

# Kerala Climate

Monthly Newsletter of Institute for Climate Change Studies (ICCS), Kottayam, Kerala-686 004  
(Research Organisation under Environment Department, Government of Kerala)

## Logo of ICCS released



Hon'ble Chief Minister of Kerala, Shri Pinarayi Vijayan, released the logo of ICCS at Thiruvananthapuram, on 28 July 2016, by handing over the logo to Shri V S Senthil IAS, Additional Chief Secretary, Environment Department, Government of Kerala, in the inaugural function of Orientation Programme on Climate Change and Disaster Risk Reduction organised by ICCS for the Mayors

and Municipal Chairpersons. The logo symbolically indicates the two major impacts of climate change (i) the temperature increase and resultant melting of ice mountains represented by the triangles in the top with deep/light blue colour; and (ii) the sea level rise indicated by the quarter circle in the bottom with deep/light blue colour.



Shri Pinarayi Vijayan, Hon'ble Chief Minister, releases the logo by handing over it to Shri V S Senthil IAS, ACS, Environment Department. Dr George Chackacherry, Director, ICCS, and Shri Pratheesh C Mammen, Scientist, are also seen.

## CM to inaugurate Workshop on Climate Variability

ICCS, in association with India Meteorological Department, and State Disaster Management Authority, has scheduled to conduct a workshop on "Climate Variability in Kerala in Recent Years: Climate Change Perspectives", at Thiruvananthapuram on 21 November 2016. Shri Pinarayi Vijayan, Hon'ble Chief Minister of Kerala will inaugurate the workshop. Shri V S Senthil IAS, Additional Chief Secretary, Environment Department, will preside over.

The workshop is organised in the wake of unprecedented heat wave conditions and wide variations in the rainfall pattern experienced in Kerala recently, which has caused several climate related issues. Though there are striking variability observed in climate, it has to be confirmed whether it is associated with the 'Climate Change' phenomenon. Also, it is important to understand the magnitude of change in various climate parameters.

Around 30-40 scientists/experts are expected to participate. The deliberations of the workshop will be centred on change in temperature, change in rainfall patterns, the influence of *El-Nino*, *La Nina* and other features in the neighbourhood that impacts Kerala's weather. A document will be brought out based on the workshop outlining the Kerala specific trends in various climate parameters in the context of climate change perspectives and suggesting measures for combating the issues caused due to the climate variability.

## Government of India sanctions 2.5 crore to ICCS

The Department of Science and Technology, Government of India, has sanctioned financial assistance of Rs. 2.48 crore to ICCS for setting up the Climate Change Knowledge Centre in Kerala State, under the National Mission on Strategic Knowledge for Climate Change.

The main aims of the five-year project are (i) to build data-bank and knowledge repository for storing and retrieving Climate Change information at the state level to be useful to all sectoral line departments/agencies/universities, general public, etc; (ii) to establish a network with various stakeholders within the State; (iii) to assess risk and vulnerability due to Climate Change in the State and to develop bench mark/assessment relevant for all adaptation and mitigation sectors; (iv) to develop capacity building for all relevant departments/agencies and stakeholders; and (v) to develop a web portal for assisting decision makers in framing appropriate policy interventions in the activities of various departments/agencies. In fact, the Knowledge Centre seeks to establish link between Climate Change Sciences and knowledge base to policy makers, planners, etc. to support strategic planning of government policies, to cope up with Climate Change risks and vulnerabilities. This will be achieved by main-streaming Climate Change Knowledge into development and planning process and strengthen the activities of the Government at grass root level as envisaged in the State Action Plan on Climate Change.

## CM Inaugurates Orientation Programme

Shri Pinarayi Vijayan, Hon'ble Chief Minister of Kerala, inaugurated the Orientation Programme on Climate Change and Disaster Risk Reduction, organised by ICCS for the Mayors and Chairpersons of Corporations and Municipalities of Kerala, at Thiruvananthapuram on 28 July 2016. Shri V S Senthil IAS, Additional Chief Secretary, Environment Department, presided over the meeting.

Hon'ble Chief Minister, in the inaugural address, pointed out that global warming and climate change are ultimately making life miserable for the poor in the society. Increasing acidity of the sea water and global warming are causing depletion of marine resources. He said that global warming is a socio-economic issue with adverse impact on the lives of the poor. The depletion of the marine resources is draining the income of fishermen. Hon'ble Chief Minister emphasised the urgent need for a shift to nature-friendly development and said that afforestation could be the better means to check the rise in temperature and to reduce carbon emission. He pointed out that once the greenery of a place increases, it would help reducing the temperature and carbon emission.



