ECODIVERSITY FOR CLIMATE RESILIENCE

Editors

Dr. S.C. Joshi IFS Dr. V. Balakrishnan Dr. Preetha N.



KERALA STATE BIODIVERSITY BOARD

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Biodiversity for Climate Resilience

[This book is a compilation of the papers presented as part of the 1st Kerala State Biodiversity Congress held during 2018]



Editors

Dr. S.C. Joshi IFS, Dr. V. Balakrishnan, Dr. Preetha N.

Editorial Board

Dr. K. Satheeshkumar Sri. K.V. Govindan Dr. K.T. Chandramohanan Dr. T.S. Swapna Sri. A.K. Dharni IFS

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PINARAYI VIJAYAN CHIEF MINISTER



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MESSAGE

I am glad to note that Proceedings of the Kerala State Biodiversity Congress, 2019 is being published.

I am sure that the proceedings will enable policy makers, researchers, students and the general public to understand the theme of the KSBC 2019, 'Biodiversity for Climate Resilient Kerala' and in preparing a road map for ensuring a 'Nava Keralam', which mainstreams biodiversity conservation strategies in governance.

My best wishes.

Pinarayi Vijayan

Tel: (0471) 2333812 & 2333682 Fax: (0471) 2333489 e-mail : chiefminister@kerala.gov.in website : www.keralacm.gov.in

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INTRODUCTION

II iological diversity" refers to the variability among living organisms from all D sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. The direct drivers of biodiversity loss include Habitat loss and degradation, Climate change, Excessive nutrient load and other forms of pollution, Over-exploitation and unsustainable use and Invasive alien species. According to the Millennium Ecosystem Assessment, Climate change is likely to become the dominant direct driver of biodiversity loss by the end of the century. It is suggested that climate change may be as important as land use change in driving biodiversity loss over the next 50 years. Conserving natural terrestrial, freshwater and marine ecosystems and restoring degraded ecosystems (including their genetic and species diversity) is essential for the overall goals of both the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change because ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services that are essential for human well-being and the achievement of the Sustainable Development Goals.

The role of Biodiversity for Adaptation and Mitigation of Climate Change is explored in this book "Biodiversity for Climate Resilience" through two section "Best practices of Biodiversity Conservation" and "Biodiversity Conservation Strategies and Priorities". The devastating effect of flood and landslides in Kerala during 2018 is one of the examples of how vulnerable our biodiversity rich state is to climate vagaries. This collection of best practices is part of a wider effort to cope with climate change, and the focus of this report is on adaptation and includes both best practices of ecosystem conservation and species/varietal conservation. The case studies presented in Chapters 1 through 4 respectively ranges from best practices of ecosystem rejuvenation as River rejuvenation-The Aadi Pamba Varattar Story, the widely acclaimed Jalasamrithi project at Kattakada, Community biodiversity garden at Wayanad to the inspiring story of Yaongyimchen Community Biodiversity Garden at Nagaland. Best practices of species conservation includes the Hornbill monitoring program with community participation at Vazhachal, Agrobiodiversity conservation-Seeds of Hope a scheme for providing emergency supply of indigenous varieties to worse affected areas by natural calamities, examples of rice ecosystem cultivation from Kerala and Conservation of small millets for nutritional security at Orissa. The best practices presented in this document are tested with success, and are practical measures worth to be considered for implementation.

The section on Biodiversity conservation priorities focus on the germplasm conservation initiatives of NBPGRI on Agrobiodiversity to legal framework for Agrobiodiversity conservation. Ecosystem-based adaptation, which integrates the use of biodiversity and ecosystem services into an overall adaptation strategy, contribute to the conservation of biodiversity. Aquatic and wetland ecosystems are more vulnerable to climate change and the challenges in conservation of aquatic biodiversity and strategies are highlighted in two chapters dealing with aquatic biodiversity and riparian vegetation. Two case studies on conservation of threatened species Humboldtia bourdillonii a species listed under Section 38 of Biological Diversity Act and butterflies considered to be an ecological indicator of climate change is also included in this section. Lastly the necessity of reaching out to people is highlighted in the initiative of Utter Pradesh Biodiversity Board "The Prakrithi Bus"

Ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services that are essential for human wellbeing and the achievement of the Sustainable Development Goals. In Kerala the LSGs now manage about one third of the State plan outlay and are responsible for much of the work on adaptation and mitigation to climate change. While international agencies and national governments play important role in establishing effective enabling environment and channelling resources and technical support, the impacts of climate change manifest themselves at the local level, and hence Local Self Governments have an important role to play in implementing Adaptation and Mitigation strategies. The majority of the available best practices for climate change adaptation are typical development measures being carried out by different Government departments but the examples compiled here are community conservation efforts whose success has been attributed to the active involvement of local community, which is hoped will be emulated by Biodiversity Management Committees for building a Climate resilient Kerala.

Dr. S.C. Joshi IFS (Rtd) and Dr. V. Balakrishnan

Biodiversity Conservation

PEOPLE'S ACTION FOR REJUVENATING LOST WATER BODIES – THE AADI PAMBA VARATTAR STORY

Beena Govindan¹ and Sajith Sukumaran²

¹ Coordinator, Aadi Pamba - Varattar Rejuvenation Campaign ² Chief Operating Officer, Kudumbashree National Resource Organisation

ABSTRACT

This paper showcases the case studies of two rivers Aadi Pamba and Varattar of 13.4 kilometres length in the flood plains of the central Travancore region of Kerala rejuvenated through a mass campaign. The campaign has been unique in terms of the challenge as well as the method. The entire stretch of the rivers was recovered, establishing water flow which had stopped decades back. While the State government has recognised the effort, accepted it as a model and has provided funds for further work, the rejuvenation campaign has already led to similar campaigns, big and small, across the State. This is, one of the replicable highly popularized model of river rejuvenation through peoples action which has received several awards at state and national level.

INTRODUCTION

Aadi Pamba is a double headed meander loop of 4 kilometre length, of Pamba, one of the important rivers of Kerala. Aadi Pamba in fact had been the original channel course of Pamba, which might have been short-circuited during floods long ago. Varattar is a rivulet originating from the south-west part of the Aadi Pamba loop, which through a course of 9.4 kilometres joins Manimala, another important river north of Pamba. The abandoned meander loop of Aadi Pamba and the rivulet Varattar continued over the years as part of the flood plain ecosystem, regulating floods by carrying water from surging Pamba to Manimala during Monsoon season.

The fluvial system not only contributed to the flood management of the area; it has been central to maintaining the water balance in the Pamba - Manimala river basins. Aadi Pamba and Varattar, together with a catchment area of 23.17 square kilometres, irrigated the fields sustaining the famous sugar cultivation of the area which had led to the geographical branding of 'Central Travancore Jaggery'. Travancore Sugars and Chemicals produced sugar and alcohol, and employed significant number of local people. Paddy and other crops were widespread in the area. The fluvial system provided water transport – both for cargo and for people - and entertainment; the area has been famous for its festive races of ornamental snake boats, integral to the local culture and traditions. The basin was rich in aquatic biodiversity and was a seasonal destination for certain species of migratory birds.

Development interventions that overlooked the hydrological dimensions of the river basin obstructed water flow at several places and the system had been destroyed over the last four decades. Causeways built across the rivers at eight places bear testimony to the above approach. Changes in cultivation pattern on the river beds with plantations spreading to large areas impacted the river system. Encroachment, conversion of the river bed for other purposes, and random constructions disrupted the flow, converting the river into a series of disconnected puddles. Dams in upstream Pamba had already affected the water flow in the main river. As the river beds of Pamba and Manimala sank due to rampant sand mining, Monsoon flood-pulsing evaded Aadi Pamba and Varattar. With increasing waste dumping, the water in the puddles that remained became polluted.

The degradation of the Aadi Pamba Varattar fluvial system had multiple impacts on the local environment and economy. Sugar and paddy cultivation were adversely affected and were stopped in most of the places. As water transport was interrupted and sugar availability dwindled, Travancore Sugars and Chemicals stopped producing sugar. The local production of jaggery was affected. As the fluvial system had direct connection to the dug wells along the river banks, these wells, which have been the main source of drinking water for the local communities got polluted. A study conducted by the Centre for Water Resources Development and Management (CWRDM) testing water samples from surface and ground water sources in June 2017 provided a bleak picture of the region's water sources. Dissolved oxygen was found to be low, all samples were contaminated with coliform bacteria, faecal coliforms and E.coli. Values of pH showed that the water was acidic; manganese and iron in the samples exceeded the limits prescribed by the Bureau of Indian Standards for drinking water. On the cultural front, the snake boat races were discontinued.



EARLY ATTEMPTS

Local communities and discerning environmentalists had long understood the relevance of reviving the river system and several attempts were made in that direction. There were a number of campaigns for saving Varattar. Kerala Legislative Assembly constituted a committee to study the matter in 2002. The committee submitted a detailed report with a number of recommendations including measures for rejuvenation and protection of the river. The State Human Rights Commission had a sitting on Varattar in 2007 and issued directions to a number of departments and agencies on rejuvenation of the river.

Malayala Manorama, the leading Malayalam daily sponsored a scientific study on Varattar in 2013. The study report cautioned against diverting water from the already water-deficit Pamba to Varattar and recommended rejuvenation of the rivers through watershed based interventions in the basin. An attempt was made to revive the rivers using Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), which did not move beyond the planning phase.

Notwithstanding the efforts of environmentalists, an intervention by the Hon'ble High Court of Kerala, A Legislative Committee, the State Human Rights Commission, and attempts through MGNREGS, rejuvenation of Varattar remained elusive. As years passed, both Aadi Pamba and Varattar underwent further degradation, to the extent of even the activists who had been in the forefront of the campaigns losing their hope.

THE NEW INITIATIVE

It was in this context that Haritha Kealam Mission organised a visit of a team comprising administrators, politicians, and activists on 1st May 2017 and initiated discussions at the local government and community levels exploring the possibility of rejuvenating the river system. The visiting team consisted of Dr T.M. Thomas Isaac, Minister for Finance, Government of Kerala, Ms Veena George, legislators representing Aranmula Assembly Constituency, Dr T.N. Seema, Vice Chairperson, Haritha Keralam Mission, and Dr Ajayakumar Varma, Scientist, other political leaders, and activists.

A consensus emerged on the need to revive the river system. However, challenges were many. River had given way to farm land, roads, pathways, and even concrete structures at many places. There was the threat of resistance from encroachers. There was no institutional mechanism that could take up the assignment. The rivers passed through two districts – Pathanamthitta and Alappuzha and through the boundaries of five local governments including a Municipality (Koipram, Eraviperoor, Kuttor, Thiruvanvandoor Grama panchayats and Chengannur municipality). This posed administrative challenges to the programme. The fact that the river beds of Pamba, Aadi Pamba and Varattar were at three levels added to the complexities of the challenge.

Mathew T. Thomas, Minister for Water Resources, Government of Kerala convened a high level meeting on 12thMay. The meeting discussed a proposal prepared by the Department of Water Resources and resolved that a people's campaign was necessary to ensure revival and protection of water sources; the idea was to go beyond a technical approach to water resources. It was decided to initiate immediate action to ensure water flow in the rivers during the imminent South West Monsoon. The proposed campaign was named 'Varatte Aar'. Two WhatsApp groups were formed immediately on that name.

THE 'VARATTE AAAR CAMPAIGN'

Haritha Kerala Mission, one of the four flagship missions of the Government of Kerala, with the mandate to create a waste-free Kerala and to protect and revive its water resources, jointly with the Department of Water Resources organised five local government level conventions between 15th and 17th May 2017. Overcoming the scepticism created by the failed initiatives of the past was the main challenge. There were even objections to a new programme from certain areas.

Following this, a joint convention of all the five local governments was held on 20th May in Chengannur Municipality. The convention discussed the proposals by the local government leaders on probable action plans. As per the decisions taken at the convention, a vehicle rally announcing the river rejuvenation campaign was held on 26th May. The rally was conducted under the leadership of the two MLAs of the region – R. Ramachandran Nair and Veena George of Chengannur and Aranmula constituencies respectively. The convention's decision to launch the campaign with a 'River Walk' covering the entire stretch of Varattar was announced in the rally. Elaborate planning was done for the successful conduct of the proposed 'River Walk'.

'River Walk', held on 29th May from the origin of Aadi Pamba covering the entire stretch of Varattar till its point of confluence with Manimala River was marked by participation of Ministers, Members of the State's Legislative Assembly, senior politicians, administrators, social activists, environmentalists, media persons, and local people. The programme led to generating acceptance to the idea of river rejuvenation. However, a method to rejuvenate these rivers, long dead and absent in many stretches, was yet to evolve.

The initial idea was to create a channel to ensure water flow through the river system before the onset of the next Monsoon rains. An early estimate of Rs 50 lakh was prepared for this by the Pathanamthitta District Panchayat. However, nothing moved till 6th June. On 7th May, five earth movers were hired to clear the channel for establishing water flow using local contributions. On 8th June, a second high level meeting was held which



decided to conduct an Environment Impact Assessment and resolved to move ahead with the work of opening channel for water flow.

What followed was a massive campaign where the initial work continued with mobilising more contributions and hiring more machines. Several nattukootams were organised in which ministers interacted with people. People from all walks of life visited the rivers and supported in their own ways. The Hon'bleChief Minister of Kerala released a song for the campaign. During heavy rains after the work gained momentum, the water from the River Pamba pushed its way through Aadi Pampa and Varattar and made it to Manimala River, over a trajectory of 13.4 kilometres on 25th June. This added a much needed momentum to the campaign.

A high point of the campaign was when the local people came forward to demolish a low causeway across Aadi Pampa on 19th June. This was a symbolic step indeed; the causeway was the main means of connectivity that a village had with the mainland. Still people of the same village came forward and demolished it to allow the river to flow. People were correcting a mistake that their forefathers had committed by reversing a process; removing a causeway to allow the river to flow again. A second causeway was removed by machines on 23rd June.

The leaders of the mass movement had put in place a system for monitoring the work as well as the financial contributions and their utilisation. This was done through two WhatsApp groups. The starting reading and finishing reading of every machine was monitored. Every rupee received and spent was recorded. Status of machine hours, receipts, offers of contributions, and payments were announced in the group every day. The programme used a total of 2411.06 machine hours to clear 13.4 kilometre stretch of the river at an expense of ₹ 28,49,542/-. The entire stretch of the river was cleaned during 7^{th} June to 10th August 2018.



The Chief Minister of Kerala dedicated the rejuvenated river to the local people on 2nd September 2017 and flagged off snake boat race in Adi Pamba for Haritha Keralam Mission Trophy.

PROGRAMME HIGHLIGHTS

The early push and sustained support by the political leadership and state government proved to be critical for the success of the campaign. The government has already announced a comprehensive follow up programme and provided budgetary support for it. Use of social media in mobilisation and monitoring has been exemplary. WhatsApp was used for sharing information and monitoring the machine as well as fund collection and utilisation, which was described by the Hon'ble Minister for Finance as the first 'concurrent audit system' used in a mass campaign. Attempts in local resource mobilisation was supported by local leaders and elected representatives. The campaign had an evolving leadership that functioned in a transparent and democratic way sharing information over the social media as well as through community level review meetings. While the Water Resource Department took the initiative to provide leadership, convergence with other departments, ensured by Haritha Keralam Mission, has been instrumental in ensuring the success of the programme.

LESSONS

Aadi Pamba – Varattar rejuvenation campaign has already led to similar initiatives of different scales and nature in various parts of the State. Beyond the early success of the programme, now given fillip with a comprehensive follow up plan, there are lessons that the campaign offers which would be useful for similar programmes in future.

The early apprehensions on the response of the families that had encroached on to the river bed in different areas were proved wrong when most people came forward to cooperate with the campaign. What the Hon'ble Minister for Finance said at the beginning of the campaign that 'once a flow is established, river would find its way and claim its land' proved prophetic. River did push its way beyond a mere channel, encouraging local volunteers to expand the scope of the work to recover the original width of the river over long stretches. As mentioned earlier, people even took initiative to remove causeways to clear the way for water to flow. People who had kept parts of the riverbed with them came forward to remove protective walls and give the land back to the river. Such actions created tremendous positive energy.

During the course of the campaign, new sections joined the campaign cutting across political lines. Several local people took responsibilities and emerged as natural leaders of the campaign. The support and advice of the government and state level political leadership turned out to be critical in building networks.

Most of the local government leaders who actively participated in the programme did that in their personal capacity. There were occasions when vested interest groups and individuals openly challenged the campaign and threatened to stop it. The concurrent audit system managed through social media made financial management too transparent and that led to the campaign getting wider acceptance.

AN IMMEDIATE RESULT – FLOOD CONTROL

As mentioned earlier, the flood plain systems of the region have historically played a critical role in mitigating the impacts of seasonal floods. This role was evident in the Kerala Floods of 2018, when Pamba and Manimala rivers surged to flood most of the areas in its lower basin. Water Resource Department has estimated that the unhindered water flow through Aadi Pamba and Varattar helped in lowering the flood level in Chengannur area by 45 to 50 cm, which significantly reduced the impact of floods on human life and property.

THE FOLLOW UP PLAN

The state government has declared the follow up plan for the Aadi Pamba Varattar river system. Panchayat level micro watershed plans have already been prepared. These plans are expected to rejuvenate all the channels – big and small – in the river basin, adding to the sustainability of the river system. As the riverbeds of Pamba and Manimala have been significantly lowered compared to the riverbeds of Aadi Pamba and Varattar, and also considering the state of Pamba River, the rejuvenated river system is likely to have regular flow only during the Monsoon season. Therefore, reviving the river basin through rejuvenation of contributory channels and other water bodies and enhancing and protecting aquatic biodiversity are critical for the river system.

The Environment Impact Assessment (EIA) conducted at the beginning of the campaign will have to be revised considering the recent floods and its impacts. Any deepening of the river bed should be after comprehensive hydrological assessment. Government has provided funds for replacing the causeways with bridges, which will be an important step forward in protecting the river system. Agreement has been signed to create a walk way along the river banks. Biodiversity Board has initiated steps to develop a biodiversity park along the river banks.

Intensive sensitisation and community surveillance would be needed to prevent pollution of the rivers. Sand mining on the riverbed will have to be completely avoided. Early indications show that these would require systematic efforts and involvement of the local governments and ownership of the communities.

JALASAMRUDHI – A MODEL INITIATIVE ON WATER CONSERVATION

Nizamudeen, A.

Land Use Commissioner, Kerala State Land Use Board

ABSTRACT

Kattakada Legislative Assembly Constituency, once prosperous and sufficient in water availability is now facing acute water shortage in spite of the presence of 2 main rivers, numerous streams, canals and ponds. The idea of formulating an integrated water conservation and management project, viz. Vattatha Uravak-kay Jalasamrudhi to mitigate the water scarcity problem was conceived by Sri. I. B. Satheesh MLA and was whole heartedly taken up by the district administration which ensured public participation and involvement of the various Government Departments implementing water conservation schemes. Kerala State Land Use Board (KSLUB) was entrusted the task of preparing a technically feasible and economically viable management plan, converging the activities proposed by line departments. Short term and long term programmes were proposed and implemented which includes utilization of existing water resources in areas facing acute water shortage, renovation of public wells and ponds, construction of new ponds & check dams for retention & storage of excess water received during heavy rains, construction of rain water harvesting structures, adoption of well recharging techniques and soil & water conservation measures.

SCIENTIFIC PLANNING & PEOPLE'S PARTICIPATION

KSLUB prepared a comprehensive data base on existing water resources through primary data collection coupled with Satellite Image interpretation. The entire database has been brought in the GIS platform. The database was enriched by secondary data and fine-tuned through user interaction workshops and stake holder discussions. A series of seminars, discussions and trainings were conducted to ensure community participation in project planning. The co-ordination committee of various district level officers provided required technical assistance for the project. Extensive survey involving public participation was conducted through local volunteers for collection of data. Trainings were conducted at block level and Grama Panchayath level to the volunteers in connection with base line data collection. KSLUB monitored the base line survey activities. Ward members were asked to submit their proposals in a structured questionnaire. Data on existing water resources, drought prone areas, public wells, public institutions and new sites for water storage were collected. A workshop was conducted on 6th March 2017 to analyse and consolidate the primary and secondary data collected from various sources. The workshop was attended by people's representatives from all three tiers of Governance, NGOs, volunteers and officials of line departments. The participants took earnest efforts to identify the major problems leading to water scarcity and their solutions to eliminate them. Short term and long term programmes were proposed which includes utilization of existing water resources in areas facing acute water shortage, renovation of public wells and ponds, construction of new ponds & check dams for retention & storage of excess water received during heavy rains, construction of rain water harvesting structures, adoption of well recharging techniques and soil & water conservation measures.

The existing water resources were identified with its problems and the reasons for the present situation. Based on detailed discussions, exploring the possibility of conserving the water received through rainfall, rejuvenation/revival of deteriorated water resources and creation of new water storage structures were evolved.

MAJOR PROBLEMS ENCOUNTERED

Lowering of water table

Kattakada LAC and the neighbouring areas fall under the semi critical category. As per the data of State Ground Water Department, the level of water table in the observation well at Nemom, has gone down to 5.80 m below ground level during 2016, which was 2.5 on below ground level during 2007. A similar statistics was noticed in the observation bore well located at Vilappilsala where the water table has gone down to 10.2 m from 8.9 m. The high intensity of drains and reduction in the amount of rainfall received contributes to water scarcity. No proper water conservation measures are adopted in the drainage line enabling the water to drain out at a higher speed. In spite of the heavy rains received during 2015, there was no significant rise in the ground water table.

Drying wells and poor water quality

The primary information gathered during the survey revealed that out of 43043 wells, the main drinking water source of the people in the constituency, 19681 wells dry up in summer. In addition to this, the quality of available water was also poor in majority of the areas. There are instances of salt water intrusion noticed in parts of Vilavoorkkal Grama Panchayat.

Reduction in wetlands/paddy lands

Satellite image interpretation with ground truth verification conducted by KSLUB shows that the extent of wet lands (paddy lands) has decreased drastically from 1291.31 hectares to 104.67 hectares. Paddy lands which are the water bowls of the area have been converted to built up areas or brought under other plantation crops, which also accounts for scarcity of water or drought.

Deteriorating surface water resources

Data collected revealed that majority of the water resources including drains, head ponds and canals were in a neglected and deteriorated stage. The width of the drains has reduced, area of ponds shrunk and canals are not properly utilized.

Major achievements

The project was launched on 22ndMarch 2017, World Water Day. The Management Plan includes the details of all water resources, its problems and suggestions for conservation and management of these resources. Jala clubs were formed in all 68 schools in the constituency to sensitize and ensure the participation of students in water conservation activities. A volunteer force comprising of 5 members in each ward, 'Jalamithrams' were selected and trained by Suchitwa Mission and Youth Welfare Board. Mass awareness programmes such as rallies and public functions were organized with the active participation of students, Kudumbashree, NGOs, National Service Scheme (NSS) units, youth clubs and Students Police Cadets.

During the last nineteen months, number of programmes including planting of seedlings, digging rain water pits, protecting ponds and streams using coir geotextiles, rejuvenation of ponds and streams, artificial recharging of wells in schools and public buildings, digging of 300 plus new farm ponds, paddy cultivation, inland fisheries in renovated ponds, water quality testing in all 122 wards, establishment of water quality testing labs in 6 schools, Haritha Vidhyalayams, etc. were taken up under this program. Rain water pits were digged in the households with the support of Residents Associations, Libraries and Youth clubs, under the campaign, VeetiloruMazhakuzhi. As part of the project innovative ideas such as drawing water from abandoned granite quarries and routing the supply to a recharge pit that is positioned close to the targeted wells in a manner that facilitates gravitational flow of water were implemented. Earnest efforts were taken to bring back the streams and ponds that are being encroached.

Neerthada Samakshana Yathra was conducted in two streams to create awareness among the general public on the need for conserving the water and making the streams perennial. 6 km stretch of Kollod thodu was rejuvenated under MGNREGS by cleaning the stream and constructing 53 temporary check dams in the stream. Preparation of detailed action plan for rejuvenating Kulathummal thodu is in progress.

A week long Kalajatha, Manthrangalillathe Manassunarthunnavaron the need for conservation of water was conducted during 7 – 12, May 2018 in 30 locations. Seminars, exhibitions, street plays and other activities are done to showcase the activities of Jalasamrudhi and to create awareness among the people. During the last 19 months, several activities were successfully implemented through the convergence of Local Self Government Institutions, line departments, autonomous bodies and other agencies.

Possibilities of convergence of the activities by various departments were explored and it was decided to complete the whole programme within 4 years. An organizational set up has been constituted for monitoring the implementation of the various programmes with the active people's participation from various walks of life.

