

# ANNUAL REPORT ON FORESTS FIRES IN TAMIL NADU

## 2024

TAMIL NADU FOREST DEPARTMENT
Tamil Nadu State Forest Fire Control Centre

TAMIL NADU FOREST DEPARTMENT

# Annual Report on Forest Fires in Tamil Nadu

## 2024





# Executive Summary

The Annual Report on Forest Fires in Tamil Nadu: 2024 underscores the alarming rise in forest fire incidents across the state, revealing critical trends, impacts, and strategic interventions undertaken during the year. With 218 large forest fire (LFF) incidents recorded in 2024, this marks a 171% increase compared to 80 incidents in 2022 and a notable rise from 156 in 2023. The sharp escalation in fire incidents reflects a combination of prolonged dry spells, rising temperatures, delayed monsoons, and increased human activity in forested regions.

The fire-sensitive period, spanning primarily from February to May, emerged as the most vulnerable window, with 60% of fire incidents concentrated in March and April alone. The highest number of fires occurred in April 2024, with 2,752 incidents, compared to just 402 in April 2023, highlighting the growing severity of the fire season. Similarly, March saw a spike to 1,924 incidents in 2024, a significant jump from 1,274 in 2023, further emphasizing the need for targeted pre-fire season activities and real-time monitoring during these months.

Geographic analysis revealed that certain regions are highly vulnerable and sensitive to forest fires. Dindigul Circle recorded the highest fire detections, with 1,352 incidents, followed by Vellore (1,193) and Dharmapuri (786). At the division level, Kodaikanal (34 large fires), Hosur (29), and Vellore (25) emerged as hotspots, where dense forests and human activities such as grazing, agricultural practices and tourism could have contributed to fire vulnerability. The Denkanikottai range alone reported 499 fire incidents, making it the most affected range in 2024, followed by Mannavanur (282 incidents) and Perumpallam (236 incidents). At the micro-level, specific beats such as Paricombai West (201 incidents) and Poomparai West (125 incidents) highlighted localized areas of extreme sensitivity.

Despite the rising number of incidents, Tamil Nadu’s response mechanisms demonstrated significant improvements in efficiency. 72% of large fires were doused within 24 hours, a marked achievement in rapid fire control. 20.18% of LFFs were extinguished within three days, and only 2.29% required up to 10 days. Notably, only one fire in 2024 lasted more than 10 days. The Mannavanur-4 fire in the Dindigul Division/Kodaikanal area, which remained active for more than 10 days and reported 247 fire pixels in total, was one of the most prolonged incidents, highlighting the challenges posed by extended dry conditions and dense vegetation of invasive species in specific zones.

Technological integration played a pivotal role in improving fire detection, monitoring, and response. The Tamil Nadu Forest Fire Management Information System (TNFFMIS) provided real-time fire alerts sourced from satellite-based systems like FSI, MODIS, and SNPP VIIRS, enabling faster and more accurate identification of fire incidents. Additionally, thermal drones were deployed extensively in vulnerable areas like Kodaikanal, Salem, Namakkal, and Coimbatore, offering early detection of fire hotspots, real-time monitoring, and actionable insights for firefighting teams. These drones, equipped with thermal imaging cameras, allowed round-the-clock surveillance of high-risk zones and significantly reduced response times.

Geospatial dashboards further enhanced decision-making by tracking active fire incidents, burnt area assessments, fire spread patterns, and resource deployment. For instance, fire lines totalling 5,452.71 km were created and maintained in 2024, providing crucial physical barriers to slow fire spread. These included 3,927.48 km of 3-meter fire lines, 1,375.23 km of 6-meter lines, and 150 km of 12-meter lines. Such pre-fire season activities proved instrumental in mitigating the intensity and scale of fire incidents.

Community participation remained a cornerstone of Tamil Nadu's fire management strategy. Over 5,200 individuals registered for the FSI's SMS-based alert system, empowering local communities with real-time information on fire incidents. The Village Forest Committees (VFCs) actively engaged in fire prevention and suppression, conducting awareness campaigns, organizing firebreak maintenance, and assisting forest officials in initial firefighting efforts. The Tiruvannamalai Model, which integrated local community involvement with departmental strategies, stands out as a replicable framework for reducing fire risks and improving response efficiency.

The ecological and socio-economic impacts of these fires were significant. Extensive damage to dry deciduous forests—one of the most affected vegetation types—resulted in reduced biodiversity, habitat destruction, and loss of ecosystem services such as carbon sequestration and water regulation. Burnt area assessments revealed widespread degradation, with long-term consequences for soil fertility, wildlife habitats, and forest-dependent communities.

The report identifies key lessons and actionable recommendations to strengthen Tamil Nadu's Forest Fire Management framework:

1. Expanding Early Detection Systems: Broader deployment of thermal drones, satellite-based fire alerts, and geospatial analytics.
2. Strengthening Fire Lines and Firebreaks: Increased creation and maintenance of fire lines, particularly in high-risk zones such as Dindigul, Vellore, and Hosur.
3. Enhancing Community Engagement: Training programs, awareness campaigns, and incentivized community participation to reduce human-induced fire risks.
4. Leveraging Advanced Tools: Wider use of tools like GPS-enabled walkie-talkies, mobile apps, and dashboards to improve communication and coordination during fire incidents.
5. Integrated Restoration Efforts: Targeted afforestation initiatives and habitat restoration programs to rebuild degraded areas and enhance forest resilience.

The findings of the 2024 Annual Report highlight Tamil Nadu's commitment to combining advanced technology, strategic planning, and community-driven approaches to address the growing challenge of forest fires. As fire incidents continue to rise, the need for a comprehensive, proactive strategy remains critical to protecting the state's rich biodiversity and supporting the livelihoods of millions dependent on forest resources. By adopting these measures, Tamil Nadu is poised to set a benchmark in sustainable Forest Fire Management for other regions to follow.





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# 01

# Overview of Forest Fire

# Chapter 1: Forest Fire – An Overview

## Introduction

Forest fires are a natural phenomenon that have shaped ecosystems for centuries, influencing their structure, dynamics, and ecological balance. These fires can play a beneficial role by clearing dead vegetation, recycling nutrients, and facilitating the regeneration of grasses, herbs, and saplings. Controlled fires are often used as a resource management tool to improve ecological conditions and reduce fuel buildup. However, the benefits of fires are overshadowed by the substantial damage caused by uncontrolled occurrences. Uncontrolled forest fires pose significant threats to biodiversity, habitats, and human life. Factors such as prolonged drought, high wind speeds, low humidity, and rising temperatures exacerbate the risk of fire outbreaks. Human negligence, including improper land use practices and carelessness, is a major contributor to forest fire incidents. The impacts of these fires extend far beyond the immediate loss of vegetation, leading to the destruction of ecosystems, habitat degradation, and reduced forest productivity. Forest-dependent communities often face disrupted livelihoods and diminished access to vital resources. Effectively managing forest fires is essential for mitigating these adverse effects and sustaining forest ecosystems. A comprehensive approach that integrates scientific research, policy interventions, and community engagement is critical to balancing the ecological benefits of fire with the need to prevent its destructive consequences.

The ecological role of forest fires is evident in various biomes where fire-dependent species and ecosystems have adapted to periodic burns. Fires can stimulate seed germination, open up forest canopies to sunlight, and control invasive species. However, when mismanaged or occurring at unsustainable frequencies, they lead to irreversible damage. The loss of flora and fauna disrupts food chains and alters the structure of ecosystems. Furthermore, forest fires are a significant contributor to global climate change, releasing vast quantities of greenhouse gases such as carbon dioxide and methane into the atmosphere, which intensify global warming. This dual role—as both a natural process and a destructive force—makes Forest Fire Management a critical global challenge.

In addition to their ecological impact, forest fires have profound socio-economic implications. They destroy livelihoods by consuming agricultural land, timber resources, and non-timber forest products (NTFPs) such as honey, medicinal plants, and fuelwood. Communities reliant on forest resources are often the most affected, experiencing not only economic losses but also disruptions to cultural and social systems tied to the forests. Moreover, forest fires pose significant public health risks. The smoke generated from wildfires contains fine particulate matter (PM2.5), which can cause respiratory illnesses, cardiovascular diseases, and premature deaths in both humans and animals.

Forest fires are also symptomatic of broader environmental issues, such as deforestation, habitat fragmentation, and unsustainable land-use practices. As forests shrink and become fragmented, they lose their natural resilience to fire, leading to an increased frequency of intense and uncontrolled fires. This makes the prevention, mitigation, and management of forest fires a multi-faceted challenge requiring a combination of scientific research, technological advancements, community engagement, and strong policy frameworks.

Efforts to address the challenges posed by forest fires require a comprehensive understanding of their causes, impacts, and potential solutions. From the role of human negligence to the effects of climate change, this introduction highlights the importance of integrating traditional knowledge with modern techniques to achieve sustainable forest management. The following sections delve into the global, national, and state-specific perspectives on forest fires, with a focus on Tamil Nadu, to provide a detailed overview of this pressing environmental issue.

## Global Perspective

Forest fires are a critical global environmental issue, with implications that extend beyond regional ecosystems to influence global climatic and atmospheric conditions. They serve as agents of renewal in certain ecosystems by promoting nutrient cycling, reducing excessive vegetation, and fostering the growth of fire-adapted species. However, the scale and frequency of forest fires have increased alarmingly in recent decades, largely driven by human activities and climate change.

According to the Global Forest Resource Assessment (GFRA) of 2020, approximately 98 million hectares (Mha) of forests were affected by fires in 2015, accounting for 3% of the global forest area. Tropical regions were particularly affected, with 4% of their forest area impacted. These fires have resulted in significant biodiversity loss, including the destruction of habitats for rare and endangered species, and disruption of ecosystem services such as carbon sequestration, water regulation, and soil stability. The environmental toll of these fires extends to the atmospheric level, where greenhouse gas emissions from forest fires are a major contributor to global warming. The Intergovernmental Panel on Climate Change (IPCC) estimates that forest fires contribute 2.5 to 4 billion tons of CO2 annually, exacerbating global climate instability.

In addition to climate change, human factors such as land conversion for agriculture, urban expansion, and deforestation are major drivers of increased fire incidences. Reports from WWF (2020) highlight that nearly 75% of wildfires are human-induced, resulting from agricultural practices, land conversion, and negligence. These fires have far-reaching consequences, including landscape degradation, loss of biodiversity, and severe health impacts due to smoke inhalation. Smoke from landscape fires is estimated to cause 260,000 to 600,000 premature deaths annually, highlighting the significant human health implications of forest fires.

Global efforts to combat forest fires include initiatives such as the Global Wildfire Information System (GWIS), which provides real-time data on fire occurrences and risk assessment. The emphasis is on adopting integrated

fire management practices, combining advanced technologies like satellite monitoring with traditional ecological knowledge, and enhancing community participation in fire prevention and control.

## Forest Fires and Climate Change

Forest fires and climate change are deeply interconnected, creating a vicious cycle of mutual reinforcement. Climate change, characterized by rising temperatures, prolonged droughts, and erratic rainfall patterns, exacerbates fire risks by making forests drier and more flammable. These conditions increase the likelihood, frequency, and intensity of forest fires, further destabilizing ecosystems.

Forest fires also induce significant changes in land use and land cover (LULC), transforming forested areas into degraded lands or grasslands. This conversion disrupts carbon storage, as forests act as major carbon sinks. Degraded lands not only store less carbon but also release additional greenhouse gases through soil erosion and reduced vegetation cover. The LULC changes caused by fires often pave the way for further deforestation and unsustainable agricultural practices, compounding the impact on climate change.

Conversely, forest fires contribute significantly to climate change by releasing vast amounts of carbon dioxide and other greenhouse gases into the atmosphere. According to estimates, fires account for up to 20% of global annual carbon emissions. This not only accelerates global warming but also reduces the capacity of forests to act as carbon sinks, further undermining efforts to mitigate climate change.

Extreme weather events, such as heatwaves and prolonged dry spells, are becoming more common due to climate change, heightening the vulnerability of forests worldwide. In tropical regions, delayed monsoons and lower-than-average rainfall make forests particularly susceptible to fire outbreaks. The destruction caused by these fires leads to the degradation of soil, loss of water retention capacity, and disruption of local weather systems.

Addressing the relationship between forest fires and climate change requires a multipronged approach. Efforts should focus on enhancing forest resilience through afforestation and sustainable management practices, implementing advanced fire detection and suppression technologies, and reducing greenhouse gas emissions from all sectors. Integrated global and local strategies are essential for breaking this destructive cycle and protecting forests and the climate.

## National Perspective: India

India's diverse forest ecosystems, ranging from tropical rainforests to dry deciduous woodlands, face a unique set of challenges when it comes to forest fires. These fires have far-reaching implications for biodiversity, ecosystem services, and the livelihoods of millions who depend on forest resources. According to the India State of Forest Report (ISFR) 2021, approximately 36% of India's forest cover is prone to frequent fires, with 2.81% classified as extremely fire-prone and 7.85% as very highly fire-prone.

India predominantly experiences surface fires, which are confined to the forest floor. However, their intensity and frequency vary across regions and forest types. Dry deciduous forests, which dominate the central and northern parts of the country, are particularly susceptible due to the accumulation of dry leaves and vegetation. Evergreen and semi-evergreen forests are comparatively less prone but not entirely immune to fire incidents. Climate change, characterized by prolonged droughts, erratic rainfall, and rising temperatures, has further intensified the vulnerability of Indian forests to fire outbreaks.

Human-induced activities play a significant role in forest fires across India. Shifting cultivation, particularly in the northeastern states, is a major contributor. Known as Jhum cultivation, this practice involves clearing forested areas by slash-and-burn methods, leading to frequent and severe fires. Similarly, the large-scale collection of non-timber forest products (NTFPs), such as tendu leaves and mahua flowers, often results in accidental fires in central and western India. Unsustainable grazing practices, mining, and tourism-related activities further aggravate the risk of fires in various regions.

The socio-economic impact of forest fires is profound, especially in rural India, where an estimated 275 million people depend on forests for their livelihoods. Fires disrupt the availability of essential forest resources, including fuelwood, fodder, and NTFPs, thereby affecting local economies and livelihoods. Additionally, the loss of biodiversity and ecosystem services due to fires directly impacts agriculture, water security, and climate regulation, leading to broader societal and economic consequences.

To address these challenges, the National Disaster Management Authority (NDMA) has categorized forest fires as a national disaster. The launch of the National Programme on Forest Fire Management (NPFFM) marks a significant step toward adopting a holistic approach to forest fire prevention, detection, and mitigation in India. This program emphasizes the use of advanced technologies, such as satellite-based monitoring and early warning systems, coupled with community-driven initiatives for effective fire management.

## Tamil Nadu Perspective

Tamil Nadu, located in the southern part of India, is home to diverse forest types, including tropical dry deciduous forests, tropical thorn forests, and evergreen forests in the Western Ghats. These forests play a crucial role in supporting the state's rich biodiversity, regulating climate, and sustaining the livelihoods of local communities. However, forest fires have emerged as a persistent challenge, with significant environmental and economic repercussions.

The state's dry deciduous and scrub forests are particularly vulnerable to fire incidents, driven by factors such as prolonged dry spells, high temperatures, and human activities. Fires in Tamil Nadu are often linked to agricultural practices, grazing, and the collection of forest resources. Accumulation of dry biomass, combined with human negligence, frequently results in accidental fires. The consequences are far-reaching, including loss of timber, destruction of wildlife habitats, and degradation of microflora and fauna.

In Tamil Nadu, forest fires disrupt the state's ecological balance by threatening wildlife, including endemic and endangered species. The Western Ghats, a biodiversity hotspot, is particularly susceptible, where fires not only destroy habitats but also lead to long-term ecological degradation. Fires also exacerbate soil erosion, reduce water retention capacity, and negatively impact local weather patterns, contributing to a cycle of environmental decline.

Forest fires in Tamil Nadu also disrupt local livelihoods by reducing the availability of non-timber forest products (NTFPs) such as honey, medicinal plants, and fodder. This has a cascading effect on forest-dependent communities, particularly those residing near forested areas. Women and marginalized groups, who rely heavily on forest resources, are disproportionately affected, facing increased economic hardships and food insecurity.

The state government has implemented various measures to address these challenges, including early warning systems, satellite-based fire detection, and community participation in fire management. Tamil Nadu's forest department has also undertaken afforestation and reforestation initiatives to restore degraded areas and mitigate fire risks. Collaborative efforts with local communities, non-governmental organizations, and research institutions are being strengthened to enhance fire preparedness and response capabilities.

The state's initiatives align with national programs such as the NPFFM, focusing on building resilience against forest fire threats. By integrating modern technologies with traditional practices, Tamil Nadu is working to create a sustainable model for Forest Fire Management that balances ecological conservation with socio-economic development.

## Structure of Forest

Forests are structurally defined based on crown cover percentage, minimum tree height, and minimum stand area. The Food and Agricultural Organization (FAO) defines forests as land with a tree crown cover (or equivalent stocking level) exceeding 10% and spanning an area of more than 0.5 hectares. Similarly, the Forest Survey of India (FSI) defines forest cover as "all lands larger than one hectare with a tree canopy density of more than 10%, regardless of ownership or legal status." This definition also encompasses orchards, bamboo, and palm plantations, even if they are not part of officially recorded forest areas. Broadly, forest definitions fall into three categories: administrative, land use, and land cover. Administrative definitions are based primarily upon the legal designations of land, and commonly bear little relationship to the vegetation growing on the land.

Land use definitions categorize forests based on their primary purpose, such as land primarily used for timber production. Land cover definitions classify forests based on the type and density of vegetation. These definitions often specify forests as areas where tree cover exceeds a certain threshold.

Forests play a critical role in providing a wide range of ecological, social, and economic benefits, including:

- Supplying clean water for drinking and other household needs.
- Providing food, medicine, fodder, and other essential resources.
- Acting as a buffer in natural disasters, such as floods and heavy rainfall.
- Protecting watersheds by reducing or slowing erosion and preventing chemicals from reaching waterways.
- Serving as a habitat for more than half of the world's land-based species.

## Threats to Forests

The world's forests play many vital roles, including providing renewable raw materials and energy, maintaining biodiversity, and protecting the environment. However, forests are threatened by various destructive agents, such as insect infestations, diseases, droughts, floods, and fires. While these natural threats are part of forest dynamics, forests have historically replenished, rejuvenated, and recovered.

Today, forests face an increasing number of threats, particularly from clearing and degradation. Forest degradation refers to the reduction of a forest's capacity to provide goods and services (FAO, 2012a). The clearing and deforestation of forests for agriculture, housing, and infrastructure development, along with degradation due to unsustainable logging practices and man-made fires, pose the most destructive threats, leading to irreversible losses in forest ecosystems.

Agriculture remains the most significant driver of global deforestation, while forest fires are a potential contributor to forest degradation. This degradation adversely affects biodiversity and atmospheric carbon flux and can serve as a precursor to forest conversion. The degradation of the world's forests harms communities, economies, and wildlife, as well as the fundamental ability of forest ecosystems to function and provide essential services, such as fresh water and a clean environment, that benefit people everywhere. Many of the remaining forests are severely fragmented and compromised in their capacity to provide services to people or to shelter wildlife.

## Forest fire

A forest fire is an uncontrolled incident that causes significant damage to forest vegetation. It is one of the leading causes of forest degradation worldwide. However, the role of fire in forest management is complex and multifaceted. In some ecosystems, natural fires are essential for maintaining ecological dynamics, biodiversity, and productivity. Fire is also widely used as a tool to achieve land management objectives.

Despite its benefits in certain contexts, forest fires destroy millions of hectares of forests, woodlands, and other vegetation annually, resulting in the loss of human and animal lives, immense economic costs from resource destruction, and suppression efforts. Forest fires disrupt natural balance and threaten biodiversity by depleting flora and fauna.

The impacts extend beyond forests, affecting society and the environment. These include adverse effects on human health from smoke, loss of biological diversity, greenhouse gas emissions, and damage to recreational values and infrastructure.

## Forest fire and Wildlife

Forest fires devastate habitats and disrupt the intricate relationships among diverse flora and fauna, leading to a loss of ecosystems and biological diversity. The most significant impact of fire on wildlife is the alteration of their habitats. Fires change the proportion, arrangement, and characteristics of habitats across the landscape. Immediately following a fire, there can be a temporary loss of food and shelter, resulting in the displacement of territorial birds and mammals, destruction of nesting sites, and direct mortality. These changes can upset the local ecological balance, ultimately contributing to the decline of wildlife populations (Barkley Y, 2010).

Burned forests often become impoverished in terms of small mammals, birds, reptiles, and rodents, while carnivores tend to avoid these burned areas. The reduction in populations of reptiles, burrowing animals, and small mammals, such as rodents, can adversely affect the food supply for small carnivores. Additionally, the loss of key organisms within forest ecosystems—such as invertebrates, pollinators, and decomposers—along with reduced seed deposits, can significantly hinder the recovery and regeneration of the forest (Boer, 1989).

However, fire can also be used as a tool in forest management. Prescribed or controlled burning helps reduce hazardous fuel loads, prepare sites for seeding or planting, improve wildlife habitat, dispose of logging debris, and control diseases, among other benefits.

## Causes for fire

Most of the forest fires are caused by human activities. These motivations include land clearing, agricultural practices, maintaining grasslands for livestock, extracting non-wood forest products, industrial development, resettlement, hunting, negligence, and arson. Indigenous communities have used fire for thousands of years to manage and shape landscapes.

In contrast, in very remote regions of Europe and America, lightning remains a significant natural cause of fires (FAO). Forest fires can arise from various factors, including both human-induced and natural causes.

**Natural causes**: Forest fires can result from natural events such as lightning strikes, power transmission line failures, or volcanic eruptions. However, volcanic eruptions are rare in the Indian context.

**Anthropogenic causes**: Most forest fires are human-induced, either intentionally or unintentionally. In India, approximately 99% of forest fires are linked to human activities, with many deliberately set due to socio-economic factors (NRSA, 2006).

**Intentional causes include**

Fires caused with the motivation of profit making like

- Fire set in an attempt to encroach forestlands
- For renewal of pastures at the expense of forests
- To regain agricultural terrain at the expense of forests

Fire caused by poachers, timber smugglers etc.,

- To destroy evidences of illegal activities
- Fire by miscreants
- Fires caused by the burning of waste in illegal dumps
- Fires caused by locals for livelihood like
- Fire by grazers for fresh growth of grass for their cattle.
- Fire to facilitate easy NTFP collection.
- Fire set to clear forests for Shifting cultivation
- Fire thrown after honey collection
- To scare/flush out animals to hunt
- Incendiary fires against forest officials/policies etc.,

**Unintentional/negligent causes include**

- Fire leftover by travellers, campers and picnickers
- Fire that escapes from neigh-boring agricultural lands while clearing agricultural residues
- Fire that escapes from prescribed burning/control burning etc.,
- Fire due to power lines.

## Impacts of forest fire

Forest fires have far-reaching adverse impacts at local, regional, and global levels, affecting social, economic, and ecological systems. These impacts include:

- Degradation of water catchment areas, leading to a loss of water resources.
- Soil erosion, which reduces soil productivity and affects agricultural output.
- Alteration of the local microclimate, creating unhealthy living conditions.
- Loss of valuable timber resources, resulting in reduced production and economic losses.
- Decline in natural regeneration, leading to a reduction in forest cover.
- Loss of biodiversity, including the extinction of plant and animal species.
- Destruction of wildlife habitats, threatening species survival.
- Increase in greenhouse gas emissions, contributing to a rise in atmospheric temperatures.
- Global warming and climate change, driven by the depletion of carbon sinks such as forests.

## Types of Fire

**Creeping Fire**: A slow-moving fire that spreads across the ground surface with low flames.

**Ground Fire**: Burns the forest floor vegetation, affecting shrubs and lower-level flora to a certain extent.

**Surface Fire**: The most common type of forest fire, spreading along the ground and consuming surface litter such as dried leaves, twigs, and grasses. It impacts ground flora, herbs, shrubs, undergrowth, and young regeneration.

**Crown Fire**: The most destructive type of forest fire, which burns the crowns of trees in the upper canopy. It is often sustained by an underlying surface fire and causes extensive damage to tree crowns and shrubs.

## Forest Fire and its severity

Factors influencing forest fires and their severity can be classified into four main groups;

**Forest type and density**

The type and density of forests play a critical role in determining the availability of flammable material. Plant residues, trees, shrubs, and grasses form the fuel load that sustains a fire. In a forest environment, the forest type and density significantly contribute to this fuel base.

**Climatic Factors**

Climatic conditions influence vegetation type and density in each area, thereby affecting the availability of fuel. Warmer climates dry out fuels faster, increasing the likelihood and intensity of fires, whereas moisture reduces fire risks. Precipitation plays a crucial role in fire prevention by maintaining higher moisture levels in vegetation.

**Topographic Factors**

The terrain has a direct impact on forest fire behaviour. Elevation, aspect, and slope affect microclimatic conditions, indirectly influencing vegetation and fuel distribution. Slopes facing south and southwest, which receive direct sunlight, are more prone to fires. Fires also spread uphill more quickly than downhill due to the influence of slope. Additionally, at higher elevations, stronger winds accelerate the spread of fire.

**Human Influence**

Human activities significantly increase the frequency of forest fires. Proximity to roads, settlements, and human interference provides opportunities for both accidental and intentional fires, amplifying the risk to forest ecosystems.

## Fire Combustion Triangle

Combustion is the chemical reaction that provides heat to sustain a fire. The fire triangle (or combustion triangle) illustrates the essential ingredients for most fires, comprising three elements required for ignition: heat, fuel, and an oxidizing agent (usually oxygen). To extinguish a fire, any one of these elements must be removed. A fire occurs naturally when these elements are present and combined in the right proportions.




Without fuel, a fire will cease. Fuel can be depleted naturally, as when the fire consumes all burnable material, or manually, by mechanically or chemically removing the fuel source. Fuel separation is a critical factor in forest fire suppression and forms the basis of many major tactics, such as prescribed burning and fire line clearing.

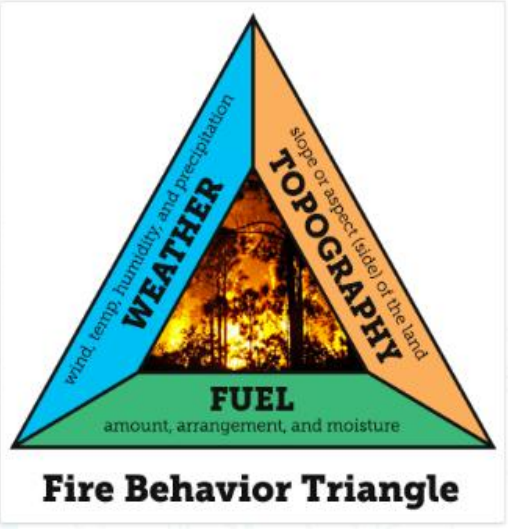
Similarly, without sufficient heat, a fire cannot ignite or continue. Heat can be reduced by applying a substance that absorbs heat, thereby lowering the temperature available for the combustion reaction. Additionally, without adequate oxygen, a fire cannot start or sustain itself. A decrease in oxygen concentration slows the combustion process.

The fire tetrahedron adds a fourth component—the chemical chain reaction—to the three elements of the fire triangle. Once a fire has started, the exothermic chain reaction sustains it, allowing it to continue until one of the four elements is blocked or removed. As soon as any one of these elements is eliminated, combustion stops.

## Fire behaviour

The Fire behaviour triangle illustrates the components that a fire needs for its severity and spread. The components,

- Fuel load – Amount/Arrangement/Moisture
- Weather – Wind/Temperature/Humidity and Precipitation
- Topography – Slope or aspect/Elevation/influence the behaviour and spread of the fire.



## Fuel Load

Fuel is a major factor in determining the intensity of a fire. Fires spread based on the type and quantity of fuel that surrounds them. Fuel can include a wide range of materials, such as trees, underbrush, shrubs, grass, leaves, litter, and mulch. The amount of flammable material surrounding a fire is referred to as the fuel load, which is measured by the amount of available fuel per unit area, typically expressed in tons per acre.

Several fuel characteristics influence the impact of forest fires, including size and shape, arrangement, and moisture content. Small fuels, often referred to as light, flashy, or fast-burning fuels, typically consist of dry grass, dead leaves, twigs, and brush. In contrast, large fuels, known as heavy or slow-burning fuels, include limbs, large stems, logs, and stumps. Small and flat fuels are termed flashy fuels due to their ability to ignite and burn rapidly

**Classification of Fuel**

A smaller fuel load may cause a fire to burn and spread slowly with low intensity. In contrast, a larger fuel load can result in more intense fires that spread rapidly. The dryness of the fuel also significantly influences fire behaviour. Drier fuels heat up more quickly, causing the surrounding materials to ignite faster.

Fuels are classified into four categories based on their response to changes in moisture. The rate at which fuel moisture changes in response to environmental factors—such as temperature, rainfall, humidity, and shade is referred to as time lag.

According to time lag, the four categories of fuels are:

- 1-hour fuels: up to ¼ inch in diameter
- 10-hour fuels: ¼ inch to 1 inch in diameter
- 100-hour fuels: 1 inch to 3 inches in diameter
- 1000-hour fuels: 3 inches to 8 inches in diameter

Grass, leaves, litter, and mulch are categorized as one-hour fuels and serve as the primary carriers of fire. Larger-diameter fuels take more time to respond to environmental changes. Fire intensity increases with heavier fuel loads, and fuel loading also affects other fire behaviour such as ignition, rate of spread, and torching (Stevens R).

Based on size, fuel is classified as light, medium, or heavy:

- Light Fuels (also called fine fuels, flashy fuels, or flash fuels): These include short grasses and light brush up to 2 feet tall. They burn rapidly, and their moisture levels can change significantly.
- Medium Fuels: These include brush up to 6 feet tall, often mixed with patchy fuels like grass. Fires in medium fuels spread more slowly but can burn with moderate to very high intensity.

- Heavy Fuels: These consist of continuous brush over 6 feet tall and slash. Fires in heavy fuels have a slower to moderate rate of spread but burn with high intensity.

Understanding these fuel categories is crucial for determining the type of heat transfer, potential changes in moisture content, and the likely forward spread of a fire.

## Conclusion

Forest fires represent a complex and multifaceted challenge with ecological, economic, and social dimensions. Globally, their increasing frequency and intensity are alarming, driven by climate change and human activities. In India and Tamil Nadu, the interplay of natural factors and human interventions necessitates a comprehensive approach to Forest Fire Management.

This report delves into the trends, impacts, and strategies associated with forest fires in Tamil Nadu during 2024. By examining these aspects in detail, it aims to provide actionable insights and recommendations for mitigating fire risks and enhancing the resilience of Tamil Nadu's forests.

# 02

# Fire Preparedness: Infrastructure and Pre-Fire Activities



# Chapter 2: Fire Preparedness: Infrastructure and Pre-Fire Activities

## Fire Response Mechanism

Tamil Nadu Forest Department has established State level Forest fire control centre for fast flow of information and coordination of activities during the forest fire incidents is located in Panagal Maaligai, Chennai -15. State Forest Fire Control Centre and the District Control Centres are expected to provide adequate support for the Forest Fire Management at three different levels viz.

- Pre-fire (preparatory planning for fire control),
- During-fire (fire detection, spread and control planning) and
- Post-fire (mitigation, damage assessment and planning)

The State Forest Fire Control Centre will receive the near real time fire information from FSI/NRSC/MODIS/NASA/SNPP-VIIRS, integrate the data with State Forest Administration GIS database and communicate to the respective Divisions over Email/Phone for on-field fire control measures. Each Forest Division is provided with Forest Fire Risk/Sensitivity beats details to prioritize fire prevention, monitoring and planning mitigation measures.

## State Forest Fire Control Centre

Tamil Nadu Forest Department had established a “State Forest Fire Control Centre” (SFFCC) for fast flow of information and coordination of activities during the crisis of fire. The objective of Tamil Nadu Forest Fire State Control Centre is to function as a command centre for the District Forest Fire Control Centre and shall coordinate with the nationalized organisations/institutions and the state authorities on the subject of forest fire. SFFCCs is operated by the Protection and Vigilance wing which takes care of the fire management activities at the State level.

### Duties of SFFCC

The duties to be performed by the Tamil Nadu Forest Fire State Control Centre (SFFCC)are,

1. The centre will receive the real time fire information from FSI/NRSC/MODIS/NASA/SNPP-VIIRS
2. Integrate the data with State Forest Administration GIS database and communicate to the respective District Forest Fire Control centre.
3. To get regular updates from all the Forest Division on the status of the forest fire and also to gather details to prioritize fire prevention, monitoring and planning mitigation measures.
4. To render guidance regarding the fire location
5. To coordinate between nationalised institutions, State authorities and District centres
6. To keep Nodal Officers updated about the fire and action being taken

7. To render assistance in carrying out the burnt area assessment
8. To carry out data analytics on the forest fire, prepare vulnerability reports, identify sensitive beats.
9. To adopt latest ICT technologies for effective Forest Fire Management
10. To act as communication and command centre for Forest Fire Management

## Functioning of State Forest Fire Control Centre – Roles & Responsibilities

**Forest Fire Alert System - Real Time Fire information from FSI/NRSC**:

Fire Alerts received from FSI and NRSC will be immediately viewed at the centre. Though the forest staff and officers have registered for the fire alerts in the FSI portal, this centre will be intimated of all the alerts through the Tamil Nadu Forest Fire Management Information System which has been developed by the IT wing of TNFD. Presently the alerts are generated four times in a day based on the satellite passing and the fire alerts are received as message on the registered mobile. Sometimes, there are chances for the field personnel to miss these alert messages, but the centre will immediately respond to the alert through the 24 hours manned personnel (during forest fire season) and the respective district and field officers will be alerted which will ensure the immediate response to the forest fire

**Forest Fire Response Tracking, Reporting and Data Analysis**

The centre uses Tamil Nadu Forest Fire Management Information System for tracking the status of each forest fire case that is reported. The status will be followed up as and when the concerned district officer updates the status from the field. Daily reports will also be generated with the updated status. This will help to assess and arrange for required support to the concerned District Forest team to douse the forest fire at the earliest possible. When the final report is generated, the respective forest fire comes to an end, after which the district forest team has to provide the burnt area assessment details. Necessary technical support will be provided in terms of geo-spatial technology assistance to the district forest team. The staff availability at this centre shall be - one Forest Range Officer, two Foresters, one GIS expert, one Technical Assistant and one Assistant. These works will be carried out under the guidance of APCCF PV and DCF GIS.

Regular updating of database from the field such as extent and distribution of the fire affected areas, the total area burnt, type of damage, etc. which is useful for forest managers for mitigation planning shall be carried out. Fire mapping with fire reports compilation is thus an important activity after fire. The centre will have dedicated forest personnel to work on the fire data, carry out data analysis, assess vulnerabilities, burnt area, predictive index for forest fire etc.,

**Coordination with Nationalised Institutions and State Authorities**

There is a continuous flow of information from MoEFCC, FSI and NRSC related to forest fire. SFFCC will be the nodal centre of the state to coordinate on the forest fire alert with the national level organisations and institutions. It will engage in works to collect the satellite images, carrying out assessments, collating forest fire

data, developing guidelines, generating annual state forest fire reports based on the district reports. The centre will develop its expertise in using latest ICT tools and geo-spatial technologies for the effective Forest Fire Management. SFFCC will also work along with the State Disaster Management Authority in the matters of forest fire.

SFFCC will work closely with FSI with respect to the Pre-warning Alert system developed by FSI which is generated based on short term weather variables, is valid for 1 week and communicated to the District FFCC. It will in turn ensure intensification of patrolling and monitoring for fire sensitive beats indicated by the pre-alert for the week.

**Forest Fire – Centre of Excellence**

SFFCC shall be the repository of information on forest fires which also includes display of forest firefighting equipment and rescue kits to sensitize the front-line forest staff. It will gather all relevant information on the forest fire and will develop expertise on Forest Fire Management. SFFCC will work towards becoming a centre of excellence for Forest fire.

## District Forest Fire Control Centres

District Forest Fire Control Centre (DFFCC) is established for fast flow of information and co-ordination of activities during forest fire season at the district forest headquarters in the state. The objective of District Forest Fire State Control Centre is to function as a command centre to coordinate with the field staff during the forest fire events and also act as local unit in collating data on fire occurrences, updating fire data and to coordinate the activities under the guidance of TN forest fire State control centre.

### Duties of DFFCC

The following are identified as the duties of the District Forest Fire Control centre,

1. To act as a nodal centre of the division/ district in handling forest fires.
2. To respond to the fire alerts and sending quick communication to field staff and fire volunteers to address the fire.
3. To coordinate with the local staff and rendering support to arrange for additional support while fighting the fire.
4. To update the status of forest fire in the Tamil Nadu Forest Fire Management Information System (TNFFMIS)
5. To be equipped with adequate firefighting and rescue kits to support the field staff during crisis.
6. To generate reports with respect to forest fire and to carry out burnt areas assessments after the fire occurrence.

## Functioning of DFFCC – Roles & Responsibilities

**Response to Fire Alerts**

The DFFCC will immediately respond to the fire alerts received either from FSI or SFFCC. The centre shall ensure that all the field staff and local volunteers are registered for fire alerts in the FSI portal. On receiving any information on a fire incident, quick communication shall be sent to the concerned field staff and the local fire volunteers. The DFFCC shall compile and display the contact information of all the field staff, volunteers, district fire officers, senior forest officers and the disaster management teams. The centre will ensure that the forest field staff have reached the location of the fire and shall get continuous updates from the field.

There shall be a dedicated district level toll free number or contact number for the public to report the fire incidences. The information received shall be compiled along with the caller details like name, phone number, location, time of call etc., During the Forest fire season- the centre should be operating 24 X 7 to ensure quick and immediate response to the alerts.

**Action on Fire**

A Rapid Response Team (RRT) shall be formed for each Division at the range level who will respond to all information pertaining to fire and galvanize into action for fire control without delay. The concerned Range officer shall be the nodal point of contact to coordinate the field operations under the guidance of DFO/DD. The FRO shall also update the status of action to the DFFCC. Personnel at the DFFCC shall ensure that the real time status updating in the Tamil Nadu Forest Fire Management Information System dashboard.

**Support to Local Forest staff**

The DFFCC shall arrange for local support to the firefighting team by means of available firefighting equipment's, rescue kits or human assistance by pooling staff from adjacent ranges and divisions, volunteers, district fire rescue team etc.,

**Tracking response & real time updation in the dashboard**

DFFCC shall ensure that the Tamil Nadu Forest Fire Management Information System is updated on real time basis with required information like location details, photos, personnel attending to the fire etc, The DFFCC shall engage in constant updation of the dashboard, generating reports and assisting the local forest staff in calculating the burnt area after the fire is doused.

**Coordination with SFFCC**

The DFFCC being the district nodal centre for forest fire shall be in constant touch with the TN Forest Fire state Control centre to get timely inputs from the state centre and to have effective coordination. The following facilities are identified as preliminary requisites for the DFFCCs,

**IT infrastructure**

In order to carry out the above-mentioned functions, the required IT infrastructure includes,

- One dedicated Workstation with the advanced configuration to operate the dashboards and GIS software.
- Software – Access to TNFFMIS Dashboard, ArcGIS (desktop version), Google Earth Engine Pro, Anti-virus and Internet security software, Software for documentation and reporting.

**Duties of Nodal officer for DFFCC**

- The District Forest Officer shall be the District Nodal Officer for the respective district to deal with the crisis of forest fires in the district and shall coordinate with Incident Response Teams, District administration and other government agencies to mobilize resources and manpower in the event of outbreak of forest fire.
- They will also inform the Circle level Rapid Response teams and call for assistance of Forest Elite Force based on the status of the fire incident.
- Fire and Rescue Services, Police, Medical, Animal Husbandry and Revenue departments shall be called upon to work in tandem with forest department when so required.
- The Headquarters Range Officer shall be in charge of the DFFCC who will work under guidance of DFO/DD. One Forester and one Forest Guard with basic computer knowledge and documentation skills shall be posted at this DFFCC.
- Based on the availability of funds, one technical assistant shall be engaged to carry out the technical works in handling/updating the dashboards on real time, generating reports, carrying out analysis using GIS tools.
- The centre will be functioning 24X7 during the forest fire season.
- The technical assistant will also be attending to the calls received in the toll-free number.




**Figure 1: 34 District Forest Fire Control Centres**

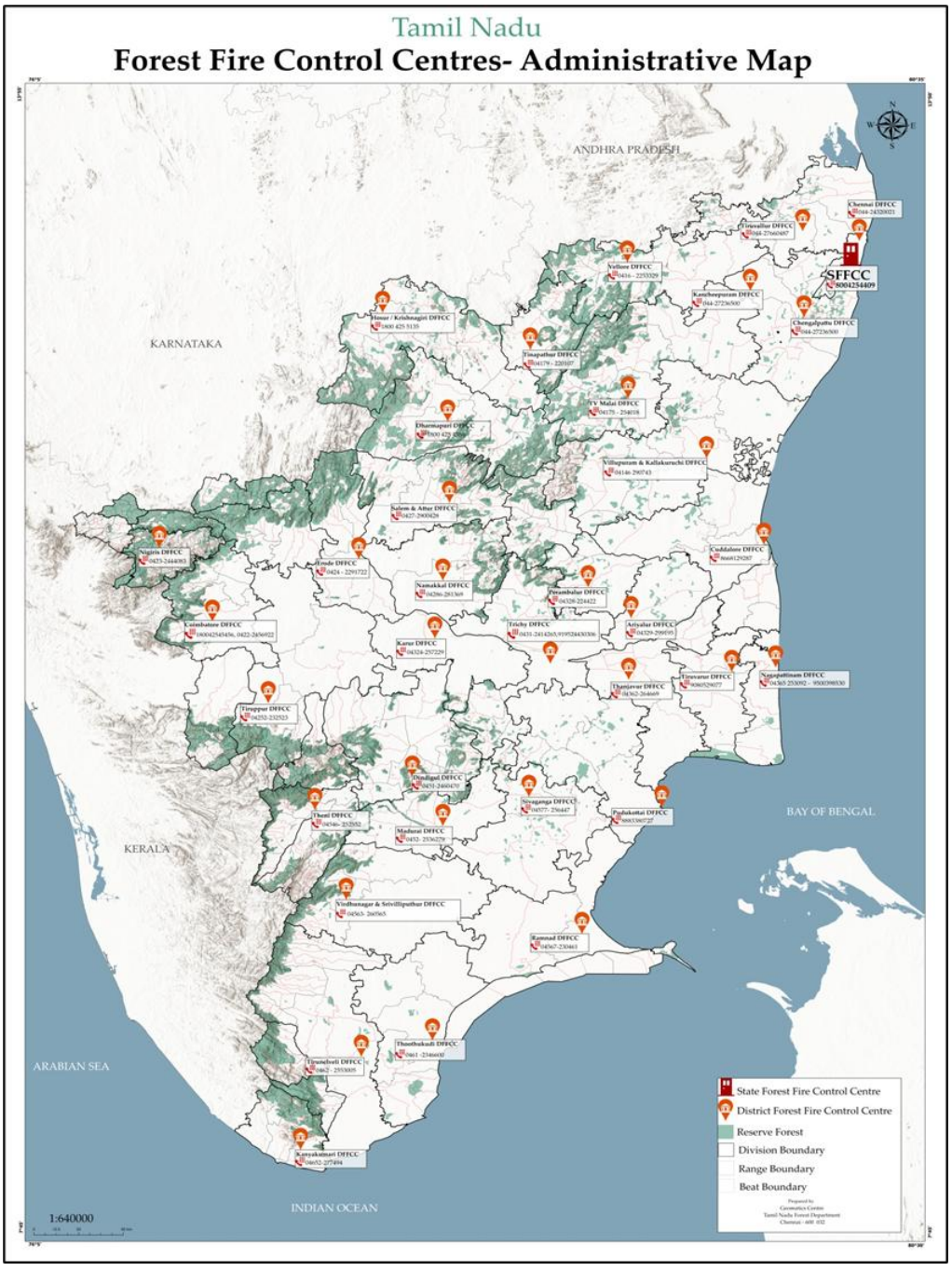



**Figure 2: Administrative Map of District Forest Fire Control Centers**

## Inventory of Fire Equipment

Forest fires are unpredictable and dangerous natural events that can quickly spread across vast areas of land. To prevent the loss of life, property, and ecosystems, it is essential to use the right equipment for wildfire suppression. Firefighters rely on specialized tools and machinery to control and extinguish fires in forested areas, often under challenging conditions. This equipment is designed to combat the intense heat, difficult terrain, and large scale of forest fires.

The Advanced Forest Fire control equipment and rescue gears were purchased and supplied to 13 circle and identified 30 divisions in Tamil Nadu Forest Department at cost of Rs.170 lakhs during 2023-2024 under

Modernization of Forest Scheme. Further, a sum of Rs.60 lakhs have been provided to the divisions for the period of 2024-25 under CSS - Forest Fire Prevention and Management Scheme for the purchase of Forest Fire Control equipment and rescue gears.

| Sl. No. | Modern Forest Fire Fighting Equipment | Quantity (No.) |
|---|---|---|
| 1 | Leaf Blower | 30 |
| 2 | Handheld Brush Cutter | 30 |
| 3 | Power Chain Saw | 30 |
| 4 | Mist Blower with 10Kg. Powder | 30 |
| 5 | Shovel | 117 |
| 6 | Fire Rake | 284 |
| 7 | Fire Beaters | 141 |
| 8 | Fire Retardant Suit | 111 |
| 9 | Shoes | 111 |
| 10 | First Aid Kit | 450 |
| 11 | Rescue Rope | 150 |
| 12 | Climbing Belt | 150 |
| 13 | Flood Torch | 600 |
| 14 | Head Torch | 600 |
| 15 | Stretcher | 90 |
| 16 | Customized Bag pack | 600 |
| 17 | Face mask & Protective Gears | 450 |
| 18 | Night Vision Goggles | 450 |
| 19 | Oxygen Cylinder (2Kg.) | 60 |
| 20 | Portable Fire Extinguisher (1Kg.) | 225 |

**Table 1:Procurement of Forest Fire Control Equipment and Rescue Kits (Modernization of Forest Force Scheme 2023-24)**



**Figure 3: Fire Fighting Equipment**



Figure 4: Dousing of fire using procured equipment, inspection by higher officials

## Fire Lines

Fire lines are physical barriers created by clearing vegetation and other combustible materials from a strip of land. They may be dug out as trenches, ploughed by bulldozers, or cleared manually by firefighters. The idea behind a fire line is to remove or reduce the fuel in an area where a fire is expected to burn. Without fuel, the fire cannot continue to spread. Fire lines are generally established before a fire breaks out, but they can also be created during the course of a wildfire. In some cases, fire lines are used in combination with other tactics such as controlled burns (backburns) to ensure that the fire doesn't leap over the line. Through various schemes, the fire lines are created and maintained in Tamil Nadu forests (Details provided in the tables below). The below images depict the creation and maintenance of fire lines, controlled burning as a preparedness activity in Attur Division.

| Type | Length (in Km) |
|---|---|
| 3m Fire Line | 3927.48 |
| 6m Fire Line | 1375.23 |
| 12m Fire Line | 150.00 |
| **Total length of Fire Line** | **5452.71** |

Table 2: Total length of fire lines in Tamil Nadu created and maintained during 2023-24

| Length of fire line Created and maintenance by Divisions during 2023- 2024 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sl. No. | Circle | Division | FL Created during 2023- 2024 | | | FL maintenance during 2023-2024 | | |
| | | | 3m fire-line (in Km) | 6m fire-line (in Km) | 12m fire-line (in Km) | 3m fire-line (in Km) | 6m fire-line (in Km) | 12m fire-line (in Km) |
| 1 | Chennai | Chennai | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | | Chengalpattu | 0.00 | 0.00 | 0.00 | 0.00 | 2.25 | 0.00 |
| 3 | | Tiruvallur | 4.22 | 19.17 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | Villupuram | Villupuram | 0.00 | 0.00 | 0.00 | 30.00 | 0.00 | 0.00 |
| 6 | | Cuddalore | 0.00 | 0.00 | 0.00 | 14.00 | 0.00 | 0.00 |
| 8 | Vellore | Vellore | 90.00 | 44.13 | 0.00 | 47.00 | 0.00 | 0.00 |
| 9 | | Tirupathur | 10.00 | 10.00 | 0.00 | 3.17 | 0.00 | 0.00 |
| 10 | | Tiruvannamalai | 50.00 | 25.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | Dharmapuri | Dharmapuri | 27.38 | 9.00 | 0.00 | 480.00 | 20.00 | 0.00 |
| 12 | | Hosur | 94.00 | 15.40 | 0.00 | 400.00 | 100.00 | 0.00 |
| 15 | Salem | Salem | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | | Attur | 16.00 | 8.00 | 0.00 | 12.50 | 0.00 | 0.00 |
| 17 | | Namakkal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | Dindigul | Dindigul | 0.00 | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 |
| 20 | | Kodaikanal | 0.00 | 0.00 | 0.00 | 100.00 | 12.00 | 0.00 |
| 21 | | Karur | 0.00 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| 22 | Trichy | Trichy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 23 | | Perambalur | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 24 | | Ariyalur | 16.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25 | | Pudukottai | 8.00 | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 |
| 26 | | Nagai | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27 | | Tanjavur | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28 | | Tiruvarur | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 29 | SMTR | Madurai | 0.00 | 0.00 | 0.00 | 46.00 | 0.00 | 0.00 |
| 30 | | Theni | 0.00 | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 |
| 31 | | Megamalai WL | 5.00 | 0.00 | 0.00 | 105.10 | 30.74 | 0.00 |
| 32 | | Srivilliputhur WL | 0.00 | 0.00 | 0.00 | 194.30 | 0.00 | 0.00 |
| 33 | | Ramnad WL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | | Ramanathapuram | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | | Sivagangai | 0.00 | 0.00 | 0.00 | 50.00 | 0.00 | 0.00 |
| 37 | STR | Erode | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 38 | | Sathy WL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 39 | | Hasanur WL | 0.00 | 0.00 | 0.00 | 14.00 | 0.00 | 0.00 |
| 40 | MTR | DD Udhagai | 0.00 | 0.00 | 0.00 | 0.00 | 210.00 | 49.00 |
| 41 | | DD Masinagudi | 0.00 | 0.00 | 0.00 | 13.00 | 380.00 | 0.00 |
| 42 | | Nilgiris | 0.00 | 7.04 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | | Gudalur | 380.00 | 200.00 | 25.50 | 500.00 | 70.00 | 25.50 |
| 44 | ATR | Coimbatore | 0.00 | 0.00 | 0.00 | 418.00 | 0.00 | 0.00 |
| 45 | | ATR, Pollachi | 0.00 | 0.00 | 0.00 | 260.00 | 0.00 | 0.00 |
| 46 | | ATR, Tiruppur | 10.00 | 12.50 | 0.00 | 351.00 | 200.00 | 50.00 |
| 47 | KMTR | Kalakkadu | 0.00 | 0.00 | 0.00 | 61.00 | 0.00 | 0.00 |
| 48 | | Ambasamuthram | 0.00 | 0.00 | 0.00 | 50.00 | 0.00 | 0.00 |
| 49 | | Kanyakumari | 25.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | | Tirunelveli | 0.00 | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 |
| 51 | | Thoothukudi | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | | | **735.60** | **350.24** | **25.50** | **3191.88** | **1024.99** | **124.50** |

Table 3: Length of fire line created and maintenance by divisions during 2023-24




**Figure 5: Fire line creation and maintenance, control burning**

## FSI Portal – Status of Registration

The Forest Survey of India (FSI) has a system for individuals to receive SMS alerts directly on their mobile phones. To avail of this service, individuals must register with the FSI system. Registration ensures that users receive real-time updates tailored to their specific areas of concern. This initiative is particularly beneficial for people residing in vulnerable regions, as it empowers them with quick access to location, enabling better preparedness and response during emergencies.

From Tamil Nadu alone, around **5,600 persons** have registered for this service. This demonstrates the growing awareness and adoption of the SMS alert system among the public. As more people register, the effectiveness of the alert system in mitigating risks and ensuring safety will significantly improve.

1. Faster response to the fire detections due to the increased number of subscribers and subsequent management response might have resulted in decreased fire detections.

