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Editorial

Indian Forests in Comatose

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Keywords: Biodiversity, Forest ecosystem, Forest fire, Forest land transfer, Forest health, Ecosystem goods and services, Tropical moist deciduous forest, Forest Conservation Amendment Act 2023.

India has 2.5 percent of global earth share which supports 7.8 percent of global biodiversity and 18 percent of the world population (Ministry of Environment and Forests, 2009). India is one of the 17 mega biodiversity countries with a very rich flora and fauna. There are 55048 recorded plant species which constitutes 11.8 percent of the world flora (Ministry of Statistics & Programme Implementation, 2022). Out of the 55048 recorded plant species, 18,500 plants are recorded as angiosperms of which 32 % are endemic to India. India is very rich in faunal biodiversity also and has 1,03258 animal species which accounts for 6.45% of the world's recorded fauna (Ministry of Statistics & Programme Implementation, 2022). India being one of seventeen megadiverse countries, is home to 7.6% of all mammalian, 12.6% of all avian, 6.2% of all reptilian, 11.7% of all fishes, and 4.4% of all amphibians (Stephen et al., 2015). The biodiversity in Indian forests has not been fully identified as yet therefore, therefore, its loss cannot be assessed in terms of its contribution and function in an ecosystem in case the forest area is shrinking on account of multiple reasons. The total forest and tree cover of the country is 80.9 million hectares which is 24.62 % of the geographical area of the country (Ministry of Environment, Forest and Climate Change, 2021). As compared to the assessment of 2019, there is an increase of 2,261 sq. km in the total forest and tree cover of the country (Ministry of Environment, Forest and Climate Change, 2021). Out of this, the increase in the forest cover has been observed as 1,540 sq. km, and that in tree cover is 721 sq. km. The Coastline of India is very long and runs approximately 7516 km long, with nine coastal states, four union territories, and two groups of islands. The Coastline of India borders the Arabian Sea and the Indian Ocean in the west and the Bay of Bengal in the east. Among all the states, the longest Coastline in India is Gujarat, while in the UTs, the largest coastline is of Andaman and Nicobar Islands. There are twenty coastal cities with 40 million people engaged in fisheries which contributes 1 % of GDP.

All parameters of a healthy forest are down in India

The quality of Indian forests has declined over the last five years in all the parameters. The Government of Indian religious biennial report called India State Forest Report gives a detailed account of the State of Forest in India. The latest (Ministry of Environment, Forest and Climate Change, 2021) claims a marginal increase of 0.22% in the country's forest cover from its last assessment carried out in the year 2019. Closer analysis of the report says that between 2019 and 2021, the quality of India's forest has deteriorated across 15183 Sq.km of forest were either cut down or thinned out (Ministry of Environment, Forest and Climate Change, 2021). The Global Forest Watch Report published in 2024 also reveals that India has lost a staggering figure of 414000 hectares of humid primary forest, which constitutes 4.1% of the total tree cover between 2002 and 2023 (Global Forest Watch Report, 2024). The report further adds that a striking 95% of

the tree cover in the natural forest has been lost in India between 2013 and 2023. But the maximum tree cover loss of 189000 hectares was found to be in the year 2017 followed by 175000 hectares in 2016 and 144000 hectares in 2023. The report finds that the five Indian states account for 60% of all the tree cover loss reported between 2001 and 2022. Of all the five States Assam has been reported to lose maximum tree cover at 324000 hectares beside Mizoram, Arunachal Pradesh, Nagaland, and Manipur also registering significant high losses. Recently an article published by Nature Sustainability revealed that in the last three years from 2019 to 2020, India has lost close to 5.8 million fully-grown trees in agricultural lands (Brandt et al., 2024). This is also reported that 56% of India is covered by farmland and 24.56% with forest cover which also includes forest cover in areas other than recorded forest area, therefore, such a huge loss of trees in farmland is very critical to the forest ecosystem. Forest health seems to be extremely bad and Indian forests seem to be comatose. Forest health is defined by the Society of American Forests as 'the perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of un-usual levels of insects or disease, and resilience to disturbance (Finley & Chhin, 2016). Ecosystem services are the benefits obtained from ecosystem that are quintessentially linked to human well-being (Costanza et al. 1996; Reid, et al., 2005; Dorell et al., 2010). Ecosystem goods include food fiber, medicinal plants, genetic resources, and services expressed as pollution control, soil carbon, recreation, water, disease control, etc. Ecosystem goods and services are extremely important for the survival of humanity. There are many tangible and intangible benefits from the forest ecosystem but the goods and services are diminishing substantially over some time. The growth rate of the forest cover does not entail the complete story. The forest fire has gone up by 25% in the last three years and 36% of the Indian forest is prone to forest fire of which 6% forest is very highly prone to forest fire and 4% is extremely prone to forest fire (Ministry of Environment, Forest and Climate Change, 2021). The Global Forest Watch Report 2024 also says that forest fire is responsible for the loss of 1.6% of tree cover loss in India between 2001-2023 and the year 2008 saw a loss of 3,000 hectares of forest fire (Global Forest Watch Report, 2024). This has been estimated that 45%-64% of Indian forests may be impacted by climate change by the turn of 2030 (Ministry of Environment, Forest and Climate Change, 2021). ISFR 2019-21 says that 66% of the Indian State and Union Territories have seen a decline in very dense forests and moderately dense forests (Ministry of Environment, Forest and Climate Change, 2021). Yet another report published by a UK-based utility bidder reveals that India has recorded the second-highest rate of deforestation in the last 30 years and lost 668400 hectares of forest cover (Utility Bidder Report, 2023). The recent (Global Forest Watch Report, 2024) also reveals that India has lost 2.33 million hectares of tree cover since the year 2000 - 2023 and this loss amounts to a 6% decrease in tree cover, the report further adds that the loss of humid primary forest has been found to the tune of 4.1% between 2002 and 2023 and a striking 95% the tree cover loss in India has been reported in between 2013 and 2023. The maximum tree cover loss of 189000 hectares occurred in 2017 which is closely followed by 175000 hectares in 2016 and 144000 hectares in 2023. The report also finds that five Indian States namely Assam, Mizoram, Arunachal Pradesh, Nagaland, and Manipur accounted for 60% of forest cover loss between 2001 and 2023. Of the five States Assam lost a maximum of 324000 hectares of forest between 2001 and 2023. The important components of the forest ecosystem are soil depth, humus, soil organic carbon, and regeneration of the forest (Ministry of Environment, Forest and Climate Change, 2013; Ministry of Environment, Forest and Climate Change, 2015). Overall, at the national level above 67% of the forest area has medium to deep soil depth and 32% of the forest area has shallow to very shallow soil depth. Similarly, tropical moist deciduous forests, tropical dry deciduous forests, and tropical thorn forests either have no humus or very shallow humus which is directly proportional to the productivity of the forest areas in question. Soil Organic Carbon is related to soil fertility. At the national level, this has been found that alpine areas have the highest soil organic carbon per unit area while tropical thorn and tropical dry deciduous forests have the lowest soil organic carbon. The process of natural regeneration is an extremely important component of the forest ecosystem, this process helps in replacing old crops with the younger generation. At the

national level, natural regeneration is found to be inadequate or absent in 45% of the forest area which is much lower by any standard. Regeneration is also defined by the size of the forest crop in different forest groups and the Ministry of Environment, Forest and Climate Change (2013) has revealed that the percentage area under the 'big timber' size class is maximum for Himalayan dry temperate forests (41.94%) followed by Himalayan Moist Temperate forests (39.90%) and sub-Alpine forests (30 %). most of the tropical thorn forests and littoral and swamp forests are either in regeneration class or in pole crop class. The montane wet temperate forests have having maximum of 66.65 % area under 'mixed size class 'which may be considered a positive sign from a population structure angle point of view.

Land transfer cases

The Government of India has not been transparent on the transfer of forest land in the last 10 years. Forest Conservation Amendment Act (2023) was passed to be able to ease the process of forest land transfer by amending the definition of forest itself. The Government of India has approved 1,21781.60 hectares of forest land between 2015 and 2023 and in reply to a question in the parliament, the government accepted that 1,20,00,000 trees have been cut down between 2014 and 2023. Many other parameters define our forest as "not in good health", for example, the size of the wetland area in the recorded forest area has declined by 35.49% between 2019 and 2021 and growing stock has also come down by 20.93% during the same period. The Indian forests seem to be in distress and need immediate attention in the form of policy intervention because the forest does not need us but we need forest for our survival. Today, the forest has been at a critically low point and almost reached a tipping point, and in some forest types, it has tipped for sure. This is relevant to examining eastern Himalayan hill Sal (Shorea *robusta*) forests to understand the permanent changes being brought in the Indian forests. Kamrup and Khasi hill Sal in the (Eastern Himalayan Sal region) forests are now dominated by Tak (*Tectona grandis)* and some semi-evergreen species, with very few individuals of Sal species. East Himalayan bhabar sal is also found to have associated dominant species, like *Lagerstroemia microcearpa* (syn. *L. lanceolata*) and *Aphanamies polystachya* (syn. *Amoora rohituka*). Peninsular (Coastal) Sal forests have indicated the decline of Sal and its complete absence from some of the areas in coastal Odisha. Moist peninsular high-level Sal has shown the occurrence of the dry teak type in the stand in place of Sal. The present status of teak forests has also shown some disturbing results about density and regeneration status. Over-exploitation, invasion of weeds, recolonization of undergrowth, and management intervention are possible causes for the decline of the teak. India has seen rapid deforestation in recent years, primarily due to its focus on economic development. 14,000sq km of forests were cleared to accommodate 23,716 industrial projects across India over the last 30 years. Forest encroachments in India are increasing at an alarming rate with government data placed on the floor of the parliament indicating a whopping 146 % rise in a year. From 3,03,324.18 hectares in 2022, the encroachments have risen to 7,45,591 hectares in 2023. The problems of the bigger dimension the country is facing today are the loss of net primary productivity of the forests, diminishing forests, and the capital itself that is forest land.

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Research

Rapid Assessment of Floral Diversity in Green Spaces within Mumbai City, MS, India

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Abstract

Forests are one of the most biologically active terrestrial ecosystems. They are known to provide varied ecological services and play an important role in maintaining ecological balance. Especially in a metropolitan city like Mumbai, the last remaining tracts of green help in maintaining the microclimate, enriching the groundwater table, and curbing pollution levels. Despite these valuable services provided by forests, deforestation has become rampant in the present era, causing several environmental problems. Urgent steps are required to identify and protect the remaining green areas to maintain ecological balance and slow the pace of climate change. The present study deals with the identification and assessment of the floral diversity of green spaces within Mumbai city and suburban areas. The floristic survey was carried out from June 2021 to October 2022. A total of 111 plant species from 43 families, encompassing 5 herbs, 14 shrubs, 3 climbers, 1 grass, 1 fern, and 87 angiospermic trees, were identified. Through our report, we attempt to shed light on these important green spaces to ensure that they are not treated as isolated spaces but as spaces that complement our daily lives and well-being.

Keywords: Floral diversity, Green spaces, Mumbai City, Flora, Biodiversity, Conservation, Micro-climate regulation, Floristic survey

Introduction

Since the emergence of life on Earth, vegetation has been a crucial component of the ecosystem. Life is directly or indirectly reliant on vegetation for its survival. Forests stand as pivotal bastions of biodiversity and ecological stability within terrestrial ecosystems, wielding an array of vital services crucial for sustaining life on Earth (Brockerhoff et al., 2017). Particularly in urban landscapes like Mumbai, characterized by diminishing green spaces, the significance of forests transcends mere aesthetics, encompassing pivotal roles in micro-climate regulation, groundwater enrichment, and pollution mitigation. Despite their undeniable ecological value, contemporary times witness a distressing surge in deforestation, exacerbating environmental perils. Urgent interventions beckon to safeguard extant forested enclaves, pivotal for preserving ecological equilibrium and ameliorating the pace of climate change.

In a broader context, Maharashtra boasts a forest cover spanning 50,798 sq. km., constituting approximately 16.51% of its total geographical expanse. Remarkably, major Indian cities, including Mumbai, collectively harbour 509.72 sq. km. of forest cover, representing a critical yet diminishing fraction of their total geographic footprint. Alarming statistics reveal a 42.5% decline in Mumbai's green spaces over three decades, underscoring the urgent need for conservation efforts (Ministry of Environment, Forest and Climate Change, 2021). Moreover, Maharashtra ranks fourth nationally in forest land diversion for non-forest uses, exacerbating the vulnerability of Mumbai's forests, compounded by a surge in wildfires from 702 in 2014 to 3,487 in 2017.

