maps:

Required maps for the study area to aid the carrying capacity assessment are prepared with ArcGIS/QGIS platforms along with Google Earth Pro.

Stage 5: Carrying Capacity Assessment:

With the help of selected methodologies, secondary literature and the data therein and maps, conducting carrying capacity assessment.

1.3 Details of the study area

Sanjay Gandhi National Park is located in Mumbai city, Maharashtra. The park's boundaries consist of North – Nagla Forest Block, South – Vihar lake, West – Goregaon, Malad, Kandivali & Borivali suburbs, East – Township of Bhandup, Mulund & Thane. The total area of the park is about 103.9 km² [2], of which 87 km², as indicated in the literature. The coordinates of the park are 19°24'N 72°68' E. **Fig.1.1** shows the location of SGNP, Mumbai-Maharashtra.

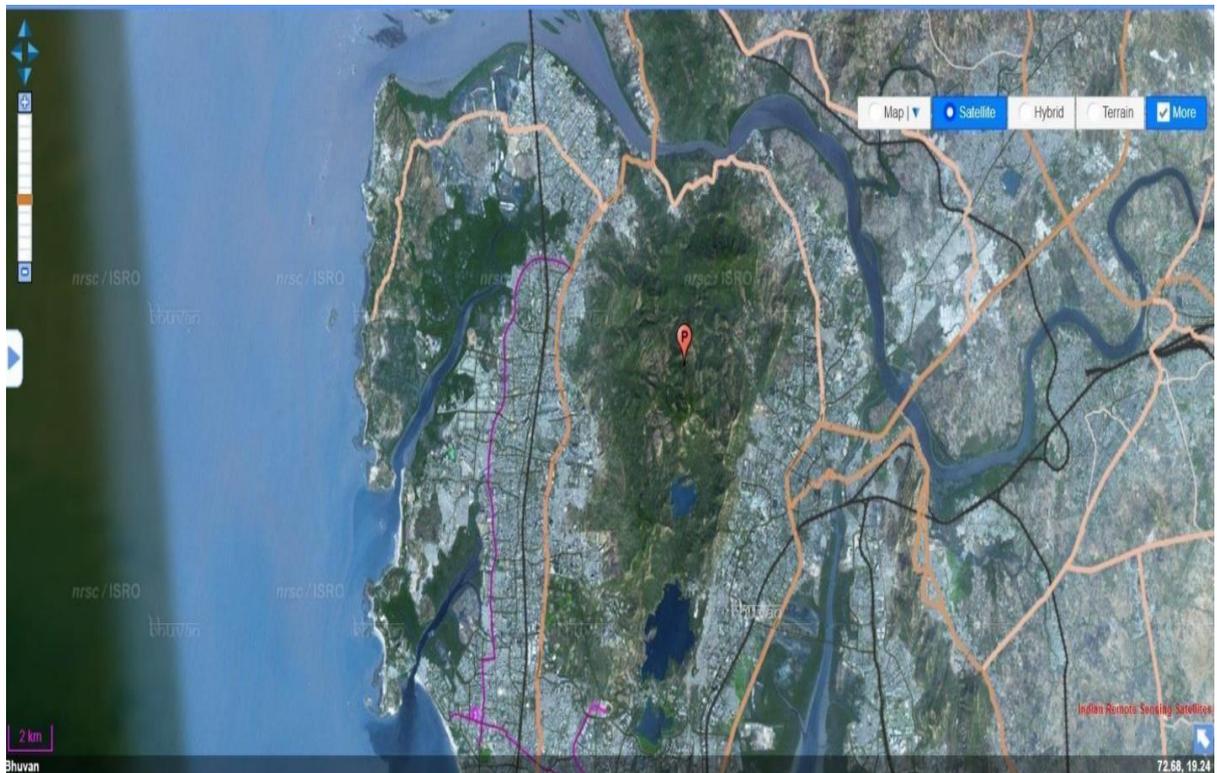
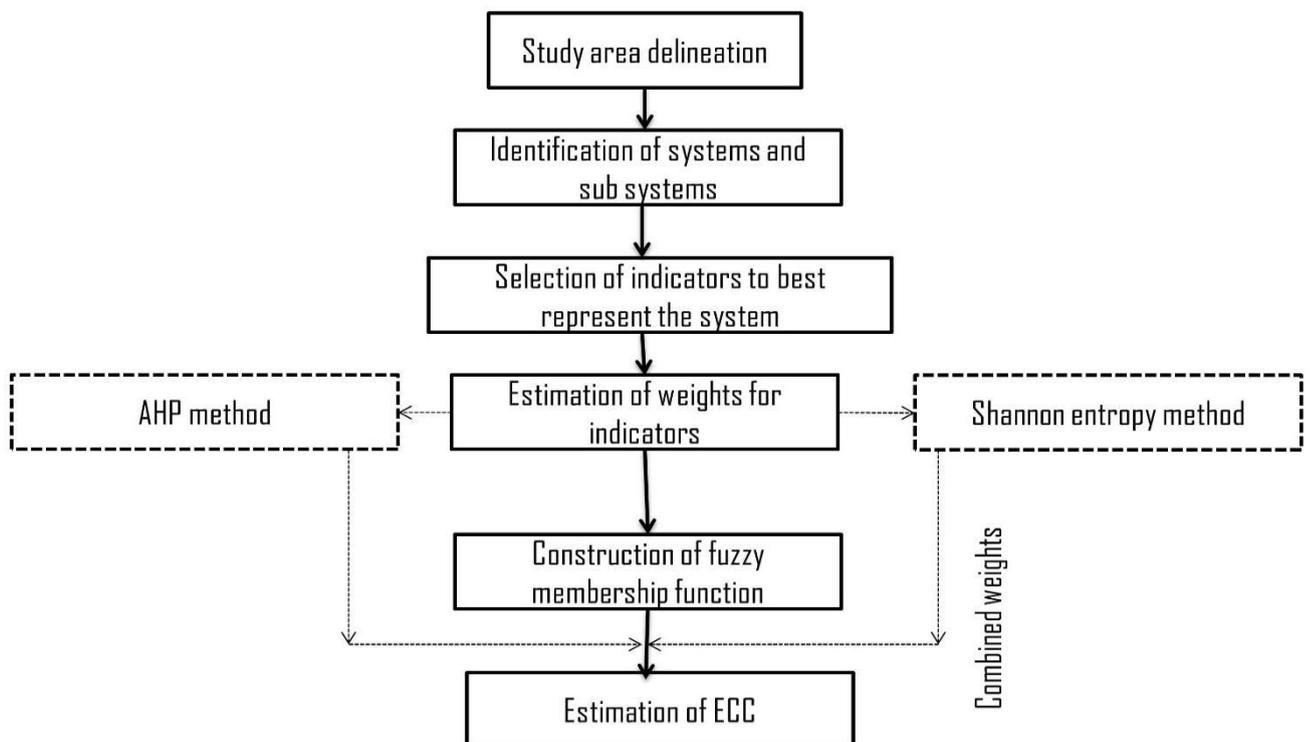


Fig. 1.1: Location of the study area of SGNP, Mumbai, Maharashtra (Bhuvan Map)

2.0 METHODOLOGIES FOR ASSESSMENT OF ENVIRONMENTAL CARRYING CAPACITY

Environmental Carrying Capacity (ECC) or specifically Ecological Carrying Capacity (ECC) in this case of eco-sensitive zone, estimation for the region is important to ascertain the limits of development within the sustainable framework. This is especially significant in light of the United Nations' 2030 Sustainable Development Goals. Goal 15: Preserve, Recover, and Encourage the sustainable usage of terrestrial ecosystems; conserve biodiversity sustainably; prevent desertification; and prevent soil erosion and loss of biodiversity.

The estimations of carrying capacity for the identified ecosystem can be expressed as the relationship between natural resources, environment and human economy to achieve sustainable and overall development. This concept along with maintaining resources includes socio-economic growth of the society and in turn, the public at large. Therefore, estimation of ECC becomes essential for any ecosystem so that inclusive growth can be ascertained. These estimations help in deriving the supporting and pressure forces for the ecosystem. The methodology to be followed for estimating ECC of study area can be understood and done as per the flowchart:



AHP: Analytic Hierarchy Process

Fig. 2.1: Flowchart Showing methodology for estimating ECC

The above method is detailed and needs varied data points to complete the assessment. Some of the data points are described in the **Table 2.1** below. The study area represented by a categorical selection of processes for ecological resilience and ecological pressure needs to be quantified for estimating ECC. This study can use 12 factors that act as an indicator to subsystems to include resilience and pressure of the ecological system. The factors to quantify resilience are Slope (R1), Land Use (R2), Land Stress Index (R3), Habitat Quality Index (R4), Water Network denseness index (R5), Vegetation Cover (R6), Annual Total Rainfall (R7), Annual Total Temperature (R8), and for pressure, the selected ones are Aerosol Optical Depth (P1), PM_{2.5} (P2), Temperature (P3), Heat Intensity (P4). The selected indicators are those which can capture the interactions existing between subsystems, processes and amongst each other. These 12 indicators are believed to have an impact on the ECC of the study area. These selected indicators can be distributed spatially and temporally for estimations of ECC, and a map representing such variations becomes handy for regional development. [6]

Table 2.1: Select ECC Parameters*

Criterion Layers	Sub - Criterion Layers	Factor Layers
Ecological Resilience (A1)	Soil Erosion (B1)	<ul style="list-style-type: none"> • Slope (U1) • Land Use (U2) • Land Stress Index (LSI) (U3)
	Land Cover (B2)	<ul style="list-style-type: none"> • Habitat Quality Index (HQI) (U4) • Water Network Denseness Index (WNDI) (U5) • Vegetation Cover (VC) (U6)
	Climatic Factors (B3)	<ul style="list-style-type: none"> • Annual Total Rainfall (U7) • Annual Total Temperature (U8)
Ecological Pressure (A2)	Air pollution (B4)	<ul style="list-style-type: none"> • AOD (U9) • PM_{2.5} (U10)
	Urban Heat Island (B5)	<ul style="list-style-type: none"> • Temperature (U11) • Heat Intensity (U12)

In order to conduct a detailed assessment as above, the study area is to be defined critically. Here a buffer zone is chosen around the SGNP. Buffer Zone is usually an area assumed to fortify the preservation of protected area. For the carrying capacity assessment study, selected a radius of 5 km as buffer zone around SGNP to control some activities around national parks and wildlife refuges in order to reduce detrimental impacts on the fragile ecosystem

surrounding them. Protected places benefit from Eco Sensitive Zones, which are designed to act as a "shock absorber." In this case, the buffer zone is used to map the environmental attributes in and around the SGNP. The raw area of SGNP and the buffer area should give information for assessment of ECC.

While assessment of ECC based on above methods is a tedious and complex process, a simplified indicative approach can also be used to get the indicative results. This simplified process is applied for Water, Noise, Air and Tourism carrying capacity assessment of SGNP. The Analytic Hierarchy Process (AHP), modeling and Fuzzy logic based complex processes can be explored once this simplified approach is applied and ascertained. The detailed methods for each of the above environmental attributes for the simplified approach are described in subsequent sections.

2.1 Water Environment Carrying Capacity (WECC)

Water is essential to all life and plays a vital role in human survival and regional socio-economic development. Water resources are valuable natural resources, such as surface water, groundwater and frozen water. Employment of water incorporates agricultural, industrial, household, recreational and environmental activities. Technologies such as recycling and desalination processes are also used to provide fresh water to society [7]. Contradictions between the environment, population, and social development have become more obvious as a result of rapid population growth and ongoing economic development. As a result, resolving these inconsistencies has become a major topic in water resource studies, and the study of Water Environment Carrying Capacity (WECC) is at the heart of any environmental sustainability and water security policy.

The SGNP consists of lakes, major & minor streams, waterholes, and wells as its water resources. Out of these, the two lakes of SGNP - Tulsi and Vihar are over a 100 years old and are the primary source of drinking water supply to Mumbai city. Since, it is feeding water to one of India's most populated cities and wildlife population, its water resource carrying capacity assessment is a necessity of this hour.

Water Environment Carrying Capacity (WECC) Estimation:

To evaluate the WECC of SGNP, it is essential to understand and study the available water

resources present in the SGNP. The characteristics and data of available water resources such as its catchment area, surface area, maximum & minimum depth, surface elevation and water volume are considered for our study [2]. The available water resources can be defined as the maximum water resources that may be exploited without causing harm to the environment. It is defined as the sum of surface water, groundwater, trans-boundary water, and reclaimed water that is locally available.

The quantity of accessible water supplies was determined using an estimated total of atmospheric and water source technical conditions, as well as a quota set by higher-level administrations. [7]. It is estimated by using the following equation.

$$E_{ws} (m^3) = W_s + W_g + W_t + W_{uc} \quad [7]$$

Where,

E_{ws} = Quantity of available water resources

W_s = Total available surface water

W_g = Quantity of available groundwater

W_t = Total transfer water from cross-boundary regions

W_{uc} = Reclaimed water sources including wastewater recycling

Data related to the quantity of water taken for utilization from the available water resources of SGNP are collected from respective organizations and the total water consumption in a year is calculated. The Utilization Ratio (UR) was used to investigate how much WECC was used by the economy. The UR of available water resources can be estimated by using the equation given below [7].

$$UR_{\text{Available Water Resources}} = \frac{\text{Amount of Water Consumed}}{\text{Total Available Water Resources}}$$

If UR > 100%, the resources are overused, or the ecosystem is being overburdened. [7].

2.2 Air Environment Carrying Capacity (AECC)

Air is a critical resource for humans, plants, animals, and all other living organisms within a natural habitat. The oxygen within the air is essential for the creatures to survive since we utilize this oxygen to create energy from the nourishments we eat. The air also plays an

essential role in regulating the earth's temperature and causes different weather patterns. Polluting the air environment by discharging hazardous chemicals hence debilitates life and can change climatic patterns. Many air contaminants, including tropospheric O₃ and NO_x, interact with carbon emissions fixation by the tree canopy by affecting the metabolic activity of the plants. Air pollution can affect wildlife indirectly by changing plant communities.

There are two basic ways that destroy animals which are depicted below:

- a) It has an impact on the ecosystem or habitat where they dwell.
- b) It has an impact on the food supply's quality and quantity.

Air Environment Carrying Capacity (AECC) Estimation:

For the assessment of Air Environment Carrying Capacity (AECC) of SGNP, details about the sources in the vicinity and within the park are evaluated. The data considered include air pollution sources, type of air pollutant, and the baseline air quality of SGNP [2]. The baseline air quality data includes the amount of SO₂, NO₂, SPM, and RSPM emitted, is compared with National Ambient Air Quality Standard (NAAQS) values of sensitive regions, and the Utilization Ratio is estimated for each air pollutant.

$$UR_{\text{Air Environment}} = \text{Amount of pollutant load} / \text{ECC}$$

If UR > 100%, the resources are overused, or the ecosystem is being overburdened. [7].

2.3 Tourism Carbon Carrying Capacity (TCC)

Tourism has been one of the fastest-growing economic sectors in the world, yet it also has the highest carbon emissions. Tourism is responsible for 5% of global carbon emissions, significantly impacting global warming [3]. Moreover, tourism can cause significant disturbances to animals in their natural habitats. More people engage with wildlife as wildlife tourism grows in a certain location. This can be a serious issue because certain wild animals dislike being around people, and humans frequently leave trash and other things that might harm a species' environment. Because of such ecological and environmental problems, the Tourism Carbon Carrying Capacity (TCC) value for SGNP must be calculated since it is one of the major national parks within a metropolis limit and is one of the world's most visited parks.

Tourism Carbon Carrying Capacity (TCC) Estimation:

For the assessment of TCC of SGNP tourism, details such as tourist spots inside the park premises, tourist inflow rates, etc., of SGNP are assorted [2] and the carbon carrying capacity which refers to the quantity of fixed CO₂ engrossed by various vegetation's in a zone each year is used for calculations. [3].

The land-use study of SGNP is conducted and the aggregated details include land use pattern, area, etc.

The TCC is calculated by using the following equation:

$$\begin{aligned} \text{CC} &= \text{S} \times \text{C}_{\text{NEP}} \times (44 \div 12) & [3] \\ \text{TCC} &= \text{CC} \times \text{r} & [3] \end{aligned}$$

Where,

CC = Region's carbon carrying capacity,

S = Area of forest,

C_{NEP} = Amount of carbon absorbed by vegetation's in one year, TCC = Tourism carbon carrying capacity,

R = Tourism carbon carrying capacity coefficient, which is the ratio of Gross regional tourism revenue to Gross Regional Product (GDP)

2.4 Noise Carrying Capacity (NCC)

Sound, much like accessibility of building materials or sources of food, is critical to the ecosystem's survival. The auditory environment is critical for activities including identifying desirable habitat and partners, avoiding predators, safeguarding the young, and developing territory.

Sound is what we hear, but noise is the unwanted sound. In general, a rising number of studies show that noisy surroundings stress animals, much as they do humans. Noise pollution makes it more difficult for them to do these duties, which has a negative impact on their ability to survive. Caterpillars' hearts beat quicker and bluebirds have fewer offspring when they hear loud noises, according to studies. Hence, a detailed study should be conducted to determine the sound pressure levels generated due to visitor noises, vehicles, due to any industries within and near SGNP, to strengthen the existing baseline data for

future long term monitoring of the impacts of sound on wildlife since SGNP which is a green oasis with its rich biodiversity, its picturesque landscape, its lakes and stream and act as a respite to millions of inhabitants of Mumbai city from the drudgery of a hectic yet monotonous existence.

Noise Carrying Capacity (NCC) Estimation:

It is necessary to figure out the visitor attraction sites within the SGNP where there is maximum visitor footfall. Thereafter, it is essential to record the sound levels in different seasons with (Impact) and without (Control) the presence of visitors in these specific zones [5]. Determination of NCC involves measuring the sound levels existing in high visitor usage sites through a control-impact design check whether the ambient noise level (Leq in dB) [5] remains within the prescribed noise level standard limits as decided by CPCB for Silence Zones.

The above factors of Noise, Air, Water and Tourism are critical for carrying capacity and above simplified approaches as indicated. The detailed assessment of ECC needs assessment of various factors as described in **Table 2.1** of ECC parameters. The assessment method for Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST), Digital Elevation Model (DEM), Land Use Land Cover Map (LULC), Normalized Difference Water Index (NDWI), Land Stress Index (LSI), Habitat Quality Index (HQI), Aerosol Optical Dispersion (AOD), and Fuzzy Comparative Evaluation is detailed below.

2.5 Normalized Difference Vegetation Index (NDVI)

The heat transfers at the earth's surface and within the planetary boundary layer is influenced by greenery, which often mitigates local temperature extremes. Vegetation cover has immense importance in wildlife because it releases oxygen and sequesters carbon, it protects soil from degradation and convert solar energy into biomass which is the foundation of all food chains. For SGNP, with its rich green canopy and existing within a metropolis, it is essential to monitor any changes in its vegetation cover due to human activities. For this purpose, Normalized Difference Vegetation Index (NDVI) maps of SGNP for various years can be prepared and are used to study any decrease in its vegetative cover by comparing the maps.

The normalized difference vegetative index (NDVI) is a simple graphical indication used to examine remote sensing measurements, typically from a space platform, to determine if the observed target has live green vegetation. The NDVI scale is used to measure the healthiness of greenery and is useful for determining vegetation density and detecting plant growth and development. NDVI is calculated as the ratio between the RED (R) and NEAR INFRARED (NIR) values. For various studies, satellite images such as Landsat 3, 5, 8 data can be downloaded from U.S. Geological Survey (USGS) Earth Explorer.

