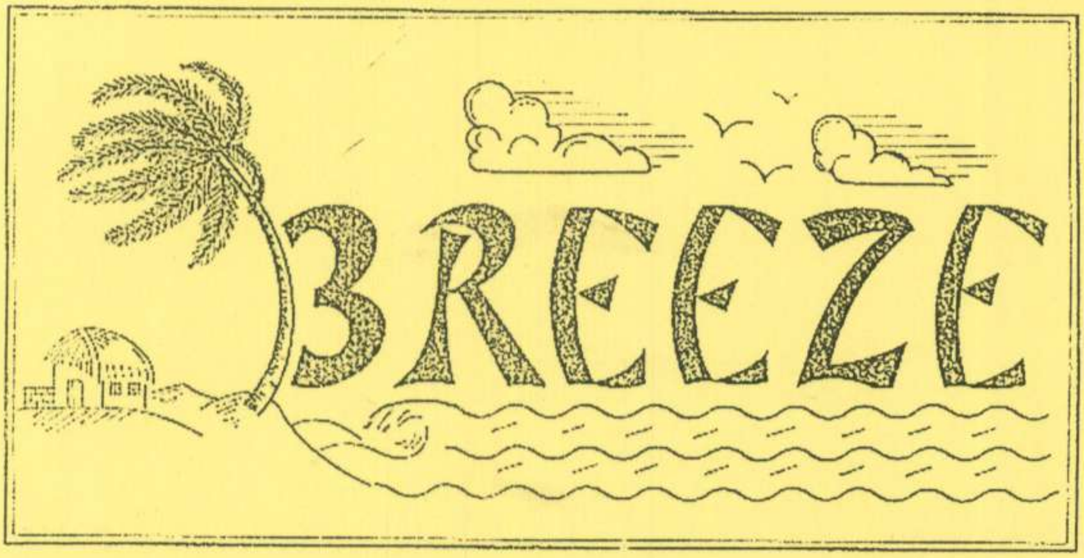

The newsletter of Indian Meteorological Society, Chennai chapter

Vol 8 - Issue 1, May 2005

Contents

EDITORIAL

Dear Member,

I have the great pleasure to release this issue, Volume No.8, Issue –1, of Breeze with seasonal greetings.

The proposed seminar on "Public Weather Services" has been postponed to September 2005 due to certain unforeseen circumstances. Contributions are invited from members and other well wishers, for this seminar. The details of the seminar will be intimated to the members soon.

The next issue of Breeze is likely to be finalised in December 2005. Members who desire to send articles for publication may send it to the Editor by 15 November 2005 through e-mail. Articles can be send to pvrimd@hotmail.com

With Best Wishes,

P.V.Revikumar
Editor
Chennai May 2005

Those who wish to become members of IMS can download the application form and the other details from the website of IMS Chennai Chapter.

Website : http://education.vsnl.com/ims chennai
E-mail : ims_chennai@vsnl.net

The Editor and the IMS-Chennai Chapter are not responsible for the views expressed by the authors.

Membership details of IMS-Chennai Chapter as on April 2005

Life Members: 71 Ordinary Members: 72 Total : 143

THE METEOROLOGIST'S ROLE IN SOCIETY

S. Raghavan*

Science was once considered as purely the pursuit of knowledge. One scientist is quoted as saying "May it be of no use to anyone"! Application of science for practical benefit came later. Michael Faraday is said to have apprised the then British Prime Minister of his discovery of electromagnetic induction. The PM asked "What use is it, Mr. Faraday?" Faraday is reported as replying "You may be able to tax it some day". It was perhaps Faraday's view that tax was the only thing a politician would understand. But Faraday's words were prophetic. Latter day politicians and administrators are reluctant in funding research in pure science and appreciate only the applications.

Coming to Meteorology, a few decades ago, the meteorologist was content with practising his/her science. For example, if a cyclone was detected in the Bay of Bengal the job of the meteorologist was just to issue forecasts and warnings. It was for the recipients of the warnings to think of the consequences and take action to mitigate the disaster. Seeing that this did not work well, the India Meteorological Department under the leadership of Dr. P. Koteswaram, initiated a coordination between the meteorologists and various other organisations. This has helped disaster managers and the public to a considerable extent to appreciate the nature of a cyclone, and prepare for it rather than lament after the event. More remains to be done in this area.

But apart from cyclone disasters there are several other aspects of weather and climate which impact on us in terms of health, quality of life, and economic development. Floods, water scarcity, air pollution, wind and solar energy and the much talked about climate change are all issues where meteorology is an important factor. On the positive side, weather and climate are *resources* which when properly exploited can yield large economic benefits. By choosing not to load additional fuel for possible diversions whenever a reliable terminal aerodrome forecast (TAF) indicated fair weather, an Australian airline saved Australian $16 million in a year (Anaman et al., 1998). A fertiliser firm plans its distribution based on weather and climate information. The impact of air pollution can be minimised by locating industries considering the meteorological factors determining pollutant distribution. A knowledge of the wind distribution is obviously necessary for planning location of wind mills.

The *impact* of any meteorological phenomenon or event on society depends on various factors, natural, social, economic and political. For example scarcity of water gets often attributed to lack of rain, while actually the scarcity may be due to various other factors, such as increasing demand, overexploitation of ground water and lack of storage facilities (Raghavan, 2003). The increasing damage in all countries due to tropical cyclones is often attributed to an increase in frequency or intensity of cyclones perhaps due to global warming,

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but it has been shown that this is not true (IPCC, 2001); the increased damage is due to increased economic activity and population increase in coastal areas (Pielke and Landsea, 1998; Raghavan and Rajesh, 2003). *Thus it is necessary to distinguish between the phenomenon and its impact.* Politicians and administrators as well as the public have to evaluate the impact on society of the various phenomena and take decisions in the face of uncertainties. Apparently scientific but incorrect or sensational information is often fed to them. *The meteorologist has therefore a responsibility in bringing about a correct appreciation of the nature of the meteorological phenomena and the factors which determine their impact, on the part of politicians, administrators and society in general and in removing misconceptions.*

To give a seemingly trivial example, there was an agitation against wind power generators in Maharashtra recently because of a belief that the wind mills were driving away the clouds and causing drought. One is reminded of the belief some decades ago (now taken as a joke) that hydroelectric power stations were taking away electricity from the water, which was rendered unfit for irrigation! But the agitation had to be taken seriously as it became a convenient stick for the opposition parties to beat the government with.

A much misunderstood phenomenon is "global climate change". There is a widespread impression that

(1) the world is getting warmer and this is due to increase of greenhouse gases emitted by human activities and
(2) that because of this there will be dire consequences such as rise in sea level, flooding of low lands, melting of glaciers, heat waves, increase of floods, droughts and tropical cyclones, changes in biota and so on in many parts of the world.

This has been dramatised recently in an American movie "*The Day After Tomorrow*". How much of this is really true?