Despite the knowledge of the extent of forest cover available to the government, little or no effort has been made to identify and protect these green patches since 1996. We are at a crossroads in time and history where delay can no longer be accepted. The vulnerabilities and challenges presented by population outbursts, climate variability, and massive human-induced alterations of the terrestrial landscape (Alkama & Cescatti, 2016; Steffen et al., 2015), particularly in the context of forests, water, and their interaction, necessitate a much faster response to and resolution of this debate than has previously been possible. In the past few decades, there has been increased concern about the management and fate of our remaining forest lands (Lund, 2018).

The present study undertakes the critical task of identifying and evaluating the floral diversity across 18 sites housing vulnerable and often overlooked green spaces within Mumbai City. The study serves to illuminate the rich tapestry of plant resources nestled within these green spaces from a conservationist standpoint. Our endeavour extends beyond mere enumeration, striving to underscore the profound interconnectedness between these green spaces and our collective well-being. Through first-hand observations and in-depth research, we aim to illuminate not only the ecological significance but also the historical and contextual relevance of these green spaces, alongside the communities intricately intertwined with them. Against this backdrop, our study endeavours to shed light on the intrinsic value of these imperiled ecosystems, advocating for their holistic preservation and integration into urban planning paradigms. By unraveling the botanical wealth hidden within these green spaces, we aspire to catalyze concerted efforts towards their conservation, ensuring their perpetuation as vital repositories of biodiversity and ecological resilience.

Material and methods

Areas in Mumbai with green spaces larger than 1 hectare were identified using Google Earth satellite imagery. Field surveys were carried out to assess the plant diversity prevailing in the selected locations. A checklist of the floral diversity was prepared during the field surveys along with the field notes. Specimens and photographs of unidentified plant species were collected during the field visits for review. The collected specimens were identified using existing literature (Bentham & Hooker, 1862–83; Cooke, 1901–08) and preserved in the form of photographs.

Figure 1: Satellite Image of the study area

Study area

The city of Mumbai, renowned as both the capital of Maharashtra and the financial capital of India, has a population of approximately 20 million, ranking it as the eighth most populous urban centre globally according to the United Nations. Nestled within the Konkan region along the western coast of India, Mumbai encompasses seven islands clustered on a narrow peninsula southwest of Salsette Island. Embraced by the Arabian Sea to the west, Thane Creek to the east, and Vasai Creek to the north, Mumbai's topography showcases a mosaic of features, ranging from hills and mountains to creeks and estuaries.

Within Mumbai's confines lie two significant protected areas: the Sanjay Gandhi National Park and the Thane Creek Flamingo Bird Sanctuary. These verdant sanctuaries, often revered as the "Lungs of Mumbai," boast extensive tree cover. Beyond these vital forests, Mumbai hosts numerous green spaces harbouring a diverse array of life forms, including terrestrial trees, as well as mangroves lining the coastline. Recognizing and conserving these potential green areas is imperative for maintaining Mumbai's ecological equilibrium. Consequently, through a comprehensive study, 18 sites within the city have been identified.

Result and discussion

The focus of this study is to document the green spaces within Mumbai and conduct a comprehensive analysis of their flora. Utilizing GIS, 18 locations with substantial greenery accounting for an area of more than 1 hectare, were surveyed, revealing diverse topographies across the city. This topographical variation has led to a rich array of plant life, including grasses, herbs, shrubs, and angiosperms, totaling 111 species. Among these, there were 5 herbs, 14 shrubs, 3 climbers, 1 grass, 1 fern, and 87 angiospermic trees, representing 42 families.

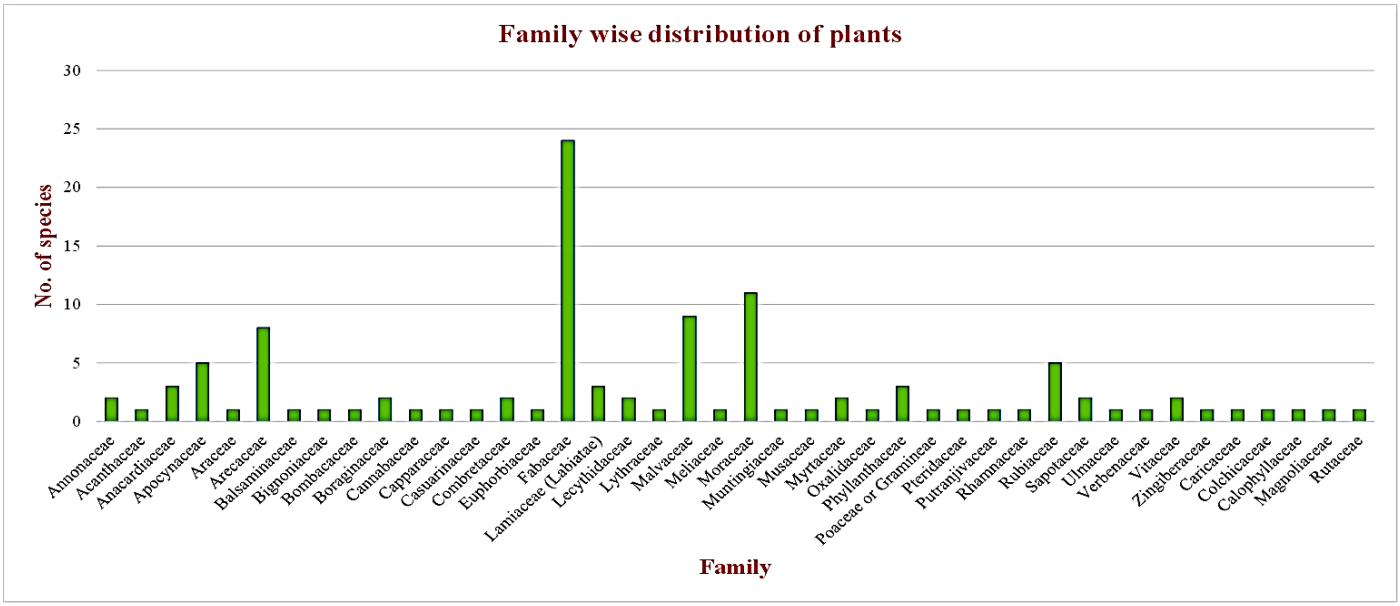

Figure 2: Family-wise distribution of Plants

India boasts a rich botanical heritage, with approximately 47,513 plant species (Singh & Dash, 2014), contributing significantly to global flora. Within India, there are about 257 plant families, with 213 dicotyledonous and 44 monocotyledonous families. The study area encompassed plants from 42 families. There are approximately 257 plant families in India, of which 213 are dicotyledonous and 44 are monocotyledonous. The 42 families into which the plants in the study area belonged are Annonaceae, Acanthaceae, Anacardiaceae, Apocynaceae, Araceae, Arecaceae, Balsaminaceae, Bignoniaceae, Bombacaceae, Boraginaceae, Cannabaceae, Capparaceae, Casuarinaceae, Combretaceae, Euphorbiaceae, Fabaceae, Lamiaceae (Labiatae), Lecythidaceae, Lythraceae, Malvaceae, Meliaceae, Moraceae, Muntingiaceae, Musaceae, Myrtaceae, Oxalidaceae, Phyllanthaceae, Poaceae or Gramineae, Pteridaceae, Putranjivaceae, Rhamnaceae,

Rubiaceae, Sapotaceae, Ulmaceae, Verbenaceae, Vitaceae, Zingiberaceae, Caricaceae, Colchicaceae, Calophyllaceae, Magnoliaceae and Rutaceae families respectively. The dominant families were Fabaceae (24 species), Moraceae (11 species), Malvaceae (9 species), Aracaceae (8 species), Apocynaceae (5 species), Rubiaceae (5 species), Phyllanthaceae (3 species), Lamiaceae or Labiatae (3 species), Anacardiaceae (3 species), Vitaceae (2 species), Sapotaceae (2 species), Myrtaceae (2 species), Lecythidaceae (2 species), Combretaceae (2 species), Boraginaceae (2 species), Annonaceae (2 species) and the remaining families showed single member belonging to them.

Despite Mumbai's total geographical area being 603.4 sq. km, only 110.77 sq. km are designated as forests in the 2021 State of Forest Report. The study accounted for 13.78 sq. km, indicating a notable 12.34% increase in green cover within the city. Among the surveyed locations, Trombay Hills and Bhabha Atomic Research Centre had the largest geographical extents, followed by IIT Mumbai, Dindoshi Dongri, and Hiranandani Helipad Hill. Royal Palm in Aarey exhibited the highest species diversity with 73 plant species, followed by IIT Mumbai and Gorai Essel Parking Hill. Noteworthy plant diversity was observed in several areas, emphasizing the importance of conserving these green spaces amidst urbanization pressures.

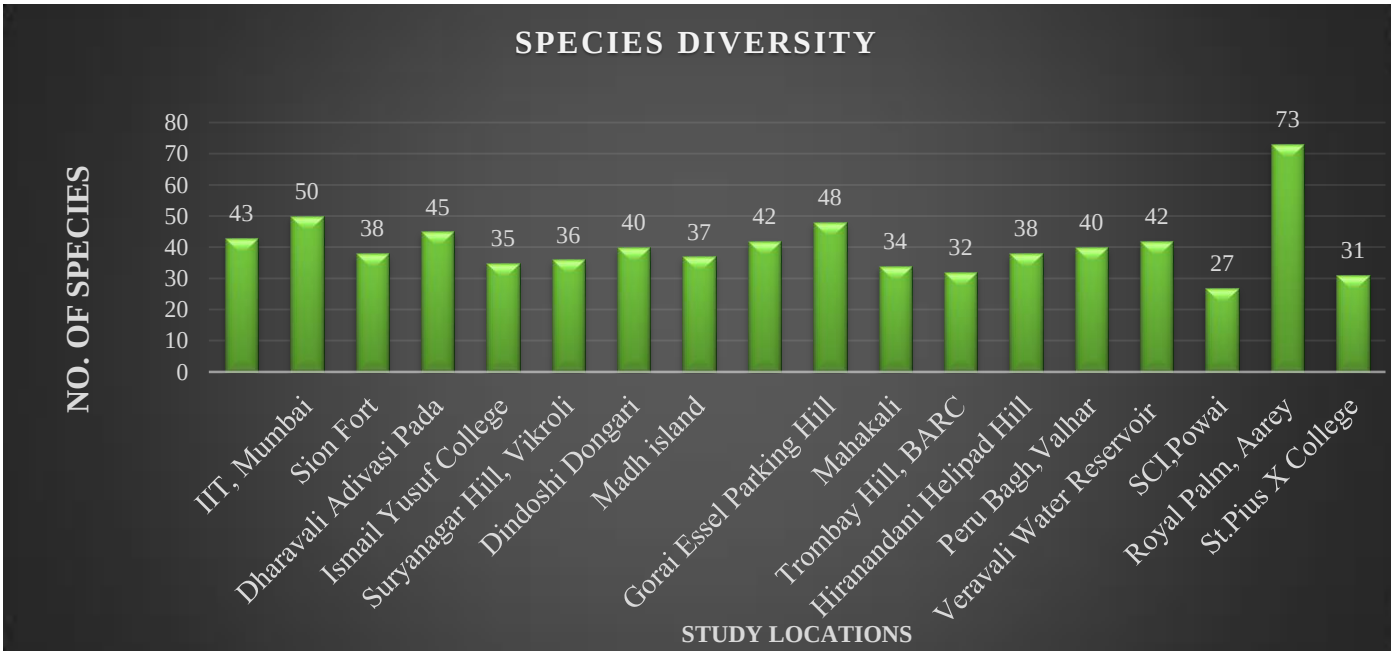

Figure 3: Species diversity within the selected study locations

Preserving such diverse ecosystems within the city limits is crucial to safeguarding biodiversity and ensuring a sustainable future for generations to come.

Conclusion

Assessing floral diversity is crucial for the conservation of natural resources. Without proper documentation and assessment, it's impossible to effectively conserve the rich biodiversity, including both flora and fauna. The escalating demands for food and shelter due to population growth have led to increased deforestation. Therefore, it's imperative to conserve these green spaces by assessing the unknown flora, which provides essential tangible and intangible benefits to humanity.

The present study aims to protect and preserve the green spaces within Mumbai, recognizing their significance and the need for conservation efforts. The findings reveal Mumbai's wealth of resources that contribute to the well-being of its residents. Identifying 18 areas with substantial plant diversity, totaling an additional 13.68 sq. km. underscores the potential for expanding the city's green areas. By safeguarding these regions, Mumbai could increase its green cover by 12.34%, contributing to the city's ecological sustainability.

