WEATHER EXTREMES IN ISLAND AGRO-CLIMATIC REGION

Informed decision making through agromet advisory services

2017

AGROMET FIELD UNIT - PORT BLAIR

ICAR-CENTRAL ISLAND AGRICULTURAL RESEARCH INSTITUTE

PORT BLAIR-744 101

and

AGRIMET DIVISION

INDIA METEOROLOGICAL DEPARTMENT, PUNE

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हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

2017

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Preface

Information on soil, water, crop production and protection, livestock management, weather parameters etc. are vital for agricultural planning and enhancing production in the islands. Managing the risk associated with climate variability or vagaries of weather is integral to any comprehensive strategy for adapting agriculture and food systems to a changing climate. Accurate information on weather particularly occurrence of flood and moisture stress and suitable advisories on various aspects of agriculture based on current weather offer great potential to help farmer decision-making process in the face of increasing uncertainty, improve management of climate-related agricultural risk, and help farmers adapt to change. In addition, providing weather based agricultural advisories at district level will be immensely helpful to the farmers to know the recent crop production methods/ techniques, plant protection measures, input management in addition to best practices in livestock farming and aquaculture.

This is very much pertinent to Andaman and Nicobar Islands located in the remotest part of the country. The location, crop and livestock specific farm-level advisories as well as descriptions of prevailing weather, soil and crop conditions, and suggestions for taking appropriate measures will minimize losses and optimize inputs in the form of irrigation, fertilizer or pesticides. Therefore, location-specific weather forecasts in the medium range hold greater potential for tailoring content and format to farm-level decision-making, more particularly, for resource poor and tribal farmers. Since June 2008, CIARI in collaboration with agromet division of IMD, Pune has helped the island farmers in timely operation and efficient use of available resources through its widely circulated agromet advisory services. In addition, the institute has greatly improved and expanded its services to provide agro-meteorological information to all the stakeholders through the internet and mobile based applications.

This publication is the outcome of our experiences gained over the years which is further reinforced by the literature updates, experiences gained at national level on agromet advisories, farmers' experiences and climatic data analysis. The ultimate objective of this technical bulletin is to improve agricultural productivity by appropriate methods and timely management of resources in accordance with the prevailing weather conditions. This will also help in long term crop planning, land development and agricultural planning in various sectors of agriculture.

Authors

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1. The Island Region: An Introduction

1.1 Geographical location

The Andaman and Nicobar archipelago comprises of about 556 small and big islands with a coastline of 1,962 km between 92-94° E longitude and 6-14° N latitude in the Bay of Bengal (Fig. 1) with a total geographical area of 8,249 sq km. The northern group of islands forms the Andaman Islands, while the southern group of islands forms the Nicobar Islands, which is separated by 10° channel. The North Andaman, Middle Andaman, and South Andaman islands occupy major land mass. The Andaman and Nicobar group of islands fall under hot humid to par humid island climatic region designated as the island region 15. The tropical ecosystem of the Andaman and Nicobar Islands is very unique having diverse species with wide range of genetic diversity in varying density. High rainfall, extremely humid climate, undulating terrain and backwater creeks are very conducive for faunal and floral diversity. Evergreen and littoral forests, mangroves and coral reefs are important components of the existing ecosystems prevailing in the islands. The total population in these islands is about 3,79,944 (Population Census, 2011). Out of 556 islands, 38 are inhabited in which 25 are in Andaman group and 13 are in Nicobar group of islands.

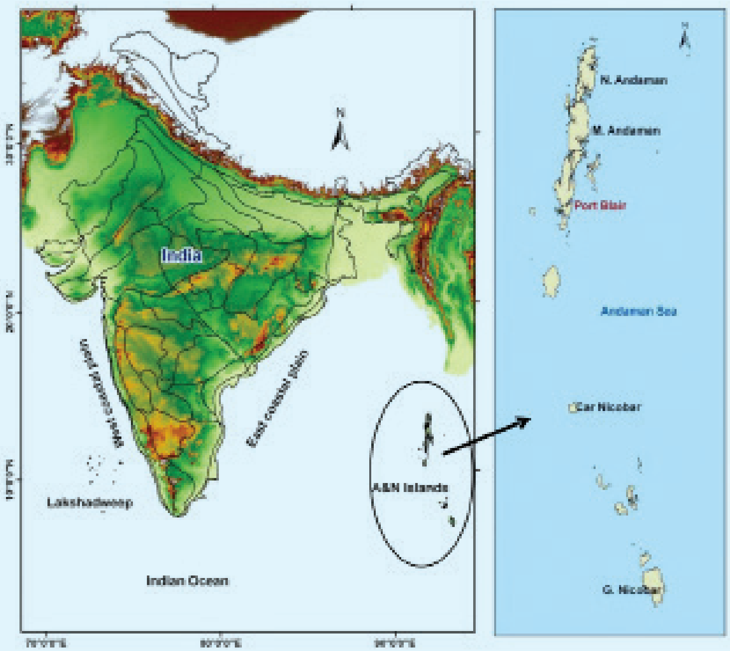


Fig. 1. Meteorological sub-divisions of India and location of A&N Islands

1.2 Physiography and Land use

The topography of Andaman and Nicobar islands is rolling with low range hills to narrow valleys at the foothills forming undulating terrain ranging from steep slopes (>45°) to plains (<5°). The soils are formed by the dominant influence of climate and vegetation. Soils are medium to deep, red loamy including marine alluvium derived soils along the coast. They qualify for the Great Groups of **Hapludalfs, Dystropepts, Eutropepts** and **Sulfaquents** (along the coast). The soils have low to medium available water holding capacity, slightly to strongly acidic in nature and are moderate to low (40- 70%) in base saturation. Seasonal salinity (4.0 - 5.9 dSm^{-1}) along with acidity (pH 4.8 - 5.4) is the major constraint for crop production (Singh and Mongia, 1985).

Forest covers nearly 86% of the total geographical area of 8249 km^2, agriculture and other land uses accounts for the remaining area. The land distribution system during the settlement, in general, allowed each settler 4.4 ha of land consisting of 2 ha of low-lying paddy land, 2 ha of hilly land generally planted with coconut, arecanut, banana, papaya and spices and 0.4 ha land for the homestead. Agriculture is dominated by plantation crops in the hill slopes followed by rice in the valley and coastal plains wherein soil and climate play a major role in limiting rice productivity. Coconut and arecanut grown mostly in the side slopes of longitudinal hills alone accounts for 53% of cultivated area followed by oil palm and rubber grown in the undulating terrain. Pulses are mostly grown in North Andaman after the harvest of rice while vegetables are predominantly grown in slightly elevated land in North and Middle Andaman Islands.

1.3 Observed climatic pattern

The Planning Commission of the Government of India, divided the country into 15 broad agro-climatic zones (ACZ) based on physiography and climate, with a view to develop the resources and their optimum utilization in a sustained manner within the framework of resource constraints and potential of each region. Andaman and Nicobar islands falls under island region (15) which is very unique having diverse species with wide range of genetic diversity in varying density. High rainfall, extremely humid climate, undulating terrain, deep islets and creeks are very conducive for faunal and floral diversity.

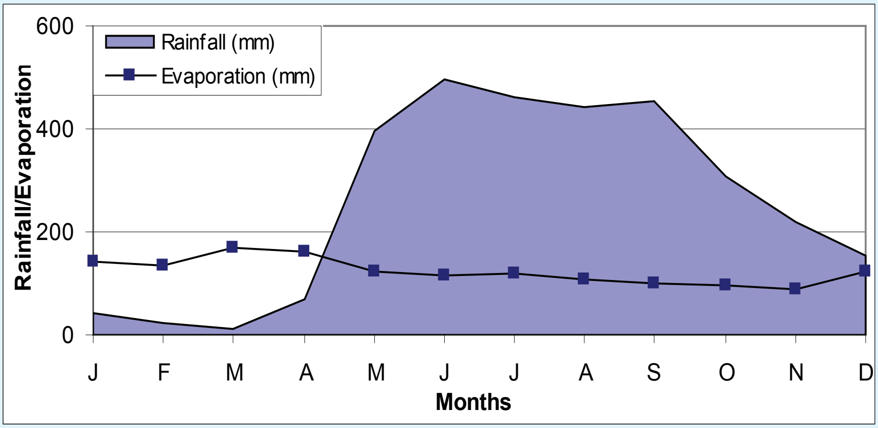


Fig. 2. Monthly average rainfall and evaporation

Evergreen and littoral forests, mangroves and coral reefs are important components of the existing ecosystems in the islands. On an average, these islands receive 3074 mm of rainfall distributed over 7- 8 months but deficit moisture is experienced from January to April (Fig. 2). The relative humidity varies from 68 to 86% and the maximum and minimum temperature is 32 and 22 °C, respectively. The undulating terrain results in severe water crisis during the period which is aggravated by higher evapotranspiration. The LGP is more than 210 days which is long enough to support double cropping system and plantation crops grown in the area. Presence of rich flora and fauna establishes that the climate is congenial to many cultivated crops, livestock and fisheries.

2. Occurrence of Flood and Drought in the Island

2.1 Occurrence of flood and drought

India is susceptible to floods due to its geographical location surrounded by water on three sides and droughts caused by combination of natural, physical and anthropogenic factors. At times one part of the country is affected with flood while other part happens to reeling under drought. Out of the total geographical area of India, about one-sixth area with 12% of the population is found to be susceptible to drought and 8% of the total area of India is cyclone prone. This severely challenged the food security of India. Therefore, there is a need to identify the most severely flood and drought affected areas so that contingency measures can be taken at appropriate level. This requires recording and analysis of climatic data in spatio-temporal scale.

The island ecosystem of Andaman and Nicobar island receive more than 3050 mm annual rainfall spread over 7-8 months while moisture deficit is experienced during February to April. The crop growing season in A & N islands can be grouped into wet and dry season. Wet season is between May to November during which rainfall is received in 126 rainy days and the evaporation is much lesser than rainfall during the period. The dry season starts mostly from second fortnight of December to April, which has on an average only 17 rainy days. During this period evaporation is much higher than rainfall making crop production difficult without irrigation facilities.

In Andaman and Nicobar full scale meteorological drought won't occur as it is located in the humid zone. But due to high evaporation coupled with rapid loss of water from soil due to gravitational movement of water, stress is experienced in the plant. This happens probably when the length of dry spell exceeds more than 10 days. Therefore, in this island moisture stress itself very significant in affecting the crop performance which is very prominent during the dry season.

2.2 The historical pattern

The historical climatic pattern of these Islands is presented in table 1 which indicated that the wettest year 1961 received as high as 4370 mm of rainfall and driest year 1979 received 1577 mm of rainfall. However, there was lots of variation in different months even within the wettest and driest year. The heaviest rainfall recorded in 24 hours is 374 mm during 1976 which caused severe floods. Similarly from January to April very scanty rainfall is received with the length of dry spell ranging from 10 to 110 days in different years. The usual range of wind speed varied from 5 to 15 kmph in different months, but during cyclonic weather it can exceed 60 kmph.