There is a preponderance of scientific opinion (see e.g. IPCC, 2001) that temperatures in most parts of the world are increasing and that much of the increase is probably anthropogenic i.e. due to human activities. Some scientists disagree about the existence of global warming and others think that there are causes other than greenhouse gases. Therein lies the scientific method. Unlike in matters of faith, scientific inferences are based on experiment and inquiry. Any scientific hypothesis is subject to overthrow if new findings are made, which are not explicable by the theory.

The science behind global warming is complicated by several phenomena working at cross purposes and the play of several negative and positive feedback mechanisms. To mention only a few, increase of greenhouse gases may cause warming, but will also increase clouding which may reduce the warming. Melting of sea ice will lead to more warming. Aerosols are also generated by human activities and some of these cool the atmosphere. Changes in different regions may be different. Changes in regional or even global temperatures can be brought about by changes in *land use processes* e.g. conversion of forests into farms (see e.g. Pielke et al., 2002). It may not be safe to extrapolate the warming over the future. A single catastrophic event e.g. a major volcanic eruption, can cause cooling for several years, partially neutralising the warming. Temperature changes can occur due to astronomical causes e.g. variation in solar radiation or changes in earth's orbital parameters (Clement et al., 2001). Though astronomical changes are very slow, there can be sudden switches in a time frame of a few decades. On a shorter time scale there is a recent finding relating low sunspot activity to low crop yield! (*New Scientist*, 18 November 2004).

Glaciers in Switzerland and in the Himalayas are said to be melting (New Scientist News Service, 16 April 2002). This is an expected result of global warming. But it is also found that evaporation (measured by pan evaporimeters) and potential evapotranspiration are *decreasing* over the years (Chattopadhyay and Hulme, 1997; Roderick and Farquhar, 2002). This is contrary to the expectation that air will become drier but can be explained in terms of decreases in sunlight resulting from increasing cloud coverage and aerosol concentration.

Impact of floods and probably floods themselves are increasing not because of global warming but because of other human activities, e.g. land use changes, deforestation and occupation of flood plains due to population pressures.

Another whipping boy is the El Niño, which is supposedly the cause of all the ills of the world. There are some who claim to forecast weather for long periods using the El Niño as the sole input. Such *simplistic* predictions often boomerang badly. In 1997, when a major El Niño developed, widespread fears of a major drought in southern Africa were generated. This did not materialise. People made decisions based on the likelihood of drought, such as not planting, that ultimately hurt them (Dilley, 2002). There are numerous other examples of simplistic wrong predictions.

Based on findings of the INDOEX programme of the late nineties, a report appeared of an "Asian Brown Cloud" (ABC) in the form of pollution from the Asian mainland spreading over south Asia and the adjacent Indian Ocean, and it was claimed that it would have serious adverse effects on the monsoon and agriculture. However, Srinivasan and Gadgil (2002) have pointed out that such sensational claims have no scientific basis. Similar pollution occurs over other parts of the globe but that is being underplayed. Also the ABC occurs in the period January to March and has little relevance to the monsoon.

We are also frequently told that the monsoon rains have decreased over the years and there is consequent drought. Examination of rainfall data over various regions of India shows that while there are large year-to-year variations, there is no trend of decreasing rainfall. It is however true that water has become scarcer. The reason for this is not failure of rainfall but our inability to plan for water storage, conservation and augmentation of resources and even our deliberate destruction of existing resources in the name of development (Raghavan, 2003).

Several remedies for water scarcity are suggested e.g. linking of rivers, desalination of sea water and rain enhancement by seeding of clouds. We see many desperate crisis management programmes of cloud seeding in times of drought, which are not likely to succeed and only result in expenditure. Since weather modification is not a proven technology, it is necessary to gain a scientific understanding of cloud processes and plan seeding programmes carefully and evaluate them objectively (NAS, 2003). A scientific programme is being planned in India.

Unfortunately some of the misconceptions mentioned above are not born solely out of a lack of appreciation of meteorological science. *Misinformation is often deliberately propagated.* If water scarcity is attributed to lack of rainfall, that becomes an act of God and the authority responsible for water management is absolved of failure. If the impact of drought is exaggerated, more funds can be obtained from the authorities concerned. If adverse consequences are predicted from climate change, funding can be obtained ostensibly for their mitigation. Business interests have an obvious advantage in denying or down-playing the effects of air pollution or green house gas emissions. Conflict of interest between different sections of the population is often generated. Political considerations may often lead to exaggeration of some phenomena such as the ABC or the role of methane generated by cattle of India and China.

Wrong or pseudo-scientific inferences often lead to wrong solutions and diversion of resources to misguided programmes. It is therefore appropriate for meteorologists to present balanced scientific evidence on such issues to governments and the public. They should also create an awareness of how to benefit from weather and climate as resources. This will enable society to gain the maximum benefits and mitigate adverse consequences. It is necessary to build up credible mechanisms such that the voice of meteorologists will be heard with attention at all fora. The Indian Meteorological Society should organise itself to do this.

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GLOBAL FEATURES ASSOCIATED WITH INDIAN SOUTHWEST AND NORTHEAST MONSOONS – 2004

Y.E.A.Raj*

1. Southwest monsoon 2004

The overall performance of southwest monsoon 2004 over India was disappointing. The June-September southwest monsoon rainfall over India realised during the years 1999-2004 and the monthly and seasonal rainfall figures of India for the southwest monsoon season for 2004 along with the normal values are presented below in Tables 1 & 2 respectively.

Table 1 : SW Monsoon (Jun–Sep) rainfall over India, 1999 - 2004

Year	1999	2000	2001	2002	2003	2004
Rainfall % anomaly	-5	-8	-8	-19	5	-13

Table 2 : Monthly distribution of SW Monsoon rainfall over India in 2004

Month	June	July	August	September	JJAS
Rainfall % anomaly	0	-17	-5	-29	-13
Normal Rainfall (mm)	157	286	258	169	869

As seen from the above tables, the performance of southwest monsoon during 1999 – 2004 was generally subnormal with a mean percentage anomaly of –8 %. The year 2003 was the sole exception with an excess rainfall of 5 %. During this 6-year period there were as many as 2 drought years 2002 & 2004, the former described as a severe drought year. The 5% excess rainfall of monsoon 2003, which to some extent compensated the severe rainfall deficiency of 2002, has also blunted the drought of 2004.

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(Synopsis of the lecture delivered at the Monsoon Seminar, IMS Chennai Chapter on 28 February 2005)

2. Northeast monsoon 2004

As seen from Table 3, the northeast monsoon rainfall was normal in Tamil Nadu only, with deficiencies ranging from 10–40 % registered in the other 3 subdivisions.

Table 3 : Northeast monsoon (Oct – Dec) rainfall in 2004

Subdivision	Actual mm	Normal mm	% anomaly
Tamilnadu	435	430	1
Kerala	438	485	-10
CAP	236	326	-28
Rayalaseema	127	212	-40

Over Tamil Nadu, since 1998, the October–December northeast monsoon rainfall had negative anomalies with percentage anomalies of –6, -23, -15, -12 & -7 for the years 1999, 2000, 2001, 2002 & 2003 respectively. The year 2004 with 1 % excess rain has broken the run of negative departures.

