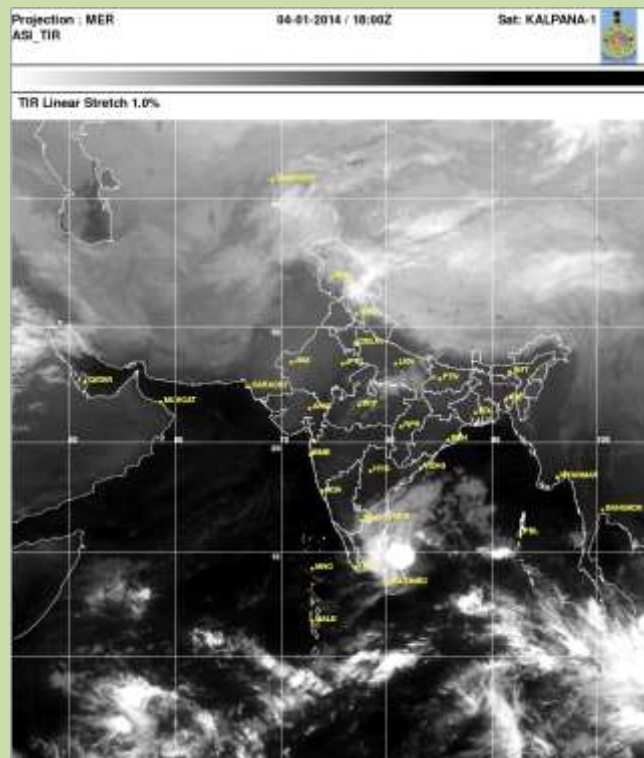




**GOVERNMENT OF INDIA**  
**MINISTRY OF EARTH SCIENCES**  
**EARTH SYSTEM SCIENCE ORGANISATION**  
**INDIA METEOROLOGICAL DEPARTMENT**  
**A Preliminary Report on Depression over Bay of Bengal**  
**(4 – 7 January, 2014)**



**KALPANA IMAGERY BASED ON 1800 UTC OF 4<sup>th</sup> JAN, 2014**

**CYCLONE WARNING DIVISION, NEW DELHI**

**JANUARY 2014**

## **1. Introduction**

A depression formed over the southwest Bay of Bengal on 4<sup>th</sup> January 2014. It moved west-north-westwards initially and then westwards and crossed Sri Lanka coast near lat.  $9.2^{\circ}$  N long.  $80.8^{\circ}$  E between 0500 UTC and 0600 UTC of 06<sup>th</sup> January 2014. It then moved southwestwards across Sri Lanka and weakened gradually into a well marked low pressure area over Sri Lanka and adjoining Gulf of Mannar at 0300 UTC of 07<sup>th</sup> January 2014. The salient features of this depression are given below.

- (i) It was the first cyclonic disturbance in the month of January after 2005. The cyclonic storm (HIBARU) formed during 13<sup>th</sup> - 17<sup>th</sup> January 2005 over Bay of Bengal. It however weakened into a well-marked low pressure area over the Bay of Bengal and adjoining Equatorial Indian Ocean while moving westwards.
- (ii) This is the only cyclonic disturbance formed over southwest Bay of Bengal in January 2014 which crossed Srilanka coast as per the records of IMD (1891 onwards).
- (iii) The low vertical wind shear around the depression centre throughout its life period helped it to maintain the intensity of depression till landfall.

## **2. Monitoring and prediction**

The depression was mainly monitored by satellite. The half hourly INSAT/Kalpana imageries and products, Oceansat-II surface winds along with the products from newly launched INSAT-3D satellite and other internationally available satellite products were also used for monitoring of this depression. Various numerical weather prediction (NWP) models and statistical- dynamical models including IMD's global and meso-scale models were utilized to predict the genesis, track and intensity of the depression. Tropical Cyclone Module in the digitized forecasting system of IMD was utilized for analysis and comparison of various observational, NWP model products and decision making process.

## **3. Genesis**

Under the influence of an active inter-tropical convergence zone, a low pressure area formed over southeast and adjoining southwest Bay of Bengal at 0300