2. Active participation of the local communities apart from the SFDs might have controlled and doused the fires at the nascent stage even before their detection by the passing satellite. (Source: ISFR 2023)

| STATE | DISTRICT | CIRCLE | DIVISION | RANGE | BLOCK | BEAT | TOTAL |
|---|---|---|---|---|---|---|---|
| **628** | 439 | 705 | 1404 | 1629 | 142 | 653 | 5600 |

**Table 4: Category-wise FSI Subscription**

| CIRCLE | NO OF REGISTERED USERS (CIRCLE) | DIVISION | NO OF REGISTERED USERS (DIVISION) |
|---|---|---|---|
| **AAZP, VANDALUR** | 1 | _ | _ |
| **ATR** | 323 | COIMBATORE | 80 |
| | | WL ATR POLLACHI | 66 |
| | | WL ATR TIRUPPUR | 102 |
| | | DIVISION NOT MENTIONED | 75 |
| **CHENNAI** | 107 | CHENGALPATTU | 28 |
| | | TIRUVALLUR | 72 |
| | | DIVISION NOT MENTIONED | 7 |
| **DHARMAPURI** | 585 | DHARMAPURI | 339 |
| | | HOSUR | 181 |
| | | DIVISION NOT MENTIONED | 65 |
| **DINDIGUL** | 415 | DINDIGUL | 155 |
| | | KARUR | 12 |
| | | KODAIKANAL | 208 |
| | | DIVISION NOT MENTIONED | 40 |
| **KMTR** | 265 | KANYAKUMARI | 65 |
| | | THOOTHUKUDI | 31 |
| | | TIRUNELVELI | 86 |
| | | WL, KMTR | 36 |
| | | DIVISION NOT MENTIONED | 47 |

| | | | |
|---|---|---|---|
| **MTR** | 325 | GUDALUR | 92 |
| | | NILGIRIS | 144 |
| | | WL, MTR | 30 |
| | | DIVISION NOT MENTIONED | 59 |
| **SALEM** | 535 | ATTUR | 136 |
| | | NAMAKKAL | 116 |
| | | SALEM | 162 |
| | | DIVISION NOT MENTIONED | 121 |
| **SMTR** | 885 | MADURAI | 86 |
| | | RAMANATHAPURAM | 30 |
| | | SIVAGANGAI | 61 |
| | | THENI | 260 |
| | | WL, MARINE NP | 35 |
| | | WL, MEGAMALAI | 244 |
| | | WL, SRIVILLIPUTHUR | 102 |
| | | DIVISION NOT MENTIONED | 67 |
| **STR, ERODE** | 261 | ERODE | 78 |
| | | WL, STR HASSANUR | 26 |
| | | WL, STR SATHY | 97 |
| | | DIVISION NOT MENTIONED | 60 |
| **TRICHY** | 177 | ARIYALUR | 16 |
| | | PERAMBALUR | 34 |
| | | PUDUKKOTTAI | 23 |
| | | THANJAVUR | 2 |
| | | TIRUCHIRAPPALLI | 83 |
| | | WL, NAGAPATTINAM | 7 |
| | | DIVISION NOT MENTIONED | 12 |
| **VELLORE** | 514 | TIRUPPATTUR | 111 |
| | | TIRUVANNAMALAI | 198 |
| | | VELLORE | 86 |
| | | DIVISION NOT MENTIONED | 119 |
| **VILUPPURAM** | 144 | CUDDALORE | 10 |
| | | VILUPPURAM | 100 |
| | | DIVISION NOT MENTIONED | 34 |
| **Grand Total** | **4537** | | |
| **1063 - OTHERS (STUDENTS, NGOs, LOCAL COMMUNITY)** | | | |

**Table 5: Division-wise FSI Registered Users**

# Capacity Building and Community participation

Effective Forest Fire Management is a multi-faceted effort requiring advanced technology, robust institutional frameworks, and the active participation of individuals, organizations, and communities. Recognizing this, Tamil Nadu has prioritized capacity building and community engagement as key components of its sustainable Forest Fire Management strategy. These efforts aim to equip stakeholders with the skills, knowledge, and resources necessary to prevent, detect, and respond to forest fires effectively.

## Capacity Building Initiatives

**Training Programs for Field Staff**

Tamil Nadu places significant emphasis on training forest officials, fire watchers, and frontline staff to enhance their capabilities in managing forest fires. These programs focus on modern fire prevention, detection, and suppression techniques while introducing participants to advanced tools such as GPS devices, mobile applications like the Tamil Nadu Forest Fire Management Information System (TNFFMIS), and fire mapping technologies. The training ensures that staff are prepared to effectively handle fire incidents with both traditional and cutting-edge methods.

**Mock Drills and Emergency Preparedness**

Simulated fire scenarios are regularly organized to prepare field staff for real-life emergencies. These drills focus on improving team coordination, streamlining communication, and ensuring swift responses during actual forest fire incidents. Mock drills also help identify gaps in current strategies and equip staff with the confidence and practical experience needed to manage high-stress situations effectively.

**Knowledge Dissemination**

Workshops and seminars serve as platforms to share the latest advancements in Forest Fire Management. These events cover topics such as scientific fire prediction methods, strategic firebreak planning, and controlled burning techniques. Collaborations with national and international organizations, including the Forest Survey of India (FSI) and the National Disaster Management Authority (NDMA), further enrich these programs by introducing global best practices and innovative approaches to fire management.

**Resource Allocation**

Adequate resources are vital for efficient firefighting. Tamil Nadu ensures that field staff are equipped with essential tools such as fire beaters, blowers, water tanks, and fire-resistant gear. Additionally, well-equipped fire control rooms have been established at strategic locations, enabling prompt coordination and rapid responses to fire incidents.



**Figure 6: Training and capacity building on fire-fighting methods for frontline staff, student, youths and village communities in Attur Division.**




**Figure 7: Community Participation**

## Community Participation

**Involving Local Communities**

Local communities living near forested areas play a pivotal role in early fire detection and initial response. Tamil Nadu actively involves these communities by training them to identify fire hazards, report incidents promptly, and participate safely in firefighting operations. This approach not only improves response times but also fosters a sense of shared responsibility for forest protection.

**Village Forest Committees (VFCs)**

Village Forest Committees are grassroots organizations that engage communities in fire management and forest conservation activities. These committees organize awareness campaigns on fire risks and prevention methods, such as controlled grazing and safe disposal of agricultural residues. By empowering communities to take proactive measures, VFCs enhance the overall resilience of forest ecosystems against fires.

**Awareness Campaigns**

Public awareness drives are conducted to educate communities about the causes and consequences of forest fires. These campaigns emphasize the critical role individuals play in fire prevention, from avoiding open flames near forests to responsibly discarding cigarette butts. By promoting safer practices and increasing awareness, these initiatives aim to reduce the incidence of accidental fires.

**Joint Forest Management (JFM)**

Under the Joint Forest Management framework, local communities collaborate with the forest department to create and implement fire management plans. This partnership emphasizes shared responsibilities and benefits, fostering trust and cooperation between communities and government authorities. JFM not only enhances fire management efforts but also strengthens the relationship between local stakeholders and the forest ecosystem.

## A Case Study: Tiruvannamalai Model of Combating Forest Fires through Community Initiatives

The Tiruvannamalai Model stands as a remarkable case study that demonstrates how community participation and collaborative efforts can significantly mitigate forest fire incidents. This holistic model integrates preventive measures, fire response mechanisms, capacity building, and ecological restoration, empowering local communities to play a central role in Forest Fire Management.

### *Community Fire Prevention*

The foundation of the Tiruvannamalai Model is the active involvement of local communities in preventing forest fires through organized groups and systematic approaches.

**1. Fire Protection Watchers and Volunteer Groups**

- Trained fire watchers are deployed to patrol vulnerable forest areas during the fire season.
- Volunteer groups known as **"Friends of Forests"** are formed with local community members, who are tasked with fire detection, quick reporting, and initial fire suppression efforts.
- These groups act as the first line of defence in fire prevention and management, creating a sense of ownership and accountability.

**2. Creation of Firebreaks and Buffer Zones**

- Firebreaks—strips of cleared or less vegetated land—are created to act as barriers, preventing the spread of fire across forested areas.
- Buffer zones are developed at forest edges and near human settlements to protect both ecosystems and communities.
- Regular maintenance of these zones is carried out with community participation.

### *Afforestation and Ecosystem Restoration*

Preventing forest fires is closely tied to maintaining healthy ecosystems. Community involvement in afforestation and ecosystem restoration ensures long-term fire resilience.

**1. Plantation Drives with Community Involvement**

- Tree plantation initiatives are conducted with the active participation of local communities. These drives promote soil stabilization, increase green cover, and reduce fire-prone dry vegetation.
- Native and fire-resistant species are planted to enhance biodiversity and reduce fire risks.

**2. Eco-guards for Forest Management**

- **Eco-guards** are selected from local communities to assist forest officials in monitoring and managing forested areas.
- They help identify fire-prone zones, implement preventive measures, and create awareness about sustainable forest management practices.

## *Partnerships*

Collaboration among key stakeholders is a cornerstone of the Tiruvannamalai Model. By leveraging partnerships, greater resources and expertise are brought into the system.

**1. Coordination with Tamil Nadu Forest Department and Local Panchayats**

- The Tamil Nadu Forest Department collaborates closely with local Panchayats (village governing bodies) to implement fire management programs.
- Panchayats play a crucial role in mobilizing community members and organizing awareness campaigns.

**2. Engagement with CSR Funds and NGOs**

- Corporate Social Responsibility (CSR) funds are utilized to support fire prevention activities, such as providing firefighting equipment, organizing training programs, and conducting plantation drives.
- Non-Governmental Organizations (NGOs) contribute by facilitating community training, awareness programs, and ecosystem restoration projects

## *Capacity Building*

Building the skills and knowledge of local communities is central to sustaining fire prevention efforts.

**1. Fire Education Programs**

- Awareness campaigns are conducted to educate local communities about the causes and impacts of forest fires.
- Programs emphasize safe practices, such as avoiding open fires near forests, proper disposal of agricultural residue, and reporting fire incidents promptly.

**2. Fire Prevention Training Programs**

- Training programs are organized to equip community members with fire management techniques, including fire suppression methods and the use of firefighting tools.
- Practical sessions, such as mock drills, prepare volunteers and fire watchers for real-life fire emergencies.

**3. Community Leadership Development**

- Local leaders are identified and trained to guide community fire prevention initiatives.
- These leaders act as focal points for coordination with forest departments and other stakeholders, ensuring effective communication and mobilization during fire events.

The teams consisting of local villagers, EDC/VFC members, local field staff and forest front line staff from adjoining forest divisions work as a team during fire suppression even in the interior inaccessible forest areas.

# 03

# Application of Technology in Forest Fire Management



# Chapter 3: Application of Technology in Forest Fire Management

The rapid evolution of technology has significantly transformed Forest Fire Management, offering innovative tools for early detection, monitoring, response, and mitigation. In Tamil Nadu, the adoption of cutting-edge geospatial technology, advanced information systems, and drone surveillance has redefined traditional approaches to combating forest fires. These technologies enable efficient data collection, real-time analysis, and seamless communication between field teams and central command centres, ensuring swift and targeted interventions.

This chapter delves into the various technological advancements implemented by the Tamil Nadu Forest Department, including the development of customized dashboards, the Tamil Nadu Forest Fire Management Information System (TNFFMIS), and the integration of drone surveillance for enhanced monitoring. By leveraging these tools, the state has built a robust framework for proactive Forest Fire Management, reducing the risks and damages associated with fire outbreaks while safeguarding its rich biodiversity and forest ecosystems.

## Geospatial Technology: Comprehensive Dashboard Using ArcGIS Enterprise for Forest Fire Management

The Tamil Nadu Forest Department has effectively utilised **ArcGIS Enterprise** to develop a comprehensive and customized dashboard system designed to revolutionize Forest Fire Management. This cutting-edge platform integrates geospatial technology with real-time data, enabling seamless monitoring, planning, management, and reporting of forest fires. Tailored to address the unique challenges of Forest Fire Management, the dashboard caters to the specific needs of various operational teams, enhancing their preparedness and response capabilities. The dashboards are not just tools but pivotal elements of an emergency response system designed to save time, resources, and lives during forest fire incidents.

**1. Daily Fire Alerts Dashboard**

The Daily Fire Alerts Dashboard is a real-time monitoring tool that aggregates forest fire alerts provided by the **Forest Survey of India (FSI)**. These alerts, based on satellite data, enable swift dissemination of fire-related information to field staff, ensuring timely action to mitigate risks.

- Displays active fire alerts received from FSI daily, with a timestamp and geolocation details.
- Visual representation of fire alerts on a map, categorized by intensity and proximity to vulnerable areas.
- Automated notifications sent to registered field personnel, ensuring immediate intimation of fire incidents.
- Ability to filter and prioritize alerts by administrative divisions, such as forest circles and divisions, aiding in targeted response planning.

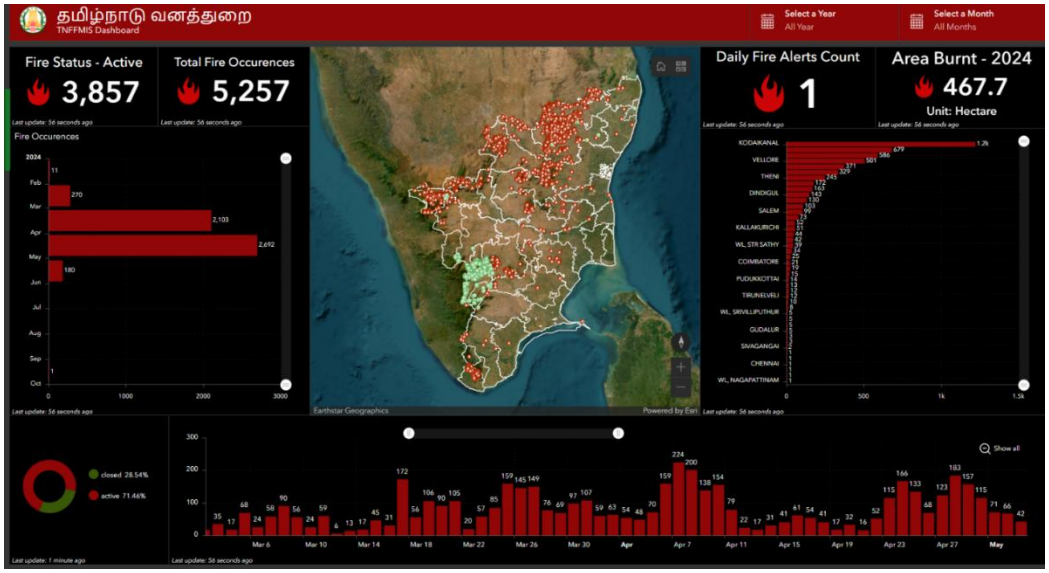



Figure 8: Daily Fire Alert Dashboard

**2. Report Tracking Dashboard**

The Report Tracking Dashboard is designed to manage the flow of information between field staff and the central command, streamlining the communication process during firefighting efforts. This dashboard plays a vital role in maintaining coordination across teams and ensuring accountability in fire response.

- Tracks reports submitted by field staff at various stages of a fire incident, from initial detection to post-fire evaluation.
- Consolidates data from multiple sources, including flash reports, final reports, and manual entries.
- Provides a timeline view of actions taken, enabling the central command to monitor progress in real-time.
- Highlights pending actions or updates, ensuring that all necessary steps are completed promptly.

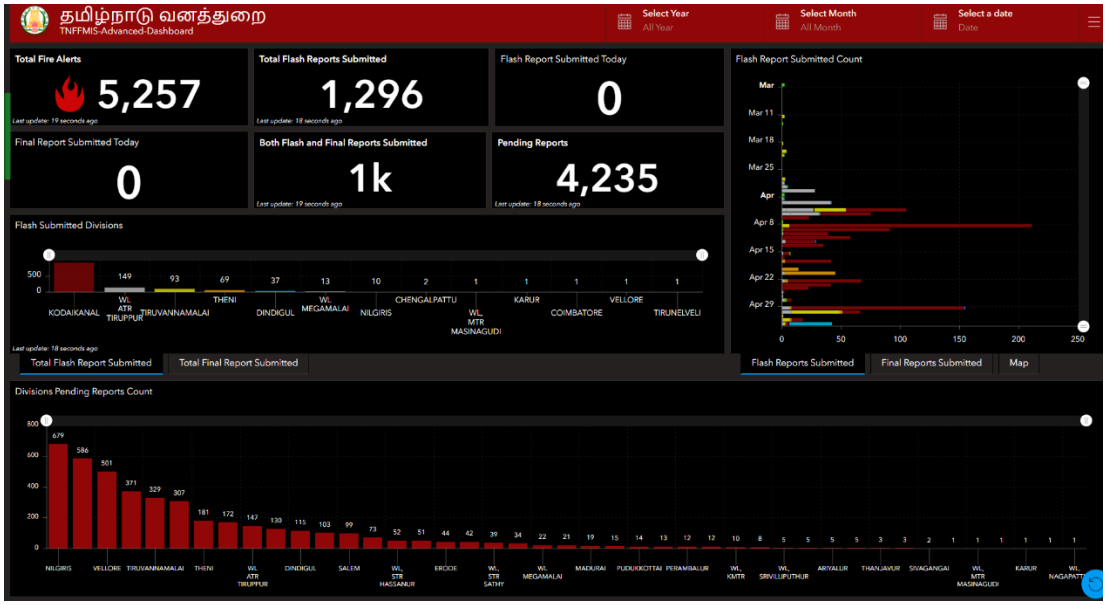



Figure 9: Report Tracking Dashboard

**3. Large Forest Fire Dashboard**

The Large Forest Fire Dashboard is a specialized tool designed to address the unique challenges posed by extensive and complex forest fire incidents. This dashboard provides detailed insights into the spread and impact of large-scale fires, allowing authorities to allocate resources strategically and mitigate risks effectively.

- Displays comprehensive data on active large-scale forest fires, including the number of active pixels, spread trajectory, and intensity.
- Integrates administrative data to show the areas impacted by the fire, including forest beats, divisions, and nearby human settlements.
- Provides predictive analytics based on historical fire patterns and current environmental conditions, aiding in proactive planning.
- Includes a heat map feature to visualize fire intensity and hotspots, enabling targeted firefighting efforts.

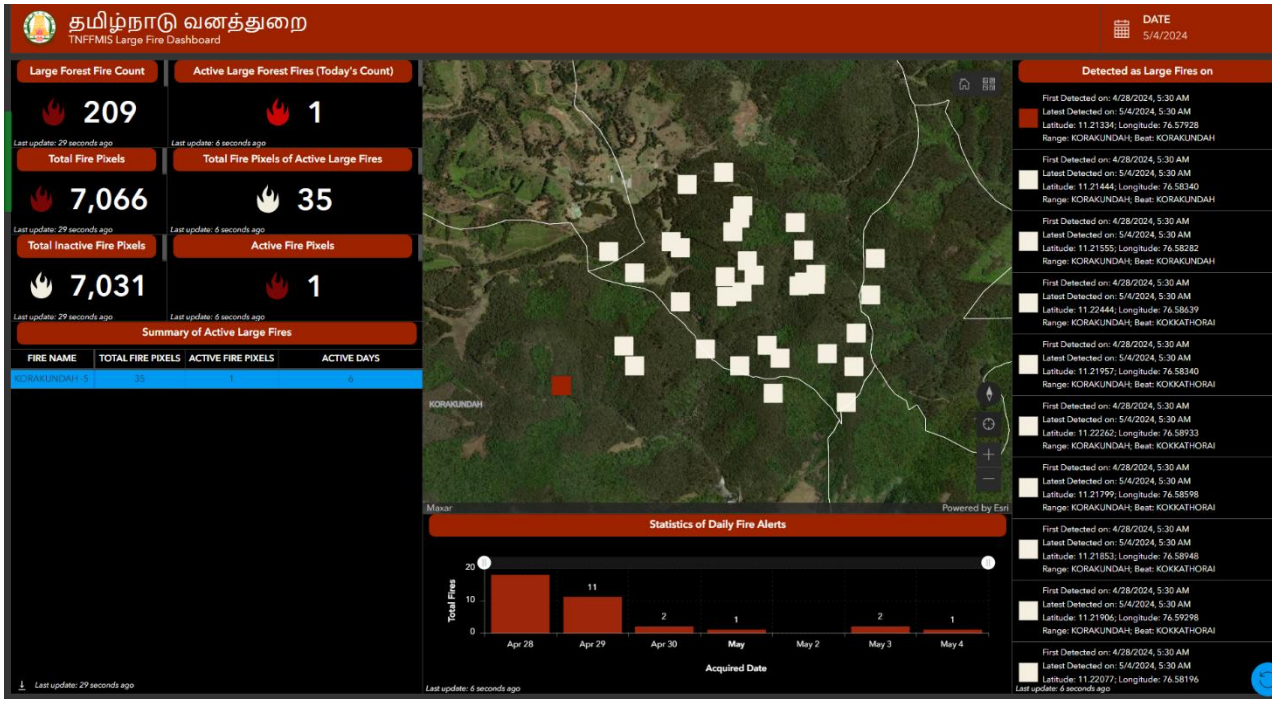



Figure 10: Large Forest Fire Dashboard

**4. Historical Forest Fire Dashboard**

The Historical Fire Data Dashboard is a powerful analytical tool that provides insights into forest fire trends from 2016 onwards. This dashboard serves as a repository of past fire data, enabling users to analyse patterns, identify vulnerable areas, and devise informed strategies for fire management. It is a critical resource for planning proactive measures, ensuring preparedness, and minimizing the risk of recurring fire incidents.

- Displays historical fire incidents with geospatial mapping for precise location details.
- Provides data categorized by forest circles, divisions, ranges, and beats.
- Highlights fire-sensitive zones and vulnerable areas using heat maps and trend graphs.
- Offers insights into seasonal fire intensity patterns to predict high-risk periods.
- Integrates historical data with other dashboards for comprehensive analysis.
- Facilitates predictive modelling to anticipate future fire risks and optimize resource allocation.
- Enables forest managers to prioritize prevention activities and enhance seasonal preparedness.
- Supports targeted measures for long-term risk mitigation.
- Serves as a training and reference tool for forest staff, enhancing decision-making capabilities.

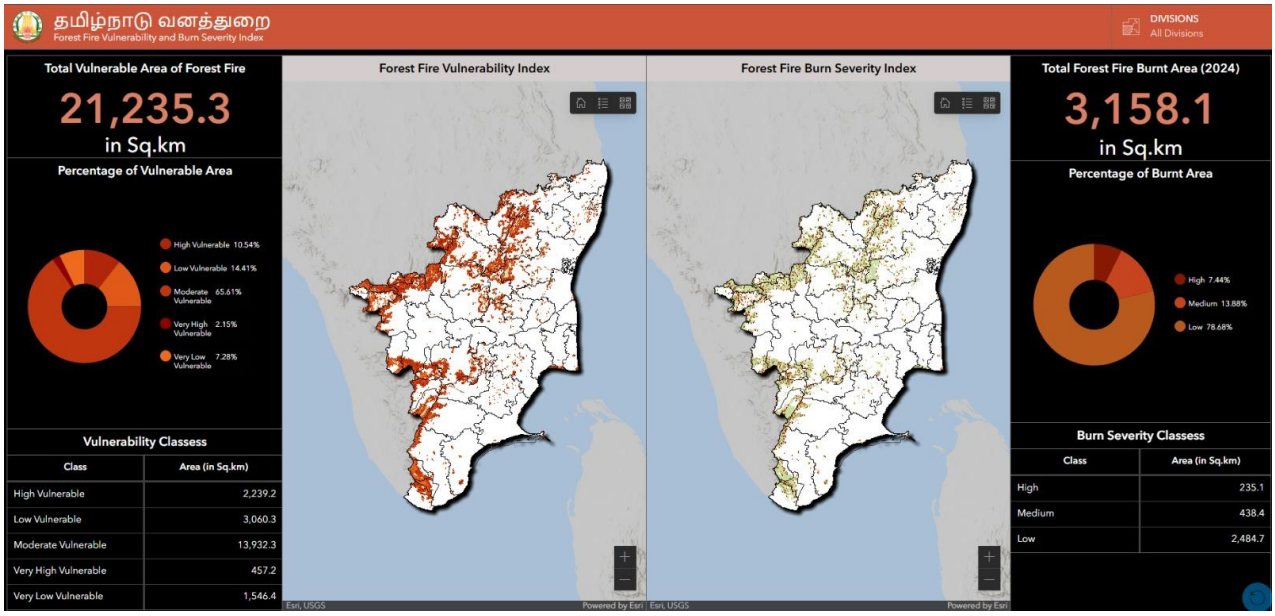



**Figure 11: Advanced Geo-spatial Dashboards for FFM**

The integration of advanced geospatial dashboards into Tamil Nadu's Forest Fire Management system has revolutionized the state's ability to prevent, detect, and respond to forest fires. These dashboards leverage real-time data and geospatial analytics to provide field teams with actionable insights, ensuring a rapid and efficient response. Their intuitive, user-friendly interfaces and customizable features enable personnel at all levels to effectively access and utilize critical information, fostering seamless coordination and collaboration across the forest management network.

Beyond operational efficiency, these geospatial tools facilitate advanced fire data analysis to address multiple dimensions of Forest Fire Management. The software is intensively utilized for diverse analyses, including:

- Fire Risk Analysis: Identifying areas with the highest likelihood of fire occurrences based on historical and environmental data.
- Fire Vulnerability Analysis: Assessing the susceptibility of specific forest regions to fire damage.
- Fire Sensitivity Analysis: Determining areas requiring heightened monitoring and preventative measures.
- Burnt Area Assessment: Mapping and quantifying the extent of fire-affected regions for post-fire recovery planning.
- Fuel Risk Analysis: Evaluating the availability and distribution of combustible material to prioritize resource allocation.
- Forest Cover and Fire Data Correlation: Understanding the interplay between forest density, cover type, and fire patterns for better mitigation strategies.

These analytical capabilities provide forest managers with a comprehensive understanding of fire dynamics, enabling data-driven decision-making and proactive planning. Detailed discussions on each of these analytical tools and their applications are elaborated in subsequent chapters of this report.

The deployment of these geospatial dashboards exemplifies the transformative potential of technology in addressing one of the most critical challenges in forest conservation. Tamil Nadu's commitment to adopting innovative solutions and enhancing Forest Fire Management sets a benchmark for other regions aspiring to build resilient and sustainable conservation practices. These advancements not only protect biodiversity and forest

ecosystems but also ensure the safety and livelihoods of communities that depend on these vital natural resources.

## TN Forest Fire Management Information System (TNFFMIS)

The Tamil Nadu Forest Department is using the Tamil Nadu Forest Fire Management Information System (TNFFMIS) as a Web Dashboard and a Mobile Application to monitor and manage forest fires. The system is designed to receive alerts from MODIS/SNPP VIIRS satellite sensors and send them to registered personnel through the Web and Mobile Application. The officers can then create reports that are recorded and stored in a central repository.

The main purpose of the forest dashboard is to provide real-time monitoring, recording, and analysis of forest fires. This helps to streamline the process for reporting and make it more efficient, as they no longer have to rely on paper reports. The dashboard allows for seamless monitoring and response, improving the ability of the department to manage forest fires.

Forest Survey of India (FSI) relies on satellite data to detect active fire pixels, captured due to the timing of satellite overpasses between 1.30am and 1.30pm for SNPP-VIIRS, 1.30am and 1.30pm for MODIS (Aqua), 10.30am and 10.30pm for MODIS (Terra). Some fire detections might be missed if they occur beyond the satellite's observation schedule. Fires that ignite after a satellite pass and are extinguished before the next pass may go unregistered in the automated system. To address this limitation, TNFFMIS includes an option for manual reporting. This feature allows forest officials and ground teams to log fire incidents that may otherwise be missed.

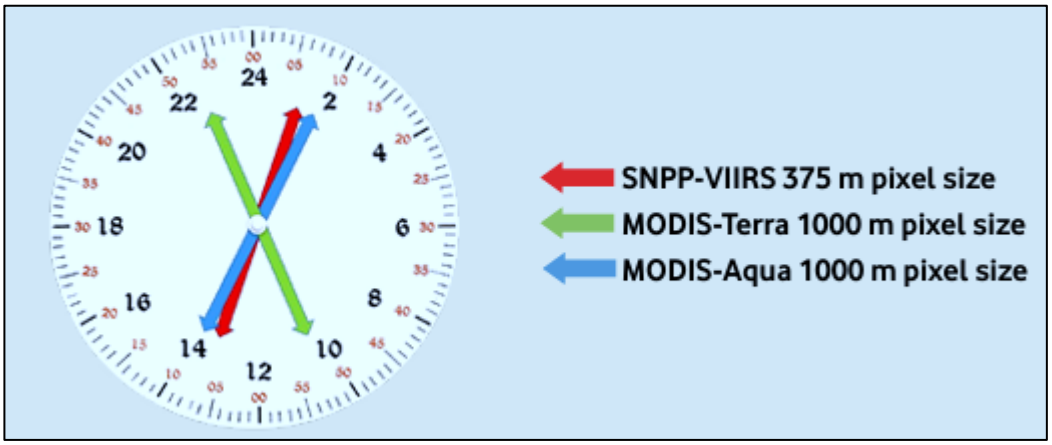



**Figure 12: Approximate Time of Satellite Pass of MODIS and SNPP-VIIRS Sensor**




**Figure 13: Tamil Nadu Forest Fire Management System (TNFFMIS)**

**Features of TNFFMIS:**

**Dashboard**

The dashboard serves as the central interface for visualizing and analysing fire-related data. It is designed to provide users with a clear overview of forest fire incidents through various statistical representations and monitoring tools. Key features include,

**1. Fire Count**

- Summarizes fire alerts received from the FSI on daily, monthly, and yearly timescales.
- Enables users to view fire alert data categorized by administrative divisions, such as forest circles and divisions, for targeted analysis.

**2. Fire Monitoring**

- Displays details of fires that are currently active within the state.
- This feature allows for real-time tracking of ongoing fire incidents, helping authorities prioritize areas requiring immediate attention.

**3. Burnt Area**

- Provides detailed statistics on the total area affected by fires.
- This information is further broken down based on forest circles and divisions, offering a granular view of the impact of fire incidents.

**4. Response Time**

- Tracks and reports the time taken by field staff to respond and extinguish fires.
- Displays response time statistics organized by circles and divisions, enabling authorities to assess the efficiency of firefighting operations.

**Fire Reports**

The system includes a module for generating detailed reports on fire incidents. These reports consolidate information such as the number of alerts received, affected areas, response times, and measures taken by the field staff. This functionality ensures that all fire-related data is documented for review, planning, and compliance purposes.

**1. Flash Report**

- The **Flash Report** is submitted immediately by the field staff upon reaching the site of the fire incident.
- Mobile application is used by the field staffs to upload the flash report immediately from the field.
- The report contains preliminary details, such as the location of the fire and the immediate situation, to facilitate quick action and monitoring.

**2. Final Report**

- The **Final Report** is submitted after the fire has been extinguished, providing a detailed account of the incident.
- This report includes, a precise measurement of the area affected by the fire, Photos and videos documenting the fire and the affected area, a schematic representation of the impacted region.

**Create Manual Report**

TNFFMIS also provides the option to create manual reports. This feature allows field staff and administrators to input data not automatically captured by the system. These reports can be tailored to specific requirements, aiding in decision-making and strategic planning.

## Drone Surveillance

The increasing frequency and intensity of forest fires have necessitated the adoption of innovative technologies to enhance surveillance, monitoring, and response. Among these advancements, drones have emerged as a game-changing tool in Forest Fire Management. These unmanned aerial vehicles (UAVs) provide unparalleled capabilities to detect, track, and analyze forest fire incidents in real-time, enabling faster decision-making and resource allocation.

Tamil Nadu has been at the forefront of integrating drone technology into its Forest Fire Management systems. Leveraging advanced sensors, geospatial imaging, and AI-powered analytics, drones facilitate early detection of hotspots, continuous monitoring of vulnerable areas, and detailed post-fire assessments. Different types of drones—each with specialized features—are deployed based on the unique needs of Forest Fire Management. From thermal imaging drones capable of detecting fires invisible to the naked eye to long-range fixed-wing drones designed for large-scale monitoring, Tamil Nadu's drone deployment strategy reflects a comprehensive and proactive approach to forest conservation. This section explores the various types of drones used in Tamil Nadu's Forest Fire Management, detailing their technical features, applications, and contributions to building a resilient and sustainable forest ecosystem.

**1. Thermal Imaging Drones**

Thermal imaging drones are equipped with infrared cameras that detect heat signatures, enabling them to locate fire hotspots even in low-visibility conditions such as dense smoke or darkness. These drones provide precise and actionable data to firefighting teams. Thermal drones are a transformative technology in Forest Fire Management, providing an efficient and accurate method to identify and monitor fire hotspots.

**Working of Thermal Drones**

1. **Heat Detection**: Thermal cameras onboard the drones capture infrared radiation emitted by fire hotspots, distinguishing them from the cooler surrounding environment.
2. **Real-time Monitoring**: The drones transmit live thermal imagery to the control centre, enabling continuous observation of fire-prone areas.
3. **Data Analysis**: Advanced software processes the thermal data to identify the intensity, location, and spread of fires, offering actionable insights for firefighting teams.

- **Features**: Thermal cameras capture temperature variations and transmit live imagery to command centers.
- **Applications**: Ideal for early detection of hotspots and active fire monitoring, thermal drones were successfully deployed in Kodaikanal and Coimbatore Forest areas.
- **Technical Details**: Operate in the 8–14 µm wavelength range, capable of detecting temperatures from -20°C to 2,000°C.

**2. Multispectral Drones**

Multispectral drones monitor vegetation health and pre-fire risk factors by capturing data in multiple wavelengths, such as visible and near-infrared. This helps identify fuel loads and stressed vegetation prone to ignition.

- **Features**: Equipped with sensors operating in 5–10 spectral bands and integrated with GIS platforms for mapping fire vulnerabilities.
- **Applications**: Used for fuel risk analysis and identifying pre-fire conditions to prioritize preventive measures.
- **Technical Details**: Provide 3–5 cm/pixel resolution with a flight duration of 40–90 minutes.

**3. Fixed-Wing Drones**

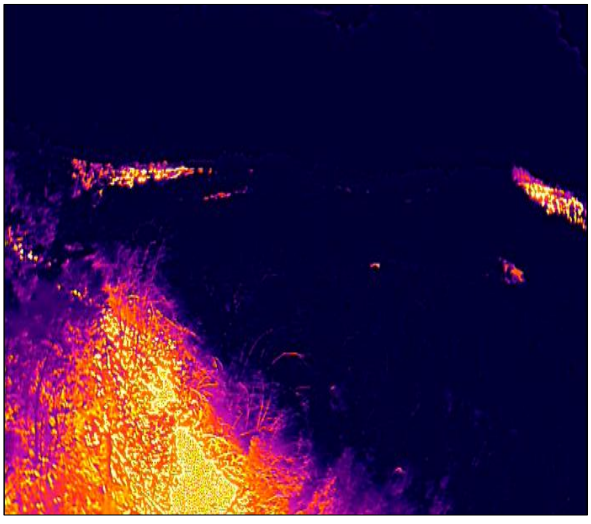
Fixed-wing drones are designed for long-range and large-scale monitoring, making them suitable for surveying vast forested areas. They rely on aerodynamic lift for energy efficiency, allowing extended flight times.

- **Features**: High-resolution cameras capture wide-area imagery, while GPS-guided autonomous flight ensures precision.
- **Applications**: Used for tracking large fires and monitoring post-fire landscapes.
- **Technical Details**: Capable of flying up to 100 km in a single mission with a cruising speed of 60–120 km/h.

**4. Hybrid Drones**

Hybrid drones combine the endurance of fixed-wing drones with the maneuverability of quadcopters, making them versatile for diverse operations. They can switch seamlessly between vertical take-off and horizontal flight modes.

- **Features**: Dual payload bays accommodate multiple sensors, and hybrid motors enable extended flight durations.
- **Applications**: Suitable for missions requiring both wide-area surveillance and localized monitoring.
- **Technical Details**: Flight times up to 4 hours, with payload capacities ranging from 2–5 kg.



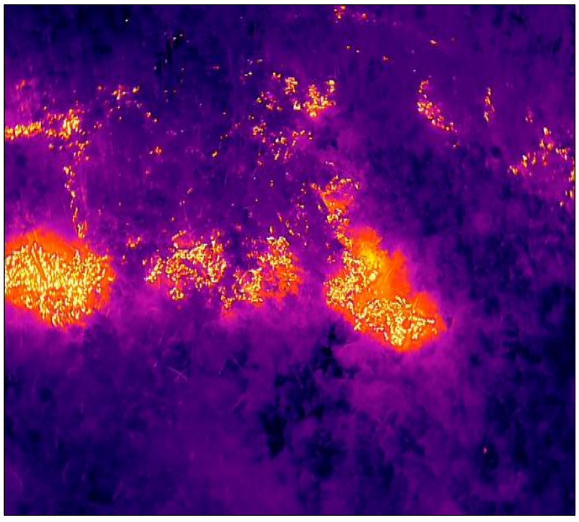




**Figure 14: Utilization of Thermal Drones and Analysis using Thermal imagery**

## Wireless Communication Technologies

Effective communication is essential for Forest Fire Management, enabling real-time coordination between field teams and command centres. Tamil Nadu has established integrated wireless communication technologies in few divisions where mobile network is a challenge. They have established a network integrated with walkie-talkies, wireless base stations, and satellite phones into its Forest Fire Management strategy to ensure seamless information flow, especially in remote and challenging terrains. These tools play a critical role in ensuring prompt action, efficient resource allocation, and enhanced safety during fire incidents.

**Walkie-Talkies**

Walkie-talkies are a primary communication tool for Forest Fire Management teams in Tamil Nadu. These handheld devices are highly portable, reliable, and easy to use, making them indispensable for field teams operating in remote areas where cellular networks are often unavailable. Walkie-talkies operate on VHF (Very High Frequency) or UHF (Ultra High Frequency) bands, ensuring clear communication even in dense forest environments. They are built to withstand harsh conditions such as heat, smoke, and humidity, providing uninterrupted connectivity during fire suppression operations. Walkie-talkies are particularly effective in enabling quick communication between firefighting teams and command centres, ensuring coordinated and timely responses to fire alerts.

**Wireless Base Stations**

Wireless base stations act as fixed communication hubs, providing extended coverage and reliable connectivity in large forested areas. These stations are strategically located at district forest headquarters and other critical points to support communication between field teams and higher authorities. Equipped with high-powered transmitters, wireless base stations enhance the range and clarity of signals, bridging communication gaps across vast regions. Additionally, these stations are backed by robust power systems to ensure uninterrupted operation during fire-related power outages. By facilitating centralized coordination, wireless base stations enable better resource deployment and decision-making during forest fire incidents.

**Satellite Phones**

Satellite phones serve as a critical communication tool in remote areas where other wireless systems may not function. These devices operate via satellite networks, providing reliable connectivity regardless of terrestrial network availability. Satellite phones are particularly valuable during severe fire incidents or in regions with rugged terrain, ensuring that field teams can report real-time updates and receive instructions from command centres. Many satellite phones used in Tamil Nadu are GPS-enabled, allowing precise location tracking to aid in resource allocation and emergency planning. Their durability and ability to function under extreme conditions make them a vital part of the state's Forest Fire Management infrastructure.



**Figure 15: Wireless Communication in Field**



# 04

# Forest Fire Scenario - 2024

# Chapter 4: Forest Fire Scenario of 2024 in Tamil Nadu

## Trend Analysis of Forest Fire

The field data from the Forest Survey of India (FSI) clearly indicates a rising trend in forest fires from 2023 to 2024. A comparison of the data between these two years highlights an increase in the frequency and intensity of forest fires across Tamil Nadu. This shift in fire patterns is concerning, as it reflects not only changes in forest conditions but also the influence of external factors such as weather patterns.

In addition to the field data, various weather parameters such as **temperature**, **precipitation**, and **wind speed** are known to directly influence the occurrence and spread of forest fires. For instance, higher temperatures, coupled with **reduced rainfall** (as observed in the **2024 dry spell**), create drier vegetation, which increases fire susceptibility. Furthermore, stronger **winds** help propagate fires more rapidly, exacerbating the situation. The convergence of these environmental factors is a key driver of the observed increase in forest fires across the region in **2024** compared to the previous year.

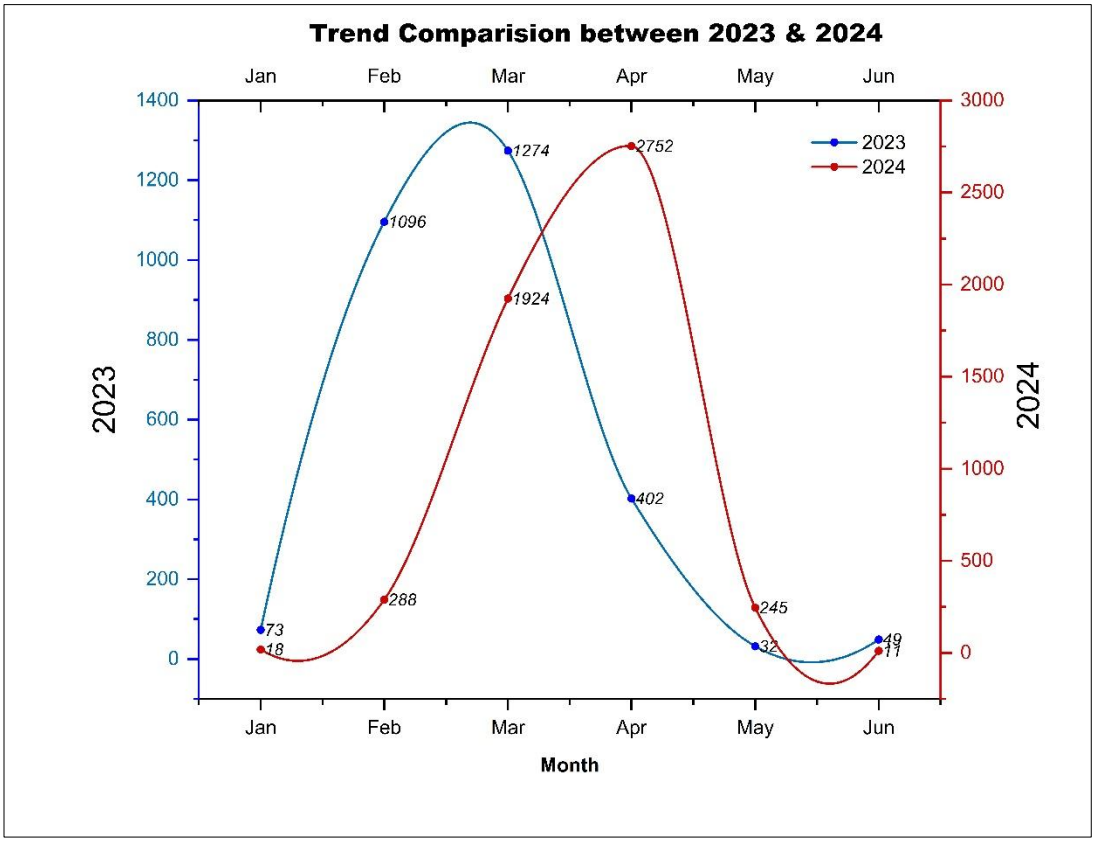



Figure 16: Trend Comparison between fire detections of 2023 & 2024

**Trend Comparison between 2023 and 2024: Fire-Sensitive Period**

The graph compares forest fire trends between 2023 and 2024, highlighting variations in the number of fire incidents during the fire-sensitive months of January to June. A significant increase in fire incidents is observed

in 2024 compared to the previous year, particularly during the critical months of March and April, which mark the peak fire season.

- **January**: In 2023, fire incidents were minimal at 73, whereas 2024 saw an even lower count of 18. This indicates effective pre-season planning in 2024 for early mitigation.
- **February**: A sharp rise in fire incidents was recorded in both years, with 2023 reporting 1,096 and 2024 showing a substantial increase to 1,274. This rise correlates with the onset of dry conditions and accumulation of flammable materials.
- **March**: The peak month in 2024 with 1,924 incidents, a marked increase compared to 1,274 incidents in 2023. This highlights the intensified fire risk due to prolonged dry spells and rising temperatures.
- **April**: Fire incidents reached their highest in 2024 at 2,752, nearly seven times the count in April 2023 (402 incidents). This peaking in April is also attributed to the late onset of summer rains during 2024. This dramatic spike underscores the necessity for heightened monitoring and resource deployment during this period.
- **May and June**: Incidents gradually declined in both years as pre-monsoon showers alleviated fire risks. In 2024, May recorded 245 incidents, compared to 352 in 2023. June marked a negligible count of 49 in 2024, aligning with 2023 trends.

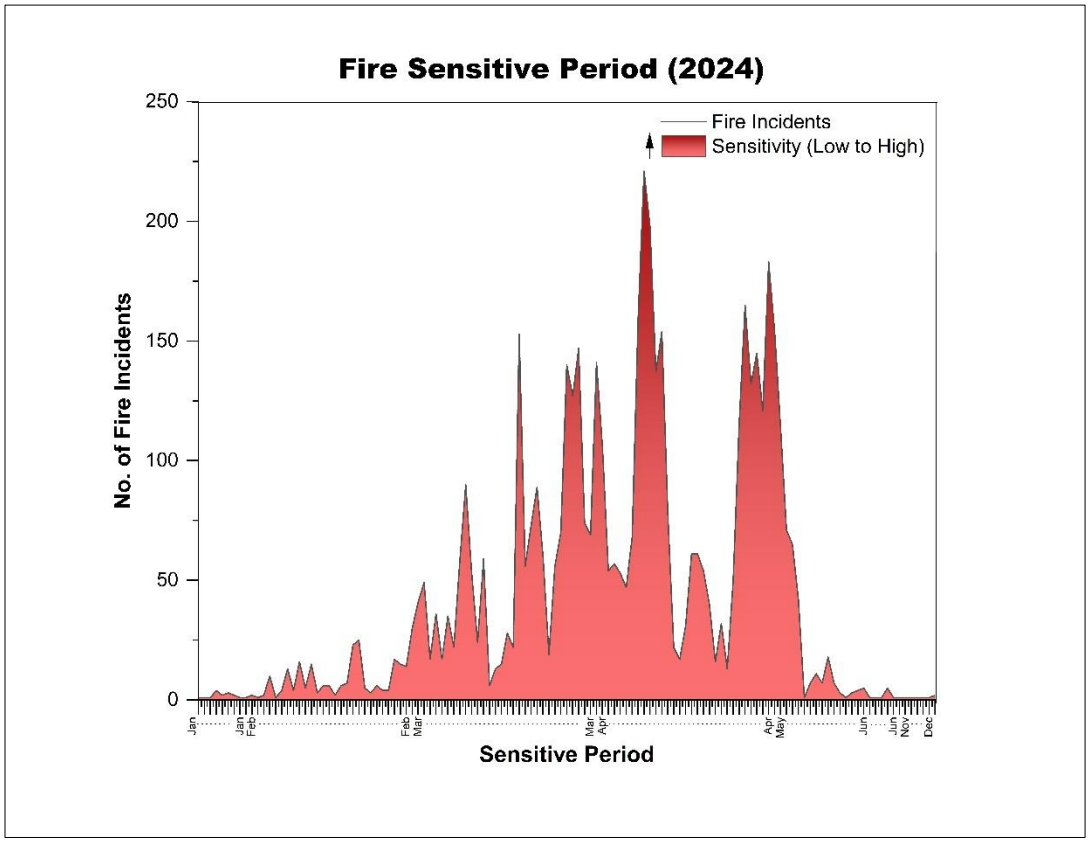



Figure 17: Fire Sensitive Period of 2024

**Fire Sensitive Period (2024)**

The comparison between 2023 and 2024 underscores the variability in fire sensitivity during the dry season. As shown, March and April consistently emerge as the most critical months for fire incidents, with a significant

escalation in 2024. This increase can be attributed to prolonged dry weather, delayed monsoons, and rising temperatures that exacerbate fire-prone conditions.

The sharp surge in incidents during these months necessitates the following actions:

- **Strengthened Early Detection Systems**: Real-time monitoring through advanced technologies such as satellite-based alerts and drone surveillance is crucial during these peak months.
- **Enhanced Preparedness**: Mobilizing rapid response teams and pre-positioning firefighting equipment in high-risk areas before March can mitigate the impact of fire outbreaks.
- **Community Awareness Programs**: Engaging local communities in fire prevention measures, especially during March and April, is vital to reducing human-induced fire risks.

The comparative trend analysis reinforces the importance of refining fire management strategies to address seasonal variations in fire incidents, ensuring targeted interventions during the most fire-sensitive periods of the year.

**Circle-wise Detections (2024)**

This chart presents the circle-wise distribution of forest fire incidents in 2024. The Dindigul circle recorded the highest number of fire incidents (1,352), followed by Vellore (1,193) and Dharmapuri (786). These areas are characterized by extensive dry deciduous forests, which are particularly susceptible to fire during the dry season. Circles like Trichy and Villupuram reported significantly fewer incidents, indicating relatively lower fire risk. This data helps prioritize resource allocation and fire management strategies for high-risk circles.

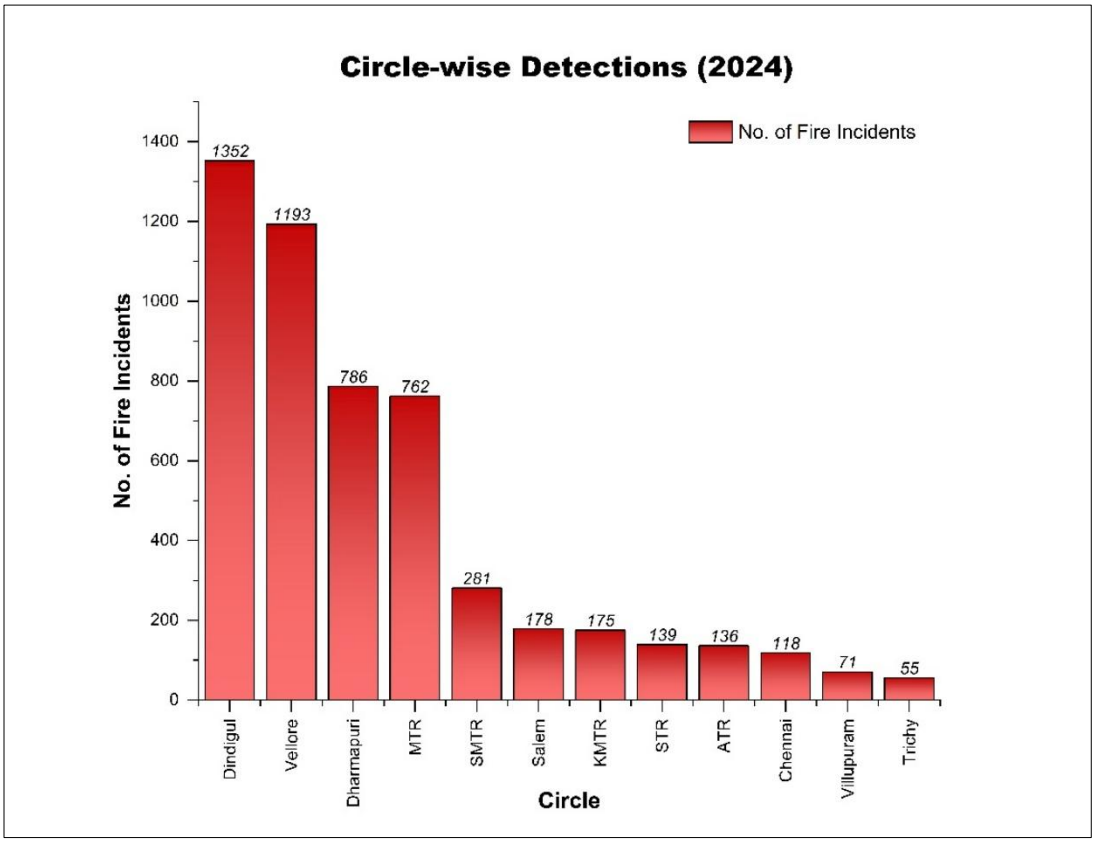



**Figure 18: Circle-wise Detections of 2024 Fire Incidents**

**Division-wise Detections (2024)**

The division-wise data highlights specific regions with a high frequency of fire incidents in 2024. Kodai Kanal division experienced the highest number of incidents (1,205), followed by The Nilgiris (1,175) and Hosur (615). These divisions feature dense vegetation, combined with human activities like grazing and firewood collection, contributing to higher fire susceptibility. On the other hand, divisions like WL Nagapattinam and Ramanathapuram reported minimal fire activity. The insights provided by this graph can guide targeted interventions and planning for high-risk divisions.