Table 1. Historical climatic pattern of A&N Islands

Month	Max. RH (%)	Max Clouds (okta)	Rainfall					
			Total (mm)	No. of Rainy days	Total (mm) in wettest month with year	Total (mm) in driest month with year	Heaviest fall in 24 hours	Date & Year
Jan	77	4.7	052.2	2.8	583.7 1912	000.0	208.3	22 1922
Feb	74	3.8	020.3	1.3	180.1 1961	000.0	131.1	07 1902
Mar	73	3.8	009.9	0.9	206.3 1910	000.0	67.1	26 1881
Apr	75	4.9	072.8	3.7	446.8 1974	000.0	206.8	20 1922
May	83	6.6	428.0	16.2	1060.6 1961	062.0 1934	264.9	31 1891
June	86	7.1	495.6	19.5	1054.1 1888	124.7 1966	258.3	01 1908
Jul	87	7.1	465.4	19.8	929.9 1959	133.9 1929	166.0	20 1964
Aug	87	7.1	441.6	19.3	924.8 1934	72.9 1932	173.2	13 1934
Sep	88	6.6	469.4	18.4	1123.0 1954	126.2 1927	191.1	01 1970
Oct	87	6.0	321.1	16.1	579.9 1889	82.3 1930	153.2	11 1926
Nov	84	5.5	225.9	11.9	648.7 1907	24.1 1931	147.3	09 1901
Dec	79	5.1	186.6	5.9	709.7 1980	1.7 1979	**374**.3	31 1976

2.3 Frequencies of rainfall distribution

The total rainfall received in any year may not exactly reflect the occurrence of flood or moisture deficit situation. Though the island receive high amount of total annual rainfall there are large monthly variations, rainfall intensity and its distribution. The long-term average (1970-2005) rainfall was categorised into **No rain**, **very light rain, Light rain, Moderate Rain, Heavy Rain, Very Heavy Rain and Extremely Heavy Rain** based on the amount of rainfall received (Fig. 3). The data showed that no rainfall is received in 49% of days in a year. Higher percentage of rainy days occurs under moderate rainfall category followed by very light rain, light rain and heavy rain. Very heavy rainfall occunts for only 0.26% and extremely heavy rainfall (0.01%) is used to be a rare occurrence. Drought and floods normally occurs during no rainfall and very heavy rainfall days, respectively.

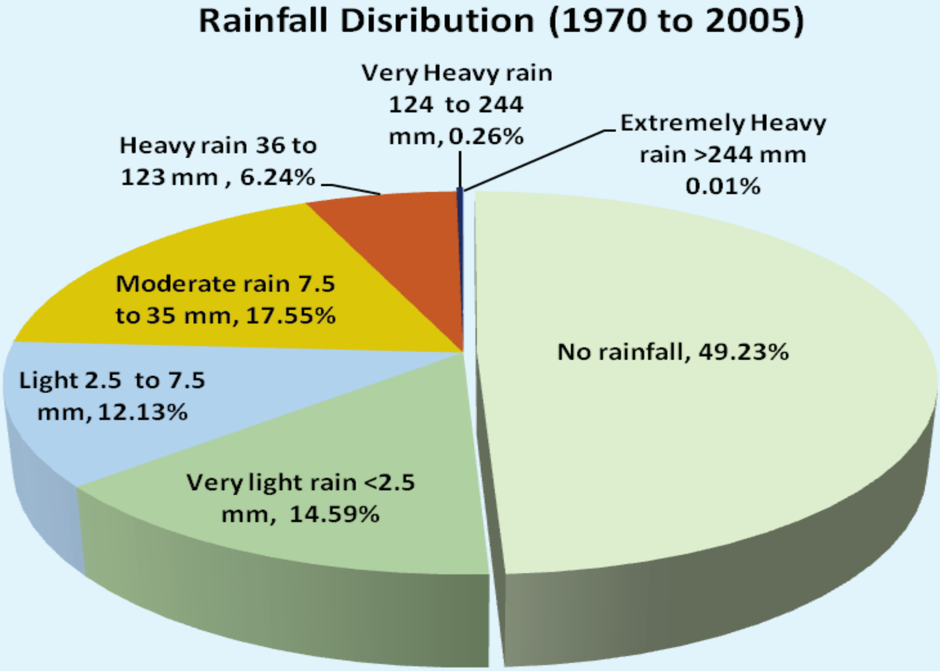


Fig. 3 Frequencies of rainfall distribution (1970-05)

Such pattern of rainfall distribution and the emerging climate change situations stress the transformation of island agriculture as it is practised today to a resilient agricultural system (Fig.4). The resilient agricultural system is a combination of different agricultural practices which aim at providing better resistance and adoptability to the crops, livestock, fisheries to various natural disasters such as floods and drought besides efficient use of natural resources.

Flooding of rice field

Mulching to reduce moisture loss

Fig. 4 Effect of flood and drought management

3. Importance of Agromet Advisories

Managing the risk associated with climate variability or vagaries of weather is integral to any comprehensive strategy for adapting agriculture and food systems to a changing climate. Although farming communities throughout the world have survived by mastering the ability to adapt to widely varying weather and climatic conditions, increasingly erratic climate variability and the rapid pace of other drivers of change are overwhelming indigenous knowledge and traditional coping practices. Effective climate information and advisory services based on current weather offer great potential to help the farmers in decision-making in the face of increasing uncertainty, improve management of climate-related agricultural risk, and help farmers adapt to change (Fig.5). In addition, providing crop penology centric advisories for a district or block will be immensely helpful to the farmers to know the recent crop production methods/ techniques, plant protection measures, input management in addition to best practices in livestock farming and aquaculture.

Fig. 5 Sowing of land was postponed dur to forecasted heavy downpour

Andaman and Nicobar islands are located in the remotest parts of the country. More often access to timely and relevant information in the form of agricultural advisories is greater constraint to improve the agricultural production and minimise the input losses. In recent times the developments in information and communication technology made it possible to reach out to the farmers to assist him in operational decision making in farming. The AMFU, Port Blair has established direct contact with more than 9,500 farmers across different islands to disseminate such information. The location, crop and livestock specific farm-level advisories as well as descriptions of soil and crop conditions, and suggestions for taking appropriate measures based on the severity of drought or flood will minimize losses and optimize inputs in the form of irrigation, fertilizer or pesticides (Fig.6).

Fig. 6 Timely application of fertilizers enhances the efficiency

In addition, forecasts issued can be fine-tuned to the specific requirements of farmers particularly during the extreme events. This is much more pertinent to Andaman and Nicobar Islands as the climatic condition of the islands favours the prevalence of parasitic diseases in cattle but the isolated location of these islands offer scope for its containment if detected and treated in time. Therefore, location-specific weather forecasts in the medium range (3-10 days in advance) and advance information on drought and flood hold greater potential for tailoring content and format to farm-level decision-making, more particularly, for resource poor and tribal farmers. In addition, web-based services have been greatly improved and expanded to provide agro-meteorological information to all the stakeholders at all times through the Internet.

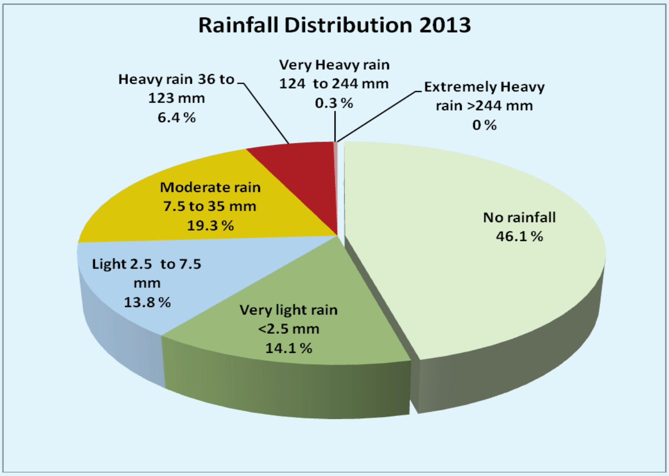
4. Recent changes in weather pattern

Analysis of observational data showed a global mean temperature increase of around 0.6°C during the 20th century, while mean sea level rose by about 2 mm/yr, although sea-level trends are complicated by local tectonics and El Niño-Southern Oscillation (ENSO) events (Mimura et al., 2007). Owing to their high vulnerability and low adaptive capacity, small islands have concerns about their future, based on observational records, experience with current patterns and consequences of climate variability, and climate model projections. Although emitting less than 1% of global greenhouse gases, many small islands have already perceived a need to reallocate scarce resources away from economic development and poverty alleviation, and towards the implementation of strategies to adapt to the growing threats posed by global warming (Nurse and Moore, 2005). With this background, it is understandable that development of short-term and long-term adaptation strategies is very pertinent to these islands. Some of the recent changes which are deviation from the observed climatic normal of Andaman and Nicobar islands need to be analysed to develop adaptation strategies and should be included in the weather based services to the stakeholder. This should essentially include forewarning about flood and drought and their management practices to minimise the production losses which are dependent on weather.

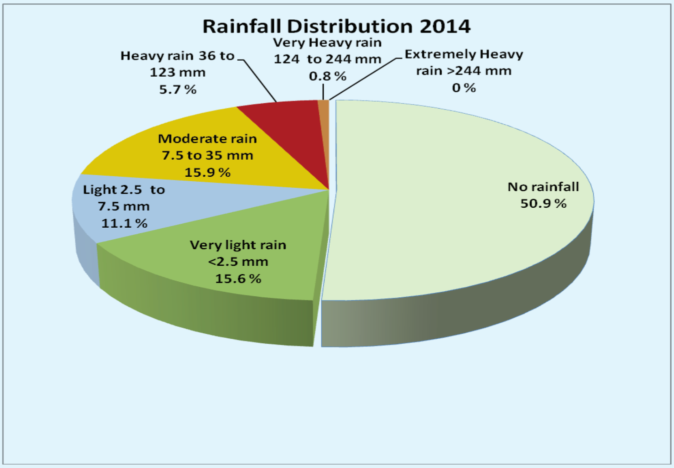
4.1 Rainfall frequencies

The climate regimes of small islands located in the Indian Ocean are predominantly influenced by the Asian monsoon; the seasonal alternation of atmospheric flow patterns which results in two distinct climatic regimes: the south-west or summer monsoon and the north-east or winter monsoon, with a clear association with ENSO events (Mimura et al., 2007). In response to the global level changes, in recent years, the rainfall pattern and its frequencies of Andaman and Nicobar islands have shown trend which are deviation from the climatic normal. Most of these changes were observed in its seasonal distribution pattern rather than annual mean values which results in extreme events perhaps with large uncertainty.

Analysis of rainfall frequencies of Andaman and Nicobar islands (2013-16) indicated increase in heavy to very heavy rainfall categories which ranged from 6.5 to 8.8% as compared to the climatic normal (6.5%). On the other hand the percentage of total rainless days and total rainfall remains more or less unchanged. This means that the total number of rainy days remains same but the category of rainfall event has changed. Yet this doesn't explicitly indicate anything on the occurrence of drought or moisture stress whereas flooding is experienced in different months due to increase in heavy rainfall events. The recent experiences of flooding from 2013 to 2016 showed that heavy rainfall is not the phenomena of monsoon season, it also happened even during the post monsoon and premonsoon season as well. Thus the analysis suggested that uncertainty associated with flooding has come down. In other words the predictability of flooding due to heavy rainfall has increased. The major rainfall frequency category is light to moderate rainfall which is the characteristic feature of island climate (Fig.7).