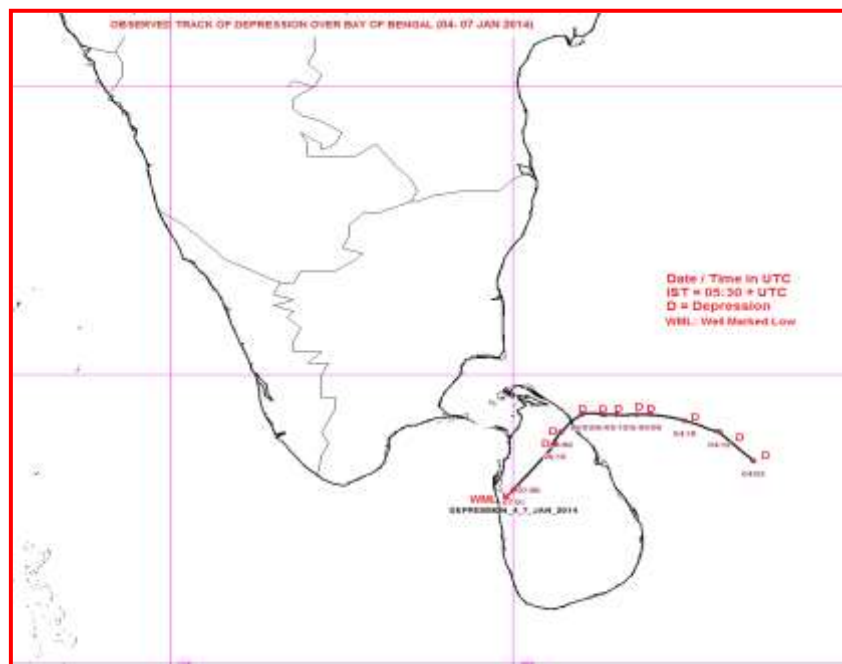
UTC of 2<sup>nd</sup> January, 2014. It moved northwestwards and became a well-marked low at 0300 UTC of 3<sup>rd</sup> January it concentrated into a depression at 0300 UTC of 4<sup>th</sup> January, 2014 and lay centred near latitude 8.5<sup>o</sup> N and longitude 83.5<sup>o</sup> E, about 470 km southeast of Nagapatinam and 250 km east of Trincomalee(Sri Lanka) over southwest Bay of Bengal. The OceanSat wind data indicated cyclonic circulations in associated with wind speed of 25-30 knots around the system centre. The winds were stronger in the northern semicircle of the system. The low level convergence along with low level relative vorticity and upper level divergence increased from 3<sup>rd</sup> to 4<sup>th</sup> January favouring cyclogenesis. The sea surface temperature was 26<sup>o</sup>- 28<sup>o</sup>C and ocean thermal energy was 60-80 kJ/cm<sup>2</sup> around system centre. The vertical wind shear was moderate (10 – 20 kts) which was favourable for cyclogenesis. Satellite imageries indicated intense to very intense convection with lowest cloud top temperature of about -75<sup>o</sup>C.

The best track parameters are shown in Table 1. The track of the system is shown in Fig.1. The typical satellite imageries of depression are shown in Fig.2 respectively. The IMD GFS analysis of wind at 10m and 850 hPa, 500 hPa and 200 hPa levels are shown in Fig.3 based on 0000 UTC of 4 – 7<sup>th</sup> January 2014.

**Table 1 Best track positions and other parameters of the Depression over the Bay of Bengal during 04-07 January, 2014**

Date	Time (UTC)	Centre lat. <sup>o</sup> N/ long °E	C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
04/01/2014	0300	08.5/83.5	1.5	1006	25	3	D
	0600	09.0/83.0	1.5	1006	25	3	D
	1200	90./83.0	1.5	1006	25	3	D
	1800	9.2/82.5	1.5	1006	25	3	D
05/01/2014	0000	9.3/82.0	1.5	1006	25	3	D
	0300	9.3/82.0	1.5	1006	25	3	D
	0600	9.3/81.8	1.5	1006	25	3	D
	1200	9.3/81.5	1.5	1004	25	4	D

	1800	9.3/81.3	1.5	1004	25	4	D
06/01/2014	0000	9.3/81.3	1.5	1004	25	4	D
	0300	9.4/81.0	1.5	1006	25	4	D
	0600	9.0/80.7	Crossed Sri Lanka coast near lat. 9.2 <sup>0</sup> N long. 80.8 <sup>0</sup> E between 0500 UTC and 0600 UTC of 06 <sup>th</sup> January 2014				
	1200	8.8/80.6	-	1006	25	3	D
07/01/2014	0000	8.0/80.0	-	1006	25	3	D
	0300	Weakened gradually into a well-marked low pressure area over Sri Lanka and adjoining Gulf of Mannar.					



