Sasthamkotta Lake

An Integrated Management Plan for Conservation and Wise Use

SWAK

Wetlands INTERNATIONAL

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Sasthamkotta Lake

An Integrated Management Plan
for Conservation and Wise Use

Wetlands International South Asia • State Wetland Authority Kerala

January 2025

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Abbreviations

ADAK	Agency for Development of Aquaculture, Kerala
AKSZ	Achan-Kovil Shear Zone
amsl	Above Mean Sea Level
APHA	American Public Health Association
AUEGS	Ayyankali Urban Employment Guarantee Scheme
AWB	Asian Wetland Bureau
AWC	Asian Waterbird Census
BMC	Biodiversity Management Committee
BPL	Below Poverty Line
BOD	Biochemical Oxygen Demand
CAM	Climate Change Adaptation and Mitigation
CBOs	Community-Based Organisations
CCDU	Capacity Development Unit
CESS	Centre for Earth Science Studies
CGWB	Central Ground Water Board
CMIP 5	Coupled Model Intercomparison Project Phase 5
CSOs	Civil Society Organisations
CWRA	Central Wetland Regulatory Authority
CRA	Climate Risk Assessment
CWRDM	Centre for Water Resources Development and Management
DO	Dissolved Oxygen
DoECC	Directorate of Environment & Climate Change
DoF	Department of Fisheries
DoT	Department of Tourism
DTPC	District Tourism Promotion Council
EPA	Environment Protection Act
ERRC	Environmental Resource Research Centre
ESSVA	Ecosystem Services Shared Value Assessment
FBOs	Farmer-Based Organisations
FFDA	Fish Farmer's Development Agency
FIB	Farm Information Bureau
FIRMA	State Fisheries Resource Management Society
GCM	General Circulation Model
GIS	Geographic Information System
HH	Household
ICAR	Indian Council of Agricultural Research
ICEM	International Centre for Environmental Management
IMD	India Meteorological Department
IUCN	International Union for Conservation of Nature
KAU	Kerala Agricultural University
KIHMS	Kerala Institute of Hospital Management Studies
KILA	Kerala Institute of Local Administration
KITTS	Kerala Institute of Travel and Tourism Studies
KLDC	Kerala Land Development Corporation
KSBB	Kerala State Biodiversity Board
KSCSTE	Kerala State Council for Science, Technology and Environment
KSMDB	Kumbalathu Sankupillai Memorial Devaswom Board
KSPCB	Kerala State Pollution Control Board
KSSP	Kerala Sastra Sahitya Parishad

KTDC	Kerala Tourism Development Corporation
KUFOS	Kerala University of Fisheries and Ocean Studies
KWA	Kerala Water Authority
LANDSAT	Land Satellite
LPG	Liquefied Petroleum Gas
LSGs	Local Self Governments
LULC	Land Use Land Cover
MAP	Management Action Plan
MCM	Million Cubic Metre
MET	Monitoring, Evaluation, and Tracking
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MLD	Million Litres per Day
MoEFCC	Ministry of Environment, Forest and Climate Change
MPN	Most Probable Number
MT	Metric Ton
MW	Mega Watt
NASA	National Aeronautics and Space Administration
NCESS	National Centre for Earth Sciences Studies
NGOs	Non-Governmental Organizations
NH	National Highway
NPCA	National Programme for Conservation of Aquatic Ecosystems
NWIA	National Wetland Inventory and Assessment
OLI	Operational Land Imager
PBRs	People's Biodiversity Registers
QWSS	Quilon Water Supply Scheme
RCP	Representative Concentration Pathway
RIC	Ramsar Interpretation Centre
RIS	Ramsar Information Sheet
R-METT	Ramsar Management Effectiveness Tracking Tool
RSIS	Ramsar Sites Information Service
SAC	Space Application Centre
SAPCC	State Action Plan on Climate Change
SHGs	Self-Help Groups
SKSB	South Kerala Sedimentary Basin
SWA	Sasthamkotta Wetland Authority
SWAK	State Wetland Authority Kerala
SWMU	Sasthamkotta Wetland Management Unit
TOC	Total Organic Carbon
WIAMS	Wetland Inventory, Assessment and Monitoring System
WMU	Wetland Management Unit
WRIS	Water Resources Information System
WWF	World Wide Fund for Nature
ZoI	Zone of Influence

EXECUTIVE SUMMARY

SASTHAMKOTTA LAKE: THE QUEEN OF LAKES

Located in the Kunnathur Taluk, Kollam District of Kerala, Sasthamkotta Lake is the largest freshwater lake in the state, covering 365.9ha. Designated as a Ramsar Site in 2002, this vital wetland serves as a crucial source of drinking water for nearly half a million people in Kollam City and its suburbs. The scenic beauty and deep cultural connections of people living around the wetland underpin the moniker, the 'Queen of Lakes'.

Sasthamkotta Lake forms a part of an extensive wetland regime formed on the alluvial deposits of River Kallada and is surrounded by lush green hills in the direct catchment spanning 1,125 ha. At least 16 fish species, 136 amphibian species, and 14 waterbirds are known to inhabit the wetland.

This management plan prepared by the State Wetland Authority, Kerala, in collaboration with Wetlands International South Asia, affirms the commitment of the State Government to wetland wise use. The plan has been prepared under the aegis of the Global Environment Facility (GEF)-United Nations Environment Programme (UNEP)-MoEFCC funded Integrated Management of Wetland Biodiversity and Ecosystem Services (IMWBES) project.

CHANGES IN WETLAND ECOLOGICAL CHARACTER SINCE RAMSAR SITE DESIGNATION

The designation of Sasthamkotta Lake as a Wetland of International Importance (Ramsar Site) commits the governments and stakeholders to ensure its wise use, which is the maintenance of the site's ecological character based on management aligned with an ecosystem approach and within the framework of sustainable development. An evaluation of wetlands' ecological, hydrological, and socioeconomic features indicates the following trends:

1. The area of Sasthamkotta Lake roughly corresponds with 16 m amsl water level and includes a mosaic of open water area, marshes and fragments of exposed wetland bed. While the area under inundation during post-monsoon has increased from 210 ha in 2003 to 310 ha in 2022, the area under pre-monsoon inundation has declined from 366 ha in 2003 to 300 ha in 2022. The increasing inter-annual variability in the inundation regime has resulted in a larger wetland area transforming into intermittent marshes. Currently, only 40% of the area of Sasthamkotta Lake remains inundated throughout the year.
2. Land use and land cover change within the direct catchment of Sasthamkotta Lake has undergone a significant transformation. From 1988 to 2022, the area under agriculture has increased from 5% to 13%, while that under settlements increased from 0.4% to 6%. Conversely, the area under marshes, plantations, and wetlands decreased by 3%, 2%, and 3%, respectively, during the same period.
3. Surface run-off from rainfall within the drainage basin and direct rainfall on the Ramsar Site constitute the major sources of inflow. The long-term trends indicate a decrease in total inflow to Sasthamkotta from 29 MCM in 2015 to 20 MCM in 2022. In 2022, 13.68 MCM was extracted from Sasthamkotta for the Quilon Water Supply scheme, with an additional 8 MCM to keep the emergency requirements of other water supply schemes. While this level of extraction has remained unchanged in the last decade, this is considerably higher than the original design. The shifts in rainfall patterns and reduced sub-surface connectivity with the River Kallada have subjected the wetland to an increase in exposed beds.
4. Sasthamkotta maintains adequate oxygen levels to support aquatic life. The high BOD in certain seasons and persistently elevated coliform levels indicate potential concerns related to organic pollution and contamination, particularly from runoff. Such patches are prominent during summer and in regions around Kuthira Munamb and Ambalakkadavu.
5. Recorded species richness of various groups, such as phytoplankton, zooplankton, macrophytes, and fish, have declined in the last 20 years. However, such changes may also be attributed to changes in survey methods and their comprehensiveness.

6. A strong wetland-dependent community of approximately 300 to 400 households currently resides in Sasthamkotta Lake. About 18% of these households depend on natural resource-based livelihoods like fishing. However, there has been a rapid decline in active fishers, reducing from 155 registered fishers in 2015 to only nine at present.
7. The Ramsar Site faces high climate risks. The mean annual precipitation has increased from 1884 mm in 2002 to 2002 mm in 2022. The pre-monsoon (February–May) and monsoon (June–September) precipitation has increased by 48% and 33%, respectively, between 2002 and 2023. However, the north-east monsoon precipitation has reduced by 33% during the same period. The climate change projections indicate that by 2050, the average maximum temperature in the region will rise by approximately 1°C across all seasons. Specifically, an increase of 0.75°C during the north-east monsoon, 0.6°C during the south-west monsoon, and 0.8°C in the non-monsoon season are anticipated. Concurrently, precipitation patterns are projected to shift significantly; an increase of 35% is anticipated during the north-east monsoon, while a decrease of 26.5% is expected during the south-west monsoon. Under a business-as-usual scenario, the change in climate patterns may result in reduced water inflow, declining water quality, reduced water availability, and proliferation of invasive species.

INTEGRATED MANAGEMENT FRAMEWORK

Management of Sasthamkotta Lake needs to be based on recognition of the full range of ecosystem services and biodiversity values of the wetland and their mainstreaming into management plans at all levels. The effectiveness of management will be reflected in the ability to sustain multiple uses of the wetland based on the hydrological regime and the key ecological and social processes that underpin the functioning of the Ramsar Site. The goal of integrated management of Sasthamkotta Lake is to secure the ecological integrity of the wetland ecosystem while providing ecological, economic and cultural benefits to the society on a sustainable basis. The purpose of management is to a) preserve cultural, recreational, aesthetic, and educational values, b) provide a reliable water source to Kollam City, c) provide a buffer against water-mediated risks to adjoining communities, and d) secure habitat for wetland-dependent species.

The management goal and purpose are envisaged to be achieved through the following eight management objectives:

Objective	Outcomes
1. Naturalness of the Ramsar Site is maintained in line with extant regulation	No conversion of wetland area to non-wetland use as compared with Ramsar Site designation date baseline
	Restrict adverse change in LULC within the watershed to 1% as compared with the current land use land cover
	No instances of violations of extant regulatory regimes
2. Storage capacity, surface and sub-surface water level are maintained within the permissible limit	Desired levels are maintained as per thresholds/standards
	Water abstraction is optimised in line with requirements for maintenance of the Ramsar Site health
	Sediment load in the wetland is reduced by 50% of the current sediment load
3. Diversity of species and their habitat is maintained and enhanced	Maintain the population of bird species to the average of last five years
	Maintain fish diversity to the average of last five years
	Habitat quality and extent is maintained to the Ramsar Site designation baseline

	No new establishment of invasive macrophytes colonies as against Ramsar Site designation baseline
4. Livelihood vulnerability of wetland-dependent communities is reduced	Additional livelihood opportunities from environment-friendly sources are increased
5. Nature tourism is developed to showcase the biodiversity, ecosystem services and cultural values of the Ramsar Site	Nature tourism is within the carrying capacity of wetland and maintains the naturalness of the site
	Primary stakeholders gain additional income through engagement in nature tourism and allied activities
6. Individual and collective capacity and opportunities for stakeholders to participate in wetland management and contribute to wetlands wise use are enhanced	Community views, rights and capacities are integrated in management plan integration and monitoring
	Local action for preventing adverse land use change, encroachment, pollution abatement and over-harvesting of biological resources
7. Systematic Wetlands Inventory, Assessment and Monitoring System is used to inform management decisions and assess effectiveness	Time series data on wetlands features and threats is accessible on SWAK WIAMS web portal
	Monitoring data is systematically analysed and presented in SWAK meetings and made available to decision-makers and stakeholders
8. Integration of multiple values of wetlands in sectoral development plans, programmes and investments is enhanced	SWAK meets periodically to review sectoral plans, programmes and investments in terms of their implications for Sasthamkotta Lake and communicates to the respective departments
	SWAK establishes convergence with development plans, programmes and investment, aligning these with functioning of Sasthamkotta Lake

RECOMMENDATIONS FOR THE MANAGEMENT PLAN

The management plan for Sasthamkotta Lake adopts a multi-faceted approach focusing on hydrological restoration, biodiversity conservation, sustainable livelihoods, and community participation. It is aligned with national and international wetland management frameworks, including the Ramsar Convention's 'wise use' principle and India's recent Amrit Dharohar initiative.

MANAGEMENT COMPONENT AND ACTIVITIES

The management framework organises objectives under five key components to address the wetland's ecological, hydrological, and socio-economic challenges:

Component 1: Institutions and Governance

Establishment of the Wetland Mitra Network to enhance community engagement in wetland conservation. The Wetland Mitras will be engaged in raising awareness, monitoring wetland health, and reporting violations such as encroachment, pollution, and illegal activities.

Establishment of the Sasthamkotta Wetland Management Unit (SWMU) to oversee and coordinate all management and conservation activities. The SWMU will be a dedicated administrative body working with local communities, NGOs, and government agencies to ensure effective wetland management.

Improvement and maintenance of an integrated Wetland Inventory, Assessment, and Monitoring System (WIAMS) platform to address the overall information needs of wetland management and to provide a robust decision support system. This will also include setting up a wetland ecosystem monitoring facility with capabilities for monitoring the wetland features of Sasthamkotta Lake.

Undertaking Management Effectiveness Tracking, using the Ramsar Site Management Effectiveness Tracking Tool (R-METT) to derive management effectiveness scores every two years. A mid-term and end-term review of management plan implementation will be undertaken to assess the extent to which stipulated objectives have been achieved with a high degree of resource efficiency and participation with stakeholders.

Capacity development of the officials of State Wetland Authority Kerala, concerned State Government departments, agencies, and local communities through professional training and hand-holding support in integrated wetland management, water management, biodiversity conservation, wetland inventory and assessment, and sustainable livelihoods.

Setting up of wetland learning centre in Kumbalathu Sankupillai Memorial Devaswom Board (KSMDB) College as a wetland education hub. The learning centre will serve as a platform for awareness generation on wetlands and enable students to acquire skills and capacities related to wetland management.

Component 2: Land and Water Management

Development of a water allocation plan for the equitable distribution and management of water resources, considering both environmental needs and human demands to ensure sustainable use and conservation. This also includes the provision of an alternate source of drinking water for Kollam City so that the current levels of abstraction from the wetland may be reduced.

Protection and management of the catchment area surrounding a wetland to reduce erosion, control runoff, and maintain water quality. It includes implementing soil conservation measures in 685 ha through treatment of degraded micro-watersheds with vegetative measures, restoring native vegetation, managing inlet drains to prevent discharge, desilting, and managing land use practices to sustain the health of the wetland ecosystem.

Augmenting the waste processing facilities of surrounding local bodies, including upgrading existing infrastructure, increasing processing capacity, and implementing advanced technologies for efficient waste management. This will also include the construction of a sewage treatment plant of 8 MLD in Sasthamkotta town to improve waste treatment in the direct drainage basin of Sasthamkotta Lake.

Component 3: Species and Habitat Conservation

Conservation of fish and waterbird habitat through: a) survey and mapping of fish breeding grounds and key waterbird habitats, b) restoration of degraded areas, and c) community workshops on developing and implementing habitat management action plans.

Integration of wetland biodiversity in People's Biodiversity Registers (PBRs) to enhance biodiversity management and planning. This will include organising workshops for the Local Self Governments Biodiversity Management Committee and Joint Biodiversity Management Committee and comprehensive updation of the biodiversity registers for each Local Self Government around Sasthamkotta Lake.

Conducting the Asian Waterbird Census by surveying waterbird populations, recording data on species and their habitats, and analysing the results to track trends and support conservation efforts. This will also include training volunteers to assist with fieldwork and data collection for the Asian Waterbird Census.

Component 4: Nature Tourism

Refurbishment of wetland interpretation centre at Ambalakkadavu, near Sastha Temple, to serve as a hub for wetland outreach and nature tourism facilities. This will include renovating the space to create functional offices and educational areas, installing exhibits and interactive displays, and ensuring the facility supports management operations and public education on wetland conservation.

Installation of signages in appropriate locations to provide clear information and guidelines for conserving Sasthamkotta Lake and enhancing public awareness on do's and dont's around the wetland.

Enhancing skills and knowledge for promoting and managing nature tourism through training to Wetland Mitras to serve as nature guides and equip them with ecological information, communication strategies, and visitor engagement to ensure

that they can effectively lead tours and educate tourists about Sasthamkotta Lake.

Component 5: Wetland Livelihoods

Development of Micro-enterprise for wetland products. This will include training, resources, and market access to 150-200 people, enabling them to sustainably produce and sell items derived from wetland resources such as *Pandanus* and Bamboo, promoting local livelihoods and conservation.

Incentivising local fishers to use sustainable fishing nets. This will include distributing eco-friendly nets to around 75 fishers that minimise environmental impact, offering financial or material support to encourage adoption, and educating them on the benefits of sustainable fishing practices to protect wetland ecosystems and ensure long-term fishery resources.

Installation or retrofitting of septic tanks for selected households to improve sanitation and protect wetland water quality. This includes assessing household needs, coordinating installing or upgrading septic systems, and ensuring they meet environmental standards to prevent contamination of nearby wetlands.

IMPLEMENTATION ARRANGEMENTS

The implementation of the Sasthamkotta Lake Integrated Management Plan will be overseen by a multi-tier institutional arrangement. At the core of this arrangement is the Sasthamkotta Wetland Management Unit (WMU), which will be the central authority responsible for coordinating and executing all conservation and management activities. The WMU will engage with key stakeholders, including government agencies like the Kerala Water Authority, local communities, NGOs, and civil society organisations, ensuring a participatory approach to wetland conservation. A critical element of the implementation strategy is the Wetland Mitra Network, an informal, voluntary group composed of local citizens. This network will play a key role in community engagement, serving as the primary means for raising awareness, monitoring wetland activities, and reporting issues such as pollution or illegal encroachments. Regular stakeholder meetings and workshops will facilitate ongoing community involvement, while adaptive management practices will ensure that strategies evolve based on monitoring and new data. This approach is designed to foster local ownership of the conservation efforts and ensure the sustainability of wetland management activities.

BUDGET

The management plan implementation will require an estimated budget of ₹ 16.7 crores over a period of five years. Of the total funds, 67.3% are earmarked for land and water resource management and 21% for institutions and governance. The components of nature tourism, species and habitat management and livelihood have been allocated 6.4%, 2.3%, and 3% of the funds, respectively.

01

Introduction

1.1 BACKGROUND

Sasthamkotta Lake, located in Kunnathur Taluk of Kollam District, is the largest freshwater lake in Kerala (Map 1.2). Spanning 373 ha, the wetland is the principal source of water for nearly 0.5 million people living in Kollam City and its suburbs. Sastha Temple, from which the wetland is believed to have got its name, is an important religious and cultural centre for the region. The striking beauty of Sasthamkotta Lake's placid waters surrounded by lush green hills has earned it the distinction of 'Queen of Lakes'. Sasthamkotta Lake was designated a Ramsar Site in 2002, thereby underlining the commitment of the National and State Governments to its conservation and sustainable management.

Sasthamkotta Lake is evolving towards a marsh-dominated stage due to frequent drying out of its lakebed. Rapid land use intensification within the catchments, declining average annual storage and wetland water quality, increasing spread of macrophytes, and decline in fish species have impaired the health of the wetland ecosystem. Waste management practices in the shoreline grama panchayats are far from comprehensive. The continued prevalence of these trends is only likely to adversely impact ecosystem functioning and increase water insecurity for the dependent communities.

This management plan for Sasthamkotta Lake, prepared by the State Wetland Authority, Kerala, in collaboration with Wetlands International South Asia, affirms the commitment of the State Government and stakeholders for wetlands conservation and wise use. The management plan has been prepared under the aegis of the Global Environment Facility (GEF)-United Nations Environment Programme (UNEP)-Ministry of Environment, Forest and Climate Change (MoEFCC) funded Integrated Management of Wetland Biodiversity and Ecosystem Services (IMWBES) project.

1.2 MANAGEMENT TO DATE

The first management plan for Sasthamkotta Lake was drafted in 2001 by the Centre for Water Resources Development and Management (CWRDM) and approved for implementation by the MoEFCC. However, only limited funding for the implementation of the plan was provided by the MoEFCC under the National Wetlands Conservation Programme (presently consolidated into the National Plan for Conservation of Aquatic Ecosystems, NPCA). The wetland, however, went through a

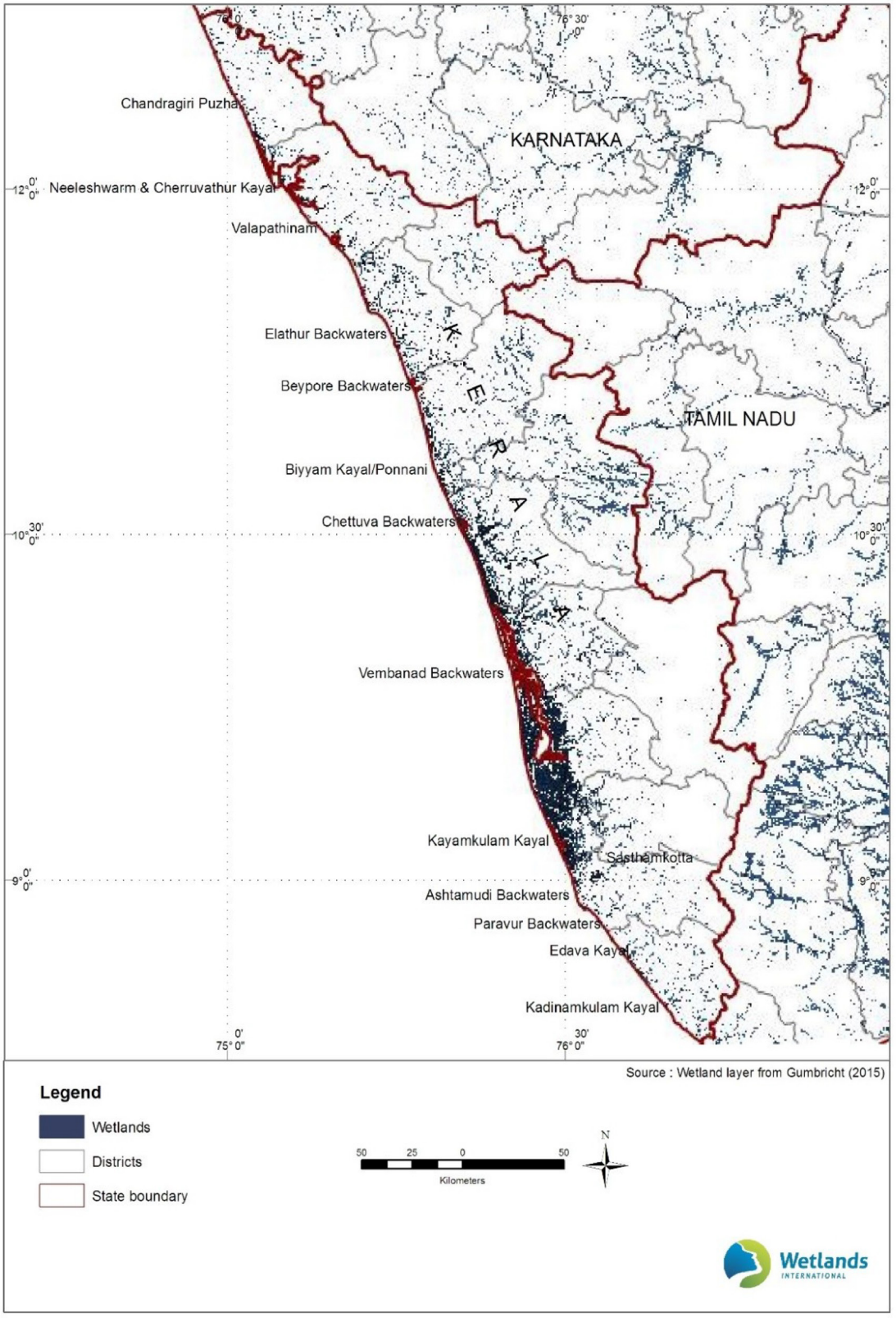
prolonged dry phase in 2009–10, thus necessitating a review of management. The revised management plan prepared by CWRDM in 2010 was kept in abeyance. This plan was revised in 2017 for implementation over a period of five years with a budget of ₹ 98.63 crore. Approval of the plan was accorded by MoEFCC, and the funds for annual implementation (₹ 59.625 lakh) were made available in 2018 under the NPCA. Throughout the plan implementation duration, a range of activities were implemented, including conserving wetland catchment area through vegetative measures, the establishment of a Wetland Inventory, Assessment and Monitoring System (WIAMS), an in-depth study of fish diversity within the wetland, a comprehensive bathymetry study of the wetland's topography, and Community Engagement and Public Awareness (CEPA) initiatives. The catchment conservation committee for the conservation of the wetland catchment was constituted in 2019. The Department of Soil Survey and Soil Conservation prepared a draft plan for Sasthamkotta Lake catchment conservation. Unfortunately, challenges, including a shortage of personnel and the disruptive impact of the COVID-19 pandemic, impacted the efficiency of plan execution. The management plan expired in 2022.

In 2021, Sasthamkotta Lake was included as a demonstration site under the IMWBES project, and a decision to update the plan was made. Project funds were made available for the same, including a detailed bathymetric study of the wetland and socio-economic surveys conducted among local communities.

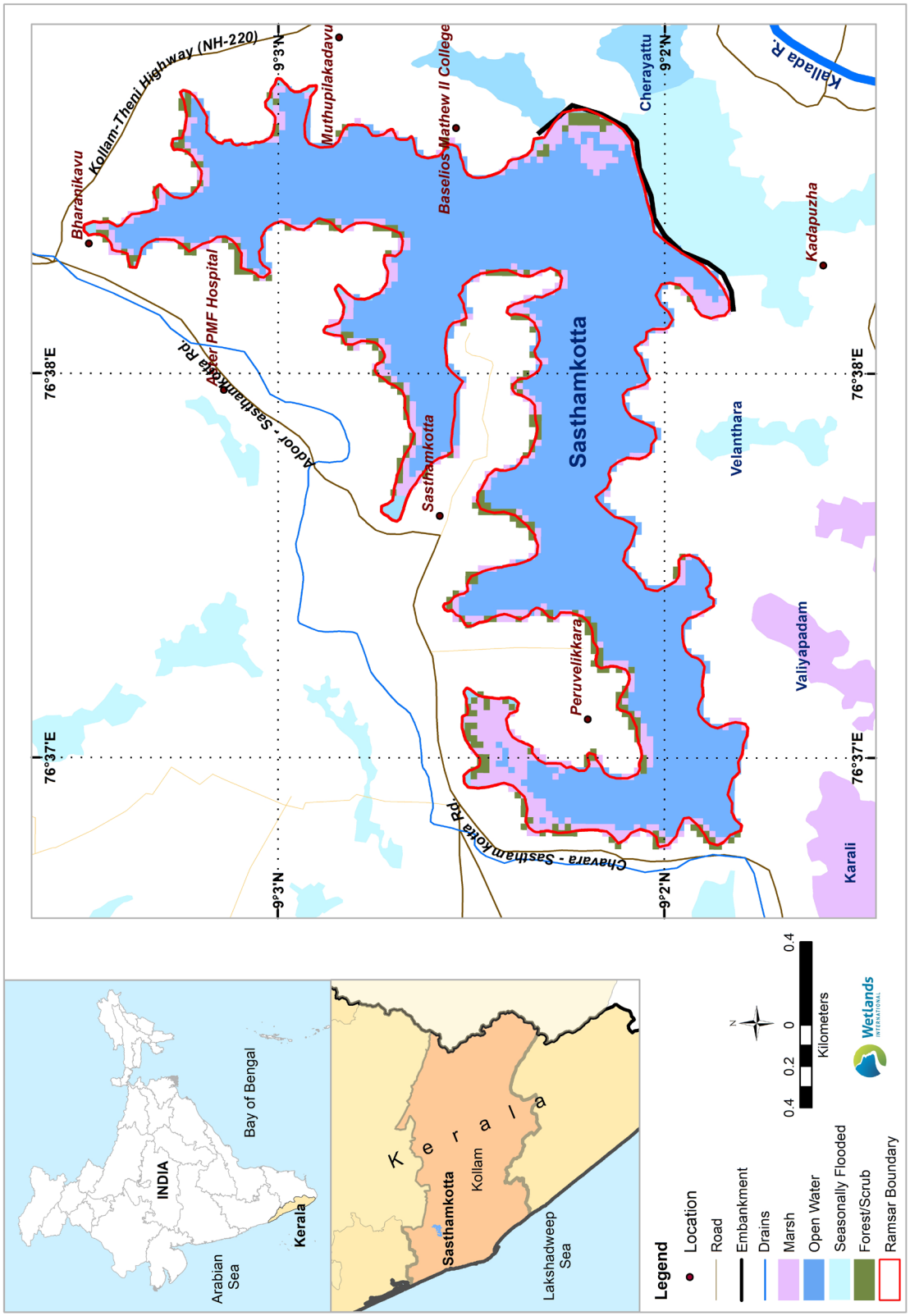
1.3 MANAGEMENT PLANNING PURPOSE AND OBJECTIVES

The overall purpose of management planning for Sasthamkotta Lake is to outline a strategy and specific actions for the conservation and wise use of the Ramsar Site. The management planning process addresses the following specific objectives:

- Development of a baseline inventory of wetland features and governing factors
- Assessment of status and trends in ecosystem components, processes and services, and risks of adverse change
- Participatory appraisal with communities to reflect their views, rights and capacities in the context of integrated management
- Evaluation of sectoral plans and management practices and identification of interlinkages and coordination needs for integrated management
- Development of management planning framework ensuring linkages with existing sectoral plans being implemented by various government agencies



Map 1.1 | Wetlands of Kerala



Map 1.2 | Location of Sasthamkotta Lake

- Estimation of financial resources required for integrated management
- Recommending an effective institutional mechanism with clear-cut roles and responsibilities of participating institutions supported by appropriate policies and regulations
- Designing an effective monitoring and evaluation framework for sustainable management

1.4 MANAGEMENT PLANNING APPROACH AND METHOD

The 'wise use' of wetlands is the central tenet of wetland management. The Ramsar Convention on Wetlands defines wise use as *'the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development'*. Ecological character is *'the combination of ecosystem components, processes and benefits/services that typify the wetland at a given point in time'*. Ecosystems approach requires consideration of the complex relationship between various ecosystem elements and promotion of integrated management of land, water and living resources. Wise use, through emphasis on sustainable development, calls for resource use patterns which can ensure that human dependence on wetlands can be maintained not only in the present, but also in the future.

The approach adopted for management planning of Sasthamkotta Lake is in line with the New Guidelines for Management Planning endorsed by the *Eighth Meeting of Contracting Parties to the Ramsar Convention* (Ramsar Convention Secretariat, 2010a). The guidelines call for the adoption of diagnostic approaches for assessing management needs, based on systematic evaluation of wetland features and their governing factors. The guidelines also call for integrating site management plans into developmental planning systems at local, regional and national levels. In order to safeguard sites and their features, the guidelines recommend adoption of an adaptable management process which allows wetland managers to respond to the legitimate interest of others, adapt to an ever-changing political climate, accommodate uncertain and variable resources, and survive the vagaries of the natural resources.

Management of Sasthamkotta Lake has thus far aimed at maintaining the wetland's capacity to support water supply for the inhabitants of Kollam City and its suburbs. The limitations of current management are apparent in frequent exposure of wetland bed, pollution, and community resentment of deteriorating environs. Wise use of Sasthamkotta Lake entails putting in place management arrangements which can ensure

the provision of societal benefits from the wetland on long-term basis without compromising ecosystem health and integrity. Therefore, integrated management planning is aimed at providing a programmatic framework for achieving wise use of Sasthamkotta through restoration of ecological character in a 'healthy state' and embedded within the environmental and socio-economic sustainability objectives pursued through the on-going developmental programming in the State of Kerala.

The management planning approach adopted herein is also in line with the National Environment Policy (2006) of the Government of India, which recommends integrating conservation and wise use of wetlands into river basin management involving all relevant stakeholders, particularly local communities. The guidelines of MoEFCC's flagship scheme for wetlands, NPCA (National Plan for Conservation of Aquatic Ecosystems), also recommend integrating wetland conservation in developmental programming by emphasising convergence opportunities, stakeholder engagement and diagnostic evaluation approaches. The National Water Policy (2012) also espouses river basin scale planning and integrated approaches in water resources management. In 2022, MoEFCC launched Mission Sahbhagita, an initiative for the participatory conservation and wise use of wetlands of national and international importance. Amrit Dharohar, an initiative to promote the unique conservation values of the Ramsar Sites, was launched in June 2023. This management plan aligns interventions with the aforesaid initiatives.

The need for integrated approaches is equally stressed in various policies of the State Government. Kerala Water Policy (2007) calls for a multidisciplinary and holistic approach for management, considering water as part of the ecosystem for the benefit of all and not for the profit of a few. Conservation and sustainable use of wetlands adopting a basin approach while systematically addressing the drivers of degradation, namely pollution and unsustainable water harvest is listed as priority area within Kerala State Environment Policy 2009. Kerala is also a front runner in putting in place a regulatory mechanism for wetlands in the form of Kerala Conservation of Paddy Land and Wetland Act (2008) which restrict conversion and reclamation of wetlands.

The management plan also responds to the requirements of Wetlands (Conservation and Management) Rules, 2017. These rules require the specification of wetland boundaries and a zone of influence, as well as enforcing a number of prohibitions and regulations of developmental activities detrimental to wetland ecosystem health.

In line with available international and national guidelines and best practices, the management plan for Sasthamkotta Lake has been developed using a diagnostic

approach. Status and trends in hydrological, ecological, and socio-economic features have been assessed to determine key factors limiting integrated management. An evaluation of institutional arrangements (including sectoral programmes, policy and regulatory frameworks and stakeholder arrangements) has been carried out to identify coordination opportunities. An integrated and hierarchical assessment, monitoring and evaluation system has been recommended to enable adaptive management. These analyses form the basis of an action plan, with well-defined objectives and outcomes, to achieve wise use.

The management plan has been prepared by a team of experts from the State Wetland Authority of Kerala and Wetlands International South Asia, with support from the Centre for Water Resources Development and Management (CWRDM) drawn from disciplines of hydrology, ecology, watershed management, sociology, and economics. Data on hydrological and ecological aspects was collected from various State Government departments, agencies and research institutes. Detailed socio-economic surveys and participatory assessments were conducted in grama panchayats around the wetland and its catchment to determine wetland livelihood interlinkages. Secondary literature was also collated to establish the status and trends in wetland features. To the extent possible, all available

Image 1 | Aerial view of Sasthamkotta Lake (17 June 2023)

data has been presented in the form of thematic maps. The action plan has been developed with due consideration of existing departmental plans. Five consultations were held with communities and concerned line departments to incorporate their issues and priorities into the management plans.

1.5 MANAGEMENT PLAN STRUCTURE

The management plan follows the format prescribed under NPCA and is organised into three sections with eight chapters. Following the introduction, section one of the plan (Chapters 2, 3, and 4) contains a description and evaluation of the wetland features, governing factors, and an analysis of current institutional arrangements in terms of the capability of addressing the risk of adverse change and ensuring wetlands wise use. Section 2 of the plan (Chapters 5 and 6) discusses the management framework (management goal, purpose, strategy and objectives, and monitoring arrangements). Section 3 (Chapters 7 and 8) includes the detailed action plan, five-year budget, and possible financing arrangement.

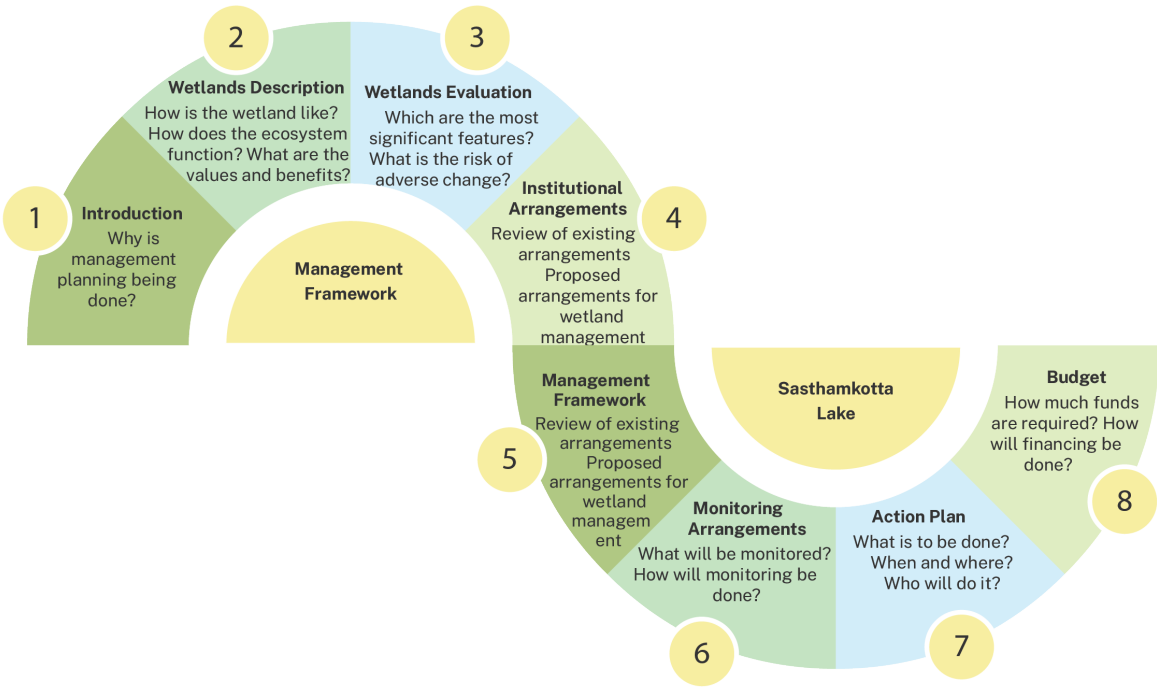


Figure 1.1 | Framework for Integrated Management Planning

02

Description of Wetland Features

2.1 LOCATION AND EXTENT

Sasthamkotta Lake forms part of an extensive wetland regime formed on the alluvial deposits of River Kallada. These wetlands are conspicuous between Bharanikavu Town and the confluence of River Kallada with Ashtamudi Estuary at Kovilli. Besides Sasthamkotta, Karali, Velanthara, Veliyapadam, and Kadapuzha are significant marsh-dominated areas flanking the right bank of the Kallada River. Sasthamkotta Lake is surrounded by slightly elevated ridges, having an average water level of 13.5 m amsl and steeply ascending to nearly 35 m amsl on its northern, western, and southern flanks. The south-eastern margins, which would have naturally drained into River Kallada, were embanked in the 19th century. The earthen embankment was made permanent in 1956 under the Quilon Water Supply Scheme supported by Indo-Norwegian Foundation. The embankment at most places is about 25 m amsl elevation.

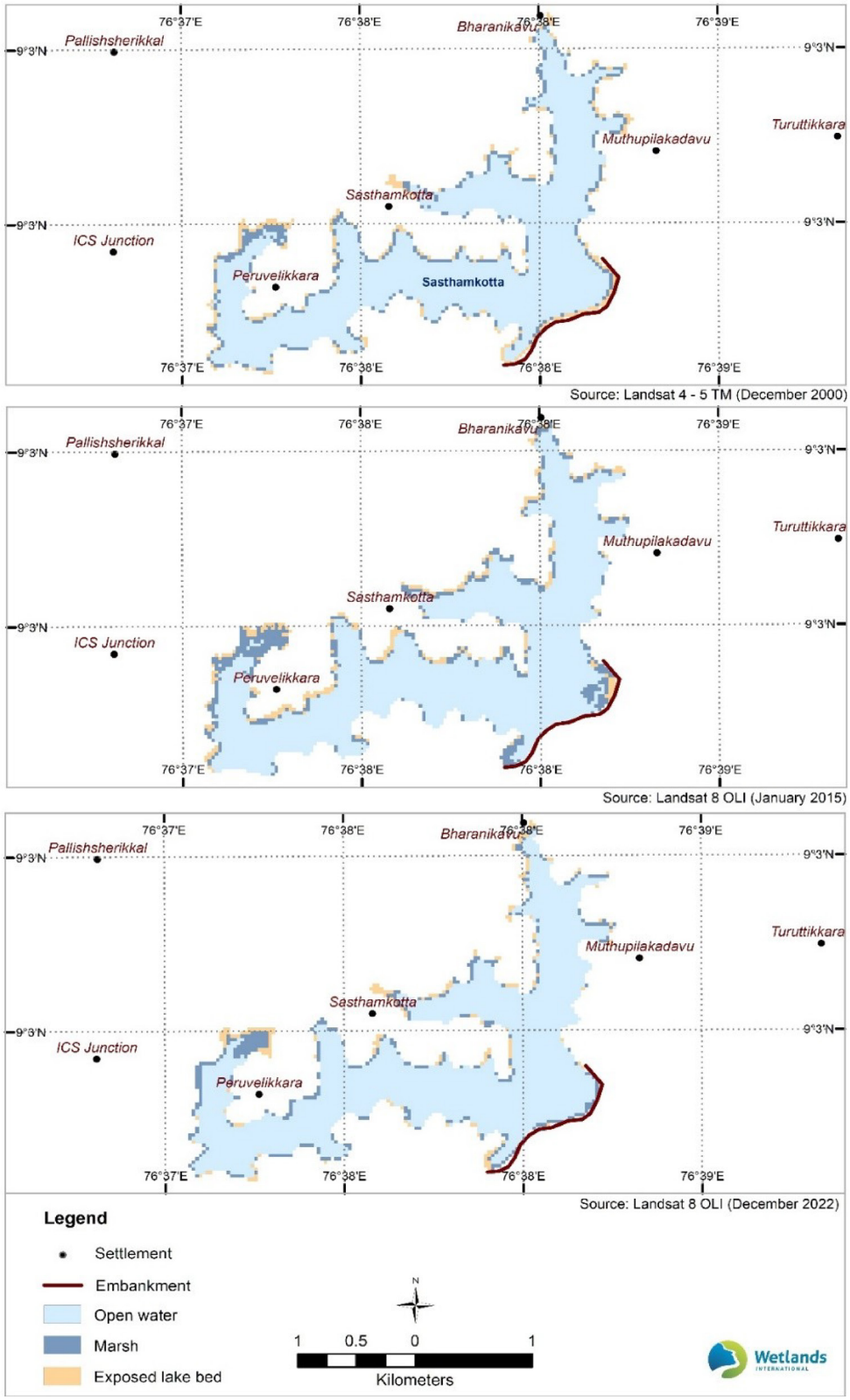
Kollam City is located at a distance of 26 km from the Ramsar Site. The Kollam-Theni Highway NH 220 runs parallel to its eastern margin. The Adoor-Sasthamkotta-Chavara Road and the Kadapuzha-Karalimukku Road run along the Ramsar Site's north-western and southern margins.

The inundated area within Sasthamkotta Lake reaches its peak mainly during July, when the south-west monsoon onsets, spanning nearly 351.2 ha. This gradually recedes by the end of April, when large parts of the inundated area along the embankment and northern shorelines transform into marshes.

A delineation of the wetland boundary was done in 2007 by the Kerala Water Authority and Revenue Department. Based on the survey, 387 boundary pillars were installed 50 m from the peak inundation area. The wetland area has been delimited to 373 ha (roughly corresponding with 16 m amsl water level), including open water area, marshes and fragments of exposed wetland bed. Later as a part of the notification process of the wetland under Wetlands (Conservation and Management) Rules, 2017, implementation guidelines of the same and the Ramsar Information Sheet (RIS) updating, the extent was corrected and updated as 365.91 ha (Map 1.2). Seasonal transitions in land use and land cover within the wetland is presented in Table 2.1 and Map 2.1. Figure 2.1 depicts the monthly variation in the land use land cover for the period of 2022.

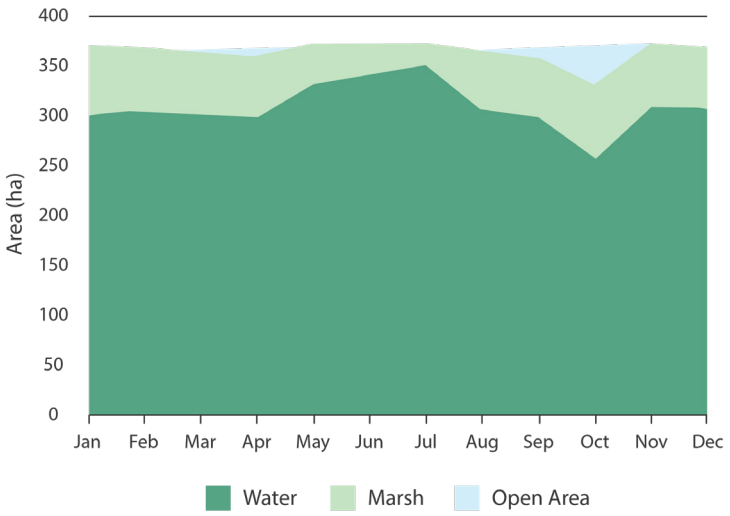
Table 2.1 | Land use land cover change within Sasthamkotta Lake during post-monsoon

Land cover	December 2000	January 2015	December 2022
Water	308	306	306
Marsh	46	47	46
Open Area	20	20	21
Total Area (ha)	373	373	373



Map 2.1 | Land use land cover change within Sasthamkotta Lake during post-monsoon

Figure 2.1 | Monthly variation in land use land cover within Sasthamkotta Lake during 2022



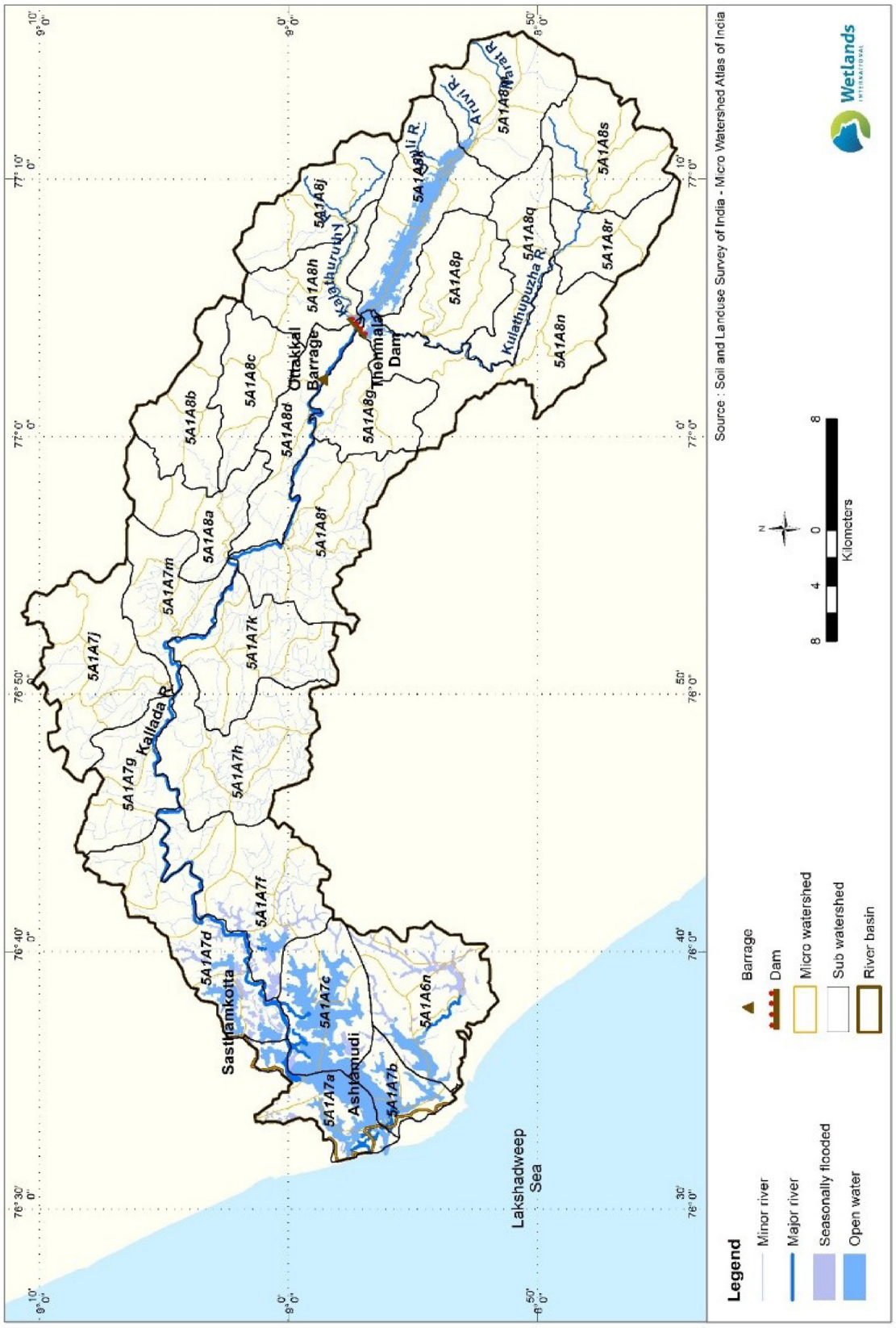
2.2 WETLAND CATCHMENT

Developmental planning, particularly land and water use changes within the basin of the River Kallada, significantly affects the status of Sasthamkotta Lake. Within this basin, a direct catchment spanning ~1125 ha is isolated by moderately elevated ridges around the Ramsar Site except on the southern side, where an embankment has been constructed.

The direct basin of the Sasthamkotta Lake forms a part of the basin of River Kallada. River Kallada originates as the Chendurni River in the Papanasam Range of the Western Ghats, at an altitude of 900 m amsl. Just after the source, Chendurni is joined on its right bank by three major seasonal streams, namely the Aruvi, the Uruli and the Narat. At Parappar, before which the river channel is joined by Kalathuruthy on the right bank and Kulathupuzha on the left bank, a 335 m dam has been constructed (completed in 1986), leading to the formation of reservoir with gross storage capacity of 504.92 MCM. Five kilometres further downstream of the dam, a pick-up weir has been constructed at Ottakkal with a capacity of 17 MCM, wherein the right and the left branch canals take off for irrigating a cultivable command area of 53,514 ha. Water from the reservoir is also used to generate 15 MW hydropower, and the tailrace is reconnected to irrigation channels.

Before its confluence with the Ashtamudi Estuary, Kallada flows for a length of 121 km, drains a 1,699 km^2 catchment area[1] and is joined by 47 tributaries, generating an average annual stream flow of 2,152 MCM (Chithra et al., 2022). The majority of the basin area (84%) lies within Kollam District. The direct drainage basin of Sasthamkotta Lake lies within watershed 5A1A7d2 (Map 2.2) and spans an area of ~1125 ha (inclusive of a 373 ha wetland area).

[1] The basin area has been delineated using the elevation data of Shuttle Radar Topography Mission 3, Version 2.1, collected in February 2000 by NASA. The basin area reported by WRIS is however 1,699 km^2.



Map 2.2 | Watersheds of Kallada River Basin

Image 2 | View of Kallada River from Cheekkalkkadavu Bridge (20 April 2022)

Sasthamkotta Lake is part of several wetlands separated by natural ridge features that dot the Kallada basin. The Kallada basin exhibits a typical linear valley and ridge-type topography with a number of wetland formations. At least fifteen wetlands can be identified from the satellite images on either side of the Kallada River. The elevation difference between the river bed, river banks, and adjoining lands (on the left and right banks of river) causes the inundation of several low-lying valleys. These valleys are further fed by rainfall from the surrounding hills. These wetlands have direct hydrological linkages with the Kallada River or previously had such linkages. The natural sedimentation process has severed the riverine connection of many of these wetlands. A few wetlands, such as Sasthamkotta Lake and Chelurpola Kayal, located very close to Ashtamudi because of low elevations, are influenced by sea conditions during dry summer months. Interventions were made to maintain wetland conditions and bunds were constructed separating these wetlands from the Kallada River.

Climate

The Sasthamkotta Lake catchment experiences a warm and humid tropical climate characterised by hot, wet summers and mild, dry winters. The region receives moderate to heavy rainfall during the peak monsoon season from June to September, accounting for approximately 41% of the total annual rainfall. An additional 27% of the rainfall occurs during the retreating north-east monsoon from October to December. The period between January and March is generally dry, while summer rains are common in April and May. Figures 2.2 and 2.3 illustrate the monthly and annual precipitation trends in the Kollam District from 1991 to 2023. In 2023, the annual precipitation in Kollam was recorded at 2,001.56 mm. Notably, precipitation in the region declined from 2005 to 2017, but after 2017, there has been a slight increase, benefiting the wetlands.

In 2023, the annual evapotranspiration rate for the Kollam District was 1,129.16 mm, indicating significantly high levels in the region (as shown in Figure 2.4). The average annual temperature in the region ranges from 26.9°C to 28.95°C (Figure 2.5 and 2.6). Figures 2.2 and 2.3 illustrate the monthly and annual precipitation trends in the Kollam District from 1991 to 2023. In 2023, the annual

Figure 2.2 | Monthly precipitation (1991–2023) of Kollam
Data source: India-WRIS

https://indiawris.gov.in/wris/#/rainfall

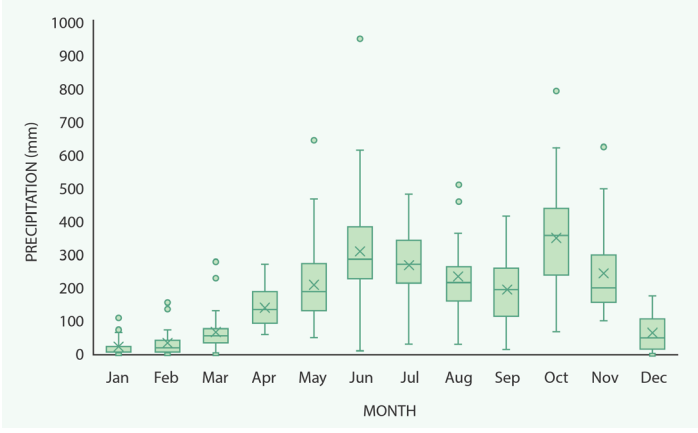


Figure 2.3 | Annual precipitation (1991–2023) of Kollam
Data source: India-WRIS

https://indiawris.gov.in/wris/#/rainfall

precipitation in Kollam was recorded at 2,001.56 mm. Notably, precipitation in the region declined from 2005 to 2017, but after 2017, there has been a slight increase (Figure 2.3).

Figure 2.4 | | Monthly evapotranspiration (2019–2023) of Kollam
Data source: India-WRIS

https://indiawris.gov.in/wris/#/evapotranspiration

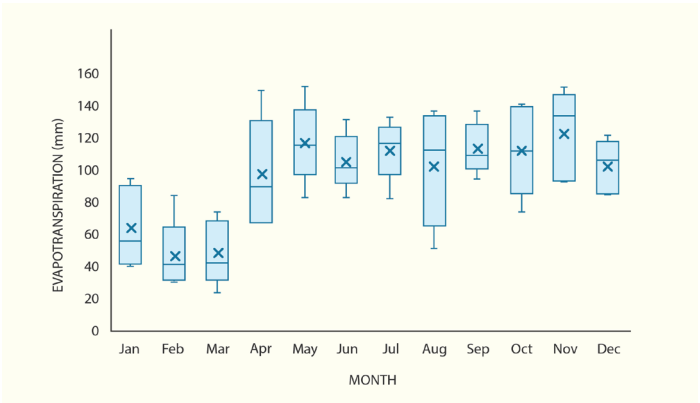


Figure 2.5 | Monthly temperature (1991–2022) of Sasthamkotta Lake
Data source: NASA POWER

https://power.larc.nasa.gov/data-access-viewer/

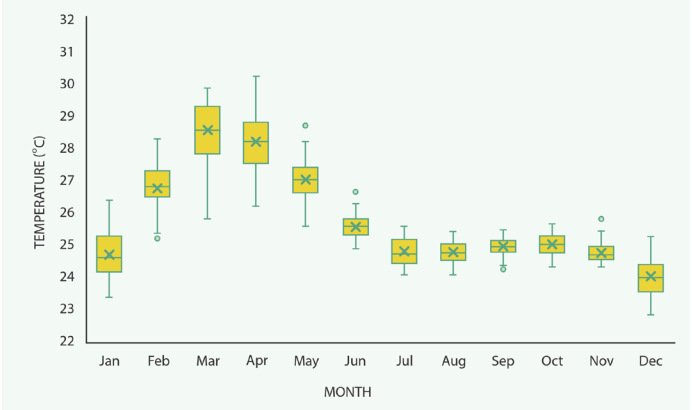
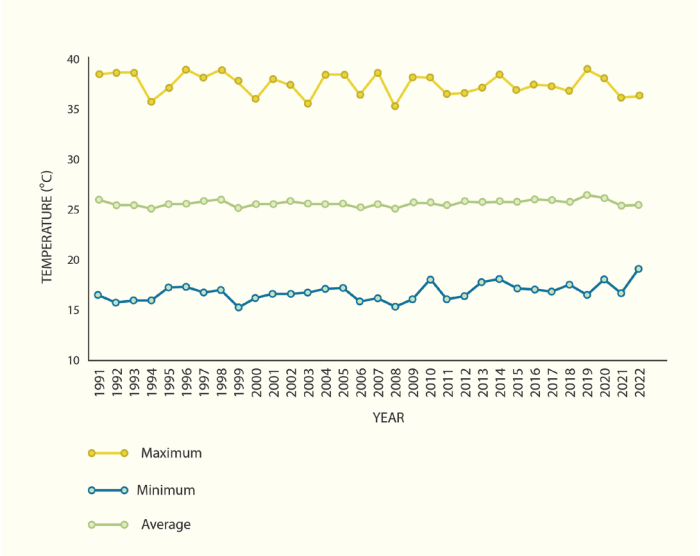


Figure 2.6 | Temperature (1991–2021) of Sasthamkotta Lake
Data source: NASA POWER

https://power.larc.nasa.gov/data-access-viewer/



Climate Risk Assessment for Sasthamkotta Lake

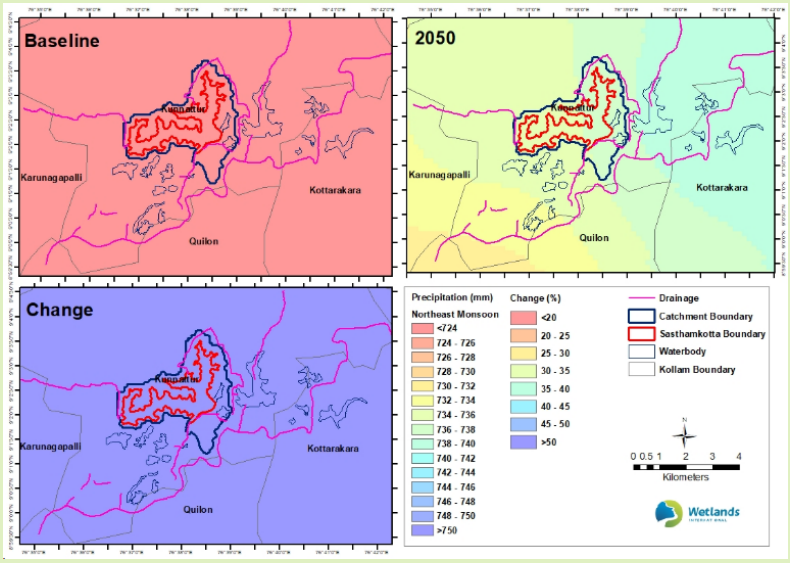
Sasthamkotta Lake precipitation and temperature projections were based on the General Circulation Model (GCM) MIROC-5, following the Representative Concentration Pathway (RCP) 4.5 and Coupled Model Intercomparison Project Phase 5 (CMIP 5) protocols. The assessment compared projections for precipitation and minimum and maximum temperatures for the 2050s against a baseline from 2020.

Precipitation

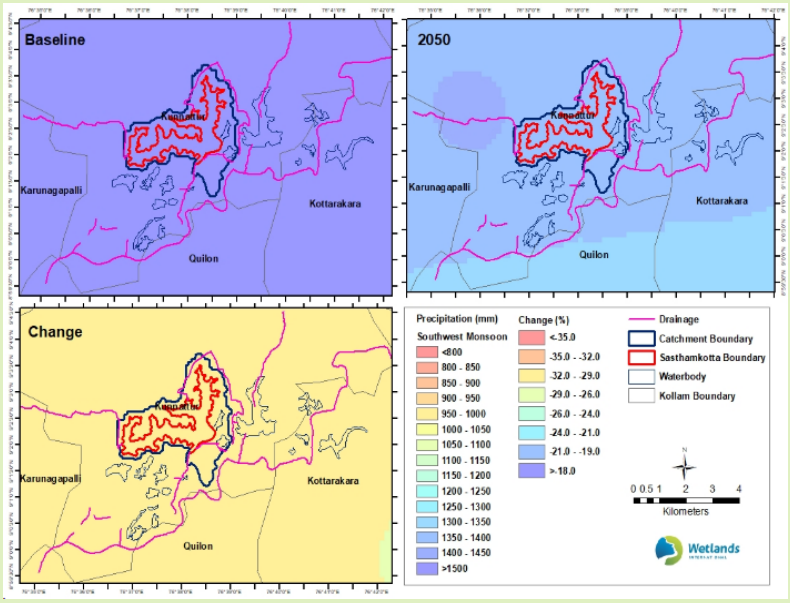
The precipitation is projected to decrease by 26.5% and 10% during the south-west monsoon and non-monsoon seasons, respectively. The north-east monsoon season foresees an increase of 35% in precipitation from 2020 to 2050.

The expected decline in precipitation will likely lead to reduced water levels, exposing the lakebed and potentially expanding the littoral zone. The decreased water inflow will limit the water available for human consumption. This will negatively impact the agricultural productivity, leading to substantial losses for farmers. Water scarcity will increase, particularly during the non-monsoon season. Furthermore, groundwater recharge will decrease, and salinity levels may rise. This will likely result in reduced water availability for agriculture, drinking, and industrial purposes.