3. Influence of ENSO on Southwest and Northeast monsoons of 2004

Some of the global features associated with the southwest and northeast monsoons of 2004 will now be discussed. Table 4 presents the values of Southern Oscillation Index (SOI) & sea surface temperature (SST) anomalies over Niño 3.4 region for each month of 2004. The SOI during pre-monsoon does not provide any clear indication about the ensuing poor monsoon but SOI during JJAS was negative with a mean value of –0.8, manifesting reasonably good concurrent relation with monsoon rainfall. The SST anomaly over Niño 3.4 region, based on which, El-Niño is normally appraised, was positive from April 2004 and firmed up in July 2004 to reach 0.6 ° C and the positive anomaly continued afterwards.

Table 4 : Monthly variation of SOI, Niño 3.4 and SST during 2004

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SOI	-	1.1	0.2	-	0.9	-	-	-0.8	-	-	-0.9	-1.1
Niño 3.4	0.2	0.2	-0.1	0.2	0.2	0.3	0.6	0.8	0.8	0.8	0.8	0.9

Both the SOI and SST anomaly over Niño 3.4 clearly indicate the development of moderate El Niño in July. This appears to have played its part in effecting the poor performance of Indian Monsoon 2004. The out going Long wave Radiation and precipitation over Niño regions did not clearly indicate development of large-scale convection. However western Pacific manifested above normal convection throughout the season. Most of the Pacific typhoons took a N/NW track in 2004, some what similar to 2002. Though typhoon activity over west Pacific was close to normal, Japan was affected by large number of typhoons. Over the Indian regions convection was conspicuously less in August.

The moderate El Niño which prevailed during June–October 2004, is definitely a favourable factor for a good northeast monsoon. But this broad-based relation appeared to hold true only in the early part of the northeast monsoon. Despite continuation of El Niño up to the year end, December was almost dry over Tamil Nadu and the adjoining subdivisions. In December, OLR anomalies indicated enhanced convection over the Bay of Bengal south of 5°N and over the Indo-China region. This type of feature was also associated with a weak northeast monsoon during December 2003.

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SOUTHWEST MONSOON – 2004

S.R.Ramanan*

Southwest monsoon onset took place over Kerala on 18 May 2004. Though it was ahead of schedule by two weeks, its overall performance was very erratic when compared with southwest monsoon 2003. During 2004, the country ended up with a deficit of 13 percent [In 2003, it ended up with a figure of 105 percent of its LPA (Long Period Average)]. Weak/Break monsoon conditions prevailed during late June, most of July, late August and early September over different parts of the country.

The onset of monsoon over Andaman Sea was much ahead of schedule (13 May over Andaman sea and advanced to south Bay on 14 May instead of 20 May). The formation and movement of a Very Severe Cyclonic Storm over the Bay during the period 16 – 19 May resulted in the surge of westerlies over Kerala. Due to the presence of this storm over Bay of Bengal heat wave conditions developed in Andhra Pradesh and parts of Tamil Nadu. The Very Severe Cyclonic Storm crossed Myanmar coast on 19 May without disrupting the monsoon pattern. The advance of the monsoon over south peninsula and central parts of India was almost around the normal date of 18 June. Afterwards weak monsoon conditions prevailed for the remaining part of June. The monsoon revived as a weak current during the first week of July with the formation of a low-pressure area over Bay. The Arabian sea branch also surged towards Rajasthan. The monsoon covered most parts of the country outside parts of Rajasthan, Punjab and Haryana by 5 July. Again weak monsoon conditions prevailed. Another low pressure area on 13 July revived the monsoon and the entire country was covered by Monsoon by 18 July.

A week by week cumulative rainfall study indicates that till 23 June, the percentage departure was on the positive side. The week ending 30 June showed a negative departure of 60 %. Till September, only the first two weeks of August showed positive departures. So the monsoon ended with a negative departure of 13 % at the end of the season.

The following table gives the number of districts that had normal/excess rainfall during the past few years.

Year	Number of districts Normal/Excess
1999	67
2000	65
2001	68
2002	39
2003	75
2004	56

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Semi permanent Systems

Monsoon Trough

The western end of the trough remained in the foothills of the Himalayas on 22 and 23 June. After regaining the normal position, the eastern end of the trough moved northwards towards the foothills of the Himalayas. Again it was the turn of the western end during the period 19 to 26 July. Break Monsoon situation prevailed as the entire trough was over the foothills of the Himalayas from 26 August to 8 September. A low-pressure area over Northwest Bay revived the Monsoon. The trough shifted to near normal position on 10 September and remained there till 22 September.

Heat Low

The heat low made its appearance near its normal position on 15 May and remained more or less in its normal position (though diffused on many days during August & September). The lowest pressure value in different months and the dates on which it occurred are given below.

Month	Value (hPa)	Date
June	990	17
July	992	7
August	991	2
September	998	9 & 10

Tibetan Anticyclone

The Tibetan anticyclone was established on 13 June at the 500, 300 and 200 hPa levels. It remained east of the normal position during the second half of June and was not seen during most days in the first half of July. It was present in its normal position during many days in August except at 500 hPa. It remained south of its normal position at all levels until 18 September.

Tropical Easterly Jet stream

Jet speed winds were reported at Thiruvananthapuram from 10 May to 30 September with a maximum value of 175 Knots at 157 hPa. The Jet was seen over Chennai from 19 May to 30 September. Over Minicoy it was seen from 16 June to 22 June. The wind speed of 180 Knots was seen over Mumbai on 22 June at 118 hPa. On many occasions jet wind speeds were reported over Port Blair, Vishakapatnam, Hyderabad and Nagpur.

Cross equatorial flow over the Bay

The winds were having values greater than normal (8-10 knots) by 10-15 Knots during June and nearly normal during July. During August, they were greater than normal by 05-10 knots up to the middle of the month and normal during rest of the period. In the month of September 2003, the wind values were greater than normal by 10-15 knots.

Cross equatorial flow over Arabian Sea

The following table gives the magnitude cross equatorial flow over the Arabian Sea. The last column gives the departure of actual winds with respect to normal.

Month	Normal Value (knots)	Values in 2004 (knots)
June	10-12	+5
July	12-14	-5
August	10-12	Near normal
September	8-10	Near normal

Synoptic disturbances

There were three depressions (Two deep depressions in June and one land depression in September) and one Cyclonic Storm formed over Arabian Sea and Bay of Bengal. Three well-marked low pressure areas (one in July and two in August) and five low pressure areas (three in July and two in August).

Off shore trough

The off-shore trough along different parts of the west coast (surface and lower levels) persisted on most of the days from 19 May to 16 September except during the periods 27 May-3 June, 8-11 June, 23-24 June, 29 August-7 September.

Withdrawal of Monsoon

Monsoon withdrew over West Rajasthan on 24 September, most parts of northwest India and parts of central India on 27 September. It withdrew from most of north India by 8 October, most parts of southern peninsula and northeast India by 11 October and entire India by 18 October.