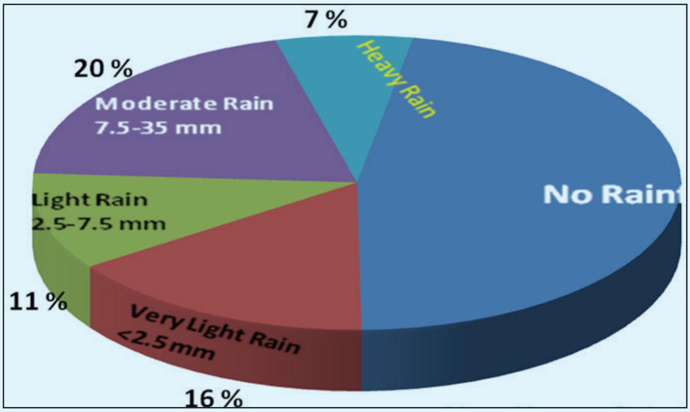


2013



2014

2015



2016

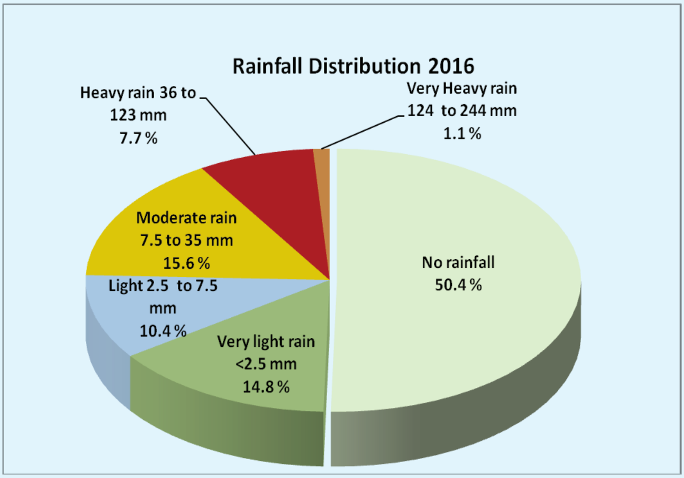


Fig. 7. Frequency distribution of rainfall during 2014-16

4.2 Monsoon performance

The performance of monsoon is vital for agricultural growth and food security of our country. Of late, it started reflecting on our overall economy as well. In Andaman and Nicobar Islands the performance of rainfall during monsoon and summer season is equally important, as the entire island is rainfed. The islands receive rainfall from both southwest and northeast monsoon. Since the islands are mostly discrete and the topography, types of vegetation, forestry as also the geographical localizations are varied, it reflects in the rainfall distribution which are highly varied and anomalous. This can be evidenced from the rainfall record of the islands. The long period average (LPA) of the annual rainfall of the islands for the period 1949-2005 is 3070 mm which is received in 143 rainy days. The South-West monsoon

(June - September) accounted for 60.8 % of total annual rainfall followed by 22% in North-East monsoon period (October-December). Only 4.8% of the total rainfall is received during summer (January- April) and the rest 12.3% is received during post monsoon season (May). Out of twelve months in a year these islands experience wet condition for 8 months and the remaining 4 month dry condition. During the active monsoon periods, occasionally, a few low-pressure waves originating in the ITCZ move westwards across the southern peninsula without touching Andaman Sea or Western Bay of Bengal. When this happens there is a sudden decrease of rainfall over this island along with intensive solar radiation which favours high evapotranspiration. This creates a break in monsoon consequently stress in the plant system particularly kharif rice due to high evapotranspiration and soil moisture deficit.

During 2016 the Islands received a total annual rainfall of 3542.8 mm which was 97% of the total annual rainfall while only 3% of total rainfall was received during summer season. As compared to 2015 performance it was 14% excess rainfall but during summer rainfall was deficit. The average rainfall of 5 years (2011-15) showed that 88% of total annual rainfall was received in monsoon season while 12% was received during summer season. In rainfed agriculture with high rainfall and evapo-transpiration, distribution of rainfall rather than total amount is very important for crop production. Because even if it is little amount summer rainfall is vital for the success of crop production during dry period whereas deficit or deviation from normal will results in moisture stress or some times poor crop performance. Although it is not a repeating event in a decadal scale, this indicated deviation of monsoon pattern rather than trend.

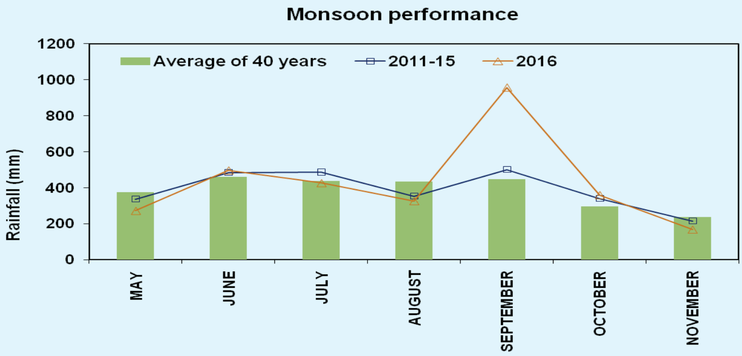


Fig. 8. Vatiation in monthly rainfall during the monsoon period

In recent years rainfall has increased towards the end of the monsoon period which makes up the early period deficit and the total monsoon season rainfall. But it is received in the form of heavy rainfall resulting in flooding during September-October months (Fig. 8). The data presented above supports the view that the southwest monsoon is well marked over these islands but the activity of the southwest monsoon is not uniform in time and space during the whole season.

4.3 Temperature

4.3.1 Maximum temperature

The tropical island of Andaman and Nicobar experience hot and humid climate which is strongly influenced by the conditions of the surrounding sea. Normally summer months maximum temperature ranges from 28 to 32 ^{o}C and beginning from January it starts increasing. It moves up and down around the normal mean but with in -1 ^{o}C to +1 ^{o}C. However, in recent times the maximum temperature is always above the normal temperature by more than 1 ^{o}C. This is in conformity to the IPCC projection of general warming trend in surface air temperature in all small-island regions and seasons (Lal et al., 2002). This changes in air temperature is categorised as normal (-1 ^{o}C to +1 ^{o}C), above normal (+2 ^{o}C), appreciably above normal (+3 ^{o}C to +4 ^{o}C), markedly above normal (+5 ^{o}C to +6 ^{o}C) and above +7 ^{o}C is indication of severe heat wave condition. In Andaman and Nicobar Island the temperature rises during the post monsoon season beginning from December. This rapid rise in temperature will accelerate the rate of evaporation resulting in soil moisture depletion and moisture stress in the plant.

It was observed that during January to April (2011-15) the maximum air temperature was higher compared to the 20 years average maximum temperature. Similar trend was observed for the same period in 2016 as well. For January and February it was above normal (+2 ^{o}C) and during March-April it was appreciably above normal (+3.5 ^{o}C). In January 2016 it was markedly above normal (+6.4 ^{o}C) temperature making it one of the hottest January month in the last two decades. On an average the maximum temperature during the summer months of 2011-16 were above normal. This may have link with the global warming phenomena or long term cyclical changes but the aberration has profound effect on the island agriculture and water resources (Fig.9).

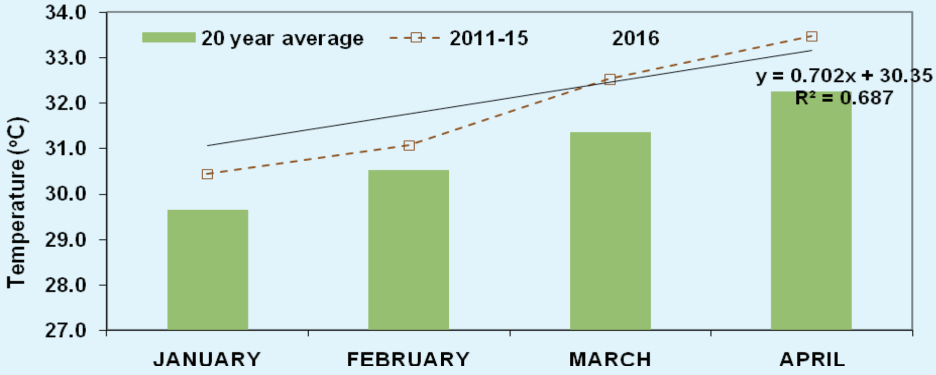


Fig. 9. Variation in summer months maximum temperature

4.3.2 Minimum temperature

The increase in minimum air temperature is very important aspect of global climate change than the maximum temperature. This affects several life processes besides adaptation and survival of plants and animals. This is more pertinent to the biodiversity rich Andaman and Nicobar Islands. The analysis of minimum temperature from 2011 to 2015 showed that during January - February, the increase was markedly above normal while during March - April it was appreciably above normal. In 2016 rapid increase in minimum temperature touched severe heat wave condition. In other words, February 2016 experienced warmer nights in the last two decades (Fig.10).

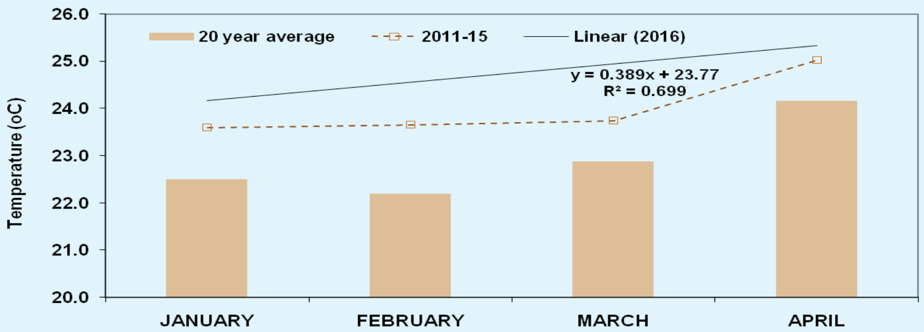


Fig. 10. Variation in summer months minimum temperature

The analysis showed that the percentage of days having very warm maximum or minimum temperatures has increased considerably since the 2011 while the percentage of days with cold temperatures has decreased when compared to the long-term average. In this context it is worth mentioning that IPCC report also the projected increase in surface air temperature for all regions of the small islands for the three 30-year periods (2010 to 2039, 2040 to 2069 and 2070 to 2099) relative to the baseline period 1961 to 1990 using coupled atmosphere ocean general circulation models (Ruosteenoja et al., 2003). Considering the importance of minimum temperature during night issue of advisories covering livestock, crop management and post harvest processing would be immensely useful to the farmers.