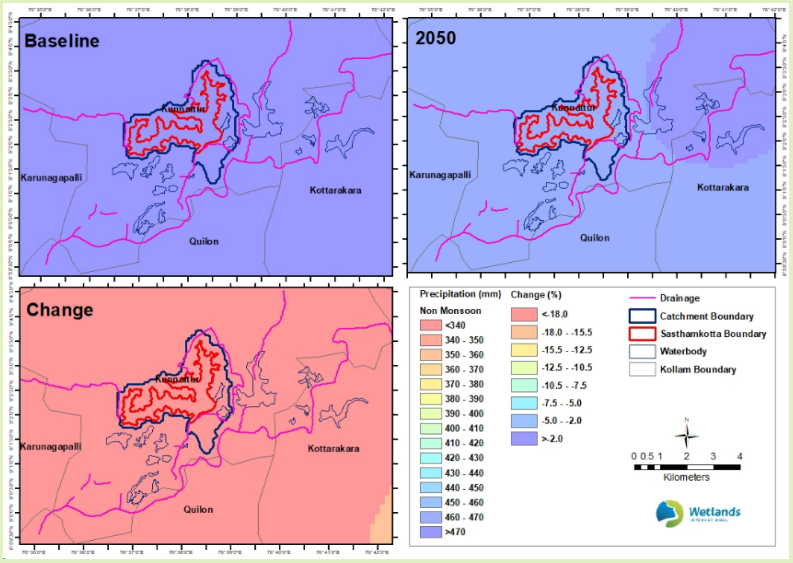
With the increased precipitation during the north-east monsoon season, the water inflow will rise, ensuring sufficient water is available for human



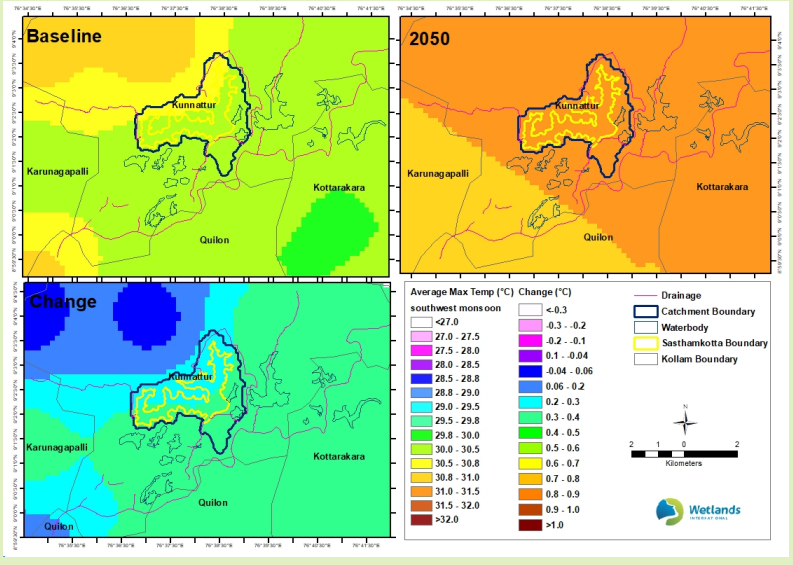
Projections for precipitation during north-east monsoon season (June–September)



Projections for precipitation during south-west monsoon season (October–January)



Projections for precipitation during non-monsoon season (February–May)

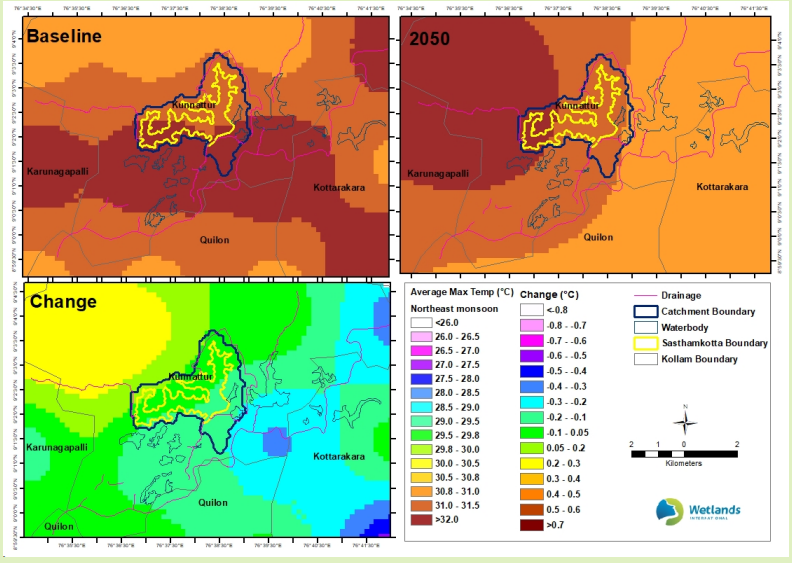


Projected maximum temperature for the south-west monsoon season (June–September)

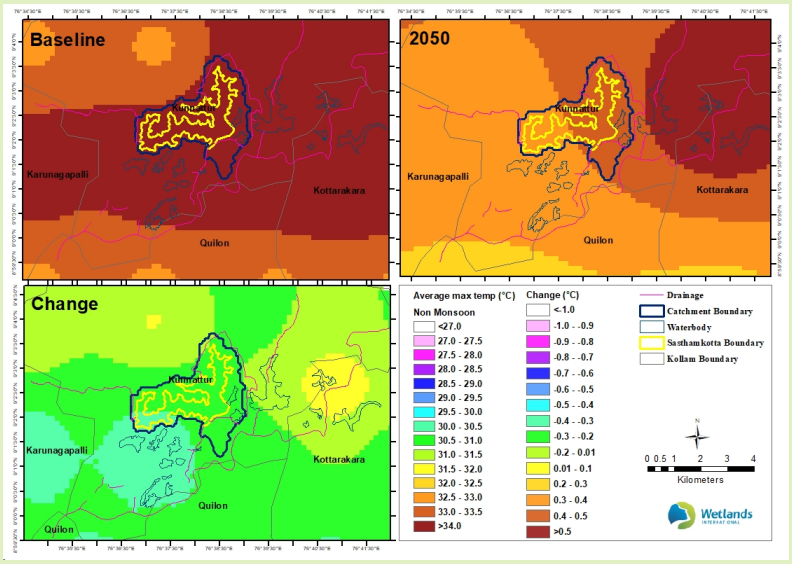
needs. The conditions will be conducive for the breeding of wetland-dependent species. This, in turn, will enhance biodiversity and improve the aesthetics of the wetland.

Temperature

The maximum temperature is expected to increase by 0.6°C during the south-west monsoon season. During the north-east and non-monsoon seasons, the maximum temperature is expected to increase by 0.75°C and 0.80°C, respectively. The rise in maximum temperature will lead to elevated water temperature in the wetland. The wetland water levels are likely to recede, exposing the lakebed and possibly leading to the expansion of the littoral zone. Additionally, the water inflow is expected to decrease, leading to a decline in water quality. There will be increased proliferation of invasive species. These changes will significantly impact the local communities that depend on the wetland.



Projected maximum temperature for the north-east monsoon season (October-January)



Projected maximum temperature for the non-monsoon season (February-May)

Extreme events

Kollam district has faced several extreme climate events. Severe floods hit the district in 1961, 1992, and 2018. The district experienced drought in 1980 and 2013.

The extreme weather events are projected to increase in both frequency and intensity.

The increased heavy rainfall will result in more frequent flash floods. The water quality will decline, and the wetland's hydrology will be altered. There could be a rise in the incidences of waterborne diseases, reduced agricultural productivity and disruption of the local economy. Additionally, extreme rainfall events will likely damage roads, bridges, and other infrastructure.

On the other hand, the increased drought occurrences will reduce water inflow. This will lead to lower water levels and deterioration of water quality.

Such conditions may result in to more fish kills and migration issues, adversely impacting the fisheries. Furthermore, there will be proliferation of invasive species, drying up of native vegetation and decline in water available for human use. This could potentially result in the loss of the ecosystem services provided by the wetland.

NEXT PAGE FIGURE: Impact and Vulnerability Assessment for Sasthamkotta Lake (Exp- Exposure, Sens- Sensitivity, Imp- Impact, Adc- Adaptive Capacity, Vul- Vulnerability, VH- Very High, H- High, M-Medium, L-Low, VL-Very Low)

	Inundation Regime					Groundwater					Water Inflow Quality(DO)					Water Inflow Quality (PO4)					Water Inflow Quantity					Flood Buffering					Water Storage					Navigation				
Climate Induced Threats	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul
Temperature																																								
Increase in maximum temperature (SW Monsoon-JJAS)	M	L	M	VH	L	VL	L	L	VH	L	H	M	H	M	H	M	M	M	L	M	M	VL	L	M	M	M	L	M	H	M	L	L	L	M	M	VL	VL	VH	VL	VL
Increase in maximum temperature (NE Monsoon-ONDJ)	M	L	M	VH	L	VL	L	L	VH	L	H	M	H	M	H	M	M	M	L	M	M	VL	L	M	M	M	L	M	H	M	L	L	L	M	M	VL	VL	VH	VL	VL
Increase in maximum temperature (Non-Monsoon-FMAM)	M	L	M	VH	L	VL	L	L	VH	L	H	M	H	M	H	M	M	M	L	M	M	VL	L	M	M	M	L	M	H	M	L	L	L	M	M	VL	VL	VH	VL	VL
Precipitation																																								
Decrease in precipitation (SW Monsoon)	H	H	H	VH	M	H	L	M	VH	L	M	L	M	M	M	H	H	H	L	H	VH	L	H	M	H	H	VL	M	H	M	VH	VH	VH	M	VH	H	VL	VH	VL	L
Increase in precipitation (NE Monsoon)	H	VH	VH	VH	H	H	L	M	VH	L	M	L	M	H	M	H	H	H	L	H	VH	VL	H	H	M	H	VL	M	H	M	VH	M	VH	H	H	H	VL	VH	M	L
Decrease in precipitation (Non-Monsoon)	H	H	H	VH	M	H	L	M	VH	L	M	L	M	M	M	H	H	H	L	H	VH	VL	H	M	H	H	VL	M	H	M	H	VH	VH	M	VH	M	VL	VH	M	L
Extreme events																																								
Increase in extreme rainfall events leading to floods in monsoon	VH	VH	VH	VH	VH	VH	L	H	VH	M	H	L	M	H	M	VH	VH	VH	VL	VH	VH	VH	VH	H	H	H	VH	VH	L	VH	VH	L	H	H	M	H	H	L	L	H
Increase in drought events	M	H	M	VL	H	M	H	M	VL	H	M	H	M	VL	H	M	H	M	VL	H	M	H	M	L	M	M	VL	L	H	L	M	H	M	VL	H	L	H	VL	M	H

	Water Supply Units					Velanthara Embankment					Nutrient Cycling					Species of Global Conservation					Catchment Vegetation					Ecosystem connectivity					Spiritual					Aesthetics				
Climate Induced Threats	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul	Exp	Sen	Imp	Adc	Vul
Temperature																																								
Increase in maximum temperature (SW Monsoon-JJAS)	L	VL	L	VH	L	VL	VL	VL	VH	VL	M	L	H	M	M	L	L	L	VH	L	L	VL	L	VH	L	L	VL	L	H	L	L	VL	L	VH	L	L	VL	L	M	M
Increase in maximum temperature (NE Monsoon-ONDJ)	L	VL	L	VH	L	VL	VL	VL	VH	VL	M	L	H	M	M	L	L	L	VH	L	L	VL	L	VH	L	L	VL	L	H	L	L	VL	L	VH	L	L	VL	L	M	M
Increase in maximum temperature (Non-Monsoon-FMAM)	L	VL	L	VH	L	VL	VL	VL	VH	VL	M	L	H	M	M	L	L	L	VH	L	L	VL	L	VH	L	L	VL	L	H	L	L	VL	L	VH	L	L	VL	L	M	M
Precipitation																																								
Decrease in precipitation (SW Monsoon)	L	M	M	VH	L	VL	VL	VL	VH	VL	H	L	H	M	M	L	L	L	VH	L	H	VL	M	VH	L	H	M	H	H	M	M	VL	L	VH	L	L	M	M	H	M
Increase in precipitation (NE Monsoon)	L	L	L	VH	L	VL	VL	VL	VH	VL	M	VL	H	L	L	L	L	L	VH	L	H	VL	M	VH	L	H	L	M	H	M	M	VL	L	VH	L	L	VL	L	H	L
Decrease in precipitation (Non-Monsoon)	L	M	M	VH	L	H	VL	M	VH	L	H	L	H	M	M	L	L	L	VH	L	H	VL	M	VH	L	H	M	H	H	M	M	VL	L	VH	L	L	VL	L	H	L
Extreme events																																								
Increase in extreme rainfall events leading to floods in monsoon	H	M	H	L	H	VH	VH	VH	M	VH	H	L	L	M	M	H	L	M	H	M	H	L	M	VH	L	VH	VL	H	H	M	H	H	H	VH	M	VH	VH	VH	L	VH
Increase in drought events	M	H	M	VL	H	VL	VL	VL	VH	VL	L	H	L	M	M	L	H	M	L	M	M	M	M	M	M	M	H	M	L	M	L	H	M	VH	L	M	H	M	VL	H

Impact and Vulnerability Assessment for Sasthamkotta Lake (Exp- Exposure, Sens- Sensitivity, Imp- Impact, Adc- Adaptive Capacity, Vul- Vulnerability, VH- Very High, H- High, M-Medium, L-Low, VL-Very Low)

Table 2.2 | Slope characteristics of direct catchment of Sasthamkotta Lake

Slope categories	Area (ha)	% of total
Nearly level (0–1%)	258	23
Sloping (2–10%)	731	65
Steep (11–25%)	136	12
Very steep (> 25%)	0	0
Total catchment area*	1125	100

*(*Catchment area includes 373 ha of Ramsar Site area)*

Physiography

Elevation within the direct catchment of Sasthamkotta range between 15–40 m amsl characterised by hillocks, valley hills and gently sloping alluvial floodplains. Lower elevation (16–18 m amsl) on the west of Sasthamkotta mark the place where the wetland bears connection with adjoining Karali marshes.

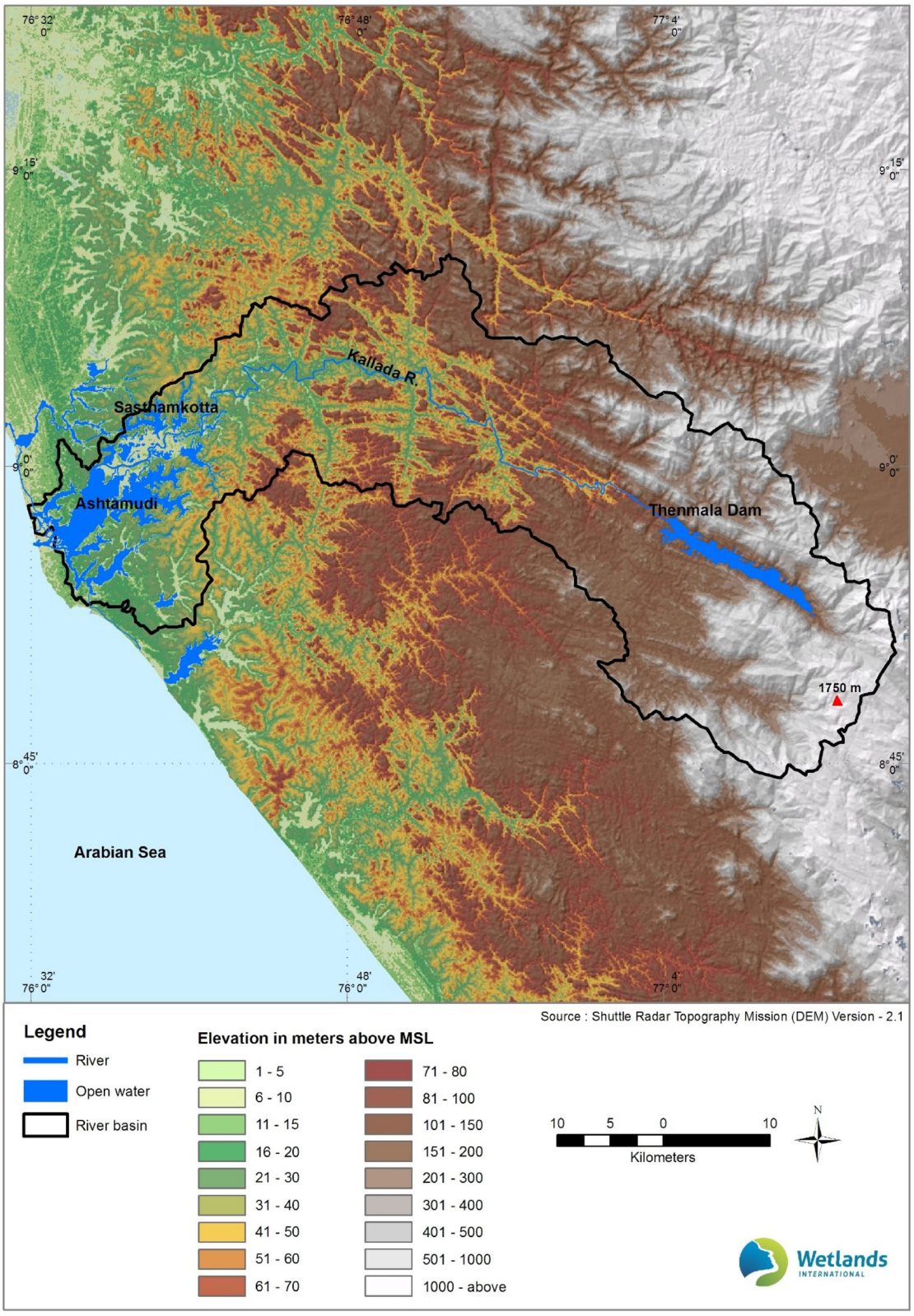
State Highway 37 (Adoor-Sasthamkotta), NH 220, and Chavara-Sasthamkotta Road border the Ramsar Site along the north, east and west. At a point below the embankment near the Thiruvatta-Mahadevar Temple where the river takes a small U-turn after flowing southwards for some distance, the left bank of Kallada River is depressed by as much as 3–4 m as compared with its right bank and its adjoining floodplains, and probably marks the area of spill of Kallada water into the connecting marshes and subsequently into the wetland. The surface water connectivity is presently hindered by the Karalimukku-Kadapuzha Road, which runs along the right bank of the river (Table 2.2).

Geology and Geomorphology

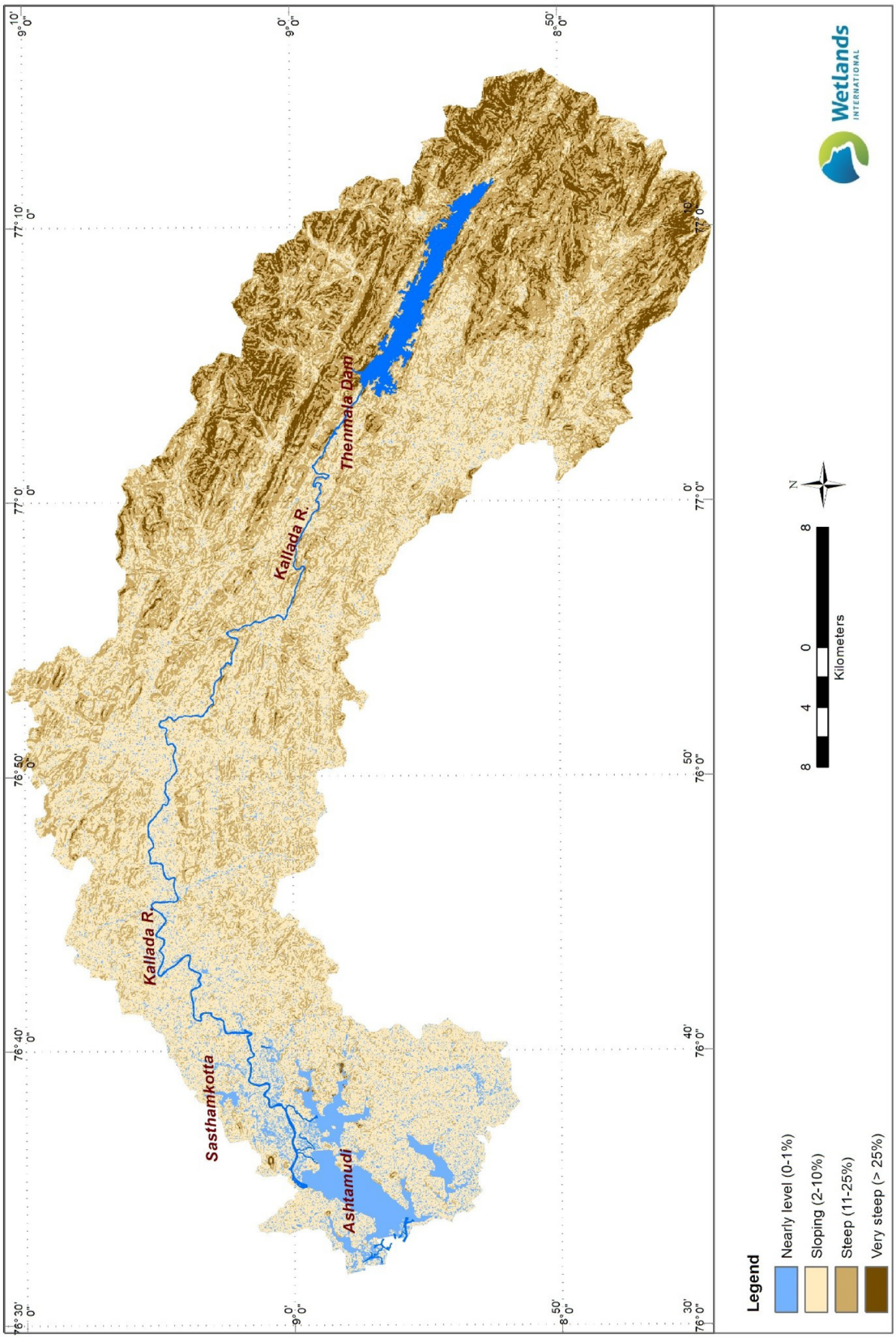
Sasthamkotta has developed on the uplifted South Kerala Sedimentary Basin (SKSB) (Nair et al., 2006). The SKSB was formed by crustal thinning (Qureshy, 1982) during the Late Oligocene or Early Miocene. This basin has a sediment fill of approximately 700 m thick with 600 m of the early to middle Miocene sediments and the remaining 100 m of quaternary age (Nair et al., 2010). Siliciclastic sediments with interbedded lignite seams dominate the Cenozoic sedimentary succession in the onshore part of the Kallada Basin (Reuter et al., 2010). The sources for siliciclastics are the Western Ghats sediments deposited by the rivers in marginal lagoons.

Tertiary sediments in the direct drainage basin belong to the Quilon and Warkalli Formations of Lower Miocene age. The laterite hillocks surrounding the Sasthamkotta are part of the Warkalli Formation, composed of sandstones, variegated clays, and lenticular seams of lignite in certain pockets. This formation is underlain by more compact marly sandstone with shell fragments and thin horizons of limestone, known as the Quilon Formation.

The Quilon Formation, occurring below the Warkalli Formation is represented by fossiliferous limestone and sandy carbonaceous clay. Found in Paravoor and in the neighbourhood of Kollam, this is popularly known as the Kollam or Quilon limestone and is extensively exploited. Incidentally, Kollam District produces 36% of crude clay and 43.5% of processed clay in the state, accounting for 9.08% of the country's total China Clay production. The areas around the Sasthamkotta have rich reserves of China clay.



Map 2.3 | Elevation profile of Kallada River Basin



Map 2.4 | Slopes in Kallada River Basin

In most regions of Kerala, bauxite is associated with laterite and occurs as capping over the crystalline and tertiary sedimentary rocks, forming a lateritic plateau rising from 50 to 150 m amsl. At Chattannur and Kundara in Kollam District, a zone of about 2 m thick bauxite is recognised at the contact between the crystalline and the overlying sedimentary rocks. The bauxite at the base of the sedimentary indicates an earlier pre-Warkalli spell of lateralisation.

Soils

The National Bureau of Soil Survey and Land Use Planning, Nagpur, has identified seven soil types in the Kallada Basin, showcasing a geological sequence from the Western Ghats to the coast. Soil samples reveal classifications of clay, sandy, and sandy clay loam.

In low-lying coastal areas near the Ashtamudi Estuary mouth, deep, imperfectly drained clayey soils (Fine, Mixed Typic Dystropepts and Fine, Mixed Aeric Tropaquepts) with a shallow water table. These soils are on level lands with valleys with slight erosion. Narrow valleys and level lands west of Sasthamkotta Lake and along the Kallada River contain patches of well-drained to imperfectly drained hydromorphic alluvial soils (Typic Dystropepts and Typic Tropaquepts). These soils are formed from sedimentation and show hydromorphic traits such as grey horizons, mottling, hard pans, and organic matter deposits (Map 2.6).

Heavy rainfall and high temperatures in south Kerala are conducive for laterisation. Extensive laterite soils, poor in available Nitrogen and Phosphorus with high clay content and low Cation Exchange Capacity, are found in Kallada Basin over coastal laterites and lateritic mounds in midlands and hilly areas. Very deep, well-drained, gravelly clay soils occur on coastal laterites. Kaolinitic clays, belonging to the type Typic Kandiustults along with Typic Kanhaplustults, in coastal stretches west of Sasthamkotta belong to these categories. A major part of the middle basin of the Kallada River, beginning from Sasthamkotta till Punalur, is characterised by very deep, well-drained, gravelly clay soils with moderate surface gravelliness formed on gently sloping midland laterites.

Very deep, well-drained gravelly clay soil with moderate surface gravelliness is found on moderately sloping laterite mounds and on gentle slopes around Sasthamkotta and the middle and upper reaches of the basin. It is found around Bharanikavu, spreading to Pattazhy, Maloor, and Edamon, situated in the foothills of the Western Ghats. These comprise the Clayey, Kaolinitic, Ustic Kanhaplohumults and the Clayey, Kaolinitic, Typic Kandiustults soil types.

Map 2.6 | Soil types around Sasthamkotta Lake

Land use land cover change

Within the direct catchment, plantations form the major land use, accounting for 40.6% of the area, followed by open water accounting for 32.8%. These plantations constitute mostly of coconut-based homestead agroforestry system, intermixed with mango (*Mangifera indica*), cashew (*Anarcardium occidentale*) and jackfruit (*Artocarpus heterophyllus*).

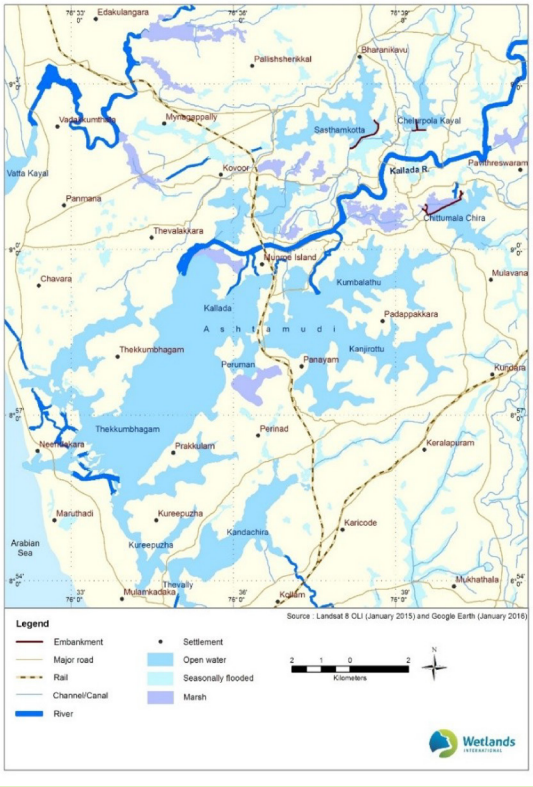
Major crops grown in the area include cashew, coconut, tapioca, jackfruit and areca nut (Figure 2.7 and Map 2.7).

Evolutionary History of Sasthamkotta Lake

Extending along the coast between Kollam and Kondungallur, the Southern Kerala Sedimentary Basin (SKSB) is the landward extension of Offshore Kerala Konkan Basin (Nair et al., 2006). The basin has a fill of about 700 m of sediments of which about 80 m are made up of Quaternary sediments. A characteristic feature of this basin is presence of largest coast-perpendicular estuary (Ashtamudi) and several marshes and lakes in a similar fashion. The formation of these wetlands is closely linked with the Quaternary geology of the basin (Map 2.5).

During the Pleistocene period that ended about 11,700 years ago, the climate of the basin was drier and cooler. The rivers that flowed in the region, had established extensive riparian floodplains and swamp forests. The evidences of these swamps, particularly Myristica swamps can be seen at present as far as Chendurni Wildlife Sanctuary within the basin. These swamps are regarded as relic habitats and are one the most primitive of angiosperms with the family believed to have originated before the break up of Gondwana land. The tree exhibits physiological adaptations for waterlogged conditions such as protrusions, stilt roots, flying buttresses, aerial adventitious roots. These adaptations made them ideal species to establish and proliferate along the entire western coast.

During the early Holocene, as the Earth started warming up, heavy rainfall was experienced which flooded the existing river valleys. This flooding which occurred around 8,500–5,500 years ago, submerged the thick riparian forests with bank sediments derived from the nearby lateritic hills. Thus, the extensive Pleistocene forests were converted into swamps, marshes and lakes. As sea levels receded about 4,000 years ago, sediments were deposited at the head of the river mouths, forming the Kerala Bay Head Delta. The Bay Head Delta propagated seawards, filling up half of the Ashtamudi. River meandering and migration together with rapid sedimentation, as revealed by the sedimentary records of boreholes, was responsible for cut off of many broad, scoured valleys into wetlands like Sasthamkotta, Chelupola, Chittumala, etc..



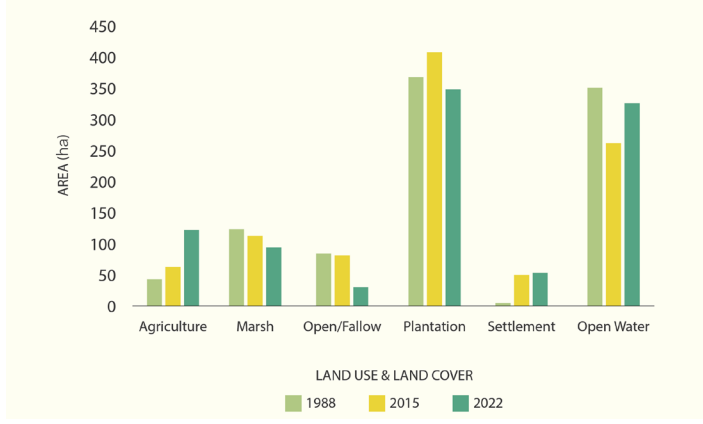
Map 2.5 | Ashtamudi and Sasthamkotta wetland complex

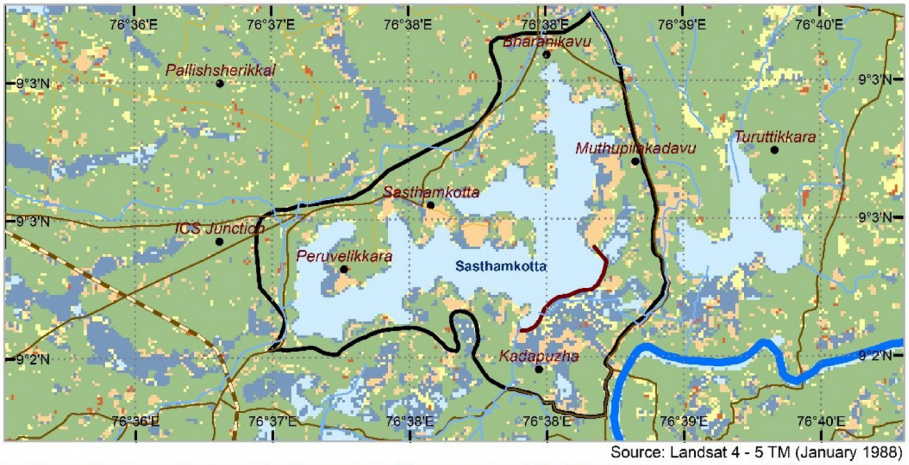
Land use and land cover change within the direct drainage basin of Sasthamkotta Lake indicates the conversion of natural vegetation into plantations and the expansion of settlements. There are no forest patches left in this direct catchment any more, as it has been reclaimed for plantation and agriculture. During the 80s, the shoreline areas were planted with *Acacia* under a World Bank-sponsored Social Forestry Project. However, post 2010, when the wetland exhibited frequent drying, efforts were being made to remove the plantation and restore native vegetation. Wild pineapple varieties have been planted in certain areas to increase soil stability. There has also been extensive construction of roads and related infrastructure. The slopes have been encroached on for tapioca, rubber, and other plantations, and run-off and sedimentation have enhanced agricultural practices.

Figure 2.8 illustrates that between 1988 and 2022, the Sasthamkotta Lake direct catchment experienced significant land use and land cover transformation. Plantation areas decreased from 489 ha to 457 ha, primarily converted to agriculture (63 ha), settlements (28 ha), marshes (22 ha), and fallow land (16 ha). Wetlands were reduced by approximately 55 ha, while marsh was reduced by 30 ha, largely replaced by plantations. Open and fallow land decreased from 95 ha to 41 ha, mostly transformed into agriculture and settlements. Agriculture expanded from 49 ha to 145 ha, and settlements grew from 5 ha to 57 ha, reflecting increased development and land conversion.

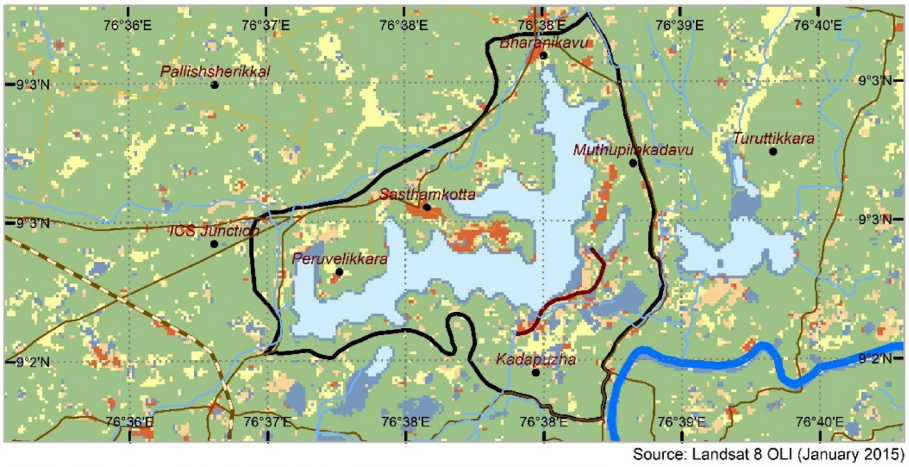
Land use within the Kallada River Basin and Sasthamkotta's direct catchment has intensified over time. Several of these changes affect the wetland's hydrological connectivity and inundation regime stability. Many of the marsh areas around Sasthamkotta have been converted to agricultural paddies and mixed cropping plantations to paddies. The replacement of natural forests with plantations and the reclamation of land for agriculture in the Kallada catchment have enhanced soil erosion. The replacement

Figure 2.7 | Land use land cover change in direct catchment of Sasthamkotta Lake

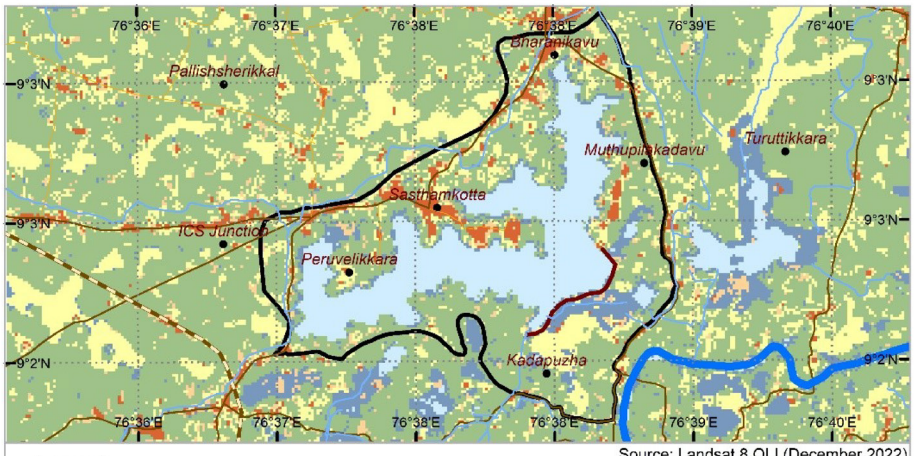




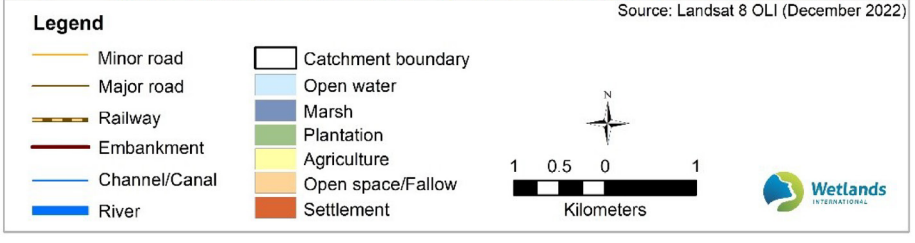
Source: Landsat 4 - 5 TM (January 1988)



Source: Landsat 8 OLI (January 2015)



Source: Landsat 8 OLI (December 2022)



Map 2.7 | Land use land cover change in direct catchment of Sasthamkotta Lake

Image 3 | Rubber plantation near Muthupilakadavu (2017)

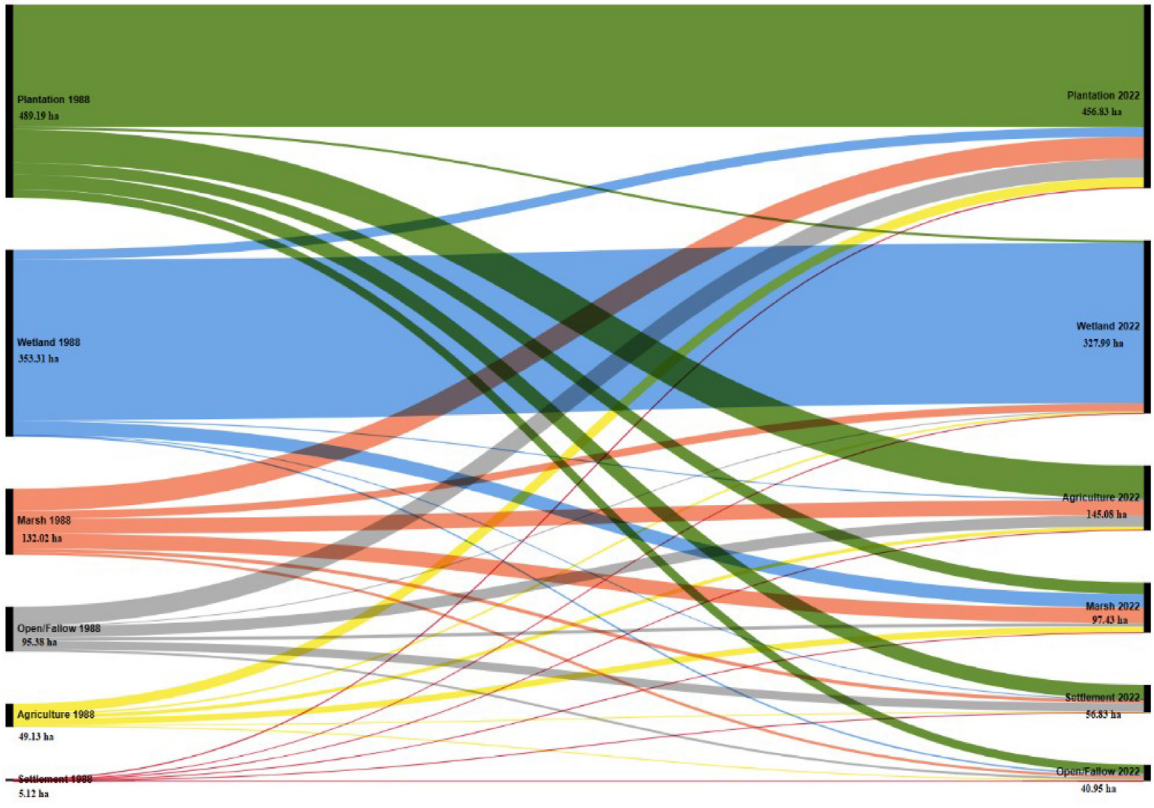


Figure 2.8 | Land use land cover transformation within direct catchment of Sasthamkotta Lake (1988–2022)

Image 4 | Eroded soil near DB College (20 April 2022)

of native vegetation with *Acacia* and *Eucalyptus* trees has skewed the natural soil's moisture regimes.

Many plantation companies are located in Punalur along the banks of the Kallada River[2]. Pulp and paper mills are considered one of the most polluting industries. The paper-making process demands a large amount of fresh water and produces enormous quantities of wastewater that is contaminated by a number of organic and inorganic chemicals, which generally have low biodegradability due to the presence of recalcitrant compounds. Disposal of such wastewater in rivers and wetlands can have severe adverse impacts on the physicochemical characteristics and the biodiversity they support.

Significant pressure on wetlands is created by mining within the floodplains. Along River Kallada, there are over 108 mining sites and the landscape is marked by the presence of several deep pits. Alluvial plains near the river, a rich clay and sand source, are exploited extensively. The alluvial river sand underneath is extracted after digging out the clay from the surface layers. It has been reported that very deep mining up to the extent of 90 to 100 m below the surface has been carried out here. In recent years, illegal mining activity has been banned in the region.

It is reported that at least one-third of the total area of West Kallada panchayat had been mined for sand, often using heavy-duty motors. The craters left at many locations are at a lower level than the nearby Sasthamkotta. The State Government banned sand mining from Kallada in 2015. Illegal sand mining was a great concern along the banks of the Kallada River, making the banks more vulnerable to erosion and floods.

Extensive laterite mining was also conducted in addition

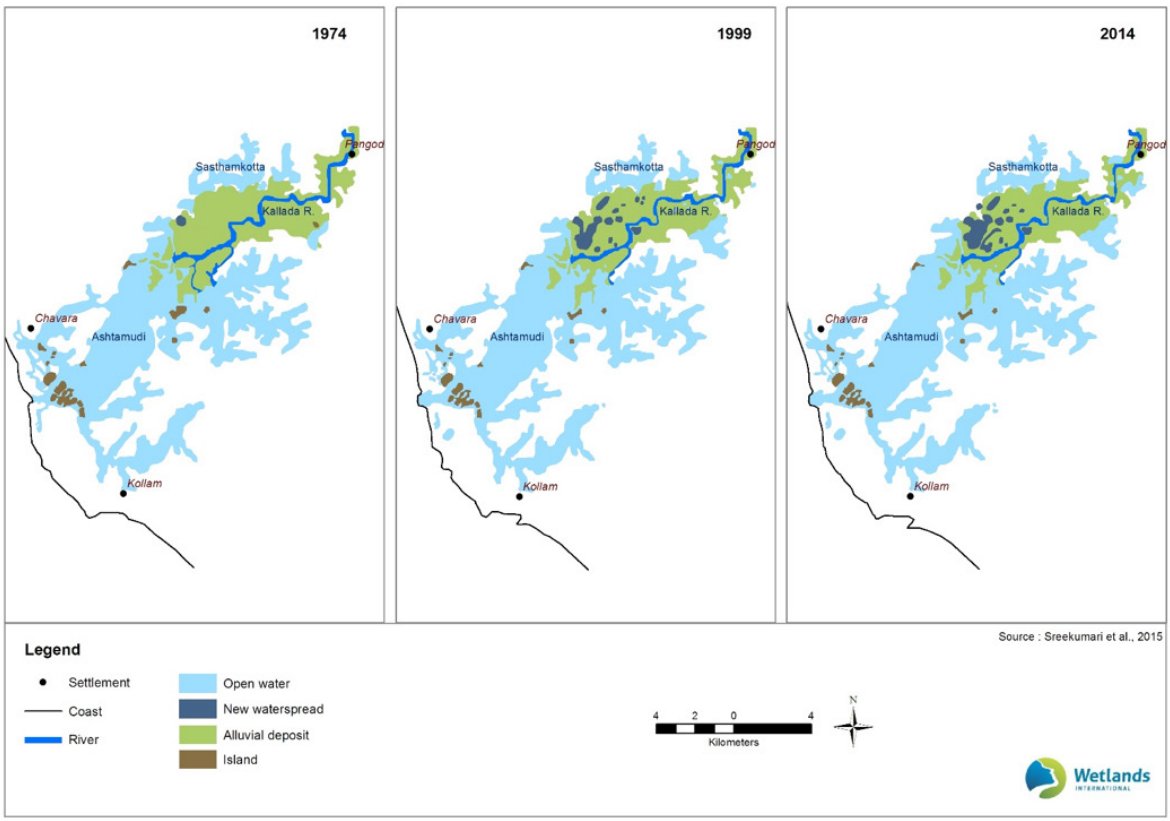
[2] The Punalur Paper Mills and the Rehabilitation Plantations Limited are located in Punalur. The latter is a joint venture company of the Government of India and Government of Kerala set up in 1972 with the objective of rehabilitating repatriates from Sri Lanka. It is involved in manufacture of ammoniacal latex and rubber sheets.

to sand. Moist laterites can easily be cut with a spade into regular-sized blocks, and they harden upon exposure, making them ideal construction materials. Several of the lateritic hillocks surrounding Sasthamkotta Lake have been mined for construction purposes.

Large-scale conversion of paddy fields has also been observed for clay mining. Local dailies reported that 332 ha of paddy fields were converted for clay mining, and only 162 ha of agricultural land remained in the Grama Panchayat (Irshad, 2015).

No mining activities have occurred in the Kallada region since the prohibition on sand and laterite mining in 2015.

Map 2.8 indicates changes in alluvial floodplain structure due to mining. A significant consequence, further elaborated in the discussion on hydrological regimes, is impeded subsurface connectivity of the river with wetland, thus altering hydrological regimes and making the ecosystem more vulnerable to variability in the monsoon.



Map 2.8 | Changes in alluvial floodplain structure due to sand mining in lower reaches of Kallada River Basin

2.3 HYDROLOGICAL REGIMES

Characterisation of hydrological regimes of wetlands should ideally be done using long-term data on inundation regimes, water inflow and outflow patterns, sedimentation, water quality and the way water is managed. However, the current hydrological monitoring of Sasthamkotta Lake is limited to recording water levels, water withdrawal, and water quality parameters by the Kerala Water Authority (KWA). The analysis contained in this section is based on the following datasets, is indicative, and is primarily intended to highlight issues relevant to the management of hydrological regimes:

- Rainfall data from Kollam Station of the Indian Meteorological Department (IMD) for 32 years (1991–2023)
- Water level data made available for 27+ years (1997–2023) by KWA. The level is gauged at the Authority's pump house used for water withdrawal
- Bathymetry study for 2022 conducted by Kerala Hydrographic Survey Wing
- Water quality for select parameters obtained from Centre for Water Resources Development and Management (CWRDM) for the period 2021–2024 as part of the Wetland Inventory, Assessment and Monitoring Systems (WIAMS) project.
- Additional data from published literature has also been used

Inundation regimes

Sasthamkotta Lake experiences notable inter-annual variations in its inundation regime. In a typical rainfall year, the wetland is fully inundated by July with water levels around 16 m amsl. Post-monsoon, water levels drop to about 13 m amsl by October, shrinking the inundated area to approximately 257.3 ha. This leads to the wetland bed being exposed, transforming into marshes, with some areas remaining dry and devoid of vegetation.

Image 5 | Water level monitoring station at pump house (10 May 2024)

The known long-term trend in water level is presented in Figure 2.9. Post 2012, there was a conspicuous decline in levels. The period also coincided with a decline in rainfall and an increase in the withdrawal of water from the Ramsar Site on account of commissioning additional water supply projects. In May 2013, the water levels dipped to 11.7 m amsl, at which time over half of the wetland bed was exposed, causing serious concerns about the tenability of water use, which depends on Sasthamkotta. Figure 2.10 captures the probability of exceedance of various water levels for Sasthamkotta Lake.

Water inflow, outflow and balance

Sasthamkotta Lake has a direct catchment of 1125 ha. Surface run-off from rainfall within this drainage basin and direct rainfall on the wetland constitute the major sources of inflow. The Kerala Water Authority withdraws water from Sasthamkotta Lake to supply Kollam

Figure 2.9 | Trends in water level of Sasthamkotta Lake (1997–2023)

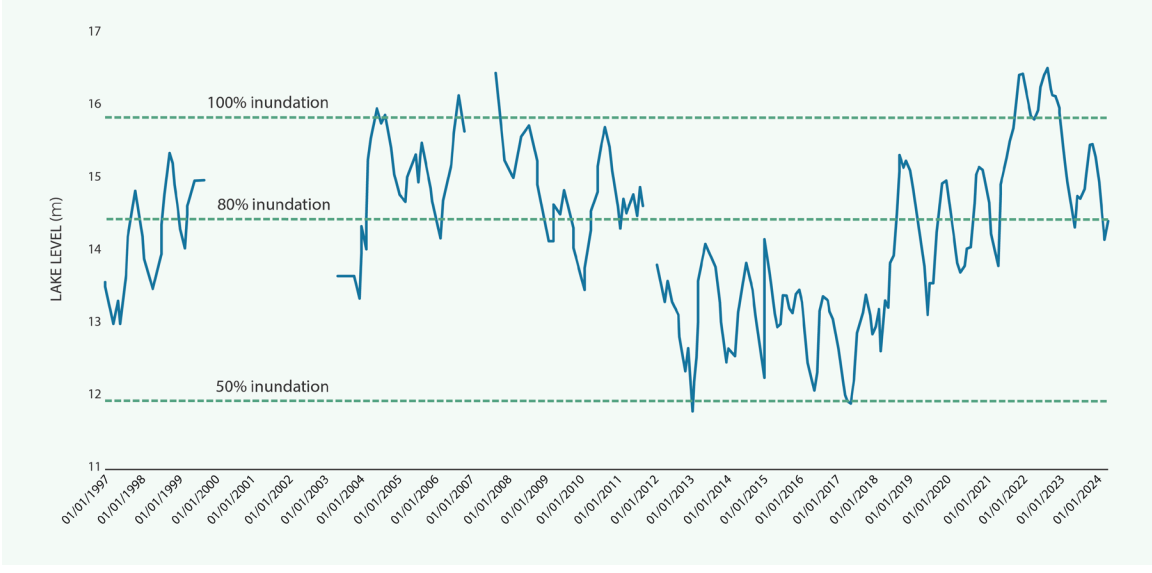
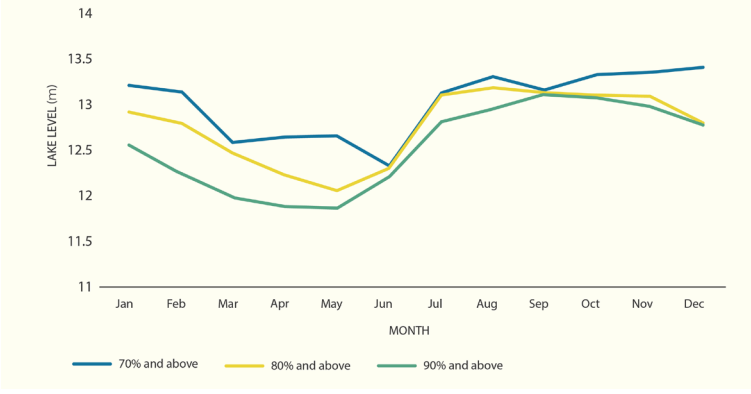
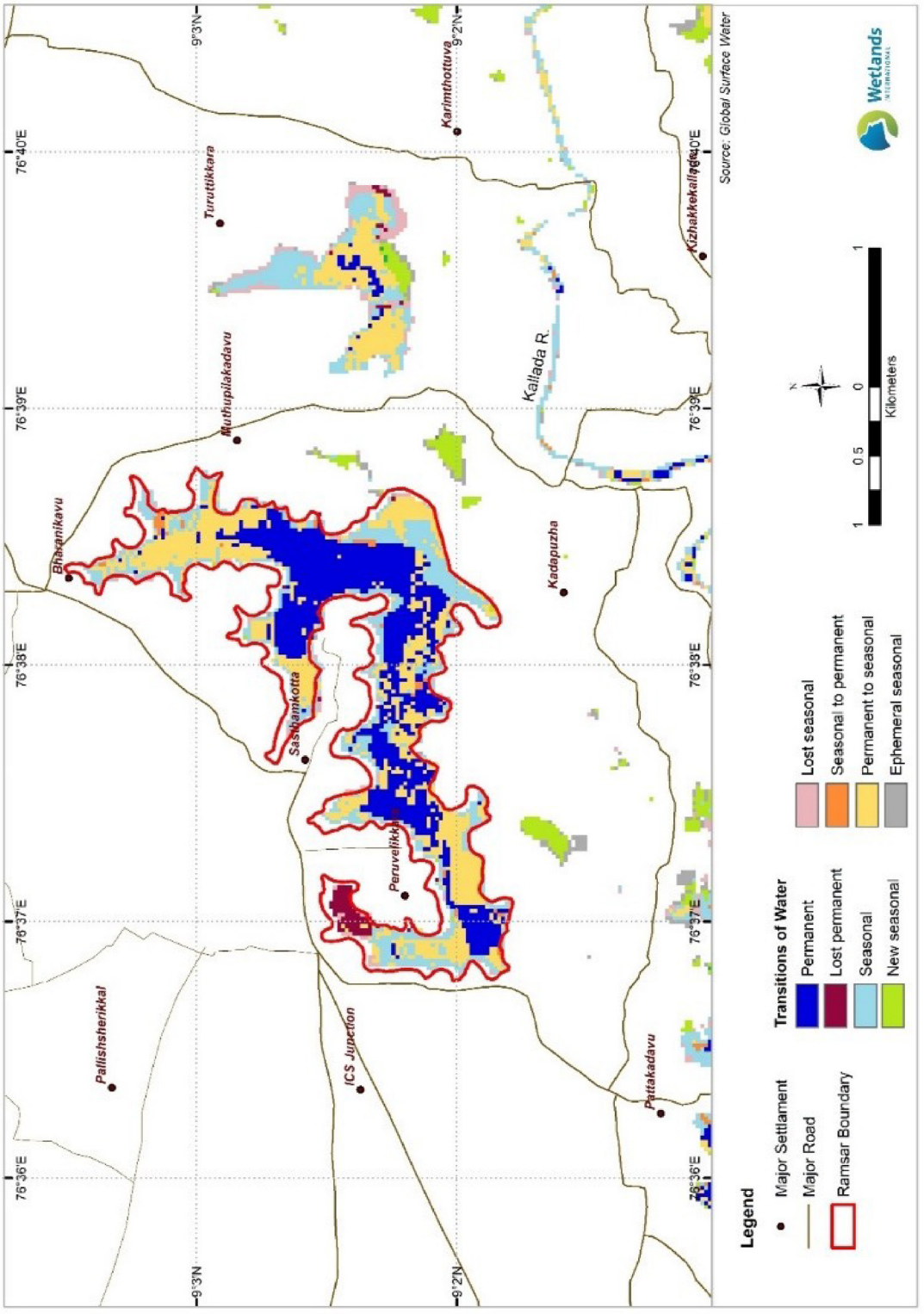
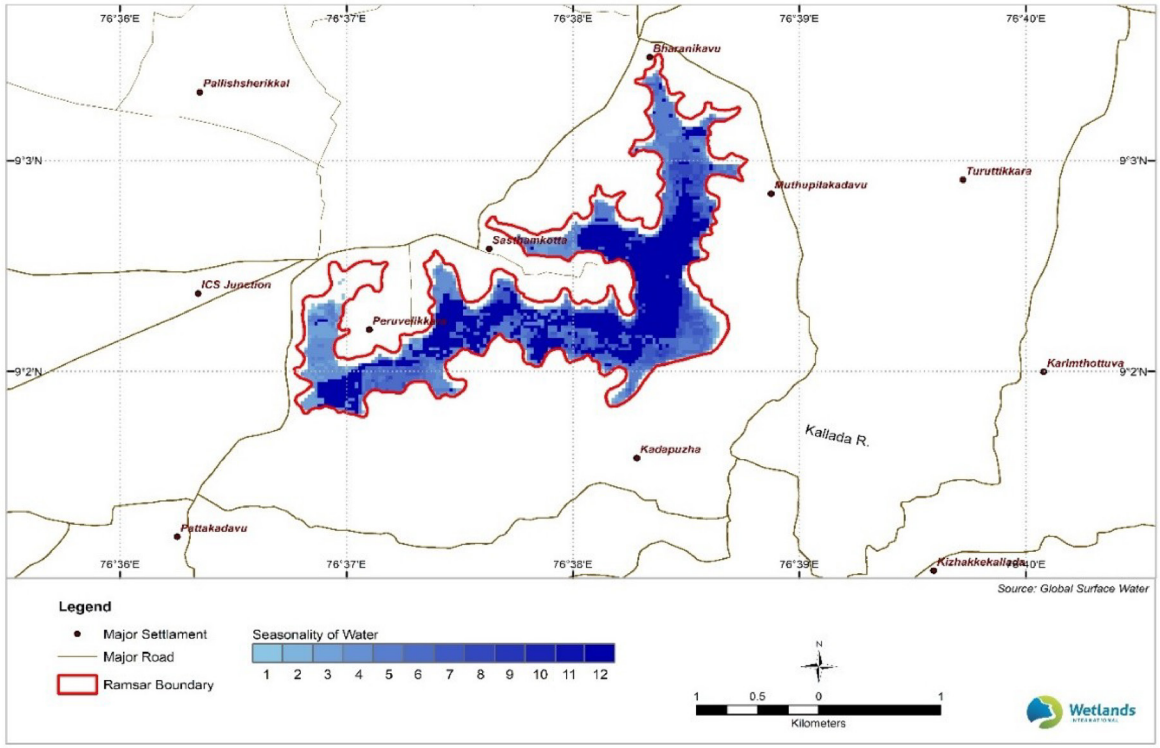


Figure 2.10 | Probability of exceedance of water level during different months

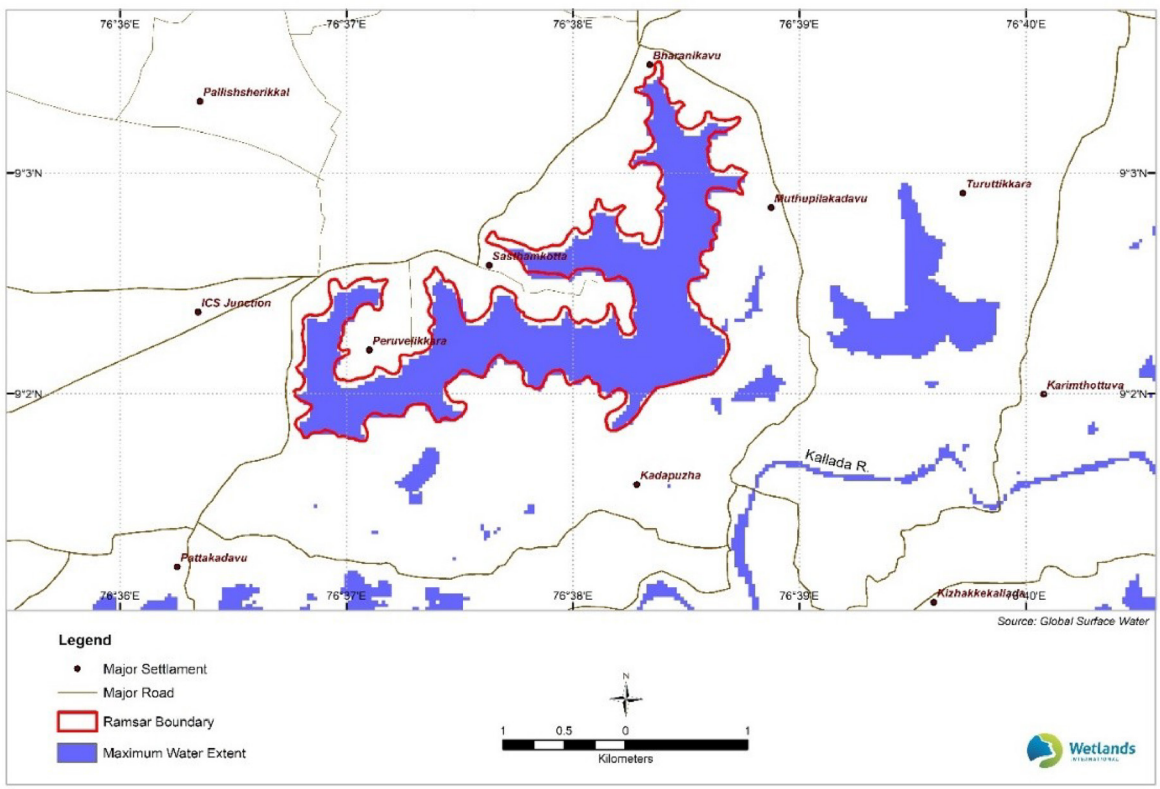




Map 2.9 | Changes in alluvial floodplain structure due to sand mining in lower reaches of Kallada River Basin



Map 2.10 | Seasonality of water of Sasthamkotta Lake (2021)



Map 2.11 | Maximum water extent of Sasthamkotta Lake (1984–2021)

Image 6 | Receding level of water at Sasthamkotta Lake (10 May 2024)

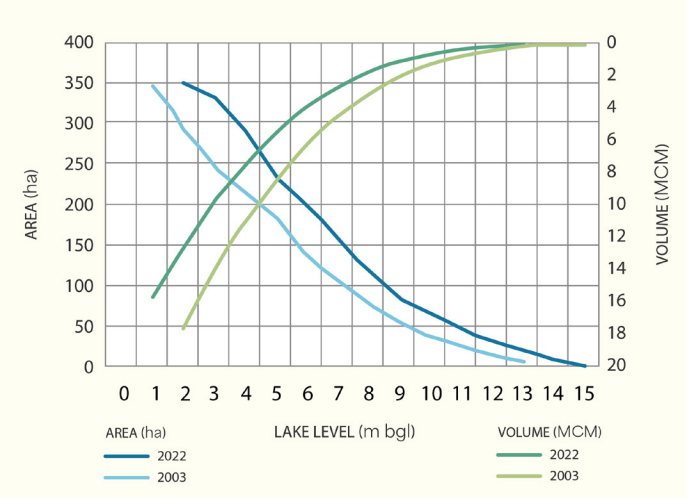
City and its suburbs. Evaporation from the water bed also constitutes a significant proportion of water outflow.

Located at the gateway of the Indian monsoon (general reference to Kerala as being on the southernmost tip, it is the first state to receive monsoon rainfall). As per the records of 1991–2023, the Ramsar Site and its surroundings receive a 2,002 mm (maximum being 3,341 mm in 2021 and minimum of 1026 mm in 2005). Rains are received in two spells, south-west (June–August) and north-east (September–November). The two seasons contribute ~65 % of the total annual rainfall. Rainfall during south-west monsoon is the predominant component, accounting for ~36 % of the total rainfall.

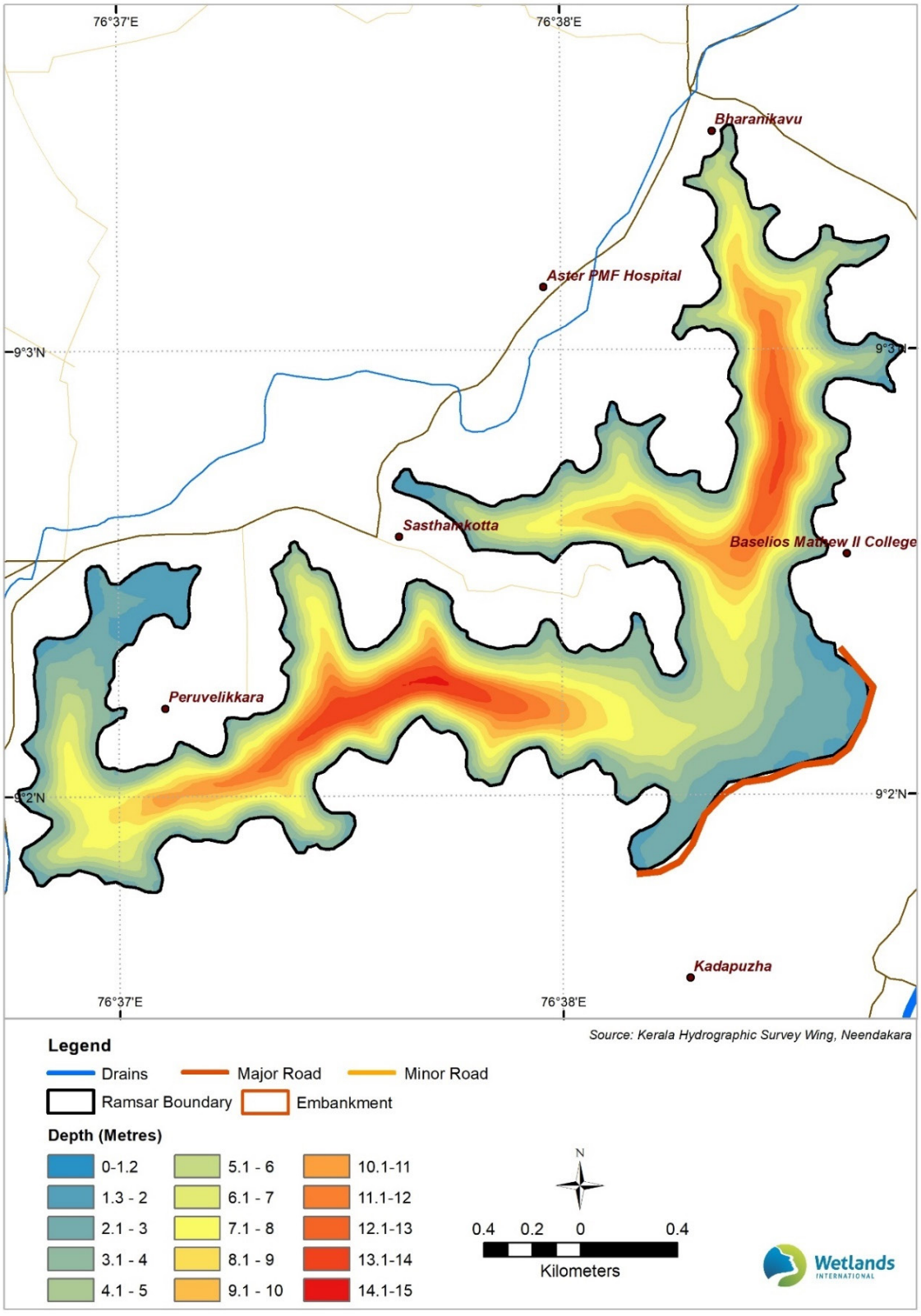
As per 2022 data, water withdrawal from Sasthamkotta Lake for the Quilon Water Supply Scheme (QWSS) is around 37.5 million litres per day (equivalent to 13.68 MCM/year). An additional 22 MLD (equivalent to 8.03 MCM/year) is kept to meet the emergency water requirements of four water supply schemes (WSS for Chavara-Panmana, WSS for Sasthamkotta, Sooranad (S) and West Kallada; and WSS for Thevalakkara-Thekkumbhagam).