Summary of Southwest Monsoon 2004

In marked contrast to 2003, SW Monsoon 2004 was highly erratic. Weak/break conditions prevailed during late June, most July, late August and early September. In 2003, out of 36 subdivisions, 3 were deficit and 7 were excess and all the rest were normal. In 2004, seasonal rainfall was normal over 23 subdivisions and deficit in 13 subdivisions. Seasonal rainfall was 87% of Long Period Average. If considered region-wise, there are five homogeneous regions in the country and seasonal rainfall was deficit in all. Among them Northwest India had a deficit of 22 %, Central India 11%, Northeast India 6% and South Peninsula 15%. As far as districts are concerned, 56% registered excess or normal and the remaining were deficit or scanty. During the Southwest Monsoon 2004, Jammu and Kashmir, Himachal Pradesh, West Uttar Pradesh, Punjab, West Rajasthan, Vidarbha and Telangana experienced moderate drought conditions. Their percentage deficiencies are given in the following table.

Sub divisions	Per centage departure
Jammu and Kashmir	-25
Himachal Pradesh	-45
West Uttar Pradesh	-36
Punjab	-44
West Rajasthan	-40
Vidarbha	-31
Telangana	-27

Even though the all India seasonal rainfall was 13% below normal, since the areal extent of drought conditions was less than 20 %, the year 2004 was not considered as an All India Drought Year.

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SALIENT FEATURES OF NORTHEAST MONSOON - 2004

P.V.Revikumar*

The overall performance of northeast monsoon 2004 over Tamil Nadu was near normal but in several districts especially those located in the northern part, rainfall was deficient.

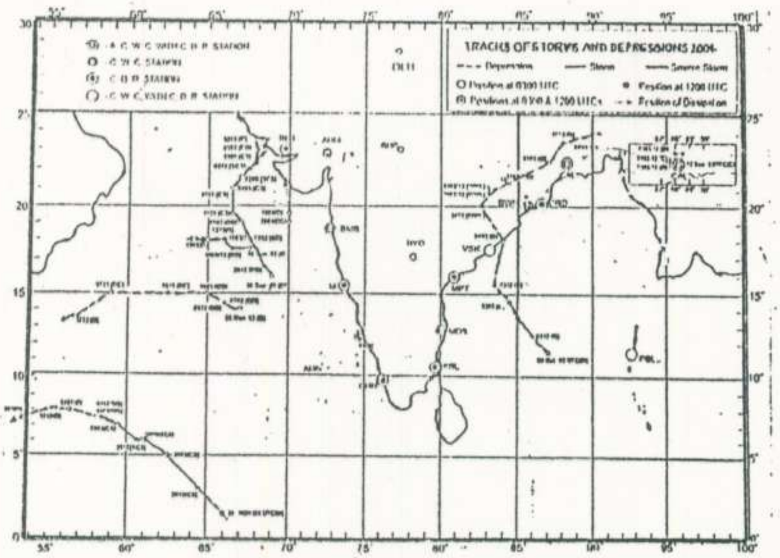
Northeast monsoon rains commenced over Tamil Nadu and adjoining areas on 18 October, well in time. The onset dates during the past ten years are given in Table I.

Table 1 : Onset dates of northeast monsoon

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Date of onset	23 OCT	11 OCT	13 OCT	28 OCT	23 OCT	02 NOV	16 OCT	25 OCT	19 OCT	18 OCT

Source : India Meteorological Department

The significant features of this year's northeast monsoon period were i) Cyclonic activity over the Bay of Bengal was very much subdued ii) No depressions or cyclonic storms affected Tamil Nadu coast as such. iii) The only one depression, which formed over the Bay of Bengal, crossed the Andhra Pradesh coast near Kalingapatnam on October 4 well before the onset of the monsoon. iv) The Arabian Sea was comparatively active in this year. Two cyclonic storms and one depression formed in the Arabian Sea but all of them dissipated over the ocean without producing any weather over the Indian subcontinent. The tracks of all the systems are given in Figure I.



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The performance of the northeast monsoon over Tamil Nadu was not very satisfactory in the year 2004. Though a trough of low pressure was seen off the Tamil Nadu coast on a number of occasions, the rainfall activity was good only on a very few days and that too concentrated on the central and southern parts of the state. This resulted in deficient rainfall over the northern districts including Chennai, almost like the monsoon performance during 2003.

A look at the progress of rainfall on a weekly basis reveals that there were four significant spells viz. 1- 4 October, 12 October – 2 November, 6 - 16 November and 26 - 27 November. The monsoon activity was vigorous on three days and was active on four days during this season but the rainfall activity over the northern parts of the state came to an abrupt end by the middle of November, which is rather early. The sub- divisional rainfall statistics are given in Table 2.

Table 2 : Rainfall (in mm) over various subdivisions

Sub Division	Coastal Andhra Pradesh	Rayalaseema	South Interior Karnataka	Coastal Karnataka	Kerala	Tamil Nadu and Pondicherry
Actual	235	127	138	183	303	435
Normal	311	215	203	267	327	430
Departure from Normal %	-28	-27	-31	-24	-10	1

Source : IMD, Weekly Weather Reports.

The performance of northeast monsoon rainfall over Tamil Nadu and over Chennai district during the past ten years are given in the following Tables 3 & 4.

Table 3 : Northeast monsoon Rainfall over Tamil Nadu (in mm)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Actual	593	610	618	501	343	377	395	435	435
Normal	477	478	478	478	478	478	478	469	430
Departure from Normal %	24	70	29	5	-28	-21	-14	-7	1

Source: IMD, Weekly Weather Reports.

Table 4 : Northeast Monsoon Rainfall over Chennai (in mm)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Actual	1260	1570	720	530	400	1020	910	350	590
Normal	760	760	760	760	760	760	760	760	760
Departure from Normal %	66	98	2	-32	-41	35	20	-54	-21

Source :IMD, Weekly Weather Reports.

The performance of the northeast monsoon over Tamil Nadu, after the record performance in 1997 and 1998, is not very satisfactory, over the last five years accumulated deficiency in rainfall resulted in ground water depletion in several parts of the state.

If we examine the rainfall statistics over Chennai district, an almost similar pattern of deficient rainfall has been noticed from 1999 with a little respite during the years 2001 and 2002. However the accumulated deficiency of rainfall in Chennai may lead to the depletion of ground water potential resulting in water crisis.

Summary

The performance of the northeast monsoon over Tamil Nadu in 2004 was not very satisfactory. No major synoptic systems such as cyclonic storms, depressions or low pressure areas affected the state as such. The only one depression formed over Bay of Bengal moved towards Andhra Pradesh coast. Though the monsoon onset was well in time, the rainfall activity subsided from November 15 due to the early shifting of the seasonal pressure trough and wind shear zone to the south. The Inter Tropical Convergence Zone remained either close to or south of the equator throughout the season except on few occasions when state received good rainfall. The Southern Hemispheric Equatorial Trough was found to be active through out the monsoon season. Though the cyclonic activity over the west Pacific was above normal, all the systems recurved northeastwards and no system emerged into the Bay of Bengal. This was again a negative factor for the Indian northeast monsoon. All these factors contributed to a low rainfall activity over several parts of Tamil Nadu in the year 2004.