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Research

Navakiranam- A Novel Program in Kerala, A Win-Win Strategy for Biodiversity and People Through Voluntary Relocation

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Abstract

Human-wildlife conflict, deterioration, and degradation of forests due to the presence of people and their livestock are a burning problem in our country. In tandem is the disaffection of the people living within forest hamlets due to poor access to education medical facilities, modern amenities, etc., especially due to a lack of financial capacity and requisite skillsets to relocate outside the forest.

The Navakiranam program is a Kerala government-sponsored program that provides financial support as well as social handholding for people within forests of Kerala to voluntarily relocate outside forests to gain access to a better life for themselves and their children. While supporting people, the program also provides ecological restoration to the vacated forests making room for biodiversity and wildlife to flourish.

The Navakiranam program is a win-win project for people and forests, being successfully implemented in Kerala, which also needs to be scaled and replicated in the rest of the country.

Keywords: Biodiversity, Forest ecosystem, Tiger reserves, National parks, Wildlife sanctuaries, Western Ghats, Dwelling communities, Human-wildlife conflict

Introduction

Western Ghats is a megadiverse region that is home to the largest wild population of Bengal Tigers and the Asian elephants in India, in addition to being home to thousands of other rare and endemic species of flora and fauna. The landscape is the headwaters of all major peninsular rivers in India, ensuring water security for the region. The Western Ghats, therefore is not only important for India but also holds immense value for the world, due to which it has been recognized as a UNESCO heritage site. The Western Ghats are also home to millions of people, many of whom still reside inside forests and protected areas. It is estimated that presently there are 10,976 households present inside Protected Areas (PAs) of the Western Ghats in the states of Karnataka, Kerala (Wayanad Wildlife Sanctuary), and Tamil Nadu (Mudumalai and Sathyamanglam Tiger Reserve). While Western Ghats is known for its biodiversity as well as rich cultural heritage, the landscape has experienced a spurt in economic and infrastructure development in the past few decades. This is causing large-scale fragmentation, loss of ecological value, and negative biodiversity impacts, which are also negatively impacting the human populations outside the forests due to a loss of ecosystem services. The communities living inside the forests of the Western Ghats feel isolated and marooned, especially the younger generation who are eager to partake in the benefits of economic development, and desperately seek better lives and a good future for their children outside forests. They seek better livelihood options, healthcare, education, and access to basic facilities like electricity, public ration shops, etc. Many of the younger generations of these forest-dwelling communities have already started migrating out of the forests at great personal and financial loss without any support from the Government or other organizations. There have been many instances where parents send their children out of the forests to

live with their relatives in the hope of a better future through improved education and livelihood opportunities. However, many of these children are either badly treated by their relatives or end up working as laborer's in the towns and cities. In addition to the lack of proper facilities inside the forests and the associated social issues, the forest-dwelling communities also live in constant threat of human-wildlife conflict. There are numerous examples where such forest-dwellers have lost their lives or have been gravely injured during incidences of human-wildlife conflict while carrying out simple, daily-life activities such as using toilets, collecting forest produce, etc.

Figure 1*: An elephant walking through an agriculture farm (Pic. courtesy Ashwin Bhat)*

Often forest-dwelling communities continue to live in the forests facing huge adversity due to the lack of financial opportunities, education, and awareness, as well as the fear of the unknown, even though they wish to go out and are desperate to seek a better life. They ultimately become a prisoner of their circumstances and continue living a sub-par life inside the forests often against their will. In their pursuit of better education for their children as well as to escape human-wildlife conflict, the forest-dwelling families take loans from money lenders and become indebted for life. These circumstances limit their ability to exercise their democratic right to a better life. Taking cognizance of this issue as well as safeguarding the wildlife and natural habitats, the Government of India introduced the scheme of voluntary relocation wherein they provide support to such forest-dwelling communities to move out of the forests and start a new life. This process is entirely voluntary where people give their free consent. Voluntary relocation is a social welfare scheme being offered by the government that allows such forest-dwelling communities to seek a better life, who otherwise have been disenfranchised and disadvantaged for generations.

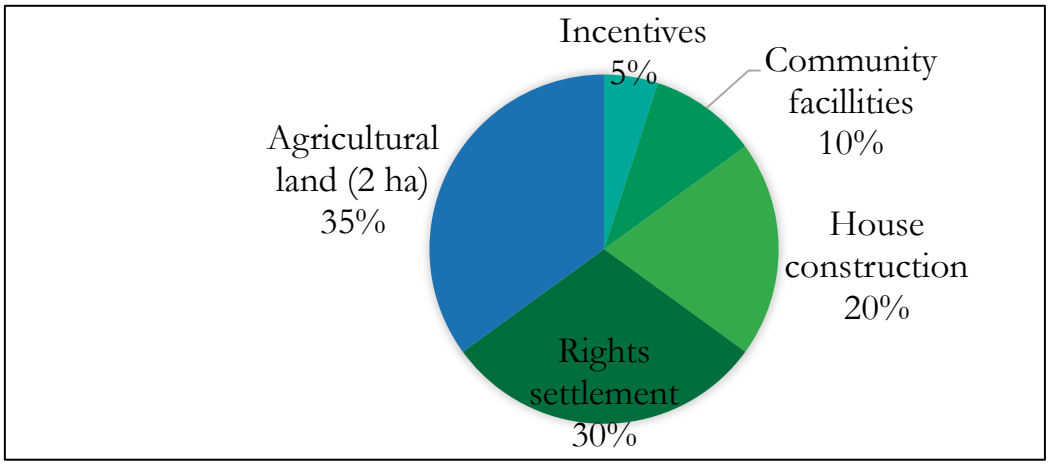
Centrally sponsored scheme for voluntary relocations from tiger reserves, national parks and wildlife sanctuaries

The Government of India has an ongoing scheme of voluntary relocation under the National Tiger Conservation Authority for Tiger Reserves and the Centrally Sponsored Scheme- Development of Wildlife Habitats for other National Parks and Wildlife Sanctuaries wherein families wishing to voluntarily relocate from Critical Tiger habitats (CTH) and Critical Wildlife Habitats (CWH) are supported for voluntary relocation by financial support of Rs. 15 lakh per family.

The Ministry of Environment, Forests and Climate Change (MoEF&CC) schemes under the National Tiger Conservation Authority/Integrated Development of Wildlife Habitats' guidelines provide two options for voluntary relocation from protected areas:

1) Option I: Only Cash Payment of the entire package amount INR 15 lakh

2) Option II: Rehabilitation by FD as per the break-up of funds of Rs 15 lakh per family



Wayanad Wildlife Sanctuary is obtaining funding from the Centrally Sponsored scheme under the Development of Wildlife Habitats and 454 families from the Sanctuary have availed of the scheme and voluntarily relocated from the Sanctuary from 2012 till 2017. In 2023 funding has been received for voluntary relocation for another 246 families from Waynad Wildlife Sanctuary. However, the Central government scheme is restricted to critical wildlife habitats of National Parks and Wildlife Sanctuaries and does not address this need across all forest areas.

CONTEXT IN KERALA

Kerala is a highly populous state which also has a rich heritage of geological, geographic, and biological attributes which make the state unique. The population census (2011) says that the total population of Kerala is 33,406,061, or 2.76 % of India's population, and at 859 persons per km^2; its land is three times as densely settled as the rest of India (Economic Review, 2017). Kerala is one of the most progressive states amongst the Indian states and it ranks on top in terms of overall performance (NITI Aayog, 2023). The social milieu, highly aware people, and political, educational, and civic development, make this a highly progressive and unique state requiring innovative and focused programs acceptable to the people. Inhabitants living in the forest do not have opportunities for quality education for their children and access to health facilities and amenities. They also suffer from poor communication with the outside world making life difficult especially during rainy seasons. The demand for bringing development to such far-flung and remote areas means further disturbance to forests, ensuing fragmentation, escalating costs, and further hardships to people. This fragmentation leads to the degradation of surrounding wildlife habitats and confines wildlife, increasing the number of incidents of Human-Wildlife conflict, etc. Forest fragmentation is a common consequence of human activities with impacts on habitat connectivity, tree dynamics, microhabitat conditions, and biodiversity. Fragmentation leads to the loss of connectivity among forested landscapes, which is important for biological conservation and biodiversity maintenance. Fragmentation analysis carried out on 20 years time interval in northern-Western Ghats revealed that the area of dense forests in intact forests has decreased from 1985-87 to 2005, this essentially means the loss of quality habitat in the area (Kale et al., 2010). It is clear that over the years, the interaction between forests and human beings has become quite intense. Kerala being a thickly populated geographical region, there is heavy demand on every available space for settlement and development which has caused insurmountable pressure on natural forests and wildlife. There is enough scientific evidence to show that the long-term

ecological security of Kerala lies in securing and safeguarding its forests and other natural resources. However, at the same time, the legitimate livelihood and development aspirations of the people also need to be addressed. People who are living in and around the forests are under a high sense of insecurity; mainly from landslides, landslips, and other natural disasters apart from the issues of negative human-wildlife interfaces. While damages due to landslides and other natural disasters include loss of life and property, damages due to wildlife are in various forms including damage to cultivated crops, cattle lifting, injury to people, and loss of human life etc. While we discuss human-wildlife interfaces, it also leads to the retaliatory killing of wild animals which could put conservation efforts in jeopardy.

The increase in human population and its consequent demand for natural resources has led to the degradation and fragmentation of forests, the natural wildlife habitats of Kerala. The fragmented nature of the Indian landscape, with people all around, has increased the risk of forest dwellers whenever there is a natural calamity. The State of Kerala is no exception, and the direct impact was seen in the unprecedented calamities in the recent past. Though nearly one-third of the land area of Kerala is under forest cover, a significant portion of this forest area is either already fragmented or under the threat of fragmentation due to human activities such as infrastructure facilities like roads and electric lines.

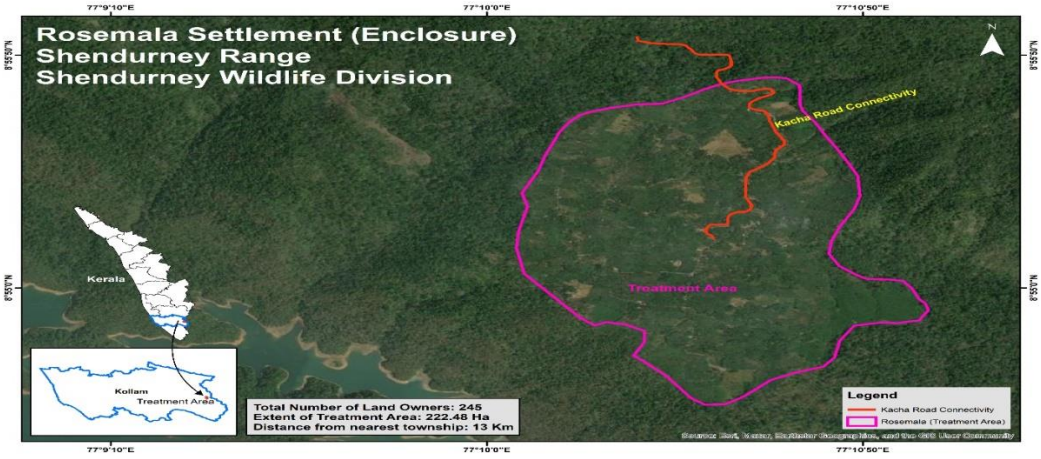
From a developmental perspective, the forest enclosures are in a perpetually disadvantageous position on account of their remoteness, inaccessibility, and scattered existence. It is also pertinent to note that on account of the same reasons, the level of development in such enclosures is significantly lower compared to other settlements or villages outside the forest. The poor reach of rural development programs puts these areas in extreme income poverty and vulnerability. In most areas, even basic human developmental inputs (access to education, justice, energy, healthcare, livelihoods, etc.) are not adequately developed. However, even if one wants to provide such facilities to these enclosures, the cost of bringing development to such far-flung and remote areas would be economically unviable. Moreover, it has to circumvent several legal and technological hurdles too. Besides, normal development in such areas through physical infrastructure developmental activities shall only lead to further degradation, ecological problems, and pressure on forests.

Genesis of non-tribal settlements within forests of Kerala

After independence, under the "Grow More Food Program", many families were settled deep within the forests where they formed settlements. Most of such families were non-tribals forming such settlements deep within the forests. Therefore, in Kerala, there are several human settlements lying scattered throughout the forests which form the core of the conflict between forest management and the developmental aspirations of the people.

An example of how interior forest areas were settled in Kerala by non-tribal settlements can be illustrated by the settlement of Rosemala in Shenderuny Wildlife Sanctuary in Trivandrum. Rosemala is 13 km within the forests from the township of Arayankavu with only a kuccha road leading to the settlement through very difficult undulating mountainous topography.