4.4 Post Monsoon rainfall

In recent times rainfall distribution during post-monsoon season (January – April) recorded significant changes besides observable variations in total annual rainfall. These changes have become more prominent from 2012 onwards. From December-2013 to April-2014, different situations unfolded in the weather pattern which was different from the observed long-term trend (Fig. 11). During this period only 109.3 mm of rainfall was received with only 3 rainy days while the climatic normal was 284.4 mm with 16.5 rainy days. This was even different from rainfall (175.5 mm) and rainy days (11.1 days) recorded in the previous year (2012-13). The variation in weather pattern was more prominent from January to April 2014 (post-monsoon) during which only 1.3 mm of rainfall was received as against the climatic normal of 148.4 mm received over 10 rainy days. Last rainy day was recorded on 16th December 2013 followed by consecutive 141 days of dry spell making it the record dry spell over the Islands. In December 2016 and January 2017 excess rainfall of 69.4 % and 49.6 % respectively, was observed after deficit rainfall for 3 consecutive years. However, the trend reversed, and less than the normal amount of rainfall was observed for February-March, 2017. This is a matter of concern for post-rainy season crops as it has negative consequences on soil moisture conditions and biological productivity of these islands.

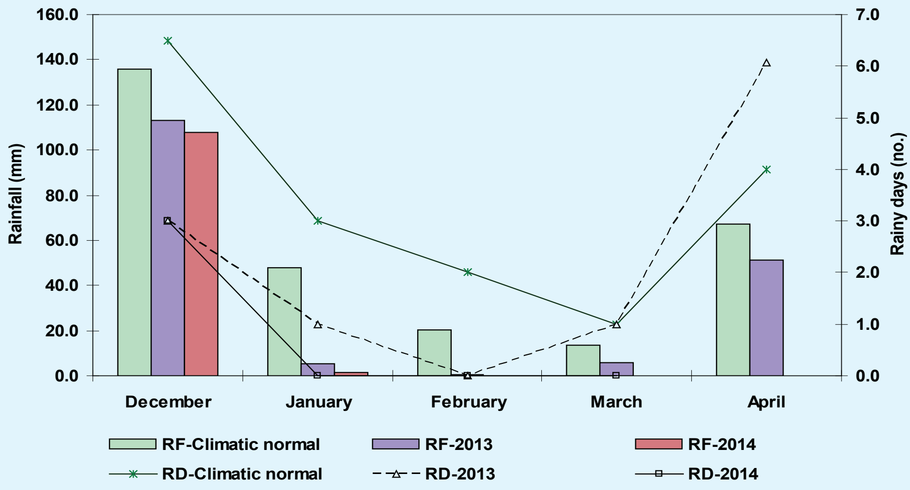


Fig. 11 Recent changes in rainfall and rainy days over Andaman Islands

Further, it was observed that the variations during the post monsoon season of 2014 are different from the long-term trend over these Islands. There are three possible reasons for these changes based on its teleconnection in South and East-Asian region and other published reports. It is reported that the El Nino Southern Oscillation (ENSO), Sea Surface Temperature Anomaly and small scale regional cycle linked to larger Pacific cycle. This kind of variations in global weather pattern is generally associated with the strength of ENSO. In February to March gradual development of El Nino events was observed and most of the models predicted ENSO-neutral (-0.5ºC to +0.5ºC) or El Niño (greater or equal to +0.5ºC) during 2014. But, it did not develop into a full ENSO and direct evidence for its link with the post monsoon dryness in the Island is also not clear. Because similar such long dry spell and low post-monsoon rainfall were also observed in 1980, 1986, 1997 and 2002 which were not an ENSO year. The historical analysis of Indian monsoon also showed that the presence of El Nino has not guaranteed drought (Sahai et al., 2003). However, most of these studies linked ENSO with Indian summer monsoon (south west monsoon) which usually starts by the end of May. In a recent study on Asian monsoon and its link with ENSO concluded that ENSO can only be considered as influential to the Asian monsoon rainfall pattern to an extent of its year to year variability (Kripalani and Kulkarni, 1997).

5. Weather extremes

The greatest seasonal change in global circulation is the development of monsoon while annual and monthly variations are reflected in the rainfall distribution. Conversely intensive solar radiations and high evaporation are experienced in certain months during which the rainfall is very low. As a result the tropical island of Andaman and Nicobar experiences hot and humid climate with a distinct wet and dry season. Sometimes these weather phenomena / features deviate significantly than the normal trend resulting in flood and moisture stress, denoted as weather extremes. This greatly affects the performance of island agriculture. In this context, the magnitude of loss can be minimised by dissemination of suitable but timely agromet advisories.

5.1 Flood

Although the south-west monsoon is well marked over these islands but the activity of the south-west monsoon is not uniform in time and space during the whole season. The intensity and the distribution of rainfall are controlled by a series of tropical disturbances (lows, depression and cyclonic storms) which either originate near the head of Bay of Bengal or arrive there from the China seas across South-East Asia. These low pressure systems move in a west-northwesterly direction crossing these islands causing heavy rainfall which results in flooding of lowlying areas (Fig.12).

A) A view of Rainfall extreme in south Andaman which hacks away transport to rural Areas

B) Paddy field totally submerged in rain

Fig. 12 Flood during a cyclonic storm

During the north-east monsoon period nearly 2 to 3 depressions and sometimes cyclonic storms are experienced over these islands resulting in heavy downpour. Sometimes cyclonic system develops close to Andaman and Nicobar islands. Consequently on an average 20 rainy days per month were experienced during the south-west monsoon period (June to September) whereas October and November (northeast) experienced only 15 rainy days. There were 12 cyclonic disturbances in region 7-14°N/92-94°E during pre-monsoon season and 32 disturbances during October – December (post-monsoon season) since 1901 to 2007.

However, there are large year-to-year variations in number of these low-pressure systems and their durations. Even when these depressions and lows are of normal frequency and intensity, their tracks determine the distribution of rainfall over these islands. There is no clear cyclonic tract over these islands and the geographical area is small to evade the influence of such cyclonic systems. For these reasons flooding is normally experienced all over the islands particularly in the coastal areas during August to October. Rarely flooding occurs during the post-rainy season due to local weather phenomena or late formation of depression. However, in 2012 South Andaman experienced a series of unprecedented downpours in the month of May, June and September. Thus, it can be said that the above-mentioned low-pressure systems occurring in the south-west and north-east monsoon is an important factor that controls the distribution of rainfall over these islands. These in turn affect water resource, soil moisture and agricultural production including livestock and fisheries.

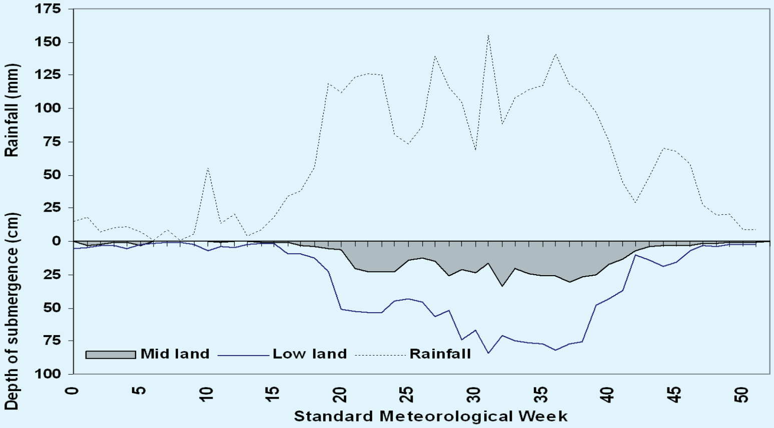


Fig. 13. Relationship between weekly rainfall and depth of submergence

In general, the depth of submergence recorded for both plains and foot slope in the coastal low land closely followed the rainfall pattern of the Island (Fig. 13). During the rainy season (20th -45th SMW) the depth of submergence ranged from 15 – 25 cm in the foot slope compared with 25-85 cm in the plain. Besides, the plains are also subjected to waterlogging with inundation of up to 15cm even during the dry season. Farmers in the plains have to leave the land fallow till mid-February because of the waterlogging until the next rice season (July-August). Further, plains are mainly influenced by the sea water inundation during high tides and the depth of submergence becomes higher when it coincides with high rainfall leading to impeded drainage.

5.2 Moisture stress

On the other hand during the summer months the evaporation exceeds the precipitation due to intensive solar radiation. Unlike the South Asian countries, rarely in some years these low-pressure systems are weak or scarce, resulting in less than normal rain but most of its effect is observed in its distribution. This results in occurrences of soil moisture stress of varying degrees rather than drought. Besides this, the undulating terrain and coarse soils favour gravitational movement of water from the soil. As a result moisture stress is experienced from January to April. Sometimes the length of dry spell exceeds more than 50 to 60 days causing severe moisture stress or drought like situations in the islands. For these reasons flooding and moisture stress of different magnitude have been an annual feature of Island climate.

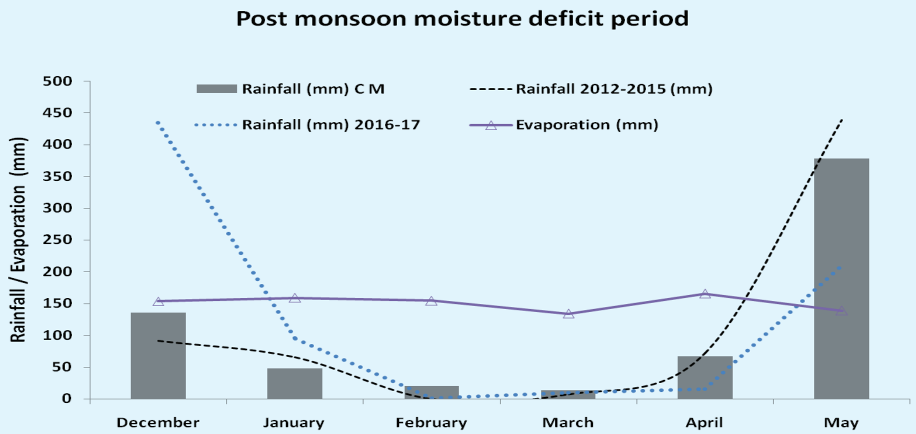


Fig. 14. Variation in moisture deficit during the summer months

Usually the rainfall commences from the third week of May every year but in recent decades it has receded to first week of June as happened in 2001, 2002 and 2003. In 2002 due to low premonsoon rainfall followed by delay in on set resulted in drought like situation and the water storage touched its lowest level. However, the major impact of moisture stress was observed during the post-monsoon season rather than break in monsoon. The analysis of historical weekly rainfall and the estimation of weekly probable rainfall showed that the probability of getting rainfall significantly decreases in post monsoon period during which the Island faces moisture stress condition. This was experienced from January to April during 2012-16 (Fig. 14). Consequently irrigation becomes essential to cope with the moisture stress in summer crops and plantations. In certain years (2002, 2014) the dry spell is too lengthy to manage besides high evapo-transpiration which resulted in crop failure.

In addition to this during this period low water availability was observed in pond and other water bodies which affected the aquaculture. Crops grown in hilly areas and slopes experienced severe moisture stress particularly arecanut and coconut, on which the livelihood of most of the island farmers are derived.

5.3 Cyclonic Disturbances

Several cyclones like Roanu, Kyant, Nada and Vardah were experienced during the year 2016 but among the cyclone only Nada and Vardah passed with significant impact to Andaman and Nicobar Islands. **Roanu** formed on 14th May 2016 and **Kyant** formed on 21st Oct 2016 in Bay of Bengal. The cyclone **Nada** formed on 29th Nov 2016 at Bay of Bengal and moved towards North-Westwards. During these cyclones heavy downpour was experienced throughout the island resulting in heavy floods in the coastal areas (Fig. 15).