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TELECOMMUNICATION IN IMD - A REGIONAL PERSPECTIVE

V.K. Raman and K.G. Suresh Kumar*

Introduction

The main functions of IMD can be categorized as (a) Recording observations of meteorological parameters all over the country and the adjoining areas, both at the surface and the upper air, by maintaining different types of observatories, besides collecting data from aircraft, ships, satellites. (b) Transferring these data into various charts, analysing and interpreting them, issuing forecast and current weather information required by different agencies and issue warnings for different purposes including protection of life and property.

The necessity of transmitting the huge volume of data collected from a widely distributed area of the country to the forecasting centres and the processed data back to the respective user groups explains the fundamental need of a fast telecommunication network in the Department. It is a well-known fact that an efficient and reliable communication system is one of the prerequisites of an efficient and reliable meteorological service. So, the India Meteorological Department maintains one of the fastest, widest telecommunication links within the country as well as outside for collection and dissemination of meteorological observations, and the products on a global scale. There is a division for Telecommunications exclusively for the functional control of the meteorological communications in the Department.

Meteorological data need to be collected and exchanged without delay – in other words we can say, it needs "real time exchange". In order to reduce the time lag between the time of observations and the time of issue of warnings and generation of various products, IMD has devised a three-tier data collection and communication strategy. In this, the flow of observational data is between (i) Observatory and the Collection centre, (ii) Collection Centre and the Regional Collection Centre and (iii) Regional Collection Centre and the Regional Telecommunication Hub (RTH) at New Delhi.

Domestic collection of observational data is done through dedicated Teleprinter links, HFRT (High Frequency Radio Transmission) links, Telephone, fax, VSAT. DoT's landline telegraph system is also utilised for collection of observational data from remote areas.

The present meteorological communication setup of IMD comprises of an extensive network of communication links connecting all the aviation meteorological offices, storm warning centres and the meteorological centres at state capitals. To speed up and streamline data flow, the telecom division has automated the exchange through introduction of regional Automatic Message Switching Systems (AMSS) and linked them to the central communication computer system at RTH New Delhi.

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Chennai Region

RMC Chennai is the Regional technical / administrative head quarters of the department for the four southern states, viz. Andhra Pradesh, Tamilnadu, Karnatak and Kerala and the union territories of Pondicherry & Lakshadweep. The Regional Collecting Centre at (Meteorological Office) Chennai is responsible for the communication facilities of the region.

Automatic Message Switching System (AMSS) at Chennai is the nerve centre of communication network of the region. At present about 25 point-to-point teleprinter circuits are connected to the system. As a part of the national plan, AMSS at Chennai has been upgraded with a state-of-the-art system, which is capable of handling high-speed data circuits. The preliminary works for replacement of some of the low speed (50 baud) teleprinter circuits, with high-speed computer-based communication links, is in progress.

WeatherMan 'hard-ware' and 'software' form the heart of AMSS. It is a Value –added weather message routing system through which different weather messages in WMO formats are received, stored and routed to their respective destinations. The system Hardware consists of two major components:- (1) Data Communication Server and (2) Data Base Processor. Data communication ports can be individually configured to support differing electrical interface and transmission protocols. All WeatherMan components are provided with standby, thereby permitting a fault-tolerant communications capability.

WeatherMan software Components transform raw weather data into valuable information that can be moulded to suit user's demands. In this, the communication process is started when raw streams of data are delivered to the outer layers of WeatherMan by the data communication modules. Here the streams are separated into distinct messages, which are then passed to the classification layer. This layer identifies message types such as WMO, AFTN or FAX. Not only are, conventional the WMO text format, including addressed messages, fully supported, the recently incorporated binary formats such as BUFR (Binary Universal Form for the representation of Meteorological data) and GRIB (Gridded Binary) are also accepted. Messages with errors are siphoned off to hold streams with pre-designated memory locations in the server for suitable correction by specialist operators.

Once classified, messages are registered in the system, adhering to strict, configurable security measures. Key weather information is extracted from the registered messages and added to the database. Before being distributed, this information is validated to ensure conformity to GTS (Global Telecommunication System) Standards.

WeatherMan integrates seamlessly with Ethernet based LAN (Local Area Network) environments, as its interfaces are founded on standard mechanisms such as TCP/IP (Transmission Control Protocol/Internet Protocol) and FTP (File Transfer Protocol). This allows other workstations to be connected to WeatherMan either as a Telnet VT100 terminal or as a X-Windows client using a graphics window interfaces viz,WMCC (Weather Man Control Centre)

Some of the salient features of this new AMSS are discussed below:

a) **FAX on Demand (FOD)**

It is a remote access facility. Using Fax on Demand, pre loaded data from the system, be it in the form of a chart or text can be retrieved using a Telefax machine over a telephone line from any remote location. It is the cheapest mechanism, in which frequently used charts/text data can be retrieved by a user from a remote locality.

b) **Dial-up access**

With dial-up connectivity WeatherMan server can be directly accessed. This facility provides for both data retrieval and input. Any of the outstations with PC with modem and a phone connection can have access to the server at Chennai. Dedicated phone lines are used for this purpose as well as FOD. Intended users will be given necessary password (code) for accessing the system for security purpose.

c) **A standalone workstation with 'Flightman' software**

This is one of the most useful components of the new AMSS. Flightman is a system, which generates 1. Synoptic weather charts 2. Upper wind / Temp charts and Significant weather charts 3. Composite Tafs / Metars / Sigmets. Raw observational data in alphanumerical form and WAFC data in GRIB, BUFR and Fax formats are fed into the system from the communication server. It decodes and validates the data according to the WMO / ICAO specifications. Based on the error-free data, synoptic weather charts, upper air charts, Tephi-grams, Prognostic wind / Temp and Significant weather charts are generated by Flightman as per the required validity period and area of coverage. We can schedule automatic generation of all pre-flight bulletin materials, time /area and route wise, using Flightman as per our requirements

In short, Flightman has brought about revolutionary changes in providing fast and efficient Met Services by automated generation of neat, accurate and ICAO-approved world class products to meet the challenges of increasing demands.

Conclusion

Compared to earlier times, the users are now more quality-conscious. Therefore, we have to lay more emphasis on the quality of the weather products we generate as well as to ensure the efficient and timely delivery of these products to various user agencies. The installation of the new AMSS is a quantum jump in the right direction. Now, the steps of upgrading the communication set-ups of our sub-offices to a comparative level is on the anvil.