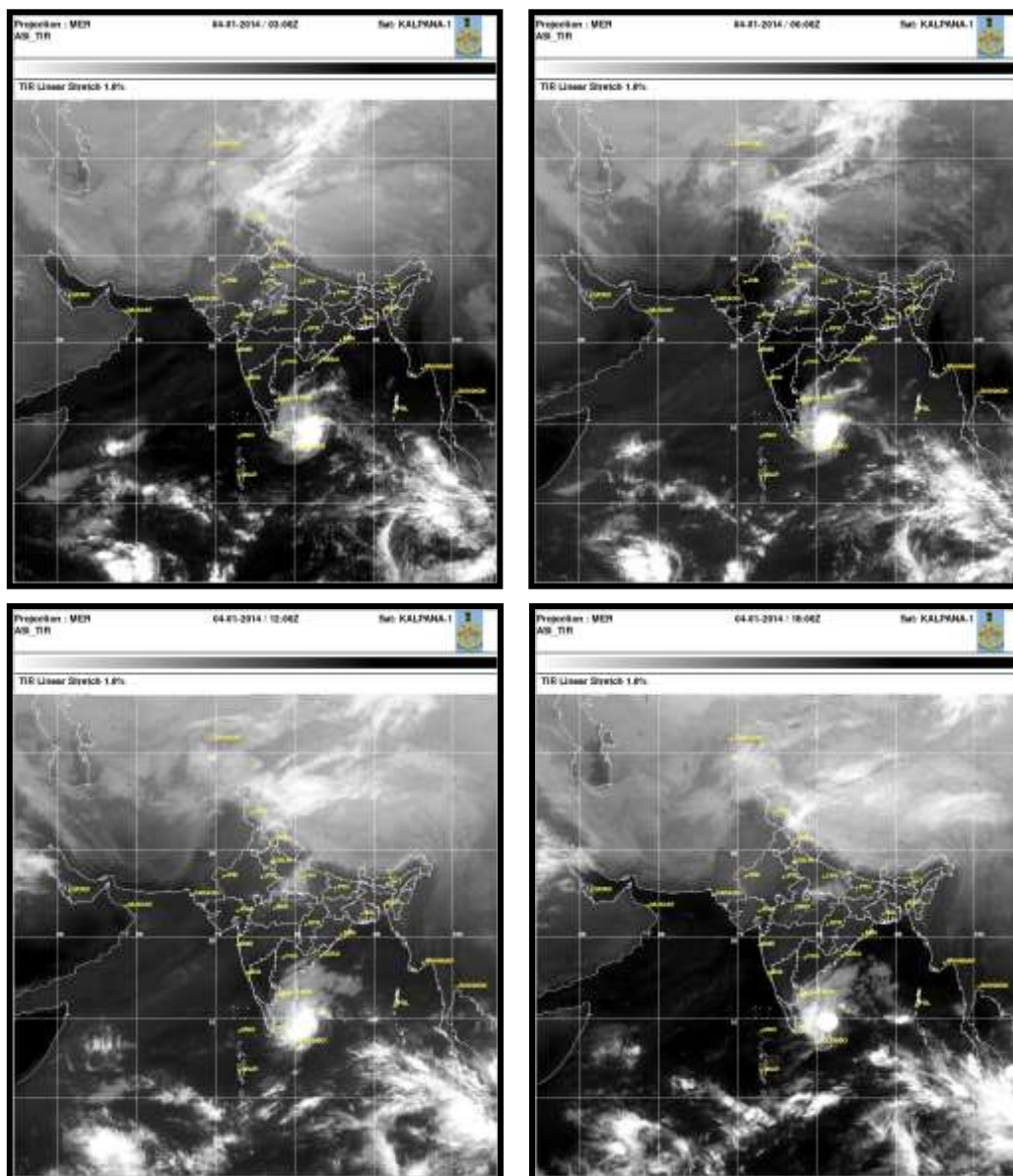
**Fig.1. Track of Depression over Bay of Bengal (4-7 January 2014)**

#### 4. Intensification and movement

The favourable condition of lower level relative vorticity, lower level convergence, upper level divergence, warmer SST (26-28<sup>0</sup> C) and associated convection persisted during 4<sup>th</sup> to 6<sup>th</sup> January 2014. However as the system came closer to SRILANKA coast, it experienced relatively colder sea winds and ocean thermal energy of less than 50 KJ/cm<sup>2</sup>. Further, the system interacted with land surface from 6<sup>th</sup> January onwards as it lay close to the coast. The convection was sheared to the west of system centre. As a result the depression did not intensify further and gradually weakened after crossing the coast. The southwestwards movement of the system over Sri Lanka was also not favourable for maintaining the intensity of the system. The Madden Julian Oscillation (MJO) index lay in phase 6