After downloading the satellite image raw data, atmospheric correction and pre-processing are done through Open Source Geographic Information System (QGIS) software. ArcGIS 10.6.1 platform is used to calculate the Normalized Difference Vegetation Index based on the following equation:

$$\text{NDVI} = (\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED})$$

Maps are thus prepared for the years 1978, 1987, 2000 & 2020, and the total Vegetative and Non-Vegetative area of SGNP is calculated and compared.

2.6 Land Surface Temperature (LST)

In this present era of rapid urbanization, one of the major threats that facing global warming, leading to climatic change and exhibits new challenges for the survival of human beings and wild animals. Another crucial variable in the earth's climate system is land surface temperature. It regulates the rate and timing of plant growth by describing processes such as the exchange of energy and water between the land surface and the atmosphere. Many factors influence land surface temperature, including solar incoming radiation, angle of incidence of solar radiation, surface roughness, moisture content, vegetation extent, and air temperature. Land Surface Temperature (LST) is also affected by Land use / Land cover changes. By preparing LST maps of SGNP and comparing them to get an idea about the increase in surface temperature pronounced by any change in land use/land cover.

The Land Surface Temperature can be estimated or calculated using the Landsat Satellites Landsat 5, 8 thermal bands. It requires applying a set of equations through a raster image calculator in Arc Map, ArcGIS10.6.1 and QGIS. The first step is to download a Landsat 5, 8

images from a particular location, unzip it, and check certain information needed (within the metadata) to execute this procedure and to create Land Surface Temperature (LST) map using the Landsat 8 bands. In particular, band 10 is used as the thermal band, and bands 4 and 5 to calculate the Normal Difference Vegetation Index (NDVI).

To estimate LST, the different USGS formulas are used to calculate the TOA (Top of Atmospheric) spectral radiance which is converted to brightness temperature conversion, NDVI, proportion of vegetation (P_v), Emissivity (ϵ) and finally LST is calculated.

As a result, a map of the Land Surface Temperature will be created and, it should be noted that it is not be equal to the air temperature.

2.7 Digital Elevation Model (DEM)

Cell-based digital elevation models are the most popular digitized data about the geometry of the earth's surface (DEM). This information is used to quantify the land surface's properties. It is mainly used to determine terrain attributes such as elevation at any point, slope and aspect. DEM maps of SGNP are very essential to perform carrying capacity assessment since it gives immense data for the assessment process. SRTM DEM data downloaded from USGS Earth Explorer and processed in ARCGIS 10.6.1 are used for making slope Map of SGNP with 5 km Buffer Zone Area. The slope of the land must be taken into account in order to reduce building costs, lower the risk of natural disasters such as flooding and landslides, and reduce the negative effects of proposed development on environmental assets such as soils, plants, and the water system. Hence, it is very important to understand the slope of a region and a map indicating the topography of an area along with an analysis of topographic features is a slope map. Slope Maps of SGNP created from DEM data and processed in ARCGIS Software are used to compare and study its effects.

2.8 Land Use Land Cover Map (LULC)

Land-use and land-cover maps (LULC maps) are useful for addressing environmental issues, supporting planning efforts, and maintaining natural resources such as water. It also refers to man's activity on land and the different purposes to which it is put. By comparing LULC maps of various years, the total area of a region utilized for development activities can be evaluated, and the same procedure is used for SGNP and for Carrying capacity assessment. It

can also be used for habitat quality index, land stress index, water denseness index studies of SGNP. ArcGIS 10.6.1 software platform is used for LULC map creation, and supervised classification is done for LULC Classification of SGNP with 5 km buffer zone area. Landsat 3, 5, 8 OLI data are used to calculate LULC in SGNP and from LULC Classification areas are measured such as Forest, Vegetation, Settlements, Barren lands, Waterbodies, Agriculture & Mangroves of the Sanjay Gandhi National Park Area, Mumbai with 5 km buffer zone.

2.9 Normalized Difference Water Index (NDWI)

The Normalized Difference Water Index (NDWI) is used to track changes in water content in water bodies. It's also utilized to tell the difference between water and dry land, and it's ideal for water body mapping. In the visible infrared wavelength region, water bodies have minimal radiation and high absorbability. It's also a remote sensing-derived indicator that estimates the amount of water in the leaves at the canopy level. Water stress can influence the vegetation canopy during drought episodes, affecting plant development in general and perhaps causing crop failure or lower crop yield in agricultural areas.

Landsat 8 data is downloaded from USGS Earth Explorer. After downloading satellite image raw data, atmospheric correction and pre-processing is done through QGIS software. NDVI is calculated as a ratio between the NEAR INFRARED (NIR) and SHORT-WAVE INFRARED (SWIR) values.

$$\text{NDWI} = (\text{NIR} - \text{SWIR}) / (\text{NIR} + \text{SWIR})$$

2.10 Land Stress Index (LSI)

The Land Stress Index (LSI) is the degree of stress on the land quality in the assessment area and is expressed by the area of the stress type, such as soil erosion, land desertification and land development, per unit area in the assessment area.

For SGNP, land stress index map is created through Soil Loss Equation processing - Rainfall (R), Soil (K), DEM (Process – Slope – LS), LULC (C), and Land Management (P).

Therefore, the Universal Soil Loss Equation, $(A) = R * K * L * S * C * P$ is used.

Where,

Rainfall and Runoff Factor (R)

Soil ErodibilityFactor (K)
Slope Length-Gradient Factor (LS)
Crop/Vegetation and Management Factor (C)
support practice factor (P)

Throughout the algorithm is processed in Map Algebra Tool and Land Stress Index Map of SGNP is created by ArcGIS 10.6.1 Software.

The formula for LSI is as follows:

$$\text{LSI} = A_{\text{ero}} * (0.4 * \text{severe erosion area} + 0.2 * \text{mod erosion area} + 0.2 * \text{construction land area} + 0.2 * \text{other land stress})/\text{area}$$

Where,

A_{ero} = Normalization coefficient of LSI, with reference value of 236.0435677948.

2.11 Habitat Quality Index (HQI)

The Habitat Quality Index (HQI) is primarily used to assess the habitat quality of the most important protected items in green spaces [9,10]. For SGNP Habitat Quality Index map is created by processing the following data - DEM (Process – Slope – LS), LULC (C), and Land Management(P). Throughout, the algorithm is processed in Map Algebra Tool and Habitat Quality Index Map of SGNP is created by ArcGIS 10.6.1 Software.

The formula for HQI is as follows:

$$\text{HQI} = A_{\text{bio}} * (0.35 * \text{forest} + 0.21 * \text{grass} + 0.28 * \text{water} + 0.11 * \text{agricultural land} + 0.04 * \text{construction land} + 0.01 * \text{unused land})/\text{area}$$

Where,

A_{bio} = Normalization coefficient of HQI, and the reference value is 511.2642131067.

2.12 Aerosol Optical Dispersion and PM_{2.5}

Aerosol Optical Depth (AOD) is a degree of the extinction of the solar beam by dust and haze. In other words, dust, smoke, and pollution in the atmosphere can obstruct sunlight by absorbing or dispersing light. The value depends mainly upon meteorological conditions and anthropogenic activities in a region. Higher values of AOD denotes poor meteorological

conditions with high anthropogenic activities. Likewise, by comparing PM_{2.5} values of a region with NAAQS, a clear picture of air pollution existing in a region can be understood.

For this purpose, due to the data gapping in Moderate Resolution Imaging Spectroradiometer (MODIS) Dark Target (DT)-AQUA, AODMODIS derived from DT-TERRA reflection with a spatial resolution of 3 km at 0.55 μm is used to characterize the spatial variation of aerosol optical depth and PM_{2.5} over our study region. The study area is extracted using ArcGIS tools. In this, each dataset is converted to a point shape file using Arc tools for spatial interpolation. Generated maps are used for analyzing spatial distribution patterns of aerosol and PM_{2.5} [8].

Once all above environmental attributes are evaluated, it is possible to use more complex methods including Fuzzy and/or Analytical Hierarchy Process and (or) Shanon Entropy Method for evaluation of ECC. In this study, Fuzzy Analytic Hierarchy Process (FAHP) is used for assessment of ECC. The method is described in brief below.

2.13 Fuzzy Comprehensive Evaluation method:

The Fuzzy Analytic Hierarchy Process (FAHP) method is a two-step process used for estimation of ECC. First, the weights of selected parameters are estimated through Analytic Hierarchy Process (AHP) and once the weights are estimated the function is created based on evaluation factors to estimate ECC. The AHP is a multi- criterion and multi-objective decision-making method that combines qualitative and quantitative analysis and is applicable to problems which are difficult to fully quantify. The flowchart indicating the forces and parameters which were selected to comprehensively estimate the ECC for Sanjay Gandhi Park are shown in **Fig 2.2**.

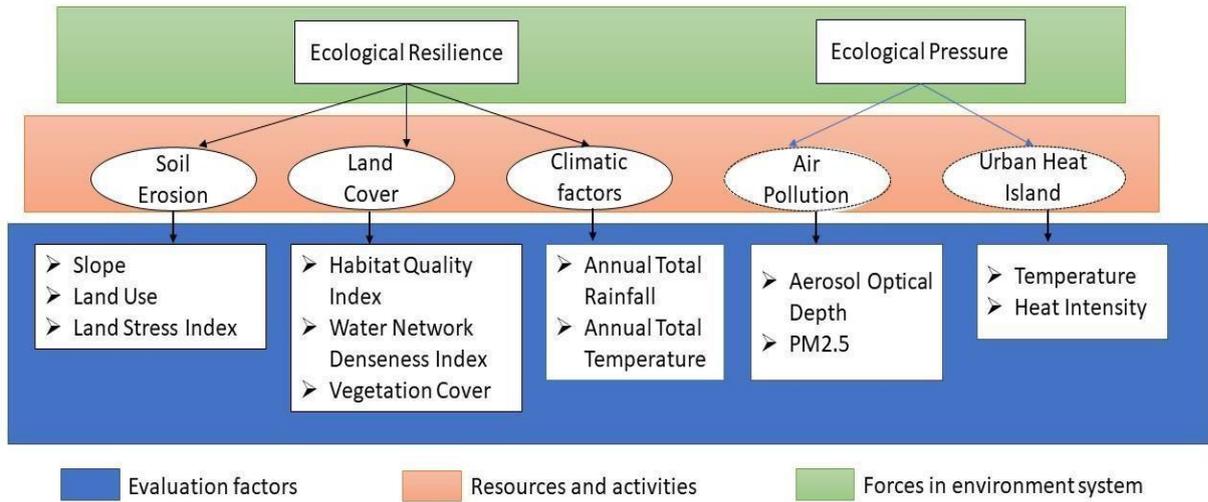


Fig. 2.2: Flowchart representing Evaluation Factors

The hierarchical relations of the evaluation factors for a comprehensive system are constructed through judgement matrix in AHP process. For the judgement matrix, evaluation factors are compared at same level and experts evaluate the importance of these factors according to Saaty’s 9-point scale.

For estimating, the ECC evaluation rating domain was used under a finite group $V = [V_1, V_2, \dots, V_5]$ representing the aggregate of remark grades by the experts considering Saaty’s scale. In this study, V_1 is a very low grade, V_2 is a low grade, V_3 is a moderate grade, V_4 is a high grade, V_5 is a very high grade. Then the membership function was created to describe membership degree of the evaluation factors for estimating ECC. The final matrix representing ECC is shown in equation:

$$ECC = [W_1, W_2, \dots, W_n] \begin{pmatrix} u_{1V_1} & \dots & u_{1V_n} \\ \dots & \dots & \dots \\ u_{mV_1} & \dots & u_{mV_n} \end{pmatrix}$$

In this study, the ECC for the study area was estimated for year 1987, 2000 and 2020 along with estimation of ECC considering buffer zone for all these years as well.

3.0 ASSESSMENT OF ENVIRONMENTAL CARRYING CAPACITY AND ENVIRONMENTAL ATTRIBUTES

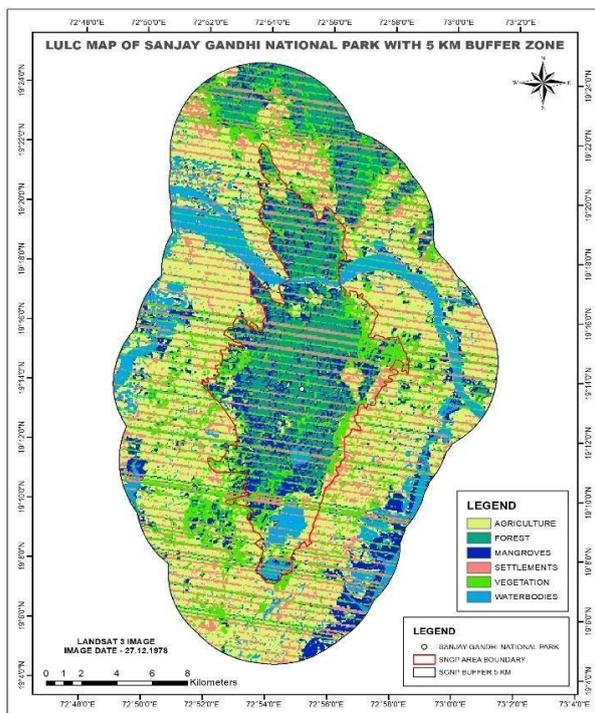
The calculations of the different parameters of the Environmental Carrying Capacity are done with the estimation methods that are discussed above in the methodologies and by considering the data from the Environmental Management Plan for Sanjay Gandhi National Park 2000.

3.1 Calculation of Tourism Carbon Carrying Capacity (TCC)

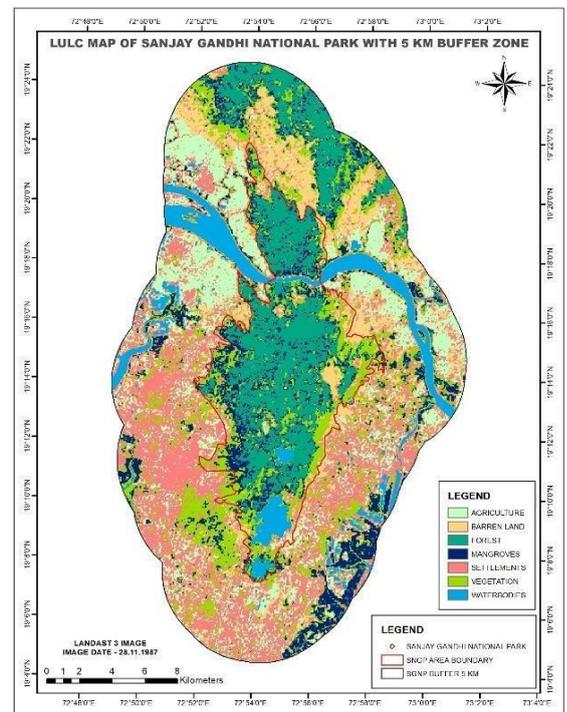
For the calculation of Tourism Carbon Carrying Capacity (TCC), area is considered from the Land Use and Land Cover (LULC) maps created by ArcGIS and tourist inflow details are taken from Environmental Management Plan for SGNP 2000. TCC is estimated by using the CO₂ sequestration method and the calculations are as follow:

Land Use Land Cover (LULC) of SGNP with Buffer Zone:

The maps of Land Use Land Cover (LULC) of the study area with buffer zone for the different years are shown below:



(a) 1978



(b) 1987

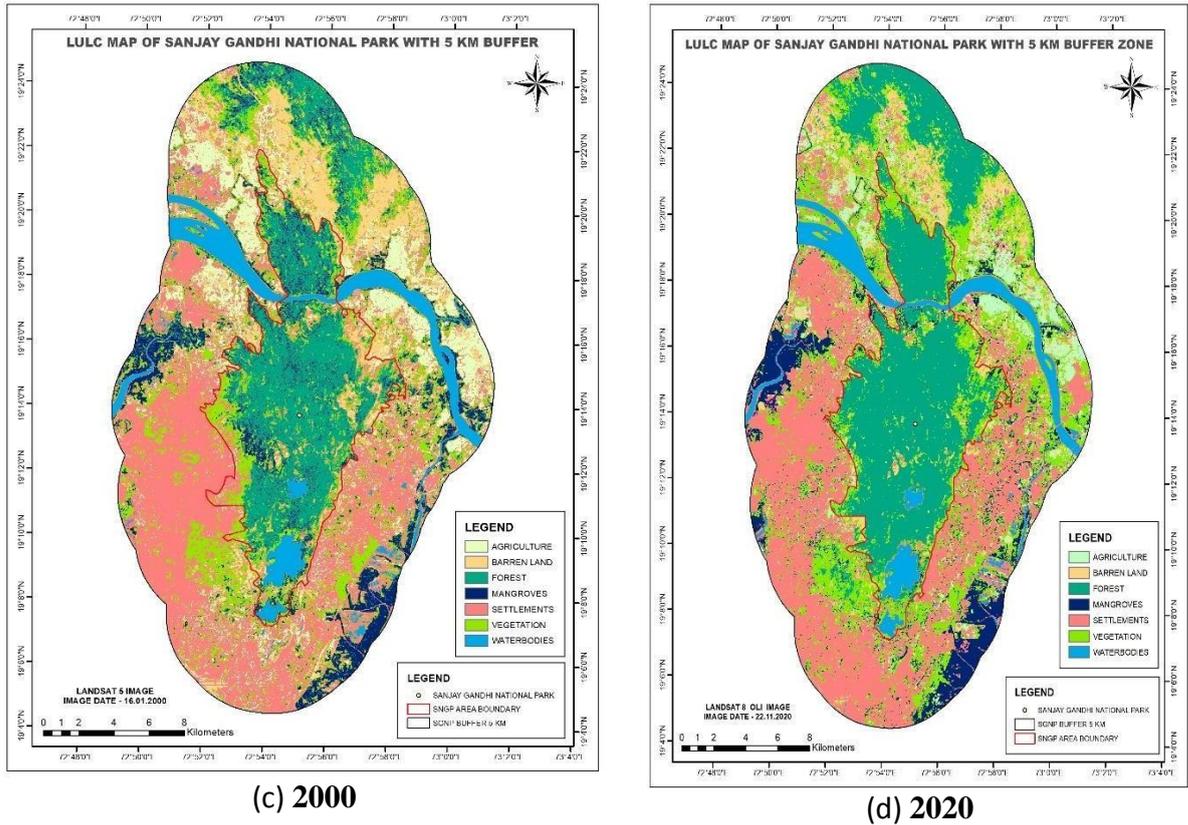


Fig. 3.1(A) LULC Map of SGNP with Buffer Zone: (a) 1978, (b) 1987, (c) 2000, (d) 2020

The details of land use land cover for the study area with buffer Zone are as shown in Table 3.1 (a) follows:

Table 3.1(a): Details of LULC Map of SGNP with Buffer

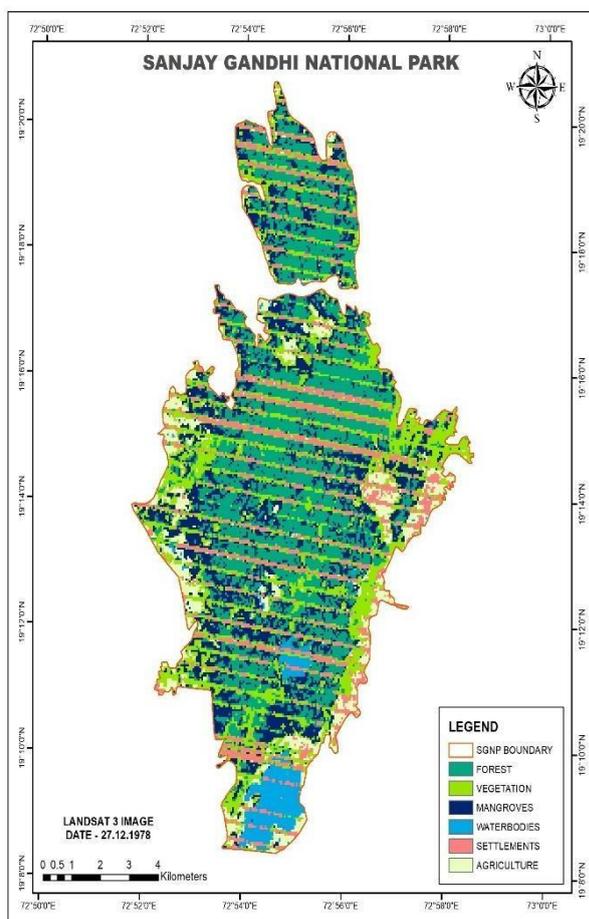
Category	Year-1978	Year-1987	Year-2000	Year-2020
	Area (km ²)			
Forest	67.7	88.70	96.93	127.23
Vegetation	110.59	92.30	92.77	124.57
Mangroves	58.78	59.11	43.50	38.52
Water bodies	48.73	36.36	31.76	30.18
Settlements	83.60	136.83	180.96	163.87
Agriculture	181.76	89.13	60.78	32.91
Barren land	--	48.74	44.49	33.89
Total Area	551.19	551.19	551.21	551.21

The LULC classification area for SGNP from 1978-2020 shows a positive increase of forest land which will be beneficial for the wildlife ecosystem. Mangroves and water body areas are however decreasing year by year and indicates a threat to the balance of the

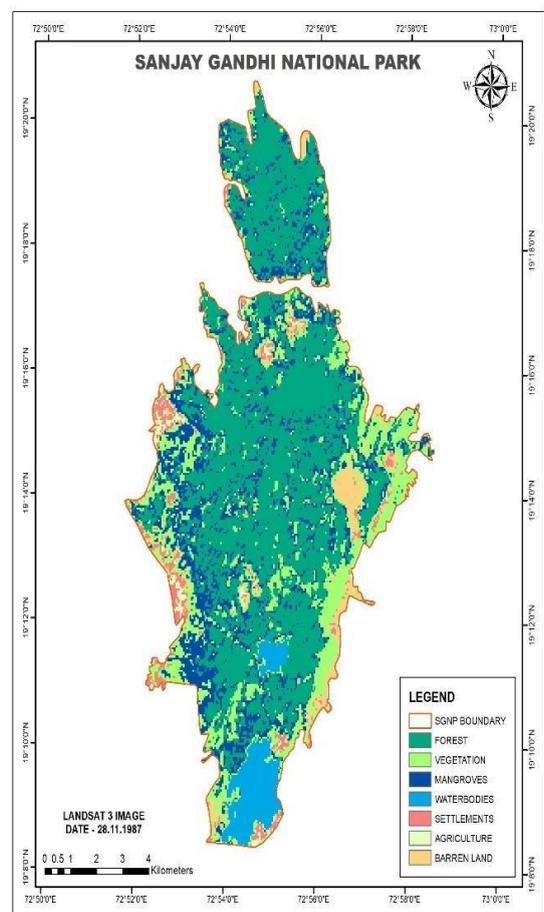
environment. Human settlements are also increasing year by year till the year 2000, while showing reduction after that. *However, the remote sensing data should be ground verified to understand the actual status of human settlements in the SGNP. In general terms, encroachments in the ecologically sensitive area should be prevented in order to maintain the balance of fragile ecosystem.*

Land Use Land Cover (LULC) of SGNP:

The maps of LULC of the study area of SGNP for the different years are shown below:



(a) 1978



(b) 1987

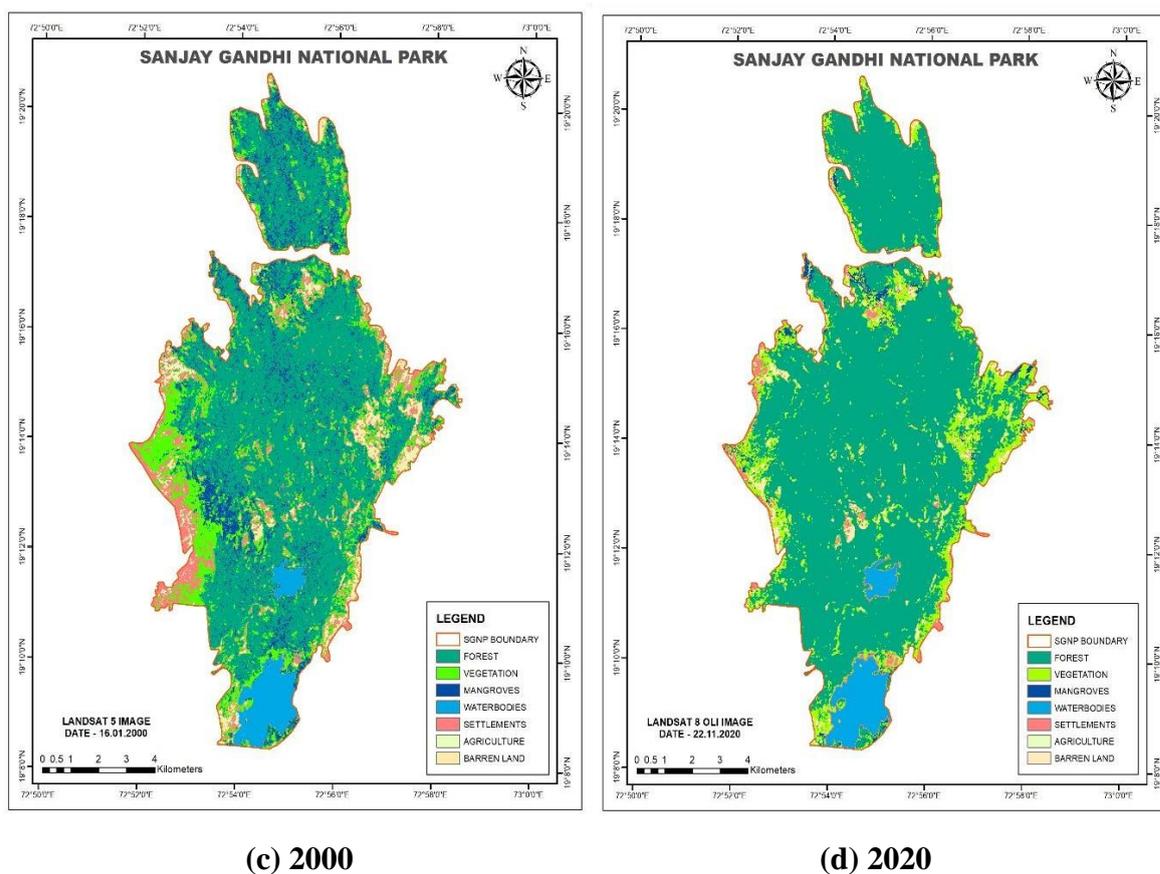


Fig. 3.1(b) Land Use Land Cover Map of SGNP: (a) 1978, (b) 1987, (c) 2000, (d) 2020

The details of land use land cover for the study area of SGNP is shown in Table 3.1 (b) below:

Table 3.1(b): Details of LULC Map of SGNP:

Category	Year-1978	Year-1987	Year-2000	Year-2020
	Area (km ²)			
Forest	40.16	59.84	68.35	90.31
Vegetation	26.93	22.09	18.30	15.68
Mangroves	24.67	22.47	11.78	1.89
Water bodies	4.23	5.24	5.17	5.24
Settlements	--	3.98	9.99	2.89
Agriculture	9.28	1.64	1.71	0.67
Barren land	--	4.39	4.34	2.96
Error in Image	14.36	-	-	-
Total Area	119.67	119.67	119.66	119.66

Normalized Difference Vegetation Index:

NDVI is used to measure the healthiness of greenery, determining vegetation density and detecting plant growth and development. Accordingly, the NDVI of SGNP with Buffer and for area of SGNP over the years i.e. 1978, 1987, 2000 and 2020 is Shown in **Table 3.2 (a)** and **Table 3.2 (b)** below:

Table 3.2(a): Area of SGNP with Buffer: ArcGIS Maps

Name	Area (Hectare)			
	1978	1987	2000	2020
Forest (Evergreen)	3385	4435	4847	6362
Forest (Deciduous)	3385	4435	4847	6362
Vegetation	11059	9230	9277	12457
Mangroves	5878	5911	4350	3852

Table 3.2(b): Area of SGNP: ArcGIS Maps

Name	Area (Hectare)			
	1978	1987	2000	2020
Forest (Evergreen)	2008	2992	3417	4515
Forest (Deciduous)	2008	2992	3417	4515
Vegetation	2693	2209	1830	1568
Mangroves	2467	2247	1178	189

Table 3.3: Calculation of Biomass based on SGNP: [3], [4]

Name	Standing Biomass (t/ha)	Biomass (MT) (Standing Biomass * Area)			
		1978	1987	2000	2020
Forest (Evergreen)	485	974006	1451275	1657696	2190073
Forest (Deciduous)	258	518131	772018	881825	1165028
Vegetation	74.25	199993	164068	135928	116449
Mangroves	213.8	527615	480511	251916	40581
Total		2219746	2867873	2927366	3512132

Table 3.4: Calculation of CO₂ Sequestration and Tourism CC based on SGNP: [3]

Name	1978	1987	2000	2020
Carbon Absorbed (Total biomass * 0.5)	1109873	1433936	1463683	1756066
CO₂ Sequestration (Carbon Absorbed * 3.67)	4073235	5262548	5371718	6444763
Tourism Carrying Capacity (CO₂ Sequestration * r)	130343	168401	171894	206232

Sample Calculation (TCC) For Year 2020:

- Area of Forest (Evergreen) = 4515 ha
- Standing Biomass = 485 t/ha [4]
- Biomass = Area * Standing Biomass [3]
= 4515 * 485 = 21,90,073 tonnes
- Total Biomass: 3,51,23,132 tonnes
- Carbon Absorbed = Total biomass * 0.5 [3]
= 35,12,132 * 0.5 = 17,56,066 tonnes
- CO₂ Sequestration = Carbon Absorbed * 3.67 [3]
= 1756066 * 3.67 = 6444763 tonnes
- TCC = CO₂ Sequestration * r [3]
= 6444763 * 0.032 = 206232 footfall

The total footfall value observed for the study from Environmental Management Plan of SGNP 2000 was 1466359, while the calculated footfall values by CO₂ sequestration method is found to be 206232. *While the value of actual footfall seems to be high, it is necessary to understand the actual number of visitors spending whole day in SGNP, peak time for visitors and related parameters and normalize this value of actual footfall accordingly so that correct comparison with the carrying capacity value can be made.*

3.2 Calculation of Water Environment Carrying Capacity (WECC):

The Water Environment Carrying Capacity (WECC) calculations are shown below based on data assorted from Environmental Management Plan for SGNP 2000 for Vihar and

Tulsi lakes and are based on utilization ratio.

Table 3.5: Baseline Data of Water: [2]

Lake	Volume of water (m ³)	Consumption of water (MLD)
Vihar Lake	42000000	68
Tulsi Lake	10430000	18

$$UR_{\text{ Available Water Resources}} = \frac{\text{Amount of water consumed}}{\text{Total Available Water Resources}}$$

$$\begin{aligned} \text{Amount of water Consumed} &= 18 + 68 = 86 \text{ MLD} \\ &= 86000 \text{ m}^3/\text{day} \\ &= 31390000 \text{ m}^3/\text{year} \end{aligned}$$

$$\text{Total Available Water Resources (Year)} = (42000000 + 10430000) = 52430000 \text{ m}^3$$

Therefore,

$$\begin{aligned} UR_{\text{ Available Water Resources}} &= \frac{\text{Amount of water consumed}}{\text{Total Available Water Resources}} \\ &= (31390000 / 52430000) * 100 \\ &= 59.87 \% \end{aligned}$$

The utilization ratio of available water resources in SGNP is 59.87% which is less than the reference value of 100%. While 100% indicates that the carrying capacity has reached, the idea is to never reach 100% and sufficient measures should be applied to keep the utilization ratio within the range of current assessment i.e. 60-65%. ***This also calls for regular monitoring of WECC, so that if UR is increasing, corrective measures should be applied to restore the balance.***

3.3 Calculation of Noise Carrying Capacity (NCC):

For Noise level calculations the following 3 areas are selected and Environmental Management Plan for SGNP 2000 provides noise level ranges of these selected regions for three seasons. The values are compared with CPCB standards for silence zone. The following tables below shows the noise level measured in SGNP and CPCB Noise standards for comparison.

Table 3.6: Seasonal Baseline Noise Level Data in Study Area [2]

Location	Season	Noise Levels dB (A)		
		Day Time	Night Time	Average
Tulsi lake	Winter	35-36	30-36	36
	Summer	39-47.3	38-39.5	43
	Post Monsoon	41-56	39-47	47
Yeur Village	Winter	33-56	34-47	41
	Summer	39-58	38-41	44
	Post Monsoon	40-58	39-50	50
SGNP Entrance	Winter	35-61	35-46	47
	Summer	39.5-65.3	37-49.5	51
	Post Monsoon	40-60	38-53	49

Table 3.7: Ambient Noise Standards [2]

Category of Area	Limits in dB (A)	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

The baseline seasonal noise level data in SGNP shows that it is within the limit in some regions while in some regions it exceeds. The maximum noise level measured during daytime near Tulsi lake during post-monsoon, Yeur village and SGNP Entrance gate in all seasons are showing values greater than the day time limits of CPCB for silence zone. Likewise, the maximum noise level measured during night time near Tulsi lake during post-monsoon and in all seasons for Yeur village, SGNP entrance exceeded the night time limits of CPCB for silence zone. However, *the average values of noise levels are within the limit except for the SGNP entrance gate due to high traffic flows and other human activities.*

While the current NCC assessment is restricted on the basis of standards defined as per human thresholds, it is important that impacts on faunal biodiversity is understood in detail for tailored understanding of NCC. Similarly, the impact of illumination should also be explored in detail in order to determine its thresholds.

3.4 Calculation of Air Carrying Capacity (ACC):

The values of air pollutants such as SO₂, NO₂, SPM and RSPM measured in the SGNP environment, provided in Environmental management plan for SGNP 2000 are considered and compared with NAAQS values of each pollutant to harness the Utilization ratio for AECC calculation and are estimated as follows:

$$UR_{SO_2} = \frac{7.3}{15} * 100 = 48.66 \%$$

$$UR_{NO_2} = \frac{32.7}{30} * 100 = 124 \%$$

$$UR_{SPM} = \frac{162}{100} * 100 = 162 \%$$

$$UR_{RSPM} = \frac{105}{75} * 100 = 140 \%$$

The utilization ratio for air calculated should be within the reference value of 100% so that the resource is not overused and environment is not overloaded. However, the calculated value is exceeding the reference value for the air pollutants considered in our study except for SO₂. It shows that air pollutants like NO₂, SPM and RSPM are polluting which are mainly due to vehicular emissions and particulate matter due to which the SGNP environment is getting affected very badly.

The calculations done above are based on the selected fundamental methodologies of carrying capacity assessment. But estimation of ECC is critical and should be done precisely as far as possible, advanced tools such as Remote sensing and GIS are being used to assess the environmental attributes like NDVI, LST, LULC, NDWI, LSI and HQI, which are analyzed for the SGNP and the buffer area and is explained further in trailing sections.

3.5 Assessment of Environmental Attributes for ECC:

For the study area of SGNP, GIS and Remote Sensing based ecological parameter maps are generated with 5 km buffer Zone and are studied well for the ECC assessment. The study objectives also extend this approach to the core zone in the near future. The different parameters analyzed are explained below:

3.5.1 Normalized Difference Vegetation Index (NDVI) of SGNP:

The maps of Normalized Difference Vegetation Index (NDVI) of the study area for the different years are shown in **Fig. 3.2** below:

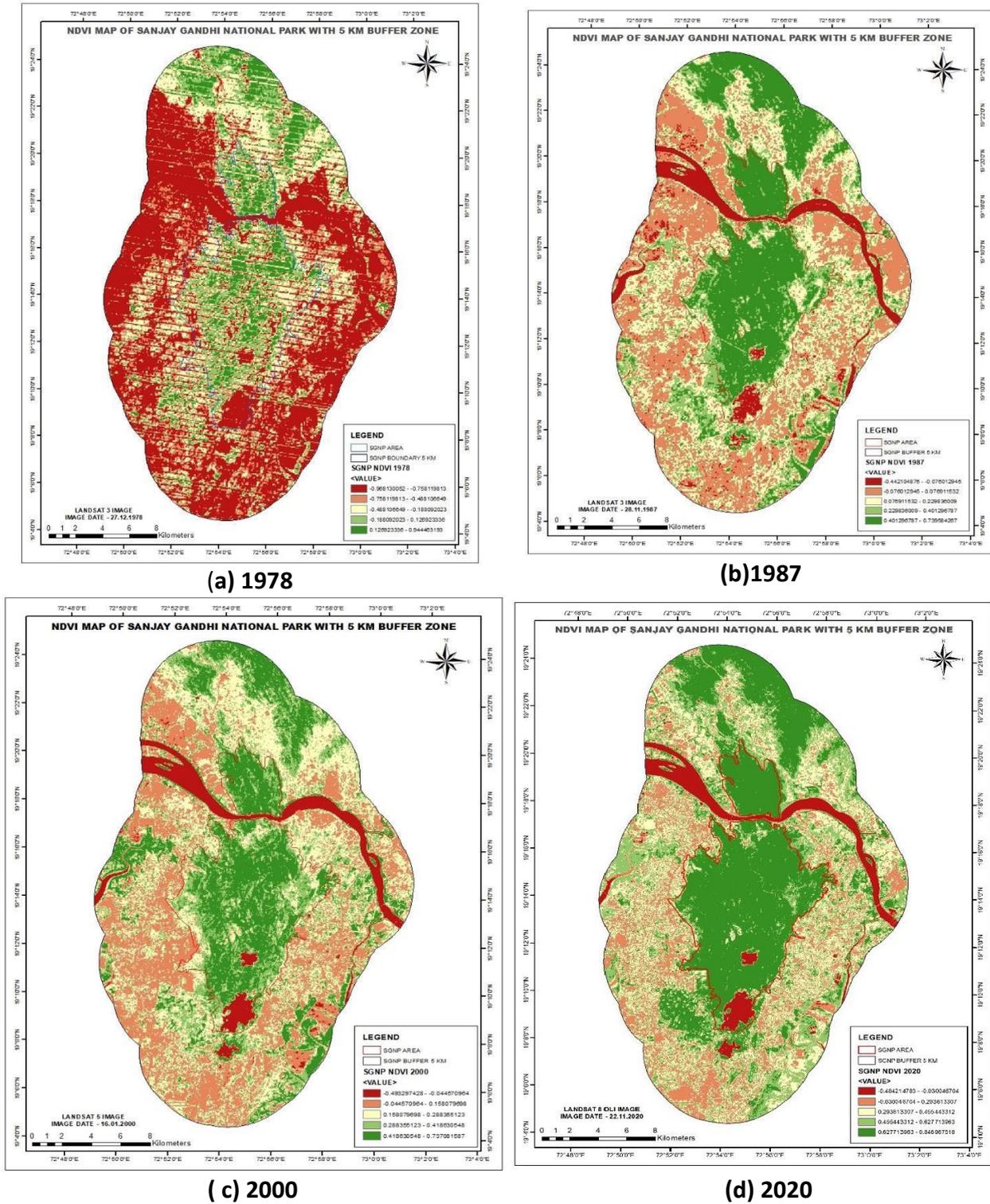


Fig. 3.2 Normalized Difference Vegetation Index (NDVI) of SGNP: (a) 1978, (b) 1987, (c) 2000, (d) 2020

For Landsat 4-7, $NDVI = (Band\ 4 - Band\ 3) / (Band\ 4 + Band\ 3)$ and For Landsat 8, $NDVI = (Band\ 5 - Band\ 4) / (Band\ 5 + Band\ 4)$ are used.