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EARTHQUAKES AND TSUNAMIS

P.C.S.Rao*

Introduction

"Kya hai yeh tsunami?! Abhi tak yeh naam bhi nahin *suna* !" commented a reporter on the third day of the occurrence of tsunami. Now tsunami is well known in India particularly in the southern parts. True, when the birds of Pulicat found place in Hussain Sagar in Hyderabad on 25 December 2005, it did not evince any interest, as this matter itself was deduced *post-facto*.

Earthquakes are one of the worst natural hazards causing widespread damage, loss of human lives and property due to collapse of structures or buildings. An earthquake is a rupture within the earth caused by stress. Earthquake is a natural process, where there is a sudden release of strain energy accumulated during extensive time intervals. It is due to sudden dislocation of a segment of the earth along a plane of weakness called fault. This energy is propagated radially in all directions in the form of elastic waves or seismic waves.

The earthquakes cause immense destruction especially in populous areas. They can cause ground shaking, faulting, landslides, avalanches, liquefaction, cracks and fissures on the earth. The extent of damage at any given place depends on several factors such as the magnitude, the hypocenter, epicentral distance, terrain, type of population, structural design of the buildings, weather conditions, time of occurrence and so on. Earthquakes are found to be the major cause for the occurrence of Tsunamis.

The earth with a radius of 6370 km is divided into three layers - core, mantle and crust. The outermost layer of crust is a cooled solid with passive stresses of about 10,000 Pascals at a depth of 40 km. The thickness of the crust varies from 5 to 70 km being thick under continents and thin under the oceans. The next layer of mantle extends to a depth of 2900 km. The central portion is the core and is further divided into solid inner core and liquid outer core.

Majority of earthquakes can be explained by the theory of plate tectonics. The earth's outermost part called lithosphere consists of crust and part of rigid upper mantle. This lithosphere is broken into 12 –14 slabs called plates. The lower layer is called Aesthenosphere. By conduction the lower portion of the crust is heated and the upper portion of the lithosphere cooled. All through the lithosphere the temperature varies and the sress vary in relation to temperature. The solid matter become viscoelastic one, softens and becomes fluid after different stages of viscosity. The aesthenosphere is the level at which the matter is no longer rigid allowing isostatic balance to be re-established. The lower part of the lithosphere and the upper part of asthenosphere are intermingled at a depth of about 100 – 200 km.

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These plates are under constant motion; some plates colliding with each other, where subduction takes place. They move apart at mid oceanic ridges called spreading zones, and at some places they slide apart each other. At these plate boundaries, large deforming forces or tectonic forces are exerted on the rocks causing changes in terms of energy.

Focus or hypocentre is the actual location within the earth where the earthquake originates. It is actually more of a line than a point since earth block movements generally occur along a fault or a line of weakness in the earth. *Epicentre* is a point on the surface of the earth vertically above the place of origin of an earthquake. This place is expressed by geographical latitude and longitude. This is the region of the earth's surface where most severe effects are felt. The Magnitude of an earthquake is a quantity to measure the size of an earthquake in terms of its energy and is independent of the place of observation. It is expressed on Richter Scale or as body wave magnitude Mb, surface wave magnitude Ms, duration magnitude Md, Moment Magnitude Mw and so on. The Intensity is the rating of the effects of the earthquake at a given place, based on the observations of the damages, which are descriptive. It is expressed in Modified Mercaulli Scale, Medreder Sponheurer Karnik(MSK) Scale etc.

Various classification of earthquakes

a) Interplate, intraplate and Stable Continental Region (SCR) earthquakes: About 85 % of earthquakes are found to occur in the plate boundaries. These are called interplate earthquakes. Though majority of earthquakes occur in the boundaries, many earthquakes occur within the plates as well. These are called intraplate earthquakes. Quite rarely earthquakes also occur in very stable and older parts of continents called cratons. Latur earthquake is an example.

b) Depending on the depth of the focus, earthquakes are classified as Shallow (focal depth within 70 km), Intermediate (70- 300 km), Deep (more than 300 km).

c) According to epicentral distance earthquakes are classified as Local shock (distance less than 4 degrees), Near shock (distance 4 – 10 degrees), Distant shock (distance 10 – 20 degrees), Teleseismic (distance more than 20 degrees).

d) According to magnitude, Earthquakes are classified as Slight (magnitude upto 4.9), Moderate (5.0 – 6.9), Great (7.0 – 7.9), Very Great (8 and more).

Seismic Zones:

Based on the seismicity and geological inputs, India is divided into four zones, ZONE II, III, IV, and V (Figure 1). Zone V is the most seismically active region whereas Zone II is the least. The Modified Mercaulli scale intensity associated with different zones is as follows:

Figure1: Seismic zoning map of India

Seismic zones	Intensity on mm scale
II (Low intensity zone)	VI (or less)
III (Moderate intensity zone)	VII
IV (Severe intensity zone)	VIII
V (Very severe intensity zone)	IX (and above)

Recurrence intervals of earthquakes: Recurrence interval is the average time interval between two strong earthquakes of comparable magnitude in the given location. It varies from one region to other. Recurrence interval for large earthquakes in the active regions like Himalayas is considered to be of the order of a few hundreds of years. In contrast, the recurrence interval for such earthquakes in peninsular India may be much larger.

The Sumatra earthquake of 2004

The earthquake of magnitude 8.6 Ms, that occurred on 26 December, 2004 at 0629 IST off west coast of Sumatra island was widely felt in Andaman-Nicobar islands and in the eastern parts of South India.

There are three main belts on the globe featuring a majority of earthquakes. They are:

1. Circum Pacific belt, where volcanoes and tsunamis are not uncommon.
2. Himalayan Alpine belt or Trans-Asiatic seismic belt and
3. Mid-Atlantic ridge

The Andaman - Sumatra section of subduction zone is part of Himalayan seismic belt extending from south Pacific islands through Jawa, Sumatra, Central Asian mountains, Caucasus mountains, Greece, Italy and Spain. This region has produced many large earthquakes and several moderate earthquakes. Several