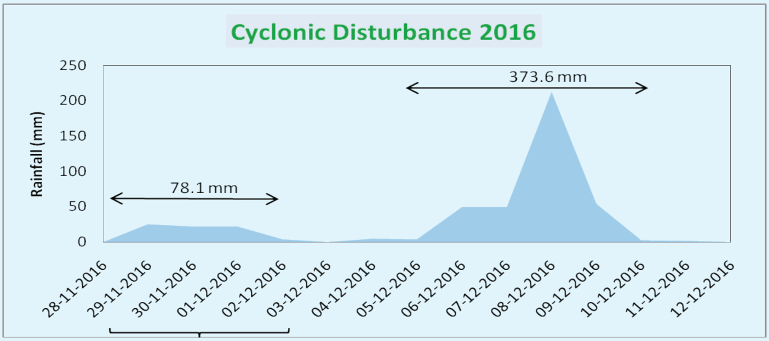


Fig. 15. Rainfall received during the cyclonic disturbances

After Cyclone Nada, **Vardah** was formed in Andaman Sea on 6th Dec 2016 and moved towards North-Westwards with deep depression over Andaman and Nicobar Islands. Thereafter it intensified into cyclonic storm to severe cyclonic storm within 7th to 9th Dec 2016 and moved towards Tamilnadu with wind speed of 120 kmph. During the cyclone Vardah Islands received a total 373.6 mm of rainfall. During which heavy rainfall was received during 6th, 7th and 9th Dec where as very heavy rainfall of 212.4 mm was received during 8th Dec 2016. During Vardah cyclone, the Islands faced severe damage to crops, land slide, flooding and damage to other infrastructure of the islands (Fig.16). Arecanut planted in upland area got damaged due to high wind speed and in North and Middle Andaman farmers faced damage to their kharif rice crops due to heavy rainfall followed by flooding. This also caused overflow of river and nallas however, there were spatial variations (Fig. 17 & 18).

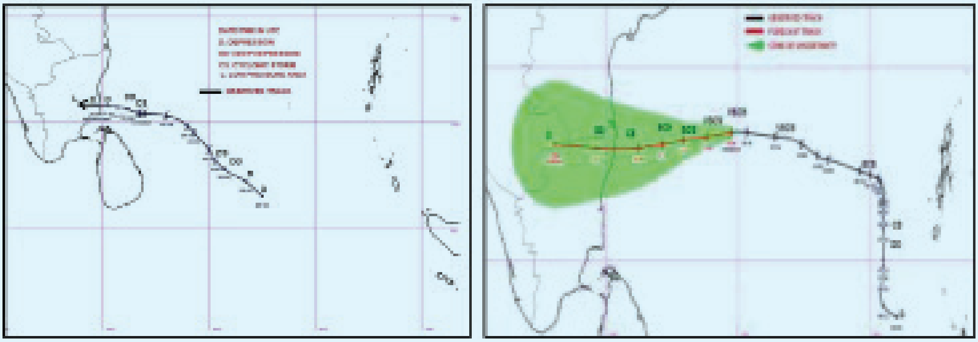


Fig. 16. The tract of cyclonic disturbances close to Andaman & Nicobar Islands

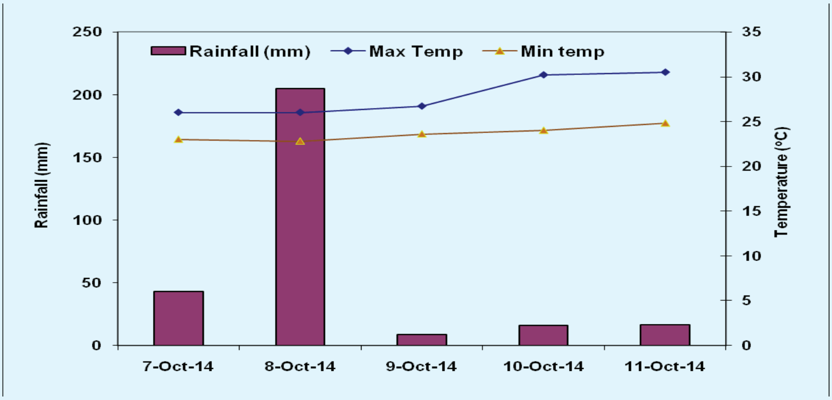


Fig. 17 Weather during the cyclone Hud Hud

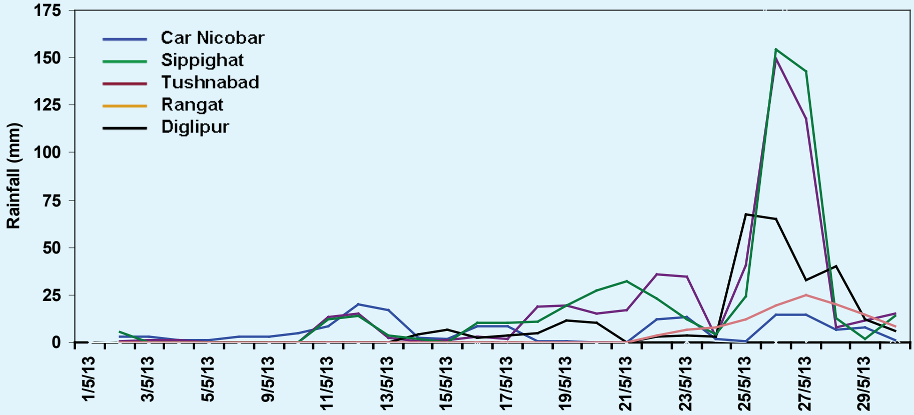


Fig. 18 Spatial variation in daily rainfall during the onset of monsoon

6. Standardized Precipitation Index (SPI) Map

6.1 Introduction

The Standardized Precipitation Index (SPI) is a tool which was developed primarily for defining and monitoring drought. The SPI is based on the probability of precipitation for any time scale and can calculate short term monthly upto 24 month of precipitation distribution. It can also be used to determine periods of anomalously wet events. Over the years, many other drought indices were developed and used by meteorologists and climatologists around the world. Drought indices, such as the Palmer Drought Severity Index (PDSI), Decile Index (DI, Surface Water Supply Index (SWSI) and Standardized Precipitation Index (SPI) (McKee et al., 1993), are the most common tools for detecting and monitoring droughts. There are also many different methodologies for monitoring drought. Droughts are regional in extent and each region has specific climatic characteristics. Temperature, wind and relative humidity are also important factors to include in characterizing drought. Drought means different things to different users such as water managers, agricultural producers, hydroelectric power plant operators and wildlife biologists.

6.2 Use fullness of SPI

Many drought planners use SPI map for future planning in different sectors. It is also used by a variety of research institutions, universities, and National Meteorological and Hydrological Services across the world as part of drought monitoring and early warning efforts. Gramin krishi mausam seva unit at CIARI, Port Blair, is using SPI map for the preparation of Agro Advisory bulletins and the same is disseminated to farmers and other stockholders. Long range seasonal bulletin for Andaman and Nicobar Island are also prepared based on SPI map and disseminate through media.

6.3 Strength

It ranges from extremely wet to extremely dry (2.0 to -2.0). The SPI (McKee and others, 1993, 1995) is a powerful, flexible index that is simple to calculate. In fact, precipitation is the only required input parameter. In addition, it is just as effective in analysing wet periods/cycles as it is in analysing dry periods/cycles. The program can run in both Windows and UNIX environments. The SPI can be computed for different time scales, provide early warning of drought and help assess drought severity.

6.4 Limitation of SPI Map

SPI can only quantify the precipitation deficit. During calculation or programme the presence of missing data will affects the confidence of the results. Values based on preliminary data may change, and values may get changed as the period of record grows.

6.5 Importance of SPI for Island region

Andaman and Nicobar Island is essentially dependent on precipitation for their agricultural and livestock sectors. The entire agriculture is rainfed and face severe water shortage during dry season. Population of these Islands fulfil their basic water requirement from fresh water dam which is exclusively recharged by rainfall. Drought analysis is very necessary for the Island and SPI is one of the strong tools which could help to manage the drought period of the Island. As there is no big river is present in the Island except Kalpong river which is situated at Digliput. The SPI map is capable to predicting short term as well as long term drought period which could be beneficial to various sectors of the Island's.

6.6 SPI Map of different period

The SPI map of India along with the Andaman and Nicobar Island represent different values with the time scale (Fig. 19). We took the SPI values (map) during drought and flood period and Pre and Post-monsoon season. From the dry period SPI map it was observed that in South Andaman, Little Andaman and Campbell bay mildly dry with the SPI values ranging from 0 to -0.99. During the same period, eastern region of India has SPI ranging from 0 to 0.99 with moderately dry, while other region it ranges -1 to -1.49 and most of the region mildly wet with range 0 to 0.99. During monsoon period, flood occurred in Andaman Islands and in Little Andaman SPI value was found to be more than 2.0 with extremely wet. However, in Campbell bay mildly wet was observed and in main land India most of the region experienced mildly wet during this period. During pre-monsoon South and Little Andaman as well as Campbell bay experienced SPI value of 2.0 and it indicated extremely wet while in eastern, western and southern India it was mildly wet. During the same period it was observed that northern India experienced mildly to moderately dry.

During Post monsoon season South Andaman and Campbell bay experienced mildly dry but in little Andaman mildly wet condition was experienced due to rainfall. In mainland India during this period the value greatly varied spatially with region experiencing mildly dry / severely dry / extremely dry but some region experienced mildly wet also.

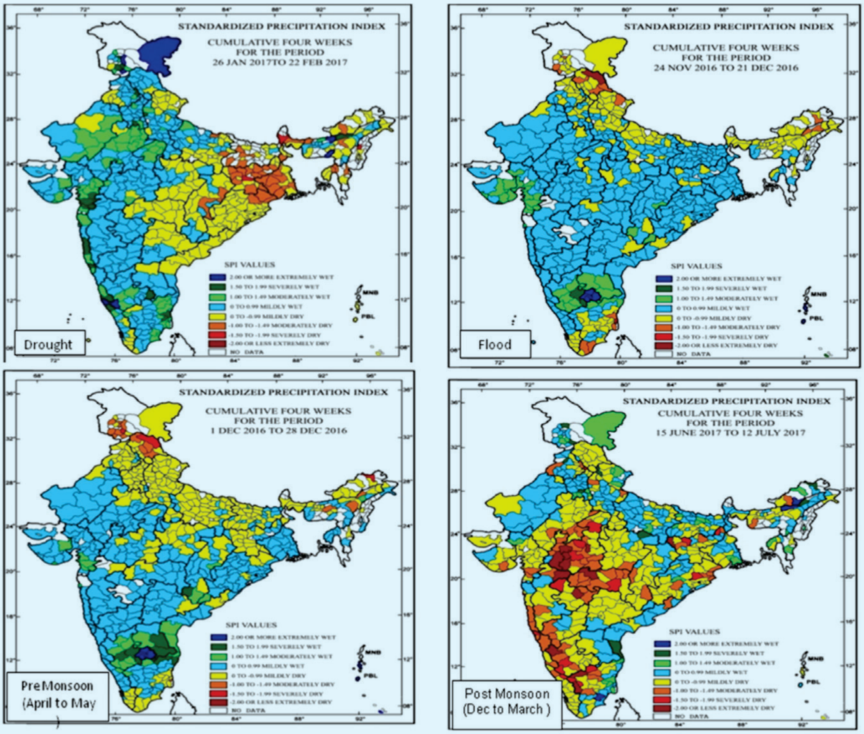


Fig. 19 SPI Map during Drought, Flood, Pre and Post monsoon

Legend	SPI Values	Description
	2.0 or More	extremely wet
	1.5 to 1.99	Severely wet
	1.0 to 1.49	moderately wet
	0 to 0.99	Mildly wet
	0 to -0.99	Mildly dry
	-1.0 to -1.49	moderately dry
	-1.5 to -1.99	severely dry
	-2 or less	extremely dry

SPI value analysis for drought and flood

After Programming and calculation of SPI value it was observed that it ranged from 0 to +2 and 0 to -2 which indicated various probabilities which were used to analyse the drought and wet period precipitation.