The details about the NDVI data for SGNP is as follows:

Table 3.8: Details of NDVI Map:

Data extracted from	Date	Non vegetative area (km ²)	Vegetative area (km ²)
Landsat 8 OLI	22.11.2020	250.88	300.32
Landsat 5	16.01.2000	325.86	225.34
Landsat 3	28.11.1987	331.56	219.63
Landsat 3	27.12.1978	435.16	116.03

The comparison of NDVI values of SGNP from 1978 to 2020 shows a positive increase in vegetation area from 116.03 Sq.km to 300.32 sq.km. It indicates that *vegetation cover of SGNP increased over the years which is a good sign for the enhancement of its carrying capacity.*

3.5.2 Normalized Difference Water Index (NDWI) of SGNP:

The map of Normalized Difference Water Index (NDWI) of the study area is shown below:

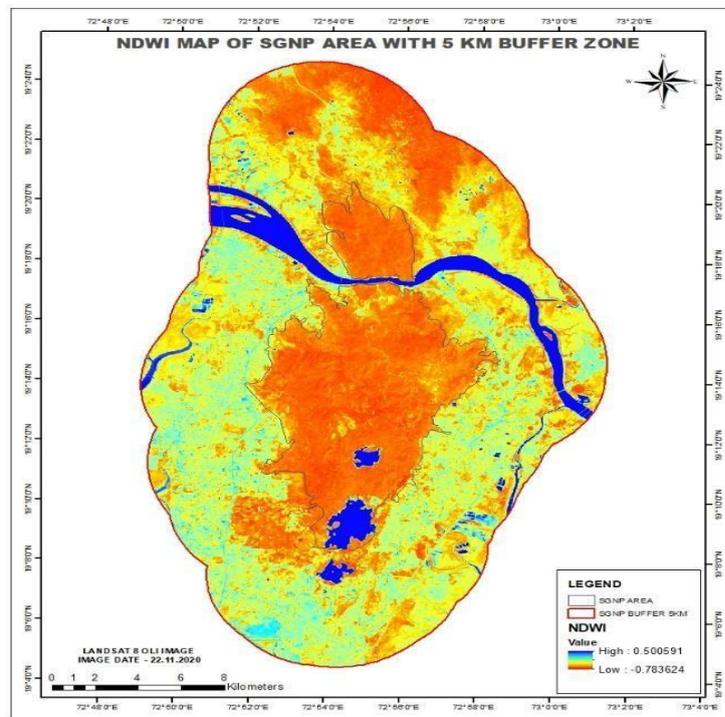


Fig. 3.3 Normalized Difference Water Index (NDWI) Map of SGNP

NDWI value of SGNP area dated 22.11.2020 shows a low value of -0.78 to a high value of 0.5. High values indicate water body while low values indicate dry land.

3.5.3 Land Stress Index (LSI) of SGNP:

The map of Land Stress Index (LSI) of the study area is shown in **Fig. 3.4** below:

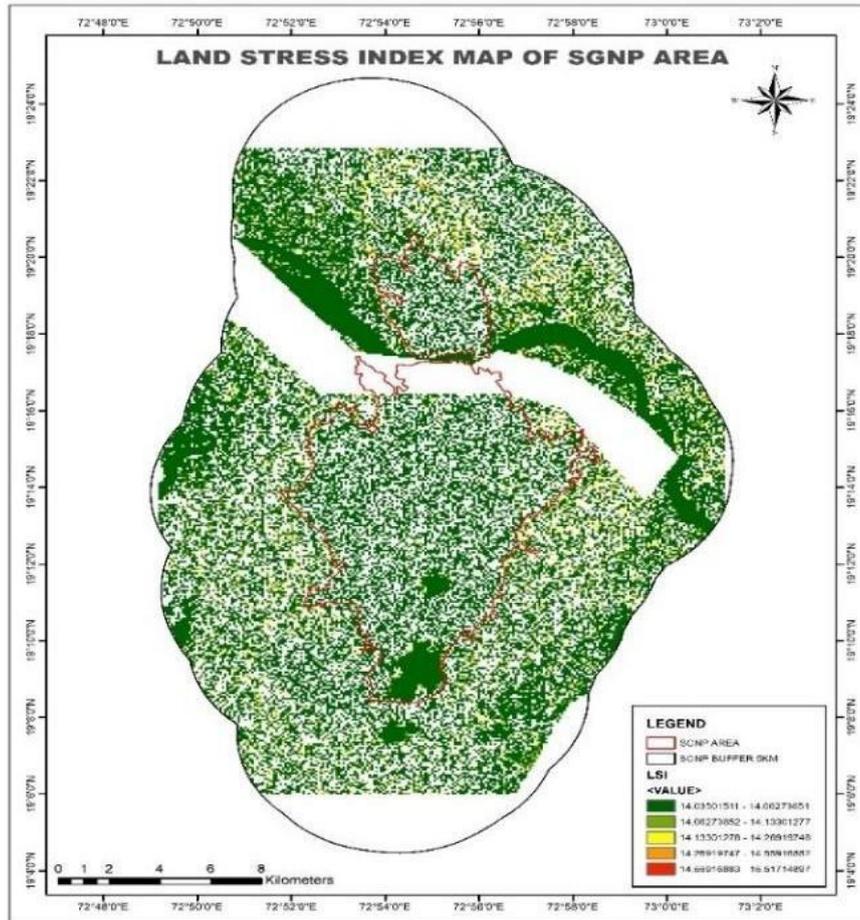


Fig. 3.4 Land Stress Index (LSI) Map of SGNP

The approximate areas of LSI in SGNP (in km²), are as follows:

Table 3.9: Details of Soil Erosion Classification:

LSI	Very Low	Low	Moderate	High	Very High
Area (km ²)	266.16	0.91	0.13	0.03	0.02

The above data depicts that most of the area of SGNP comes under very low land stress index, less chances of erodibility. On ground verification of the remotely sensed data is necessary in this case along with secondary literature.

3.5.4 Slope Map of SGNP:

The slope map of the study area is shown **Fig. 3.5** below:

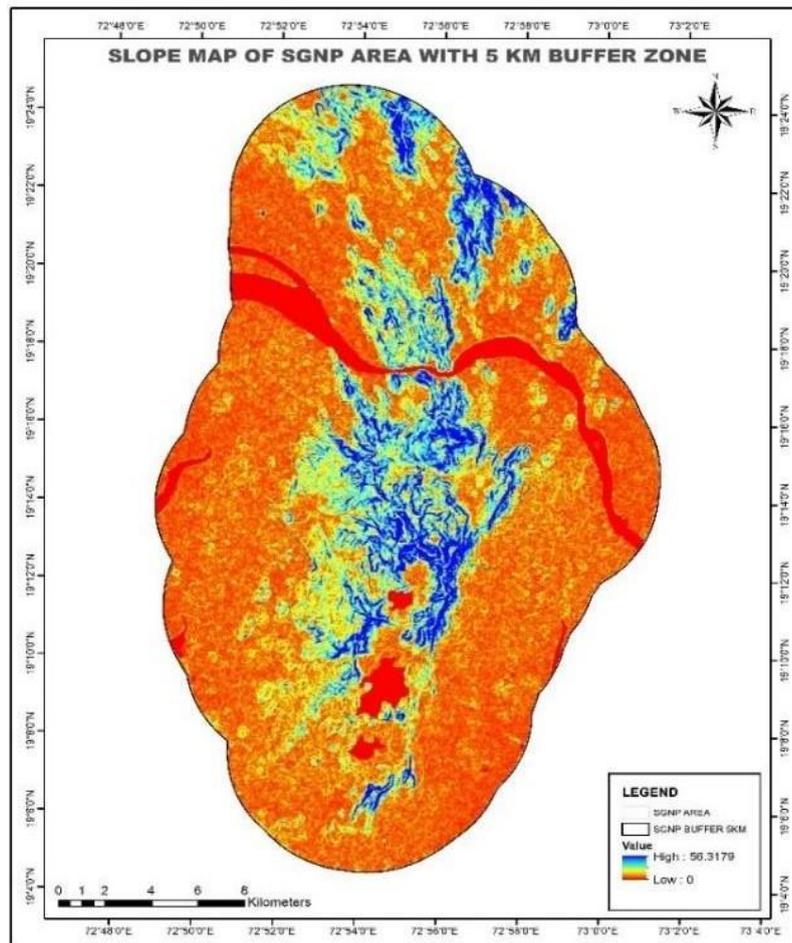


Fig. 3.5 Slope Map of SGNP

Slope values of SGNP ranges from 0 to 56.31. Lower values indicate low altitude area while higher values indicate high altitude areas.

3.5.5 Land Surface Temperature (LST) of SGNP:

Landsat 5, 8 data are used to calculate the Land Surface Temperature of SGNP area and the image dates are 22.11.2020 & 16.01.2000. The LST maps of SGNP displays that Land surface temperature has increased in 2020 when compared to 2000. The lowest temperature reported in 2000 was 17.93° C which has increased to 24.34° C in 2020. This increase needs attention and should be monitored constantly. The LST map of the study area for year 2000 and 2020 is shown in **Fig. 3.6** below:

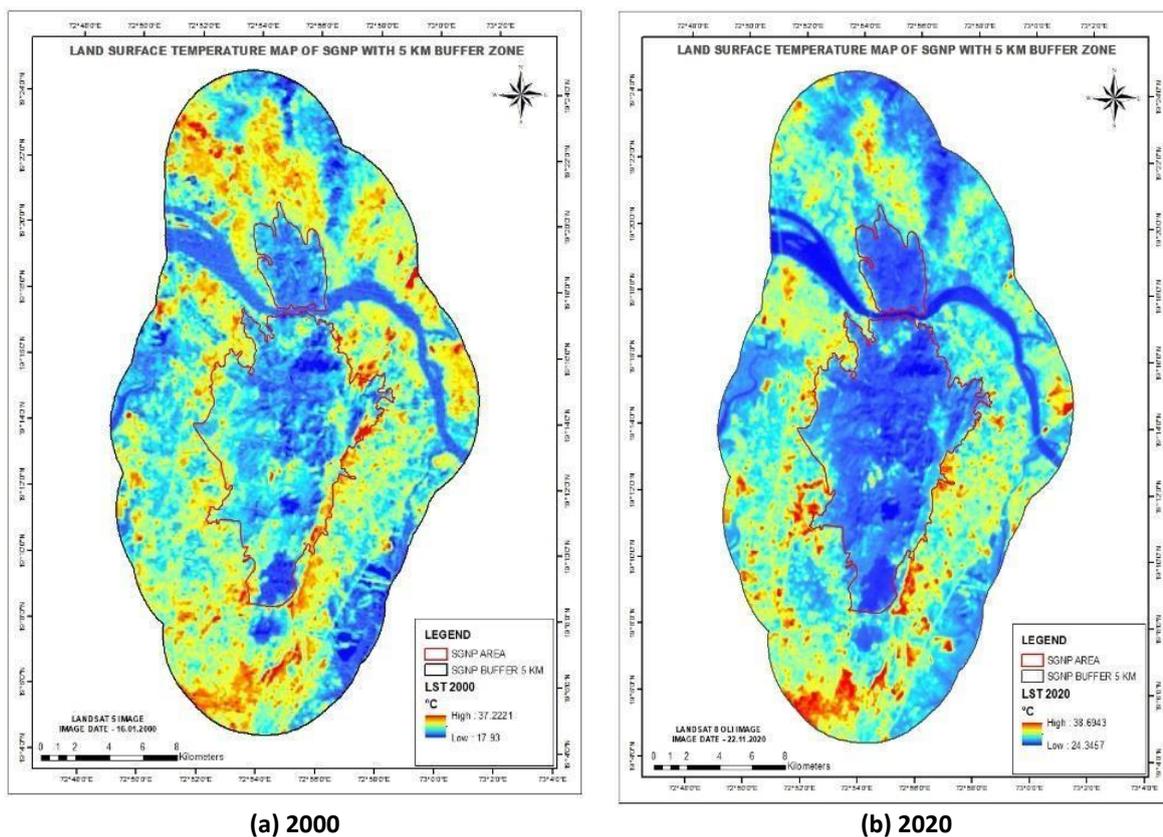


Fig. 3.6 Land Surface Temperature (LST) Map of SGNP: (a) 2000, (b) 2020

3.5.6 Habitat Quality Index (HQI) of SGNP:

The Habitat Quality Index (HQI) is primarily used to assess the adequacy of the habitat quality of the most important protected items in natural habitats. The Habitat Quality Index map of SGNP have a higher value of 267.74 and a lower value of 74.28. Higher values indicate high habitat suitability and lower values indicates low habitat suitability based on habitat quality. Most of the area of SGNP have higher HQI values hence greater habitat suitability for wildlife population. The HQI map depicting the study area is shown in **Fig. 3.7** below. On ground validation of the remotely sensed data is necessary.

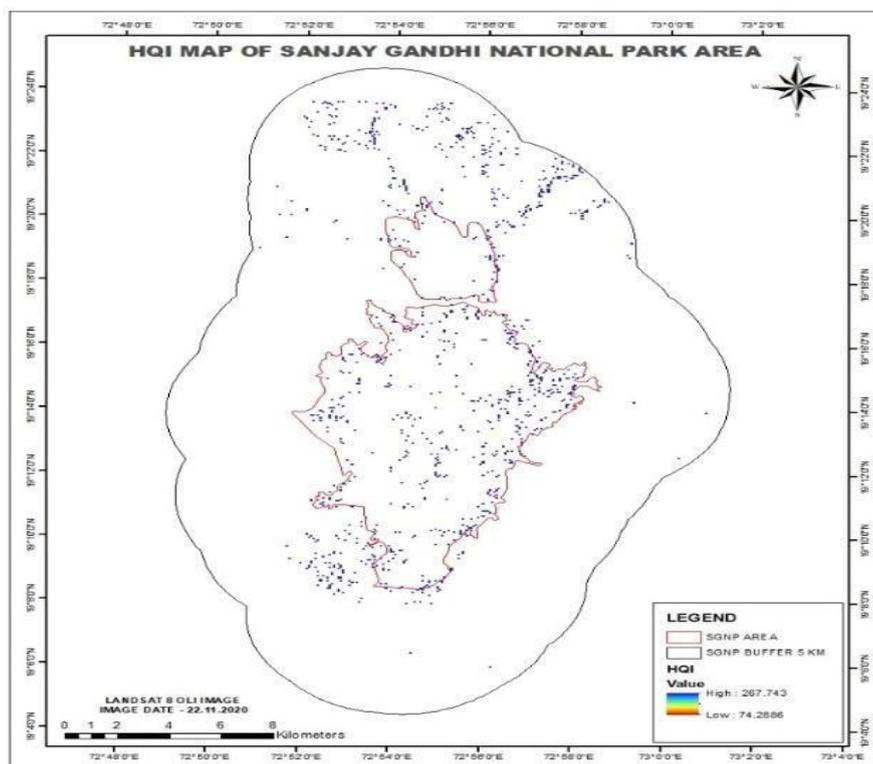


Fig. 3.7 Habitat Quality Index (HQI) Map of SGNP

3.5.7 Aerosol Optical Depth (AOD) and PM_{2.5} of SGNP:

For the analysis of the Aerosol Optical Depth (AOD) and PM_{2.5} data is extracted from AODMODIS with a spatial resolution of 3 km. The study area is extracted using ArcGIS tools. The details of the map are shown in the **Table 3.10** below:

Table 3.10: AOD and PM_{2.5} at Sanjay Gandhi National Park

Sr. No	Date	Aerosol Optical Depth (AOD)	Particulate Matter - PM _{2.5} (µg/m ³)
1	01.03. 2019	0.29	45.11
2	04.12.2019	0.02	14.36

The mean values of AOD and PM_{2.5} are showing variations. The estimate indicates higher anthropogenic activities and air pollution due to poor meteorological conditions. The map showing the details of aerosol optical depth and PM_{2.5} is shown in **Fig. 3.8 & Fig.3.9**. Detailed analysis of AOD and PM_{2.5} with better time resolution and continued monitoring is necessary to conclude this. These parameters form a crucial factor layer in the analytic

hierarchy process.