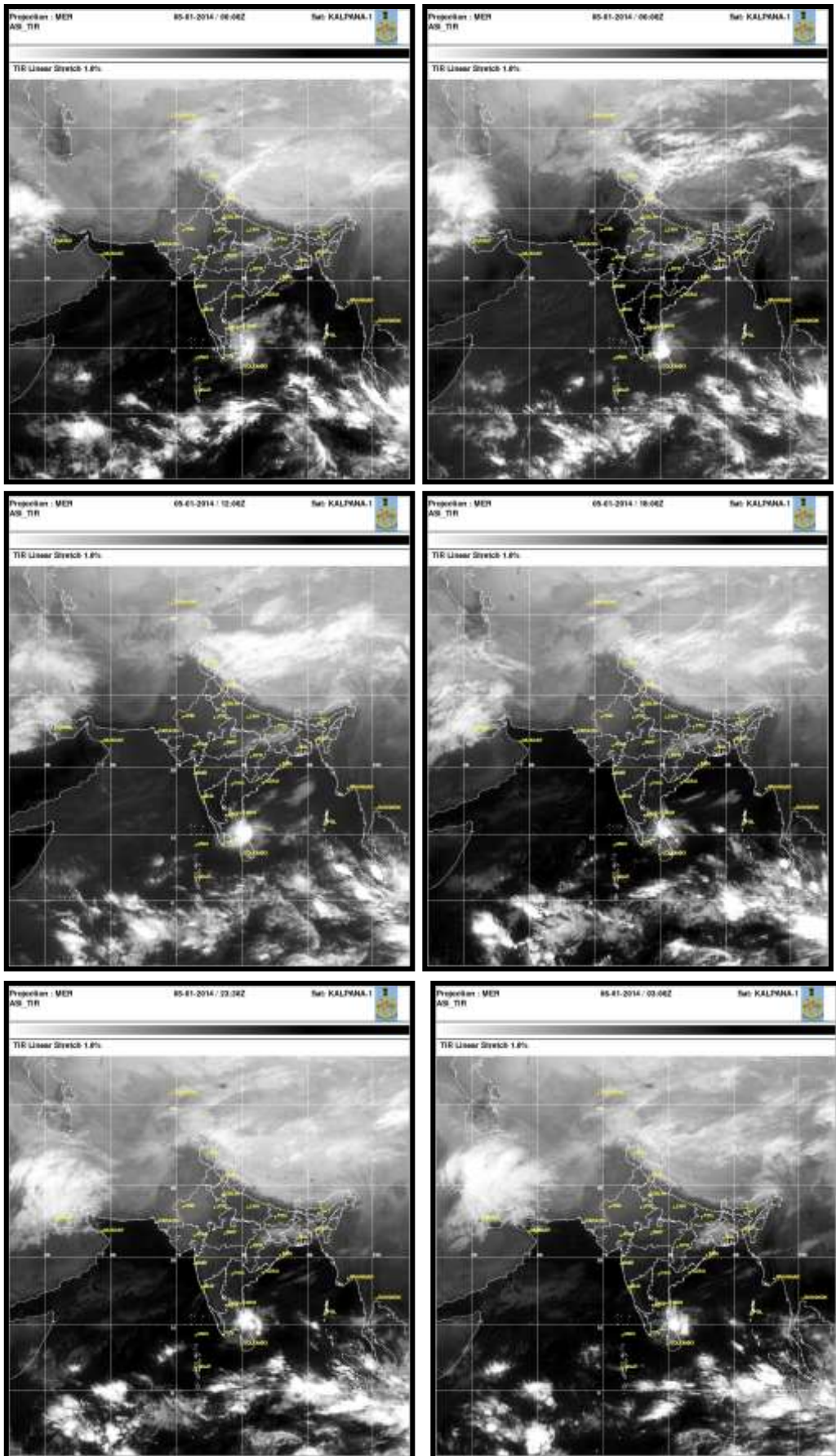
with amplitude less than 1 during the life period of the depression. The phase 6 is not favourable for intensification of the system over Bay of Bengal.

The depression lay to the south of upper tropospheric ridge which ran along lat  $11^{\circ}$  N on 4<sup>th</sup> January 2014. It led to west-northwestwards movement of the depression initially. However from 5<sup>th</sup> onwards, the upper tropospheric ridge shifted northwards and lay along  $13^{\circ}$  N on 6<sup>th</sup> January. It leads to move westward component of the movement of depression. With the gradual weakening of the system over SriLanka, it was steered southwestwards under the influence of the easterly waves and northeast monsoon circulation.