6.7 Island dry period SPI

Dry period SPI is depicted in Fig 20 and it is observed that during dry season, SPI values ranged from 1.5 to – 1.0 for explanation, SPI values of southern most Island Campbell bay and the central island South Andaman was considered. It was observed that Campbell bay experienced mildly dry during February and March with value ranging from 0 to -0.99 where as during the same period South Andaman experienced moderately wet indicating wide variation in rainfall distribution during the dry season. On the other hand, during April, mildly dry was experienced in South Andaman while Campbell Bay experienced moderately wet indicating summer season rainfall at Campbell bay with SPI ranging from 1.0 to 1.49.

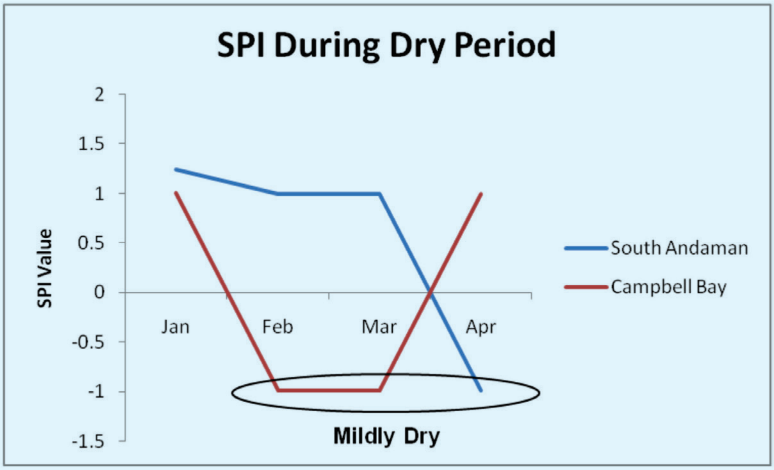


Fig. 20. Dry period SPI

6.8 Island Wet period SPI

In contrast to the dry period SPI, during wet period of the Island (Jue-Aug) Campbell bay experienced mildly dry with SPI value ranging from 0 to -0.99 (Fig. 21). At the same time South Andaman experienced moderately wet condition. The reversal was observed during the post monsoon season in South Andaman. During which severe depression or cyclonic weather was experienced particularly in recent time. This resulted in extremely wet and flood condition with SPI value of 2 or more.

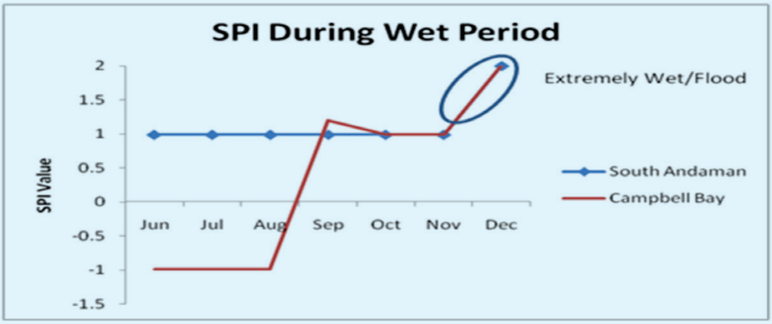
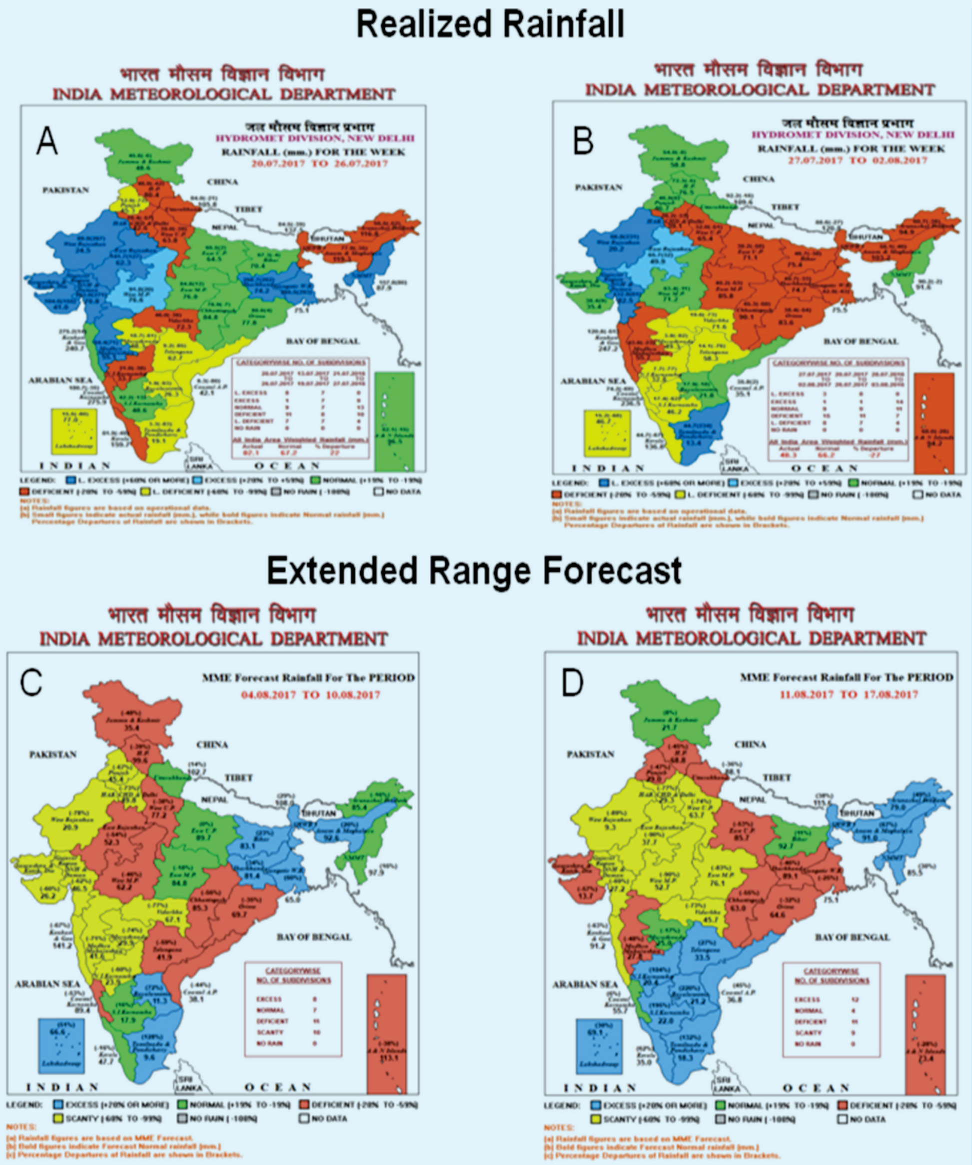


Fig. 21. Wet period SPI

7. Use of Realized Rainfall and Extended Range Forecast for the Preparation of Bulletin

Forecast given more than 10 days in advance is normally termed as extended range forecast. This forecast is used during preparation of agro advisory bulletin for the farmers. it helps to plan for precautionary measures and long term plan related to crop, land and livestock. This kind of extended weather based agro advisories minimises the losses, and help to mobilize the resources in a reasonable period of time. Realised rainfall and extended range forecast is issued weekly twice. In case of extended range forecast five categories are used to depict the expected situation in weather (Fig. 22).

- In Andaman and Nicobar Island, weekly realised rainfall from 20 to 26th July 2017 was 96.5 mm, for the same period the actual rainfall was 82.1 mm which was -15 % departure from the normal. In general the normal rainfall departure varies from +19% to -19%, therefore, it was normal rainfall.
- For the period from 27th July to 2nd August 2017, the normal rainfall is 94.2 mm and the actual was 68.0 mm which showed departure of -28 % which was termed as deficient (-20% to -59 %).. The deficit rainfall distribution is seen in the figure.
- The extended forecast for the period 4th to 10th August 2017 showed – 38 % deficient during which only 113.1 mm rain was received.
- Similarly the extended range forecast issued for the period 11th to 17th August 2017 showed departure of 28 % which is the deviation form the normal rainfall of 73.4 mm.



Legend	Category Description	Percent Departure of RF
	Excess Rainfall	+20% or More
	Normal	+19% to -19%
	Deficient	-20% to -59%
	Scanty	-60% to -99 %
	No Rain	-100%

Fig. 22 Realized and extended range forecast

8. Integrated Agromet Advisories

8.1 Advisory service

Climate information and advisories based on current weather offer great potential to support farmers' decision-making in the face of increasing uncertainty, improve management of climate-related agricultural risk, and help farmers adapt to change. In addition, providing crop penology centric advisories for a district or block will be immensely helpful to the farmers to know the recent crop production methods/ techniques, plant protection measures, input management in addition to best practices in livestock farming and aquaculture. Therefore, location-specific weather forecasts in the medium range (3-10 days in advance) hold greater potential for tailoring content and format to farm-level decision-making, more particularly, for resource poor and tribal farmers. This will help in timely operation and efficient use of available resources. In addition, web-based services have been greatly improved and expanded to provide agro-meteorological information to all the stakeholders at all times through the Internet. Realising the importance Agromet Advisory services was initiated on 23rd June 2008 at Central Agricultural Research Institute, Port Blair.

8.2 Advisories for all situations

In Andaman and Nicobar Islands the performance of rainfall during monsoon and summer season is equally important, as the entire island is rainfed. Therefore the advisories are regularly issued covering all the major sectors of agriculture such as Crop husbandry, Animal Science, Fisheries, Land and water management etc. The analysis of historical rainfall data at Central Island Agricultural Research Institute, Port Blair revealed that vegetable and arecanut production is significantly affected by summer monsoon. The onset and advancement of monsoon had less effect on rice production particularly on the long duration rice crop. However, heavy downpour during October and early November had negative effect on rice production due to lodging and crop damage. The available data may not provide concrete evidence of these changes with global climate change but it certainly traced some of the changes which are deviation from the normal. These changes are in the form of long dry days, less number of rainy days and break in monsoon which has consequences for agricultural and allied sectors.