NO		DEDA DTMENIT/A CENICY	
NO.	ACTIVITY	DEPARTMENT/AGENCY	
1	Water quality testing completed in 122 wards	CCDU	
2	Planting of seedlings	Kudumbasree & MGNREGS	
3	Artificial recharging in 14 schools	Ground Water	
4	150 new farm ponds	MGNREGS	
5	NeerthadaSamrakhanaYathra	All Departments	
6	ThoduPunarsamarppanam	MGNREGS	
7	Coir geotextiles of ponds & streams	Coir Research Institute & MGNREGS	
8	NSS Camps (schools, Colleges & ITIs)	Education	
9	Jala clubs in schools	Education	
10	Jalamithrams	Youth Welfare Board	
11	Well recharging	MGNREGS	
12	Awareness activities (seminars, exhibitions,	Suchitwa Mission	
	group discussions, cleaning of ponds, Sand-	ShasthraSahityaParishad	
	heshayathras, Mass run, Street plays, Pledge,	Nehru Yuva Kendra	
	etc.)	Student Police Cadets	
		National Service Scheme	
13	Well recharging from quarry	MGNREGS	
14	Stream rejuvenation	MGNREGS	
15	Widening of ponds in Government land	Revenue & MGNREGS	
16	JalasamrudhiKalajadha	MGNREGS	
17	Technical Study on Water Storage	HKM & Trinity College	
18	Inland Fisheries	Fisheries	
19	Avoid waterlogging through water storage	PWD	

Some of the major highlights during first year are the following:

The activities proposed during 2018-19, under Jalasamrudhi are given below:

No.	Activity	Department/Agency
1	Renovation of 10 ponds	Minor Irrigation (HKM)
2	Lift Irrigation Scheme for paddy cultivation	Minor Irrigation (HKM)
3	Lift Irrigation Scheme for paddy cultivation	MLA Fund
4.	Organic Vegetable Cultivation in schools	Agriculture Department/ State Horticulture Mission

5	Litter free schools	Suchitwa Mission	
6	Green Schools	HarithaKeralam Mission	
7	Artificial Recharging in Public Buildings	Ground Water	
8	Mini Drinking Water Schemes	Ground Water	
9	Renovation of bore wells	Ground Water	
10	Well Recharging of Anganavadis	MLA Fund/Ground Water	
11	Meenampallythodu watershed scheme	Soil Conservation	
12	Rejuvenation of water bodies (Kaduvkuzhi – Anthiyoorkonamthodu)	Soil Conservation	
13	Establishing water quality testing labs in schools	CCDU	
14	Water Auditing & Budgeting in Public Buildings	CWRDM	
15	Well recharging	LSGIs	
16	Model BMC projects (Kattakada & Maranalloor Grama Panchayaths)	Biodiversity Board	
17	Strengthening of Jala clubs	Education	

RISE IN WATER LEVEL

Through the integrated approach adopted in the Constituency through various projects, it is found that the ground water level has increased, which is substantiated by the observation wells in the area. The water level in the wells where artificial recharging was done has increased and has become perennial. The water level in the nearby wells has risen in areas where new farm ponds were dug.

It is hoped that Jalasmarudhi project of Kattakada Legislative Assembly Constituency will be a replicable model for water conservation projects on account of the active people's participation, effective planning and coordination of the activities of all the departments and organizations involved in implementation, for ensuring water prosperity in the days to come.

BEST PRACTICES IN BIODIVERSITY CONSERVATION: A CASE OF M. S. SWAMINATHAN BOTANIC GARDEN IN WAYANAD, KERALA

Dr. N. Anil Kumar, Mr. Jithin, M.M. and Dr. Smitha S. Thankappan

M. S. Swaminathan research foundation Community agro-biodiversity centre, wayanad 673 121

ABSTRACT

The Biodiversity conservation programme in the state needs to be oriented towards helping the elected Local Self Governments to mainstream biodiversity in local development and thereby achieving the various conservation goals. In order to operationalize the triple objectives of CBD, MSSRF had established Community Agrobiodiversity Centres in the biodiversity hotspots like Wayanad in Western Ghats and Kolli hills and Koraput hills in the Eastern Ghats. M. S. Swaminathan Botanical Garden: A Community Biodiversity Garden is a small conservation area spread in about 17 ha of land near Kalpetta town in Wayanad district as part of MSSRF's Community Agro-biodiversity Centre. A total of 2,033 live plant species have now been conserved in the Garden, of which about 200 are tree species, 512 are endemic to Western Ghats and 579 falling under IUCN's threatened plant species category. The Garden is a member garden of the Botanic Garden Conservation International, and one of the Lead Gardens promoted by the Ministry of Environment and Forests, Govt. of India for conserving RET plants of Western Ghats.

INTRODUCTION

The best practice for biodiversity conservation is the custom of mainstreaming conservation ethos and methods in the socio-economic development of the people of a region. Biodiversity mainstreaming is a process of getting biodiversity concerns potentials, needs and risks - fully reflected in development policies, plans and activities in order to achieve sustainable outcomes for both biodiversity and development. It is as much a political and institutional issue as it is a technical one, requiring a process of change and time consuming. Mainstreaming is a long term, iterative process that entails integrating biodiversity in national, sector and local policies, plans and budgets - and then supporting their implementation. The Biodiversity conservation programme in the state needs to be oriented towards helping the elected Local Self Governments to mainstream biodiversity in local development and thereby achieving the various conservation goals. This practice is intended more than applying 'safeguards' to make sure development processes do no harm to biodiversity. The National Biodiversity Targets, the Global Strategy for Plant Conservation: 2011-2020, and the overarching SDGs are the primary goals in this context. The targets need to be achieved in close collaboration with the local community, in particular through the Biodiversity Management Committees of the elected Panchayath Raj System and other stakeholders in India and around the globe.

By combining conservation and cultural heritage with the ethos of economically sustainable utilization of biodiversity, a perfect balancing of "people, planet-prosperity" goal in resource management can be demonstrated at local level. The genetic resources conservation demonstrated through this synergistic approach with focus on bio-economy and bio-cultural, dimensions and traditions will be a unique practice in conservation.

MSSRF's significant contribution in the area of Indian biodiversity is its leadership in getting prepared two relevant legislations- the Draft Biodiversity Act 2002 and PPVFRA Act 2004. In order to operationalize the triple objectives of CBD, MSSRF had established Community Agrobiodiversity Centres in the biodiversity hotspots like Wayanad in Western Ghats and Kolli hills and Koraput hills in the Eastern Ghats.

Two decades of work of the Community Agrobiodiversity Centre in Wayanad resulted in collection and conservation of many endangered plant species and little known species and varieties of food, nutrition, health and ecological value found in the Western Ghats. Through a network of the 'custodian farmers' of Wayanad district, there are over 200 traditionally cultivated crop varieties (mostly food crops), more than 200 RET plant species, and over 600 species of ethno-medicinal plants conserved on-farm in the district. The mix of these collections came from on-farm to wilderness and forests were later brought in the form of a Botanic Garden with distinct components for agro-biodiversity, medicinal plants, Rare, Endemic and Threatened (RET) species of trees and so on.

M. S. Swaminathan Botanical Garden (MSSBG): A Community Biodiversity Garden

MSSBG is a small conservation area spread in about 17 ha of land near Kalpetta town in Wayanad district as part of MSSRF's Community Agro-biodiversity Centre. The Garden is growing since the year 2010 with diverse representative species of tropical flora consisting crop wild relatives, wild orchids, medicinal plants, and germplasm of varieties of food plants like roots and tubers, legumes, citrus, and wild edible greens. The purpose of starting a community centric botanic garden is to demonstrate the best practices, methods, skills and strategies needed for enhancing the community conservation efforts that have stronger impacts on the food, nutrition, health and livelihood security of the forest dependant and small holder farm families. Over the years, the concept of community agro-biodiversity management become perfected with the approach of integrating conservation, cultivation, consumption and commerce – a 4C dimension of sustainable genetic resource management, partnering with local communities and synergising modern science and traditional knowledge.

Differing from the conventional concept of Botanical Gardens, MSSBG gives equal priority to wild, natural and cultivated traditional and horticultural species and varieties of plants. The Garden pays special attention to conservation of RET species, especially trees of

southern Western Ghats. A total of 2,033 live plant species have now been conserved in the Garden, of which about 200 are tree species, 512 are endemic to Western Ghats and 579 falling under IUCN's threatened plant species category.

A shade-coffee farm in about 10 ha, where Robusta coffee is grown under the canopy of native wild tree species is also maintained. The Garden thus is rare of its kind that houses curious wild flora along with vanishing crop varieties, "crop wild relatives" and bio-diverse coffee farm. This helps the Garden to niche its climate, which in turn attract and retain diverse kinds of birds, butterflies, and other minor fauna of the region. As part of the Garden, a collection of local landraces of rice, pulses and wild mushrooms, and an Endemic Plants Information Centre have also been maintained.

The Garden is a member garden of the Botanic Garden Conservation International, and one of the Lead Gardens promoted by the Ministry of Environment and Forests, Govt. of India for conserving RET plants of Western Ghats.

MSSBG is growing steadily as a 'conservation speck' in the Western Ghats through a growing network of Farmer Gene Banks in Wayanad district. There are already 100 small holder farm families in the district taking part in this venture. The Garden has evolved into a practical institution to achieve concomitantly biodiversity conservation, culture protection and poverty reduction in biodiversity hot spots.

SOME EXAMPLES OF THE BEST PRACTICES OF THE GARDEN

The major outcomes derived from the activities of the Garden are in three major areas; firstly the vast array of genetic materials needed for improving the climate resilience is documented, conserved and promoted in the form of diverse PGRs; secondly, the genetic diversity of crop varieties, horticultural and wild species is studied, conserved is and promoted for nutrition smart consumption and thirdly high quality evidences that prove the link between culture and nature, and the role of former in conservation and enhancement of biodiversity is studied and communicated. These three areas are described in detail:

1. Promotion of Climate Smart Biodiversity Conservation

Western Ghats-the most populous among the 36 global biodiversity hotspots have a larger share of endemic and endangered biodiversity of the country, and continually face severe developmental pressures, largely in the form of conversion or degradation of habitats of biodiversity for alternate land uses. The loss of biodiversity is alarming across all the known species groups from the region. Knowledge and information in particular is limited on the distributional pattern and conservation status of the threatened tree species of the Ghats, especially in the light of climate change variations, with predictions indicating that around 10 per cent of all tree species of India would be lost in near future.

Climate change is a major driver for biodiversity loss, and loss of biodiversity is the critical driver for loss of food and agriculture. In an agro-ecosystem, climate change will intensify pests and disease attack, increase the soil evaporation and lower yields, and reduce species diversity; undermining not just the ecological balance but also creating havoc in food production and distribution. The Western Ghats where agriculture is the pre-dominant occupation and where a major percentage of population depends on the local biodiversity for their sustenance are particularly affected by climate change. The small and marginal farmers may suffer more as they may not be able to successfully adapt to the changes.

Though global scale adaptation and mitigation methods are important, the effect of climate on agriculture and the biodiversity of agricultural landscapes need to be understood at a local level rather than on a uniform global level. Every species matters to counteract the deleterious effect of climate change, hence biodiversity conservation, whether in situ on farm or ex situ in gene banks will help in a future which is still unclear. It is obvious long-term storage in gene banks is energy intensive and often insecure because of electricity shortage. Difficulties in seed drying and very high backlog of timely regeneration are the other serious issues associated with cryogenic preservation. But, a combined approach of ex-situ live gardens and on farm conservation of biodiversity is much more important and a reliable form of conservation, as species that are suitable for a particular agro-climatic zone has been perpetuated by generations of farmers who have understood the agro ecological conditions and their needs.

Although climate vulnerability assessment is being mapped throughout in some states of India to understand the diverse and very often deleterious effect of change in the climate, taking such kind of assessment to the spectrum of genetic diversity of farmers' fields and biodiversity found outside forests (e.g. biodiversity rich shade coffee farms) is very limited. This is calling urgently for corrective steps to stem the erosion of the plant genetic resources as well as wild species.

MSSBG play a lead role in linking the Farmer Gene Banks, Sacred Groves, Agro-forests, and the protected areas of the Western Ghats to maximise biodiversity conservation efforts to address the climate vulnerabilities. We aim to popularise the idea of integrated genetic garden where 100s of varieties of crops and species are actively conserved through Farmer-Scientist Networks. By the ex-situ, in-situ and on-farm integration, the maintenance of intra-species variability can be made viable without stopping the opportunities for further evolution of distinct genetic strains and by protecting the bio-cultural heritage of the region.

Educational programmes at MSSRF in general focus on multiple stakeholders to create awareness on biodiversity conservation, climate resilience, and to persuade society to reduce carbon footprint. Prof. M.S. Swaminathan formulated a unique educational programme called 'Every Child A Scientist' to increase the scientific inquisitiveness of children and inspire them to learn about the environment. MSSRF initiated the biodiversity conservation programme at Manikavu, Meenangadi with the support of Meenagadi Grama panchayat and Sultan Bathery block Panchayat. Motivated with this programme, Meenagadi grama panchayath initiated the carbon neutral programme. MSSRF advised on selection of suitable plants of 100 species and involved in floral and faunal studies. *Vateria indica, Melia dubia, Turpinia malabarica, Vatica chinensis, Baccaurea courtallensis, Hopea* species and so on are a few species to state.

With the objective to increase the carbon sequestration and to reduce the carbon emission through green cover, MSSRF planted 4500 saplings of 150 spp. in 36 acres. It was observed that this increased the ground water level, enhanced the faunal diversity and had a positive cooling effect on surrounding environ.

In addition to that the scientific team of MSSRF has discovered various new species and conserved at MSSBG conservatory. With the support of SDTT researchers of MSSRF studied 160 species which were on the verge of extinction and raised the seedlings at the nursery and distributed the plants to carry out phytochemical analysis as a part of education programme to promote conservation, sustainable and equitable use of biodiversity.

MSSRF initiated a programme 'Aruvikkoru Punarjani', a rejuvenation programme for streams, rivulets and rivers in 10 km stretch from Meppadi to Kalpetta. A team of MSSRF along with the society cleaned the water bodies, widened the water course, planted Reeds and Pandanus along the river bank through the programme. Subsequent to that the Meppadi Gramapanchayath carried out the programme consistently along the stretches of waterbody.

MSSRF has provided skill development training for farmers and replicated a model of Low External Input Sustainable Agriculture (LEISA) in MSSRF to ensure low cost production, high profitability and less environment harm. It is a practical business model for reaping the advantages of rural-urban continuum.

No	Journal name	Common name/ Scien- tific name	Family	Author	Link/ Doi
1	<i>Sonerila janakiana</i> sp. <i>nov.</i> , a <i>stoloniferous</i> species of Melastomataceae from India	Sonerila jana- kiana	Melastomata- ceae	M. K. Ratheesh Narayanan, C. N. Sunil , M. Sivadasan et al.	https://doi. org/10.1111/ njb.01297
2	<i>Liparis sanamalabarica</i> (Orchidaceae): a new species from South Western Ghats, India	Liparis sana- malabarica	Orchidaceae	Pichan M. Salim	tai2.nitu. edu.tw/tai- wania/pdf/ ai.2017.62.345. pdf

3	Eriocaulon govindiana sp. nov.(Eriocaulaceae), from southern Western Ghats, Kerala, India Dendrobium anilii (Orchidaceae), a New Species from the South- ern Western Ghats, India.	Eriocaulon govindiana Dendrobium anilii	Eriocaulaceae Orchidaceae	C. N. Sunil, M. K. Ratheesh Narayanan, V. V. Naveen Kumar et al Pichan M. Salim, Jose	http://tai2. ntu.edu.tw/ taiwania/pdf/ ai.2017.62.387. pdf http://www. bioone. org/doi/ full/10.5735 /085.053.0606
5	The genus Atuna (Chrysobalanaceae) in peninsular india.17th Annual conference on india Association of an- giosperm taxonomy and international seminar on multidisciplinary ap- proaches in angiosperm systematics.	Atuna	Chrysobala- naceae	Sujanapal p and N.sasidharan	
6	Zingiber anamalayanum sp. nov. (Zingiberaceae) from India	Zingiber ana- malayanum	Zingiberaceae	Sujanapal and N. Sasidharan	DOI: 10.1111 /j.1756-1051. 2009.00530.x
7	A New Species of "Sala- cia" (Celastraceae) from India	Salacia wayanadica	Celastraceae	Kanjiraparambil Arjunan Sujana , S. Nagaraju, M. K. Ratheesh Narayanan,et al.	https://www. researchgate. net/ publication/ 283524165
8	A new species of Soner- ila Roxb. (Melastomata- ceae) from Kerala, India.	Sonerila veld- kampiana	Melastomata- ceae	M. Sivadasan, Ahmed H. Alfarhan, Rath- eesh Narayanan M.K et al	http://dx.doi. org /10.11646 /phytotaxa. 110.1.5
9	A new species of Ceropegia (apocyna- ceae: Asclepiadoideae) from India with notes on rare and threatened ceropegia in Nilgiris of western ghats.	Ceropegia manoharii	Apocynaceae: Asclepia- doideae	P. Sujanapal, P.M. Salim, N. Anil Kumar et al	https://www. researchgate. net/publica- on/289854285

10	<i>Eriocaulon kannurense</i> (Eriocaulaceae), a new species from Kerala, India	Eriocaulon kannurense	Eriocaulaceae	Jayesh P.Joseph, N. Anil Kumar Sunil, C. N., M. K. Ratheesh Narayanan	
11	Rotala khaleeliana sp. nov. (Lythraceae), a new species from lateritic hills of Kannur, Kerala, India	Rotala khaleeliana	Lythraceae	C.N.Sunil, M.K. Ratheesh Narayanan, M.K. Nandaku- mar et al	http://www. journalijar.com /uploads/2013- 04-23_145324 _833.pdf
12	<i>Sonerila gadgiliana</i> , a new scapigerous species of Melastomataceae from India	Sonerila gadg- iliana	Melastomata- ceae	M.K.Ratheesh, N.Arayanan, M. Sivadasan, C.N. Sunil, et al	https://www. researchgate. net/profile/ Sivadasan_M/ publica- on/281161874
13	<i>Memecylon clarkeanum</i> Cogn.(Melastomatace- ae)-a threatened species, new record for India.	Memecylon clarkeanum Cogn	Melastomata- ceae	Ambikabai Raghavanpillai Sivu, Matalai Kokkaramath, Ratheesh Narayanan,et al	http://tai2. ntu.edu.tw/ taiwania/pdf/ ai.2012.57.327. pdf
14	<i>Impatiens johnsiana</i> (Balsaminaceae), a new scapigerous balsam from Western Ghats, India.	Impatiens johnsiana	Balsamina- ceae	M.K.Ratheesh Narayanan, N. Anil Kumar, Jayesh P. Joseph,et al	https://www. jstor.org/sta- ble/41972381
15	<i>Lindernia madayipa- rense</i> (Linderniaceae)–a new species from Kerala, India.	Lindernia madayipa- rense	Linderniaceae	M.K.Ratheesh Narayanan, CN Sunil, MK Nandaku- mar,et al	http://www. ijpaes.com/ admin/php/up- loads/199_pdf. pdf
16	<i>Impatiens theuerkaufi- ana</i> (Balsaminaceae), a new scapigerous species from the Western Ghats, India.	Impatiens theuerkaufi- ana	Balsamina- ceae	M.K Ratheesh Narayanan, Jayesh P Joseph, N Anil Kumar,et al	https://www. biotaxa.org/ Phytotaxa/ article/view- File/phy- toa.83.1.3/1093
17	<i>Oberonia swaminathani</i> sp. nov. (Orchidaceae) from Kerala, India.	Oberonia swamina- thanii	Orchidaceae	M.K. Ratheesh Narayanan, K.M.Manudev, P. Sujanapal, et al	DOI: 10.1111 /j.1756-1051. 2010.00822.x
18	A New Scapigerous Species of Impatiens (Balsaminaceae) From India.	Impatiens minae	Annonaceae	M.K. Ratheesh Narayanan, P.Sujanapal, N. Anil Kumar, et al.	https://www. biotaxa.org/ Phytotaxa/arti- cle2.1.4/17340

11	<i>Miliusa gokhalaei,</i> a new species of Annon- aceae from India with notes on interrelationships, population structure and conservation status.	Miliusa gokhalaei	Annonaceae	M.K. Ratheesh Narayanan, P.Sujanapal, N. Anil Kumar, et al.	https://www. biotaxa.org/ Phytotaxa/ar- ticle/ download /phy- to.42.1.4/17340
20	<i>Impatiens mohana</i> (Balsaminaceae), A New Scapigerous Balsam From Wayanad, Western Ghats, India.	Impatiens mohana	Balsaminace	N. Anil Ku- mar Ratheesh Narayanan, M.K., K. A. Su- jana, R. Meera Raj.	https://doi.org/ 10.1017/ S09604286 1200008X
21	On the identity and typification of Amomum cannicarpum (Zingiber- aceae):	Amomum cannicarpum	Zingiberaceae	V. P. Thomas, M. Sabu and P. M. Salim	https://www. jstor.org/sta- ble/23489041
22	<i>Impatiens veerapazha- sii</i> (Balsaminaceae), a new scapigerous balsam from Wayanad, Western Ghats, India.	Impatiens veerapazhasii	Balsamina- ceae	K. A. Sujana & Mithunlal Anil Kumar, N., M. K. Ratheesh Narayanan, et al.	https://www. jstor.org/ sta- ble/41972502
23	Novelties in the family Acanthaceae from South Western Ghats, India.	Asystasia variabilis, Hygrophila auriculata var. alba new species; Strobilan- thes philip- mathewiana	Acanthaceae	Jose Mathew Regy Yohannan P.M. Salim and K.V. George	https://www. research- gate.net/ profile/Jose_ Mathew16/ publica on/312031924_ Novelties_in_ the_family_ Acanthaceae_ from_South_ Western_ Ghats_India
24	Seidenfadeniella salimii A New Plant Species (Orchidaceae) from South Western Ghats, India.	Seidenfade- niella salimii	Orchidaceae	Jose Mathew, T.K. Hrideek, V.B. Sreekumar, et al.	http://dx.doi. org/10. 080/00837792. 2016.1158410
25	<i>Miliusa wayanadica</i> (Annonaceae), a new species from Western Ghats, India.	Miliusa waya- nadica	Annonaceae	M.K. Ratheesh Narayanan, P Sujanapal, N Anil Kumar, et al.	https://www. jstor.org /sta- ble/41971970

2. Promotion of Nutrition-sensitive On-farm Conservation

Several locally available food plants play a critical and important role during chronic food shortages in many of the poor households. Many of these species and varieties are able to withstand severe drought and remain as reserve food beneath the soil for a period of four to five years. Assistance need to be extended to local communities in their efforts to identify, catalogue and manage diverse food plants and crop varieties that are nutrition sensitive. We realize that one of our important interventions for helping local communities of the critically vulnerable locations of Western Ghats is to place 'safety nets' that ensure household food and nutrition security. Developing nutrition smart gardens and new seed materials to address the under nutrition issue is an important priority in our agenda.

The renewed and expanded Garden will comprise many components and as mentioned earlier concentrate on collection and preservation of intra-specific variability of crop species and other PGRs of community food, nutrition, income and cultural value. Live collections of bio-fortified plants to provide horticultural remedies for nutritional deficiencies will be a part of this garden. This effort supported with scientifically credible research methods and capacity development programmes will ensure increased and continued availability of biological diversity for all key stakeholders. Also, it is clear that only by integrating agriculture, nutrition and health that we can overcome the wide spread problem of malnutrition.

The germplasn conservation plot maintained at MSSBG with the support of DST has expanded and the concept has extended to the community. Community conservation plots of Banana, Tubers, Leafy Greens and Legumes were established in various community plots. As the II phase of the programme two plots each in two communities have been introduced with preferred edibles of the traditional food basket but nutrient dense. It was a conservation effort for preventing malnutrition eventually.

Maintained home nutrition garden since I phase of DST project, the concept of the project has evolved to eradicate malnutrition of vulnerable community chiefly Adivasis and introduced the garden in three major tribal communities. With the objectives for addressing child malnutrition, Anganvadi nutrition garden with traditional nutri rich crops has been introduced. This will further facilitate to enhance nutrition literacy.

A nutrition intervention titled 'Food and Nutrition Security Initiatives (FANSI)' with the core support of Department of Science and Technology (SEED Division) has been under taken to reduce malnutrition of tribes, enhance agricultural biodiversity and livelihood and Pulses cultivation by establishing pulses seed villages. The activities for the achievement of the objectives include training & skill development, nutritional health assessment, nutritional assessment of local crops, nutri- product development with locally and seasonably available resources MSSRF act as centre for Ethanobotany in Kerala. The custodian farmers of the satellite community garden associated with MSSBG conserves the biodiversity with active effort. They conserve the traditional varieties of rice, pepper, vegetables and legumes.

3. Promotion of Cultural heritage for conservation of biodiversity

Western Ghats' biodiversity is greatly influenced by the management approaches of diverse "socio-cultural groups" who live in this hotspot. Their way of life including food, clothing, housing, language, religion and arts of the diverse communities shaped the biodiversity around. The communities of this region have consciously interwoven the elements of their natural habitat with the cultural traditions and practices. Though this Bio-cultural diversity is crucial for bringing harmonious link between nature and culture, unfortunately, this heritage is under threat because of the trend for a unified global culture!