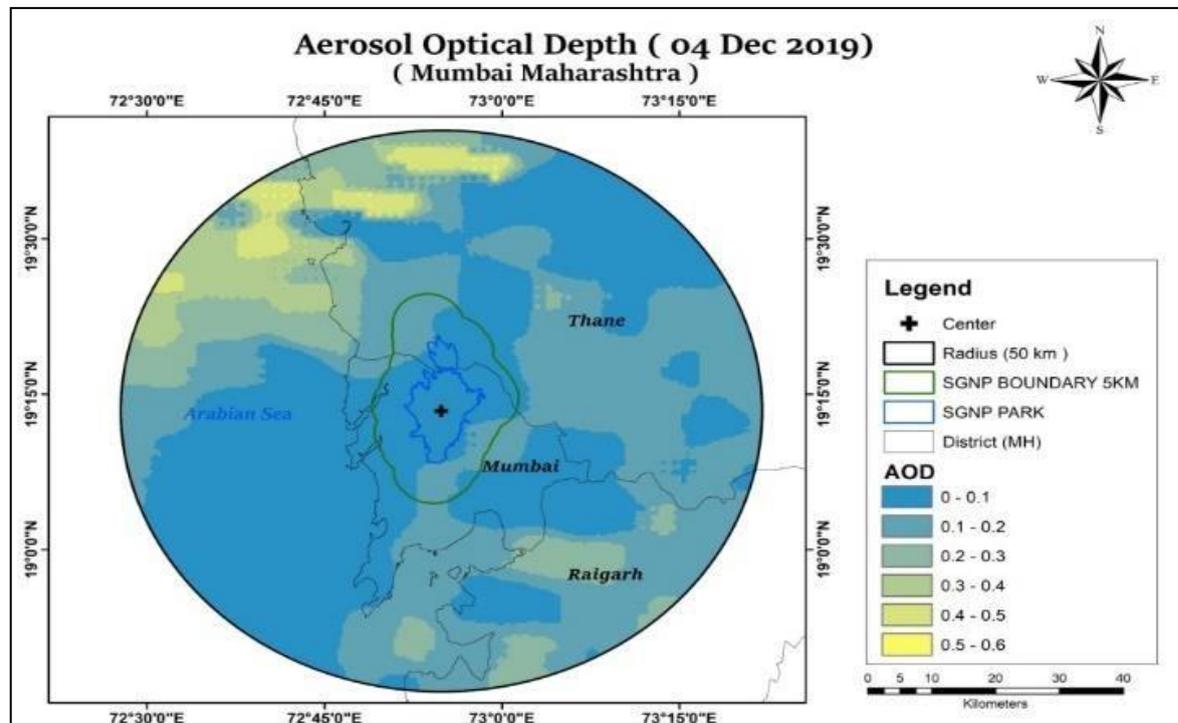
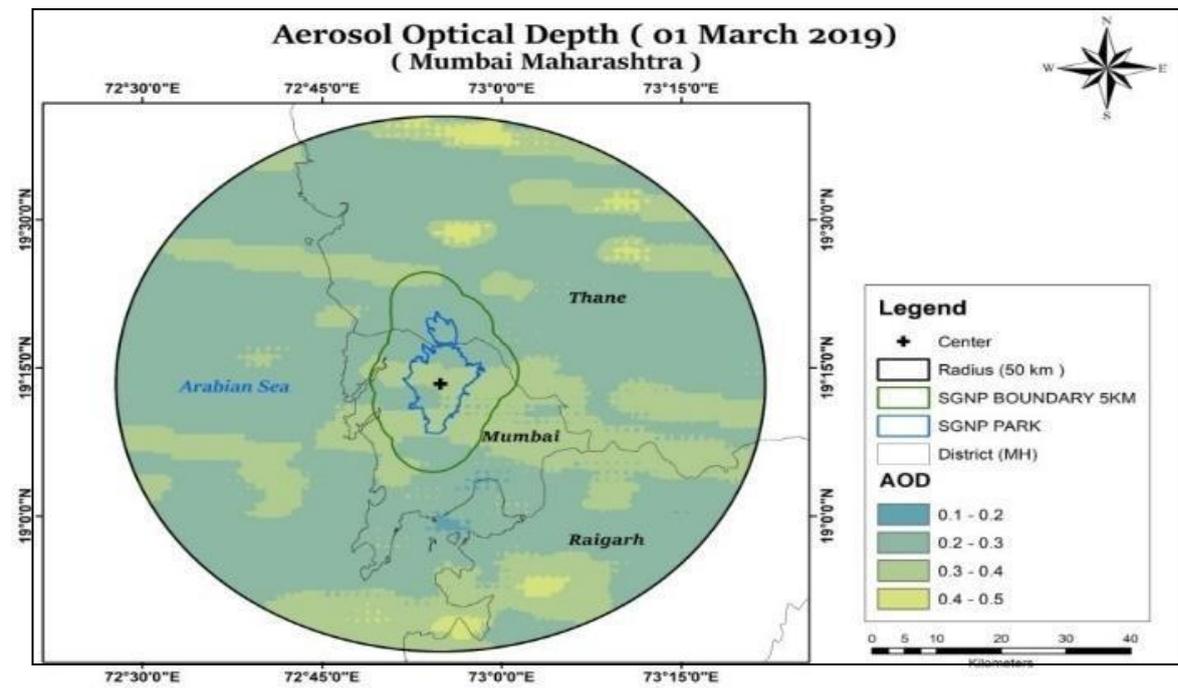


Fig. 3.8 Aerosol Optical Depth Map of SGNP

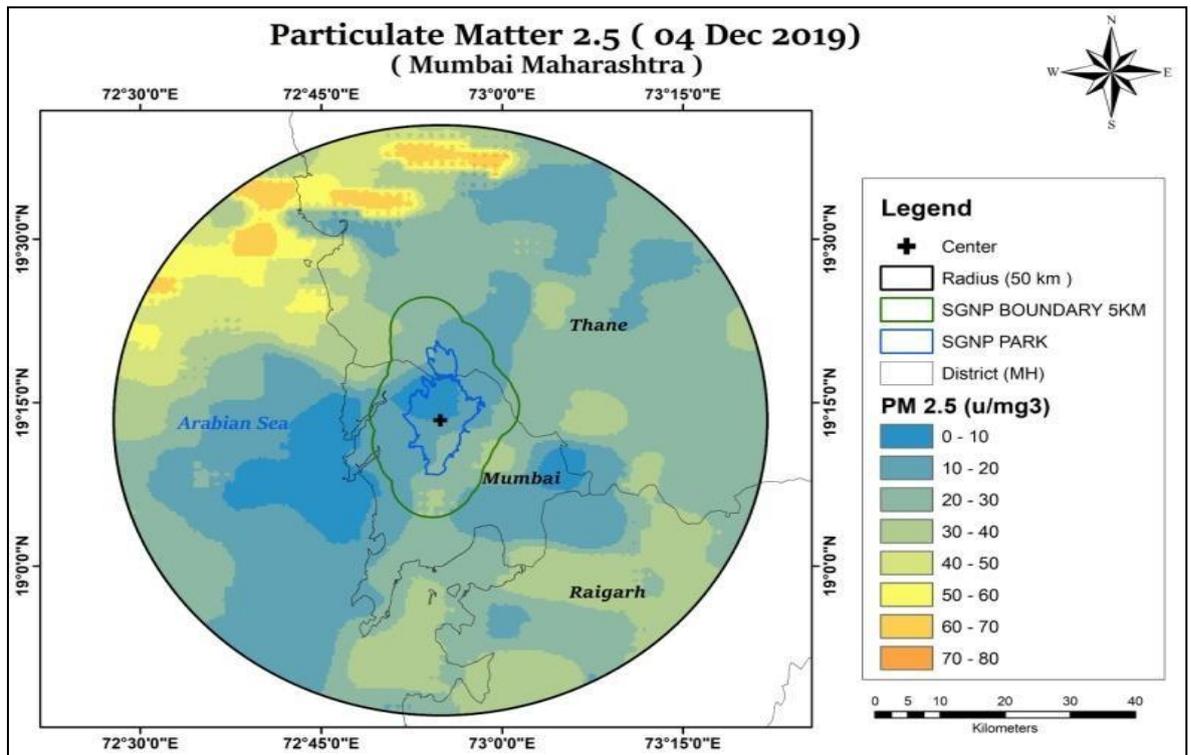
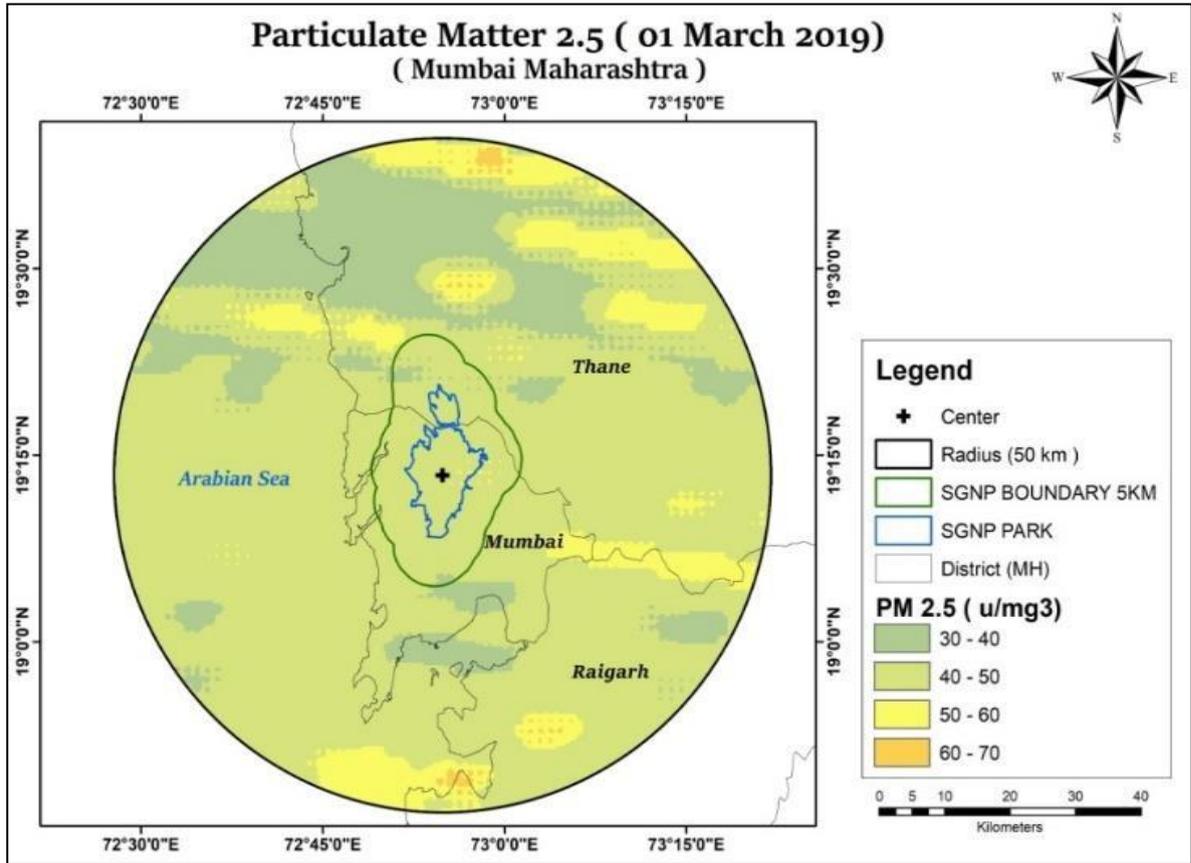


Fig. 3.9 Particulate Matter PM_{2.5} Map of SGNP

From the analysis of above environmental attributes, it has been seen that there are certain parameters which suggests that there is a breach of environmental carrying capacity. Parameters such as land use, air pollution, AOD, PM_{2.5}, Noise, Tourism and so on indicate that the park might be under tremendous environmental pressure while other factors such as biomass, forest, NDVI, NDWI etc., indicate that sufficient environmental carrying capacity is maintained. Hence this preliminary analysis is substantiated with more data and further assessment of environmental carrying capacity using Fuzzy Analytic Hierarchy Process (FAHP) is done in this study.

3.6 Assessment of Environmental Carrying Capacity (ECC) using AHP:

Based on the described methodology, the Environmental Carrying Capacity (ECC) was estimated for different years and the weights obtained using AHP process for evaluation factors is shown in **Table 3.11**.

Table 3.11: Subjective Weights based on Analytical Hierarchy Process Method:

Evaluation factors	Factor type	Weight
1. Slope	Negative	0.191
2. Land Use	Negative	0.084
3. Land Stress Index (LSI)	Negative	0.19
4. Habitat Quality Index	Positive	0.016
5. Water Network Denseness Index	Positive	0.066
6. Vegetation Cover	Positive	0.016
7. Annual Total Rainfall	Negative	0.034
8. Annual Total Temperature	Negative	0.05
9. AOD	Negative	0.097
10. PM 2.5	Negative	0.103
11. Temperature	Negative	0.057
12. Heat Intensity	Negative	0.097

The fuzzy matrix obtained for estimating ECC is shown in **Table 3.12** for SGNP without buffer.

Table 3.12: Fuzzy Matrix for year 2020 for SGNP without buffer

Evaluation factors	Remark Grades				
	Very Low (V1)	Low (V2)	Moderate (V3)	High (V4)	Very High (V5)
Slope	0.3427	0.6572	-1.4469	FALSE	0
Land Use (km ² ,)	0	0	0	0	0
Land Stress Index (LSI)	0.21875	0.7812	-0.7241	FALSE	0
Habitat Quality Index	FALSE	FALSE	0.6379	0.3620	1
Water Network Denseness Index	0	0	0	0	1
Vegetation Cover (km ² ,)	FALSE	FALSE	FALSE	0.3863	1
Annual Total Rainfall (mm)	0	0.7528	0.2471	FALSE	0
Annual Total Temperature	0	0.3571	0.6428	FALSE	0
AOD	0	0	2.4	0.6363	0.3636
PM 2.5	0	0	0.3636	0.6363	0
Temperature (°C)	0	0.6995	0.3004	FALSE	0
Heat Intensity (°C)	0	0.1428	0.8571	FALSE	0

The fuzzy matrix was constructed for different years i.e. 1987, 2000 and 2020 and then it was multiplied with weights to estimate the ECC. The ECC thus found was for SGNP with and without buffer under different grades. The maximum value of ECC corresponding to grade was selected as final ECC for SGNP and SGNP buffer and corresponding ECC status was estimated. The estimation of ECC for different years in the study are with and without buffer is shown in **Table 3.13**.

Table 3.13: Environmental Carrying Capacity (ECC) values for SGNP

Year	Environmental Carrying Capacity	
	SGNP	SGNP with buffer
1987	1.497 (Moderate)	0.519 (Moderate)
2000	0.2334 (very low)	0.381 (Low)
2020	0.25 (Low)	0.371 (Low)

The values in **Table 3.12**, are maximum of the values obtained across V₁ to V₅ grade and corresponding grade in which they were lying is shown in brackets below. From, **Table 3.13** it can be inferred that SGNP area was under moderate carrying capacity in year 1987 and after that due to air pollution and urban heat island effect the ECC of the region started deteriorating and in year 2000 it reached to very low stage. After 20 years, the inside of SGNP has improved but still the ECC remains low which is a matter of concern. Therefore, the efforts are required to maintain the area in such a way that it can be taken to its state of year 1987 when it has moderate ECC.

4.0 SUMMARY OF THE STUDY

Eco-Sensitive Zones (ESZs) or Ecologically Fragile Areas (EFAs) are areas in India notified by the MoEF&CC around Protected Areas, National Parks and Wildlife Sanctuaries. The purpose of declaring ESZs is to create "shock absorbers" to the protected areas by regulating and managing the activities around such areas. These zones are indispensable for a nation as they preserve biologically and ecologically rich areas and potentially valuable and unique natural resources that would be difficult to replace once annihilated. The ecosystem is quite delicate around these areas and needs to be protected against human intervention. They are of immense importance to human society as they are ecologically and economically important, maintain ecological stability and preserve the rarity of the ecosystems they harbor.

Ecosystems and populations have a limited capacity to cope with environmental stress; stress above a certain threshold may be detrimental for the ecosystem. Hence, Environmental Carrying Capacity (ECC) Assessment, which is a tool to determine "the growth limits that an area can accommodate without violating environmental capacity goals", are a need of the hour to protect such ESZs. The estimation of carrying capacity for the ecosystem identified can be expressed as the relationship between natural resources, environment and human economy to achieve sustainable and overall development. The estimation of ECC becomes essential for any eco system so that inclusive growth can be ascertained.

As the assignment is time bound (3 months) as directed by Hon'ble National Green Tribunal, out of 106 National Parks in the country, six national parks are within the state of Maharashtra, Sanjay Gandhi National Park (SGNP), Mumbai was identified for undertaking carrying capacity assessment, considering the advantages for immediately initiating study i.e. where the secondary data was available. The Eco-Sensitive Zone is spread over an area of 59.456 sq.km to an extent of 100 meters to 4 kilometers from the boundary of Sanjay Gandhi National Park.

Sanjay Gandhi National park, is located around 25 km north of Mumbai city and 8 km from the shores of Arabian Sea. It lies between 72° 53' & 72° 50' East longitude and 19° 88' & 19° 21' North latitude. Geographically, the southern boundary of the park is shaped by the Shore of Vihar Lake, the eastern by the townships of Bhandup, Mulund, and Thane,

and the western by Goregaon, Malad, Kandivali, and Borivali suburbs of Mumbai. The northern boundary expands past Bassein creek and incorporates the Nagla forest block. The park has a total area of 103.09 km², of which the recreational sector alone takes up 5.06 km². SGNP is one of the foremost highly visited national parks within the country.

Owing to the limited literature, data availability, selected methodologies, the calculations and findings with respect to Carrying Capacity of Tourism, Water environment, Noise and Air environment show that some of the environmental attributes are within the permissible limits of carrying capacity while some have exhausted the limits. The main findings are:

- ❖ The Utilization Ratio (UR) of available water resources in Sanjay Gandhi National Park is 59.87%, which is less than the reference value of 100%. However, the carrying capacity should be evaluated consistently in order to understand the changes in UR and plan for restoration, if needed.
- ❖ The total calculated footfall (Tourism carrying Capacity), in terms of tourists, shows that it is in a critical stage and has exceeded the maximum footfall possible when compared with the carbon sequestration potential of the area and hence that can affect the wildlife and its carrying capacity.
- ❖ The average values of noise levels are within the limit except for the Sanjay Gandhi National Park entrance gate and Yeur Village due to high traffic flows and other human activities. The noise level in these areas are exceeding the Noise Limits prescribed for Silence Zone during Day and Night time. The same should be controlled by suitable measures.
- ❖ The Utilization Ratio calculations for air pollutants show some of the air pollutants (NO₂, and Particulate Matters) are exceeding the prescribed National Ambient Air Quality Standards which are mainly due to vehicular pollution.

With appropriate air pollution and noise control management measures, the Air and Noise values can be maintained within limits without affecting the tourism population and the flora and fauna of the park.

- ❖ The Normalized Difference Vegetation Index (NDVI) values indicates that the

vegetation covers of Sanjay Gandhi National Park increased over the years, which is a good sign for the enhancement of its carrying capacity.

- ❖ The Land Use Land Cover (LULC) classification area for Sanjay Gandhi National Park from 1978-2020 shows a positive increase in forest land, which must be beneficial for the wildlife and overall ecosystem. Whereas, Mangroves and Water body areas within the Sanjay Gandhi National Park and buffer area, analyzed through remote sensing data, are decreasing year by year.
- ❖ Human settlements are increasing year by year till 2000 in the Sanjay Gandhi National Park area, while the increase is noted till date in the area including buffer, indicating a threat to the balance of the environment. The construction in the area should be avoided, as it might disturb the balance of ecological systems.
- ❖ The Land Surface Temperature (LST) maps of Sanjay Gandhi National Park displays that surface temperature increased in 2020 (24 - 34° C) when compared to 2000 (17.93° C). This increase needs attention and should be continuously monitored.
- ❖ Preliminary analysis of Sanjay Gandhi National Park indicates limited land stress which should be maintained as is for ecological balance to be maintained. The mean values of Aerosol Optical Depth (AOD) and PM_{2.5} show variations, and the maximum values of AOD and PM_{2.5} estimated in Sanjay Gandhi National Park in 2019 indicate higher anthropogenic activities and air pollution, which is also confirmed by the ground data.

The above environmental attributes are indicating that the eco sensitive zone under consideration is at a critical stage and in order to make a positive intervention and to restore the qualities of the eco-sensitive zone the assessment of carrying capacity is unavoidable and the same is evaluated in this report.

Parameters like air and noise might be clearly indicating a pressurized state, however, improvement in vegetation is a positive sign. In order to clearly understand the carrying capacity of the Sanjay Gandhi National Part, these critical environmental attributes are weighed scientifically and Fuzzy Analytic Hierarchy Process (FAHP) is used to derive a

meaningful conclusion in relation to environmental carrying capacity. The above parameters and the values ascertained using remote sensing and secondary literature forms the baseline scenario and is used for above advanced tool to estimate the overall environmental carrying capacity of the eco-sensitive zone.

The preliminary conclusion based on secondary data analysis concludes the following points:

1. Construction within the premises of the Sanjay Gandhi National Park should be discouraged as it will affect the fragile ecosystem of the area and will also put pressure on other environmental attributes such as water, air and noise which will affect the overall environmental carrying capacity.
2. Assessment of Noise Carrying Capacity will need a detailed analysis with biodiversity centric focus, given the impact of species present in the area can be severely affected. This aspect is to be explored in depth and a long term study is needed in this regards.
3. Suitable measures to curb the impacts of air and noise pollution in the area should employed at the earliest to preserve the floral and faunal biodiversity.
4. The slope factors of the area show a reduced stress on land which should be maintained by avoiding construction activities in the area.