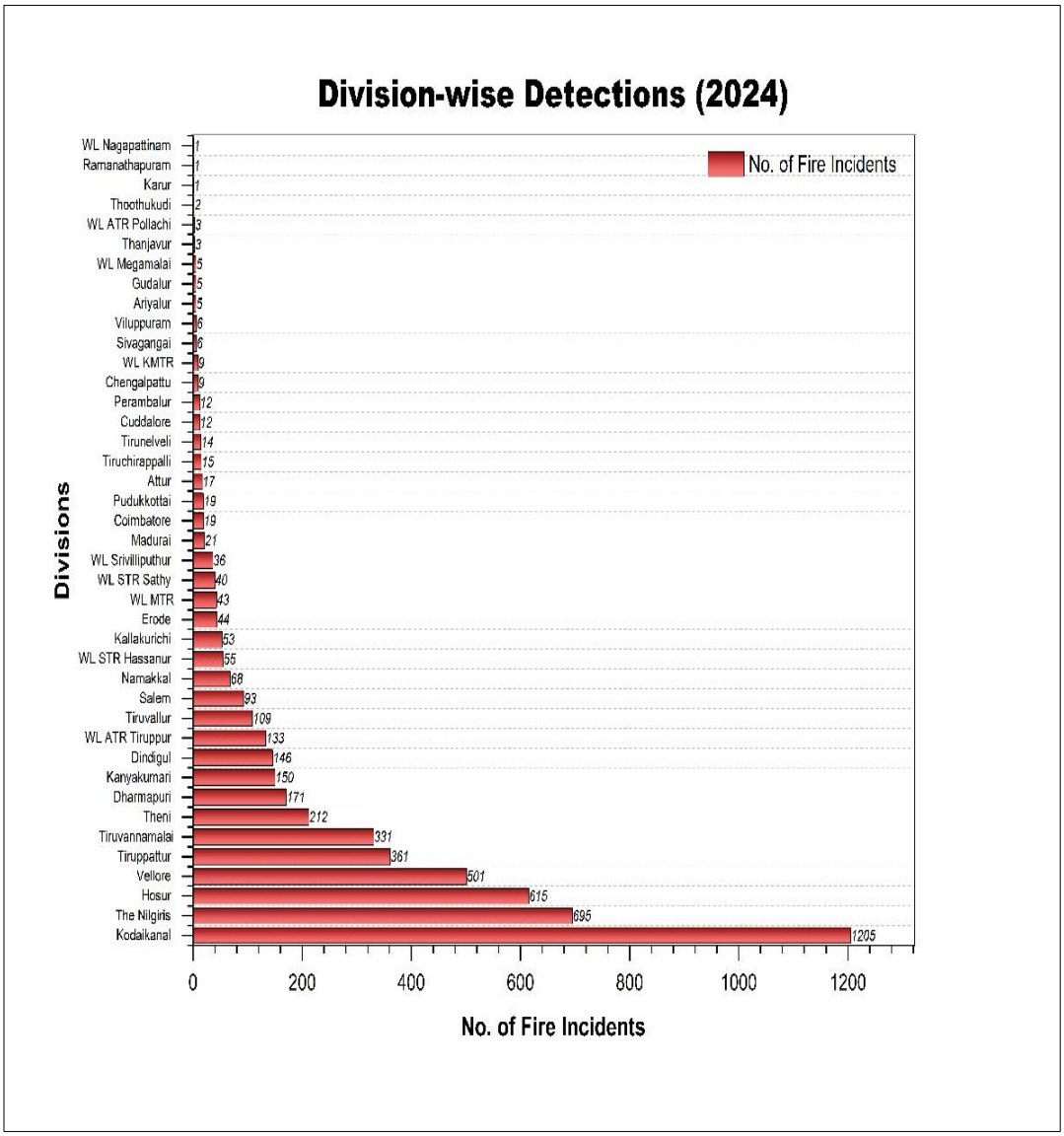



**Figure 19: Division-wise Detections of 2024 Fire Incidents**

**Range-wise Detections (2024)**

The range-wise analysis reveals the top 30 ranges with the highest number of fire incidents in 2024. Denkanikottai recorded the most incidents (499), followed by Poonapari (289) and Mannavanur (282). These ranges are characterized by a combination of dense forests and high human activity, increasing their fire vulnerability. Lower-ranked ranges, such as Pykara and Kottapatty, reported fewer incidents, reflecting better

fire management or reduced fire risks. Understanding the dynamics of fire-prone ranges is crucial for improving localized fire mitigation strategies.

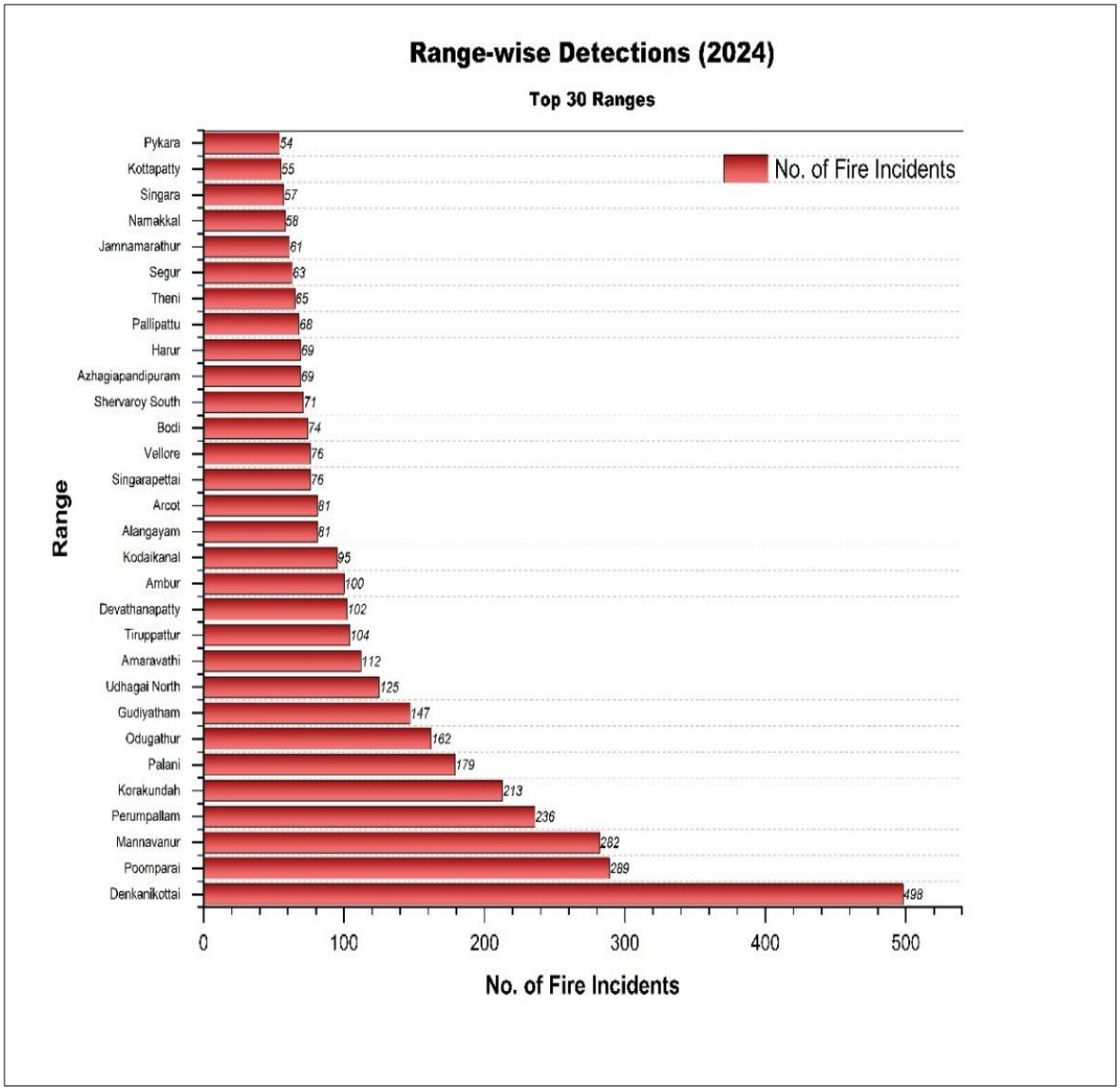



**Figure 20: Range-wise Detections of 2024 Fire Incidents**

**Beat-wise Detections (2024)**

The beat-wise data focuses on the top 30 beats with the highest fire detections. Paricombai West recorded the most incidents (201), followed by Poomparai West (125) and Upper Bhavani (112). These beats are hotspots for fire incidents due to their specific environmental and human-induced conditions, such as fuel accumulation and agricultural residue burning. Beats with fewer detections, like Singarapettai East and Balasamudram West, indicate relatively effective fire prevention measures or lesser fire risks. This granular data aids in pinpointing precise areas for intervention and resource deployment.

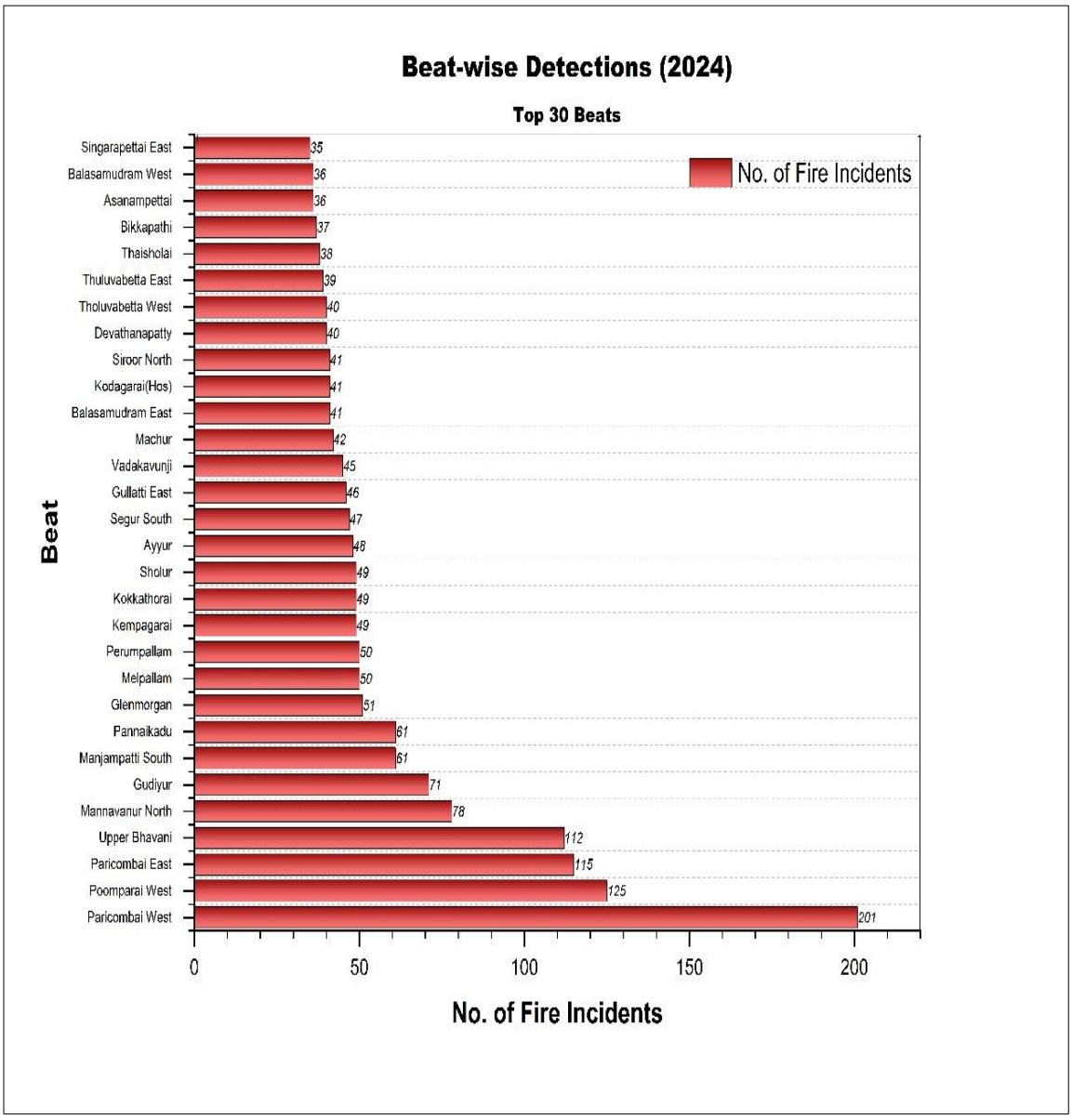



**Figure 21: Beat-wise Detections of 2024 Fire Incidents**



# Analysis of Weather Parameters & their influence on Forest Fire

## Temperature Patterns of Tamil Nadu (2023 vs. 2024)

**A. Temperature Increase**:

Monthly average temperatures in 2024 are slightly higher than in 2023, particularly in pre-monsoon months (March–June). This aligns with global warming trends and regional climatic anomalies. Higher maximum temperatures observed during summer and fire-prone months intensify vegetation drying. March, May, and June show the most significant increases in temperature, with **March** seeing a rise of **+1.1°C**, followed by **May** and **June** at **+1.0°C**. (Source: IMD)

**B. Heatwaves and Seasonal Impacts**:

2024 shows an increase in heatwave occurrences compared to 2023, with March to May experiencing higher deviations from historical averages. This is indicative of a trend toward hotter summers.

**C. Late Monsoon Temperature Anomalies**:

Elevated temperatures during the late monsoon and post-monsoon periods (Sept-Nov) contribute to prolonged drying of forest vegetation, reducing the natural recovery period after the monsoon.

| Month | 2023 Average Temperature (°C) | 2024 Average Temperature (°C) | Increase/Decrease (°C) |
|---|---|---|---|
| **January** | 24.75 | 26.09 | +1.35 |
| **February** | 25.61 | 27.66 | +2.05 |
| **March** | 27.92 | 29.03 | +1.11 |
| **April** | 29.41 | 31.24 | +1.83 |
| **May** | 29.56 | 30.70 | +1.14 |
| **June** | 30.41 | 29.64 | -0.77 |
| **July** | 29.45 | 29.59 | +0.13 |
| **August** | 29.57 | 28.94 | -0.63 |
| **September** | 28.77 | 29.12 | +0.35 |
| **October** | 28.17 | 27.33 | -0.84 |
| **November** | 26.60 | 25.90 | -0.70 |
| **December** | 26.25 | 25.81 | -0.44 |

**Table 6: Temperature of Tamil Nadu 2024**

**Temperature Impacts on Forest Fires**

**A. Vegetation Dryness**:

Higher temperatures accelerate the evaporation of soil and vegetation moisture. This leads to drier forests and increased flammability, especially in forested areas like the Western Ghats and Nilgiris. Prolonged dryness can lead to a buildup of dead organic material (leaves, branches), increasing fuel availability for fires.

**B. Fire Intensity**:

Elevated temperatures boost the energy release from fires, making them harder to control. Fires in 2024 are expected to be more intense due to drier vegetation conditions.

**C. Extended Fire Season**:

Increased temperatures, combined with rainfall deficits observed in 2024, extend the fire season beyond the usual peak months (April–June). Dry post-monsoon conditions in October–December heighten risks.

**D. Increased Vulnerability**:

Regions already prone to fires, like dry deciduous forests and scrub areas, are more susceptible to ignition under high temperatures. Human settlements near these areas face greater risks.

## Precipitation Patterns of Tamil Nadu (2023 vs. 2024)

**Key Months with Deficit Rainfall**

1. **January to April:** The first quarter of the year shows a consistent reduction in rainfall in 2024, with deficits ranging from 8.42 mm to 9.28 mm. While these months are typically dry, reduced rainfall further dries out the soil and vegetation, creating favourable conditions for wildfires.
2. **June:** The June deficit is particularly significant at 14.83 mm, impacting the beginning of the monsoon and hindering the natural replenishment of soil moisture.
3. **September and October:** Both September and October show considerable deficits of 27.44 mm and 32.82 mm, respectively. These months, typically associated with the Northeast Monsoon, are crucial for replenishing forest moisture. Their deficits increase the vulnerability of forests to fire during the post-monsoon period. (Source: IMD)

**Impact of Precipitation Deficits on Forest Fires**

**Soil and Vegetation Dryness**

Reduced rainfall increases soil evaporation, leading to drier vegetation, especially in forested regions. This creates abundant fuel for wildfires, as drier leaves, branches, and grass ignite more easily and burn faster. Forests in the Western Ghats and Nilgiris are particularly vulnerable during these months.

**Longer Dry Periods**

The delayed onset of rains and monsoon deficits extend the fire season, pushing it well beyond the usual months of April–June. With reduced precipitation, the monsoon moisture that typically helps to temper fire risks comes late, prolonging the fire-prone conditions during October–December.

**Heightened Fire Intensity**

Forest fires during periods of precipitation deficit tend to be more intense, as dry conditions create an abundance of combustible material. High-intensity fires are harder to control and spread quickly, especially in areas with strong winds.

**Post-Monsoon Fire Risk**

The deficits in September and October, combined with higher temperatures in 2024, make forests highly susceptible to ignition. Despite the typical arrival of the Northeast Monsoon in October, which is expected to reduce fire risks, the rainfall shortfalls delay moisture recovery, leaving the forests at risk during the crucial late monsoon and early post-monsoon periods.

| Month | 2023 Average Rainfall (mm) | 2024 Average Rainfall (mm) | Deficit (mm) |
|---|---|---|---|
| **January** | 2.31 | 12.95 | +10.65 |
| **February** | 8.50 | 0.08 | -8.42 |
| **March** | 9.63 | 0.35 | -9.28 |
| **April** | 12.70 | 3.96 | -8.74 |
| **May** | 23.25 | 28.03 | +4.78 |
| **June** | 17.77 | 2.94 | -14.83 |
| **July** | 12.62 | 4.51 | -8.11 |
| **September** | 30.73 | 3.30 | -27.44 |
| **October** | 33.45 | 0.63 | -32.82 |

**Table 7: Precipitation of Tamil Nadu 2024**

## Wind Patterns of Tamil Nadu (2023 vs. 2024)

**Key Observations and Implications for Forest Fires**

**Increased Wind Speed in 2024**

2024 sees a slight increase in wind speed compared to 2023, particularly during summer months, where the wind speeds increase by 1 km/hr on average. These stronger winds can significantly influence fire behaviour, making fires more unpredictable and harder to control. Increase in wind speeds suggests that fire-spread is likely to be faster and more intense. (Source: IMD)

**Seasonal Wind Patterns**

During summer and pre-monsoon months (March–June), higher wind speeds can blow embers across vast areas of dry vegetation. The combined effect of high temperatures and strong winds results in an increased fire risk as dry grasses, bushes, and trees become more combustible. In post-monsoon months (September–December), the impact of wind is amplified due to the reduced moisture levels in vegetation after a drier than usual monsoon season (as observed in 2024), making fires more likely to spread.

**Wind Speed's Role in Forest Fire Behaviour**

Higher wind speeds in 2024 suggest that forest fires will likely spread faster, and firefighting efforts will face increased challenges. Winds are a primary agent in fire propagation, and stronger winds make wildfires more difficult to contain. Even if firefighting teams control a fire in one location, wind can push the flames to other, more vulnerable areas of forest, leading to the rapid spread of fire.

| Month | 2023 Average Wind Speed (km/h) | 2024 Average Wind Speed (km/h) | Increase (km/h) |
|---|---|---|---|
| **January** | 6.87 | 5.71 | -1.16 |
| **February** | 6.03 | 6.23 | +0.20 |
| **March** | 6.70 | 5.28 | -1.41 |
| **April** | 5.98 | 5.87 | -0.11 |
| **May** | 7.21 | 6.22 | -0.98 |



# 05

## Large Forest Fire

# Chapter 5: Large Forest Fires of 2024 in Tamil Nadu

The concept of a **Large Forest Fire (LFF)** is defined based on the number of active fire pixels detected within a specific area and time frame. Criteria for declaring a Large Forest Fire is when **more than three active fire pixels** are detected in the same location or closely clustered areas. These active fire pixels indicate significant burning, which surpasses the threshold of smaller or isolated fires.

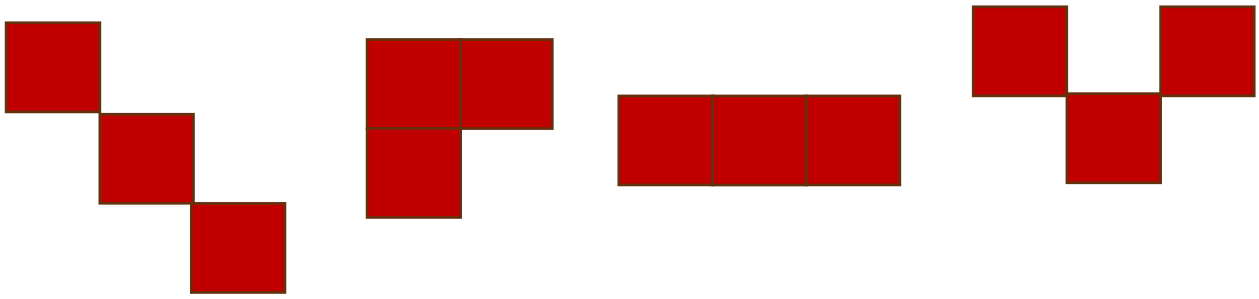


**Figure 22: Candidate Large Forest Fire Detection in 3 Contiguous Pixels**

Large Forest Fires (LFFs) represent one of the most severe threats to forest ecosystems, causing extensive damage to biodiversity, habitat integrity, and resources that support local livelihoods. Tamil Nadu witnessed a significant increase in Large Forest Fires during 2024, with a total of 218 incidents, marking a 171% rise compared to 2022. These fires, which lasted multiple days in several instances, were concentrated in specific divisions and required coordinated response strategies to mitigate their impact.

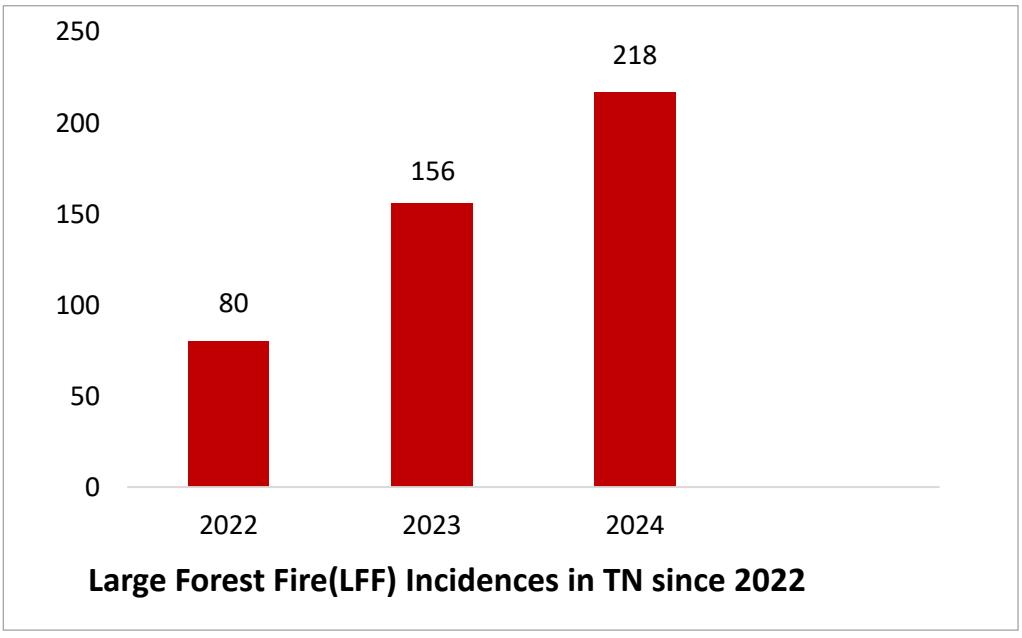



**Figure 23: LFF incidences (2022-24)**

In 2024, Tamil Nadu recorded a total of **218 Large Forest Fires (LFFs)**, comprising **7268 active fire pixels**. These incidents highlight the growing challenges of Forest Fire Management in the region. The most significant LFFs

were reported in the **Kodaikanal** and **Nilgiris Forest Divisions**, where fires persisted for nearly **23 days**. Several factors contributed to the prolonged duration of these fires:

- **Inaccessible Terrain**: Many of the affected areas were remote and challenging for ground teams to access, delaying containment efforts.
- **Difficult Fire Suppression**: Steep slopes, dense vegetation, and smoke in certain locations made dousing the fire particularly arduous.
- **Climatic Conditions**: Dry weather, high temperatures, and wind patterns likely exacerbated the spread and intensity of the fires.

A unique system for naming the large forest fire events has been developed. In every fire season, individual LFF event is recorded by the name of the Range of the State Forest Department where it was first detected. If the State has not provided the administrative boundary, the LFF event is recorded after the name of the district. In cases, where multiple LFF events are detected in the same Range, the numerical numbering is suffixed after the name of the Range. For example, if 4th LFF event is detected in Range Mannavanur, then this LFF event will be recorded as Mannavanur - 4 in the large forest fire database.

**Overview of Large Forest Fires in 2024**

The analysis of large forest fire incidents in 2024 highlights the increasing frequency and severity of such events. The primary contributors to the rise in Large Forest Fires include prolonged dry conditions, delayed monsoons, and human activities such as agricultural residue burning and improper land use practices.

**Key highlights:**

- **Incidence Increase**: Tamil Nadu reported 218 Large Forest Fires in 2024, compared to 156 in 2023 and 80 in 2022.
- **Top Divisions Affected**: Kodaikanal Division recorded the highest number of large forest fire incidents (34), followed by Hosur (29) and Vellore (25). These divisions are characterized by dense forests, which, combined with human-induced factors, increase fire vulnerability.

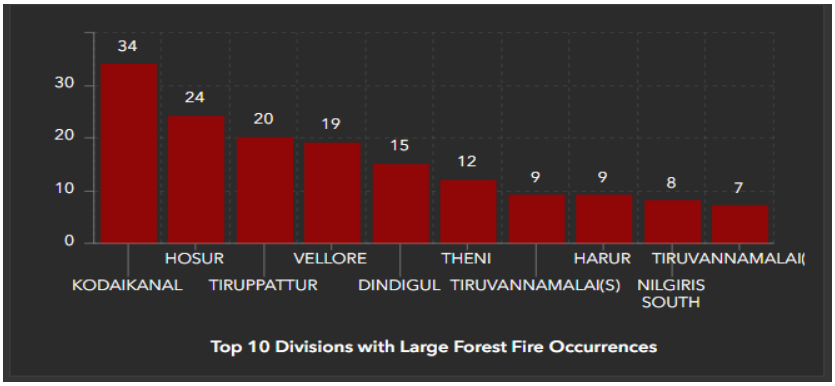



Figure 24: Top 10 divisions with LFF occurrences

### Analysis of Active Days and Fire Response

Large Forest Fires in Tamil Nadu during 2024 varied in duration, with many fires lasting for multiple days. Quick response and efficient suppression efforts helped mitigate their impact.

- **Duration Analysis**:
  - **72%** of large fire events (157 incidents) were doused within 24 hours.
  - **20.18%** were extinguished in less than three days.
  - **5%** lasted up to five days, while **2.29%** took up to ten days.
  - Only one fire took more than ten days to be extinguished.
- **Key Divisions with Prolonged Active Fires**:
  - Kodaikanal had the highest number of prolonged fires lasting more than one day (35 instances).
  - Hosur (29 instances) and Vellore (25 instances) followed, highlighting the need for enhanced fire management in these regions.

Table 9: Fires active more than 1 day

| Division | Instances where fire was active for more than 1 day |
|---|---|
| KODAIKANAL DIVISION | 35 |
| HOSUR DIVISION | 29 |
| VELLORE DIVISION | 25 |
| TIRUPPATTUR DIVISION | 23 |
| TIRUVANNAMALAI DIVISION | 22 |
| MTR BUFFER | 17 |
| NILGIRIS DIVISION | 14 |
| THENI DIVISION | 6 |
| HARUR DIVISION | 6 |
| WL, STR HASSANUR DIVISION | 5 |
| DINDIGUL DIVISION | 4 |
| WL ATR TIRUPPUR DIVISION | 3 |
| KANYAKUMARI DIVISION | 3 |
| MADURAI DIVISION | 3 |
| NAMAKKAL DIVISION | 3 |
| SALEM DIVISION | 2 |
| TIRUVALLUR DIVISION | 2 |
| WL, MTR DIVISION | 1 |
| DHARMAPURI DIVISION | 1 |
| ERODE DIVISION | 1 |

### Geographical Distribution

The spatial distribution of Large Forest Fires across Tamil Nadu provides valuable insights for prioritizing fire prevention and management strategies:

1. **Top Divisions for Large Fires**:
   - **Kodaikanal Division**: 35 incidents
   - **Hosur Division**: 29 incidents
   - **Vellore Division**: 25 incidents
   - **Tiruppattur Division**: 23 incidents
   - **Tiruvannamalai Division**: 22 incidents
2. **Division-Specific Patterns**:
   - Regions with dense forest cover and significant human activity, such as human habitations and tourism, experienced the highest number of fires.

# Response Time

The response time to douse large fires is critical in mitigating their impact on ecosystems, property, and human life. The ability to contain a wildfire swiftly depends on various factors, such as the size and intensity of the fire, weather conditions, availability of resources, and the effectiveness of response strategies. The statistics for 2024 reveal significant data on response times for Large Forest Fires;

**Large Forest Fires and Response Overview**

In 2024, a total of **218** Large Forest Fires (LFF) were reported. Among these, the majority, **72%** (157 LFF), were successfully doused within **24 hours** of ignition. This highlights the effectiveness of initial response strategies and the availability of resources that are often mobilized immediately after a fire starts.

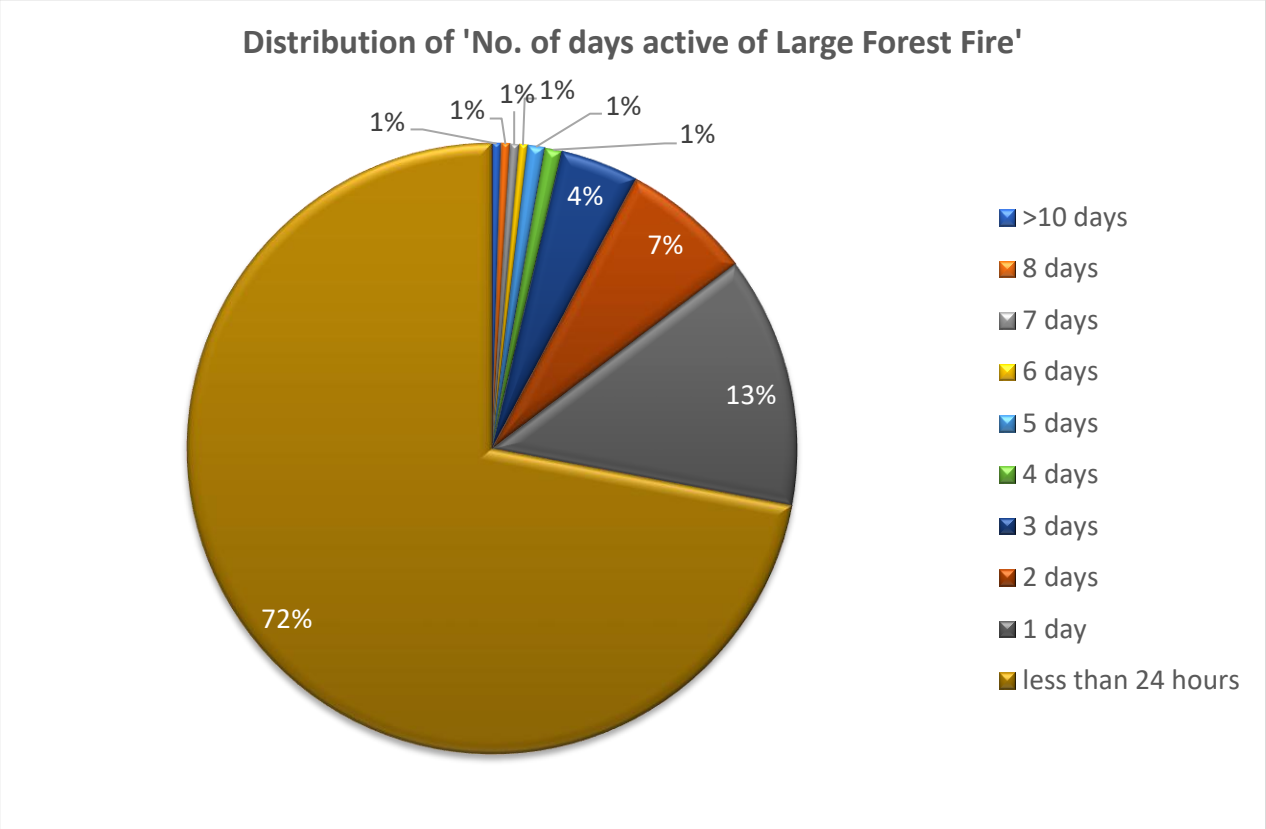



Figure 25: Distribution of Active days of LFF in 2024

**Fast Response to Douse Fires**

The **72%** response **within 24 hours** is a promising figure, indicating that the majority of fires are being detected early and tackled quickly. Rapid response in the first few hours is critical to prevent the fire from spreading. Several factors contribute to this quick turnaround, (Refer Table: 2.1 in Annexure)

i. **Early detection** through satellite technology, drones, and ground surveillance.

ii. **Adequate resource allocation** and ground crews are often deployed as soon as the fire is reported.

iii. **Strategic planning** for fire containment, where fire breaks and controlled burns are utilized to limit the fire's spread.

**Fires Doused in Less Than 3 Days**

A significant portion, **20.18%** (44 LFF), were successfully doused in less than **3 days**. While this is still a relatively fast response, it may indicate that the fire was larger, more intense, or situated in difficult-to-reach locations that delayed the full suppression efforts. This category highlights the fact that while initial response teams act quickly, the nature of the fire or environmental conditions may lead to extended containment times, (Refer Table: 2.2 in Annexure)

i. **Unpredictable weather** such as high winds and dry conditions can exacerbate fire spread, making it harder to control.
ii. **Challenging terrain**, including dense forests or mountainous areas, can slow down the movement of ground crews and machinery.
iii. **Fire behaviour** can be volatile, and certain fires may resist containment due to complex fuel sources, such as large swaths of dry timber or vegetation.

**Fires Doused in Less Than 5 Days**

A smaller percentage, **5%** (11 LFF), were doused within **5 days**. This suggests that while initial suppression efforts may have been successful, the fire may have grown too large or intense to fully control within the initial 72 hours. Fires in this category might have escalated beyond initial expectations, requiring additional reinforcements and coordinated efforts between federal, state, and local fire agencies. Factors that contribute to fires taking up to 5 days to suppress include, (Refer Table: 2.3 in Annexure)

i. **High-intensity fires** that burn uncontrollably due to the sheer scale or combustible materials available.
ii. **Resource limitations**, where more firefighting equipment, manpower, or funding might be needed.
iii. **Delayed weather improvements**—in some cases, firefighting efforts depend on favourable weather, and without rain or a change in wind direction, efforts may not be as effective.

**Fires doused in less than 10 Days**

A small percentage, **2.29%** (5 LFF), were doused in **less than 10 days**. The persistence of these fires indicates exceptional challenges. Fires that burn for extended periods often become "complex" incidents, where the firefighting effort requires long-term planning and sustained resources. Factors influencing the persistence of these fires include, (Refer Table: 2.4 in Annexure)

i. **Escalating complexity** as the fire spreads to remote or difficult areas, requiring logistical coordination.
ii. **Limited accessibility** due to geographical features, such as deep forests or rugged terrain.
iii. **Low water availability**, hindering the use of air tankers or helicopters to drop water or fire retardants.
iv. **High winds or dry conditions**, which can rapidly reignite dormant areas of a fire or cause flare-ups.

**Fires took more than 10 Days**

Only one fire took over **10 days** to extinguish completely. This reflects the extreme rarity of such prolonged firefighting efforts. When a fire continues for over 10 days, it is likely because the situation escalated beyond usual response capacities. This may involve, (Refer Table: 2.5 in Annexure)

i. **Significant loss of resources**, where the fire continues to outpace the available firefighting capacity.
ii. **Adverse weather conditions** such as sustained heat waves, drought, or irregular wind patterns.
iii. **Environmental and logistical challenges**, which include remote locations and a lack of coordinated international assistance.

| S.No | Forest Fire Name (As per FSI portal) | Division | Fire Date | Fire Closure Date | Active Days (FSI*) | Total Fire Pixels in Van Agni Portal* |
|---|---|---|---|---|---|---|
| **1** | MANNAVANUR -4 | Kodaikanal Division | 10-04-2024 | 03.5.24 | 23 | 247 |
| **2** | DENKANIKOTTAI -12 | Krishnagiri District | 01-04-2024 | 09-04-2024 | 8 | 32 |
| **3** | PERUMPALLAM -5 | Dindigul (Kodai Division) | 14-03-2024 | 21-03-2024 | 7 | 59 |
| **4** | MANNAVANUR -3 | | 25-03-2024 | 31-03-2024 | 6 | 50 |
| **5** | UDHAGAI NORTH -2 | Nilgiris North Division, The Nilgiris District | 25-04-2024 | 30-04-2024 | 5 | 31 |
| **6** | SEGUR -1 | - | 05-04-2024 | 10-04-2024 | 5 | 23 |
| **7** | PERUMPALLAM -7 | Dindigul Division | 17-03-2024 | 21-03-2024 | 4 | 13 |
| **8** | PERUMPALLAM -6 | Dindigul (Kodai Division) | 17-03-2024 | 21-03-2024 | 4 | 9 |
| **9** | TIRUPPATTUR -8 | Tiruppattur Division, Vellore District | 25-04-2024 | 28-04-2024 | 3 | 19 |
| **10** | HASSANUR -4 | Hassanur Division, Erode District | 24-04-2024 | 27-04-2024 | 3 | 10 |
| **11** | TIRUPPATTUR -5 | - | 22-04-2024 | 25-04-2024 | 3 | 6 |
| **12** | PALANI -6 | Dindigul Division/Kodaikanal Division | 09-04-2024 | 12-04-2024 | 3 | 39 |

**Table 10: Fires took more than 10 days**



# Case Study 1: Kodaikanal Forest Division

Kodaikanal Forest Division ($77^0$ 16'- $77^0$45' E and $10^0$ 20'-$10^0$5' N), a part of the Dindigul forest circle is renowned for its rich biodiversity and distinct forest types. Located along the eastward spur of the western ghats, it houses unique tropical montane cloud forests known as shola forests, characterized by evergreen trees interspersed with grasslands. Moist deciduous forests thrive at lower elevations, while above the tree line, grasslands dominate the landscape. The landscape has been infested with invasive alien species like wattle *(Acacia mearnsii*), pine *(Pinus patula),* eucalyptus *(Eucalyptus globulus)* aiding to the addition of dried litter.

Kodaikanal Forest Division is administratively divided into 7 forest ranges. The recent forest fire occurred in the ranges of Mannavanur and Poombarai range.

**Forest Fire Incidences in Kodaikanal – 2024**

Kodaikanal reported around 94 forest fires in the year 2024, with April month witnessing the highest, around 51 incidents. April also had several fire incidences reported in very close proximity to two ranges – Mannavanur and Poombarai ranges. The first fire detected in this area was reported on April 10,2024, which was reported to be caused by natural reasons. Several small fires were reported in these ranges between April 10$^{th}$ and 26$^{th}$.

**Large Forest Fire in Kodaikanal Division – "Mannavanur – 4 LFF"**

Dated: 26.04.2024 – 03.05.2024, Mannavanur & Poombarai Range.



**Figure 26: During Kodaikanal Large Forest Fire**

On 26th of April, sparks from an electric pole inside a Patta land triggered fires in Mannavanur range lasting until May 3rd, the fire gradually spread across Paricombai West Beat and its adjacent areas, lasting for around 23 days. This fire had spread across 2 ranges affecting an area of around 356 Ha.

1. Mannavanur Range: Paricombai West Beat and Mannavanur North Beat – 256 Ha.
2. Poombarai Range: Poombarai West Beat – 100 Ha.

Thus, a total of around **356 Ha**. were affected by this Large Forest Fire (LFF).

**Chain of Events**

1) **10.04.2024** – Fire originated in Mannavanur North beat, near the periphery of Paricombai West Beat in the Amphilldown RF
2) **12.04.2024** – The fire weakens after being confined in the same area with minimal spread.
3) **16.04.2024** – Another fire in the same area affecting both Mannavanur North and Paricombai West Beats
   a) It progressed further in the following days, spreading in all directions.
4) **26.04.2024** – The Fire became more active especially towards North and East directions.
   a) Availability of Fuel loads and prevailing dry weather conditions along with favourable wind velocity allowed for further progression.
   b) Intensive fire suppression activities with around 200 Forest staff and local labourers were carried out.
   c) Inter departmental coordination.
5) **27.04.2024** – The fire started spreading extensively.
   a) Forest teams from adjacent divisions were requested to assist in the firefighting efforts.
   b) District Administration was in involved.
   c) Water tankers were provided by the Municipal and Panchayat administrations.
   d) District Fire Control & Rescue Department get involved, provided necessary Fire suppression vehicles and staff for assistance.
6) Four exclusive fire-fighting teams were assigned for Poombarai Range and Five were assigned for Mannavanur Range, totally around 300 People.
   a) Includes villagers, local field staff, and frontline forest staff from adjoining forest divisions.
   b) 70 Personnel from Fire Rescue Department.
   c) 133 staff from adjoining forest divisions.
   d) 10 from Elite Forces – Alpha & Delta from Tamil Nadu Forest Academy (TNFA), Coimbatore.
   e) 90 EDC & Local labourers.
7) Local Communication System was established, to facilitate communication with Frontline staff,
   a) Repeater Base station at Poombarai Range.
   b) Walkie Talkies from Police Department was also used.

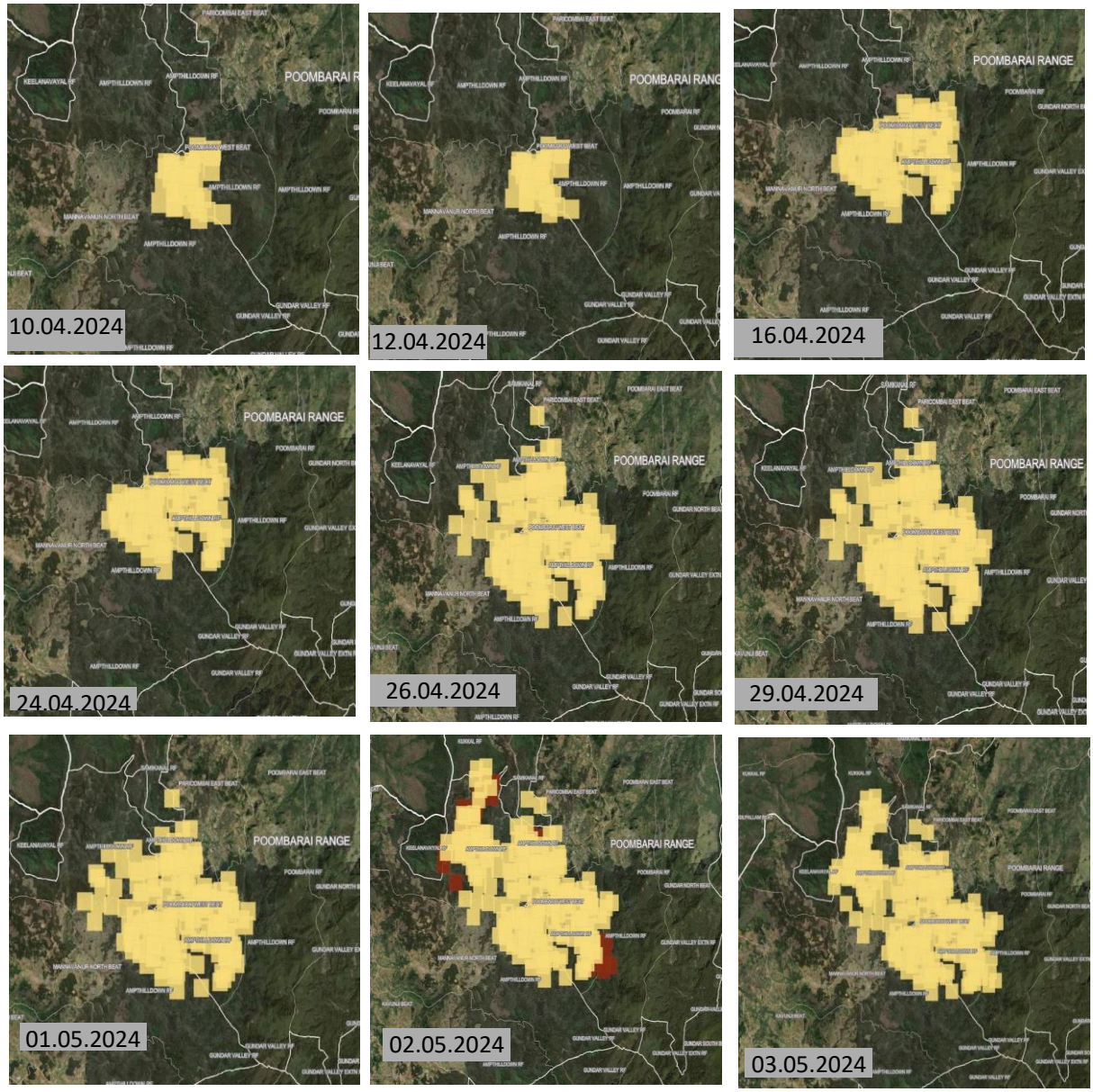



**Figure 27: Active Pixels of Kodaikanal Division**

8) A total of 17 Vehicles from the fire department, local municipal water tankers, and privately available tankers were deployed for dousing the fire.
   a) Two Varun (Specialized Fire Vehicles) Vehicles from Kanyakumari & Tuticorin Districts were deployed.
   b) The District Collector made necessary arrangements to oversee the logistics
9) **01.05.2024** – Tourist and Heavy Vehicular movements were prohibited in and around the two affected ranges.
10) Thermal Drones were deployed to monitor the region on a 24/7 basis.
   a) Sensitive areas were identified with the help of these Thermal Drones.
11) **02.04.2024** - of the fire towards North into Kookal beat and sparsely into the borders of Anamalai TR.

12) The whole operation was carried out on a 24-hour basis. Hence regular supply of food, water and medical care were ensured.

13) **03.05.2024** – The Fire was successfully suppressed.

14) **03.05.2024 to 08.05.2024** – Post Fire Suppression activities were carried out.

| Sl. No. | Name of the RF | Date of Fire Occurrence | Area Affected (in ha) |
|---|---|---|---|
| **1** | Arunkanal | 09.02.2024 | 1.5 |
| **2** | Ayakudi RL | 10.02.2024 | 2 |
| **3** | Ayakudi RL | 11.02.2024 | 0.2 |
| **4** | Palani Hills Southern Slope | 26.02.2024 | 1.5 |
| **5** | Palani Hills Southern Slope | 27.02.2024 | 1.5 |
| **6** | Ayakudi RL | 27.02.2024 | 0.5 |
| **7** | Maruthanadhi | 28.02.2024 | 1.5 |
| **8** | Maruthanadhi | 29.02.2024 | 0.5 |
| **9** | Poombarai Vilpatti Valley | 29.02.2024 | 0.5 |
| **10** | Ayakudi RL | 04.03.2024 | 1 |
| **11** | Perumalmalai | 05.03.2024 | 1.25 |
| **12** | Ayakudi RL | 05.03.2024 | 2 |
| **13** | Ayakudi RL | 06.03.2024 | 2 |
| **14** | Anaigiri Shola | 07.03.2024 | 1.8 |
| **15** | Perumalmalai | 07.03.2024 | 1.15 |
| **16** | Oliyanoothu | 08.03.2024 | 1.2 |
| **17** | Poombarai Vilpatti Valley | 09.03.2024 | 0.75 |
| **18** | Perumalmalai | 09.03.2024 | 1.75 |
| **19** | Amburuvi | 14.03.2024 | 2.5 |
| **20** | Perumalmalai | 16.03.2024 | 1.8 |
| **21** | Murugamalai | 16.03.2024 | 3.5 |
| **22** | Perumalmalai | 16.03.2024 | 1.5 |
| **23** | Perumalmalai | 17.03.2024 | 1.7 |
| **24** | Perumalmalai Shola | 17.03.2024 | 1.45 |
| **25** | Perumalmalai | 17.03.2024 | 1.12 |
| **26** | Ayakudi RL | 18.03.2024 | 0.5 |
| **27** | Perumalmali | 20.03.2024 | 0.5 |
| **28** | Perumalmali | 20.03.2024 | 0.7 |
| **29** | Pambar | 21.03.2024 | 0.25 |
| **30** | Sengalvarayar | 25.03.2024 | 2.25 |
| **31** | Tiger shola | 25.03.2024 | 1.8 |
| **32** | Adukkam | 30.03.2024 | 2.25 |
| **33** | Adukkam | 31.03.2024 | 2.25 |
| **34** | Adukkam | 31.03.2024 | 2 |
| **35** | Adukkam | 31.03.2024 | 2.1 |
| **36** | Palani Hills Southern Slope | 31.03.2024 | 2.1 |
| **37** | Palani Hills Southern Slope | 31.03.2024 | 2 |

| | | | |
|---|---|---|---|
| **38** | Moolaiyar | 01.04.2024 | 1.5 |
| **39** | Murugamalai | 01.04.2024 | 2.5 |
| **40** | Perumalmalai | 01.04.2024 | 0.5 |
| **41** | Moolaiyar | 02.04.2024 | 1 |
| **42** | Ampthilldown | 05.04.2024 | 0.5 |
| **43** | Palani Hills Southern Slope | 06.04.2024 | 2.25 |
| **44** | Perumalmalai | 07.04.2024 | 1 |
| **45** | Perumalmalai | 07.04.2024 | 1 |
| **46** | Perumalmalai | 07.04.2024 | 2.1 |
| **47** | Palani Hills Southern Slope | 07.04.2024 | 2.5 |
| **48** | Palani Hills Southern Slope | 07.04.2024 | 2.5 |
| **49** | Pambar | 07.04.2024 | 2.5 |
| **50** | Murugamalai | 07.04.2024 | 2.5 |
| **51** | Pambar | 08.04.2024 | 2.5 |
| **52** | Pambar | 08.04.2024 | 2.5 |
| **53** | Ampthilldown | 08.04.2024 | 2 |
| **54** | Ampthilldown | 08.04.2024 | 1 |
| **55** | Palani Hills Southern Slope | 08.04.2024 | 2.5 |
| **56** | Poombarai Vilpatti Valley | 09.04.2024 | 0.5 |
| **57** | Ampthilldown | 09.04.2024 | 1 |
| **58** | Pambar | 09.04.2024 | 2.25 |
| **59** | Palani Hills Southern Slope | 09.04.2024 | 2.25 |
| **60** | Ayakudi RL | 09.04.2024 | 1 |
| **61** | Ampthilldown | 09.04.2024 | 1 |
| **62** | Ampthilldown | 09.04.2024 | 1 |
| **63** | Ayakudi RL | 10.04.2024 | 1 |
| **64** | Arunkanal | 10.04.2024 | 1 |
| **65** | Ampthilldown | 10.04.2024 | 4.5 |
| **66** | Poombarai Vilpatti Valley | 10.04.2024 | 1.5 |
| **67** | Perumalmalai | 11.04.2024 | 1.1 |
| **68** | Ampthilldown | 11.04.2024 | 2.5 |
| **69** | Ampthilldown | 15.04.2024 | 4.5 |
| **70** | Oliyanoothu | 17.04.2024 | 0.5 |

**Table 11: Chain of Events of Kodaikanal LFF**

**Challenges**

1. **Inaccessibility:** The rocky terrain was highly inaccessible due to its steep slopes. The continuous stretch of rocky portions made it impossible to manually control the fire's spread.
2. **Poor communication network:** The mobile network in these areas was inadequate, making it difficult for staff to communicate, especially the frontline staff working in the interior forest areas. A local repeater station was later arranged to address this issue.

3. **High fuel load:** The high fuel load led to persistent subsurface heat. Coupled with high wind velocity, this caused the fire to spread to more locations, making it difficult to reach certain points. This led to recurring fires.
4. **More wind-fallen trees:** All the dead and wind-fallen trees, mainly eucalyptus, caused major problems while dousing the fire. The burning wood produced high smoke and embers, which led to the further spread of the fire.

## Case Study 2: The Nilgiris Forest Division

**Coonoor Forest Fire Incident – 2024.**

Date: 12.03.2024 to 19.03.2024.

Block Bridge RF – Coonoor Range.

**Chain of Events**

1) **12.03.2024** – Fire started from Patta land
   a) Fire moved along the Hi-Field side
   b) 10 Staffs from Coonoor Range was deployed on 12.03.2024 for fire control.
2) **13.03.2024** - 20 Staff from Coonoor Range was deployed for fire control.
3) **14.03.2024** – Fire jumped to Hidden Valley Side
   a) 50 Staffs and Laborers from Nilgiris were deployed
   b) Additionally, 30 Staffs from Coimbatore was deployed in the same day.
   c) Also, Water Tractors and Fire pumps were deployed.



Figure 28: During Coonoor Large Forest Fire

4) **15.03.2024** – A combined strength of 150 Staff and Labourers from Nilgiris, Gudalur, Coimbatore and ATR were deployed.
   a) Also, a total of 4 Water Tractors, 5 Hand Pumps and 5 Power saw were deployed.
   b) The fire continued on both sides of the RF.
   c) Fire watchers were deployed on both sides at the vantage points and Hi field.
5) **16.03.2024** – IAF Bambi Bucket Operation was carried out over the Hidden Valley Side.