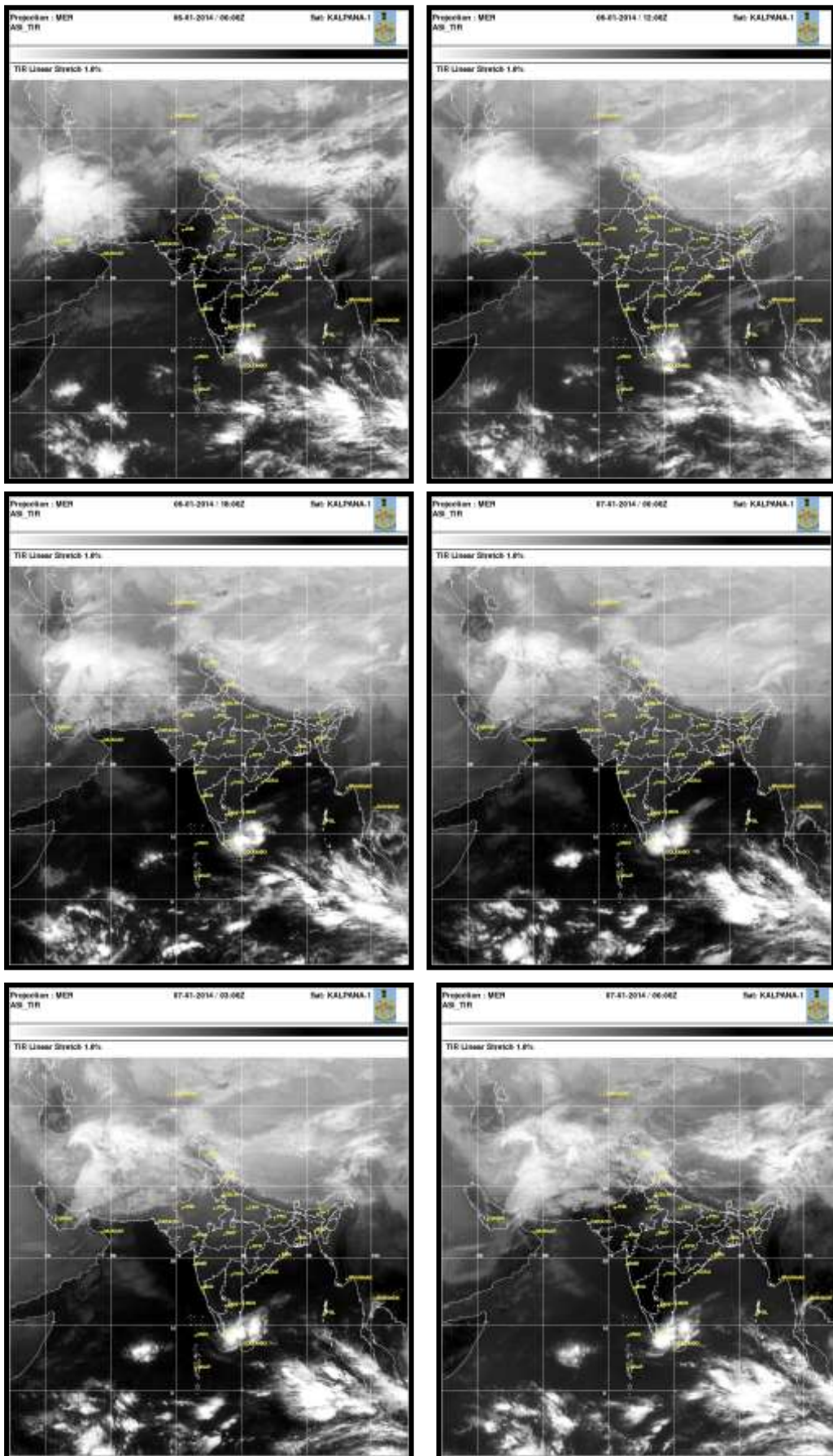


**Fig.2(a). Kalpana-1 satellite imageries of depression over the Bay of Bengal at 03,06,12 & 18 UTC of 4<sup>th</sup> January**



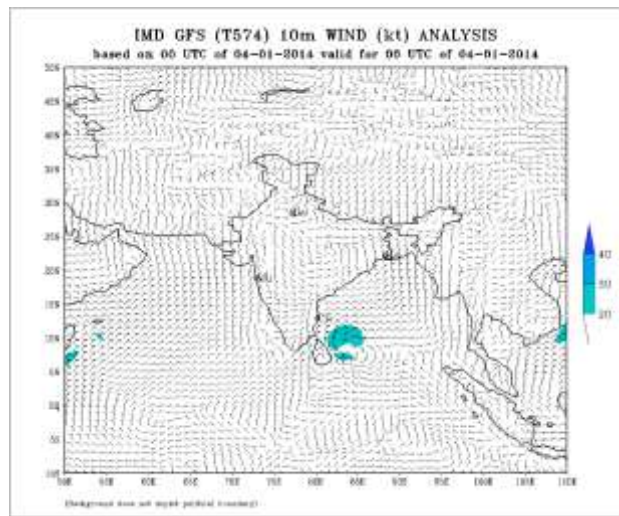
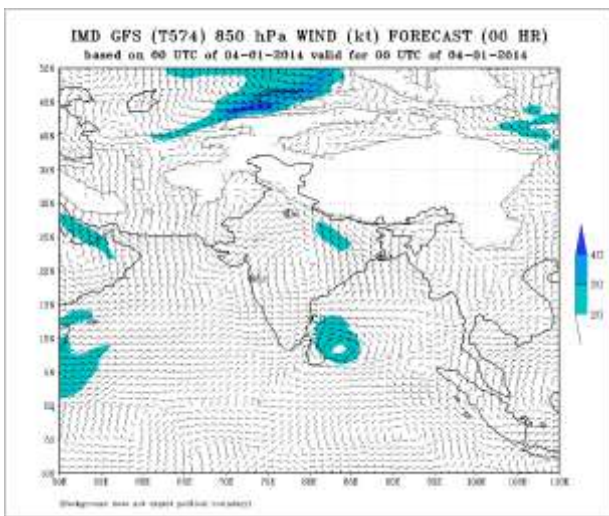
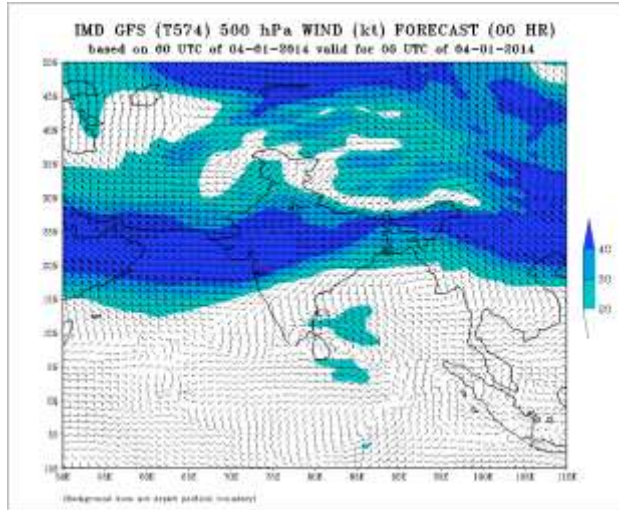
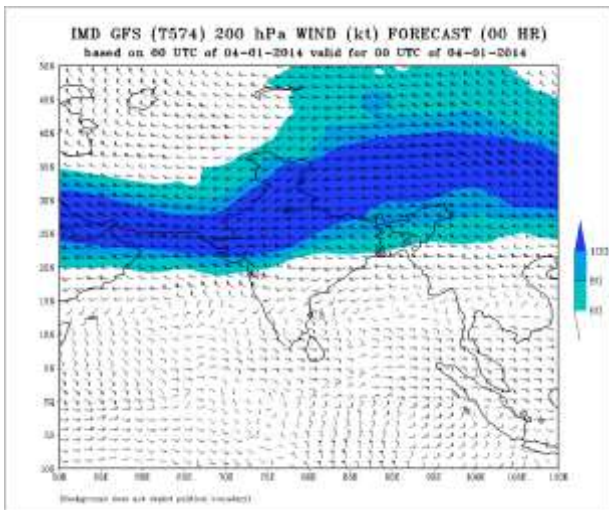