Shri Pinarayi Vijayan, Hon'ble Chief Minister inaugurates the orientation programme on climate change for Mayors and Municipal Chairpersons



Smt Soumini Jain, Mayor, Cochin Corporation, speaks in the orientation programme. Shri Thottathil Ravindran, Mayor, Kozhikode Corporation also is seen.

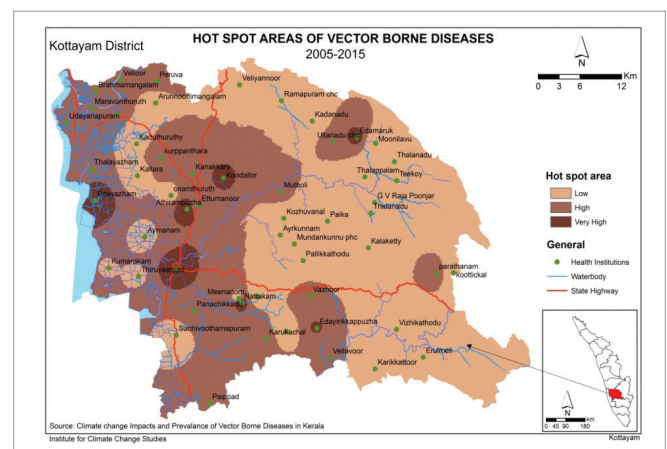
He called upon the Mayors and Chairpersons of Municipalities to give importance to source-based waste treatment in their LSGIs concerned. Shri V S Senthil, Additional Chief Secretary, in his presidential address, pointed out that climate change is a reality and it has local impacts. Therefore, development programmes taken up by Local Self Government Institutions should encompass adaptation and mitigation strategies. Dr Sekhar L Kuriakose, Member Secretary, State Disaster Management Authority, presented the lead paper in the programme. Dr Oommen V Oommen, Chairman, State Biodiversity Board, Dr N B Narasimha Prasad, Executive Director, Centre for Water Resources Development and Management, Dr E Sreekumar, Scientist, Rajiv Gandhi Biotechnology Centre, and Shri John Mathai, former Scientist, National Centre for Earth Sciences led the discussion afterwards.

## Research Highlights

### Climate Change Impacts and Vector Borne Diseases

The ongoing project, "Climate Change Impacts and the Prevalence of Vector Borne Diseases in Kerala" is carried out with the funding of Environment Department, Government of Kerala. The main objectives of the project are (i) to study the prevalence of vector-borne diseases and their linkages to Climate Change; (ii) to develop a database on vector-borne diseases as part of health information system; and (iii) to create awareness on Climate Change related health impacts and their mitigation strategies among all concerned. The study is focussed on three districts – Kottayam, Alappuzha and Pathanamthitta.

During the period, the collection of data from the Kottayam district and the analysis of the data collected have been completed. Data have been collected from 79 health institutions of the district. Interim Report on Kottayam District has been prepared. Data from health institutions of Pathanamthitta is ongoing and the details have already been collected from 37 health institutions. As per the Interim Report, a total of 4036 cases of vector-borne diseases were reported in the Kottayam District during the period from January 2001 to December 2015. Dengue cases were the highest reported (n=2663), followed by Leptospirosis cases. From the hotspot analysis using the disease prevalence data and the



case location, it was evident that low land area in Kottayam district is more vulnerable to vector-borne diseases than other areas. The presence of water bodies in the eastern end of Vembanad wetland could be one of the reasons. There were some hotspot pockets like Edamaruk and Parathanam, which were in the highland, having high prevalence of all the cases. Dengue cases also were predominant in Panchikkadu, and Ettumanoor regions of Kottayam district. The main factor for the disease outbreak in this region may be inappropriate water storage and intermittent rain fall.



