

GOVERNMENT OF INDIA MINISTRY OF EARTH SCIENCE INDIA METEOROLOGICAL DEPARTMENT

VERIFICATION OF STORM SURGE ASSOCIATED WITH TROPICAL CYCLONES OVER NORTH INDIAN OCEAN

Extremely Severe Cyclonic Storm "MOCHA" over Southeast Bay of Bengal (9-

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
10.05.2023/0300UTC	Storm surge with height of about 1.5-2.0m above the astronomical tide is likely to inundate low lying areas of north Myanmar and adjoining southeast Bangladesh coasts during the time of landfall.	The realised storm surge as reported by DMH, Myanmar was 5-10 feet (1.5-3.0m) along Myanmar coast near landfall.
11.05.2023/0300UTC	Storm surge with height of about 2.0-2.5m above the astronomical tide is likely to inundate low lying areas of north Myanmar and adjoining southeast Bangladesh coasts during the time of landfall.	
12.05.2023/0300UTC	Storm surge with height of about 2.0-2.5m above the astronomical tide is likely to inundate low lying areas of north Myanmar and adjoining southeast Bangladesh coasts during the time of landfall.	
13.05.2023/0300UTC	Storm surge with height of about 2.5-3.0m above the astronomical tide is likely to inundate low lying areas of north Myanmar and adjoining southeast Bangladesh coasts during the time of landfall.	
14.05.2023/0300UTC	Storm surge with height of about 3.0-3.5m above the astronomical tide is likely to inundate low lying areas of north Myanmar and adjoining southeast Bangladesh coasts during the time of landfall.	

15 May, 2023)

Extremely Severe Cyclonic Storm "BIPARJOY" over Southeast Arabian Sea (6-19 June, 2023)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
11.06.2023/0300UTC	Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of Kutch, Devbhumi Dwarka, Porbandar, Jamnagar and Morbi districts of Gujarat during the time of landfall.	Estimated storm surge of height 2-2.5 m above astronomical tide inundated the low lying areas Kutch and Morbi districts. Peak surge of height 2.1 m was observed at the south of Naliya and 2.2 m
12.06.2023/0300UTC	Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of Kutch, Devbhumi Dwarka, Porbandar, Jamnagar and Morbi districts of Gujarat during the time of landfall.	near Navlakhi
13.06.2023/0300UTC	Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of Kutch, Devbhumi Dwarka, Porbandar, Jamnagar and Morbi districts of Gujarat during the time of landfall. The astronomical tides along these districts could be upto 3-6 meters in different places.	
14.06.2023/0300UTC	Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of Kutch, Devbhumi Dwarka, Porbandar, Jamnagar and Morbi districts of Gujarat during the time of landfall. The astronomical tides	

	along these districts could be upto 3-6 meters in different places.
15.06.2023/0300UTC	Storm surge of about 2 -3 m above the astronomical tide is likely to inundate the low lying areas of Kutch, Devbhumi Dwarka, Porbandar, Jamnagar and Morbi districts of Gujarat during the time of landfall. The astronomical tides along these districts could be upto 3-6 meters in different places.

Extremely Severe Cyclonic Storm "TEJ" over Southwest Arabian Sea (20-24th October, 2023)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
24.10.2023/0300UTC	Storm surge of about 2 meter height above the astronomical tide is likely to inundate low lying areas between Al Ghaydah and Al Faydami near the landfall point at the time of landfall.	IMD predicted storm surge of height 2.0-2.5 m to inundate the low lying areas of Yemen between Al Ghaydah and Faydami. The estimated peak surge was about 1.5 m.

Very Severe Cyclonic Storm "HAMOON" over Westcentral Bay of Bengal (21-25 October)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
23.10.2023/0300UTC	Storm surge of about 1.0-1.5 meter height above the astronomical tide is likely to inundate low lying areas between Khepupara and Chittagong around the time of landfall.	Not Available
24.10.2023/0300UTC	Storm surge of about 1.3 meter height above the astronomical tide is forecasted for the coast of Bangladesh.	