After the British left, the area in Rosemala was retained by a British citizen. A lady named Roselyn Mummy was his assistant during his visits to his bungalow at Rosemala. On his final return to England, he handed over the whole 699 acres of land to the lady, Roselyn Mummy. Later, Ms. Mummy sold the whole property to a landlord, Mr. Mohammed Kunji Musliar. Musliar leased out the land for agriculture to small-scale farmers. Later, Musliar sold the whole property to the government at a rate of Rs. 400 per acre. In 1976, the government distributed 455 acres of this land to landless people and issued 'patta' for some of them. Thus, Rosemala was settled.



Need for the project: Navakiranam

This program started after the devastating floods in 2018, when large-scale landslides, mudslides, and loss of human life, dwellings, and livestock were the outcome of the major calamity. What started as an attempt to rehabilitate such impacted families restricted to some pockets impacted by the grievous devastation, resulted in an all-state program where non-tribal families were brought under the fold of a Kerala-funded project under the aegis of Rebuild Kerala Initiative and was called the Rebuild Kerala Development Program (RKDP) in which an amount of Rs100 crore was sanctioned initially for the whole project. The project was given the unique name "Navakiranam"- meaning a new dawn-in 2022 and the project allotment was hugely scaled up to Rs. 290 crore for the project with an assurance for further allocation depending on traction with eligible beneficiaries and utilization of the project and its funding.

Packages for Relocation

The relocation package was adapted from the model of the voluntary relocation package approved by the National Tiger Conservation Authority (NTCA) for voluntary relocation from villages in the notified core/critical tiger habitats with modifications to suit the field conditions of Kerala. The compensation package under this model provides funding support of Rs.15.00 lakh per eligible willing family vide Government Order No. GO (RT) No.483/2018/PEA dated 14-11-2019.

The meaning of eligible willing family is in line with the NTCA guidelines *i.e.*, the following persons are treated as separate eligible families, even if they currently live together with other relatives within the main family;

Major sons/daughters of the applicant (over 18 years), irrespective of his/her marital status; Physically or mentally challenged person (Son/Daughter/Brother/Sister), of the applicant irrespective of age and sex with at least 40% of disability; Minor orphan who has lost both his/her parent; A widow or a woman divorcee (daughter/daughter in law/ sister) of the applicant.

A full package of Rs.15.00 lakh is available for an eligible family having land up to 2 Ha for both resident and non-resident applicants.

In the case of a non-resident eligible family, the compensation is limited to one eligible family, even if there is a major son/daughter, etc. in the family. Many families have already moved out of the forests and left their land behind in the forest. Such families are also supported by Government funding through the Navakiranam project.

In case of land more than 2 Ha in extent, each additional 2 Ha is treated as one residential unit. For example, in the case of a resident family with 2 eligible families and having 3 Ha, the first 2 Ha will be treated as two residential units and the balance 1 Ha as the third eligible unit. If this family has 4.1 ha, it will be counted as the fourth eligible unit.

The cut-off date to decide the extent of land and residential status is 14/11/2019, which is the date on which the scheme/fund was finally initiated in the Forest Department by the Government.

Material and methods

Methodology for effecting voluntary relocation

The applicant makes an application for relocation on a plain paper to the Range Officer which is examined by a ***Range Level Committee***. This Committee calls for all the relevant ownership records and eligible units for the family. These records are examined by a team of the ***Land Acquisition Unit*** headed by a Tahsildar and a survey team assigned to the Special Officer RKDP. Once the Tahsildar verifies the applications the ***Divisional Level Committee*** recommends them to the ***Regional Level Committee*** which is headed by the regional CCF and has members of the Revenue Department and concerned political representatives. Once the Regional Level Committee approves the applications, the Special Officer RKDP allows 50% payment to the applicant on the signing of an agreement between the DFO and the eligible applicant. A month is then allowed for the applicant to demolish their house within the forest and remove their belongings after which the balance 50% funding is transferred to the applicant. All fund transfers are done only through bank transactions to ensure transparency and keep out middlemen.

The whole program is monitored by a ***State-Level Empowered Committee*** headed by the Chief Secretary and comprising all Department Heads, Collectors, DFO's, etc.

Another unique feature of the project is that the applicant gets to choose and buy their own house or certify that they are shifting to their own home in a township using the funds provided by the Government for voluntary relocation. This is to ensure that the family is not homeless after availing the Government funds and they stay in a township and house of their liking for a better future safe from the hardships they faced in the forests.

Once the vacated land is taken over by the forest department the concerned DFO mutates the land in favor of the Forest Department and notifies the areas as Reserved forest.

Slow Take Off Of The Project

Once the program was initiated, there was a very slow take-off and by August 2022, only some 150 families in small pockets in Trivandrum, Waynad & Kannur had availed the scheme. The program was on the verge of being wound up when I joined as Special Officer RKDP in August 2022. We took many steps to upscale the project and our efforts were met with resounding success. By July 2023, within a year, as many as 618 families had availed of the project across Kerala. The project expenditure was Rs.75 crore and an area of 132 hectares was added to the forests of Kerala and Navakiranam became an all-state being implemented in all the districts of Kerala.

Training and Awareness

In July 2022 it was analyzed that one of the reasons for poor uptake of the project was lack of information both amongst the staff as well as the beneficiaries. Added to that was false information being circulated that it was a deliberate attempt on the part of the Government to push out people from the forests. We conducted a massive awareness and training program for all the staff of the Forest Department at every level, especially our field staff. As many as 130 training programs were conducted within the year. Training and interaction were also conducted for various line departments of the projects such as Revenue Department officers, Local Self Government Officers, and Registration Department officers. Awareness programs were organized at potential location sites in the state based on public demand.

Appointment of Navakiranam Coordinators and Facilitators

We appointed Coordinators from our field staff and facilitators from the community for each voluntary site and provided them intensive training on the importance of the project as well as its implementation to form a strong and effective interface between the community and the Forest Department. They ensured proper information was provided to the communities and ensured and facilitated all the paperwork and other administrative requirements including obtaining requisite documents from Revenue

and other authorities. We understood the massive acceptance of the project when during a public meeting which also had local politicians speaking against the project, the people told them to remain silent and it was their need to avail the project!

Skilling of beneficiaries

We addressed the issue of fear of the unknown and uncertain future by hand-holding the families moving out of the forests. A very unique component added to the voluntary relocation program was providing skills to the relocated families. To help the families assimilate into their new setting, every willing family member is provided skilling from a reputed and recognized agency and the forest department provides a certificate of skilling. The requirement and interest of the beneficiary is obtained and skilling is then provided. The requirement for skilling is obtained in the agreement signed between the DFO and the beneficiary at the time of agreeing to relocation. The Coordinators and facilitators ensure smooth implementation of the skilling component.

Computer applications, tailoring, driving, weed cutting, cattle rearing, electrical, flooring, and plumbing work are the most preferred jobs as of now.

Figure 2: Training in tailoring and weed cutting

Timely action and smooth transfer of funds

The Navakiranam project is a difficult project that requires commitment from the staff as it requires honest and unfettered interaction with the people is time-consuming and can often be frustrating.

Once our staff at all levels got involved in the project, we moved as a well-oiled machine and almost every officer worked in project mode across the state. This ensured that applications were obtained and processed in a timely manner. The Finance Department and the RKI secretariat seeing the success of the project provided timely funding which we could disburse in time. This helped the beneficiaries overcome their fear that there will be delays in releasing funds which may impact their lives. The type of coordination and smooth functioning of a project we could achieve is what dreams are made of!

Success stories from the beneficiaries

All 618 families who relocated voluntarily by July 2023 have given their feedback and their satisfaction in availing of the scheme. This can be read in our coffee table book, the link to which is given below. A few cases are illustrated below:

Karunakaran Pillai

Karunakaran Pillai lived in the interior forests of Vatakarikakam in Thiruvanthapuram. A river divides the forest and the main town and there is no bridge between the forest and the main road. There is no connectivity during the rainy seasons and his daughter could not go to school. To add to his problems, agriculture, and personal safety were badly impacted by the presence of wildlife and resultant conflict.

The family availed of the scheme and received 2 units amounting to Rs. 30 Lakhs. Using this he bought 10 cents of land and a house in the township of Mylamoodu, Kulathupuzha.

The family says that after relocating they now sleep peacefully without fear of wildlife attacks, and have easy access to education and medical facilities.

Thankaswamy

He was staying miserably in Rosemala with his autistic son. He could not give ample medical assistance to his son owing to the poor transport facilities. He obtained **t**wo units (30 lakhs) including one subunit for his son. He has then been able to buy 6 cents of land and a home at Punalur for 20 lakhs. The remaining 10 lakhs have been deposited in a bank for the son's treatment. He is so excited about this project as he is now able to give good medical care to his son as medical facilities are now available in the vicinity.

Figure 3: Thankaswamy's old house in the forest and his new home in Punalur

Philip M A

He wanted to give his grandchildren better education facilities. When he was in CRP Kunnu, the transportation facilities were very poor. During monsoons, no vehicle could reach the place. Human-wildlife interface was also a grave issue. He obtained **two units (30 lakhs)** as a financial package. He bought 17 cents of land and a new house near Mananthavady, Wayanad. Navakiranam has provided skilling in tailoring to his daughter-in-law and also supported her with an electric sewing machine.

Chacko P A

For John, reaching a nearby hospital and getting the required medicine for his treatment were the greatest hurdles he faced. John had to travel a long distance for this purpose. Crop damage due to human-elephant conflicts had also put his life on a knife-edge. He obtained two units (30 lakhs) as a financial package. He then availed the scheme and is now staying in Kurumbupadam, Idukki in a rented house. He is in the process of buying a new house

Figure 4: Chaco's old home in the forest

Santosh. G

Santhosh and his family lived deep within the forest and had to walk through a swamp to reach the main road to buy daily necessities and also to go to the hospital and for other civic needs. Due to the presence of wildlife in the swamp, no autorickshaw drivers were willing to come through the swamp. Santosh therefore availed the Navakiranam project and received 1 unit with which he bought 15 cents in the township of Navatanchira in Kulathupuzha. Now travel facilities are easy, and his family is happy and at peace.

Applications in pipeline

Applications were pouring in even in July 2023 and as many as 894 applications were in different stages of being processed to the tune of Rs.134 crores. Another 5000 new applications had also been received.

It is understood that the project is going strong and by December 2023, 800 families have availed the scheme and 155 hectares have been added to the forests of Kerala.

Rapid Biodiversity Assessment (RBA)

While people have benefitted from the scheme, even the forest habitat from where people have moved out has recovered. Rapid Biodiversity surveys were conducted at 8 sites with the goal of conducting such monitoring and surveys at all vacated sites at regular intervals. Diversity and population estimation is being conducted by laying out sample plots in each case

Rapid Biodiversity Assessments were conducted in Rosemala, Channamala, Dalikkarikkam, Kaithappara, Kodanad, Nilambur, Ottamala, and CRP Kunnu. Biodiversity assessment included the number and species of birds, trees, and invertebrates (Butterflies, dragonflies, and damselflies) encountered. The data was collected and compiled from the above project areas and the findings are presented below.

Trees

The assessment revealed the presence of many fruit trees that play a vital role in supporting a variety of organisms. The rapid biodiversity assessment recorded saplings, poles, and trees of the forest trees. The study could identify and record 47 species of forest trees from the study sites.

Figure 5: Myristica swamp in Kolathupuzha

Birds

92 species of birds were recorded from the project areas. Among them, 10 species are endemic to the Western Ghats and two species are coming under the Near-threatened

category of IUCN. The birds of Western Ghats especially those of evergreen forests and adjacent habitats are among the most geographically restricted Indian birds.

Figure 6: Long-tailed Shrike

Damselflies

A total of 30 species of Odonata including 14 species of Anisoptera (dragonflies) and 16 species of Zygoptera (damselflies) were recorded from the study area. The Libellulidae was the dominant among Anisoptera followed by Aeshnidae and Gomphidae. Among the Zygoptera, the dominant family was Coenagrionidae followed by Calopterygidae, Chlorociphidae, and Platycnemididae.

Butterflies

The treatment areas are rich in terms of invertebrates and birds. 47 species of butterflies were reported, three species are endemic to the Western Ghats and one is endemic to Western Ghats and Sri Lanka. Butterflies are indicators of a healthy environment and healthy ecosystem. These collectively provide a wide range of environmental benefits, including pollination and natural pest control.

A biannual assessment of biodiversity will be done in these areas and changes in biodiversity will be recorded scientifically on a long-term basis. Sample plots have been laid scientifically for such biodiversity surveys.