### Case Typology and Vector Borne Diseases in Kottayam District

		Name of Disease							Total
		Chikungunya	Dengue	Filariasis	Japanese Encephalitis	Leptospirosis	Malaria	Others	
Case Typology	Confirmed	93	2627	4	2	852	379	19	3976
	Negative	0	1	0	0	0	0	0	1
	Suspected	0	35	0	0	24	0	0	59
<b>Total</b>		<b>93</b>	<b>2,663</b>	<b>4</b>	<b>2</b>	<b>876</b>	<b>379</b>	<b>19</b>	<b>4,036</b>

### Gender and Prevalence of Vector Borne Diseases

		Name of Disease							Total
		Chikungunya	Dengue	Filariasis	Japanese Encephalitis	Leptospirosis	Malaria	Others	
Gender	Female	42	1217	2	0	274	79	8	1622
	Male	51	1446	2	2	602	300	11	2414
<b>Total</b>		<b>93</b>	<b>2,663</b>	<b>4</b>	<b>2</b>	<b>876</b>	<b>379</b>	<b>19</b>	<b>4,036</b>

In the case of Dengue, 2005 to 2008 showed no variations in number of cases indicating lower number of cases. But from the year 2009 to 2015 a peak in the number of dengue cases were observed during the months May to August. In the case of 2009 and 2010 the peak started in the month of June but this trend started earlier in the month of May and extended till August. This trend has to be explored further using various climate data. The peaks of disease prevalence might correspond to the monsoon and the magnitude of rainfall during that season. Extended study and analysis of data to be collected from other two districts (Alappuzha and Pathanamthitta) may lead to more findings related to climate variability and diseases incidence.

As part of the project four awareness programmes were conducted for ASHA workers and health staff during the period under report at, Nattakom, Parampuzha, Kuruppunthara, and Kumarakom.



ASHA and health workers training at Kumarakom

## Paleoclimate Records in the High Ranges

The project on "Investigation on Paleoclimate Records in the High Ranges of Kerala" is funded by the Environment Department, Government of Kerala. The study aims at unfolding the paleo climatic and paleo ecological conditions of High ranges of Idukki district during the Quaternary period, using depositional framework analysis. High altitude areas in Idukki are one of the most important and oldest landforms in Western Ghats. It plays a crucial role in regulating the climate of Kerala. Changes in climate and vegetation can be well described in higher latitudes. They are considered as archives of palynological and sedimentological evidences. Sedimentary sequence provides information about composition of sediments, degree of weathering etc. that influence landform development.

Preliminary fieldwork was carried out in 13 suitable sites and 74 soil samples were collected. Soil analysis was carried out for the parameters namely Organic Carbon, Potassium, Phosphorus, Calcium and Magnesium. Cluster analysis was carried out using a software PAST. In the non-constrained cluster analysis of Organic Carbon, similarity on Organic Carbon content was analysed across the sites of soil samples up

to the depth 60 cm. In the cluster, Meesappulimala samples which have higher carbon content, show dissimilarities with other two clusters. Samples collected from Nagarampara shows very close similarity to the samples in Meesappulimala. Vagamon and Calvary Mount I have the least value of organic carbon. All other samples have almost similar organic carbon content. The goodness of the fit of this clustering is estimated using Copenetic correlation coefficient (CP). Since CP is 0.9508, this model fits well for all the accounted similarities.

Meesappulimala samples which have higher carbon content showed more similarity in the cluster analysis. So the result of Meesappulimala was compared with the organic carbon content of Eravikulam National Park, which was published by Kerala Forest Research Institute. These two regions are at an average elevation of 2100m MSL. Pedological literature has already documented the increasing organic carbon content of soil with increasing elevation and increasing latitude, which may be due to slow microbial activities caused by cooler climate and acidic soil. Organic carbon content of these areas was varying along with depth.

Comparison between the organic carbon content and altitude of Meesappulimala samples with reference to Eravikulam

No	Reference Places*	Altitude (m)	Vegetation type	Soil depth (cm)			Sample Places	Vegetation type	Altitude (m)	Soil depth (cm)			
				0-20	20-40	40-60				0-15	15-30	30-45	45-60
1.	Eravikulam	2180	Grassland	12.42	8.42	7.95	Meesappulimala II	Shrub ecotone	2450	10.6	4.05	1.12	1.92
2.	Eravikulam	2170	Grassland	12.51	8.66	7.18	Meesappulimala III	Grassland	2229	10.92	6.06	1.68	1.62
3.	Eravikulam	2145	Shrub ecotone	7.25	6.61	6.18	Meesappulimala IV	Grassland	2424	8.67	7.38	5.01	3.57