Cyclonic Storm "MIDHILI" over Westcentral Bay of Bengal (15-18 November, 2023)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
16.11.2023/0300UTC	Storm surge of about 1-2 meter height above the astronomical tide is like to inundate over low lying areas of Bangladesh near the landfall point at the time of landfall.	Not Available
17.11.2023/0300UTC	Storm surge of about 1-2 meter height above the astronomical tide is like to inundate over low lying areas of Bangladesh near the landfall point at the time of landfall.	

Severe Cyclonic Storm "MICHAUNG" over Southeast & adjoining southwest

Bay of Bengal (1-6 December, 2023)

Date	Storm Surge Forecast	Realised Storm Surge
02.12.2023	Storm surge of about 1-1.5 meter above astronomical tide likely to inundate south Coastal Andhra Pradesh districts at the time of landfall.	Storm surge of height 1.0-1.5 m was realised over low lying areas of south coastal
03.12.2023	Storm surge of about 1-1.5 meter above astronomical tide likely to inundate south Coastal Andhra Pradesh districts at the time of landfall.	Andhra Pradesh (maximum over Krishna and Bapatla districts) at the time of landfall.
04.12.2023	Storm surge of about 1-1.5 meter above astronomical tide likely to inundate south Coastal Andhra Pradesh districts at the time of landfall.	
05.12.2023	Storm surge of about 1-1.5 meter above astronomical tide likely to inundate south Coastal Andhra Pradesh districts at the time of landfall.	
06.12.2023	 West Central Bay of Bengal along & off north Andhra Pradesh and Odisha Coasts: Moderate sea condition is likely to prevail over the region during next 06 hours and would gradually improve thereafter. 	

Severe cyclonic storm Asani over Bay of Bengal (07-12 May, 2022)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
11.05.2022/0300UTC	Storm surge of height about 0.5 m above astronomical tide is likely to inundate low lying areas of Krishna, East & West Godavari districts of Andhra Pradesh and Yanam of UT of Puducherry.	Not reported

Cyclonic Storm	Sitrang over	Bay of Benga	I (22-25 October, 2022))
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Date/Base Time of	Storm Surgo Ecropost at 0200	Poplicod surge
observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
23 Oct/ 0300 UTC 24 Oct/ 0300 UTC	 (I) Tidal wave of about 2.0 m height above astronomical tide is likely to inundate low lying areas of Bangladesh coast near the landfall area around the time of landfall. (ii) Tidal wave of about 1.0 m height above astronomical tide is likely to inundate low lying areas of West Bengal (North & South 24 Parganas) around the time of landfall. (iii) Astronomical tide of about 5-6 m height is likely along & off West Bengal-Bangladesh coast on 25th October. (I) Tidal wave of about 2.0 m height above astronomical tide is likely to inundate low lying areas of Bangladesh coast near the landfall area around the time of landfall. (ii) Tidal wave of about 2.0 m height above astronomical tide is likely to inundate low lying areas of Bangladesh coast near the landfall area around the time of landfall. (ii) Tidal wave of about 1.0 m height above astronomical tide is likely to inundate low lying areas of Bangladesh coast near the landfall area around the time of landfall. 	The peak storm surge of about 1.7 m above astronomical tide occurred around Sitakund area of Bangladesh, whereas the maximum storm surge of about 0.5 m occurred along the West Bengal coast (Sunderbans). This peak storm surge occurred near Sitakund at a distance of about 130 km to the right of the cyclone's landfall point mainly because of the strong onshore winds in the cyclone's right forward quadrant at a distance equal to radius of maximum wind and the funnelling shape of the head BoB along the coastal stretch between Chattogram and Sitakund of Bangladesh.
	inundate low lying areas of West Bengal (North & South 24 Parganas) around the time of landfall.	

Severe Cyclonic Storm Mandous over Bay of Bengal (06-10 December, 2022)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
8 th Dec/ 0300 UTC	The storm surge of about 0.5 m height above the astronomical tide likely to inundate low lying areas of north coastal Tamilnadu and Puducherry during the time of landfall.	
9 th Dec/ 0300 UTC	The storm surge of about 0.5 m height above the astronomical tide likely to inundate low lying areas of north coastal Tamilnadu and Puducherry during the time of landfall.	0.4 10 0.0 metre.