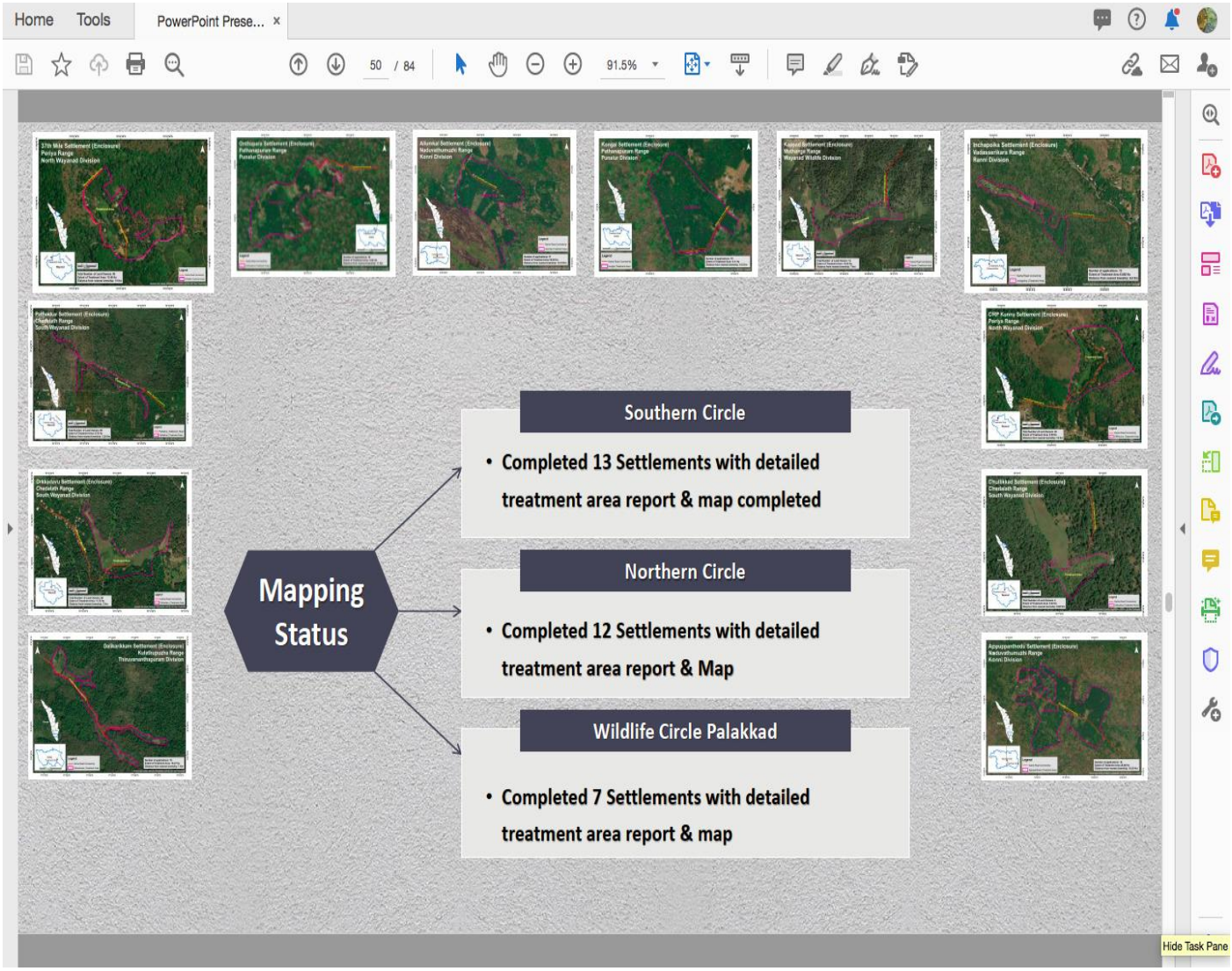


Figure 7: Voluntary relocation site demarcation and GIS survey

Navakiranam in the web

A Facebook and Instagram accounts of Navakiranam were launched in March 2023, to give wide publicity and authentic information about the project to interested people as well as beneficiaries to understand and confidently avail the life-changing Navakiranam scheme.

Scaling of the program

While the project is going strong in Kerala and is an impactful solution for both people and forests, it is essential that the program is funded and given Government support on a long-term basis till every eligible person who wants to avail of the project can do so.

It is also important that this project is implemented in other states to provide benefits to people as well as provide space for our biodiversity to regenerate. This will add green cover to our forest lands and provide ecosystem services and ecological security for our country.

The ACS Forests of Kerala has written to the MoEFCC as well as DoPT in July 2023 to adopt this program and implement this program throughout the country.

Figure 8: Elephants roaming in the forests vacated due to voluntary relocation

Result and discussion

The Navakiranam program has shown very promising and successful results. The project had poor response in the first few years with only 150 families availing the project from 2019 till 2022. However, the situation changed in August 2022 after massive training programs were conducted for forest, revenue, and registration department staff as well as awareness programs for potential beneficiaries. Appointing coordinators and facilitators, from the Forest Department as well as the participating forest villages brought a close interface between the department and beneficiaries which built confidence in the people and ensured large-scale participation of people in the project. Introducing the skilling component further gave a fillip to the program. By July 2023, about 750 families had benefitted from the project, while some 800 applications were at advanced stages of scrutiny and sanction and another 5000 new applications had been received from across the state.

Recovery of the forest habitat was also recorded with elephants, other wildlife, and birds occupying the vacated forests as well as recording of regeneration of forest species.

Long-term assessment will reveal the ecological and social impacts of the project which appear very promising from the baseline assessment that has been done.

Conclusion

The Navkiranam program is an excellent program of the Kerala Government which is successfully addressing the needs of people marooned within forests as well as the requirement of large tracts of inviolate forests for biodiversity, wildlife as well as ensuring ecological security for people while ensuring smooth flow of ecosystem services. The project will effectively address issues of human-wildlife conflict, regeneration of forests, and even forest fires.

However, to be truly effective, there needs to be massive, focused, and long-term funding for the program within the state. Further, the project needs to be implemented on a vast scale throughout the country on a long-term basis to show impactful results and ensure the reduction of ills that face our forests due to the very complicated and extensive interface between people and forests with their wildlife.

Governments need to make this program a priority and fund the project as well as give it the recognition, importance and focus it deserves.

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Research

Preliminary Phytochemical Screening of Catharanthus Roseus (L.) G. Don

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Abstract
Catharanthus roseus is a well-known ayurvedic herb. The therapeutic effect of plant materials in a variety of diseases has prompted their continuous investigation and use. This led us to investigate the preliminary phytochemical components of *Catharanthus roseus* plant extracts. The techniques were used to conduct phytochemical screening of ethanolic and aqueous extracts of the *C.roseus* leaves.

Keywords: Ethanolic extract, Aqueous extract, Phytochemical screening, Hypo glycemic action, Leaf extract, Alkaloids, Lymphosarcoma, Choriocarcinoma

Introduction

Catharanthus roseus (L) G. Don (previously Vinca rosea L., Apocynaceae) is generally known as the Madagascar periwinkle. It is a perennial evergreen herb that grows to be 30-100 cm tall. It was originally endemic to Madagascar but is now widely distributed across the tropics (Mir et al., 2018). The relevance of the concerned plant leaves is mostly from their ability to manufacture a variety of terpenoids and alkaloids with therapeutic effects. The chemicals indicated above have a wide variety of uses, primarily in the treatment of lymphocytic cancer, Wilkins' cancer, neuroblastoma, reticulum cell tumour, Hodgkin's disease, lymphosarcoma, and choriocarcinoma (Aslam et al., 2010). Alkaloids have been found and isolated to a greater degree than other natural chemicals in C. roseus (Kumari and Gupta, 2013; Tikhomiroff and Jolicoeur, 2002). *Catharanthus roseus*, which is a powerful therapeutic herb many of pharmacological actions such as antimicrobial, antioxidant, anthelmintic, antifeedant, anti sterility, antidiarrheal, antidiabetic effect, etc (Wang et al., 2012; Asma et al., 2016).

Catharanthus roseus (L.), an important medicinal plant belonging to the Apocynaceae family used to treat many deadly diseases, contains a realistic abundance of useful alkaloids used in diabetes, hypertension, asthma, constipation and cancer, and a menstrual problem. The plant has spread all over tropical and subtropical parts of India and grows wild all over the plains and lower foothills in the Northern and Southern hills of India. In Malaysia, it is locally called as Kemunting Cina. The periwinkle logo as a symbol of hope for cancer patients is used by the National Cancer Council of Malaysia (Loh, 2008).

The ethanolic extracts of the leaves and flower of C. roseus revealed that a dose-dependent decreasing of blood sugar is similar to the standard drug. Decreasing of blood sugar reported in *Catharanthus roseus* (Paarakh et al., 2019). The Hypo glycemic action has been aroused due to the result of the increased glucose utilization in the liver (Chattopadhyay et al., 1991; Singh et al., 2001).

Material and methods

Collection of plant materials

Fresh *C.roseus* leaves were taken from the garden. The plant parts were properly rinsed with tap water, followed by sterilized distilled water. The plant parts were dried in the shade at room temperature before being utilized as raw materials to extract preliminary phytochemical studies of the plant.

Qualitative analysis of phytochemical

Test for alkaloids

To 1ml of leaf extract added in 1ml of Meyers reagent and a few drops of iodine solution. The formation of yellow colour precipitate indicates the presence of alkaloids.

Test for flavonoids

The filtrate was shaken with 1 mL of 1% ammonium chloride solution, where light yellow colour was observed. It indicated the presence of flavonoids.

Test for glycoside:

0.5g of extract was diluted to 5 ml in water was added 2 ml of glacial acetic acid containing one drop of FeCl3. This was underlaid with 1 ml of conc. Sulphuric acid. A brown ring at the interface. A violet ring has appeared below the brown ring. A greenish ring may form just above the brown ring.

Test for terpenoids:

1ml of concentrated sulphuric acid added to 1ml crude extracted and heated for 2 minutes, and greyish colour would show the presence of terpenoids.

Test for carbohydrate:

One ml of plant extract was taken in a test tube and added 1ml of Barfoed s reagent and heat on water bath for 1 minute. The formation of Brown coloured precipitate showed the presence of carbohydrates.

Test for steroids

2 mL of acetic anhydride and 2 mL of H_2SO_4 were added to the extracts. The colour changed from violet to blue or green, which indicated the presence of steroids.

Test for saponins

A small quantity of different extracts was diluted with 4 mL of distilled water. The mixture was shaken vigorously and then observed appearance of a foamy layer, which indicated the positive.

Test for tannin:

2ml of crude extract sample in a test tube and add 3% of ferric acid chloride drop. The appearance of bluish-black precipitate indicated the presence of tannin.

Test for fatty acid

The sample to be tested is rubbed between the folds of filter paper. The appearance of a translucent spot confirms the presence of fats in the given sample.

Test for gums

Each extract was dissolved in 10 mL of distilled water and 25 mL of absolute alcohol was added to it with constant stirring. White or cloudy precipitate indicated the presence of gums.