For instance, the food habits and cultural preferences of the diverse local communities of India helped us to maintain rice paddies in almost all ecological terrains and conserve over 100,000 varieties of rice. Rice paddies are rich ecosystems that play many key ecosystem services! MSSRF's study results had shown the abundance of biodiversity – fish, insects, frogs, reptiles, birds, medicinal plants, edible plants, forage grasses and so on- in traditionally maintained rice field. The water retention and recharging service of rice fields is unique. But, India lost over 90% of its Rice Diversity! We need to have such varieties to make our future crops nutrition rich, high yielding, and culturally satisfying. We can't retrieve, what we have lost, but we can certainly protect what we have now left in Farmer's Fields, if we are able consider Culture as an important Capital.

Because of the multitude of culturally unique communities (over 4500 ethnic communities and nearly 760 active spoken languages) in this country, each community developed diverse foods and drinks out of every possible genetic resource. Several such culinary dishes and offers to GOD, are documented from some of the sites in Western Ghats. Fast erosion of the belief systems, traditional knowledge, cultural practices, art forms, and music associated with bio resource has occured. Validation and Revitalisation of the TK, art and culture becomes very urgent, and so is the need for preserving and promoting the traditional culinary diversity in order to conserve the plant genetic diversity.

MSSRF were pioneers to prepare the People Biodiversity Register in 1998 in Wayanad district to understand the appropriate components in designing conservation efforts with the involvement of local community and panchayat. Based on this data respective panchayaths Board and MSSRF jointly identified and declared the local heritage sites for the conservation. MSSRF identified steps in preparing a comprehensive People Diversity Register. The local heritage sites identified were Palukavu in Kottathara panchayat, Thrikaipatta in Meppady panchayat, Sugandagiri in Thariode panchayat and Pathamvayal in Thariodu panchayath. 'Biological Diversity Act' was approved in 2002 and came into

action in 2004 along with 'Biological Diversity Rules'. Biodiversity act 37 (I) and 41(I) represent the necessity of identification of heritage site for the conservation, and the rules were formulated in 2008 for Kerala.

M S Swaminathan botanical garden in association with the custodian farmers focus to address the practical problems faced by the region's tribal communities, the custodians of its rich and diverse natural wealth and genetic diversity in achieving food, nutrition and health security while preserving their cultural heritage.

The species augmentation programme conducted at 'Kootakavu', 'Manikavau', 'Pazhassi tomb'. It supported planting of 500 saplings of 65 spp at Kootakavu, 4500 saplings of 150 spp. at Manikavu and 150 saplings of 50 spp. at Pazhassi tomb. The plant conservation effort has eventually increased the ground water level and improved the water bodies, enhanced the faunal diversity, increased the soil fertility with organic matter and humus.

CONCLUSION

In response to the increased demand and the emerging needs of the society, the scope and purpose of ex-situ and on-farm conservation methods need to be changed to the level of a holistic functioning of the natural and cultural heritage which benefit in multiple ways the local communities. This has to be promoted by way of mainstreaming biodiversity in the local development within the scope of the provisions in the Biological Diversity Act 2002. The focal interventions in conservation can be around Bio-Economythe interface operation between biodiversity and economic enterprises developed at local level, and "Bio-cultural diversity" -the interface management of the diversity of nature and culture in a complex socio-economic adaptive system. In India, over 4500 inhabitant ethnic communities exists, each of them have developed multitude of foods, drinks and medicines out of every possible genetic resource. Multitude of culinary dishes, curative remedies and spiritual offers based on biodiversity are known from the Malabar region. But, unfortunately, before getting validated (scientifically)bulk of the traditional knowledge, and practices associated with bio resource management is getting lost. Slowing the pace of this loss, and simultaneously taking steps to revitalise the critically important practices and knowledge with back- up of scientific evidences thus, becomes very important and urgent, before this heritage is lost forever. Intervention in this area is all the more important, in view of the great potential for developing such heritage in a transition economy. This will be possible only by a holistic approach in conservation, consumption and commercialization aspects of resource management. The emphasis therefore, should be balancing the "trilema of development"-protection of ecology and culture, achieving equitable social progress and sustainable economic development.

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YAONGYIMCHEN COMMUNITY BIO-DIVERSITY CONSERVATION AREA, NAGALAND

Y. Nuklu Phom

Chairman (Team Leader), LEMSACHENLOK

ABSTRACT

Yaongyimchen Community Bio-Diversity Conservation Area covers the entire forest areas of Awakung, Owau, Akching, Mangkoyo and Rivers: Dula, Duthet, Shiung, Okyong. Qualifying the concept of Community Bio-Diversity Conservation logging, hunting and fishing in any form, use of gun, catapult, and any form of local trap, trapping or killing of Amur Falcons within its entire jurisdiction is strictly restricted. The initiative contributes much towards the restoration of Flora and Fauna, and habitation of many wild species and the Amur Falcons roosts in terms of millions every year, perhaps the greatest congregation in the world since 2016. Meanwhile, the community has owned the biodiversity initiative and even without financial support from donors, have been able to consistently work toward the Conservation and today, the biodiversity Conservation area is one of the largest in the state and it gives asylum to hundreds of species including many endangered species, one of the successful stories is the roosting of millions of Amur Falcons since 2012.

INNOVATIVE AND ADAPTATION MEASURES UNDER LEMSACHENLOK

Community Biodiversity Conservation, an Initiative towards Innovative and Improved Environment Protection Measures under LEMSACHENLOK: Yaongyimchen, Alayong and Sanglu (Alayong and Sanglu are migrated/outshoot villages from Yaongyimchen) under the Society LEMSACHENLOK took up the issue of Bio-Diversity Conservation from 2008. The concern wasn't a success in the initial stages since the community had no financial support from any sector. Small Agricultural activities, selling firewood, Logging, timber selling, and for some hunting and fishing were the only means of earning their livelihood.

In 2008 December, LEMSACHENLOK took up the concern and presented to Citizen's Annual General Body meeting, and the matter was descriptively deliberated. However, convincing the economically constrained Citizens to implement the plan was a big challenge. However, despite so much of resistance, the Citizen's Body resolved to declare some forest areas as Yaongyimchen Bio-Diversity Conservation Area. During 2009 and 2010, the Members continued to sensitize the people on expansion of the Bio-Diversity Conservation area. Citizen's General Body Meeting December, 2010 resolved to establish Community Conservation Area. Since then the entire Community worked towards conserving forest including Rivers, preserving all the wild species.

During its Student's Golden Jubilee in December, 2012, the Yaongyimchen Community Bio-Diversity Conservation was officially launched. Today Yaongyimchen Community Bio-Diversity Conservation Area covers the entire forest area: Awakung, Owau, Akching, Mangkoyo and Rivers: Dula, Duthet, Shiung, Okyong. Qualifying the concept of Community Bio-Diversity Conservation logging, hunting and fishing in any form, use of gun, catapult, and any form of local trap, trapping or killing of Amur Falcons within its entire jurisdiction is strictly restricted.

1. LEMSACHENLOK is a Thinking, Working, Planning, Fund raising Society. LEMSACHENLOK strives towards planning, setting up programs and projects, monitoring and assessment of different community development programs under the three villages. Entire program of the Community is being executed under the Supervision of LEMSACHENLOK. Members of LEMSACHENLOK and other well wishers voluntarily contribute funds for community welfare through which all the works have been executed.

2. An Innovative Community Bridge over 60 feet long stream has been constructed which leads to the Community Bio-Diversity Conservation Area and the Amur Falcon Roosting site.

The purpose of the Innovative Community Bridge is for Conservation of the water species and especially for preservation of the Rivers so that they are not contaminated. Stones and boulders from the rivers have been collected for different business purposes. When the community members are offered some remunerative funds, they surrender the resources to few contractors and other agencies, who scrub the rich mineral resources which has been there for generations. Once the project is launched and some compensation given, no one can stop miles and miles of River Belt from being damaged beyond repair. This directly impinges on the environment, leading to soil erosion and the rivers and the adjacent lands are affected creating mud slides, huge soil erosion and floods in many unexpected areas.

The Innovative Bridge is a mechanism to stop damaging the rivers and its natural resources. The bridge is purely built with timber and locally available resources and has a CGI sheet roofing to protect from heat and rain. This is a low cost innovative Community Bridge which is just 6 feet tall. The height of the Bridge is maintained so that except small vehicles no big vehicles can pass through. The bridge connects to the main Dikhu River.

Despite many developmental activities taking place like big buildings being constructed, the Rivers stretching some 7-10 Kilometres have been securely conserved. The Bridge has been there for the last 6 years now.

3. Handholding and Concern towards Land Use: A Recent Initiative:

i. Land Communitization: One of the achievements LEMSACHENLOK could accomplish was asking the individuals, families, clans to hand over their land to LEMSACHENLOK. If certain area of forest or land is found fit for some developmental works for the entire community, the land owner willingly hand it over to the Community development society. LEMSACHENLOK a society engaged in Biodiversity conservation will critically analyse which land, forest is to be used for different community development programs. In the process, environmental

protection is given importance. Under this Land Communitization initiative, an Act titled "Yaongyimchen Community Land Act" was Passed in 22nd June, 2013 "Res. No. YCGM. No, 7. YCLA, 22/06/2013."

ii. Shifting regular Jhum to another location from its regular cycle: Traditionally, depending on the cycle of years forest are cleared and new Jhum fields are being cultivated just for two years. The Jhum cycle is counted on the basis of years left untouched and after 10-15 years the farmers once again return to the same location for jhum cultivation. This is a traditional practice for many many generations.

In 2016, the forest opposite to the Community Conserved Areas which is also adjacent to the Amur Falcon Roosting site was supposed to be used for Jhum cultivation purpose as per the cycle. However, seeing that the Amur Falcons started roosting in the adjacent forest, the Land Communitization Act was applied to sensitize the community to shift the Jhum to another location. However, with the request from LEMSACHENLOK, the community willingly accepted to shift the 2016 Jhum to another location. This was a huge initiative, a breakthrough disassembling the traditional practice.

The Initiative contributed much towards the restoration of Flora and Fauna, and habitation of many wild species. Having shifted the Jhum, now the Amur Falcons roosts in terms of millions every year, perhaps the greatest congregation in the world since 2016 after the Jhum was shifted to another location.

iii. Escalating Existing Jhum Practice to a Augmented Land Use, Shifting of Regular Jhum to Permanent, Innovative and Integrated Bench Terracing in the Sloppy Terrain:

a. Jhum for Three Years: Witnessing the catastrophic environmental impact, it is also realized that deforestation equally contributes to this affect. Traditionally, every year one forest area is being slashed and burned destroying the entire bio-diversity purely for Jhum purpose adding to the decay of its flora and fauna. Therefore, this issue was seriously deliberated during the Citizen's Annual General Body Meeting of Yaongyimchen Alayong and Sanglu in December, 2017. The concern was a big challenge for the planning body, yet the General Body Meeting resolved that in 2018 the citizens will not go for a new jhum but they will continue the jhum in the existing previous year's jhum field-the fallow land. Which means that cultivation of fallow Jhum will be stretched to three years. Traditionally, each jhum field is cultivated for two years only and left for regeneration for around 10-15-17 years. With so much of forest areas being set aside as Bio-Diversity Conserved areas, the jhum cycle has been reduced to 6-7 years.

Thus, LEMSACHENLOK, in its meeting with the Village Council on the 10th of October, 2017 during JÜKDHOK (The community brings in their contribution of Paddy for the Council and the Council Court decide the location for the forthcoming Jhum) resolved not to go for new jhum in 2018.

"Yaongyimchen, Alayong and Sanglu Citizens through its Council Court resolved that in 2018 the community will not go for Slash and Burn New Jhum but continue to cultivate the Fallow Land (previous year's Jhum) in order to reduce the deforestation."

b. Innovative and Integrated Bench Terracing in the Sloppy Terrain: Having resolved to conserve 800 – 1000 hectares of forest areas: Owau, Awakung, Akching, Mangkoyo which has not been cultivated for more than 35-40 years along with the adjacent Rivers Dula, Duthet, Shiung, Okyong, the Jhum cycle has been reduced to only 6-7 years now which earlier was 15-17 years. This Biodiversity Conservation is purely a singular effort of the community, though the community have become too exhausted and their resources have become too constrained so that no one come forward to facilitate the Community for their livelihood sustenance.

Land is the only source of their livelihood sustainability. Therefore, with the decrease in Jhum cycle, the quantum of production in the immediate jhum field is reduced which cannot sustain the community and with this depressive production drift, the community would resort to jhum in the conserved forest which is the only source for livelihood. This posed a huge challenge posed. Therefore, unless some alternative Livelihood intervention measures were conferred, the community cannot be stopped from cutting down the jungles for jhum purpose purely for their sustenance. However, the practice would on a large scale contribute towards the environmental degradation. Therefore, a new system of cultivation was necessitated.

With the shifting of the traditional jhum farming towards terrace farming and other alternative methods, forest re-generation will take place and this concept will contribute towards the conservation effort.

The Innovative and Integrated Terracing was conceptualized and deliberated at the community level on several occasions during the last 2 years. The concept has been evolving within the community for the last two years and the entire community members have been open to the idea except that the leaderships couldn't raise funds for the concept to have it implemented in reality.

The Innovative and Integrated Terracing is to integrate multiple crops in once acre land so that the farmers are introduced to farming different multiple crops. While Paddy is being cultivated as the primary crop, the farmers are able to have seasonal harvest with different and numerous crops. This is possible since the land is conducive to absorb the multiple crops.

The Integrated Bench terrace farming will also contribute towards social integration. The traditional method of Terrace farming is very individualistic and people work in isolation from each other. In the traditional method only those who can afford or those financially secure can only take up Terrace farming which creates disproportion amongst the community. Therefore, the new Innovative and Integrated Terracing will not just integrate multiple crops but the new concept will definitely bring in a lot of social integration, as in one hectare Terrace field, many families can come together. **c. Preserving indigenous Floral Species:** Beside the condensing of slash and burn method of agriculture which has been practiced for many many years, the 3 years continuous farming in the existing jhum field will definitely augment the forest restoration and regeneration of new Species.

d. Tree Plantation: There are abandoned Jhum where no farming is done for 5-7 years, however, no new trees germinates except shrubs. Therefore, as part of Forest regeneration attempt, different trees conducive to the forest and the climate of the land will be planted in large quantity. The plantation initiative restrict soil erosion, mud sliding and land slides which blocks the drainage, streams and rivers causing flood.

e. World Environment Day: During the last 7 years, every year during the first week of June, the officers of LEMSACHENLOK have been engaged in preparing dramas, skits, songs, prayers and special speeches which is being distributed all over Nagaland, and the first Sunday of June is always observed as the World environment Sunday. Through this campaign initiatives, pouching has been reduced and in many places it has completely ceased. If only there are good support, we can augment this movement all over the country.

f. International Wildlife Week: October first week being the International Wildlife week, the citizen leaders take the responsibility to sensitize the people of Nagaland in safeguarding the wild species. This is done by preparing special sermons and distributed all over Nagaland to be read in all the churches, and it has been resolved that October first Sunday will be observed as wildlife Sunday in all the churches.

4. FROM MEGA PROJECTS TO INNOVATIVE AND CLIMATE RESISTANT COMMUNITY PROJECTS.

LEMSACHENLOK continues to stress towards focusing on small and mini hydro projects and not huge mega dams which brings a lot of environmental degradation. The small and mini dam can facilitate block wise (area wise) electrification. The River adjacent to the Community Biodiversity Area has been on several occasion proposed for setting up a huge power generating Mega Hydro, however, the community has resolved not to damage the natural resources through setting up of projects.

For all these initiatives, LEMSACHENLOK has set up a team of volunteers, who have been trained for execution of the plans and even for guiding tourist and other visitors.

5. LEMSACHENLOK winning the India Biodiversity Award, 2018.

Out of some 200 applicant, the National Biodiversity Authority through the evaluation team along with Juries, nominated LEMSACHENLOK as the Winner of the India Biodiversity Award 2018.

One of the reasons for being nominated for the Award is the Conservation initiative of the community. The conservation initiative is singularly the effort of the community

without any support from any sector even the Government. The work was initiated from 2008 and during the last 10 years, the community took up innovative and climate resilent work activities.

Meanwhile, the community has owned the biodiversity initiative and even without financial support from donors, have been able to consistently work toward conservation and today, the biodiversity Conservation area is one of the largest in the state and it gives asylum to hundreds of species including many endangered species, one of the successful stories is the roosting of millions of Amur Falcons since 2012.

Many Amur Falcons have been satellite tagged by the Government from different locations, however, all the satellite tagged birds have stopped transmitting signal. But the Amur Falcon named after the district as "Longleng" is the only bird which still transmit information giving the location status of the millions of the Amur Falcons. Longleng was satellite tagged in November 2016 under the initiative of LEMSACHENLOK with Prayers by the Church and after completing two cycles it is presently in South Africa on its Third Journey. Though community biodiversity conservation is not given much global recognition, it still contributes in the area of climate change adaptation measures through diverse activities undertaken by the community.

HORNBILL MONITORING TO ECOLOGICAL MONITORING – ONE AND HALF DECADE OF INDIGENOUS COMMUNITY BASED CONSERVATION AND MONITORING OF ENDANGERED RAINFOREST SPECIES AND HABITAT IN WESTERN GHATS

Amitha Bachan K.H¹, Fasila P.K² and Sreehari S. Nair³

¹Assi. Prof & Research Guide, ²PhD, Fellow, ³Research fellow Research Department of Botany MES Asmabi College. ¹Founder member Western Ghats Hornbill Foundation and Member, IUCN Species Specialist Group for Hornbills

ABSTRACT

One and half decade long experience of studies and conservation interventions involving indigenous communities in the Vazhachal – Parambikulam Tiger Reserve part of Forest in the Anamalai landscape of Southern Western Ghats is narrated here. The Hornbill conservation and monitoring programme has been an important biodiversity and habitat conservation programme to conserve our State bird Great Hornbills and their pristine habitat. Evolution of the process of ecological monitoring of endangered species and habitat involving communities has implication in ensuring natural justice to the indigenous people and provide replicable model for community based long-term monitoring and conservation of biodiversity in the inclusive conservation regime in compliance with various international and national declarations and legislations such as UNRIP (2007), CBD (2003-2018), FRA (2006), FCA (1980) and Biodiversity Act (2002).

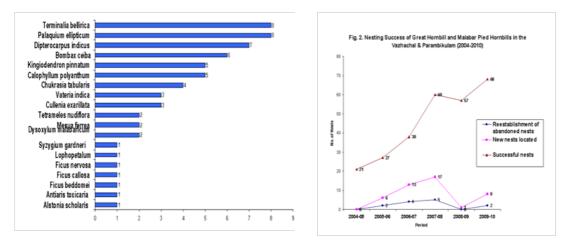
INTRODUCTION

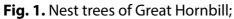
The forests of Vazhachal occupies a pivotal position in connecting a continuous stretch of evergreen especially wet evergreen (rainforest) patches that extent from Nelliyampathy hills in Nenmara Forest Division, Prambikulam Tiger Reserve, Chalakkudy Forests of North and North-West and Malayattur-Mankulam-Munnar and Eravikulam National Park in the South and South west portions of Anamalai hills and The Topslip-Valparai part of Indira Gandhi Tiger Reserve of Tamil Nadu part of Anamalai hills in the East. The availability of comparatively less disturbed primary rainforests in the Malakkappara –Sholayar and Vazhachal region along with very low elevation riparian evergreen forests made the landscape suitable as important habitat of our endangered state Bird Great Hornbills (*Buceros bicornis*). The presence of Great hornbills and their nests was initially reported from Topslip and Kavalai by Kannan (1993), Kannan and James (1998) and the presence of sympatric nesting of three important hornbills i.e. Great Hornbill, Malabar Pied Hornbills and Malabar Grey hornbills in the low elevation riparian evergreen forests (180m MSL at Vazhachal) was reported by Bachan (2003, 2006).

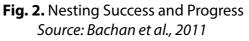
Consumption of hornbill squabs sometimes by Kadar indigenous and PVTG (Particular Vulnerable Tribal Community) endemic to rainforest habitat of Anamalai was reported as one of the issues of the conservation of the bird (Kannan, 1993) and these assumptions were without going very deep into the scientific aspects of threat actually faced by hornbills and their nesting trees. This has led us to initiate a programme to involve Kadar community in Protection and Monitoring of hornbill nests, nesting trees and habitat with the support and involvement of Kerala Forest Department.

CONSERVATION PRIORITIES AND BEST PRACTICES

The community based conservation programme conceptualised by us was conceived by Mr. V. Gopinathan IFS, former PCCF and Chief Wildlife Warden, Mr NageshPrabhu IFS, then conservator of the forest, central circle and S. Muralidharan, then DFO of Vazhachal forest division. Dr. Bachan did the comprehensive survey of hornbill nest in the Vazhachal forest division area involving the Kadar community in nine villages within Vazhachal forest division. Twenty three nests of great hornbill and six nests of Malabar pied hornbills were located during that year (2004-2005). The tribal community were empowered in scientific monitoring of hornbill, their nesting tress, and the threat factors of their nesting habitat. This was continued as a long term community involved rain forest flag ship species monitoring and conservation programme till today (Nagesh-Prabhuet al., 2005; Bachan, 2006; Bachan et al., 2009)







An interim analysis was presented in the 5th international hornbill conference held at Singapore. The degradation of the old growth trees of rainforest because of various government policies supporting conversion of primary forest for industrial and other forestry plantation and also for river valley project were identified as important threat. The consumption of hornbill squabs by the tribes was very less frequent and could be detrimental only when population of the hornbill are very low. The experience so far in empowering the community merging their traditional knowledge on forest, landscape and species along with scientific methods was enchanting and augmented to documentation of indigenous territory in recognition of indigenous rights on forest conservation under Forest Right Act (FRA 2006). A support from Critical Ecosystem Partnership Fund (CEPFATREE) for the conservation of Western Ghats region helped to strengthen the scientific basis, understanding hornbill habitat degradation for identifying priority conservation areas and standardising the methodology to monitor other endangered species including Minor Forest Produce (MFP) as an ecological monitoring process. The community involved Hornbill monitoring programme was replicated to the adjacent forest areas within the Anamali forest areas such as Prambikulam tiger reserve, Malayattor, Nenmara and Nelliyampathi forest division.

Table 1. Hornbill Nest Tree Monitoring involving local ethnic community
groups - Anamalai landscape (Source: Bachan and Anitha, 2013)

Sl.	Forest Divi-	No. of	No. of	No of	No of	No of	No. of	Loss
No	sion	Tribal	Nests	nests	Suc-	New	Re-	of nest
		Settle-	identi-	Moni-	cessful	nests	estab-	tree/
		ments	fied	tored	nests		lished	pre-
		in-					nests	vious
		volved						years
1	Vazhachal	8	71	71	63	9	3	5
2	Chalakkudy	1	10	9	7	0	0	2
3	Malayattur	1	4	4	4	0	0	1
4	Nenmara	2	6	6	5	0	0	1
5	Parambikulam	3	17	10	9	0	0	1
6	Anamalai TR–Topslip	1	10	6	6	0	0	1
7	Valparai	1	6	0	0	0	0	0
	Total	17	117	106	94	9	3	11

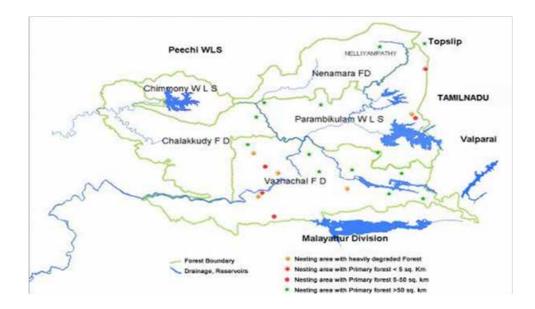
A methodology developed (Bachan 2010) to understand heterogenic forest composition along succession and degradation gradient was also incorporated to suggest eco restoration of hornbill habitats.

The areas of the forest were divided into various grids using GIS and stratified systematic sampling areas were identified for monitoring of species and ecosystem (various forest types). All the traditional forest dwelling routes of the indigenous community across the forest land scape were mapped using GPS along with indigenous village resource collection territories, traditional conservation areas and important wild life habitats. This

was superimposed with systematic sampling grids to engage the community in scientific monitoring. An ecological monitoring protocol in local language was developed for hornbill, their nesting trees, habitat phenology, threats, endangered species such as Tiger, Leopard, Lion tailed macaque, Nilgiri languor, Cochin forest cane turtle and endangered MFP such as Black Dammar (Canarium strietum) and wild nutmeg (Myristica beddomei). The community members were involved in collection of bench mark data as a training process. The experience of hornbill monitoring guards were also used and the ecological monitoring process and protocol was finalised. The data and the process were published in various reports and also was useful in empowering and involving community in long term monitoring without obstructing indigenous rights. The ecological monitoring is conceived as an important process in the modern inclusive paradigm linked with climate change and carbon trade and are as follows.