During the post-monsoon months of October and November 2023, the State Hydrological Survey Wing conducted the bathymetric survey for Sasthamkotta Lake, employing an echo-sounder and DGPS technology. The echo-sounder emitted sound waves to measure water depth, while DGPS ensured precise location data. Conducting the survey

Figure 2.11 | Comparative analysis of area capacity curve for Sasthamkotta Lake (2003–2022)



post-monsoon minimised weather-related inaccuracies. The collected data was processed to create a detailed bathymetric map showcasing water depths at different points. Bathymetric data (Map 2.12), based on surveys conducted in 2022, indicate the water holding capacity of the Ramsar Site at 15 m bgl to be 17.5 MCM (Figure 2.11).



Map 2.12 | Bathymetry of Sasthamkotta Ramsar Site (Period of Survey: 28 September 2022–10 November 2022)

A monthly water balance has been computed to assess the water inflow and outflow patterns (Annex I). For estimating the catchment run-off, a factor of 0.76 has been used. Rainfall and evapotranspiration have been computed from the IMD Data. The groundwater exchange is a derived estimate based on the water level at the beginning and close of every month.

The water balance analysis for 2023 indicates a total inflow of 20.16 MCM, of which run-off from the catchment and direct rainfall on the wetland bed contribute 12.69 MCM and 7.47 MCM, respectively.

The monthly water balance and contribution of different components to inflow and outflow are presented in Figure 2.12 (Annex II) and 2.13 respectively. The connectivity of Sasthamkotta Lake with River Kallada has an important bearing for water balance of the wetland. Studies conducted on lithological characteristics of borehole cores indicate the presence of an upper sand dominated layer, intervened by comparatively thin, silt and clay dominated sediments. This layer rests over clay or mud dominated organic rich sediments, deposited on an erosional surface (Sreekumari et al., 2015). This sand bed acted as a hydrological conduit between the river and the wetland. Surface flows between the river and wetland were received in the form of flood

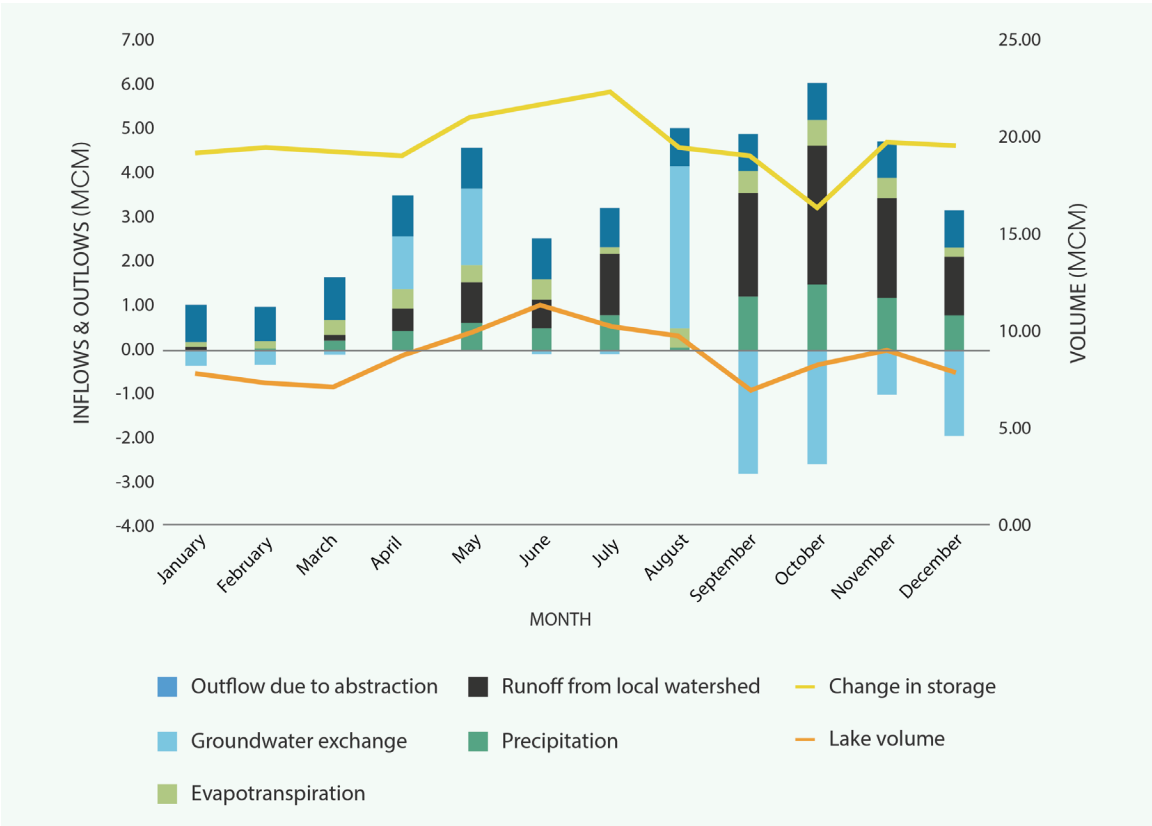
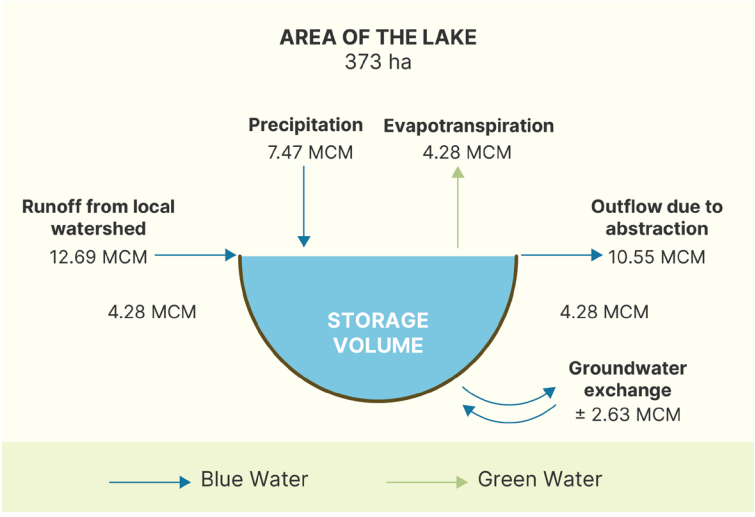


Figure 2.12 | Water balance of Sasthamkotta Ramsar Site (2023) (Modelled)

pulses during the south-west and north-east monsoon. This connection has been impeded by construction of Velanthara Embankment. As discussed in the previous section of wetland catchments, extensive sand mining within the floodplains had led to fragmentation of sub-surface pathways (Figure 2.14) until it was permanently banned since 2015. Studies based on isotopes indicate the river water no longer reaches the wetland through surface or sub-surface pathways (Joseph et al., 2003).

Figure 2.13 | Contribution of different components to water balance of Sasthamkotta Lake



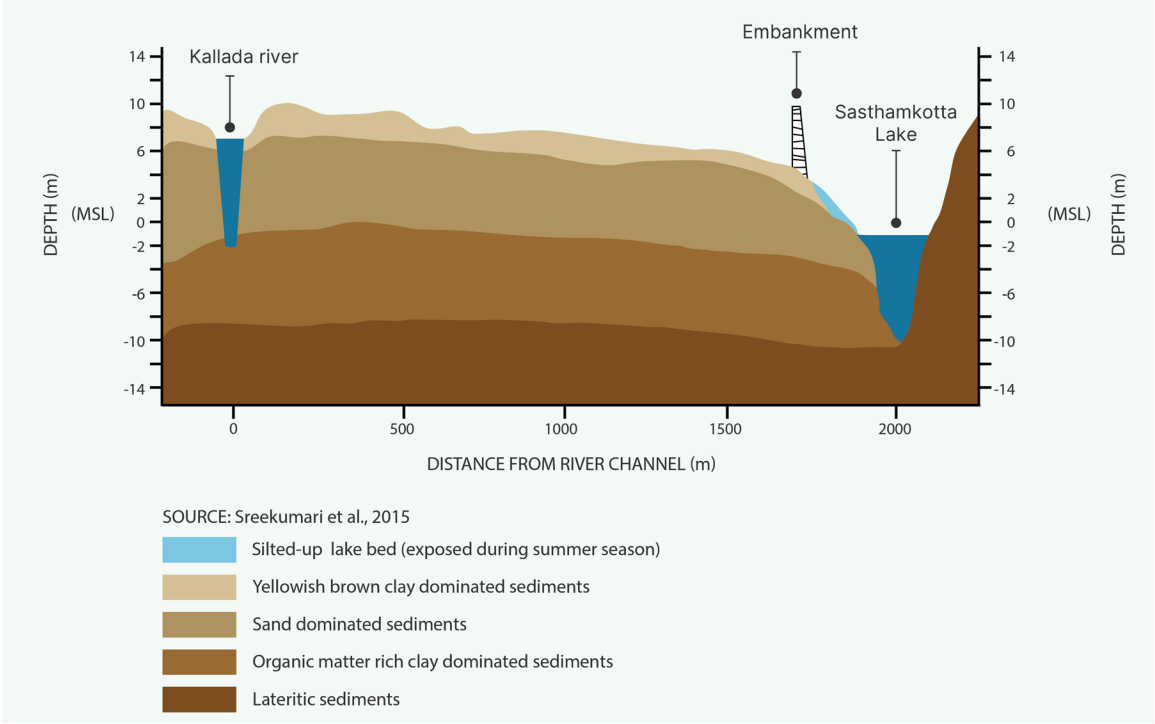


Figure 2.14 | Sub-surface profile of River Kallada floodplains

Sedimentation

Hydrological investigation in the drainage basin of Sasthamkotta, carried out jointly by Bhabha Atomic Research Centre and CWRDM, Kozhikode, using environmental isotopes (D, 18O, 3H, 137Cs), has indicated that recent sedimentation in the wetland ranges from ~0.18 to 1.81 cm/year, with higher values very close to the Velanthara Bund.

The field study on Sasthamkotta Lake revealed significant sediment composition and quality variations between 2021 and 2022. The texture of the sediments remained predominantly clay and clay loam across both years. However, a noticeable decline in pH levels was observed, with values decreasing from 4.0-5.1 in 2021 to 2.77-4.19 in 2022, indicating increasing acidity in the lake sediments. Additionally, the Total Organic Carbon (TOC%) content exhibited a downward trend, with average values decreasing from 8.85% in 2021 to a lower range of 1.45%-9.39% in 2022.

Water quality

Sasthamkotta Lake maintains a low salt, well oxygenated and low nutrient water, despite severe anthropogenic stresses on the Ramsar Site, including extensive catchment degradation, discharge of sewage, community bathing and washing, and prolonged dipping of coconut leaves for thatching. Several explanations have been made, including the presence of large numbers of *Chaoborus* sp. larvae, which are known to feed voraciously on smaller zooplanktons

Image 7 | Sediment deposition near Velanthara Embankment (2017)

(eg. Pillai, 1981) and locking up of phosphorus in sediments (Prakasam and Joseph, 1991 and Sreejith, 1998).

The most recent data on water quality, from 2021 to 2024 (Table 2.3), provides an insightful overview of the Sasthamkotta Lake's condition. The wetland is characterised by being well-oxygenated but nutrient-poor and neutral to weakly alkaline.

Throughout the seasons, dissolved oxygen levels remained within a sufficient range. The lowest DO concentration recorded was 5.42 mg/l during the monsoon season of 2024, slightly lower than the 6.14 mg/l observed in the monsoon of 2021. The consistent DO levels reflect a healthy oxygenation state across different years and seasons. The BOD levels varied, with post-monsoon seasons typically showing higher values. For instance, in May 2024, BOD levels were recorded at 4.39 mg/l, exceeding the threshold, similar to the December 2021 values (3.39 mg/l). However, pre-monsoon and monsoon seasons generally showed BOD levels within permissible limits, ranging from 0.31 mg/l to 2.92 mg/l.

Coliform levels consistently exceeded permissible limits across all seasons, with total coliforms reaching 2400 MPN/100 ml across multiple data points from 2021 to 2024. The highest levels of faecal coliforms were noted during the pre-monsoon season of 2021, with values reaching 2400 MPN/100 ml. The elevated coliform levels, especially during the monsoon season, can be attributed to runoff from the catchment areas draining directly into the wetland.

Overall, while the Sasthamkotta Lake maintains adequate oxygen levels, the high BOD in certain seasons and persistently elevated coliform levels indicate potential concerns related to organic pollution and contamination, particularly from runoff.

Groundwater

The region around Sasthamkotta has phreatic and confined to semi-confined aquifers. The weathered crystalline, laterite, and alluvial formations form the major phreatic aquifers, while the deep fractures in the crystalline and granular zones in the tertiary sedimentary formations form the confined to semi-confined aquifers. The drainage basin of Sasthamkotta contains mostly very deep, well-drained clayey soil on gently sloping coastal laterites. The clay is Kaolinite, which does not allow much infiltration from the surface.

The decadal average groundwater level for the Sasthamkotta block in 2023 was 8.74 m bgl pre-monsoon and 7.04 m bgl post-monsoon (CGWB, 2023). An isotope study on groundwater movement conducted by CWRDM in 2018 observed that the wells on the south-eastern margins of the wetland were getting recharged by the wetland,

Table 2.3 | Maximum and minimum water quality report of Sasthamkotta Lake during 2021-2024

Date	Feb-21		Jun-21		Sep-21		Dec-21		Apr-22	
Parameters	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temperature (°C)	29.2	32.8	29.0	31.1	29.8	30.6	27.8	29.0	30.0	32.0
pH	8.1	9.0	7.10	8.00	7.00	7.20	6.40	7.61	6.41	7.90
Salinity (ppt)	0.04	0.06	0.04	0.04	0.04	0.08	0.03	0.04	0.04	0.16
Electrical Conductivity (µS/cm)	74.8	110.3	67.9	73.69	65.85	171.70	65.30	85.30	71.10	245.00
TDS	-	-	-	-	-	-	-	-	38.60	118.00
Magnesium (mg/l)	2.1	6.9	0.94	3.89	0.96	2.90	0.93	4.63	0.93	2.80
Calcium (mg/l)	0.6	1.9	1.60	4.80	1.59	3.18	1.52	4.57	1.54	6.14
Chloride (mg/l)	23.1	36.9	20.5	25.98	21.15	49.30	18.24	22.55	21.07	89.25
Sulphate (mg/l)	6.4	8.1	3.80	5.96	0.96	3.56	7.36	16.84	3.40	37.90
Flouride (mg/l)	BDL	BDL	0.22	0.46	BDL	BDL	BDL	BDL	BDL	BDL
Nitrate-Nitrogen (mg/l)	0.2	0.4	0.18	1.60	0.46	1.12	0.10	0.61	0.50	0.86
Phosphate-Phosphorus (mg/l)	0.01	0.4	0.01	0.06	0.01	0.05	0.03	0.11	0.04	0.11
Silicate (mg/l)	3.8	7.3	5.18	6.12	4.58	6.12	5.46	6.56	4.16	6.52
Dissolved Oxygen (mg/l)	8.1	9.6	6.14	9.07	7.01	8.53	6.40	9.54	5.85	7.80
Biological Oxygen Demand (mg/l)	0.8	1.9	0.31	2.92	0.66	2.24	0.51	3.39	1.12	3.76
Chemical Oxygen Demand (mg/l)	1.5	5.9	1.36	9.62	2.96	9.42	2.64	11.32	6.40	12.30
Total Coliforms MPN/100 ml	240	2400	1100	1100	460	2400	1100	2400	460	2400
E.coli MPN/100 ml	21	1100	110	1100	3	75	21	460	28.00	460.00
Fecal Coliform	21	2400	64	460.00	9.00	150.00	1100.0	1100.0	210	1100

Date	Nov-22		May-23		Jul-23		Nov-23		May-24	
Parameters	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temperature (°C)	28.8	31.2	31.1	32.4	30.6	32.2	30.2	33.2	31.8	38.70
pH	6.84	8.26	6.36	7.94	6.88	8.80	6.57	7.48	6.92	8.29
Salinity (ppt)	0.04	0.05	0.04	0.06	0.03	0.07	0.03	0.04	0.04	0.06
Electrical Conductivity (µS/cm)	57.10	88.20	63.7	102.80	66.6	98.20	53.4	80.70	64.80	124.4
TDS	40.60	62.50	45.1	58.80	47.4	69.80	38.0	57.30	43.56	88.90
Magnesium (mg/l)	0.45	2.97	0.00	4.62	0.97	3.89	0.97	5.83	0.95	14.29
Calcium (mg/l)	2.22	5.18	3.04	9.12	1.60	6.40	1.60	6.40	1.57	4.70
Chloride (mg/l)	18.38	25.64	17.7	27.58	10.0	26.00	15.2	20.92	24.70	38.00
Sulphate (mg/l)	0.56	1.08	1.60	3.44	7.56	15.88	17.8	19.2	1.72	7.08
Flouride (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.02	0.05
Nitrate-Nitrogen (mg/l)	0.44	0.73	0.40	0.68	0.34	2.75	0.48	0.71	1.32	1.70
Phosphate-Phosphorus (mg/l)	0.01	0.05	0.01	0.10	0.01	0.03	0.00	0.01	0.01	0.12
Silicate (mg/l)	0.95	1.62	6.58	7.19	0.41	10.12	0.35	6.08	8.04	8.26
Dissolved Oxygen (mg/l)	6.60	8.55	6.40	7.38	7.45	9.36	6.60	8.55	5.42	8.00
Biological Oxygen Demand (mg/l)	0.89	2.40	1.18	2.94	1.06	2.98	0.89	2.40	1.55	4.39
Chemical Oxygen Demand (mg/l)	5.34	8.15	7.46	37.31	8.06	33.02	8.26	49.54	8.06	104.8
Total Coliforms MPN/100 ml	460	1100	43	1100	11	1100	93	2400	1100	2400
E.coli MPN/100 ml	11	93	21	240	150	240	240	460	210	460
Fecal Coliform	210	460	15	460	4	460	11	1100	460	1100

whereas the rest contributed water into the wetland (Warrier, 2007). The assessments further confirm the significant surface-groundwater exchange, critical for maintaining Sasthamkotta Lake's hydrological regimes.

In 2003, instances of land subsidence and earth fissures were reported along the embankment, which have been attributed to the mining of groundwater aquifers (Kuriakose, 2013). However, since the ban on sand and laterite mining, assessments are required to understand the interaction between the surface and the groundwater around Sasthamkotta Lake.

Water use patterns

Water withdrawal for supply to Kollam City and its suburbs forms the principal water use of Sasthamkotta Lake. Any significant reduction in the inundation regime directly impinges on water availability to meet this purpose and is of immense significance to management. The water supply project was conceived in the 1960s, to meet the drinking water requirements of the city. The population has since increased to 0.3 million, with the wetland being still the principal water source. The increasing frequency of drastic shrinkages in inundation levels and dips in water levels has raised concerns among planners and decision-makers on the sustainability of such use.

The Kerala Water Authority extracts water from Sasthamkotta Lake using its pumping station, which is located on the northern shore along the Chavara-Adur Road. The water is filtered and sterilised at the station before being transported through 28 concrete pipes, each with a diameter of 28 inches, to Kollam town, situated 25 km away from the wetland.

In 2010, the Kerala Water Authority pumped 37.5 million litres daily from the wetland. This amount decreased to approximately 30 million litres daily (equivalent to 10.95 Mm^3) in 2017. However, by 2022, water withdrawal

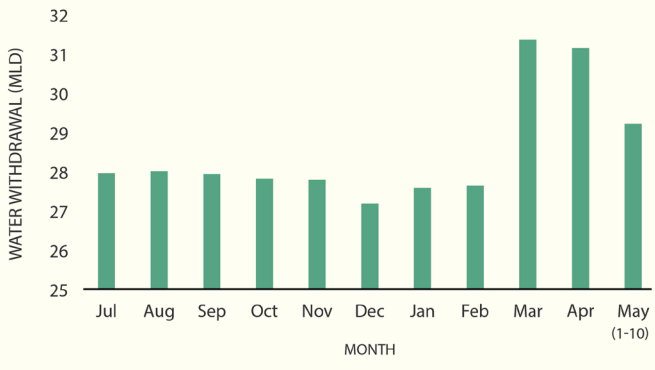


Figure 2.15 | Monthly average of dailywater intake from Sasthamkotta Lake by Kerala Water Authority(KWA)

increased again to 37.5 million litres per day (10.55 MCM/year), with an additional 22 MLD (equivalent to 8.03 MCM/year) being extracted to meet the emergency water requirements of four water supply schemes.

The current data (July 2023 to May 2024) indicates that approximately 28.5 MLD (equivalent to 10.40 MCM/year) was pumped, with a peak at 31.39 MLD in March 2024. No information on additional water withdrawal has been provided for 2024. The data also reveals that the highest water outflow occurred in March and April, coinciding with a severe dry spell, indicating increased water extraction during the driest months. This pattern suggests a responsive water management strategy in fluctuating water availability.

2.4 BIODIVERSITY

Fragmented attempts at documenting the biodiversity and ecology of Sasthamkotta have been made since the 80s. Aspects of primary productivity and water sediment interactions were investigated by Thomas et al. (1980) and Prakasam and Joseph (1991). A summary of this information was used to develop a profile of Sasthamkotta for inclusion in the 'Directory of Indian Wetlands' published in 1993 (WWF-India & AWB, 1993). A project titled '*Ecology, Biology and Pollution of Sasthamkotta Lake*' was implemented in 1991 with the support of MoEFCC (the then MoEF). Biodiversity and ecological information used for Ramsar Site designation and preparation of Ramsar Information Sheet is mostly based on this information.

Several kinds of literature provided information on the number of phytoplankton species, macrophytes, terrestrial vegetation, zooplankton, and insects (butterflies). In 2011, the Kerala State Biodiversity Board initiated the consolidation of a Biodiversity Register for Sasthamkotta, as per the framework of the Biological Diversity Act, 2002. A fish study conducted by the Department of Fisheries Resource Management of Kerala University of Fisheries and Ocean Studies (2021) and waterbirds (Asian Waterbird Census, 2022) as part of the implementation of the approved Management Action Plan (MAP) of the lake by SWAK provided complementing information on the biodiversity of Sasthamkotta. An overview of available information on species richness and their conservation status is summarised in Table 2.4.

Planktons

Plankton plays a crucial role in the food chain within an aquatic system. Available information on plankton in Sasthamkotta Lake indicates the presence of at least 23 species of phytoplankton (Pournami et al., 2022) (Annex III).

The zooplankton communities are represented by 22 species (Annex IV).

Phytoplanktons are most abundant post-monsoon, with higher percentages in the areas adjoining Sasthamkotta Town and minimum around the western margins. The distribution and abundance of planktonic organisms in Sasthamkotta Lake were investigated by collecting samples from four stations during the pre-monsoon period. In total, 23 species of phytoplankton and 22 species of zooplankton were identified. The phytoplankton population in the wetland primarily consisted of three major families: Chlorophyceae, Cyanophyceae, and Bacillariophyceae. Notably, the study revealed the presence of pollution-tolerant species such as *Nitzschia*, *Navicula*, *Euglena*, *Cyclotella*, *Microcystis aeruginosa*, and *Oscillatoria*. Meanwhile, the zooplankton population is characterised by three major families: Protozoa, Rotifers, and Arthropoda (Pournami et al., 2022). Zooplanktons in Sasthamkotta are majorly from group Nauplius, Rotifer and Copepod with a small component of Cladocerans. The count of Nauplius builds gradually from pre-monsoon period to predominating during monsoon. Rotifers do not exhibit much variability and increase only marginally during monsoon. Copepods, at their peak, form around 5% of the zooplankton population.

Primary productivity assessed during 2004–05 (Girijakumari, 2007) showed low concentrations, ranging from 0.072–4.5 mgC/m^3/day. Primary productivity increased during post-monsoon gradually and decreased during pre-monsoon.

Table 2.4 | Conservation status of flora and fauna in Sasthamkotta

Biodiversity	Group	No. of Species	Source	Status						
				CR	EN	VU	NT	LC	DD	NE
Flora	Phytoplankton	23	Pournami et al., 2022							
	Macrophyte	12	Field Survey, 2015, Field Survey 2024					12		
	Terrestrial vegetation	158	Nayar et al., 2011		1	1	1	19	3	133
Fauna	Zooplankton	22	Pournami et al., 2022							
	Insect (Butterfly)	23	Nayar et al., 2011					2		21
	Fish	16	SWAK-KUFOS Study Report 2022			1	3	27	2	3
	Waterbird	14	Asian Waterbird Census 2022				1	13		

CR-Critically Endangered; EN-Endangered; VU-Vulnerable; NT-Near Threatened; DD-Data Deficient; LC-Least Concern; NE-Not Evaluated

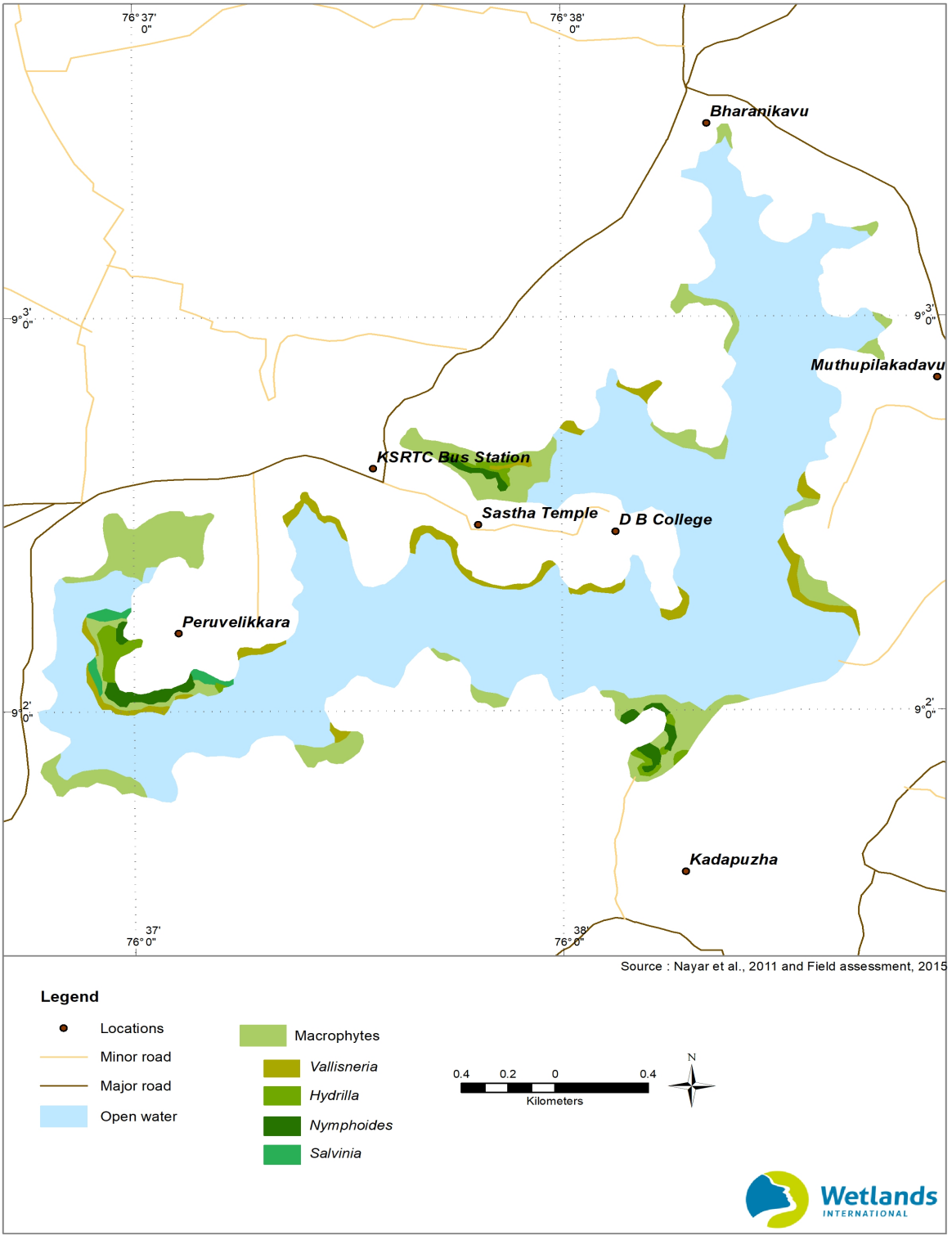
The wetland area near Velanthara Bund showed the highest productivity throughout the year. Low primary productivity has also been reported by Thomas et al. (1980) and Prakasam and Joseph (1991). No data on present status of primary productivity for Sasthamkotta was found to assess the trend.

Macrophyte

Available studies and field assessments indicate the presence of at least 12 macrophytes in Sasthamkotta Lake (Annex V). Their distribution is confined mainly to the regions adjoining the Velanthara Embankment, Rajagiri, Bharanikavu and Sasthamkotta Town. These areas are also significant point sources of pollution in the wetland. *Vallisneria*, *Hydrilla* and *Blyxa* are the dominant amongst submerged macrophytes, whereas *Salvinia*, *Utricularia* and *Pistia* form dominant free-floating forms; *Ipomoea* and *Nymphoides* form the dominant rooted-floating-leaved forms (Map 2.13). *Monochoria* and *Hygrophila* often mix with *Colocasia* and *Pandanus* to form thick emergent vegetation growth. Mats of *Salvinia* were observed near Rajagiri old fish hatchery. Notably, 12 ha under these invasive was manually removed from this area around 2013 but has re-emerged. Agglomeration of the free-floating plant *Pistia* sp. was also observed during the post-monsoon period in areas adjoining D.B. College and Rajagiri.

Field visits indicated choking of Valiyapadam marshes, once connected with Sasthamkotta, with *Salvinia*. Apparently, growth of macrophytes within Sasthamkotta is kept in check due to the dynamic inundation regime and low nutrient status. However, continued discharge of untreated sewage, agriculture run-off, silt from catchments and shrinkage of inundation regime is highly likely to create conducive

Image 8 | Mats of Nymphoides adjacent to Rajagiri area (20 April 2022)



Map 2.13 | Macrophytes in Sasthamkotta Ramsar Site (Field Survey 2015 & Field Survey 2024)

conditions for proliferation of invasive macrophytes.

In the recent field visit, patches of Screw Pine (*Pandanus odoratissimus*) were observed in this area. Other notable plant species observed in this area include, *Rhynchospora corymbosa*, *Cynodon dactylon*, *Wedelia trilobata*, *Ischaemum travencorense*, *Monochoria vaginalis* and *Nymphoides indica*.

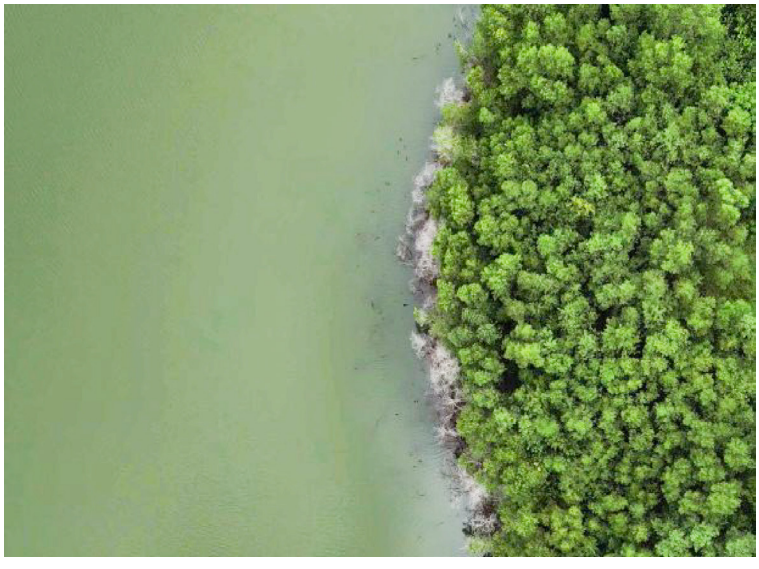
Terrestrial Vegetation

Field work done for management plan preparation indicated the presence of 11 species occurring along the shorelines of Sasthamkotta Lake and 60 species within the overall catchment area. Patches of Screw Pine (*Pandanus odoratissimus*) exist near the Velanthara Embankment. The eastern shoreline has patches of insectivorous plant, Indian Sundew (*Drosera* sp.). The hinterland has at least 97 species, whereas, the homesteads have 21 species. Collating the information on the terrestrial species yields a list of 158 species growing around Sasthamkotta Lake (Annex VI). In some areas, wild pineapple varieties have been planted for increasing soil stability and prevent soil loss. The micro watershed around the wetland has mainly coconut-based agroforestry system with trees such as *Mangifera indica*, *Anacardium occidentale*, and *Artocarpus heterophyllus*.

The shorelines were planted with *Acacia* under a social forestry project of the World Bank during the 80s. However, much of the plantations were removed post 2010 after the wetland exhibited frequent drying, and *Acacia* was considered as one of the causative factors. The Kerala Forest and Wildlife Department is working with Grama Panchayats on removal of the species in the wetland's direct drainage basin.

Image 9 | Plantations all along the fringes of Sasthamkotta Lake

(Coordinates—9°02'26.7"N 76°37'44.52"E; nearby Sasthamkotta Temple Arattu Kadavu; 17 June 2023)



Insect

At least 23 species of butterflies have been reported from the Ramsar Site (Annex VII). Majority of these belong to two families — Nymphalidae and Papilionidae (Nayar et al., 2011). Maximum concentration can be seen near the Velanthara Embankment area which has relatively higher number of grasses and herbs species. Studies done in the 80s (eg. Pillai, 1981) indicated presence of large numbers of *Chaoborus* sp. larvae which is known to feed voraciously on smaller zooplanktons. Studies need to be taken up on the present status of the species in Sasthamkotta and its overall water quality contribution.

Fish

Compilation of available species richness records indicate presence of at least 16 species of fish (Final Report, SWAK-KUFOS Study, 2022). Previously, at least 38 fish species were recorded in Sasthamkotta Lake (Annex VIII and Map 2.14). The list includes *Horabagrus brahysoma,* classified as Vulnerable in the IUCN Red List of Threatened Species. Two families (Cyprinidae and Bagridae) account for 11 species. *Etroplus suratensis*, the State Fish of Kerala is commonly found inthe Ramsar Site. *Etroplus maculatus* another species of thesame genus has also been recorded in the Ramsar Site. Thespecies is largely confined to South India and Sri Lanka.

Six of the recorded species (*Dayella malabarica*, *Horabagrus brachysoma*, *Macrognathus guentheri*, *Mystus oculatus*, *Ompok malabaricus* and *Parambassis dayi*) are endemic to the country. Disruption of flood pulse through construction of embankment along Sasthamkotta Lake has impeded species exchange between River Kallada and the Ramsar Site. Kurup et al. (2004) indicated that, several species (*Etroplus maculatus*, *Horabagrus brachysoma* and *Ompok bimaculatus*) are common between the two, but the wetland population has been isolated.

During community surveys, fishers of Rajagiri identified breeding and spawning habitats along the embankment and the southern margins of the wetland. Species abundance surveys done in 2004–05, indicated highest abundance of *Dayella malabarica*, *Puntius filamentosus* and *Parambassis dayi*. Most of these species were considerably smaller in size and did not contribute significantly to economic landings.

Waterbird

Assessments conducted under Asian Waterbird Census Checklist (for the year 2022 indicate the presence of at least 14 species of waterbirds in Sasthamkotta Lake (Annex IX). Most of the reported species are shoreline foragers (egrets, herons and bitterns) and waders (sandpipers).

Map 2.14 | Active fishing zone in Sasthamkotta Ramsar Site

Marshes around the fringes of the wetland serve as foraging grounds for both migratory and resident waterbirds.

Of the reported species, one species (Oriental Darter) is classed as Near Threatened as per IUCN Red List of Threatened Species (ver. 2016-3). A sporadic sighting of Asian Woolly Neck (*Ciconia episcopus*), a vulnerable waterbird species was reported in 2015 by Sasthamkotta Biodiversity Management Committee.

The number of species and counts in Sasthamkotta Lake are apparently lower than adjoining Ashtamudi Estuary which has higher food availability and diversity of habitats. Yet, Sasthamkotta Lake retains its significance as an important habitat in the network of wetlands used by waterbirds inhabiting the region.

Image 10 | Flock of birds near Rajagiri fish hatchery (2017)

Image 11 | Screwpine on shoreline of Sasthamkotta Lake. Water under these are habitat for fishes, especially *Etroplus* sp. (20 April 2022)

Image 12 | Biodiversity in and around Sasthamkotta Lake

(Top-left: White-throated Kingfisher (20 April 2022), Top-right: Brahminy Kite (20 April 2022); Bottom-right: Olive-backed Sunbird (01 December 2022); Bottom left: Ditch Jewel (18 June 2023)

2.5 LIVELIHOODS

The livelihoods of communities around the wetland significantly impact the ecological character and the potential for wise use. This assessment of community livelihoods near Sasthamkotta Lake is based on the Ecosystem Services Shared Value Assessment (ESSVA) Tool, conducted in May 2023. The survey included 140 households, representing 50% of those in the Sasthamkotta and West Kallada Grama Panchayats who rely on the wetland. Households were chosen through random sampling based on primary occupation, and Focal Group Discussions were held to gather insights on community perceptions and attitudes towards the wetland's ecosystem services.

Livelihood settings

Community livelihoods around Sasthamkotta Lake have undergone a gradual change in response to broader regional development planning. Evidence shows that the ecosystem services and biodiversity of wetlands were often overlooked, with a focus on converting them into productive agricultural lands throughout the 19th century. In the early 19th century, Colonel Munro, the Prime Minister of Travancore, implemented flood protection measures in Kollam District. He constructed an earthen embankment around Sasthamkotta to prevent flooding of agricultural fields and to harness water for drinking purposes. By 1960s, a system of land tenure was implemented within the reclaimed marshlands, rents being largely fixed as per agricultural productivity. However, as the complete exclusion of inundation and river flood pulses was not possible, winter paddy (Mundakan Paddy), sown after the monsoon months and harvested during winter, remained the principal crop. Native vegetation within the direct drainage basin was gradually removed to pave the way for plantations, and by the 1980s, almost no natural vegetation area could be discerned.

Image 13 | Focal group discussion with key stakeholders at Grama Panchayat office, Sasthamkotta (01 December 2022)

In 1956, Sasthamkotta Lake's water storage became crucial for the Quilon Water Supply Scheme, providing water to Kollam City. The earthen embankment was raised by 1.2 m to increase capacity. Alongside agricultural growth, rail and road infrastructure was developed for better transportation.

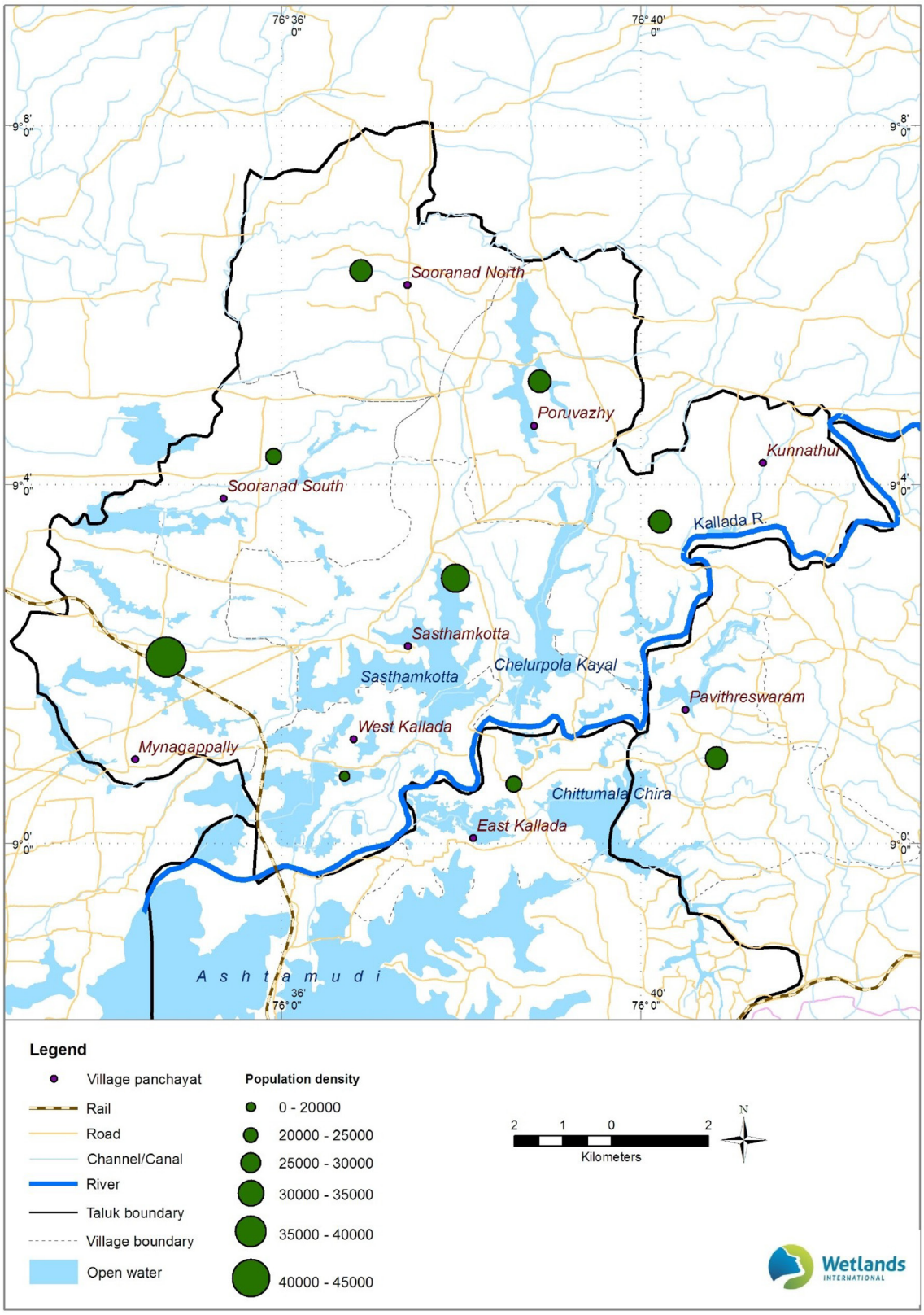
In 1961, severe flooding in the Kallada River area submerged low-lying regions like East Kallada, West Kallada, and Munroe Island, causing significant damage. This prompted the construction of the Parappar Reservoir for flood protection and irrigation. Additionally, the river became a hotspot for sand mining due to rising construction demands, and water extraction increased with new drinking water supply projects. In the 1980s, *Acacia* plantations were established under a World Bank initiative to boost fuelwood availability.

The cumulative impact of developmental projects has led to a decline in fisheries in Sasthamkotta and a rapid shrinkage of inundation regimes. Recognising the adverse effects, sand mining from six rivers, including Kallada, was banned in 2015. While environmental conditions deteriorated, Kerala experienced a shift from a resource-based economy to one driven by the service sector, with significant immigration to Gulf countries beginning in the 1970s. Infrastructure development increased demand for sand, creating jobs in mining. Consequently, only a small community of fishers in Rajagiri relies directly on wetland resources, while the larger population depends on water security and cultural aesthetics.

Profile of communities in and around Sasthamkotta

The shoreline of Sasthamkotta Lake is home to three Grama Panchayats: Sasthamkotta, West Kallada, and Mynagapally, within Kollam District (Map 2.15). Over half of the shoreline is in Sasthamkotta Panchayat, with the remainder shared equally by Mynagapally and West Kallada. Of the 25,602 households (total population 92,500), 57% (13,400 households, 53,300 people) are in Sasthamkotta's drainage basin (Annex X).

Image 14 | Mixed cropping of banana and coconut on the fringes of Sasthamkotta Lake near Muthupilakadavu (2017)



Map 2.15 | Village panchayats around Sasthamkotta Lake

Image 15 | Fisher with fishing gear in fishermen colony of Sasthamkotta (2017)

Population density is high, especially in the northern shoreline with large settlements like Sasthamkotta and Bharanikavu, reaching 1,609 persons per square kilometer — double that of Kerala. West Kallada features lowland paddy fields with sparser settlements, while Mynagapally has rubber plantations. The Sasthamkotta community mainly consists of progressive farmers and traders, whereas West Kallada and Mynagapally have a mix of farming and fishing communities, predominantly Ezhava and Latin Catholic fishermen. A profile of the primary and secondary occupations of the sampled households is presented in Table 2.5.

Over half of the households (54%) in Sasthamkotta rely on wage labour in sectors like construction, rubber plantations, or international migration for jobs. About 18% depend on natural resource-based livelihoods such as fishing and farming. The workforce participation rate is 42%, higher than Kollam District. Kerala excels in gender equity in workforce participation, reflected in the local population. The overall literacy rate is 85%, with males at 87% and females at 84%.

The annual average per capita income for Kollam District is ₹ 1,71,054, lower than Kerala's average of ₹ 2,33,855. This is partly due to the exclusion of migrant income in the sample. Kerala receives significant international remittances, contributing to nearly a quarter of the per capita income. Wage labourers, fishers, and farmers have notably lower incomes, yet household expenditures are similar across occupations (Figure 2.16). About half of the households are in debt, with an average loan of ₹ 1,25,200. Of these, 40% used formal banking for credit, mainly for household needs (60%), health (12%), and education (10%).

Figure 2.17 shows that households with migrant earners have higher income inequality (Gini Coefficient = 0.475) than the overall average of 0.38. Communities reliant on fishing, agriculture, and plantations exhibit the least inequality among those assessed. A profile of access to

Table 2.5 | Occupation profile of communities living around Sasthamkotta Ramsar Site (2011)

Occupation	% of Total HH	Agriculture, Farming & Plantation	Fishing	Small Business	Service	Wage Labour	Others
Agriculture, Farming & Plantation	2%	100%	0%	0%	0%	0%	0%
Fishing	16%	0%	100%	14%	8%	22%	0%
Small Business	12%	14%	0%	100%	5%	14%	0%
Service	17%	8%	0%	8%	100%	8%	19%
Wage Labour	30%	17%	0%	2%	0%	100%	0%
Migrants	24%	4%	6%	4%	46%	23%	100%

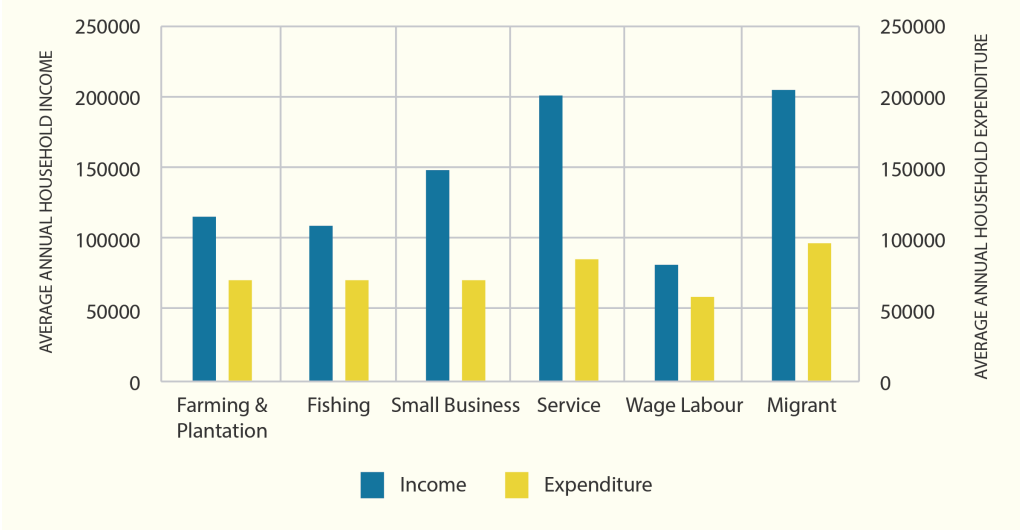


Figure 2.16 | Income and expenditure profile of various stakeholder

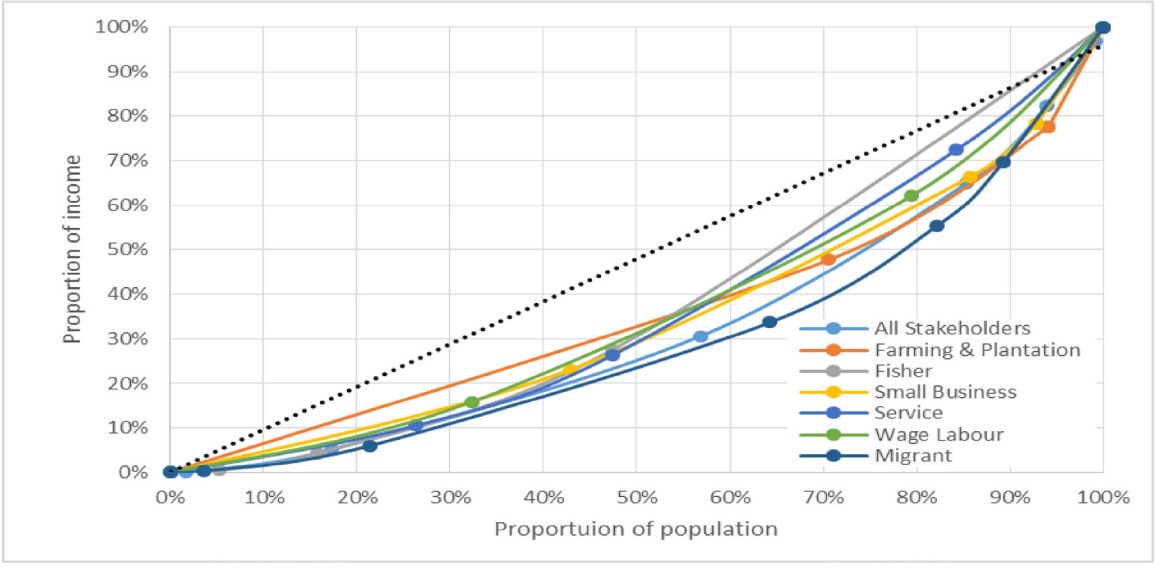


Figure 2.17 | Pattern of income distribution

basic amenities and communities segregated for various major stakeholder groups is presented in Table 2.6. Fishers and wage labourers rank among the lowest in the surveyed communities. Although Sasthamkotta Lake supplies water to much of Kollam City, only 39% of households in the drainage basin benefit from it. Sanitation coverage is nearly complete at 99%, but 70% of toilets are single pits, leading to significant faecal coliform leaching into wetland waters.

The most direct dependence of communities on Sasthamkotta Lake is as a source of water supply. The Quilon Water Supply Scheme (QWSS) withdraws 37.5 million litres of water for supply to 0.3 million population living within Kollam City and its suburbs. In addition, 22 million litres are

Table 2.6 | Asset holding by various stakeholder categories

			HOUSEHOLD OCCUPATION						
		Unit	Total	Farming and Plantation	Fishing	Small Business	Service	Wage Labour	Migrant
EDUCATION									
Adult literacy	Male	% adult in household	99.53%	100%	100%	96%	100%	100%	100%
	Female	% adult in household	97.47%	100%	100%	96%	95%	96%	100%
QUALITY OF HOUSING									
Owned		% household	99%	100%	100%	100%	100%	97%	100%
Concrete house		% household	43%	50%	36%	50%	65%	25%	64%
Semi- Concrete house		% household	23%	0%	21%	28%	15%	34%	10%
Earthen house		% household	34%	50%	42%	21%	20%	37%	25%
Electricity	> 8 hrs	% household	99%	100%	100%	100%	95%	100%	100%
Drinking water	House piped water supply	% household	44%	50%	52%	43%	15%	28%	42%
	Well	% household	32%	50%	32%	29%	60%	31%	32%
	Public piped water supply	% household	4%	0%	5%	0%	0%	2%	0%
Energy for Cooking	Only LPG	% household	3%	0%	0%	0%	0%	0%	11%
	Only Fuelwood	% household	18%	0%	21%	7%	5.0%	43%	0%
	LPG and Fuel Wood	% household	78%	100%	74%	93%	95%	54 %	89%
	Fuel Wood and Kerosene	% household	2%	0%	5%	0%	0%	3%	0%
Toilets		% household	99%	100%	95%	100%	100%	97%	100%
	Single Pit	% household	96%	100%	90%	93%	95%	94%	96.%
	Double Pit	% household	4%	0%	5%	7%	5%	3%	4%
	Own Agriculture land	% household	32%	100%	11%	21%	40%	34%	43%
Agriculture land and livestock	Landholding	Average, acre	0.50	0.30	0.32	0.27	0.38	0.25	0.81
	Own Livestock	% household	12%	0%	16%	0%	5%	20%	11%
	Own Poultry	% household	9%	0%	0%	14%	0%	17%	11%
ANNUAL INCOME		Average	143879	115000	108947	148571	200000	81471	205000
		SD	102395	49497	47830	99758	96321	39630	134976

			HOUSEHOLD OCCUPATION						
		Unit	Total	Farming and Plantation	Fishing	Small Business	Service	Wage Labour	Migrant
ANNUAL EXPENDITURE		Average	74455	70000	69211	70000	85000	58636	96111
		SD	43611	28284	26471	23664	46233	22613	66511
PROPORTION OF EXPENDITURE									
	Food	% of monthly Expenditure	41%	53%	41%	43%	30%	42%	44%
	Education	% of monthly Expenditure	10%	10%	8%	13%	14%	8%	8%
	Health	% of monthly Expenditure	18%	20%	16%	16%	18%	19%	17%
	Transport	% of monthly Expenditure	11%	10%	11%	13%	7%	12%	12%
	Repair and maintenance of house	% of monthly Expenditure	9%	0%	8%	7%	16%	11%	9%
	Main livelihood activity (fisheries, agriculture, etc.)	% of monthly Expenditure	12%	7.5%	17%	7%	16%	7%	10%
INDEBTED		% household	23%	0%	8%	1%	2%	11%	6%
Purpose	Occupational needs		6%	0%	11%	0%	0%	0%	14%
	Household needs		63%	0%	44%	100%	50%	69%	71%
	Education		19%	0%	22%	0%	50%	23%	0%
	Medicine/hospital		3%	0%	11%	0%	0%	0%	0%
	Other		9%	0%	11%	0%	0%	8%	14%
Main source of credit	Local money lander		0%	0%	0%	0%	0%	0%	0%
	Bank		78%	0%	89%	100%	50%	85%	57%
	SHGs		22%	0%	11%	0%	50%	15%	43%
Outstanding Credit		Average	115714	0.00	111111	900000	175000	107884	224285
		SD	110490	0.00	110698	0.00	170776	94911	189636
MEMBERSHIP TO KUDUMBSHREE		% household	44%	100%	89%	36%	25%	34%	39%
Role	General member	% household	40%	0%	82%	0%	40%	0%	36%
	Office bearer	% household	2%	0%	0%	0%	20%	0%	9%
	No role	% household	58%	0%	18%	0%	40%	0%	55%

also withdrawn from the wetland daily to provide for emergency water supply needs of communities living within Chavara, Panmana, Sasthamkotta, Sooranad, West Kallada, Thevalakkara and Thekkumbhagam.

Sasthamkotta is also a source of rich recreational and cultural values. Kollam District is historically significant as a trade destination. Every year, thousands of tourists visit the district to see its beaches and wetlands. According to Department of Tourism (DoT) 2022, Kollam District has registered high growth in tourist arrival accounting 4,21,380 tourists (both foreign and domestic), while Kerala has registered number of foreign and domestic tourist accounting 1,92,12,963. Kerala tops the domestic travel visits with a share of 71.51% in 2022. The District Tourism Promotion Council (DTPC) lists Sasthamkotta as one of the 7 major touristic destinations. Some of the other sites of Sasthamkotta, such as Velanthara Embankment, Rajagiri, Punnakkad and Kunnampuram, provide significant views of the Ramsar Site. Connection with National Highway 220 and Kollam-Ernakulum rail network enhances ease of access to the district as well as the Ramsar Site. Annually, Sasthamkotta receives over 2,000 visitors. The region surrounding the Ramsar Site holds significant cultural value. The wetland is believed to be named after the local deity,

Image 16 | Entrance to Sastha Temple (2017)

Lord Sastha, who has a temple located along the shoreline. The new moon day of each month is considered auspicious, attracting many locals to both the temple and the wetland.

In addition to the Lord Sastha temple, several other important religious sites are situated nearby, including Ammankovil Devi (or Bhadrakali) Temple in Sasthamkotta Mannakkara, Thalayinakkavu Shiva Parvathi Temple, Poruvazhy Peruviruthi Malanada Duryodhana Temple, and Anayadi Narsimhaswamy Temple. Mount Horeb Ashramam, a monastic community of the Malankara Orthodox Church, was established in 1991 on the banks of Sasthamkotta Lake.

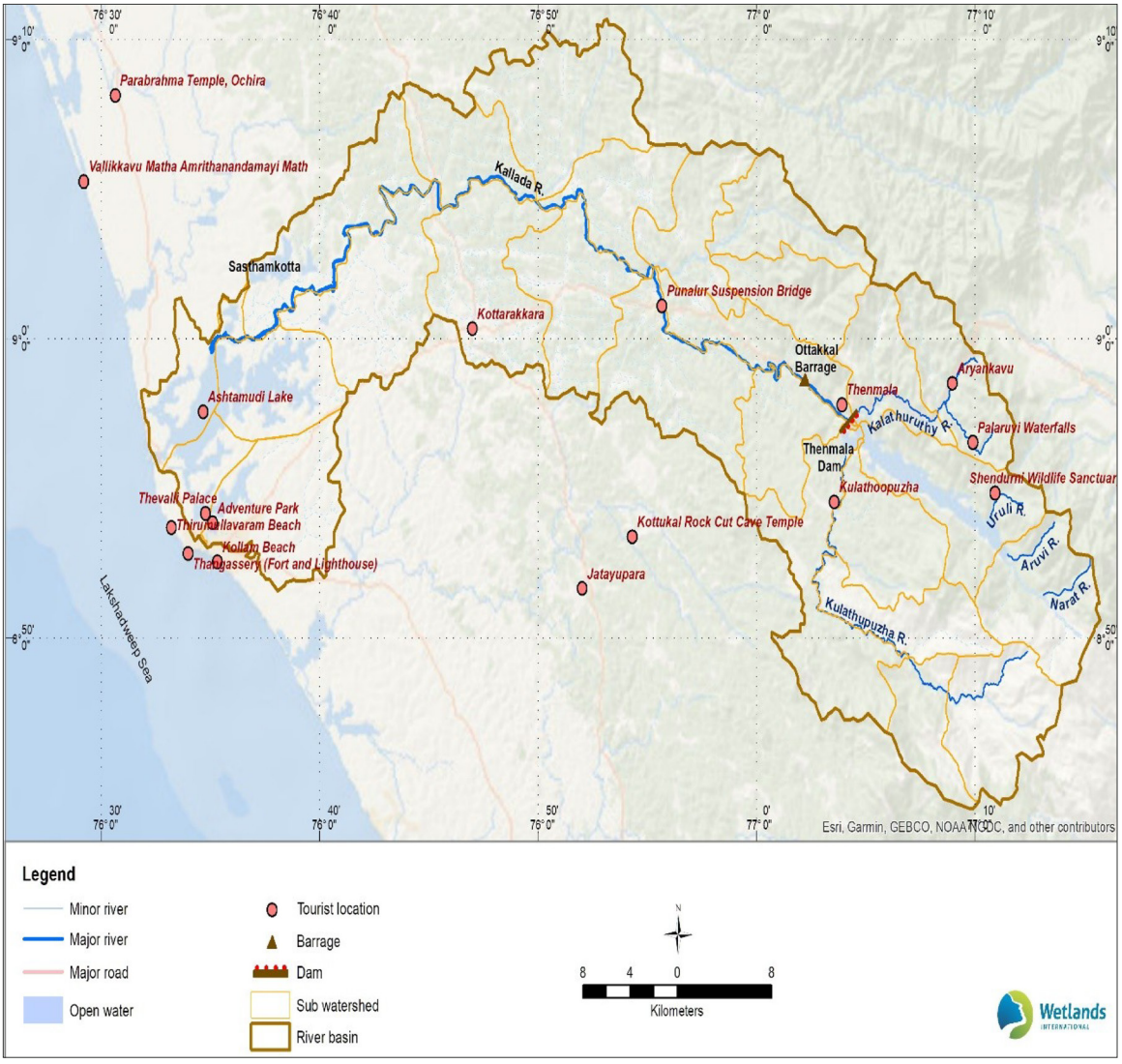
There is also a ferry service that connects Ambalakadavu (Sasthamkotta Grama Panchayat) and Vettolikadavu (West Kallada Grama Panchayat), with a nominal fare of ₹ 10 per passenger for a one-way trip.

Nature Tourism

Several attractions around Sasthamkotta have immense potential to attract tourists. These include historic landmarks such as Jatayu Earth Centre, Cave Temple at Kottukal, and a backwater experience in Ashtamudi wetland (Map 2.16).

However, the communities around the wetland have decided not to promote commercial tourism. Motorised boats are not allowed to ply in the wetland.

Image 17 | Jatayu Earth's Centre, Chadayamangalam (18 June 2023)



Map 2.16 | Tourist locations around Sasthamkotta Lake

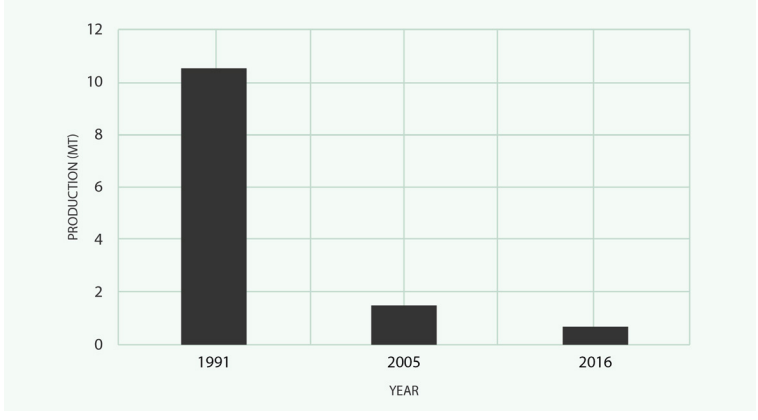
Sasthamkotta Lake has limited commercial fisheries due to low primary productivity and a lack of riverine connections. Subsistence fishing by 36 fishers has seen a significant decline in catch, from nearly 10.5 MT in 1991 to less than 0.65 MT in 2015. Factors contributing to this decline include an inefficient food chain, flood pulse regulation, and the destruction of breeding grounds. Fisher cooperatives, such as the Padappakada Rural Fish Cooperative Society, founded in 1995 and the Sasthamkotta Rural Fish Cooperatives Society in 1997, have also declined due to resource depletion and lack of operational capital. Sasthamkotta Lake supports hydrological regimes vital for agriculture in the region, with major crops being Mundakan paddy and *Sesamum*. However, agriculture in Kerala faces rising labour and input costs.