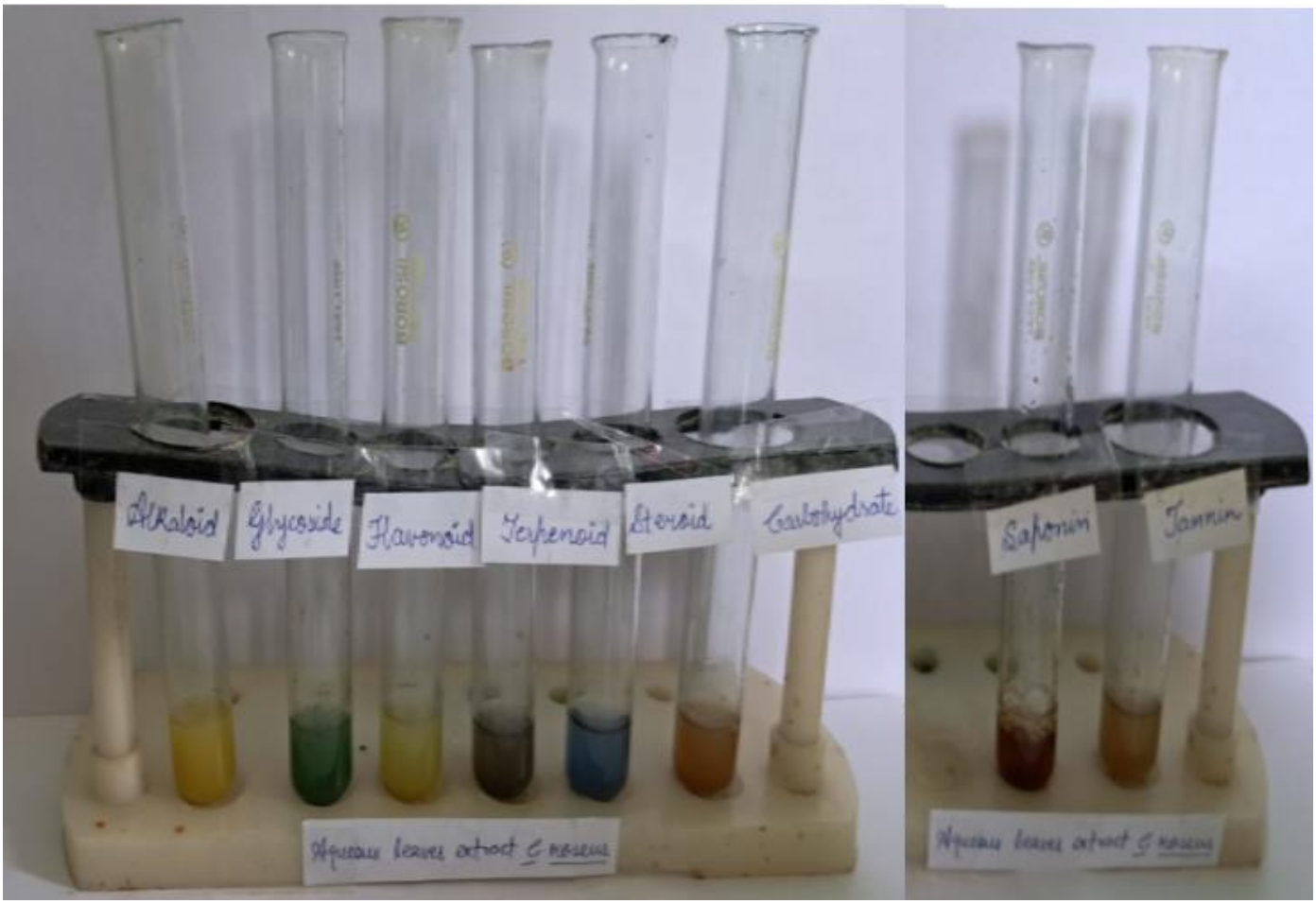
Table 1: Preliminary phytochemical screening of *C. Roseus* leaves

Test	Ethanol	Distilled water
Alkaloids	+	+
Glycoside	-	+
Flavonoid	+	+
Terpenoids	+	+
Carbohydrate	+	+-
Steroid	+	+
Saponin	-	+
Tannin	-	-
Fatty acid	+	+
Gum	-	-

(+symbol indicates presence and – indicates absence with respect to extract solvents).

Result and discussion

The investigation showed that Catharanthus roseus contains alkaloids, flavonoids, terpenoids, steroid, carbohydrates and fatty acids were present in ethanol and aqueous extract (Table 1). Glycoside is present in only aqueous extract. Tannin was absent in both extracts, similar results also reported by some authors.



Conclusion

The plant includes massive phytochemical compounds of diverse therapeutic uses, which may work directly or in conjunction with other metabolites to conquer a particular condition. Vinca has made a significant contribution to modern medicine. Numerous research has proven some of its medical applications, but more of its hidden qualities have to be discovered. As a result, the majority of research might be conducted on the aforementioned plant to uncover undiscovered secrets that would aid the current pharmaceutical industry.

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Research

Knowledge and Documentation of Wild Edible and Non-Edible Mushrooms Used by the Local Communities of Jharkhand

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Abstract
The wonderful world of fungi has always fascinated the human race, by their appearances and characteristic nature**.** The word **mushroom** is used for fungi and moulds in French. Since ancient times, mushrooms have been regarded as a special kind of nutritious food. They are diverse in both their growing habitats as well as their medicinal and physiological benefits**.** Mushroom foraging has been practiced by humans for the same reason**.** The forest provides large and diverse options to the villagers in the form of varieties of wild edible and non-edible mushrooms. Wild edible mushrooms are very important in the food security of tribal groups throughout Jharkhand. The aim of this study is to produce a prior mushroom checklist based on the collection and document the edible and non-edible mushrooms from Jharkhand state which are collected during the rainy season by tribals for their livelihood.

Keywords: Mushroom, Nutritious, Health advantages , Anti-cancer Properties,Tribal people, Basidiomycetes, Hypogeous, Low-fat content

Introduction

Humans are innately and emotionally attracted to other living organisms. The biophilia concept states that we are inherently drawn to environments that have supported human life in the past, so attraction toward nature is part of our genetic makeup. Mushrooms are one of such organism which has incurred the interest of human beings in the past and in the present for their health advantages in addition to standard nutrients. In recent years, the presence of bioactive compounds has fuelled the interest towards mushrooms. These compounds have been found to have hypocholesterolemic, anti-cancer, and hepatoprotective properties and are appropriately referred to as functional food.

The word **mushroom** is used for fungi and moulds in French. Since ancient times, mushrooms have been regarded as a special kind of nutritious food. Greeks preferred mushrooms as a commodity providing strength for warriors in battle and the Romans regarded mushrooms as the "Food of God". From ancient times wild mushrooms were collected from their natural growing habitats (Cooke, 1977). Thousands of years ago, the fruiting body of higher fungi (Basidiomycetes or Ascomycetes) has been used as a source of food (Mattila et al., 2001) due to their chemical composition, association with termites, trees of forest which is attractive from the nutrition and economical point of view. In most countries including India, mushrooms are an important delicacy because of their unique flavor and texture though they do not contribute a significant portion of the human diet (Valentao et al., 2005). The high-energy values with low-fat content are their natural endowment. The tribal people over here have a very good knowledge of

wild edible and non-edible mushrooms because they collect them from the forest during the rainy season for their consumption or for sale.

Jharkhand state is located in the eastern region of India; it lies between 23°15′N to 24°45′N longitudes and 83°17′ E to 87°45′E latitude. Jharkhand has a deciduous forest; decaying leaves make rich humus for mushrooms' growth therefore Jharkhand has a rich diversity of wild edible and non-edible mushrooms. The tropical climate of Jharkhand, especially Khunti, is suitable for the growth of mushrooms. The Munda tribes of Jharkhand mostly found in the Khunti district are involved in mushroom cultivation. These mushrooms are consumed frequently by various tribes inhabiting nearby the forest. These tribal groups are engaged in the collection and consumption of wild edible mushrooms based on their traditional knowledge. Mushrooms are macrofungi with outstanding fruiting bodies that can be hypogeous or epigeous, large enough to be seen with the naked eye, and can be picked by hand (Chang ST & Miles, 1992). The consumption of edible mushrooms in Jharkhand represents a cuisine tradition. Some species of mushrooms are traditionally eaten and received several popular local names such as Bala khukhri, Patiyari khukhri, Jamun khukhri, Chirkho khukhri, Bans khukhri, Patra Khukhri, Machu Khukri, Leche etc. In the Khunti district, a large diversity of wild edible and non-edible mushrooms are found growing on the forest floor, twigs, branches, rotting plants, and cattle dung. Although, it is difficult to estimate the number of extent of mushrooms present in the wild habitat. The objective of the present work is to compile and document the diversity of wild edible and non-edible mushrooms from the biodiversity-rich Khunti District.

Material and methods

The local market and forest area of the Khunti district was surveyed and wild edible and non-edible mushrooms were collected during the rainy season and a list of these was prepared based on the local knowledge. Samples were collected using sturdy knives to dig down to bases. Each collected mushroom was carefully rolled in wax paper and then kept in zippered plastic bags with lots of air trapped in them to act as cushions. After collection specimens were kept in sterile containers, each container was labeled with their date & place of collection and brought to the laboratory for identification and preservation. Identification of the specimen was done by morphological characteristics of the fruiting body, traditional knowledge provided by ethnic tribal communities, and guidelines mentioned in the manual of Purkayastha and Aindrila (1985). Specimens were preserved in a 6:3:1 ratio of distilled water, ethanol, and formalin for further analysis.

Documentation of the collected mushrooms

To 1ml of leaf extract added in 1ml of Meyers' reagent and a few drops of iodine solution. The formation of yellow colour precipitate indicates the presence of alkaloids.

1. Local or vernacular Name
2. Habitat
3. Growth habit
4. Width of Pileus
5. Shape
6. Colour and colour change
7. Length of Stipe
8. Annulus: Present or Absent
9. Pseudorhiza: Present or Absent

Result and discussion

The specimens were collected from the Khunti district. The forest of Khunti District possesses abundant Sal crop species; in the rainy season, this forest receives heavy rainfall that is favorable for the growth of mushrooms. A total of 27 mushroom species

were collected and identified, out of the 27 species 15 species were wild edible mushrooms. Among them, 14 species were identified and 1 species was unidentified. 12 species were non-edible.

Conclusion

Total of ten species were studied, these mushrooms are wild edible and distributed in the forest and other areas of the Khunti district. The tribal people of Ranchi have extensive knowledge of wild mushrooms. There is a need to cultivate these varieties for the economical benefit and as an alternative to plant and animal-derived food. It has been seen that there is a huge market of these species in the rural as well as urban mass.

It is also found that the tribal communities have the most knowledge about the nutritional and medicinal value of wild mushrooms. Wild edible mushrooms are widely distributed in the Khunti district and it is an important source of nutrient, health, and income generation. There is an urgent need to increase the use and consumption of wild edible mushrooms for the welfare of the state and to combat malnutrition among tribal people. The use of wild edible mushrooms can also help in the improvement of the livelihood of the local people.

a) *Boletus edulis*
b) *Termitomyces clypealus*
c) *Termitomyces microcarpus*
d) *Astraceus hygrometricus*
e) *Termitomyces hiimii*
f) *Amanita exitialis*
g) *Russula foetens*
h) *Unidentified*
i) *Amanita caesarea*
j) *Termitomyces alchetron*
k) *Termitomyces albunainosa*
l) *Russula cyanoxanth*
m) *Unidentified*
n) *Termitomyces clypeatus*
o) *Termitomyces spp.*

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Review

Renewable and Sustainable Energy Review

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Abstract

The review introduced in this paper depends upon point by point survey of the Zeroed on the utilization of phase change material (PCM) for PV-Module. Thermal regulation & electrical efficiency improve the impact of high temperatures. On PV power age has been analyzed and the discoveries have featured the significance of visible high temp. guideline for PV-model. Different cooling technique utilized to keep up better PV execution are examined and the as of late arising PV-PCM framework idea for high-temperature guidelines is presented.

A comprehensive paper review of best in class part of this innovation like framework improvement, execution, assessment material choice, heat remove improvement mathematical model, reproduction, and application in practice is given. The PVST-PCM system for example coordinated with a sunlight base warm (ST) system. Has subsequently been explored as the put-away intensity can be extricated for the warm application. The double PCM jobs exhibit huge application possibilities for consolidated innovation in any case. Both PV-PCM and PVST-PCM framework (system) are still mostly in the exploration and research faculty test stage, with clear extension for viable application yet with orderly difficulties. Ideas for the future work are introduced.

Keywords: PV-PCM, PVST-PCM, Solar thermal radiation, Electricity converter, solar power system, Optimum temperature, Optimum working temperature, Solar panels.

Introduction

Now a days technologies are increasing day-by-day which requires fossil fuels which has been in limited quantities under the ground level on earth so we tries to shift on renewal sources of energy. Here we use such as solar energy, wind energy, hydro energy, etc.

Solar or Photovoltaic (PV) cells are made of semiconductors materials that can convert sunlight into electricity. When the sunlight is falls on the surface of the solar cells in the form photons and it convert in electricity by the help of converter. In solar power system the PV cells are heated more due to solar thermal radiation and decrease the efficiency of PV cells so we use different type phase change materials and different types of technique which is maximum heat transfer to the environment and further reduced the heat of PV cells and increase its efficiency.

Material and methods

Ideal working temperature for solar panels

The optimum working temperature of solar panels, according to solar panel manufacturers, is 77F (25C). Solar panels are expected to absorb the maximum amount of sunlight and convert it to usable power at this temperature (peak efficiency).

Previous research agrees on the optimum temperature recommended by manufacturers but expands it to be a range. According to many research findings, the average temperature range is 59F-95F (15C-35C).

Effects of overheating on solar panels

Reduces efficiency

With proper cooling, you should expect your solar panels' efficiency to be near the top of the standard efficiency range (19-23%).

Causes regular maintenance

High temperatures have an impact on all electronics, including solar panel components.

Negative financial effect

Overheating causes energy loss, which means you're paying more for electricity.