\*Reference Places – KFRI Research Report No.154 on Vegetation Dynamics of the Grassland – Forest Ecosystem in the Western Ghats of Kerala

As the project team faced a lot of challenges during field work related to protocol for sampling and sample preservation, identification of ideal samples, unavailability of borehole device/ soil core sampling device, institutional collaboration for further analysis, etc. a consultative workshop was conducted at ICCS on 14 July 2016. The discussions in

the workshop was led by Dr P K Thambi, former Scientist, NCESS, Dr K R Nisha, Professor, CUSAT, Dr K K Ramachandran, Scientist, NCESS, and Shri John Mathai, former Scientist, NCESS. The team also reviewed the objective, methodology and work plan of the project and gave suggestions for the preparation of E-W transect (Wayanad, Munnar, Kulathupuzha), secondary data collection, field reporting, research organisations to be collaborated with, etc.

Ozone Day Observed



Ozone Day celebration at Mount Carmel School, Kottayam

ICCS, in association with Mount Carmel Higher Secondary School, Kanjikkuzhi, Kottayam, organised a seminar on “Ozone and Climate:

Restored by a World United “ at Mount Carmel School, on 23 September 2016. Dr Keshav Mohan, former Director, Institute for Land and Disaster Management and ICCS delivered the key-note address in the seminar. Sr. Sheila, Headmistress, Mount Carmel School presided over. Dr George Chackacherry, Director, ICCS, Dr Pratheesh C Mammen, Project Scientist and Smt Bindu C Thomas, Technical Expert, ICCS, led the discussions. Students of the school attended the seminar.

Participates in Exhibition

ICCS put up a stall in the exhibition conducted by DoECC at Kanakakkunnu Palace, Thiruvananthapuram, as a part of World Environment Day 2016 celebrations on 05 June 2016. Shri Pinarayi Vijayan, Hon'ble Chief Minister of Kerala, who inaugurated the celebrations, visited the stall.

Capacity Building Programmes

Training Programme on Climate Change and Disaster Risk Reduction

Capacity building programmes have been taken up by ICCS on “Climate Change and Related Disaster Risk Reduction” for the elected representatives and officials of Local Self Government Institutions in the rural and urban level. The programmes are intended for sensitising the participants on perspectives of climate change, disasters that could happen due to climate change in the State, and adaptation/mitigation measures possible at the local level. Funding for the programme is by the Environment Department, Government of Kerala.



Training at Kozhikode. Dr P S Harikumar, Scientist, CWRDM, takes class.



Training at Kottayam. Dr K P Joy, Chairman, SEIAA, takes class.

During the period under reference, 13 programmes were conducted at various districts as detailed in Table below. The participants included presidents and secretaries of Gram Panchayats and Block Panchayats, and Mayors/Chairpersons of Urban Local Bodies. A total of 1065 persons attended in the programmes. Besides the Director and Scientist of ICCS, visiting faculty were drawn for the capacity building programmes. They included Dr K P Joy, Chairman, State Environment Impact Assessment Authority, Dr Oommen V Oommen, Chairman, State Biodiversity Board, Dr Narasimha Prasad, Executive Director, Centre for Water Resources Development and Management, Dr Sekhar L Kuriakose, Member Secretary, Kerala State Disaster Management Authority, Dr P S Harikumar, Head, Water Quality Division, CWRDM, Shri John Mathai, former Scientist, NCESS, Dr G Sankar, former Scientist, NCESS, Dr P Harinarayanan, Scientist, KSCSTE, and Dr M G Manoj, Scientist, CUSAT.

No.	Districts represented and Venue of Programme	Date
<b>Gram Panchayat Secretaries</b>		
1.	Thiruvananthapuram (Rest House Hall)	14.06.2016
2.	Kasargod and Kannur (Shishak Sadan, Kannur)	22.06.2016
<b>Gram Panchayat Presidents</b>		
3.	Thiruvananthapuram and Kollam (Rest House Hall, Thiruvananthapuram)	12.07.2016
4.	Kottayam and Pathanamthitta (Orest Bhavan, Kottayam)	22.07.2016
5.	Malappuram, Wayanad, and Kozhikode (Planetarium Auditorium, Kozhikode)	18.08.2016
6.	Thrissur and Palakkad (Ramanilayam Government Guest House, Thrissur)	19.08.2016
7.	Kannur and Kasargod (Shishak Sadan, Kannur)	25.08.2016
9.	Alappuzha, Ernakulam and Idukki	31.08.2016
<b>Mayors and Chairpersons of Urban Local Bodies</b>		
10.	Thiruvananthapuram (Planetarium Seminar Hall)	28.07.2016
<b>Block Panchayat Presidents and Secretaries</b>		
11.	Kottayam, Idukki, Ernakulam and Thrissur (Orest Bhavan, Kottayam)	27.09.2016
12.	Kannur, Kasrgod, Kozhikode, Malappuram and Palakkad (Planetarium Auditorium, Kozhikode)	04.10.2016
13.	Trivandrum, Kollam, Pathanamthitta and Alappuzha (Rest House Hall, Thiruvananthapuram)	07.10.2016