Image 18 | Ferry service in Sasthamkotta Lake (20 April 2022)

Community perspectives on wetland issues

Surveyed communities unanimously agreed that the wetland is degrading. The most significant negative trends identified include the shrinking of the wetland area, siltation, and the planting of *Acacia* trees along the shorelines. These issues were followed closely by excessive water abstraction, sand and laterite mining in the direct drainage basin, and an increase in pollution levels. While fishing communities noted the destruction of fish breeding grounds within the wetlands as a significant adverse change, they ranked it as the least important issue among those identified (Figure 2.18). Communities recommended a combination of management and regulatory measures to improve the health of the Sasthamkotta Lake ecosystem. Desilting the wetland bed, promoting rainwater harvesting, and controlling siltation from the catchment area were identified as high-priority actions. There was a strong emphasis on increasing community awareness about the significance of Sasthamkotta. Regulating mining activities within the direct catchment area, managing groundwater abstraction, and reducing water withdrawal were recommended as the next priorities. Additional measures suggested included

Figure 2.18 | Fish production trends of Sasthamkotta Lake



improving hydrological connectivity with the Kallada River, protecting fish breeding grounds, regulating land use, and developing eco-tourism opportunities. Figure 2.19 illustrates various recommendations proposed by the community for restoring the ecosystem health of Sasthamkotta Lake.

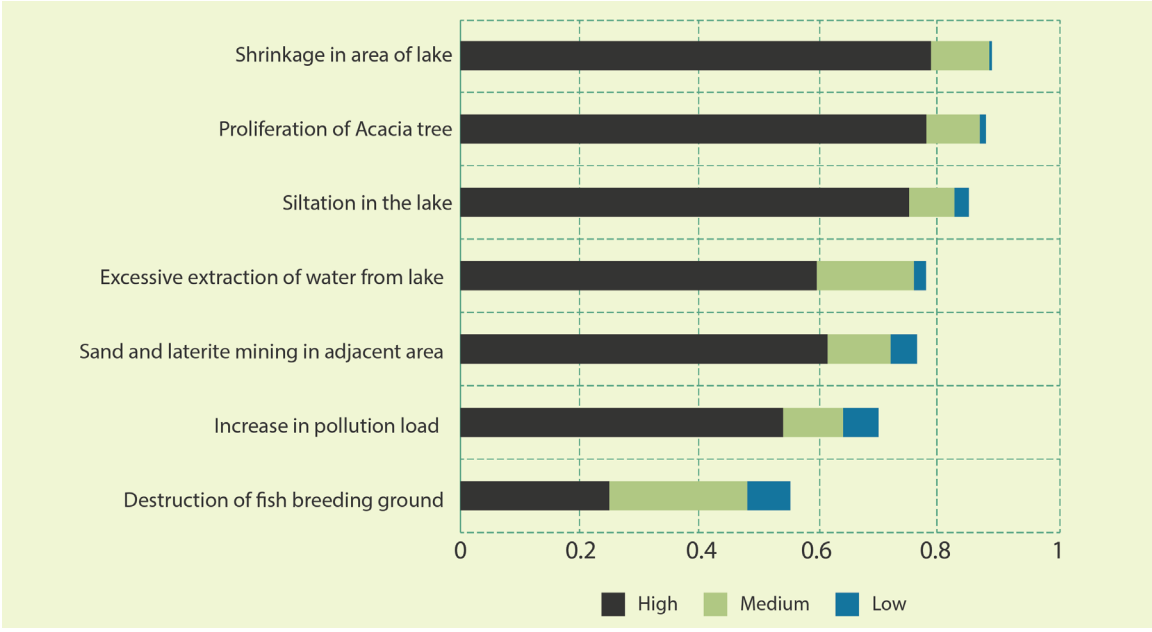


Figure 2.19 | Community perception on key issues in Sasthamkotta Lake

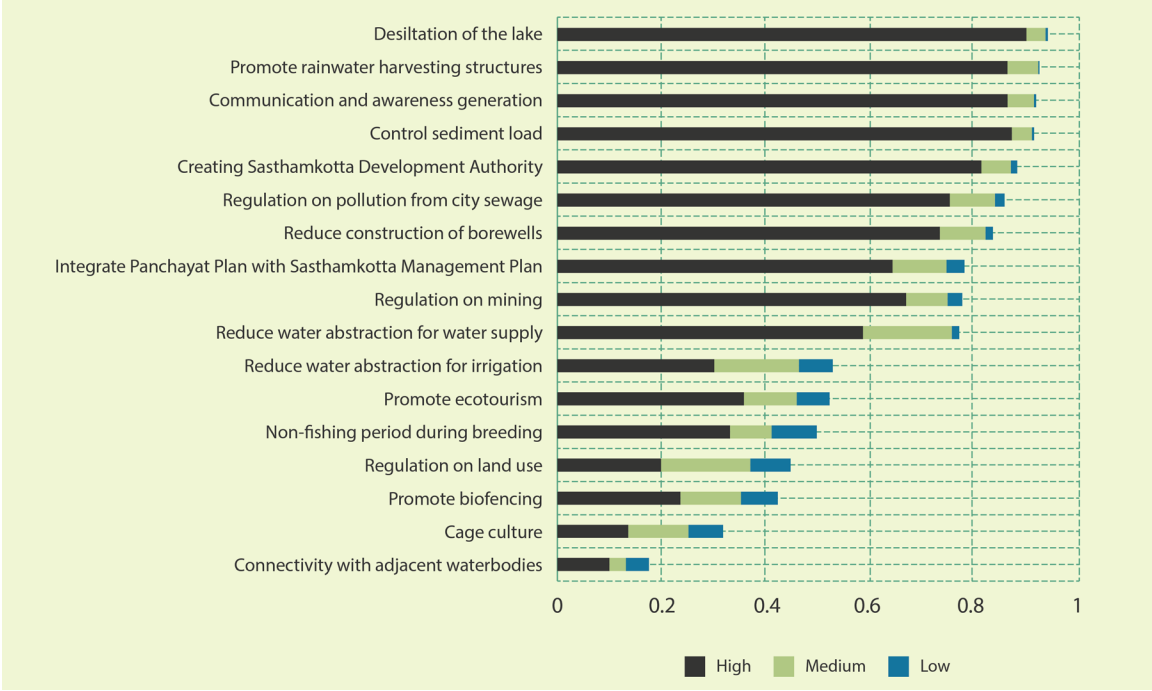


Figure 2.20 | Key restoration measures identified

Ecosystem Services Shared Value Assessment in Sasthamkotta Lake

The Ecosystem Services Shared Value Assessment (ESSVA) tool is a questionnaire-based survey tool that provides stakeholders with an opportunity to identify and overcome perception gaps. It helps in developing a sense of ownership in the basin population, thereby facilitating community participation in the wetland basin management process. It further provides a methodology for government to listen to the voices of the community to develop policies and programmes that are widely supported and easily implemented.

Wetlands International South Asia carried out an ESSVA survey around Sasthamkotta to understand the perception, preferences and attitudes of the local community towards the ecosystem services provided by the wetland.

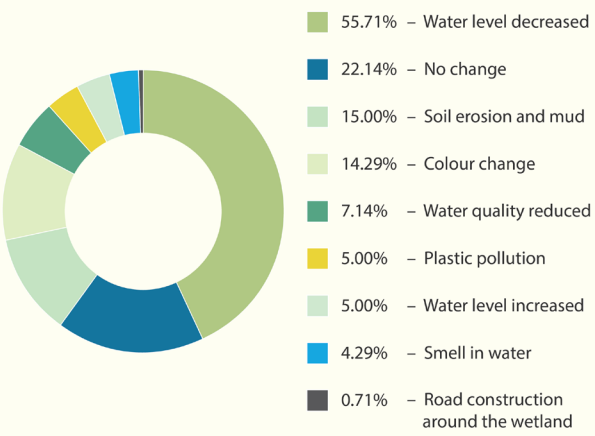
The survey was carried out in two villages located on opposite sides of Sasthamkotta Ramsar Site: Sasthamkotta and West Kallada. About 300–400 households are directly dependent on the wetland. Approximately 50% of the total households were randomly sampled in this study to get a better representation of wetland users. Efforts were made to include participants from all sides of villages and all community groups.

Perception regarding changes in the wetland along with its impact on health and economy

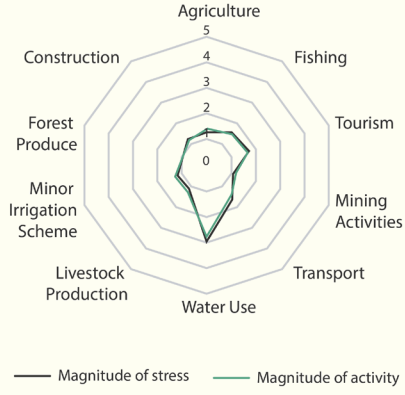
The majority of the community members were aware of the decline in the water levels of the wetland. However, a few members reported an increase in wetland water levels. The State Wetland Authority Kerala report further validates these findings stating that while overall, the wetland water levels have declined, 2021 is an exceptional year in which the wetland water levels increased due to an increase in the rainfall received. The community members also raised the issue of plastic pollution and soil erosion. The changes in wetland, as believed by most community members, had no impact on their health and economy. Yet a few individuals complained about skin allergies. Economy-wise, the income of fishermen has declined due to a reduction in fish catch. They stated that earlier, they used to earn ₹ 5000–₹ 10,000 per day, but this has now reduced to ₹ 2,000–₹ 5,000. *Pandanus* species have declined around the wetland, forcing the people who were dependent on these plants for their livelihood to seek alternative sources of income.

Perception regarding provisioning services

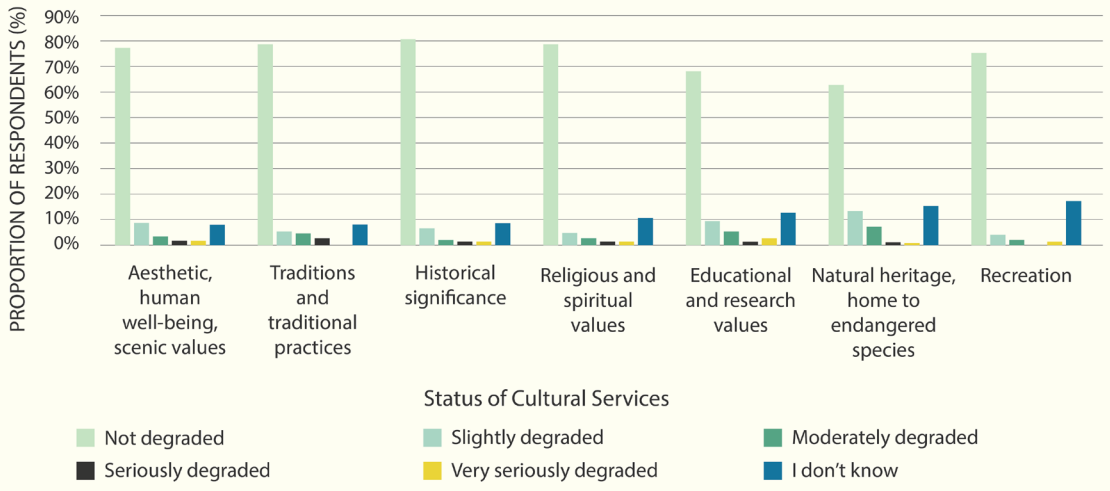
The wetland is mainly being utilised for drinking and domestic purposes by the community. In the survey, they accorded the highest score to water use (2.81) in terms of the magnitude of activity. The community members mentioned that there is over-extraction of the water by the Kerala Water Authority to meet water demand which is one of the major reasons for the decline in wetland water levels. They also suggested low levels of mining activities (1.18). These mining activities were mainly reported from the West Kallada village.



Perception of people about change in wetland characteristics



Perception of people about the different provisioning services offered by the wetland



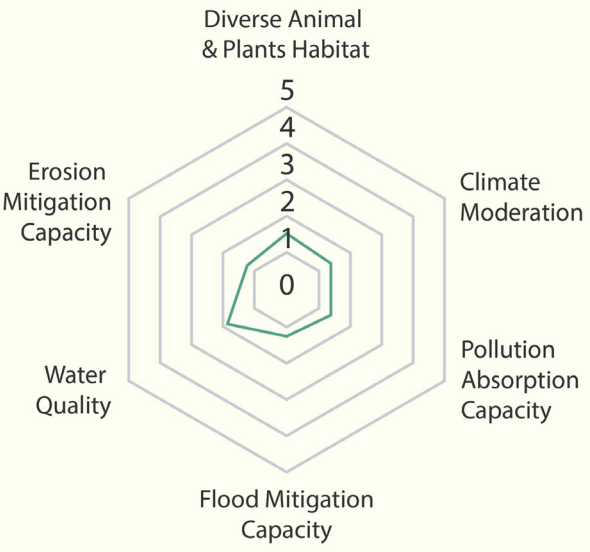
Perception of people regarding the status of cultural services in and around Sasthamkotta Lake

Perception regarding regulatory and supporting services

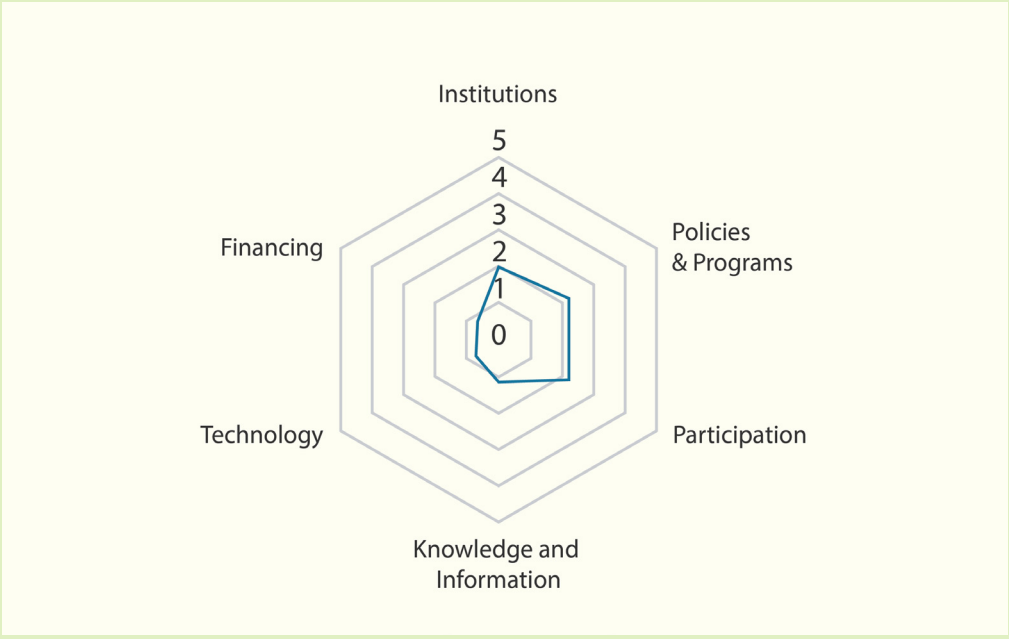
The majority of the community members believed that there is no impairment in the regulatory and supporting services offered by the wetland. Among the members who believed that there is impairment in regulatory and supporting services, they accorded the highest score to the water quality (1.91). During the survey, the local people mentioned about change in the colour of the water. The reasons mentioned by the people varied. Some suggested it is due to *Acacia* species leaves falling into the wetland, while others attributed it to the presence of iron pipes.

Perception regarding improvement in basin governance

The community members believed that there is a little to moderate need to improve the basin governance pillars. They accorded the highest score to participation (2.13) and policies (2.13),



Impairment of regulatory and supporting services offered by Sasthamkotta Lake (average score)



Improvement of basin governance (average score)

followed by institutions (1.90), wherein score 1 means none, score 2 means a little, and score 3 means moderate improvement. Approximately half the respondents during the interview were not aware of knowledge and information, technology and financing as pillars of governance.

Suggestions from the community regarding possible improvement in wetland management

More than 40% of the community members suggested that there is a need for bio-fencing around the Ramsar Site. Other suggestions include improving wetland water quality, removing *Acacia* species, desilting, preventing soil erosion, promoting eco-tourism and removing aquatic weeds. Suggestions also include planting native plant species such as *Pandanus* species which would not only promote native biodiversity but also provides livelihood to the people. The members of the community also suggested that native bamboo varieties need to be planted, which can help in binding soil and prevent soil erosion. Some members stated that the stakeholders need to work together and integrate sectoral policies for better management. One of them suggested that a local management body needs to be established whose only objective is to effectively manage the wetland. About 3.57% of the community members proposed building canals alongside the wetland such that the treated wastewater coming from the wastewater management plant first passes through the canal instead of entering the wetland directly. This water can undergo further treatment in the canal and then be discharged into the wetland.

03

Ecological Character Description

Documenting and understanding wetlands ecological character is central to managing and conserving them. As a signatory to the Ramsar Convention, Contracting Parties are expected to manage the Ramsar Sites so as to maintain the ecological character of each site, remain informed of any changes to the ecological character of Ramsar Sites and notify the Ramsar Secretariat of any changes at the earliest opportunity (Ramsar Convention 1987, Article 3.2 and further clarified by the Parties in Resolution VIII.8, 2002; Ramsar Convention 2005, Resolution IX.1 Annex B).

Ecological character is the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time (Ramsar Convention 2005a, Resolution IX.1 Annex A). Changes to the ecological character of the wetland outside natural variations may signal that uses of the site or externally derived impacts on the site are unsustainable and may lead to the degradation of natural processes and, thus, the ultimate breakdown of the ecological, biological and hydrological functioning of the wetland (Ramsar Convention 1996, Resolution VI.1). Describing ecological character helps to prioritise features, understand multiple values, identify stakeholders, and set management objectives. It also serves as a mechanism to determine whether change is occurring.

For wetland managers to be able to implement management that ensures the maintenance of ecological character, it is important to identify and retain the site's essential ecological functions, which underpin the wetland's ecosystem services and biodiversity. Implicit within this recommendation is the need to identify key elements of ecological character, maintaining which would constitute the site's wise use. The extent to which ecological character is maintained and adverse human-induced changes prevented is reflected in these key features. The wise use implementation framework (MoEFCC, 2024) encourages the adoption of a socio-ecological systems perspective for defining and assessing ecological character so as to enable consideration of the interactions social actors and institutions have with biophysical components of wetlands.

The Ramsar Convention's Guidelines for ecological character description are contained in Ramsar Resolution X.15. These elements have also been formally and systematically included in the 2015 revision of the Ramsar Site Information Sheet (RSIS) format, which needs to be updated every six years.

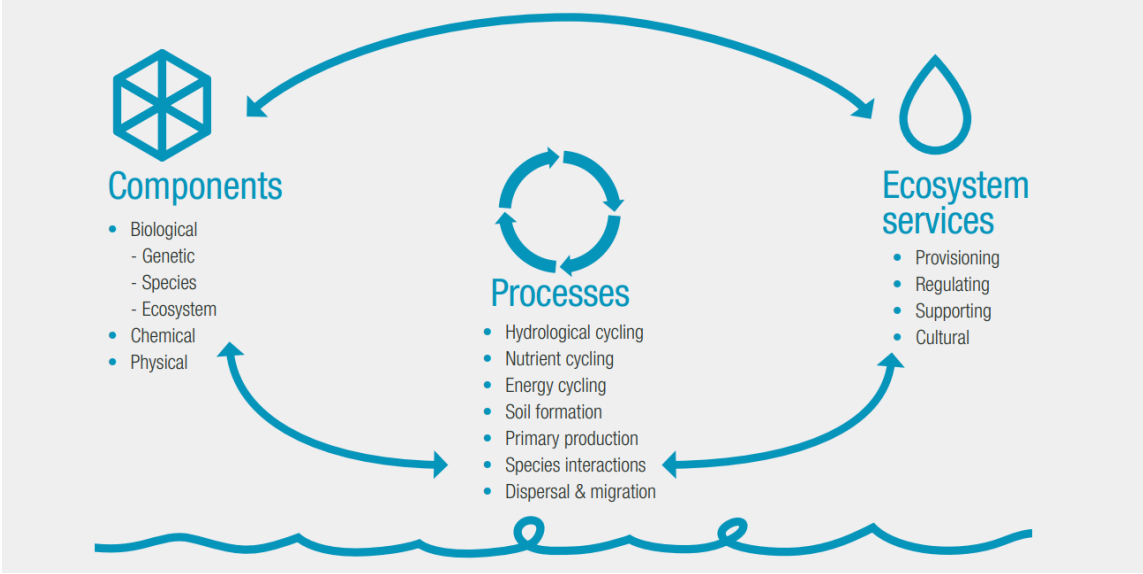


Figure 3.1 | Components of wetland ecological character (Global Wetland Outlook, 2018)

This chapter of the management plan presents an evaluation of Sasthamkotta Lake's ecological character based on the assessment of wetland features presented in the previous chapter. A description of ecological character is provided herein, highlighting key elements, the maintenance of which may be the focus of management. Status and trends in the key elements are discussed next, followed by an analysis of threats and risks of adverse change in ecological character. The chapter concludes with a listing of knowledge gaps.

3.1 ECOLOGICAL CHARACTER DESCRIPTION

Sasthamkotta Lake is a freshwater wetland. Spanning an area of 373 ha, this inverted L-shaped Ramsar Site has a maximum depth of 14.27 m, is well oxygenated, has low nutrient concentrations and is neutral to weakly alkaline. As per the bathymetric study conducted in 2022, Sasthamkotta can hold up to 23.8 MCM of water. The water spread area peaks to 351.2 ha in July during the south-west monsoon and 310.8 ha in November during the north-east monsoon. Well-drained clayey soils on gently sloping laterites predominantly constitute the wetland bed, which caps a sand layer up to 6 m deep, intervened by comparatively thin silt and clay-dominated sediments. Recorded biodiversity includes 23 species of phytoplankton, 12 species of macrophytes, 158 species of terrestrial vegetation, 16 species of fish and 14 species of waterbirds. The overall biodiversity is lower due to hydrological isolation, low nutrient status and relatively higher depth.

Sasthamkotta forms a part of the extensive floodplain wetland formation of River Kallada. The present form and shape of the wetland are believed to have been acquired about 4,000 years

ago, when extensive sedimentation, heavy load of siltation from the rivers along with meandering and migration cut-off isolated lakes and marshes. Sasthamkotta is surrounded by narrowly elevated ridges rising upto 35 m amsl on all sides except the south-west wherein a 20 m amsl high embankment separates the waterbody from the floodplains of River Kallada. The direct catchment extends ~1125 ha, about 40.6 % of which is under plantation. The direct catchment is inhabited by 13,400 households who have livelihoods in the form of wage labour, migrant employment, small business and fishing. Presently, more than half of the water inflows into the wetland are received from rainfall, and the rest from catchment runoff, given that groundwater inflow to the wetland has not yet been assessed. Velanthara Embankment on the south-eastern margin isolates any surface water connectivity with the river Kallada.

The wetland and its direct catchment are situated in a warm, humid tropical climate. The average annual rainfall is 2,001.56 mm, majorly received in two spells of south-west and north-east monsoon. Rainfall during the south-west monsoon season is the predominant component, accounting for 41% of the total rainfall. Temperature ranges between ~ 20°C–35°C. The evapotranspiration rate is highest (~152 mm) during October and minimum in January (~31 mm). Relative humidity ranges from 63% in January to 87% in June–July. Wind speed ranges from 1.3–2.1 km/hour.

The following ecological character elements underpin the ecosystem functioning and services of Sasthamkotta:

- A variable inundation regime that keeps territorialisation processes in check
- A significant water-holding capacity in the landscape that enables water storage and subsequent use for human purposes
- A mix of water inflow sources (rainfall, surface run-off and groundwater) that render stability to inundation regime
- Low nutrient and metal concentrations and relatively high oxygen content levels make the water fit for human consumption and prevent excessive growth of macrophytes
- Presence of diverse flora and fauna, especially species of high conservation significance (present records indicate four fish species and three waterbirds as species of conservation significance)
- High aesthetic appeal in the form of open expanse with vegetated hills forming the background
- A rich cultural heritage which makes Sasthamkotta an important natural asset

Maintaining the aforementioned ecological character elements requires the following conditions:

- Maintaining surface and sub-surface hydrological connectivity with catchment run-off and river floodplains
- Aligning water abstraction with natural variability of inundation regime of the wetland
- Maintaining a vegetated catchment and natural shoreline to prevent excessive siltation
- Preventing anthropogenic enrichment of wetland waters with nutrients, metals and other pollutants
- Maintaining species habitats
- Maintaining scenic beauty and naturality of the landscape
- Fostering wetland positive behaviour amongst the communities living around the wetland aligned with wetland wise use

3.2 STATUS AND TRENDS

Based on the available information on wetland features and governing factors discussed in Chapter 2, the status and trends in wetland ecological character, with reference to their condition at the time of Ramsar Site designation in 2002[3], is in Annex XI. Following are the major trends:

Wetland Extent: The area of Sasthamkotta Lake has been delineated to 373 ha (roughly corresponding with 16 m amsl water level), including open water area, marshes and fragments of exposed wetland bed. Later, as a part of the notification process of the wetland under Wetlands (Conservation and Management) Rules, 2017, implementation guidelines of the same and the Ramsar Information Sheet (RIS) updating, the boundary was revised to 365.91 ha, excluding the inundation area adjoining Velanthara Embankment, and more accurate delineation of the boundary. The relative proportions of open water and marsh areas in post-monsoon have largely remained unchanged during 2000–2022.

Wetland Catchment: Land use and land cover change within the direct catchment of Sasthamkotta Lake has undergone a significant transformation. From 1988 to 2022, the area under agriculture increased from 5% to 13%, while that under settlements increased from 0.4% to 6%. Conversely, the area under marshes, plantations, and wetlands decreased by 3%, 2%, and 3%, respectively, during the same period.

Hydrological Regime: The area under inundation (post-monsoon) has increased from 210 ha in 2003 to 310 ha in 2022. The area under pre-monsoon inundation has declined from 373 ha in 2003 to 300 ha in 2022. The increasing inter-annual variability in the inundation regime has resulted in a larger area transforming into intermittent marshes. Currently, only 40% of the area of Sasthamkotta Lake remains inundated throughout the year.

[3] Reference to the condition at the time of designation is taken from 2002–2003 due to data availability in the designation year

Surface run-off from rainfall within the drainage basin and direct rainfall on the Ramsar Site constitute the major sources of inflow. The long-term trends indicate a decrease in total inflow from 29 MCM in 2015 to 20 MCM in 2022, of which run-off from the catchment and direct rainfall on the wetland bed contribute 12.69 MCM and 7.47 MCM, respectively. In 2022, 13.68 MCM was extracted from Sasthamkotta Lake for the Quilon Water Supply scheme, with an additional 8 MCM to keep the emergency requirements of other water supply schemes. This level of extraction has been maintained in the last decade despite shifts in rainfall patterns and reduced sub-surface connectivity with the River Kallada.

Sasthamkotta Lake maintains adequate oxygen levels. The high BOD in certain seasons and persistently elevated coliform levels indicate potential concerns related to organic pollution and contamination, particularly from runoff.

Species and Habitat: Recoded species richness of various groups, such as phytoplankton, zooplankton, macrophytes, and fish, have declined in the last 20 years, however, such changes may also be attributed to changes in survey methods and their comprehensiveness. The survey indicates an increase in the abundance of high-conservation species.

Climate: The Sasthamkotta catchment experiences a warm and humid tropical climate characterised by hot, wet summers and mild, dry winters. The region receives moderate to heavy rainfall during the peak monsoon season, from June to September, accounting for approximately 41% of the total annual rainfall. An additional 27% of the rainfall occurs during the retreating north-east monsoon from October to December.

While the long-term trends in temperature show no significant change, the mean annual precipitation has increased from 1,884 mm in 2002 to 2,002 mm in 2022. The pre-monsoon (February–May) and monsoon (June–September) precipitation has increased by 48% and 33%, respectively, between 2002 and 2023. However, the north-east monsoon precipitation has reduced by 33% during the same period.

Wetlands Livelihoods: A strong wetland-dependent community of approximately 300 to 400 households currently resides in Sasthamkotta. About 18% of these households depend on natural resource-based livelihoods like fishing.In 2015, there were 155 registered fishermen in the Co-operative Society. There are around nine active fishers in Sasthamkotta Lake. Sasthamkotta Lake supports hydrological regimes vital for agriculture in the region, with major crops being Mundakan paddy and *Sesamum*. Currently, two licensed boats are also operating in Sasthamkotta Lake.

Institutions and Governance: The State Government of Kerala constituted the State Wetland Authority Kerala (SWAK) in 2015 as the state's nodal agency for wetland management.

Prior to the constitution of SWAK, the responsibility of management of the Sasthamkotta was held by the Kollam District Administration. Over the years, the number of community-based organisations linked with Sasthamkotta has also increased, including the Sasthamkotta Lake Protection Council, 'Paristhiti Samrakshana Ekopana Samithi', 'Kayalkoottayma', as well as the Kerala Sastra Sahitya Parishad (KSSP).

3.3 THREATS AND RISK OF ADVERSE CHANGE

An evaluation of threats and risks of adverse change in the ecological character of Sasthamkotta Lake is in Table 3.1.

Table 3.1 | Risk of adverse change for priority features, trend summary, likely impact on biotic and abiotic components/processes/services, drivers of change, knowledge gap, capability of existing institutional regime to address the risk of adverse change and degree of impact (low, moderate, high)

Threats	Risk of adverse change in ecological character	Level of risk (high/ moderate/low)
Physical regime alteration The inter-annual variability of inundation regime has increased due to a combination of changes in rainfall patterns, loss of groundwater regime connectivity with River Kallada and a high rate of water abstraction. The overall water-holding capacity of Sasthamkotta Lake has also declined by 22% between 2011 and 2021.	→ Overall reduction in wetland regime → Habitat destruction and loss of fish species → Increased soil erosion and sediment load	High
Over abstraction of water Increase in the extraction of water for water supply by the Kerala Water Authority from 30 MLD in 2015 to 37.5 MLD in 2022, despite a shift in rainfall patterns and prolonged exposure of lakebed. The intensity of groundwater use from shallow aquifers around the wetland has also increased.	→ Reduction in hydrological regime buffering capacity → Reduced freshwater availability → Reduced water storage → Increase in water stress, accentuating shrinkage in inundation regime	High
Pollution There is an increase in alkalinity, hardness, TDS, nitrate, phosphate and faecal coliform levels, which correlate with pollution from catchment runoff and activities such as unauthorised vehicle washing along the shore of the wetland. Littering of plastic and glass bottles, multi-layered plastic packs, tetra packs, etc., are also reported.	→ Adverse impact on aquatic life and related processes and health of communities living around the wetland	Moderate
Proliferation of invasive species Proliferation of invasive species has been observed. Mats of *Salvinia molesta, Cabombo caroliniana* and *Pistia stratiotes* have been recorded in post-monsoon season along the shorelines and shallow areas of the wetland.	→ Habitats of native species is adversely affected	Moderate

Threats	Risk of adverse change in ecological character	Level of risk (high/ moderate/low)
Increasing Climate Risks Climate Risks Assessment indicate that under a business-as-usual scenario, the change in climate patterns may result in reduced water inflow, declining water quality, and proliferation of invasive species. This could result in reduced water availability for human use. The agricultural productivity may decline, leading to economic losses for farmers. Additionally, the cultural and recreational practices of the communities will be disrupted. Increased frequency and intensity of extreme weather events, such as floods and droughts, will exacerbate these changes, leading to further deterioration of the wetland and possible transformation from a lake to a marsh unless appropriate actions are taken.	→ Reduce stability of the inundation regime → Increase in the risk of flash floods → Decline in wetland health → Decline in crop yield and overall vegetation in wetland catchment	Moderate

3.4 KNOWLEDGE GAPS

The following knowledge gaps need to be assessed to be able to track changes in ecological character and refine the management of Sasthamkotta Lake:

- Land use and land cover data of Sasthamkotta Lake during the time of Ramsar Site designation
- Surface-groundwater interactions and relationship with water levels of Sasthamkotta Lake.
- Nutrient cycles and implication for water quality and expansion of macrophytes.
- Role of ecological communities, especially microbial communities, in regulating water quality.
- Climate risk and vulnerability to assess the perception of climate risks
- Status of breeding and spawning grounds of fish.
- Trend study on the proliferation of invasive species
- Inland navigation impacts on the wetland habitat
- Utilisation pattern of Sasthamkotta Lake and adjoining marshes as waterbird habitat.
- Inventory and assessment of vascular plants, annelid, arachnid, crustacean, mollusc, odonate, coleopteran, hemipteran, reptile and mammalian abundance.

04

Institutional Arrangement

Institutions play an important role in governing and coordinating relationships between various wetland stakeholders; therefore, their fit with ecological character has an important influence on wise use outcomes. Institutional requirements for conservation and wise use of the wetland complex are defined by the ability to ensure integration of site management within broad-scale conservation and development plans, programmes and investments and enabling inclusive and participatory management, particularly engaging local communities whose livelihoods are linked to the wetland ecosystem.

This section of the management plan presents an analysis of existing institutions and governance settings to arrive at recommendations for managing the Sasthamkotta Lake.

4.1 POLICY AND REGULATORY INSTRUMENTS

Wetlands conservation draws strength from India's legacy of environmental preservation through various legislations, policies, and regulatory regimes. The Indian Constitution, in its Article 51-A(g), stipulates that "*it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures*."

Wetlands conservation for wise use has been placed within the Ministry of Environment, Forest and Climate Change (MoEFCC) mandate. Since 2013, the MoEFCC has been implementing the National Plan for Conservation of Aquatic Ecosystems (NPCA), which aims at '*mainstreaming the full range of wetlands biodiversity and ecosystem services within development plans and programmes at various levels*'. The NPCA provides guidelines for promoting an integrated and multi-disciplinary approach to conservation and sustainable management of wetlands.

Under the provisions of the Environment (Protection) Act, 1986, a regulatory framework for wetlands was introduced by the MoEFCC through the notification of Wetlands (Conservation and Management) Rules, 2017. As per the provisions of these Rules, State Wetlands Authorities have been constituted as the main policy and regulatory bodies within states and stipulate the prohibition and regulation of a range of developmental activities within a wetland notified under its provision by the state governments. The MoEFCC issued an Office Memorandum on March 8, 2022, reiterating that the 2,01,503

wetlands (>2.25 ha) as per the National Wetland Inventory and Assessment (NWIA), 2011 should be protected as per Rule 4 of the Wetlands (Conservation and Management) Rules, 2017.

Wetlands receive protection from a number of central enacted rules and regulations. Provisions of the Indian Forest Act 1927, the Forest (Conservation) Act, 1980 and the Indian Wildlife (Protection) Act, 1972 define the regulatory framework for wetlands located within forests and designated protected areas. The Indian Fisheries Act, 1897; The Water (Prevention and Control of Pollution) Act, 1974; and The Biological Diversity Act, 2002, provide instruments for regulating various development threats on wetlands. Further, under the Biological Diversity Act 2002, the Central Government can issue directives to State Governments to take immediate ameliorative measures to conserve any area rich in biological diversity, biological resources and their habitats, especially when the area is threatened by overuse, abuse or neglect. The said Act also gives State Governments the powers to notify areas of biodiversity importance as biodiversity heritage sites.

The National Environment Policy of 2006 has laid down the overarching policy elements for the conservation and sustainable management of wetlands. Wetlands have been identified as components of 'freshwater resources', and the recommended policy actions for wetlands conservation include integration in developmental planning, management based on prudent use strategies, promotion of ecotourism, and implementation of a regulatory framework. India's National Wildlife Action Plan (2017–2031) identifies the conservation of inland aquatic ecosystems as one of the 17 priority areas. It envisages the development of a national wetlands mission and a national wetlands biodiversity register as key interventions (MoEFCC, 2017). Integration of wetlands in river basin management has been identified as a strategy for managing river systems (MoWR, 2012). The National Water Policy (2012) recommends adopting a basin approach for water resources management and identifies the conservation of river corridors, waterbodies and associated ecosystems as an essential action area (MoWR, 2012). The National Action Plan for Climate Change includes wetland conservation and sustainable management in the National Water Mission and the Green India Mission (MoEF, 2008b).

The National Water Policy (2012) provides a critical policy framework for linking wetlands to water resources management. It recommends the adoption of a basin approach for water resource management and identifies the conservation of river corridors, water bodies, and the associated ecosystems as an important action area and all together is proposed in the Draft River Basin Management Bill, 2018.

The Kerala State Environment Policy (2009) has a vision of ensuring clean air, water, soil and food to the people of Kerala and its sustainability for healthy living conditions, as well as ensuring the conservation of natural resources, including species, ecosystems and genetic wealth of the State. The Policy aims to create environmental awareness for all sections of society, sensitising all sections on the critical need for sustainability of the ecosystems and environment to meet the growing human development needs and to promote public involvement in all environmental activities. Conservation and sustainable use of wetlands to ensure water and food security and economic benefit for the people is included as a specific action plan within the State Environment Plan 2022. The unprecedented floods in 2018 brought back the focus on improved water and river basin management in the state. The Kerala State Water Policy (2008) emphasises the maintenance of ecosystem integrity, adopting a watershed approach, ensuring people's participation, and constant upgrading of the water environment through environmental interventions such as salinity regulation, water quality monitoring, and pollution abatement. The policy also prescribes the constitution of a wetland authority for the protection, conservation, development, and management of wetlands in the state and a State Level River Authority for river basin planning and management. The state government, under the Rebuild Kerala agreement with the World Bank, has initiated the process of establishing a River Basin Conservation and Management Authority. A bill to this effect, named the Kerala River Basin Conservation and Management Authority Bill, is currently being reviewed.

Table 4.1 | Key regulations and their implications on Sasthamkotta Lake

Regulation	Purpose	Scope	Key implications for the management of Sasthamkotta Lake
Wetlands (Conservation and Management) Rules, 2017 under Environment (Protection) Act, 1986	Provides the regulatory framework for the conservation and management of wetlands in the country	All wetlands >2.25 ha except those covered under the Indian Forest Act, 1927, the Wildlife (Protection) Act, 1972, the Forest (Conservation) Act, 1980	→ Wetland boundary and zone of influence needs to be demarcated → A management plan for the wetland needs to be formulated in line with the framework recommended under the Guidelines for the Implementation of Wetlands (Conservation and Management) Rules, 2017 → Prohibits: • conversion for non-wetland uses • solid waste dumping • discharge of untreated waste and effluents from cities and towns • poaching • construction of permanent new building except boat jetties in 50 m buffer from the wetland boundary towards land

Regulation	Purpose	Scope	Key implications for the management of Sasthamkotta Lake
Environment (Protection) Act, 1986	Umbrella law to provide for the protection and improvement of the environment and for matters connected therewith	Covers all forms of pollution and empowers the central government to take any/all measures for improving environment quality and lay down standards for emissions and discharges throughout the country	The EPA, 1986 and related Acts as the Water Act, 1974, the Water Cess Act 1977, the Wetlands (Conservation and Management) Rules, 2017 lay the framework of regulatory tools to deal with pollution from industries, towns and settlements located along the wetland The provision of the Act can be invoked to make new statutes
The Indian Wildlife (Protection) Act, 1972	Protection of wild animals, birds and plants and for matters connected therewith	Applies to all wild habitats, protected areas, wild animals, specified plants, wildlife trade and related matters	Provides the regulatory framework for the protection of wild animals, specified plants in Sasthamkotta Lake
The Water (Prevention and Control of Pollution) Act of 1974	Aims to prevent and control water pollution and to maintain/restore the wholesomeness of water by establishing central and state pollution control board to monitor and enforce the regulations	National (Rules pertain to the State of Kerala)	Lays down effluent discharge standards of sewage and sullage Provides for the constitution of State Level Boards for enforcement of various provisions of the Act
The Biological Diversity Act, 2002	Conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected in addition to that or incidental thereto	National (Rules pertain to the State of Kerala)	→ Prohibits, without the approval of the National Biodiversity Authority → Obtaining any biological resource or knowledge associated thereto for research, commercial utilisation, or for bio-survey and bio-utilisation → Transferring results for monetary consideration → Application for intellectual property rights
The Indian Forest Act, 1927	An Act to consolidate the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce	Applicable to the whole of India. Wetlands lying within notified forest areas are regulated as per the provisions of the Indian Forest Act of 1927, Forest Conservation Act of 1980	The Act provides for the conservation of wetlands within the notified forest areas within the catchments of Sasthamkotta Lake

Regulation	Purpose	Scope	Key implications for the management of Sasthamkotta Lake
The Kerala Conservation of Paddy Land and Wetland Act, 2008	To conserve the paddy land and wetland and restrict the conversion or reclamation thereof to promote agricultural sector growth and sustain the ecological system	Extends to the entire state of Kerala	This State Act prohibits the conversion and reclamation of paddy lands, except for ten cents in a Panchayat and five cents in a Municipality/ Corporation, for the construction of residential buildings for the owner of the paddy land. The act prohibits the reclamation of wetlands and removal of sand except for removal of slurry and mud to maintain the ecological condition of wetlands. The act has over riding powers over Kerala Panchayat Raj Act (1994) and The Kerala Municipality Act (1994)
The Kerala Town and Country Planning Act, 2016	To provide for the promotion of planned development and regulation of growth of urban and rural areas with a focus on scientific planning and improving the liveability of ambient spaces for inhabitants	Extends to the state of Kerala	The Act has provisions for preparing a Perspective Plan for the State containing long-term policies and strategies for spatial development with a time horizon of twenty years to deal with the protection of environmentally and ecologically sensitive areas and conservation of national and state-level heritage areas. Similarly, the District Planning Committee and the Metropolitan Planning Committee, constituted under sections 53 and 54, respectively, of the Kerala Municipality Act, 1994, prepares the development plan for the district and metropolitan area with a long-term perspective. It co-ordinates planning and development activities among the Government departments and quasi-government institutions within the district/metropolitan in the context of Plans
The Kerala Inland Fisheries and Aqua Culture Act 2010 The Kerala Inland Fisheries and Aquaculture (Amendment) Act, 2021	Sustainable development, management, conservation, propagation, protection, exploitation and utilisation of the inland fishery sector, promote social fisheries, regulate aquaculture activities and ensure livelihood of fishers and food security	Extends to the State of Kerala	Vests the power to develop and manage fisheries in public water bodies with the government, including powers to designate aquaculture areas, regulate and prohibit detrimental fishing practices and pollution of water bodies, and establish a Local Fisheries Management Council. The Act also prohibits the use of paddy lands that can support one crop for aquaculture purposes

Regulation	Purpose	Scope	Key implications for the management of Sasthamkotta Lake
The Kerala Irrigation and Water Conservation Act, 2003	To consolidate and amend the laws relating to the construction of irrigation works, conservation and distribution of water for irrigation and levy of water cess and to provide for the involvement of farmers in the water utilisation system	Extends to the state of Kerala	The Act vests all the water courses with the government and prohibits acts that divert or diminish the flow of water, sand mining in water courses or structures maintained by the department, misuse of water from irrigation works for purposes other than domestic purposes and prescribes development of an irrigation calendar aligned with cropping pattern in consultation with the beneficiaries
The Kerala Protection of River Banks and Regulation of Removal of Sand Act, 2001	To protect river banks and river beds from large-scale dredging of river sand and to protect their biophysical environment system and regulate the removal of river sand	Extends to the state of Kerala	The provisions of the act and corresponding rules have been applied to ban sand mining in six rivers of the state, including Kallada

4.2 KEY DEPARTMENTS AND ORGANISATIONS

Environment Department

The Directorate of Environment and Climate Change (DoECC) within the Environment Department serves as the nodal agency for the planning, promotion, co-ordination and overseeing the implementation of central and state environmental protection and conservation policies and programmes and for formulating climate change-related schemes, plans, programmes and their execution. It coordinates, inter alia, the programmes for revision and implementation of the State Action Plan on Climate Change (SAPCC).

State Wetland Authority Kerala (SWAK)

In pursuance of Section 5(1) of the Wetlands (Conservation and Management) Rules 2017, the Government of Kerala have constituted the State Wetland Authority Kerala (SWAK) vide GO (MS) No. 14/2017/Envt. dated 28.12.2017 with the Chief Minister as the Chairman, Chief Secretary to Government as the Vice Chairperson and the Director of Environment & Climate Change as the Member Secretary. SWAK is the statutory authority functioning as the State-level nodal agency to implement policy development, regulatory frameworks, integrated management, planning, implementation of management plans, capacity building, research, networking, communication, awareness, creation and raising of funds for wetland management.

Kerala Forest and Wildlife Department

The catchment of Sasthamkotta Lake falls under the Kollam Social Forestry Range under the Department of Forests and Wildlife. The Social Forestry division's main functions are conserving biodiversity and promoting green cover at public places, maintaining Compensatory Afforestation areas, and spreading nature awareness through classes, the film shows, and farmers' training, among others.

Acacia plantations around Sasthamkotta Lake were raised in available public lands under the Kerala Social Forestry Project funded by the World Bank that concluded in 1993. As *Acacia* is known to be water-consuming, a joint programme has been implemented since 2010 to replace the *Acacia* trees with native vegetation. Kerala State Biodiversity Board (KSBB) also launched a tree-planting drive to create a bio-fence around the wetland.

Kerala Water Authority

The Kerala Water Authority provides for developing and regulating water supply and wastewater collection and disposal in Kerala. The main functions of the authority include:

- Preparation, execution, promotion, operation, maintenance and financing of the schemes for water supply and wastewater disposal
- Provision of all necessary services related to water supply, collection and disposal of wastewater to the Government, private institutions or individuals
- Preparation of state plans for water supply and collection and disposal of wastewater
- Fixation & revision of tariffs, taxes and charges of water supply and maintenance services
- Establishment of state standards for water supply and wastewater services

The authority has the power to abstract water for drinking purposes from any natural source, enter into contracts with other firms, lay down fees, acquire, possess and hold lands to carry water or sewerage works and obtain specific information from local bodies to make provision for the supply of water and efficient sewerage services. Sasthamkotta, being a water infrastructure, water abstraction and supply, is looked after by the Kerala Water Authority.

Kerala State Pollution Control Board

Kerala State Pollution Control Board is the nodal agency for implementing provisions of a gamut of laws and rules on environment — Water (Prevention and Control of Pollution) Act, 1974, Water (Prevention and Control of Pollution) Cess Act, 1977; Environment (Protection) Act, 1986; Hazardous Wastes

(Management, Handling and Transboundary Movement) Rules, 1989; Rules for Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms, Genetically Engineered Organisms or Cells, 1989; Biomedical Waste (Management and Handling) Rules, 1998; Municipal Solid Wastes (Management and Handling) Rules, 2000 and Environment Impact Assessment Notification, 2006. The authority under the power vested by the Water (Prevention and Control of Pollution) Act 1974 has issued a notification of June 9, 2010, prohibiting the following activities around the wetland:

- Bathing and washing clothes, animals and vehicles in the wetland
- Discharge of wastewater from hotels, commercial establishments, industries, healthcare establishments and others into drains or pathways leading into the wetland
- Discharge of sewage into the wetland or pathways leading into the wetland
- Mining of sand, granite, laterite, clay or soil from within 500 m of wetland periphery
- Storage of materials, polluted leachate from the which is likely to flow towards the wetland, within 500 m periphery of the wetland
- Agricultural activities within 100 m periphery of the wetland
- Catching of fish from the wetland using explosives
- Construction of any sewage disposal facility (such as pit latrines) inferior to laid down minimum standards for septic tanks within 500 m periphery of the wetland
- Disposal of overflow from septic tank into land other than through soak pit with concreted bottom, perforated ring or honeycomb brick wall, within 500 m from the periphery of the wetland

Kerala State Biodiversity Board

Kerala State Biodiversity Board (KSBB) was constituted in 2004 under the provisions of the Biological Diversity Act 2002, Rules 2004 and Kerala State Biological Diversity Rules 2008. The KSBB is dedicated to conserving and protecting the state's agro, plant, and fish diversity. The major function of the State Biodiversity Board is to advise the State Government on any guidelines issued by the Central Government on matters relating to biodiversity conservation. A Chairman, a Member Secretary, and a team of expert board members and government officials head the Board.

The Biodiversity Management Committees (BMCs) have been constituted in all Local Self Governments, including Grama Panchayats, Municipalities and Corporations during 2011–2012

for successfully implementing the Biological Diversity Act 2002. A joint Biodiversity Management Committee around Sasthamkotta was constituted comprising members of three Grama Panchayaths — Sasthamkotta, West Kallada and Mayangapalli. Sasthamkotta Block Panchayat, the president, was appointed as the chairman. The committee is entrusted to take action to protect biodiversity, conserve it, and augment the indigenous fish stock of Sasthamkotta. KSBB has published a Biodiversity Register for the wetland ecosystem covering the catchment area of Sasthamkotta. The register results from a year-long mapping exercise carried out in association with the joint BMC comprising representatives of the three Grama Panchayats.

Department of Tourism

Sasthamkotta attracts many tourists because of its scenic beauty and religious significance. The Department of Tourism is the nodal agency managing tourist inflow in Kerala. It is responsible for developing and providing directions to tourism in the state. The Tourism Department works with line departments, institutions and organisations such as Kerala Tourism Development Corporation (KTDC), Tourist Resorts (Kerala) Ltd., District Tourism Promotion Council, Kerala Institute of Travel and Tourism Studies (KITTS) and Kerala Institute of Hospitality Management Studies (KIHMS). The Tourism Department supports District Tourism Promotion Councils (DTPCs) in all districts of Kerala. The Kerala Tourism (Conservation and Preservation of Areas) Act, 2005 provides for the conservation, preservation and development of special tourism zones declared by the government. Steps have been taken to make tourism environment-friendly.

Department of Fisheries

The Department of Fisheries is the nodal agency for all affairs related to fisheries, including increasing production, conservation and sustainable exploitation of fisheries wealth, promoting the cultivation of fish and prawns, development of fish harbours and facilities for landing and marketing of fish and for upliftment and welfare of the fishers. The Department and its allied agencies viz. Matsyafed, ADAK, KFWEB, FIRMA and FFDA implement the Government's vision and schemes in this sector. The Department constructed a hatchery at Rajgiri for seed production of Pearlspot (Karimeen) (*Etroplus suratensis*). The hatchery is presently defunct.

Department of Soil Survey and Soil Conservation

The Department's mandate is to process and maintain a database on soil and land resource data, undertake soil surveys of Panchayats and watersheds, prioritisation of watersheds and implementation of soil and water

conservation activities basis, enhancement of irrigation potential and infrastructure creation in rural areas for augmenting agricultural production. The department undertakes investigation, preparation and execution of all soil conservation work through its District Conservation Offices. In the Sasthamkotta watershed, the department has executed soil and water conservation activities under which about 934 ha of the area has been brought under effective treatments whereby erosion from catchment could be moderated to the permissible limit.

Harithakeralam prepares watershed maps with the help of the LSGs and block-wise watershed master plans for which priority-wise projects are placed for approval at appropriate levels. Implementation is done with the support of local bodies under the supervision of a technical committee, including line departments and agencies.

Department of Mining and Geology

Sand and laterite mining are major issues in the wetland catchments. Department of Mining and Geology is Kerala's statutory body for mineral exploration, prospecting and administration. The Department carries out short-term investigations/studies and, being a scientific organisation, also undertakes geosciences projects sponsored by agencies like Kerala State Council for Science, Technology and Environment (KSCSTE).

Laterite, sand and clay fall under the category of minor minerals. In exercise of the powers conferred by sub-section (1) of section 15 of the Mines and Minerals (Development and Regulation) Act, 1957, the Government of Kerala has made the Kerala Minor Mineral Concession Rules, 2015 that replaces similar rules of 1967 to regulate the extraction of minor minerals in the state. Quarrying is not permitted within a distance of 50 m from any reservoir, tanks, canals, rivers, forest lands or Grama Panchayat roads among others, except with the previous permission of the authorities concerned or the Government or the competent authority. As per the provisions of the Kerala Protection of River Banks and Regulation of Removal of Sand Act (2001), sand mining is guided by the recommendation of a District committee. Notably, the State Government has banned all sand mining in River Kallada.

Department of Agriculture Development and Farmers Welfare

The department deals with formulating and implementing various programmes to augment the production of both food crops and cash crops in the state. It undertakes activities among the farmers to promote scientific methods of cultivation, plant protection, etc. and also arranges

the supply of high-yielding varieties of seeds, seedlings, planting materials and plant protection chemicals to farmers. The main functions of the agriculture department are agriculture research, education and extension.

The department functions through its district and grama panchayat offices and has a presence in all grama panchayats through Krishi Bhavans. The Farm Information Bureau (FIB) established in 1969 acts as a single nodal agency to provide active and complete information support to accelerate the extension and development of Agriculture, Animal Husbandry and Dairy Development. It links research stations and farming communities by disseminating scientific knowledge and providing feedback to research stations.

A comprehensive District Agriculture Plan for Kollam District has been prepared for integrated and participatory action for the development and local area in general, agriculture, and allied sector. The ultimate objective of the plan is to attain substantial growth in the agriculture sector with optimal utilisation of the available resources.

Irrigation Department

The Irrigation Department facilitates sustainable agricultural development and food security in the state. The department has six wings headed by a Chief Engineer. The Projects-II wing of the Irrigation Department plans, monitors and constructs dams and regulators and undertakes maintenance of completed projects. The wing has been involved in carrying out river desiltation works in major river basins in coordination with the District Disaster Management Authorities, which are creating Room for River. Dredging and desilting of dams, reservoirs and barrages, rivers and canals for maintenance and upkeep and for disaster management has been exempted from the otherwise mandatory environmental clearance for sand mining as per the provisions of section 23 and 24 of the Disaster Management Act, 2005. Funds for the same have been channelised from the MGNREGS, the Ayyankali Urban Employment Guarantee Scheme (AUEGS), the State Disaster Response Fund as well as the department's funds.

Kerala Land Development Corporation (KLDC)

KLDC is responsible for developing, implementing, and handing over quality infrastructure works in the state's agriculture and allied sectors at a reasonable cost. In 2017, the Corporation was accredited by the State Government to undertake and execute general civil construction works of any department or agency in the State.

Local Self Government (Planning) Department

The department functions as the nodal agency for ensuring the planned development of urban and rural

settlements in the state. It grants statutory approvals for constructions and land developments, prepares plans at the state, district and local levels and advises the LSGs and Government on matters related to the planning and development of settlements. It also serves as the technical secretariat for the Art and Heritage Commission.

LSGs connect with a number of institutions for the implementation work of Local Development Plans, such as the Rural Development Commissionerate, Panchayat Directorate, Town and Country Planning Department, Kerala Institute of Local Administration (KILA), Information Kerala Mission (IKM), Kudumbashree and State Institute of Rural Development. Planning for three-tier Panchayats located within Sasthamkotta direct catchment is placed within the ambit of the Local Self Government (Planning) Department.

The department has been planning interventions in the wetland catchment. Land use zoning has been prescribed and is supported by zoning regulations. It has been prescribed that septage, sewage, solid and liquid waste management be done in adherence to the Kerala Municipality Building Rules, 2019 and the Kerala Panchayat Building Rules, 2011.

Suchitwa Mission is the Technical Support Group in waste management under the Local Self Government Department, Government of Kerala. The mission is responsible for the provision of technical and managerial support to the Local Self Governments and for conceptualisation, action planning, capacity development programmes, research and publications and monitoring activities in the Waste Management Sector. The Mission is also the nodal agency for implementing the Swachh Bharat Mission (Urban), Swachh Bharat Mission (Rural) and Communication and Capacity Development Unit (CCDU) in the State.

Under its various sanitation schemes, sewage treatment plants at Government Taluk Hospital, Sasthamkotta (eco-restoration of Sasthamkotta) are under construction. 322 latrines have been provided to BPL families at the Sasthamkotta catchment area. Six girl-friendly toilets and nine biogas plants have been constructed at the Sasthamkotta catchment area.

Research and Academia

Research and development needs for wetland management are met through the Kerala State Council for Science, Technology and Environment (KSCSTE) and a number of autonomous research and development centres such as the Centre for Water Resources, Development and Management (CWRDM), National Centre for Earth Sciences Studies (NCESS) and a number of academic institutions.

Centre for Water Resources, Development and Management (CWRDM) — a premier research and development

organisation of the Government of Kerala under KSCSTE and the official knowledge partner of SWAK designated by MoEFCC, Government of India — periodically undertakes hydrological investigations in Sasthamkotta Lake. CWRDM has been monitoring continuous wetland ecosystem parameters under the Wetland Inventory, Assessment and Monitoring System (WIAMS) for the Ramsar Site under a project commissioned by SWAK. Department of Fisheries Resource Management, Kerala University of Fisheries and Ocean Studies (KUFOS) recently completed a project wherein they assessed the current status of fish diversity of Sasthamkotta Lake. The project was commissioned by SWAK.

Civil Society Organisations (CSOs)

Kerala has a strong tradition of proactive civil society organisations engaging in matters related to the environment, which is well reflected in Sasthamkotta. Sasthamkotta Lake Protection Council, 'Paristhiti Samrakshana Ekopana Samithi', and 'Kayalkoottayma' are the major civil society organisations voicing issues related to wetland management with the government. The former was formed in 1997 to address sanitation issues in communities living around the wetland and is today a major community force triggering action for wetland conservation. In March 2010, the action council launched a hunger strike to move the government into taking positive actions for wetland restoration, thus triggering the revision of the management plan. Kayalkoottayma is another civil society organisation working to conserve the wetland. The organisation has been working for more than 10 years to create awareness among the masses and take steps to manage the wetland better. Within the state, The Kerala Sastra Sahitya Parishad (KSSP) founded in 1962 as a people's science movement, has been vocal in raising issues related to the environmental degradation of wetlands.

4.3 STAKEHOLDER ANALYSIS

The actions of the stakeholders mentioned above may have positive or adverse impacts on Sasthamkotta Lake and its management. Based on stakeholder mapping, a stakeholders' matrix has been formulated considering two key variables: a) influence, degree of current involvement in decision-making for wetland management and b) impact, ability to effect changes in wetland ecological character and its management (Annex XII). Based on the analysis, the stakeholders are categorised into three groups, guiding their degree of engagement in the management of Sasthamkotta Lake:

a) High-priority stakeholders: The implementation of the management plan should actively involve this group of stakeholders to enhance and maintain wetland values while reducing current and potential threats to ecological character.

b) Medium-priority stakeholders: The stakeholders in this category must be kept informed and satisfied to build a knowledge base that supports conservation efforts for the wise use of Sasthamkotta. They should be made aware of the interconnections among the various features of the Ramsar Site. This group also includes individuals whose actions may impact the ecological character of the area. Therefore, it is crucial that they are adequately informed about ongoing developments, and frequent interaction is essential to prevent any major conflicts from arising in the future.

c) Low-priority stakeholders: It is critical to monitor the activities of this group of stakeholders to ensure that their actions do not have adverse impacts on the wetland.

The import of stakeholder analysis is included in the management plan implementation arrangement, discussed in Section 4.4 and the action plan in Chapter 7.

Figure 4.1 | Influence-Impact matrix of stakeholders of Sasthamkotta Lake

INFLUENCE	LOW	MEDIUM	HIGH
MEDIUM	→ India Meteorological Department	→ Ministry of Environment, Forest and Climate Change → National Biodiversity Authority → Kerala State Pollution Control Board → Department of Mining and Geology → Department of Agriculture Development and Farmers Welfare → Department of Irrigation → District Tourism Promotion Councils → Zoological Survey of India	→ Department of Environment and Climate Change → State Wetland Authority Kerala → Kerala Forest and Wildlife Department → Kerala Water Authority → Kerala State Biodiversity Board → Department of Tourism → Department of Fisheries → Department of Soil Survey and Soil Conservation → Grama Panchayats → Centre for Water Resources Development and Management → Wetlands International South Asia
HIGH	→ Kerala Land Development Corporation → National Centre for Earth Sciences Studies	→ District Disaster Management Authorities → Fishing Cooperative Society → Kerala State Council for Science, Technology and Environment → Kerala University of Fisheries and Ocean Studies → Kerala Hydrographic Survey Wing	→ Biodiversity Management Committees → Sasthamkotta Lake Protection Council → Kerala Sastra Sahitya Parishad
LOW	→ Kollam Municipal Corporation		→ Local Communities → Fisher Communities → Farmers
	IMPACT		

Low Priority Stakeholder **High Priority Stakeholder** **Medium Priority Stakeholder**

Evaluation of Existing Institutional Arrangements

The institutional regimes and governance arrangements discussed above must be sufficient to address the risk of adverse change in wetland ecological character. An evaluation of existing institutional arrangements is discussed in this section:

Table 4.2 | Evaluation of existing evaluation framework

Enabling institutional conditions and implications for wetland management	Status of current institutional arrangements	Key gaps
Define user and resource boundaries		
The presence of well-defined boundaries around Sasthamkotta Lake is required to ensure that management zones and actions are defined in spatial terms and linked with user access rights, adverse land and water use change is prevented, and communities have incentives for protecting the wetland.	The boundaries of Sasthamkotta Lake are delineated on a map. 387 boundary pillars have been established on-ground at a distance of 50 m from the peak inundation area in 2007. The rights of the delineated area are vested with the Government; however, the revenue records indicate the presence of private rights in some parts of the wetland. Land within the direct drainage basin is under private ownership.	Ground demarcation of wetland boundary demarcated based on the Wetlands (Conservation and Management) Rules, 2017 is not yet done.
Congruence		
Rules for the management of Sasthamkotta Lake conform to the functioning of biophysical and social systems. The rules also balance the cost of enforcement of management with the benefit derived from wetland ecosystem services and biodiversity.	Wetlands (Conservation and Management) Rules, 2017 sets the overarching regulation and management framework for the Wetlands of International Importance under the Ramsar Convention and specifies restricted, permitted and regulated activities within the wetland. A zone of influence has been delineated, and a listing of regulated activities has been undertaken and included in the brief document of the Ramsar Site.	While the regulatory regimes are specified, the rules for the management of Sasthamkotta Lake are very weakly articulated and not well communicated to all stakeholders. There is an absence of wetland-specific mechanisms, such as the Sasthamkotta Wetland Management Unit (SWMU), to ensure that the management of developmental activities in the catchment is aligned with ecosystem functioning.
Conflict resolution mechanism		
Low cost and effective conflict resolution mechanisms are available to support wetland management implementation.	Conflict resolution mechanisms are specified under Wetlands (Conservation and Management) Rules, 2017	The implementation of conflict resolution mechanisms is not efficient. WIAMS platform is used as a monitoring and regulatory tool to implement the existing approved Management Action Plan. WMU of Sasthamkotta Lake can ensure the conflict resolution and coordination of all stakeholders/actors

Enabling institutional conditions and implications for wetland management	Status of current institutional arrangements	Key gaps
Minimal recognition of Community participation		
The participation of communitiesin defining management objectives for Sasthamkotta Lake is not counter to existing government rules and regulations.	Communities enjoy traditional rights and privileges to access wetland resources.	Checks and balances are to be placed to regulate community rights and privileges in accessing wetland resources subject to the threshold levels, ensure equitable sharing of benefits, and maintain wetland ecological character.
Institutional arrangements for the management of Sasthamkotta Lake are linked with wider developmental planning within the river basin	The State Wetland Authority is entrusted with cross-sectoral coordination at the State and District levels.	Sasthamkotta Lake is not comprehensively reflected in sectoral plans, programmes and investments.