6) **17.03.2024** – IAF Bambi Bucket Operation was carried out over the Hi – Field Side.
7) **18.03.2024** – Three Quick Response Vehicles were engaged.
8) **18.03.2024** – Fire was extinguished at Hidden Valley Side.
9) **19.03.2024** – Fire was extinguished at Hi – Field Side.
10) **19.03.2024 to 22.03.2024** – Smothering continued in the Fire Burnt Area.
11) **23.03.2024** – Health Check – up for Field Staff was carried out.

| Sl. No. | Name of the RF | Date of Fire Occurrence | Area Affected (in ha) |
|---|---|---|---|
| **1.** | Wenlockdowns | 27.04.2024 | 4 |
| **2.** | Gudakkal RF | 07.04.2024 | 5 |
| **3.** | Black Bridge RF | 12.03.2024 | 4 |
| **4.** | Bikkapathy RF | 28.03.2024 | 5 |
| **5.** | Kundah RF | 06.04.2024 | 18 |
| **6.** | Kundah RF | 09.04.2024 | 17 |
| **7.** | Kundah RF | 10.04.2024 | 4.5 |
| **8.** | Kundah RF | 27.04.2024 | 15.05 |
| **9.** | Kundah RF | 29.04.2024 | 18.05 |
| **10.** | Kundah RF | 02.05.2024 | 8 |

**Table 12: Chain of Events of Coonor LFF**

**Causes of Forest Fires in Nilgiris Forest Division.**

- Cattle gazers inducing recurrent fires.
- Honey Collection.
- MFP (Minor Forest Produce) Collection.
- Pilgrims along Pilgrimage routes and pilgrimage centres.
- Travellers and tourists along the bus routes.
- Retaliatory Arson.
- Fire spread from Adjacent Patta land – Agricultural/ Estate Lands.

**Challenges**

- **Terrain Conditions** posed a major challenge making it difficult for Fire engines and other Fire response vehicles to reach the affected areas.
- **Access Difficulties** were also due to Densely grown bushed and Wattle. There were no proper ways to reach the location of the fire affected areas.
- **Presence of Fuel Load,** especially fallen leaves and dry wattle acting as fire fuel, creating excessive smoke, resulting in breathing difficulty among those deployed.
- **Hazardous Environment,** as a result of the heat wave in the field posed a greater threat to those deployed at the field level.
- **Distance from Water Source,** in many cases the area affected by the fire was far away from water sources, necessitating the use of Water Tractors and Fire Engines.



Figure 29: During Fire Dousing

## Lessons Learnt

**Fuel Load Management**: A lack of previous forest fires for two decades led to a massive accumulation of fuel in this case. So, there is need for a carrying out fuel load management practices in proactive manner that includes controlled burning and removal of invasive species in vulnerable areas could help prevent such large-scale fires.

**Early Detection and Rapid Response**: The fire spread due to high wind speeds and hilly terrain in this case. So early detection, combined with rapid response teams' involvement at the initial stage, is essential to contain fires before they escalate.

**Enhanced Communication:** Poor communication networks hindered coordination. Establishing reliable communication infrastructure in forest areas, such as repeater stations, is crucial for effective emergency response. Steps will be taken up to improve the communication infrastructure in such fire vulnerable areas.

**Accessibility and Resource Deployment:** Inaccessibility to rocky, steep areas hindered firefighting efforts. Therefore, it's essential to develop comprehensive plans for resource deployment in such areas. Alternative approaches, such as aerial support and specialized equipment for rugged terrains, can significantly enhance fire containment efforts in challenging landscapes.

**Collaboration Across Agencies:** The need for assistance from multiple agencies underscored the importance of inter-agency collaboration. Coordinating efforts among District, state, and central agencies like NDMA, IAF is crucial for effective fire management. This includes sharing of resources, knowledge, and strategies to ensure a unified response.

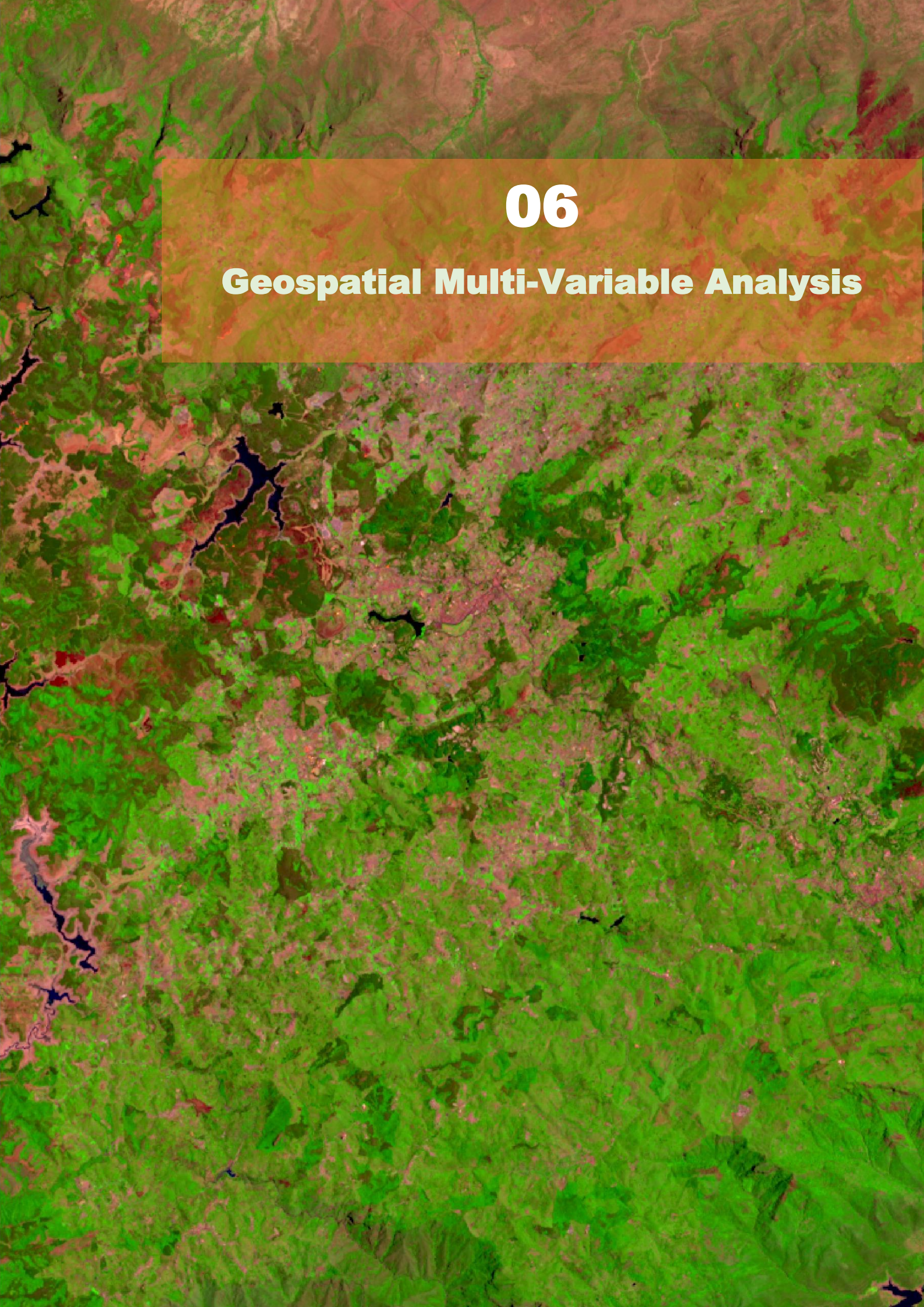
**Regular Assessment and Monitoring:** Regular monitoring using technologies like thermal drones and satellite imaging allows for early identification of high-risk areas, improving preparedness and response times. Continual assessment can help in understanding changing conditions and adjusting strategies to mitigate potential fire

outbreaks. LIDAR Drones can help in assessing the fuel load. So, deploying LIDAR drone survey in fire vulnerable areas can help to plan Fireline establishment.

**Comprehensive Post-Fire Analysis:** A thorough post-fire analysis is crucial for understanding the cause and impact of the fire, as well as evaluating response strategies. Such analyses can provide insights into improving future fire management practices by highlighting what worked, what didn't, and areas needing improvement.

**Deployment of a dedicated technical resource personnels at Divisions:** There is a need to engage technical resource personnel knowledgeable in remote sensing and technology to continuously update ground status with the State Forest Fire Control Centre at headquarters. As the DFO and other officials may not be available in the office during such emergency situations, these technical personnel, who have adequate field knowledge, are the only resource persons available to send timely reports to the headquarters and to update the real-time dashboards developed by the TNSFFCC.





# 06

# Geospatial Multi-Variable Analysis

# Chapter 6: Geospatial Multi-Variable Analysis of Forest Fire

Geographic Information Systems (GIS) based multi-variable analysis of forest fire dynamics by integrating spatial and temporal datasets, including vegetation type, topography, climate variables (temperature, humidity, wind speed), human activities, and historical fire occurrences, in order to identify patterns, assess risks and vulnerability, and to inform sustainable forest management and fire mitigation strategies was carried out by Tamil Nadu State Forest Fire Control Centre. A Geographic Information Systems (GIS) and Remote Sensing (RS) technology-based multi-variable evaluation was employed to map forest fire vulnerability. Key factors, including terrain, vegetation types, and human influence, were analysed to assess fire risk levels and produce a comprehensive fire vulnerability for the reserved forests in Tamil Nadu. In conjunction with satellite image analysis, ground-truthing for 2024 fire data was carried out to enhance validation and support more effective management.

## Dataset Used

- Tamil Nadu Forest Administrative layer; Source: Geomatics Centre, Tamil Nadu Forest Dept.
- Forest fire data for the years 2016 – 2024; Source: Forest Survey of India (FSI)
- Tamil Nadu Forest Types; Source: National Remote Sensing Centre (NRSC)
- Tamil Nadu Forest Cover (2021); Source: National Remote Sensing Centre (NRSC)
- Road Networks; Source: Geological Survey of India (Bhukosh)
- Location of Villages enclosed to Reserve forests and Reserve Lands; Source: Esri Living Atlas
- Digital Elevation Model (DEM) – Shuttle Radar Topography Mission (SRTM); Source: USGS Earth Explorer.

## Software Used

- ArcGIS Pro
- ArcGIS Map
- Earth Engine
- Origin Lab
- Microsoft Apps

## Approach

The methodology adopted for this analysis is structured below,

- **Data Generation:** Required datasets are derived and compiled from original sources.
- **Data Processing**: Pre-processing of collected data to ensure consistency, accuracy, and readiness for analysis.
- **Data Analysis:** Analytical techniques are applied to the processed data to extract multiple parameters.
- **Multi-Variable Assessment:** An integrated evaluation of multiple parameters to get the required output
- **Result Interpretation:** The findings are synthesized to support decision-making and further application.

## Data Generation

As a first step of study, the required data from the raw sources of various platforms was generated. The details of those are provided below,

1. **Tamil Nadu Forest Administrative Boundary**

   The primary vector data source for this study was the Tamil Nadu Forest Administrative Boundary, which includes Reserved Forests (RF) and Reserved Lands (RL). These boundaries form the core areas for analysis. Using ArcGIS software, various administrative layers were generated from the Forest Administration data, including Division, District, Range, and Beat boundaries, as well as the boundaries of Reserved Forests and Lands.

2. **Forest Fire Data**

   Forest fire alerts for Tamil Nadu from the Forest Survey of India (FSI) Forest Fire Portal were collected for the period 2016 to 2024. The alerts, derived from MODIS (Moderate Resolution Imaging Spectroradiometer) and SNPP-VIIRS (Suomi National Polar-orbiting Partnership - Visible Infrared Imaging Radiometer Suite), were integrated with the forest boundary data for subsequent analysis.

3. **Road Networks and Village locations**

   A 1 km buffer was created around the Reserved Forest and Reserved Land boundaries using ArcGIS software to identify road networks falling within the buffered area. Additionally, the locations of villages within or adjacent to the Reserved Forests and Lands were extracted for further analysis.

4. **Forest Type and Forest Cover Data**

   The forest type and forest cover for Tamil Nadu for the year 2021 were sourced from the National Remote Sensing Centre (NRSC). The data was categorized based on forest groups and classes, which were then mapped for spatial analysis.

5. **Elevation Data**

   To analyse topographic features, the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) data was acquired through USGS Earth Explorer. The SRTM 1 Arc-Second Global Elevation data provides a worldwide coverage at a 30-meter resolution. Using ArcGIS Pro software, various elevation-based outputs were generated, including Aspect, Elevation, and Slope for Tamil Nadu, based on the high-resolution SRTM data.

## Data Processing and Analysis

**Field-reported Fire Incidents**

Forest fires are typically reported by frontline staff within the department. The staff members conduct field inspections to assess the extent of damage following an incident. Upon identifying a fire, the frontline staff submits a report to the respective District Forest Officer (DFO), along with a location sketch indicating the fire's location. This location is then marked on the divisional control map for further tracking and analysis.

For the year 2024, a total of **782 fire incidents** were reported by the field staff so far. These reports serve as the primary source of data for post-incident investigation and damage assessment.

## MODIS & SNPP-VIIRS Fire Alerts (2016-2024)

**MODIS Hotspot Detection**

The Moderate Resolution Imaging Spectroradiometer (MODIS) sensor, onboard NASA's Terra and Aqua satellites, detects fire hotspots using data from infrared bands. Fire spot detection is based on the analysis of pixel brightness and temperature variations compared to the surrounding background. A fire hotspot is flagged when the temperature of a pixel exceeds the ambient temperature, indicating the presence of an active fire. Each detected hotspot represents the centre of a 1 km pixel, which may contain one or more active fires within its area. This method allows for the monitoring of fire events over large areas, enabling timely detection and response to wildfires.

## VIIRS Active Fire Detection

The Visible Infrared Imaging Radiometer Suite (VIIRS) sensor aboard the Suomi National Polar-orbiting Partnership (SNPP) satellite provides an advanced active fire product at a higher spatial resolution of 375 meters. VIIRS detects active fires by capturing both visible and infrared wavelengths, offering enhanced sensitivity to temperature differences and improving fire detection accuracy.

The 375m spatial resolution of VIIRS data allows for more precise identification of smaller fires that may not be detectable by MODIS, which operates at a coarser resolution. This increased resolution also enables better mapping of large fire perimeters, making it particularly valuable for monitoring the spread of significant wildfire events. The VIIRS product includes fire radiative power (FRP) data, which helps estimate the intensity and size of the fire, providing valuable information for assessing fire behaviour and potential risks.

Both MODIS and VIIRS datasets are crucial for near-real-time monitoring of forest fires, providing essential data for fire management studies. The integration of these datasets allows for comprehensive wildfire tracking, improving our ability to mitigate and manage fire-related risks globally.

# Forest Fire Scenario in Tamil Nadu

**Forest Fire Incidences (2016-2024)**

Between 2016 and 2024, both the MODIS and SNPP-VIIRS satellite sensors detected approximately **20,165 fire incidents** within the notified forests of Tamil Nadu. The data indicates a noticeable upward trend in the frequency of forest fires over this period. This increasing trend highlights the growing challenge of Forest Fire Management and underscores the importance of proactive monitoring and response strategies to mitigate the impact of such events

| Year<br>Month | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Jan** | 0 | 22 | 4 | 179 | 55 | 9 | 17 | 73 | 18 | **377** |
| **Feb** | 8 | 116 | 51 | 1763 | 294 | 146 | 162 | 1096 | 288 | **3924** |
| **Mar** | 61 | 115 | 146 | 2778 | 803 | 844 | 937 | 1274 | 1924 | **8882** |
| **Apr** | 35 | 34 | 15 | 1495 | 637 | 319 | 223 | 402 | 2752 | **5912** |
| **May** | 6 | 8 | 7 | 240 | 81 | 66 | 79 | 32 | 245 | **764** |
| **Jun** | 3 | 6 | 5 | 75 | 28 | 24 | 36 | 49 | 11 | **237** |
| **Jul** | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | **6** |
| **Aug** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Sep** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Oct** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Nov** | 0 | 0 | 5 | 3 | 0 | 0 | 5 | 3 | 4 | **20** |
| **Dec** | 0 | 0 | 22 | 3 | 0 | 4 | 6 | 4 | 4 | **43** |
| **Total** | **113** | **301** | **255** | **6542** | **1898** | **1412** | **1465** | **2933** | **5246** | **20165** |

**Table 13: Forest Fire Incidences (2016-2024)**

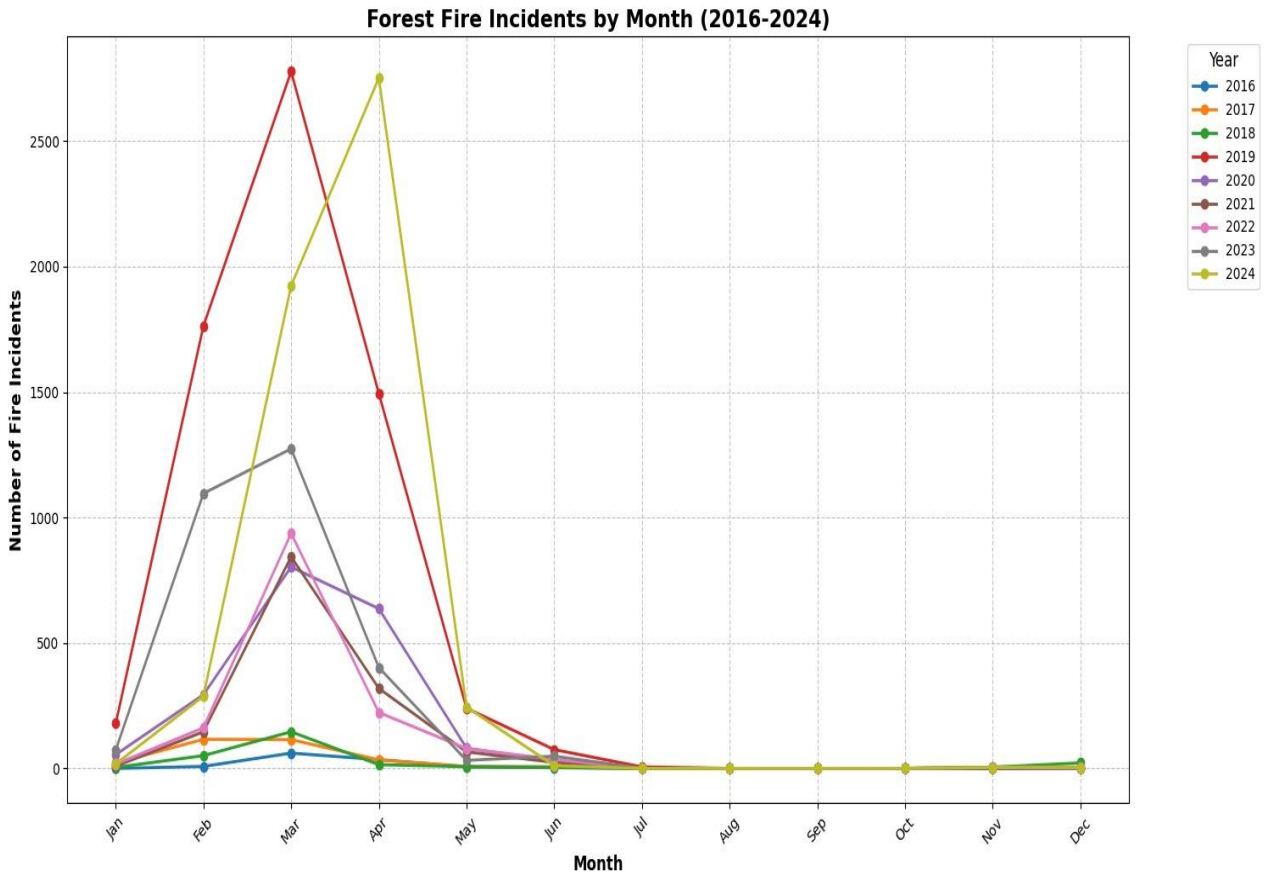



**Figure 30: Monthly Trend of Fire detections from 2016-2024 (Source: FSI)**

# Spatial Analysis

## Fire Sensitive Beats

During 2016-2024, about **20,165 fire incidents** within the forest area in Tamil Nadu was detected. At an average, around 1600 fire incidents per annum was detected during the assessment period 2016-2024. The total frequency of forest fire points in each beat has been determined by the summing the frequency of forest fire points observed in the respective beats which ranges from 1 to 204.

The maximum frequency of fire occurrence was 204 times over the period of 9 years (2016-2024) in Paricombai West Beat in the Mannavanur Range of Kodaikanal division, Gudiyur Beat in Denkanikottai Range of Hosur Division with 185 times, and Perumpallam Beat in Perumpallam Range of Kodaikanal Division with 158 times. The minimum frequency is "1" in about 551 beats during this period. Average annual frequency of observed forest fire in each beat has been computed by dividing total frequency by number of years i.e. 9.

The average number of fire incidents was calculated by dividing the total number of fire incidents by 9 (number of years). Then the frequency class was divided into five classes adopting the same classification used in previous years. Around 90 beats come under Very High, High and Moderate category.

| Sl. No | Sensitivity Class | Fire Frequency | No of Sensitive Beats (2016-2024) |
|---|---|---|---|
| **1** | Very Low | 0 to 3 | 785 |
| **2** | Low | 3 to 6 | 134 |
| **3** | Moderate | 6 to 9 | 46 |
| **4** | High | 9 to 12 | 24 |
| **5** | Very High | 12 & above | 20 |
| **Total** | | | **1009** |

**Table 14: Classification of Sensitivity based on frequency**

**90 Sensitive beats have been identified** based on the fire data from 2016-2024. Those are listed below,

| CIRCLE | DIVISION | RANGE | BEAT |
|---|---|---|---|
| **DINDIGUL** | KODAIKANAL | MANNAVANUR | PARICOMBAI WEST |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | GUDIYUR |
| **DINDIGUL** | KODAIKANAL | PERUMPALLAM | PERUMPALLAM |
| **MTR** | WL, MTR | MUKURTHY | AVALANCHE(WL) |
| **ATR** | WL ATR TIRUPPUR | UDUMALAIPETTAI | KOMBU WEST |
| **MTR** | NILGIRIS SOUTH | KORAKUNDAH | UPPER BHAVANI |
| **VELLORE** | VELLORE | ARCOT | PUNGANUR NORTH |
| **DINDIGUL** | KODAIKANAL | POOMPARAI | POOMPARAI WEST |
| **CHENNAI** | TIRUVALLUR | THIRUTTANI | MADDUR |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | GULLATTI EAST |

| | | | |
|---|---|---|---|
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | THULUVABETTA EAST |
| **ATR** | WL ATR TIRUPPUR | UDUMALAIPETTAI | THIRUMOORTHIMALAI |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | AYYUR |
| **DINDIGUL** | KODAIKANAL | POOMPARAI | PARICOMBAI EAST |
| **DINDIGUL** | KODAIKANAL | PALANI | KALAYAMPUTHUR |
| **DINDIGUL** | KODAIKANAL | PERUMPALLAM | PANNAIKADU |
| **KMTR** | KANYAKUMARI | AZHAGIAPANDIPURAM | THADIKARANKONAM SOUTH |
| **DINDIGUL** | KODAIKANAL | PERUMPALLAM | VADAKAVUNJI |
| **KMTR** | KANYAKUMARI | AZHAGIAPANDIPURAM | ASAMBU |
| **DINDIGUL** | KODAIKANAL | KODAIKANAL | PERUMALMALAI(K) |
| **DHARMAPURI** | HOSUR | JAWALAGIRI | JAWALAGIRI |
| **DINDIGUL** | KODAIKANAL | PERUMPALLAM | MELPALLAM |
| **VELLORE** | VELLORE | ARCOT | PUNGANUR SOUTH |
| **STR** | WL, STR HASSANUR | HASSANUR | GEDDESAL |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | THOLUVABETTA EAST |
| **DINDIGUL** | KODAIKANAL | PALANI | BALASAMUDRAM EAST |
| **KMTR** | KANYAKUMARI | AZHAGIAPANDIPURAM | AZHAGIAPANDIPURAM |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | BETTAMUGILALAM |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | GALIGATTAM |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | KEMPAGARAI |
| **DINDIGUL** | DINDIGUL | KANNIVADY | SITHAYANKOTTAI |
| **DINDIGUL** | KODAIKANAL | KODAIKANAL | MACHUR |
| **DINDIGUL** | KODAIKANAL | PALANI | KAVALAPATTY |
| **VELLORE** | VELLORE | GUDIYATHAM | RANGAMPETTAI |
| **VELLORE** | VELLORE | ODUGATHUR | AGARAM |
| **ATR** | WL ATR POLLACHI | VALPARAI | AKKAMALAI |
| **ATR** | WL ATR TIRUPPUR | UDUMALAIPETTAI | KOKKANAMALAI |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | BELLATTY |
| **SALEM** | SALEM | SHERVAROY SOUTH | KURUMBAPATTY |
| **KMTR** | KANYAKUMARI | KALIYAL | KALIYAL |
| **ATR** | WL ATR TIRUPPUR | AMARAVATHI | KEELANAVAYAL |
| **VELLORE** | VELLORE | VELLORE | PALAMADI |
| **VELLORE** | TIRUPPATTUR | SINGARAPETTAI | SINGARAPETTAI EAST |
| **VELLORE** | VELLORE | GUDIYATHAM | NAICKENERI(VLR) |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | THOLUVABETTA WEST |
| **VELLORE** | VELLORE | ARCOT | AMMUR |
| **DINDIGUL** | KODAIKANAL | MANNAVANUR | MANNAVANUR NORTH |
| **SMTR** | THENI | BODI | ARUNGULAM EAST |
| **MTR** | NILGIRIS NORTH | SEGUR | SIROOR SOUTH |
| **MTR** | WL, MTR | MASINAGUDI | KARADIBETTA |
| **VELLORE** | VELLORE | ODUGATHUR | ASANAMPETTAI |
| **SMTR** | THENI | UTHAMAPALAYAM | THEVARAM SOUTH |
| **DHARMAPURI** | HOSUR | JAWALAGIRI | ULIBANDA |
| **KMTR** | KANYAKUMARI | KULASEKARAM | PECHIPARAI |

| | | | |
|---|---|---|---|
| **ATR** | WL ATR TIRUPPUR | AMARAVATHI | MANJAMPATTI SOUTH |
| **SMTR** | THENI | THENI | TAMBIRANKANAL |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | GULLATTI WEST |
| **KMTR** | KANYAKUMARI | VELIMALAI | CHELLAMTHURUTHI |
| **KMTR** | KANYAKUMARI | VELIMALAI | SURULACODE |
| **VELLORE** | TIRUPPATTUR | TIRUPPATTUR | SWAMIMALAI(VLR) |
| **SMTR** | THENI | UTHAMAPALAYAM | KOMBAI |
| **SALEM** | SALEM | SHERVAROY SOUTH | GUNDUR EAST |
| **CHENNAI** | TIRUVALLUR | PALLIPATTU | PUDUR |
| **DINDIGUL** | KODAIKANAL | PALANI | PALLANGI EAST |
| **MTR** | NILGIRIS SOUTH | KUNDAH | THAISHOLAI |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | KODAGARAI(HOS) |
| **DINDIGUL** | KODAIKANAL | PALANI | PALLANGI WEST |
| **VELLORE** | TIRUPPATTUR | ALANGAYAM | VELLAKUTTAI |
| **MTR** | NILGIRIS NORTH | UDHAGAI NORTH | SHOLUR |
| **DHARMAPURI** | DHARMAPURI | HARUR | NOCHIKUTTAI |
| **DHARMAPURI** | HOSUR | DENKANIKOTTAI | MARANDAHALLI NORTH |
| **VELLORE** | VELLORE | ARCOT | MAHIMANDALAM |
| **ATR** | WL ATR TIRUPPUR | UDUMALAIPETTAI | KOTTAIYARU |
| **DINDIGUL** | DINDIGUL | SIRUMALAI | KODAI ROAD |
| **VELLORE** | VELLORE | GUDIYATHAM | SATHGUR |
| **DINDIGUL** | KODAIKANAL | PALANI | BALASAMUDRAM WEST |
| **DINDIGUL** | KODAIKANAL | KODAIKANAL | PERAMBUKANAL |
| **MTR** | NILGIRIS NORTH | KATTABETTU | BIKKAPATHI |
| **DHARMAPURI** | HOSUR | URIGAM | KESTHUR |
| **SALEM** | NAMAKKAL | NAMAKKAL | NADUCOMBAI |
| **DHARMAPURI** | HOSUR | HOSUR | KOTTASATHANA PALLI |
| **VELLORE** | TIRUVANNAMALAI(S) | CHENGAM | CHEYYAR |
| **ATR** | WL ATR POLLACHI | VALPARAI | GRASS HILLS |
| **DHARMAPURI** | HOSUR | JAWALAGIRI | THALI NORTH |
| **KMTR** | KANYAKUMARI | VELIMALAI | VELIMALAI NORTH |
| **MTR** | NILGIRIS NORTH | SEGUR | SIROOR NORTH |
| **MTR** | NILGIRIS NORTH | UDHAGAI NORTH | GLENMORGAN |
| **SMTR** | THENI | BODI | KURANGANI SOUTH |
| **VELLORE** | TIRUPPATTUR | AMBUR | ARANGALTHURGAM |
| **VELLORE** | TIRUPPATTUR | TIRUPPATTUR | MAMBAKKAM |

**Table 15:List of 90 Sensitive Beats**

## Forest Type & Cover Sensitive to Fire

Forest type and cover significantly influence forest fire behaviour by affecting fuel availability, flammability, and the intensity of fire spread. By overlaying forest burnt area data with observed forest type and cover layers, and validating the results through ground truthing, a detailed understanding of fire-sensitive forest types and covers can be achieved.

| BURNT AREA 2024 OVER FOREST TYPE | | | |
|---|---|---|---|
| **Forest Type Group** | **Burnt Area (in ha)** | **Burnt Area (in Sq.km)** | **Burnt Area (in % of Total Burnt Area)** |
| **Littoral and Swamp Forests** | 12911.07167 | 129.11071 | 32.864% |
| **Montane Wet Temperate Forests** | 10608.57758 | 106.08577 | 27.003% |
| **Subtropical Broadleaved Hill Forests** | 4265.44305 | 42.65443 | 10.857% |
| **TOF/Plantation** | 2503.83266 | 25.03832 | 6.373% |
| **Tropical Dry Deciduous Forests** | 1874.96179 | 18.74961 | 4.773% |
| **Tropical Dry Evergreen Forests** | 869.62435 | 8.69624 | 2.214% |
| **Tropical Moist Deciduous Forests** | 731.09197 | 7.31092 | 1.861% |
| **Tropical Semi- Evergreen Forests** | 293.01474 | 2.93014 | 0.746% |
| **Tropical Thorn Forests** | 274.74916 | 2.74749 | 0.699% |
| **Tropical Wet Evergreen Forests** | 24.46379 | 0.24463 | 0.062% |

**Table 16: Percentage of Burnt Area over Forest Type (2024)**

| BURNT AREA 2024 OVER FOREST COVER (2021) | | | |
|---|---|---|---|
| **Forest Cover Classes** | **Burnt Area (in ha)** | **Burnt Area (in sq.km)** | **Burnt Area (in % of Total Burnt Area)** |
| **Open Forest** | 9259.149074 | 92.591491 | 23.709% |
| **Moderately Dense Forest** | 9210.229753 | 92.102298 | 23.583% |
| **Very Dense Forest** | 5184.30139 | 51.843014 | 13.275% |
| **Scrub** | 2203.844555 | 22.038446 | 5.643% |

**Table 17: Percentage of Burnt Area Over Forest Cover (2024)**

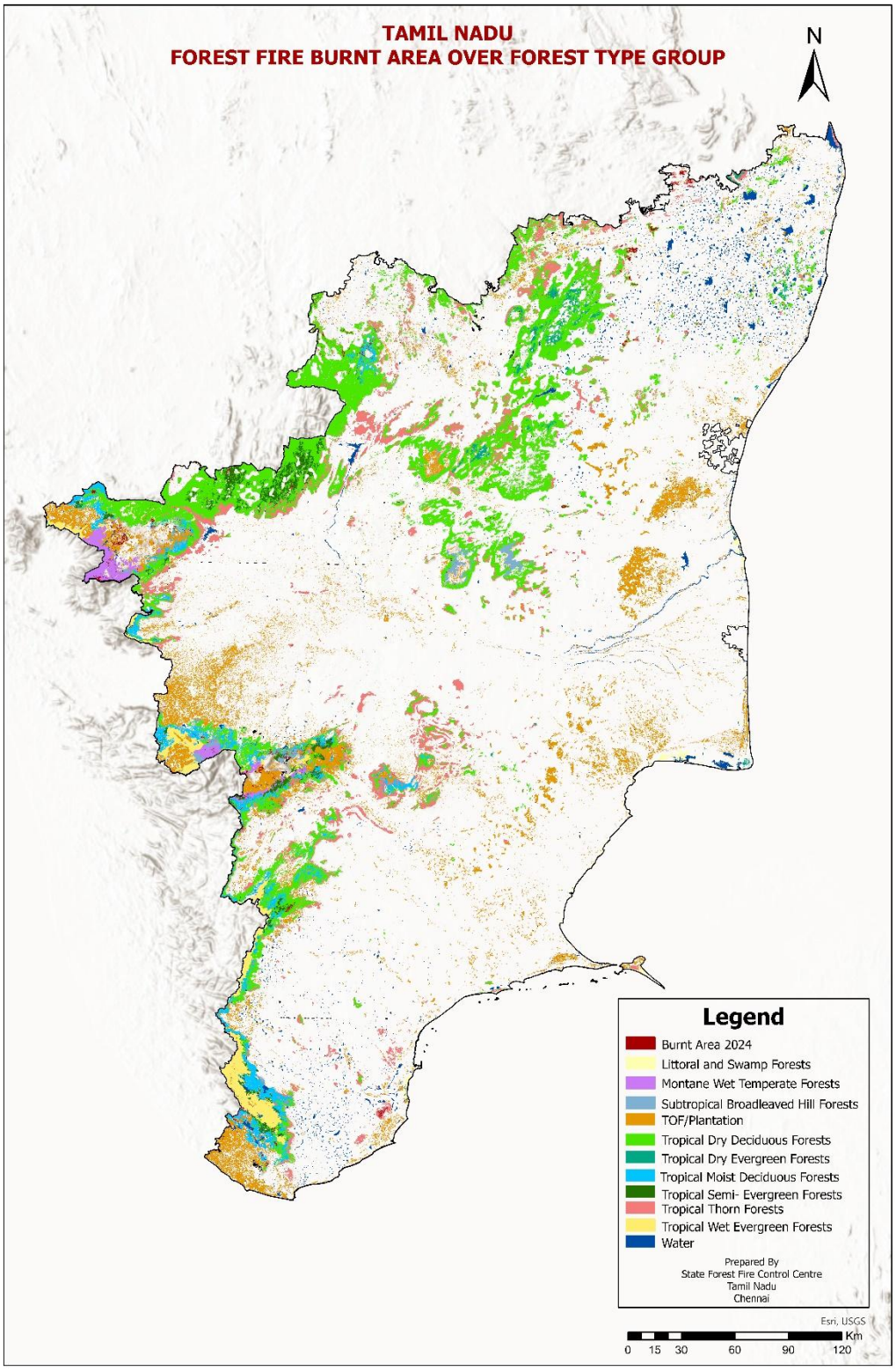



**Figure 31: Forest Fire Burnt Area over Forest Type Group (2021)**

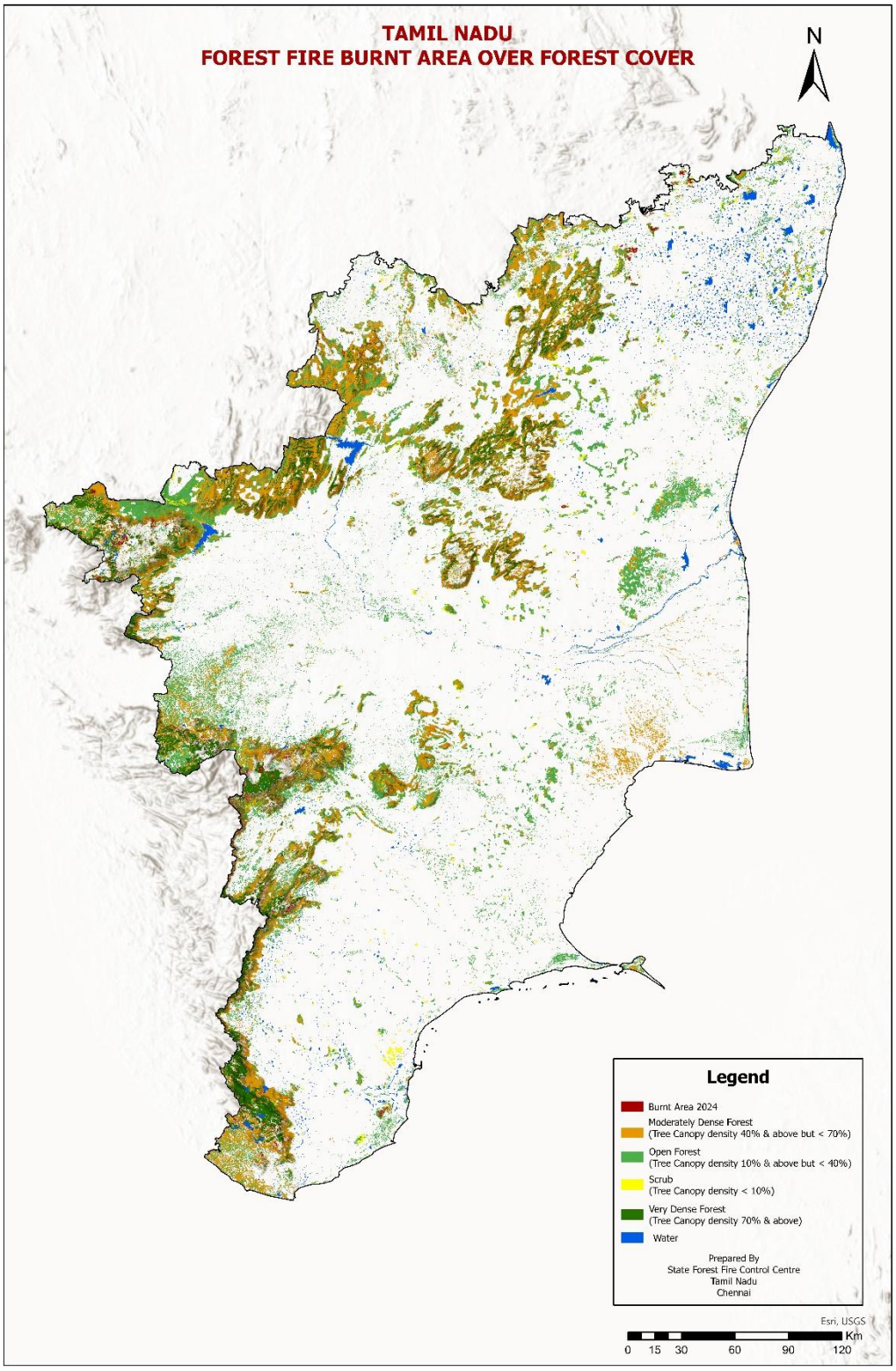



**Figure 32: Forest Fire Burnt Area over Forest Cover (2021)**

# Temporal Analysis

Temporal analysis involves examining changes in geographic features and their relationships over a specific period of time. It helps in understanding how an area evolves or behaves by comparing various aspects, such as frequency, duration, and intensity of events across different time intervals.

In the case of forest fires, temporal analysis allows for a deeper understanding of fire dynamics and the factors influencing fire occurrences. By comparing data from different years, can observe the frequency, intensity, and seasonality of fires, as well as how these elements change over time.

## Annual Detections

The intensity of forest fires in Tamil Nadu has shown a noticeable increasing trend over the past three years, from 2022 to 2024. While a similar upward trend was observed between 2016 and 2018, the fire activity during this earlier period was not as pronounced as in the most recent years. Notably, the year 2019 experienced an exceptionally high number of fire detections, surpassing the trends of both the preceding and subsequent years. This fluctuation in fire intensity highlights the dynamic nature of forest fire in Tamil Nadu.

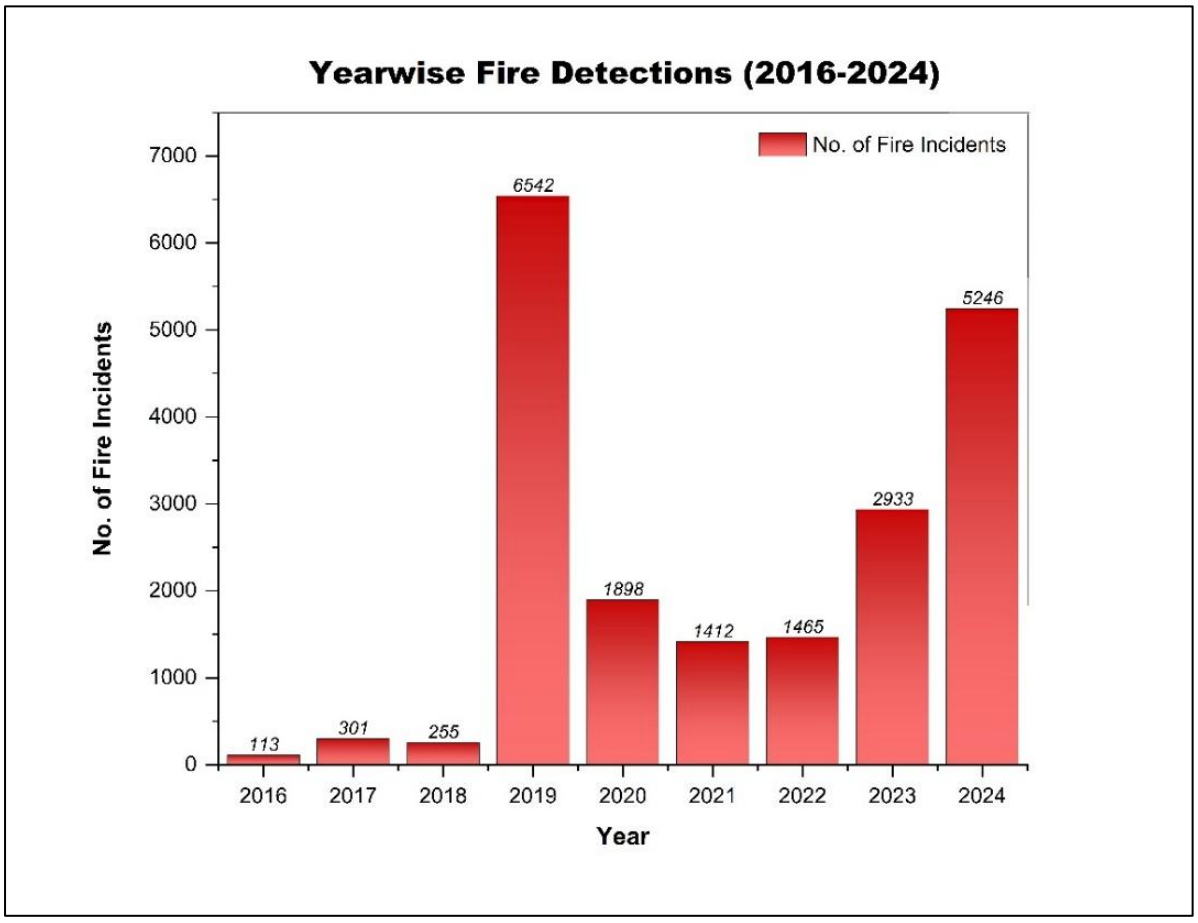



**Figure 33: Year-wise Detections of Fire Incidents**

## Monthly Detections

The data reveals a clear seasonal pattern in forest fire occurrences. Fires typically begin in January, with activity steadily increasing as the year progresses. The number of fire incidents reaches its peak in March and April, before gradually declining by the end of June, coinciding with the arrival of the monsoon season. This trend underscores the importance of focused fire management and preventive measures during the dry months leading up to the monsoon, when fire risk is at its highest.

- 42.8% of fire incidents were detected during the month of March
- 29.8% of fire incidents were detected during the month of April
- 20.1% of fire incidents were detected during the month of February
- Overall, 80.5% of fire incidents were detected over the period of 2016-2024, where February to May is at its highest.

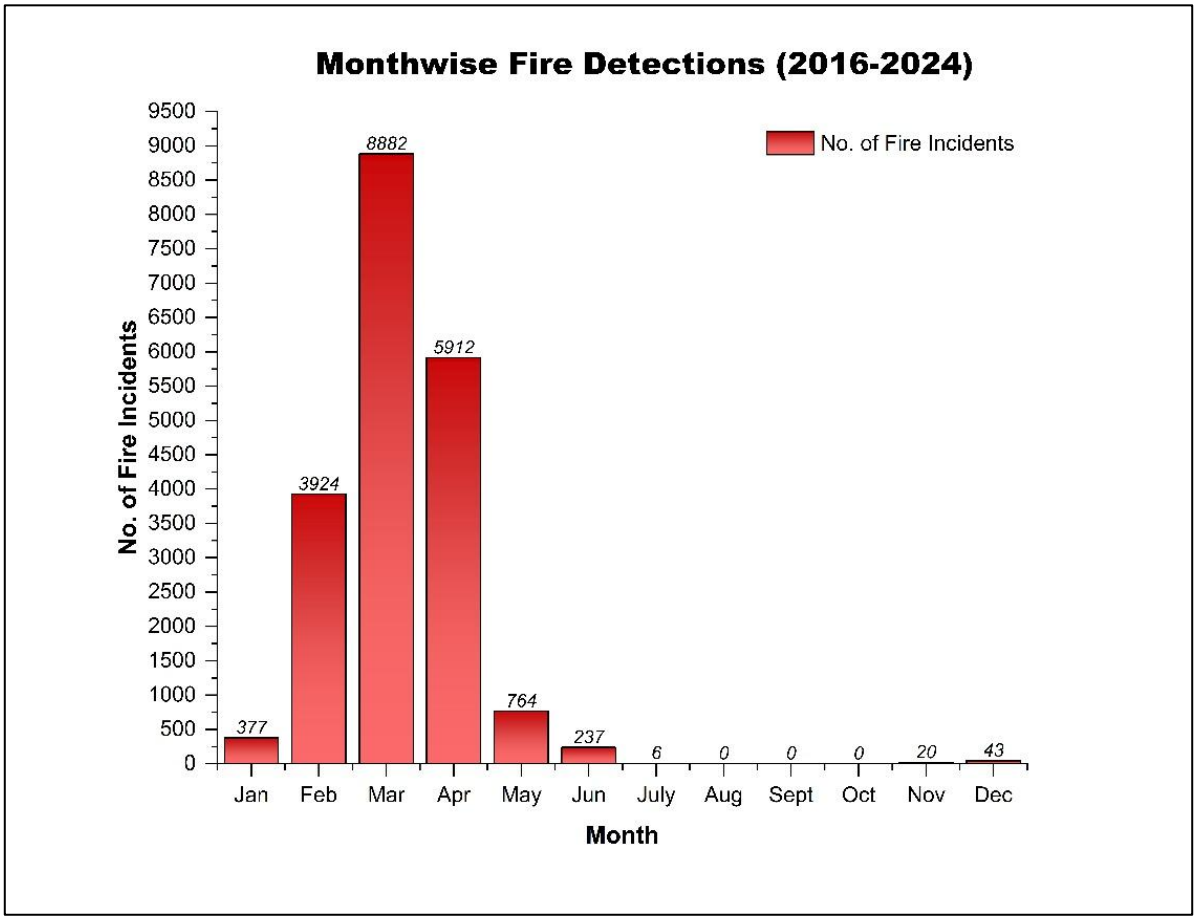



**Figure 34: Month-wise Detections of Fire Incidents**

## Diurnal Detections

Satellite sensors provide day and night coverage, capturing the diurnal range of approximately between 1.30am and 1.30pm for SNPP-VIIRS, 1.30am and 1.30pm for MODIS (Aqua), 10.30am and 10.30pm for MODIS (Terra). Active fires occurring on the ground during these time frames are detected by the sensors. Analysis indicates that fire intensity peaks during the early morning hours of 1:00–2:00 AM and the afternoon hours of 1:00–2:00 PM.

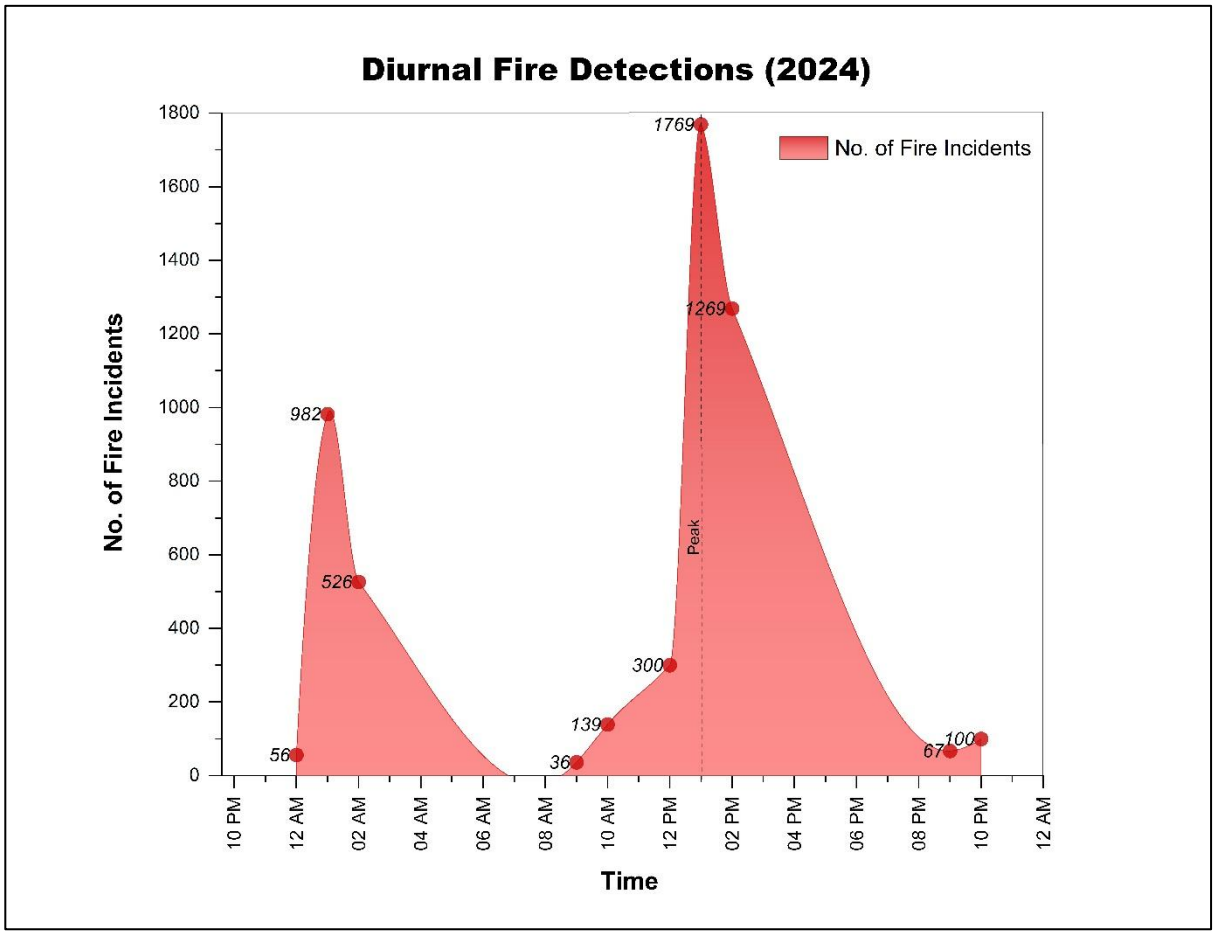



**Figure 35: Diurnal Fire Detections of 2024 Fire Incidents**





# 07

# Vulnerability Analysis

# Chapter 7: Multi-Variable Fire Vulnerability Analysis of Forests in TN

Multi-variable analysis is a spatial analysis technique that plays a crucial role in understanding complex phenomena, such as forest fire vulnerability. A key step in this analysis is identifying the variables, sub-variables, criteria, or factors that influence events in the real world.

In this study, three primary factors human influence, forest type, and topography are identified as critical determinants of forests vulnerability to fire:

**Human Influence :** With 99% of forest fires in India being anthropogenic in origin, human activity is a significant factor in forest fire studies. Human presence and proximity to forests are key variables for assessing fire vulnerability.

**Forest Type (Fuel Load) :** The type of forest influences the availability of fuel, which in turn determines the intensity of a fire. As a result, forest type and associated fuel loads are critical variables in evaluating fire risk.

**Topography :** Landscape patterns, such as aspect, slope, and elevation, significantly affect the spread of fire in natural environments. These topographic factors are therefore integral to assessing fire vulnerability.

Additionally, sub-variables may be considered based on specific requirements. For example, vegetation type, dry matter availability, and other natural factors further refine the analysis.

**Spatial Variability of Vulnerability**

The identified variables topographic, natural, and human exhibit spatial variability, meaning that forests differ in their degree of vulnerability based on their unique characteristics. This variability highlights the need for a tailored approach to fire risk assessment.

**Data Formats and Processing in GIS**

The variables are represented in different formats, with some in raster and others in vector format. To perform the analysis in a Geographical Information Science (GIS) environment, all variables are assigned uniform numerical rankings or weightage based on their zone of influence or importance to fire vulnerability.