- a. Involving community in monitoring and conservation of species without curtailing their rights: It is the right of the local community to conserve as well as sustainably use the resources they depend on (UNRIP 2007, FRA 2006, CBD2003-2018, and Biodiversity Act 2002).
- b. Ensure their rights on access to land and resource, sustainable use and conservation.
- c. Monitoring of climate change: The long term monitoring of hornbills, nesting trees, other endangered species and habitats including phenology in long term involving community can generate huge amount of data for long period of time.
- d. There is an inequity or dis balance resulting in injustice in access to resources in the global developmental arena between the main stream people (depend on high carbon living) and indigenous or ecosystem people. The ecological monitoring becomes a methodology to provide carbon fund (including RED PLUS, CAMPA) pooled from the main stream living to compensate as lively hood option for the ecosystem people.
- e. One of the cheapest and inclusive method of monitoring conservation of forest and forest resources. The community involved programme provide them with right to decide priority areas of conservation, areas of resource use, seasonality, etc. in the Grama Sabhas or traditional institutions requires less input in terms of money compared with other conventional research programmes.

It is mandatory to incorporate all such research outputs on forest species and habitat into working and management plan of each forest administrative division in compliance with Supreme Court judgements, Indian Forest Conservation Act 1980 and the guideline for preparation of working plan of MoEFCC. The recent working plan guideline (MoEF 2014) has a majority mandate for conservation and management for natural forest and species comparing with old priority in management of forest plantation. The FRA 2006 (section 4(i) e, f,g rules 2012) mandate each tribal Gram Sabhas to prepare a management plan for the forest area they have traditional access and the forest department to incorporate that into working plan. All the standardised methodology and data evolved for the last one and



Map 1. Important hornbill nest locations of the Anamalai Land scape (Kerala part) (Source: Bachan and Anitha, 2013)

half decade during the community based hornbill monitoring and ecological monitoring process have been incorporated into a recent working plan of Vazhachal forest division. The hornbill monitoring and ecological monitoring protocol is being published and a hornbill monitoring online and android platform as a joint initiative of Forest Department, Western Ghats Hornbill Foundation and Research department of Botany MES Asmabi College. This data and intervention has helped in an ongoing assessment of flood impact on biodiversity and ecosystem supported by Kerala state Biodiversity Board (KSBB).

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BEST PRACTICES IN AGROBIODIVERSITY CONSERVATION FOR CLIMATE RESILIENCE

Dr. Vandana Shiva

Navdanya Trust

ABSTRACT

Seeds of Hope (AshaKeBija) program of Navdanya aim at providing an emergency supply of indigenous varieties of seeds in those regions, which are worse effected, either by the natural calamities or as a result of the policies. Under the program, Navdanya continues its efforts to supply seeds to those who are in the need of it and have lost their local varieties due to natural disaster or Green Revolution policy of the government.

INTRODUCTION

For the past 30 years ,Navdanya has been conserving agrobiobiodiversity , including biodiversity of climate resilient seeds.

Multifunctional, biodiverse farming systems and localized diversified food systems are essential for ensuring food security in an era of climate change. Farmers' Breeding and Nature's Evolution maintains Biodiversity and Genetic diversity and farmer's breeding has enabled agriculture to respond to changes over the past 10,000 years, and it is precisely this diversity that will play a key role in adapting agriculture to climate change in the decades ahead. The two most important resources for adapting agriculture to local climate change conditions are the genetic diversity of plants and the diverse knowledge and practices of farming communities.

Crop genetic diversity plays a key role in coping with environmental stresses, and traditional and indigenous knowledge systems incorporate essential principles of adaptation, diversity and plurality

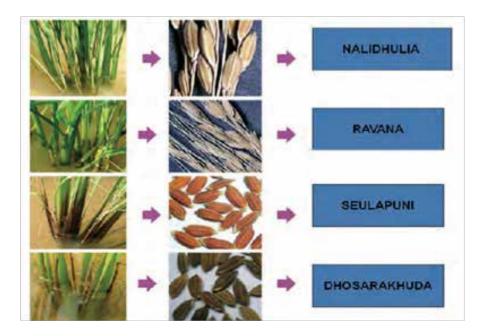
There are 4 ways in which Biodiversity and Seed Freedom creates climate resilience and is a climate solution

- 1. Firstly farmers have bred Climate Resilient Seeds and varieties that are contributing to resilience.
- Secondly, Diversity of crops increases the resilience of farming to climate change. If you have only one crop in a monoculture, it is more vulnerable to changing climate. Farmers growing monocultures of commodity crops are also more vulnerable to exploitative markets.

- 3. Thirdly, biodiversity intensification allows more carbon to be absorbed from the air, returned to the soil, thus decreasing excess carbon in the atmosphere while also increasing the resilience of soils to draught, floods and climate change.
- 4. Fourthly, when farmers have their own renewable, regenerative seed, they can replant after a climate disaster, which contributes to both climate resilience and economic resilience.

ACHIEVEMENTS OF THE PROJECT.

Climate resilient traits are becoming increasingly important in times of climate instability. Along coastal areas, farmers have evolved flood tolerant and salt tol- erant varieties of rice such as "Bhundi", "Kalambank", "Lunabakada", "Sankarchin", "Nalidhulia", "Ravana", "Seulapuni", "Dhosarakhuda".



The climate resilient varieties , specially the salt tolerant varieties have been distributed after climate disasters and natural disasters

Seeds of Hope for natural calamities

Seeds of Hope (AshaKeBija) program of Navdanya aim at providing an emergency supply of indigenous varieties of seeds in those regions, which are worse effected, either by the natural calamities or as result of the policies. Under the program, Navdanya continues its efforts to supply seeds to those who are in the need of it and have lost their local varieties due to natural disaster or Green Revolution policy of the government.

Salt tolerant varieties

Navdanya has conserved 33 salt tolerant varieties.

Orissa super cyclone 1999

During the Odisha super cyclone in 1999 Navdanya provided the victims with total of 100 quintals of paddy seeds of 14 varieties of native and nativised paddy in 3 devastated villages, namely Talang, Dharijan and Junagari under Gadabishnupur GP in Ersama block of Jagatsingpur district on 27thMay 2000 through the ChachakhaiYubakSangh and one such village, Mandu- ki under Astranga block of Puri district on 28thMay 2000. Other than paddy native vegetable seeds were also given to the farmers and district administration for free distribution.

Udasiali, an indigenous photosensitive kharif paddy variety was transported over 500 kilometers from Balasore to Erasama in Jagatsingpur as part of post 1999 super cyclone disaster agricultural rehabilitation.

Tsunami, 2004

During Tsunami in the year 2004 Navdanya Odisha gifted 100 quintals saline resistant native paddy diversity of 3 varieties to the Joint Director of Agriculture, Nagapattinam, Tamilnadu for free distribution of on 9th July 2005 at Nagapattinam

Four select Odisha salt tolerant paddy varieties of Odisha-Lunabakada, Kalambank, Bhundi, and Dhala sola-were transported over a distance of over 1500 kilometers from Balasore to Nagapattinam in Tamilnadu under the 'seeds of hope' programme following 2004 tsunami which yielded three times more and far better than any known high yielders. The same varieties behaved even better when cultivated in Indonesia, another 1000 or more kilometers away, in 2006 by Professor FriedhelmGoltenboth of Hohenheim University, Germany.

Sartha, 2007

During the year 2007- Distributed 10 quintals of 8 saline resistant paddy varieties among 80 deluged families of SarthaPanchayat under SadarBalasore block on 22nd July, 2007 at the Mangrove Field Office, Sartha.

Nandigram, 2007

On 31st May, 2007Navdanya established a seed bank at village Bajkul under disaster hit Nandigram block in Midinapur district of West Bengal with 10 quintals of 5 saline resistant native paddy varieties through the Taj Group of volunteers led by Sk. AhmmadUddin.

Phailin, 2013

After the massive destruction of standing rice crop in coastal Odisha in 2013 by cyclone Phailin, Navdanya distributed 100 quintals of 20 flood and salt tolerant indigenous rice seeds to 400 farmers of Balasore and Mayurbhanj districts.

Flood tolerant varieties

In last 20 years Navdanya has conserved 54 flood tolerant varieties in Odisha. Of these 8 varieties are extremely water tolerant. These varieties are being conserved and multiplied at Navdanya's biodiversity conservation farm and Seed Bank in village Chandipur, Balasore as well as by the Navdanya member farmers in Odisha.

Drought tolerant varieties

It is one of most serious worldwide problems for agriculture owing to very less rainfall. About 4/10th of the World's agricultural land lies in arid and semiarid regions, where less water demanding crops like millets, pulses and oil seeds are cultivated.

Plants of these climate resilient native rice varieties have long vertical roots, no lateral roots with least leaf curling (drought stress). Plants of the short duration variety normally are drought tolerant to some extent. Navdanya is conserving 39 drought tolerant rice varieties in Odisha.

Drought resistant aromatic and therapeutic rice varieties

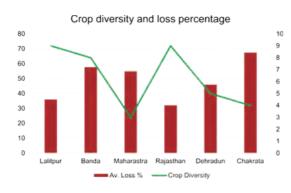
Besides, there are two other unique rice varieties, such as Differently Aromatic rice varieties (plenty) and Therapeutic (medicinal) rice varieties (few). Aromatic rice varieties have the ability to sustain in water deficit conditions (semi drought) unlike other normal longer days duration paddy varieties. Therapeutic rice varieties also sustain drought to considerable extent. Navdanya has conserved 55 aromatic and 2 therapeutic rice varieties in Odisha.





Agro-biodiversity, climate resilience and sustainability

Recently Navdanya did a study on the impact of Crop diversity in food security and economic sustainability in 5 regions of Uttarakhand, 2 regions in Bundelkhand and one region each in Maharashtra, and Rajasthan.



In the study crop loss due to untimely rainfall occurred during crop ripening and harvesting period was observed. Results clearly reveal a positive correlation between decreasing agro-diversity and quantitative increase in crop loss. Increasing diversity within the species coupled with use of traditional open pollinated strains show increased food and economic security against climate change related crop damage. As per Government

reports over 2 million tons of pulse crop production is reduced due to changed weather condition during the rabi crop season.

In Rajasthan, Maharastra, Uttar Pradesh and Dehradun and chakrata area of Uttarakhand production of major wheat reduced by 30 to 70%. Within the wheat varieties wheat lokman (Lokone) in Lalitpur (Bundelkhand, U.P.) and wheat 306 in Rajasthan, affected margin- ally as both varieties are old selection varieties. In pulses only traditional variety of lentil called Teen Fool walimasoor could survive, whereas all other lentil varieties could not sustain in the changed weather conditions.

Higher diversity of crops in Rajasthan and lalitpur also showed correlation with less crop loss. While in Maharashtra, Banda and Chakrata area where diversity was less farmers suffered heavy crop loss.

BEST PRACTICES ON BIODIVERSITY CONSERVATION IN RICE ECOSYSTEMS OF KERALA

Dr. C. Bhaskaran

Former Professor & Head (Agril. Extension), KAU

ABSTRACT

Kerala, the 'God's own Country' and the land of coconuts, spices and rice paddies, has been an epicenter of 'innovation by tradition' in settled agriculture too. This pristine land has been witness to many 'firsts' in the recorded history of human and societal development. From being abundant in rice production, the State is now struggling to meet even 15 per cent of the rice requirements. Rice, the staple food crop of Kerala is almost disappearing from the State. From nearly 9 lakh ha in 1970s, the rice area has declined to 1.97 lakh ha at present. Many innovative models of rice development have been experimented in various parts of Kerala in the recent times. Based on available literature and field inventorisation some of the best practices in rice ecosystem conservation are listed here.

INTRODUCTION

Rice is Life and Rice Agriculture is the lifeline of human culture and civilization. Being the staple food of a vast majority of the human race, rice occupies a prime place in the history and development of nations in the world. In the hunt for rice- based food, human society, has over the years, evolved innovations and initiatives to nurture rice culture for prosperity in perpetuity. Rice farming has impacted not only the food security of humans and animals but the biodiversity, water, energy, employment and gender security too. In fact, the current thrust globally is on food sovereignty and food independence in which rice has a pivotal place and significance.

Kerala, the 'God's own Country' and the land of coconuts, spices and rice paddies, has been an epicenter of 'innovation by tradition' in settled agriculture too. This pristine land has been witness to many 'firsts' in the recorded history of human and societal development. Not to be left far behind, Kerala had its share of 'ups' and 'downs' in every aspect of human life - rice being life, it had many 'highs' and 'lows' in Kerala society too. From being abundant in rice production, the State is now struggling to meet even 15 per cent of the rice requirements. Rice, the staple food crop of Kerala is almost disappearing from the State. From nearly 9 lakh ha in 1970s, the rice area has declined to 1.97 lakh ha at present (Economic Review,2018). While food independence remains as a distant dream, the people of Kerala, however are striving their best to sustain rice culture through many innovative initiatives, including technological and institutional, and the present attempt is to outline such significant moments and movements in nurturing rice culture in the culturally rich landscape of Kerala.

Recent Innovative initiatives in Rice Ecosystem Conservation in Kerala

Many innovative models of rice development have been experimented in various parts of Kerala in the recent times. Though an exhaustive account of all these attempts is difficult here, based on available literature and field inventorisation some of the best practices in rice ecosystem conservation are listed here.

- 1. Aswathi Palakkadan Jaiva Matta- The success of organic paddy value addition from Vadakancheri
- 2. Krishi Bhavan, Thiruvilwamala- 'Vilwadri', first branded pesticide-free, ready –tocook rice
- 3. Revival of Pokkali rice cultivation through innovative interventions
- 4. The GALASA as an innovation in rice development in Kerala
- 5. Kalatharakkal Sustainable rice development model
- 6. Krishibhavan, Pullampara: System of Rice Intensification (SRI) yielded 11 MT/ ha.
- 7. 'Seed Villages'- Granary of Tribal Traditional Rice varieties in Wayanad
- 8. Joint family farming in the International Year of Family Farming:
- 9. 'Together they sow and reap Rice only'.
- 10. Fish labourers ' of Sri.T.F.Varkey: 'One rice- one fish' in Wayanad district.
- 11. Save Our Rice Campaign (SOR) by 'Thanal', an NGO.
- 12. Rice initiatives in Karavaram: 'Samagra Karshika Vikasanavum tharisu rehita panchayatum'.'
- 13. Revival of premium, indigenous rice variety'Palthoni' in Vandanmedu, Idukki
- 14. 'Paddy Challenge' of Thiruvali Krishi Bhavan in Malappurama la
- 15. 'Ice bucket challenge'
- 16. Rice Culture in House Terraces
- 17. Impact Investing, Iconic Agriculture and Spirituality rice
- 18. Facebook Group as a harbinger of rice development
- 19. Convergence approach by Kanniyeri Farmers' Club
- 20. Concurrent cropping of Rice with Daincha: Innovative initiatives in Kodakara
- 21. Group farming in paddy cultivation in Nedumbassery
- 22. The Wadakkanchery modelFood Security Army: An innovation in labour and machinery service provision.

Strategies for scaling up of best practices with special reference to rice farming in Kerala.

Historically, rice has been so much a cultural value that it comprehended all agriculture as practised in a locality. The pressures that have led to conversion of paddy fields to other uses and the reduction of the area under paddy here are likely to apply to all such systems as a whole, as a result of the present economic trends.

From the foregoing analysis of the innovative models of rice farming in Kerala, it could be deduced that there can be no blueprint for when and how to take these innovations to scale. Rather, a case- to- case interpretation will be required while attempting to scale up successful and innovative models of rice development to other larger areas keeping in mind the agro-edaphic, socio-economic and political realities. However, some Good Innovation Practices (GIP),a la Good Extension Practices (GEP) enumerated by Bhaskaran (2004), emerge from a scrutiny of the innovative models of rice development in Kerala.

- 23. Development of low external input agro-ecological agriculture
- 24. Off-farm and non-farm income generation
- 25. Strengthening of local value
- 26. Knowledge- based decision making
- 27. Enhancement of social capital
- 28. Participatory analysis, planning, monitoring and evaluation
- 29. Farmer experimentation
- 30. Integration of indigenous and modern knowledge
- 31. Promoting farmers' movements and institutional innovations
- 32. Encouragement of interdisciplinary, holistic and system based social learning Synthesizing the experiences so far in Kerala in this regard, the following suggestions are put forth for consideration

Summay and Conclusions:

- 1. Protection of economy and ecology can be attained through initiatives like group farming meditated by the Krishi Bhavans and the Local Self Government Institutions
- 2. Ensure the involvement of Kudumbasree units in group farming for women empowerment through agripreneurship development.
- 3. Encourage mechanized paddy farming and overcome shortage of labour.
- 4. The activities necessary for the cultivation of paddy must be included in the permissible works under MGNREGS.
- 5. Effective implementation and monitoring of laws against the conversion of rice lands have to be ensured. Among the strategies for increasing rice production in the state, the 'focus block approach' can be adopted for rice intensification.
- 6. Methods like System of Rice Intensification, precision farming, organic farming, rain guns for irrigating Padasekharams and other Good Agricultural Practices have to be promoted.
- 7. Comprehensive multimedia strategy, including IT/ ICT and social media, must be employed for creating awareness about food independence ,food safety and the agro- ecological, and livelihood security considerations of rice farming particularly among the younger generation.

- 8. Irrigation and water management are serious problems affecting rice cultivation in Kerala. The right over irrigation water should be that of the farmer and to enable this the Command Area Development Agencies must be restructured.
- 9. Organic manures, green manures and green leaf manures, bio fertilizers, bio control agents etc. should be produced in a decentralized manner taking into consideration the local requirements so as to improve the soil fertility status for rice cultivation.
- 10. Quality seeds must be produced by farmers identified and trained for the urpose. Seed production technology should become the community skill and R & D institutions must focus only on the development and supply of breeder seeds and foundation seeds. Indigenous seeds with proven potential to come up well in specific situations should be promoted by the R & D units after refinement.
- 11. Farmer Field Schools, Demonstrations, trainings and other awareness campaigns should be organized in farmers' fields and surroundings. For effectivising field extension work of the departmental officials, they should be freed from routine and redundant paper work. Effective e- governance systems should be put in place to see that the professional extension officials are not bogged down in 'pen pushing'.
- 12. To make rice farming remunerative, Government's policy support is indispensable. Attractive minimum support price, production bonus, unified service delivery including information advisories, quality inputs, farm machinery, farm labour provision, value addition ventures etc. must be made available to farmers. The 'LEADS' Pilot Project now implemented in four districts must be \extended to all the fourteen districts of the state. The Agro Service Centres should be established in all the Block Panchayats on a war- footing. 'Labour Banks' have to be started in all Grama Panchayats urgently.
- 13. Integrated Farming System should be promoted involving 'rice-fish-duck-pigpoultry-cattle' rearing. Instead of 'one rice-one fish', 'fish along with rice' should be encouraged in areas with potential.
- 14. Experience in the 'LEADS' pilot project in Wayanad district has shown that rice yields could be increased by about one MT/ha with the application of soil health card-based critical inputs like Psuedomonas sp., Boron, lime etc. Hence, soil health cards should be distributed to all the farmers to enable them adopt Integrated Nutrient Management practices.
- 15. IRRI studies have indicated that use of chemical insecticides and pesticides can be reduced to the tune of 96 per cent in rice farming without affecting productivity through following ecological engineering. Hence, the Crop Health Management Project now being implemented in 273 Grama Panchayats should be extended to all the areas in the state.
- 16. Special rice development schemes should be designed and implemented for the relatively low productive systems of rice farming like Pokkali, Kaipad, Onattukara etc. R & D efforts to develop improved technologies and innovative extension approaches for sustaining these ecologically vulnerable tracts should be taken up.

- 17. Rice varieties with Geographical Indication, Organic label and medicinal values should be cultivated to fetch premium price in niche markets.
- 18. Social capital development through group organization including producers' organisations, Farmer Extension Organisations etc. will help in overcoming the limitations of land size in rice development in Kerala.
- 19. Social security measures such as health insurance, life insurance, crop insurance etc. should be extended to rice farmers as in the case of the other vulnerable sections of Kerala society.
- 20. 'Catch them Young' should be the campaign slogan to sensitise and attract youth to rice farming. Schools and colleges should be used as the platforms for developing a heritage- conscious, healthy and independent younger generation particularly attuned to the renaissance of rice culture in Kerala. Conventional mass media, traditional media, new media, hybrid media and social media should be used in tandem in the media strategy to support the 'Rice is life' campaign in Kerala.

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Biodiversity Conservation Priorities

AGROBIODIVERSITY CONSERVATION: PARTICIPATORY MANAGEMENT SYSTEMS IN SMALL MILLETS

E.D. Israel Oliver King

M.S. Swaminathan Research Foundation oliverking@mssrf.res.in, 9443364287

ABSTRACT

India is among the countries with the most malnourished children, thus facing a significant nutrition challenge. Nearly every third child in India is undernourished – underweight (35.7%) or stunted (38.4%) and 21% of children under five years are wasted as per NFHS 4 2015-16. This paper shares the experiences that aimed to empower small and marginal holders and hill dwellers for enhanced household food and nutritional security and income through participatory approaches.

INTRODUCTION

India is among the countries with the most malnourished children, thus facing a significant nutrition challenge. Nearly every third child in India is undernourished - underweight (35.7%) or stunted (38.4%) and 21% of children under five years are wasted as per NFHS 4 2015-16. Moreover, the NFHS-4 data indicates that every second child is anemic (58.4%). Hidden hunger - micro-nutrient deficiency in infants and young children is alarming. Nutritive and Underutilized Species (NUS) belongs to Genera Eleusine, Setaria, Panicum, Paspalum are sources of micronutrients such as calcium, iron, and folic acid, in addition to being climate hardy crops. The area under these NUS in India has significantly decreased since the 1950s, which is ascribed to a number of agronomic and socio-economic aspects: Lack of suitable improved varieties and cultivation practices, poor extension systems for yield enhancement and crop promotion, lack of specific post-harvest and processing technologies for small users, low economic competiveness, poorly organized value chains, lack of attractive, modern food recipes, and insufficient awareness of nutritional value and income opportunities. With the support of IFAD and Bioversity International, these challenges were addressed in a holistic '7C' approach (Chronicling, Conservation, Cultivation, Consumption, Commerce, Collectives and Communication) over the last decade, involving custodian farmer communities, State government, research and development institutions, and the private sector in various ecological and social conditions across India.

This paper shares the experiences that aimed to empower small and marginal holders and hill dwellers for enhanced household food and nutritional security and income through participatory approaches.

a) On farm management of Genetic resources

Farmer participatory technological interventions: together with appropriate capacity building; conducting yield enhancement trials (line sowing, inter cropping with tapioca), Vermicomposting technologies, application of bio fertilizer and organic manure for increasing productivity and production of locally important under-utilized small millets (finger millet, little millet, foxtail millet) and other associated with the traditional millet-based cropping system.

b) Drudgery removal and skill enhancement

Reducing drudgery of women: through development and introducing simple, affordable and workable technological solutions such as row maker, cono weeder, modified spade, de-stoner, de-husking and pulverizer flour mill to tedious crop management and postharvest operations.

c) Value addition and marketing

Extending Small holder-centric farm-to-market value chain with value added products: from the local under-utilized crops for enhancing household income through organizing Farmers Clubs and Self Help Groups and providing them with required machinery, training, bank and market linkages.

d) Nutrition Education

Nutrition education to women and children to improve the nutritional status of the rural households: promotion of household consumption of under-utilized food grains and continuous capacity building of women and men farmers on different technological interventions such as conducting competition for school children.

e) Campaigning for Millets

Popularizing values of climate smart nutritive millets among various stakeholders in urban and rural areas using innovative strategies and influencing though policy.

AGRO-BIODIVERSITY: STATUS, TRENDS AND CONSERVATION PRIORITY

Latha M., Suma A. and Joseph John K.

ICAR-National Bureau of Plant Genetic Resources Regional Station, KAU (P.O.), Thrissur 680656

ABSTRACT

Agro-biodiversity refers to the nature and extent of variability present in the domesticated plants and their wild relatives. Kerala, which covers hardly two per cent of the land area of India, has recorded nearly 25 per cent of the country's plant biodiversity. ICAR-National Bureau of Plant Genetic Resources (NBPGR) is the nodal agency for Agro-biodiversity conservation in the country, with one of its regional station located in Thrissur, Kerala. Since its inception, a total of 29,690 accessions were collected in 244 missions from trop-ical, humid regions of Southern Western Ghats. A total of 8306 accessions comprising 74 crops and their wild relatives are maintained in field genebank and medium term storage facility. Station possesses unique collections in Rice, Momordicas, Cucumis, Garcinias, other potential crops and wild relatives. As a mechanism to boost on-farm conservation, station conducts diversity appreciation days to expose the diversity in landraces of various crops to farmers. In continuation of this, nearly 600 farmers throughout Kerala were supplied seeds/seedlings of selected germplasm of their choice thus bringing back sustainable management of agro-biodiversity.