4.4 PROPOSED INSTITUTIONAL FRAMEWORK FOR MANAGING SASTHAMKOTTA LAKE

Mission Sahbhagita, launched in 2022 to commemorate 75 years of independence, is a Government of India initiative for the conservation and wise use of wetlands of national and international importance. The Mission prescribes a multi-tier institutional arrangement for the management of wetlands that is relevant and can be suitably adopted in the given context. In accordance with the Mission guidelines, the following institutional arrangement is proposed for the management of Sasthamkotta Lake:

At site level: There should be a Sasthamkotta Wetland Management Unit (SWMU) headed by the Wetland Prabhari/Ramsar Site Manager assisted by key technical officers and a network of Wetland Mitra coordinating site management, local governments, line government departments and agencies, knowledge partners, civil society organisations and corporate sector.

At District level: The District Wetland Committee ensures convergence with district-level conservation and development plans and programmes, such as that of the Department of Forest and Wildlife, Department of Tourism, and Department of Fisheries, among others.

At State level: The State Wetland Authority Kerala reviews and approves site management plans and provides access to funds for implementing management from central and state-level public sector schemes and corporate sector partnerships. SWAK also helps build convergence with plans, programmes, and investments of relevant line Ministries. Additionally, the organisations such as Wetlands International South Asia, and CWRDM will be engaged for strengthening the knowledge base as well as building capacities of the stakeholders at all levels.

Roles and Responsibilities

Sasthamkotta Wetland Management Unit & Wetland Prabhari/Ramsar Site Manager

The SWMU and the Wetland Prabhari/Ramsar Site Manager may be responsible for the implementation of the Integrated Management Plan of the wetland with the following key activities:

- Install signages displaying information on the wetland site's uniqueness, conservation significance, cultural significance and management arrangements
- Nurture a network of 'Wetland Mitra' for stakeholder engagement in wetland management actions
- Coordinate the development of an action plan for conservation and sustainable management
- Identify 'cultural icon(s)' and run community campaigns relating the icon to wetlands conservation and sustainable management
- Organise events linked to local legends/ cultural values of the wetland
- Design and implement citizen science programmes such as the Asian Waterbird Census, to engage citizens in wetlands monitoring and management
- Coordinate targeted stakeholder education, awareness and behaviour change campaigns to incentivise affirmative actions for wetlands conservation and sustainable management through existing or refurbished Wetland/Ramsar Interpretation Centre (RIC)
- Commission baseline wetland inventories through the support of knowledge partners, R&D or academic institutions, corporate and civil society partners
- Connect with Local Self Governments in the vicinity; connect with local schools and teachers for awareness-raising among children and youth
- Coordinate implementation of the wetland action plan through funds from ongoing development plans and programmes, including through engagement with corporates
- Coordinate periodic wetlands monitoring and management effectiveness review to assess whether mid-course correction in wetland management plan implementation is required.

The Wetland Management Unit (WMU) is proposed to have the following divisions and staff structure (Table 4.3):

Table 4.3 | Divisions and staff structure of Sasthamkotta Wetland Management Unit (SWMU)

Division	Role and responsibilities	Staffing
Research, Monitoring and Evaluation	→ Conduct wetland monitoring as per the approved monitoring plan → Publish periodic monitoring reports/ wetland health cards → Coordinate implementation of specific research studies to address knowledge gaps	→ Wetland Specialist/Ecologist – 1 → Hydrologist – 1 → RS-GIS Specialist – 1 → Social Scientist – 1
Participation and Networking	→ Engage with stakeholders to assess their views, rights, and capacities for wetland management → Develop networks with local, national and international organisations to support wetland management → Monitor partnerships in terms of their contribution to the overall objectives of wetlands management	→ Networking Officer – 1
Communication and Outreach	→ Design and implement the communication, education, participation and awareness plan for the conservation and wise use of Sasthamkotta Lake → Conduct capacity development programmes for various line departments, and stakeholders for integrated management of Sasthamkotta Lake	→ Communications Officer – 1 → Capacity Development Officer – 1
Legal and Regulation	→ Monitor implementation of extant wetland regulatory regimes → Ensure enforcement of extant regulatory regimes through the concerned authority or nodal government department → Collect public grievances related to the management of Sasthamkotta Lake and bring them to the notice of the concerned administrative authority	→ Legal & Public Grievance Officer – 1
General administration	→ Provide direction for the wise use and conservation of Sasthamkotta Lake as per the provision of the approved management plan → Facilitate management and business operations of the organisation → Providing development review, control, and approval functions → Handling the accounts for the WMU	→ Administrative Officer – 1 → Accounts Officer – 1

District Wetland Committees

District Wetland Committee, headed by the District Magistrate, Kollam, with District Environmental Engineer/ Environmental Scientist as member secretary and administrative functionaries like the Municipal Commissioner; Additional District Officer (Revenue branch), District/ Divisional Forest Officer; District Agriculture Officer; District Panchayati Raj Officer; District Planning Officer; Executive Engineer (Micro Water resources); Executive Engineer (Water Resources); District Fisheries Officer; Kerala State Pollution Control Board, Kollam; Deputy Collector (District Land acquisition branch) and one nominated wetland expert as members is to be constituted.

The major responsibilities of the Kollam District Wetland Committee are as follows:

- Ensuring compliance with Wetlands (Conservation and Management) Rules, 2017 and report to WMU and State Wetland Authority
- Formulation of an Integrated Management Plan for conservation and wise use of Sasthamkotta Lake
- Review wetland management plans in consultation with all relevant departments and sectors
- Facilitate integration of wetland management actions within district-level environment plans, disaster risk reduction plans, district development plans and others
- Build convergence of wetland management plan with district-level development plans
- Constitution of Wetland Mitra Network in consultation with Wetland Prabhari/Ramsar Site Manager & SWMU
- Periodic review of the integrated management plan implementation and monitoring outcomes
- Coordinate implementation of the integrated management plan components aimed at:
    - restoration of hydrological regimes, including improvement of water quality
    - control of silt loading from catchments
    - management of plant and animal invasive species
    - ecological maintenance and habitat improvement
    - sustainable development of capture and culture fisheries
    - improving livelihoods and quality of life of wetland-dependent communities
    - community-managed eco-tourism development
- Work towards resolution of stakeholder conflicts

- Facilitate monitoring activities that are prohibited or regulated as per Wetlands (Conservation and Management) Rules, 2017
- Approach State Wetland Authority Kerala for enactment of any regulation that is pivotal for ensuring the conservation and sustainable management of Sasthamkotta Lake
- Preparation/revision of Brief documents
- Facilitating Capacity building, Communication, Education and Outreach programs

The State Wetland Authority Kerala

The State Wetland Authorities Kerala will have the following key roles:

- Mapping of wetland site with the WMU, District Wetland Committee, Knowledge Partners, Corporate Sector and CSO Partners.
- Establish the Sasthamkotta Wetland Management Unit and designate a Wetland Prabhari/Ramsar Site Manager with a mandate to deliver roles and responsibilities as prescribed.
- Review and approve the Integrated Management Plan for Sasthamkotta Lake.
- Ensure access to funds for implementing management plan actions by building convergence with conservation and development sector schemes.
- Provide a platform for business engagement in wetlands management.
- Review wetlands monitoring information and undertake mid-term course correction as may be required.
- Enforce regulations for the maintenance of the ecological character of the Sasthamkotta Lake.
- Notify wetland sites under Wetlands (Conservation and Management) Rules, 2017 and other extant regulations.

05

Management Framework

Management of Sasthamkotta Lake needs to be based on recognition of the full range of ecosystem services and biodiversity values of the wetland and their mainstreaming into management plans at all levels. The effectiveness of management will be reflected in the ability to sustain multiple uses of the wetland based on the hydrological regime and the key ecological and social processes that underpin the functioning of the Ramsar Site.

The evaluation of wetland features, as summarised in Chapters 2 and 3 of the management plan and the institutional arrangements in Chapter 4, indicates that the current management arrangements are focused on regulation and select provisioning ecosystem services of the wetland. Most wetland features have been oriented to support production systems in and around the wetland.

The current chapter sets out the management planning framework, including setting the management goal and purpose, objectives, targets and indicators, and likely risks and risk mitigation options for implementing the management plan.

5.1 GOAL AND PURPOSE

The goal of the integrated management of Sasthamkotta Lake is to secure the conservation and wise use of the Ramsar Site.

The purpose of management is to:

- preserve cultural, recreational, aesthetic, and educational values
- provide a reliable water source to Kollam City
- provide a buffer against water-mediated risks to adjoining communities
- secure habitat for wetland-dependent species

5.2 STRATEGY

Putting in place an institutional setup for integrated management

Integrating the management of Sasthamkotta Lake requires a dedicated institution to coordinate the implementation of sectoral action plans, maintain an overview of wetland status and trends, promote stakeholder engagement, and represent concerns related to the wetland in sectoral planning. It is envisaged to constitute a Wetland

Management Unit (WMU) under the provisions of the Wetlands (Conservation & Management) Rules, 2017, its implementation guidelines of 2020 and under the purview of State Wetland Authority Kerala for integrated management of Sasthamkotta. An important task of the WMU will be to ensure the mainstreaming of the full range of ecosystem services and biodiversity values of Sasthamkotta within the sectoral planning for agriculture, fisheries, rural development, tourism, forestry wildlife and others.

Stakeholder-led management

In line with the wise use philosophy, implementing the management plan is envisaged to be stakeholder-led. Proactive measures would be taken to seek community consent and endorsement for specific actions involving communities in implementation and post-intervention monitoring. The Local Self Governments would be the key institutions driving wetland management.

Harmonising water abstraction with ecological condition

Hydrological assessments underline the need to link any water abstraction with the ecological condition of Sasthamkotta Lake, particularly, the stability of its hydrological regimes. It is, therefore, proposed to link water abstraction from Sasthamkotta to the quantum of rainfall received. The management plan also includes a proposal for an alternate water supply to Kollam City, as a reduction in water off-take in Sasthamkotta will result in reduced water availability to the city.

Enforcing regulation

The Wetlands (Conservation and Management) Rules, 2017, provide the necessary regulatory framework for the management of Sasthamkotta as it is designated as a Ramsar Site. The Rules require clear demarcation of wetland boundary and its zone of influence and prohibiting a number of detrimental activities, including reclamation, discharge of untreated wastes and effluents, solid waste dumping, construction of permanent nature and any activity likely to have an adverse impact on the ecosystem. The 2010 Notification of Kerala State Pollution Control Board prohibits a range of polluting activities within 500 m periphery of the lake and agriculture activities within 100 m periphery of the Ramsar Site. Mining of sand from the alluvial plains of the River Kallada has also been banned by the State Government. The management plan envisages enforcement of the aforementioned regulations by the identified agencies to maintain and improve the ecological health of Sasthamkotta. The WMU and SWAK shall coordinate the corresponding regulatory enforcement agencies. Notably, controlling

pollution is urgently required to slow down the transition of Sasthamkotta Lake towards a marsh-dominated stage.

Integrating Sasthamkotta Lake in Kallada River Basin management

The ecosystem services of Sasthamkotta have a critical role in the functioning of River Kallada. Conversely, land and water-related human activities within River Kallada Basin can have a significant influence on the ecological character of Sasthamkotta and associated wetlands. It is of utmost importance to recognise the value of Sasthamkotta within the management of river basin and integrate these into water sector planning.

Multiple values of nature and nature's contribution to people

The implementation of a management plan will consider the diverse ways in which nature and nature's contribution to people support well-being. These will include intrinsic values (the values of Sasthamkotta as an ecosystem with its complex ecological functions), instrumental values (the value of Sasthamkotta towards meeting food security, water quality regulation and climate moderation), and relational values (the values linked with a sense of place and cultural identity which communities attribute to Sasthamkotta). The management plan will be built on the full range of values to bring in multiple perspectives in decision-making and implementation of programmes.

Management zoning for multiple ecosystem services and biodiversity values

The multiplicity of land uses co-existing with high biological diversity and interlinkages with fluvial processes calls for adopting a management zoning approach for the floodplain wetland complex basin. Ramsar boundary can be treated as core zone boundary, wherein the emphasis should be on the maintenance of ecological character by prioritising the maintenance of waterbird habitats, capture fisheries and abating proliferation of invasives. The buffer, which includes areas under permanent agriculture, can be managed as sustainable production systems, ensuring that production processes do not directly impact ecosystem components and processes (e.g., through discharge of nutrient-rich flows, impeding hydrological regimes). A set of activities contributing to the risk of adverse change can be regulated. In the entire basin, land and water use needs to be influenced to ensure that wetlands retain hydrological connectivity with the river and surface-groundwater interactions are in balance (for example, by limiting extraction of groundwater beyond the level wherein changes in net recharge in Sasthamkotta Lake takes place).

Adaptive management

Given the range of drivers and pressures that act on Sasthamkotta at multiple spatial, temporal, and political scales, its management planning needs to be prepared for and accommodate uncertainties and challenges. This is envisaged to be achieved by using an adaptive management strategy allowing for suitable modification of management based on continuous site monitoring and assessment of new information. Since the ability of the plan to meet all the site management objectives is influenced by the availability of information as well as resources, management is considered as a process, with planning gradually getting complex from a minimal version to one meeting all site management requirements as resources and information become available. However, the lack of full scientific uncertainty should not be used as a reason to postpone measures to prevent ecological degradation.

Adaptive management will be enabled in the management of the Sasthamkotta Lake wetland by a combination of processes, such as:

- Structured decision-making to clarify management goals, objectives, and actions, involving stakeholders
- Investing in monitoring and learning for management. Each management intervention, in reality, is an experiment based on a working hypothesis of ecosystem functioning. Monitoring enables the assessment of whether the hypothesis works in reality
- Investing in cross-scale communication. Understanding change at multiple scales may help better understand ecosystem functioning and variability
- Adaptive governance, based on collaborative and participatory management, has the flexibility of sharing management responsibilities

Successful adaptive governance has required leadership with a vision, systematic monitoring, and complementary legislation framework, allowing for adaptive management, information flow amongst stakeholders, and clear opportunities for stakeholders to collaborate.

Having a system to detect such changes, in particular, human-induced adverse changes in ecological character is critical for the success of management. Equally important is the need to periodically assess the effectiveness of management in terms of the ability to achieve wise use with broad stakeholder participation. The already existing Integrated Wetland Inventory, Assessment and Monitoring System (WIAMS) is proposed to be continued in place to address the diverse information needs for managing Sasthamkotta and undertake mid-course correction. A research strategy to address the

gaps in the existing knowledge base and assess future risks will form an integral part of the system. It is proposed that CWRDM be mandated to manage the monitoring system by systematic reporting to the Sasthamkotta Wetland Management Unit and the State Wetland Authority Kerala.

5.3 MANAGEMENT OBJECTIVES

The management objectives have been framed to address the threats identified through the evaluation of the ecological character of Sasthamkotta Lake and aim towards its conservation and wise use.

The management strategies have been translated into eight objectives that reflect the desired state of the key features of wetlands. For each objective, the performance indicators are the attributes which can indicate change. The strategies reflect the target the management plan envisages achieving within five years, thus providing a monitoring framework to assess effectiveness.

Management planning for Sasthamkotta Lake is proposed to be structured around the five components: a) Physical Regime, b) Hydrology, c) Species and Habitat, d) Ecosystem Services, and e) Institution and Governance.

Table 5.1 | Management objectives, strategies and performance indicator

Objective	Performance Indicator	Outcomes
1. Naturalness of the Ramsar Site is maintained in line with extant regulation	Land use and land cover	No conversion of wetland area to non-wetland use as compared with Ramsar Designation date baseline
	Land use and land cover change	Restrict adverse change in LULC within the watershed to 1% as compared with the current land use land cover
	Number of violations of extant regulatory regimes such as Wetlands (Conservation and Management) Rules, 2017	No instances of violations of extant regulatory regimes
2. Storage capacity, surface and sub-surface water level are maintained within the permissible limit	Water quality of the Ramsar Site	Desired levels are maintained as per Thresholds/Standards
	Water level of the Ramsar Site	Water abstraction is optimised in line with requirements for maintenance of the Ramsar Site health
	Sediment load	Sediment load in the wetland is reduced by 50% of the current sediment load

Objective	Performance Indicator	Outcomes
3. Diversity of species and their habitat is maintained and enhanced	Population of native and migrant bird species	Maintain population of bird species to the average of last five years
	Fish diversity and richness	Maintain fish diversity to the average of last five years
	Key habitat areas	Habitat quality and extent is maintained to the Ramsar Site designation baseline
	Occurrence of invasive species in the Ramsar Site	No new establishment of invasive macrophyte colonies as against Ramsar Site designation baseline
4. Livelihood vulnerability of wetland-dependent communities is reduced	Proportion of income derived from Ramsar Site	Additional livelihood opportunities from environment friendly sources are increased
5. Nature tourism is developed to showcase the biodiversity, ecosystem services and cultural values of the Ramsar Site	Number of nature-tourists	Nature tourism is within the carrying capacity of wetland and maintains the naturalness of the site
	Local livelihood opportunities	Primary stakeholders gain additional income through engagement in nature tourism and allied activities
6. Individual and collective capacity and opportunities for stakeholders to participate in wetland management and contribute to wetlands wise use are enhanced	Participation of wetland communities and community-based institutions in wetland management	Community views, rights and capacities are integrated in management plan integration and monitoring
	Evidences of affirmative behaviour change within communities living in and around Sasthamkotta Lake supporting wetlands wise use	Local action for preventing adverse land use change, encroachment, pollution abatement and over-harvesting of biological resources
7. Systematic wetlands inventory, assessment and monitoring system is used to inform management decisions and assess effectiveness	Availability of time-series data on wetland ecological character	Time series data on wetlands features is accessible on SWAK WIAMS web portal
	Availability of data on threats leading to adverse change in ecological character	Data on trend in threats is accessible on SWAK WIAMS web portal
	Evidences of use of data generated from WIAMS in decision-making	Monitoring data is systematically analysed and presented in SWAK meetings and made available to decision makers and stakeholders

Objective	Performance Indicator	Outcomes
8. Integration of multiple values of wetlands in sectoral development plans, programmes and investments is enhanced	Number of sectoral plans, programmes and investments (which influence Sasthamkotta Lake) which take into account wetland values and ecosystem services	SWAK meets periodically to review sectoral plans, programmes and investments in terms of their implications for Sasthamkotta services and communicates to the respective departments
	Reduction in number of sectoral plans, programmes and investments which adversely impact Sasthamkotta Lake's ecological health	SWAK establishes sectoral convergence benefitting Sasthamkotta Lake's ecosystem

5.4 RISKS AND RISK MITIGATION OPTIONS

The management plan design is based on certain assumptions. The table below identifies the risks of these assumptions impacting management plan implementation adversely, and possible risk management measures.

Table 5.2 | Risks and risk mitigation measures

Risks	Risk management measures
At goal level	
Local communities do not engage in the conservation and management of Sasthamkotta Lake	A Community Advisory Group will be constituted to advise on management plan implementation and disseminate information within communities.
At objective level	
Trained human resources are not available for management of Sasthamkotta Lake	SWAK and the Sasthamkotta WMU staff will be imparted training on various aspects of wetlands management, and hand-holding support provided.
Communities are not sufficiently organised to engage in and take ownership of the project activities	The Community Advisory Group will be used as a mechanism to support and strengthen community networks.
A long-term financial framework is not established for maintaining the expanded SWAK programme	Funding from various convergence sources will be leveraged, including from private sector organisations and by instituting user fees or usage charges.
At output level	
Qualified trainers and experts are not available	A roster of experts and trainers will be prepared for supporting capacity development including experts from the official Knowledge Partners.
Strategies do not offer flexibility for adaptation	The SWMU and SWAK will present progress of management plan implementation in the meetings. Data from monitoring will also be analysed to assess effectiveness of interventions.

06

Monitoring Plan

The management of Sasthamkotta Lake aims at maintaining the Ramsar Site's ecological character and retaining those essential ecological and hydrological functions that underpin the provision of the full range of ecosystem services and provide habitats to diverse life forms. Having a system to describe, monitor and detect changes in ecological character is critical to support the management of Sasthamkotta Lake.

The present system for monitoring Sasthamkotta Lake is highly fragmented and disjointed. A few agencies (for example, the Department of Water Resources, Central Water Commission, Central Ground Water Board, State Pollution Control Board, Zoological Survey of India, and others) collect information on specific parameters of interest. The KWA records the lake levels through its manual gauge at the pump house. Selected water quality parameters are recorded monthly by the Kerala State Pollution Control Board. In contrast, the Groundwater Department maintains the status of borewells around the region as a part of the larger pan-India groundwater monitoring network. Information on changes in the status of catchments and pressures as mining and pollution are largely derived from assessments done by agencies such as NCESS. As most of these studies do not form part of a systematic monitoring framework design, there is a high risk of adverse trends being undetected for long periods of time and not leading to any management intervention. There is no systematic collection of data on various wetland features limiting the possibility of objectively defining the status and trends of various wetland features and identification of related drivers and pressures. This chapter describes monitoring objectives, strategy, parameters and indicators, and infrastructure and human resources requirements.

The monitoring framework for Sasthamkotta Lake is built around the Ramsar Framework for Integrated Wetland Inventory, Assessment and Monitoring (Ramsar Convention Secretariat, 2010c). The cost implications of the monitoring plan are factored in Chapter 7 (Action Plan) and Chapter 8 (Budget and Financing).

6.1 MONITORING OBJECTIVES

Developing a monitoring plan for Sasthamkotta Lake requires addressing the inter-related requirements of wetland inventory (the collection and collation of core information for wetland management) and wetland assessment (identification of status and threats to wetlands as a basis

for collection of more specific information). Therefore, the imperative is to put in place an integrated Wetland Inventory, Assessment and Monitoring System (WIAMS) to address the overall information needs of wetland management and to provide a robust decision support system. The specific objectives for establishing WIAMS include:

- Establishing the ecological character baseline (inventory) to measure change
- Establish status, trends and threats to wetland using inventory information (assessment)
- Assess changes in status and trends, including a reduction in existing threats or appearance of new threats, or even changes in management effectiveness (monitoring)
- Identifying risks to the ecological character and supporting the development of response strategies
- Informing decision-makers and stakeholders on the status and trends in biodiversity, ecological functioning, and ecosystem services
- Supporting compliance with the extant regulatory framework
- Assessing wetland management effectiveness

6.2 MONITORING STRATEGY

The information needs for managing Sasthamkotta pertains to:

→ inventory — to establish the ecological character baseline;

→ assessment — to verify status, trends, and threats to wetland using inventory information;

→ monitoring — to assess changes in status and trends, including a reduction in existing threats or appearance of new threats, or even differences in management effectiveness.

As this information pertains to various spatial scales, the overall information requirements can be classified following a hierarchy in line with the three identified information levels:

- Level I: Sasthamkotta Ramsar Site
- Level II: Direct catchment of Sasthamkotta Lake (which is also the zone of direct influence)
- Level III: Kallada River Basin

A hierarchical classification of inventory, assessment, and monitoring needs for managing Sasthamkotta is presented in Table 6.1. Specific parameters, indicators, and monitoring methods, and frequency are in Table 6.2. The information needed for inventory is derived from the core datasets required to establish a baseline on ecological character for

Sasthamkotta Lake, containing all essential ecosystem components processes, and services, as well as management-related parameters that characterise the site. At the basin scale, the information requirement is related to geomorphological and climatological setup, as well as basin wide management arrangements, particularly those related to land and water resources. As the direct catchment is the zone of direct influence on the lake, information needs to include land and water management practices which have a direct influence on the wetland status, including assessing the habitat connectivity and water, sediment, energy and nutrient flux which influence its ecological character. Finally, at the site scale, the information requirements pertain to important ecosystem components, processes and services which are applicable to the site condition. At all levels, information on institutional arrangements and management practices is included so as to enable creation of a baseline on sectoral programmes, and the linked stakeholders, which are likely or have an impact on the wetland state.

Information needs related to assessment are aimed at deriving the status, trends and existing or likely threats to wetland. At the site scale, the focus is on deriving ecological character change and ecosystem services valuations and trade-offs. At the drainage basin scale, the focus is on deriving the land use change and implications for water, sediment and nutrient flux. At the Kallada River Basin scale, the assessments are aimed at determining the climate induced risks to ecological character, ultimately aimed at developing a suitable response strategy for risk reduction and management. While not explicitly mentioned, strategic environmental assessments can be commissioned for any developmental project that has or likely to have negative impact on the wetlands.

Information needs for monitoring Sasthamkotta Ramsar Site have been derived from assessment of ecological character carried out for development of the management plan. Four clusters of needs have been identified: a) land use and land cover change, to assess the dynamics of land use within the drainage basin; b) hydrological regimes, to assess the flux of water, sediments and nutrients; c) ecological components and processes, to assess the biodiversity, habitat quality and resource productivity; and d) socio-economics and livelihoods, to assess the trends in ecosystem services–livelihoods interlinkages.

Inventory, assessment, and monitoring would form an integral part of wetland management and, thereby, the core activity of the Government department entrusted with site management (SWMU & Wetland Prabhari). The management plan proposes the establishment of a Sasthamkotta Wetland Management Unit under the aegis of the State Wetland Authority Kerala. Monitoring functions can be delivered by the

Centre for Water Resources Development and Management (CWRDM), which has existing human and technical resources and expertise to manage such a function. The management plan proposes establishing a dedicated wetland monitoring unit in the WMU with adequate infrastructure and human power support to deliver this function effectively.

Linkages also need to be developed so that data from the existing monitoring networks of different agencies (for example, inundation and flooding information from Central Water Commission and Irrigation Department; groundwater quality and quantity from Central Ground Water Board; select surface water quality parameters from Kerala State Pollution Control Board) can be accessed and shared. Similarly, provision for participation of Wetland Mitra (NGOs and civil society organisations) in a monitoring programme has also been built, especially for socioeconomics and livelihoods aspects and biodiversity monitoring (for example, the waterbird census being implemented by Kerala Agricultural University and NGOs under the aegis of Asian Waterbird Census). Thematic management needs-based research can be taken up by specialised agencies such as CIFRI, ZSI, BSI, and other research institutions to complement the monitoring programme.

Table 6.1 | Information needs for the Integrated Wetland Inventory, Assessment and Monitoring System for Sasthamkotta Lake

Information Level	Wetlands Inventory	Wetlands Assessment	Wetlands Monitoring
Sasthamkotta Lake	→ Physical setting (area, boundary, topography, shape, habitat type and connectivity, climate) → Water regime (inflow, outflow, balance, surface-groundwater interactions, inundation regimes, quality) → Sediment regime (inflow, outflow, balance, distribution and transport) → Wetland soils (texture, chemical and biological properties) → Biota (plant and animal communities, conservation status) → Energy and nutrient dynamics (primary productivity, nutrient cycling) → Species interaction (invasion, competition, succession) → Processes that maintain animal and plant population (recruitment, migration)	→ Ecological character change (change in ecosystem components, processes and services — can also be derived based on assessment of indicators related to ecosystems, habitat, species and/or management) → Land use land cover change in lake fringes	→ Climate risks → Impacts of land use land cover change in lake fringes on water quality → Changes in inundation patterns and impacts on vegetation

Information Level	Wetlands Inventory	Wetlands Assessment	Wetlands Monitoring
	→ Ecosystem services, stakeholders and trade-offs (Provisioning: water abstraction for various uses, fisheries, inland navigation; Regulating: flood moderation; Cultural: tourism and recreational values) → Institutional arrangements (governance, formal and informal rights and ownership, application of acts and regulations)		
Direct catchment of Sasthamkotta Lake	→ Wetland area → Species exchange → Resource harvest levels → Climate (precipitation, temperature, wind, humidity, evaporation) → Land use, land cover and management practices → Physical setting (area, boundary, connectivity) → Water regime (riverine flows, surface-groundwater interactions, inundation regimes, quality, regulation, abstraction) → Sediment regime (inflow, outflow, balance, distribution and transport) → Sectoral programmes and institutional arrangements for management of land and water resources and biodiversity conservation	→ Trends in land use and land cover → Trends in surface water connectivity → Trends in groundwater level → Trends in resource harvest levels → Ecological character risk and vulnerability (limits of acceptable change for critical ecosystem components, processes and services; sensitivity and adaptive capacity of critical components; risks of adverse change in ecological character)	→ Land use and land cover change and impacts on lake hydrodynamics (water availability and allocation for various human uses) → Impact of mining on stability of inundation regimes
Kallada River Basin	→ Wetland soils → Species and Habitat → Socioeconomic and livelihoods → Ecosystem Services → Geology and Geomorphology (soils, elevation, slope, drainage pattern) → Climate (precipitation, Temperature) → Land use and land cover → Water regimes (river flows, upstream abstraction)	→ Trends in ecological character → Trends in regulatory regime → Climate risk and vulnerability (changes in river flows, vegetation changes and implications for the wetland)	→ Land use and land cover with respect to Ramsar Site designation baseline → Ecological character with respect to Ramsar Site designation → Ramsar Site designation criteria fulfilment → Management effectiveness → Individual and collective behaviour → River basin management planning → (water regulating structures and water allocation/discharge plans along the river basin)

Table 6.2 | Monitoring and assessment parameters and indicators

Parameter	Indicator	Priority	Monitoring Scale	Monitoring Method	Monitoring Frequency
Land use and land cover change	% Area under various land use and land cover classes (agriculture, forest cover, marshes, settlements, open water and silt)	High	Sasthamkotta Ramsar Site	GIS and Remote Sensing	Annual
		High	Sasthamkotta Direct Catchment	GIS and Remote Sensing	Once in 3 years
		High	Kallada River Basin	GIS and Remote Sensing	Once in 5 years
Rainfall	Quantum in mm	High	Kallada River Basin	Weather stations	Daily
Temperature	Changes in minimum, maximum and average temperature	High	Kallada River Basin	Weather stations	Daily
Evapotranspiration	Actual evapotranspiration	High	Kallada River Basin	Weather stations	Daily
Wind	Wind velocity	High	Kallada River Basin	Weather stations	Daily
Air quality	Suspended Particulate Matter (PM 2.5, PM 10)	High	Sasthamkotta Ramsar Site	Standard procedures laid by CPCB for air quality monitoring	Daily
	Temperature and Relative Humidity	High	Kallada River Basin	Weather stations	Daily
Water and sediment flux	Water inflow	High	Sasthamkotta Ramsar Site	Flow meters at gauging stations	Daily
	Water outflow	High			Daily
Water and sediment flux	Sediment inflow	High	Sasthamkotta Ramsar Site	Sediment staff gauge at gauging stations	Monthly
	Sediment outflow	High			Monthly
Water holding capacity	Bathymetry	High	Sasthamkotta Ramsar Site	Bathymetric surveys	Once in 5 years
Hydrological connectivity	Shrinkage rate of wetland shoreline	High	Sasthamkotta Direct Catchment	Remote sensing supported with ground check	Annual
	Siltation rate	High			Annual
Inundation Regime	Seasonal fluctuation in water spread area	High	Kallada River Basin	Remote sensing supported with ground check	Seasonal (Pre-Monsoon, Monsoon, Post-monsoon)

Parameter	Indicator	Priority	Monitoring Scale	Monitoring Method	Monitoring Frequency
Surface water quality	Temperature	Medium	Sasthamkotta Ramsar Site	Standard procedures of APHA	Once in 15 days
	pH	High			Once in 15 days
	Dissolved Oxygen	High			Once in 15 days
	Specific Conductivity	High			Once in 15 days
	Nutrients and Nutrient Cycling (Nitrate, Phosphate, Silicate)	High			Once in 15 days
	Cations and Anions (Calcium, Magnesium, Sulphate, Chloride, Fluoride, Sulphite)	High			Once in 15 days
	Chemical Oxygen Demand	Low			Once in 15 days
	Transparency	Medium			Once in 15 days
	Heavy metals (Arsenic, Mercury)	Low			Once in 15 days
	Biological Oxygen Demand	Medium			Once in 15 days
	Total Coliform	Medium			Once in 15 days
	Faecal Coliform	Medium			Once in 15 days
	Microplastics	High			Annual
Sediment Quality	Texture	Low	Sasthamkotta Ramsar Site	Standard procedures of APHA	Once in a month
	pH	High			Once in a month
	Organic carbon	High			Once in a month
	Available nitrogen	High			Once in a month
	Available phosphorus	High			Once in a month
	Available calcium carbonate	Medium	Sasthamkotta Ramsar Site	Standard procedures of APHA	Once in a month
	Heavy metals (Arsenic, Mercury, Cadmium, Chromium, Lead)	High			Once in 6 months

Parameter	Indicator	Priority	Monitoring Scale	Monitoring Method	Monitoring Frequency
Ground water Quality	Water level	High	Sasthamkotta Direct Catchment	Methodology approved by Groundwater Estimation Committee (1997)	Seasonal (Pre-Monsoon, Monsoon, Post-monsoon)
	Conductivity	Medium			Conductivity
	Total hardness	Medium			Total hardness
	Chloride	Medium			Chloride
	Fluoride	High			Fluoride
	Arsenic	Medium			Arsenic
	Iron	High			Iron
Water abstraction	Water abstracted for irrigation	Medium	Sasthamkotta Ramsar Site	Survey, Measurements from KWA	Annual
	Water abstracted for domestic use and drinking water	High			
	No. of hydrological structures	High	Sasthamkotta Direct Catchment	Survey	Once in 5 years
Flora	Phytoplankton (diversity and abundance)	Medium	Sasthamkotta Ramsar Site	Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal (Pre-Monsoon, Post-monsoon)
	Periphyton	Medium			Seasonal (Pre-Monsoon, Post-monsoon)
	Macrophytes (diversity and abundance)	High			Seasonal (Pre-Monsoon, Post-monsoon)
	Species invasion	High	Sasthamkotta Ramsar Site	Habitat Sampling and Remote sensing (using high resolution data)	Seasonal (Pre-Monsoon, Post-monsoon)
	Primary production	High		Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal

Parameter	Indicator	Priority	Monitoring Scale	Monitoring Method	Monitoring Frequency
Fauna	Zooplankton (diversity and abundance)	Medium	Sasthamkotta Ramsar Site	Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal (Pre-Monsoon, Post-monsoon)
	Aquatic macro-invertebrates	Medium		Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Once in 5 years
	Aquatic Insects	Medium		Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Once in 5 years
	Fish diversity	Medium		Taxonomic studies	Once in 5 years
	Amphibians	Medium		Taxonomic studies	Once in 5 years
	Reptiles	Medium		Taxonomic studies	Once in 5 years
	Fish breeding, spawning and migration pattern	High		Specific assessments and tagging experiments	Once in 5 years
	Fish catch and effort (number of harvest cycles, catch)	High		Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Monthly
	Bioaccumulation in fish	High		Environmental monitoring protocols of ICAR - CIFRI	Annual
	Water Bird population and diversity	High	Sasthamkotta Direct Catchment	Census and Taxonomic studies	Annual
	Waterbird migration pattern	High		Specific assessments and tagging experiments	Once in 5 years

Parameter	Indicator	Priority	Monitoring Scale	Monitoring Method	Monitoring Frequency
Fauna	Avian disease	Medium	Sasthamkotta Direct Catchment	Surveillance	Annual
	Habitat quality of bird congregation sites: - Number of nests or egg - Type of vegetation - Water level - Abundance of macro benthos	Medium		Assessment of bird habitat quality and Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10 (for macro benthos)	Annual
Community dependence on wetland ecosystem services	Water abstracted from hydrological structures	High	Sasthamkotta Ramsar Site	Socioeconomic survey	Quarterly
	Fish catch	High			Monthly
	Performance of fish collection cooperatives (Capitalization, infrastructure, catch processed, membership)	High			Annual
	% Contribution of fisheries to income and employment	High			Annual
	Number of households benefitting from the water withdrawn from lake	High			Once in 5 years
	Number of tourists visiting wetland and direct and indirect spending	High			Annual
	Number of boat trips for inland navigation	High			Daily
	Number of communities	High			Once in 5 years
Livelihood status of wetland dependent communities	Physical capital, financial capital, social capital, human capital indicators of livelihood systems	Medium	Sasthamkotta Ramsar Site	Socioeconomic survey	Once in 5 years
	Number of reported instances of conflicts	Medium			Once in 5 years
Encroachment of wetland area	Number of violations of extant regulation as per the Wetlands (Conservation and Management) Rules, 2017	High	Sasthamkotta Ramsar Site	Mobile based surveillance system operated by LSG monitoring committees	Daily
				Drone mapping and other imaging technologies for surveillance of land use change	Once in every six months

Parameter	Indicator	Priority	Monitoring Scale	Monitoring Method	Monitoring Frequency
Sustainable tourism practices	Number of boats	High	Sasthamkotta Ramsar Site	Surveillance by designated government agencies	Annual
	Number of violations	High			Annual
Sustainable fishing practices	Violations of extant regulation	High	Sasthamkotta Ramsar Site	Surveillance by designated government agencies	Annual
Sustainable agriculture practices	Adherence to crop calendars decided by multi-stakeholder group	Medium	Sasthamkotta Direct Catchment	Surveillance by designated government agencies	Biannual
	Use of pesticides and fertilisers	Medium			Biannual
Formal meetings	Representation from various stakeholders	Medium	Sasthamkotta Ramsar Site	Meeting records	Once a month
Informal meetings	Representation from various stakeholders	Medium		Meeting records	Once a month/ As and when required

6.3 PARTICIPATORY COMMUNITY BASED MONITORING

Several parameters in the Sasthamkotta Lake monitoring framework can benefit from participatory community-based monitoring supported by a network of fishers, ecotourism guides and community members from surrounding Grama Panchayats.

These have been indicated in the monitoring strategy above and further elaborated in parts of the Action Plan in Chapter 7. Community-based monitoring, although not a substitute to scientific monitoring, can be highly effective in the early detection of changes in the wetland and in gathering anecdotal data.

Department of Forests and Wildlife has been engaging with the local community to conserve habitats and key species check grazing activities. It is proposed that this engagement be further enhanced, involving Fishing Cooperatives and Gram Panchayats.

The scope for community-based monitoring includes the following:

- Reporting any suspicious behaviour of bird or animal species that could be infected with a transferable disease
- For migratory waterbirds, disturbances like fishing in bird congregating areas is to be monitored with the support of fish cooperatives
- Setting up systems to disseminate early warnings in the case of extreme events
- Local fishers with necessary sensitisation workshops in collaboration with the Fisheries Department are to be involved in monitoring fishing activities during nesting seasons
- Community-based monitoring to keep in check grazing and cultivation by unlicensed groups/ individuals
- Conducting social audits to ensure transparency, accountability, local ownership and social equity and inclusivity.

6.4 MONITORING ARRANGEMENTS

State Wetland Authority Kerala (SWAK), under the Department of Environment housed in the premises of the Directorate of Environment & Climate Change (DoECC) will take the lead administratively for monitoring. SWAK, Kollam District Wetland Committee and the Sasthamkotta Wetland Management Unit (SWMU) will ensure that monitoring data reports are shared with them on a timely basis by various departments (e.g., Forest, Fisheries, Water, etc.) as per the monitoring plan.

SWAK, with support from the SWMU and the Site Manager/ Wetland Prabhari, ensures timely implementation of the monitoring plan. Additionally, SWAK (with support from SWMU and site manager) are to consolidate monitoring data into annual Wetland Health Cards (MoEFCC's NPCA format) and Wetland Health Report Cards (specific to Sasthamkotta Lake). Site Manager/SWMU, Kollam District Wetland Committee and SWAK should have periodic multi-stakeholder meetings to review monitoring reports and take prompt adapted management action where required.

6.5 ASSESSING MANAGEMENT EFFECTIVENESS

In order to ensure wise use of Ramsar Sites, site managers must be able to anticipate new risks and respond to these effectively and timely. This requires conducting regular and open management effectiveness assessments and learning from successes and failures. With this backdrop, the Contracting Parties to the Ramsar Convention, in their 12th Meeting Conference, adopted a specific resolution on evaluating and ensuring the effective management of Ramsar Sites (Ramsar Convention Secretariat, 2015).

Simply stated, management effectiveness assessment is a tool for knowing how well a conservation area is being managed. Periodic assessments of management effectiveness for Sasthamkotta and incorporation of its results, would improve planning management of the wetland. It would also, pave way for adaptive management and promote accountability and transparency.

Sasthamkotta Lake is a dynamic ecosystem and so are its management needs. Management plans, which are developed based on assumptions known to managers, need to be periodically assessed to make sure that the set goals and objectives are being achieved.

The effectiveness of management towards achieving the overarching objective of maintenance of ecological character can be greatly enhanced if the following questions are periodically reflected upon:

- What is the current status of the wetlands in the landscape?
- Is the management achieving the goal of

maintenance of ecological character?

- What are the current and future threats?
- Are adequate resources available for implementing management, and if not, how can they be accessed?
- Are management processes adequate, effective, and efficient?
- What other steps can be taken to improve management?
- What outputs generated as a result of the implementation?
- What outcomes achieved with respect to the intended objectives?

The Contracting Parties to the Ramsar Convention adopted R-METT (Ramsar Site Management Effectiveness Tracking Tool) to assist Ramsar Site managers in assessing the effectiveness of management in achieving wetland-wise use outcomes. The assessment looks into the following aspects:

- Context of management (wetland ecological character, threats, and risks of adverse change).
- Management planning defines how the management goals and objectives have been defined.
- Inputs including human, technical, and financial resources applied to implement management actions.
- Process of management plan implementation.
- Outputs (tangible and intangible) that result from implementing management actions.
- Outcomes concerning the objectives defined by the management plan

It is proposed that a management effectiveness assessment for Sasthamkotta Lake is done at least once in three years so that management action plans are revised and updated to reflect the real-time condition of wetlands as well as the ability of management to prevent adverse changes in ecological character. The baseline assessment of management effectiveness conducted as a part of management plan preparation is in Annex XIV.

6.6 INFRASTRUCTURE AND HUMAN RESOURCE REQUIREMENTS

Implementing the monitoring strategy as outlined in the previous sections requires physical and human infrastructure support. Under the aegis of the current management plan, it is proposed to create a Ramsar Site Wetland Management Unit including a site monitoring unit with the following infrastructure and human power:

- Remote Sensing and GIS unit with advanced capabilities

of remote sensing image processing, preparation of maps, and development and maintenance of spatial datasets.

- Ecological monitoring laboratory equipped with instruments for chemical, physical, and biological water and soil analyses. Portable water quality monitoring kit, GPS, Basic microbial analytical facilities etc.
- Database system for storing and retrieving monitoring and assessment data. The monitoring data would be stored along with metadata, as per the quality control procedures suggested in the following sections.
- Network of hydro-meteorological and water quality stations for real-time weather monitoring hydrological -biological variables.
- Ramsar Interpretation Centre (RIC) will be attached to this Wetland Management Unit.
- Conference hall with a minimum seating capacity of 30 numbers.

The aforementioned infrastructures should preferably be incorporated in one building with an area of at least 3,000–4,000 sq ft. The human resources required to implement the monitoring programme are described in the organogram for the wetland management unit. Training on wetland monitoring for the monitoring staff, along with those of concerned state government departments, would be carried out as a part of the authority's overall capacity development programme.

Deployment of the aforementioned resources can be done cost-effectively by availing the existing infrastructure of the CWRDM and Kumbalathu Sankupillai Memorial Devaswom Board College, Sasthamkotta. The college's Science Departments has the necessary infrastructure and experience to conduct ecological monitoring. Therefore, a sub-centre for coordinating ecological monitoring may be created at the college campus.

6.7 REPORTING AND QUALITY CONTROL

Reporting constitutes an important element of the wetland monitoring programme. The intended user group, format, style, and peer review requirements need to be set in the initial phases of the monitoring programme setup.

Periodic reports, for example, as a part of the annual report of the State Wetland Authority Kerala, should aim to provide a summary overview of the monitoring outcomes.

Annual monitoring reports summarising information generated from the WIAMS are proposed to be published. These reports will also examine the extent to which wetland wise use is being met, support to management is achieved, and the monitoring system remains relevant for maintaining the

wetland state (particularly in the light of new and emerging threats). In line with the recommendations of MoEFCC, a wetland health card (MoEFCC's NPCA format) and Wetland Health Report Cards (specific to Sasthamkotta) summarising ecological, hydrological, socio-economic, and institutional information in specific metrics would be published annually.

Outcomes of specific assessments, for example, ecological character status and trends, economic valuation, and environmental flows, among others, could be made available in the form of a technical report series, with an extended summary for a general readership. As the monitoring programs get sophisticated over time, real-time monitoring options through satellite-based data communication techniques will be explored.

Quality control in monitoring systems is required to ensure the scientific validity of sampling, laboratory analysis, data analysis, and reporting. They also play a crucial role in preventing the introduction of random and systematic errors in data collection, analysis, and reporting.

It is recommended that a Quality Management and Assurance Plan is developed for the monitoring programme. The plan should determine, among other things:

- Specification of objectives for the sampling programme are,
- Data quality objectives: maximum amount of uncertainty that can be tolerated to ensure that the data is fit for intended use
- Sampling programme design: Statistical robustness of sampling frame; means to ensure that samples are representative of the environment; sample recording; procedures for minimising environmental impact
- Documentation: Procedures for field sample record keeping and methods of documentation
- Sample processing validity (especially for water quality and biological components)
- Data quality control methods: processes for quality control samples, duplicates and replicates
- Performance audit procedures, including data and systems audit

6.8 COMMUNICATING RESULTS THROUGH HEALTH CARD

Wetland Health Card helps prioritise immediate threats and identify priority areas for future conservation efforts. Monitoring results are to be communicated using two types of health cards:

- Wetland Health Cards (MoEFCC's NPCA format)

Wetland Health Card online

https://indianwetlands.in/view-wetland-health-card/?ID=NTc=

- Wetland Health Report Card (specific to Sasthamkotta Lake for year-on-year comparison)

The NPCA Wetland Health Card (MoEFCC) assesses wetlands using nine indicators across four broad categories — Area, Hydrology, Biodiversity and Governance.

Sasthamkotta Lake Health Card for 2019 and a draft for Sasthamkotta Lake Health Card (2020–21) is provided in Annex XV.

6.9 REVIEW AND ADAPTATION

A periodic review of the monitoring programme is required to determine the extent to which the objectives, mainly supporting the management, is achieved and monitoring systems remain relevant for the wetland (particularly in the light of new and emerging threats). The review process should also aim at increasing the monitoring system's sophistication to assess complex landscape-scale processes affecting the ecological character of wetlands and related management.

The review process should include documentation on how wetland inventory, assessment, and monitoring information is used to support management planning and policy goals. The review should also include the identification of appropriate alternate resource flow mechanisms to ensure that wetland monitoring is continued in the event of a funding shortfall.

07

Action Plan

The management framework for Sasthamkotta Lake has eight objectives (Chapter 5, Section 5.3), which have been clustered under five Action Plan components, namely: a) Institutions and Governance, b) Land and Water Management, c) Species and Habitat Conservation, d) Nature Tourism, and e) Wetland Livelihoods (Table 7.1). Figure 7.1 depicts the priority actions proposed under these components.

This aligns the Ramsar Site Action Plan with Amrit Dharohar, an initiative to promote the unique conservation values of the Ramsar Sites launched by MoEFCC in June 2023.

Table 7.1 | Management plan components

Component	Management Objectives
Component 1 Institutions and Governance	→ ***Objective 6:*** Individual and collective capacity and opportunities for stakeholders to participate in wetland management and contribute to wetlands — wise use is enhanced → ***Objective 8:*** Integration of multiple values of wetlands in sectoral development plans, programmes and investments is enhanced
Component 2 Land and Water Management	→ ***Objective 1:*** Naturalness of the Ramsar Site is maintained in line with extant regulation → ***Objective 2:*** Storage capacity, surface and sub-surface water level are maintained within the permissible limit → ***Objective 7:*** Systematic wetlands inventory, assessment and monitoring system is used to inform management decisions and assess effectiveness
Component 3 Species and Habitat Conservation	→ ***Objective 3:*** Diversity of species and their habitat is maintained and enhanced → ***Objective 7:*** Systematic wetlands inventory, assessment and monitoring system is used to inform management decisions and assess effectiveness
Component 4 Nature Tourism	→ ***Objective 5:*** Nature tourism is developed to showcase the biodiversity, ecosystems services and cultural values of Ramsar Site
Component 5 Wetland Livelihoods	→ ***Objective 4:*** Livelihood vulnerability of wetland-dependent communities is reduced

7.1 COMPONENT 1: INSTITUTIONS AND GOVERNANCE

Establishment of Wetland Mitra Network

'Wetland Mitra' is conceived as an informal, voluntary and non-statutory network of concerned citizens to foster and promote community engagement in wetlands conservation and management efforts. An effective 'Wetland Mitra' network enables wetlands managers to gain access to local views, rights and capacities for supporting wetlands management. The network is also aimed as a communication and outreach vehicle for promoting awareness of the value of wetlands and management and conservation efforts. By involving themselves within the Wetland Mitra Network, citizens gain an opportunity to shape wetlands management by bringing onboard indigenous and local knowledge, and views of diverse stakeholder groups. As Wetland Mitra Network member, the communities also built their capacity on various dimensions of wetlands management.

Key roles and responsibilities of Wetland Mitras are as follows:

- Promote awareness of the values and functions of wetlands among local communities, students, resident welfare groups and other stakeholders.
- Participate in wetlands management planning and implementation processes and bring on board stakeholder views.
- Promote consideration of wetlands in local development plans of Grama Panchayats and Municipal Areas as may be the case.
- Alert authorities of any detrimental activities on wetlands such as encroachment, conversion, dumping of solid waste, discharge of untreated waste, release of non-native species, and others.

To deliver the aforementioned roles and responsibilities, all members of the Wetland Mitra Network:

- Make themselves aware of the values and functions of wetlands by participating in training workshops and outreach events, connecting with experts by self-reading, making field observations, and using other mechanisms as feasible.
- Make themselves aware of the government officials responsible for wetlands management.
- Understand the wetlands management approach and key activities being undertaken or planned.
- Dedicate a part of their time towards promoting awareness of wetlands values and functions, keeping watch and ward, and participating in wetlands management planning, implementation and monitoring activities.

Figure 7.1 | Priority actions proposed for Sasthamkotta Lake

SASTHAMKOTTA LAKE

Wetland of International Importance

Ramsar ID: 1212
Location: Kollam District, Kerala
Area: 365.91 ha

WHAT IS ITS IMPORTANCE?

- → Source of water for Kollam City
- → Buffers floods and extreme events
- → Home to 19 species of fish (six endemic the country), 1 species of crustacea, 14 species of waterbirds, 23 species of butterflies, and 11 species of flora
- → Serves as cultural centre with Sastha temple located on periphery

WHO HAS A KEY ROLE IN MANAGING SASTHAMKOTTA LAKE?

- → Directorate of Environment and Climate Change
- → State Wetland Authority Kerala
- → Department of Forests and Wildlife
- → Kerala Water Authority
- → State Biodiversity Board
- → Department of Tourism
- → Department of Fisheries
- → Department of Soil Conservation
- → Irrigation Department
- → Local Self Government
- → Civil Society Organisations Source of water for Kollam City

ACTIONS Treatment of degraded micro-watersheds | Desilting | Managing inlet drains | Enhancing the waste processing facilities | Fish Habitat Assessment

WHAT ARE THE PRIORITY ACTIONS?

Institutions and Governance

- → Establishing a network of Wetland Mitra
- → Establishment of Sasthamkotta Wetland Management Unit
- → Improving Wetland Inventory, Assessment, Monitoring System
- → Wetland management effectiveness evaluation

Land and Water Resources Management

- → Develop a water allocation plan
- → Treatment of degraded micro-watersheds with vegetative measures
- → Desilting
- → Managing inlet drains
- → Enhancing the waste processing facilities

Direct Catchment Area	980 ha
Source of Water	Rainfall, Runoff from catchment, groundwater

What is the projected change in climate by 2050?

Season	Precipitation Change (%)	Temperature Change (^{0}C)
Non-Monsoon (Feb-May)	-10 ▼	0.8 ▲
SW Monsoon (Jun-Sep)	-26.5 ▼	0.6 ▲
NE Monsoon (Oct-Jan)	35 ▲	0.75 ▲

WHAT ARE THE THREATS?

- → Reduced water holding capacity
- → Increased inter-annual variability of inundation regime
- → Increased extraction of water for supply by Kerala Water Authority
- → increase in alkalinity, hardness, TDS, nitrate, phosphate and faecal coliform levels
- → Proliferation of invasive species
- → Increase in frequency and intensity of extreme events

Species and Habitat Conservation

- → Fish and Waterbird Habitat Assessment
- → Integration of eco-profiles in People's Biodiversity Registers
- → Management of invasive species
- → Conducting Asian Waterbird Census
- → Enhancing the waste processing facilities

Nature Tourism and Wetland Livelihoods

- → Installation of signages
- → Micro-enterprise development for wetland products
- → Setting up of interpretation centre
- → Training of Wetland Mitras for nature guides

- Understand that their role as a Wetland Mitra Network member is completely on voluntary basis and does not confer any special rights or privileges.

The following are the activities involved in the constitution of Wetland Mitra Network:

Developing a list of potential members in consultation with the community
Identifying and selecting individuals from the community through consultations to form a group of dedicated volunteers or stakeholders for wetland conservation efforts.

Meeting to onboard Wetland Mitras
Organising a meeting at the district/Panchayat headquarters to present the purpose and objectives of the Wetland Mitra Network to the communities and seek nominations. Constituting the network ensures a fair representation of all stakeholders and that half of the members are women.

Capacity building workshop for Wetland Mitras
Conduct a workshop on capacity building of Wetland Mitras on key aspects of wetland conservation, including monitoring techniques, ecological assessment, community engagement, and sustainable management practices, ensuring they are well-prepared to support the wetland management initiatives.

Establishment of Sasthamkotta Wetland Management Unit

Creating a dedicated administrative body responsible for overseeing and coordinating all conservation and management activities related to Sasthamkotta Ramsar Wetland. This unit will serve as the central authority for implementing wetland management plan, engaging with stakeholders, conflict resolution and ensuring the sustainable preservation of the wetland's ecological integrity.

The following are the activities involved in the constitution of the Sasthamkotta Wetland Management Unit (SWMU):

Appointment of staff
Staffing and work allocation would be as per the structure suggested in Section 4.4 of Chapter 4.

The unit will comprise of five divisions, namely: Research, Monitoring and Evaluation; Participation and Networking; Communication and Outreach; Legal and Regulation; and General Administration. The Chief Executive Officer, SWMU is to be designated as the head of the unit, responsible for implementation of the various work programmes of the organisation. Representatives from Wetland Mitra will be included in the Advisory Board/Executive Committee of the SWMU.

Government notification for constitution
Issue the necessary government orders and notifications to officially establish the Sasthamkotta Wetland Management Unit, providing it with legal authority and framework to

operate and manage wetland conservation efforts effectively. Details on the proposed institutional arrangements are provided in Section 4.4 of the management plan.

Designation of office space and office expenditure
The Sasthamkotta Wetland Management Unit office will be created within the premises of the proposed wetland interpretation centre. In the stakeholder consultation meeting, it was proposed that the WMU may be housed in the Sasthamkotta Soil Conservation Office.

Meetings/Engagement of the stakeholders/local community
The Chief Executive Officer of the SWMU will prepare annual plans detailing the year-wise activities to be executed based on the approved IMP. These yearly plans will take into account the year-wise progress of the IMP implementation and address any delays and bottlenecks in the execution of the activities through adaptive planning after seeking suggestions andreview. Organise and conduct meetings with stakeholders and local community members to discuss wetland management plans, gather input, foster collaboration, and ensure community involvement in conservation efforts.

Integrated Wetland Inventory, Assessment and Monitoring System

The Integrated Wetland Inventory, Assessment and Monitoring System (WIAMS) platform is used as a monitoring and regulatory tool instituted as part of the implementation of the existing approved Management Action Plan. WIAMS will address the overall information needs of wetland management and provide a robust decision support system.

The following activities are proposed:

Establishment of wetland monitoring facility
Setting up a Wetland Ecosystem Monitoring Facility, including site selection and construction, and equipping the centre with technology for data collection. It also encompasses staffing, training, and developing monitoring protocols to ensure effective management and analysis of wetland ecosystems. A list of necessary equipment to be procured for the centre is in Annex XVI.

Improvement and Maintenance of the WIAMS-Sasthamkotta Lake
A publicly accessible database system for storing, retrieving, and analysing the WIAMS is proposed to be set up in a GIS environment. This will include:

- Development of data quality management and assurance plan, including specification of data collection objectives, data quality objectives, sampling programme design, data and metadata documentation procedure, data quality

control methods and performance audit procedures.

- Development of a GIS-based database management system.

Establishment of hydrological and climatological monitoring stations

Setting up hydrological and climatological monitoring stations to collect and analyse data on water levels, flow rates, precipitation, and weather conditions. This includes site selection, equipment installation, and data management to support informed decision-making and effective management of water resources.

Wetland monitoring and evaluation

Wetland monitoring and inventory protocols for land use and land cover, hydrological regimes, ecosystem processes and biodiversity and socioeconomics and livelihoods, as proposed in Chapter 6, will be implemented.

Compliance with the provision of following rules and laws will be comprehensively monitored, and violations reported to the concerned authority to ensure remedial action:

- Provisions of Wetlands (Conservation and Management) Rules, 2017 — prohibiting the conversion of wetlands into non-wetland usages, discharge of untreated sewage, solid waste dumping and activities likely to affect wetland ecosystem health adversely.
- Notification of zone of influence as per the requirements of Wetlands (Conservation and Management) Rules, 2017. It is recommended that the boundary of the direct drainage basin be demarcated and notified as the zone of influence.
- Provisions of the Kerala Conservation of Paddy Land and Wetland Act, 2008, barring reclamation of wetlands.
- Provisions of The Kerala Protection of River Banks and Regulation of Removal of Sand Act (2001) under which mining is banned in Kallada River.
- Notification of The Kerala State Pollution Control Board (2010) barring a range of polluting activities around the lake and its adjoining areas. The actions prescribed herein may be considered prohibited and restricted activities within the zone of influence.

Ecosystem Health Report Cards

It is proposed that Ecosystem Health Report Cards be developed and published annually to assess and communicate wetland monitoring information to decision-makers and stakeholders. The health report card summarises indicators along major indices (water quality, catchment status, biodiversity status), representing various ecosystem features of the wetland and reporting

against respective thresholds set in line with management goals. The following activities are to be taken:

- Convening a methodology workshop for Sasthamkotta wetland management unit for firming up variables to be used for assessment and data requirements
- Development of Ecosystem Health Report Card
- Report card publication
- Stakeholder dissemination workshop

Publication of annual monitoring reports
The monitoring reports will be published on the WIAMS web portal and the website of SWAK periodically to inform all the stakeholders and the public.

Wetland Management Effectiveness Evaluation

Assessing the impact of management actions on wetland health. It includes collecting and analysing data on conditions, comparing results to goals, and reporting findings to guide improvements in management strategies.

Management effectiveness would be assessed using the MET tool. Activities to be undertaken are:

Constitution of the assessment team
Forming a dedicated team to conduct assessments of wetland ecosystems. This includes selecting and recruiting members with relevant expertise, defining team roles and responsibilities, and ensuring the team is trained and equipped to perform thorough evaluations and reporting.

Workshop for wetland managers and stakeholders
Organising a workshop for wetland managers and stakeholders. This includes planning the agenda, securing speakers, arranging logistics, and facilitating discussions on best practices, management strategies, and collaborative approaches to wetland conservation. The goal is to enhance knowledge, share experiences, and foster partnerships for effective wetland management.

MET evaluation
Conducting a Monitoring, Evaluation, and Tracking (MET) evaluation to assess the performance and impact of wetland management activities. This includes reviewing data, evaluating the effectiveness of management strategies, identifying strengths and areas for improvement, and providing recommendations to enhance wetland conservation efforts.

Dissemination workshops
Organising dissemination workshops to share findings and insights from wetland research and monitoring. This includes planning the event, preparing presentations and materials, inviting stakeholders, and

facilitating discussions to communicate key results and recommendations effectively. The aim is to ensure that research outcomes are widely shared and used to inform and improve wetland management practices.

Capacity development

Capacity building of State Wetland Authority Kerala, concerned State Government departments, agencies and local communities is proposed to be undertaken through professional training in integrated wetland management, water management, biodiversity conservation, wetland inventory and assessment and sustainable livelihoods.

At the initial stage, two training programmes for all concerned institutions on integrated wetland management and wetland risk assessment are proposed. In addition, provision for exposure visits to Sasthamkotta and other sites wherein management has been relatively successful has also been made.

Major activities proposed for this are:

Training workshops for wetland managers
Training workshops for wetland managers involve developing the training curriculum, arranging logistics, delivering sessions on wetland management best practices, and providing tools and resources to enhance managerial skills and effectiveness in wetland conservation.

Training workshops for communities
Training workshops for communities involve creating educational content, coordinating event logistics, conducting sessions on wetland conservation, and providing practical tools and knowledge to empower community members in protecting and managing local wetland resources.

Training workshops for CBOs, SHGs
Training workshops for CBOs and SHGs involve developing tailored training materials, coordinating logistics, delivering sessions on wetland conservation and management, and equipping these groups with skills and resources to effectively contribute to local wetland protection and sustainable practices.

Communication, Education, Participation and Awareness

CEPA involves sharing information, providing education, engaging stakeholders, and raising public awareness to support wetland conservation and management. Stakeholder engagement in wetland management will be promoted by creating awareness of the values and functions of Sasthamkotta, management strategies adopted and opportunities for participation. Specific activities to be undertaken include:

Development of Wetland Learning Centre
Setting up a Wetland Learning Centre in Kumbalathu Sankupillai Memorial Devaswom Board (KSMDB) College, including designing and establishing the facility, developing educational programs and exhibits, and setting up resources for interactive learning. The centre aims to educate students about wetland ecosystems and promote conservation through hands-on experiences and informative displays.

Training of students
Organising and delivering training sessions for students on wetland conservation and management. This includes developing educational materials, conducting interactive workshops, and providing practical experiences through exposure visits to enhance students' understanding and engagement with Sasthamkotta Lake's ecosystem.

Publication of outreach materials
Creating and distributing outreach materials to raise awareness about wetland conservation. This includes designing and producing newsletters, brochures, fact sheets and awareness material on Sasthamkotta Lake, as well as managing their distribution to effectively communicate key messages to target audiences through publishing materials in English and Malayalam.

Awareness generation, sensitisation activities
Organising activities to raise awareness and sensitise the public about wetland conservation includes planning and executing campaigns, workshops, and events to educate people, highlighting the importance of wetlands, and encouraging positive actions for their protection. Public events are proposed to be organised on the eve of World Wetlands Day (February 2), World Environment Day (June 5) and International Day for Biological Diversity (May 22) as a means of reaching out to the public on the issues of wetland conservation and wise use. Public events on specific issues, as pollution control or water management, are also proposed to be organised as a means of engaging with stakeholders.

7.2 COMPONENT 2: LAND AND WATER MANAGEMENT

Work under the land and water management component of the management plan is aimed at improved management of agricultural land and homesteads, strengthening drainage lines, enhancing groundwater recharge and overall soil moisture regime, enhance overall vegetative cover, regulating outflows and improving hydrological connectivity within different parts of the wetland complex. Map 7.1 highlights the prioritisation of the 14 watersheds within the Sasthamkotta Lake catchment area. This prioritisation is based on two key factors: elevation and the loss of vegetation observed from 2017 to 2023, as analysed through land use and land cover (LULC)

change assessments. By focusing on these criteria, the map visually represents the areas most affected by ecological degradation, aiding in the strategic planning of conservation efforts to restore and sustain the watershed's health.

Develop a water allocation plan

Creating a strategic plan for the equitable distribution and management of water resources, considering both environmental needs and human demands to ensure sustainable use and conservation.

The following are the specific actions:

Meetings and workshops for stakeholders on water allocation planning
Organising stakeholder meetings and workshops to discuss and develop a water allocation plan. This includes coordinating sessions, facilitating discussions, and gathering input to ensure that diverse perspectives are considered in the planning process for effective and equitable water resource management.