**Fig.2(b). Kalpana-1 satellite imageries of depression over the Bay of Bengal at 00, 06,12 & 18 UTC of 05<sup>th</sup>, 00 & 03UTC of 6<sup>th</sup> January 2014.**

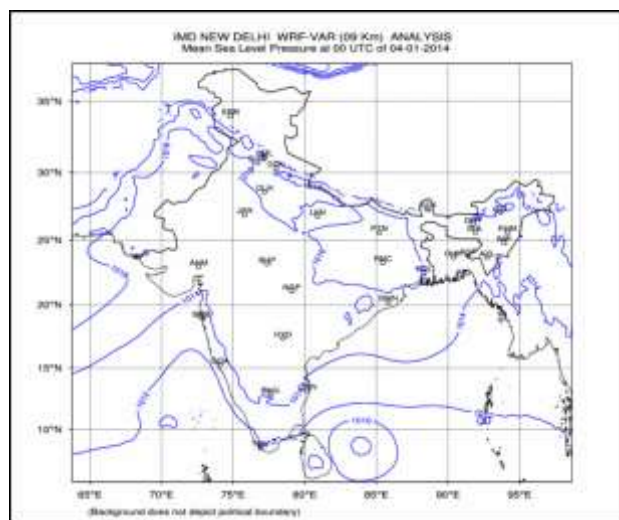
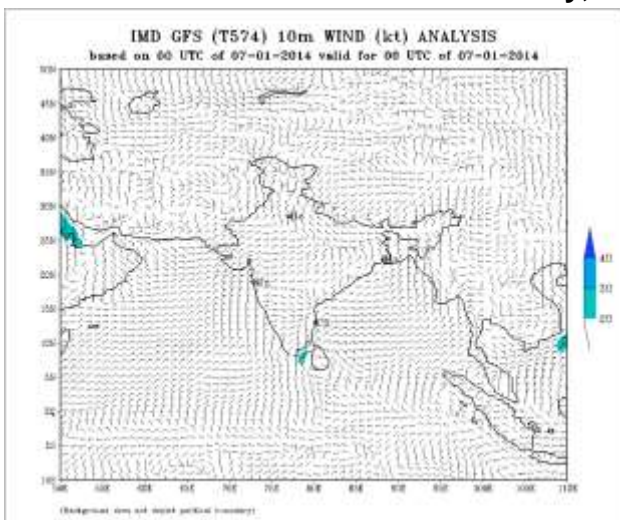


**Fig.2(c). Kalpana-1 satellite imageries of depression over the Bay of Bengal at 06,12 &18 of 6<sup>th</sup> and 00,03 & 06 UTC of 7<sup>th</sup> January 2014**





**Fig.3 (a) IMD GFS winds at 850, 500 & 200 hpa levels and 10meter wind based on 00 UTC of 04<sup>th</sup> January, 2014.**



**Fig.3 (b) IMD GFS 10meter wind based on 00 UTC of 7<sup>th</sup> Jan & WRF MSLP analysis based on 4<sup>th</sup> Jan 2014**



## 5. Warning services

The Cyclone Warning Division / Regional Specialised Meteorological Centre (RSMC)-Tropical Cyclones, IMD, New Delhi mobilised all its resources for monitoring and prediction of Depression. It issued 3/6 hourly warning/advisory bulletins to national disaster management agencies. It issued forecast and warning bulletins to various national and international disaster management agencies including National Disaster Management (NDM), Ministry of Home Affairs (MHA), concerned state Govts. and other users in regular intervals. It also issued advisories to World Meteorological Organisation (WMO)/Economic and Social Cooperation for Asia and the Pacific (ESCAP) Panel member countries including Bangladesh, Myanmar, Thailand, Pakistan, Oman, Sri Lanka and Maldives during depression period.