INTRODUCTION

Agro-biodiversity is a specialized discipline of Biodiversity. It is the mainstay for human survival by sustaining and strengthening food and nutritional security. Out of the 250,000 species of higher plants described, 3,000 species are of agricultural importance and 30 species are of importance for food use. India is the Centre of Origin and Diversity for crops like rice, black gram, green gram, black pepper, turmeric, cardamom, ginger, jackfruit, mango, banana, sugarcane etc. These important food and nutritional resources are major components of agro-biodiversity in India and viewed as a link with the ethnic and cultural diversity that encompasses over 550 tribal communities living in diverse agro-ecological regions across the country. Kerala is home to about 36 tribal communities of which 55.47 per cent constituted by agricultural labourers and agrarian tribes like Kurichya, Muthuvan and Mannar are the custodians of landrace diversity in indigenous crops. Agriculture sector provides them with the main means of livelihood.

The Western Ghats forms one among the 34 globally recognized Mega Biodiversity hotspots and of late UN has accorded a world Heritage status to the region comprising a sizable part of Kerala. Nayar (2010) has estimated 5000 species of flowering plants in the Western Ghats area, of which about 1700 are endemic. Kerala, which covers hardly 2 per cent of the land area of India, has recorded nearly 25 per cent of the country's plant biodiversity. Out of the 356 crops cultivated in India, over 115 species are cultivated in

Kerala with about 150 crop wild relatives. Ecosystem diversity is also tremendous in the state with various cropping systems along various altitudinal ranges and niche habitats. The vegetation of Western Ghats is influenced by rainfall and temperature and it shows a north to south increase in luxuriance and diversity of species. The Agro-biodiversity of Western Ghats is threatened due to alien invasive species spread, developmental projects, replacing landraces by high-yielding varieties and hybrids, erosion of seed storage practice at homestead level, abandoning of agriculture, non-involvement of youth etc. Kerala witnessed a drastic area reduction of traditional crops in favour of plantation/ monocrops, high penetration of agri-extension/ development activities all conducive for genetic erosion of landraces in Kerala.

IMPLEMENTING AGENCY

ICAR-National Bureau of Plant Genetic Resources (NBPGR) established in 1977 is the nodal agency for Agro-biodiversity conservation in the country and played a very distinct and significant role in augmenting and conserving crop genetic resources. Presently a total of 3,96,189 accessions of germplasm of different Agri--horticultural crops are being conserved in the National Gene Bank. NBPGR operates through its National Gene Bank (NGB) at Delhi with long-term (-180C up to 100 years) and medium-term (4-70C upto 20 years) storage facilities, cryo-preservation and in vitro conservation facility for recalcitrant and vegetatively propagated species, genomic repository and over 57 National Active Germplasm Sites (NAGS) for specific crops and 10 regional stations of NBPGR spread across the varied agro-ecological zones. Realizing the importance of the PGR wealth of Western Ghats and the West Coast, the ICAR has established a Regional Station of the ICAR- National Bureau of Plant Genetic Resources at the Kerala Agricultural University campus, Thrissur in 1976.

ACHIEVEMENTS

Germplasm provides the raw material for the breeder to develop various crops. Thus, conservation of germplasm assumes significance in all breeding programmes. The very objective of germplasm conservation (or storage) is to preserve the genetic diversity of a particular plant or genetic stock for its use at any time in future. The germplasm has to be maintained in such a state that there is minimum risk for its loss There are two main approaches for germplasm conservation: Ex-situ and In-situ.

Since its inception, the station has been actively contributing to the conservation and utilization of crop genetic resources with special emphasis on landraces and wild relatives. From 1978 to 2018, a total of 29,690 accessions were collected in 244 missions from A&N Islands (887 samples), Andhra Pradesh (146), Arunachal Pradesh (60), Assam (203), Goa (237), Gujarat (71), Karnataka (4462), Kerala (14553), Lakshadweep (106), Madhya Pradesh (117), Maharashtra (94), Mizoram (156), Nagaland (177), Puducherry (16), Sikkim (29), Tamil Nadu (8125), Tripura (101), West Bengal (34) and Nepal (105 samples) based on the crop priorities fixed from time to time, independently or in collaboration with ICAR/ SAU/ International institutes. Six taxa new to science namely, Abelmoschus enbeepeegearensis, Vigna konkanensis, Momordica sahyadrica, Curcuma karnatakensis, C. kudagensis and Piper velayudhani have been described. New reports of extended distribution of the species *Curcuma albiflora, C. oligantha, Dioscorea piscatorum, Vigna dalzelliana* and *Ziziphus subquenervia* were made from the Western Ghats/ Andaman & Nicobar Islands. A total of 8306 accessions comprising 74 crops and their wild relatives (140 species in 23 genera) and other economic plants (173 species) are maintained (in field gene bank and medium term storage) and 18680 accessions were sent to National Gene Bank for long-term storage. Eight rice landraces of rice from Wayanad district, which survived the recent floods after complete inundation in water for 5-6 days were identified and collected at priority. However, despite this strong ex-situ conservation effort at national level, initiatives to support maintenance of diversity in-situ and mainstreaming crop diversity on-farm in the country are very limited.

Station possesses unique collections of scented rice, saline tolerant Pokkali land races, upland varieties of rice, flood tolerant rice landraces, wild and semi-domesticated bitter gourds, poly-embryonic mango land races, medicinal ash gourd, Chinese spinach, underutilized and potential vegetables namely Momordica cochinchinensis, M. subangulata subsp. renigera and potential condiment cum oil seed trees Malabar tamarind and Kokum, rare and endemic species diversity of A& N Islands to its credit. Efforts were also made to characterize and evaluate germplasm resources to identify promising genotypes to register with ICAR. Based on the evaluation / characterisation of germplasm, eight accessions with unique traits were registered by the Plant Germplasm Registration Committee of ICAR. Twelve field days were conducted in crops and crop wild relatives involving scientists and students from SAUs and ICAR institutes. As a part of PGR awareness generation, four biodiversity fairs including two in tribal areas, five grass-root level trainings including two trainings especially for women farmers were conducted. Three orientation trainings and two general trainings with special emphasis on wild relatives, and awareness training were also conducted for the co-operating centres and SAUs under NATP-PB. PGR conservation awareness was generated among the farming community in Kerala through five grass-root level trainings covering three districts benefiting 372 male and 312 women farmers and among college students through biodiversity fairs and seminars conducted in eight colleges benefiting over 5000 students. As a mechanism to boost on-farm conservation, station conducts diversity appreciation days/farmers day to expose the diversity in landraces of various crops in the experimental farm in full fruiting stage. The farmers were given opportunity to select the germplasm of their choice for specific traits and small quantity seeds of the selected accessions will be supplied to the farmers for cultivation and on-farm maintenance under the monitoring of the scientists of the station. In continuation of various farmers day conducted at this staion, nearly 600 farmers throughout Kerala were supplied seeds/seedlings of non-bitter type of Aloe vera, dwarf Burmese fish tail palm (Caryota mitis) collected from Andaman Islands, Chop-chopa (Garcinia kydia) - a good monsoon season fruit, Sweet gourd (Momordica cochinchinensis) and Teasel gourd (*M. subangulata* subsp. *renigera*) as potential vegetables/ economic plants for food and livelihood security.

Recently, as part of the conservation efforts of agro-biodiversity, a focus has been mainly centered towards conservation of crop wild relatives (CWRs). CWR diversity, like that for many species, is at a declining stage; which is associated with the loss of genetic diversity (Hopkins and Maxted 2010; Ford-Lloyd et al. 2011). Therefore, the need for novel genes for developing climate resilient varieties, increasing pressure on wild species populations and habitats and the present meagre ex situ collections, all accentuate the importance of locating and collecting germplasm of wild relatives. Wild relatives of vegetables have received significant attention for exploration at ICAR-NBPGR, as witnessed by the massive collection of 4,221 acc. of 47 CWRs belonging to 16 crops. CWR genera with the highest number of collections at ICAR-NBPGR include Abelmoschus, Cucumis, Momordica, Solanum, Trichosanthes, Amaranthus, Vigna, Piper, Garcinia and Artocarpus.

WAY FORWARD

Action plans at regional, state and national levels are to be set up for efficient conservation of agro-biodiversity for sustainable development. At the local/ panchayat level, listing of local crops and development of land races catalogues with the active participation of Biodiversity Management Committees (BMCs). The rare and unique/ potential landraces to be identified and group them based on their rarity as common, vulnerable, endangered or extinct. Agro-biodiversity mapping in terms of local names given by farmers can be done. Establishing and strengthening house hold genebanks will be a boost to conservation efforts of Agro-biodiversity. Characterization and naming of available landraces using their specific trait will add value to the germplasm and exclude the duplicates or the ones which are known by different names in different locations. Establishment of herbarium, museum, image banks will provide correct identity to the germplasm. With the identification of diversity-rich spots, availability of location details of intended taxa, India is moving forward in the systematic collecting of CWR from diverse habitats for conservation and sustainable use. Only one third of shortlisted taxa have been assembled by ICAR-NBPGR; among them more than half the taxa with <10 accessions. Analysis of gaps in collection in a scientific manner (keeping in view the conserved material, actual variability/ diversity present in habitats, best utilization of GIS tools) through a mission-mode approach is on the way. In addition, detailed studies on habitat ecology, floral biology and breeding system, crossability (with crop), seed dormancy and storage behaviour of species will enable their meaningful conservation and sustainable utilization. Grass root level awareness on role of CWR in crop improvement under changing climatic conditions; and also encouraging their mass planting along roadside, waste and degraded lands, vacant community lands, field boundaries, and even inside the forests affording protection is important. Sensitizing forest officials on the importance of CWR and close collaboration with forestry department and research institutes would pave way for facilitating germplasm collection across the distribution range. Herbaceous wild relatives quite often occupy disturbed, pre-climax communities; this preference had a negative impact as well, in the sense of widespread cleaning/clearing in roadside/ forest edge, use of brush cutter in fields/ borders, besides the necessity to compete with invasive alien weeds. It is essential to undertake a more objective approach on systematic threat assessment using IUCN or national criteria or both, since only scanty information available in the prioritised CWR. Strong networking among all the stakeholders working on characterization, evaluation and conservation is the need of the hour, as it is difficult for a single institute to collect, conserve and evaluate all the target species due to paucity of land, resources and expertise.

VILWADRI CATTLE BREED: AN EPITOME OF BIODIVERSITY CONSERVATION

Gayathri S. L.¹ and Muhammed Asif M²

 ¹M. V. Sc. Scholar, College of Veterinary Sciences and Animal Husbandry, Bhubaneswar Odisha University of Agriculture and Technology, Odisha-751003
 ²M. V. Sc. Scholar, Department of Veterinary and Animal Husbandry Extension, College of Veterinary and Animal Sciences, Mannuthy Kerala Veterinary and Animal Sciences University, Wayanad- 673576 E mail: gayathrisherlylal@gmail

ABSTRACT

Thiruvilwamala is a hilly village famous for its cultural, spiritual and religious leanings throughout the history, located at the northern terrains of Thrissur district, the 'Cultural Capital of Kerala' in southern India. The Vilwadrinatha temple dedicated to Lord Rama, is an icon of Thiruvilwamala, enjoys a unique status in different ways among the ancient sacred temples of Kerala. Located at Vilwamala, beyond the "Eighteen and a half hills", lapped in the luxurious abundance of the beauty of nature and caressed by the lullabies of the famous river Nila the temple is located 47 kilometres towards north-east of the District Headquarters Thrissur.The temple is on the top of a hill 100 ft above the sea level, along the side of Bharathappuzha. It is believed that the bottom of the temple is also a cave, and a golden vilwa tree exists there, and thus the place came to be known as 'Thiruvilwamala'. The Vilwadri cattle breed is being conserved since ancient times in and around the adjoining areas of this temple. This breed is also known as Vilwadrinatha's own cattle. This indigenous native breed is said to have evolved across the 150 acres of rocky mountain areas of Vilwadri near to the hills of Thiruvilwamala and Nila boundaries of Palakkad and Thrissur Districts, and has been preserved by nature since this day.

VILWADRI CATTLE BREED: NATURES HIDDEN TREASURE

The indigenous cattle breed,Vilwadri is unique in its predisposition of having beauty similar to the hilly village of Thiruvilwamala, strength of Vilwadri Rock Mountains and magnificence of river Nila. Owing to the breed similarities with other indigenous cattle varieties such as Vechur, Wayanad Dwarf, Cheruvalli, Kasargod Dwarf, Vadakara, Anangan Mala, Kuttanbhuzha in the aspect of phenotypic characters, milk production, and medicinal properties of milk, theVilwadri breed shows unique features with respect to its origin. The 3 ecological biodiversity of forest, hills and Bharathappuzha sanctified the breed with distinctive physical and behavioural characteristics. Breed shows exclusive potential in its climatic adaptation abilities, disease resistance, physical fitness, reproductive efficiency and life span of more than 40 years. History revealed the presence of 2 or more cows of Vilwadri in each and every the households of Thiruvilwamala village. Also more than 1000s of cattle of this breed occupied the area and the ancestral generation of these breeds have significance similar to theVilwadrinatha temple.



Fig. 1: A Vilwadri cow at Farmers' household

Today, the Vilwadri breed is under the threat of extinction. Only 300 cattle is left in and around the areas of Thiruvilwa mala Gramapanchayath such as Vilwadri, PambadiThiruvilwamala, Ivormadom, Lakkidi, Akkaparambu, Constraints associated with Kuniambulli. Artificial Insemination and distribution of semen among the remote areas, traditional rituals followed by the temple authority in maintaining the bull calves are the major hurdles in this breed conservation. The introduction of crossbred cattle and increased slaughter of these animals for meat enhanced their way to become vulnerable. The intervention of cross bred semen to these indigenous breeds have deteriorated the

quality of these pure breed stock. Though these constraints have reduced their number, but still these population exists in handful pockets among the villages and temple authority. The topmost among them is Ivormadom Korappath Trust headed by Ramesh Korappath who owns 80 cattle of Vilwadri breed.

SAVE VILWADRI BREED

High yielding cross bred cattle population is at risk due to its lowered disease resistance capacity and climatic adaptability. In this context indigenous breeds can be made utilised to overcome these problems related to persisting climatic variations. Along with other indigenous breeds of Kerala, its high time that we have to protect these breeds, genetic potential along with breed propagation. Around 3.5 lakhs has been spent by theThiruvilwamala Gramapanchayath authority during the year 2018 for the preservation



Fig. 2: Vilwadri cattle population grazing near the Nila River

of this breed and the cows were distributed to 14 households. To conduct these kind of activities in an extensive manner, funds and support from the Devasom authorities and Biodiversity board are essential. Farmers involved in native breed farming must be given appreciation. Kerala Veterinary and Animal Sciences University has to take up extensive genetic studies and conservation strategies similar to Vechur model to increase the Vilwadri breed population. Hence forth it's the responsibility of each and every citizens to conserve the biodiversity of ones area for the future generation.

PROTECTION AND CONSERVATION OF AGRO-BIODIVERSITY-STRATEGIES AND PRACTICES

C. R. Elsy, Susan George and R. Athira

IPR Cell- Kerala Agrl. University, ARS, Mannuthy.email : iprcell@kau.in

ABSTRACT

Agro-biodiversity can be defined as the variability of animals, plants and micro organisms that are used directly or indirectly for food and agriculture including crops,livestock,forestry and fisheries (FAO, 1999). It comprises the diversity of genetic resources (varieties, breeds) and species for food,fodder, fibre, fuel and pharmaceuticals. India is rich in agro-biodiversity including land races, traditional cultivars and farmers' varietieswhich are major gene sources in conventional and molecular plant breeding programmes and hence need conservation and protection. In tune to TRIPS Agreement (1994), India enacted 'The Protection of Plant Varieties and Farmers Right (PPV&FR) Act, 2001' to protect the rights of Breeders, Farmers and Researchers. India enacted 'The Geographical Indications of Goods (Registration and Protection) Act, 1999'commonly referred as GI Act to protect the unique products of our country. The present paper highlights the various provisions under PPV&FR Act, (2001), GI Act, (1999) and the activities of IPR Cell-KAU for legal protection of Agro biodiversity, Farmers rights and unique products under these Acts.

PROTECTION OF PLANT VARIETIES AND FARMER'S RIGHTS.

The first initiative to develop Indian legislations on Plant Variety Protection(PVP) occurred in late 1980. The draft bill for PVP was tabled in the LokSabha on 14 December 1999 and(PPV&FR) Act, 2001 and was passed during 2001. The rules were notified on 12 September 2003. The Act came into force in August 2005. During May 2007, the PPV&FR Authority started receiving applications for notified species.

The main objectives of PPV&FR Act are to provide for the establishment of an effective system for protection of plant varieties, to encourage the development of new varieties of plants, to provide for the rights of farmers and plant breeders, to recognize and protect the rights of farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties and to provide the needed incentives and encouragement to protect agro biodiversity and its usage(GOI,2001)

New varieties, extant varieties, essentially derived varieties and farmer's varieties can be registered for protection under the Act. For a variety to be eligible for registration, it must confirm to the criteria of Novelty, Distinctness, Uniformity and Stability. The period of protection is for 15 years in the case of extant varieties and annuals and 18 years in the case of trees and vines. A unique aspect of the Act is that it confers three concurrent

rights to breeders, farmers and researchers. Under this Act, the farmer can save, use, sow,resow, exchange, share and sell farm produce of a protected variety except sale under a commercial marketing arrangement (branded seeds). A farmer who is engaged in the conservation of genetic resources of land races and wild relatives of economic plants and their improvement through selection and preservation shall be entitled for recognition and reward from the National GeneFund (NGF) provided the material so selected and preserved has been used as donor of genes in varieties registerable under the Act. To meet this objective, PPV&FR Authority has established three national awards viz. Plant Genome Savior Farmer Community Award, Plant Genome Savior Farmer Reward and Plant Genome Savior Farmer Recognition. The Act also provides for equitable sharing of the benefits, earned from the new variety with farming or tribal communities that had contributed parental material. Farmers are given opportunity to submit claims for benefit sharing, when their variety is used as parents. The benefit share may be disbursed from NGF to the eligible individual, community or institution.

PROTECTION OF GEOGRAPHICAL INDICATIONS (GIS)

Geographical Indications is a legal tool to protect the unique goods of our country. "Geographical Indications in relation to goods means an indication which defines such goods as agricultural goods, natural goods or manufactured goods as originating or manufactured in the territory of a country or a region or locality in that territory where a given quality, reputation or other characteristics of such goods is essentially attributable to its geographical origin and in case where such goods are manufactured goods, one of the activities of either the production or the processing or preparation of the goods concerned take place in such territory, region or locality as the case may be" (GOI, 2001).In Dec. 1999, Indian Parliament passed the "Geographical Indications of Goods (Registration and Protection) Act, 1999" (GOI, 1999). Agrl.goods registered as GIs in India include Darjeeling tea, Coorg orange, Monsooned Malabar Arabica coffee,Monsooned Malabar Robusta coffee, Feni,Nashik grapes, Mysore betel vine etc. Kerala Agricultural University has facilitated the registration of 8 GI's of Kerala (Table 1).

By registering a GI in India, the rights holder can prevent unauthorized use of the registered GI by others and promote economic prosperity of producers of goods produced in a particular region. Such identification enables the product to gain reputation and goodwill all over the world consequently resulting into premium prices in national and international market. GI Act has provision for protection of an array of products including fruits, vegetables, animals, fish, poultry, coffee, tea, cocoa, tapioca, agricultural, horticultural and forest products and natural plants.GI protection indirectly lead to biodiversity conservation and protection of traditional knowledge.

IPR CELL OF KERALA AGRICULTURAL UNIVERSITY - ACHIEVEMENTS

Realizing the prominence of IPR in Agriculture especially in the back drop of TRIPS Agreement and in accordance with the directives of the Indian Council of Agricultural Research, an IPR Cell was constituted in Kerala Agricultural University (KAU) during 2003 with Hon'ble Vice Chancellor as Chairperson and Director of Research as Co-Chairperson. Dr. C. R. Elsy, Professor, Plant Breeding & Genetics is the Co-ordinator of the Cell with scientists from different faculties as members.

SI. No.	Name of GI	Proprietors(P) /Facilitator(F)				
1	Navara Rice	Navara Rice Farmers Society, Palakkad(P)				
2	Palakkadan Matta Rice	PalakkadanMatta Farmers Producer Company Limited, Palakkad (P)				
3	Malabar Pepper	Spices Board, Ministry of Commerce & Industry(P)				
4	AlleppeyGreen Cardamom	Spices Board, Ministry of Commerce & Industry(P)				
5	Pokkali Rice	1)Kerala Agricultural University(P) 2) Pokkali Land Development Agency, Ernakulam(P)				
6	Vazhakulam Pineapple	1)Kerala Agricultural University(P) 2)Pineapple Farmers Association, Vazhakkalum(P)				
7	Central Travancore Jaggery	 Kerala Agricultural University(P) GurKhandasari Industrial Co-operative Society Ltd., Arumanoor(P) Maddhya Thiruvithamcore Karimpu Vikasana Samithi, Thiruvanvandoor(P) 				
8	Wayanad Jeerakasala Rice	1)Kerala Agricultural University(P) 2)Wayanad Jilla Sugandha Nellulpadaka Karshaka Samithi(P)				
9	Wayanad Gandhakasala Rice	1)Kerala Agricultural University(P) 2)Wayanad Jilla Sugandha Nellulpadaka Karshaka Samithi(P)				
10	Kaipad Rice	Malabar Kaipad Farmers' Society, Kannur(P) Kerala Agricultural University(F)				
11	Chengalikodan, Nendran Banana	Chengalikodan Banana Growers Association, Erumapetty(P) Kerala Agricultural University(F)				
12	Nilambur Teak	Nilambur Teak Heritage Society, Nilambur(P) Kerala Agricultural University(F)				

[Ref: GOI, 2018]

The IPR Cell is aiming for the protection and management of IPR in Agriculture especially in Kerala Agricultural University and in the State, empowerment of faculty members, students and farmers to address IPR issues in their respective areas, organizing awareness programmes and trainings for scientists, students, farmers, traders, media persons, legal experts and other stake holders, protection of Farmers' rights, Breeders' rights, patents, crop varieties, protection of GIs, development of policy guidelines for IPR and Transfer of Technology (ToT) in KAU. The IPR Cell of Kerala Agricultural University is supporting farmers to register traditional varieties to protect their rights over such resources. The Cell is facilitating the farmers to apply for National Plant Genome Saviour Awards instituted by PPV & FR Authority to meet the provisions under PPV & FR Act. Till now 22 farmers/farming communities from Kerala facilitated by IPR Cell of KAU has bagged this prestigious national award and the list is provided in Table 2. IPR Cell received National award during 2016 for nominating maximum farmers to receive Plant Genome Savior Awards/Rewards/Recognitions.

IPR Cell facilitated the registration of 8 unique agrl. products includingPokkali rice, Kaipad rice, WayanadJeerakasala rice, WayanadGandhakasala rice, Vazhakulam Pineapple, Central Travancore Jaggery, ChengalikodanNendran banana, and Nilambur teak(Table 1). The Cell is also facilitating the farmers to participate in Trade melas, Exhibitions etc. for marketing of registered Gls.The Cell received National Intellectual Property (IP) Award, 2018 instituted by Ministry of Commerce and Industry, New Delhi as "Top organization for the facilitation of registration of Geographical Indication (GI) and promotion of registered Gl's in India".