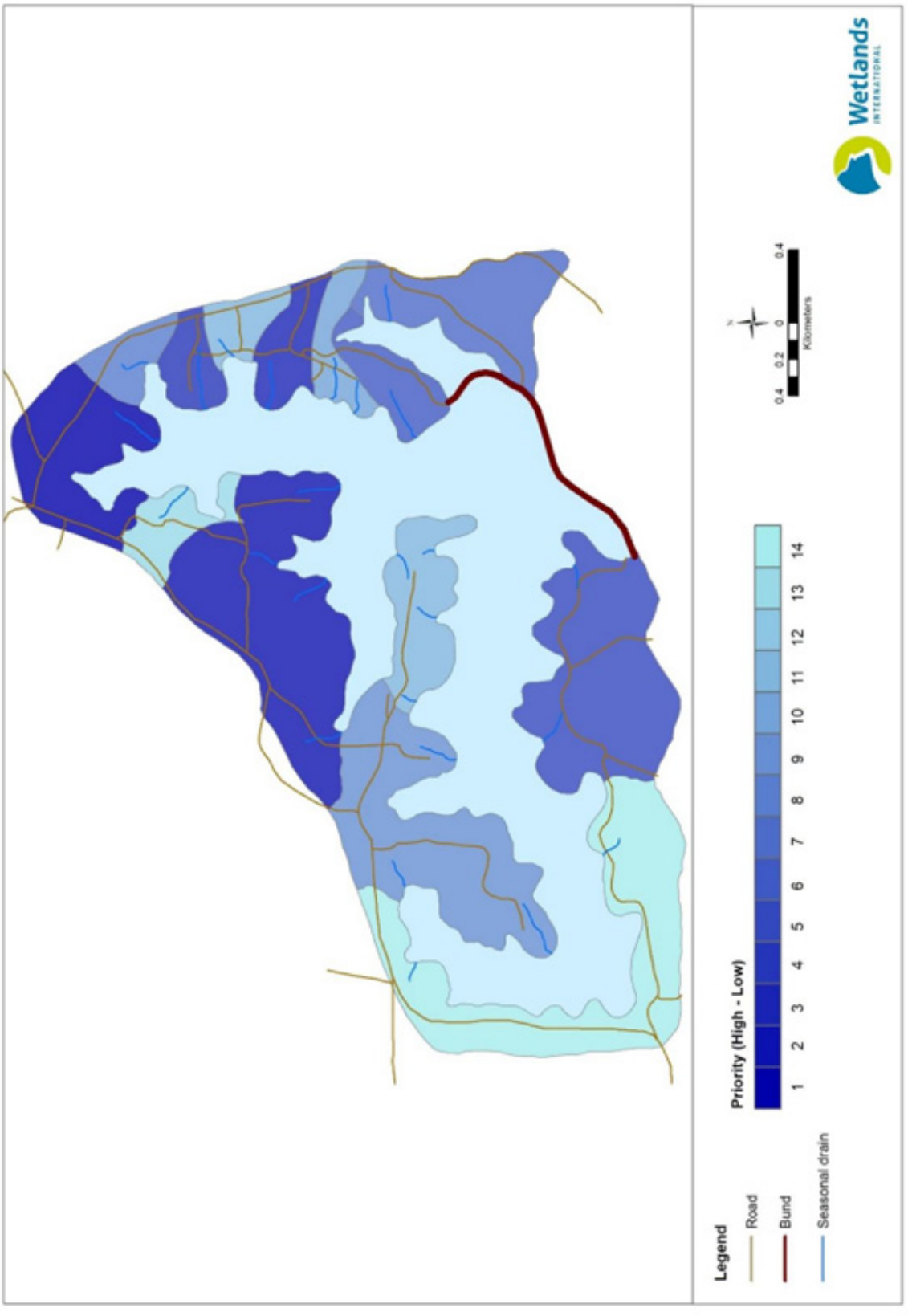
The present levels of water abstraction for providing drinking water to Kollam City are adversely impacting the stability of the inundation regimes of Sasthamkotta Lake. The management plan, therefore, envisages providing an alternate source of drinking water to the city, such that the current levels of abstraction from the lake may be reduced. This component of the management plan has been worked out by the Kerala Water Authority in the form of a separate proposal entitled 'Improvement of Water Supply System to Kollam Corporation with Njankadavu in Kallada River as Source' (KWA, 2013).

Boundary demarcation to prevent encroachment
Demarcating wetland boundaries as per the Wetlands (Conservation and Management) Rules, 2017, to prevent encroachment includes installing physical markers or barriers and setting up a monitoring system to detect and address unauthorised activities. The aim is to protect the wetland from illegal use and ensure its conservation.

Catchment Conservation

Protection and management of the catchment area surrounding a wetland to reduce erosion, control runoff, and maintain water quality. It includes implementing soil conservation measures, restoring vegetation, and managing land use practices to sustain the health of the wetland ecosystem.

Interventions within the direct catchment include a set of vegetative and small-scale engineering measures. To implement these interventions, the entire direct catchment has been delineated into 14 parts. Following are the specific actions:



Map 7.1 | Priority conservation intervention sites in sasthamkotta Lake catchment based on elevation and vegetation loss (2017–2023)

Preparation of catchment management plans
For each part, the Catchment Committees will facilitate the development of a detailed plan, with clear specifications of intervention type, location, modality and local resource requirement. The plans will also include year-wise phasing and modalities to ensure sustainability after the completion of the management plan implementation.

Training of stakeholders on catchment conservation
Organising and delivering training sessions for stakeholders on catchment conservation. This includes preparing educational materials, conducting workshops, and providing practical guidance on implementing conservation practices, managing land use, and protecting the catchment area to enhance wetland health.

Treatment of degraded micro-watersheds with vegetative measures
Rehabilitating degraded micro-watersheds using vegetative measures includes planting native vegetation, restoring riparian zones, and implementing erosion control techniques to improve soil health, enhance water retention, and support ecosystem recovery in the affected areas.

Slopes and berms of bunds are proposed to be planted with suitable grass species of fodder value. The fibrous root system of grass will offer better protection of the topsoil and filter run-off, thus trapping sediments. Conservation-based management through techniques such as balancing numbers with the grazing capacity of the grasslands, controlled grazing by fencing, area closure, cut and carry will help to preserve soil and vegetation and improve grassland productivity. The introduction of better forage species can be done by seeding, using seeds of native species or by a plantation of sods. Such plantation is estimated to be done in 14 ha.

Establishing of nursery for seedling raising
Setting up a nursery for raising seedlings includes selecting a suitable site, preparing soil, installing irrigation systems, and managing the nursery to grow and nurture seedlings for future planting and habitat restoration projects.

Enumeration and Cutting of *Acacia* and *Mangium* trees through debarking, removal and replanting with native species
Systematic removal of *Acacia* and *Mangium* trees by debarking and cutting, including the removal of the felled trees. This process is followed by preparing the site and replanting with native tree species to restore ecological balance, improve soil health, and enhance biodiversity. Lake catchments previously under *Acacia* plantation are proposed to be planted with 5,000 seedlings of tree species as Teak (*Tectona grandis*), Mahogany (*Swietenia*

mahogani), Aanjili (*Artocarpus hirsutus*); fruit trees like Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*), Java plum (*Syzygium cumini*) and Guava (*Psidium guajava*). Planting would be done in the narrow hedge with weeding and pruning operations. Controlled grazing, border row plantations, and bund plantations would be promoted. In addition, 1,000 saplings of medicinal plants as Neem (*Azadirachta indica*), Asoka (*Saraca asoca*), and Amla (*Emblica* sp.) are also proposed to be planted. Along stream banks and gully mouths, native bamboo, *Pandanus*, Vetiver, and other seeding species are proposed to be soil binders. Such plantation would be taken up in 14 ha.

Regular Monitoring and Removal of Acacia and Mangium Sapling

To prevent re-establishment, the site will be monitored continuously to detect and remove any regenerating *Acacia* and *Mangium* saplings. This process will involve frequent site visits to identify young growth and immediate removal to allow native species to establish dominance. Sapling removal will be done manually or with minimal-impact tools to avoid soil disturbance, followed by supplementary planting of native species in cleared spots to promote soil stability and biodiversity. By maintaining a regular schedule for monitoring and removal, we aim to sustain the restoration process and ensure successful native species reestablishment across the site.

Management of inlet drains to prevent waste discharge

Managing inlet drains to prevent the discharge of waste into wetland areas includes monitoring and maintaining drains, installing filtration systems or barriers to trap contaminants, and ensuring proper waste disposal practices (including treating the waste water generated after drinking water treatment by KWA) to protect water quality.

Desilting

Desilting a wetland removes accumulated sediment and improves water quality. This includes assessing sediment levels, using machinery or manual methods to extract silt, and properly disposing of the removed material. The process helps restore the wetland's depth, enhance its ecological function, and improve water flow and storage capacity.

Augmenting the waste processing facilities of surrounding local bodies

Enhancing the waste processing facilities of local bodies surrounding a wetland. This includes upgrading existing infrastructure, increasing processing capacity, and implementing advanced technologies for efficient waste management.

To improve waste treatment in the direct drainage basin of Sasthamkotta, a Sewage Treatment Plant of 8 MLD capacity is proposed to be constructed in Sasthamkotta

Town. A tentative location has been identified by the CWRDM team and needs to be firmed up. This treatment capacity is sufficient to cater to the needs of 60,000 people. The population of Sasthamkotta Town, as per 2011 census, is 33,285, which is projected to increase to 53,300 by 2050 (using a 1.94% decadal growth as per census). A Sequential Batch Reactor-based technology is proposed, considering a low land requirement. The management of the plant would be vested in the Local Self Government.

7.3 COMPONENT 3: SPECIES AND HABITAT CONSERVATION

Fish and Waterbird Habitat Assessment

Sasthamkotta forms an important component of a network of sites which are used by wetland-dependent waterbirds. The waterbird census conducted within the framework of the Asian Waterbird Census provides a useful information base for assessing their regional and global populations. The Ramsar Site designation of Sasthamkotta Lake is based on Criterion 1, 2, 7 and 8. Criteria 2, 7 and 8 are related to the presence of diverse freshwater fish, including some of the high conservation significance within the lake. It is proposed that current freshwater fish diversity, habitat preferences, and conditions be systematically assessed (specifically on *Etroplus sp*. and other endemic species). Such information would form the basis of a habitat conservation plan for securing freshwaterfish diversity in the lake.

The following activities are to be carried out:

Survey and mapping of fish breeding grounds
Conducting a survey and creating detailed maps offish breeding grounds. This includes identifying key spawning areas, collecting fish populations and habitatdata, and using mapping tools to document and visualise these critical sites. This also includes an assessment of Otter population and impacts on the ecosystem. The assistance of Kerala University of Fisheries and Ocean Studies (KUFOS) and State Fisheries Department will betaken to undertake this assessment.

Survey and mapping of key waterbird habitats
An assessment of distribution and breeding concentrations of all waterbird species (reed bed, marsh and tree nesting) in Sasthamkotta Lake and adjoining wetlands (Karali marshes, Chittumala, Veliyapadam marshes and Chellurpola Kayal) is proposed to be undertaken to determine the current baseline population of breeding birds. Studies of the habitat preferences, precise requirements, the ecology of key waterbird species and determination of current threats are proposed to enable the planning and execution of measures to manage and improve existing habitats, identify potential

breeding areas and restore degraded areas to increase breeding habitats and address increased prey requirements. The services of the Bombay Natural History Society or Salim Ali Center for Ornithology and Kerala Agricultural University (KAU) will be sought to implement this study.

Knowledge of the health of resident and migratory waterbird species is critical for assessing the risk and potential threat of avifaunal diseases. Knowledge of the health of these species that inhabit the wetland is critical to understanding the risk and potential threat of transmission of avifauna diseases. It is proposed to train the State Wetland Authority Kerala in the general identification of traits of common diseases as well as avian influenza. The authority will also be networked with surveillance teams of the State Animal Husbandry Department to enable a timely response.

Community workshops on habitat management action plan development and its implementation
Organising community workshops focused on developing and implementing habitat management action plans. This includes facilitating discussions on habitat needs, guiding participants through the planning process, and providing training on effective implementation strategies. The aim is to engage the community in managing and conserving local habitats through collaborative and informed approaches.

Integration of eco-profiles in People's Biodiversity Registers

Incorporating detailed eco-profiles into People's Biodiversity Registers (PBRs). It includes gathering and documenting information on local ecosystems, species, and conservation status and integrating this data into PBRs to enhance biodiversity management and planning. The aim is to provide a comprehensive view of ecological resources and support informed decision-making for conservation efforts.

A Biodiversity Register for Sasthamkotta has been compiled through the BMCs of the three LSGs around the lake. It is proposed to support periodic updation of the register, to assess any changes in species and habitat preferences.

The following activities are to be carried out:

Workshop for the LSG biodiversity management committees and the joint BMC for the Lake
Organising a workshop for Local Self Government (LSG) biodiversity management committees and the joint Biodiversity Management Committee (BMC) for the lake. This includes facilitating discussions on biodiversity conservation strategies, sharing best practices, and developing collaborative action plans for managing and protecting the lake's ecosystem. The goal is to enhance the capacity of committees to effectively address local biodiversity issues.

Comprehensive updation of the biodiversity registers of each LSG in Sasthamkotta Lake and its ZoI and integration of the same

Comprehensively updating the biodiversity registers for each Local Self Government (LSG) in the Sasthamkotta Lake area and its Zone of Influence (ZoI). This includes collecting and verifying data on local species and ecosystems, revising the registers accordingly, and integrating the updated information to ensure accurate and comprehensive records for effective biodiversity management and conservation.

Management of invasive species

Dense beds of *Salvinia* associated with *Pistia, Cabomba* and the native grass species *Ischamemum travancorense* were observed in areas near Rajagiri, Velanthara Embankment, Sasthamkotta Town and Muthupilakadavu. A long-term check on the spread of these macrophytes is the restoration of the inundation regime and control of pollution. The following actions are proposed:

Mapping of aquatic habitats

Mapping aquatic habitats to document their locations and characteristics. This includes using GIS and remote sensing tools to identify and delineate different habitat types and compiling data on their size, condition, and ecological importance. The goal is to create accurate maps that support habitat management and conservation efforts.

Conducting Asian Waterbird Census

Organising and conducting the Asian Waterbird Census by surveying waterbird populations, recording data on species and their habitats, and analysing the results to track trends and support conservation efforts.

The following activities are proposed:

Identification of partner for AWC

Identifying and selecting suitable partners for the Asian Waterbird Census (AWC). This includes researching and evaluating potential organisations or individuals, assessing their expertise and resources, and establishing partnerships to ensure effective collaboration and successful execution of the census.

Training of volunteers

Training volunteers to assist with fieldwork and data collection for the Asian Waterbird Census. This includes developing and delivering training materials on survey techniques, species identification, and data recording, as well as ensuring volunteers understand their roles and responsibilities for effective and accurate data collection.

Conducting mid-winter AWC and monthly observations

Conducting the mid-winter Asian Waterbird Census (AWC) and performing monthly observations. This

includes coordinating field surveys to count waterbird populations during the mid-winter period and conducting regular monthly observations to monitor species numbers and habitat changes throughout the year.

Data Collection and Reporting
Collecting and analysing data from waterbird surveys and observations. This includes recording species counts, habitat conditions, and other relevant metrics and then compiling and reporting the findings to support conservation efforts and inform stakeholders about waterbird populations and trends.

7.4 COMPONENT 4: NATURE TOURISM

Installation of signages

Installing signages around Sasthamkotta Lake to provide information and guidelines. This includes designing and placing signs to educate the public, mark boundaries, and discourage harmful activities to support conservation efforts.

Signages for generating awareness among visitors are proposed to be posted at Sasthamkotta Lake in nature tourism zones regarding:

- Ramsar Site's values and services
- Safety and risk factors
- Safety protocols
- Do's and Don'ts at the Ramsar Site
- Information media

The following activities are proposed:

Designing of signages
Designing signages for wetland areas to communicate important information effectively. This includes creating visually clear and informative graphics, selecting appropriate materials for durability, and ensuring the signs convey messages on conservation practices, boundaries, and rules to guide and educate the public.

Fabrication & Installation of eco-friendly signages
Fabricating and installing eco-friendly signages for wetland areas. This includes selecting and using sustainable materials for sign production, ensuring durability and minimal environmental impact, and installing the signs in appropriate locations to provide clear information and guidelines for conservation and public awareness.

Refurbishment of a building to house the SWMU & to serve as wetland interpretation centre
Refurbishing a building to accommodate the Sasthamkotta Wetland Management Unit (SWMU) and serve as a Wetland Interpretation Centre. This includes renovating

the space to create functional offices and educational areas, installing exhibits and interactive displays, and ensuring the facility supports management operations and public education on wetland conservation.

Electric Boat
Developing and deploying an electric boat for use in wetland areas. This includes designing and constructing the boat to operate on electric power, ensuring it is environmentally friendly and suitable for navigating wetland waters, and implementing it for tasks such as monitoring, research, and eco-friendly transportation.

Capacity Building

Enhancing skills and knowledge for promoting and managing nature tourism. It includes training stakeholders in sustainable tourism practices, developing eco-tourism programs, and improving visitor engagement to ensure responsible and impactful tourism that benefits both the environment and local communities.

Identification of youth & Wetland Mitras for nature guides
Identifying and selecting youth and wetland enthusiasts to serve as nature guides. This includes recruiting individuals with a passion for wetlands, providing training on guiding techniques and conservation knowledge, and preparing them to lead educational tours and engage visitors effectively in wetland conservation efforts.

Training for nature guides
Conducting training sessions for nature guides to equip them with essential skills and knowledge. This includes providing instruction on guiding techniques, ecological information, communication strategies, and visitor engagement to ensure they can effectively lead tours and educate the public about wetland ecosystems.

Per diem for nature guides
Managing the per diem arrangements for nature guides. This includes calculating and disbursing daily allowances to cover their expenses during tours or training sessions, ensuring timely payments, and maintaining records of per diem expenditures for budgeting and accountability.

7.5 COMPONENT 5: WETLAND LIVELIHOODS

The component would aim to create community incentives for adopting sustainable land use practices within Sasthamkotta catchment. Following activities are envisaged:

Micro-enterprise development for wetland products
Supporting the creation and growth of small businesses focused on wetland products. It includes providing training, resources, and market access to

entrepreneurs, enabling them to sustainably produce and sell items derived from wetland resources, thereby promoting local livelihoods and conservation.

Formation of SHGs/FBOs/CBOs
Forming Self-Help Groups (SHGs), Farmer-Based Organisations (FBOs), and Community-Based Organisations (CBOs) to support wetland conservation and sustainable livelihoods. This includes mobilising community members, facilitating group formation, providing training on group management, and offering resources to ensure these groups can effectively collaborate and engage in conservation activities and income-generating projects.

Training workshop for wetlands products-based livelihoods
Organising training workshops focused on developing livelihoods based on wetland products. This includes providing participants with skills and knowledge on sustainable harvesting, processing, and marketing of wetland resources, as well as offering guidance on business development to support income generation while promoting conservation.

Incentives to local fishers for fishnet
Providing incentives to local fishers for using sustainable fishing nets. This includes distributing eco-friendly nets that minimise environmental impact, offering financial or material support to encourage adoption, and educating fishers on the benefits of sustainable fishing practices to protect wetland ecosystems and ensure long-term fishery resources.

Septic tank installation/ retrofitting for selected households
Installing or retrofitting septic tanks for selected households to improve sanitation and protect wetland water quality. This includes assessing household needs, coordinating installing or upgrading septic systems, and ensuring they meet environmental standards to prevent contamination of nearby wetlands.

The list of activities and sub-activities is presented in Table 7.2 in the following page

Table 7.2 | List of Activities and Sub-activities

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
Component 1: Institutions and Governance								
1.1	***Enrolling and training of Wetland Mitras***	Enrolling and educating community volunteers to monitor and conserve wetlands, fostering local stewardship and sustainable management practices.	*1.1.1*	*Developing list of potential members in consultation with community*	Identifying and selecting individuals from the community through consultations to form a group of dedicated volunteers or stakeholders for wetland conservation efforts	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	SWAK & WMU	Grama Panchayats
			1.1.2	*Meeting to onboard Wetland Mitras*	Gathering selected community volunteers to introduce them to their roles and responsibilities in wetland conservation, officially integrating them into the program.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	SWAK & WMU	Grama Panchayats
			1.1.3	*Capacity building workshop for Wetland Mitras*	Conduct a workshop to train Wetland Mitras on key aspects of wetland conservation, including monitoring techniques, ecological assessment, community engagement, and sustainable management practices, ensuring they are well-prepared to support the wetland management initiatives.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	SWAK & WMU	Grama Panchayats, Wetlands International South Asia
1.2	***Establishment of WMU***	Creating a dedicated administrative body responsible for overseeing and coordinating all conservation and management activities related to Sasthamkotta Lake. This unit will serve as the central authority for implementing wetland management plans, engaging with stakeholders, and ensuring the sustainable preservation of the wetland's ecological integrity.	*1.2.1*	*Appointment of staff*	Staffing and work allocation would be as per the structure suggested in Section 4.4 of Chapter 4. Five divisions namely: Research, Monitoring and Evaluation; Participation and Networking; Communication and Outreach; Legal and Regulation; and General Administration. The Chief Executive Officer, SWMU is to be designated as the head of the unit, responsible for implementation of the various work programmes of the organisation. Representatives from Wetland Mitra will be included in the Advisory Board/ Executive Committee of the SWMU.	Sasthamkotta	SWAK & WMU	

Activities	Description	Sub-activities		Task description	Location	Implementing agency	
						Lead	Support
		1.2.2	*Government notification for constitution*	Issue the necessary government orders and notifications to officially establish the Sasthamkotta Wetland Management Unit, providing it with legal authority and framework to operate and manage wetland conservation efforts effectively. Details on the proposed institutional arrangements are provided in Section 4.4 of the management plan.	Sasthamkotta	SWAK & WMU	
		1.2.3	*Designation of office space and office expenditure*	The WMU office will be created within the premises of proposed wetland interpretation center	Sasthamkotta	SWAK	District Administration of Kollam, Soil Conservation Sasthamkotta office
		1.2.4	*Meetings/ Engagement of the stakeholders/ local community*	The Chief Executive Officer of the SMU will prepare annual plans detailing the year-wise activities to be executed based on the approved IMP. These yearly plans will take into account the year-wise progress of the IMP implementation and address any delays and bottlenecks in the execution of the activities through adaptive planning after seeking suggestions and review. SWAK will consider and approve the annual plans and budgets of the WMU after reviewing progress and monitoring the actions. Organise and conduct meetings with stakeholders and local community members to discuss wetland management plans, gather input, foster collaboration, and ensure community involvement in conservation efforts.	Sasthamkotta	WMU	SWAK

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
1.3	***Wetland Inventory, Assessment, Monitoring System***	WIAMS platform is used as a monitoring and regulatory tool instituted as part of the implementation of the existing approved Management Action Plan	1.3.1	*Establishment of wetland ecosystem monitoring facility*	Setting up a Wetland Ecosystem Monitoring Facility, including site selection and construction, and equipping the center with technology for data collection. It also encompasses staffing, training, and developing monitoring protocols to ensure effective management and analysis of wetland ecosystems.	Sasthamkotta	SWAK	WMU, Wetlands International South Asia, CWRDM
			1.3.2	*Improvement and Maintenance of the WIAMS-Sasthamkotta*	Enhancing and maintaining the Wetland Inventory, Assessment, and Monitoring System (WIAMS) for Sasthamkotta Lake. This includes updating data, improving monitoring protocols, ensuring equipment functionality, and conducting regular maintenance to support effective wetland management and conservation.	Sasthamkotta	SWAK	WMU, Wetlands International South Asia, CWRDM
			1.3.3	*Establishment of hydrological and climatological monitoring stations*	Setting up hydrological and climatological monitoring stations to collect and analyse data on water levels, flow rates, precipitation, and weather conditions. This includes site selection, equipment installation, and data management to support informed decision-making and effective management of water resources.	Sasthamkotta	SWAK	WMU, Wetlands International South Asia, CWRDM
			1.3.4	*Wetland monitoring and evaluation*	Regularly tracking and assessing wetland health by collecting and analysing water quality, vegetation, and biodiversity data. It includes evaluating the data to understand trends and effectiveness of conservation measures and reporting findings for informed management decisions.	WIAMS Web portal	WMU	SWAK, CWRDM, Grama Panchayat, Wetland Mitra

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
			1.3.5	*Wetland Ecosystem Health Card*	The Ecosystem Health Report Card will be prepared to assess and communicate wetland monitoring information to decision-makers and stakeholders and published biannually. The health report card summarises indicators along major indices (water quality, catchment status, biodiversity status), which represent various ecosystem features of the lake and are reported against respective thresholds set in line with the management goals.	Wetlands of India Portal	SWAK	Wetlands International South Asia
			1.3.6	*Publication of monitoring reports*	Preparing and publishing detailed reports on wetland monitoring findings. This includes compiling data, analysing trends, and presenting the results clearly to inform stakeholders and support conservation efforts.	Wetlands of India Portal	SWAK	Wetlands International South Asia
1.4	***Wetland management effectiveness evaluation***	Assessing the impact of management actions on wetland health. It includes collecting and analysing data on conditions, comparing results to goals, and reporting findings to guide improvements in management strategies.	1.4.1	*Constitution of assessment team*	Forming a dedicated team to conduct assessments of wetland ecosystems. This includes selecting and recruiting members with relevant expertise, defining team roles and responsibilities, and ensuring the team is trained and equipped to perform thorough evaluations and reporting.	Sasthamkotta	SWAK & WMU	
			1.4.2	*Workshop for wetland managers and stakeholders*	Organising a workshop for wetland managers and stakeholders. This includes planning the agenda, securing speakers, arranging logistics, and facilitating discussions on best practices, management strategies, and collaborative approaches to wetland conservation.	Kollam	SWAK & WMU	Line departments, Wetlands International South Asia

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
					The goal is to enhance knowledge, share experiences, and foster partnerships for effective wetland management.			
			1.4.3	*MET evaluation*	Conducting a Monitoring, Evaluation, and Tracking (MET) evaluation to assess the performance and impact of wetland management activities. This includes reviewing data, evaluating the effectiveness of management strategies, identifying strengths and areas for improvement, and providing recommendations to enhance wetland conservation efforts.	Sasthamkotta	SWAK & WMU	Line departments, Wetlands International South Asia
			1.4.4	*Dissemination workshops*	Organising dissemination workshops to share findings and insights from wetland research and monitoring. This includes planning the event, preparing presentations and materials, inviting stakeholders, and facilitating discussions to communicate key results and recommendations effectively. The aim is to ensure that research outcomes are widely shared and used to inform and improve wetland management practices.	Sasthamkotta	SWAK & WMU	Line departments, Wetlands International South Asia
1.5	***Capacity development on integrated management***	Capacity development on integrated management involves training stakeholders in integrated management practices for wetlands. It includes workshops to enhance skills, develop educational resources, and provide ongoing support to improve	1.5.1	*Training workshops for wetland managers*	Training workshops for wetland managers involve developing the training curriculum, arranging logistics, delivering sessions on wetland management best practices, and providing tools and resources to enhance managerial skills and effectiveness in wetland conservation.	Sasthamkotta	SWAK & WMU	Wetlands International South Asia, CWRDM

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
		co-ordination and effectiveness in wetland management.	1.5.2	*Training workshops for communities*	Training workshops for communities involve creating educational content, coordinating event logistics, conducting sessions on wetland conservation, and providing practical tools and knowledge to empower community members in protecting and managing local wetland resource	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	SWAK & WMU	Wetlands International South Asia, CWRDM
			1.5.3	*Training workshops for CBOs, SHGs*	Training workshops for CBOs and SHGs involve developing tailored training materials, coordinating logistics, delivering sessions on wetland conservation and management, and equipping these groups with skills and resources to effectively contribute to local wetland protection and sustainable practices.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	SWAK & WMU	Wetlands International South Asia, CWRDM
1.6	***Communication, Education, Participation and Awareness***	CEPA involves sharing information, providing education, engaging stakeholders, and raising public awareness to support wetland conservation and management.	1.6.1	*Development of Wetland Learning Centre*	Creating a Wetland Learning Centre in KSMDB College, including designing and constructing the facility, developing educational programs and exhibits, and setting up resources for interactive learning. The centre aims to educate visitors about wetland ecosystems and promote conservation through hands-on experiences and informative displays.	Sasthamkotta	WISA & WMU	KSMDB College, SWAK
			1.6.2	*Training of students*	Organising and delivering training sessions for students on wetland conservation and management. This includes developing educational materials, conducting interactive workshops, and providing practical experiences to enhance students' understanding and engagement with wetland ecosystems.	Sasthamkotta	WISA & WMU	KSMDB College, SWAK

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
			1.6.3	*Publication of outreach materials*	Creating and distributing outreach materials to raise awareness about wetland conservation. This includes designing and producing brochures, posters, and digital content, as well as managing their distribution to effectively communicate key messages to target audiences.		WMU & SWAK	KSMDB College, Wetlands International South Asia
			1.6.4	*Awareness generation, sensitisation activities*	Organising activities to raise awareness and sensitise the public about wetland conservation includes planning and executing campaigns, workshops, and events to educate people, highlighting the importance of wetlands, and encourage positive actions for their protection.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	SWAK & WMU	KSMDB College, Wetlands International South Asia
	Component 2: Land and Water Resources Management							
2.1	***Develop water allocation plan***	Creating a strategic plan for the equitable distribution and management of water resources, considering both environmental needs and human demands to ensure sustainable use and conservation.	2.1.1	*Meetings and workshops for stakeholders on water allocation planning*	Organising meetings and workshops with stakeholders to discuss and develop a water allocation plan. This includes coordinating sessions, facilitating discussions, and gathering input to ensure that diverse perspectives are considered in the planning process for effective and equitable water resource management.	KWA Sasthamkotta	SWAK & WMU	CWRDM, Wetlands International South Asia, Catchment Conservation Committees
			2.1.2	*Boundary demarcation to prevent encroachment*	Demarcating wetland boundaries to prevent encroachment includes installing physical markers or barriers and setting up a monitoring system to detect and address unauthorised activities. The aim is to protect the wetland from illegal use and ensure its conservation.		WMU, Revenue Divisional Officer & SWAK	CWRDM, Wetlands International South Asia, Catchment Conservation Committees, District Administration of Kollam, Major Irrigation Sasthamkotta

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
2.2	***Catchment conservation***	Protection and management of the catchment area surrounding a wetland to reduce erosion, control runoff, and maintain water quality. It includes implementing soil conservation measures, restoring vegetation, and managing land use practices to sustain the health of the wetland ecosystem.	2.2.1	*Preparation of catchment conservation plans*	Developing detailed catchment conservation plans to protect and manage the area surrounding a wetland. This includes assessing current conditions, identifying key conservation measures, and outlining strategies for soil conservation, vegetation restoration, and sustainable land use to ensure the long-term health of the wetland.		SWAK, Soil Survey & Soil Conservation Department	CWRDM, Wetlands International South Asia, Catchment Conservation Committees
			2.2.2	*Training of stakeholders on catchment conservation*	Organising and delivering training sessions for stakeholders on catchment conservation. This includes preparing educational materials, conducting workshops, and providing practical guidance on implementing conservation practices, managing land use, and protecting the catchment area to enhance wetland health.		SWAK, Soil Survey & Soil Conservation Department	CWRDM, Wetlands International South Asia, Catchment Conservation Committees
			2.2.3	*Treatment of degraded micro-watersheds with vegetative measures*	Rehabilitating degraded micro-watersheds using vegetative measures includes planting native vegetation, restoring riparian zones, and implementing erosion control techniques to improve soil health, enhance water retention, and support ecosystem recovery in the affected areas.		SWAK, Soil Survey & Soil Conservation Department	CWRDM, Wetlands International South Asia, Catchment Conservation Committees
			2.2.4	*Establishment of nursery for seedling raising*	Setting up a nursery for raising seedlings includes selecting a suitable site, preparing soil, installing irrigation systems, and managing the nursery to grow and nurture seedlings for future planting and habitat restoration projects.		WMU	CWRDM, Wetlands International South Asia, Catchment Conservation Committees, Kerala Forest and Wildlife Department (Social Forestry)

Activities	Description	Sub-activities		Task description	Location	Implementing agency	
						Lead	Support
		2.2.5	*Enumeration and cutting of Acacia and Mangium trees through debarking, removal and replanting with native species*	Systematic removal of *Acacia* and *Mangium* trees by debarking and cutting, including the removal of the felled trees. This process is followed by preparing the site and replanting with native tree species to restore ecological balance, improve soil health, and enhance biodiversity. The goal is to replace invasive or non-native species with those that are better suited to the local environment.		WMU, Kerala Forest and Wildlife Department (Social Forestry)	CWRDM, Wetlands International South Asia, Kollam District Administration, Catchment Conservation Committees
		2.2.6	*Management of inlet drains to prevent waste discharge*	Managing inlet drains to prevent the discharge of waste into wetland areas includes monitoring and maintaining drains, installing filtration systems or barriers to trap contaminants, and ensuring proper waste disposal practices (including treating the waste water generated after drinking water treatment by KWA) to protect water quality.		WMU	CWRDM, Wetlands International South Asia, Catchment Conservation Committees, Grama Panchayat Sasthamkotta
		2.2.7	*Desilting of lake*	Desilting the lake to remove accumulated sediment and improve water quality. This includes assessing sediment levels, using machinery or manual methods to extract silt, and properly disposing of the removed material. The process helps restore the lake's depth, enhance its ecological function, and improve water flow and storage capacity.	Based on the recent bathymetry study—probable locations shall be Kuthiramunambu, Rajagiri, Punnakkad, north-east of Velanthara Embankment, east of Ambalakkadavu, behind town Juma Masjid Sasthamkotta	WMU, Major Irrigation Department	CWRDM, Wetlands International South Asia, Catchment Conservation Committees, State Hydrographic Survey

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
			2.2.8	*Augmenting the Waste processing facilities of surrounding local bodies*	Enhancing the waste processing facilities of local bodies surrounding a wetland. This includes upgrading existing infrastructure, increasing processing capacity, and implementing advanced technologies for efficient waste management. The goal is to reduce waste discharge into wetlands, improve local sanitation, and protect environmental quality.	Sasthamkotta GP, West Kallada GP	WMU	CWRDM, Wetlands International South Asia, Catchment Conservation Committees, Sasthamkotta Block Panchayat, Kollam District Panchayat, Suchitwa Mission
Component 3: Species and Habitat Management								
3.1	***Fish and waterbird habitat assessment***	Evaluating habitats for fish and waterbirds to determine their health and suitability. It includes surveying aquatic environments, assessing the quality of breeding and feeding grounds, and collecting data on species presence and habitat conditions. The results help guide conservation efforts and habitat management strategies.	*3.1.1*	*Survey and mapping of fish breeding grounds*	Conducting a survey and creating detailed maps of fish breeding grounds. This includes identifying key spawning areas, collecting data on fish populations and habitats, and using mapping tools to document and visualise these critical sites. This also includes an assessment of Otter population and impacts on the eco-system. The aim is to support conservation efforts and manage aquatic resources effectively.		WMU	SWAK, CWRDM, Grama Panchayats, Kerala University of Fisheries and Ocean Studies (KUFOS), Kerala University
			3.1.2	*Survey and mapping of key waterbird habitats*	Surveying and mapping key waterbird habitats. This includes identifying critical areas for nesting, feeding, and roosting, collecting data on waterbird species and their distributions, and using mapping tools to document these habitats. The goal is to support conservation efforts and ensure effective protection of vital waterbird areas.		WMU	BNHS, Kerala Agricultural University (KAU), Kollam Birding Battalion, Wetlands International South Asia, Grama Panchayats

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
			3.1.3	*Community workshops on habitat management action plan development and its implementation*	Organising community workshops focused on developing and implementing habitat management action plans. This includes facilitating discussions on habitat needs, guiding participants through the planning process, and providing training on effective implementation strategies. The aim is to engage the community in managing and conserving local habitats through collaborative and informed approaches.		WMU	BNHS, Wetlands International South Asia, Grama Panchayats
3.2	***Integration of eco-profiles in PBRs***	Incorporating detailed eco-profiles into People's Biodiversity Registers (PBRs). It includes gathering and documenting information on local ecosystems, species, and conservation status and integrating this data into PBRs to enhance biodiversity management and planning. The aim is to provide a comprehensive view of ecological resources and support informed decision-making for conservation efforts.	3.2.1	*Workshop for the LSG biodiversity management committees and the joint BMC for the Lake*	Organising a workshop for Local Self Government (LSG) biodiversity management committees and the joint Biodiversity Management Committee (BMC) for the lake. This includes facilitating discussions on biodiversity conservation strategies, sharing best practices, and developing collaborative action plans for managing and protecting the lake's ecosystem. The goal is to enhance the capacity of committees to effectively address local biodiversity issues.		BMC, LSGs	SWAK, Kerala State Biodiversity Board (KSBB), WMU
			3.2.2	*Comprehensive updation of the biodiversity registers of each LSG in Sasthamkotta Lake and its ZoI and integration of the same*	Comprehensively updating the biodiversity registers for each Local Self Government (LSG) in the Sasthamkotta Lake area and its Zone of Influence (ZoI). This includes collecting and verifying data on local species and ecosystems, revising the registers accordingly, and integrating the updated information to ensure accurate and comprehensive records for effective biodiversity management and conservation.		BMC, LSGs	SWAK, Kerala State Biodiversity Board (KSBB)

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
3.3	***Management of invasive species***		3.3.1	*Mapping of aquatic habitats*	Mapping aquatic habitats to document their locations and characteristics. This includes using GIS and remote sensing tools to identify and delineate different habitat types and compiling data on their size, condition, and ecological importance. The goal is to create accurate maps that support habitat management and conservation efforts.		WMU	CWRDM, SWAK, Wetlands International South Asia
3.4	***Conducting Asian Waterbird Census***	Organising and conducting the Asian Waterbird Census by surveying waterbird populations, recording data on species and their habitats, and analysing the results to track trends and support conservation efforts.	3.4.1	*Identification of partner for AWC*	Identifying and selecting suitable partners for the Asian Waterbird Census (AWC). This includes researching and evaluating potential organisations or individuals, assessing their expertise and resources, and establishing partnerships to ensure effective collaboration and successful execution of the census.		WMU & SWAK	BNHS, Kerala Agricultural University (KAU), Kollam Birding Battalion, Wetlands International South Asia, Grama Panchayats
			3.4.2	*Training of volunteers*	Training volunteers to assist with fieldwork and data collection for the Asian Waterbird Census. This includes developing and delivering training materials on survey techniques, species identification, and data recording, as well as ensuring volunteers understand their roles and responsibilities for effective and accurate data collection.		WMU	SWAK, Wetlands International South Asia, BNHS, SACON & Kerala Agricultural University (KAU)
			3.4.3	*Conducting mid-winter AWC and monthly observations*	Conducting the mid-winter Asian Waterbird Census (AWC) and performing monthly observations. This includes coordinating field surveys to count waterbird populations during the mid-winter >		WMU	SWAK, Wetlands International South Asia, BNHS,

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
					> period and carrying out regular monthly observations to monitor changes in species numbers and habitat conditions throughout the year.			Grama Panchayats, KAU, & Kollam Birding Battalion
			3.4.4	*Data Collection and Reporting*	Collecting and analysing data from waterbird surveys and observations. This includes recording species counts, habitat conditions, and other relevant metrics and then compiling and reporting the findings to support conservation efforts and inform stakeholders about waterbird populations and trends.		WMU	SWAK, Wetlands International South Asia, BNHS, SACON
Component 4: Nature Tourism								
4.1	***Installation of signages***	Installing signages around wetland areas to provide information and guidelines. This includes designing and placing signs to educate the public, mark boundaries, and discourage harmful activities to support conservation efforts.	*4.1.1*	*Designing of signages*	Designing signages for wetland areas to effectively communicate important information. This includes creating visually clear and informative graphics, selecting appropriate materials for durability, and ensuring the signs convey messages on conservation practices, boundaries, and rules to guide and educate the public.	Sasthamkotta	WMU & SWAK	Wetlands International South Asia
			4.1.2	*Fabrication & Installation of eco-friendly signages*	Fabricating and installing eco-friendly signages for wetland areas. This includes selecting and using sustainable materials for sign production, ensuring durability and minimal environmental impact, and installing the signs in appropriate locations to provide clear information and guidelines for conservation and public awareness.		WMU	Grama Panchayats, CWRDM, WISA

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
			4.1.3	*Refurbishment of a building to house the WMU & to serve as wetland interpretation centre*	Refurbishing a building to accommodate the Wetland Management Unit (WMU) and serve as a Wetland Interpretation Centre. This includes renovating the space to create functional offices and educational areas, installing exhibits and interactive displays, and ensuring the facility supports both management operations and public education on wetland conservation.		SWAK	Grama Panchayats, Kollam District Panchayat, Soil Conservation Sasthamkotta office, WISA
			4.1.4	*Electric Boat*	Developing and deploying an electric boat for use in wetland areas. This includes designing and constructing the boat to operate on electric power, ensuring it is environmentally friendly and suitable for navigating wetland waters, and implementing it for tasks such as monitoring, research, and eco-friendly transportation.		WMU & SWAK	Grama Panchayats, DTPC, Sasthamkotta Block Panchayat, Kollam District Panchayat
4.2	***Capacity Building***	Enhancing skills and knowledge for promoting and managing nature tourism. It includes training stakeholders in sustainable tourism practices, developing eco-tourism programs, and improving visitor engagement to ensure responsible and impactful tourism that benefits both the environment and local communities.	4.2.1	*Identification of youth & Wetland Mitras for nature guides*	Identifying and selecting youth and wetland enthusiasts to serve as nature guides. This includes recruiting individuals with a passion for wetlands, providing training on guiding techniques and conservation knowledge, and preparing them to lead educational tours and engage visitors effectively in wetland conservation efforts.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU, SWAK, Wetland Learning Center	Grama Panchayats, Wetlands International South Asia, Line Departments

Activities		Description	Sub-activities		Task description	Location	Implementing agency	
							Lead	Support
			4.2.2	*Training for nature guides*	Conducting training sessions for nature guides to equip them with essential skills and knowledge. This includes providing instruction on guiding techniques, ecological information, communication strategies, and visitor engagement to ensure they can effectively lead tours and educate the public about wetland ecosystems.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU	SWAK, Grama Panchayats, Wetlands International South Asia, Line Departments
			4.2.3	*Per diem for nature guides*	Managing the per diem arrangements for nature guides. This includes calculating and disbursing daily allowances to cover their expenses during tours or training sessions, ensuring timely payments, and maintaining records of per diem expenditures for budgeting and accountability.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU	SWAK, Grama Panchayats, Wetlands International South Asia, Line Departments
Component 5: Livelihoods								
5.1	***Micro-enterprise development for wetland products***	Supporting the creation and growth of small businesses focused on wetland products. It includes providing training, resources, and market access to entrepreneurs, enabling them to sustainably produce and sell items derived from wetland resources, thereby promoting local livelihoods and conservation.	*5.1.1*	*Formation of SHGs/FBOs/ CBOs*	Forming Self-Help Groups (SHGs), Farmer-Based Organisations (FBOs), and Community-Based Organisations (CBOs) to support wetland conservation and sustainable livelihoods. This includes mobilising community members, facilitating group formation, providing training on group management, and offering resources to ensure these groups can effectively collaborate and engage in conservation activities and income-generating projects.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU	SWAK, Grama Panchayats, Kudumbasree Mission

Activities	Description	Sub-activities		Task description	Location	Implementing agency	
						Lead	Support
		5.1.2	*Training workshop for wetlands products-based livelihoods*	Organising training workshops focused on developing livelihoods based on wetland products. This includes providing participants with skills and knowledge on sustainable harvesting, processing, and marketing of wetland resources, as well as offering guidance on business development to support income generation while promoting conservation.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU	SWAK, Grama Panchayats, Kudumbasree Mission
		5.1.3	*Incentives to local fishermen for fish net*	Providing incentives to local fishermen for using sustainable fishing nets. This includes distributing eco-friendly nets that minimise environmental impact, offering financial or material support to encourage adoption, and educating fishermen on the benefits of sustainable fishing practices to protect wetland ecosystems and ensure long-term fishery resources.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU	SWAK, Grama Panchayats, Fisheries Department
		5.1.4	*Septic tank installation/ retrofitting for selected households*	Installing or retrofitting septic tanks for selected households to improve sanitation and protect wetland water quality. This includes assessing household needs, coordinating the installation or upgrade of septic systems, and ensuring they meet environmental standards to prevent contamination of nearby wetlands.	Sasthamkotta, West Kallada, Mynagapally Grama Panchayats	WMU	SWAK, Grama Panchayats, Suchitwa Mission

08

Budget

8.1 COMPONENT-WISE BUDGET

Implementation of the management action plan as outlined in Chapter 7 entails a budget of ₹ 16.7 crore over a period of five years. Of the total funds, 67.3% are earmarked for land and water resource management and 21% for institutions and governance. The components of nature tourism, species and habitat management and livelihood have been allocated 6.4%, 2.3%, and 3% of the funds, respectively.

Component-wise funds requirement is presented in Table 8.1.

Table 8.2 provides an overview of the analysis of the activity-wise budget. Of the total budget of ₹ 16.7 crore, ₹ 12.5 crores is requested to core components of NPCA and the rest, ₹ 4.2 crores is requested to non-core components.

Table 8.1 | Budget Summary

Year-wise budget (in Lakhs)						
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Total**
Component 1. Institutions and Governance	106.4	61.6	60.7	60.7	61.2	350.6
Component 2. Land and Water Resources Management	411.5	351	144.5	142.5	72.5	1122
Component 3. Species and Habitat Management	15.8	8.3	4.7	4.7	4.7	38.2
Component 4. Nature Tourism	61.9	16.4	9.4	9.4	9.4	106.5
Component 5. Livelihood	10.7	10.7	10.2	10.2	8.4	50
Total	**606.3**	**448**	**229.5**	**227.5**	**156.2**	**1667.3**

Table 8.2 | Detailed activity-wise budget

Activities		Sub-activities		NPCA Core/ Non-Core	Unit	Physical target	Rate per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	*Total*
								(in lakhs)					
Component 1: Institutions and Governance													
1.1	**Enrolling and training of Wetland Mitras**	1.1.1	*Developing list of potential members in consultation with community*	NPCA-Core	Number of meetings	2	50,000	1					***1***
		1.1.2	*Meeting to onboard Wetland Mitras*	NPCA-Core	Number of meetings	1	50,000	0.5					***0.5***
		1.1.3	*Capacity building workshop for Wetland Mitras*	NPCA-Core	Number of workshops	10	50,000	1	1	1	1	1	***5***
1.2	**Establishment of WMU**	1.2.1	*Appointment of staff*	NPCA Non-Core	Number of years	5	45,60,000	45.6	45.6	45.6	45.6	45.6	***228***
		1.2.2	*Government notification for constitution*										
		1.2.3	*Designation of office space and office expenditure*	NPCA Non-Core			L/S	10	1	1	1	1	***14***
		1.2.4	*Meetings/Engagement of the stakeholders/local community*	NPCA Core	Number of meetings	5	50,000	0.5	0.5	0.5	0.5	0.5	***2.5***
1.3	**Wetland Inventory, Assessment, Monitoring System**	1.3.1	*Establishment of wetland ecosystem monitoring facility*	NPCA Core			L/S	15					***15***
		1.3.2	*Improvement and Maintenance of the WIAMS-Sasthamkotta Lake*	NPCA Core			L/S	5					***5***
		1.3.3	*Establishment of hydrological and climatological monitoring stations*	NPCA Core	Number of stations	1	10,00,000	10					***10***
		1.3.4	*Wetland monitoring and evaluation*	NPCA Core		5	L/S	5	5	5	5	5	***25***

Activities		Sub-activities		NPCA Core/ Non-Core	Unit	Physical target	Rate per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	*Total*
								(in lakhs)					
		1.3.5	*Wetland Ecosystem Health Card*	NPCA Core	Per workshop	5	50,000	0.5	0.5	0.5	0.5	0.5	***2.5***
		1.3.6	*Publication of monitoring reports*	NPCA Core	Number of Reports	10	30,000	0.6	0.6	0.6	0.6	0.6	***3***
1.4	***Wetland management effectiveness evaluation***	1.4.1	*Constitution of assessment team*	NPCA Core									
		1.4.2	*Workshop for wetland managers and stakeholders*	NPCA Core	Number of workshops	1	2,00,000	2					***2***
		1.4.3	*MET evaluation*	NPCA Core	Number of reports	10	25,000	0.5	0.5	0.5	0.5	0.5	***2.5***
		1.4.4	*Dissemination workshops*	NPCA Core	Number of workshops	2	50,000		0.5			0.5	***1***
1.5	***Capacity development on integrated management***	1.5.1	*Training workshops for wetland managers*	NPCA Non-Core	Number of workshops	1	40,000	0.4					***0.4***
		1.5.2	*Training workshops for communities*	NPCA Non-Core	Number of workshops	1	40,000	0.4					***0.4***
		1.5.3	*Training workshops for CBOs, SHGs*	NPCA Non-Core	Number of workshops	2	40,000	0.4	0.4				***0.8***
1.6	***Communication, Education, Participation and Awareness***	1.6.1	*Development of Wetland Learning Centre*	NPCA Core	Number of meetings	2	1,00,000	2					***2***
		1.6.2	*Training of students*	NPCA Core	Number of trainings	10	75,000	1.5	1.5	1.5	1.5	1.5	***7.5***

Activities		Sub-activities		NPCA Core/ Non-Core	Unit	Physical target	Rate per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	*Total*
								(in lakhs)					
		1.6.3	Publication of outreach materials	NPCA Core	Number of outreach materials	10	1,50,000	3	3	3	3	3	***15***
		1.6.4	Awareness generation, sensitisation activities	NPCA Core	Number of activities	10	75,000	1.5	1.5	1.5	1.5	1.5	***7.5***
								106.4	***61.6***	***60.7***	***60.7***	***61.2***	***350.6***
Component 2: Land and Water Resources Management													
2.1	***Develop water allocation plan***	*2.1.1*	*Meetings and workshops for stakeholders on water allocation planning*	NPCA Core	Number of meetings	1	50,000	0.5					***0.5***
		2.1.2	*Boundary demarcation to prevent encroachment*	NPCA Core	Km	22	1,50,000	16.5	16.5				***33***
2.2	***Catchment conservation***	*2.2.1*	*Preparation of catchment conservation plans*	NPCA Core	Meetings for plan preparation	1	1,00,000	1					***1***
		2.2.2	*Training of stakeholders on catchment conservation*	NPCA Core	Number of trainings	1	1,00,000	1					***1***
		2.2.3	*Treatment of degraded micro-watersheds with vegetative measures*	NPCA Core	Per Ha	685	1,00,000	190	190	77	75	65	***597***
		2.2.4	*Establishment of nursery for seedling raising*	NPCA Core			L/S	5	2				***7***
		2.2.5	*Enumeration and Cutting of Acacia and Mangium trees through debarking, removal and replanting with native species*	NPCA Core	Per Ha	80	2,50,000	125	75				***200***

Activities		Sub-activities		NPCA Core/ Non-Core	Unit	Physical target	Rate per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	*Total*
								(in lakhs)					
		2.2.6	*Regular monitoring and removal of Acacia and Mangium sapling*	NPCA Core	Per Ha	80	75,000			60	60		***120***
		2.2.7	*Management of inlet drains to prevent waste discharge*	NPCA Core	Number of drains	6	2,50,000	7.5	7.5	2.5	2.5	2.5	***22.5***
		2.2.8	*Desilting of lake*	NPCA Core	per Ha	20	5,00,000	50	50				***100***
		2.2.9	*Augmenting the Waste processing facilities of surrounding local bodies*	NPCA Non-Core			L/S	15	10	5	5	5	***40***
								411.5	***351***	***144.5***	***142.5***	***72.5***	*1122*
Component 3: Species and Habitat Management													
3.1	***Fish and waterbird habitat assessment***	3.1.1	*Survey and mapping of fish breeding grounds and Otter population*	NPCA Core	Per survey	1	5,00,000	5					***5***
		3.1.2	*Survey and mapping of key waterbird habitats*	NPCA Core	Per survey	1	3,00,000	3					***3***
		3.1.3	*Community workshops on habitat management action plan development and its implementation*	NPCA Core	Per workshop	2	50,000	0.5	0.5				***1***
3.2	***Integration of eco-profiles in PBRs***	3.2.1	*Workshop for the LSG biodiversity management committees and the joint BMC for the Lake*	NPCA Non-Core	Per workshop	1	50,000		0.5				***0.5***
		3.2.2	*Comprehensive updation of the biodiversity registers of each LSG in Sasthamkotta Lake and its ZOI and integration of the same*	NPCA Non-Core	Per sitting	16	20,000	1	1	0.4	0.4	0.4	***3.2***
3.3	***Management of invasive species***	3.3.1	Mapping of aquatic habitats	NPCA Core	Per survey	2	2,00,000	2	2				***4***

	Activities		Sub-activities	NPCA Core/ Non-Core	Unit	Physical target	Rate per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	*Total*
								(in lakhs)					
3.4	***Conducting Asian Waterbird Census***	3.4.1	Identification of partner for AWC	NPCA Core									
		3.4.2	Training of volunteers	NPCA Core	per training	5	20,000	0.2	0.2	0.2	0.2	0.2	***1***
		3.4.3	Conducting mid-winter AWC and monthly observations	NPCA Core	per census	60	30,000	3.6	3.6	3.6	3.6	3.6	***18***
		3.4.4	Data Collection and Reporting	NPCA Core	Per report	5	50,000	0.5	0.5	0.5	0.5	0.5	***2.5***
								15.8	***8.3***	***4.7***	***4.7***	***4.7***	***38.2***
			Component 4: Nature Tourism										
4.1	***Installation of signages***	4.1.1	*Designing of signages*	NPCA Core	per design	2	25,000	0.5					***0.5***
		4.1.2	*Fabrication & Installation of eco-friendly signages*	NPCA Core	per signage	8	50,000	2	2				***4***
		4.1.3	*Refurbishment of a building to house the WMU & to serve as wetland interpretation centre*	NPCA Core			L/S	25	5				***30***
		4.1.4	*Electric Boat*	NPCA Core	Per boat	2	L/S	25					***25***
4.2	***Capacity Building***	4.2.1	*Identification of youth & Wetland Mitras for nature guides*	NPCA Non-Core									
		4.2.2	*Training for nature guides*	NPCA Non-Core	Per training	5	40,000	0.4	0.4	0.4	0.4	0.4	***2***
		4.2.3	*Per diem for nature guides*	NPCA Non-Core	Per Guide	6	1,50,000	9	9	9	9	9	***45***

Activities		Sub-activities	NPCA Core/ Non-Core	Unit	Physical target	Rate per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Total
							(in lakhs)					
							61.9	**16.4**	**9.4**	**9.4**	**9.4**	***106.5***
Component 5: Livelihoods												
5.1	***Micro-enterprise development for wetland products***	*5.1.1* *Formation of SHGs/FBOs/CBOs*	NPCA Non-Core	per meeting	10	25,000	0.5	0.5				***1***
		5.1.2 *Training workshop for wetlands products-based livelihoods*	NPCA Non-Core	per workshop	10	25,000	0.5	0.5	0.5	0.5	0.5	***2.5***
		5.1.3 *Incentives to local fishermen for fish net*	NPCA Non-Core	per net	75	6,000	0.9	0.9	0.9	0.9	0.9	***4.5***
		5.1.4 *Septic tank installation/ retrofitting for selected households*	NPCA Non-Core	Per households	120	35,000	8.75	8.75	8.75	8.75	7	***42***
							10.7	***10.7***	***10.2***	***10.2***	***8.4***	***50***
						Total	***606.3***	***448***	***229.5***	***227.5***	***156.2***	***1667.3***

8.2 FINANCE

The implementation of the integrated management plan is proposed to be through funds provided by the MoEFCC (under the NPCA), the government of Kerala (in the form of state's share) and funds leveraged by building convergence with ongoing schemes of other departments.

In order to effectively and efficiently allocate resources, interventions have been planned to follow a phased strategy. On immediate priority is formulating a Wetland Mitra Network and catchment treatment through vegetative measures in Sasthamkotta Lake. In the medium term, interventions for reorganising the regulatory basis of wetland management in line with management zoning, enhancing nature tourism, and improving the livelihoods of wetland-dependent communities would be a priority.

Strengthening the institutional basis for wetland management through building capacity and creating awareness at all levels would also form a part of this phase. In the long term, it is expected that catchment treatment and revising institutional arrangements would provide conducive environments for nature-tourism development and upscaling management to Sasthamkotta. Table 8.3 provides a year-wise phasing of activities for integrated management of the Sasthamkotta Lake.

Table 8.3 | Year-wise phasing of activities

Activities		Sub-activities		Year 1				Year 2				Year 3				Year 4				Year 5			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Component 1: Institutions and Governance																							
1.1	***Enrolling and training of Wetland Mitras***	1.1.1	Developing list of potential members in consultation with community																				
		1.1.2	Meeting to onboard Wetland Mitras																				
		1.1.3	Capacity building workshop for Wetland Mitras																				
1.2	***Establishment of WMU***	1.2.1	Appointment of staff																				
		1.2.2	Government notification for constitution																				
		1.2.3	Designation of office space and office expenditure																				
		1.2.4	Meetings/Engagement of the stakeholders/local community																				
1.3	***Wetland Inventory, Assessment, Monitoring System***	1.3.1	Establishment of wetland ecosystem monitoring facility																				
		1.3.2	Improvement and Maintenance of the WIAMS-Sasthamkotta Lake																				
		1.3.3	Establishment of hydrological and climatological monitoring stations																				
		1.3.4	Wetland monitoring and evaluation																				

Activities		Sub-activities		Year 1				Year 2				Year 3				Year 4				Year 5			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
		1.3.5	Wetland Ecosystem Health Card																				
		1.3.6	Publication of monitoring reports																				
1.4	***Wetland management effectiveness evaluation***	1.4.1	Constitution of assessment team																				
		1.4.2	Workshop for wetland managers and stakeholders																				
		1.4.3	MET evaluation																				
		1.4.4	Dissemination workshops																				
1.5	***Capacity development on integrated management***	1.5.1	Training workshops for wetland managers																				
		1.5.2	Training workshops for communities																				
		1.5.3	Training workshops for CBOs, SHGs																				
1.6	***Communication, Education, Participation and Awareness***	1.6.1	Development of Wetland Learning Centre																				
		1.6.2	Training of students																				
		1.6.3	Publication of outreach materials																				
		1.6.4	Awareness generation, sensitisation activities																				

Activities		Sub-activities		Year 1				Year 2				Year 3				Year 4				Year 5			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Component 2: Land and Water Resources Management																							
2.1	***Develop water allocation plan***	2.1.1	Meetings and workshops for stakeholders on water allocation planning																				
		2.1.2	Boundary demarcation to prevent encroachment																				
2.2	***Catchment conservation***	2.2.1	Preparation of catchment conservation plans																				
		2.2.2	Training of stakeholders on catchment conservation																				
		2.2.3	Treatment of degraded micro-watersheds with vegetative measures																				
		2.2.4	Establishment of nursery for seedling raising																				
		2.2.5	Enumeration and Cutting of Acacia and Mangium trees through debarking, removal and replanting with native species																				
		2.2.6	Regular monitoring and removal of Acacia and Mangium sapling																				
		2.2.6	Management of inlet drains to prevent waste discharge																				
		2.2.7	Desilting of lake																				
		2.2.8	Augmenting the Waste processing facilities of surrounding local bodies																				

Activities		Sub-activities		Year 1				Year 2				Year 3				Year 4				Year 5			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Component 3: Species and Habitat Management																							
3.1	***Fish and waterbird habitat assessment***	3.1.1	Survey and mapping of fish breeding grounds																				
		3.1.2	Survey and mapping of key waterbird habitats																				
		3.1.3	Community workshops on habitat management action plan development and its implementation																				
3.2	***Integration of eco-profiles in PBRs***	3.2.1	Workshop for the LSG biodiversity management committees and the joint BMC for the Lake																				
		3.2.2	Comprehensive updation of the biodiversity registers of each LSG in Sasthamkotta Lake and its ZOI and integration of the same																				
3.3	***Management of invasive species***	3.3.1	Mapping of aquatic habitats																				
3.4	***Conducting Asian Waterbird Census***	3.4.1	Identification of partner for AWC																				
		3.4.2	Training of volunteers																				
		3.4.3	Conducting mid-winter AWC and monthly observations																				
		3.4.4	Data Collection and Reporting																				

	Activities		Sub-activities	Year 1				Year 2				Year 3				Year 4				Year 5			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Component 4: Nature Tourism																							
4.1	***Installation of signages***	4.1.1	Designing of signages																				
		4.1.2	Fabrication & Installation of eco-friendly signages																				
		4.1.3	Refurbishment of a building to house the WMU & to serve as wetland interpretation centre																				
		4.1.4	Electric Boat																				
4.2	***Capacity Building***	4.2.1	Identification of youth & Wetland Mitras for nature guides																				
		4.2.2	Training for nature guides																				
		4.2.3	Per diem for nature guides																				
Component 5: Livelihoods																							
5.1	***Micro-enterprise development for wetland products***	5.1.1	Formation of SHGs/FBOs/ CBOs																				
		5.1.2	Training workshop for wetlands products-based livelihoods																				
		5.1.3	Incentives to local fishermen for fish net																				
		5.1.4	Septic tank installation/ retrofitting for selected households																				

References

Census of India, 2011. Primary Census Abstract – Kerala. New Delhi: Office of the Registrar General and Census Commissioner, Ministry of Home Affairs, Government of India.

CGWB, 2013. Ground Water Information Booklet of Kollam District, Kerala State. [Technical Reports: Series 'D']. Kerala: Central Ground Water Board (CGWB), Ministry of Water Resources, Government of India.

Chithra, S., Joseph, S. and Kannan, N., 2022. A study of saltwater intrusion in the Kallada River, southwest coast of Kerala, India. Water Supply, 22(2), pp.2194-2211.

CWRDM, 1995. Water Atlas of Kerala. Kozhikode, Kerala: Centre for Water Resources Development and Management (CWRDM).

CWRDM, 2010. Sasthamcotta Wetland: Management Action Plan. Kozhikode, Kerala: Centre for Water Resources Development and Management (CWRDM).

DoF, 2011. Panfish Book: Kollam District. Thiruvananthapuram, Kerala: Department of Fisheries (DoF), Government of Kerala.

DoLR, 2015. Operational Guidelines for Convergence of Various Programmes with Integrated Watershed Management Programme (IWMP). New Delhi: Department of Land Resources (DoLR), Ministry of Rural Development, Government of India.

DoT, 2014. Kerala Tourism Statistics 2014. Kerala: Research and Statistics Division, Department of Tourism (DoT), Government of Kerala.

Finlayson, C. M., Davidson, N., Pritchard, D., Milton, G. R. and MacKay, H., 2011. The Ramsar Convention and ecosystem-based approaches to the wise use and sustainable development of wetlands. Journal of International Wildlife Law and Policy, 14, pp.176-198.

Finlayson, C. M., 2012. Forty years of wetland conservation and wise use. Aquatic Conservation: Marine and Freshwater Ecosystems, 22(2), pp.139-143.

Gehring, T. and Oberthür, S., 2008 . Interplay: Exploring Institutional Interaction. In: Young, O. R., King, L. A. and Schroeder, H. eds., Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers. Cambridge, Massachusetts: MIT Press, pp.187-223.

George, A. V. and Koshy, M., 2008. Water quality studies of Sasthamkotta Lake of Kerala. Pollution Research, 27(3), pp.419-424.

Girijakumari, S., Abraham, N. P. and Santhosh, S., 2006. Assessment of faecal indicating bacteria of Sasthamkotta Lake. Indian Hydrobiology, 9(2), pp.159-167.

Girijakumari, S., 2007. Resource potential of Sasthamkotta Lake with special reference to fish fauna and their sustainability. Ph. D. Thesis. Mahatma Gandhi University.

Gumbricht, T., 2015. Hybrid mapping of pantropical wetlands from optical satellite images, hydrology and geomorphology. In: Tiner, R. W., Lang, M. W. and Klemas, V. V. eds., Remote Sensing of Wetlands: Applications and Advances. Boca Raton, Florida: CRP Press, Taylor and Francis Group.