The training programmes for presidents and secretaries of District Panchayats and other elected representatives will be conducted soon.

## Tree for Tomorrow - Campaign

ICCS joined hands with Eraviperoor and Kuttoor Gram Panchayats, Pathanamthitta District Administration, Citizens India Foundation, Forest Department, State Biodiversity Board, Education Department, Public Works Department, Rural Development Department, Agriculture Department, NREGS, and Kudumbasree, to start the campaign "Nalekku Namukkoru Maram" as part of observing World Environment Day 2016. The programme was inaugurated by Smt Veena George MLA at St John's High School, Eraviperoor, in the meeting presided over by Smt Geetha Anilkumar, President, Eraviperoor Gram Panchayat. Shri T K A Nair, former Advisor, the Prime Minister of India, delivered the key-note address. Smt Veena George, in her inaugural address, pointed out that students, being tomorrows citizens, should start loving nature and environment in the beginning itself. She called up on the students to have a culture to be cultivated, loving trees and planting trees.

Shri Manu S Nair, Deputy Collector, Pathanamthitta, Smt Sreekha Reghunath, President, Kuttoor Panchayat, Adv. N Rajeev, Vice President, Eraviperoor Panchayat, Shri Sabu Joseph, Headmaster,



Shri T K A Nair, former Advisor to Prime Minister of India inaugurates the Nalekku Namukkoru Maram Campaign at Kuttoor Panchayath



Smt Veena George MLA inaugurates the Nalekku Namukkoru Maram Campaign at Eraviperoor Panchayat

St John's High School, and Dr George Chackacherry, Director, ICCS, spoke on the occasion. The campaign at Kuttoor Panchayat was inaugurated by Shri T K A Nair, in the meeting held at Kuttoor Government Higher Secondary School. Smt Sreekha Reghunath, President, Kuttoor Panchayat presided over the meeting.

At both the schools, the participants planted saplings. It was decided to plant saplings at both sides of MC Road, TK Road, school compounds, vacant spaces of government lands, etc. Proper protection will be given under the initiatives of voluntary organisations, NREGS, Kudumbasree, etc.



Tree planting in progress at Eraviperoor St Johns High School Campus



# Concerns on Changing Patterns of Climate over Kerala

Unprecedented changes in weather occurring frequently in the most climatically-reputed State of Kerala attracts the immediate attention of all those concerned. Event of heat wave conditions was not so familiar to Keralites until the pre-monsoon season of 2015. It is widely agreed that the frequency and duration of weak rainfall periods and drought condition is gradually increasing in the State. Is it a part of the short term climate variability or indicator of climate change is yet an unresolved scientific puzzle, but the present scenario demands much more inquisitive analysis of the data and scientific deliberations.

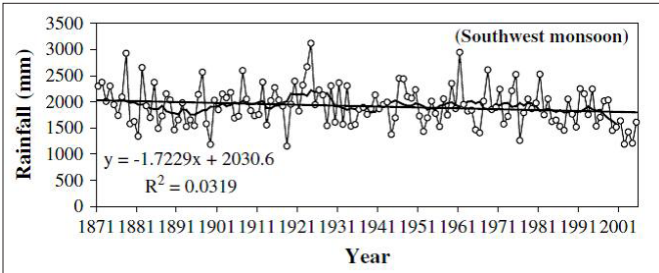


Fig. 1: Trend in South-west monsoon over Kerala (Courtesy: Krishnakumar et al, 2009)

Climatological analysis of rainfall data for the last 140 years show cyclic pattern with a significant declining trend in the south-west monsoon season for the last six decades (Figure 1). Rainfall in June and July shows a decreasing trend while that during winter and post-monsoon shows a slight increasing trend. The India Meteorological Department (2013) documents in its 'State level climate change trends in India' that Kerala is witnessing an average decline in south-west monsoon rainfall by about 2.42 mm per year. Kerala also witnesses an increase in annual mean temperature by 0.01° C/year. Most alarmingly, this trend is uniform in all seasons and at all locations of the State. Rise in day maximum and minimum temperature also shows the same trend. The severity of this significant trend is that it is manifested in the form of extreme events.