Using advanced algorithms, tools, and functions, these rankings are processed to evaluate each variable independently. The results are then aggregated and combined to derive an overall vulnerability value, providing a comprehensive spatial assessment of forests susceptible to fire.

## Multi-Variable Analysis

As per the identified variables, the fire vulnerability model is divided into three sub models namely,

1. Topographic Risk Sub Model
2. Human Influence Sub Model
3. Fuel Load Sub Model.

The variables, the data layers, chosen as the creation for such models are comprehensively determining factors in Forest fire and its spread. The variables of every sub model are given quantitative fire risk values depending upon their capacity to promote fire hazard. The risk due to each variable is assessed separately as a sub model. The sub models, according to necessity, are further subdivided and assessed.

## Topographic Risk Sub Model

Topography, defined as the configuration of a surface including its relief and features, plays a significant role in shaping forest fire behavior. The physical characteristics of the land influence the speed, direction, and intensity of fire spread through several key mechanisms:

**1. Micro-climatic Conditions**

Topographic components such as aspect, elevation, and slope directly affect microclimatic conditions. These factors influence vegetation patterns, fuel composition, and fuel moisture content, all of which are critical to fire behavior.

**2. Solar Radiation and Fuel Dryness**

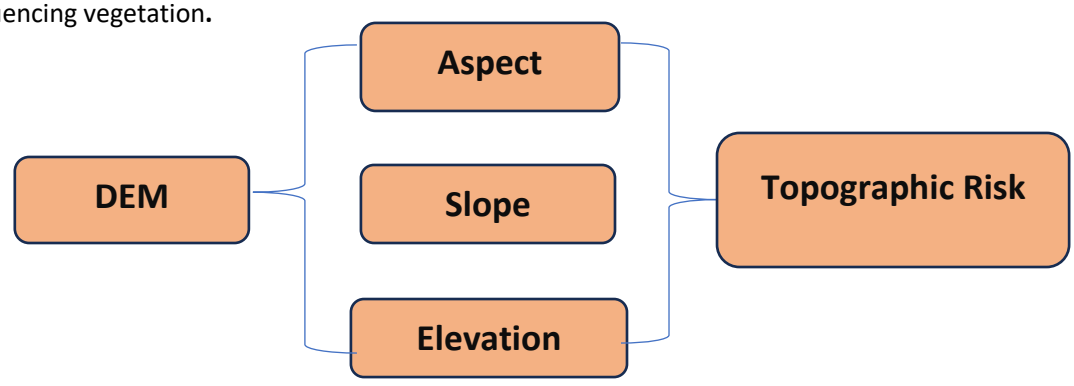
Topography determines the amount of incoming solar radiation and local wind patterns, which in turn impact fuel moisture levels. South- and west-facing slopes, which receive more sunlight, tend to be drier and hotter, influencing vegetation type, composition, and fuel load.

**3. Slope and Fire Spread**

Fires spread more rapidly and intensely on steep upward slopes due to preheating of fuel ahead of the fire front. In contrast, fire propagation is slower on flat or downward slopes.

**4. Elevation and Fire Sensitivity**

Higher elevations are generally less sensitive to fire because of reduced oxygen availability, which limits combustion. However, wind velocity tends to be higher at elevated locations, potentially accelerating fire spread and influencing vegetation.



Aspect, Slope and Elevation are independent components of topography. Risk factor for each component is calculated independently, individually, combined together using suitable algorithm to arrive topographic risk.

### i. Elevation

Elevation above sea level is a critical factor influencing fire risk. At higher elevations, fuel moisture content tends to be higher, reducing flammability and decreasing the likelihood of fire occurrence. However, the presence of flammable vegetation types, such as grass, scrub, and wattle, combined with high wind velocity at elevated locations, can still contribute to fire risk.

To assess fire risk associated with elevation, specific weightage is assigned to different elevation zones based on their influence on fire behaviour. These weightages are used to calculate the elevation risk, providing an understanding of how elevation impacts fire vulnerability.

| BURNT AREA OVER ELEVATION | | | |
|---|---|---|---|
| **Zone** | **Area (in ha)** | **Area (in sq.km)** | **Area (in %)** |
| **Below 100m** | 2837.17785 | 28.37177 | 7% |
| **100 – 500m** | 11591.23527 | 115.91235 | 30% |
| **500 – 1000m** | 8894.47662 | 88.94476 | 23% |
| **1000 – 2000m** | 6586.33465 | 65.86334 | 17% |
| **Above 2000m** | 8813.44386 | 88.13443 | 23% |

**Table 18: Percentage of Burnt Area over Elevation Zones (2024)**

### ii. Aspect

Aspect refers to the direction a slope faces concerning the Sun and plays a significant role in influencing local climate, vegetation, and fire behaviour. In the Northern Hemisphere, south-facing slopes are typically warmer than north-facing ones. This is because south-facing slopes receive more direct solar energy, with sunlight striking at a steeper angle, concentrating heat over a smaller area. Additionally, these slopes are shielded from cold northern winds, leading to drier fuels and a higher susceptibility to ignition.

During the hottest part of the day, in the afternoon, the Sun's rays are more direct on west-facing slopes, making them warmer than east-facing slopes. The variation in slope aspects significantly impacts local microclimates and vegetation types, with extended daylight hours during summer further intensifying these effects by increasing temperatures.

To evaluate fire risk associated with aspect, weightage is assigned to different slope orientations based on their exposure to solar radiation and susceptibility to drying. These weightages are used to calculate aspect risk, providing a detailed assessment of how slope orientation influences forest fire vulnerability.

### iii. Slope

The steepness of a slope significantly influences fire behaviour, with fires starting at the base of a slope often escalating into major incidents. Steeper slopes promote faster fire spread due to increased radiant and

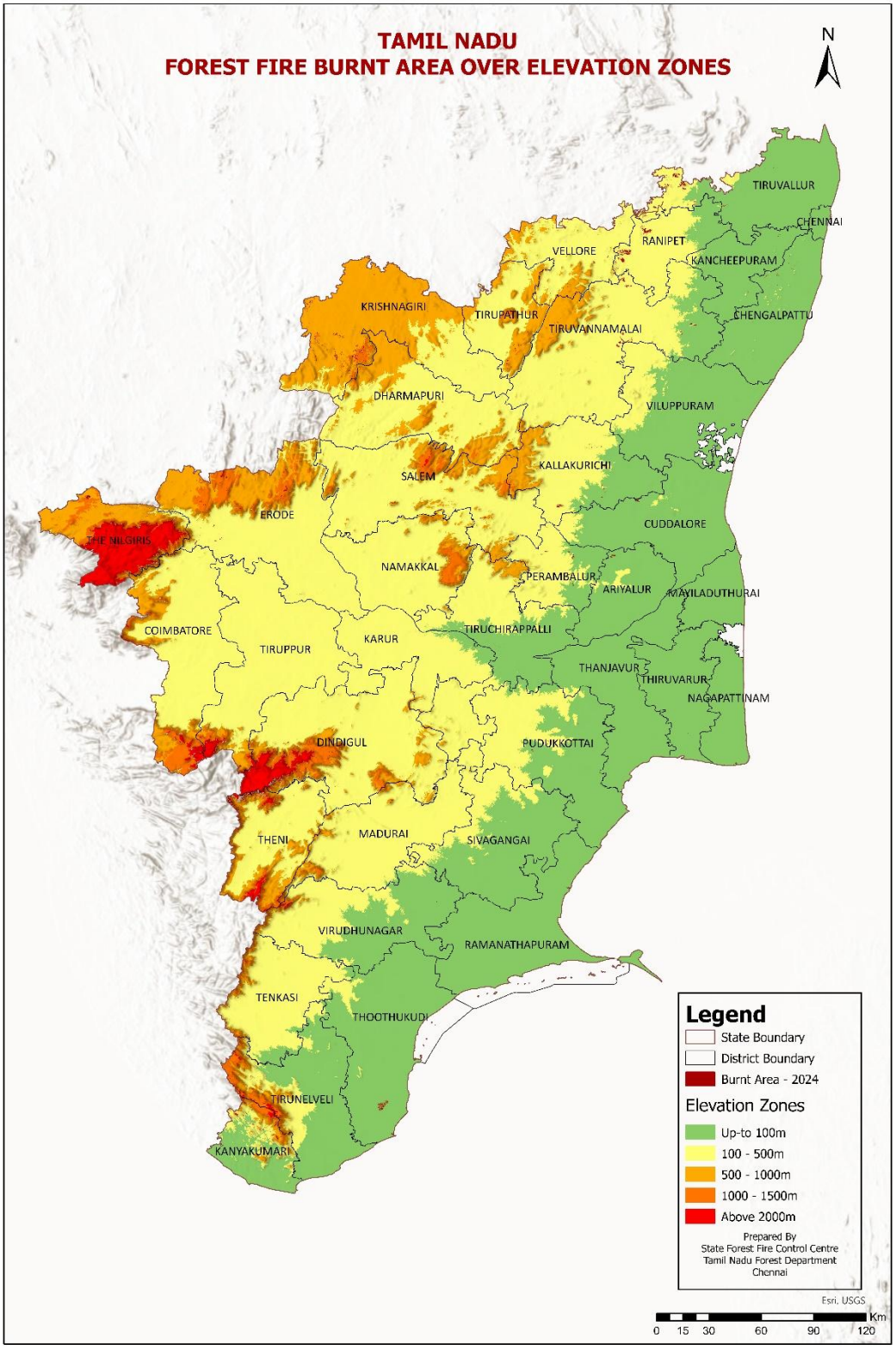



**Figure 36: Forest Fire Burnt Area over Elevation Zones**

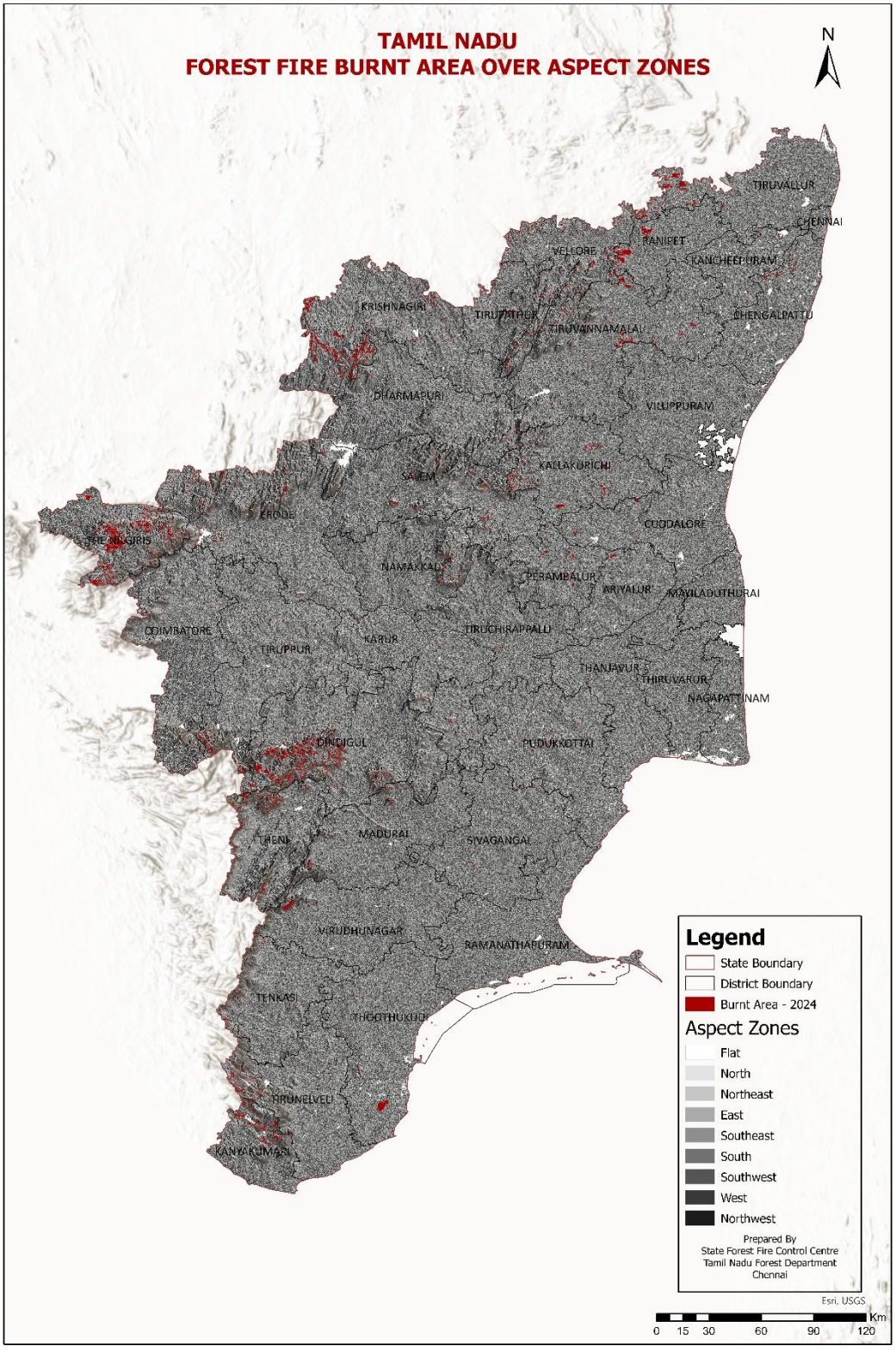



**Figure 37: Forest Fire Burnt Area over Aspect Zones**

convective heat transfer. As a result, fires on steep slopes tend to spread more rapidly upward as preheated fuels ignite more easily, aided by the upward draft of hot air.

When slopes exceed 45°, fire behaviour becomes more erratic, with burning embers and debris often moving downhill, creating unpredictable fire spread. Additionally, steep slopes are commonly dominated by flammable vegetation such as grass and scrub, which are highly susceptible to ignition.

To evaluate fire risk associated with slope, weightage is assigned to different slope zones based on their influence on fire behaviour. These weightages are then used to calculate slope risk, providing a comprehensive assessment of how slope steepness affects forest fire vulnerability.

| BURNT AREA OVER SLOPE | | | |
|---|---|---|---|
| **Zone** | **Area (in ha)** | **Area (in sq.km)** | **Area (in % of Total Burnt Area)** |
| **Above 40°** | 2132.48757 | 21.32487 | 6% |
| **30° to 40°** | 3559.08769 | 35.59087 | 9% |
| **20° to 30°** | 6709.74921 | 67.09749 | 17% |
| **10° to 20°** | 10482.53069 | 104.82530 | 27% |
| **Below 10°** | 15632.05288 | 156.32052 | 41% |

**Table 19: Percentage of Burnt Area over Slope Zones (2024)**

### iv. Topographic Risk Model

Topography does not directly influence fire ignition; it significantly affects fuel drying rates and consequently impacts fire behaviour. To assess topographic risk, the individual contributions of Aspect, Slope, and Elevation are calculated independently, with weightage assigned to each based on their influence on fire dynamics.

These three risk components are then integrated using a suitable algorithm to derive an overall topographic risk assessment, providing a comprehensive evaluation of the terrain's role in forest fire vulnerability.

## Human Influence Sub Model

Forest fires in Tamil Nadu are predominantly caused by anthropogenic activities, as forests are traversed by numerous footpaths and are often located near areas with significant human presence. Human activities are particularly concentrated around forests and along roadsides, making these areas highly susceptible to fire incidents. Roads in close proximity to reserve forests and reserved lands pose a higher fire risk due to increased vehicle and animal movement, which can lead to accidental ignitions. Similarly, the presence of settlements and villages near forests significantly elevates fire vulnerability due to various human activities in and around these areas.

To assess the impact of human influence on forest fire risk, buffer zones were created around villages and roads within reserve forests and reserved lands using ArcGIS software. Each zone was assigned a weightage based on the influence of distance on fire risk. These risks were analysed separately and independently for roads and villages. Subsequently, the road risk and village risk were integrated using a suitable algorithm to derive an overall assessment of human influence on forest fire ignition and vulnerability.

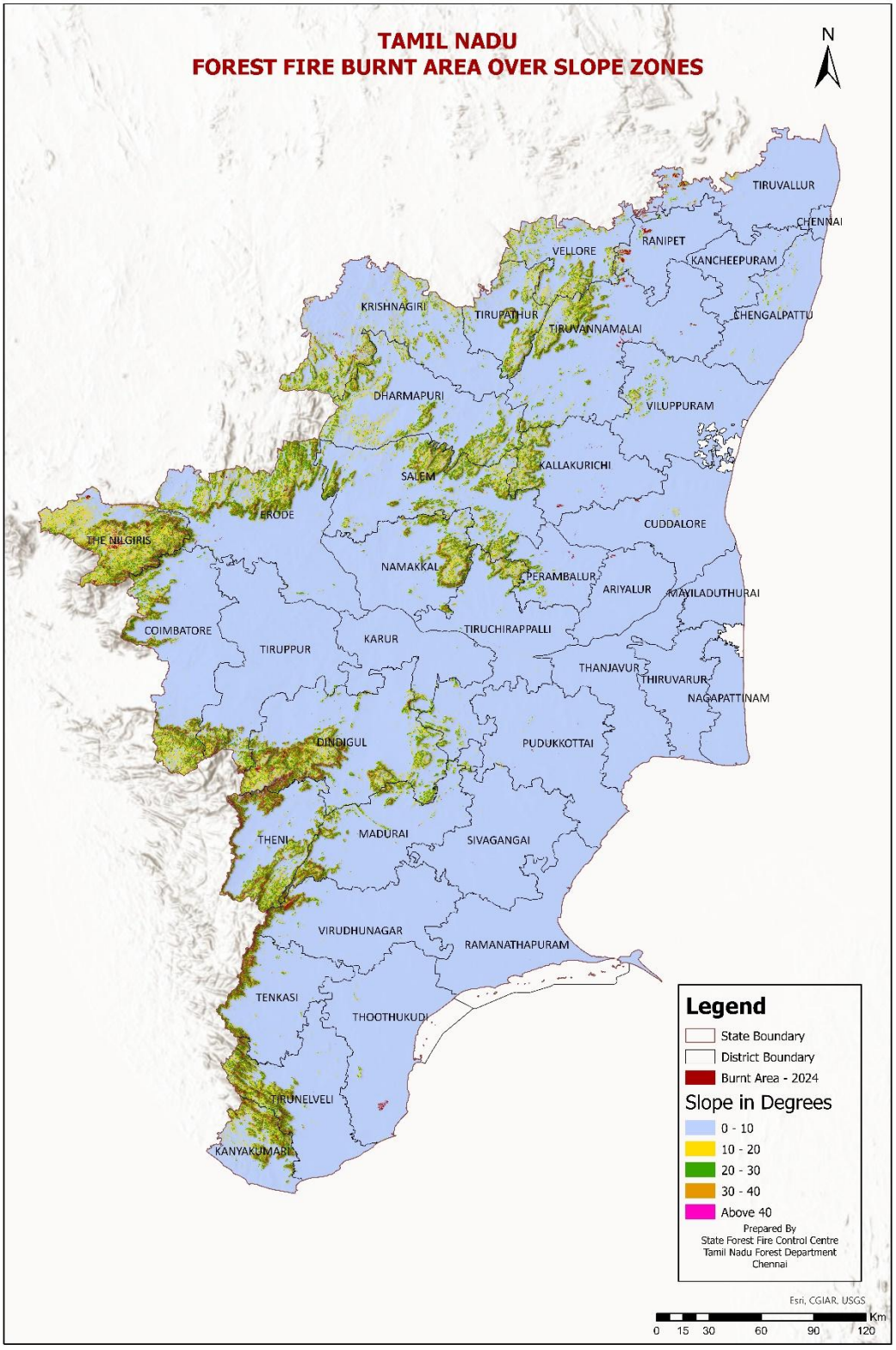
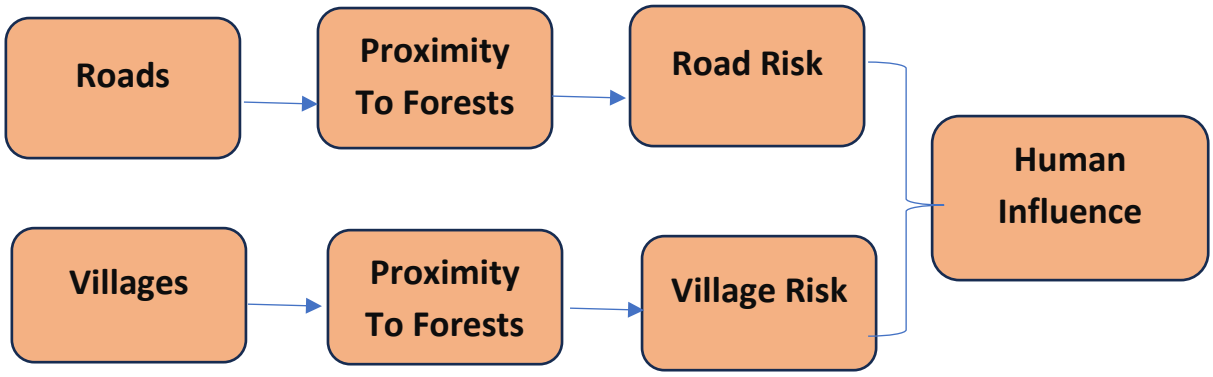



**Figure 38: Forest Fire Burnt Area over Slope Zones**




### i. Road risk and Village risk

To evaluate the impact of human activities on forest fire risk, influence zones were created around roads and villages within reserve forests and reserved lands. These zones ranged from 1 km to beyond 4 km, with the areas closest to the forest (within 1 km) exerting the greatest influence on fire ignition. This is due to higher levels of human activity which increase the likelihood of accidental ignitions.

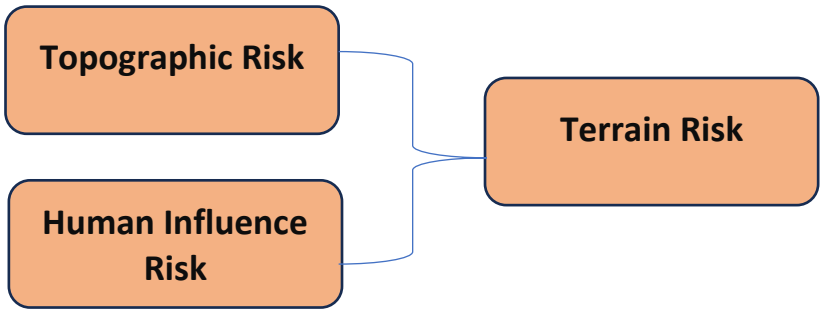
| INFLUENCE ZONES | |
|---|---|
| **Roads & Village Influence Zones** | **Class** |
| **Up-to 1 Km** | Very High |
| **1 - 2 Km** | High |
| **2 - 3 Km** | Moderate |
| **3 - 4 Km** | Low |
| **Above 4 Km** | Very Low |

**Table 20: Human Influence Zones**

### ii. Terrain Risk

The **Topographic Risk Model** and the **Human Influence Risk Model** are integrated using a suitable algorithm within a GIS platform to derive Terrain Risk Zones. This combined analysis provides a comprehensive assessment of fire vulnerability by considering both natural and anthropogenic factors that influence fire behaviour.

The Terrain Risk Zones represent spatial areas categorized by varying levels of fire risk, based on the interplay of topographic features (such as slope, aspect, and elevation) and human activities (proximity to roads, villages, and settlements). These zones highlight areas where the combined influence of terrain and human presence creates a higher likelihood of fire ignition and spread.



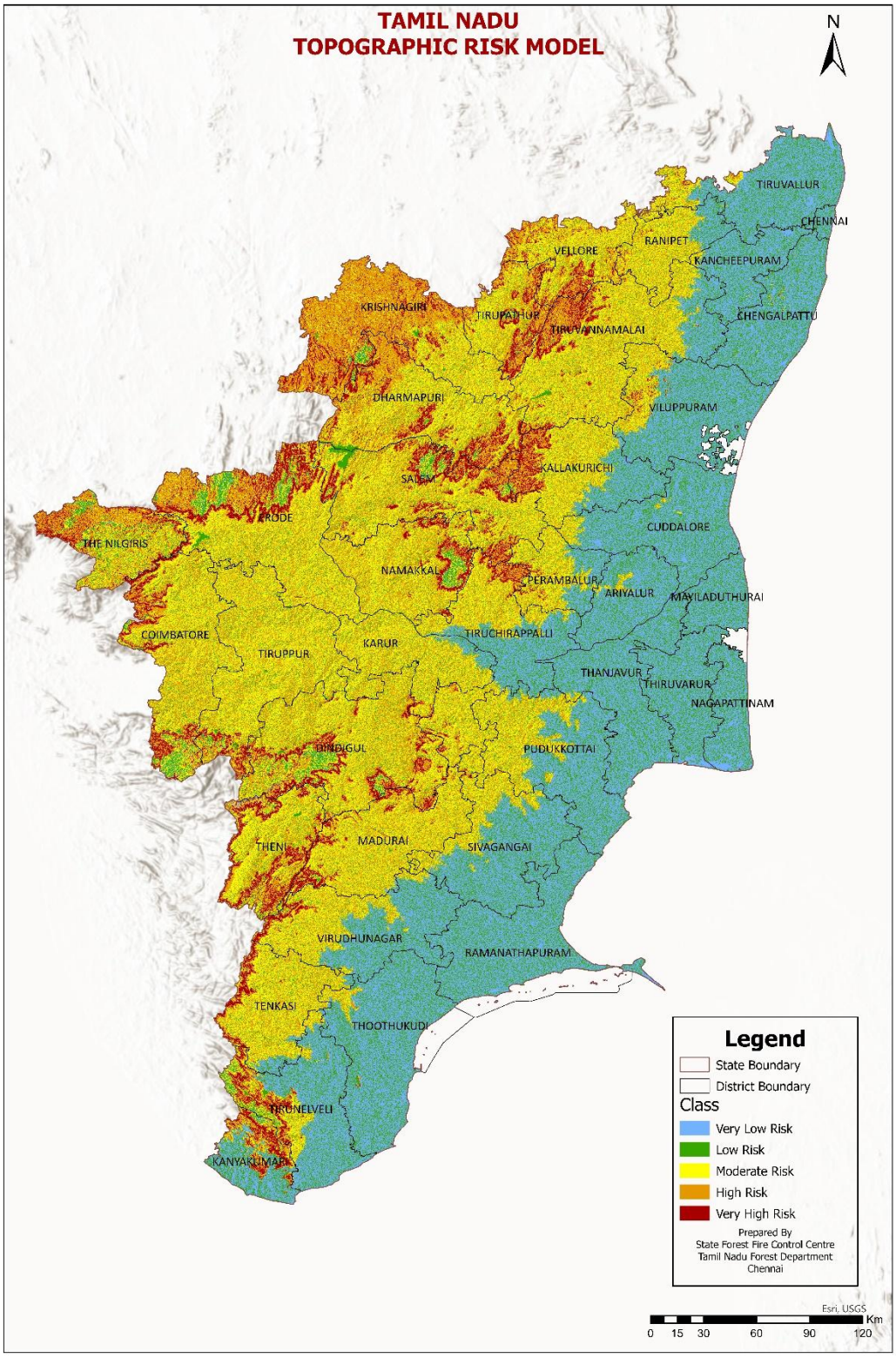



**Figure 39: Topographic Risk Model of Tamil Nadu**

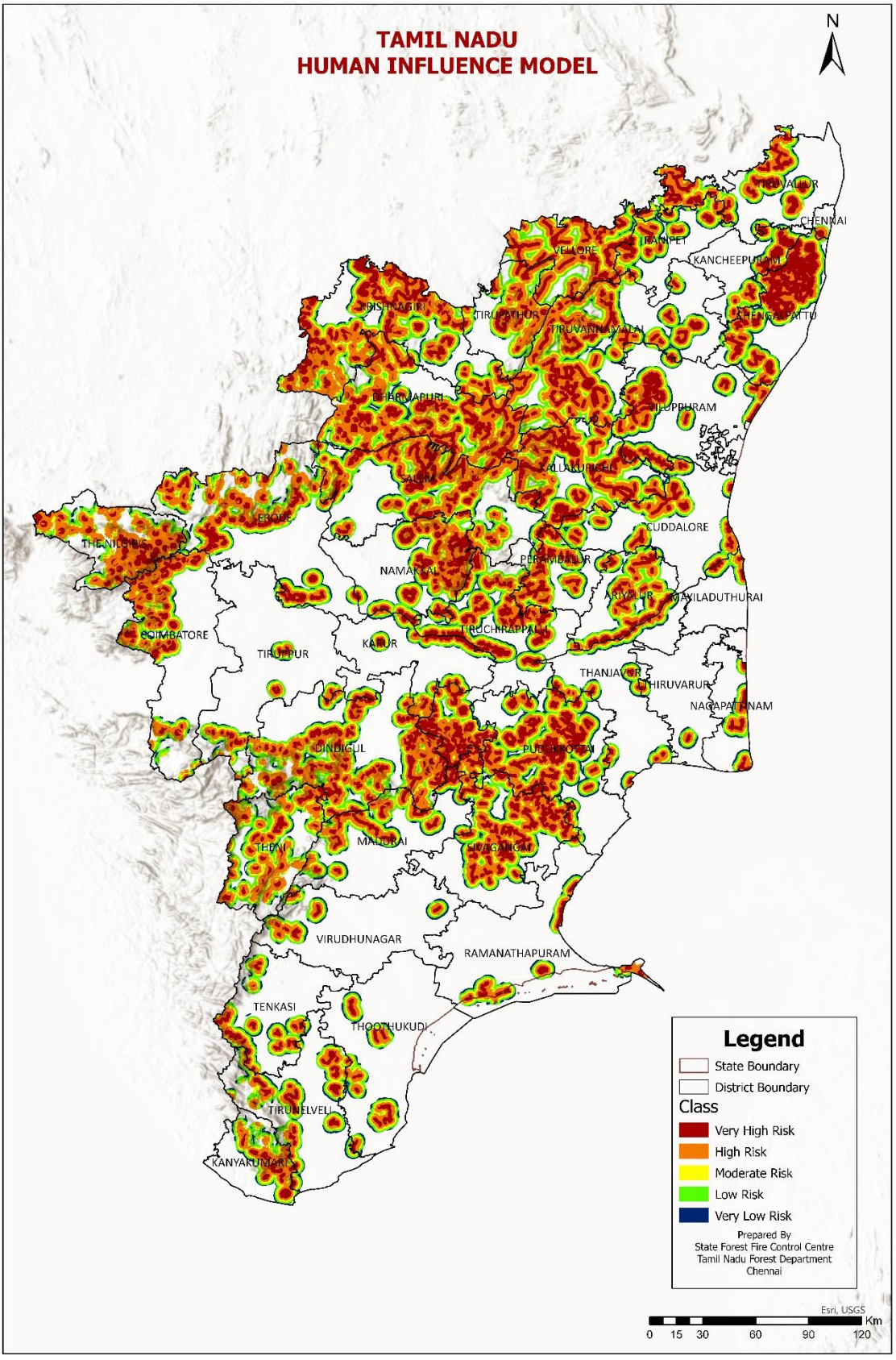



**Figure 40: Human Influence Model of Tamil Nadu**

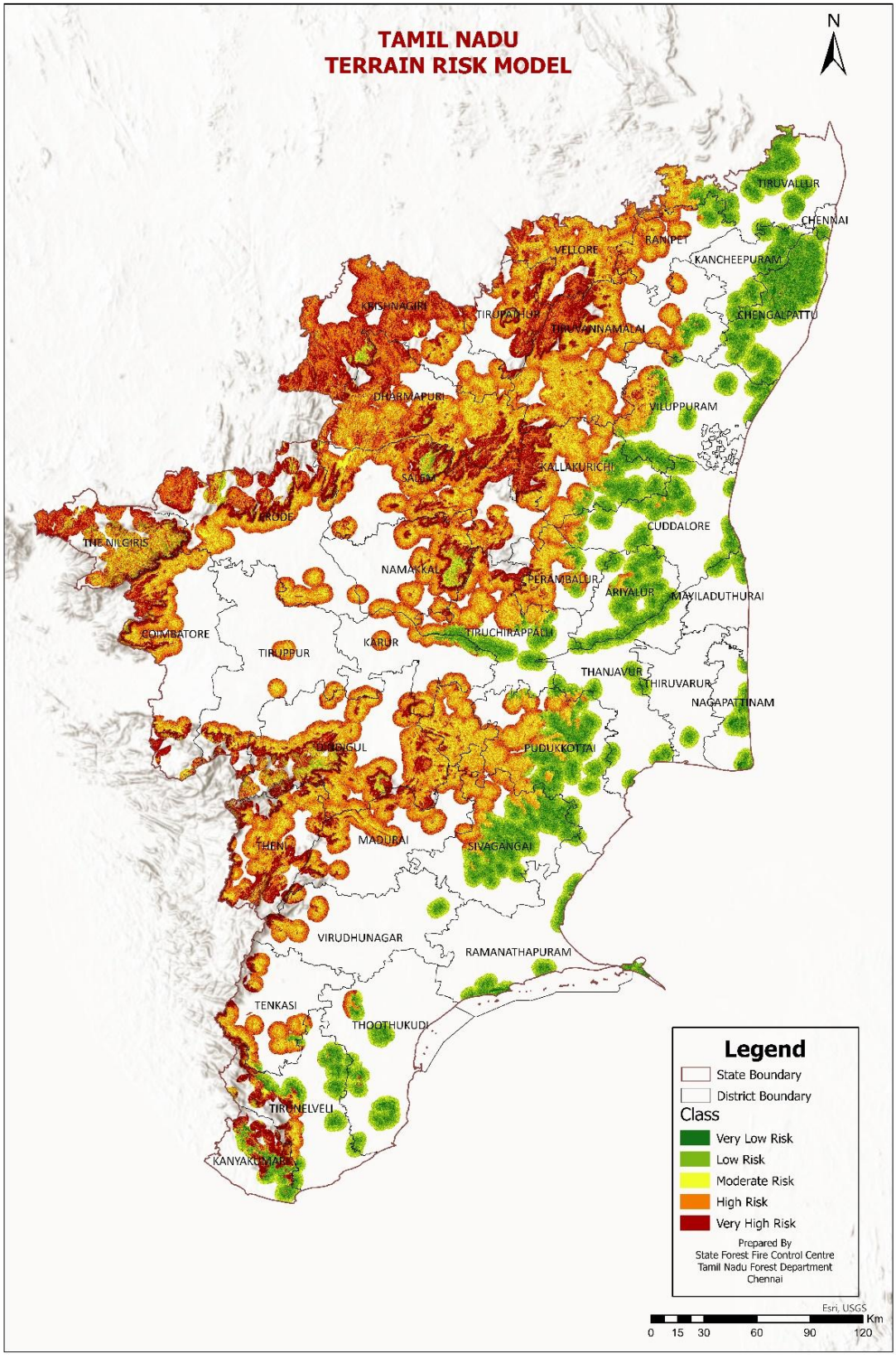



**Figure 41: Terrain Risk Model of Tamil Nadu**

### iii. Distance between Site of Occurrence and Roads/Villages

The Human Infuence of the Kurumbapatty Reserved Forest in Shervarayan south Range of Salem Forest Division was assessed using satellite imagery in ArcGIS Pro and Google Earth Pro for buffer analysis. The fire spots were located very close, at approximately **101.2 meters** from the road, and **1,482.1 meters** from the settlement of Vinnayagampatty village.

This analysis was conducted using a 2 km buffer from the roads to determine how many fire spots fell within this range and near the settlements, based on the dates provided by FSI in the respective forest divisions of Tamil Nadu in 2024. The results indicated a high possibility of forest fires originating from nearby villages which includes Kodaikanal, Nilgiris, Hosur, Vellore, Tirupattur, Tiruvannamalai and Dindigul divisions.

The analysis reveals that the Large Forest Fires in Kodaikanal and Nilgiris were predominantly caused by human activities. It is evident that the proximity of roads and villages significantly influences the occurrence of fires in these divisions.

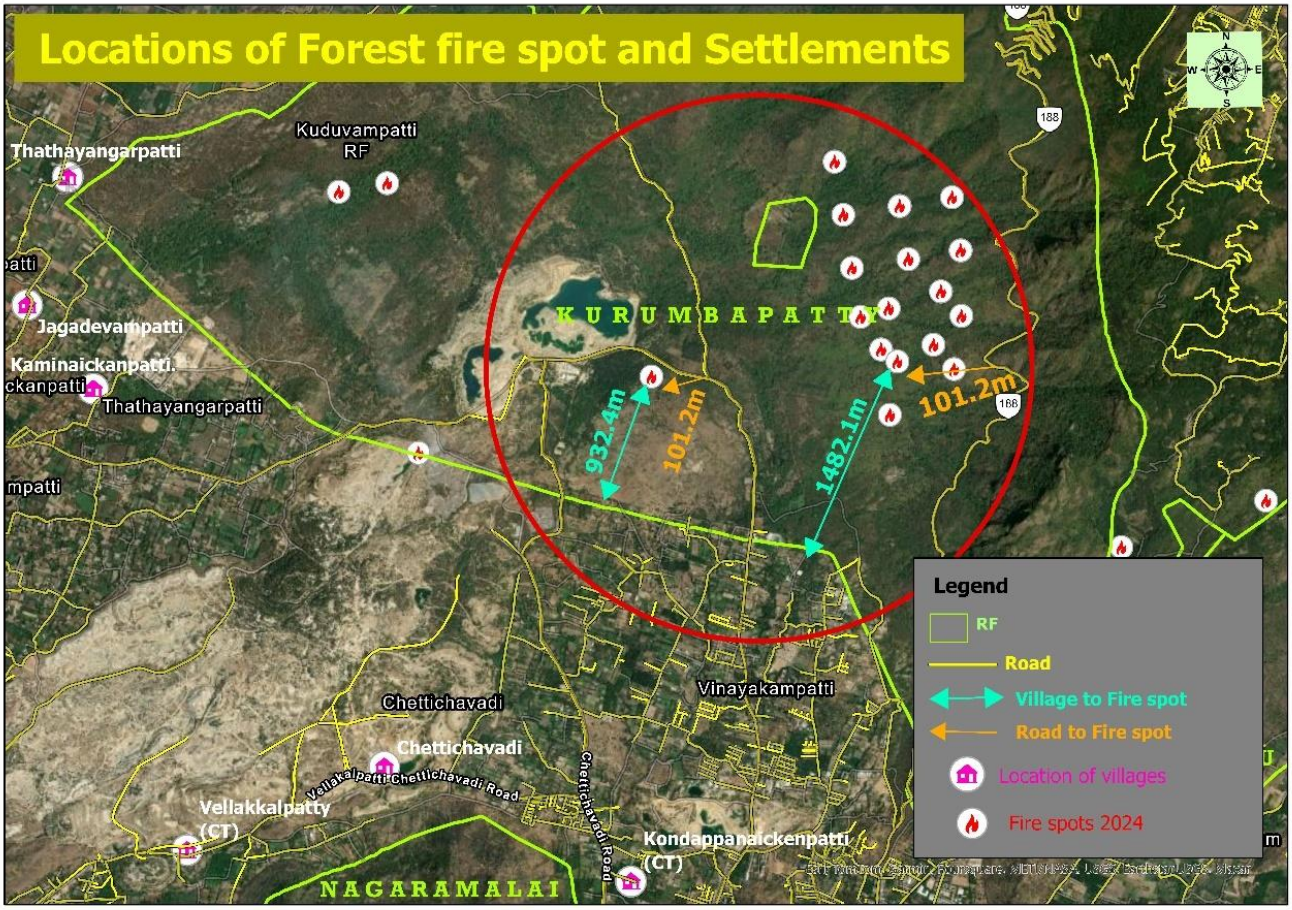



**Figure 42: Distance between Site of Occurrence and Roads/Villages in Kurumbapatty RF**

| Division | No of Fire spots with in 2km of Road (2024) |
|---|---|
| **Kodaikanal** | 746 |
| **Nilgiris** | 508 |

| | |
|---|---|
| **Hosur** | 253 |
| **Vellore** | 182 |
| **Tiruppattur** | 137 |
| **Tiruvannamalai** | 203 |
| **Dindigul** | 79 |
| **Harur** | 77 |
| **Kanyakumari** | 74 |
| **Tiruvallur** | 74 |
| **Theni** | 73 |
| **Namakkal** | 58 |
| **Salem** | 58 |
| **WL ATR Tiruppur** | 37 |
| **WL STR Sathy** | 29 |
| **WL STR Hassanur** | 25 |
| **Kallakurichi** | 24 |
| **Pudukkottai** | 15 |
| **Coimbatore** | 14 |
| **Tiruchirappalli** | 14 |
| **Attur** | 12 |
| **Cuddalore** | 12 |
| **Perambalur** | 11 |
| **Chengalpattu** | 9 |
| **WL MTR** | 7 |
| **Erode** | 6 |
| **Ariyalur** | 5 |
| **Madurai** | 5 |
| **Tirunelveli** | 5 |
| **Sivagangai** | 4 |
| **Thanjavur** | 3 |
| **Viluppuram** | 3 |
| **WL ATR Pollachi** | 3 |
| **WL KMTR** | 3 |
| **Dharmapuri** | 2 |
| **Gudalur** | 2 |
| **Thoothukudi** | 2 |
| **WL Srivilliputhur** | 2 |
| **Karur** | 1 |
| **Ramanathapuram** | 1 |
| **WL Megamalai** | 1 |
| **TOTAL** | **2779 Out of 5246** |

Table 21: Fire detections of FSI within 2km from Roads

# Fuel Risk Sub Model

## i. Categories of Forest Fuels

Fuel is any organic material that has the potential to ignite and burn. While the environment may provide the conditions conducive to the ignition of fire, ignition cannot occur in the absence of ignition sources and flammable material, known as fuel. The process of fire ignition is heavily influenced by the flammability of fuels. Forest fuels can be categorized into three main groups based on their location and characteristics:

**1. Aerial Fuels**

Aerial fuels consist of green and dead materials found in the upper forest canopy, including tree branches and crowns, snags, moss, and tall shrubs. These fuels are typically positioned above the ground and are susceptible to fire once ignited, especially in dry conditions.

**2. Surface Fuels**

Surface fuels include all flammable materials lying on the ground such as needles, leaves, duff, grass, small dead wood, downed logs, stumps, large limbs, low shrubs, and regenerating vegetation. These fuels are typically less compact than ground fuels and are often found in the first six feet of vegetation. Surface fuels are particularly conducive to faster rates of fire spread due to their less compact nature.

**3. Ground Fuels**

Ground fuels refer to combustible materials beneath the surface, including deep duff, roots, rotten or buried logs, and other woody fuels. These fuels are densely packed, resulting in slow-burning or smouldering fires that may persist for extended periods.

## ii. Characteristics of Fuel Affecting Fire Behaviour

The behaviour of fire is influenced by several characteristics of the fuel, including the following:

**1. Loading**

Fuel loading refers to the oven-dry weight of fuels in a given area, usually expressed in tons per hectare (tons/ha). It is a key factor in determining the potential for fire spread and intensity.

**2. Size and Shape**

Smaller fuels ignite and sustain combustion more easily than larger fuels, requiring less heat to remove moisture and reach ignition temperature. Smaller fuels also contribute to short-range spotting, where embers can cause fire spread. The shape of fuels also plays a role in fire behaviour, particularly in the case of rolling firebrands that may travel down slopes and ignite additional fires.

**3. Compactness**

Compactness is defined as the spacing between fuel particles. The physical arrangement of fuel particles affects both ignition and combustion rates. Fires tend to spread more slowly in tightly packed fuels compared to loosely arranged fuels, which allow for faster combustion.

**4. Horizontal Alignment**

The horizontal arrangement refers to the distribution of fuels across the landscape. Fuels such as timber litter

and logging slash fall into this category. The continuity of these horizontal fuels influences the speed and direction of fire spread. Discontinuous or patchy fuel arrangements can hinder the fire's ability to travel, making the fire less predictable.

**5. Vertical Alignment**

Vertical arrangement refers to the relative height of fuels above the ground and their vertical continuity. When fuels form a continuous vertical arrangement, they create a "fuel ladder," which allows fire to move from the ground to the upper canopy. Vertical continuity enhances the potential for a fire to spread into the forest canopy.

**6. Chemical Content**

The chemical and mineral composition of fuels can either enhance or inhibit combustion. Volatile substances, such as oils, resins, wax, and pitch, can contribute to rapid fire spread and higher intensity. Conversely, certain minerals present in the fuels can reduce fire spread and intensity.

**7. Moisture Content**

Moisture content is the percentage of water in a fuel, expressed as a percentage of the oven-dry weight of that fuel. The moisture content significantly impacts the fuel's ability to ignite and sustain combustion. Dry fuels are more easily ignited and tend to burn more intensely than moist fuels.

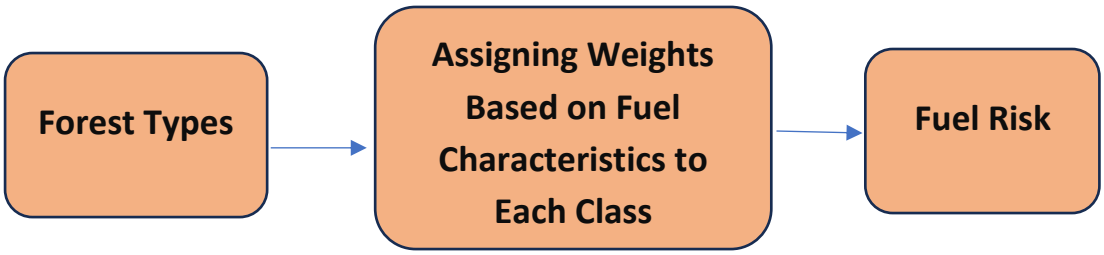
### iii. Assessment of Fire Risk Based on Fuel Characteristics

The combination of factors such as fuel load, vegetation susceptibility, moisture levels, and dryness contributes to the overall fire risk in a forested area. A Forest Type Map is used to assess fire-sensitive zones based on dry matter availability and the ability of plants to retain or lose moisture due to radiation, convection, and conduction.

### iv. Fuel Risk Model

In order to evaluate fire risk, weightage is assigned to each of 39 forest subtypes based on their fuel load, vegetation type, moisture content, and susceptibility to fire. The risk assessment takes into account the potential for fire spread and intensity based on the availability of dry matter in these areas.

Water Bodies and Barren/Rocky Areas are assigned a value of "Nil" as these areas do not contribute to fire risk due to the lack of flammable fuel.




By considering the characteristics and distribution of fuels across the landscape, the Forest Type Map helps to identify areas of higher and lower fire risk, enabling more effective fire management and prevention strategies.

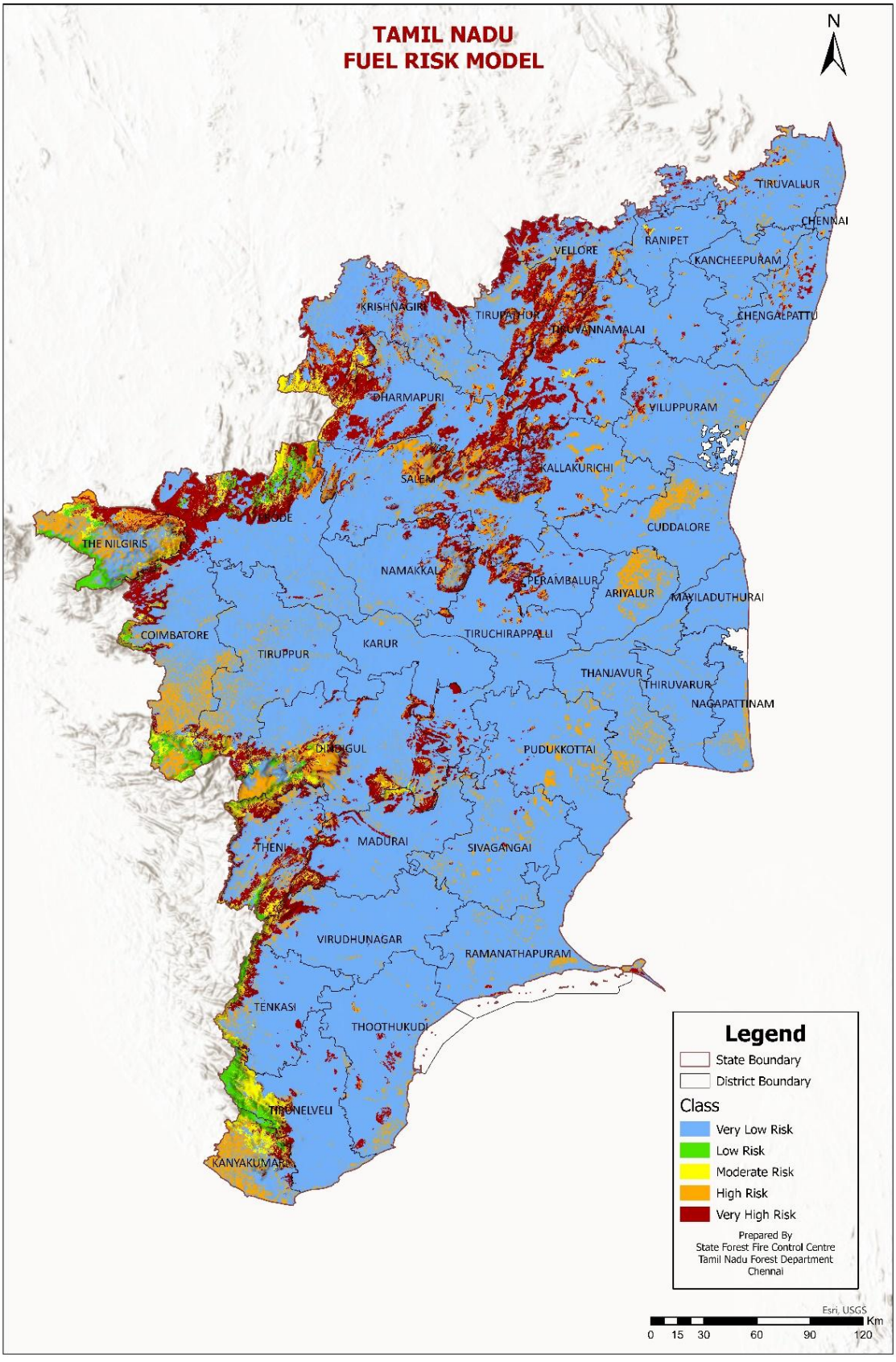



**Figure 43: Fuel Risk Model of Tamil Nadu**

# Forest Fire Vulnerability

Forest fire vulnerability mapping is a critical tool for assessing the potential risk and impact of wildfires across forested landscapes. By combining various factors that influence fire behaviour and risk, such as terrain, fuel characteristics, and other environmental variables, this mapping provides a clear visualization of areas most susceptible to wildfires.

**1. Integration of Developed Sub-Models**

The Forest Fire Vulnerability Map is derived by integrating developed sub-models, where each sub-model assesses different aspects that contribute to fire risk. By combining these models, fire vulnerability is assessed holistically, considering both the physical landscape and the combustible materials present.

**2. Classification**

Once the terrain and fuel risk data are integrated, the final fire vulnerability map is classified into five levels of vulnerability:

- Very Low
- Low
- Moderate
- High
- Very High

This classification helps prioritize fire prevention and mitigation efforts, focusing resources on the highest-risk areas.

**3. Application**

The Forest Fire Vulnerability Map is an essential tool for:

- Fire Management and Prevention: Helps in allocating resources more effectively by identifying high-risk areas that require more intensive monitoring and management efforts.
- Fire Risk Communication: Provides a clear and easily understandable visual representation of fire risks to policymakers, the public, and local authorities.
- Resource Allocation: Assists in determining where firefighting resources, such as personnel and equipment, should be stationed or moved to during fire seasons.
- Strategic Planning: Facilitates long-term forest management planning by identifying areas that may require fuel management, controlled burns, or other mitigation strategies.