Further evaluation of the Environmental Carrying Capacity for Sanjay Gandhi National Park using Fuzzy Analytic Hierarchy Process (FAHP) and considering the ecological parameters selected on a time scale shows that the ecological pressure is increasing in the area in terms of pollution and increasing temperatures. Hence seeing the temporal variation, the following conclusions are made:

- ❖ The ecological resilience factors like land cover which can be improved, should be done on priority.
- ❖ The ecological pressure inducing factors such as air pollution needs to be minimized by controlling the particulate matter.
- ❖ The State Government shall ensure the implementation of all the measures mentioned in Notification of Sanjay Gandhi National Park dated 05.12.2016

To summarize, the Environmental Carrying Capacity for Sanjay Gandhi National Park has deteriorated considerably, and efforts should be made ahead of time to ensure that the

present

Carrying capacity is protected and improved upon.

Further, to undertake carrying capacity of Eco-Sensitive Area in all the State/UTs, the Hon'ble NGT order in O.A no. 462/2018 dated 17.03.2021 directed that *“such exercise may be got conducted by concerned State/UT to be coordinated by a Joint Committee comprising state PCB, Secretary/Director Environment and Chief Wildlife Warden”*. In order to comply with court order and conducting such similar studies in the remaining 105 National Parks by the proposed Joint Committee of concerned States /UTs, a template is prepared for carrying out Environmental Carrying Capacity Study based on the present study, the same is given as **Appendix II**.

Secondly, while some of the activities could be allowed in all the eco-sensitive areas, others will need to be regulated / prohibited. The Chief Wildlife Warden shall ensure the group of activities listed i.e. Prohibited, Restricted with Safe Guards, and Permissible as per the Guidelines for Declaration of Eco – Sensitive Zones around the National Parks and Wildlife Sanctuaries of Ministry of Environment, Forest & Climate Change (MoEF&CC). The list of activities is listed as **Appendix III**.

Thirdly, the concerned department of State Government and Maharashtra State Pollution Control Board shall ensure the implementation of all the measures / regulations in respect of environmental pollution due to discharge of effluents, air pollution, noise pollution, solid waste & bio-medical waste management, vehicular traffic, establishment of industries, list of permitted activities etc. as mentioned / specified in the Notification of Sanjay Gandhi National Park dated 05.12.2016 by MoEF&CC.

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Annexure IA

Details of National Parks

State & UT	State Area (km ²)	No. of NP	Area (km ²)	% of State Area
1. Andhra Pradesh	160229	3	1368.87	0.85
2. Arunachal Pradesh	83743	2	2,290.82	2.74
3. Assam	78438	7	2,634.04	3.36
4. Bihar	94163	1	335.65	0.36
5. Chhattisgarh	135191	3	2,899.08	2.14
6. Goa	3702	1	107.00	2.89
7. Gujarat	196022	4	480.12	0.24
8. Haryana	44212	2	48.25	0.11
9. Himachal Pradesh	55673	5	2,256.28	4.05
11. Jharkhand	79714	1	226.33	0.28
12. Karnataka	191791	5	2,794.05	1.46
13. Kerala	38863	6	558.16	1.44
14. Madhya Pradesh	308245	11	4349.14	1.41
15. Maharashtra	307713	6	1,273.60	0.41
16. Manipur	22327	2	140.00	0.63
17. Meghalaya	22429	2	267.48	1.19
18. Mizoram	21081	2	150.00	0.71
19. Nagaland	16579	1	202.02	1.22
20. Odisha	155707	2	990.70	0.64
21. Punjab	50362	0	0.00	0.00
22. Rajasthan	342239	5	3,947.07	1.15
23. Sikkim	7096	1	1,784.00	25.14
24. Tamil Nadu	130058	5	827.51	0.64
25. Telangana	114840	3	19.62	0.02
25. Tripura	10486	2	36.71	0.35
26. Uttar Pradesh	240928	1	490.00	0.20
27. Uttarakhand	53483	6	4,915.02	9.19
28. West Bengal	88752	6	1,981.48	2.23
29. Andaman & Nicobar	8249	6	1,216.95	14.75
30. Chandigarh	114	0	0.00	0.00
31. Dadra & Nagar Haveli	491	0	0.00	0.00
32. Daman & Diu	112	0	0.00	0.00
33. Delhi	1483	0	0.00	0.00
34. Jammu & Kashmir	163090	4	2432.45	1.49
36. Ladakh	59146	1	3350.00	5.66
37. Lakshadweep	32	0	0.00	0.00
38. Puducherry	480	0	0.00	0.00
TOTAL	32,87,263	106	44,372.42	1.35

State wise details of National Park

S. No.	State	Name of National Park	Year of Notification
1.	Andhra Pradesh	1. Papikonda	2008
		2. Rajiv Gandhi (Rameswaram)	2005
		3. Sri Venkateswara	1989
2	Arunachal Pradesh	1. Mouling	1986
		2. Namdapha	1983
3	Assam	1. Dibru-Saikhowa	1999
		2. Kaziranga	1974
		3. Manas	1990
		4. Nameri	1998
		5. Rajiv Gandhi (Orang)	1999
		6. Raimona	2021
		7. Dihing Patkai	2021
4	Andaman & Nicobar Islands	1. Campbell Bay	1992
		2. Galathea Bay	1992
		3. Mahatama Gandhi Marine (Wandoor)	1983
		4. Mount Harriett	1987
		5. Rani Jhansi Marine	1996
		6. Saddle Peak	1987
5	Bihar	1. Valmiki	1989
6	Chhattisgarh	1. Guru Ghasidas (Sanjay)	1981
		2. Indravati (Kutru)	1982
		3. Kanger Valley	1982
7	Goa	1. Mollem	1992
8	Gujarat	1. Blackbuck (Velavadar)	1976
		2. Gir	1975
		3. Marine (Gulf of Kachchh)	1982
		4. Vansda	1979
9	Haryana	1. Kalesar	2003
		2. Sultanpur	1989
10	Himachal Pradesh	1. Great Himalayan	1984
		2. Inderkilla	2010
		3. Khirganga	2010
		4. Pin Valley	1987
		5. Col. Sherjung Simbalbara	2010
11	Jharkhand	1. Betla	1986
12	Jammu & Kashmir	1. City Forest (Salim Ali)	1992
		2. Dachigam	1981
		3. Kazinag	2000
		4. Kishtwar High Altitude	1981
13	Karnataka	1. Anshi	1987
		2. Bandipur	1974

Assessment of Environmental Carrying Capacity of ESZ-SGNP

S. No.	State	Name of National Park	Year of Notification
		3. Bannerghatta	1974
		4. Kudremukh	1987
		5. Nagarahole (Rajiv Gandhi)	1988
14	Kerala	1. Anamudi Shola	2003
		2. Eravikulam	1978
		3. Mathikettan Shola	2003
		4. Pambadum Shola	2003
		5. Periyar	1982
		6. Silent Valley	1984
15	Ladakh	1. Hemis	1981
16	Madhya Pradesh	1. Bandhavgarh	1968
		2. Dinosaur Fossils	2011
		3. Fossil	1983
		4. Pench	1975
		5. Kanha	1955
		6. Kuno	2018
		7. Madhav	1959
		8. Panna	1981
		9. Sanjay	1981
		10. Satpura	1981
		11. Van Vihar	1979
17	Maharashtra	1. Chandoli	2004
		2. Gugamal	1975
		3. Nawegaon	1975
		4. Pench (Jawaharlal Nehru)	1975
		5. Sanjay Gandhi (Borivilli)	1983
		6. Tadoba	1955
18	Manipur	1. Keibul-Lamjao	1977
		2. Shiroi	1982
19	Meghalaya	1. Balphakram	1986
		2. Nokrek Ridge	1997
20	Mizoram	1. Murlen	1991
		2. Phawngpui (Blue Mountain)	1992
21	Nagaland	1. Intanki	1993
22	Odisha	1. Bhitarkanika	1988
		2. Simlipal	1980
23	Rajasthan	1. Desert	1992
		2. Keoladeo Ghana	1981
		3. Mukundra Hills	2006
		4. Ranthambhore	1980
		5. Sariska	1992
24	Sikkim	1. Khangchendzonga	1977
25	Tamil Nadu	1. Guindy	1976
		2. Gulf of Mannar Marine	1980
		3. Indira Gandhi (Annamalai)	1989
		4. Mudumalai	1990
		5. Mukurthi	1990

Assessment of Environmental Carrying Capacity of ESZ-SGNP

S. No.	State	Name of National Park	Year of Notification
26	Telangana	1. Kasu Brahmananda Reddy	1994
		2. Mahaveer Harina Vanasthali	1994
		3. Mrugavani	1994
27	Tripura	1. Clouded Leopard	2007
		2. Bison (Rajbari)	2007
28	Uttar Pradesh	1. Dudhwa	1977
29	Uttarakhand	1. Corbett	1936
		2. Gangotri	1989
		3. Govind	1990
		4. Nanda Devi	1982
		5. Rajaji	1983
		6. Valley of Flowers	1982
30	West Bengal	1. Buxa	1992
		2. Gorumara	1992
		3. Jaldapara	2014
		4. Neora Valley	1986
		5. Singalila	1986
		6. Sunderban	1984

Notification of Sanjay Gandhi National Park

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 5th December, 2016

S.O. 3645(E).—Whereas, a draft notification, declaring Eco-sensitive Zone around Sanjay Gandhi National Park, Borivali in Mumbai of Maharashtra State, was published in the Gazette of India, Extraordinary, vide notification of the Government of India in the Ministry of Environment, Forest and Climate Change number S.O. 229(E), dated the 22nd January, 2016, inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS, copies of the Gazette containing the said notification were made available to the public on the 22nd January, 2016;

AND WHEREAS, objections and suggestions received from all persons and stakeholders in response to the draft notification have been duly considered by the Central Government;

AND WHEREAS, the Sanjay Gandhi National Park (hereinafter referred to as the National Park) is a unique habitat enclosed in the metropolis of Mumbai and is located in the Thane and Mumbai District of Maharashtra State between N 19° 8.8" to 19° 21" latitude and E 72° 53" to 72° 58" longitudes;

AND WHEREAS the National Park is home to a number of endangered species of flora and fauna and harbours approximately 1300 species of flowering plants, 45 species of mammals, 43 species of reptiles, including 38 species of snakes, 12 species of amphibians, 300 species of birds, 150 species of butterflies;

AND WHEREAS, the area is known for mammalian species such as Leopard (*Panthera pardus*), Wild Boar (*Sus sp*), Four Horned Antelope (*Tetracerus quadricornis*), Blacknaped Hare, Wild Cat (*Felis chaus*), Jackal (*Canis aureus*), and Porcupine (*Hystrix indica*) and also harbours many bird species such as Peacock (*Pavo cristatus*), Lesser Grebe, Purple Heron (*Ardea purpurea*), Smaller Egret, Lesser Whistling Teal, Pariah Kite, Bulbul and many reptiles are also found in the National Park including snakes as Indian Cobra and Viper;

AND WHEREAS, the vegetation of the area ranges from littoral forests to western sub-tropical hill forests and as per the revised classification of Indian Forest Types by Champion and Seth, the National Park has Southern Tropical Moist Mixed Deciduous Forest and Western Sub Tropical Hill Forest and some of the tree species are *Tectona grandis*, *Terminalia tomentosa*, *Acacia catechu*, *Adina cordifolia*, *Mitragyna parviflora*, *Pterocarpus marsupium*, *Holarrhena antidysentrica*, *Butea monosperma*, and *Diospyros melanoxylon* etc.;

AND WHEREAS, it is necessary to conserve and protect the area the extent and boundaries of which is specified in paragraph 1 of this notification around the Sanjay Gandhi National Park as Eco-sensitive Zone from ecological and environmental point of view and to prohibit industries or class of industries and their operations and processes in the said Eco-sensitive Zone;

NOW Therefore, in exercise of the power conferred by sub-section(1) and clauses (v) and (xiv) of sub-section (2) and sub-section (3) of section 3 of the Environment (Protection) Act 1986 (29 of 1986) read with sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby notifies an area to an extent of 100 meters to four kilometers from the boundary of Sanjay Gandhi National Park in the State of Maharashtra as the Sanjay Gandhi National Park Eco-sensitive Zone (hereinafter after referred to as Eco-sensitive Zone) details of which are as under, namely:-

1. Extent and boundaries of Eco-sensitive Zone.—(1) The Eco-sensitive Zone is spread over an area of 59.456 sq.km to an extent of 100 meters to four kilometers from the boundary of Sanjay Gandhi National Park and the boundary description of the Eco-sensitive Zone is given in **Annexure I**.

(2) The map of the Eco-sensitive zone along with latitude and longitude is included in **Annexure II**.

(3) The list of the villages falling within Eco-sensitive Zone is included in **Annexure III**.

2. Zonal Master Plan for Eco-sensitive Zone.—(1) The State Government shall, for the purpose of the Eco-sensitive Zone prepare, a Zonal Master Plan, within a period of two years from the date of publication of this

notification in the Official Gazette, in consultation with local people and adhering to the stipulations given in this notification.

- (2) The said Plan shall be approved by the Competent Authority in the State Government.
- (3) The Zonal Master Plan for the Eco-sensitive Zone shall be prepared by the State Government in such manner as is specified in this notification and also in consonance with the relevant Central and State laws and the guidelines issued by the Central Government, if any.
- (4) The Zonal Master Plan shall be prepared in consultation with all concerned State Departments, namely:-
 - (i) Environment;
 - (ii) Forest;
 - (iii) Urban Development;
 - (iv) Tourism;
 - (v) Municipal;
 - (vi) Revenue;
 - (vii) Agriculture;
 - (viii) Maharashtra State Pollution Control Board;
 - (ix) Irrigation;
 - (x) Public Works Department;

for integrating environmental and ecological considerations into it.

- (5) The Zonal Master Plan shall not impose any restriction on the approved existing land use, infrastructure and activities, unless so specified in this notification and the Zonal Master Plan shall factor in improvement of all infrastructure and activities to be more efficient and eco-friendly.
- (6) The Zonal Master plan shall provide for restoration of denuded areas, conservation of existing water bodies, management of catchment areas, watershed management, groundwater management, soil and moisture conservation, needs of local community and such other aspects of the ecology and environment that need attention.
- (7) The Zonal Master Plan shall demarcate all the existing worshipping places, village and urban settlements, types and kinds of forests, agricultural areas, fertile lands, green area, such as, parks and like places, horticultural areas, orchards, lakes and other water bodies.
- (8) The Zonal Master Plan shall regulate development in Eco-sensitive Zone as to ensure Eco-friendly development for livelihood security of local communities.

3. Measures to be taken by State Government.—The State Governments shall take the following measures for giving effect to the provisions of this notification, namely:-

- (1) **Land use.**—Forests, horticulture areas, agricultural areas, parks and open spaces earmarked for recreational purposes in the Eco-sensitive Zone shall not be used or converted into areas for commercial or industrial related development activities:

Provided that the conversion of agricultural lands, including the lands included in the category of the no development zones in the Development Plan of the adjoining cities, within the Eco-sensitive Zone may be permitted on the recommendation of the Monitoring Committee, and with the prior approval of the State Government, to meet the residential needs of local residents, and for the activities listed against serial numbers 10, 16, 22, 32 and 35 in column (2) of the Table in paragraph 4, namely:-

- (i) Eco-friendly cottages for temporary occupation of tourists, such as tents, wooden houses, etc. for Eco-friendly tourism activities;
- (ii) Widening and strengthening of existing roads, construction of new roads and other infrastructure works such as Mumbai metro rail, etc.;

- (iii) Renovation and augmentation and upgradation of civic amenities including creation of infrastructure for water supply and storage and other civic amenities, including augmentation and upgradation of existing transmission lines, telecommunication towers, etc and establishment of new underground transmission cables and communication cables, etc;
- (iv) Small scale industries not causing pollution,
- (v) Rainwater harvesting, and
- (vi) Cottage industries including village industries, convenience stores, local amenities, public utility and community buildings:

Provided further that no use of tribal land shall be permitted for commercial and industrial development activities without the prior approval of the State Government and without compliance of the provisions of article 244 of the Constitution or the law for the time being in force, including the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (2 of 2007):

Provided also that any error appearing in the land records within the Eco-sensitive Zone shall be corrected by the State Government, after obtaining the views of Monitoring Committee, once in each case and the correction of said error shall be intimated to the Central Government in the Ministry of Environment, Forest and Climate Change:

Provided also that the above correction of error shall not include change of land use in any case except as provided under this sub-paragraph.

Provided also that there shall be no consequential reduction in green area, such as forest area and agricultural area and efforts shall be made to reforest the unused or such unproductive agricultural areas.

(2) **Natural Springs.**—The catchment areas of all natural springs shall be identified and plans for their conservation and rejuvenation shall be incorporated in the Zonal Master Plan and the guidelines shall be drawn up by the State Government in such a manner as to prohibit development activities at or near these areas as which are detrimental to such areas.

(3) **Tourism.**—

(a) The activity relating to tourism within the Eco-sensitive Zone shall be as per the Tourism Master Plan, which shall form part of the Zonal Master Plan.

(b) The Tourism Master Plan shall be prepared by the Department of Tourism, Government of Maharashtra in consultation with Department of Revenue and Forests, Government of Maharashtra.

(c) The activity of tourism shall be regulated as under, namely:-

(i) all new tourism activities or expansion of existing tourism activities within the Eco-sensitive Zone shall be in accordance with the guidelines issued by the Central Government in the Ministry of Environment, Forest and Climate Change and the eco-tourism guidelines issued by National Tiger Conservation Authority, (as amended from time to time) with emphasis on eco-tourism, eco-education and eco-development and based on carrying capacity study of the Eco-sensitive Zone;

(ii) new construction of hotels and resorts shall not be permitted within one kilometer from the boundary of the Sanjay Gandhi National Park or the extent of Eco-sensitive Zone, whichever is nearer, except for accommodation for temporary structures for tourists related to Eco-friendly tourism activities:

Provided that beyond one kilometer from the boundary of protected area till the extent of the Eco-sensitive Zone, the establishment of new hotels and resorts shall be permitted only in pre-defined and designated areas for Eco-tourism facilities as per Zonal Master Plan;

(iii) till the Zonal Master Plan is approved, development for eco-tourism and expansion of existing tourism activities shall be permitted by the concerned regulatory authorities based on the actual site specific scrutiny and recommendation of the Monitoring Committee.

(4) **Natural Heritage.**—All sites of valuable natural heritage in the Eco-sensitive Zone, such as the gene pool reserve areas, water bodies, rock formations, waterfalls, springs, gorges, groves, caves, points, walks, rides, cliffs, etc. shall be identified and preserved and plan shall be drawn up for their protection and

conservation, within six months from the date of publication of this notification and such plan shall form part of the Zonal Master Plan.

(5) **Man-made heritage sites.**—Buildings, structures, artifacts, areas and precincts of historical, architectural, aesthetic, and cultural significance shall be indentified in the Eco-sensitive Zone and plans for their conservation shall be prepared within six months from the date of publication of this notification and incorporated in the Zonal Master Plan.

Noise pollution.—The Environment Department of the State Government or Maharashtra State Pollution Control Board shall implement the regulations for control of noise pollution in the Eco-sensitive Zone in accordance with the provisions stipulated of The Noise Pollution (Regulation And Control) Rules, 2000 under the Environment (Protection) Act, 1986.

(6) **Air pollution.**—The Environment Department of the State Government or Maharashtra State Pollution Control Board shall draw up guidelines and regulations for the control of air pollution in the Eco-sensitive Zone in accordance with the provisions of the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and the rules made thereunder.