The State Action Plan on Climate Change has identified the four districts – Alappuzha, Palakkad, Idukki and Wayanad- categorized as climate change 'Hot Spots' in Kerala due to the high degree of vulnerability to natural hazards like flood and drought, and impact on biodiversity and human life. The degree of susceptibility is based on the climate change impacts on agriculture, fisheries and forests, tribal and coastal population, etc. Several reports are available on the decline of agricultural yield, loss of biodiversity, drying up of rivers and freshwater bodies, and associated loss of income in the State attributed to the impacts of climate change. Loss of micro-level climate regulating elements adds to the grave situation.

Due to increase in anthropogenic activities and emissions, global temperatures have shown a warming trend of 0.85 °C over the period 1880–2012. This is a permanent factor in increasing the

surface temperatures, even at our State too. During the recent years, minimum temperatures (night-time) have increased more than daytime temperatures, suggesting the possible role of moisture and the greenhouse gases. The year 2015 saw the record of maximum temperature – Palakkad registering 41.9 °C - in the State. The maximum temperatures recorded in many parts of the State either crossed or reached near the critical level of 40 °C, leading to unpleasant living condition. Since hot air can hold more water vapour, the excess amount of humidity in the atmosphere intensifies the adverse effect of heat on human and animal body by slowing the natural evaporative cooling mechanism, a special concern for the Kerala in the context of heat burn and sun-stroke related health risks and deaths. Figure 2 shows the chart of Heat Index for which necessary level of precaution should be taken in the context of changing climate.

A frightening feature to be noted is that Kerala, the most abundant

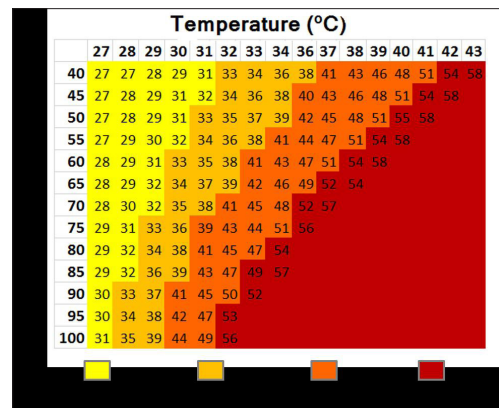


Fig. 2: Chart of Heat index

rainfall-receiving State of the Country, witnessed the most deficient receiver this year. The large-scale dynamics driven by warming in the Indian Ocean and changes in rainfall pattern has resulted in a deficient monsoon for Kerala this year. The projections of climate change for Kerala reveals an increase in temperature by 2-3° C by the end of this century. Severe weather events such as intense lightning and thunder, gusty winds and rainfall, heat waves, droughts, polluted environment, pattern shifts in crop, reduced plant and animal productivity etc. are some among the consequences. Together with the past observed data, consecutive droughts together with heat wave conditions could be ringing the bell of climate change for this otherwise heavenly State. We should be second to none in adopting any proactive measures!

(Dr M G Manoj, Research Scientist, Advanced Centre for Atmospheric Radar Research, CUSAT)



## Impact of Rise in Temperature, Low Rainfall, and Extreme Weather Events in Kerala in Recent Years

Rising temperature and altered rainfall distribution have been two most important changes noticed in climate along the different districts in Kerala. India Meteorological Department (IMD) has reported an increase of 0.8 °C, 0.2 °C and 0.5 °C increases in maximum, minimum and mean temperatures respectively over Kerala during the recent decade. It is also reported that the maximum temperature of Kerala increased by 0.64 °C while the minimum temperature rose 0.23 °C during a period of 50 years from 1956 (Rao, et al. 2009). Extreme heat events increase not only in frequency but also impact a larger area of land under warming. An increasing trend with respect to the indices of extreme temperature events in Kerala has reported recently which may eventually lead to the warming up of the region (Jayasooran et al. 2015). Studies on the reasons for the occurrence of extreme temperature events and its relationship to urbanization, land use pattern and global climatic change provided positive relationship to heat islands and changing temperature (Jain and Kumar. 2012). Therefore, more studies on extreme weather events throughout Kerala are highly relevant since the impacts of these events are more visible and severe at regional level in the State.