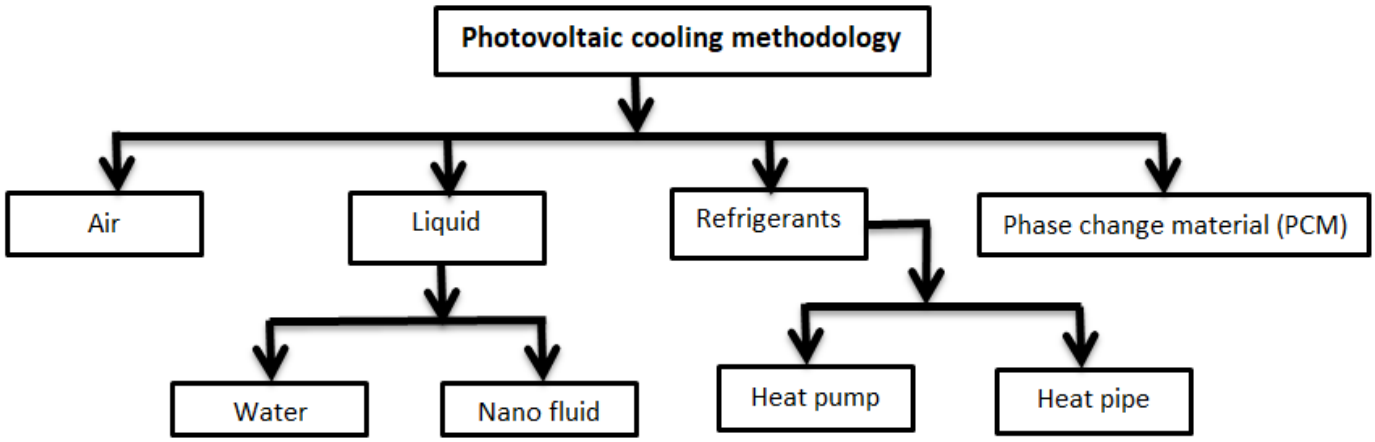
Methods of cooling

(Ma et at., 2014; Sainthiya et al., 2017) Various types of cooling technologies to use enhance the efficiency of PV-module like as Air based, heat pipe-based, and phase change material PCM) based. There are two types of cooling technique used –

1. Active cooling system
2. Passive cooling system

Active cooling system refers in which the device consume power supply. In active cooling like as fans, motors and water pump on the surface onto the panel to remove heat from it. Although an active system consume power so it is used situation where the added efficiency to the panels is grater then the energy demanded to the power system.

Passive cooling system refers in which reduce temperature of PV system by absorbing heat from it without consuming any type of additional power source. In the PCM there are many types of methods of passive cooling options available such as copper and aluminium, or an array of fins and other type of extruded surface of solid of maximum heat transfer to the surrounding. Passive cooling does not required any type of power consumption to drive the system. Phase change material (PCM) thermal regulation is also passive cooling methods. The passive cooling methods are mostly used as compare to the active cooling methods because in the passive cooling methods not require any electrical power consumption so its require less maintenance.



Literature review

(Sarikarin et al., 2019) Using methods cooling enhancement of photovoltaic cell via the use of phase change material in a different designed container shape and find the result-

- **Groove type**- the temperature that is decreased by 4.764 °C and the electrical power increased by 0.466 Watts, resulting to an increase of electrical efficiency by 4.042 percent.
- **Tube type-** the temperature that is decreased by 5.265 °C and the electrical power increased by 0.505 Watts, resulting to an increase in electrical efficiency by 4.307 percent.
- **Fins type-** the temperature that is decreased by 6.167 °C and the electrical power increased by 0.596 Watts, resulting to an increase in electrical efficiency by 4.858 percent.

So we found that maximum temperature decreased by 6.167 °C and electrical efficiency increased by 4.858 % in fins-type containers. (Lim et al., 2018) Investigating the Performance Improvement of a Photovoltaic System in a Tropical Climate Using Water Cooling Method and Find the Result- the temperature distribution profiles of the solar panels were obtained from the thermography images taken by the thermography camera, and they were compared with the temperature readings from the temperature sensors. The thermography images of the solar panels before and after the water-cooled with a flow rate of 20 L/min are shown in Figure The readings from the temperature sensors are listed in Table 1 the thermography images were taken within 1 minute after the water cooling was started. The average temperature was reduced by 24.4°C within a minute.

Table 1: The readings from the temperature sensors

Sensor	T1	T2	T3	T4	T5	T6	T7	T8	T9
Before cooling °C	56.2	61.9	58.7	59.7	63.3	63.1	56.0	58.0	58.5
After cooling °C	35.1	35.0	34.9	35.5	35.4	35.6	34.8	34.8	34.9

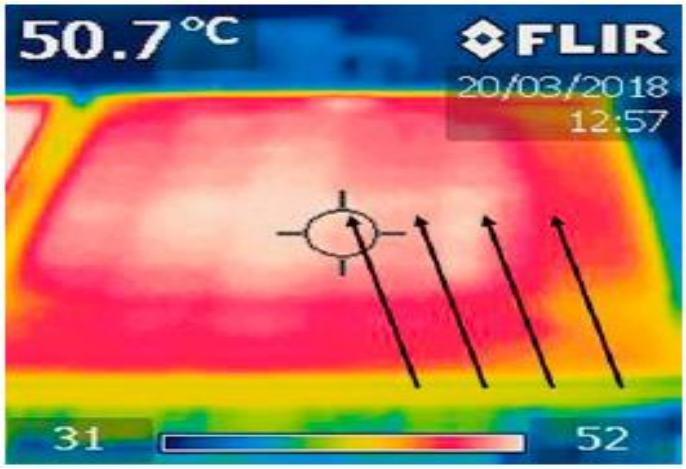


Figure 1: Thermography image before cooling water was Temp. varies across the solar panel.

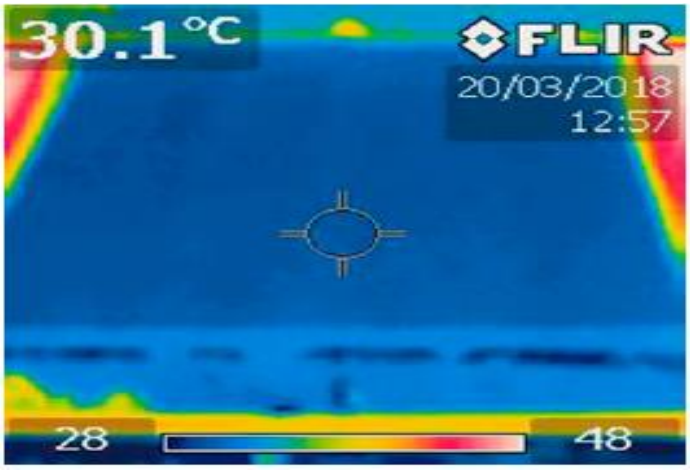


Figure 2: Thermography image was taken within 1 minute after cooling water was supplied. A uniform temp. distribution was observed across the solar panel.

(Bashir et al., 2018) Performance investigation of PV modules by back surface water cooling method used and find the result- experiment was performed on the top roof of the Department of Mechanical Engineering, MUST, for different sunny days of two months (July and August 2015). It was assumed that there was 1-D heat input (perpendicular to the front glass). The maximum power, electrical efficiency, thermal efficiency, and overall efficiency of two different PV modules were measured and the comparison is presented here. The results showed that there is a

considerable efficiency increment with the back surface cooling of PV modules. Days of measurements were sunny. Figure shows the hourly average solar irradiance from 8:00 AM to 5:00 PM. The average solar radiation increased linearly up to 12 p.m. and then decreased after that. The highest average solar irradiance measured was 971 W/m2.

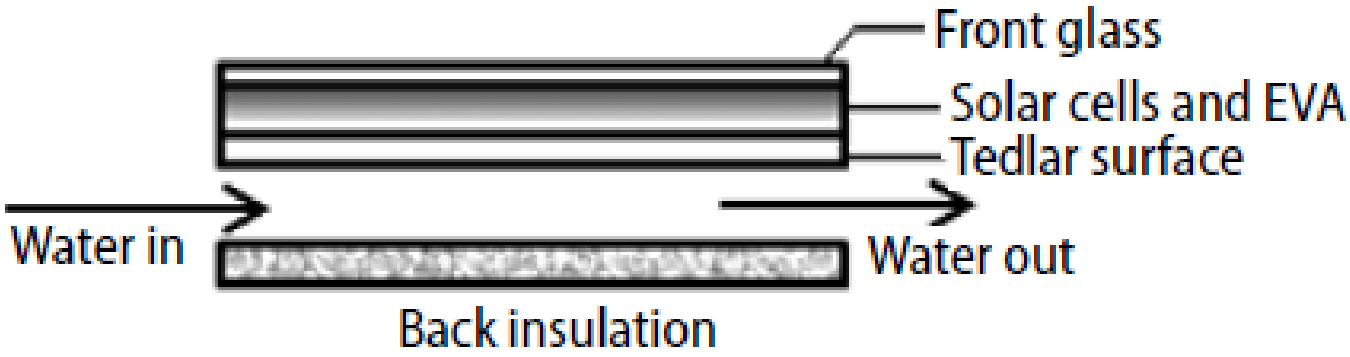


Figure 3: Cross-section of the PV module with dust

Figure 4: Experimental set-up; PV modules with cooling and without cooling

(Azzouzi et al., 2013) "Improving silicon solar cell efficiency by using the concept of the impurity photovoltaic effect (IPV) to enhance the cell conversion efficiency. The concept of IPV is based on the insertion of deep defects in the solar cell. They investigate the effect of the impurity and structure parameters on silicon solar cell characteristic.

(Abd-Elhady et al., 2013) Enhancing the performance of photovoltaic panels by water cooling and find the result- It is found that a rise in the solar cells temperature by 10 ºC from 35ºC to 45ºC results in decreasing the efficiency of the cells from 12% to 10.5% the average efficiency decreased by 12.5%. The cooling system was operated to solve the overheating problem, where it was observed from Figure 5 that operating the cooling system for 5 min results in a decrease in the solar cells temperature by 10ºC, and an increase in the solar cell efficiency by 12.5%.

(Agyekum et al., 2021) Effect of dual surface cooling of a solar photovoltaic panel on the efficiency of the module: experimental investigation and find the result by this method The maximum output power of 15.04 W was recorded around 11:30 am when the highest solar irradiation was recorded during the experiment for the cooled PV panel, whiles the uncooled panel recorded 11.60 W during that same period. This is about a 29.66% improvement in the energy yield as a result of the implementation of the cooling approach proposed in this study. The average power for the entire experimental period for the cooled panel is 13.03 W compared to 10.00 W for the uncooled PV panel. It can be said that the 23.55˚C reduction of the

temperature as presented earlier in this research led to an overall increment of 30.3% in the output power. As shown in Figure 6.