SI. No	YEAR	DETAILS						
Plant	Plant Genome Savior Community Award (Rs.10 lakhs, memento and citation)							
1	2007	Akampadam Chimpachala Padasekara Samithy, Palakkad District, Kerala.						
2	2011	Pokkali Rice Farming Community (Kadamakkudy- VarappuzhaJaivaPokkali ICS), P.O. Kadamakudy, Dist. Ernakulam, Kerala						
3	2012	Rice Farming Communities of Palakkad District, Kerala						
4	2014	Chengalikodan Banana Growers Association, Erumapetty, Thrissur.						
5	2016	Thayannakudy Tribal Settlement, Chinnar, Idukki						
Plant G	Plant Genome Savior Farmer Reward (Rs.1.5 lakhs, memento and citation)							
6	2012	Mr. N. Vasavan, Kannur						
7	2012	Mr. Ciby George Kallingal, Thrissur						
8	2013	Mr. Benny Mathew, Palakkad						
9	2013	Mr. MelethilBeerankutty, Malappuram						
10	2013	Mr. K V Kannan, Kannur						
11	2013	Mr. Mohammed Moopan, Malappuram						
12	2014	Mr. Shaji N M, Wayanad						
13	2015	Mr. T. T. Thomas, Idukki						
14	2015	Mr.Reji Joseph, Palakkad						
15	2016	Mr. P.V. Jose, Thrissur						

	Plant Genome Saviour Farmer Recognition (Rs.1.0 lakh, memento and citation)			
16	2012	Mr. Sajeevan Kavumkara, Kannur		
17	2013	Mr. K Raman, Wayanad		
18	2013	Mr.K.Narendran, Kollam		
19	2013	Mr.P.Krishnan, Palakkad		
20	2014	Mr. Aravind K, Palakkad		
21	2014	Mr. N A Chandran, Thrissur		
22	2016	Mr. K.R. Jayan, Thrissur		

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CIRCUMVENTING THE SHORTFALLS IN AQUATIC BIODIVERSITY DOCUMENTATIONOF KERALA AND PRIORITIZING RESEARCH: THE WAY FORWARD

Biju Kumar A

Department of Aquatic Biology and Fisheries, University of Kerala, Thiruvananthapuram 695581, Kerala e-mail: bijupuzhayoram@gmail.com

ABSTRACT

This paper describes the challenges in aquatic biodiversity documentation and conservation in Kerala and highlights a few case studies and strategies to move forward in better understanding ecosystem services and strategies towards conservation and sustainable management, besides strengthening biodiversity science. The paper highlights the priorities to be set for the aquatic biodiversity documentation at species and ecosystem levels, in the context of threats and conservation demands.

INTRODUCTION

As a maritime state with a unique network of inland ecosystems, Kerala presents an interesting scenario of aquatic biodiversity. In the Kerala part of the Western Ghats Hotspot, a globally important eco-regionharbouring unique freshwater taxa, around 130 species of freshwater-dependent fauna belonging to five taxonomic groups (fish, amphibians,crabs, shrimps and odonates) are endemic, of which 25% have a high risk of extinction. Moreover, more than half of the 130 species are not represented in the current protected area (PA) network, and the distributions of 12 endemic and threatened species (10 fish, one amphibian and one shrimp), of which five are single-locationspecies, also fall wholly outside the PA network (Raghavan et al., 2016). Though our dependence on coastal and marine ecosystems for various ecosystem services is so high, the knowledge base on this sector remains far from complete.

The taxonomic impediment prevailing in other parts of the world is effervescent in India (and Kerala in particular) as many academic and research institutions working on faunal surveys and documentation have lesser number of globally competent taxonomists to carry out extensive surveys and identification, not to speak of infrastructure facilities tosupport such exploratory research in marine ecosystems. As revealed by the analysis of publications on taxonomy from Kerala in the last two decades and analysing the vision documents of research and funding institutions, taxonomy is not projected as a priority item. If at all proposals are placed in paper, no strategies and action plans were suggested to overcomethe taxonomic impediment. Further, human resources in taxonomy for satisfying the ever growing demands from various sectors, including marine

bioprospecting and biotechnology, is abysmally poor even in institutions dedicated to biodiversity documentation. The paper also highlights implications of wrong identification of species and publication of results in predatory journals, adding chaos to the existing taxonomy. Though a few researchers contribute substantially, resulting in the discovery of several new species of aquatic species in the last one decade.

One of the ways to circumvent the taxonomic impediment is topromote co-ordinated taxonomic research involving practicing taxonomists. Further, international collaboration in taxonomy should be promoted to document the diversity of all marine taxa as comprehensive data bases provide platform for advanced research and policy making towards conservation and sustainable utilisation of resources, besides planning effective adaptation and mitigation strategies to face extreme climate events. Developing trained manpower in taxonomy is yet another priority to promote taxonomy, besides reserving positions for taxonomists in all the research institutions and universities to develop globally competent taxonomists from the country. Further, the curricula should be framed in schools and colleges involving taxonomy as a 'joyful' activity rather than a'cumbersome' task, with more field oriented activities.

While analysing the recent biodiversity research in Kerala, the major lacuna is the lack of a good quality updated data base in the public domain. The available checklists including that of the species in various schedules of Wildlife (Protection) Act of India document the synonyms and are not taxonomically validated, further contributing to the chaos in taxonomy. As a foundation element of biology, it is imperative that taxonomy is practised in a highly professional manner, as dubious taxonomy destabilizes the foundation of science, with potentially serious set back in basic and applied research, and therefore publications in predatory journals hamper development of taxonomy in India (Rajeev et al., 2014). Therefore, publications that appear inpredatory journals, without even mentioning anything on voucher specimens and accession numbers would not support taxonomic research. The existing databases have to be strengthened by validating species identity of all the collections by the research vessels of various organisations in India. Good quality handbooks and field guides of various aquatic taxa formanother requirement for strengthening biodiversity research in Kerala.

The ecosystem based studies are primarily limited towards documenting species, that too towards specific taxa. Extensivesurveys are required along continental shelves, sea mounts and deep seas (depth more than 200m) along Kerala coast. Ecosystem-based in-depth surveys are required todocument species diversity of wetlands, rocky reefs, coral patches, mud flats, sandy beaches, estuaries and backwaters, intertidal and subtidal ecosystems. Considering the discovery of bizarre and evolutionarily interesting species from the subterranean ecosystems of Kerala, subterranean biodiversity and ecology may be given special attention. Identification and documentation of lesser known freshwater (eg: phytoplankton, microalgae, periphyton, sponges, aquatic insects, freshwater molluscs) and marine (all lower phyla, specifically in the intertidal and rocky beaches, species in

deeper waters) taxa remains another task to achieve. Specific taxon based studies are also required to preparecomprehensive data bases and involving citizen scientists in this process would help speed up documentation. Species categorised as 'taxon inquirendum (name which is listedfrom a literature source, but has not been recently re-evaluated for taxonomicvalidity and/or generic or familial placement) and 'nomendubium (namewhich resists revision because the description and other supporting data aredeficient) also require priority attention by taxonomists. Further, stockassessments and ecosystem based studies are required for species included inRedlist of IUCN and in various schedules of Wildlife (Protection) Act of India.In the era where consumptive and non-consumptive values of taxa are held with much esteems, the services of taxonomists are all the moreimportant not only to confirm identification of species involved in variouseconomic benefits but also for preparing policy documents for conservationand sustainable use of molluscan resources.

'Integrative taxonomy' is defined as the science that aims to delimit the unitsof life's diversity from multiple and complementary perspectives(phylogeography, comparative morphology, population genetics, ecology,development, behaviour, etc.) (Dayrat, 2005). Molecular analyses play a veryimportant role in elucidating extent, origin and history of aquatic biodiversity, and molecular techniques provide adequate information regarding thephylogenetic relationships and divergence times of evolutionary lineages andclades. Understanding the distribution and origin of diversity in the Western Ghats biodiversity hotspot and in largermarine ecosystems, especially Indo-Pacific is a fundamental problem in biogeography.Further, molecular studies would also facilitate identification of crypticspecies and speed up the process of biodiversity documentation. There is a need todevelop specific course content focusing on 'integrative taxonomy' that needsto be taught first before training in systematics (Pisupati, 2015).

Making taxonomy a combined study and science that brings on board non-experts and nonbiologists to support identification of species as a hobby, passion and love for nature with support coming from trained scientists (Pisupati, 2015). In Kerala the possibility of involving citizen scientists and civilsociety in biodiversity documentation were not fully explored, thoughopportunities for such an exercise are awesome. Long term biodiversitymonitoring studies and preparation of inventories can be tried by expanding the network of local communities and civil societies. The scope of the Biodiversity Management Committees (BMCs) at the local level can be broadened with the inclusion of people interested in natural history studies in order to develop Biodiversity Monitoring Groups and Biodiversity Armies at panchayath level and this group can serve as parataxonomists to assist the state biodiversity board to achieve future goals such as preparation of biodiversity management and action plans at the grass roots. There is also a need to validate and update the species documentation in all the people's biodiversity registers and make it into a dynamic system, with frequent updating, specifically on the status of the species and ecosystem in addition to their commercial use. The depositions in the natural history museums and repositories reveal thegreat natural history and biodiversity of the nation and a source material forthe taxonomists and biotechnologists to pursue their research. It alsoprovides identification services on natural objects and rich fauna, flora and minerals resources to user groups. The priority therefore should be to prepare a database of type materials available in each of the repository and to simplify the procedure for sharing the data to practicing taxonomists/biodiversity experts. All the repositories should go for rampant modernisation, with thehelp of latest science and technology inputs. For examples, leading museumsall over the world are in the process of digitisation of collections, which hasnot been done by national repositories in India. The digitisation include taking photographs of the type specimens and preparing 3D images of the specimens using modern software, preparing DNA fingerprints of typespecimens (as technology is now available for preparing DNA barcodes fromformalin-preserved specimens) and preparing collections details and maps inGIS platform. The preparation of DNA barcodes has implications for upstream sample collection and preservation methods, as well asdownstream implications for highlighting biorepository specimens availablefor genetic and genomic research (Hanner and Gregory, 2007).

Despite their high diversity and importance for humankind aquatic biodiversity is not given due priority by researchers in Kerala, as reflected in the lesser number of practicing taxonomists involved in the process. This situation canbe improved only by taking concerted efforts in the following key areas: (i) aquatic biodiversity and their critical ecosystem roles should be brought to the attention general public in order to remove the public dilemma in this subject; (ii)policymakers and stakeholders are mostly unaware of conservation problems involving aquatic organisms and betterment of this political dilemma can bedone only by involving them in conservation thinking through practical examples of social and economic benefits arising out of aquatic biodiversity;(iii) biodiversity studies, especially those involving economically 'insignificant' invertebrate taxa are underfunded and betterfunding options should be provided to the taxonomists to complete theinventory of each taxa in every aquatic ecosystem of Kerala.

As suggested by Cardoso et al. (2011) this is all the more important since most species are undescribed (the Linnean shortfall), the distribution of described species is mostly unknown (the Wallacean shortfall), the abundance of species and their changes in space and time are unknown (the Prestonian shortfall) and species ways of life and sensitivities to habitat change are largely unknown (the Hutchinsonian shortfall); and (iv) thinking beyond achieving biodiversity targets fixed by the United Nations Convention on BiologicalDiversity through Aichi Targets 2020, government should plan urgent strategies and action plans to prepare a biodiversity data portal in the public domain, publish high quality field guides and monographs on aquatic taxa, train a set of internationally competent taxonomists to cater to the future demands in biodiversity science, ensuring positions for taxonomists in each research institution involved in ecology studies, nurturing young generation of taxonomists through appropriate revisions in curricula, and involving citizen scientists and local communities in biodiversitydocumentation process.

ECORESTORATION AND BIODIVERSITY CONSERVATION OF RIPARIAN FORESTS ALONG THE CHALAKKUDY RIVER, SOUTHERN WESTERN GHATS

Amitha Bachan K.H¹ and Pooja Suresh²

¹ Assi. Prof & Research Guide, Research Department of Botany MES Asmabi College & Founder member Western Ghats Hornbill Foundation

² PhD Fellow, Research Department of Botany MES Asmabi College

ABSTRACT

This article elucidates the studies and conservation intervention on the Riparian Forests and vegetation along the Chalakkudy River in the Anamalai part of Southern Western Ghats as a pioneering work in India. A methodology developed through the process has been used for understanding heterogenic community composition along bioclimatic gradient useful for classification and ecorestoration. The methodology has application in other forest and wetland ecosystems and is being applied in collaboration with various state agencies including Kerala State Landuse Board, Kerala Forest Department and Kerala State Biodiversity Board. The ecorestoration protocol prepared in detail for Chalakkudy River has been added to the working plan of the Forest Department in the Vazhachal Forest Division.

INTRODUCTION

Chalakkudy River is the fifth longest and most fish diverse river in Kerala (NBFGR, 2000). The river is originating from the Anamalai landscape unit of southern Western Ghats covering Nelliyampathy, Parambikulam valley, Valparai- Malkkaparaiplatue, Sholayar valley and Vazhachal- Athirappilly forests. The rich fish diversity in the river is a reflection of availability of different bioclimatic regimes (Dry Deciduous, Moist Deciduous, Wet Evergreen, Evergreen, Dry Evergreen, Semi evergreen, Low elevation evergreen) and availability of river stretches in 6-7 altitudinal planes with good amount of Riparian vegetation and riverine micro habitat (Bachan et al., 2014).

The catchment forests of Chalakkudy River within the Anamalis considered as one of the hottest hotspot (Nayar, 1996; Bawaet al., 2007) in terms of biodiversity with in the Western Ghats Sri Lanka biodiversity hotspot. The riparian forest along the river is very unique in its structure and floristic composition with good number of endemic and threatened flora and fauna (Bachan and Pradeep, 2015) the low elevation evergreen riparian forests in the Vazhachal - Athirappilly region (50-350m Elevation) has been recognised as unique ecosystem because of unavailability of similar vegetation across the Western Ghats (Bachan, 2010; Bachan and Pradeep, 2015). The presence of true evergreen flora, nesting of three Hornbills especially Great hornbills, Malabar Pied Hornbills and many endemic and endangered flora and fauna indicates its biological significance.

CONSERVATION PRIORITIES AND BEST PRACTICES

The studies on biodiversity and conservation significance of Riparian forests across Chalakkudy River and major initiatives on conservation and Ecorestoration has reflections in four different aspects a. Uniqueness of the vegetation and its biodiversity significance, b. Pioneer effort in India to understand the community structure and composition of riparian forests in relation with bioclimate and its classification, c. The methodology to understand heterogenic community structure of vegetation across a landscape cutting across the conventional methodologies used in our region and d. Methodological and practical inputs to prioritise Ecorestoration areas and selection of species corresponding to the bioclimate and succession or degradation stages.

a. Pioneering the studies on riparian vegetation revealing the conservation significance

The first attempt to understand and map the composition of low elevation riparian forests along Chalakkudy river especially downstream to the Vazhachal – Athirapilly region done in 2001-2003 period (Bachan, 2003) which revealed good amount of riparian vegetation in the very lower elevations 220m to 50m MSL (Vazhachal to Thumburmuzhy) including islands with evergreen forest composition. The detailed report was published (Bachan, 2003; Bachan, 2005). This could be useful for BMC in the Grama Panchayaths along the Chalakkudy river as a guideline for the restoration of riparian vegetation and river banks.

The riparian vegetation along various gradients account for the high fish diversity, endemic flora, endemic fauna and many unique features contributing to the Biodiversity significance of the region. Sympatric nesting of three important Hornbills Great Hornbill, Malabar Pied Hornbills and Malabar Grey Hornbills where recorded from Vazhachal were with the Great hornbill nest at 180 m on an endangered tree *Kingiodendron pinnatum*. The Malabar Pied Hornbills is confined to low elevation forests and now reported only from Vazhachal-Athirapilly riparian forests along Chalakkudy River and Aralam Wildlife Sanctuary in Kerala part of Western Ghats (Bachan 2003, Bachan 2006, Bachan et al., 2011).

The riparian and streamside vegetation along the Chalakkudy River contains 70% of the total flora in the region including 80% of the endemics and 75% of the endangered and threatened species (Bachan 2010, Bachan and Pradeep 2015). The endangered Cochin Forest Cane Turtle (*Vijayachelious sylvatica*), Purple Frog (*Nasutabatrachus sahyadrica*), Lion Tailed Macaques (*Macaca silinus*), King Cobra (*Ophiophagus hannah*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Slender Ioris (*Loris malabaricus*) etc have been reported from the riparian forests at Vazhachal (Bachan et al., 2018). The river recorded highest diversity of fresh water fishes and the Orukombankooty, Vazhachal, Athirapilly are important regions (Ajithkumaret al., 1999; Raghavanet al., 2008).

b. Understanding the Community Composition and Classification of the riparian vegetation

The heterogenic community composition of the riparian forests correlating with bioclimate was identified for the first time in India and Western Ghats region (Bachan 2003, 2010). The entire river basin was mapped and rainfall and temperature data pooled for more than 20 years to reveal the different bioclimate existing in the river basin following the methods provided by Mehr-Homji (2001). Five different bioclimates were identified from the region (Bachan et al., 2014). Champion and Seth (1968) in their revised classification of the forests types in India mention riparian vegetation only in the dry deciduous regions in the Deccan region and the next comprehensive attempt (Bachan, 2010) classifies nearly 24 sub types in four major forest types for the riparian forests (Bachan and Pradeep, 2010, 2015). This has made a bench mark information to understand the riparian vegetation across the Western Ghats region and progressive efforts are ongoing adding to the information. The studies and methodology on riparian vegetation is being used in the assessment of flood impact on Riparian forests along four major rivers in Kerala including Chalakkudy by Kerala State Biodiversity Board.

c. The methodology to understand heterogenic community structure of vegetation across a landscape cutting across the conventional methodologies used in our region.

A new methodology to understand heterogenic composition as well as succession stages or degradation types was developed and applied in the study of riparian forests in the Chalakkudy river basin of the Anamalai landscape unit (Bachan, 2010). The conventional method of pooling phytosociological data across a landscape based on altitude or administrative boundaries resulting in masking of subdominant communities or degradation stages with dominant community composition was modified to reveal the heterogenic diverse community composition (Bachan and Pradeep, 2010). All the enumerated phytosociological data were segregated with the heterogenic species composition. This methodology was used by Kerala State Land use Board (KSLUB) in the preparation of Ecorestoration protocol in the Kurumali river basin (Nizammudeenet al., 2018). Also enumeration of natural forest in the preparation of working plan Vazhachal Forest Division. A standardised methodology for collection of bench mark data, understanding heterogenic community composition and succession or degradation stages and a guideline to prioritise species for Ecorestoration has been developed for practical application. (Bachan, 2018).

d. Methodological and practical inputs to prioritise Ecorestoration areas and selection of species corresponding to the Bioclimate and succession or degradation stages.

Heterogenic riparian community composition enumerated from Chalakkudy river basin were ranked for its succession or degradation stages using the methodology developed (Bachan, 2018). A detailed ecorestoration plan including species composition representing each successional or degradation stages were prepared and a chart to prioritise species for Ecorestoration developed as a comprehensive site specific plan for long term monitoring and Ecorestoration of riparian forests of Chalakkudy river basin within the administrative boundary of Vazhachal forest division. This was added to the newly prepared working plan of Vazhachal forest division. A detailed guide line on monitoring and Ecorestoration of riparian forests including the Ecorestoration methodology is being published for the use of academicians as well as general public.

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IMPACT OF FLOOD ON THREATENED PLANTS IN KERALA STATE: HUMBOLDTIA BOURDILLONII- A CASE STUDY

Anoop P. Balan¹ and A.J. Robi²

¹Malabar Botanical Garden and Institute for Plant Sciences, GA College P.O., Kozhikode, Kerala-673 014, India; E-mail: anooppb01@gmail.com ²Department of Botany, Bishop Abraham Memorial College, Thuruthicad, Pathanamthitta, Kerala-689 597, India

ABSTRACT

Endemic and threatened plants confined to the state of Kerala should be the prime concern while planning the biodiversity conservation strategies in post flood scenario. About 260-300 plants are exclusively endemic to our state and majority are restricted to their type localities. A single threatening event like a landslide can wipe out the entire taxon from the surface of the earth. Hence, immediate action is needed to access the present status of plants which are exclusively endemic to the state through extensive field surveys of expert teams.

INTRODUCTION

Kerala, one of the smallest states in the country, with varied topographic features, warm humid climate coupled with a network of perennial water resources has given rise to a flora of great diversity which is exceptional because of the presence of high endemism. The state is situated on the south-west corner of the Indian Peninsula, bounded on the north by Karnataka, south by Tamil Nadu, east by the Western Ghats and west by the Arabian Sea. The Western Ghats, one of the biodiversity hotspots in India, run all along the eastern border of the state is the major reason for the high endemism in the region. As per the enumeration of Sasidharan (2004) there are 4679 taxa of flowering plants in Kerala, out of which 1637 species are Indian endemics of which 263 are exclusively endemic to the state.

The unique feature of the state is the presence of 44 rivers, their innumerable tributaries and several streams forming a network of river system. The state receives the maximum rainfall during the south west monsoon from June to September. The average annual rainfall in the state varies from 101 to 362 cm. However, in August 2018, Kerala received the highest rainfall after 1924, which was about 75% more than the usual rain fall in the state. The extra ordinary rainfall resulted severe flood in midlands and lowlands and landslides in highlands across the state. The worst flood in Kerala in nearly a century drastically affected millions of people, wildlife and livestock.



Kerala, before (left) and after (Right) the floods, released by NASA, United States

POSITIVE AND NEGATIVE IMPACTS OF FLOOD

Flooding can have a variety of direct impacts on the environment and ecosystems contained within a flooded region. Some of these impacts are positive. Flooding is a natural ecological process that plays an integral role in ensuring biological productivity and diversity in the flood plain. Flood is responsible for creating different site conditions and soil formations, preferred by different types of vegetation. If a flood is large enough, it can result in a loss of wildlife and biodiversity in the flooded region. This may reduce the level of biodiversity, habitat potential and food present in the ecosystem, creating long-term impacts for surviving wildlife. Similarly, landslides are also destructive and can have long-lasting effects on the environment. Landslides can even pollute streams and water bodies with excess sediment.

IMPACT ON THREATENED FLORA

The major victims of flood and landslides in highlands are endemic plants which are restricted to certain pockets of Western Ghats in the boundary of Kerala state. *Humboldtia bourdilloni* Prain (Adimundan in Malayalam), an endangered legume tree species is a living victim of the heavy flood and landslide that occurred in Kerala state during the month of August 2018. This tree species is thought to be endemic to tropical wet evergreen forest in the Arjunan Kotta and Poonkavanam area of Periyar Tiger Reserve. The plant was described by Sir David Prain based on the collections of T.F. Bourdillon, from the Peermade

plateau of southern Western Ghats in Kerala state in 1894 with no further information on the species thereafter. Nearly after 100 years, Sasidharan (1998) relocated the species from the Periyar Tiger Reserve, (Peermade plateau, Idukki Dt., Kerala). The species has a discrete distribution, found in few patches, with an area of occurrence of approximately 2 km² with about 1000-1200 mature individuals. In June 2018, we could locate a declining population of H. bourdilloni from the Vagamon hills of Kottayam district, Kerala, about 100 km away from its type locality. It is the very first report of this species from other than the type locality after the rediscovery of the species.



Location of Humboldtia bourdillonii Prain, before (Left) and after (Right) the landslide

The trees were growing in flood area of streams, as well as areas between streamlets, 10 - 50 m away from the water course preferring high slope. The population of H. bourdillonii is extremely small with 8 mature individuals and 20-25 sub-adults and saplings. The plants were confined to an area of < 0.4 sq. km in steep hill slope in the side of a stream. The mature trees were in fruiting stage. In October 2018 the authors made a revisit to the said locality, but failed to relocate the early said population, since the entire patch was washed away in a severe landslide occurred during the time of heavy flood in Kerala in August 2018. After extensive surveys in the adjacent areas we could locate 5 sub-adult trees which are also under threat due to human encroachments. As the numbers of individuals are very limited with poor regeneration, all the sub-adults and saplings of H. bourdillonii in the said locality should be preserved immediately.

CONSERVATION PRIORITIES

Endemic and threatened plants confined to the state of Kerala should be the prime concern while planning the biodiversity conservation strategies in post flood scenario. About 260-300 plants are exclusively endemic to our state and majority are restricted to their type localities. A single threatening event like a landslide can wipe out the entire taxon from the surface of the earth. Hence, immediate action is needed to access the present status of plants which are exclusively endemic to the state through extensive field surveys of expert teams. Endemic and threatened plants found to be affected by the flood should be immediately identified and should be conserved in-situ or ex-situ through botanic gardens and conservatories. Survived individuals should be multiplied maximum in the nurseries and should be reintroduced into their original localities as far as possible.

AN ACTION PLAN TO MITIGATE THE IMPACTS OF CLIMATE CHANGE ON THE NATIVE BIOTA OF KERALA (INDIA): A PROPOSAL WITH SPECIAL REFERENCE TO BUTTERFLIES

George Mathew¹ & Elizabeth Varghese²

¹Formerly, KFRI, Peechi; ²Formerly, UAS, Bangalore

ABSTRACT

This paper summarizes information on the impact of climate change on butterflies and possible mitigation measures. Development of a database of butterflies with details of habitat preferences, host associations, natural mortality factors and responses to various environmental conditions; 2) preparation of a Climate Change Indicator for butterflies and, 3) habitat enrichment, are suggested.

INTRODUCTION

The biodiversity that we find on this universe are the results of millions of years of evolution. If we examine the 350 million years' history of life, we can find that new species have evolved in different geological eras and at the same time mass extinctions of species have occurred in various episodes. Climate change (glaciations), volcanic eruptions, continental drift, collision of meteorites etc., are assumed to be the reasons for such large scale extinction of life on earth.