Precipitation changes are projected under continued warming with substantial adverse consequences for water availability in many parts of Kerala. Several studies have shown alterations in the distribution and amount of rainfall received in different parts of the State (Rajeevan et al. 2008). The increasing trends of extreme precipitation events reported in the southern Indian peninsula were closely related with the global warming and climate change. The changing pattern of rainfall in Kerala especially a significant reduction of rainfall during south west monsoon (SWM) and an increase in northeast monsoon (NEM) during the last 135 years was reported earlier from IMD (Krishnakumar et al. 2009). An increasing trend in extreme rainfall during winter and autumn and the decreasing trend in the rainfall during spring season in Kerala may lead to water scarcity in the pre-monsoon time and delaying the onset of monsoon. The high intensity of instant summer rains in the southern peninsula of India may be related to the increasing temperature events.

A variation in the precipitation pattern of Kerala requires special attention while discussing about climate change responses of several agricultural crops and food production in the State. The risks of reduced crop yields and production losses increase rapidly above 1.5°-2°C warming in general. Increasing drought and flooding events represent a major risk for agriculture in this region. Alappuzha, Palakkad, Idukki and Wayanad districts in Kerala are hotspots for climate change with a high degree of vulnerability to natural calamities like drought and flood. Palakkad has a very highly risk due to high percentage of population relying on agriculture. Alappuzha district is also in the same category because of the network of environmentally sensitive wetlands, lagoons and sandy beaches. Idukki and Wayanad, the two hilly districts are categorized as hotspots for climate change due to the large dense forest cover in the major land area. In due course of time, shifts in the terrestrial ecosystem are projected with increasing temperatures and changes in precipitation patterns which may significantly reduce the valuable ecosystem services in the State.

The State's economy is largely dependent on the production of plantation crops such as coconut, rubber, tea, coffee, pepper, several other varieties of spices etc. The growth and yield of these crops are mainly influenced by the weather conditions which are very crucial

during the yielding phase of every crop. A slight shift in temperature or change in rainfall pattern can make severe impact in crop production. For example, change in rainfall pattern in the crop season in Idukki affected flowering and yield of black pepper. There are reports in different crops like, paddy, coconut, rubber, cashew, pepper etc. that rise in day temperature lead to lower the crop productivity significantly. The changes in minimum and maximum temperatures are crucial for crop productivity as each crop has a specific thermal kinetic for its optimum growth and yield.

The moisture index across the State was changing from B4 to B3 humid condition, indicating that the State is moving from wetness to dryness within the humid climate. The intensity of summer droughts was also increasing across the State and also witnessed more number of droughts in the recent decades. Under the projected climate change scenario, the frequencies of such instances are likely to be more and hence it is a threat to both food grain production and cash crops in the State. Changing precipitation patterns and increase in extreme heat events pose high risks to agricultural production and regional food security.

As the agricultural crops are more vulnerable to short term weather variations rather than long term climate changes, the impact of such variables on the growth and yield of crops has to be studied in detail. More investigations are required to understand the short and long term effects of climate change in the case of plantation crops through crop-simulation models. Hence, R&D initiatives are needed in climate change adaptations for sustainable agricultural production in the state.

Climate change poses significant threats to fisheries on top of many other concurrent pressures such as overfishing, habitat degradation, pollution, introduction of new species and so on. It is likely going to lead fluctuations in fish stocks which will have major economic consequences for many vulnerable communities and State economy that heavily depend on fisheries. Changes in biophysical characteristics of the aquatic environment and frequent occurrence of extreme weather events will have significant effects on the aquatic ecosystems that support fisheries and aquaculture. This will also affect food security in multiple ways.

Outbreak of epidemics, flood, drought, biodiversity loss and ecosystem damages, heavy loss in agriculture, landslides, traffic problem, economic loss, social vulnerability etc., are some of the possible impacts of extreme weather events. Extreme temperatures, both maximum and minimum temperature, have particular importance due to relationship with biodiversity and human thermal comfort.