Extremely Severe Cyclonic storm (ESCS) TAUKTAE (14-19 May 2021)

Date/Base	Storm Surge Forecast at 0300 UTC of	Realized surge
Time	date	_
of observation		
14.05.2021/0300	above the astronomical tide is very likely to inundate low lying areas of Lakshadweep Islands on 15th& 16th May.	astronomical tide over Diu and of coastal districts of
15.05.2021/0300	Tidal wave of about 2- 3 m above astronomical tide is likely to inundate coastal areas of Morbi, Kutch, Devbhoomi Dwarka & Jamnagar districts and 1-2 meters along Porbandar, Junagarh, Gir Somnath, Amreli, Bhavnagar and 0.5 to 1m over the remaining coastal districts of Gujarat during the time of landfall.	
16.05.2021/0300		
	Tidal wave above astronomical tide is likely to inundate coastal areas as per details below: about 3 -4 meter (m) over Anand & Amreli, Gir Somnath, Diu, Bhavnagar, 2- 3 m over Bharuch, southern parts of Ahmedabad, 1-2 m over Surat, Navsari, Valsad, and 0.5 – 1m over the remaining coastal districts of Gujarat during the time of landfall.	
18.05.2021/0300	Tidal wave above astronomical tide is likely to inundate coastal areas during next 06 hours, as per details below: About 1-2 meter (m) over Anand & Amreli, Gir Somnath, Diu, Bhavnagar, 1 m over Bharuch, southern parts of Ahmedabad, Surat, Navsari, Valsad, during next 06 hours.	

Very Severe Cyclonic storm (VSCS) YAAS (23-27 May 2021)

Forecast Storm Surge (m)	Realised Storm Surge (m)
Tidal waves of height 2-4 meters above	Estimated storm surge of about 2-4 meters height
astronomical tide to inundate low lying	above astronomical tide inundated low lying areas
areas of Balasore, Bhadrak Medinipur,	of Balasore and Bhadrak districts of north Odisha
South 24 Parganas, and about 1-2	and West Bengal (South 24 parganas, North 24
meters above astronomical tide to	parganas, Purba Medinipur districts) and 1-2
inundate low lying areas of Kendrapara	meters height above astronomical tide inundated
& Jagatsinghpur Districts around the	low lying areas of Kendrapara and Jagatsinghpur
time of landfall.	districts of north Odisha during time of landfall.

Super Cyclonic Storm "AMPHAN" over the Bay of Bengal (16-21 May-2020)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
18.05.2020/0300	Storm Surge of about 4-5 meters above Astronomical Tide is likely to inundate low lying areas of south & north 24 Parganas and about 3-4 meters over the low lying areas of East Medinipur District of West Bengal during the time of Landfall.	Maximum tidal wave of 4.6 meters height inundated the low lying areas of South & North 24
19.05.2020/0300	Storm Surge of about 4-5 meters above Astronomical Tide is likely to inundate low lying areas of south & north 24 Parganas and about 3-4 meters over the low lying areas of East Medinipur District of West Bengal during the time of Landfall.	Parganas districts and adjoining areas of east Medinipur district of West Bengal as
20.05.2020/0300	Storm Surge of about 4-5 meters above Astronomical Tide is likely to inundate low lying areas of south & north 24 Parganas and about 3-4 meters over the low lying areas of East Medinipur District of West Bengal during the time of Landfall.	Bengal as estimated by the post Cyclone landfall survey Team of ACWC Kolkata. No significant Storm Surge has been reported along Odisha coast.