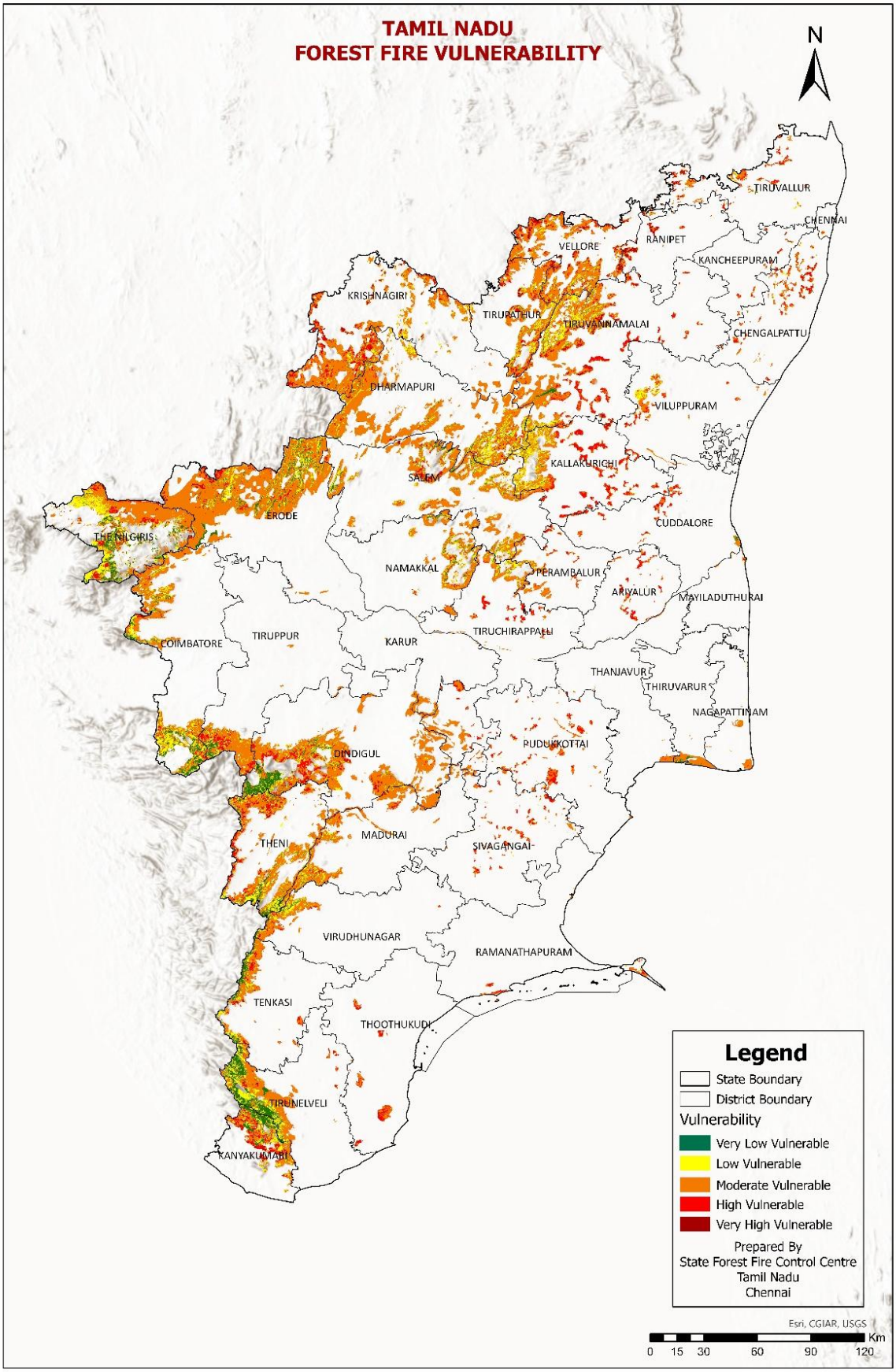



**Figure 44: Forest Fire Vulnerability of Tamil Nadu**

# Forest Fire Sensitivity

Fire sensitivity refers to how easily an ecosystem or vegetation type reacts to fire, including its ignition threshold and its response to exposure. This concept plays a vital role in understanding fire behaviour, predicting fire risk, and guiding forest management strategies. Fire-sensitive areas are those that are more likely to ignite and sustain fire, either due to their vegetation composition, moisture content, or overall susceptibility to environmental factors such as temperature and wind.

**Fire Sensitivity Mapping**

To assess fire sensitivity in Tamil Nadu, a detailed analysis was conducted using the total number of fire incidents that occurred over the period from 2016 to 2024. This analysis was integrated with administrative boundaries and forest types to generate a comprehensive fire sensitivity map for the state.

The following steps were involved in creating the fire sensitivity:

**1. Incident Data Analysis**

The total number of fire incidents recorded from 2016 to 2024 were analysed to identify areas with frequent fire occurrences by overlaying the incidents on the administrative layer of Tamil Nadu.

**2. Classification of Incident Data**

The number of fire incidents was categorized into equal intervals, allowing the identification of regions with varying degrees of fire frequency. Areas with a higher number of incidents were considered more sensitive to fire, as they experience more frequent ignitions and fire spread. The classification helped to create different levels of fire sensitivity, such as high, moderate, and low sensitivity zones.

**3. Incorporating Forest Type**

Along with the fire incident data, forest type was also taken into account to derive the fire sensitivity of different regions as different forest types have varying degrees of fire sensitivity.

The forest fire sensitivity was analysed Division, Range, Beat and RF wise were attached on the annexure Table:1.2, 1.3, 1.4, 1.5 respectively.

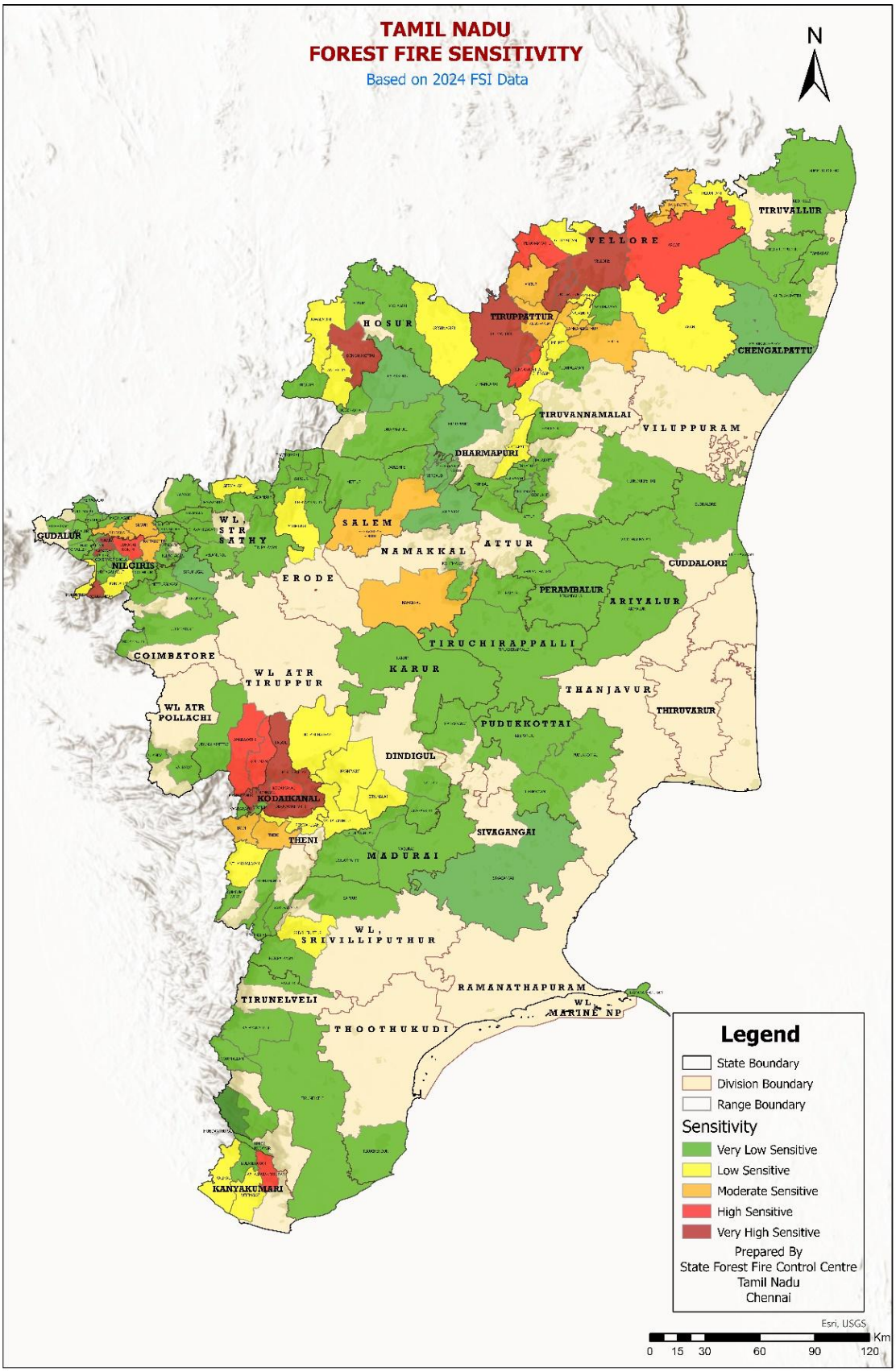



**Figure 45: Forest Fire Sensitivity of Tamil Nadu**

## Forest Fire Burnt Area Severity

Forest Fire Burnt Area Severity is a key metric for understanding the impact of forest fires on ecosystems and landscapes. Using advanced remote sensing techniques, burnt area severity is commonly assessed through indices such as the delta Normalized Burn Ratio (d-NBR) and the Relativized Burn Ratio (RBR). These indices measure the difference in vegetation reflectance pre- and post-fire, which correlates with fire damage.

For Tamil Nadu in 2024, this assessment leveraged Google Earth Engine (GEE), an efficient platform for analysing large-scale geospatial data. The d-NBR is calculated by comparing pre-fire and post-fire imagery to highlight the extent and intensity of vegetation change. RBR further refines these results by normalizing the d-NBR values against pre-fire vegetation conditions, improving accuracy in areas with sparse vegetation. These indices were classified into severity levels based on standardized thresholds proposed by the USGS, enabling detailed mapping of fire impacts.

The workflow in GEE included:

1. Selection of cloud-free Landsat imagery for pre-fire and post-fire dates.
2. Calculation of d-NBR and RBR metrics for the Tamil Nadu region.
3. Thresholding to classify burn severity into categories, such as low, moderate, and high severity.
4. Integration with GIS tools to mask fire severity layers specifically within reserve forest boundaries.

This methodology has been validated in similar studies globally, where fire severity maps showed high accuracy when compared to field data, indicating the reliability of satellite-derived indices for monitoring impacts of fires.

| Aspect | Vulnerability | Sensitivity | Severity |
|---|---|---|---|
| **Definition** | Likelihood of fire occurrence | Ease of ignition and response to fire | Impact and damage caused by fire |
| **Stage** | Pre-fire | Pre-fire and during fire | Post-fire |
| **Focus** | Risk assessment and prediction | Fire behaviour and ignition likelihood | Intensity and ecological consequences |
| **Application** | Risk mitigation and preventive measures | Fire danger ratings and management | Post-fire recovery and impact studies |

**Table 22:Difference between Forest Fire Vulnerability, Sensitivity and Severity**

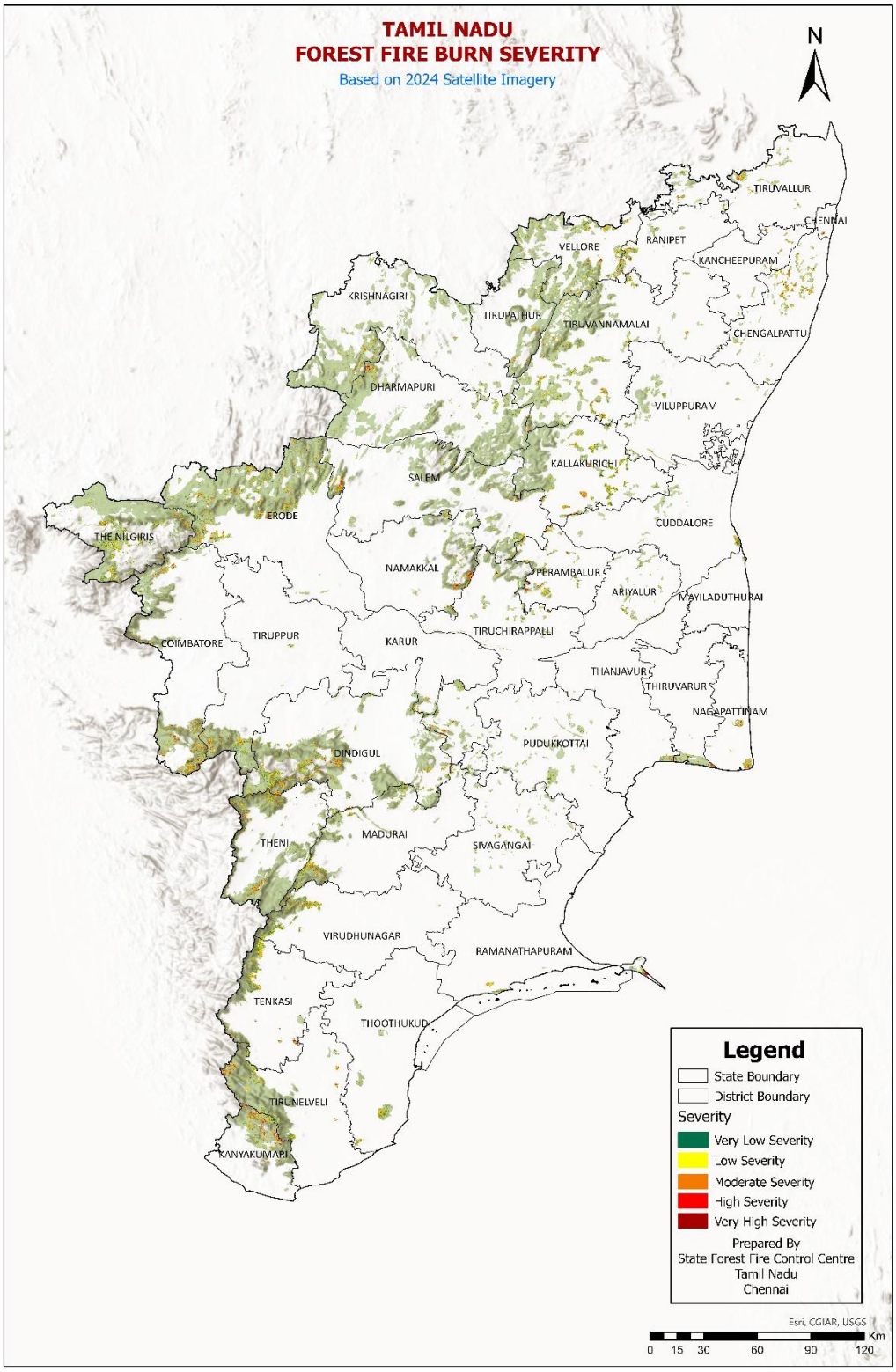
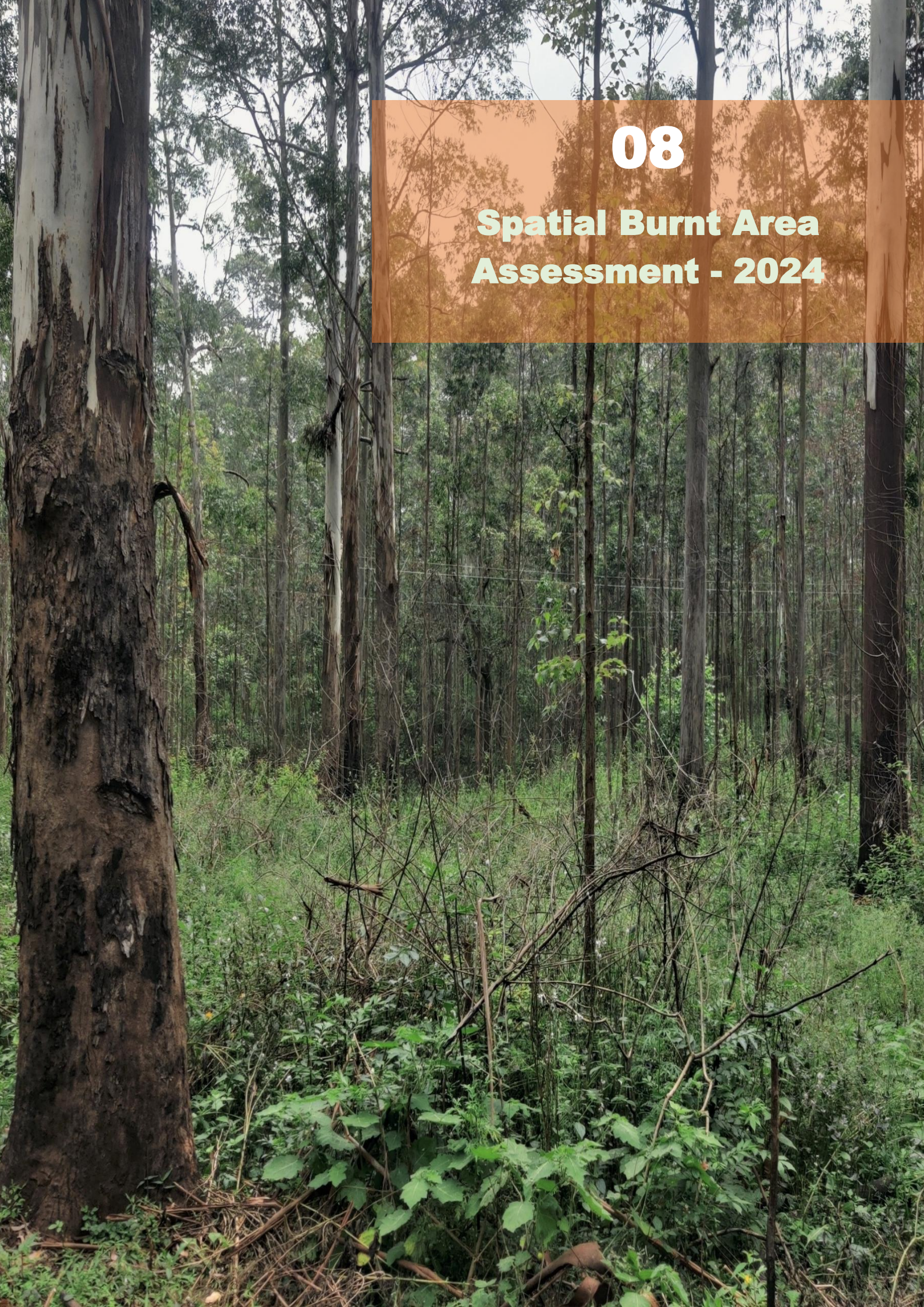



**Figure 46: Forest Fire Burn Severity of Tamil Nadu**



# 08

# Spatial Burnt Area Assessment - 2024

# Chapter 8: Spatial Burnt Area Assessment – 2024

## Overview

GIS (Geographic Information Systems) and Remote Sensing data are powerful tools for monitoring, analysing, and managing forest fires and assessing burnt areas. These technologies enable efficient data collection, analysis, and visualization to aid in decision-making and resource management. Remote sensing provides real-time and periodic data using satellites like Landsat-8, Sentinel-2, and MODIS. These systems detect active fires and monitor fire progression. Sensors like MODIS and VIIRS detect hotspots, even in remote areas, using thermal bands. These are derived from satellite data to notify authorities about active fire incidents in near real-time FSI Forest survey of India.

Spatial burnt area analysis recommends using NIR (Near-Infrared) and SWIR (Short-Wave Infrared) bands in satellite data to differentiate burnt areas from unburnt vegetation. Calculating indices such as the Normalized Burn Ratio (NBR) and differencing pre-fire and post-fire NBR values (ΔNBR) is effective in quantifying burnt regions. Temporal analysis (change detection) using pre-fire, during-fire, and post-fire images highlights areas affected by fires. Integrating spatial layers, such as administrative boundaries, forest divisions, ranges, beats, and reserved forest boundaries from GIS databases, ensures accurate assessment (ground truthing) and mapping of fire incidents within the jurisdictional limits of Tamil Nadu forest department.

Mapping burnt areas and ground truthing aid in planning afforestation and restoration activities. Furthermore, long-term monitoring using remote sensing helps track ecosystem recovery, supporting restoration and post-fire recovery efforts.

## Materials /Dataset used

Open-source Landsat-8 OLI (Operational Land Imager) provides 15-meter panchromatic and 30-meter multi-spectral spatial resolutions, covering a 185 km (115 mi) swath. Imagery can be accessed from the USGS Earth Explorer portal (earthexplorer.usgs.gov). For this analysis, cloud-free satellite imagery from January 1 to May 31, 2024, was utilized.

For Burnt Area assessments using Landsat-8 OLI, the following bands are highly recommended: Band 2 (Blue), Band 3 (Green), Band 4 (Red), Band 5 (NIR), and Band 7 (SWIR). The relevant path and row combinations for area coverage include 142/051, 142/052, 142/053, 143/051, 143/052, 143/053, 143/054, 144/051, 144/052, and 144/053.

Additionally, Sentinel-2A imagery, with a 10-meter spatial resolution and up to 10% cloud-free coverage, was used for analysing temporal changes during pre-fire, active fire, and post-fire periods. This multi-spectral satellite imagery is highly recommended for such analyses. The composite bands used include Band 2 (Blue), Band 3 (Green), Band 4 (Red), Band 8 (NIR), and Band 12 (SWIR). These bands are particularly effective for spatial forest

fire assessments and burn area mapping for 2024. Spatial data, including administrative boundaries, Forest Divisions, Forest Ranges, Beats, and Reserved Forest boundaries, is sourced from the Geomatics Centre of the Tamil Nadu Forest Department.

| Band | Resolution | Wavelength (µm) | Description |
|---|---|---|---|
| **B1** | 30 m | 0.433 to 0.453 | Coastal / Aerosol |
| **B2** | 30 m | 0.450 to 0.515 | Visible blue |
| **B3** | 30 m | 0.525 to 0.600 | Visible green |
| **B4** | 30 m | 0.630 to 0.680 | Visible red |
| **B5** | 30 m | 0.845 to 0.885 | Near-infrared |
| **B6** | 30 m | 1.56 to 1.66 | Short wavelength infrared |
| **B7** | 30 m | 2.10 to 2.30 | Short wavelength infrared |
| **B8** | 15 m | 0.50 to 0.68 | Panchromatic |
| **B9** | 30 m | 1.36 to 1.39 | Cirrus |
| **B10** | 100 m | 10.3 to 11.3 | Long wavelength infrared |
| **B11** | 100 m | 11.5 to 12.5 | Long wavelength infrared |

**Table 23: Bands of Landsat-8**

| Sentinel-2 Bands | Central Wavelength (µm) | Resolution (m) |
|---|---|---|
| **Band 1 - Coastal aerosol** | 0.443 | 60 |
| **Band 2 - Blue** | 0.49 | 10 |
| **Band 3 - Green** | 0.56 | 10 |
| **Band 4 - Red** | 0.665 | 10 |
| **Band 5 - Vegetation Red Edge** | 0.705 | 20 |
| **Band 6 - Vegetation Red Edge** | 0.74 | 20 |
| **Band 7 - Vegetation Red Edge** | 0.783 | 20 |
| **Band 8 - NIR** | 0.842 | 10 |
| **Band 8A - Vegetation Red Edge** | 0.865 | 20 |
| **Band 9 - Water vapour** | 0.945 | 60 |
| **Band 10 - SWIR - Cirrus** | 1.375 | 60 |
| **Band 11 - SWIR** | 1.61 | 20 |
| **Band 12 - SWIR** | 2.19 | 20 |

**Table 24: Bands of Sentinel-2**

## Software

- ArcGIS Enterprise platform and ArcGIS Pro
- Google Earth engine
- Microsoft
- Basecamp

## Hardware

- Workstation: Hp Intel core i7
- Garmin GPS 72 Ha

# Methodology

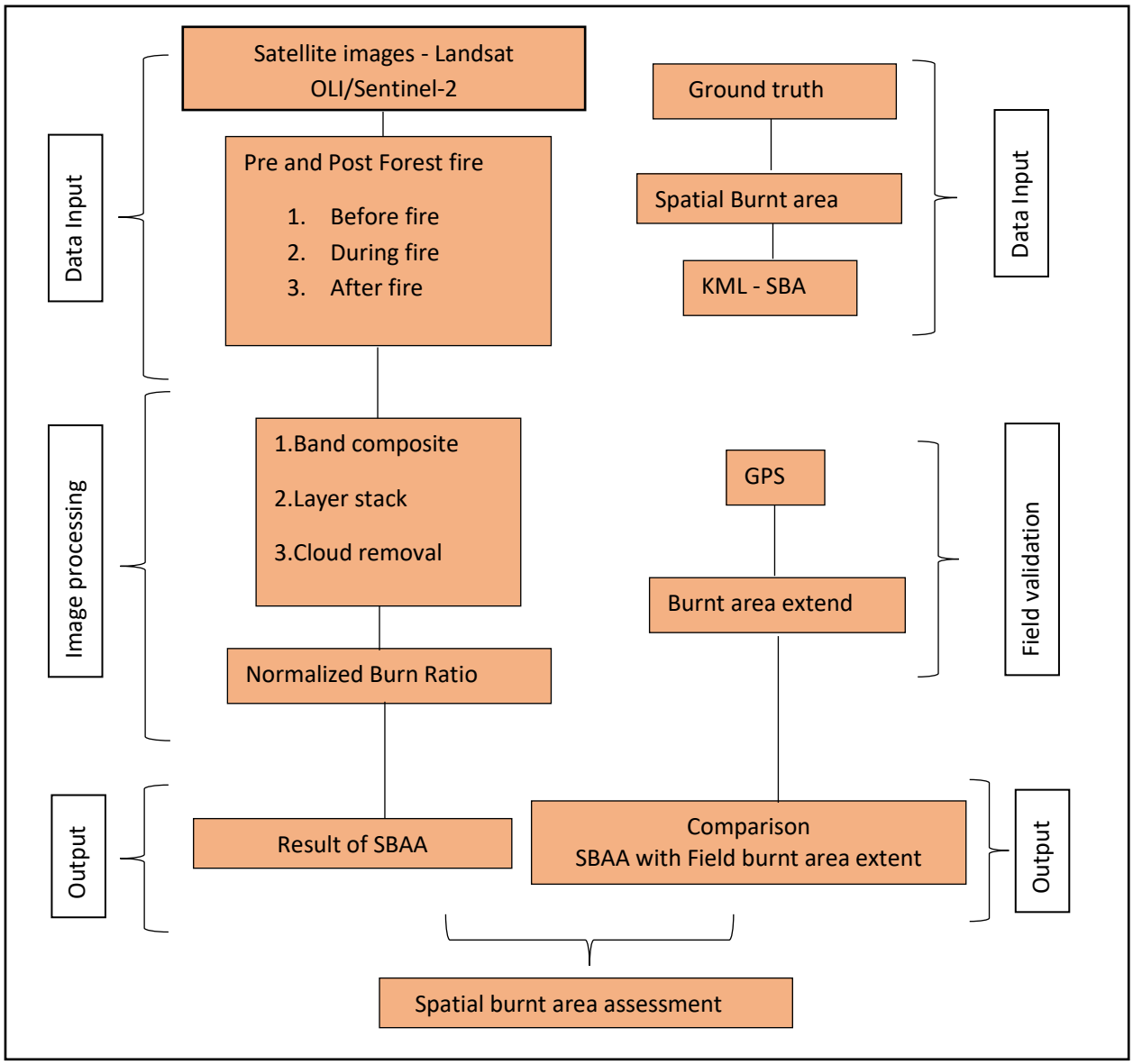



**Figure 47: Methodology of Burnt Area Assessment**

# Data Analysis

Landsat 8 OLI imagery was utilized to assess the spatial extent of burned areas in the forested regions of Tamil Nadu. A severe forest fire occurred in March 2024. Pre-fire imagery was collected starting from January 1, 2024, while post-fire imagery was acquired between May 15 and May 31, 2024.Landsat imagery has desirable temporal, spatial and spectral characteristics, so it is highly preferred for burnt area mapping (Hudak et al.2002). Satellite images used were acquired by Landsat OLI sensors and geometrically rectified using terrain correction algorithms.

The Normalized Burn Ratio (NBR), derived from Landsat NIR and SWIR bands, has received significant attention in recent years for its effectiveness in mapping burned areas (Miller & Yool, 2002; Brewer et al., 2005; Epting et al., 2005; Key & Benson, 2005).

**NBR = NIR-SWIR/NIR+SWIR**

Landsat OLI Band-5 (NIR) and Band-7 (SWIR) were utilized to calculate the Normalized Burn Ratio (NBR). NBR is particularly sensitive to the significant reduction in near-infrared reflectance (NIR) caused by plant canopy damage and fire-induced consumption (Chuvieco et al., 2006), as well as the notable increase in shortwave infrared reflectance (SWIR) (White et al., 1996).

Advance geo technical software ArcGIS Pro highly recommended for the burnt area assessment with supportive tools of NBR and BAI based on the band NIR and SWIR algorithm calculation deriving burnt area based on the colour tone and it generates the signature for same colour in entire images. Supervise technique is another one method to analysis for same signature will generate our own interpretation knowledge to find out the colour tone for the burn area.

This NBR techniques generated to burnt area assessments with FSI fire alert (Latitude and longitude) overlaid with the satellite imagery for indicate the signature to accurate spots for the fire burnt area. Normalized Burn Ratio (NBR) and Burned Area Index (BAI), which are based on the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) band algorithms. These tools analysis satellite imagery to detect burnt areas by identifying specific colour tones associated with burnt regions. The software generates signatures for these colour tones and applies them across the entire image, enabling precise identification of burnt areas.

Another effective method for burnt area analysis is the supervised classification technique. This approach involves generating signatures using user-defined interpretation, where an analyst identifies burnt area colour tones based on their expertise and creates a custom classification model. This allows for a more tailored and accurate analysis, particularly in complex landscapes.

The NBR technique, combined with Forest Survey of India (FSI) fire alerts that provide latitude and longitude coordinates, enhances the accuracy of burnt area assessments. By overlaying FSI fire alert data with satellite imagery, the exact locations of fire-affected areas can be pinpointed. This integrated approach ensures precise mapping of fire-burnt areas, enabling effective monitoring and management of forest fires.

Next, apply the Reclassify tool to categorize the BAI values, distinguishing burnt areas from non-burnt areas based on a defined threshold. After reclassification, convert the raster into vector format using the Raster to Polygon tool to generate a shapefile, ensuring polygons represent burnt regions. Optionally, overlay the resultant shapefile with fire alert data, such as Forest Survey of India (FSI) fire alerts, to validate and enhance accuracy. Finally, save and export the shapefile with appropriate metadata and proper project coordinate system of WGS 1984 North 44 zone for further analysis or reporting.

Change detection of forest fire burnt area assessment using ArcGIS Pro involves comparing satellite imagery from pre-fire and post-fire periods to identify and quantify the extent of the burnt area. Start by loading the imagery from both timeframes into the software and ensuring consistent spatial resolution and projection. Subtract the pre-fire index raster from the post-fire index raster to create a difference map that highlights changes in vegetation and burnt regions. Reclassify the difference map to define thresholds for burnt, unburnt, and regrowth areas. So different time serious of Satellite images contribute to the Temporal changes of the burnt area assessment.

GPS (Global Positioning System) and DGPS (Differential GPS) are essential tools for accurately assessing burnt areas in forest fire. GPS provides location data by capturing satellite signals, enabling the mapping of fire-affected regions with reasonable accuracy of below 3 meters for handheld GPS and 1mm for DGPS. In burnt area assessment, GPS and DGPS are used to ground-truth satellite imagery by recording coordinates of specific fire-affected sites. These tools help in verifying burnt area extent, capturing field data, and integrating it with spatial data in GIS platforms of ArcGIS Pro. Additionally, GPS-enabled devices streamline the process of collecting spatial data during on-site surveys, allowing for real-time mapping and integration with fire alert systems for better planning and response.

ArcGIS Pro is a powerful geospatial tool widely used for burnt area assessment. Its advanced functionalities allow users to process and analysis satellite imagery effectively to detect, map, and quantify burnt areas. And supports change detection workflows, enabling the comparison of pre-fire and post-fire satellite images to assess the extent and severity of damage. Additionally, tools like Raster Calculator and Reclassify allow for classification and extraction of burnt area data, which can be converted into shapefiles for further spatial analysis.

The software's capability to overlay auxiliary datasets, Forest Survey of India (FSI) fire alerts and GPS/DGPS ground-truthing data, enhances the accuracy and reliability of assessments with its intuitive interface and integration with various geospatial datasets.

## Pre-Forest Fire

Sentinel Satellite images captured on March 3, 2024, prior to the forest fire, highlighted the Area of Interest (AOI) in yellow. The AOI corresponds to the Reserved Forests of Mannavanur and Manjampatti, located within the Kodaikanal Forest Division and the Wildlife Division of the Anamalai Tiger Reserve.

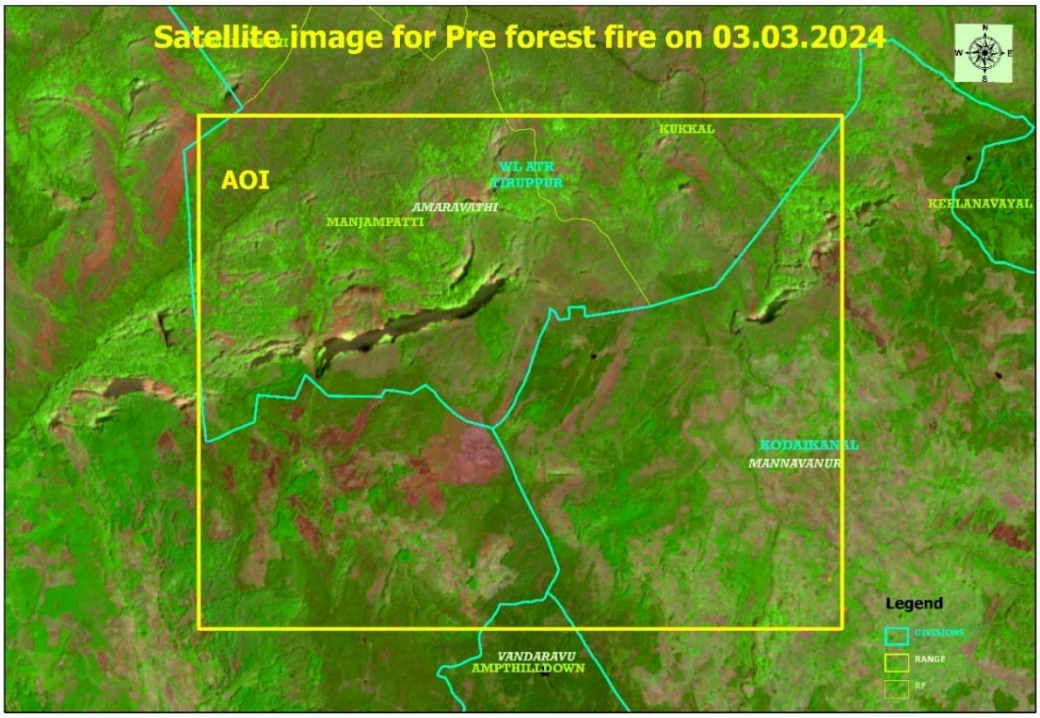



**Figure 48: Pre-forest Fire Analysis using Satellite Imagery**

## During Forest Fire

Sentinel Satellite images acquired on March 26, 2024, during the forest fire, captured the Reserved Forests of Mannavanur and Manjampatti. These areas are situated within the Kodaikanal Forest Division and the Wildlife Division of the Anamalai Tiger Reserve.

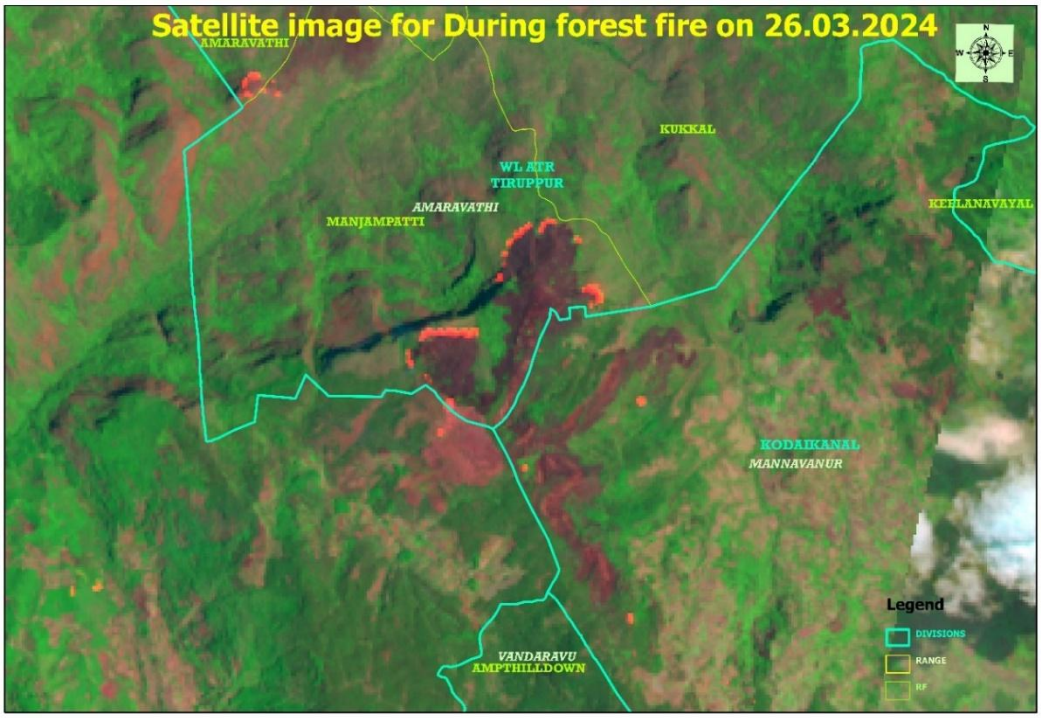



**Figure 49: Fire Analysis using Satellite Imagery**

## Post-Forest Fire

Satellite imagery focusing on the Reserved Forests within the Kodaikanal Forest Division and the Anamalai Tiger Reserve reveals distinct changes post-forest fire on April 07, 2024. Healthy vegetation is represented in green, while burnt areas are indicated in brown.

The affected regions are in hilly terrain, and the temporal changes in forest fire dynamics, along with the extent of the burnt area, are clearly discernible through the satellite imagery.

Multispectral resolution satellite data from Landsat OLI and Sentinel-2A were utilized for spatial burnt area assessment, carried out using ArcGIS Pro. Image processing and spatial algorithms were applied, including geometric corrections and the use of the WGS 1984 UTM Zone 43N projection system. The extent of the burnt area **(595.5ha)** was calculated based on these corrections.

The differentiation between healthy vegetation and burnt areas was achieved using the Normalized Burn Ratio (NBR) algorithm, which identifies variations in pixel colour tones. These colour signatures distinguish healthy

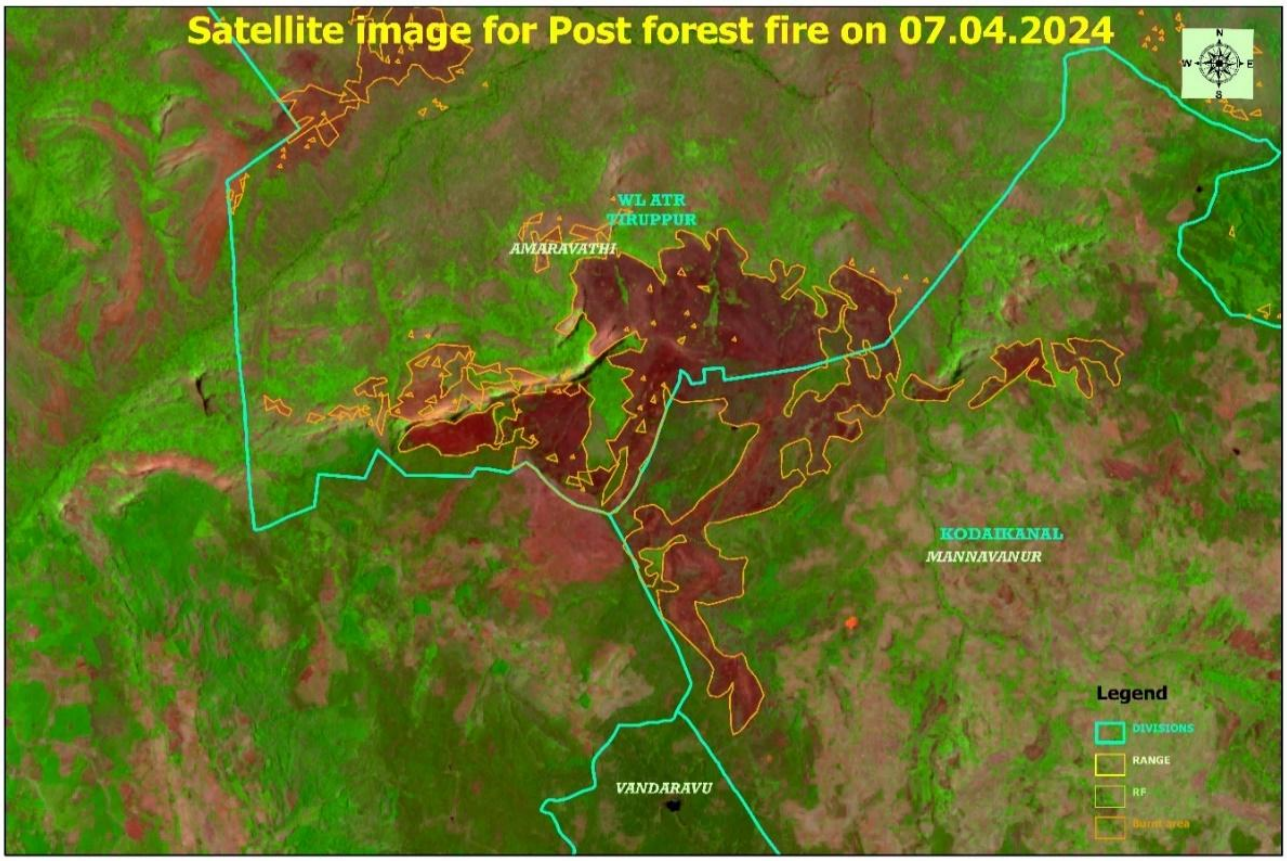



**Figure 50: Post Forest fire Analysis using Satellite Imagery**

vegetation from non-healthy vegetation and highlight burnt areas. In true-colour composite satellite imagery, this differentiation is visually represented, allowing for clear identification of the fire-affected regions.

## Regeneration

Satellite images showing regeneration of burnt area on 19th September,2024. Plant regeneration after a fire is a vital ecological process that contributes to the recovery of ecosystems. Fire, while destructive, often plays a crucial role in shaping the structure and function of natural habitats. The regeneration process varies depending on plant species, fire severity, and environmental conditions.

**Mechanisms of Regeneration**

1. **Seed Germination**

   Some plants have seeds that require heat or smoke to break dormancy. Fire clears vegetation and enriches the soil with nutrients, creating ideal conditions for seed germination.

2. **Resprouting from Roots or Stems**

   Many plants resprout from underground structures like lignotubers, rhizomes, or deep roots that survive the fire. Examples include eucalyptus and grass species.

3. **Vegetative Reproduction**

   Certain species regenerate from surviving plant parts.

4. **Seedbank Activation**

   Soil seedbanks, containing dormant seeds, are often stimulated to germinate by post-fire conditions such as increased sunlight, reduced competition, and enriched nutrients.

**Factors Influencing Regeneration**

1. **Fire Severity and Frequency**: Low-intensity fires often allow for quicker recovery since roots and seeds are less likely to be destroyed. High-intensity fires may lead to slower regeneration but can still trigger the growth of fire-adapted species.

2. **Climate and Soil Conditions**: Post-fire rainfall and soil fertility significantly influence regeneration rates. Favourable conditions accelerate recovery, while drought or poor soils may slow the process.

3. **Invasive Species**: In some cases, invasive species may outcompete native vegetation during regeneration, altering the ecosystem composition.

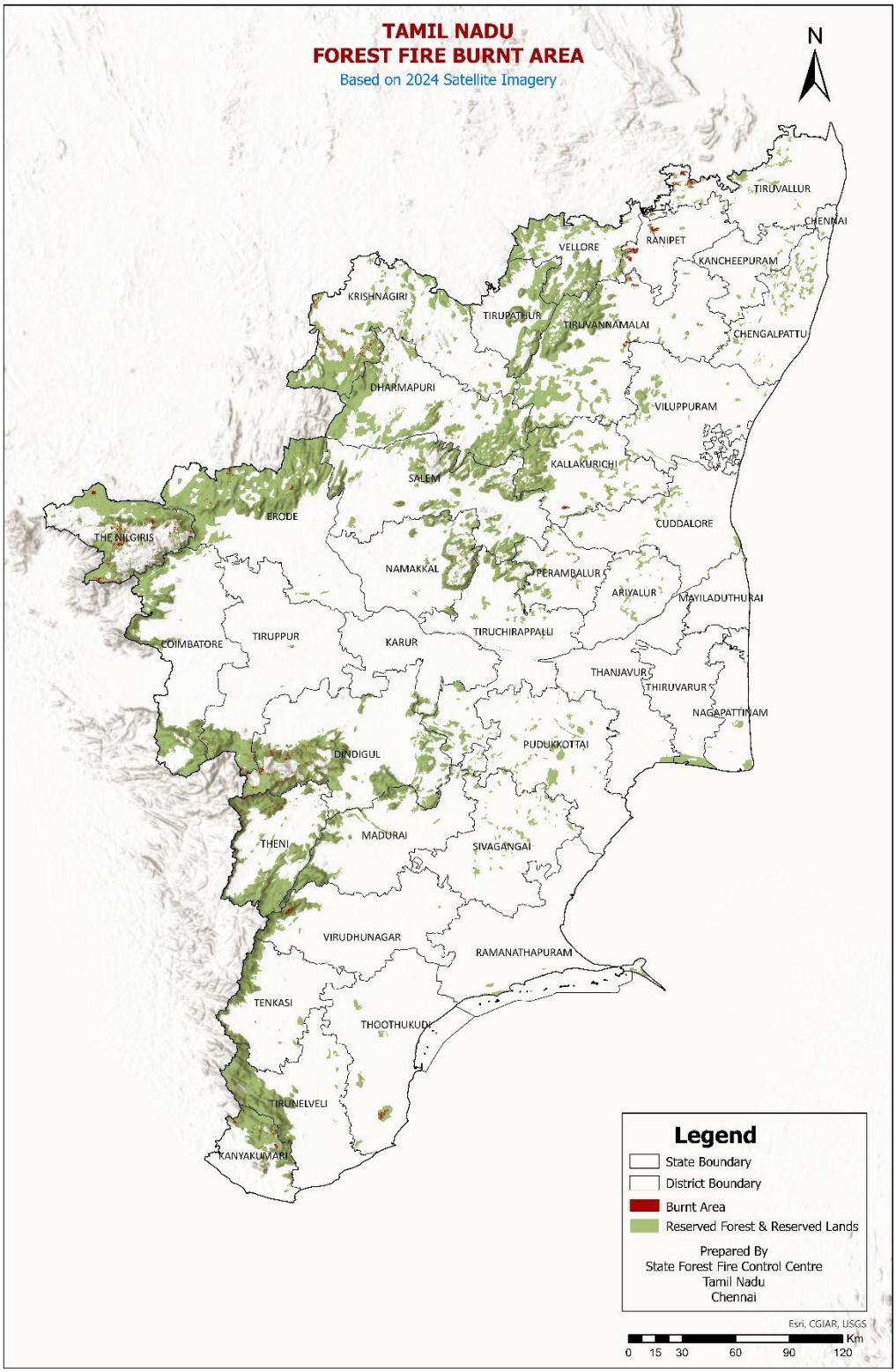



**Figure 51: Spatial-Burnt Area of 2024 using Satellite Imagery**

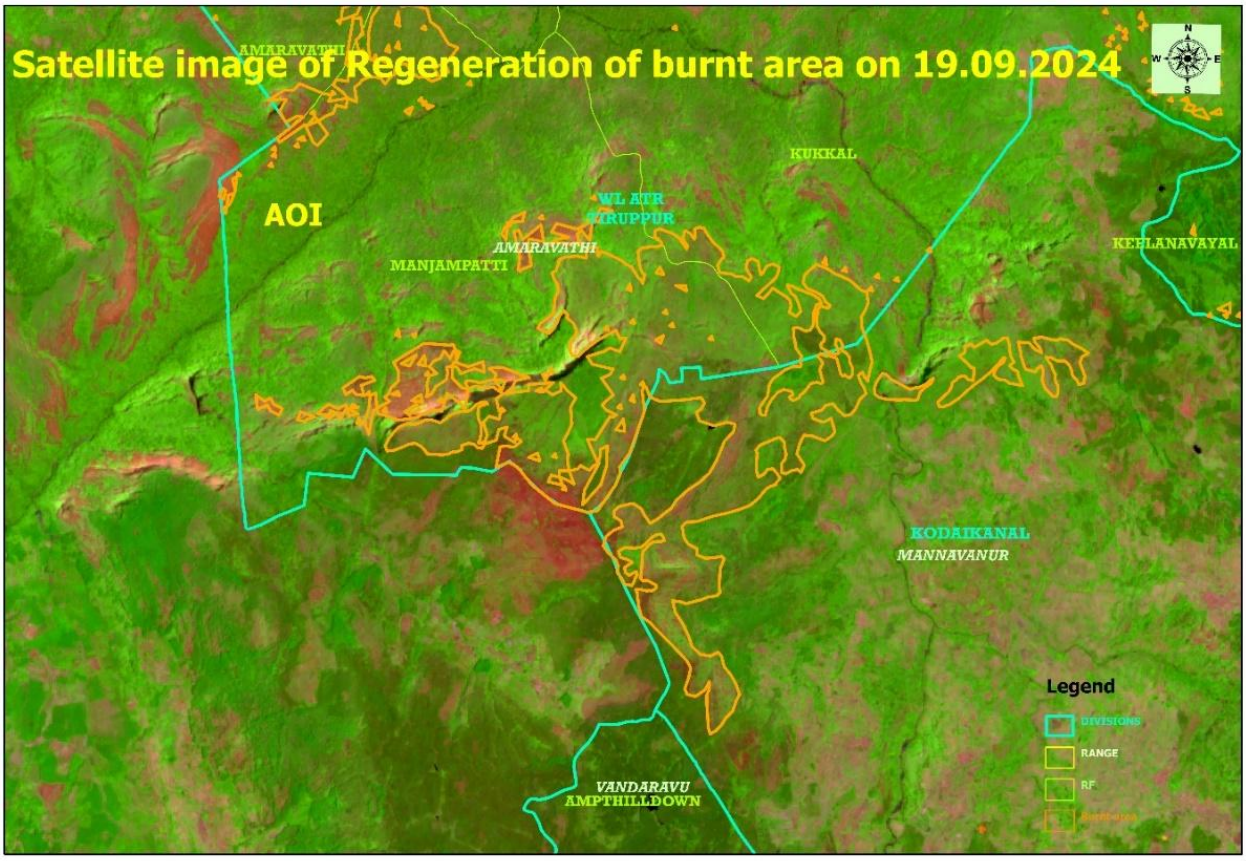



Figure 52: Regeneration of Burnt Area

**Ecological Benefits of Post-Fire Regeneration**

- **Promotes Biodiversity:** Fire creates a mosaic of habitats, encouraging diverse plant and animal species.
- **Soil Fertility:** Ashes from burnt vegetation enrich the soil with minerals, aiding plant growth.
- **Natural Succession:** Fire resets ecological succession, allowing new plant communities to establish.

**Human Interventions**

- **Reforestation:** Planting native species can aid regeneration in severely damaged areas.
- **Soil Stabilization:** Erosion control measures, such as mulching or terracing, help protect recovering ecosystems.
- **Invasive Species Management:** Removing invasive plants ensures native species thrive.

Plant regeneration after a fire highlights the resilience of nature and its ability to recover and adapt to disturbances. Proper management of post-fire ecosystems can further enhance this recovery process, ensuring long-term ecological stability.

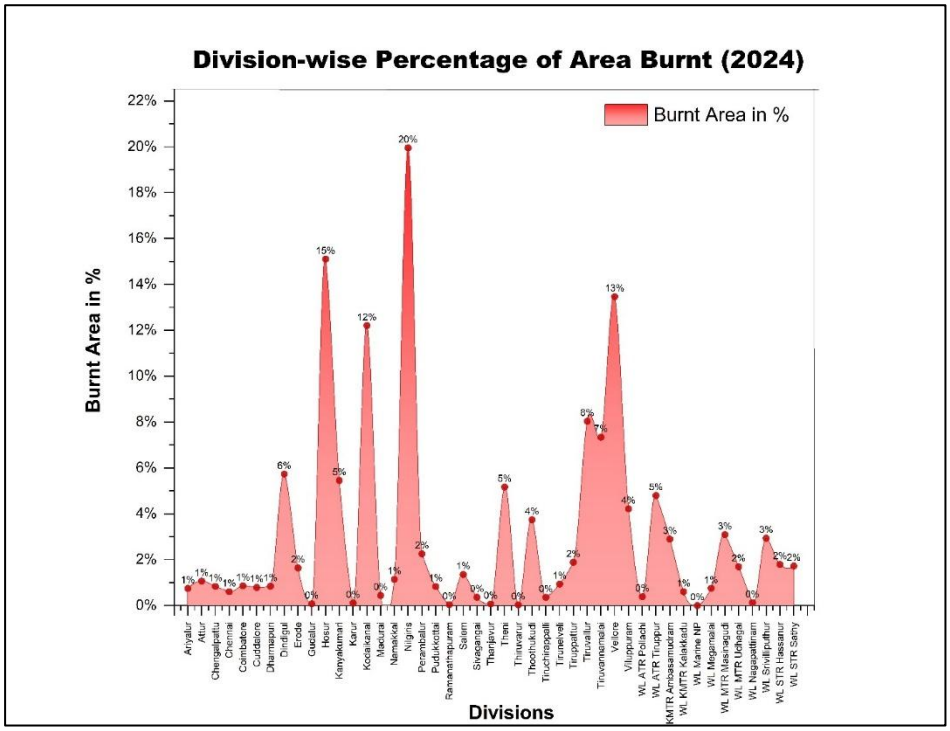



Figure 53: Division-wise Burnt Area in % of Total Burnt Area (2024)

# Ground Truthing of Burnt Area Assess using Satellite Imagery

Ground truthing is an essential process in remote sensing and geographical information systems (GIS) that involves validating and verifying the accuracy of satellite or aerial imagery data by collecting data on the ground. In the context of assessing forest burnt areas, ground truthing helps ensure the reliability of the information obtained from remote sensing technologies. Here's an overview of the process, methodologies, and significance of ground truthing for burnt area assessment.