(7) **Discharge of effluents.**—The discharge of treated effluent in Eco-sensitive Zone shall be in accordance with the provisions of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the rules made thereunder.

(9) **Solid wastes.**—Disposal of solid wastes shall be as under:-

(i) the solid waste disposal in Eco-sensitive Zone shall be carried out as per the provisions of the Solid Waste Management Rules, 2016 published by the Government of India, Ministry of Environment and Forests and Climate Change vide notification number S.O. 1357 (E), dated the 8th April, 2016 as amended from time to time;

(ii) the local authorities shall draw up plans for the segregation of solid wastes into biodegradable and non-biodegradable components;

(iii) the biodegradable material shall be recycled preferably through composting or vermiculture;

(iv) The inorganic material may be disposed in an environmental acceptable manner at site identified outside the Eco-sensitive Zone and no burning or incineration of solid wastes shall be permitted in the Eco-sensitive Zone.

(10) **Bio-medical waste.**— The bio-medical waste disposal in the Eco-sensitive Zone shall be carried out as per the provisions of the Bio-Medical Waste Management Rules, 2016 published by the Government of India, Ministry of Environment, Forest and Climate Change vide Notification number GSR 343 (E), dated the 28th March, 2016 as amended from time to time.

(11) **Vehicular traffic.**—The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions in this regard shall be incorporated in the Zonal Master Plan and till such time as the Zonal master plan is prepared and approved by the Competent Authority in the State Government, the Monitoring Committee shall monitor compliance of vehicular movement under the relevant Acts and the rules and regulations made thereunder.

(12) **Industrial Units.**—

(a) No establishment of new wood based Industries within the proposed Eco-sensitive Zone shall be permitted except the existing wood based Industries set up as per the Law.

(b) No establishment of any new Industry causing water, air, soil, noise pollution within the proposed Eco-sensitive Zone shall be permitted.

4. List of activities prohibited or to be regulated within the Eco-sensitive Zone.—All activities in the Eco sensitive Zone shall be governed by the provisions of the Environment (Protection) Act, 1986 (29 of 1986), and the rules made thereunder and be regulated in the manner specified in the Table below, namely:-

TABLE

S. No.	Activity	Remarks
Prohibited Activities		
1.	Commercial Mining, stone quarrying and crushing units.	New and existing mining (minor and major minerals), stone quarrying and crushing units shall be prohibited except for the domestic needs of bona fide local residents with reference to digging of earth for construction or repair of houses and for manufacture of country tiles or bricks for housing for personal use. The license/lease of existing mines and stone crushers shall not be extended. If license violates the existing rules under different Acts, the license will be terminated The mining operations shall strictly be in accordance with the interim order of the Hon'ble Supreme Court dated 04.08.2006 in the matter of T.N. Godavarman Thirumulpad Vs. UOI in W.P.(C) No. 202 of 1995 and order of the Hon'ble Supreme Court dated 21.04.2014 in the matter of Goa Foundation Vs. UOI in W.P.(C) No. 435 of 2012.
2.	Setting up of saw mills.	No new or expansion of any existing saw mills shall be permitted within the Eco-sensitive Zone.
3.	Setting up of Industries causing water or air or soil or noise pollution	No new or expansion of polluting Industries in the Eco-sensitive Zone shall be permitted
4.	Establishment of hydroelectric projects and thermal power plants	Prohibited (except as otherwise provided) as per applicable laws.
5.	Use or production of any hazardous substances.	Prohibited (except as otherwise provided) as per applicable laws.
6.	Discharge of untreated effluents and solid waste in natural water bodies or land area.	Prohibited (except as otherwise provided) as per applicable laws.
7.	New wood based industry.	Establishment of new wood based industry shall not be permitted within the limits of Eco-sensitive Zone: Provided the existing wood-based industry may continue unless prohibited under any law for the time being force
8.	New encroachments and their regularization.	Encroachments of all kinds shall be prohibited.
9.	Lease out of submergence areas by irrigation department.	Total ban on lease for farming, fishing or any other activity in the submergence area, not related to the stated purpose (water supply & ancillary works thereto) of the lakes and tanks.
Regulated Activities		
10.	Establishment of hotels and resorts.	No new commercial hotels and resorts shall be permitted, within one kilometer of the boundary of the Protected Area or the extent of Eco-sensitive Zone whichever is nearer, except related to eco-friendly tourism activities:

S. No.	Activity	Remarks
		<p>Provided that beyond one km. from the boundary of the Sanjay Gandhi National Park area and up to the extent of the Eco-sensitive Zone, all new eco-tourism activities or expansion of existing activities shall be in conformity with the Zonal Master Plan.</p>
11.	Construction activities.	<p>Construction shall be permitted within the Eco-sensitive Zone as per the provisions of the approved Development Plan and other applicable rules and regulation under the Maharashtra Regional and Town Planning Act:</p> <p>Provided that the under construction/renovation of commercial buildings including group housing societies, offices, and services such as Information Technology/Information Technology Enabled Services, Parks, Roads, Power Transmission lines and cables, Telecommunication Towers and cables, Sewage lines, civic amenities, etc., and new construction projects such as Mumbai Metro Rail Shed, and creation of new civic amenities such as water supply related infrastructure and facilities and Operation & Maintenance of infrastructure, facilities of civic amenities sanctioned by concerned Local Self Government under approved Development Plan under the Maharashtra Regional and Town Planning Act, may be permitted within ESZ subject to applicable rules and regulations.</p> <p>Provided further that commercial redevelopment, reconstruction, repairs of existing structures which includes group housing societies, sanctioned by concerned Local Self Government under approved Development Plan under the Maharashtra Regional and Town Planning Act, may be allowed within Eco-sensitive Zone subject to applicable rules and regulations:</p> <p>Provided further that the commercial redevelopment reconstruction, repairs of existing structures which includes group housing societies, sanctioned by concerned Local Self Government under approved Development Plan under the Maharashtra Regional and Town Planning Act, may be allowed within the Eco-sensitive Zone subject to applicable rules and regulations.</p> <p>The construction activity related to small scale industries not causing pollution shall be permitted as per applicable rules and regulations, if any, with the prior permission from the competent authority.</p> <p>The Approved Development Plan shall be in conformity with the Zonal Master Plan taking into consideration the conservation aspects of the Eco-sensitive Zone.</p>
12.	Felling of trees.	<p>There shall be no felling of trees on the forest or Government or revenue or private lands without prior permission of the competent authority in the State Government.</p>

S. No.	Activity	Remarks
		The felling of trees shall be regulated in accordance with the provisions of the concerned Central or State Act and the rules made thereunder.
13.	Commercial water resources including ground water harvesting.	The extraction of surface water and ground water shall be permitted only for bona fide agricultural use and domestic consumption of the occupier of the land. Extraction of surface water and ground water for industrial or commercial use including the amount that can be extracted, shall require prior written permission from the concerned regulatory authority: The construction activities of water supply infrastructure facilities of Municipal Corporation/Council related to maintenance, rehabilitation and augmentation are permitted. No extraction of surface water or ground water shall be permitted; however sale of bottled water, water in containers and tankers for the requirement as applicable shall be permitted. Steps shall be taken to prevent contamination or pollution of water from any source including agriculture.
14.	Erection of electrical cables and telecommunication towers.	Regulated as per applicable laws. Construction/Augmentation and renovation of Power Transmission lines and cables, Telecommunication Towers and cables is permitted. New underground cabling is promoted.
15.	Fencing of existing premises of hotels and lodges.	Regulated as per applicable laws. A tall fence shall be erected over the existing boundary wall of the Sanjay Gandhi National Park.
16.	Widening and strengthening of existing roads, bridges, infrastructure and construction of new roads, public utility or community buildings.	Shall be done as per applicable laws to these activities without adverse impact within the Eco-sensitive Zone.
17.	Movement of vehicular traffic at night.	Regulated for commercial purpose under applicable laws.
18.	Introduction of exotic species.	Regulated as per applicable laws.
19.	Protection of hill slopes and river banks.	Regulated as per applicable laws.
20.	Discharge of treated effluents in natural water bodies or land area.	Recycling of treated effluent shall be encouraged and for disposal of sludge or solid wastes shall be in accordance with the applicable regulations
21	Commercial Sign boards and hoardings.	Regulated as per applicable laws.
22.	Small scale industries not causing pollution.	Non-polluting, non-hazardous, small-scale and service industry, agriculture, floriculture, horticulture or agro-based industry producing products from indigenous goods from the Eco- Sensitive Zone, and which do not cause any adverse impact on environment shall be permitted.

S. No.	Activity	Remarks
23.	Collection of Forest produce or Non-Timber Forest Produce (NTFP).	No collection centre shall be permitted within hundred metres from the boundary of Wild Life Sanctuary or National Park
24.	Air and vehicular pollution.	Regulated as per applicable laws.
25.	Use of polythene bags by shopkeepers.	Regulated as per applicable laws.
26.	Drastic Change of Agriculture systems.	Regulated as per applicable laws.
27.	Commercial use of firewood.	Regulated (except as otherwise provided) as per applicable laws.
28.	Undertaking activities related to tourism such as over-flying the National Park Area by aircraft, hot-air balloons, drones, etc.	Regulated (except as otherwise provided) as per applicable laws.
29.	Solid Waste Management.	Regulated (except as otherwise provided) as per applicable laws.
30.	Eco-Tourism.	Regulated (except as otherwise provided) as per applicable laws.
Promoted Activities		
31.	Ongoing agriculture and horticulture practices by local communities along with dairies, dairy farming, aquaculture and fisheries.	Permitted under applicable laws
32.	Rain water harvesting.	Shall be actively promoted.
33.	Organic farming.	Shall be actively promoted.
34.	Adoption of green technology for all activities.	Shall be actively promoted.
35.	Cottage industries including village industries, convenience stores, local amenities, public utility and community buildings.	Shall be actively promoted.
36.	Use of renewable energy sources.	Bio gas, solar light etc. to be promoted
37.	Agro-Forestry.	Shall be actively promoted
38.	Skill Development.	Shall be actively promoted
39.	Environment Awareness.	Shall be actively promoted

5. Monitoring Committee.— (1) The Central Government for effective monitoring of the Eco-sensitive Zone, hereby constitutes a Monitoring Committee, which shall comprise of the following, namely:-

- (a) Municipal Commissioner/ Additional Municipal Commissioner, - Chairman
Municipal Corporation of Greater Mumbai (MCGM).
- (b) Chief Conservator of Forests and Director, Sanjay Gandhi - Member
National Park.

(c)	Additional Municipal Commissioner, Municipal Corporation of Thane	-	Member
(d)	Deputy Collector Mumbai Suburban District.	-	Member
(e)	Deputy Collector, Thane District		Member
(f)	Deputy Collector, Palghar District	-	Member
(g)	One representative of Non Governmental Organisation working in the field of environment to be nominated by the Government of Maharashtra for a term of one year in each case.	-	Member
(h)	One expert in the area of ecology and environment to be nominated by the Government of Maharashtra	-	Member
(i)	Regional Officer, Maharashtra State Pollution Control Board, Mumbai/Thane.	-	Member
(j)	Town Planning Officer, Mumbai/Thane/Palghar.	-	Member
(k)	Assistant Conservator of Forest (L.R.P.) Thane.	-	Member
(l)	Member of State Biodiversity Board	-	Member
(m)	Deputy Conservator of Forests, Thane Forest Division	-	Member Secretary

6. Terms of Reference

(a) The Monitoring Committee shall monitor the compliance of the provisions of this notification.

(b) The tenure of the Monitoring committee is for three (3) years.

(c) The activities that are covered in the Schedule to the notification of the Government of India in the erstwhile Ministry of Environment and Forest number S.O. 1533(E), dated the 14th September, 2006, and are falling in the Eco-sensitive Zone, except for the prohibited activities as specified in the Table under paragraph 4 thereof, shall be scrutinized by the Monitoring Committee based on the actual site-specific conditions and referred to the Central Government in the Ministry of Environment, Forests and Climate Change for prior environmental clearances under the provisions of the said notification.

(d) The activities that are not covered in the Schedule to the notification of the Government of India, Ministry of Environment and Forest and Climate Change number S.O. 1533 (E), dated the 14th September, 2006 and are falling in the Eco-sensitive Zone, except for the prohibited activities as specified in the Table under paragraph 4 thereof, shall be scrutinised by the Monitoring Committee based on the actual site-specific conditions and referred to the concerned regulatory authorities.

(e) The Member Secretary of the Monitoring Committee or the concerned Collector(s) or the concerned Forest Officers shall be competent to file complaints under section 19 of the Environment (Protection) Act, 1986 against any person who contravenes the provisions of this notification.

(f) The Monitoring Committee may invite representatives or experts from concerned Departments, representatives from Industry Associations or concerned stakeholders to assist in its deliberations depending on the requirements on issue to issue basis.

(g) The Monitoring Committee shall submit the annual action taken report of its activities as on 31st March of every year by 30th June of that year to the Chief Wildlife Warden of the State as per pro forma given in **Annexure IV**.

(h) The Central Government in the Ministry of Environment, Forest and Climate Change may give such directions, as it deems fit, to the Monitoring Committee for effective discharge of its functions.

7. The Central Government and State Government may specify additional measures, if any, for giving effect to provisions of this notification.

8. The provisions of this notification are subject to the orders, if any, passed, or to be passed, by the Hon'ble Supreme Court of India or the High Court or National Green Tribunal (NGT).

Annexure I**A. Description of Boundaries of proposed Eco-sensitive Zone of Sanjay Gandhi National Park**

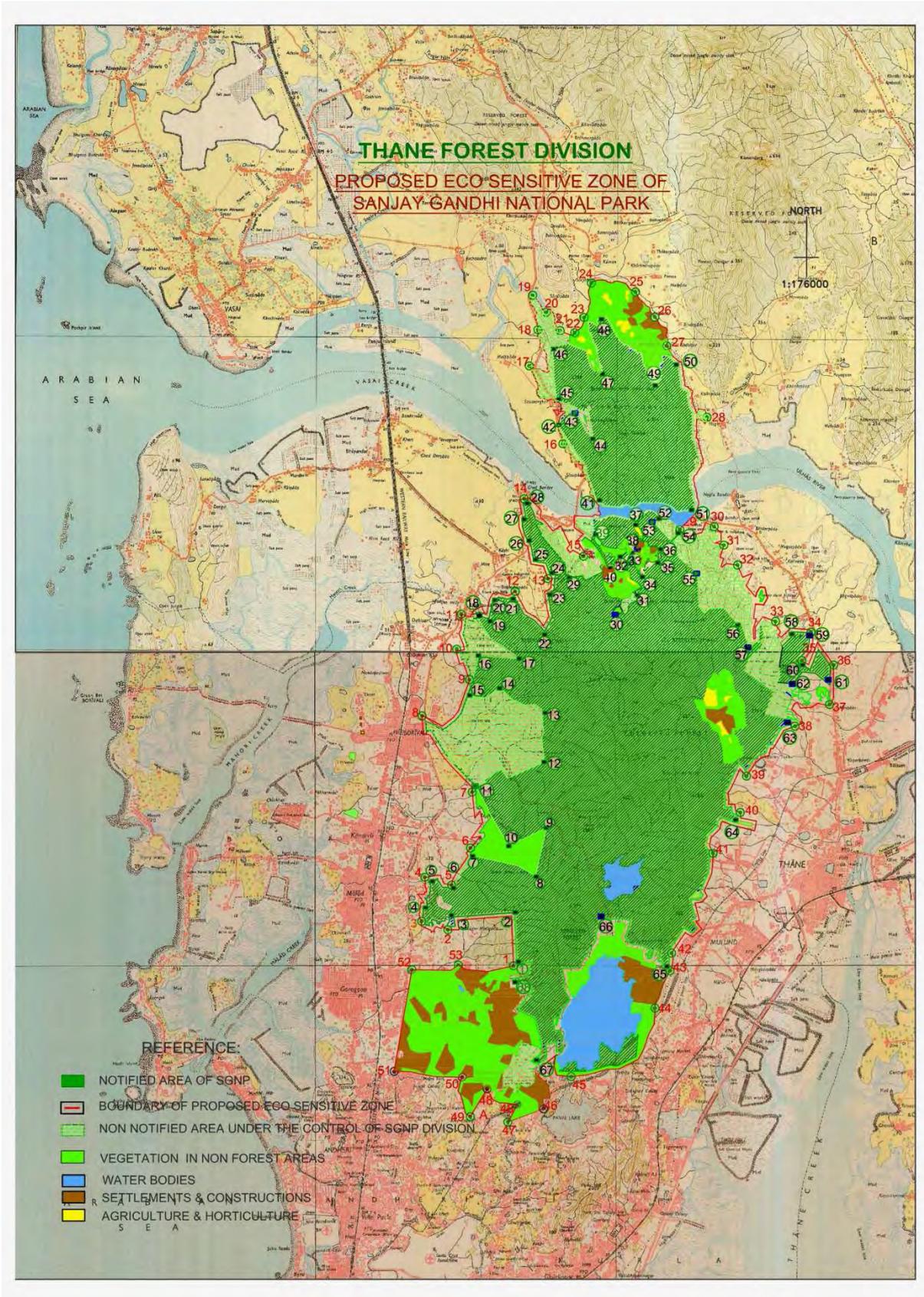
Direction	Bounded by
North	Boundary of Sasunavghar (Malji pada) Nala. [Latitude 19020'48.91"N] [Longitude 72053'32.47"E]
East	Boundary of Nagle (pt), Owala (pt.), Borivade (pt.) Vadavali (pt.), Kavesar (pt), Kolshet (pt.), Manpada (pt.), Majiwada (pt.), Pachpakhadi (Pt.), Mulund (Pt.), Nahur (Pt.), Clerabad (Pt.), Vihar. [Latitude 19014'39.38"N] [Longitude 72053'11.73"E]
South	Area of Aarey Dairy Division Boundary, Villages Sai (Pt.). [Latitude 19007'45.13"N] [Longitude 72052'46.89"E]
West	Area of Aarey Dairy Division Boudary, Malad (Pt.), Akurli (pt.), Poisar (Pt.), Magathane (Pt.), Kanheri (Pt.), Dahisar(Pt.), Kashi (Pt.), Mira (Pt.), Ghodbunder (Pt.), Varsave (Pt.), Sasunavghar (Pt.) [Latitude 19013'53.22"N] [Longitude 72051'45.76"E]

B. GPS readings of the Location points on the Boundary of Notified Area of the Sanjay Gandhi National Park,

Point No.	Latitude (North)	Longitude (East)
1	19°10'8.16"	72°53'24.20"
2	19°10'54.76"	72°53'21.39"
3	19°10'52.86"	72°52'24.25"
4	19°11'3.42"	72°51'57.48"
5	19°11'29.34"	72°52'11.50"
6	19°11'16.29"	72°52'28.47"
7	19°11'39.98"	72°52'37.72"
8	19°11'27.68"	72°53'37.85"
9	19°12'15.25"	72°53'47.49"
10	19°11'59.78"	72°53'10.39"
11	19°12'49.65"	72°52'53.93"
12	19°13'19.23"	72°53'46.01"
13	19°14'6.58"	72°53'47.26"
14	19°14'30.32"	72°53'2.28"
15	19°14'24.12"	72°52'29.69"
16	19°15'2.33"	72°52'41.47"
17	19°14'58.68"	72°53'22.63"
18	19°15'36.10"	72°52'41.70"
19	19°15'37.22"	72°52'50.51"
20	19°16'1.54"	72°52'58.31"
21	19°16'5.97"	72°53'10.06"
22	19°15'26.30"	72°53'45.42"
23	19°16'17.91"	72°53'50.70"