Severe Cyclonic Storm "NISARGA" over the east-central and adjoiningsoutheast Arabian Sea (01st-04th June 2020)

Date/Base Time of observation	Storm Surge Forecast at 0300 UTC of date	Realised surge
02.06.2020/0300	Storm surge of about 1-2 meters height above astronomical tide to inundate low lying areas of Mumbai up to about 1.0 to 1.5 km, Thane and Raigad districts and 0.5-1.0 meter height above the astronomical tide likely to inundate low lying areas of Ratnagiri district during the time of landfall.	mheight
03.06.2020/0300	Storm surge of about 1-2 meters height above astronomical tide to inundate low lying areas of Mumbai, Thane and Raigad districts and 0.5-1.0 meter height above the astronomical tide likely to inundate low lying areas of Ratnagiri district during the time of landfall.	during the

Very severe cyclonic storm "NIVAR" over the Bay of Bengal (22-27 November-2020)

Date/Base Time ofobservation	Storm Surge Forecast at 0300 UTC of date	Realised surge
24.11.2020/ 0300UTC	Tidal wave of about 1m height above the astronomical tide is very likely to inundate the low lying areas of north coastal districts of Tamilnadu & Puducherry near the place of landfall.	No report of any significant Storm surge
25.11.2020/ 0300UTC	Tidal wave of about 1-1.5m height above the astronomical tide is very likely to inundate the low lying areas of north coastal districts of Tamilnadu & Puducherry near the place of landfall.	

Cyclonic Storm "BUREVI" over the Bay of Bengal (30th November - 05th December 2020)

Date/Base Time ofobservation	Storm Surge Forecast at 0300 UTCof date	Realised surge
02.12.2020/ 0300 UTC	Storm surge of about 1.0 m height above astronomical tide is very likely to inundate low lying areas of south coastal Tamilnadu (Ramanathapuram, Thoothukudi, Tirunelveli and Kanniyakumari districts) during the time of landfall.	No significant storm Surge reported
03.12.2020/ 0300 UTC	 Storm surge of about 1.0 m height above astronomical tide is very likely to inundate low lying areas of south coastal Tamilnadu (Ramanathapuram, Thoothukudi, Tirunelveli and Kanniyakumari districts) during the time of landfall and northwest Sri Lanka coast during next 06 hours. 	

Cyclonic Storm "PABUK" over Andaman Sea (04-08 January-2019)

Date/ Time(UTC)	Storm Surge Forecast	Recorded storm surge
05/01/2019 0300 UTC	Storm surge of height of about 0.5 m above the astronomical tides likely to inundate the low lying areas of Andaman Islands at the time of landfall.	was reported from

Very Severe Cyclonic Storm "Titli" over Eastcentral Bay of Bengal (08-13 October 2018)

Date/	Storm Surge Forecast	Recorded storm surge
Time(UTC) 09/10/2018 0600 UTC	Storm surge of height of about 0.5 m above astronomical tide is very likely inundate low lying areas of Srikakulam district of Andhra Pradesh; Ganjam, Khurda & Puri districts of Odisha at the time of landfall.	reported tide height of 0.85m and Palasa (Andhra Pradesh)
10/10/2018 0300 UTC	Storm surge of height of about 1.0 meter above astronomical tide is very likely to inundate low lying areas of Srikakulam district of Andhra Pradesh; Ganjam, Khurda & Puri districts of Odisha at the time of landfall.	landfall.

Very Severe Cyclonic Storm "Gaja" over southeast Bay of Bengal (10-19 November 2018)

Date/	Storm Surge Forecast	Recorded
Time(UTC)	Ğ	storm surge
12/11/2018 0300 UTC	Storm surge of height of about 1.0 meter above astronomical tide is very likely inundate low lying areas of	Storm surge of about 1
	Nagappattinam & Cuddalore districts of Tamil Nadu and Karaikal district of Puducherry at the time of landfall.	metre above astronomical
13/11/2018 0300 UTC	Storm surge of height of about 1.0 meter above astronomical tide is very likely to inundate low lying areas of Nagappattinam, Thanjavur, Pudukkottai and Ramanathapuram districts of Tamil Nadu and Karaikal district of Puducherry at the time of landfall.	
14/11/2018 0300 UTC	-DO-	coast near the landfall point.
15/11/2018 0300 UTC	-DO-	
17/11/2018 0300 UTC	Storm surge of height of about 0.5 meter above astronomical tide is very likely to inundate low lying areas of Lakshadweep Islands (Androth, Amini, Agatti, Cherium, Kalpeni, Kavaratti, Bangaram, Suheli Islands) at the time of landfall.	