Irshad, S. M., 2015. Cashing in on Natural Resource Mismanagement: A Study on Depleting Sasthamkotta Fresh Water Lake in Kerala. Natural Resources and Conservation, 3(3), pp.50-56.

Joseph, M. L., 1994. Ecology of Sasthamkotta Lake. Ph. D. Thesis. University of Kerala.

Joseph, T. B., Kumar, U. S., Deodhar, A. S. and Mohokar, H. V., 2003. Environmental isotope investigation on a fresh water lake and its catchments. In: Singh, V. P. and Yadava, R. N. eds., Advances in Hydrology. New Delhi: Allied Publishers, pp.387-394.

Kerala Forests and Wildlife Department, 2010. Forest Statistics 2009. Thiruvananthapuram: Kerala Forests and Wildlife Department. Available at: <http://www.forest.kerala.gov.in/index.php?option=com_content&task=view&id=439&Itemid=147> [Accessed 10 December 2016].

Krishnakumar, K. N., Prasada Rao, G. S. L. H. V. and Gopakumar, C. S., 2009. Rainfall trends in twentieth century over Kerala, India. Atmospheric Environment, 43, pp.1940-1944.

Kuriakose, S. L., 2013. Land Subsidence and Earth Fissures in West Kallada Area of Kollam District. Thiruvananthapuram, Kerala: Department of Revenue and Disaster Management, Government of Kerala, Institute of Land and Disaster Management.

Kurup, B. M., Radhakrishnan, K. V. and Manojkumar, T. G., 2004. Biodiversity status of fishes inhabiting rivers of Kerala (S. India) with special reference to endemism, threats and conservation measures. In: Welcomme, R. L. and Petr, T. eds., 2004. Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume 2. [RAP Publication 2004/17]. Phnom Penh, Kingdom of Cambodia, 11-14 February 2003. Bangkok, Thailand: FAO Regional Office for Asia and Pacific.

KWA, 2013. Improvement of WSS to Kollam Corporation with Njankadavu in Kallada River as source – Proposal. Kollam, Kerala: Kerala Water Authority (KWA).

Ministry of Environment, Forest and Climate Change, Government of India, 2024. Wetland Wise Use: An implementation framework.

Nair, K. M., Padmalal, D. and Kumaran, K. P. N., 2006. Quaternary geology of South Kerala Sedimentary Basin – an outline. Journal of Geological Society of India, 67(2), pp.165-179.

Nair, K. M., Padmalal, D., Kumaran, K. P. N., Sreeja, R., Limaye, R. B. and Srinivas R., 2010. Late quaternary evolution of Ashtamudi–Sasthamkotta lake systems of Kerala, south west India. Journal of Asian Earth Sciences, 37(4), pp.361-372.

Nayar, M. P., Alexander, T. and Thushara, L., 2011. Biodiversity and Conservation of Sasthamkotta Fresh Water Lake of Kerala. Dehradun: Bishen Singh Mahendra Pal Singh.

Palmer, C. M., 1980. Algae and Water Pollution. England: Castle House Publication Limited. p.123.

Pillai, K. N. R., 1981. Studies on some aspects of ecology of larval chaoborus in lake Sasthamkotta. M.Phil Dissertation. University of Kerala.

Pournami, P., 1*, Ajeev, J., Lekshmi, L., Zoology Research Centre, St. Stephen's College, Pathanapuram, University of Kerala, India, Zoology Research Centre, St. Stephen's College, Pathanapuram, University of Kerala, India, & Department of Zoology, Sree Narayana College, Kollam, Kerala, India, 2022. Distribution and abundance of planktonic organisms of Sasthamkotta Lake, Kerala, India. YMER, 10, 1312–1313

Prakasam, V. R. and Joseph, M. L., 1991. Lake Sasthamkotta: Water sediment interaction and productivity. In: Proceedings of the Third Kerala Science Congress. Kozhikode, India, 28 February – 3 March 1991.

Qureshy, M. N., 1981. Gravity anomalies isostasy and crust–mantle relations in the Deccan trap and contiguous regions, India. In: Subba Rao, K. V. and Sukheswala, R. N. eds., 1981. Deccan Volcanism and Related Basalt Provinces in Other Parts of the World. Karnataka: Geological Society of India, pp. 184-197.

Rajesh, K. G. and Chetty, T. R. K., 2006. Structure and tectonics of the Achankovil Shear Zone, southern India. Gondwana Research, 10(1-2), pp.86-98.

Ramsar Convention Secretariat, 1996. Resolution VI.1: Working Definitions of Ecological Character, Guidelines for Describing and Maintaining the Ecological Character of Listed Sites, and Guidelines for Operation of the Montreux Record. In: Proceedings of the 6th Meeting of the Conference of the Contracting Parties. Brisbane, Australia, 19-27 March 1996. Gland, Switzerland: Ramsar Convention Secretariat.

Ramsar Convention Secretariat, 2010a. Managing wetlands: Frameworks for managing Wetlands of International Importance and other wetland sites. Ramsar handbooks for the wise use of wetlands. [4th edition]. vol. 18. Gland, Switzerland: Ramsar Convention Secretariat.

Ramsar Convention Secretariat, 2010b. River basin management: Integrating wetland conservation and wise use into river basin management. Ramsar handbooks for the wise use of wetlands. [4th edition]. vol. 9. Gland, Switzerland: Ramsar Convention Secretariat.

Ramsar Convention Secretariat, 2010c. Inventory, assessment, and monitoring: an Integrated Framework for wetland inventory, assessment, and monitoring. Ramsar handbooks for the wise use of wetlands. [4th edition]. vol. 13. Gland, Switzerland: Ramsar Convention Secretariat.

Ramsar Convention Secretariat, 2010d. Wise use of wetlands: Concepts and approaches for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands. [4th edition]. vol. 1. Gland, Switzerland: Ramsar Convention Secretariat.

Ramsar Convention Secretariat, 2015. Resolution XII.15: Evaluation of the management and conservation effectiveness of Ramsar Sites. In: 12th Meeting of the Conference of the Parties to the Convention on Wetlands (Ramsar, Iran, 1971). Punta del Este, Uruguay, 1-9 June 2015. Gland, Switzerland: Ramsar Convention Secretariat.

RCSE-SU and ILEC, 2014. Development of ILBM Platform Process: Evolving Guidelines through Participatory Improvement. [Second Edition]. Otsu, Japan: Research Center for Sustainability and Environment, Shiga University (RCSE-SU) and International Lake Environment Committee Foundation (ILEC).

Reuter, M., Piller, W. E., Harzhauser, M., Kroh, A., Rogl, F. and Coric, S., 2010. The Quilon Limestone, Kerala Basin, India: an archive for Miocene Indo-Pacific seagrass beds. Lethaia, DOI: 10.1111/j.1502-3931.2010.00226.x.

SAC, 2010. National Wetland Atlas: Kerala. [SAC/RESA/AFEG/NWIA/ATLAS/14/2010]. Ahmedabad: Space Applications Centre (SAC), Indian Space Research Organisation (ISRO). p. 130

Sreejith, S., 1998. Hydrochemistry of the Sasthamcotta Lake, Kollam District, Kerala, with special reference to sediment-water interaction. In: Proceedings of the Tenth Kerala Science Congress. Kozhikode, 2 – 4 January 1998.

Sreekumari, V. M., John, S. E., Rajan, R. T., Kesavan, M., Kurian, S. and Damodaran, P., 2015. Human interventions and consequent environmental degradation of a protected freshwater lake in Kerala, SW India. Geosciences Journal.

Thomas, P. A., Abraham, T. and Abraham, K. G., 1980. Preliminary report on the fish fauna of Sasthamkotta Lake. In: Alexander, K. M. ed., 1980. Proceedings of the All India Symposium on Environmental Biology. 27-29 December, 1977. Kerala, India: Department of Zoology, University of Kerala.

Warrier, C. U., 2007. Environmental isotope signatures of the largest freshwater lake in Kerala. In: Venkataramani, B., Puranik, V. D., Apte, S. K., Gour, H. N., Sharma, S.K., Sharma, L. L., Durve, V. S., Gupta, H. C. L., Verma, P. C. and Sharma, B. K. eds., 2007. Proceedings of DAE-BRNS National Symposium on Limnology (NSL-07). Udaipur, Rajasthan, 19-21 February 2007. Mumbai: Board of Research in Nuclear Sciences, Department of Atomic Energy, Government of India. pp.400-403.

WWF-India and AWB, 1993. Directory of Indian Wetlands. New Delhi: World Wide Fund for Nature, India (WWF India) and Kuala Lumpur: Asian Wetland Bureau (AWB).

Annexes

WATER BALANCE

It is an equation used to describe the flow of water in and out of the system. It is basically a statement of law of conservation of matter as applied to the hydrological cycle. It states that all water entering in a specified area must be there in storage or withdrawn from there only. The general water balance equation is

$I - O = \pm \Delta S$

Where I = Total Inflow, O = Total Outflow, ΔS = Change in Storage

Here, the total inflow is combination of Rainfall, Runoff, city inflow and groundwater interchange. The outflow is the combination of evaporation throughout and the withdrawal for the city water supply.

$I = P + Rf + GWi + Wi$

Where I = Total Inflow, P = Precipitation/Rainfall, Rf = Runoff, GWi = Ground Water Interaction, Wi = Water inflow

$O = E + Wo$

Where O = Total Outflow, E = Evaporation of lake water, Wo = Water Withdrawal Outflow

From the above equation, the water balance can be re-written as: -

$(P + Rf + GWi + Wi) - (E + Wo) = +-\Delta S$

Knowing the inflow and the outflow data like rainfall, waste inflow, evaporation, water withdrawal& the lake level from various sources like the Indian Metrological Department (IMD) & Kerala Water Authority (KWA), the groundwater interchange was calculated with the help of water balance. For all the above cases the lake level is assumed to be 13 m at the starting of December, when both the south-west and north-east monsoon are over so the lake level is at its higher limit for the year, when the lake bed is not exposed. The various scenarios given below gives us an idea how reduction in rainfall is affecting the inundation pattern of the lake, thus stating the importance of rainfall in the system, which is on a declining trend of the last few years.

WATER BALANCE OF SASTHAMKOTTA RAMSAR SITE (2023)

Month	Outflow due to abstraction	Groundwater exchange	Evapotranspiration	Runoff from local watershed	Precipitation	Change in storage	Lake volume
January	0.86	-0.34	0.12	0.00	0.08	-1.24	19.31
February	0.77	-0.29	0.15	0.03	0.04	-1.16	19.57
March	0.97	-0.10	0.34	0.12	0.23	-1.06	19.28
April	0.94	1.20	0.46	0.50	0.43	0.74	19.12
May	0.97	1.71	0.38	0.93	0.62	1.91	21.16
June	0.94	-0.07	0.45	0.66	0.51	-0.29	21.78
July	0.86	-0.07	0.19	1.36	0.81	1.04	22.41
August	0.87	3.67	0.45	0.01	0.06	2.42	19.56
September	0.84	-2.81	0.51	2.36	1.21	-0.59	19.14
October	0.86	-2.57	0.57	3.13	1.51	0.64	16.42
November	0.83	-0.98	0.46	2.27	1.17	1.17	19.83
December	0.84	-1.93	0.22	1.33	0.79	-0.88	19.67

Annex III

PHYTOPLANKTON RECORDED IN SASTHAMKOTTA LAKE

(Source: Pournami et al, 2022)

Chlorophyceae

1. *Pediastrum tetras*
2. *Pediastrum angulosum*
3. *Cosmarium conspersum*
4. *Chlorella vulgaris*
5. *Treubaria triappendiculata*
6. *Tetraendron triangular*
7. *Synechocystis pevalekii*
8. *Chlorosterium ehrenbergii*
9. *Zygnema*

Bacillariophyceae

10. *Eunotia pectinalis*
11. *Achanthes exigua*
12. *Navicula panhagarhensis*
13. *Nitschia fonticola*
14. *Peridinum thorianum*
15. *Euglena polymorpha*
16. *Gomophonema abbreviatum*
17. *Cocconeis*
18. *Cyclotella*

Cyanophyceae

19. *Aphanothece microscopica*
20. *Microcystis aeruginosa*
21. *Oscillatoria subbrevis*
22. *Nostoc*
23. *Anabena*

ZOOPLANKTON RECORDED IN SASTHAMKOTTA LAKE

(Source: Pournami et al, 2022)

Protozoa

1. *Euglena asus*
2. *Amoeba*
3. *Didinum nasutum*
4. *Colpoda cucullus*
5. *Paramoecium*
6. *Stentor coerleus*
7. *Glenodinum cinctum*
8. *Chlorogonium euchlorum*

Rotifera

9. *Brachionus quadridentus*
10. *Brachionus caudate*
11. *personatus*
12. *Philodena citrina*
13. *Lepadella crestata*
14. *Keratella*

Arthropoda

15. *Artema salina*
16. *Allona dhiloni*
17. *Chirocephalus priscus*
18. *Simocephalus*
19. *acutirostratus*
20. *Trichocera porcellus*
21. *Moina*
22. *Calanus*
23. *Diaptomus*
24. *Cyclops*

Annex V

MACROPHYTES RECORDED IN SASTHAMKOTTA LAKE

(Source: Nayar et al., 2011 and Field Assessment, 2015)

Acanthaceae

1. *Hygrophila auriculata* (Schumach.) Heine

Aponogetonaceae

2. *Aponogeton natans* (L.) Engl. & K.Krause

Araceae

3. *Colocasia esculenta* (L.) Schott
4. *Pistia* sp.

Convolvulaceae

5. *Ipomoea aquatica* Forssk.

Hydrocharitaceae

6. *Hydrilla verticillata* (L.f.) Royle
7. *Vallisneria spiralis* L.
8. *Blyxa octandra* (Roxb) Planch. ex Thwaites

Lentibulariaceae

9. *Utricularia reticulata* Sm.
10. *Menyanthaceae*
11. *Nymphoides indica* (L.) Kuntze

Nymphaeaceae

12. *Nymphaea stellata*

Poaceae

13. *Hygroryza aristata* (Retz.) Nees ex Wight & Arn.
14. *Paspalidium geminatum* (Forssk.) Stapf
15. *Oryza rufipogon* Griff.

Pontederiaceae

16. *Eichhornia crassipes* (Mart.) Solms
17. *Monochoria vaginalis* (Burm.f.) C.Presl

Salviniaceae

18. *Salvinia molesta* D. S. Mitch.

Scrophulariaceae

19. *Limnophila heterophylla* (Roxb.) Benth.

TERRESTRIAL VEGETATION RECORDED AROUND SASTHAMKOTTA LAKE

(Source: Nayar et al., 2011)

Acanthaceae

1. *Barleria prionitis*

Amaranthaceae

2. *Achyranthes aspera* L.
3. *Aerva lanata* (L.) Juss. ex Schult.
4. *Amaranthus spinosus* L.

Anacardiaceae

5. *Anacardium occidentale* L.
6. *Holigarna arnottiana* Wall. ex Hook. fil.
7. *Lannea coromandelica* (Houtt.) Merr.
8. *Mangifera indica* L.

Annonaceae

9. *Annona squamosa* L.

Apiaceae

10. *Centella asiatica* (L.) Urb.

Apocynaceae

11. *Allamanda cathartica* L.
12. *Alstonia scholaris* (L.) R.Br.
13. *Calotropis gigantea* (L.) W. T. Aiton
14. *Cerbera odollam* Gaertn.
15. *Hemidesmus indicus* (L.) R. Br.
16. *Plumeria alba* L.
17. *Tabernaemontana heyneana* Wall.
18. *Vinca rosea* L.

Araceae

19. *Alocasia indica* (Lour.) Spach
20. *Amorphophallus paeoniifolius* (Dennst.) Nicolson
21. *Amorphophallus* sp.
22. *Colocasia esculenta* (L.) Schott

Arecaceae

23. *Areca catechu* L.
24. *Borassus flabellifer* L.
25. *Calamus rotang* L.
26. *Caryota urens* L.
27. *Cocos nucifera* L.

Asparagaceae

28. *Agave americana* L.
29. *Asparagus racemosus* Willd.

Asteraceae

30. *Ageratum conyzoides* subsp. *houstonianum* (Mill.) M.Sharma
31. *Elephantopus scaber* auct. non L.
32. *Emilia sonchifolia* (L.) DC. ex Wight
33. *Eupatorium odoratum* Walter
34. *Spilanthes calva* DC.
35. *Vernonia cinerea* (L.) Less.

Balsaminaceae

36. *Impatiens balsamina* L.

Bignoniaceae

37. *Pajanelia longifolia* (Willd.) K.Schum.
38. *Spathodea campanulata* Beauv.

Bromeliaceae

39. *Ananas comosus* (L.) Merr.

Campanulaceae

40. *Lobelia trigona* Roxb.

Caricaceae

41. *Carica papaya* L.

Casuarinaceae

42. *Casuarina equisetifolia* L.

Clusiaceae

43. *Calophyllum inophyllum* L.
44. *Garcinia gummi-gutta* (L.) N. Robson

Colchicaceae

45. Gloriosa superba L.

Combretaceae

46. Terminalia catappa L.

47. Terminalia paniculata Roth

Convolvulaceae

48. Ipomoea carnea

49. Ipomoea repens (L.) Lam.

50. Merremia tridentata (L.) Hall. fil.

Cucurbitaceae

51. Cucurbita pepo L.

52. Cucurbita sp.

53. Luffa acutangula (L.) Roxb.

54. Momordica charantia

55. Trichosanthes dioica Roxb.

Cyperaceae

56. Cyperus rotundus L.

Dennstaedtiaceae

57. Pteridium sp.

Dipterocarpaceae

58. Hopea parviflora Bedd.

Droseraceae

59. Drosera burmanni Vahl

Euphorbiaceae

60. Hevea brasiliensis (Willd. ex A.Juss.) Müll.Arg.

61. Jatropha curcas L.

62. Jatropha glandulifera Roxb.

63. Macaranga peltata (Roxb.) Müll.Arg.

64. Manihot esculenta Crantz

65. Ricinus communis L.

Fabaceae

66. Acacia auriculiformis Benth.

67. Acacia mangium Willd.

68. Albizia chinensis (Osbeck) Merr.

69. Bauhinia purpurea L.

70. Butea monosperma (Lam.)Taub.

71. Caesalpinia pulcherrima (L.)Sw.

72. Cassia fistula L.

73. Cassia leschenaultii Wall.

74. Cassia occidentalis (L.)Rose

75. Cassia tora sensu auct.

76. Clitoria ternatea L.

77. Delonix regia (Hook.) Raf.

78. Desmodium sp.

79. Entada rheedii Spreng.

80. Mimosa pudica L.

81. Mucuna pruriens (L.)DC.

82. Peltophorum pterocarpum (DC.) K.Heyne

83. Sesbania grandiflora (L.)Pers.

84. Tamarindus indica L.

Flacourtiaceae

85. Hydnocarpus pentandrus (Buch.-Ham.) Oken

Lamiaceae

86. Anisomeles sp.

87. Clerodendrum viscosum Vent., nom. superfl.

88. Leucas aspera (Willd.) Link

89. Ocimum sanctum L.

90. Tectona grandis L.f.

91. Vitex negundo L.

Lauraceae

92. Cinnamomum malabathrum Miq.

93. Cinnamomum zeylanicum Nees

Lecythidaceae

94. Barringtonia racemosa Spreng.

Loganiaceae

95. Strychnos nux-vomica L.

Lomariopsidaceae

96. Nephrolepis sp.

Lythraceae

97. Lagerstroemia reginae Roxb.

98. Lawsonia inermis L.

Malvaceae

99. Abutilon sp.

100. Ceiba pentandra (L.) Gaertn.

101. Grewia nervosa (Lour.) G. Panigrahi

102. Hibiscus rosa-sinensis L.

103. Sida cordifolia L.

104. Thespesia populnea (L.) Soland. ex Correa

Melastomataceae

105. Osbeckia virgata D. Don ex Wight & Arn.

Meliaceae

106. Aphanamixis polystachya (Wall.) R.N. Parker

107. Azadirachta indica A. Juss.

108. Naregamia alata Wight & Arn.

Menispermaceae

109. Cyclea peltata Hook. fil. & Thoms.

Moraceae

110. Artocarpus communis J. R. & G. Forst.

111. Artocarpus heterophyllus Lam.

112. Artocarpus hirsutus Lam.

113. Artocarpus incisus (Thunb.) L. fil.

114. Ficus benghalensis L.

115. Ficus racemosa L.

116. Ficus religiosa L.

Moringaceae

117. Moringa pterygosperma Gaertn.

Musaceae

118. Musa paradisiaca L.

Myristicaceae

119. Myristica fragrans Houtt.

Myrtaceae

120. Eucalyptus globulus Labill.

121. Psidium guajava L.

122. Syzygium cumini (L.) Skeels

123. Syzygium zeylanicum (L.) DC.

Nyctaginaceae

124. Boerhavia diffusa L.

Oxalidaceae

125. Averrhoa bilimbi L.

126. Biophytum sensitivum (L.) DC.

127. Oxalis corniculata L.

Pandanaceae

128. Pandanus odoratissimus L.f.

Pedaliaceae

129. Sesamum sp.

Phyllanthaceae

130. Emblica officinalis Gaertn.

131. Phyllanthus amarus Schumach. & Thonn.

132. Phyllanthus emblica L.

Piperaceae

133. Piper nigrum L.

Plantaginaceae

134. Scoparia dulcis L.

Poaceae

135. Bambusa arundinacea Willd.

136. Cymbopogon flexuosus (Nees ex Steud.) W.Watson

137. Cynodon dactylon (L.) Pers.

138. Oryza rufipogon Griff.

139. Pennisetum polystachion (L.) Schult.

Rhamnacea

140. Ziziphus oenopolia (L.) Mill.

Rubiaceae

141. Ixora coccinea L.

142. Morinda tinctoria Noronha, nom. inval.

143. Mussaenda frondosa L.

144. Plectronia parviflora Harv. & Sond.

Rutaceae

145. Citrus maxima (Burm. fil.) Osbeck

146. Glycosmis pentaphylla (Retz.) Correa

147. Murraya koenigii (L.) Spreng.

Sapindaceae

148. Cardiospermum halicacabum L.

Sapotaceae

149. Manilkara zapota (L.) P.Royen

Scrophulariaceae

150. Bacopa monnieri (L.) Wettst.

Simaroubaceae

151. Ailanthus triphysa (Dennst.) Alston

Verbenaceae

152. Citharexylum spinosum L.

153. Lantana camara L.

154. Stachytarpheta indica (L.) Vahl

Violaceae

155. Hybanthus enneaspermus (L.) F. Müll.

Xanthorrhoeaceae

156. Aloe vera (L.) Burm.f.

Zingiberaceae

157. Curcuma longa L.

158. Zingiber officinale Roscoe

INSECTS (BUTTERFLIES) RECORDED IN SASTHAMKOTTA LAKE

(Source: Nayar et al., 2011 and Field Assessment, 2015)

Acanthaceae

1. BaLycaenidae

1. Freyeria trochylus (Freyer, 1845)

2. Lampides boeticus (Linnaeus, 1767)

3. Rathinda amor (Fabricius, 1775)

Nymphalidae

4. Danaus chrysippus Linnaeus, 1758

5. Danaus genutia Cramer, 1779

6. Euploea core Cramer, 1780

7. Junonia atlites Linnaeus, 1763

8. Junonia hierta (Fabricius, 1798)

9. Mycalesis perseus Fabricius, 1775

10. Neptis hylas Linnaeus, 1758

11. Orsotriaena medus Fabricius, 1775

12. Tirumala limniace Cramer, 1775

13. Ypthima baldus Fabricius, 1775

14. Ypthima huebneri Kirby, 1871

Papilinoidae

15. Graphium agamemnon (Linnaeus, 1758)

16. Graphium sarpedon (Linnaeus, 1758)

17. Pachliopta aristolochiae (Fabricius, 1775)

18. Papilio demoleus Linnaeus, 1758

19. Papilio clytia lanata Fruhstorfer, 1907

Pieridae

20. Catopsilia pomona (Fabricius, 1775)

21. Delias eucharis (Drury, 1773)

22. Eurema hecabe (Linnaeus, 1758)

23. Leptosia nina (Fabricius, 1793)

Annex VIII

FISH SPECIES RECORDED IN SASTHAMKOTTA LAKE

S.no	Order/Family/Genus/Species/ Vernacular Name/IUCN Red List Status	
1	**Order: CICHLIFORMES** **Family:** Cichlidae *Etroplus suratensis* (Bloch 1790) **Common Name:** Pearl Spot **Vernacular name:** കരിമീന് **IUCN Red List Status:** LC	
2	**Order:** CICHLIFORMES **Family:** Cichlidae *Pseudetroplus maculatus* (Bloch 1795) **Common Name:** Orange Chromide **Vernacular name:** പള്ളത്തി **IUCN Red List Status:** LC	
3	**Order:** PERCIFORMES **Family:** Ambassidae *Parambassis dayi* (Bleeker 1874) **Common Name:** Glassy Perchlet **Vernacular name:** ഡേ ഗ്ലാസ്മത്സ്യം **IUCN Red List Status:** NE	
4	**Order:** ANABANTIFORMES **Family:** Channidae *Channa diplogramma* (Day 1865) **Common Name:** Tiger Snakehead **Vernacular name:** പുലിവാക **IUCN Red List Status:** VU *Species show morphological variations at various points of their life cycle. There is a distinct Ontogenic colour pattern seen in juveniles to adult individuals	  

S.no	Order/Family/Genus/Species/ Vernacular Name/IUCN Red List Status	
5	**Order:** ANABANTIFORMES **Family:** Channidae *Channa pseudomarulius* (Gunther 1861) **Common Name:** Giant Snakehead **Vernacular name:** ഡറുമീന് **IUCN Red List Status:** NE	
6	**Order:** ANABANTIFORMES **Family:** Channidae *Channa striata* (Bloch 1793) **Common Name:** Striped Snakehead **Vernacular name:** വരാല് **IUCN Red List Status:** LC	
7	**Order:** CYPRINIFORMES **Family: Cyprinidae** *Dawkinsia filamentosa* (Valenciennes 1844) **Common Name:** Filament Barb **Vernacular name:** പൂവാലി പരല് **IUCN Red List Status:** LC	 
8	**Order:** SILURIFORMES **Family:** Bagridae *Mystus occulatus* (Valenciennes 1840) **Common Name:** Spotted Mystus **Vernacular name:** മുട്ടിക്കൂരി **IUCN Red List Status:** LC	
9	**Order:** SILURIFORMES **Family:** Siluridae *Ompok malabaricus* (Valenciennes 1840) **Common Name:** Malabar Butter Catfish **Vernacular name:** പുലലുവാള IUCN Red List Status: LC	
10	**Order:** SILURIFORMES **Family:** Horabagridae *Horabagrus brachysoma* (Gunther 1864) **Common Name:** Yellow Catfish **Vernacular name:** മഞ്ഞക്കൂരി**IUCN Red List Status:** VU	

S.no	Order/Family/Genus/Species/ Vernacular Name/IUCN Red List Status	
11	**Order:** SILURIFORMES **Family:** Heteropneustidae *Horabagrus brachysoma* (Bloch 1794) **Common Name:** Stinging Catfish **Vernacular name:** കാരി **IUCN Red List Status:** LC	
12	**Order:** BELONIFORMES **Family:** Belonidae *Xenentodon cancila* (Hamilton 1822) **Common Name:** Needlefish **Vernacular name:** ഡകാലാന്റ് IUCN Red **List Status:** LC	
13	**Order:** CYPRINODONTIFORMES **Family:** Aplocheilidae *Aplocheilus lineatus* (Valenciennes 1846) **Common Name:** Striped Panchax **Vernacular name:** മാനത്തുകണ്ണി **IUCN Red List Status:** LC	
14	**Order:** CLUPEIFORMES **Family:** Clupeidae *Dayella malabarica* (Day 1873) **Common Name:** Day's Round Herring **Vernacular name:** ഡയേടെ ഉരുളന്റ് ടനഡത്താലി **IUCN Red List Status:** LC	
15	**Order:** SYNBRANCHIFORMES **Family:** Mastacembelidae *Macrognathus guentheri* (Day 1865) **Common Name:** Malabar Spiny Eel **Vernacular Name:** ആരകൻ **IUCN Red List Status:** LC	
16	**Order:** PERCIFORMES **Family:** Nandidae *Nandus nandus* (Hamilton 1822) **Common Name:** Leaf-Fish **Vernacular Name:** കരിയില മീൻ **IUCN Red List Status:** LC	

WATERBIRDS RECORDED AT SASTHAMKOTTA LAKE

Species	Common Name	Family	IUCN status
Haliastur indus	Brahminy Kite	Accipitridae	LC
Alcedo atthis	Common Kingfisher	Alcedinidae	LC
Nettapus coromandelianus	Cotton Pygmy-Goose	Anatidae	LC
Anhinga melanogaster	Oriental Darter	Anhingidae	NT
Ardea purpurea	Purple Heron	Ardeidae	LC
Ixobrychus sinensis	Yellow Bittern	Ardeidae	LC
Bubulcus ibis	Cattle Egret	Ardeidae	LC
Ardeola grayii	Indian Pond-heron	Ardeidae	LC
Egretta garzetta	Little Egret	Ardeidae	LC
Hirundo rustica	Barn Swallow	Hirundinidae	LC
Hydrophasianus chirurgus	Pheasant-tailed Jacana	Jacanidae	LC
Phalacrocorax fuscicollis	Indian Cormorant	Phalaropidae	LC
Amaurornis phoenicurus	White-breasted Waterhen	Rallidae	LC
Tringa glareola	Wood Sandpiper	Scolopacidae	LC

Annex X

PANCHAYAT WARD CONNECTED WITH SASTHAMKOTTA LAKE

	Sasthamkotta		West Kallada		Mayangapally		*Total*	
Ward Number	HH	Population	HH	Population	HH	Population	*HH*	*Population*
1.	-	-	-	-	-	-	-	-
2.	-	-	-	-	-	-	-	-
3.			482	1,960	-	-	*482*	*1,960*
4.	535	2,133	348	1,404	-	-	*883*	*3,537*
5.	-	-	551	2,078	-	-	*551*	*2,078*
6.	527	1,930	334	1,397	-	-	*861*	*3,327*
7.	-	-	-	-	-	-	-	-
8.	516	1,981	-	-	327	1,372	*843*	*3,353*
9.	522	2,022	-	-	501	2,082	*1,023*	*4,104*
10.	479	1,768	-	-	-	-	*479*	*1,768*
11.	495	1,888	-	-	-	-	*495*	*1,888*
12.	367	1,398	-	-	-	-	*367*	*1,398*
13.	-	-	-	-	-	-	-	-
14.	-	-	-	-	-	-	-	-
15.	-	-	-	-	-	-	-	-
16.	-	-	-	-	-	-	-	-
17.	-	-	-	-	-	-	-	-
18.	547	2,189	-	-	-	-	*547*	*2,189*
Total	**3,988**	**15,309**	**1,715**	**6,839**	**828**	**3,454**	***6,531***	***25,602***

ECOLOGICAL CHARACTER DESCRIPTION

Feature	ECD Descriptor	*Indicator*	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
Physical Regime	Wetland boundary	*Total Ramsar Site area*	ha	365.91	Ramsar Information Sheet	373	Ramsar Information Sheet	Revised to exclude the inundation area adjoining Velanthara Embankment	Unassessed
		Shape		Inverted L-shape	Ramsar Information Sheet	Inverted L-shape	Ramsar Information Sheet	No change	No change
		Total area of Ramsar Site area notified under Wetlands Rules	notified or not; if yes area in ha	Not notified		Not notified			Unassessed
		Zone of Influence as per Wetland Rules	Demarcated or not	Demarcated 1124.89 ha	Brief Document by SWAK, 2023				Unassessed
	Location	*Administrative location*	Nearest district/Grama Panchayats	Kollam	Ramsar Information Sheet				
		Biogeographic location	BGZ	Western Ghats	Ramsar Information Sheet				
	Topographic setting	*Maximum elevation*	m amsl	~40	Google Earth Imagery, 2022	~40	Google Earth Imagery, 2013	No change	No change
		Minimum elevation	m amsl	~18	Google Earth Imagery, 2023	~18	Google Earth Imagery, 2014	No change	No change

Feature	ECD Descriptor	*Indicator*	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Soils	*% Organic*	%	2.5 - 6.5	Soil Grid Data, 2020	No historical assessment		No historical data to establish a trend	Unassessed
	Wetland types	*Marsh area in post-monsoon (Intermittent and Permanent)*	% of total Ramsar Site area	12.27	LULC analysis, 2022	29	LULC analysis, 2013	Reduction	Adverse
	Non-wetland habitats	*Area of non-wetland habitats in Ramsar Sites*	Ha	21.36	LULC analysis, 2022	19.62	LULC analysis, 2000	No significant change	No significant change
	Climate	*Pre-monsoon precipitation (Feb-May)*	mm	625.64	India-WRIS; 2023	420.75	India-WRIS; 2002	Significant increase	Unassessed
		Post-monsoon precipitation (Oct-Jan)	mm	605.92	India-WRIS, 2023	809.51	India-WRIS; 2002	Significant reduction	Unassessed
		Monsoon precipitation (June-Sep)	mm	871.59	India-WRIS, 2023	654.22	India-WRIS; 2002	Significant increase	Unassessed
		Average number of rainy days	days/year	260	India-WRIS, 2023	247	India-WRIS; 2002	Increase	Unassessed
		Average number of rainy days in monsoon	days	103	India-WRIS, 2023	98	India-WRIS; 2002	Increase	Unassessed
		Mean Annual precipitation	mm	2001.56	India-WRIS, 2023	1884.15	India-WRIS, 2002	Increase	Unassessed
		Post-monsoon Average Maximum temperature (Oct-Jan)	Degree Celsius	29.42	NASA Power Data, 2022	30.85	NASA Power Data, 2002	No significant change	No significant change
		Post-monsoon Average Minimum temperature (Oct-Jan)	Degree Celsius	19.91	NASA Power Data, 2022	19	NASA Power Data, 2002	No significant change	No significant change

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
		Pre-monsoon Average Maximum temperature (Feb- May)	Degree Celsius	34.53	NASA Power Data, 2022	36.86	NASA Power Data, 2002	No significant change	No significant change
		Pre-monsoon Average Minimum temperature (Feb-May)	Degree Celsius	20.49	NASA Power Data, 2022	21.6	NASA Power Data	No significant change	No significant change
		Monsoon Average Maximum temperature (Jun-Sep)	Degree Celsius	29.06	NASA Power Data, 2022	29.67	NASA Power Data	No significant change	No significant change
		Monsoon Average Minimum temperature (Jun-Sep)	Degree Celsius	22.51	NASA Power Data, 2022	22.37	NASA Power Data	No significant change	No significant change
		Mean Annual temperature	Degree Celsius	27.86	NASA Power Data, 2022	27.69	NASA Power Data	No significant change	No significant change
		Pre-monsoon Evapotranspiration	mm	355.1	India-WRIS, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Post-monsoon Evapotranspiration	mm	364.43	India-WRIS, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Monsoon Evapotranspiration	mm	427.67.17	India-WRIS, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Mean Annual Evapotranspiration	mm	1227.52	India-WRIS, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Number of extreme events	Number	9	EMDAT Public, 2013-2022	8	EMDAT Public, 1993-2002	Increase	Adverse

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
		Maximum wetland area inundated (Post-monsoon)	ha	310.8	Water balance assessment, 2022	210	Centre for Earth Sciences, 2003	Increase	Positive
		Minimum wetland area inundated (Pre-monsoon)	ha	299.7	Water balance assessment, 2022	373	Centre for Earth Sciences, 2003	Reduction	Adverse
		Wetland area permanently inundated for 12 months	%	40.64%	Global Surface Water	No historical assessment	Centre for Earth Sciences, 2003	No historical data to establish a trend	Unassessed
		Wetland completely inundated for 6 months	%	63.04%	Global Surface Water	No historical assessment	Centre for Earth Sciences, 2003	No historical data to establish a trend	Unassessed
	Source of water	*Total annual inflow*	MCM	20.16	Water balance assessment, 2023	29.10	1905-2015: IMD; 1997-2015: Kerala Water Authority (KWA)	Reduction	Adverse
	Water destination	*Total annual outflow*	MCM	14.83	Water balance assessment, 2023	29.10	1905-2015: IMD; 1997-2015: Kerala Water Authority (KWA)	Reduction	Adverse
	Water quality	*Temperature*	Degree celsius	31.8 – 38.7	SWAK-WIAMS, 2024	27.63 - 31.5 °C	Kerala State Pollution Control Board, 2011-2014	Increase	Adverse
		pH		6.92 – 8.29	SWAK-WIAMS, 2024	6.45 - 7.36	Kerala State Pollution Control Board, 2011-2014	Slight increase	Adverse

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
		DO	mg/l	5.42 – 8.0	SWAK-WIAMS, 2024	5.72 - 8.06	Kerala State Pollution Control Board, 2011-2014	Slight decrease	Not much impact
		Hardness	mg/l	12.0 - 24	Kani Kani & Raj S, 2018	8 - 10.85	Kerala State Pollution Control Board, 2011-2014	Increase	Adverse
		TDS	mg/l	43.56 – 88.9	SWAK-WIAMS, 2024	21.5 - 24.19	Kerala State Pollution Control Board, 2011-2014	Increase	Adverse
		Nitrate	mg/l	1.32 - 1.70	SWAK-WIAMS, 2024	0.02 - 0.49	Kerala State Pollution Control Board, 2011-2014	Increase	Adverse
		Phosphate (mg/l)	mg/l	0.01 - 0.12	SWAK-WIAMS, 2024	0.0012 - 0.0559	Kerala State Pollution Control Board, 2011-2014	Increase	Adverse
		Specific conductivity	mmho/cm	64.80 - 124.4	SWAK-WIAMS, 2024	44 - 303.6	Kerala State Pollution Control Board, 2011-2014	Decrease	Positive
	Groundwater	*Groundwater level*	mbgl	8.74 m bgl pre monsoon 7.04 m bgl post monsoon	WRIS-CGWB, 2023	8.02 m bgl pre monsoon 7.19 m bgl post monsoon	Central Ground Water Board, 2013	Decrease	Adverse

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Hydrological structures	*Number of inlets*	Number	0	Murali & Sheeba, 2022	0	Girijakumari, 2007	No change	No change
		Number of outlets	Number	0	Murali & Sheeba, 2022	0	Girijakumari, 2007	No change	No change
		Number of hydraulic structures	Number	1, Velanthara Embankment	IMP (Chapter-2 Section 2.3), 2017	1, Velanthara Embankment	IMP (Chapter-2 Section 2.3), 2017	No change	No change
	Sediment load	*Sediment deposited*	cm/year	0.18 - 1.81	IMP (Chapter-2 Section 2.3), 2017	0.30 - 1.80	Warrier, 2007	No significant change	No significant change
	Storage	*Average annual storage*	MCM	23.8	SWAK Interim Report - Fish Data 2021	30.45	Chackacherry & Jayakumar, 2011	Reduction	Adverse
Direct Catchment	Significant Land Use and Land Cover within watershed of the wetland	*Area*	ha	~1125	LULC analysis 2022	~1125	LULC analysis 1988	No change	No change
		Area under agriculture	% of catchment area	12.89	LULC analysis 2022	4.36	LULC analysis 1988	Increase	Adverse
		Area under settlement	% of catchment area	5.0	LULC analysis 2022	0.4	LULC analysis 1988	Increase	Adverse
		Area under marsh	% of catchment area	8.6	LULC analysis 2022	11.3	LULC analysis 1988	Reduction	Adverse
		Area under plantation	% of catchment area	40.6	LULC analysis 2022	43.4	LULC analysis 1988	Reduction	Adverse
		Area under wetlands	% of catchment area	32.8	LULC analysis 2022	39.8	LULC analysis 1988	Reduction	Adverse

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Species and habitats	*Wetland habitats*	Habitat types	Wetland, marsh, plantation, agriculture	LULC analysis, 2022	Wetland, marsh, plantation, open area	LULC analysis, 1988	No significant change	No significant change
		Phytoplankton abundance	Number	23	P. Pournami et al., 2022	37	Girijakumari, 2007	Reduction	Adverse
		Macrophyte abundance	Number	12	Field Survey, 2024	18	Nayar et al., 2011 and Field Survey, 2015	Reduction	Positive
		Vascular plant abundance	Number						Data gap
		Zooplankton abundance	Number	22	P. Pournami et al., 2022	28	Nayar et al., 2011)	Reduction	Adverse
		Rotifer abundance	Number	5	P. Pournami et al., 2022	No historical assessment		No historical data to establish a trend	Unassessed
		Annelid abundance	Number	0	ZSI, 2021				Unassessed
		Arachnid abundance	Number	0	ZSI, 2021				Unassessed
		Crustacean abundance	Number	0	ZSI, 2021				Unassessed
		Arthropod abundance	Number	9	P. Pournami et al., 2022	No historical assessment		No historical data to establish a trend	Unassessed
		Mollusc abundance	Number	0	ZSI, 2021				Unassessed
		Odonate abundance	Number	0	ZSI, 2021				Unassessed

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
		Lepidoptera abundance	Number	No current assessment		23	Nayar et al., 2011	No current data to establish a trend	Unassessed
		Coleopteran abundance	Number	0	ZSI, 2021				Unassessed
		Hemipteran abundance	Number	0	ZSI, 2021				Unassessed
		Amphibian abundance	Number						Data gap
		Fish abundance	Number	16	SWAK-KUFOS Report - Fish Data, 2022	36	Girijakumari, 2007 and Nayar et al., 2011	Reduction	Adverse
		Reptile abundance	Number						Data gap
		Mammalian abundance	Number						Data gap
		Waterbird Abundance	Number	14	Asian Waterbird Census, 2022	35	Asian Waterbird Census *(for the year 2012), CWRDM (2010) and ERRC (2010)*	Reduction	Adverse
		Migratory waterbird abundance	Number	1	Asian Waterbird Census, 2022	No historical assessment		No historical data to establish a trend	Unassessed
		Resident bird abundance	Number	13	Asian Waterbird Census, 2022	No historical assessment		No historical data to establish a trend	Unassessed

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
		Abundance of species of High Conservation Value	Number	4 Fish species 1 Water bird species	Brief Document by SWAK, 2023	3 Fish species 2 Water bird species	Asian Waterbird Census (for the year 2012), CWRDM (2010) and ERRC (2010)	Increase	Positive
Ecosystem Processes	Primary production	*Rate of carbon sequestered*	mg / C /m3/ day	No current assessment		0.072 - 4.5	2004-05: Girijakumari	No current data to establish a trend	Unassessed
	Nutrient cycling	*Rate of matter produced*							Data gap
	Carbon cycling	*Rate of carbon produced*							Data gap
	Notable species interactions	*Presence of grazers/ parasites/ pathogens/ pollinators and others*							Data gap
Ecosystem Services	Water for drinking	*Freshwater withdrawal for drinking purpose*	MLD	37.5	Kerala Water Authority, 2022	30	Kerala Water Authority, 2015	Increase	Adverse
	Wetland fisheries	*Annual Fish catch*	T/Year	2	SWAK-KUFOS Report - Fish Data 2024	10	SWAK-KUFOS Report - Fish Data 2024	Reduction	Adverse
		Number of economically important fish species	Number	24	SWAK-KUFOS Report - Fish Data 2024	30	SWAK-KUFOS Report - Fish Data 2024	Reduction	Adverse

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Wetland agriculture	*Total production*	MT						Data gap
	Fodder	*Total harvest*	MT						Data gap
		Fodder for grazing	kg/year						Data gap
	Groundwater	*Total annual recharge*	MCM						Data gap
	Flood protection	*Value of assets lost to flood*	INR						Data gap
	Carbon sequestration	*Annual increase in carbon stock*	MT						Data gap
	Mineral Resources	*Minerals*	kg/year						Data gap
		Ornamental resources	kg/year						Data gap
	Regulatory services	*Flood regulation*	Number of assets lost in the flood						Data gap
		Carbon sequestration	tonnes						Data gap

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Cultural services	*No. of tourist and religious sites*	Number	2	Ecosystem Services Shared Value Assessment, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Number of tourists	Number	1000/month	Ecosystem Services Shared Value Assessment, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Inland navigation	Number						Data gap
Wetlands Livelihood	Wetland-dependent livelihood	*No. of people living within the Ramsar Site*	Number	300-400 Households	Ecosystem Services Shared Value assessment, 2023	No historical assessment		No historical data to establish a trend	Unassessed
		Population deriving livelihoods directly from wetlands	Number						Data gap
		Number of fishermen registered in Co-operative society	Number	No current assessment		155	Socioeconom-ic Survey, 2015	No current data to establish a trend	Unassessed
		Number of fishers	Number	9	Field Survey 2025, Fisheries Extension Officer, Thevalakkara Mathsyabhavan, Sasthamkotta			No historical data to establish a trend	Unassessed
		Number of people collect shells from wetlands	Number	0	Field Survey 2024			No historical data to establish a trend	Unassessed
		Number of people harvest fuelwood and fodder	Number	0	Field Survey 2024			No historical data to establish a trend	Unassessed

Feature	ECD Descriptor	*Indicator*	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
		Number of livestock local grazers	Number						Data gap
		Number of farmers	Number						Data gap
	Socio-economic condition of wetland-dependent communities	*Literacy rate within wetland dependent Grama Panchayats*	%	85	IMP (Chapter-2 Section 2.5), 2017	No historical assessment		No historical data to establish a trend	Unassessed
		Poverty rate within wetland dependent Grama Panchayats	%						Data gap
		Coverage of sanitation facility in Grama Panchayats around Ramsar Site	%	99	IMP (Chapter-2 Section 2.5), 2017	No historical assessment		No historical data to establish a trend	Unassessed
		Access to safe drinking water	% households	80	IMP (Chapter-2 Section 2.5), 2017	No historical assessment		No historical data to establish a trend	Unassessed
Institutions and Governance	Dedicated Govt dept for Site management		List	State Wetland Authority Kerala (SWAK)	IMP (Chapter 3, Section 3.3), 2017	Kollam Municipality	Ramsar Information Sheet (rsis.ramsar.org) 2002	Change to a statutory authority	Positive
	Management plan availability		List	Yes, Integrated Management Plan, 2017 and the IMP recently got expired in 2022		No historical assessment			

Feature	ECD Descriptor	*Indicator*	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Violations of existing rules		Number						Data gap
	Number of licensed boats		Number	2	Ecosystem Services Shared Value Assessment, 2023	No historical assessment		No historical data to establish a trend	Unassessed
	No of unlicensed boats		Number	Nil					Positive
	Community-based organisations linked with wetland		List	Sasthamkotta Lake Protection Council, 'Paristhiti Samraksha-na Ekopana Samithi', and 'Kayalkoot-tayma', Kerala Sastra Sahitya Parishad (KSSP)	Ecosystem Services Shared Value Assessment, 2023	Sasthamkotta Lake Protection Action Council Paristhithi-Samrakshana Ekopana Samithi	2015	Increase	Positive

Feature	ECD Descriptor	Indicator	Units	Current Condition	Data Source and Year	Historical condition	Data Source and Year	Long Term Change/ future projections	Change description and evaluation (Adverse, Positive, No change, Not evaluated)
	Protection status	*Protected area (Wildlife sanctuary)*	ha	Not Applicable		Not Applicable			
		Protected area (Wildlife sanctuary)	% of Ramsar Site area	Not Applicable		Not Applicable			
	Ownership	*Ownership*		Government of Kerala	IMP (Chapter-3 Section 3.2), 2017	Government of Kerala	Ramsar Information Sheet (rsis.ramsar.org) 2002	No Change	No Change

Influence ⊙ Impact ★

	Ability to Maintain values								Ability to influence threats															
Key departments and organisations	Maintaining hydrological connectivity		Maintaining migration corridors		Sustainable Livelihoods		Wetland positive behaviour		Physical regime alteration		Structural Modification		Introduction		Unsustainable extraction		Local climate change impact		Ability to support management through knowledge		Ability to influence knowledge, attitude and practices		Overall Score	
	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★
Government																								
MoEFCC	H	M	H	M	H	L	H	M	H	L	H	L	H	L	H	L	H	L	H	M	H	M	H	M
NBA	L	L	H	M	L	L	L	L	L	L	L	L	L	L	M	M	L	L	M	L	M	L	H	M
DoECC	H	H	H	H	H	M	H	H	H	H	H	H	H	M	H	M	H	M	H	M	H	L	H	H
SWAK	H	H	H	M	H	M	H	H	H	H	H	H	H	H	H	H	M	M	H	H	H	H	H	H
KFWD	L	L	H	H	H	H	M	L	L	L	M	L	H	M	H	H	L	L	M	L	M	M	H	H
KWA	H	H	L	L	L	L	L	L	H	H	L	L	L	L	H	H	L	L	L	L	L	L	H	H
KSPCB	L	L	L	L	L	L	M	M	L	L	L	L	H	M	L	L	L	L	M	L	L	M	H	M
KSBB	L	L	H	H	L	L	L	L	L	L	L	L	H	H	H	H	L	L	H	M	H	M	H	H
Department of Tourism (DoT)	L	L	L	L	H	H	H	L	L	L	L	L	H	H	L	L	L	L	M	M	M	M	H	H

Influence ⊙ Impact ★

	Ability to Maintain values								Ability to influence threats																	
Key departments and organisations	Maintaining hydrological connectivity		Maintaining migration corridors		Sustainable Livelihoods		Wetland positive behaviour		Physical regime alteration		Structural Modification		Introduction		Unsustainable extraction		Local climate change impact		Ability to support management through knowledge		Ability to influence knowledge, attitude and practices		Overall Score	
	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★
Department of Fisheries (DoF)	L	L	H	M	H	H	M	L	L	L	L	L	H	H	H	H	L	L	M	M	H	M	H	H		
DoSSSC	H	H	L	L	L	L	M	L	H	H	H	H	H	M	H	M	L	L	L	L	L	L	H	H		
DoMG	H	M	L	L	L	L	L	L	H	M	H	M	M	M	H	M	L	L	M	M	M	M	H	M		
DADFW	H	M	L	L	H	M	H	M	H	M	H	M	H	M	M	L	L	L	H	M	H	M	H	M		
Irrigation Department (ID)	H	M	L	L	M	M	H	M	M	M	L	L	L	L	M	M	L	L	L	L	L	L	H	M		
KLDC	L	L	L	L	L	L	L	L	M	L	M	L	M	L	M	L	L	L	L	L	L	L	M	L		
DTPCs	L	L	L	L	M	M	M	M	L	L	L	L	M	L	L	L	L	L	H	M	H	M	H	M		
DDMA	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	M	L	M	M	M	M		
Fishing Cooperative Society	L	L	M	L	M	M	L	L	L	L	L	L	L	L	M	L	L	L	M	L	M	L	M	M		

Influence ⊙ Impact ★

	Ability to Maintain values								Ability to influence threats																	
Key departments and organisations	Maintaining hydrological connectivity		Maintaining migration corridors		Sustainable Livelihoods		Wetland positive behaviour		Physical regime alteration		Structural Modification		Introduction		Unsustainable extraction		Local climate change impact		Ability to support management through knowledge		Ability to influence knowledge, attitude and practices		Overall Score	
	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★
BMC	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	M	H
Local Self Government (Planning) Department																								
Grama Panchayats (Sasthamkotta, West Kallada, Mynagapally)	L	M	L	M	L	H	H	H	L	H	L	H	L	H	M	H	L	L	H	L	H	H	H	H
Kollam Municipal Corporation	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Communities living in and around wetlands																								
Farmers	L	L	L	L	L	H	L	H	L	H	L	H	L	H	L	H	L	L	L	M	L	H	L	H

Influence ⊙ Impact ★

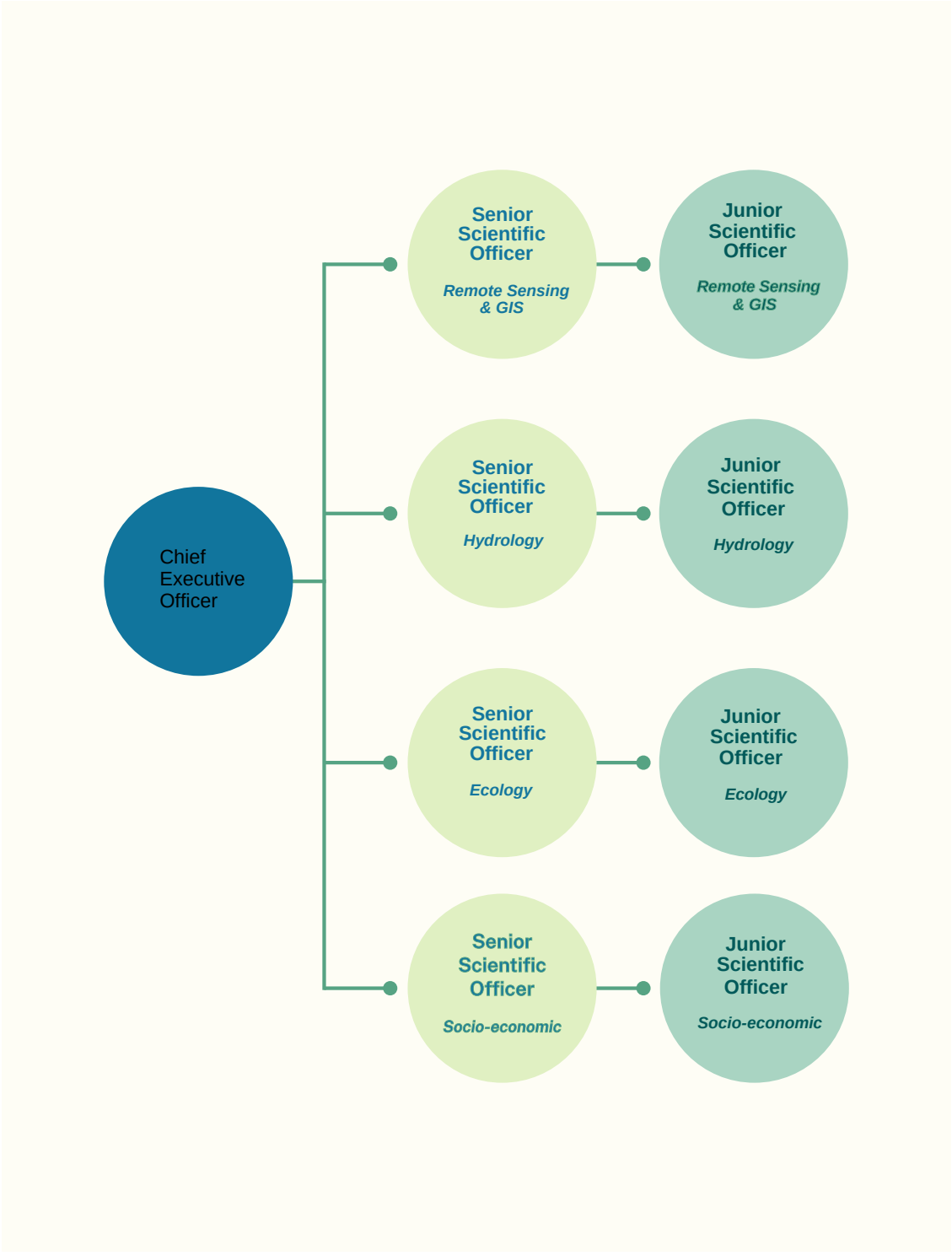
	Ability to Maintain values								Ability to influence threats																	
Key departments and organisations	Maintaining hydrological connectivity		Maintaining migration corridors		Sustainable Livelihoods		Wetland positive behaviour		Physical regime alteration		Structural Modification		Introduction		Unsustainable extraction		Local climate change impact		Ability to support management through knowledge		Ability to influence knowledge, attitude and practices		Overall Score	
	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★
Fishers	L	L	L	L	L	H	L	H	L	L	L	L	L	H	L	H	L	L	L	L	L	H	L	H	L	H
Local communities	L	M	L	M	L	M	L	H	L	M	L	M	L	H	L	H	L	L	L	L	L	L	L	L	L	H
Research and Academia																										
KSCSTE	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	M	M	M		
CWRDM	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H		
NCESS	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	M	L	M	L		
KUFOS	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	M	M	M		
WISA	L	L	L	L	L	L	H	H	L	L	L	L	M	L	M	L	H	M	H	H	H	H	H	H		
IMD	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	H	L	L	L	H	L		
ZSI	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	M	H	M	H	M		

Influence ⊙ Impact ★

	Ability to Maintain values								Ability to influence threats																	
Key departments and organisations	Maintaining hydrological connectivity		Maintaining migration corridors		Sustainable Livelihoods		Wetland positive behaviour		Physical regime alteration		Structural Modification		Introduction		Unsustainable extraction		Local climate change impact		Ability to support management through knowledge		Ability to influence knowledge, attitude and practices		Overall Score	
	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★	⊙	★
KHSW	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	L	M	M		
CSOs																										
Sasthamkotta Lake Protection Council ('Paristhiti Samrakshana Ekopana Samithi' and 'Kayalkoottayma')	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	M	H	M	H	M	H		
KSSP	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	M	H	M	H	M	H		

Annex XIII

PROPOSED STRUCTURE OF MONITORING TEAM FOR SASTHAMKOTTA LAKE



SASTHAMKOTTA LAKE METT SYNTHESIS REPORT

Brief Description:

Sasthamkotta Lake is the largest natural freshwater wetland of Kerala State, located in Kunnathur Taluk of Kollam District, spanning 373 ha. It is part of several freshwater bodies separated by natural ridge features that dot the landscape of the Kallada basin. With the main source of water being underground sprouts, the wetland is the principal source of water for nearly 0.5 million people living in Kollam City and its suburbs. Sastha temple, from which the wetland got its name, is an important religious and cultural centre for the region. Recorded biodiversity includes 37 species of phytoplankton, 18 species of macrophytes, 158 species of terrestrial vegetation, 16 species of fish, and 35 species of waterbirds.

METT Score:

Overall, management effectiveness for Sasthamkotta Lake is 'low' with an overall score of 46%. Planning is 'good' at 68%. The adequacy of inputs falls under 'extremely low' at 29%. Appropriateness of processes is 'low' at 31%, while output and outcome is 'good' at 67%.

Planning	68%
Adequacy (Input)	29%
Appropriateness (Process)	42%
Output & Outcome	67%
Overall	50%

Way ahead for management:

Management Actions and Institutional Arrangements

1. Endorsement and implementation of the Integrated Management Plan for the wetland developed following NPCA guidelines are one of the priorities. This includes establishing convergence between government departments on joint implementation of the action and monitoring plan. (Planning)
2. Establishment and strengthening the role of a wetland authority as the platform for proactive engagement with stakeholders, especially other line departments. Meetings should be scheduled periodically with all the stakeholders with the agenda of wetland management. (Planning)
3. Demarcation of the boundary with geo-tagged pillars and increasing protection at vulnerable points. (Process)

Monitoring, Research and Capacity Development

1. Training for the site manager and staff on wetland ecology, wetland rules, participatory planning and monitoring, and other measures as listed in IMP. Improving the staff capacity at the wetland level. (Input)
2. A comprehensive study on floral and faunal biodiversity. (Process)
3. Studies and research on wetland features to aid with wetland management. (Process)
4. Establishment of proper feedback channels from the monitoring to enhance decision-making and management objectives. (Process)
5. Regular management effectiveness tracking needs to be conducted in the context of the Ramsar Site/wetland. (Process)

Outreach and Communication

1. The Health Cards and METT reports should be communicated to all the stakeholders. Health Cards should be uploaded on the Wetlands of India Portal. (Process)
2. Public engagement and installation of updated signages and information boards, communication products (brochures, factsheets, maps), etc. (Process)
3. Community engagement in the wetland management activities as listed in the IMP. (Process)

Sasthamkotta Lake METT Calculation Sheet *Wetlands of India Portal (indianwetlands.in)*

Stages		Name: Sasthamkotta Lake	Criteria Score				%	Max score
	Ques #	Data Sheet 4: Assessment Questions	0	1	2	3		
Planning	1	Are regulations in place to protect the wetland?			2			3
	2	Does the delineated wetland boundary cover the entire wetland regime?				3		3
	3	Is there a management plan for the wetland?			2			3
	3a	Is there an integrated management plan for the wetland as per NPCA guidelines	0					1
	3b	Is there an annual work plan (APO) and is it being implemented?		1				1
	3c	Is the plan reviewed and updated periodically?		1				1
	4	Are there clear conservation and wise-use objectives identified and wetland managed accordingly?			2			3
	5	Are the stakeholders identified and engaged in management planning?			2			3
	6	Does the planning process identify convergence opportunities with sectoral schemes?			2			3
	7	Does the wetland reflect in sectoral planning?			2			3
	7a	Are migration pathways and ecological corridors identified in the management plan and are there mechanisms for ensuring connectivity?	0					1
		Sub-total				17	68%	25
Input	8	How often do management decisions are constrained due to data deficiency on ecological characters?		1				3
	9	Are there adequate human resources available to implement the management plan?		1				3
	10	Are staff adequately trained to effectively deliver the management plan?		1				3
	11	Is the allocated budget adequate to implement management plan completely?		1				3
	12	Are funds available on a regular basis?		1				3
	13	Are equipment and infrastructure adequate for management needs?		1				3
	14	If fees (i.e. entry fees, licenses or fines) are collected, are those funds used for wetland management?	0					3

Stages		Name: Sasthamkotta Lake	Criteria Score				%	Max score
	Ques #	Data Sheet 4: Assessment Questions	0	1	2	3		
		Sub-total				6	29%	21
Process	15	Is the boundary known and demarcated?				3		3
	16	Are the activities being implemented as per the management Plan?		1				3
	17	Are mechanisms in place to regulate access/resource use in the wetland?	0					3
	18	Is there management-oriented survey and research work carried out?			2			3
	19	Is there a monitoring system in place with provision for integrating feedback for adaptive management?				3		3
	20	Are funds available on time and for priority activities?		1				3
	21	Is there a stakeholder coordination mechanism in place for management of the wetland?	0					3
	22	Are there regular CEPA programmes on wetland values?		1				3
	22a	Are programmes implemented to enhance community welfare while ensuring conservation and wise use of wetland resources?	0					1
	22b	Does wetland management integrate aspects of gender and social equity?	0					1
		Sub-total				11	42%	26
Output & Outcome	23	Are inventory, assessment and monitoring information available for adaptive management?			2			3
	24	Is the wetland delivering economic benefits to local communities?			2			3
	25	What is the condition of the important values of the wetland?			2			3
	26	How many of the prioritised threats in and around the wetland are being reduced/ minimised, or is there an increase in threats?			2			3
		Sub-total				8	67%	12
		Total				42	50%	84

Annex XV

HEALTH CARD OF SASTHAMKOTTA LAKE

Wetlands of India Portal

Date: 03-Dec-2024 10:45:29 AM

Wetland Health Card Details

State Name	**Kerala**	Wetland Name	**Sasthamkotta Lake**	Date of Entry	**20-01-2021**
Area (hectares)	**373.00**	Wetland Type	**Natural (Inland)**	Year of Data Collection	**2019**

#	Features	Code	Indicator	Desired Value	Actual Value	Category
1	Area	A-01	% wetland converted to non-wetland use since 2000	0%	0%	A
2	Hydrology and catchment	H-01	Ratio of number of natural inlets choked and diverted to total number of natural inlets	<0.2	0-0.2	A
3	Hydrology and catchment	H-02	Ratio of number of natural outlets choked and diverted to total number of natural outlets	<0.2	0-0.2	A
4	Hydrology and catchment	Q-01	%of samples conforming to desired BOD/DO/COD levels	Biological Oxygen Demand: Between 3 – 6 mg/l or Dissolved Oxygen >= 6 mg/l or Chemical Oxygen Demand (for Urban Wetlands) <50 mg/l	80-100% sample meet the criteria	A
5	Biodiversity	B-01	% wetland area covered by invasive macrophytes	<10%	<10%	A
6	Biodiversity	B-02	Annual water bird count as a proportion of average count of last 5 years	Increasing		
7	Governance	G-01	Clearly demarcated wetlands map	Wetlands map prepared and approved by CWLW/Relevant Authority	Wetlands map prepared and approved by State	A
8	Governance	G-02	Wetland Management Plan	Management plan prepared and approved by CWLW/Relevant Authority	Management plan prepared and approved	A
9	Governance	G-03	Wetland Notification	Wetlands notified under Wetland Rules/WPA	Regulation under process	C

Actual Value Range and Grade

Indicator: % wetland converted to non-wetland use since 2000 (Desired Value : 0%)

Indicator: Ratio of number of natural outlets choked and diverted to total number of natural outlets (Desired Value : <0.2)

Indicator: %of samples conforming to desired BOD/DO/COD levels (Desired Value : Biological Oxygen Demand: Between 3 – 6 mg/l or Dissolved Oxygen >= 6 mg/l or Chemical Oxygen Demand (for Urban Wetlands) <50 mg/l)

Indicator: % wetland area covered by invasive macrophytes (Desired Value : <10%)

Indicator: Annual water bird count as a proportion of average count of last 5 years (Desired Value : Increasing)

Indicator: Clearly demarcated wetlands map (Desired Value : Wetlands map prepared and approved by CWLW/Relevant Authority)

Indicator: Wetland Management Plan (Desired Value : Management plan prepared and approved by CWLW/Relevant Authority)

Indicator: Wetland Notification (Desired Value : Wetlands notified under Wetland Rules/WPA)

Published by

Wetlands Division

Ministry of Environment, Forest and Climate Change

Government of India

Indira Paryawaran Bhawan, Jor Bagh

New Delhi - 110003

Annex XVI

LIST OF EQUIPMENT FOR WETLAND MONITORING

Hydrological Equipment and Material

1. Automatic Weather Station
2. Sunshine recorder
3. Automatic water level recorder
4. AA Current meters
5. Stream gauge
6. Piezometer
7. Staff gauge on permanent piers
8. Wireless Station
9. Thermo-hydrograph
10. Digital depth-temperature analysers
11. Ecosounders
12. Fibreglass boat with outboard motor
13. Poles fixed for float observations
14. Wading rods and cable and drum (cranes) for lowering current meters

Fisheries Equipment

15. Fishing gears
16. Plankton nets
17. Buoys
18. GPS
19. Fisheries Assessment Softwares (ELEFAN, CEDA, etc)
20. Fish base Application – Fish identification
21. Fibreglass boat with outboard motor

Research Equipment

22. DR 4000 Spectrophotometer
23. UV spectrophotometer
24. Digital pH and conductivity meters
25. Multiparameter Water quality meter
26. Water quality multi-parameter probes
27. Paqua Lab with bacteriological assembly
28. Colorimeter
29. Distillation unit
30. Kjeldahl assembly
31. Incubators
32. Autoclave
33. COD digester
34. BOD Incubator
35. Burette
36. Automatic pippettes
37. Digital Flame photometers
38. Electronic Balance
39. Centrifuge machines
40. Cold centrifuge machine
41. Grinders
42. Automatic sieves
43. Hot air oven
44. Magnetic stirrers
45. Burners & heaters
46. Ekmans Grab and potable dredgers
47. Plankton samplers
48. Glassware and Chemicals

GIS Equipment

49. GIS software (Erdas, ArcGis, QGis, etc)
50. GIS workstation
51. Plotters
52. A0 size scanner
53. GPS

Computing and Networking Equipment

54. Desktop (I 7)
55. Laptop
56. Laser printer Colour A3
57. Online UPS 2KVA
58. Broadband Internet connection
59. MS Office software and other software

Documentation and Display equipment

60. Photocopier
61. LED Projector
62. LED Panel
63. DSLR Camera with tripod
64. Binoculars

Facilities

65. Furnishing and accessories
66. Vehicle
67. Silent Generator 15 KVA

THE KERALA CONSERVATION OF PADDY LAND AND WETLAND (AMENDMENT) BILL, 2023

Fifteenth Kerala Legislative Assembly

Bill No. 172

[Translation in English of "2023-ലെ കേരള നെൽവയൽ-തണ്ണീർത്തട സംരക്ഷണ (ഭേദഗതി) ബിൽ" published under the authority of the Governor.]