The graphical display of the observed track was uploaded in the IMD's website regularly. The number of bulletins issued by the Regional Specialised Meteorological Centre and Cyclone warning division, New Delhi, are given below:

Bulletins for India	: 15
Special Tropical Weather Outlook and Tropical Cyclone Advisory	
Bulletin to all WMO/ESCAP Panel countries	: 9

In addition, special e-mails about the depression were also sent to all concerned offices.

## 6. Realized Weather:

### India:

Chief amounts of 24 hrs. Rainfall (1 cm or more) ending at 0300 UTC of 08<sup>th</sup> January, 2014 are given below:

Rameswaram-5, Manimutharu-4, Vedaranyam-4, Kanyakumari-3, Tondi-3, Vedaranyam-3, Pamban-2, Nagercoil-2, Nanguneri-2, Sivaganga-2, Ottapadiram-2, R.S.Mangalam-2, Papanasam-2, Radhapuram-2, Tirupuvanam-2, Ambasamudram-2, Srivaikuntam-2, Palayamkottai-2, Cheranmahadevi-2, Tiruvadanai-1, Ramanathapuram-1, Paramakudi-1, Muthupet-1, Manamadurai-1, Thiruthuraiipoondi-1, Arantangi-1, Colachel-1, Tuticorin-1, Tiruchendur-1, Madurai (AP) -1, Pamban-1, Ramanathapuram-1.

## **Sri Lanka:**

As estimated by satellite imagery and products, the sustained maximum wind of 25 knots prevailed along and off Sri Lanka coast, when the depression crossed this coast.

Chief amounts of 24 hrs. Rainfall (1 cm or more) ending at 0300 UTC during 4-8<sup>th</sup> January 2014 are given below:

### **4<sup>th</sup> Jan 2014:**

Jaffna-close to the Northern coast: 3;

### **5<sup>th</sup> Jan 2014:**

Jaffna-close to the Northern coast: 3, Trincomalee-close to Northeastern coast: 10;

Mannar-close to NW coast: 5; Anuradhapura-Northcentral part: 1

### **6<sup>th</sup> Jan 2014:**

Vavuniya-Northern part: 21; Puttalam-close to Northwestern coast: 8; Anuradhapura-Northcentral part and Trincomalee-close to Northeastern coast: 5 each; Jaffna-close to the Northern coast: 2; Mannar-close to NW coast: 1.