CS Maarutha, 2017

Date/ Time(UTC)	Forecast Storm surge above astronomical tide and area to be affected	Actual Storm Surge
16 April 0300 UTC	The storm surge of about one meter height above the astronomical tide is very likely to inundate the low lying areas of Myanmar coast near landfall point at the time of landfall.	Not reported
16 April 1200 UTC	The storm surge of about one to two meter height above the astronomical tide is very likely to inundate the low lying areas of Myanmar coast near landfall point at the time of landfall.	

SCS Mora, 2017

Date/ Time(UTC)	Storm Surge Forecast	Recorded storm surge
29.05.2017 0300 (21 hours in advance)	The storm surge of height of about 1 to 1.5 meter above astronomical tides is likely to inundate over low lying areas of Bangladesh coast between Sitakund and Uttar Jaldi at the time of landfall.	

VSCS OCKHI, 2017

Date/Time of issue(base time) (hours IST)	Storm Surge Forecast	Recorded storm surge
29.11.2017 1150 (0830)	NIL	
30.11.2017 1200 (0830)	NIL	
01.12.2017 1130 (0830)	Storm surge of about 1 meter above astronomical tides very likely to inundate low lying areas of Lakshadweep Islands.	
02.12.2017 1130 (0830)	Storm surge of about 1 meter above astronomical tides very likely to inundate low lying areas of north Lakshadweep Islands during next 24 hrs and storm surge of about 0.5 metre above astronomical tides very likely to inundate low lying areas of south Lakshadweep Islands during next 12 hrs.	
03.12.2017 1130 (0830)	NIL	
04.12.2017 1200 (0830)	NIL	
05.12.2017 1150 (0830)	NIL	
06.12.2017 1150 (0830)	NIL	

CS Roanu, 2016

Forecast Storm surge above astronomical tide andarea to be affected	Actual Storm Surge
 0300 UTC of 19 May Storm surge of about 0.5 to 1.0 metre is likely along Andhra Pradesh coast during next 24 hours. 0300 UTC of 20 May Storm surge of about 0.5 to 1.0 metre is likely alongAndhra Pradesh coast during next 24 hours. For Bangladesh coast: Storm surge of about 1.0 to 1.5 metre is very likely near the system centre at the time of landfall. 1200 UTC of 20 May Storm surge of about 0.5 to 1.0 metre would inundate low lying areas of districts of south coastal Odisha during next 12 hours and of about 1-1.5 metre would inundate low lying areas of districts of north coastal Odisha and West Bengal during next 24 hours. Storm surge of about 1.0 to 2 metre is very likely near the system centre at the time of landfall for Bangladesh coast. 0300 UTC of 21 May Storm surge of about 1.0 to 2 metre would occur along Bangladesh coast during next 12 hours. 	Kutubdia reported storm surge of height 1.0-1.2 metre near 21.82 ^o N/91.85 ^o E. Cox's Bazar reported storm surge of height 1.5 metre duringhigh tide and 1.0 metre during low tide near 21.45 ^o N/91.97 ^o E.

VSCS Vardah, 2016

Date/ Time(UTC)	Storm Surge Forecast	Recorded storm surge
11.12.2016 0000 UTC (36 hours in advance)	Tidal wave of about one meter height above the astronomical tide to inundate low lying areas of Chennai, Thiruvallur and Kanchipuram districts of Tamil Nadu and Nellore districts of Andhra Pradesh during the time of landfall.	1m above the astronomical tide occurred near Pulicat
12.12.2016 0300 UTC	Tidal wave of about one meter height above the astronomical tide to inundate low lying areas of Chennai, Thiruvallur and Kanchipuram districts of Tamil Nadu and Nellore districts of AP at landfall time.	that time was 0.47 m and hence the total

CS Komen, 2015

Forecast Storm surge above astronomical tide and area to be affected	Actual Storm Surge
30.08.15-0300/0600/0900 UTC	Chittagong (Bangladesh)
Tidal Wave (storm surge + astronomical tide) of about 2	reported Storm Surge of 1-
meters would inundate low lying areas of Bangladesh coast	2metre
around the time of landfall. (12 Oct 2015/ Around noon)	