THE KERALA CONSERVATION OF PADDY LAND AND WETLAND (AMENDMENT) BILL, 2023

A

BILL

further to amend the Kerala Conservation of Paddy Land and Wetland Act, 2008.

Preamble.—WHEREAS, it is expedient further to amend the Kerala Conservation of Paddy Land and Wetland Act, 2008 for the purposes hereinafter appearing;

BE it enacted in the Seventy-fourth Year of the Republic of India as follows:—

1. *Short title and commencement*. —(1) This Act may be called the Kerala Conservation of Paddy Land and Wetland (Amendment) Act, 2023.

(2) It shall come into force at once.

2. *Amendment of section 2*.— In the Kerala Conservation of Paddy Land and Wetland Act, 2008 (28 of 2008), in section 2 after clause (xv), the following clause shall be inserted, namely:—

"(xv A) "Revenue Divisional Officer" means the officer appointed by the State Government as Revenue Divisional Officer and includes the officers not below the rank of Deputy Collector authorized by the Government, by general or special order, for performing all or any of the functions under this Act;".

781/2023.

2

STATEMENT OF OBJECTS AND REASONS

The Government have decided to appoint an officer, not below the rank of Deputy Collector for exercising the powers conferred upon the Revenue Divisional Officer either wholly or partly, in case Government specially authorised in this regard, in accordance with the Kerala Conservation of Paddy Land and Wetland Act, 2008 and rules related thereunder. Though the various provisions of the Act deals with the powers and functions of the Revenue Divisional Officer, the same has not been defined, hence the Government have decided to make suitable amendment in section 2 of the said Act for defining the word Revenue Divisional Officer.

2. The Bill seeks to achieve the above object.

FINANCIAL MEMORANDUM

The Bill, if enacted and brought into operation, would not involve any additional expenditure from the Consolidated Fund of the State.

MEMORANDUM REGARDING DELEGATED LEGISLATION

Clause (xvA) of section 2 proposed to be inserted by clause 2 of the Bill seeks to empower the Government to issue general or special order to authorize an officer not below the rank of Deputy Collector to exercise all or any of the powers of the Kerala Conservation of Paddy Land and Wetland Act, 2008.

The matters in respect of which rules may be made or notifications may be issued are matters of procedure and are of routine or administrative nature. Further, the rules or notifications after they are made, are subject to scrutiny by the Legislative Assembly. The delegation of legislative power is, therefore, of a normal character.

K. RAJAN.

EXTRACT FROM THE KERALA CONSERVATION OF PADDY LAND AND WETLAND ACT, 2008

(ACT 28 OF 2008)

** ** ** **

2. *Definitions*. — In this Act, unless the context otherwise requires,—

** ** ** **

(xv) "reclamation" means such act or series of acts whereby a paddy land or a wetland as defined in this Act is converted irreversibly and in such a manner that it cannot be reverted back to the original condition by ordinary means;

(xvi) “State” means the State of Kerala;

** ** ** **

Annex XVIII

NOTIFICATION OF KERALA STATE POLLUTION CONTROL BOARD

☎: General: 0471- 2312910, 2318153, 2318154, 2318155 Chairman: 2318150 Member Secretary: 2318151
E-mail: keralapcb@asianetindia.com FAX: 2318152 web: www.keralapcb.org

KERALA STATE POLLUTION CONTROL BOARD
കേരള സംസ്ഥാന മലിനീകരണ നിയന്ത്രണ ബോർഡ്
Pattom P.O., Thiruvananthapuram – 695 004
പട്ടം പി.ഒ., തിരുവനന്തപുരം - 695 004

PCB/GEN/01/2010 Date: 09.06.2010

NOTIFICATION

WHEREAS Sasthamcotta Lake in Kunnathoor Taluk of Kollam district is the largest fresh water lake of Kerala, source of water supply to Kollam Municipal Corporation and suburbs and is a Ramsar site deserving to be protected from pollution, sedimentation and encroachment;

WHEREAS the lake is subjected to pollution of anthropogenic origin;

WHEREAS urgent preventive and mitigative measures are required to restore and protect the wholesomeness of the lake;

WHEREAS Section 24 of the Water (Prevention & Control of Pollution) Act 1974 prohibits direct or indirect discharge of any poisonous, noxious or polluting matters into any water body;

WHEREAS Section 33 A of the said Act empowers the State Pollution Control Board to issue directions for prevention and control of water pollution and maintaining or restoring of wholesomeness of water;

AND WHEREAS Section 5 of the Environment (Protection) Act 1986 read with notification no. SO 327 (E) dated 10.04.2001 empowers the undersigned to issue directions for protection of environment,

NOW THEREFORE, in exercise of the aforesaid powers, the following activities which, by themselves or in conjunction with other activities, are causing or are likely to cause pollution of Sasthamcotta Lake and aggravation of the pollution are expressly prohibited with effect from the date of publication of this notification in the official website of the Board. The prohibition shall be applicable within the following survey numbers in the catchment area and more particularly within the distances mentioned.

1) Bathing and washing clothes, animals and vehicles in the lake.

2) Discharge of waste water from hotels, commercial establishments, industries, health care establishments etc. into drains or pathways leading to the lake.

3) Discharge of sewage into the lake or into drains or pathways leading to the lake.

4) Mining of sand, granite, laterite, clay or soil from within 500 m from the lake periphery.

5) Storage of materials, polluted leachate from which is likely to flow towards the lake, within 500 m of the periphery of the lake.

6) Agricultural activities within 100 m of the periphery of the lake.

7) Catching of fish from the lake by explosives.

8) Construction of any sewage disposal facility (such as pit latrines) inferior to the minimum requirement of septic tank of IS 2470 Part-1 1985 design within 500 m of the periphery of the lake.

9) Disposal of overflow from septic tank into land other than through soak pit with concreted bottom, perforated ring or honeycomb

NOW THEREFORE, in exercise of the aforesaid powers, the following activities which, by themselves or in conjunction with other activities, are causing or are likely to cause pollution of Sasthamcotta Lake and aggravation of the pollution are expressly prohibited with effect from the date of publication of this notification in the official website of the Board. The prohibition shall be applicable within the following survey numbers in the catchment area and more particularly within the distances mentioned.

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2) Discharge of waste water from hotels, commercial establishments, industries, health care establishments etc. into drains or pathways leading to the lake.

3) Discharge of sewage into the lake or into drains or pathways leading to the lake.

4) Mining of sand, granite, laterite, clay or soil from within 500 m from the lake periphery.

5) Storage of materials, polluted leachate from which is likely to flow towards the lake, within 500 m of the periphery of the lake.

6) Agricultural activities within 100 m of the periphery of the lake.

7) Catching of fish from the lake by explosives.

8) Construction of any sewage disposal facility (such as pit latrines) inferior to the minimum requirement of septic tank of IS 2470 Part-1 1985 design within 500 m of the periphery of the lake.

9) Disposal of overflow from septic tank into land other than through soak pit with concreted bottom, perforated ring or honeycomb

brick work sidewall and 45 cm thick sand envelope around within 500 m distance of the periphery of the lake.

(The concerned Local Self Government Bodies shall take action within one year to get inferior sewage disposal facilities converted to meet the minimum requirement stated in 8 and 9 above).

Sasthamcotta Village

Block No – 13

Re Sy No - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 37, 38, 40, 41, 42, 43, 44, 45, 46, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76 77 78 81 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 119, 126, 127, 138, 141, 142, 150, 151, 152, 153, 154 ,155, 156, 157, 158, 159, 160

Block No – 14

Re Sy No - 207, 208, 209, 210, 211, 212, 213, 214, 215, 216,217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 229(Road), 230, 231, 232, 233, 234(Road), 235, 239, 241, 242(Road), 243(Road), 244

Block No – 15

Re Sy No - (Subdivisions) 152/1, 2, 3, 4, 8, 9, 12, 15, 16, 17, 18, 20, 22, 23

West Kallada Village

Block No – 12

Re Sy No - 95, 97, 98, 99, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 119, 129, 130, 131, 132, 134, 240, 246, 247, 248, 249, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274,275, 276, 277, 278, 279, 282, 283, 284, 365, 368, 385, 386, 387, 391, 392, 393(Bund Road), 394, 395(Bund Road), 397(Bund Road), 398, 402, 405(Bund Road), 406, 407, 408, 410, 411, 416, 417

Mynagappally Village

Block No – 10

Re Sy No - 167, 168, 170, 173, 174, 175, 176, 178, 579, 580, 582, 584, 586, 587, 589, 590, 602, 604, 606, 607

Take notice that non-compliance with the aforesaid requirements and directions is liable to incur punishment of imprisonment for a term upto 6 years and fine.

Dated this the 9th day of June 2010.

FOR AND ON BEHALF OF THE
KERALA STATE POLLUTION CONTROL BOARD

JEYAPRASAD S.D.
CHAIRMAN

(Republished in the Government Gazette for public information)

4

RAMSAR INFORMATION SHEET OF SASTHAMKOTTA LAKE

Ramsar Information Sheet

Published on 19 August 2002

India

Sasthamkotta Lake

Designation date	19 August 2002
Site number	1212
Coordinates	09°02'22"N 76°37'56"E
Area	373,00 ha

https://rsis.ramsar.org/ris/1212
Created by RSIS V.1.6 on - 29 November 2024

RIS for Site no. 1212, Sasthamkotta Lake, India

Color codes

Fields back-shaded in light blue relate to data and information required only for RIS updates.

Note that some fields concerning aspects of Part 3, the Ecological Character Description of the RIS (tinted in purple), are not expected to be completed as part of a standard RIS, but are included for completeness so as to provide the requested consistency between the RIS and the format of a 'full' Ecological Character Description, as adopted in Resolution X.15 (2008). If a Contracting Party does have information available that is relevant to these fields (for example from a national format Ecological Character Description) it may, if it wishes to, include information in these additional fields.

1 - Summary

1.1 - Summary description

Please provide a short descriptive text summarising the key characteristics and internationally important aspects of the site.

You may prefer to complete the four following sections before returning to draft this summary.

Summary

(This field is limited to 2500 characters)

Sasthamkotta is the largest natural fresh water lake of Kerala State, located in Kunnathur Taluk of Kollam District between 9° 1' 42" to 9° 3' 30" N latitude and 76° 36' 41" to 76° 38' 52" E longitude at an elevation of 33 m above MSL spanning over 373 ha. The main source of water is from springs. The Lake has a capacity to hold 22,390 million liters of water and is the principal source of water for nearly 0.5 million people living in Kollam City and its suburbs. Sastha temple, from which the lake is believed to have received its name, is an important religious and cultural centre for the region. The striking beauty of Sasthamkotta's placid waters surrounded by lush green hills has earned it the distinction of 'Queen of Lakes'. Sasthamkotta is part of several fresh water bodies separated by natural ridge features that dot the landscape of Kallada basin. It does not freezes in winter and the fresh water is available 365 days a year. It is surrounded by hills on all sides except south, where a bund has been constructed separating the lake from the neighbouring rice fields.

Recorded biodiversity of the Lake includes 37 species of phytoplankton, 18 species of macrophytes, 158 species of terrestrial vegetation, and 35 species of waterbirds. Compilation of available species richness records indicate presence of at least 38 species of fish belonging to 19 families in Sasthamkotta. Etroplus suratensis, the State Fish of Kerala is commonly found in the lake. Etroplus maculatus another species of the same genus has also been recorded in the lake. The representative and indigenous fish species in Sasthamkotta include Puntius ticto punctatus (Day), Puntius sarana subnasutus (Ham.), Horabagrus brachysoma (Gunther), Etroplus suratensis (Bloch), Aploch Eilus lineatus (Val.), Parambassi thomassi (Day) and Macrognathus guentheri.

2 - Data & location

2.1 - Formal data

2.1.1 - Name and address of the compiler of this RIS

Responsible compiler

Name	Padma Mahanti IFS
Institution/agency	State Wetland Authority Kerala (SWAK), Directorate of Environment and Climate Change
Postal address (This field is limited to 254 characters)	Devikripa', Pallimukku, Pettah P.O., Thiruvananthapuram - 695024, Kerala State, India
E-mail	swak.kerala@gmail.com
Phone	+91471-2742264
Fax	+91471-2742554

National Ramsar Administrative Authority

Name	Dr. John C. Mathew
Institution/agency	Directorate of Environment and Climate Change, Govt. of Kerala
Postal address (This field is limited to 254 characters)	Devikripa', Pallimukku, Pettah P. O., Thiruvananthapuram - 695024, Kerala State, India
E-mail	jcm_gis@hotmail.com
Phone	+91471-2742264
Fax	+91471-2742554

2.1.2 - Period of collection of data and information used to compile the RIS

From year: 2014

Period when the data and information for the sheet for a newly designated site was compiled
For updated RIS: Period when the data and informationfor revision of an existing sheet was updated

To year: 2017

2.1.3 - Name of the Ramsar Site

Official name (in English, French or Spanish): Sasthamkotta Lake

Unofficial name (optional):

2.1.4 - Changes to the boundaries and area of the Site since its designation or earlier update

(Update) A. Changes to Site boundary	Yes ○ No ◉
(Update) The boundary has been delineated more accurately	☐
(Update) The boundary has been extended	☐
(Update) The boundary has been restricted	☐
(Update) B. Changes to Site area	No change to area
(Update) The Site area has been calculated more accurately	☐
(Update) The Site has been delineated more accurately	☐
(Update) The Site area has increased because of a boundary extension	☐
(Update) The Site area has decreased because of a boundary restriction	☐

Important note: If the boundary of the designated site is being restricted/reduced, before submitting this updated RIS to the Secretariat the Contracting Party should have followed:
- the requirements in Article 2.5 of the Convention; or
- the procedures established by the Conference of the Parties in the annex to Resolution VIII.20 (2002); or
- where appropriate instead, the procedures in the annex to Resolution IX.6 (2005). Contracting Parties should also have provided to the Secretariat a report on changes prior to the submission of an updated RIS.

(Update) For secretariat only: This update is an extension	☐

2.1.5 - Changes to the ecological character of the Site

(Update) 6b i. Has the ecological character of the Ramsar Site (including applicable Criteria) changed since the previous RIS? Not evaluated

(Update) Are the changes Positive ○ Negative ○ Positive & Negative ◉

What extent of the Ramsar site is affected (%)

(Update) Positive %

(Update) Negative %

(Update) Optional text box to provide further information

(This field is limited to 2000 characters)

(Update) No information available ☐

Are changes the result of (tick each category which applies):

(Update) Changes resulting from causes operating within the existing boundaries? ☐

(Update) Changes resulting from causes operating beyond the site's boundaries? ☐

(Update) Changes consequent upon site boundary reduction alone (e.g., the exclusion of some wetland types formerly included within the site)? ☐

(Update) Changes consequent upon site boundary increase alone (e.g., the inclusion of different wetland types in the site)? ☐

(Update) Please describe any changes to the ecological character of the Ramsar Site, including in the application of the Criteria, since the previous RIS for the site.

(This field is limited to characters)

(Update) Is the change in ecological character negative, human-induced AND a significant change (above the limit of acceptable change) Yes ○ No ◉

(Update) Has an Article 3.2 report been submitted to the Secretariat? Yes ○ No ◉

2.2 - Site location

2.2.1 - Defining the Site boundaries

a) GIS boundaries *link*

Materials presented on this website, particularly maps and territorial information, are as-is and as-available based on available data and do not imply the expression of any opinion whatsoever on the part of the Secretariat of the Ramsar Convention concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

b) Digital map/image

IN1212_map210613__Sasthamkotta.jpg

Former maps

<no file available>

Boundaries description

(This field is limited to 2500 characters)

The Sasthamkotta lake is located physiographically in the midland region of Kerala State between 9º 1' 42" to 9º 3' 30" N latitude and 76º 36' 41" to 76º 38' 52" E longitude at an elevation of 33 m above mean sea level. Located in Kunnathur Taluk of Kollam District, Sasthamkotta is the largest freshwater lake of Kerala

Sasthamkotta forms part of an extensive wetland regime formed on the alluvial deposits of River Kallada. These open water bodies and marshes systems are conspicuous between the Bharanikavu Town and the confluence of River Kallada with Ashtamudi Estuary at Kovilli. Besides Sasthamkotta, Karali, Velanthara, Veliyapadam, and Kadapuzha are significant marsh dominated areas flanking the right bank of Kallada River. Sasthamkotta is isolated by marginally elevated ridges, rising sharply from the average lake level of 13.5 m amsl to nearly 35 m amsl on the northern, western and southern flanks. The southeastern margins, which would have naturally drained into River Kallada was embanked in the 19th century. The earthen embankment was made permanent in 1956 under the Quilon Water Supply Scheme supported by Indo-Norwegian Foundation. The embankment at most places is about 20 m amsl elevation.

Coordinates of the centre of the site, as automatically estimated from the GIS boundaries (for information only)

2.2.2 - General location

RIS for Site no. 1212, Sasthamkotta Lake, India

a) In which large administrative region does the site lie? Kollam district of Kerala State

b) What is the nearest town or population centre? Kollam City, Kunnathur Thaluk of Kollam district

2.2.3 - For wetlands on national boundaries only

a) Does the wetland extend onto the territory of one or more other countries? Yes ○ No ◉

b) Is the site adjacent to another designated Ramsar Site on the territory of another Contracting Party? Yes ○ No ◉

c) Is the site part of a formal transboundary designation with another Contracting Party? Yes ○ No ◉

d) Transboundary Ramsar Site name:

2.2.4 - Area of the Site

If you have not established an official area by other means, you can copy the area calculated from the GIS boundaries into the 'official area' box.

Official area, in hectares (ha): 373

Area, in hectares (ha) as calculated from GIS boundaries: 365.914

2.2.5 - Biogeography

Please provide the biogeographic region(s) encompassing the site and the biogeographic regionalization scheme applied:

Biogeographic regions

Regionalisation scheme(s)	Biogeographic region
Freshwater Ecoregions of the World (FEOW)	Western Ghats

Other biogeographic regionalisation scheme

(This field is limited to 2500 characters)

5A Western Ghats: Malabar Plains

3 - Why is the Site important?

3.1 - Ramsar Criteria and their justification

Tick the box against each criterion applied to the designation of the Ramsar Site. All criteria which apply should be ticked.
Please explain why you selected a criterion by filling in the relevant fields on this page, on the three other pages of this section 'Criteria & justification' and on the 'Wetland types' page of the section 'What is the site like?'. More guidance on how to justify a criterion will appear when you tick it as well as in the help box.

☑ Criterion 1: Representative, rare or unique natural or near-natural wetland types

To justify this Criterion, please select at least one wetland type as representative, rare or unique in the section What is the site like? > Wetland types and provide further details in at least one of the three boxes below.

Hydrological services provided *(This field is limited to 3000 characters)*	Over seven hundred thousand people in southern Kerala, especially around Kollam City and its suburban areas, benefit from this unique and largest freshwater lake source. The most direct dependence of communities on Sasthamkotta is as a source of water supply. The Quilon Water Supply Scheme (QWSS) withdraws 10.9 Mm3 from the lake to support half a million people in the City of Kollam. In addition, 12.2 Mm3 are also withdrawn from the lake daily to provide for the water supply needs of communities living within Chavara, Panmana, Sasthamkotta, Sooranad, West Kallada, Thevalakkaora and Thekkumbhagam grama panchayats. The Sasthamkotta water treatment plant of Kerala Water Authority produces 30 MLD of water. Of this, 13 MLD of water reaches Kollam Corporation, with the balance being supplied to neighbouring Panchayat. An estimated 5 MLD is also extracted from 35 tube wells in various places within Kollam Municipal Corporation. Sasthamkotta helps maintain the hydrological regimes of the entire drainage basin, supporting agriculture and plantation activities. Much agriculture within the basin and adjoining areas has evolved on converted marshlands.
Other ecosystem services provided *(This field is limited to 3000 characters)*	The lake supports marginal fisheries with current annual landing being less than 1 MT(Metric Ton). The portion of Sasthamkotta direct catchment located on the south-east is recharged by Sasthamkotta Lake. The lake also has significant influence on the overall availability of water in the direct drainage basin.
Other reasons *(This field is limited to 3000 characters)*	Several important sacred sites, including the Sastha Temple, are located on the banks of the lake and around it. The lake has high religious value and is visited by thousands of pilgrims every year for taking holy dip on its banks. The new moon day of each month is considered auspicious, drawing a large number of locals to the temple and to the lake. Besides, Ammankovil Devi or Bhadrakali temple situated in Sasthamkotta Mannakkara, Thalayinakkavu Shiva Parvathi Temple, Poruvazhy Peruviruthi Malanada Duryodhana Temple, and Anayadi Narsimhaswamy temple are significant religious sites located around the lake. Mount Horeb Ashramam, a monastic community of the Malankara Orthodox Church, was established in 1991 on the banks of Sasthamkotta. Sasthamkotta is distinct for its placid waters surrounded by lush green hills. Therefore, it provides scenic beauty to tourists and locals. Sasthamkotta also holds the title ‘Queen of lakes’ of Kerala State, which attracts tourists from around the region.

☑ Criterion 2 : Rare species and threatened ecological communities

Justification,see: - relevant plant species in the section Criteria & justification> Plant species (3.2) - relevant animal species in the section Criteria & justification> Animal species (3.3) - relevant ecological communities in the section Criteria & justification> Ecological communities (3.4)

Optional text box to provide further information
(This field is limited to 3000 characters)

It is because of the presence of Günther's catfish and Wallago attu, a threatened species and Wallago attu, a vulnerable species as per the IUCN Red List

☐ Criterion 3 : Biological diversity

Justification,see: - relevant plant species in the section Criteria & justification> Plant species (3.2) - relevant animal species in the section Criteria & justification> Animal species (3.3)

Justification
(This field is limited to 3000 characters)

☐ Criterion 4 : Support during critical life cycle stage or in adverse conditions

Justification,see: - relevant plant species in the section Criteria & justification> Plant species (3.2) - relevant animal species in the section Criteria & justification> Animal species (3.3) and explain the life cycle stage or nature of adverse conditions in the accompanying 'justification' box.

Optional text box to provide further information
(This field is limited to 3000 characters)

☐ Criterion 5 : >20,000 waterbirds

Justification,see:- the total number of waterbirds and the period of data collection - relevant waterbird species, and if possible their population size, in the section Criteria & justification> Animal species (3.3)

Overall waterbird numbers

Start year

End year

Source of data:

Optional text box to provide further information
(This field is limited to 3000 characters)

☐ Criterion 6 : >1% waterbird population

Justification,see:Criteria & justification> Animal species (3.3)

Optional text box to provide further information
(This field is limited to 3000 characters)

☑ Criterion 7 : Significant and representative fish

Justification,see:Criteria & justification> Animal species (3.3)

Justification
(This field is limited to 3000 characters)

The wetland supports many fish species including some indigenous fish species like: Puntius ticto punctatus (Day), Puntius sarana subnasutus (Ham.), Horabagrus brachysoma (Gunther), Etroplus suratensis (Bloch), Aploch Eilus lineatus (Val.), Parambassi thomassi (Day) and Macrognathus guentheri.

Some other species which found in the lake are:
Megalops cyprinoides (Broussonet), Puntius fialmentosus (Valenciennes), Puntiusn ticto punctatus (Day), Puntius sarana subnasutus (Ham.), Glossogobius giuris (Ham. Buch.), Horabagrus brachysoma (Gunther), Sigala spp. Mystus gulio (Ham.), Singhi Heteropneustes fossilis (Bloch), Etroplus suratensis (Bloch), Etroplus maculatus (Bloch), Amblypharyngodon melettinus (Val.), Xenentodon cancila (Ham. Buch.), Aplocheilus lineatus (Val.), Parambassi thomassi (Day), Macrognathus guentheri.

☐ Criterion 8 : Fish spawning grounds, etc.
To justify this Criterion, please give information in the box below. Completion of details on relevant fish species in the section Criteria & justification> Animal species (3.3) is optional.

Justification
(This field is limited to 3000 characters)

☐ Criterion 9 : >1% non-avian animal population
To justify this Criterion, please give details on relevant non-avian species and their population size in the section Criteria & justification> Animal species (3.3)

Optional text box to provide further information
(This field is limited to 3000 characters)

3.2 - Plant species whose presence relates to the international importance of the site

Phylum	Scientific name	Criterion 2	Criterion 3	Criterion 4	IUCN Red List	CITES Appendix I	Other status	Justification
<no data available>								

GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-07-15.

Optional text box to provide further information on plant species of international importance:

(This field is limited to 3000 characters)

3.3 - Animal species whose presence relates to the international importance of the site

Animals are listed in the following order: birds, fish, mollusc and crustacean, other animals

Phylum	Scientific name	Species qualifies under criterion				Species contributes under criterion				Pop. Size	Period of pop. Est.	% occurrence 1)	IUCN Red List	CITES Appendix I	CMS Appendix I	Other Status	Justification
		2	4	6	9	3	5	7	8								
Fish, Mollusc and Crustacea																	
CHORDATA / ACTINOPTERYGII	*Aplocheilus lineatus* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		Significant population of this indigenous species which is also consumed as food occurs in the Lake
CHORDATA / ACTINOPTERYGII	*Etroplus maculatus* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		Large population of this species which is very important as local delicacy occurs in the Lake
CHORDATA / ACTINOPTERYGII	*Etroplus suratensis* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		State Fish of Kerala is commonly found in the lake. Highly delicious and commercially very important
CHORDATA / ACTINOPTERYGII	*Glossogobius giuris* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		Good number of this important freshwater species occurs in the Lake
CHORDATA / ACTINOPTERYGII	*Heteropneustes fossilis* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		Local source of good protein. Large number found in the Lake
CHORDATA / ACTINOPTERYGII	*Horabagrus brachysoma* GBIF	☑	☐	☐	☐	☐	☐	☑	☐				VU	☐	☐		Good population of this vulnerable species found in the Lake. Local use it as a very important protein source. It is also commercially important.
CHORDATA / ACTINOPTERYGII	*Macrognathus guentheri* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		Very important freshwater species. Good number found in the Lake. Locally consumed and highly delicious
CHORDATA / ACTINOPTERYGII	*Megalops cyprinoides* GBIF	☐	☐	☐	☐	☐	☐	☑	☐				LC	☐	☐		Large population in the Lake. Locally consumed
CHORDATA / ACTINOPTERYGII	*Wallago attu* GBIF	☑	☐	☐	☐	☐	☐	☑	☐				VU	☐	☐		globally Threatened (vulnerable) fish species,

1) Percentage of the total biogeographic population at the site

GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-07-15.

Optional text box to provide further information on animal species of international importance:

(This field is limited to 3000 characters)

Compilation of available species richness records indicate presence of at least 38 species of fish belonging to 19 families in Sasthamkotta. The list includes Horabagrus brachysoma, classed as Vulnerable in the IUCN Red List of Threatened Species. Two families (Cyprinidae and Bagridae) account for 11 species. Six of the recorded species (Dayella malabarica, Horabagrus brachysoma, Macrognathus guentheri, Mystus oculatus, Ompok malabaricus and Parambassis dayi) are endemic to the country.

3.4 - Ecological communities whose presence relates to the international importance of the site

Name of ecological community	Community qualifies under Criterion 2?	Description	Justification
<no data available>			

Optional text box to provide further information
(This field is limited to 4000 characters)

4 - What is the Site like? (Ecological character description)

4.1 - Ecological character

Please summarize the ecological components, processes and services which are critical to determining the ecological character of the site. Please also summarize any natural variability in the ecological character of the site, and any known past or current change

(This field is limited to 4000 characters)

Sasthamkotta is a freshwater lake. Spanning an area of 373 ha, this inverted L-shaped lake has maximum depth of 13 m, is well oxygenated, has low nutrient concentrations and is neutral to weakly alkaline. During a normal monsoon year, the inundation peaks up to 16m amsl (above mean sea level) post southwest monsoon, and gradually depletes by about 3 m by the end of April, wherein large parts of the shoreline transform into marshes. At its peak inundation level of 16 m amsl, the lake holds up to 15.6 Mm3(Million Meter Cube) of water. Well drained clayey soils on gently sloping laterites predominantly constitute the lake bed, which cap a sand layer up to 6 m deep, intervened by comparatively thin silt and clay dominated sediments. Recorded biodiversity includes 37 species of phytoplankton, 18 species of macrophytes, 158 species of terrestrial vegetation, 26 species of fish and 35 species of waterbirds. The overall biodiversity is lower due to hydrological isolation, low nutrients status and relatively higher depth. Sasthamkotta forms a part of extensive floodplain wetland formation of River Kallada. The present form and shape of the lake are believed to have been acquired about 4,000 years ago, when extensive sedimentation, heavy load of siltation from the rivers along with meandering and migration cut-off isolated lakes and marshes. Sasthamkotta is surrounded by narrowly elevated ridges rising up to 35 m amsl on all sides except the south-west wherein, a 20 m amsl high embankment separates the waterbody from the floodplains of River Kallada.

4.2 - What wetland type(s) are in the site?

Please list all wetland types which occur on the site, and for each of them:
- rank the four most abundant types by area from 1 (greatest extent) to 4 (least extent) in the third column,
- if the information exists, provide the area (in ha) in the fourth column
- if this wetland type is used for justifying the application of Criterion 1, indicate if it is representative, rare or unique in the last column
- you can give the local name of the wetland type if different from the Ramsar classification system in the second column

Marine or coastal wetlands

Wetland types (code and name)	Local name	Ranking of extent (1: greatest - 4: least)	Area (ha) of wetland type	Justification of Criterion 1
<no data available>				

Inland wetlands

Wetland types (code and name)	Local name	Ranking of extent (1: greatest - 4: least)	Area (ha) of wetland type	Justification of Criterion 1
Fresh water > Lakes and pools >> O: Permanent freshwater lakes		1	373	Representative

Human-made wetlands

Wetland types (code and name)	Local name	Ranking of extent (1: greatest - 4: least)	Area (ha) of wetland type
<no data available>			

What non-wetland habitats are within the site?

Other non-wetland habitat

Other non-wetland habitats within the site	Area (ha) if known
<no data available>	

idem

(ECD) Habitat connectivity	With construction of Velanthara embankment, the flood pulses of Kallada River reaching into Sasthamkotta have been completely eliminated.

4.3 - Biological components

4.3.1 - Plant species

Other noteworthy plant species

Phylum	Scientific name	Position in range / endemism / other
TRACHEOPHYTA/LILIOPSIDA	*Aponogeton natans*	Important for local aquatic environment of the Lake
TRACHEOPHYTA/LILIOPSIDA	*Blyxa octandra*	Locally important freshwater aquatic species
TRACHEOPHYTA/LILIOPSIDA	*Colocasia esculenta*	Large wild population found along the margin of the Lake
TRACHEOPHYTA/LILIOPSIDA	*Hydrilla verticillata*	Good population exists in the Lake, playing a major role in the shallow bottom sediments mainatiniing the water quality
TRACHEOPHYTA/LILIOPSIDA	*Hygroryza aristata*	Some pockets of the Lake have good patches of this species
TRACHEOPHYTA/MAGNOLIOPSIDA	*Ipomoea aquatica*	Patches exists in pockets filtering sediemnnts from the upstream slopes
TRACHEOPHYTA/MAGNOLIOPSIDA	*Limnophila heterophylla*	Rooted submerged community exists in shallow pockets
TRACHEOPHYTA/LILIOPSIDA	*Monochoria vaginalis*	Locally known as 'Karimkoovalam' in Malayalam exists as patched community in shallow banks
TRACHEOPHYTA/MAGNOLIOPSIDA	*Nymphaea nouchali*	Rooted floating community seen in many areas of the Lake adding to the aesthetic value of the Lake
TRACHEOPHYTA/MAGNOLIOPSIDA	*Nymphoides indica*	Rooted floating community seen in many areas of the Lake adding to the aesthetic value of the Lake
TRACHEOPHYTA/LILIOPSIDA	*Oryza rufipogon*	Usually found along with common rice as a weed
TRACHEOPHYTA/LILIOPSIDA	*Paspalidium geminatum*	Good patches exists at very shallow banks preventinng the entry of silt flow
TRACHEOPHYTA/MAGNOLIOPSIDA	*Utricularia reticulata*	Floating susppended community found in many parts of the Lake with good flowers adding to the beauty of the Lake
TRACHEOPHYTA/LILIOPSIDA	*Vallisneria spiralis*	Rooted submerged plant helps to keep the water quality in many ways

GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-07-15.

Invasive alien plant species

Phylum	Scientific name	Impacts	Changes at RIS update
TRACHEOPHYTA/LILIOPSIDA	*Eichhornia crassipes*	Actual (minor impacts)	unknown
TRACHEOPHYTA/POLYPODIOPSIDA	*Salvinia molesta*	Actual (minor impacts)	unknown

Optional text box to provide further information

(This field is limited to 2500 characters)

There have been 11 species of higher plants recorded along the shorelines of Sasthamkotta and 60 species within the overall catchment area. Patches of Screw Pine (Pandanus odoratissimus) exist near the Velanthara embankment. The eastern shoreline has patches of the insectivorous
plant, Indian Sundew (Drosera sp.). Collating the information on the terrestrial species yields a list of 158 species growing around Sasthamkotta Lake.

Available studies and field assessments indicate the presence of at least 18 macrophytes of 12 families in Sasthamkotta. Their distribution is largely confined in the regions adjoining Velanthara embankment, Rajagiri, Bharanikavu and Sasthamkotta Town. These areas are also significant point sources of pollution into the lake. Vallisneria, Salvinia and Blyxa are the dominant amongst submerged macrophytes, whereas, Ipomoea and Nymphoides form the dominant floating forms. Monochoria and Hygrophila often mix with Colocasia and Pandanus to form thick vegetation growth. Mats of Salvinia and Eichhornia crassipes (water hyacinth) were observed near Rajagiri old fish hatchery. Agglomeration of free floating plant Pistia sp. was also observed during post monsoon period in areas adjoining D.B. College and Rajagiri. Apparently, growth of macrophytes within Sasthamkotta is kept in check due to the dynamic inundation regime and low nutrient status.

Available information on planktons in Sasthamkotta indicate presence of at least 37 species of phytoplankton belonging to 30 genera. Phytoplanktons are most abundant during postmonsoon with higher percentages in the areas adjoining Sasthamkotta Town, and minimum around the western margins Bacillariophyceae is the dominant group followed by Chlorophyceae, Cyanophyceae and Dianoflagellata. Notably, Chlorophyceae was indicated to be the dominant class in studies done in 1994 (Joseph, 1994 as cited in Girijakumari, 2007). This transition may be related with increase in pollution loading within the waterbody. Cocconeis sp., Fragilaria sp., Melosira sp., Nitzschia sp., Navicula sp. and Synedra sp., reported presently to be abundant are tolerant forms of diatoms that sustain well even in polluted waters (Palmer, 1980).

GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-07-15.

4.3.2 - Animal species

Other noteworthy animal species

Phylum	Scientific name	Pop. size	Period of pop. est.	% occurrence	Position in range /endemism/other
CHORDATA/ACTINOPTERYGII	*Anguilla bicolor*				Near threatened species found in good number in the Lake. It is edible and locals consume
CHORDATA/ACTINOPTERYGII	*Aplocheilus blockii*				Good population exists in the Lake. It is valuable for mosquito control and aquarium use
CHORDATA/ACTINOPTERYGII	*Aplocheilus panchax*				Serves as natural stock population for aquarium use. Indicator of very clean and clear water
CHORDATA/ACTINOPTERYGII	*Chanda nama*				Large population founnd in the Lake especially during rainy season. Very good for mosquito control. Edible and locally used along with other small fishes. Serves as stock population for aquarium use
CHORDATA/ACTINOPTERYGII	*Channa marulius*				Edible, locally consumed and sold in the local markets. Indicate the presence of submerged aquatic vegetation
CHORDATA/ACTINOPTERYGII	*Channa micropeltes*				Utilized as a food fish. Economic important mainly from capture fisheries and aquarium use
CHORDATA/ACTINOPTERYGII	*Dayella malabarica*				Large population exists. Good for subsistence fisheries and consumed locally
CHORDATA/ACTINOPTERYGII	*Gambusia affinis*				Used as live food for carnivorous aquarium fishes. Very effective for mosquito control
CHORDATA/ACTINOPTERYGII	*Hyporhamphus limbatus*				Good population exists and marketed as a food fish
CHORDATA/ACTINOPTERYGII	*Mystus bleekeri*				Locally consumed and act as natural stock poulation for aquarium use
CHORDATA/ACTINOPTERYGII	*Mystus oculatus*				Endemic to Western Ghats. Locally consumed as food
CHORDATA/ACTINOPTERYGII	*Mystus vittatus*				Locally consumed as food. Good for aquariumm use
CHORDATA/ACTINOPTERYGII	*Ompok bimaculatus*				Near Threatened species commecialy of importnt fisheries use
CHORDATA/ACTINOPTERYGII	*Parambassis dayi*				It is an endemic to India fish species used in aquarium
CHORDATA/ACTINOPTERYGII	*Pseudosphromenus cupanus*				Good for aquarium use
CHORDATA/ACTINOPTERYGII	*Puntius amphibius*				Detritous feeding, cleansing the Lake. Used for subsistence fisheries
CHORDATA/ACTINOPTERYGII	*Puntius dorsalis*				Useful in guinea worm control. Detritous feeding so cleans the Lake. Locally consumed and good for aquarium use
CHORDATA/ACTINOPTERYGII	*Puntius vittatus*				Good for aquarium use and as a bait fish

GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-07-15.

Invasive alien animal species

Phylum	Scientific name	Impacts	Changes at RIS update
<no data available>			

GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-07-15.

Optional text box to provide further information

(This field is limited to 2500 characters)

Compilation of available species richness records indicate presence of at least 38 species of fish belonging to 19 families in Sasthamkotta. The list includes Horabagrus brachysoma, classed as Vulnerable in the IUCN Red List of Threatened Species. Two families (Cyprinidae and Bagridae) account for 11 species. Etroplus suratensis, the State Fish of Kerala is commonly found in the lake. Etroplus maculatus another species of the same genus has also been recorded in the lake. The species is largely confined to South India and Sri Lanka. Six of the recorded fish species (Dayella malabarica, Macrognathus guentheri, Mystus oculatus, Ompok malabaricus and Parambassis dayi) are endemic to the country.

Assessments conducted under Asian Waterbird Census (for the year 2012), indicated the presence of at least 35 species of waterbirds in Sasthamkotta. Most of the reported species are shoreline foragers (egrets, herons and bitterns) and waders (sandpipers and lapwings). Marshes around the fringes of the lake serve as foraging grounds for both migratory and resident waterbirds. Of the reported species, two species (Oriental Darter and Black-headed Ibis) are classed as Near Threatened as per IUCN Red List of Threatened Species (ver. 2016-3). A sporadic sighting of Asian Woolly Neck (Ciconia episcopus), a vulnerable waterbird species was reported in 2015 by Sasthamkotta Biodiversity Management Committee.

4.4 - Physical components

4.4.1 - Climate

Please indicate the prevailing climate type(s) by selecting below the climatic region(s) and subregion(s), using the Köppen-Gieger Climate Classification System.

Climatic region	Subregion
A: Tropical humid climate	Am: Tropical monsoonal (Short dry season; heavy monsoonal rains in other months)

If changing climatic conditions are affecting the site, please indicate the nature of these changes:

(This field is limited to 1000 characters)

The lake and its drainage basin are situated in a warm humid tropical climate. The average annual rainfall is 2251.57 mm, majorly received in two spells of south-west and north-east monsoon. Rainfall during the south-west monsoon is the predominant component accounting for 48% of the total rainfall. Temperature ranges between 22-33 °C. The evaporation rate is highest (207 mm) during January and minimum in July (89 mm). Relative humidity ranges from 63% in January to 87% in June - July. Wind speed ranges from 1.3 - 2.1 km/hour.

An analysis of 100-year rainfall for IMD's (India Meteorological Department) Kollam Station indicates a decline in rainfall during south-west monsoon. This trend also underlies a decline in total rainfall. These are similar to state-wide trends.

4.4.2 - Geomorphic setting

a) Minimum elevation above sea level (in metres): 14

a) Maximum elevation above sea level (in metres): 35

b) Position in landscape/river basin:

- Entire river basin ☐
- Upper part of river basin ☐
- Middle part of river basin ☐
- Lower part of river basin ☑
- More than one river basin ☐
- Not in river basin ☐
- Coastal ☐

Please name the river basin or basins. If the site lies in a sub-basin, please also name the larger river basin. For a coastal/marine site, please name the sea or ocean.

(This field is limited to 1000 characters)

Kallada River Basin

4.4.3 - Soil

- Mineral ☐
- (Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○
- Organic ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

No available information ☑

Are soil types subject to change as a result of changing hydrological conditions (e.g., increased salinity or acidification)? Yes ○ No ◉

Please provide further information on the soil (optional)

{This field is limited to 1000 characters}

The drainage basin of Sasthamkotta consists of mostly very deep, well drained clayey soil on gently sloping coastal laterite. The clay does not allow much surface infiltration.

4.4.4 - Water regime

Water permanence

Presence?	Changes at RIS update
Usually permanent water present	decrease

Source of water that maintains character of the site

Presence?	Predominant water source	Changes at RIS update
Water inputs from surface water	☐	unknown
Water inputs from precipitation	☐	unknown
Water inputs from groundwater	☑	unknown

Water destination

Presence?	Changes at RIS update
To downstream catchment	No change
Feeds groundwater	No change

Stability of water regime

Presence?	Changes at RIS update
Unknown	No change

Please add any comments on the water regime and its determinants (if relevant). Use this box to explain sites with complex hydrology:

{This field is limited to 2000 characters}

During a normal rainfall year, the entire lake bed is inundated by November after two spells of south-west and north-east monsoon, covering an area of 373 ha. The lake levels at this juncture reaches upto 15.7 m amsl. Post monsoon, the inundation shrinks reaching its minimum of 210 ha by April, wherein levels dip to around 13 m amsl.

(ECD) Connectivity of surface waters and of groundwater: An isotope study on ground water movement indicated that some wells on the south-western margins of the lake were getting recharged by Sasthamkotta, whereas, the rest of the wells contributed water into the lake.

(ECD) Stratification and mixing regime:

4.4.5 - Sediment regime

Significant erosion of sediments occurs on the site ☐

(Update) Changes at RIS update: No change ○ Increase ○ Decrease ○ Unknown ◉

Significant accretion or deposition of sediments occurs on the site ☐

(Update) Changes at RIS update: No change ○ Increase ○ Decrease ○ Unknown ◉

Significant transportation of sediments occurs on or through the site ☐

(Update) Changes at RIS update: No change ○ Increase ○ Decrease ○ Unknown ◉

Sediment regime is highly variable, either seasonally or inter-annually ☐

(Update) Changes at RIS update: No change ○ Increase ○ Decrease ○ Unknown ◉

Sediment regime unknown ☑

Please provide further information on sediment (optional):

{This field is limited to 1000 characters}

No recent studies of lake sedimentation are available. Hydrological investigation within the drainage basin indicate the recent sedimentation in the lake to range between 0.30 and 1.80 cm/year with higher values very close to Velanthara bund.

(ECD) Water turbidity and colour: Lake water is clear with turbidity ranging between 0.8 and 2.5 NTU.

(ECD) Light - reaching wetland:

(ECD) Water temperature:

4.4.6 - Water pH

Acid (pH<5.5) ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Circumneutral (pH: 5.5-7.4) ☑

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Alkaline (pH>7.4) ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Unknown ☐

Please provide further information on pH (optional):

(This field is limited to 1000 characters)

The lake waters are slightly acidic to weakly alkaline condition ranging between 5.3 to 8.1

4.4.7 - Water salinity

Fresh (<0.5 g/l) ☑

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Mixohaline (brackish)/Mixosaline (0.5-30 g/l) ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Euhaline/Eusaline (30-40 g/l) ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Hyperhaline/Hypersaline (>40 g/l) ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Unknown ☐

Please provide further information on salinity (optional):

(This field is limited to 1000 characters)

Lake is freshwater with salinity ranging between 2.78 – 3.13 ppt (parts per thousand).

(ECD) Dissolved gases in water

(This field is limited to 1000 characters)

The lake is well oxygenated with DO level in most parts of the lake ranging between 5.3 – 8.7 mg/l. However, values lower than 3 mg/l have been recorded from the areas adjoining Velanthara bund.

4.4.8 - Dissolved or suspended nutrients in water

Eutrophic ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Mesotrophic ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Oligotrophic ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Dystrophic ☐

(Update) Changes at RIS update: No change ◉ Increase ○ Decrease ○ Unknown ○

Unknown ☑

Please provide further information on dissolved or suspended nutrients (optional):

(This field is limited to 1000 characters)

Nitrate concentrations in the lake range between 0.01 and 9.9 mg/l. No recent assessments are available for phosphate and potassium. Phosphate levels during 2001-'05 in the lake were recorded in the range of 0.0012 - 0.0559 mg/l.
Gradual increase in nitrate concentrations have been recorded within the lake. A study conducted in 1998 indicates high level of PO4-P in deeper parts of the lake, trapped within organic clastic deposits, therefore, reducing available phosphates.
Lake water is clear with turbidity ranging between 0.8 - 2.5 NTU. The stretch between Sasthamkotta and Bharanikavu Town has relatively lower turbidity than others.

(ECD) Dissolved organic carbon

(ECD) Redox potential of water and sediments

(ECD) Water conductivity

4.4.9 - Features of the surrounding area which may affect the Site

Please describe whether, and if so how, the landscape and ecological characteristics in the area surrounding the Ramsar Site differ from the site itself: i) broadly similar ○ ii) significantly different ◉

If the surrounding area differs from the Ramsar Site, please indicate how: (Please tick all categories that apply)

Surrounding area has greater urbanisation or development ☐

Surrounding area has higher human population density ☐

Surrounding area has more intensive agricultural use ☑

Surrounding area has significantly different land cover or habitat types ☐

Please describe other ways in which the surrounding area is different:

(This field is limited to 2000 characters)

As per land use land cover analysis for 2015, 68% of the direct drainage basin is under plantation, 20% under agriculture, 7% under settlements and the rest under marshes.

4.5 - Ecosystem services

4.5.1 - Ecosystem services/benefits

Please select below all relevant ecosystem services/benefits currently provided by the site and indicate their relative importance in the right-hand column.

Provisioning Services

Ecosystem service	Examples	Importance/Extent/Significance
Food for humans	Sustenance for humans (e.g., fish, molluscs, grains)	Medium
Fresh water	Water for irrigated agriculture	Medium
Fresh water	Drinking water for humans and/or livestock	High

Regulating Services

Ecosystem service	Examples	Importance/Extent/Significance
Maintenance of hydrological regimes	Storage and delivery of water as part of water supply systems for agriculture and industry	Medium
Maintenance of hydrological regimes	Groundwater recharge and discharge	High
Pollution control and detoxification	Water purification/waste treatment or dilution	Medium
Hazard reduction	Flood control, flood storage	High

Cultural Services

Ecosystem service	Examples	Importance/Extent/Significance
Recreation and tourism	Picnics, outings, touring	Low
Spiritual and inspirational	Aesthetic and sense of place values	Medium
Spiritual and inspirational	Spiritual and religious values	Medium

Supporting Services

Ecosystem service	Examples	Importance/Extent/Significance
Biodiversity	Supports a variety of all life forms including plants, animals and microorganisms, the genes they contain, and the ecosystems of which they form a part	Medium
Nutrient cycling	Storage, recycling, processing and acquisition of nutrients	Medium

Optional text box to provide further information

(This field is limited to 2500 characters)

Other ecosystem service(s) not included above:

(This field is limited to 2000 characters)

The lake is nutrient poor. However, no specific assessments have been carried out.

*Please make a rough estimate of the approximate number of people (**distinguish between residents and visitors if possible**) who directly benefit from the ecological services provided by this site (estimate at least in orders of magnitude: 10s, 100s, 1000s, 10 000s etc.):*

Within the site:

Outside the site: 50000

Have studies or assessments been made of the economic valuation of ecosystem services provided by this Ramsar Site? Yes ○ No ○ Unknown ◉

Where economic studies or assessments of economic valuation have been undertaken at the site, it would be helpful to provide information on where the results of such studies may be located (e.g. website links, citation of published literature):

(This field is limited to 2500 characters)

4.5.2 - Social and cultural values

Is the site considered internationally important for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? If so, please describe this importance under one or more of the four following categories. You should not list here any values derived from non-sustainable exploitation or which result in detrimental ecological changes.

i) the site provides a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland ☐

Description if applicable

(This field is limited to 2500 characters)

ii) the site has exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland ☐

Description if applicable

(This field is limited to 2500 characters)

iii) the ecological character of the wetland depends on its interaction with local communities or indigenous peoples ☐

Description if applicable

(This field is limited to 2500 characters)

iv) relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland ☑

Description if applicable

(This field is limited to 2500 characters)

Several important sacred sites, including the Sastha Temple, are located on the banks of the lake and around it. The lake has high religious value and is visited by thousands of pilgrims every year for taking holy dip on its banks.

4.6 - Ecological processes

This section is not intended for completion as part of a standard RIS, but is included for completeness as part of the agreed format of a 'full' Ecological Character Description (ECD) outlined by Resolution X.15

(ECD) Primary production	Recent assessments not available. Primary productivity was recorded to be low in Sasthamkotta Lake, ranging between 0.072-4.5 mg / C /m3 / day, showing peak during post-monsoon.
(ECD) Nutrient cycling	The lake is nutrient poor. However, no specific assessments have been carried out.
(ECD) Carbon cycling	
(ECD) Animal reproductive productivity	
(ECD) Vegetational productivity, pollination, regeneration processes, succession, role of fire, etc.	
(ECD) Notable species interactions, including grazing, predation, competition, diseases and pathogens	
(ECD) Notable aspects concerning animal and plant dispersal	
(ECD) Notable aspects concerning migration	

5 - How is the Site managed? (Conservation and management)

5.1 - Land tenure and responsibilities (Managers)

5.1.1 - Land tenure/ownership

Public ownership

Category	Within the Ramsar Site	In the surrounding area
Provincial/region/state government	☑	☐

Private ownership

Category	Within the Ramsar Site	In the surrounding area
Other types of private/individual owner(s)	☐	☑

Other

Category	Within the Ramsar Site	In the surrounding area
<no data available>		

Provide further information on the land tenure / ownership regime (optional):

(This field is limited to 1000 characters)

The boundaries of Sasthamkotta were delineated in 2007 through a joint survey by Kerala Water Authority and the Revenue Department, and boundary pillars were established on-ground at a distance of 50 m from the peak inundation area. The rights of the delineated area are vested with the Government, however, the revenue records indicate presence of private rights in some parts of the lake. Land within the direct drainage basin is under private ownership.

5.1.2 - Management authority

Please list the local office / offices of any agency or organization responsible for managing the site:

(This field is limited to 1000 characters)

State Wetland Authority Kerala (SWAK)

Provide the name and/or title of the person or people with responsibility for the wetland:

Padma Mahanti IFS, Member Secretary, SWAK

Postal address:

(This field is limited to 1000 characters)

Directorate of Environment and Climate Change, 'Devikripa', Pallimukku, Pettah P. O., Thiruvananthapuram - 695024, Kerala State, India

E-mail address:

swak.kerala@gmail.com

5.2 - Ecological character threats and responses (Management)

5.2.1 - Factors (actual or likely) adversely affecting the Site's ecological character

Human settlements (non agricultural)

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
Housing and urban areas	Medium impact	Medium impact	☐	unknown	☑	No change
Tourism and recreation areas	Low impact	Low impact	☑	increase	☑	unknown

Water regulation

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
<no data available>						

Agriculture and aquaculture

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
Annual and perennial non-timber crops	Medium impact	Medium impact	☐	unknown	☑	No change

Energy production and mining

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
<no data available>						

Transportation and service corridors

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
<no data available>						

Biological resource use

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
Fishing and harvesting aquatic resources		Low impact	☐	unknown	☑	No change

RIS for Site no. 1212, Sasthamkotta Lake, India

Human intrusions and disturbance

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
Recreational and tourism activities	Low impact	Low impact	☑	increase	☑	unknown

Natural system modifications

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
<no data available>						

Invasive and other problematic species and genes

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
<no data available>						

Pollution

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
Household sewage, urban waste water	Medium impact	Medium impact	☑	No change	☑	No change
Agricultural and forestry effluents	Medium impact	Medium impact	☑	No change	☑	No change

Geological events

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
<no data available>						

Climate change and severe weather

Factors adversely affecting site	Actual threat	Potential threat	Within the site	Changes	In the surrounding area	Changes
Temperature extremes	Low impact	Medium impact	☑	increase	☑	increase

Please describe any other threats (optional):

(This field is limited to 3000 characters)

A decline in the south-west monsoon (which is the predominant system of monsoon for Kerala) has been observed. Temperature extremes are also experienced recently.

5.2.2 - Legal conservation status

Please list any other relevant conservation status, at global, regional or national level and specify the boundary relationships with the Ramsar Site:

Global legal designations

Designation type	Name of area	Online information url	Overlap with Ramsar Site
<no data available>			

Regional (international) legal designations

Designation type	Name of area	Online information url	Overlap with Ramsar Site
<no data available>			

National legal designations

Designation type	Name of area	Online information url	Overlap with Ramsar Site
<no data available>			

Non-statutory designations

Designation type	Name of area	Online information url	Overlap with Ramsar Site
Other non-statutory designation			whole

5.2.3 - IUCN protected areas categories (2008)

Ia Strict Nature Reserve ☐

Ib Wilderness Area: protected area managed mainly for wilderness protection ☐

II National Park: protected area managed mainly for ecosystem protection and recreation ☐

III Natural Monument: protected area managed mainly for conservation of specific natural features ☐

IV Habitat/Species Management Area: protected area managed mainly for conservation through management intervention ☐

V Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation ☐

VI Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems ☑

5.2.4 - Key conservation measures

Legal protection

Measures	Status
Legal protection	Partially implemented

Habitat

Measures	Status
Re-vegetation	Partially implemented

Species

Measures	Status
Control of invasive alien plants	Proposed

Human Activities

Measures	Status
Management of water abstraction/takes	Proposed
Regulation/management of wastes	Proposed
Communication, education, and participation and awareness activities	Proposed
Research	Proposed

Other:

(This field is limited to 3000 characters)

5.2.5 - Management planning

Is there a site-specific management plan for the site? Yes

Is the management plan/planning implemented? Yes ◉ No ○

The management plan covers All of Ramsar Site

Is the management plan currently subject to review and update? Yes ○ No ◉

Has a management effectiveness assessment been undertaken for the site? Yes ○ No ◉

Please give link to site-specific plan or other relevant management plan if this is available via the Internet or upload it in section 'Additional material':

(This field is limited to 500 characters)

If the site is a formal transboundary site as indicated in section Data and location > Site location, are there shared management planning processes with another Contracting Party? Yes ○ No ◉

Please indicate if a Ramsar centre, other educational or visitor facility, or an educational or visitor programme is associated with the site:

(This field is limited to 1000 characters)

URL of site-related webpage (if relevant):

5.2.6 - Planning for restoration

Is there a site-specific restoration plan? Yes, there is a plan

Has the plan been implemented? Yes ◉ No ○

The restoration plan covers: All of Ramsar Site

Is the plan currently being reviewed and updated? Yes ○ No ◉

Where the restoration is being undertaken to mitigate or respond to a threat or threats identified in this RIS, please indicate it / them:

(This field is limited to 1000 characters)

Further information

(This field is limited to 2500 characters)

5.2.7 - Monitoring implemented or proposed

Monitoring	Status
Water regime monitoring	Proposed
Water quality	Proposed
Soil quality	Proposed
Plant species	Proposed
Plant community	Proposed
Animal community	Proposed
Birds	Proposed
Animal species (please specify)	Proposed

Please indicate other monitoring activities:

(This field is limited to 3000 characters)

6 - Additional material

6.1 - Additional reports and documents

6.1.1 - Bibliographical references

(This field is limited to 3000 characters)

Census of India. 2011. Primary Census Abstract - Kerala. New Delhi: Office of the Registrar General and Census Commissioner, Ministry of Home Affairs, Government of India.
CGWB. 2013. Ground Water Information Booklet of Kollam District, Kerala State. [Technical Reports: Series 'D']. Kerala: Central Ground Water Board (CGWB), Ministry of Water Resources, Government of India.
Chaudhary, R. and Pillai, R. S. 2009. Algal biodiversity and related physiochemical parameters in Sasthamcottah Lake, Kerala (India). Journal of Environmental Research and Development, 3(3): 790-795.
CWRDM. 1995. Water Atlas of Kerala. Kozhikode, Kerala: Centre for Water Resources Development and Management (CWRDM).
CWRDM. 2010. Sasthamcotta Wetland: Management Action Plan. Kozhikode, Kerala: Centre for Water Resources Development and Management (CWRDM).
DoF. 2011. Panfish Book: Kollam District. Thiruvananthapuram, Kerala: Department of Fisheries (DoF), Government of Kerala.
DoLR. 2015. Operational Guidelines for Convergence of Various Programmes with Integrated Watershed Management Programme (IWMP). New Delhi: Department of Land Resources (DoLR), Ministry of Rural Development, Government of India.
DoT. 2014. Kerala Tourism Statistics 2014. Kerala: Research and Statistics Division, Department of Tourism (DoT), Government of Kerala.
Finlayson, C. M., Davidson, N., Pritchard, D., Milton, G. R. and MacKay, H. 2011. The Ramsar Convention and ecosystem-based approaches to the wise use and sustainable development of wetlands. Journal of International Wildlife Law and Policy, 14: 176-198.
Finlayson, C. M. 2012. Forty years of wetland conservation and wise use. Aquatic Conservation: Marine and Freshwater Ecosystems, 22(2): 139-143.
Gehring, T. and Oberthür, S. 2008. Interplay: Exploring Institutional Interaction. In: Young, O. R., King, L. A. and Schroeder, H.eds., Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers. Cambridge, Massachusetts: MIT Press: 187-223.
George, A. V. and Koshy, M. 2008. Water quality studies of Sasthamkotta Lake of Kerala. Pollution Research, 27(3): 419-424.
Girijakumari, S., Abraham, N. P. and Santhosh, S. 2006. Assessment of faecal indicating bacteria of Sasthamkotta Lake. Indian Hydrobiology, 9(2): 159-167.
Girijakumari, S. 2007. Resource potential of Sasthamkotta Lake with special reference to fish fauna and their sustainability. Ph. D. Thesis. Mahatma Gandhi University.
Girijakumari S., Nelson P. A., Smrithy R. and A. Biju Kumar. 2011. Ichthyofaunal diversity of Sasthamkotta Ramsar Lake, Kerala, India. Journal of Inland Fishery Society of India, 43(1): 96-102.
Gumbricht, T. 2015. Hybrid mapping of pantropical wetlands from optical satellite images, hydrology and geomorphology. In: Tiner, R. W., Lang, M. W. and Klemas, V. V. eds., Remote Sensing of Wetlands: Applications and Advances. Boca Raton, Florida: CRP Press, Taylor and Francis Group.

6.1.2 - Additional reports and documents

i. taxonomic lists of plant and animal species occurring in the site (see section 4.3)
<no file available>

ii. a detailed Ecological Character Description (ECD) (in a national format)
<no file available>

iii. a description of the site in a national or regional wetland inventory
<no file available>

iv. relevant Article 3.2 reports
<no file available>

v. site management plan
IN1212_mgt180517__Sasthamkotta.pdf

vi. other published literature
IN1212_lit180525__Sasthamkotta.pdf
IN1212_lit180525_1__Sasthamkotta.pdf
IN1212_lit180525_3__Sasthamkotta.pdf
IN1212_lit180525_2__Sasthamkotta.pdf

Please note that any documents uploaded here will be made publicly available.

6.1.3 - Photograph(s) of the Site

Please provide at least one photograph of the site:


An Overview of Sasthamkotta (*SWAK, 10-05-2013*)


An Overview of Sasthamkotta (*SWAK, 09-02-2015*)


Water pumping intake area by Kerala Water Authority for drinking water supply (*SWAK, 29-11-2019*)

6.1.4 - Designation letter and related data

Designation letter
<no file available>

Date of Designation: 2002-08-19

STAY IN TOUCH

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