Currently, the earth is passing through another major phase of extinction which is perhaps the biggest challenge ever faced by the universe. Human activities have degraded the quality of the landscape so much so the species and their habitats do not have the capacity to respond to environmental threats-including a climate change. Climate change will affect species' life cycles, flight times, essential interactions, and ultimately survival. Among terrestrial organisms, butterflies respond very quickly to climate change mainly due to their fragile nature and high dependency on vegetation, climate and various other environmental parameters. There are many documented instances of disruption of essential interactions of butterflies with their food plants and the mismatched timing with their caterpillar food plants. Therefore, it is essential that we study the impacts of climate change on local biota and develop appropriate amelioration programmes. For this, we have to incorporate a climate adaptation component in conservation plans either from the early stage or as a later inclusion.

HABITAT PREFERENCES OF BUTTERFLIES

A recent study on the responses of habitat recreation on butterfly population has revealed characteristic habitat preferences for various groups of butterflies (Mathew, 2001). Most

papilionids like Chilasa clytia, Pachliopta pandiyana, Papilio buddha, P. helenus, P. paris, P. polymnestor, and Troides minos prefer habitats with bushy vegetation interspersed with tall trees although some like Pachliopta hector, Papilio demoleus and P. polytes preferred open areas of the garden.

The occurrence of different groups of butterflies was dependent on climatic / environmental conditions. For many butterflies, an average temperature ranging between 25-26°C was the most favourable followed by 23-25°C and 27-29°C. Similarly, atmospheric humidity between 80-100 percent was the most preferred range followed by 60-80 percent. With regard to daily rainfall, 50 mm was the most favourable level followed by 50-100 mm rainfall. Heavy rainfall was found to be unfavourable since very few butterflies were observed above 100 mm of daily rainfall. While butterflies belonging to the families Danaidae, Lycaenidae, Papilionidae and Pieridae showed continuous population trends with resident population in the study area, others of the families Hesperiidae, Nymphalidae and Satyridae showed erratic population trends. Attempts were also made to maintain populations of some species like Euploea core, *Danaus genutia, Parantica aglea* and *Tirumala limniace* in the study area for longer periods especially during the dry season by artificially maintaining higher humidity levels.

Similarly, most butterflies require body temperatures of 30–35°C for optimal growth and development (Porter, 1982; Shreeve, 1992). Butterflies have various mechanisms like sun basking, coloration, body movement etc., to maintain their body temperature at the desired level. Accordingly, butterfly activity is confined to specific times of the day. Observations at Peechi (Kerala) have shown that the pierids Catopsilia spp. and Eurema spp. and the nymphalids *Ariadne merione*, Hypolimnas spp., *Junonia lemonias* and *Moduza procris* are active in bright sunshine; the satyrids *Elymnias caudata* and *Mycalesis anaxias* in the evening and the danaids *Euploea core*, *Danaus genutia*, *Parantica aglea* and *Tirumala limniace* and the *Lycaenids Jamides celeno* and *Talicada nyseus* both in the morning and evening.

EFFECT OF CLIMATE CHANGE ON BUTTERFLY POPULATION

An increase in temperature may trigger various responses in butterflies leading to range expansion of many species at the cool margins of their range, both in latitude and in altitude, and an eventual contraction at the warmer margins (Parmesan et al., 1999; Warren et al., 2001; Parmesan & Yohe, 2003; Wilson et al., 2007). There are several ways in which climate change may affect butterflies (De Vlinderstichting, 2010):

- 1. Direct effects on the physiology: Butterflies and their caterpillars have an optimum temperature range, in which their body processes function best. If the microclimate changes, this will affect their survival and thus their distribution.
- 2. Effects on the abiotic environment: Apart from the direct effect of sea-level rise on coastal areas, the most direct effect of climate change will be on soil systems in terms of organic matter and especially water content. It could lead to drought-periods as well as heavy showers and flooding.

- 3. Climate change has an impact on the vegetation structure: May lead to greater weed / grass growth in warm years.
- 4. Climate change may provide conditions more adapted for some species and less suitable for others: May promote invasive species.
- 5. Larval food plants change their range: Many specialist butterflies depend on one or two species of food plant. If their optimal range doesn't overlap with the new food plant range, this can result in a change in the possible future range of such butterflies. This is demonstrated by Boloria titania and its larval food plant *Polygonum bistorta* (Schweiger et al., 2008). *Boloria titania* is a butterfly depending on its food plant Polygonum bistorta in most of its range. As climate change will affect the ranges of butterfly and food plant, the butterfly can only survive where climate niches of both overlap. This shows that butterflies will respond to climate change differently depending on the species and even with the same species, there may be a difference in their response to climate change depending on the specific location where it is found. Population characteristics and constraints, as well as interactions with biotic and abiotic factors, are expected to be localized and in many instances unique.

HOW TO TACKLE THE ADVERSE EFFECTS OF CLIMATE CHANGE?

There are various ways to tackle the adverse effects of climate change on butterfly population - 1) the first and foremost is developing a database of butterflies with details of habitat preferences, host associations, natural mortality factors and responses to various environmental conditions; 2) preparation of a Climate Change Indicator for butterflies; 3) habitat enrichment. Brief accounts of the various steps are given below.

1. PREPARATION OF A BUTTERFLY DATABASE:

Detailed information on the butterflies of any region is necessary for any conservation programme. This can be prepared using data on butterfly community studies from national / state / regional monitoring schemes. Information on species distribution can be generated by transect counts with the help of volunteers along transects scattered widely across the country. These counts have to be made under standardised conditions.

2. PREPARATION OF A BUTTERFLY CLIMATE CHANGE INDICATOR:

With a few exceptions, all butterflies have a distribution pattern which is restricted to a given part of its range. In India, some species are typical of the colder northern and North Eastern regions, whereas others occur primarily in the warm, southern part of our country. The preference of a species for a specific climate can be expressed by the long term average temperature over its range. This is called the Species Temperature Index (STI). In Europe, the STI has been calculated for various species using the European butterfly distribution atlas of Kudrna (2002) and the Climatic Risk Atlas of European Butterflies by Settele et al. (2008). The number of butterflies of each species occurring at a certain site

in a certain year can be described as a community. As each species has its own specific STI (Species Temperature Index), a Community Temperature Index (CTI) can be calculated as the average of each individual's STI present in the assemblage. A high CTI would reflect a large proportion of species with a high STI, i.e., of more high-temperature dwelling species. This way, the CTI can be used to measure local changes in species composition. If climate warming favours species with a high STI, then the CTI should increase locally (Devictor et al., 2008). In Europe, butterfly communities in the northern countries will mainly consist of species preferring cool conditions (and thus having a low STI) and only occasional species with a high STI will occur on those transects.

3. HABITAT ENRICHMENT: BUTTERFLY GARDENING

Habitat enrichment is an essential step to bring back the lost butterflies in our landscapes. Recently there has been a tremendous interest among the public to document and to enrich butterfly population by setting up butterfly gardens and parks. A number of parks have already been established all over the country, in homesteads, premises of resorts and hotels as well as in wildlife sanctuaries and biological parks. Butterfly gardens can be set up in any location by introducing butterfly host plants and by recreating suitable habitats. Generally, locations that are close to natural forests or natural vegetations will attract more number of species compared to urban areas. Similarly, larger gardens are likely to contain more the number of butterflies both of individuals and species.

Citrus, Albizia, Cassia, Cinnamon, Aristolochia, Milk weeds, Tylophora, Wattakakka and Mussaenda are the common larval host plants that can be introduced for attracting various butterflies found in Kerala. Ixora, Lantana, Mussaenda, Marigold, Cuphea, Zinnia and Clerodendron are some common nectar plants favoured by many species of butterflies (*Appendix 1*). Common Mime, Common Rose, Crimson Rose, Lime Butterfly, Blue Mormon, Southern Birdwing, Glassy Blue Tiger, Blue Tiger, dark Blue Tiger, Emigrants and Grass Yellows are some butterflies that can be easily sustained in the butterfly garden. As the butterfly population increases, a variety of organisms including Praying mantis, spider lizards and birds also colonise the area leading to a stabilization of habitats and bette functioning of ecosystems.

Similarly, butterflies require specific eco-climatic conditions. Habitats having brigh sunshine, shade, bushes, streams and ponds, lianas and tall trees are preferred by specif groups of butterflies. For maintaining appropriate ecoclimatic conditions, it is essential t set up ponds, waterfalls, streams, bushes, openings etc., in the garden area. Informatio boards as well as models depicting butterfly life can be set up in the garden for providin information on the life of butterflies.

Since most of the butterfly host plants are confined to natural patches of vegetation, is important to conserve such types of vegetation which is usually found along road rivers and open landscapes. As we conserve these habitats, we are indirectly conservin a variety of native plants and animals as well.

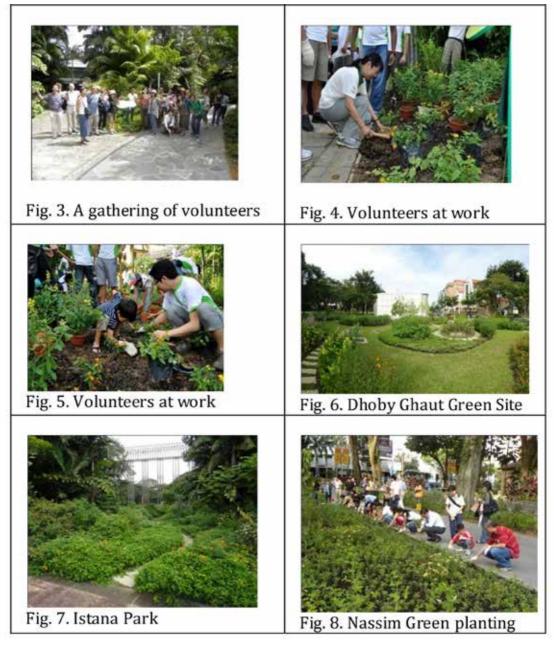
Current initiatives in butterfly gardening in other countries

The scope of incorporating butterfly garden themes for enhancement of green landscapes is well recognized and many countries such as Singapore, Britain and Brazil have made several trials in this context. In all these countries, butterfly gardens occupy a significant proportion of the urban areas. For instance, in Singapore, a 4 km long urban trail has been created along the Orchard road around the city shopping and business centre.

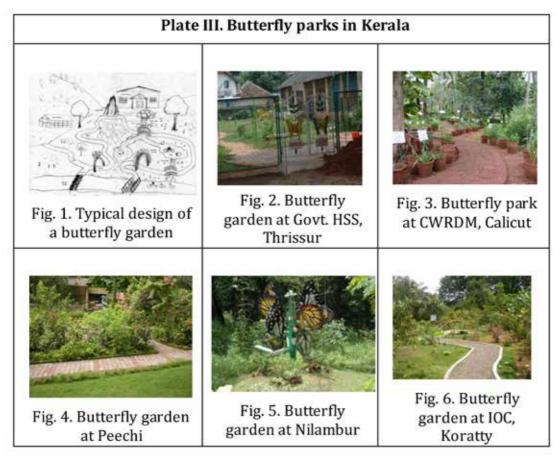
The trail is linked with 8 public places covering an area of 0.92 ha in which the butterfly host plants were introduced from Jun. 2010 to Nov. 2011 (Plate 1, Figs. 1-8). A citizen science approach was used in monitoring and data collection. In the census carried out in Apr. 2012, 60 species of butterflies were recorded compared to the base data of 28 species. This included 23 uncommon species and 6 species that are urban avoiders. These results indicate the potential of urban spaces in enhancing butterfly populations of conservation concern (Anuj Jain, 2012).

In the UK, gardens comprise approximately 19–27% of land use (Smith et al., 2005), and constitute a significant area of extensive interconnected green space (Mathieu et al., 2007) although there is very little information about their landscape or ecological roles (Smith et al., 2006; Chamberlain et al., 2004; Owen, 1991). Studies in a Wolverhampton garden demonstrate that majority of butterflies use these spaces as movement routes through the urban matrix (Plate II, Figs. 1-2). Of the 516 observed individual visits by butterflies over three recording seasons (2000–2002), only 13.8% involved a stop for some purpose. The duration of these visits was characteristically short, with a mean visit time of nine seconds. Individuals tended to fly through the garden using distinct entry and exit points largely dictated by variations in structure within the study garden and in the immediately surrounding gardens. Individual garden use by butterflies would therefore seem to be defined as much by structural imperatives as by availability of nectar or food-plant





species (Christopher Young, 2008). When considered as systems of interconnected green spaces on the level of the housing block (defined as a continuous area of residential land use bounded by infrastructure or contrasting land uses) and of the urban area as a whole, residential gardens represent an extraordinarily valuable and dynamic component of the urban habitat. Although schemes such as the UK Annual Butterfly Conservation Garden Survey use data from amateur recorders to monitor gross nationwide trends in species, no survey has explicitly investigated the mobility or duration of stay of butterflies in gardens. There appears to be a dearth of published work on this aspect (Vickery, 1995).



CONCLUSIONS

The overall impact of climate change on butterflies will be a new balance of gains and losses: species will tend to expand their range at the cold edge of their distribution, and loose populations at the southern edge or the warmer regions (Parmesan et al., 1999). In other words, as numbers are expected to rise in the colder part of their range, they are predicted to decline in their warmer part. Mountain species will be forced uphill, with the risk of local extinction after the summit is reached. In some cases, global warming might also have a positive effect on the survival of a butterfly species. This could be a positive factor in overcoming habitat fragmentation and the ability of the species to persist under new conditions.

In the past, when sufficient land was available and large areas were covered with natural vegetation, there was rich biodiversity and there was no concern about biodiversity loss. However, with the growth in human population, these areas were converted for various purposes which adversely affected the natural ecosystems and biodiversity. Establishment of butterfly gardens have been proposed as a useful measure for extending green spaces and for conserving biodiversity. Studies demonstrate that roadsides planted with native plants support more butterflies and bees than do roadsides dominated by invasive weeds. With millions of acres of land on roadsides, managing roadsides with butterflies could have a significant impact on biodiversity conservation (Jennifer L. Hopwood, 2013).

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	Appendix 1. A list of larval food plants of butterflies				
No.	Scientific name	Common name	Host plant		
	PAPILIONIDAE				
1.	Troides minos	Southern Birdwing	Aristolochia indica, Aristolochia tagala, Thottea siliquosa		
2.	Atrophaneura (Pachliopta) aristolochiae	Common Rose	Aristolochia indica, Aristolochia , bracteolata		
3.	Atrophaneura (Pachliopta) hector	Crimson Rose	Aristolochia indica, Thottea siliquosa		
4.	Graphium sarpedon	Common Bluebottle	Polyalthia longifolia, Persea macrantha, Alseodaphne semicarpifolia, Cinnamomum camphora, C. malabathrum, C. macrocarpum, Litsea chinensis, Miliusa tomentosa		
5.	Graphium doson	Common Jay	Polyalthia longifolia, Miliusa tomentosa, Cinnamomum macrocarpum, C. malabathrum, Michelia champaca, Annona lawii, Magnolia grandiflora		
6.	Graphium agamemnon	Tailed Jay	Polyalthia longifolia, Uvaria narum,Michelia champaca, Artabotrys hexap etalus, Polyalthia cerasoides, Annona reticulata, Annona squamosa, Annona muricata, Cinnamomum spp.		
7.	Graphium antiphates	Fivebar Swordtail	Annona elegans, Annona lawii, Annona zeylanica, Miliusa sp.,Uvaria sp.		
8.	Papilio clytia	Common Mime	Cinnamomum zeylanicum, Cinnamomum camphora, Cinnamomum macrocarpum, Litsea chinensis, Persea macrantha, Alseodaphne semicarpifolia		
9.	Papilio demoleus	Lime butterfly	Aegle marmelos, Glycosmis arborea, Murraya koenigii, Ruta graveolens, Chloroxylon, Swietenia, Citrus spp.		
10.	Papilio polytes	Common Mormon	Atalantia racemosa, Aegle marmelos, Glycosmis arborea, Murraya koenigii, Zanthoxylum rhetsa, Citrus spp. Triphasia spp.		
11.	Papilio polymnestor	Blue Mormon	Glycosmis arborea, Atalantia racemosa, Atalantia wightii, Paramigyna monophylla, Citrus spp.		

12.	Papilio helenus	Red Helen	Zanthoxylum rhesta, Toddalia asiatica, Evodia roxburghiana, Clausena heptaphylla, Citrus lemon, Phellodendron sp.	
13.	Papilio liomedon	Malabar Banded Swallowtail	Evodia roxburghiana, Acronychia pedunculata	
14.	Papilio dravidarum	Malabar Raven	Glycosmis arborea	
15.	Papilio paris	Paris Peacock	Evodia roxburghiana, Toddalia asiatica, Zanthoxylum ovalifolium, Citrus spp.	
	PIERIDAE			
16.	Catopsilia pomona	Lemon Emigrant / Common Emigrant	Bauhinia racemosa, Butea monosperma, Cassia fistula, Cassia tora, Cassia siamea, Cassia alata	
17.	Catopsilia pyranthe	Mottled Emigrant	Cassia fistula, Cassia alata, Cassia tora, Cassia occidentalis, Cassia auriculata, Cassia siamea, Gnidia glauca, Sesbania grandiflora, Sesbania bispinosa	
18.	Eurema hecabe	Common Grass Yellow	Cassia fistula, Cassia tora, Albizzia spp., Moullava spicata, Cassia alata, Cassia sophera, Cassia mimosoides	
19.	Delias eucharis	Common Jezebel	Dendrophthoe falcata, Helianthes elastica, Scurrula parasitica, Viscum spp.	
20.	Leptosia nina	Psyche	Cleome rutidosperma, Cleome viscosa, Capparis spinosa, Capparis zeylanica, Crateva adansonii,Capparis rheedii	
21.	Prioneris sita	Painted Sawtooth	Capparis zeylanica, Capparis tenera	
22.	Cepora nerissa	Common Gull	Capparis decidua, C. sepiaria, C. rheedii, C. zeylanica, Cadaba fruticosa, Maerua oblongifolia	
23.	Cepora nadina	Lesser Gull	Capparis moonii, C. cleghornii, C. rheedii, C. roxburghii	
24.	Anaphaeis aurota	Caper White / Pioneer	Cadaba fruticosa, Capparis spinosa, C. sepiaria, C. zeylanica, C. decidua, C. rheedii, C. pyrifolia, Maerua oblongifolia	
25.	Appias indra	Plain Puffin	Drypetes oblongifolia, Drypetes roxburghii	
26.	Appias lyncida	Chocolate Albatross	Crateva adansonii, Capparis cleghornii	
27.	Appias albina	Common Albatross	Drypetes oblongifolia, D. roxburghii, Drypetes venusta	

57.	Moduza procris	Commander	Cadaba fruticosa, Mitragyna parvifolia, Mussaenda frondosa, Neolamarckia cadamba,Ochreinauclea missionis, Wendlandia thyrsoidea, W. exserta, Hedyotis orixense	
58.	Parthenos sylvia	Clipper	Adenia hondala, Tinospora cordifolia	
59.	Tanaecia lepidea	Grey Count	Careya arborea, Melastoma malabathricum	
60.	Euthalia aconthea	Common Baron	Mangifera indica, Anacardium occidentale	
61.	Byblia ilithyia	Joker	Tragia plukenetii	
62.	Ariadne merione	Common Castor	Ricinus communis, Tragia involucrate, T. Plukenetii	
63.	Ariadne ariadne	Angled Castor	Ricinus communis, Tragia involucrate, T. plukenetii	
64.	Libythea lepita	Common Beak		
65.	Junonia hierta	Yellow Pansy	Hygrophila auriculata, Barleria spp.	
66.	Junonia orithya	Blue Pansy	Hygrophila auriculata, Lepidagathis prostrata, L. keralensis, Justicia neesii, J.procumbens	
67.	Junonia lemonias	Lemon Pansy	Corchorus capsularis, Hygrophila auriculata, Sida rhombifolia, Cannabis sativa, Barleria spp., Nelsonia canescens	
68.	Junonia almana	Peacock Pansy	Hygrophila auriculata, Phyla nodiflora, Barleria sp., Acanthus sp., Gloxinia sp.	
69.	Junonia atlites	Grey Pansy	Hygrophila auriculata, Barleria spp.	
70.	Junonia iphita	Chocolate Pansy	Hygrophila auriculata, Carvia callosa, Justicia neesii	
71.	Vanessa indica	Indian Red Admiral	Girardinia diversifolia, Urtica spp.	
72.	Kaniska canace	Blue Admiral	Smilax sp., Dioscorea sp.	
73.	Cynthia cardui	Painted Lady	Artemissia spp., Blumea spp., Debregeasia bicolor	
74.	Hypolimnas bolina	Great Egg fly	Laportea interrupta, Portulaca oleracea, Sida rhombifolia	
75.	Hypolimnas misippus	Danaid Egg fly	Portulaca oleracea, Abutilon sp., Abelmoschus sp., Asystasia lawiana, Barleria cristata, Hibiscus spp.	
76.	Kallima horsfieldi	Blue Oak leaf	Carvia callosa, Strobilanthes callosus, Lepidagathis cuspidata	

77.	Cyrestis thyodamas	Common Map	Ficus spp.	
78.	Parantica aglea	Glassy Blue Tiger	Calotropis gigantea Cryptolepis buchananii, Tylophora indica, T. tenuis, Ceropegia oculata, C. bulbosa, C. fantastica, Ceropegia sp., Vincaefolia sp.	
79.	Tirumala limniace	Blue Tiger	Asclepias curassavica, Calotropis gigantea, Tylophora indica, Wattakaka volubilis, Hoya sp.	
80.	Tirumala septentrionis	Dark Blue Tiger	Wattakaka volubilis, Vallaris heynei	
81.	Danaus chrysippus	Plain Tiger/Common Tiger	Calotropis gigantea, Asclepias curassavica, Cryptolepis buchananii, Frerea indica, Caralluma adscendens	
82.	Danaus genutia	Striped Tiger	Asclepias curassavica, Ceropegia intermedia, C. oculata, C. fantastica, Tylophora tenuis, Stephanotis sp.	
83.	Euploea core	Common Indian Crow	Ficus sp., Hemidesmus indicus, Cryptolepis buchananii, Tylophora indica, Mimusops elengi, Asclepias curassavica, Nerium oleander, N. odorum, Streblus asper, Carissa carandas	
84.	Idea malabarica	Malabar Tree Nymph	Aganosma cymosa, Parsonsia spiralis	
	LYCAENIDAE			
85.	Spalgis epius	Ape Fly	-	
86.	Castalius rosimon	Common Pierrot	Ziziphus mauritiana, Z. rugosa, Z. Xylopyrus	
87.	Caleta caleta	Angled Pierrot	Ziziphus rugosa	
88.	Discolampa ethion	Blue Banded Pierrot	Ziziphus mauritiana, Z. xylopyrus, Z. oenoplia	
89.	Tarucus ananda	Dark Pierrot	Ziziphus xylopyrus, Dendrophthoe fulcata	
90.	Leptotes plinius	Zebra Blue	Albizia lebbeck, Plumbago zeylanica, Indigofera sp., Mimosa sp., Dyerophytum indicum	
91.	Azanus ubaldus	Bright Babul Blue	Acacia nilotica, A. Leucocephala	
92.	Udara akasa	White Hedge Blue		
93.	Actolepis puspa	Common Hedge Blue	Xylia xylocarpa, Schleichera oleosa, Paracalyx scariosa, Hiptage benghalensis, H. madablota, Cratoxylum ligustinum, Cyclista scariosa	
94.	Celestrina lavendularis	Plain Hedge Blue	-	

95.	Pseudozizeeria maha	Pale Grass Blue	Oxalis corniculata, Tephrosia pauciflora, Strobilanthes sp., Nelsonia canescens	
96.	Zizeeria karsandra	Dark grass blue	Amaranthus viridis, Zornia gibbosa	
97.	Zizina otis	Lesser grass blue	Alysicarpus vaginalis, Sesbania bispinosa	
98.	Zizula hylax	Tiny grass blue	Hygrophila auriculata, Lantana camara, Nelsonia canescens, Phaulopsis dorsiflora, Strobilanthes sp., Viola sp.	
99.	Freyeria trochylus	Southern Grass Jewel	Oxalis corniculata, Pisum sativum, Lotus corniculatus,Indigofera sp., Goniogyna hirta, Rhynchosia minima, Vicia sp.	
100	Euchrysops cnejus	Gram Blue	Butea monosperma, Ougeinia oojeinensis, Pisum sativum,Vigna cylindrica, V. trilobata, Paracalyx scariosa, Acacia sp.	
101	Lampides boeticus	Pea Blue	Butea monosperma, Pisum sativum, Vigna sinensis, Crotalaria sp.	
102	Jamides celeno	Common Cerulean	Abrus precatorius, Butea monosperma, Pongamia pinnata, Saraca asoca, Trichilia connaroides, Xylia xylocarpa, Elettaria cardamomum	
103	Jamides bochus	Dark Cerulean	(Butea monosperma) Millettia peguensis,Crotalaria sp., Pongamia pinnata, Tephrosia candidas	
104	Talicada nyseus	Red Pierrot	Kalanchoe pinnata, K. Laciniata	
105	Thaduka multicaudata	Manytailed Oakblue	Trewia nudiflora	
106	Surendra quercetorum	Common Acacia Blue	(Acacia polycantha) Acacia megaladena	
107	Spindasis vulcanus	Common Silverline	Allophylus cobbe, Canthium coromandelicum, Ziziphus mauritiana, Clerodendrum inerme Cadaba fruticosa, C. Indicum	
108	Loxura atymnus	Yamfly	Dioscorea pentaphylla, Smilax sp.	
109	Bindahara phocides	Plane	Salacia sp.	
110	Rathinda amor	Monkey Puzzle	Ixora coccinea, Eugenia zeylanica, Hopea sp., Loranthus sp.	
111	Zesius chrysomallus	Red Spot	Terminalia paniculata, Anacardium occidentale, Psidium guava, Pterocarpus marsupium	

112	Zeltus amasa	Fluffy Tit	-	
113	Rapala manea	Slate Flash	Antidesma acidum, A. ghaesembilla, Camelia sinensis, Quisqualis indica, Ziziphus sp., Acacia pennata, A. torta, A. megaladena	
114	Curetis thetis	Indian Sunbeam	Abrus precatorius, Pongamia pinnata, Derris scandens, Xylia dolabriformes	
	HESPERIIDAE			
115	Hasora taminatus	White – banded Awl	Derris scandens, Pongamia pinnata	
116	Badamia exclamationis	Brown Awl	Terminalia bellerica, Combretum latifolium, C. albidium, Linociera sp.	
117	Celaenorrhinus leucocera	Common Spotted Flat	Carvia callosa, Ecbolium ligustrinum, Eranthemum roseum, Thelepaepale ixiocephala	
118	Tagiades obscurus	Immaculated / Suffused Snow Flat	Dioscorea oppositifolia	
119	Tagiades litigiosa	Water Snow Flat	Dioscorea oppositifolia, Dioscorea sp.	
120	Pseudocoladenia dan	Fulvous Pied Flat	Achyranthes aspera	
121	Pseudocoladenia indrana	Tricolour Pied Flat	Xylia xylocarpa, Mallotus philippensis, Grewia nervosa, Desmodium sp.	
122	Sarangesa desahara	Common Small Flat	Asystasia sp., Blepharis asperima	
123	Sarangesa purendra	Spotted Small Flat	Asystasia sp.	
124	Spialia galba	Indian Grizzled Skipper	Sida rhombifolia, Hibiscus., Waltheria indica	
125	Gomalia elma	African Marbled or Mallow Skipper	Abutilon indicum	
126	Ampittia discorides	Bush Hopper	Oryza sativa	
127	lambrix salsala	Chestnut Bob	Grasses	
128	Psolos fuligo	Coon	Stachyphrynium spicatum, Zingiber officinalis	
129	Notocrypta paralysos	Common Banded Demon	Curcuma sp., Zingiber sp.	
130	Notocrypta curvifascia	Restricted Demon	Costus speciosa, Hedychium coronarium, Kaempferia rotunda, Zingiber montana, Curcuma decipiens	
131	Udaspes folus	Grass demon	Curcuma aromatica, C. pseudomontana, C. decipiens, Hedychium coronarium, Zingiber sp., Hitchenia colina	

132	Suastus gremius	Indian Palm Bob	Calamus sp., Caryota urens, Cocos nucifera, Phoenix acaulis, P. Ioureii
133	Matapa aria	Common Red Eye	Bambus arundinacea
134	Gangara thyrsis	Giant Red Eye	Calamus rotang, Caryota urens, Cocos nucifera, Phoenix acaulis, P. loureii, Licuala grandis, Ornamental palms
135	Borbo cinnara	Rice Swift	Setaria glauca, Cymbopogon sp., Pennisetum sp., Oryza sativa, E ragrostis sp.