VSCS, HUDHUD, 2014

Forecast Storm surge above astronomical tide and area to be affected	Actual Storm Surge
 09.10.14/0300 UTC Storm surge of about 1-2 meters above astronomical tide would inundate low lying areas of East Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts of north coastal Andhra Pradesh at the time of landfall (12 Oct 2014/ Around noon) 10.10.14/0300 UTC Storm surge of about 1-2 meters above astronomical tide would inundate low lying areas of Visakhapatnam, Vizianagaram and Srikakulam districts of north coastal Andhra pradesh at the time of landfall (12 Oct 2014/ Around noon) 	Observed Storm Surge recorded by the tide gauge at Visakhapatnam was 1.4 m.

VSCS, Nilofar 2014

Forecast Storm surge above astronomical tide and area to be affected	Actual Storm Surge
No storm surge was forecast	No storm surge reported

Cyclonic storm 'Viyaru' over the Bay of Bengal (10-16 May, 2013)

Date/ Time(UTC)	Forecast storm surge above astronomical tide for Bangladesh	Actual storm surge
15 May 2013 1200 UTC	1.0-1.5 metre	1 metre storm surge has been reported in media.
14 May 2013 1200 UTC	1.0-1.5 metre	

Very Severe Cyclonic Storm (VSCS) Phailin over the Bay of Bengal (08-14 October 2013)

Date/Time(IST)	Forecast Surge	Observed Surge
10.10.13/1730	Storm surge with height of around 1.5-2.0 m above astronomical tide would inundate low lying areas of Ganjam, Khurda, Puri and Jagatsinghpur districts of Odisha and Srikakulam district of Andhra Pradesh during landfall.	2-2.5 metres with coastal inundation upto 500 meter to one km in low lying areas of Ganjam district
11.10.13/1730	Storm surge with height of 3.0 to 3.5 mt. above astronomical tide would inundate low lying areas of Ganjam, Khurda, Puri and Jagatsinghpur districts of Odisha and Srikakulam district of Andhra Pradesh during landfall.	
12.10.13/1730	Storm surge with height of 3.0 to 3.5 metre. above astronomical tide would inundate low lying areas of Ganjam, Khurda, Puri and Jagatsinghpur districts of Odisha and Srikakulam district of Andhra Pradesh during landfall.	

Severe Cyclonic Storm 'Helen' over Bay of Bengal (19-23 Nov 2013)

Date/Time(IST)	Forecast Surge	Observed Surge
0600 UTC	Storm Surge of about 1 to 1.5 mt. height above astronomical tide near low lying areas of Andhra Pradesh at the time of landfall	been received.
0600 UTC	Storm Surge of about 1 to 1.5 mt. height above astronomical tide near low lying areas of Andhra Pradesh at the time of landfall	
22.11.2013	No warning	
23.11.2013	No warning	

Very Severe Cyclonic Storm VSCS 'Lehar' (23-28 November, 2013)

Date & time	Storm Surge warning issued	Storm Surge Reported
24 th November 0300 UTC	Storm surge of about 1 to 1.5 metre height above astronomical tide would inundate thelow lying areas of Andaman & Nicobar Islands within 100 km from the landfall point.	No storm surge Report has received.
25 th November 0300 UTC	Storm surge of about 0.5-1.0 metre height above astronomical tide would inundate the low lying areas of Andaman & Nicobar Islands within 100 km from the landfall point during Next six hours and decrease thereafter.	
26 th November 0300 UTC	Storm surge of height about 2.0-3.0 metres above astronomical tide would inundate low lying areas of west and east Godavari, Vishakhapatnam and Krishna districts at the time of landfall.	
27 th November 0300 UTC	Storm surge of height about 2.0-3.0 metres above astronomical tide would inundate low lying areas of west and east Godavari, Guntur and Krishna districts of Andhra Pradesh and Yanam district of Puducherry and about 1 metre near Visakhapatnam district at the time of landfall.	