The monsoon performance analysis found that 7 out of 15 weeks from May in 2015 and 8 out of 15 weeks in 2016 were recorded deficit rainfall. But, the survey indicated 85 % farmers completed paddy transplanting by end of August, 2015 and had little effect on rice production. In contrast, 16 out of 18 weeks beginning from 1st January 2015 to April 2015 was deficit as compared to the climatic normal. This was evidenced from drop in production of dry season vegetables and premature nut fall in coconut and arecanut in the last two years (Fig. 23). This calls for appropriate planning and judicious use of natural resources of the island.

Further it was observed that the island has experienced 50 – 75% deficit in summer rainfall in recent years which has high probability to continue. To tide over such situations farmers should start practicing summer / dry season management practices for crop and livestock production. It calls for efficient water harvesting and utilization technology to cope with the emerging situations. In dry months vegetables requiring less water, Louki, Karaela and Cucumber may be grown. During delay in monsoon, MAT nursery for raising rice seedling and system of rice intensification (SRI) methods of transplanting will enhances the yield.

Fish culturing of carp variety requires daily feeding of spawn with powdered rice bran and groundnut oil cake in 1:1 ratio @ 3 to 5 % of body weight. Similarly farm animals should be screened for nasal discharge, wound and injuries regularly and the services of veterinary doctor may be taken for treatment.

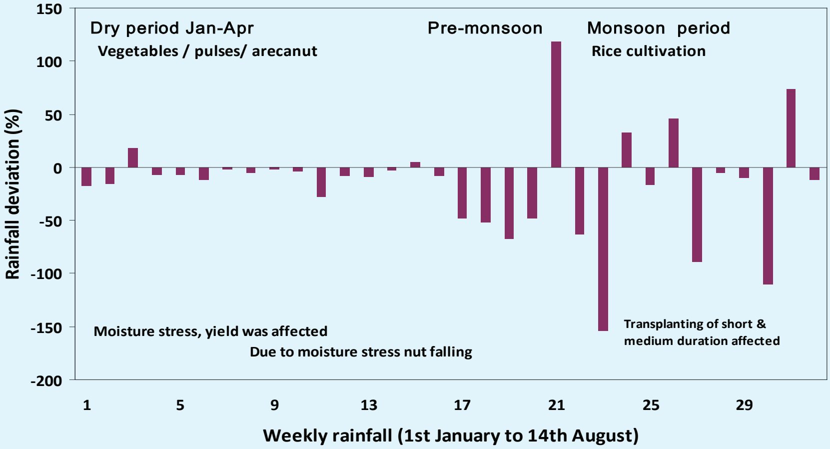


Fig. 23 General features of agro-advisory (2011-16) for the islands

8.3 General contingency practices

Under such conditions farmers should be suggested to follow the follwing contingency practices through adromet advisories.

Land and water management

- Prepare MAT nursery which requires only 15 days for raising the seedlings, if the rice sowing is delayed due to failure or heavy rainfall. Suggested for community nurseries and some cases direct sowing of sprouted seeds.
- Undertake sowing of contingent crops like fodder crops (Napier or sorghum multicut) i.e. maize (African tall) after receipt of sufficient rainfall, to get good green fodder during summer.
- During rainy season broad bed and furrow or raised beds can be used to cultivate cucurbitaceous vegetables as off season crop which fetch high price.
- Plantation crops such as Coconut, Arecanut, fruit plants such as banana and pineapple and spice crops like Black pepper, cinnamon and clove can be planted in monsoon season, but provide organic mulch or coconut husk mulch around the tree by the end of December to conserve moisture. This will help to with stand dry conditions.

Plant protection

- Observe for any stem borer incidence in the nursery, if observed apply *Trichogramma japanicum* @ 5 ml per ha at weekly interval, and clip the tip of the leaf before transplanting. Set up light trap to monitor the pest incidence.

Fisheries

- For successful fish culturing it is vital that the bund of nursery pond should be repaired and fencing with small meshed net to prevent entry of amphibians and snakes. Daily feeding of spawn with powdered rice bran and groundnut oil cake in 1:1 ratio @ 400% of initial body weight or 6kg/million/day should be done.

Livestock management

- Clean drinking water should be provided to animals during hot summer days and water troughs should be regularly cleaned. Most importantly animals to be screened for nasal discharge, wound and injuries regularly and the services of veterinary doctor be taken for treatment During the high rainfall or water logged conditions, animals need to be dewormed with suitable anti-helmentic drug and be checked and treated for ecto-parasites, if any.
- Ensure periodic vaccination of animals against FMD, Haemorrahagic Septicaemia and Anthrax to improve the productivity and reduce the mortality. In the case of poultry units day old chicks should be provided extra heat for brooding. As coccidiosis problem has cropped up during earlier monsoon period, keep the litter dry and mix bleaching power at the rate of 100 gm with litter material inside poultry shed.
- Add 20 gram of mineral mixture along with regular feeding of cattles.
- Keep newly hatched chicks under confinement with provision of fresh air, proper feed, water and most importantly under electric bulbs of 60 watts taking care of not getting too heat. Keep night shelters of backyard poultry birds dry and hygienic by lime sparaying after cleaning the faecal materials and other objects.
- Give colocasia to pigs for better growth. Colacasia should be cut into pieces, boiled, water drained and cut intompieces for being fed to pigs.

8.4 Dissemination of advisories – SMS, New papers, TV, AIR

The agromet advisories are prepared taking into account the existing ground situations and predicted weather conditions on every Tuesday and Friday. Advisories on land improvement, cropping systems and other larger changes requiring sufficient time and suitable weather conditions are also prepared and disseminated. During weather extremes pre and post incidence advisories are prepared and disseminated through mass media and personal contact with some of the progressive farmers.

Every year approximately 104 bulletins are issued separately on English and Hindi covering all the three districts of Andaman and Nicobar Islands. The bulletins are regularly published in the most circulated newspapers of the A&N Islands viz., The Daily Telegrams, The Echo of India and Dweep Samachar. The information is also broadcasted on All India Radio, Port Blair in Hindi and Tamil and telecasted on Doordarshan Kendra, Port Blair. Altogether 50 farmers are identified from various Islands for collecting the feedback on Agromet Advisory Services.

AMFU Port Blair at CIARI has activated **mkisan** portal on 24th June 2014. Followed by this a total of 9500 farmers from farmers of South Andaman, North and Middle Andaman and Nicobar Islands were registered. The registered farmers of three districts have been receiving advisories through SMSs on every Tuesday and Friday in Hindi and English which accounts for nearly 80% of operational holding of this island. The advisories cover all the major sector of Agriculture such as Crop husbandry, Animal Science, Fisheries, Land and water management etc. In addition, AMFU Port Blair is regularly uploading the Agromet Advisory Bulletin in IMD and CIARI web sites. In addition, advisories have been posted in a agromet whatsapp group. This has attracted the attention of not only the farmers but several other stakeholders across the country.

8.5 Verification of rainfall forecast

Verification of forecasted and observed values of rainfall is very important to know the reliability of disseminated information. It was carried out for pre- monsoon, monsoon and post- monsoon periods for Andaman and Nicobar districts (Table 2). During pre-monsoon season, out of 61 days of forecast, observed and forecasted occurrence of rainfall was matching 55 days for Andaman islands which was 21% higher than the last year forecast. But for Nicobar it was only 41 days matching cases which was less than the accuracy for Andaman. Similarly, for Andaman it was 99 days for monsoon which is 24 % lower than last year but Nicobar was better at 101 days. In post monsoon period Andaman recorded 81 days of matching case while it was only 73 days for Nicobar. The analysis (2016-17) revealed that premonsoon recorded highest percentage of correctness followed by post-monsoon and monsoon period. In general the predictability is fairly accurate for Andaman Islands than Nicobar. This also includes onset and passing over of depression indicating the useful of these information to the farmers during the preparatory cultivations. Pre-monsoon recorded 90.2 % of matching cases for Andaman whereas for Nicobar it was only 67.2 %. For monsoon season 54.1 % recorded for Andaman and 55.2 % for Nicobar.

Post-monsoon registered only 66.9 % for Andaman and 58.7 % matching cases for Nicobar.

Table 2. Verification of forecast

Sl. No.	Particulars	State	Pre Monsoon (April to May 2016)	Monsoon (June to Nov 2016)	Post Monsoon (Dec 2016 to March 2017)
1	No. of Day when rain was forecasted and also observed (YY)	Andaman	12	92	18
		Nicobar	8	97	36
2	No. of Day when rain was observed but not forecasted (YN)	Andaman	2	1	4
		Nicobar	1	5	3
3	No. of Day when rain was not observed but forecasted (NY)	Andaman	4	83	36
		Nicobar	19	77	45
4	No. of Day when rain was not observed and also not forecasted (NN)	Andaman	43	7	63
		Nicobar	33	4	37
5	No. of Matching case (YY+NN)	Andaman	55	99	81
		Nicobar	41	101	73
6	Skill Score or ratio score in rainfall	**Andaman**	**90.2**	**54.1**	**66.9**
		Nicobar	**67.2**	**55.2**	**58.7**

Verification of forecasted and observed values of actual amount of rainfall from first to fifth day of forecast was carried out for pre–monsoon, monsoon and post-monsoon period (Table 3). The results revealed that on an average forecasted and observed values are matching to the tune of 80.0 % during pre- monsoon period while it is only 40.7 % during monsoon season and 67.9 % during post-monsoon period. Throughout the year, the highest percentage of correctness was observed for first day forecast which recorded 66.2% of matching cases followed by second day forecast. The highest correctness was observed with 91.7 % both in the third day of pre monsoon season (Table 2).

Table 3. Per cent correctness of forecasted and observed values of rainfall during pre monsoon, monsoon and post monsoon period (difference of with in 10 mm is considered as correct)

Days after forecast	Premonsoon (April-May, 16)	Monsoon (Jun-Nov, 16)	Post monsoon (Dec14- 16 to Mar 17)	Mean
First day	75.0	48.6	75.0	66.2
Second day	75.0	42.5	75.0	64.2
Third day	91.7	32.0	62.5	63.0
Fourth day	75.0	44.4	62.5	60.6
Fifth day	83.3	36.1	62.5	60.3
Mean	80.0	40.7	67.9	

9. Success stories

Based on the forecasted weather and agro-advisories many island farmers have been benefited in terms of saving inputs, wastage of time and efficient use of agricultural inputs. In addition to the forecasting of extreme events their management or adaptive management is highly appreciated.

- During high wind speed farmers were advised to provide support to the banana or harvest the matured bunches to avoid damage. In Collinpur and Laxmipur village 5 progressive farmers followed the advisory and saved the crop. For the neighbours it was total crop loss due to the inclement weather.

- During the dry season, forecast of heavy rain (unseasonal) helped farmers to postpone land shaping activities in low lying areas of Chouldhari. This led to savings in cost of labour as labour cost is very high in this Island. Similarly, timely advice to the farmers based on low rainfall forecast during monsoon season helped the farmers to strengthen their field bunds of rice and mud plastering of bunds to store rain water. This helped to harvest the rainwater and saved the cost of irrigation during critical period of rice crop.