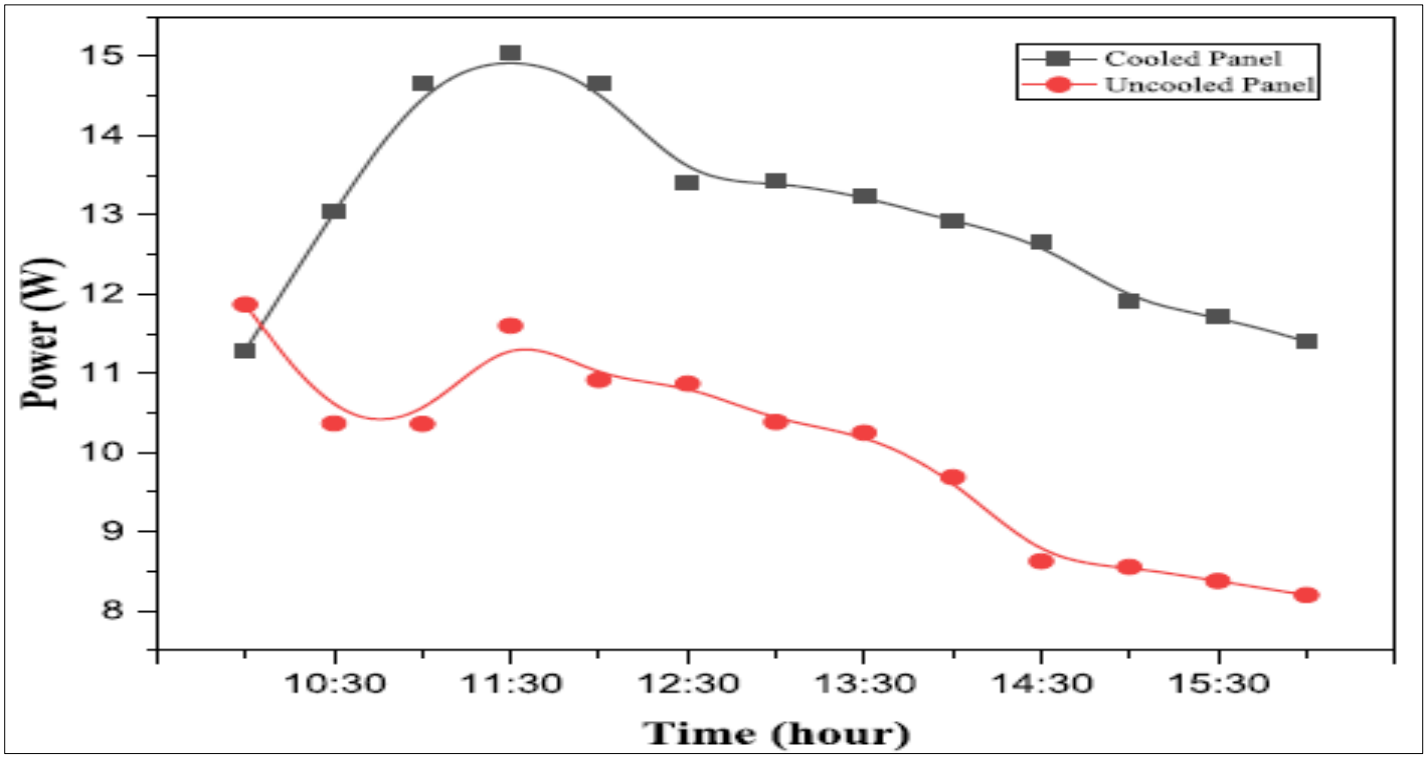


Figure 5

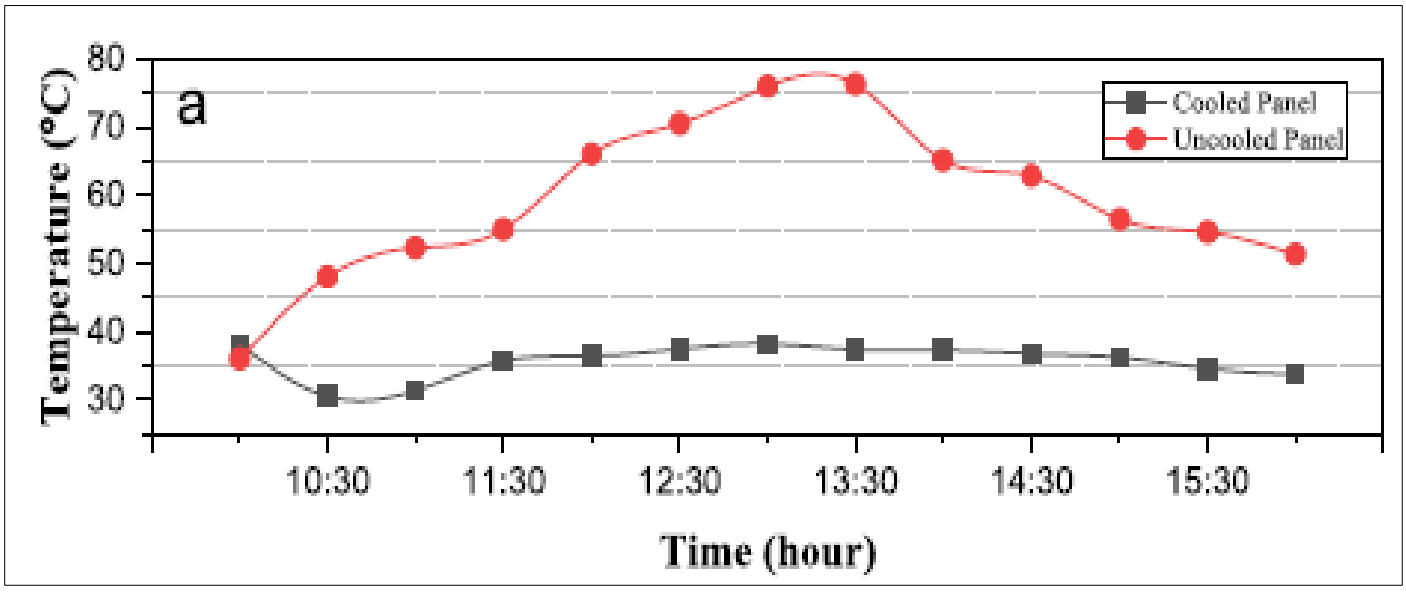


Figure 6

(Elminshawy et al., 2018) Performance of PV panel coupled with geothermal air cooling system subjected to hot climatic, in this methods EAHE (Earth Air Heat Exchanger) use as geothermal air cooling and find the result- The performance of the PV module was researched using geothermal cooling. A significant PV surface temperature drop up to 24.5% is achieved and improvement in the PV module output power up to 18.90% is achieved. PV electrical efficiency is increased up 22.98% using proposed cooling system. The LCE (levelized cost of energy) for (PVC) is improved by 12% using geothermal cooling.

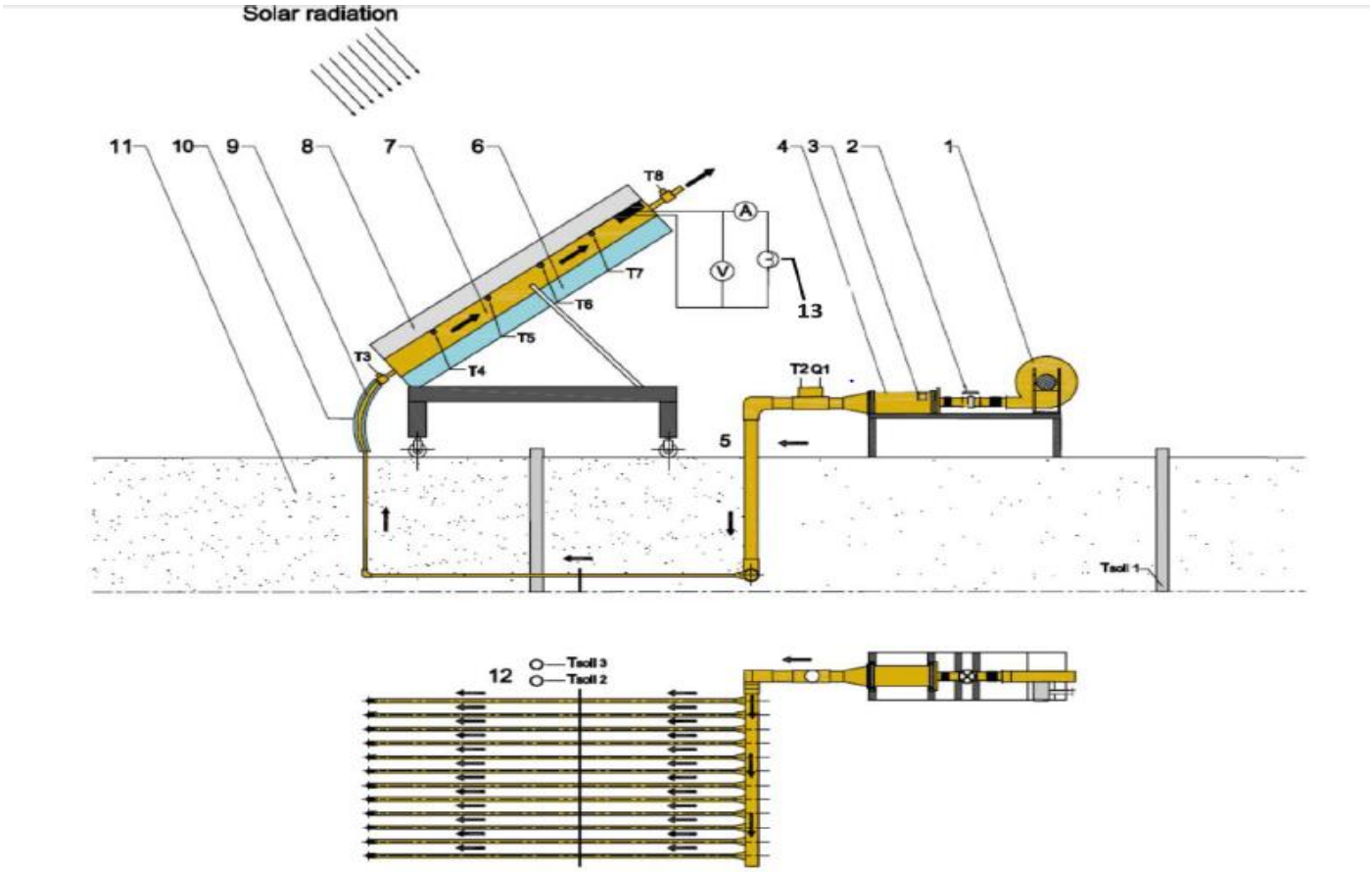


Figure 7

Figure 7 Schematic diagram of the experimental test rig, 1- air blower, 2-control valve, 3-temperature control, 4- air heater, 5-inlet to EAHE, 6-insulation, 7-air cooling channels, 8-PV module, 9-pre-cooled air exit, 10-exit pipe insulation, 11-soil, 12-soil temperature locations, *Tsoil2* and *Tsoil3*, 13- electrical load, DC bulbs (24 V).

(Sarikarin et al., 2019) conducted experiments for PCM passive cooling. Three PCM boxes, i.e. grooved, tubed, and finned configurations, were investigated. Data were recorded during the period 11.00 am–1.00 pm where the solar irradiance was almost constant at high values. The preliminary results are shown in the Table given below. The temperatures of the two PV modules, with and without cooling, were monitored. The module without cooling had a temperature of 50–55 °C and the ambient temperature during the test was 29–35 °C with an average of 32.9 °C. Thus, when cooling the module with palm wax in the finned container, the heat was absorbed by the palm wax to change it from solid to liquid phase.

PCM container	Grooved	Tubed	Finned
Avg. temperature of PV without PCM cooling (˚C)	54.8	54.4	57.9
Avg. temperature of PV with PCM cooling (˚C)	50.1	49.1	51.8
ΔAvg. temperature of PV (˚C)	−4.7	−5.3	−6.1
Avg. ambient temperature of PV (˚C)	31.4	29.3	32.9
Avg. power output of PV without PCM cooling (W)	11.82	12.35	12.77
Avg. power output of PV with PCM cooling (W)	12.28	12.86	13.37
Δ Avg. power output of PV (W)	+0.46	+0.51	+0.60
Avg. energy conversion efficiency of PV without PCM cooling (%)	9.84	9.91	10.20
Avg. energy conversion efficiency of PV with PCM cooling (%)	10.23	10.32	10.68
Improvement of energy conversion efficiency of PV (%)	+4.04	+4.31	+4.86
Avg. irradiance (W/m^2)	871	910	919

Figure 8

(Hachicha et al., 2015) Enhancing the Performance of a Photovoltaic Module Using Different Cooling Methods and Find the Result For almost the same irradiance back cooling is able to decrease the temperature of the PV cell by 1.7% compared to the uncooled case, while the power is increased by 2.3%. For front cooling, an increase of 3.6% in output power has been observed and the open circuit voltage increases from 20.38 V to 20.72 V. A significant decrease of 11.3% of the cell temperature is observed with front cooling leading to an increase of electrical efficiency by 3.6% respect to the uncooled case. The cell temperature is decreased by 7.7°C using the double cooling corresponding to a drop of 18.3 % compared to the uncooled case. As a consequence, the maximum power point is increased by 5.5% which is consistent with the temperature coefficient for silicon solar cell (0.065%/K). The short circuit current is almost constant for different scenario and only a slight decrease is observed when double cooling were implemented. The electrical efficiency and the fill factor of the PV panel have been calculated for different cooling techniques and compared to the uncooled case. In the table, double cooling shows an increase of 4% in electrical efficiency of the PV panel which means a relative increase of 0.5%/K. However, the fill factor is increased by only 2.9% which corresponds to a relative increase of 3.5%/K.

Table 2: Electrical performance of the pv panel

	η (%)	**FF**
No cooling	10.58	0.686
Back cooling	10.81	0.692
Front cooling	10.78	0.700
Double cooling	10.99	0.706

Conclusion

This review investigated the different types of cooling techniques to achieve the maximum power output by decreasing the PV cell temperature. PV cooling via fin heat sink offers enhanced heat transfer area to promote a more significant heat transfer rate

from the rear surface of the PV module to the ambient mainly via natural convection. This method can be considered as the most economical in comparison to the other passive cooling techniques, technically feasible under different climatic conditions, and easy to implement or install. In the heat transfer mechanism by natural convection, the heat flow is highly dependent on the geometry of the surface (heat sinks) and its orientation.

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