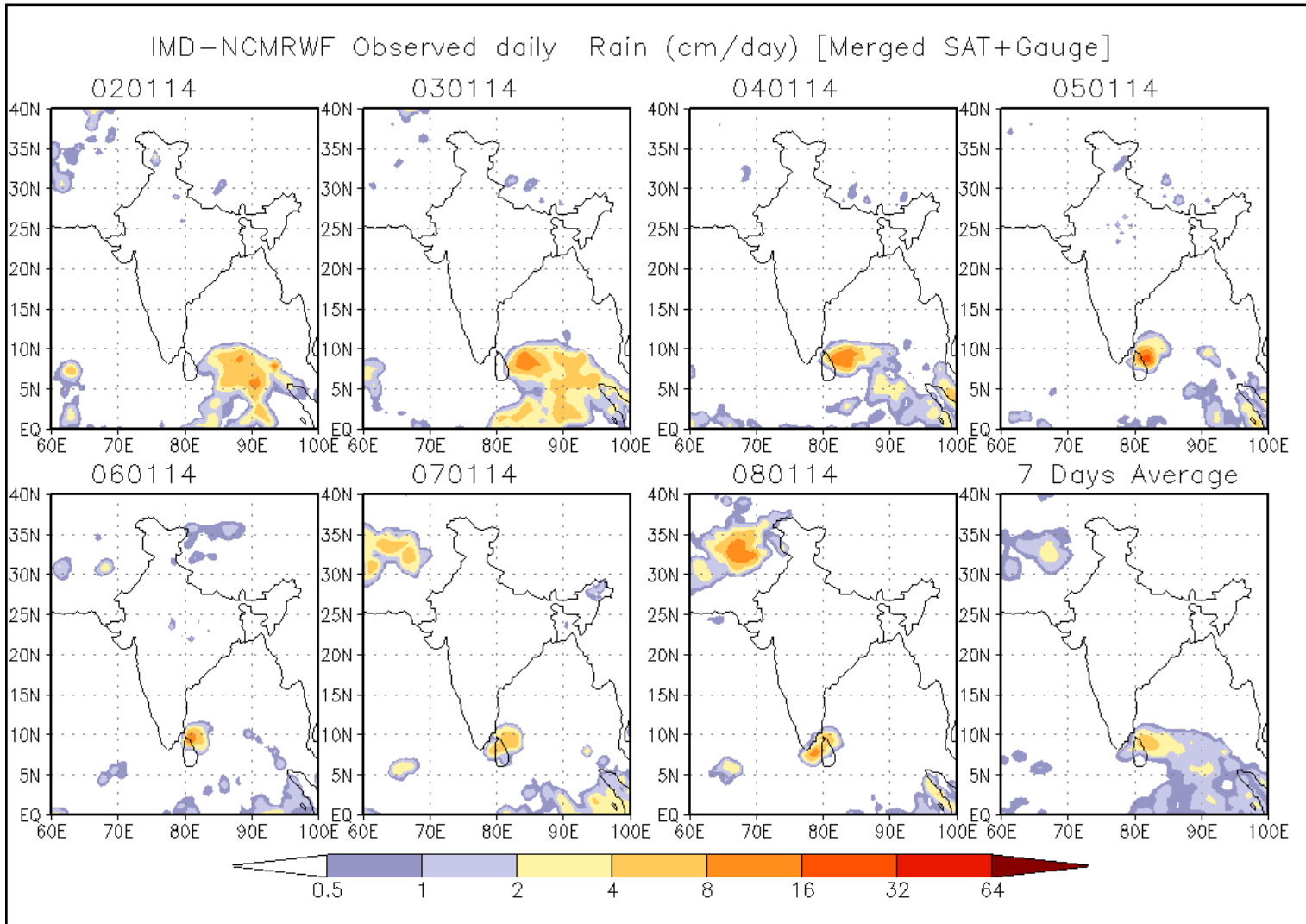
### **7<sup>th</sup> Jan 2014:**

Jaffna-close to the Northern coast: 3; Mannar-close to NW coast: 2; Anuradhapura-Northcentral part, Puttalam-close to Northwestern coast, Trincomalee-close to Northeastern coast and Vavuniya-Northern part: 1 each.

### **8<sup>th</sup> Jan 2014:**

No station reported 1 cm rainfall.

The realised rainfall as per the gridded rainfall data of IMD/NCMRWF based satellite estimation over sea area and point rainfall over land region during 2-8 January, 2014 are shown in Fig.4. It indicates that the maximum rainfall occurred over the left forward sector of the depression. The rainfall intensity was maximum (8-16 cm) during 3-5<sup>th</sup> January, 2014.



**Fig.4: Daily rainfall distribution based on merged grided rainfall data of IMD/NCMRWF during 2-8 January 2014.**

## 7. Forecast verification

### Rainfall forecast

The heavy rainfall warning issued by IMD along with the actual heavy rainfall is given in Table 2.

Table 2: Rainfall forecast verification		
Date & time	Warning issued	24 hr heavy rainfall realised at 0300UTC of date
04/01/2014 0300 UTC	Rainfall would occur at many places with isolated heavy to very heavy falls over south coastal Tamil Nadu and isolated heavy fall over south interior Tamil Nadu commencing from 6 <sup>th</sup> January 2014.	Nil
05/01/2014 0300 UTC	Rainfall would occur at many places over south Tamil Nadu with isolated heavy falls on 6 <sup>th</sup> and isolated heavy to very heavy falls on 7 <sup>th</sup> January 2013.	Nil
06/01/2014 0300 UTC	Rainfall would occur at many places over south Tamil Nadu with isolated heavy falls during next 24 hours and isolated heavy to very heavy falls during subsequent 24 hours.	Nil
07/01/2014 0300 UTC	Rainfall would occur at many places with isolated heavy falls over south coastal Tamil Nadu during next 24 hours.	Moderate to rather heavy (1 – 5 cm) over south coastal Tamilnadu.

### Landfall forecast error:

The landfall forecast errors are given in Table 3. It was about 55 km or less for all forecasts ranging from 12-48 hrs.

Table 3: Landfall point and time forecast verification								
Lead time	Landfall forecast point		Landfall point (Actual)		Landfall forecast error in km	Landfall forecast time	Actual landfall time	Landfall Time error hrs UTC
	Lat ° N	Long ° E	Lat ° N	Long ° E				
12	9.25	80.5	9.2	80.8	57	6 <sup>th</sup> 00.30 UTC	6 <sup>th</sup> 05.30 UTC	-5



24	9.5	80.5	9.2	80.8	47	5 <sup>th</sup> 18.30 UTC	6 <sup>th</sup> 05.30 UTC	-11
36	9.5	80.5	9.2	80.8	47	5 <sup>th</sup> 12.30 UTC	6 <sup>th</sup> 05.30 UTC	-17
48	9.2	80.5	9.2	80.8	33	5 <sup>th</sup> 12.30 UTC	6 <sup>th</sup> 05.30 UTC	-17

#### 8. Damages:-

The depression caused damage over Sri Lanka as follows and there was no damage over India.

DISTRICT	DISASTER	DATE	AFFECTED		DEATHS	INJURD PEOPLE	MISSING PEOPLE	HOUSE DAMEGED	
			FAMILIES	PEOPLE				FULLY	PART
Mullative	Strong winds	2014.01.05	532	1657	0	0	0	5	219
Vavuniya	Heavy Rain	2014.01.07	48	185	0	0	0	10	35
Puttalam	Flash Flood	2014.01.07	20		0	0	0	0	0
Anuradhapura	Flood	2014.01.07	142	574	0	0	0	0	0
Batticaloa	Flood	2014.01.07	675	2659	0	0	0	0	0
			2	9	0	0	0	0	0
		Total	1419	5084	0	0	0	15	254

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