Point No.	Latitude (North)	Longitude (East)
24	19°16'45.43"	72°53'28.84"
25	19°16'57.91"	72°53'23.54"
26	19°17'11.76"	72°53'25.25"
27	19°17'11.02"	72°53'33.71"
28	19°17'35.83"	72°53'25.07"
29	19°16'11.23"	72°54'17.76"
30	19°15'52.51"	72°55'11.79"
31	19°16'9.14"	72°55'26.93"
32	19°16'36.03"	72°55'2.82"
33	19°16'41.23"	72°55'15.57"
34	19°16'22.88"	72°55'24.78"
35	19°16'34.36"	72°55'42.66"
36	19°16'47.70"	72°55'44.04"
37	19°17'7.19"	72°55'16.90"
38	19°16'43.05"	72°55'18.63"
39	19°17'5.25"	72°54'34.73"
40	19°16'25.43"	72°54'50.96"
41	19°17'27.38"	72°54'40.61"
42	19°18'42.31"	72°53'57.51"
43	19°19'0.11"	72°54'12.05"
44	19°18'34.46"	72°54'30.47"
45	19°19'8.68"	72°53'56.70"
46	19°20'3.00"	72°53'50.52"
47	19°19'36.40"	72°54'40.11"
48	19°20'28.82"	72°54'38.73"
49	19°19'23.77"	72°55'34.30"
50	19°19'44.11"	72°55'58.89"
51	19°17'22.34"	72°56'13.89"
52	19°17'18.29"	72°55'37.79"
53	19°16'49.75"	72°55'45.22"
54	19°17'7.38"	72°56'1.54"
55	19°16'15.25"	72°56'19.81"
56	19°15'17.36"	72°57'3.70"
57	19°14'24.40"	72°57'40.96"
58	19°15'21.93"	72°57'36.87"
59	19°15'33.26"	72°58'10.71"
60	19°14'50.47"	72°58'3.69"
61	19°14'30.88"	72°58'29.70"
62	19°14'8.58"	72°57'32.63"
63	19°13'55.19"	72°57'53.22"
64	19°12'21.27"	72°56'58.75"
65	19° 9'58.36"	72°55'43.04"
66	19°10'52.55"	72°54'41.24"
67	19° 8'32.17"	72°53'37.74"
68	19° 9'49.24"	72°53'22.17"

Annexure II



B. Villages and survey numbers with its area included in the Eco-sensitive Zone

Sl. No.	Taluka	Name of Villages	Eco-sensitive Zone				Total (Ha.)
			Private Land Survey No.	Private Land (Ha.)	Forest land Survey no.	Forest Area (Ha.)	
1	Kurla	Mulund	377/351pt, 380pt, 247pt, 232pt, 247pt, 248pt, 249pt, 251pt, 250pt, 245pt.	18.5900	377/351pt	2.8000	21.3900
2		Nahur	150pt (17Apt), 147pt, 146pt, 155pt, 176/148, 165, 167.	15.6800	177/148pt	2.8730	18.5530
3	Borivali	Gundgoan (Vihar Lake)	Vihar Lake.	293.1100	124pt,	45.5270	338.6370
4		Vihar (Vihar Lake)	61, 62, 63, 58, Vihar Lake.	510.7900			510.7900
5		Area of Aarey Dairy Division & areas handed by Aarey to other State Departments	-	1114.7400			1114.7400
6	Borivali	Area of the Filmcity - Maharashtra Film, Stage and Cultural Development Department. (under village Aarey-pt, Saei- pt & Gundgaon pt)	1/1, 1/3 pt, 1/4pt, 188pt (124pt), 19pt.	210.8300			210.8300
7	Andheri	Marol (Moroshi)	169	97.0000	CTS Nos.	76.0000	173.0000
8	Borivali	Saie	162, 168, 6, 7, 160, 118pt, 8, 179, 9, 10, 128, 19, 18, 5, 169, 12, 15, 170, 17, 16, 173, Lake.	137.3100	19pt	3.3150	140.6250
9		Clerabad	55,56.	10.6817	57pt	0.3950	11.0767
10		Malad	239/1pt, 269, 267pt, 271, 272, 253pt, 273pt, 274pt, 275pt, 276, 277pt, 278pt, 237pt, 221pt, 227pt, 226pt, 224, 223pt, 234, 222pt, 225pt, 228pt, 233pt, Kurar village part area.	95.1200			95.1200
11		Akurli	88pt, 86pt, 87A-pt.	17.2300	87A-pt	99.7090	116.9390
12		Poisar	41pt, 42Apt.	16.1200	42/A-pt, 46	119.4910	135.6110

Sl. No.	Taluka	Name of Villages	Eco-sensitive Zone				Total (Ha.)
			Private Land Survey No.	Private Land (Ha.)	Forest land Survey no.	Forest Area (Ha.)	
13		Magathane	148pt, 80, 88pt, 99pt, 98pt, 97pt, 96pt, 105pt, 95pt, 94pt, 57pt, 58pt, 50pt, 34pt, 47pt, 48pt, 89pt, 34B-pt.	26.2800	34B-pt	575.3310	601.6110
14		Kanheri	17pt, 16pt, 18Apt, 18B, 19pt, 21pt, 10pt, 97pt, 20pt, 9pt.	19.7700	11, 12, 13, 14, 15.	12.6060	32.3760
15		Dahisar	345C-pt, 210pt, 211pt, 164pt, 163pt, 151pt, 149pt, 147pt, 146pt, 101pt, 100pt, 99pt, 98pt.	39.7400	345A-pt	87.8330	127.5730
16	Thane	Kashi	89pt, 83pt, 82,79pt, 80, 90pt, 103pt, 77pt, 69pt, 68pt, 66pt, 58pt, 65, 64pt, 61pt, 62, 100pt, 101, 60, 55pt, 96pt, 102pt, 54pt, 52pt, 104pt, 53,63, 47pt, 67pt, 43pt, 44pt, 45pt, 94pt, 50pt.	34.0900			34.0900
17		Mira	95pt, 96pt, 94pt, 93pt, 92, 85pt, 84pt, 83pt, 79pt, 78pt, 77pt, 76pt, 69pt, 68pt, 67pt, 66pt, 65pt, 98pt, 70.	23.0000			23.0000
18		Ghodhunder	Khadi part, 244, 205, 241pt, Gavthan, Gavthan (pt) 236, 235, 237, 202, 203pt, 200, 240, 198, 14pt, 17pt, 18pt, 19pt, 191, 193pt, 188, 187pt, 186, 184, 183pt, 185pt, 177, 178pt, 215, 176pt, 174pt, 173, 216pt, 182pt, 180pt.	38.0400	217 pt	0.5570	38.5970
19		Versava	5pt, 6, 7, 10, 9pt, 11, 13, 14, 15, 16pt, 2, Gavthan, 109pt, 105pt, 106, 107, 108, 103, 102, 101pt, 91, 88, 89, 90, 87pt, 85pt, 86, 80pt, 78, 79, 77, 69, 68, 67, 66, 65, 72pt, 70, 71, 58, 62, 63, 64, 61, 57, 59, 60, 56pt, 52pt, 53pt, 54pt, 34pt, 21pt, 36pt, 35pt, 42pt, 27pt, 28, 29, 30.	58.6500	3pt, 34pt, 31, 32pt, 33pt.	102.0840	160.7340
20		Chene	Whole Area.	185.3700	101pt, 9pt,	13.9150	199.2850
21		Owala	Khadi part, 296, 286, 287, 288, 291pt, 285pt, 274pt,	92.6500	120/11, 273/3, 273/5,	415.1470	507.7970

Sl. No.	Taluka	Name of Villages	Eco-sensitive Zone				Total (Ha.)
			Private Land Survey No.	Private Land (Ha.)	Forest land Survey no.	Forest Area (Ha.)	
			273pt, 275pt, 276pt, 268pt, 269pt, 271, 272pt, 250pt, 245pt, 244, 243pt, 241pt, 240, 238, 239, 162pt, 161pt, 124pt, 121pt, Lake, 251pt, 249pt, 247pt, 237pt. 119, 120/1-10, 122pt, 117pt, 118pt, 106pt, 115pt, 113pt, 124pt.			291, 297	
22		Vadavali	19pt.	1.9100			1.9100
23		Borivade	1/2, 1/1pt, 2/6, 2/5, 2/4, 2/3, 2/2, 2/1, 3pt, 4/2, 4/1, 4/3, 6/3pt, 5/2, 6/1, 6/2, 8/5pt, 8/4, 8/1pt, 74pt., 75pt., 78pt, 91/3, Gavthan, 91/1pt, 91/2pt, 92pt.	11.5900	83/1, 2, 4, 9, 10, 5/1, 84/1/1, 85/1/2, 86/1/2, 79, 80.	136.8300	148.4200
24		Kavesar	142, 143pt, 145pt, 154pt, 151pt, 147pt, 149, 150, 158pt, 159, 160, 161, 163pt, 162pt, 165pt, 166pt, 168pt, 170pt, 169pt, 196pt, 193pt, 185pt, 196, 197, 198, 141pt, 139pt, 146pt.	42.0000			42.0000
25		Kolshet	291pt, 100pt, 99pt, 114pt, 113pt, 112, 111pt, 110pt, 109/107, 108pt, 107, 106, 285pt.	10.8400			10.8400
26		Manpada	57/3, 57/1pt, 57/2, 59A/30/1pt, 59A/31pt, 59/32, 59/27, 58/1pt, 59B-pt, 59/1pt, 59/16pt, 59/18pt, 59/19pt, 59A/28pt, 59A/20, 59A/2, 59A/3, 59A/4, 59A/5, 59A/13, 59A/11pt, 70, 59A/10, 71, 59/C, 59A/6, 59A/7, 59A/8, 59A/9.	49.4054	59/1pt	68.1410	117.5464
27		Majiwada	380pt, 254pt, 260pt, 261pt, 269, 263pt, 264pt, 268pt.	66.8900	419pt	1.7200	68.6100
28		Pachpakhadi	432pt, 431pt, 430pt, 423pt, Dheari nursary area, 263pt, 264pt, 265pt, 266pt, 267pt, 520pt, 373pt, 371pt, 270pt, 287pt, 288pt, 286pt, 285pt, 289pt, 291pt, nala area-pt, 163pt, 160pt, 159, 158pt.	42.0000	519pt, 520pt	4.8350	46.8350
29		Yeur	Whole Area.	197.4530	42/1, 14, 20,	6.1690	203.6220
30	Vasai	Sasunavghar	312/A/1/(80), 312pt, 249pt, Gavthan, 38(81),	103.3200	312pt, 249	130.5810	233.9010

Sl. No.	Taluka	Name of Villages	Eco-sensitive Zone				Total (Ha.)
			Private Land Survey No.	Private Land (Ha.)	Forest land Survey no.	Forest Area (Ha.)	
			Gavthan, 232(79), 244(77), 245(73), 248(76), 362pt, 251, 328, 68, 13(66), 12(67), 14(64), 16(65), 15(63), 17(62), 18(61), 374(60), 19(59), 11(69), 355(77), 21(78), 22(79), 23(80), 28(82), 26(83), 27(84), 24(81), 28(85), 32 (86), 33(88), 34(87), 35(91), 36(90), 37(92), 38(96), 39(97), 71(154), 72(157), 74(156), 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, Karnala pada 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57.				
31		Mori	Whole Area.	164.5300			164.5300
32		Poman	220, 188, 187, 217, Pada, 216, 212, 214, 185, 219, 249, 184, 183, 221, 222, 186, 181, 182, 17, 175, 176, 174, 179, 223, 178, 177, 211, 169, 173, 172, 171, 247, 170, pada, 168, 167, 163, 164, 160, 161, 162, 166, 165.	79.1300			79.1300
33		Kaman	99, 149, 148, 147.	12.1400			12.1400
34		Shilottar	5, 4, 3, 1pt, 21pt, 6.	3.6300			3.6300
35	Borivali	Shimpoli	-		20	4.8460	4.8460
36		Borivali Tarf Malad			143, 146, 147	7.2490	7.2490
37		Kandivali			164A	0.7520	0.7520
38		Tulsi	Lake	120.0000			120.0000
39		Nagle	7, 72pt, 6, 65pt, 92pt, 5, 4pt, 16pt, 15pt, 14pt, 21pt, 20pt, 70, 69, 22, 11, 67, 24pt, 10pt, 25pt, 29pt, 66, 30pt, 32pt, 33pt, 35pt, 34pt, 59pt, 37pt, 38pt, 39pt.	39.3202	23	6.2625	45.5827
40		Paspoli	22pt, 23pt.	18.7100			18.7100
41		Kanjur		3.0000			3.0000

Sl. No.	Taluka	Name of Villages	Eco-sensitive Zone				Total (Ha.)
			Private Land Survey No.	Private Land (Ha.)	Forest land Survey no.	Forest Area (Ha.)	
	Total			4020.6603		1924.9685	5945.6288

N.B.: 1. The above survey numberwise list is as per available village maps and records of the office of the DCF, Thane.

ANNEXURE-IV**Performa of Action Taken Report: - Eco-sensitive Zone Monitoring Committee.—**

1. Number and date of meetings :
2. Minutes of the meetings: mention main noteworthy points. Attach Minutes of the meeting as separate Annexure.
3. Status of preparation of Zonal master Plan including Tourism master Plan :
4. Summary of cases dealt for rectification of error apparent on face of land record : Details may be attached as Annexure
5. Summary of cases scrutinised for activities covered under the Environment Impact Assessment Notification, 2006: Details may be attached as separate Annexure.
6. Summary of cases scrutinised for activities not covered under the Environment Impact Assessment Notification, 2006: Details may be attached as separate Annexure.
7. Summary of complaints lodged under Section 19 of the Environment (Protection) Act, 1986 :
8. Any other matter of importance:

[F. No. 25/47/2014-ESZ-RE]

Dr. T. CHANDINI, Scientist 'G'

Template for Conducting Carrying Capacity Studies for Eco-Sensitive Zones / National Parks

S. No.	Chapter	Remarks
1.	Background	About Identified Eco Sensitive Zone, Total Area, Location details , Longitude -Latitude, Notification details, Sources of Water, environmental issues etc.
2.	Objective of the Study	Objective of the Study with its scope, duration of study etc.
3	Methodology	<p>Methodology adopted for Assessment of Environmental Carrying Capacity shall cover the following:</p> <ul style="list-style-type: none"> ❖ Air Environment Carrying Capacity (AECC) ❖ Water Environment Carrying Capacity (WECC) ❖ Noise Carrying Capacity (NCC): ❖ Tourism Carbon Carrying Capacity (TCC) ❖ Normalized Difference Vegetation Index (NDVI) ❖ Land Surface Temperature (LST) ❖ Digital Elevation Model (DEM) ❖ Land Use Land Cover map (LULC) ❖ Normalized Difference Water Index (NDWI) ❖ Land Stress Index (LSI) ❖ Habitat Quality Index (HQI) ❖ Aerosol Optical Dispersion (AOD) & PM2.5
4	Assessment of Environmental Carrying Capacity and Environmental Attributes	<p>To Assess the Environmental Carrying Capacity of the Environmental Attributes for the identified National Part, the environmental data of Base Year and Year of study in respect of Water, Air, Noise, Tourism, Land Use, Land cover etc. are to be collected and compared based on available information and actual monitoring. The details of models and data set used etc. are to be mentioned.</p> <ul style="list-style-type: none"> A. Assessment of Tourism Carbon Carrying Capacity <ul style="list-style-type: none"> ➤ Land Use Land Cover of National Park ➤ Land Use Land Cover of National Park with Buffer ➤ Estimation of Biomass ➤ Estimation of CO2 sequestration and TCC B. Assessment of Water Environment Carrying Capacity <ul style="list-style-type: none"> ➤ Baseline of Water Sources & volume, area etc. ➤ Total Available water resources and consumption ➤ Estimation of Utilisation Ratio C. Assessment of Air Carrying Capacity

		<ul style="list-style-type: none"> ➤ Identification regions for monitoring ➤ Baseline data for various seasons ➤ Monitoring of Ambient Air Quality ➤ Estimation of Carrying Capacity <p>D. Assessment of Noise Carrying Capacity</p> <ul style="list-style-type: none"> ➤ Identification regions for monitoring ➤ Baseline data for various seasons and timings ➤ Monitoring of present Noise level ➤ Estimation of Carrying Capacity <p>E. Assessment of Environmental Attributes</p> <ul style="list-style-type: none"> ➤ Mapping Normalised Difference Vegetation Index ➤ Mapping Normalised Difference Water Index ➤ Mapping Land Stress Index ➤ Mapping Slope Map of National Park ➤ Mapping Land Surface Temperature ➤ Mapping Habitat Quality Index ➤ Analysis of Aerosol Optical Depth & its Mapping <p>F. Assessment of Environmental Carrying Capacity</p> <ul style="list-style-type: none"> ➤ Assessment of Environmental Carrying Capacity using Fuzzy matrix
5	Summary of Study	Based on the baseline data, present monitoring on various environmental attributes, mapping, and the assessment of environmental carrying capacity of National Park, shall summaries the findings, causes, and suggest suitable and appropriate control measures for improvement of Carrying Capacity.
6	References	For baseline data, Notification of National Park, Guidelines, zonal master plan, etc.

Appendix III

Identification of Activities

Ref: Guidelines for Declaration of Eco – Sensitive Zones around the National Parks and Wildlife Sanctuaries

S. No.	Activity	Prohibited	Regulated	Permitted	Remarks
1	Commercial Mining	✓			Regulation will not prohibit the digging of earth for construction or repair of houses and for manufacture of country tiles or bricks for housing for personal consumption
2	Felling of trees		✓		With permission from appropriate authority
3	Setting of saw mills	✓			
4	Setting of industries causing Pollution (Water, Air, Soil, Noise, etc.)	✓			
5	Establishment of hotels and resorts		✓		As per approved master plan, which takes care of habitats allowing no restriction on movement of wild animals.
6	Commercial use of firewood	✓			For hotels and other business related establishment
7	Drastic change of agriculture systems		✓		
8	Commercial use of natural water resources including ground water harvesting		✓		As per approved master plan, which takes care of habitats allowing no restriction on movement of wild animals.
9	Establishment of major hydroelectric projects	✓			
10	Erection of electrical cables		✓		Promote underground cabling
11	Ongoing agriculture and horticulture practices by local communities			✓	However, excessive expansion of some of these activities should be regulated as per the master plan
12	Rain Water harvesting			✓	Should be actively promoted
13	Fencing of premises of hotels and lodges		✓		
14	Organic farming			✓	Should be actively promoted
15	Use of polythene		✓		

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S. No.	Activity	Prohibited	Regulated	Permitted	Remarks
	bags by shopkeepers				
16	Use of renewable Energy sources			✓	Should be actively promoted
17	Widening of roads		✓		This should be done with proper EIA and mitigation measures
18	Movement of vehicular traffic at night		✓		For commercial purpose
19	Movement of vehicular traffic at night		✓		For commercial purpose
20	Introduction of exotic species		✓		
21	Use or production of any hazardous substances	✓			
22	Undertaking Activities related to tourism like over-flying the National Park area by any aircraft, hot-air balloons.	✓			
23	Protection of hill slopes and river banks		✓		As per the master plan
24	Discharge of effluents and solid waste in natural water bodies or terrestrial area	✓			
25	Air and vehicular pollution		✓		
26	Adoption of green technology for all activities			✓	Should be actively promoted.