FIG 2. FREQUENCY OF AFTERSHOCKS (M>5) OF SUMATRA EARTHQUAKE OF 26 DEC 2004

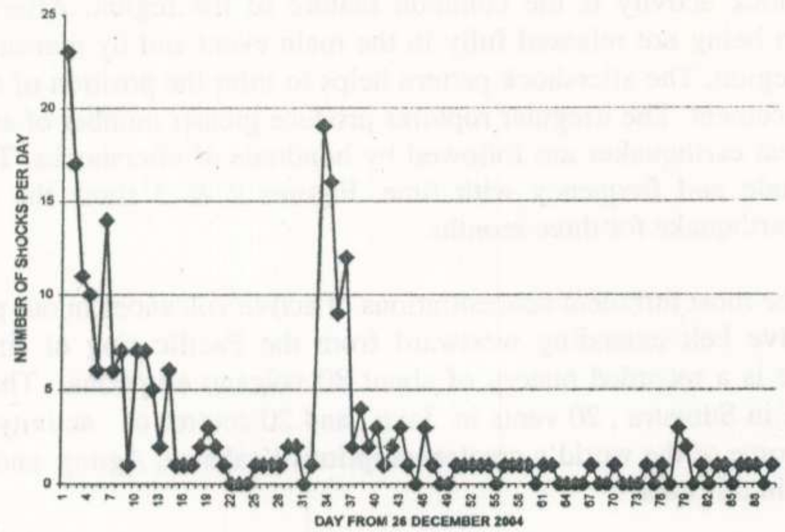
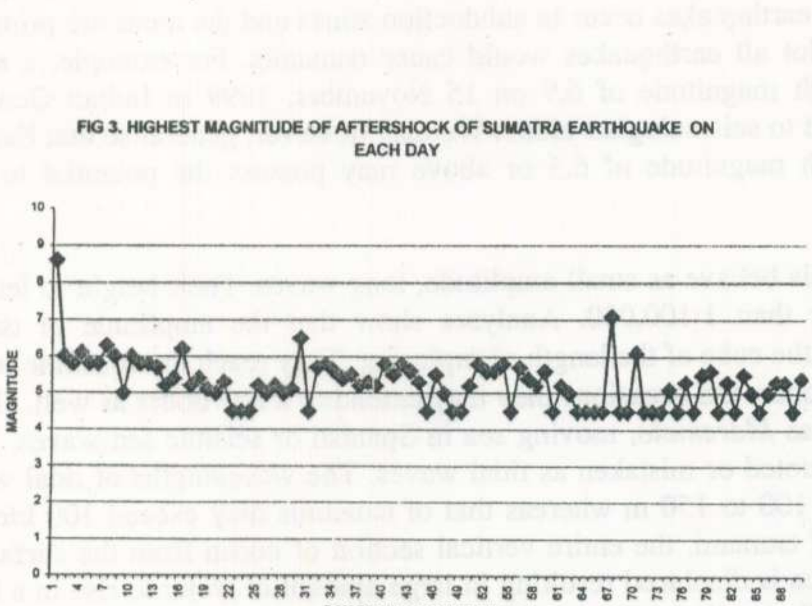


FIG 3. HIGHEST MAGNITUDE OF AFTERSHOCK OF SUMATRA EARTHQUAKE ON EACH DAY



earthquakes have occurred in the past in this region, M 8.7(1833), M8.5 (1861), M8.1 (1941) are a few of them, which are of interest. The magnitudes of earthquakes of 1833 and 1861 have exceeded 8.5. The 1881 event was reported to have triggered Tsunamis. The earthquake of 1941 of the Andaman caused severe damages. The oldest known earthquake of Andaman region was on 28 January 1679. Moderate earthquakes of 16 Nov 1962 and 08th Feb 1978 were also widely felt in the Bay islands. Aftershock activity is the common feature of the region. Aftershocks are caused by strain being not released fully in the main event and by rearrangement of stresses in the region. The aftershock pattern helps to infer the position of the fault or the block displacement. The irregular ruptures produce greater number of aftershocks. Moderate to great earthquakes are followed by hundreds of aftershocks. They decay both in magnitude and frequency with time. Figures 2 & 3 show the aftershock activity of this earthquake for three months.

One of the most turbulent concentrations of active volcanoes in our present era is along an active belt extending westward from the Pacific ring of fire through Indonesia. There is a recorded history of about 80 volcano eruptions. There are 12 active volcanoes in Sumatra , 20 vents in Java , and 20 centres of activity in Lesser Sunda islands. Some of the world's greatest eruptions Krakatoa, Agung and Tambora – have occurred in this area.

Tsunami, a wave train or a series of waves in a body of water, is an oceanic gravity wave generated by submarine earthquakes or other geological processes, such as volcanic eruptions and landslides or meteoric explosions. More than 80% of the tsunamis are found to be associated with earthquakes. When tectonic earthquakes with crustal deformations over large areas occur beneath the sea, tsunamis are generated. About 90% of earthquakes occur in subduction zones and the areas are prime sources for tsunami. Not all earthquakes would cause tsunamis. For example, a near great earthquake with magnitude of 6.9 on 15 November, 1999 in Indian Ocean was a matter confined to seismologists alone. We may however, generalise that Earthquakes in the sea with magnitude of 6.5 or above may possess the potential to generate Tsunamis.

Tsunamis behave as small amplitude, long waves. Their height to length ratio may be higher than 1:100,000. Analyses show that the amplitude of tsunami is proportional to the cube of the length of rupturing. They reach the coastline with a gap of 15 to 30 seconds. On occasions they may extend to a few hours as well. Tsunamis are also called as *Maremoto,* moving sea in Spanish or seismic sea waves. They are popularly misquoted or mistaken as tidal waves. The wavelengths of tidal waves are of the order of 100 to 150 m whereas that of tsunamis may exceed 100 km in open seas. In case of tsunami, the entire vertical section of ocean from the surface to the bottom of the sea is displaced resulting in large amount of water to rise in a heap and propagate radially in all directions.

Tsunami extremely long and low seismic waves, which travel with high speeds, *transform* while approaching the coast. The velocity of the wave equals to the square root of the product of the acceleration due to gravity and the depth of water. Thus the velocity of the wave, which compares with that of a jet plane drastically, reduces as it reaches the coast. The kinetic energy is conserved by the increase in the wavelength rising to as much as 20 to 30 feet near the coast. This height and the force of the tsunami depend on the topography of the sea bottom and continental shelf and by the shape of the shorelines. Some times the water level initially falls due to the trough of the wave denuding beaches, exposing the anchors of the ships in harbours. At some places, the approach of tsunami is gradual, some places sudden and some places, the trough may not be followed by the crest at all. *Seiches* are sometimes misquoted as tsunamis. Seiches are oscillations of water (standing waves) in lakes and reservoirs due to distant large earthquakes. The great Assam earthquake of 1950 was reported to have caused seiches in the lakes of Norway and England.

The 22 May 1960 Chile earthquake of Magnitude $M_w = 9.5$ caused devastating tsunami along Chilean coast and after 16 hours lashed the Hawaiian Islands and after seven hours struck the coast of Japan. The Aleutian earthquake of 1 April 1946 caused severe damages and loss of life in Hawaiian Islands. This is a classic case of *Tsunami earthquake.* A *tsunami earthquake* is defined as an earthquake that excites much larger tsunami than expected from its seismic waves. This gave birth to the Pacific Tsunami Warning System.

The highest wave reported (525 metres) was in Lituya Bay, Alaska on 10 July 1958. The wave was due to the rockslide following an earthquake. Since the waves were confined to Bay, this is not considered as a typical tsunami. The 1883 Krakatoa eruption may be termed as a global event where the tsunami had its impact even up to the Cape of Good Hope, an abnormal rise in water in the English channel nearly after a day and half.