**Importance of Ground Truthing**

- **Data Validation:** Ground truthing allows researchers to confirm the accuracy of satellite imagery and GIS data, ensuring that classifications of burnt and unburnt areas are correct.
- **Improved Analysis:** Accurate field data can enhance the analysis of fire impacts, regeneration processes, and recovery of vegetation.
- **Training Data for Algorithms:** Field observations can provide training data for machine learning algorithms used in classifying satellite images.

## Methodology of Ground Truthing

**Preparation**

- **Define the Study Area:** Identify specific locations within the forest burnt area to target for ground truthing.

- **Plan Field Surveys:** Develop a field survey plan that includes logistics, routes, and specific sites for data collection.

**Data Collection**

- **Use of GPS:** Equip field teams with Hand held GPS or DGPS devices to record the geographic coordinates of sampled points within the burnt area. GPS data helps in accurately mapping the location of burnt areas in GIS software.
- **Field Surveys:** Conduct field visits to collect data on vegetation type, degree of burn, and soil condition. Assess the health of vegetation (e.g., signs of regeneration or death) and record the presence of invasive species.
- **Photographic Documentation:** Take photographs of the site to visually document the conditions of the burnt area. Ensure that photos are geotagged using GPS to relate them to specific locations.

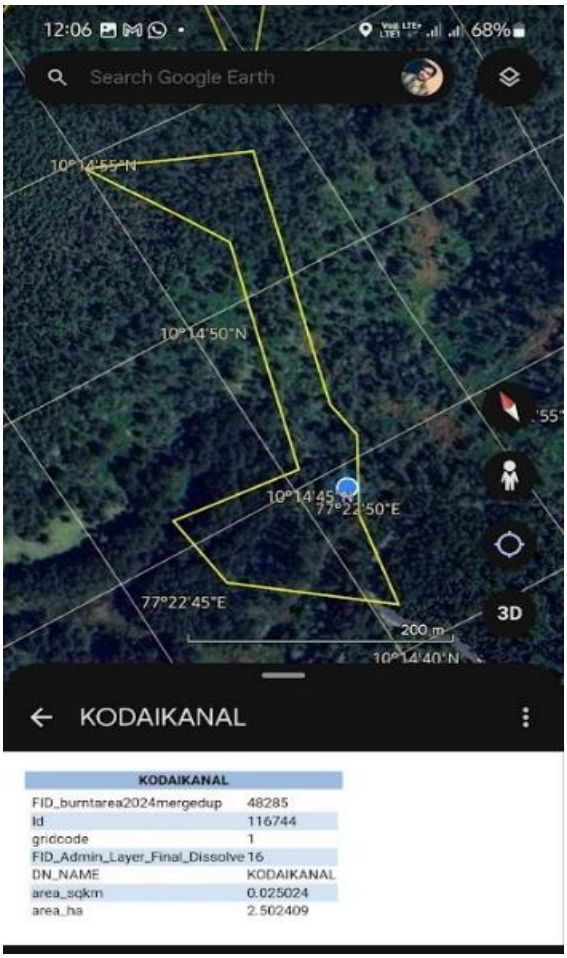



Figure 54: Ground-Truthing in Kodaikanal

**Data Recording and Processing**

- **Integration with GIS:** Import GPS data and field observations into GIS software to create accurate maps of burnt areas. Use remote sensing data (e.g., NBR, NDVI) alongside ground truth data to improve classification accuracy.

**Analysis of Ground Assessment Data**

- **Comparison with Remote Sensing Data:** Compare field data with satellite imagery classifications to identify discrepancies and improve accuracy.
- **Statistical Analysis:** Use statistical methods to analyse the relationship between ground truth data and remote sensing metrics. Assess the effectiveness of different algorithms in identifying burnt areas.

## Field observations of Burnt area assessment

The Keyhole Markup Zipped (KMZ) file of spatial burnt layers is used to accurately locate ground truth assessment sites. Spatial burnt layers are converted to the KMZ file format using ArcGIS Pro. This file format is compatible with mobile applications, enabling navigation to specific locations using latitude and longitude

coordinates while in the field. The yellow colour represents the spatial burnt area, while the blue point indicates the navigator's current location in the field. The above image shows the ground truth assessment conducted in Kodaikanal.

A large forest fire was observed in Kodaikanal Forest Division on 27.04.2024. The high-resolution Sentinel imagery from 07.05.2024 was used to assess the spatial extent of the burnt area, indicated in red. A ground truthing assessment was conducted after the fire in the Ampthill Down Reserved Forest of the Poombarai Forest Range, Kodaikanal Division. A handheld GPS was used to calculate a small burnt area of **2.88 ha**, represented in yellow, and it was compared with the spatial burnt area of **2.50 ha**, shown in green. The extent of the spatial burnt area is almost equal to that of the ground truthed assessment. The affected area predominantly consisted of *Acacia mearnsii, Eucalyptus spp.*, and pine trees. Both natural and anthropogenic factors, including an electric line, were significant contributors to this forest fire.

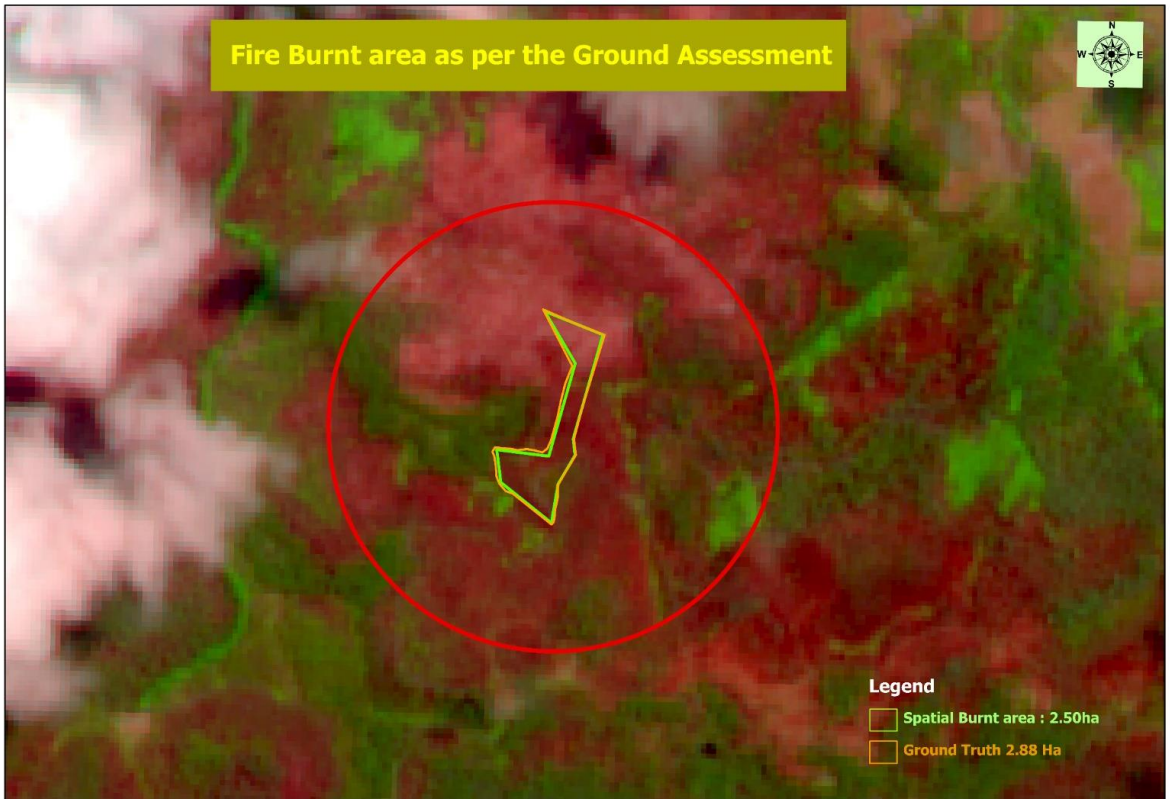



**Figure 55: Validation between Spatial Burnt and Ground-Truth Data**

In another sample fire data of the Salem Forest Division, Sentinel satellite imagery of the pre-fire (07.04.2024) and post-fire (22.04.2024) was used for the analysis. The extent of the spatial burnt area was calculated as **38.36 ha** (indicated in green), while the handheld GPS ground truth assessment measured the burnt extent as **39.61ha** (indicated in yellow) in the Kurumbapatty Reserved Forest of the Shervarayan South Range in Salem Division. Both natural and anthropogenic factors were significant contributors in this case, with *Casuarina equisetifolia* species being another key factor triggering the forest fire.




**Figure 56: Pre-forest Fire Analysis in Salem Division**

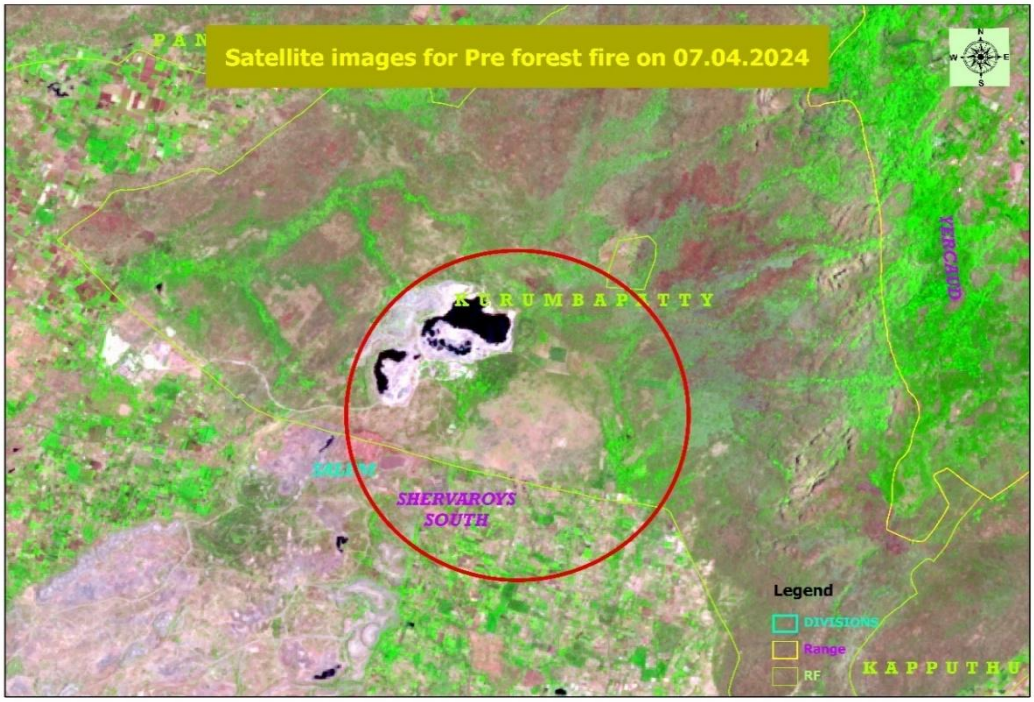



**Figure 57: Post Forest fire Analysis**

## Division-wise Spatial Burnt Area

There are 45 forest divisions in Tamil Nadu, with the top 10 divisions identified as having the highest potential for forest fires in 2024. These include **Nilgiris, Hosur, Vellore, Kodaikanal, Thiruvallur, Tiruvannamalai, Dindigul, Kanyakumari, Theni, and WL ATR Tiruppur.** These areas are particularly vulnerable due to their adjacency, which facilitates the rapid spread of forest fires to neighboring divisions.

An analysis of division wise spatial burnt areas revealed a total of approximately 38,169.2 hectares affected by fire. The division-specific contributions to burnt area are as follows Nilgiris accounted for 20%, Hosur for 15%, Vellore for 13.5%, Kodaikanal for 12.2%, Thiruvallur for 8.0%, Tiruvannamalai for 7.3%, Dindigul for 5.7%, Kanyakumari for 5.5%, Theni for 5.2%, and WL ATR Tiruppur for 4.8%. List of divisions were attached as an annexure 3.1 for further details

## Range-wise Spatial Burnt Area

The spatial burnt area assessment, derived for around 204 forest ranges, focused on forest fires in Tamil Nadu in 2024. This assessment technique utilized high-resolution satellite images from 1 January to 30 May 2024. However, the top 50 ranges have been listed in the table. The top 10 ranges 2% of forest fire occurred and total spatial burnt area extend is **392.87 sq.km in 2024.** These ranges fall under the forest divisions of **Kodaikanal, Theni, WL Megamalai, Coimbatore, Nilgiris, WL Hassanur, Erode, Salem, and Hosur**. These are the high-sensitivity zones of forest fire in Tamil Nadu. Further details were attached in Annexure 3.2.

## Beat-wise Spatial Burnt Area

The forest administrative boundary was prepared by the Geoinformatics Centre using ArcMap and ArcGIS Pro software. It is a shapefile with spatially Geo-rectified data of all forest divisions, beats, and reserved forest boundaries. Nearly 1,060 forest beats fall under the high-vulnerability category, while 100 vulnerable beats have been listed. The top 10 beats in the spatial burnt area assessment show burnt areas ranging from **1.1% to 1.9%,** with **460.1 to 769.6** hectares classified as high-sensitivity fire zones in the forest divisions of **Kodaikanal, Theni, WL Megamalai, Coimbatore, Nilgiris, WL Hassanur, Erode, Salem, and Hosur in 2024**. Further details were attached in annexure 3.3.

## RF-wise Spatial Burnt Area

According to the spatial burnt area assessment, around 1,040 reserved forests fall under the high-sensitivity forest fire division and are classified as highly vulnerable to forest fires. A list of 150 high fire-sensitive reserved forests is provided below. Based on the extent of burnt areas, the top 50 reserved forests range from 151.1 to 2,492.3 hectares (0.4% to 6.9%) across various forest divisions, including **Kodaikanal, Theni, WL Megamalai, Coimbatore, Nilgiris, WL Hassanur, Erode, Salem, and Hosur, in 2024**. Further details were attached in annexure 3.4

## Applications of Ground Truthing in Burnt Area Assessment

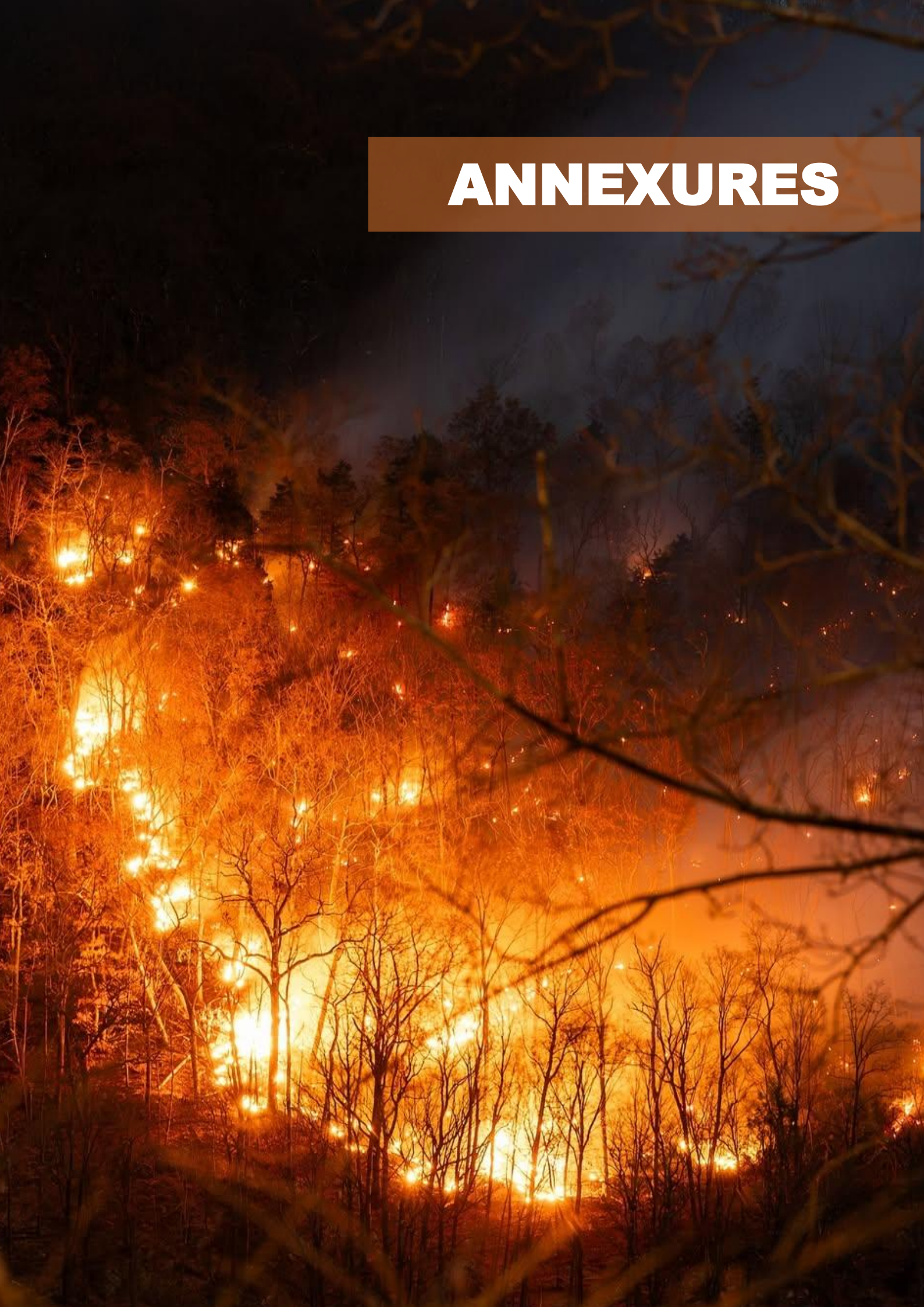
- **Fire Management:** Ground truthing helps in assessing the effectiveness of fire management strategies and understanding the ecological impacts of fire.
- **Restoration Planning:** Information obtained can guide restoration efforts, such as selecting appropriate native species for replanting.
- **Long-term Monitoring:** Ground truth data can support ongoing monitoring of burnt areas and recovery processes, contributing to ecosystem management.




**Figure 58: Ground-truthing in Kodaikanal and Salem divisions**



# ANNEXURES



# Annexures

## Administrative Boundaries Sensitive to Forest Fire (2016-2024)

**Based on 2016 – 2024 FSI Forest Fire Alerts**

### Table: 1.1 Ranking of Circles based on Sensitivity to Forest fire

| SI.NO | RANKING OF CIRCLE BASED ON SENSITIVITY TO FOREST FIRE |
|---|---|
| 1 | VELLORE |
| 2 | DHARMAPURI |
| 3 | DINDIGUL |
| 4 | ATR |
| 5 | SMTR |
| 6 | KMTR |
| 7 | SALEM |
| 8 | STR |
| 9 | CHENNAI |
| 10 | MTR |
| 11 | VILUPPURAM |
| 12 | TRICHY |

### Table: 1.2 Ranking of Divisions based on Sensitivity to Forest fire

| SI.NO | RANKING OF DIVISIONS BASED ON SENSITIVITY TO FOREST FIRE |
|---|---|
| 1 | HOSUR |
| 2 | KODAIKANAL |
| 3 | VELLORE |
| 4 | THENI |
| 5 | TIRUPPATTUR |
| 6 | KANYAKUMARI |
| 7 | WL ATR TIRUPPUR |
| 8 | NILGIRIS |
| 9 | TIRUVANNAMALAI |
| 10 | DINDIGUL |
| 11 | TIRUVALLUR |
| 12 | HARUR |
| 13 | WL, MTR |
| 14 | SALEM |
| 15 | TIRUNELVELI |
| 16 | WL, STR HASSANUR |
| 17 | WL ATR POLLACHI |
| 18 | COIMBATORE |
| 19 | WL, MEGAMALAI |

| | |
|---|---|
| **20** | VILUPPURAM |
| **21** | NAMAKKAL |
| **22** | WL, STR SATHY |
| **23** | ERODE |
| **24** | WL, SRIVILLIPUTHUR |
| **25** | DHARMAPURI |
| **26** | WL, KMTR |
| **27** | MADURAI |
| **28** | ATTUR |
| **29** | CHENGALPATTU |
| **30** | GUDALUR |
| **31** | TIRUCHIRAPPALLI |
| **32** | PUDUKKOTTAI |
| **33** | PERAMBALUR |
| **34** | SIVAGANGAI |
| **35** | CUDDALORE |
| **36** | ARIYALUR |
| **37** | THOOTHUKUDI |
| **38** | KARUR |
| **39** | THANJAVUR |
| **40** | WL, MARINE NP |
| **41** | RAMANATHAPURAM |
| **42** | WL, NAGAPATTINAM |
| **43** | THIRUVARUR |

## Table: 1.3 Top 50 Ranges Sensitive to Forest Fire

| SI.NO | TOP 50 RANGES SENSITIVE TO FOREST FIRE |
|---|---|
| **1** | DENKANIKOTTAI |
| **2** | PALANI |
| **3** | UDUMALAIPETTAI |
| **4** | PERUMPALLAM |
| **5** | GUDIYATHAM |
| **6** | ODUGATHUR |
| **7** | BODI |
| **8** | ARCOT |
| **9** | AZHAGIAPANDIPURAM |
| **10** | VELLORE |
| **11** | TIRUPPATTUR |
| **12** | POOMPARAI |
| **13** | JAWALAGIRI |
| **14** | PALLIPATTU |
| **15** | SHERVAROY SOUTH |

| | |
|---|---|
| **16** | KODAIKANAL |
| **17** | AMBUR |
| **18** | MANNAVANUR |
| **19** | KORAKUNDAH |
| **20** | VELIMALAI |
| **21** | THENI |
| **22** | UTHAMAPALAYAM |
| **23** | SINGARAPETTAI |
| **24** | VALPARAI |
| **25** | AMARAVATHI |
| **26** | KULASEKARAM |
| **27** | ALANGAYAM |
| **28** | HARUR |
| **29** | KOTTAPATTY |
| **30** | URIGAM |
| **31** | DEVATHANAPATTY |
| **32** | MUKURTHY |
| **33** | THIRUTTANI |
| **34** | CUMBUM |
| **35** | HASSANUR |
| **36** | SIRUMALAI |
| **37** | MASINAGUDI |
| **38** | POLUR |
| **39** | UDHAGAI NORTH |
| **40** | NAMAKKAL |
| **41** | KALIYAL |
| **42** | SEGUR |
| **43** | GUDALUR(T) |
| **44** | HOSUR |
| **45** | CHENGAM |
| **46** | KANNIVADY |
| **47** | SANKARANKOIL |
| **48** | ANCHETTY |
| **49** | MEGAMALAI |
| **50** | BOLAMPATTY |

## Table: 1.4 Top 90 Beats Sensitive to forest fires

| SI.NO | TOP 90 BEATS SENSITIVE TO FOREST FIRE |
|---|---|
| **1** | PARICOMBAI WEST |
| **2** | GUDIYUR |
| **3** | PERUMPALLAM |

| | |
|---|---|
| **4** | AVALANCHE(WL) |
| **5** | KOMBU WEST |
| **6** | UPPER BHAVANI |
| **7** | PUNGANUR NORTH |
| **8** | POOMPARAI WEST |
| **9** | MADDUR |
| **10** | GULLATTI EAST |
| **11** | THULUVABETTA EAST |
| **12** | THIRUMOORTHIMALAI |
| **13** | AYYUR |
| **14** | PARICOMBAI EAST |
| **15** | KALAYAMPUTHUR |
| **16** | PANNAIKADU |
| **17** | THADIKARANKONAM SOUTH |
| **18** | VADAKAVUNJI |
| **19** | ASAMBU |
| **20** | PERUMALMALAI(K) |
| **21** | JAWALAGIRI |
| **22** | MELPALLAM |
| **23** | PUNGANUR SOUTH |
| **24** | GEDDESAL |
| **25** | AZHAGIAPANDIPURAM |
| **26** | BALASAMUDRAM EAST |
| **27** | THOLUVABETTA EAST |
| **28** | BETTAMUGILALAM |
| **29** | GALIGATTAM |
| **30** | KEMPAGARAI |
| **31** | SITHAYANKOTTAI |
| **32** | KAVALAPATTY |
| **33** | MACHUR |
| **34** | RANGAMPETTAI |
| **35** | AGARAM |
| **36** | AKKAMALAI |
| **37** | KOKKANAMALAI |
| **38** | BELLATTY |
| **39** | KALIYAL |
| **40** | KURUMBAPATTY |
| **41** | KEELANAVAYAL |
| **42** | PALAMADI |
| **43** | SINGARAPETTAI EAST |
| **44** | NAICKENERI(VLR) |
| **45** | AMMUR |

| | |
|---|---|
| **46** | THOLUVABETTA WEST |
| **47** | ARUNGULAM EAST |
| **48** | MANNAVANUR NORTH |
| **49** | ASANAMPETTAI |
| **50** | KARADIBETTA |
| **51** | SIROOR SOUTH |
| **52** | THEVARAM SOUTH |
| **53** | PECHIPARAI |
| **54** | ULIBANDA |
| **55** | MANJAMPATTI SOUTH |
| **56** | TAMBIRANKANAL |
| **57** | CHELLAMTHURUTHI |
| **58** | GULLATTI WEST |
| **59** | SURULACODE |
| **60** | SWAMIMALAI(VLR) |
| **61** | KOMBAI |
| **62** | GUNDUR EAST |
| **63** | PALLANGI EAST |
| **64** | PUDUR |
| **65** | KODAGARAI(HOS) |
| **66** | PALLANGI WEST |
| **67** | THAISHOLAI |
| **68** | VELLAKUTTAI |
| **69** | NOCHIKUTTAI |
| **70** | SHOLUR |
| **71** | MARANDAHALLI NORTH |
| **72** | MAHIMANDALAM |
| **73** | KODAI ROAD |
| **74** | KOTTAIYARU |
| **75** | SATHGUR |
| **76** | BALASAMUDRAM WEST |
| **77** | PERAMBUKANAL |
| **78** | BIKKAPATHI |
| **79** | KESTHUR |
| **80** | NADUCOMBAI |
| **81** | CHEYYAR |
| **82** | KOTTASATHANA PALLI |
| **83** | GRASS HILLS |
| **84** | THALI NORTH |
| **85** | VELIMALAI NORTH |
| **86** | ARANGALTHURGAM |
| **87** | GLENMORGAN |

| | |
|---|---|
| **88** | KURANGANI SOUTH |
| **89** | MAMBAKKAM |
| **90** | SIROOR NORTH |

## Table: 1.5 Top 150 RF & RL Sensitive to Forest Fires

| SI.NO | TOP 150 RF & RL SENSITIVE TO FOREST FIRE |
|---|---|
| **1** | ANAIMALAI RESERVED FORESTS |
| **2** | VIRAPULI RESERVED FORESTS |
| **3** | AMPTHILLDOWN RESERVED FORESTS |
| **4** | BODI NORTH HILL RESERVED LANDS |
| **5** | KUNDAH RESERVED FORESTS |
| **6** | AYAGUDI RESERVED LANDS |
| **7** | P V VALLEY RESERVED FORESTS |
| **8** | AIYUR RESERVED FORESTS |
| **9** | WENLOCK DOWN RESERVED FORESTS |
| **10** | GUTTIYALATTUR RESERVED FORESTS |
| **11** | THOLUVABETTA RESERVED FORESTS |
| **12** | MEGAMALAI RESERVED LANDS |
| **13** | PUNGANUR RESERVED FORESTS |
| **14** | ASAMBU RESERVED FORESTS |
| **15** | TALAMALAI RESERVED FORESTS |
| **16** | KOLATTI RESERVED FORESTS |
| **17** | INNER JAVADI RESERVED FORESTS |
| **18** | PERUMALMALAI (DGL) RESERVED FORESTS |
| **19** | SIRUMALAI RESERVED LANDS |
| **20** | SEGUR RESERVED FORESTS |
| **21** | KUDIRAIYAR RESERVED FORESTS |
| **22** | KURUMBAPATTY RESERVED FORESTS |
| **23** | MOYAR RESERVED FORESTS |
| **24** | KALAMALAI RESERVED FORESTS |
| **25** | KUKKAL RESERVED FORESTS |
| **26** | VANNATHIPARAI RESERVED FORESTS |
| **27** | KANNIVADI BLOCK I RESERVED LANDS |
| **28** | KOMBAI RESERVED FORESTS |
| **29** | ARASAMPATTU RESERVED FORESTS |
| **30** | MORDHANA RESERVED FORESTS |
| **31** | VASUDEVANALLUR RESERVED FORESTS |
| **32** | KARUTHAMALAI RESERVED FORESTS |
| **33** | MUDUMALAI & KUMBARAKOLLI RESERVED FORESTS |
| **34** | NORTH BARGUR RESERVED FORESTS |
| **35** | KEMPAKARAI RESERVED FORESTS |

| | |
|---|---|
| **36** | SINGARAPETTAI EXTN RESERVED FORESTS |
| **37** | THENMALAI RESERVED FORESTS |
| **38** | AMBUR RESERVED FORESTS |
| **39** | JAWALGIRI RESERVED FORESTS |
| **40** | MANJAMPATTI RESERVED FORESTS |
| **41** | SAMERI RESERVED FORESTS |
| **42** | GALIGATTAM RESERVED FORESTS |
| **43** | AMARAVATHI RESERVED FORESTS |
| **44** | MAMBAKKAM(V) RESERVED FORESTS |
| **45** | KARAVALLI COMBAI RESERVED FORESTS |
| **46** | MOOLAIYAR RESERVED FORESTS |
| **47** | VIRAPPANUR RESERVED FORESTS |
| **48** | MORDHANA EXTN RESERVED FORESTS |
| **49** | SANANKUPPAM RESERVED FORESTS |
| **50** | MADDUR RESERVED LANDS |
| **51** | VELIMALAI RESERVED FORESTS |
| **52** | BOLAMPATTI II RESERVED FORESTS |
| **53** | PAPANASAM RESERVED FORESTS |
| **54** | PH SOUTHERN SLOPE RESERVED FORESTS |
| **55** | THEVARAM RESERVED FORESTS |
| **56** | SAPTUR RESERVED FORESTS |
| **57** | KAPPUTHU RESERVED FORESTS |
| **58** | KOTTAGUDI RESERVED LANDS |
| **59** | NAICKANERI RESERVED FORESTS |
| **60** | OLIYANUTHU RESERVED FORESTS |
| **61** | AMMOOR RESERVED FORESTS |
| **62** | PALAMATHY RESERVED FORESTS |
| **63** | PUTHUR RESERVED FORESTS |
| **64** | ULIBANDA RESERVED FORESTS |
| **65** | KESTHUR RESERVED FORESTS |
| **66** | BODI WEST HILLS RESERVED FORESTS |
| **67** | KOTTAPATTY EXTN RESERVED FORESTS |
| **68** | NOCHIKUTTAI EXTN RESERVED FORESTS |
| **69** | KARAPATTU RESERVED FORESTS |
| **70** | MARANDAHALLI EXTN RESERVED FORESTS |
| **71** | PANAI RESERVED FORESTS |
| **72** | ALANGAYAM RESERVED FORESTS |
| **73** | MAHIMANDALAM RESERVED FORESTS |
| **74** | NEKKANAMALAI RESERVED FORESTS |
| **75** | THALLY RESERVED FORESTS |
| **76** | GUTTIRAYAN RESERVED FORESTS |
| **77** | SOUTH BARGUR RESERVED FORESTS |

| | |
|---|---|
| **78** | MURUGAMALAI RESERVED FORESTS |
| **79** | PATRAKAD RESERVED FORESTS |
| **80** | MALAYALAM RESERVED FORESTS |
| **81** | ADUKKAM RESERVED FORESTS |
| **82** | AIYUR EXTENSION I RESERVED FORESTS |
| **83** | MANGALAM RESERVED FORESTS |
| **84** | MARANDAHALLI RESERVED FORESTS |
| **85** | CHARAGALLU RESERVED FORESTS |
| **86** | PARVATHAMALAI RESERVED FORESTS |
| **87** | THAGGATTY RESERVED FORESTS |
| **88** | AGAMALAI RESERVED FORESTS |
| **89** | ANDIPATTY RESERVED FORESTS |
| **90** | NOGANUR RESERVED FORESTS |
| **91** | THELLAI RESERVED FORESTS |
| **92** | ERASAKKANAYAKKANUR RESERVED FORESTS |
| **93** | KARNATAGIRI RESERVED FORESTS |
| **94** | MACHAKKAL RESERVED FORESTS |
| **95** | NILGIRI EASTERN SLOPES RESERVED FORESTS |
| **96** | KOTTAPATTY RESERVED FORESTS |
| **97** | NEDIUM RESERVED FORESTS |
| **98** | AMMAPALAYAM RESERVED FORESTS |
| **99** | PANAMADANGI RESERVED FORESTS |
| **100** | SETHUR RESERVED FORESTS |
| **101** | KAVUTHIMALAI RESERVED FORESTS |
| **102** | SRIVILLIPUTHUR RESERVED FORESTS |
| **103** | MARUTHANATHI RESERVED FORESTS |
| **104** | PERIYAMALAI (TVM) RESERVED FORESTS |
| **105** | SAMIKANAL RESERVED FORESTS |
| **106** | KALAMALAI (KMTR) RESERVED FORESTS |
| **107** | KANIYAMBADI RESERVED FORESTS |
| **108** | MORAPPUR RESERVED FORESTS |
| **109** | MULAKKADU RESERVED FORESTS |
| **110** | NOCHIKUTTAI RESERVED FORESTS |
| **111** | PANNAIKARADU RESERVED FORESTS |
| **112** | ANDIAPPANUR RESERVED FORESTS |
| **113** | BIKKAPATHIMUND RESERVED FORESTS |
| **114** | KADAYANALLUR RESERVED FORESTS |
| **115** | AMBUR DURG RESERVED FORESTS |
| **116** | BILLIKKAL RESERVED FORESTS |
| **117** | TIGER SHOLA RESERVED FORESTS |
| **118** | PALLIPATTI RESERVED FORESTS |
| **119** | ALIALAMANGALAM RESERVED FORESTS |

| | |
|---|---|
| **120** | SANAMAVU RESERVED FORESTS |
| **121** | SURANGANAR RESERVED FORESTS |
| **122** | VELLAKKALTHERI RESERVED FORESTS |
| **123** | PALLIKONDA RESERVED FORESTS |
| **124** | SEGUR BL II RESERVED FORESTS |
| **125** | SIVAGIRI RESERVED FORESTS |
| **126** | THOLUVABETTA EXTN RESERVED FORESTS |
| **127** | SITILINGI RESERVED FORESTS |
| **128** | ANANDAVADI RESERVED FORESTS |
| **129** | MADDUR EXTN RESERVED LANDS |
| **130** | MANCHI RESERVED FORESTS |
| **131** | NEDUNGUNAM RESERVED FORESTS |
| **132** | PERUMAL MALAI SHOLA RESERVED FORESTS |
| **133** | PONNERI RESERVED FORESTS |
| **134** | KADAVUMALAI RESERVED FORESTS |
| **135** | MAHARAJAKADAI RESERVED FORESTS |
| **136** | S U VANAM RESERVED FORESTS |
| **137** | WAGUTHUMALAI RESERVED FORESTS |
| **138** | ANAIKATTY SOUTH RESERVED FORESTS |
| **139** | KALLAR (DGL) RESERVED FORESTS |
| **140** | KANNIVADI RESERVED LANDS |
| **141** | KESTHUR EXTN RESERVED FORESTS |
| **142** | NOCHILI RESERVED FORESTS |
| **143** | PARAVAMALAI RESERVED FORESTS |
| **144** | THALLY EXTN RESERVED FORESTS |
| **145** | KENGODU NORTH RESERVED FORESTS |
| **146** | PEDDARAMAPURAM RESERVED LANDS |
| **147** | PUNIMANGADU RESERVED LANDS |
| **148** | THAISHOLA RESERVED FORESTS |
| **149** | COURTALLAM RESERVED FORESTS |
| **150** | NATRAPALAYAM RESERVED FORESTS |



# Response Time of Large Forest Fires – 2024

## Table: 2.1 Less than 24 hours (157 LFF)

| Sl. No | Fire Name | Division | Total Pixels | First Detection Date | First Detection Time | Last Detection Date | Last Detection Time | No. of days active |
|---|---|---|---|---|---|---|---|---|
| 1 | VRIDDHACHALAM -1 | CUDDALORE | 3 | 01-01-2024 | 10:00 | 01-01-2024 | 15:00 | 0 |
| 2 | SRIVILLIPUTTUR -1 | SRIVILLIPUTHUR | 23 | 02-01-2024 | 09:30 | 02-01-2024 | 14:30 | 0 |
| 3 | PALANI -11 | KODAIKANAL | 3 | 02-01-2024 | 11:45 | 02-01-2024 | 16:15 | 0 |
| 4 | SIRUMALAI -5 | DINDIGUL | 3 | 03-01-2024 | 10:15 | 03-01-2024 | 13:45 | 0 |
| 5 | POLUR -2 | TIRUVANNAMALAI | 6 | 03-01-2024 | 11:00 | 03-01-2024 | 17:00 | 0 |
| 6 | HARUR -4 | DHARMAPURI | 4 | 04-01-2024 | 09:00 | 04-01-2024 | 14:00 | 0 |
| 7 | KOTTAPATTY -7 | DHARMAPURI | 3 | 05-01-2024 | 10:45 | 05-01-2024 | 15:45 | 0 |
| 8 | VELLORE -1 | VELLORE | 11 | 06-01-2024 | 08:30 | 06-01-2024 | 13:00 | 0 |
| 9 | SINGARA -1 | MASINAGUDI | 38 | 06-01-2024 | 10:00 | 06-01-2024 | 16:30 | 0 |
| 10 | ODDANCHATRAM -3 | DINDIGUL | 16 | 07-01-2024 | 09:30 | 07-01-2024 | 15:00 | 0 |
| 11 | ODDANCHATRAM -4 | DINDIGUL | 3 | 07-01-2024 | 10:15 | 07-01-2024 | 16:00 | 0 |
| 12 | TIRUVANNAMALAI -2 | TIRUVANNAMALAI | 5 | 08-01-2024 | 11:30 | 08-01-2024 | 15:30 | 0 |
| 13 | UDUMALAIPETTAI -3 | TIRUPPUR | 16 | 09-01-2024 | 09:00 | 09-01-2024 | 14:45 | 0 |
| 14 | KOTTAPATTY -6 | DHARMAPURI | 4 | 09-01-2024 | 10:45 | 09-01-2024 | 16:15 | 0 |
| 15 | SINGARAPETTAI -5 | TIRUPPATTUR | 3 | 10-01-2024 | 08:15 | 10-01-2024 | 14:00 | 0 |
| 16 | KORAKUNDAH -5 | THE NILGIRIS | 41 | 10-01-2024 | 09:45 | 10-01-2024 | 17:00 | 0 |
| 17 | KUNDAH -2 | THE NILGIRIS | 6 | 11-01-2024 | 10:00 | 11-01-2024 | 15:00 | 0 |
| 18 | KORAKUNDAH -4 | THE NILGIRIS | 3 | 11-01-2024 | 11:15 | 11-01-2024 | 16:45 | 0 |
| 19 | AMBUR -7 | TIRUPPATTUR | 6 | 12-01-2024 | 08:45 | 12-01-2024 | 13:30 | 0 |
| 20 | KODAIKANAL -5 | KODAIKANAL | 3 | 12-01-2024 | 09:30 | 12-01-2024 | 14:45 | 0 |
| 21 | BATHALAGUNDU -4 | DINDIGUL | 3 | 27-04-2024 | 01:29 | 27-04-2024 | 01:29 | 0 |
| 22 | ODUGATHUR -3 | VELLORE | 4 | 26-04-2024 | 12:57 | 26-04-2024 | 12:57 | 0 |
| 23 | GUDIYATHAM -12 | VELLORE | 2 | 25-04-2024 | 13:16 | 25-04-2024 | 13:16 | 0 |
| 24 | TIRUPPATTUR -7 | TIRUPPATTUR | 3 | 25-04-2024 | 13:16 | 25-04-2024 | 13:16 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 25 | PALANI -10 | KODAIKANAL | 5 | 25-04-2024 | 02:06 | 25-04-2024 | 02:06 | 0 |
| 26 | AMBUR -6 | TIRUPPATTUR | 4 | 24-04-2024 | 13:35 | 24-04-2024 | 13:35 | 0 |
| 27 | MELPET -2 | TIRUVANNAMALAI | 7 | 24-04-2024 | 13:35 | 24-04-2024 | 13:35 | 0 |
| 28 | JAMNAMARATHUR -2 | TIRUVANNAMALAI | 3 | 24-04-2024 | 13:35 | 24-04-2024 | 13:35 | 0 |
| 29 | NADANUR -1 | TIRUVANNAMALAI | 4 | 24-04-2024 | 13:35 | 24-04-2024 | 13:35 | 0 |
| 30 | AMIRTHI -1 | VELLORE | 3 | 24-04-2024 | 13:35 | 24-04-2024 | 13:35 | 0 |
| 31 | TALAMALAI -1 | SATHYAMANGALAM | 8 | 24-04-2024 | 02:25 | 24-04-2024 | 02:25 | 0 |
| 32 | GUDIYATHAM -10 | VELLORE | 4 | 23-04-2024 | 13:54 | 23-04-2024 | 13:54 | 0 |
| 33 | GUDIYATHAM -11 | VELLORE | 4 | 23-04-2024 | 13:54 | 23-04-2024 | 13:54 | 0 |
| 34 | ODDANCHATRAM -2 | DINDIGUL | 9 | 22-04-2024 | 14:13 | 22-04-2024 | 14:13 | 0 |
| 35 | PALAKKODU -3 | DHARMAPURI | 3 | 22-04-2024 | 14:13 | 22-04-2024 | 14:13 | 0 |
| 36 | GUDIYATHAM -9 | VELLORE | 3 | 22-04-2024 | 14:13 | 22-04-2024 | 14:13 | 0 |
| 37 | MADURAI -1 | MADURAI | 7 | 22-04-2024 | 01:23 | 22-04-2024 | 01:23 | 0 |
| 38 | UTHAMAPALAYAM -3 | THENI | 27 | 21-04-2024 | 01:42 | 21-04-2024 | 01:42 | 0 |
| 39 | BHAVANISAGAR -1 | SATHYAMANGALAM | 9 | 20-04-2024 | 02:01 | 20-04-2024 | 02:01 | 0 |
| 40 | HASSANUR -3 | HASSANUR | 4 | 17-04-2024 | 14:07 | 17-04-2024 | 14:07 | 0 |
| 41 | PALANI -8 | KODAIKANAL | 3 | 17-04-2024 | 01:16 | 17-04-2024 | 01:16 | 0 |
| 42 | DENKANIKOTTAI -18 | HOSUR | 5 | 16-04-2024 | 14:25 | 16-04-2024 | 14:25 | 0 |
| 43 | PALANI -7 | KODAIKANAL | 12 | 15-04-2024 | 01:54 | 15-04-2024 | 01:54 | 0 |
| 44 | ODDANCHATRAM -1 | DINDIGUL | 8 | 15-04-2024 | 01:54 | 15-04-2024 | 01:54 | 0 |
| 45 | KOTTAPATTY -5 | DHARMAPURI | 3 | 14-04-2024 | 13:22 | 14-04-2024 | 13:22 | 0 |
| 46 | DENKANIKOTTAI -17 | HOSUR | 3 | 13-04-2024 | 13:41 | 13-04-2024 | 13:41 | 0 |
| 47 | DENKANIKOTTAI -16 | HOSUR | 4 | 11-04-2024 | 14:19 | 11-04-2024 | 14:19 | 0 |
| 48 | AZHAGIAPANDIPURAM -5 | KANYAKUMARI | 5 | 11-04-2024 | 01:29 | 11-04-2024 | 01:29 | 0 |
| 49 | DENKANIKOTTAI -15 | HOSUR | 3 | 10-04-2024 | 12:57 | 10-04-2024 | 12:57 | 0 |
| 50 | AMBUR -5 | TIRUPPATTUR | 4 | 08-04-2024 | 13:35 | 08-04-2024 | 13:35 | 0 |
| 51 | SANTHAVASAL -1 | TIRUVANNAMALAI | 4 | 08-04-2024 | 13:35 | 08-04-2024 | 13:35 | 0 |
| 52 | ANDHIYUR -1 | ERODE | 17 | 08-04-2024 | 02:25 | 08-04-2024 | 13:35 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 53 | DEVATHANAPATTY -5 | KODAIKANAL | 3 | 08-04-2024 | 02:25 | 08-04-2024 | 02:25 | 0 |
| 54 | NAMAKKAL -2 | NAMAKKAL | 7 | 08-04-2024 | 02:25 | 08-04-2024 | 13:35 | 0 |
| 55 | KOTTAPATTY -2 | DHARMAPURI | 3 | 07-04-2024 | 13:54 | 07-04-2024 | 13:54 | 0 |
| 56 | GUDIYATHAM -8 | VELLORE | 3 | 07-04-2024 | 13:54 | 07-04-2024 | 13:54 | 0 |
| 57 | KOTTAPATTY -4 | DHARMAPURI | 5 | 07-04-2024 | 13:54 | 07-04-2024 | 13:54 | 0 |
| 58 | AMBUR -4 | TIRUPPATTUR | 9 | 07-04-2024 | 13:54 | 07-04-2024 | 13:54 | 0 |
| 59 | THIRUTTANI -3 | TIRUVALLUR | 6 | 07-04-2024 | 13:54 | 07-04-2024 | 13:54 | 0 |
| 60 | DEVATHANAPATTY -4 | KODAIKANAL | 7 | 07-04-2024 | 01:04 | 07-04-2024 | 13:54 | 0 |
| 61 | KANNIVADY -2 | DINDIGUL | 10 | 07-04-2024 | 01:04 | 07-04-2024 | 01:04 | 0 |
| 62 | DENKANIKOTTAI -13 | HOSUR | 3 | 05-04-2024 | 12:51 | 05-04-2024 | 12:51 | 0 |
| 63 | GUDIYATHAM -7 | VELLORE | 6 | 04-04-2024 | 13:10 | 04-04-2024 | 13:10 | 0 |
| 64 | UTHAMAPALAYAM -2 | THENI | 11 | 03-04-2024 | 13:29 | 03-04-2024 | 13:29 | 0 |
| 65 | BODI -5 | THENI | 16 | 03-04-2024 | 13:29 | 03-04-2024 | 13:29 | 0 |
| 66 | BARGUR -1 | ERODE | 4 | 03-04-2024 | 13:29 | 03-04-2024 | 13:29 | 0 |
| 67 | THIRUTTANI -1 | TIRUVALLUR | 24 | 03-04-2024 | 13:29 | 03-04-2024 | 13:29 | 0 |
| 68 | UPPER KODAYAR -1 | KALAKAD | 15 | 02-04-2024 | 00:57 | 02-04-2024 | 13:47 | 0 |
| 69 | ARCOT -5 | VELLORE | 6 | 02-04-2024 | 00:57 | 02-04-2024 | 00:57 | 0 |
| 70 | DENKANIKOTTAI -11 | HOSUR | 3 | 31-03-2024 | 14:25 | 31-03-2024 | 14:25 | 0 |
| 71 | KOTTAPATTY -1 | DHARMAPURI | 3 | 31-03-2024 | 14:25 | 31-03-2024 | 14:25 | 0 |
| 72 | JAMNAMARATHUR -1 | TIRUVANNAMALAI | 7 | 31-03-2024 | 12:45 | 31-03-2024 | 12:45 | 0 |
| 73 | PALAKKODU -1 | DHARMAPURI | 8 | 31-03-2024 | 12:45 | 31-03-2024 | 12:45 | 0 |
| 74 | NILGIRIS EASTERN SLOPE -1 | THE NILGIRIS | 7 | 31-03-2024 | 01:35 | 31-03-2024 | 01:35 | 0 |
| 75 | THENI -2 | THENI | 7 | 31-03-2024 | 01:35 | 31-03-2024 | 01:35 | 0 |
| 76 | DEVATHANAPATTY -2 | KODAIKANAL | 25 | 31-03-2024 | 01:35 | 31-03-2024 | 12:45 | 0 |
| 77 | DENKANIKOTTAI -9 | HOSUR | 8 | 30-03-2024 | 13:04 | 30-03-2024 | 13:04 | 0 |
| 78 | DENKANIKOTTAI -10 | HOSUR | 4 | 30-03-2024 | 13:04 | 30-03-2024 | 13:04 | 0 |
| 79 | HARUR -3 | DHARMAPURI | 7 | 30-03-2024 | 13:04 | 30-03-2024 | 13:04 | 0 |
| 80 | CHENGAM -4 | TIRUVANNAMALAI | 4 | 30-03-2024 | 13:04 | 30-03-2024 | 13:04 | 0 |
| 81 | VELIMALAI -1 | KANYAKUMARI | 33 | 30-03-2024 | 01:54 | 30-03-2024 | 13:04 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 82 | DENKANIKOTTAI -8 | HOSUR | 7 | 28-03-2024 | 13:41 | 28-03-2024 | 13:41 | 0 |
| 83 | AMBUR -3 | TIRUPPATTUR | 6 | 28-03-2024 | 13:41 | 28-03-2024 | 13:41 | 0 |
| 84 | KORAKUNDAH -1 | THE NILGIRIS | 1 | 28-03-2024 | 02:31 | 28-03-2024 | 02:31 | 0 |
| 85 | ARCOT -4 | VELLORE | 12 | 28-03-2024 | 02:31 | 28-03-2024 | 13:41 | 0 |
| 86 | DENKANIKOTTAI -7 | HOSUR | 6 | 27-03-2024 | 14:00 | 27-03-2024 | 14:00 | 0 |
| 87 | BODI -3 | THENI | 20 | 27-03-2024 | 01:10 | 27-03-2024 | 14:00 | 0 |
| 88 | BODI -2 | THENI | 22 | 27-03-2024 | 01:10 | 27-03-2024 | 01:10 | 0 |
| 89 | HASSANUR -2 | HASSANUR | 6 | 26-03-2024 | 14:19 | 26-03-2024 | 14:19 | 0 |
| 90 | PALANI -5 | KODAIKANAL | 11 | 26-03-2024 | 14:19 | 26-03-2024 | 14:19 | 0 |
| 91 | DENKANIKOTTAI -6 | HOSUR | 8 | 26-03-2024 | 14:19 | 26-03-2024 | 14:19 | 0 |
| 92 | DENKANIKOTTAI -5 | HOSUR | 6 | 26-03-2024 | 14:19 | 26-03-2024 | 14:19 | 0 |
| 93 | GUDIYATHAM -6 | VELLORE | 3 | 26-03-2024 | 14:19 | 26-03-2024 | 14:19 | 0 |
| 94 | ODUGATHUR -2 | VELLORE | 10 | 26-03-2024 | 14:19 | 26-03-2024 | 14:19 | 0 |
| 95 | DENKANIKOTTAI -4 | HOSUR | 12 | 25-03-2024 | 12:58 | 25-03-2024 | 12:58 | 0 |
| 96 | YERCAUD -1 | SALEM | 3 | 25-03-2024 | 12:58 | 25-03-2024 | 12:58 | 0 |
| 97 | KODAIKANAL -4 | KODAIKANAL | 4 | 25-03-2024 | 01:48 | 25-03-2024 | 01:48 | 0 |
| 98 | SIRUMALAI -3 | DINDIGUL | 3 | 24-03-2024 | 02:07 | 24-03-2024 | 02:07 | 0 |
| 99 | THANIPADI -1 | TIRUVANNAMALAI | 8 | 24-03-2024 | 02:07 | 24-03-2024 | 02:07 | 0 |
| 100 | GUDIYATHAM -5 | VELLORE | 3 | 23-03-2024 | 13:35 | 23-03-2024 | 13:35 | 0 |
| 101 | PUDUPALAYAM -1 | TIRUVANNAMALAI | 11 | 22-03-2024 | 13:54 | 22-03-2024 | 13:54 | 0 |
| 102 | AZHAGIAPANDIPURAM -3 | KANYAKUMARI | 6 | 21-03-2024 | 01:22 | 21-03-2024 | 01:22 | 0 |
| 103 | DEVATHANAPATTY -1 | KODAIKANAL | 21 | 21-03-2024 | 01:22 | 21-03-2024 | 01:22 | 0 |
| 104 | SINGARAPETTAI -3 | TIRUPATTUR | 4 | 20-03-2024 | 01:41 | 20-03-2024 | 12:51 | 0 |
| 105 | HARUR -1 | DHARMAPURI | 7 | 19-03-2024 | 13:10 | 19-03-2024 | 13:10 | 0 |
| 106 | TIRUPPATTUR -4 | TIRUPATTUR | 3 | 19-03-2024 | 13:10 | 19-03-2024 | 13:10 | 0 |
| 107 | ODUGATHUR -1 | VELLORE | 9 | 19-03-2024 | 13:10 | 19-03-2024 | 13:10 | 0 |
| 108 | AZHAGIAPANDIPURAM -1 | KANYAKUMARI | 21 | 19-03-2024 | 02:00 | 19-03-2024 | 02:00 | 0 |
| 109 | ATTUR -1 | ATTUR | 3 | 17-03-2024 | 13:47 | 17-03-2024 | 13:47 | 0 |
| 110 | PERAMBALUR -1 | PERAMBALUR | 3 | 17-03-2024 | 13:47 | 17-03-2024 | 13:47 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 111 | AMARAVATHI -1 | TIRUPPUR | 3 | 17-03-2024 | 00:57 | 17-03-2024 | 00:57 | 0 |
| 112 | KANNIVADY -1 | DINDIGUL | 24 | 17-03-2024 | 00:57 | 17-03-2024 | 13:47 | 0 |
| 113 | TIRUVANNAMALAI -1 | TIRUVANNAMALAI | 14 | 17-03-2024 | 00:57 | 17-03-2024 | 00:57 | 0 |
| 114 | UDUMALAIPETTAI -1 | TIRUPPUR | 18 | 16-03-2024 | 01:17 | 16-03-2024 | 01:17 | 0 |
| 115 | KOTHAGIRI -1 | THE NILGIRIS | 5 | 15-03-2024 | 01:35 | 15-03-2024 | 01:35 | 0 |
| 116 | TIRUPPATTUR -3 | TIRUPPATTUR | 3 | 11-03-2024 | 14:00 | 11-03-2024 | 14:00 | 0 |
| 117 | BATHALAGUNDU -1 | DINDIGUL | 6 | 11-03-2024 | 01:10 | 11-03-2024 | 01:10 | 0 |
| 118 | SIRUMALAI -2 | DINDIGUL | 3 | 11-03-2024 | 01:10 | 11-03-2024 | 01:10 | 0 |
| 119 | DENKANIKOTTAI -2 | HOSUR | 16 | 10-03-2024 | 14:19 | 10-03-2024 | 14:19 | 0 |
| 120 | ARCOT -3 | VELLORE | 19 | 10-03-2024 | 14:19 | 10-03-2024 | 12:38 | 0 |
| 121 | BODI -1 | THENI | 25 | 09-03-2024 | 01:47 | 09-03-2024 | 01:47 | 0 |
| 122 | KODAIKANAL -2 | KODAIKANAL | 11 | 09-03-2024 | 01:47 | 09-03-2024 | 12:57 | 0 |
| 123 | SHERVAROY SOUTH -1 | SALEM | 6 | 08-03-2024 | 13:16 | 08-03-2024 | 13:16 | 0 |
| 124 | AMBUR -2 | TIRUPPATTUR | 11 | 08-03-2024 | 13:16 | 08-03-2024 | 13:16 | 0 |
| 125 | PALLIPATTU -4 | TIRUVALLUR | 6 | 08-03-2024 | 13:16 | 08-03-2024 | 13:16 | 0 |
| 126 | SIRUMALAI -1 | DINDIGUL | 13 | 08-03-2024 | 02:06 | 08-03-2024 | 02:06 | 0 |
| 127 | TIRUPPATTUR -2 | TIRUPATTUR | 10 | 08-03-2024 | 02:06 | 08-03-2024 | 02:06 | 0 |
| 128 | ANCHETTY -1 | HOSUR | 10 | 07-03-2024 | 13:34 | 07-03-2024 | 13:34 | 0 |
| 129 | SINGARAPETTAI -2 | TIRUPPATTUR | 3 | 07-03-2024 | 13:34 | 07-03-2024 | 13:34 | 0 |
| 130 | GUDIYATHAM -3 | VELLORE | 20 | 07-03-2024 | 13:34 | 07-03-2024 | 13:34 | 0 |
| 131 | POLUR -1 | TIRUVANNAMALAI | 7 | 07-03-2024 | 13:34 | 07-03-2024 | 13:34 | 0 |
| 132 | GUDIYATHAM -2 | VELLORE | 10 | 05-03-2024 | 14:12 | 05-03-2024 | 14:12 | 0 |
| 133 | CHENGAM -2 | TIRUVANNAMALAI | 8 | 05-03-2024 | 14:12 | 05-03-2024 | 14:12 | 0 |
| 134 | KODAIKANAL -1 | KODAIKANAL | 19 | 05-03-2024 | 01:22 | 05-03-2024 | 01:22 | 0 |
| 135 | AMBUR -1 | TIRUPATTUR | 14 | 05-03-2024 | 01:22 | 05-03-2024 | 01:22 | 0 |
| 136 | ARCOT -2 | VELLORE | 11 | 02-03-2024 | 02:19 | 02-03-2024 | 02:19 | 0 |
| 137 | MUDUMALAI -1 | THE NILGIRIS | 5 | 01-03-2024 | 13:47 | 01-03-2024 | 13:47 | 0 |
| 138 | KUPPAM -3 | - | 1 | 01-03-2024 | 13:47 | 01-03-2024 | 13:47 | 0 |
| 139 | ARANI -1 | TIRUVANNAMALAI | 12 | 01-03-2024 | 13:47 | 01-03-2024 | 13:47 | 0 |
| 140 | PALLIPATTU -3 | TIRUVALLUR | 11 | 01-03-2024 | 13:47 | 01-03-2024 | 13:47 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 141 | TALAVADI -1 | HASSANUR | 3 | 29-02-2024 | 14:06 | 29-02-2024 | 14:06 | 0 |
| 142 | HASSANUR -1 | HASSANUR | 3 | 29-02-2024 | 14:06 | 29-02-2024 | 14:06 | 0 |
| 143 | PALANI -1 | KODAIKANAL | 9 | 29-02-2024 | 01:16 | 29-02-2024 | 01:16 | 0 |
| 144 | TIRUPPATTUR -1 | TIRUPATTUR | 14 | 28-02-2024 | 14:25 | 28-02-2024 | 14:25 | 0 |
| 145 | PALLIPATTU -2 | TIRUVALLUR | 17 | 28-02-2024 | 12:45 | 28-02-2024 | 12:45 | 0 |
| 146 | PERUMPALLAM -3 | KODAIKANAL | 9 | 28-02-2024 | 01:35 | 28-02-2024 | 01:35 | 0 |
| 147 | PERUMPALLAM -2 | KODAIKANAL | 8 | 27-02-2024 | 01:54 | 27-02-2024 | 01:54 | 0 |
| 148 | PALLIPATTU -1 | TIRUVALLUR | 12 | 25-02-2024 | 13:41 | 25-02-2024 | 13:41 | 0 |
| 149 | DENKANIKOTTAI -1 | HOSUR | 10 | 19-02-2024 | 13:54 | 19-02-2024 | 13:54 | 0 |
| 150 | ALANGAYAM -1 | TIRUPATTUR | 13 | 18-02-2024 | 14:12 | 18-02-2024 | 14:12 | 0 |
| 151 | GUDIYATHAM -1 | VELLORE | 13 | 18-02-2024 | 14:12 | 18-02-2024 | 14:12 | 0 |
| 152 | ARCOT -1 | VELLORE | 16 | 18-02-2024 | 14:12 | 18-02-2024 | 14:12 | 0 |
| 153 | PERUMPALLAM -1 | KODAIKANAL | 15 | 11-02-2024 | 01:53 | 11-02-2024 | 01:53 | 0 |
| 154 | CHENGAM -1 | TIRUVANNAMALAI | 12 | 09-02-2024 | 13:41 | 09-02-2024 | 13:41 | 0 |
| 155 | GOVERNOR SHOLA -1 | THE NILGIRIS | 19 | 07-02-2024 | 14:18 | 07-02-2024 | 14:18 | 0 |
| 156 | HOSUR -1 | HOSUR | 6 | 07-02-2024 | 14:18 | 07-02-2024 | 14:18 | 0 |
| 157 | PUDUKKOTTAI -1 | PUDUKKOTTAI | 4 | 04-02-2024 | 13:35 | 04-02-2024 | 13:35 | 0 |