- In several instances after agromet advisory, farmers in South Andaman provided clean drinking water with glucose and vitamin C to the back yard birds to avoid heat stress during the summer months. This was issued based on the maximum-minimum temperature. Similarly during rainy season and cloudy conditions it was advised to vaccinate the poultry birds to avoid mortality. Poultry farmers from Chouldhari village (Sudhir Dutta, Swaran Singh and Kasiviswanath), S. Andaman greatly benefited from these advisories.

- Coconut slug caterpillar was wide spread in Neil Isalnd in May and June, 2017 during the dry weather. Gramin Krishi Mausam Seva of ICAR-CIARI, Port Blair taken initiative to manage the pest and measures to recover the plant (Fig. 24 &25). Awareness campaign was conducted and timely advices given through SMS, TV, Radio, News paper and personal contacts. The caterpillar incidence came down after the onset of monsoon. The pest is controlled by root feeding, biocontrol agents, light traps and burning the residues at night. This helped to save the total crop failure.

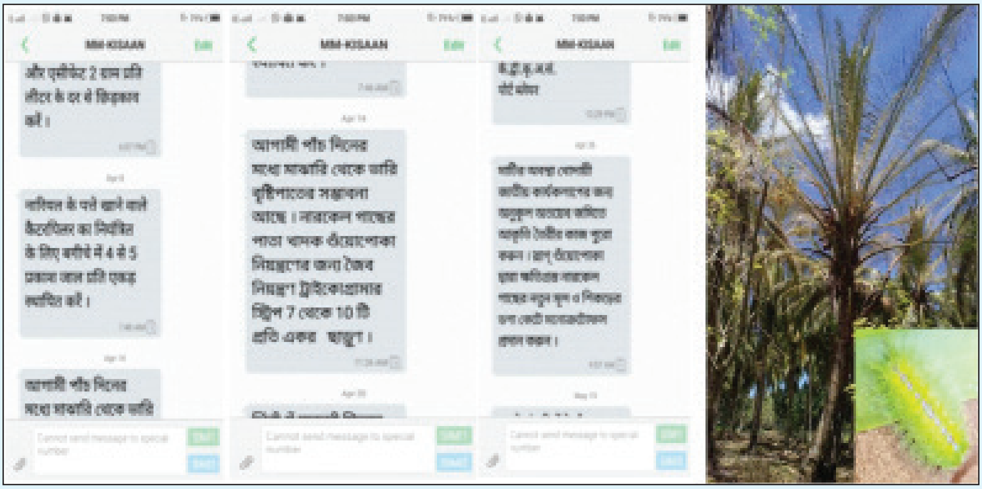


Fig. 24. Agromet advisories during the pest infestation period

A. Spraying

B. Root Feeding

C. Input Distribution

Fig. 25 Demo and Input Distribution at farmers field of Neil Island

A. Sorghum in raised ridges during uncertain rainfall

B. Raised bed and furrow system to harvest rainwater and facilitate drainage

Fig. 26 Management of moisture stress and water logging

10. List of contact farmers

Sl. No.	Name of The farmers	Contact No.	Sl. No.	Name of The farmers	Contact No.
1	Hari Das	9933294546	27	Surojit	9531911420
2	Gowaya Biswas	9474175919	28	Rajiv Mondal	9933292987
3	Ram Krishna Biswas	9474201387	29	Bablu	9933294164
4	Bishow Biswas	9933212947	30	Swapan Mondal	9933219391
5	Ramesh Das	9933294631	31	Yavray	949175226
6	Dinesh biswas	9933299648	32	K.Andi Swamy	9933293836
7	Biva Rani Das	9476071909	33	Mridanjay Das	9933235768
8	Chintaharan Biswas	9474222428	34	Snimotha Roy	9933209412
9	Sandeep Kumar Das	9474241310	35	Amol Biswas	9933292661
10	Namita Das	9476035769	37	K.Nagalaxmi	9474267866
11	Ramesh Mondal	9933293300	38	Naresh chdarn	9933294172
12	Rajan Das	9933292498	39	Rudesh das	9476071587
13	Joy Krishna Das	9933266900	40	Amrita Das	7063920557
14	Niyka Mondal	9476035769	41	E.R.Krishna Das	9476022995
15	Sukchan Mondal	9476036615	42	Ananda Das	9933266118
16	Panchanam biswas	9476037797	43	Ganmai mondal	9933293078
17	Subash Das	9933293468	44	Samar Biswas	9474215898
18	Nirmal Ghosh	9476095239	45	Dhiraj Das	9933217616
19	Narayan Das	9933231508	46	Narayan roy	9933294576
20	Bibha Rani	9476071909	47	Ashim Roy	9933293457
21	Robindrancha Das	9476094305	48	Sridhan	9933292897
22	Dinobandhu Roy	9531883271			
23	Ramesh Mondal	9933266541			
24	Selvakumar	9476011950			
25	Raju Harshvardan	7639430098			
26	Priyanjan Pradhan	7873794549			

11. Description of Agromet Field Unit-Port Blair

1.	**Project Title**	:	Integrated Agromet Advisory Services (Gramin Krishi Mousum Seva)
2.	**Sanction No. and date of initiation of project**	:	ASC-08/New units/2007, 1st April 2008
3.	**Start of agromet advisory service**	:	23rd June 2008
4.	**Institution's Name** **Place** **State / UT** **Nodal Dept./Div name**	:	ICAR-Central Island Agricultural Research Institute CIARI, Port Blair Andaman and Nicobar Islands Division of Natural Resource Management
5.	**Collaborating Institutions**	:	Agromet Division, IMD, Pune ICAR-CIARI, Port Blair
6.	**Sponsored by**	:	India Meteorological Department, Pune
7.	**Principal Nodal Officer** **Designation**	:	Dr. S. Dam Roy, Director, CIARI
8.	**Nodal Officer/P.I** **Designation** **Div./Section**	:	Dr. A.Velmurugan Senior Scientist Division of Natural Resource Management, CIARI
9.	**Coordinator, AAB** **Designation** **Div./Section**	:	Dr. T.Subramani Scientist Division of Natural Resource Management
10.	**Agro Advisory Panel of Experts**		Dr. A. Kundu, Head, (Animal Science) Dr. S.K. Zamir Ahmed, (Agrl. Extension) Dr.Nagesh Ram, (Coordination with farmers) Dr. T.P.Swarnam, (Agronomy) Dr. P.K. Singh, Senior Scientist (Crop Science) Mr. Kiruba Sankar, (Fisheries Science) Dr.Zakaria George (Animal science & tribal advice)
11.	**Project Staff, AAB**	:	Mr. Tapan Kumar Biswas Division of Natural Resource Management

12.	**Contact address**		Email: amfuportblair@gmail.com directorcaripb@gmail.com vels_21@yahoo.com Ph: 03192-251319
13.	**Districts covered**	:	A&N Islands (South Andaman, N & M. Andaman, Nicobar)
14.	**Medium of dissemination**	:	Print media, SMS, Doordarshan, AIR, KVK, RKC, ORC, Dept. Agriculture, Kisan call centre, Personal contact, Websites
15.	**Frequency**	:	Twice a week covering all the districts

12. Flood and moisture stress management through suitable technologies

Management of moisture stress through integrated farming system and land management

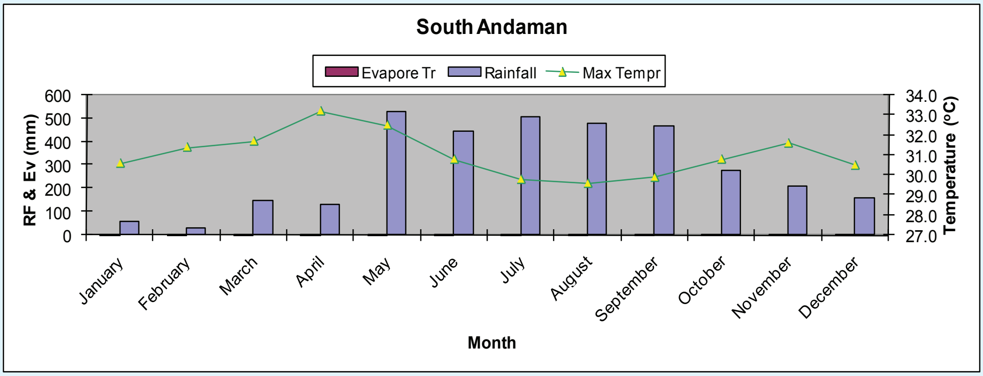
Terracing and intercropping with pineapple and tubers to avoid soil erosion

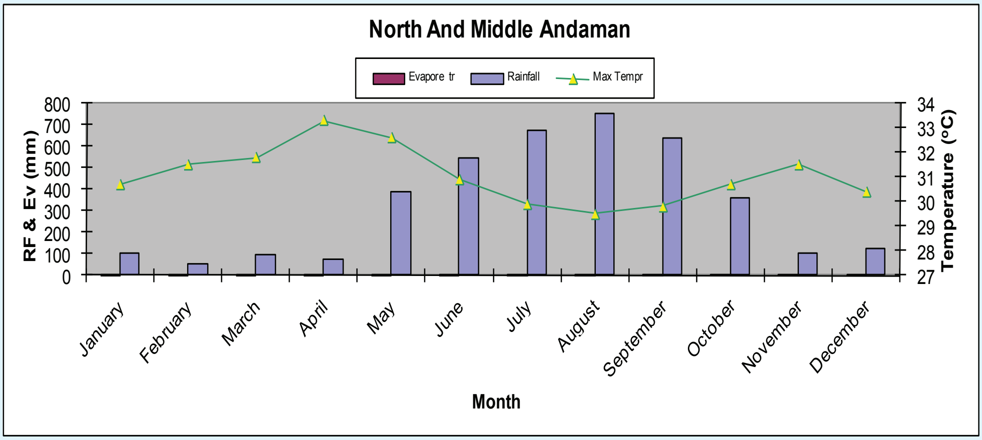
Effect of BBF during flooding

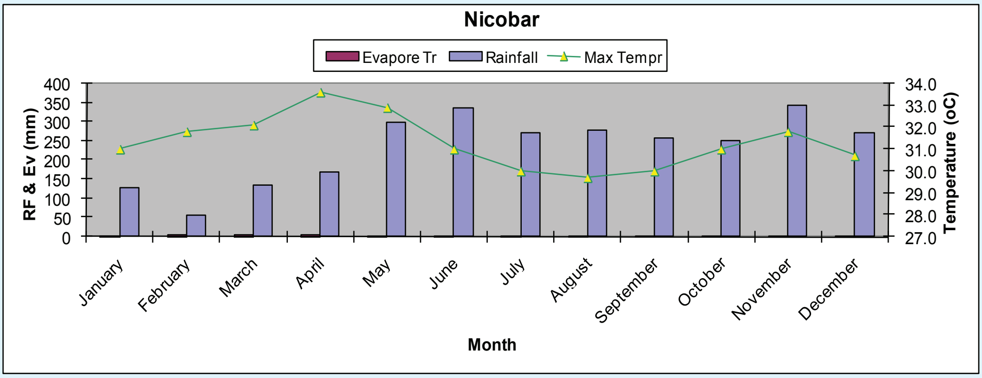
Growing of drought tolerant horse gram during dry season

Awareness campaign for drought management in crops

13. Districtwise climatic normal of Andaman and Nicobar islands







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