In recent years, Kerala Government has taken initiatives to assess the vulnerability due to climate change in different sectors, like agriculture, geology, hydrology, forestry, fisheries, energy, health, etc in the state for implementing the possible adaptation/mitigation measures. It is important to caution for the possible impacts of extreme weather events in the region. Management measures such as compensation for the loss of agricultural production and crop damage, epidemic control precautions, natural disaster mitigation strategies etc., need to be considered in the region as a part of risk management of changing weather events under the climate change scenario in the southern peninsular region of India.

Dr. R Krishna Kumar, former joint director, RRI





## India formally joined the Paris Agreement on Climate Change

India has formally joined the Paris climate change agreement by submitting country's official ratification documents to the United Nations on 02 October 2016, the birth anniversary of Mahatma Gandhi. The climate change plan was initially agreed upon by more than 180 countries at the Paris climate conference in 2015. It was signed on the Earth Day (22 April 2016) by 175 countries, including India. But under its terms, the Agreement will not become binding until it is ratified by 55 countries that contribute a total of at least 55% of global greenhouse gas emissions.

The 55-country requirement has already been fulfilled - India is No. 62 - but the emissions percentage still falls short. Even with major polluters like the US and China signing on early, and including India's addition, the current signatories account for about 52 percent of global greenhouse emissions, according to a statement of UN.

Even though it has been the world's third-largest source of carbon emissions since 2011, India's per capita emissions are barely one third of the global average. India currently produces about 4.5% of the world's greenhouse gas emissions. The main reason for India's high overall emissions is its reliance on coal. India obtained 55% of its energy from coal in 2013 almost twice the global average of 30%.

The Paris Agreement requires all countries who ratify it to come up with a national plan to limit global temperature rise, and as part of its plan India has set a goal of producing 40% of its electricity with non-fossil fuel sources by 2030. In addition this, as mentioned in the 'Intended Nationally Determined Contributions' communicated by India in the Paris Agreement, India is committed to put forward and further



propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation; to reduce the emission intensity of its GDP by 33-35% by 2030 from 2005 level; to adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development; to create an additional carbon sink of 2.5 to 3 billion tonnes of CO<sub>2</sub> equivalent through additional forest and tree cover by 2030; and to better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly in agriculture, water resources, coastal regions, Himalayan region, health and disaster management

## Deal on cutting HFC gases



Delivering the second major international agreement in less than a year to fight climate change, 197 countries adopted an amendment to the 1989 Montreal Protocol in Kigali, Rwanda, on 15 October 2016 to eliminate planet-warming HFC (hydrofluorocarbon) gases. The amendment will allow the use of ozone-saving Montreal Protocol to phase-out HFCs, a set of 19 gases in the hydrofluorocarbon family that are used extensively in the air-conditioning and refrigeration industry.

HFCs are negligibly ozone-depleting but are greenhouse gases thousands of times more dangerous than carbon dioxide in causing global warming. The phase-out scheduled under the amendment is estimated to avert 70 billion tonnes of carbon dioxide-equivalent emissions between 2020 and 2050. This is considered equivalent to shutting down more than 750 coal power plants, each of 500 MW capacity, or taking about 500 million cars off the road from now to 2050. The time limits set for phasing out is different for countries depending upon the development status, thus for the developed countries it is 2018 and for India it is 2028. Thus the deal is clear cut example of shared but differentiated responsibility.

Complete elimination of HFCs by the year 2050 is estimated to prevent a 0.5°C rise in global temperatures by the end of this century. For this reason, the Kigali Amendment, as it is being called, is considered absolutely vital for reaching the Paris Agreement target of keeping global temperature rise to below 2°C compared to pre-industrial times.

As reported internationally, a group of developing countries, including China, Brazil and South Africa, are mandated to reduce their HFC use by 85% of their average value in 2020-22 by the year 2045. India and some other developing countries — Iran, Iraq, Pakistan, and oil economies like Saudi Arabia and Kuwait — will cut down their HFCs by 85% of their values in 2024-26 by the year 2047. According to experts, "this is a major breakthrough. The world has come together to curb climate-wrecking super-pollutant HFCs. This is the biggest step we can take in the year to after the Paris Agreement against the widening threats from climate change. And bringing HFCs under Montreal Protocol sends a clear signal to the global market place to start replacing these dangerous chemicals with a new generation of climate friendly and energy efficient alternatives".