PRAKRITI BUS: A MOBILE EXHIBITION FOR RAISING AWARENESS ON BIODIVERSITY OF UTTAR PRADESH

Somesh Gupta¹ and S. P. Yadav²

¹GIS/Technical/ABS Incharge, U.P. State Biodiversity Board, Lucknow. ²Member Secretary, U.P. State Biodiversity Board, Lucknow.

ABSTRACT

Biodiversity forms the critical foundation for the human wellbeing and sustainable development. To take necessary steps to conserve the biodiversity and for maintaining life support system, it is important to have participation of people. The Aichi Biodiversity Target 1 sets an agenda that by 2020, at the latest, people are made aware of the values of biodiversity and the steps they can take to conserve and use it sustainably. Taking this background, the Convention on Biological Diversity (CBD) has set education on top priority in the Strategic Plan for Biodiversity 2011-2020 which is also declared as United Nations Decade on Biodiversity (UNDB 2011-2020). As part of the initiative, Uttar Pradesh State Biodiversity Board, Lucknow in collaboration with Lucknow University and CEE, North carried out a decentralized biodiversity awareness and conservation initiative in Uttar Pradesh by operating 'Mobile bus focused on Biodiversity of Uttar Pradesh'. The Prakriti bus is developed as a unique exhibition showcasing rich biodiversity of the State, whether it is forests, grasslands, wetlands, rivers, agriculture etc. Prakriti (Mobile bus) aimed to reach out to the broad section of the community by using a multimedia approach including display panels, interactive models, fun-filled activities, games & puzzles, and take away communication material like pamphlets, brochures, labels, and postcards. This paper deals with the efforts carried out by the Uttar Pradesh State Biodiversity Board (UPSBB) to create awareness about Biodiversity and its conservation among the children, teachers, youth, media, general public etc.

Key words: Prakriti, Mobile Bus, Awareness, Conservation initiative and exhibition.

BACKGROUND

Biodiversity forms the critical foundation for the human wellbeing and sustainable development. To take necessary steps to conserve the biodiversity and for maintaining life support system, it is important to have participation of people. The Aichi Biodiversity Target 1 sets an agenda that by 2020, at the latest, people are made aware of the values of biodiversity and the steps they can take to conserve and use it sustainably. Taking this background, the Convention on Biological Diversity (CBD) has set education on top priority in the Strategic Plan for Biodiversity 2011-2020 which is also declared as United Nations Decade on Biodiversity (UNDB 2011-2020).

In the light of this, Department of Science & Technology (DST) and Ministry of Environment, Forests and Climate Change (MoEFCC) had launched the revamped iconic mobile Science Express as Biodiversity Special (SEBS) train in 2012. The key thrust areas of the train included biodiversity of India, climate change, biogeography zones, myriad ecosystems, and its importance to the environment and human society. The Science Express train had its own limitations in terms of outreach and looking at the response SEBS received in Uttar Pradesh.

As part of the initiative, Uttar Pradesh State Biodiversity Board, Lucknow in collaboration with Lucknow University and CEE, North carried out a similar decentralized biodiversity awareness and conservation initiative in Uttar Pradesh by running 'Mobile bus focused on Biodiversity of Uttar Pradesh'. This mobile educational resource centre was aimed at reaching out to children, teachers, youth, media, general public etc.

ABOUT PRAKRITI BUS

Prakriti is a mobile exhibition bus on the nature and biodiversity education of Uttar Pradesh. It is a joint initiative by Uttar Pradesh State Biodiversity Board (UPSBB), University of Lucknow, and Centre for Environmental Education (CEE). The bus is modified on the Swaraj Mazda Chassis and runs on green and safe fuel namely "CNG" which produces less undesirable derivatives and fosters our care and concern for the environment.

DEVELOPMENT OF EXHIBITION

Uttar Pradesh is part of Gangetic Plain bio-geographic zone which supports very rich biodiversity on its diverse climatic landscape. It was a big challenge to exhibit this rich biodiversity in a small display space like a bus.

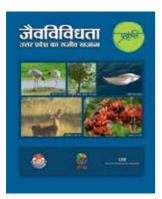
CEE with its previous experience of developing and designing Science Express Biodiversity Special (SEBS) train helped in planning the display of the bus. In train where all 10 Biogeographic zones of India were exhibited in different coaches of the SEBS train, here it was interesting to plan to showcase one biogeography zone in a bus.

The work on the Prakriti Bus in Uttar Pradesh started with reviewing the existing material available on the biodiversity of Uttar Pradesh and researching on the secondary data and reviewing various scientific papers, journals and publication of UPSBB was also referred and taken as base to design the Prakriti Bus. A booklet Biodioversity-A living treasure of Uttar Pradesh was also developed.

To exhibit the Biodiversity of Uttar Pradesh, the Bus panels were categorized based on the ecosystem based thematic plan for exhibiting the biodiversity. Bus was divided into six units for exhibiting the biodiversity. Each unit had three panels and thus six units containing total 18 panels. There were four link panels which connected each unit to maintain the flow of information. Several facts and technical information were crosschecked with experts and scientists for scientific accuracy of the content and information to be given on the panels.

WINDOW PANELS

There are seven window glass panels (three panels on each left and right side and one back panel) which covers the main theme panels of the Prakriti Bus. It was decided to exhibit



various ecosystems (forest, grassland, river, wetland, agriculture and urban ecosystem) on the side panel. Each panel displays a collage of aspects which represent that particular eco-system. These panels are meant to attract audience towards the bus and awaken curiosity. The back side window panel focused on the state symbols (state bird, state tree, state fish, state animal, state flower) of Uttar Pradesh.

RIGHT SIDE OF THE BUS

FIRST UNIT

The first unit focused simply to explain the biodiversity and some key facts of the biodiversity, 10 Biogeographic zones of India and different eco zones of Uttar Pradesh. To explain the meaning of biodiversity and its various categories like genetic diversity, species diversity and ecosystem diversity, a photo collage was designed with various photographs. The Biogeographic zones and key features were exhibited on the map of India. Four eco zones of Uttar Pradesh were shown on the map of UP with brief information and photographs. Some important facts of the biodiversity like varieties of rice, mangoes, cereals and black pepper were also shown in the first unit.

FIRST LINK PANEL

The first link Panel to connect first and second unit focused to exhibit the Ganges River Dolphin our National Aquatic Animal. The key features of the animal were explained with its distribution area. The major threats to the animal were also explained in the link panel and handprint box information was given to explain what we can do to conserve this unique animal at individual level.

SECOND UNIT

The second unit was designed to exhibit information on the river ecosystem. The ecosystem of major rivers and animals like various species of Turtles, Gharial and Crocodile and their role in the aquatic ecosystem were explained. Support was taken from the Department of Zoology, Lucknow University and Turtle Survival Alliance India (TSA) to develop the turtle panel. A photo collage of different nine species of turtles out of fourteen species found in Uttar Pradesh was developed to show the turtle diversity of UP. Major threats to the river ecosystem and aquatic animals were also explained. A handprint box to explain the conservation measures which could be taken at individual level were also designed in each panel of second unit.

SECOND LINK PANEL

The second link panel focused on the services of Biodiversity which we get in our day to day life. It contains the ecosystem, scientific, cultural, aesthetic and educational services

which we get from the Biodiversity. A photo collage of agriculture, fruits, fishing, nature camping, worship of trees and various species of plants and animals were designed to explain the services of biodiversity.

THIRD UNIT

The third unit focused on the wetland ecosystem, wetland birds and medicinal plants. Wetlands and their major role in nature and to the mankind were explained in this section. A panel on various resident and migratory birds was designed to explain the diversity of aquatic birds of Uttar Pradesh. On the panel various facts of each aquatic bird such as their feeding behavior, nesting and breeding and key features were shown with photos. For exhibiting the wetlands and aquatic birds panel information was reviewed from various sources such as wetland inventory of Uttar Pradesh and Ministry of Environment and Forest and Climate Change. Information of various plant species of medicinal values were also exhibited on one panel of third unit.

LEFT SIDE OF THE BUS

FOURTH UNIT

The fourth unit of the Prakriti Bus focused on beneficial insects and domesticated diversity i.e. crops, fruits, vegetables and livestock. During the content development it was felt that when we talk about the biodiversity we only think about the wild flora and fauna and large animals. The insects – "Pollination agents" were left alone and we generally do not recognize their role and importance in nature and in our daily life.

To highlight the insect diversity and their importance a panel on 'Our friend insects' was designed with specific information on the



beneficial insects. A panel on agricultural diversity was designed where major crops, fruits and vegetables grown in U P were covered in this section. Interesting information on various varieties of mango, guava and vegetables were shown with photo collage. A panel on major livestock of Uttar Pradesh was also designed to give information on the cattle diversity of Uttar Pradesh.

THIRD LINK PANEL

The third link panel was designed to give information on highly endangered bird, the Vultures. For designing the vulture panel photographs, facts and scientific information were shared by Zoology Department of Lucknow University. The panel was designed in

such a way, so that visitors can easily understand the importance of this scavenging bird and correlate with their immediate environment. The major threats and the conservative measures were also described in the handprint action box on the panel.

FIFTH UNIT

The fifth unit on the left side of Prakriti Bus focused on the overall forest and wildlife wealth of Uttar Pradesh. The content developers and designers were decided to give information on the Protected Areas (PAs) of UP including major wild flora and fauna present in the state. A panel visualizing the map of Uttar Pradesh with the PAs –Wildlife Sanctuaries, Bird Sanctuaries, National Park, Tiger Reserve, Elephant Reserve, Ramsar Site etc. were highlighted. The unit also covered the information of the only National Park, its forest type, location, major species and tribal of Dudhwa. One panel was focused on the facts and figures of tiger and elephants, their habitat and major threats and conservation efforts of the government.

FOURTH LINK PANEL

The fourth panel focused on the handprint actions which can be taken at individual level. Some simple measures to conserve the biodiversity at individual level were displayed with photos on the panel. The content of this panel was designed in such a way so that the visitors can easily understand and adopt the activities in their day to day life.

SIXTH UNIT

The sixth unit of the Prakriti Bus focused on the threats faced and conservation efforts for biodiversity in Uttar Pradesh. A panel was designed to show major threats to the biodiversity. The major issues like deforestation, illegal hunting and wildlife trade, introduction of alien



and invasive species, unsustainable developmental activities like dams and barrages, extensive use of chemical fertilizers and pesticides, pollution and mining activities were covered in this panel. The other panel was designed to showcase the conservation efforts being done by government and other conservation institutes and agencies. Various environment days with possible activities which could be done at school level were also displayed on one panel.

PRAKRITI BUS LAUNCH EVENTS

The Prakriti bus was developed as an unique exhibition showcasing rich biodiversity of the State. It is mobile, open to all, and is intended to benefit school students, teachers, youth, and community members in the urban and rural areas of Uttar Pradesh. The

informative panels and exhibits in the bus and related on the spot activities are designed in Hindi language and is aimed to effectively communicate the importance of nature and biodiversity conservation amongst different age groups of the society.

The prime geographical operational areas for the Prakriti bus was planned to be the schools and community areas of rural and urban locations of Lucknow and its surrounding districts. To transact information in interesting way, CEE identified science communicators who will travel with the bus. The team was trained on various aspects of how and what information will be provided to audience. Interactive games and educational activities were designed for students to be conducted during visit. The team was also responsible for planning and preparation of the visits to schools, institutions, and community locations.

The exhibition of Prakriti Bus was made ready at Ahmedabad and a team from Lucknow went to get the bus to Lucknow. This mobile bus runs on Compressed Natural Gas (CNG), which also helps to create awareness and motivation to use CNG, a clean fuel. It was ready for launch and to start its exciting journey in Uttar Pradesh. The UPSBB and CEE team was ready to capture people's reaction on the bus and share it with larger world.

LAUNCH OF THE BUS

To launch the Prakriti Bus, Uttar Pradesh State Biodiversity Board (UPSBB), University of Lucknow (LU) and Centre for Environment Education, North Regional Office (CEE North) jointly organized a launch event. To reach out to the larger target group, the launch event was publicized in local and national news papers and also an announcement

of the programme was done on Radio Mirchi 98.4 FM channel prior to the launch programme from 01 August to 02 August 2014. The announcement highlighted the purpose and objective of the Prakriti Bus and invited school students, teachers and general public to visit the exhibition at Indira Gandhi Pratisthan. The launch of the bus took place at Indira Gandhi Pratishthan on 2 August 2014 and "Prakriti Bus" was inaugurated by Shri Abhishek Mishra, State Minister, Vocational Education and Skill Development, Uttar Pradesh.



JOURNEY OF THE PRAKRITI BUS

The bus started its journey to different districts of Uttar Pradesh in different Schools, Colleges, Villages and Communities. Prakriti bus completed its entire journey in two pha ses which started from August 2014 – July 2015 (First phase) with its over-whelming success, entered into second phase from July 2015 to August 2016. The journey details of Prakriti Bus: A Mobile Exhibition on Biodiversity of Uttar Pradesh is summarized below:



Details	Phase I	Phase II	Total
Launch of Prakriti Bus for travel	2 August 2014 till 31 July 2015	August 2015 to 31 August 2016 (Phase II)	25 months
Total Visitors	1,04,959 visitors (as of 31 July 2015)	1,37,412 visitors (as of 30 August 2016)	2,42,371 visitors
Number of districts travelled	6	7	13 districts
Total Kilometres travelled by bus:	11,421 Km	14,228 Km	25,649 km
Total number of Schools & Inter Colleges Visited	230	232	462
Total number of Villages covered	96	78	174
Name of District/s travelled:	Lucknow, Barabanki, Kannauj, Unnao, Hardoi and Sitapur	Lealzabad Adra	

Overall, footfalls recorded from the first phase and second phase was 2, 42, 371 visitors. The Prakriti Bus project has been a great success and has been received with great enthusiasm by school, children and rural communities.



EDUCATIONAL MATERIALS:

Apart from the launch of the bus, educational materials viz. posters, pamphlets, books etc. was also developed by Uttar Pradesh State Biodiversity Board (UPSBB), which were distributed to various schools and colleges.

GLIMPSES OF VARIOUS VISITS OF PRAKRITI BUS



CONNECTING BIODIVERSITY AND CLIMATE RESILIENCE-WAY FOREWORD

NATIONAL AND INTERNATIONAL INITIATIVES

The three Rio Conventions—on Biodiversity (Convention on Biological Diversity), Climate Change (United Nations Framework Convention on Climate Change) and Desertification (United Nations Convention to Combat Desertification) — derived directly from The United Nations Conference on Environment and Development (UNCED) are interlinked and address interdependent issues. The Conference of Parties to each of the convention has reiterated the need for enhanced collaboration among the conventions.

United Nations Framework Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. Its objectives are to stabilize greenhouse-gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, within a timeframe sufficient to allow ecosystems to adapt naturally to climate change. The Paris Agreement builds upon the Convention and brings all nations into a common cause to combat climate change and to adapt to its effects. It was agreed by countries that efforts will be put in place to keep global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. The Paris Agreement requires all Parties to declare "Nationally Determined Contributions" (NDCs) and to strengthen these efforts in the years ahead. In response India has declared its Intended Nationally Determined Contribution (INDC) to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level and to create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030. All the three conventions emphasize the importance of the conservation, sustainable use and management of biodiversity in achieving their respective objectives.

India has instituted a National Action Plan on Assessment, Adaptation and Mitigation of Climate Change, that has specified eight national missions. These include a National Water Mission, Green India Mission, National Solar Mission, National Mission on Sustainable Habitat, National Mission on Enhanced Energy Efficiency, National Mission for Sustaining Himalayan Ecosystem, National Mission for Sustainable Agriculture, and a National Mission on Strategic Knowledge for Climate Change. Recently the Government of India has constituted a National Mission on Biodiversity taking into consideration the role of Biodiversity for achieving the overall objectives of Sustainable development.

GLOBAL BIODIVERSITY LOSS

The Living Planet Index (LPI) is a measure of the world's biological diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats and has been adopted by the Convention of Biological Diversity (CBD) as an indicator of progress towards action to halt the loss of biodiversity. The Living Planet Index 2016 shows a 58% decline between 1970 and 2012 ie animal populations are roughly half the size they were in 42 years ago. Freshwater species populations have suffered an 81% decline, an average loss much greater than that of land and marine species and fresh water species are more vulnerable to climate change. Millennium ecosystem assessment (2015) has listed the most important direct drivers of change in ecosystems as habitat change, overexploitation, invasive alien species, pollution, and climate change individually or synergistically. The major impact of climate change on biodiversity includes changes in species distributions, population sizes, the timing of reproduction or migration events, changing life cycles, and an increase in the frequency of pest and disease outbreaks. Habitat loss and other ecosystem changes are projected to lead to a decline in local diversity of native species by 2050.

BIODIVERSITY FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Ecosystem's capacity to be resilient and adaptive to environmental change relies fundamentally on genetic diversity. Mainstreaming biodiversity conservation into sectoral planning for Coastal defense through the maintenance of mangroves and other coastal wetlands, Conservation and restoration of forests or Conservation of agro biodiversity to provide specific gene pools for crop and livestock adaptation to climate change are adaptation strategies which can be adopted. A reduction of the pressures on fully- and overexploited coastal and oceanic fisheries can be an important component of adaptation measures to reduce impacts on biodiversity. Native grasslands species have adaptive characteristics that enable them to respond to climatic changes. Avoiding fragmentation and providing ecological connectivity, is of great significance in forest areas. Conservation of crop and livestock genetic resources, in situ and ex situ, and their incorporation in long term strategic programmes is also important.

The Biological Diversity Act is an Act which provides for conservation of biodiversity, Sustainable utilization and fair and equitable sharing of benefits and operates through a three tier mechanism consisting of National Biodiversity Authority at national level and State Biodiversity Board at State level and Biodiversity Management Committees at local level. Biodiversity management Committees (BMCs) are statutory bodies at local bodies comprising of eight members constituted in accordance with the Section 41 of the Biological Diversity Act 2002 and Section 22 of the Rules, 2004. BMCs are constituted for the purpose of promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms and documentation of knowledge relating to biological diversity.

CLIMATE CHANGE HOTSPOTS OF KERALA

Alappuzha, Palakkad, Wayanad and Idukki districts are climate change hotspots in Kerala, with a high degree of vulnerability to natural hazards. In Kerala for the first time Local Action Plan on Climate Change is being prepared by LSGs of these districts with support of Kerala Institute of Local Administration. Kerala was ravaged by floods and land-slides during 2018 and The Rebuild Kerala Initiative, was born out of the vision that floods should be taken as "a challenge and an opportunity to rebuild the State to ensure better standards of living to all sections of the society". The first step in this direction is the constitution of a 13th working group for Biodiversity, Environment, Climate Change and Disaster Management Committee, and also from the public, with the respective local body secretary as convenor of the group.

In the aftermath of the natural disasters which Kerala witnessed during August 2018, KSBB conducted in depth study in all the four climate change hot spots districts. Wayanad a climate change hotspot district and a biodiversity rich area has 2034 Angiosperm and 163 species of Pteridophytes reported from here. Post flood 2018 inventoried 60 major and 56 minor slope movements degrading over 50 hectares of forest area leading to a loss of forest cover and estimated a population loss for 376 angiosperm of which 200 has known medicinal properties and 21 pteridophyte species. The landslides resulted in gap formation, which causes changes in microenvironment and raise the probability of taking over of shade-intolerant species and the spread of invasive species. Landslides in Brahmagiri, Peedikapullu, Sooryamudi had also affected the grasslands as these occurred in the confluence of forest and grassland. In major landslide hit areas run off have resulted in the closure of several 1st order springs and streams which will impact the water availability downstream adversely. In Nelliampathy, Palakkad studies point out that Landslides occurred in 23 locations and Mud slips in 45 sites. The results point out that Landslides and mudslips occur in slopes above 220 and majority of landslides were in forest fringes where there is disruption of slope continuity, Biological invasion in landslide hit areas, Increase in surface temperature of forest floor by canopy opening, Excess drying up of ground vegetation and Increase in forest fire in February – March 2019 has been observed.

KSBB has developed criteria for identification of species potential for future River bank afforestation programs and 288 species are identified for future river bank afforestation programs. This include 169 trees, 43 shrubs, 54 herbs and 22 climbers under 4 prioritised classes (14 species in the very high importance, 69 high, 158 medium and another 47 low importance category). The study found that the growing population and resultant

anthropogenic interventions in the name of developmental activities along with climate change and extreme events has made many changes in the land use and land cover of catchment as well as the riparian zone. Based on the scientific concept that the rivers are far more than the waters within their banks that act as a holistic system wherein any change at any part of the basin has repercussions in other parts of the basin and wellness of the system, the study suggested a detailed framework for a management action plan for the reviving the Rivers of Kerala.

The role of Local Government Institutions and BMCs in the river conservation is highlighted as the 73rd and 74th amendments to the Indian Constitution, envisages local bodies as the third tier of government along with the Central and State governments and the Kerala has devolved a large number of development functions to local bodies and has seriously attempted to operationalise the constitutional provisions in letter and spirit. Thus planning and implementation of any activities for river basin management will be easy through the local bodies by strengthening the BMCs with active participation of KSBB and other line departments and R&D and academic institutions.



KERALA STATE BIODIVERSITY BOARD