Rupturing along active fault lines where two sections of earth's crust are moving opposite to each other causes tsunamigenic earthquakes. Fault is a fracture or a zone of fractures in rock along which the two sides have been displaced relative to each other parallel to the fracture. The total fault offset may range from centimetres to kilometres. Figure 4 shows the three types of faults that can generate a tsunami : a strike-slip earthquake on a vertical fault, a dip-slip earthquake on a vertical fault, and a thrusting earthquake on a dipping plane. A perfect strike - slip pattern may not generate Tsunami. A dip slip mechanism seems to be a logical one for tsunami generation because it abruptly displaces large section of seafloor vertically; the area uplifted cancels out the area of subsidence, resulting in small or non-existent tsunami. A thrust fault, which is characteristic of subduction zones, is a preferred region for tsunami generation. The greater the vertical displacement (or slip), the greater the amplitude of tsunami.

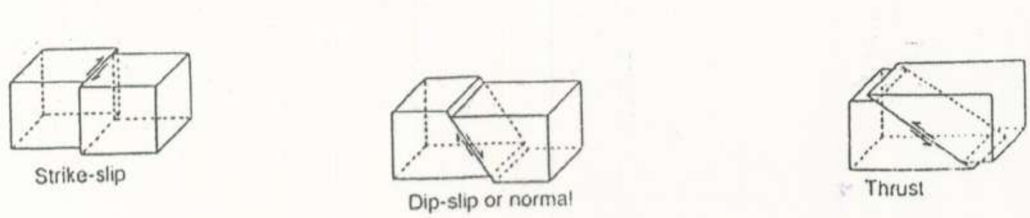


Fig 4. Basic Types of faults

Amplitude and wave heights

The amplitude varies from zero to peak, either positive or negative. The wave height, also called range or double amplitude is measured from trough to peak, while the tsunami amplitude is measured from estimated tidal level at the time.

If no tideguage records are available, the tsunami heights are measured by field surveys, the tsunami height on land measured from sea level at the time of tsunami arrival is called inundation height. The horizontal distance measured from the coast (at the time of tsunami arrival) is called inundation distance. Tsunami Run - up height usually refers to the inundation height at the maximum inundation distance. The run - up height is not necessarily the same as the inundation height near shore.

Imamura-Lida scale m is generally used to quantify tsunami

Mm= log h where the maximum run - up height in meters. Tsunami magnitude for pacific tsunamis is given as

Mt = log H + log D + 5.8, where H is the maximum amplitude on tide gauges in meters, D is the distance in kilometres.

Conclusion

Forecasting of earthquakes involving space, time and magnitude together is not scientifically practicable at present. The processes of Earthquakes are the phenomena that still need to be understood well. It is for this purpose, considerable qualitative and quantitative data is to be acquired. This can be achieved by increasing the density of network of seismographs.

Tsunami, a rare phenomenon on our coasts could be well taken care of by adhering to the coastal regulations such as the distance and elevation factors. Fortunately, our region is not threatened by the frequency of occurrence and constraint of space to escape as in the countries like Japan.

Above all, a general awareness about these phenomena is essential among the public as well as its incorporation in curriculum even at elementary school level itself.

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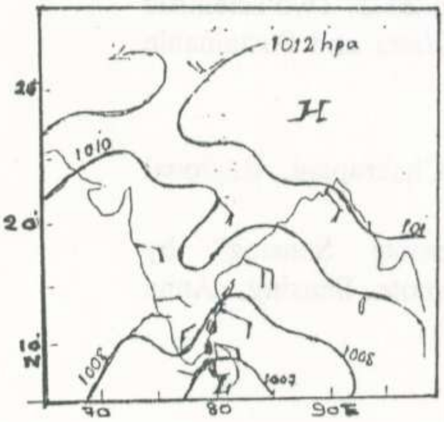
UNPRECEDENTED WET SPELL OVER SOUTH PENINSULA IN APRIL 2005

P.V.Revikumar

April is famous for scorching summer heat in peninsular India. The day temperature reaches its peak over Kerala during this month well before the wind pattern changes its course from east to west.

Due to the northward progress of the Equa.orial Trough, a trough of low pressure developed over the southwest Bay of Bengal on 3 April. It moved towards west as a shallow wave in the equatorial easterlies, and came closer to Tamil Nadu coast on 4 April bringing widespread rainfall, initially over the coastal areas of Tamil Nadu and slowly spread to the interior parts and to Kerala state. The slow movement of this shallow trough in easterlies towards west across Tamilnadu had resulted in copious rainfall activity over Tamilnadu and Kerala for nearly 3 days which is rather unusual, when many places in this part of the country were facing drought conditions. The rainfall pattern well resembles that of typical nortneast monsoon characteristics.



The wind, pressure pattern and satellite cloud imagery at 03 UTC on 5 April is given in the above figures. The cumulative rainfall from 4 - 7 April at many places had exceeded the seasonal normal rainfall by several times. Mandapam in Ramanathapuram district recorded 51 cm of rain at 0830 hours IST on 5 April which is an all time record for this station. Papanasam dam in Tirunelveli district recorded a rainfall of 45 cm on 5 April which is also an all time record for that place.

The copious rainfall activity associated with a trough of low pressure off Tamil Nadu coast which was rather unusual during this period of the year brought lot of respite from the water crisis in Tamil Nadu and Kerala by recharging the groundwater potential, thanks to the trough in Easterlies for the wet spell on summer days.

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CHAPTER NEWS

A mini seminar on "MONSOON 2004" and "EARTHQUAKE" was conducted on 28 February 2005, in connection with National Science Day celebrations. Six scientific presentations were made.

- "Review of performance of SW Monsoon 2004" by Sri.S.R.Ramanan, Director, Regional Meteorological Centre, Chennai.
- "Review of performance of NE Monsoon 2004" by Sri.P.V.Revikumar, Meteorologist Gr.I., Regional Meteorological Centre, Chennai.
- "Global features associated with SW and NE Monsoon 2004" by Dr.Y.E.A.Raj, Director, Regional Meteorological Centre, Chennai.
- "Ongoing research on Earthquakes and Tsunamis" by Dr.M.Murali, Scientist, Department of Ocean Engineering IIT, Chennai.
- "Geological features and Seisimicity of India" by Sri.G.Rajagopalan, Director, Geological Survey of India, Chennai.

World Meteorological Day was celebrated on 23 March 2005. Two scientific presentations connected with the theme "Weather, Climate, Water and Sustainable Development" were arranged.

- "Ground water scenario in Tamilnadu" by Sri. R. Chakrapani, Regional Director, Central Ground Water Board, Chennai.
- "Monitoring weather and climate through Remote Sensing" by Sri. A.Ravindran, Senior Scientist, Institute of Remote Sensing, Anna University, Chennai.

Scientific Lectures

- "Wind profilers for understanding the lower atmosphere" by Dr. K.Krishna Reddy, Scientist, Frontier Observational Research System for Global Change, Japan, on 2 July 2004.
- " Doppler Weather Radar: An overview" by Sri. S.B. Thampi, Director, CDR, Chennai, on 12 August 2004.
- " Doppler Weather Radar: Applications" by Dr. R.Suresh, Director, CDR, Chennai, on 12 August 2004.
- " South African Weather Services" by Mr. Louis Vermeak, Manager, Weather Observations, Weather Services, South Africa on 27 October 2004.

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