## Table: 2.2 Less than 3 days (44 LFF)

| Sl. NO | Fire Name | Division/ District | Total Pixels | First Detection Date | First Detection Time | Last Detection Date | Last Detection Time | No. of days active |
|---|---|---|---|---|---|---|---|---|
| 1 | PYKARA -1 | THE NILGIRIS | 6 | 26-04-2024 | 12:57 | 28-04-2024 | 14:00 | 2 |
| 2 | MANNAVANUR -6 | KODAIKANAL | 9 | 24-04-2024 | 13:35 | 26-04-2024 | 12:57 | 2 |
| 3 | MANNAVANUR -5 | KODAIKANAL | 4 | 18-04-2024 | 13:48 | 20-04-2024 | 02:01 | 2 |
| 4 | PERUMPALLAM -8 | KODAIKANAL | 17 | 09-04-2024 | 13:17 | 11-04-2024 | 01:29 | 2 |
| 5 | UDHAGAI NORTH -1 | THE NILGIRIS | 10 | 08-04-2024 | 13:35 | 10-04-2024 | 01:48 | 2 |
| 6 | DENKANIKOTTAI -14 | HOSUR | 13 | 07-04-2024 | 13:54 | 09-04-2024 | 02:07 | 2 |
| 7 | PALAKKODU -2 | DHARMAPURI | 8 | 07-04-2024 | 13:54 | 09-04-2024 | 13:17 | 2 |
| 8 | ALANGAYAM -2 | TIRUPPATTUR | 9 | 31-03-2024 | 01:35 | 02-04-2024 | 13:47 | 2 |
| 9 | BODI -4 | THENI | 31 | 27-03-2024 | 01:10 | 29-03-2024 | 02:13 | 2 |
| 10 | AZHAGIAPANDIPURAM -4 | KANYAKUMARI | 22 | 24-03-2024 | 13:17 | 26-03-2024 | 01:31 | 2 |
| 11 | PALANI -3 | KODAIKANAL | 22 | 19-03-2024 | 02:00 | 21-03-2024 | 01:22 | 2 |
| 12 | KRISHNAGIRI -1 | HOSUR | 9 | 18-03-2024 | 13:29 | 20-03-2024 | 14:31 | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **13** | SHERVAROY SOUTH -3 | SALEM | 16 | 17-03-2024 | 13:47 | 19-03-2024 | 02:00 | 2 |
| **14** | PERUMPALLAM -4 | KODAIKANAL | 11 | 06-03-2024 | 02:43 | 08-03-2024 | 02:06 | 2 |
| **15** | MANNAVANUR -1 | KODAIKANAL | 8 | 29-02-2024 | 14:06 | 02-03-2024 | 13:29 | 2 |
| **16** | MANNAVANUR -7 | KODAIKANAL | 5 | 26-04-2024 | 12:57 | 27-04-2024 | 01:29 | 1 |
| **17** | PERUMPALLAM -9 | KODAIKANAL | 10 | 26-04-2024 | 01:48 | 27-04-2024 | 14:19 | 1 |
| **18** | PALANI -9 | KODAIKANAL | 4 | 25-04-2024 | 02:06 | 26-04-2024 | 01:48 | 1 |
| **19** | DENKANIKOTTAI -19 | HOSUR | 4 | 23-04-2024 | 13:54 | 24-04-2024 | 13:35 | 1 |
| **20** | TIRUPPATTUR -6 | TIRUPPATTUR | 5 | 23-04-2024 | 13:54 | 24-04-2024 | 13:35 | 1 |
| **21** | THENI -3 | THENI | 13 | 17-04-2024 | 01:16 | 18-04-2024 | 13:48 | 1 |
| **22** | KORAKUNDAH -3 | THE NILGIRIS | 14 | 15-04-2024 | 13:03 | 16-04-2024 | 14:25 | 1 |
| **23** | DEVATHANAPATTY -6 | KODAIKANAL | 8 | 08-04-2024 | 13:35 | 09-04-2024 | 13:17 | 1 |
| **24** | DEVATHANAPATTY -7 | KODAIKANAL | 12 | 08-04-2024 | 13:35 | 09-04-2024 | 13:17 | 1 |
| **25** | SIRUMALAI -4 | DINDIGUL | 7 | 08-04-2024 | 02:25 | 09-04-2024 | 13:17 | 1 |
| **26** | SINGARAPETTAI -4 | TIRUPPATTUR | 8 | 07-04-2024 | 13:54 | 08-04-2024 | 13:35 | 1 |
| **27** | KOTTAPATTY -3 | DHARMAPURI | 8 | 07-04-2024 | 13:54 | 08-04-2024 | 13:35 | 1 |
| **28** | MELPET -1 | TIRUVANNAMALAI | 8 | 07-04-2024 | 13:54 | 08-04-2024 | 13:35 | 1 |
| **29** | THIRUTTANI -2 | TIRUVALLUR | 14 | 04-04-2024 | 13:10 | 05-04-2024 | 12:51 | 1 |
| **30** | HOGENAKKAL -1 | DHARMAPURI | 15 | 01-04-2024 | 14:06 | 02-04-2024 | 13:47 | 1 |
| **31** | DEVATHANAPATTY -3 | KODAIKANAL | 34 | 31-03-2024 | 01:35 | 01-04-2024 | 01:17 | 1 |
| **32** | UTHAMAPALAYAM -1 | THENI | 14 | 30-03-2024 | 01:54 | 31-03-2024 | 01:35 | 1 |
| **33** | AMARAVATHI -2 | TIRUPPUR | 4 | 26-03-2024 | 14:19 | 27-03-2024 | 01:10 | 1 |
| **34** | NAMAKKAL -1 | NAMAKKAL | 23 | 26-03-2024 | 01:31 | 27-03-2024 | 14:00 | 1 |
| **35** | HARUR -2 | DHARMAPURI | 8 | 25-03-2024 | 12:58 | 26-03-2024 | 01:31 | 1 |
| **36** | BATHALAGUNDU -3 | DINDIGUL | 12 | 25-03-2024 | 01:48 | 26-03-2024 | 01:31 | 1 |
| **37** | BATHALAGUNDU -2 | DINDIGUL | 30 | 24-03-2024 | 13:17 | 25-03-2024 | 01:48 | 1 |
| **38** | BERIJAM -1 | THENI | 12 | 20-03-2024 | 01:41 | 21-03-2024 | 01:22 | 1 |
| **39** | AZHAGIAPANDIPURAM -2 | KANYAKUMARI | 25 | 20-03-2024 | 01:41 | 21-03-2024 | 14:13 | 1 |
| **40** | CHENGAM -3 | TIRUVANNAMALAI | 10 | 14-03-2024 | 13:04 | 15-03-2024 | 01:35 | 1 |
| **41** | MANNAVANUR -2 | KODAIKANAL | 4 | 11-03-2024 | 14:00 | 12-03-2024 | 02:31 | 1 |
| **42** | THENI -1 | THENI | 18 | 11-03-2024 | 14:00 | 12-03-2024 | 02:31 | 1 |
| **43** | PALANI -2 | KODAIKANAL | 55 | 08-03-2024 | 13:16 | 09-03-2024 | 12:57 | 1 |
| **44** | SINGARAPETTAI -1 | TIRUPATTUR | 6 | 07-03-2024 | 13:34 | 08-03-2024 | 02:06 | 1 |

## Table: 2.3 Less than 5 days (11 LFF)

| Sl. NO | Fire Name | Division/ District | Total Pixels | First Detection Date | First Detection Time | Last Detection Date | Last Detection Time | No. of days active |
|---|---|---|---|---|---|---|---|---|
| **1** | PERUMPALLAM -7 | KODAIKANAL | 13 | 17-03-2024 | 13:47 | 21-03-2024 | 01:22 | 4 |
| **2** | PERUMPALLAM -6 | KODAIKANAL | 9 | 17-03-2024 | 00:57 | 21-03-2024 | 01:22 | 4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **3** | TIRUPPATTUR -8 | TIRUPPATTUR | 19 | 25-04-2024 | 13:16 | 28-04-2024 | 14:00 | 3 |
| **4** | HASSANUR -4 | HASSANUR | 10 | 24-04-2024 | 13:35 | 27-04-2024 | 01:29 | 3 |
| **5** | TIRUPPATTUR -5 | TIRUPPATTUR | 6 | 22-04-2024 | 14:13 | 25-04-2024 | 13:16 | 3 |
| **6** | PALANI -6 | KODAIKANAL | 39 | 09-04-2024 | 02:07 | 12-04-2024 | 01:11 | 3 |
| **7** | KORAKUNDAH -2 | THE NILGIRIS | 56 | 07-04-2024 | 01:04 | 10-04-2024 | 12:57 | 3 |
| **8** | DENKANIKOTTAI -3 | HOSUR | 12 | 23-03-2024 | 13:35 | 26-03-2024 | 14:19 | 3 |
| **9** | PALANI -4 | KODAIKANAL | 54 | 23-03-2024 | 02:25 | 26-03-2024 | 14:19 | 3 |
| **10** | KODAIKANAL -3 | KODAIKANAL | 9 | 17-03-2024 | 13:47 | 20-03-2024 | 12:51 | 3 |
| **11** | SHERVAROY SOUTH -2 | SALEM | 18 | 17-03-2024 | 02:37 | 20-03-2024 | 14:31 | 3 |

## Table: 2.4 Less than 10 days (5 LFF)

| Sl. NO | Fire Name | Division / District | Total Pixels | First Detection Date | First Detection Time | Last Detection Date | Last Detection Time | No. of days active |
|---|---|---|---|---|---|---|---|---|
| **1** | DENKANIKOTTAI -12 | HOSUR | 32 | 01-04-2024 | 01:17 | 09-04-2024 | 02:07 | 8 |
| **2** | PERUMPALLAM - 5 | KODAIKANAL | 59 | 14-03-2024 | 13:04 | 21-03-2024 | 01:22 | 7 |
| **3** | MANNAVANUR - 3 | KODAIKANAL | 50 | 25-03-2024 | 01:48 | 31-03-2024 | 14:25 | 6 |
| **4** | UDHAGAI NORTH -2 | THE NILGIRIS | 31 | 25-04-2024 | 13:16 | 30-04-2024 | 13:23 | 5 |
| **5** | SEGUR -1 | MASINAGUDI | 23 | 05-04-2024 | 14:31 | 10-04-2024 | 14:37 | 5 |

## Table: 2.5 More than 10 days

| Sl.NO | Fire Name | Division / District | Total Pixels | First Detection Date | First Detection Time | Last Detection Date | Last Detection Time | No. of days active |
|---|---|---|---|---|---|---|---|---|
| **1** | MANNAVANUR -4 | KODAIKANAL DIVISION/ DINDIGUL | 247 | 10-04-2024 | 01:48 | 03-05-2024 | 01:16 | 23 |



# Spatial Burnt Area Assessed - 2024

## Table 3.1 Division-Wise Spatial Burnt Area - 2024

| DIVISION-WISE SPATIAL BURNT AREA - 2024 | | | | |
|---|---|---|---|---|
| **Sl. NO** | DIVISION | SPATIAL BURNT AREA (in ha) | SPATIAL BURNT AREA (in sq.km) | SPATIAL BURNT AREA (in %) |
| **1** | NILGIRIS | 5660.2 | 56.6 | 14.41% |
| **2** | HOSUR | 4284.3 | 42.8 | 10.91% |
| **3** | VELLORE | 3820.3 | 38.2 | 9.72% |
| **4** | KODAIKANAL | 3462.3 | 34.6 | 8.81% |
| **5** | TIRUVALLUR | 2280.2 | 22.8 | 5.80% |
| **6** | TIRUVANNAMALAI | 2082.4 | 20.8 | 5.30% |
| **7** | DINDIGUL | 1625.8 | 16.3 | 4.14% |
| **8** | KANYAKUMARI | 1546.8 | 15.5 | 3.94% |
| **9** | THENI | 1466.1 | 14.7 | 3.73% |
| **10** | WL ATR TIRUPPUR | 1360.7 | 13.6 | 3.46% |
| **11** | VILUPPURAM | 1198.2 | 12.0 | 3.05% |
| **12** | THOOTHUKUDI | 1062.9 | 10.6 | 2.71% |
| **13** | WL, MTR MASINAGUDI | 877.9 | 8.8 | 2.23% |
| **14** | WL, SRIVILLIPUTHUR | 832.1 | 8.3 | 2.12% |
| **15** | WL, KMTR AMBASAMUDRAM | 822.4 | 8.2 | 2.09% |
| **16** | PERAMBALUR | 639.5 | 6.4 | 1.63% |
| **17** | TIRUPPATTUR | 534.7 | 5.3 | 1.36% |
| **18** | WL, STR HASSANUR | 508.7 | 5.1 | 1.29% |
| **19** | WL, STR SATHY | 490.1 | 4.9 | 1.25% |
| **20** | WL, MTR UDHAGAI | 479.6 | 4.8 | 1.22% |
| **21** | ERODE | 466.6 | 4.7 | 1.19% |
| **22** | SALEM | 384.4 | 3.8 | 0.98% |
| **23** | NAMAKKAL | 322.8 | 3.2 | 0.82% |
| **24** | ATTUR | 301.8 | 3.0 | 0.77% |
| **25** | TIRUNELVELI | 265.7 | 2.7 | 0.68% |
| **26** | COIMBATORE | 243.3 | 2.4 | 0.62% |
| **27** | DHARMAPURI | 237.6 | 2.4 | 0.60% |
| **28** | CHENGALPATTU | 237.3 | 2.4 | 0.60% |
| **29** | PUDUKKOTTAI | 236.5 | 2.4 | 0.60% |
| **30** | CUDDALORE | 224.4 | 2.2 | 0.57% |
| **31** | WL, MEGAMALAI | 213.9 | 2.1 | 0.54% |
| **32** | ARIYALUR | 212.2 | 2.1 | 0.54% |
| **33** | CHENNAI | 171.6 | 1.7 | 0.44% |
| **34** | WL, KMTR KALAKKADU | 169.0 | 1.7 | 0.43% |
| **35** | MADURAI | 125.8 | 1.3 | 0.32% |
| **36** | WL ATR POLLACHI | 109.4 | 1.1 | 0.28% |

| | | | | |
|---|---|---|---|---|
| **37** | SIVAGANGAI | 102.4 | 1.0 | 0.26% |
| **38** | TIRUCHIRAPPALLI | 101.6 | 1.0 | 0.26% |
| **39** | WL, NAGAPATTINAM | 35.7 | 0.4 | 0.09% |
| **40** | KARUR | 30.4 | 0.3 | 0.08% |
| **41** | GUDALUR | 21.5 | 0.2 | 0.05% |
| **42** | THANJAVUR | 19.0 | 0.2 | 0.05% |
| **43** | RAMANATHAPURAM | 10.7 | 0.1 | 0.03% |
| **44** | THIRUVARUR | 8.2 | 0.1 | 0.02% |
| **45** | WL, MARINE NP | 0.6 | 0.0 | 0 |
| | TOTAL | 39287.6 ha | 392.87 sq.km | 100% |

## Table 3.2 Top 50 Ranges under Spatial Burnt Analysis

| TOP 50 RANGES UNDER SPATIAL BURNT ANALYSIS | | | | |
|---|---|---|---|---|
| **SI. NO** | **RANGE** | **SPATIAL BURNT AREA (in sq.km)** | **SPATIAL BURNT AREA (in ha)** | **SPATIAL BURNT AREA (in %)** |
| **1** | ARCOT | 27.52 | 2751.8 | 7.00486% |
| **2** | DENKANIKOTTAI | 18.75 | 1874.6 | 4.77257% |
| **3** | JAWALAGIRI | 14.45 | 1445.1 | 3.67806% |
| **4** | PALLIPATTU | 13.82 | 1382.1 | 3.51770% |
| **5** | PALANI | 10.77 | 1076.9 | 2.74136% |
| **6** | UDHAGAI SOUTH | 10.37 | 1037 | 2.63955% |
| **7** | TIRUCHENDUR | 10.21 | 1021 | 2.59882% |
| **8** | ARANI | 10.08 | 1007.9 | 2.56573% |
| **9** | ULUNDURPETTAI | 8.75 | 875.1 | 2.22720% |
| **10** | THIRUTTANI | 8.64 | 863.5 | 2.19920% |
| **11** | PYKARA | 8.44 | 843.7 | 2.14829% |
| **12** | POLUR | 8.05 | 805.5 | 2.04902% |
| **13** | SRIVILLIPUTTUR | 7.07 | 707.4 | 1.79958% |
| **14** | MUNDANTHURAI | 6.82 | 681.8 | 1.73594% |
| **15** | SEGUR | 6.75 | 674.8 | 1.71813% |
| **16** | KORAKUNDAH | 6.53 | 653.2 | 1.66213% |
| **17** | GOVERNOR SHOLA | 6.37 | 637.4 | 1.62140% |
| **18** | ANCHETTY | 6.33 | 633 | 1.61122% |
| **19** | KANNIVADI | 6.03 | 602.5 | 1.53486% |
| **20** | AZHAGIAPANDIPURAM | 5.94 | 593.9 | 1.51195% |
| **21** | PERUMPALLAM | 5.87 | 587.2 | 1.49413% |
| **22** | VELLORE | 5.76 | 575.7 | 1.46613% |
| **23** | PARSONS VALLEY | 5.7 | 569.9 | 1.45086% |
| **24** | DEVADANAPPATTI | 5.6 | 560 | 1.42541% |
| **25** | UDUMALAIPETTAI | 5.4 | 540.1 | 1.37450% |
| **26** | MANNAVANUR | 5.33 | 533.4 | 1.35668% |
| **27** | ODDANCHATRAM | 5.15 | 515.1 | 1.31087% |
| **28** | BODI | 5.12 | 511.7 | 1.30323% |

| | | | | |
|---|---|---|---|---|
| **29** | KATTABETTU | 4.96 | 495.9 | 1.26250% |
| **30** | THENI | 4.57 | 457 | 1.16323% |
| **31** | KOTHAGIRI | 4.35 | 435.3 | 1.10724% |
| **32** | PERAMBALUR | 4.24 | 423.5 | 1.07924% |
| **33** | MUDUMALAI | 3.83 | 382.6 | 0.97488% |
| **34** | KODAIKANAL | 3.77 | 376.8 | 0.95960% |
| **35** | AMARAVATHI | 3.6 | 360.2 | 0.91633% |
| **36** | UDHAGAI NORTH | 3.53 | 352.5 | 0.89852% |
| **37** | ANDHIYUR | 3.32 | 331.7 | 0.84506% |
| **38** | KALIYAL | 3.28 | 328.3 | 0.83488% |
| **39** | GERMALAM | 3.27 | 327 | 0.83234% |
| **40** | POOMBARAI | 3.22 | 321.8 | 0.81961% |
| **41** | VATTALAKUNDU | 3.12 | 312.3 | 0.79416% |
| **42** | KULASEKARAM | 3.07 | 306.8 | 0.78143% |
| **43** | VELIMALAI | 2.99 | 299.4 | 0.76107% |
| **44** | KOLUMAM | 2.96 | 296.1 | 0.75343% |
| **45** | NAMAKKAL | 2.83 | 282.6 | 0.72034% |
| **46** | UTHAMAPALAYAM | 2.77 | 276.8 | 0.70507% |
| **47** | TIRUPPATTUR | 2.55 | 255.3 | 0.64907% |
| **48** | SHERVAROYS SOUTH | 2.39 | 238.6 | 0.60834% |
| **49** | VEPPANTHATTAI | 2.16 | 216 | 0.54980% |
| **50** | VRIDDHACHALAM | 2.13 | 212.7 | 0.54216% |

## Table 3.3 Top 100 Beats under Spatial Burnt Analysis

| TOP 100 BEATS UNDER SPATIAL BURNT ANALYSIS | | | | |
|---|---|---|---|---|
| **Sl. No** | **BEAT** | **SPATIAL BURNT AREA (in sq.km)** | **SPATIAL BURNT AREA (in ha)** | **SPATIAL BURNT AREA (in %)** |
| **1** | PUNGANUR NORTH | 7.696641 | 769.6641 | 1.95907% |
| **2** | AMMUR NORTH | 6.813173 | 681.3173 | 1.73419% |
| **3** | MADDUR | 6.256455 | 625.6455 | 1.59249% |
| **4** | SANDYNALLA | 6.157361 | 615.7361 | 1.56727% |
| **5** | PUNGANUR SOUTH | 5.452267 | 545.2267 | 1.38779% |
| **6** | NAZARETH | 5.24773 | 524.773 | 1.33573% |
| **7** | NATTHAM | 5.072687 | 507.2687 | 1.29118% |
| **8** | PULLUR EAST | 4.803641 | 480.3641 | 1.22270% |
| **9** | ALIALAMANGALAM NORTH | 4.696842 | 469.6842 | 1.19551% |
| **10** | POOSIMALAIKUPPAM | 4.601024 | 460.1024 | 1.17112% |
| **11** | VARANJARAM | 4.502507 | 450.2507 | 1.14605% |
| **12** | GLENMARGAN | 4.1443 | 414.43 | 1.05487% |
| **13** | KRISHNAPURAM WEST | 4.094147 | 409.4147 | 1.04210% |
| **14** | PARICOMBAI WEST | 3.9647 | 396.47 | 1.00916% |
| **15** | UPPER BHAVANI | 3.945379 | 394.5379 | 1.00424% |
| **16** | MYLAR | 3.7903 | 379.03 | 0.96477% |

| | | | | |
|---|---|---|---|---|
| **17** | JALDARAI | 3.765305 | 376.5305 | 0.95840% |
| **18** | GOVERNOR SHOLA | 3.740648 | 374.0648 | 0.95213% |
| **19** | PANAI WEST | 3.376648 | 337.6648 | 0.85948% |
| **20** | SIROOR SOUTH | 3.28868 | 328.868 | 0.83709% |
| **21** | NOGANUR | 3.19402 | 319.402 | 0.81299% |
| **22** | MANJAMPATTI SOUTH | 3.052559 | 305.2559 | 0.77698% |
| **23** | PUDUR | 3.047559 | 304.7559 | 0.77571% |
| **24** | THADIKARANKONAM SOUTH | 2.867135 | 286.7135 | 0.72979% |
| **25** | AVALANCHE | 2.789595 | 278.9595 | 0.71005% |
| **26** | THOLUVABETTA EAST | 2.707437 | 270.7437 | 0.68914% |
| **27** | VIRIYANKOIL | 2.666619 | 266.6619 | 0.67875% |
| **28** | ALIALAMANGALEM SOUTH | 2.645515 | 264.5515 | 0.67338% |
| **29** | KATCHANAVILAI | 2.620815 | 262.0815 | 0.66709% |
| **30** | BALASAMUDRAM WEST | 2.616455 | 261.6455 | 0.66598% |
| **31** | NOCHILI | 2.595706 | 259.5706 | 0.66070% |
| **32** | PARSONS VALLEY | 2.499574 | 249.9574 | 0.63623% |
| **33** | KARMARPET | 2.490603 | 249.0603 | 0.63395% |
| **34** | KOZHIMUND | 2.437482 | 243.7482 | 0.62043% |
| **35** | RANJANKUDI | 2.362038 | 236.2038 | 0.60122% |
| **36** | KANNIVADI | 2.349917 | 234.9917 | 0.59814% |
| **37** | BIKKAPATHY | 2.332261 | 233.2261 | 0.59364% |
| **38** | PONNUR | 2.325454 | 232.5454 | 0.59191% |
| **39** | THIRUTTANI | 2.315503 | 231.5503 | 0.58938% |
| **40** | THALI NORTH | 2.303436 | 230.3436 | 0.58631% |
| **41** | SITHAYANKOTTAI | 2.302981 | 230.2981 | 0.58619% |
| **42** | VANDAL | 2.300399 | 230.0399 | 0.58553% |
| **43** | MINCHIGULI | 2.232846 | 223.2846 | 0.56834% |
| **44** | BERGANI | 2.196087 | 219.6087 | 0.55898% |
| **45** | ATHITHONDU | 2.189135 | 218.9135 | 0.55721% |
| **46** | GUDIYUR | 2.166559 | 216.6559 | 0.55147% |
| **47** | ASAMBU | 2.058469 | 205.8469 | 0.52395% |
| **48** | ULIBANDA NORTH | 2.041824 | 204.1824 | 0.51972% |
| **49** | THATHANUR | 2.040539 | 204.0539 | 0.51939% |
| **50** | KALAYAMPUTHUR | 1.999074 | 199.9074 | 0.50883% |
| **51** | SIROOR NORTH | 1.988504 | 198.8504 | 0.50614% |
| **52** | THUKKARAMUND | 1.982752 | 198.2752 | 0.50468% |
| **53** | THALAKARAI | 1.95595 | 195.595 | 0.49786% |
| **54** | KOTHARU | 1.944048 | 194.4048 | 0.49483% |
| **55** | PANAI EAST | 1.871119 | 187.1119 | 0.47627% |
| **56** | KHANSAPURAM II | 1.869633 | 186.9633 | 0.47589% |
| **57** | PERALI | 1.861022 | 186.1022 | 0.47370% |
| **58** | SHOLUR | 1.849618 | 184.9618 | 0.47079% |
| **59** | AMMUR SOUTH | 1.80275 | 180.275 | 0.45886% |
| **60** | PEDDARAMAPURAM | 1.796043 | 179.6043 | 0.45716% |

| | | | | |
|---|---|---|---|---|
| **61** | JAWALAGIRI SOUTH | 1.763451 | 176.3451 | 0.44886% |
| **62** | KURANGANI SOUTH | 1.741437 | 174.1437 | 0.44326% |
| **63** | THAMMAPURAM | 1.720343 | 172.0343 | 0.43789% |
| **64** | MARUTHAMPARAI | 1.65187 | 165.187 | 0.42046% |
| **65** | PALLANGI EAST | 1.641549 | 164.1549 | 0.41783% |
| **66** | PANNAIKADU | 1.618033 | 161.8033 | 0.41185% |
| **67** | KANNIKATTY | 1.608725 | 160.8725 | 0.40948% |
| **68** | BETTAMUGILALAM | 1.593233 | 159.3233 | 0.40553% |
| **69** | ELADA | 1.588355 | 158.8355 | 0.40429% |
| **70** | KODANADU | 1.582548 | 158.2548 | 0.40281% |
| **71** | KARMANGUDI | 1.55045 | 155.045 | 0.39464% |
| **72** | VENBAVUR | 1.545224 | 154.5224 | 0.39331% |
| **73** | VARATTAR | 1.528824 | 152.8824 | 0.38914% |
| **74** | KULASEKARAM NORTH | 1.502437 | 150.2437 | 0.38242% |
| **75** | KAVALAPATTY | 1.500015 | 150.0015 | 0.38181% |
| **76** | KONMAKKANAPALLI | 1.490343 | 149.0343 | 0.37934% |
| **77** | PYKARA | 1.489475 | 148.9475 | 0.37912% |
| **78** | KALIYAL | 1.48034 | 148.034 | 0.37680% |
| **79** | KOKKANAMALAI | 1.457887 | 145.7887 | 0.37108% |
| **80** | KARIYAMUND | 1.420325 | 142.0325 | 0.36152% |
| **81** | MARANDAHALLI SOUTH | 1.419509 | 141.9509 | 0.36132% |
| **82** | AYAKKUDI | 1.391096 | 139.1096 | 0.35408% |
| **83** | GLENMORGAN(S) | 1.383173 | 138.3173 | 0.35207% |
| **84** | OODAKKADU | 1.381225 | 138.1225 | 0.35157% |
| **85** | KANIYAMBADI | 1.36996 | 136.996 | 0.34870% |
| **86** | KANAM | 1.360302 | 136.0302 | 0.34624% |
| **87** | PATCHALUR | 1.318955 | 131.8955 | 0.33572% |
| **88** | VELIMALAI NORTH | 1.282132 | 128.2132 | 0.32635% |
| **89** | MANALAR(D) | 1.281162 | 128.1162 | 0.32610% |
| **90** | THOLUVABETTA WEST | 1.262965 | 126.2965 | 0.32147% |
| **91** | RASINGAPURAM | 1.246839 | 124.6839 | 0.31736% |
| **92** | KUNDUKOTTAI | 1.225302 | 122.5302 | 0.31188% |
| **93** | GUNDAR NORTH | 1.214104 | 121.4104 | 0.30903% |
| **94** | ULIBANDA SOUTH | 1.213353 | 121.3353 | 0.30884% |
| **95** | MINJIGAN BOLI | 1.202499 | 120.2499 | 0.30608% |
| **96** | KANAVAIPATTY(D) | 1.196767 | 119.6767 | 0.30462% |
| **97** | KUMILI | 1.180514 | 118.0514 | 0.30048% |
| **98** | MACHUR | 1.174559 | 117.4559 | 0.29897% |
| **99** | MELPALLAM | 1.170621 | 117.0621 | 0.29796% |
| **100** | KANJAMALAI | 1.166918 | 116.6918 | 0.29702% |

## Table: 3.4 Top 150 RF under Spatial Burnt Analysis

| TOP 150 RF UNDER SPATIAL BURNT ANALYSIS | | | | |
|---|---|---|---|---|
| **Sl. NO** | **RESERVED FORESTS** | **SPATIAL BURNT AREA (in sq.km)** | **SPATIAL BURNT AREA (in ha)** | **SPATIAL BURNT AREA (in %)** |
| **1** | WENLOCK DOWN | 24.923181 | 2492.3181 | 6.90977% |
| **2** | PUNGANUR | 18.174008 | 1817.4008 | 5.03861% |
| **3** | KUNDAH | 11.933436 | 1193.3436 | 3.30846% |
| **4** | KUDIRAIMOLI TERI | 10.20729 | 1020.729 | 2.82990% |
| **5** | AMPTHILLDOWN | 8.72225 | 872.225 | 2.41818% |
| **6** | AMMOOR | 8.591118 | 859.1118 | 2.38182% |
| **7** | BODI NORTH HILL | 8.332813 | 833.2813 | 2.31021% |
| **8** | VIRAPULI | 8.036968 | 803.6968 | 2.22819% |
| **9** | PANAI | 7.956174 | 795.6174 | 2.20579% |
| **10** | P V VALLEY | 7.501242 | 750.1242 | 2.07966% |
| **11** | ALIALAMANGALAM | 7.311078 | 731.1078 | 2.02694% |
| **12** | SRIVILLIPUTHUR | 7.122052 | 712.2052 | 1.97454% |
| **13** | SEGUR | 6.228601 | 622.8601 | 1.72683% |
| **14** | KANNIVADI BLOCK I | 5.680195 | 568.0195 | 1.57479% |
| **15** | ANAIMALAI | 5.603415 | 560.3415 | 1.55351% |
| **16** | NEDIUM | 4.786256 | 478.6256 | 1.32695% |
| **17** | THALLY | 4.645725 | 464.5725 | 1.28799% |
| **18** | KALAMALAI | 4.377904 | 437.7904 | 1.21374% |
| **19** | GUTTIYALATTUR | 4.367911 | 436.7911 | 1.21097% |
| **20** | TOTTAPADI | 4.084567 | 408.4567 | 1.13242% |
| **21** | MUDUMALAI & KUMBARAKOLLI | 4.034169 | 403.4169 | 1.11844% |
| **22** | S U VANAM | 3.940611 | 394.0611 | 1.09251% |
| **23** | AIYUR | 3.759014 | 375.9014 | 1.04216% |
| **24** | TALAMALAI | 3.748324 | 374.8324 | 1.03920% |
| **25** | SOUTH BARGUR | 3.296856 | 329.6856 | 0.91403% |
| **26** | ULIBANDA | 3.252848 | 325.2848 | 0.90183% |
| **27** | PAPANASAM | 3.242668 | 324.2668 | 0.89901% |
| **28** | NOGANUR | 3.183578 | 318.3578 | 0.88262% |
| **29** | THOLUVABETTA | 3.172496 | 317.2496 | 0.87955% |
| **30** | MANJAMPATTI | 3.052559 | 305.2559 | 0.84630% |
| **31** | NILGIRI EASTERN SLOPES | 2.582785 | 258.2785 | 0.71606% |
| **32** | ASAMBU | 2.575526 | 257.5526 | 0.71405% |
| **33** | VETTIANTHOLUVAM | 2.48409 | 248.409 | 0.68870% |
| **34** | OLIYANUTHU | 2.427567 | 242.7567 | 0.67302% |
| **35** | NOCHILI | 2.403529 | 240.3529 | 0.66636% |
| **36** | JAWALGIRI | 2.304908 | 230.4908 | 0.63902% |
| **37** | ALWARMALAI | 2.11981 | 211.981 | 0.58770% |
| **38** | PERUMALMALAI (DGL) | 2.066317 | 206.6317 | 0.57287% |
| **39** | NADUVATTAM | 2.065604 | 206.5604 | 0.57267% |

| | | | | |
|---|---|---|---|---|
| **40** | BODI WEST HILLS | 1.823218 | 182.3218 | 0.50547% |
| **41** | KOTTAGUDI | 1.771293 | 177.1293 | 0.49108% |
| **42** | VANGARAM | 1.737353 | 173.7353 | 0.48167% |
| **43** | KUDIRAIYAR | 1.676432 | 167.6432 | 0.46478% |
| **44** | GUNDAR VALLEY EXTN | 1.652411 | 165.2411 | 0.45812% |
| **45** | PAITTUR | 1.627591 | 162.7591 | 0.45124% |
| **46** | VELIMALAI | 1.614481 | 161.4481 | 0.44760% |
| **47** | BIKKAPATHIMUND | 1.569974 | 156.9974 | 0.43526% |
| **48** | ADUKKAM | 1.53932 | 153.932 | 0.42677% |
| **49** | VENBAVUR | 1.522734 | 152.2734 | 0.42217% |
| **50** | KARAVALLI COMBAI | 1.511849 | 151.1849 | 0.41915% |
| **51** | VENGUNAM | 1.505126 | 150.5126 | 0.41729% |
| **52** | MAMBAKKAM | 1.491782 | 149.1782 | 0.41359% |
| **53** | MANGALAM (PMB) | 1.438024 | 143.8024 | 0.39868% |
| **54** | MARANDAHALLI EXTN | 1.430612 | 143.0612 | 0.39663% |
| **55** | MARANDAHALLI | 1.419199 | 141.9199 | 0.39346% |
| **56** | PAMBAR | 1.40923 | 140.923 | 0.39070% |
| **57** | MOOLAIYAR | 1.385292 | 138.5292 | 0.38406% |
| **58** | BEERGANI | 1.383928 | 138.3928 | 0.38368% |
| **59** | PH NORTHERN SLOPE | 1.314951 | 131.4951 | 0.36456% |
| **60** | KEMPAKARAI | 1.296616 | 129.6616 | 0.35948% |
| **61** | KARUTHAMALAI | 1.246823 | 124.6823 | 0.34567% |
| **62** | SENGALVARAYAR | 1.240807 | 124.0807 | 0.34400% |
| **63** | KANJAMALAI | 1.16643 | 116.643 | 0.32338% |
| **64** | SIDEVI | 1.162107 | 116.2107 | 0.32219% |
| **65** | VELAMUNDI | 1.159185 | 115.9185 | 0.32138% |
| **66** | PULIYARAI | 1.107369 | 110.7369 | 0.30701% |
| **67** | KAILASAGIRI | 1.09469 | 109.469 | 0.30349% |
| **68** | KURUMBAPATTY | 1.094437 | 109.4437 | 0.30342% |
| **69** | CHITTALI | 1.071432 | 107.1432 | 0.29705% |
| **70** | SAMERI | 1.047393 | 104.7393 | 0.29038% |
| **71** | KANIYAMBADI | 1.023021 | 102.3021 | 0.28363% |
| **72** | SAPTUR | 1.022634 | 102.2634 | 0.28352% |
| **73** | SEGUR BL II | 1.014164 | 101.4164 | 0.28117% |
| **74** | PH SOUTHERN SLOPE | 1.008081 | 100.8081 | 0.27948% |
| **75** | SWAMIMALAI | 1.003563 | 100.3563 | 0.27823% |
| **76** | KOMBAI | 0.991311 | 99.1311 | 0.27483% |
| **77** | GUDALUR(K) | 0.975412 | 97.5412 | 0.27043% |
| **78** | ARASAMPATTU | 0.926741 | 92.6741 | 0.25693% |
| **79** | CURZON VALLEY III | 0.91495 | 91.495 | 0.25366% |
| **80** | PERAIYUR | 0.902779 | 90.2779 | 0.25029% |
| **81** | MANGALAM | 0.885498 | 88.5498 | 0.24550% |
| **82** | RENGASAMY PEAK | 0.869739 | 86.9739 | 0.24113% |
| **83** | THALLY EXTN | 0.85671 | 85.671 | 0.23752% |

| | | | | |
|---|---|---|---|---|
| **84** | VIRAPPANUR | 0.834529 | 83.4529 | 0.23137% |
| **85** | KARADIKUTTU | 0.823278 | 82.3278 | 0.22825% |
| **86** | MORDHANA | 0.817442 | 81.7442 | 0.22663% |
| **87** | PONNUR | 0.81121 | 81.121 | 0.22490% |
| **88** | SAMIKANAL | 0.810002 | 81.0002 | 0.22457% |
| **89** | INNER JAVADI | 0.805878 | 80.5878 | 0.22342% |
| **90** | KOLATTI | 0.793987 | 79.3987 | 0.22013% |
| **91** | PUTHUR | 0.787056 | 78.7056 | 0.21821% |
| **92** | PALAMADI | 0.783476 | 78.3476 | 0.21721% |
| **93** | KUNNAM | 0.778008 | 77.8008 | 0.21570% |
| **94** | GALIGATTAM | 0.749941 | 74.9941 | 0.20792% |
| **95** | VENNILAI | 0.74335 | 74.335 | 0.20609% |
| **96** | MAHARAJAGADAI | 0.727292 | 72.7292 | 0.20164% |
| **97** | APPUR | 0.712282 | 71.2282 | 0.19747% |
| **98** | ARASANTHAMPATTI | 0.704015 | 70.4015 | 0.19518% |
| **99** | SIVAGIRI | 0.703749 | 70.3749 | 0.19511% |
| **100** | KENGODU NORTH | 0.703418 | 70.3418 | 0.19502% |
| **101** | AMARAVATHI | 0.685758 | 68.5758 | 0.19012% |
| **102** | POONGULAM | 0.670429 | 67.0429 | 0.18587% |
| **103** | ANCHETTY | 0.666835 | 66.6835 | 0.18488% |
| **104** | MANNUR | 0.665567 | 66.5567 | 0.18452% |
| **105** | SELUR | 0.659277 | 65.9277 | 0.18278% |
| **106** | PUTHUR ESTATE | 0.65883 | 65.883 | 0.18266% |
| **107** | AMBURUVI | 0.63904 | 63.904 | 0.17717% |
| **108** | ALAMELUMANGAPURAM | 0.638401 | 63.8401 | 0.17699% |
| **109** | KOTTAPATTY | 0.636869 | 63.6869 | 0.17657% |
| **110** | PEDDANAGAPUDI | 0.621906 | 62.1906 | 0.17242% |
| **111** | PUDUPPER | 0.617362 | 61.7362 | 0.17116% |
| **112** | AMBUR | 0.614597 | 61.4597 | 0.17039% |
| **113** | KALLAR (DGL) | 0.61132 | 61.132 | 0.16948% |
| **114** | PILLANKULAM | 0.611245 | 61.1245 | 0.16946% |
| **115** | WAGUTHUMALAI | 0.611021 | 61.1021 | 0.16940% |
| **116** | AGAMALAI | 0.604332 | 60.4332 | 0.16755% |
| **117** | KUKKAL | 0.597646 | 59.7646 | 0.16569% |
| **118** | PULLUR EAST | 0.597221 | 59.7221 | 0.16558% |
| **119** | SIRUVATTUKKADU | 0.59491 | 59.491 | 0.16493% |
| **120** | MARUTHANATHI | 0.589695 | 58.9695 | 0.16349% |
| **121** | NANGUR | 0.573247 | 57.3247 | 0.15893% |
| **122** | KADAVUMALAI | 0.561517 | 56.1517 | 0.15568% |
| **123** | MACHAKKAL | 0.552944 | 55.2944 | 0.15330% |
| **124** | SULLIKODU BL II | 0.549944 | 54.9944 | 0.15247% |
| **125** | BILIGUNDULU | 0.543974 | 54.3974 | 0.15081% |
| **126** | MEEKERU BETTU | 0.542687 | 54.2687 | 0.15046% |
| **127** | VEERARAGHAVAPURAM | 0.535469 | 53.5469 | 0.14845% |

| | | | | |
|---|---|---|---|---|
| **128** | SINGARAPETTAI EXTN | 0.534198 | 53.4198 | 0.14810% |
| **129** | AIYUR EXTN I | 0.528027 | 52.8027 | 0.14639% |
| **130** | NEDUNGUNAM | 0.518043 | 51.8043 | 0.14362% |
| **131** | GUNDAR VALLEY | 0.517288 | 51.7288 | 0.14341% |
| **132** | SANDYNALLA | 0.505509 | 50.5509 | 0.14015% |
| **133** | ATHANGUDI | 0.498977 | 49.8977 | 0.13834% |
| **134** | PACHAIPALAMALAI | 0.480843 | 48.0843 | 0.13331% |
| **135** | NORTH BARGUR | 0.475387 | 47.5387 | 0.13180% |
| **136** | PANAMADANGI | 0.472682 | 47.2682 | 0.13105% |
| **137** | KANIYANKADU | 0.469068 | 46.9068 | 0.13005% |
| **138** | BROOKELANDS | 0.462675 | 46.2675 | 0.12827% |
| **139** | SIRUMALAI | 0.461686 | 46.1686 | 0.12800% |
| **140** | GUTTIRAYAN | 0.452028 | 45.2028 | 0.12532% |
| **141** | AVIRIYUR | 0.446695 | 44.6695 | 0.12384% |
| **142** | MANCHI | 0.43775 | 43.775 | 0.12136% |
| **143** | KONASAMUDRAM | 0.43616 | 43.616 | 0.12092% |
| **144** | MORDHANA EXTN | 0.434772 | 43.4772 | 0.12054% |
| **145** | VEERAMANGALAM | 0.421762 | 42.1762 | 0.11693% |
| **146** | PORTHIMUND | 0.40472 | 40.472 | 0.11221% |
| **147** | VENUGOPALAPURAM | 0.403651 | 40.3651 | 0.11191% |
| **148** | VENKATARAJAKUPPAM | 0.39131 | 39.131 | 0.10849% |
| **149** | UTHIYUR | 0.389654 | 38.9654 | 0.10803% |
| **150** | KERADAMUND | 0.370432 | 37.0432 | 0.10270% |

# Fire detections in National Park, Sanctuary and Tiger Reserves (Source: FSI 2023)

## Table: 4.1 Number of SNPP-VIIRS Detections in National Parks

| NAME OF NATIONAL PARK | NO. OF SNPP-VIIRS DETECTIONS - 2024 |
|---|---|
| Guindy | 0 |
| Gulf of Mannar Marine | 0 |
| Indira Gandhi | 69 |
| Mudumalai | 2 |
| Mukurthi | 6 |

## Table: 4.2 Number of SNPP-VIIRS detections in the Sanctuary

| NAME OF PROTECTED AREA | SNPP-VIIRS DETECTIONS - 2024 |
|---|---|
| Indira Gandhi (Annamalai) Wildlife Sanctuary | 43 |
| Kanyakumari Wildlife Sanctuary | 118 |
| Megamalai Wildlife Sanctuary | 3 |
| Mudumalai Wildlife Sanctuary | 6 |
| Sathyamangalam Wildlife Sanctuary | 4 |
| Srivilliputhur Wildlife Sanctuary | 32 |

## Table: 4.3 Comparison of Number of SNPP-VIIRS Detections in the Tiger Reserves

| Name of Tiger Reserve | Number of SNPP-VIIRS sensor detections | | | | |
|---|---|---|---|---|---|
| | 2019-2020 | 2020-2021 | 2021-2022 | 2022-2023 | 2023-2024 |
| Anamalai | 77 | 30 | 82 | 312 | 500 |
| Mudumalai | 5 | 3 | 2 | 22 | 95 |
| Sathyamangalam | 20 | 20 | 12 | 36 | 78 |
| Kalakad Mundanthurai | 39 | 14 | 22 | 60 | 54 |
| Srivilliputhur Megamalai | 12 | 12 | 29 | 20 | 32 |

## Table: 4.4 Time Taken to Douse Large Forest Fire Event in Tiger Reserves

| Tiger Reserve | < 24 hrs | 1 < Day < 2 | 2 < Day < 3 | 3 < Day < 4 | 4 < Day < 5 | 5 < Day < 6 | Total |
|---|---|---|---|---|---|---|---|
| Mudumalai | 1 | 0 | 1 | 0 | 0 | 1 | 3 |

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