GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
LOK SABHA
UNSTARRED QUESTION NO. 168
TO BE ANSWERED ON WEDNESDAY, 7TH DECEMBER, 2022

EARLY WARNING SYSTEM

168. SHRI SHRIRANG APPA BARNE:
SHRI RAVI KISHAN:
SHRI RAVINDRA KUSHWAHA:
SHRI PRATAPRAO JADHAV:
SHRI SUBRAT PATHAK:
SHRI SANJAY SADASHIVRAO MANDLIK:
SHRI VINCENT H. PALA:
SHRI SUDHEER GUPTA:
SHRI DHAIRYASHEEL SAMBHAJIRAO MANE:
SHRI BIDYUT BARAN MAHATO:
SHRI PRADYUT BORDOLOI:
SHRI MANOJ TIWARI:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) whether the Government has assessed the efficacy of India's Early Warning System (EWS) for floods and cyclones;
(b) if so, the details of issues faced in warning systems for natural calamities and the steps being taken to address the same;
(c) the total number of people killed due to cyclonic storms, floods and heavy rain, year-wise from 2010-11 to 2021-22;
(d) whether there has been an increase in mortality rate due to floods and cyclones and if so, the reasons for the same;
(e) whether the Government has developed or intend to develop a scientific system for forecasting of flash floods or improving flash flood warning capabilities with sufficient lead time in the country particularly in the North East in 2022 and if so, the details thereof;
(f) whether the Government is taking any steps to improve the dissemination of forecast information to affected communities in disaster-affected States like Meghalaya and Assam and if so, the details thereof; and
(g) whether the Government has assessed the effectiveness of the Flash Flood Guidance System (FFGS) in forecasting and if so, the results thereof?

ANSWER
THE MINISTER OF STATE (INDEPENDENT CHARGE) FOR
MINISTRY OF SCIENCE AND TECHNOLOGY
AND EARTH SCIENCES
(DR. JITENDRA SINGH)

(a)-(b) Flood warning is under the mandate of Central Water Commission (CWC), and India Meteorological Department (IMD) supports flood warning services of CWC by providing observed and forecasted rainfall. In order to meet specific requirements of flood forecasting, which is provided by CWC, IMD operates Flood Meteorological Offices (FMOs) at fourteen locations viz., Agra, Ahmedabad, Asansol, Bhubaneshwar, Guwahati, Hyderabad, Jalpaiguri, Lucknow, New Delhi, Patna, Srinagar, Bengaluru, Thiruvananthapuram and Chennai. Apart from this, IMD also supports Damodar Valley Corporation (DVC) providing Quantitative Precipitation Forecast (QPF) for Damodar river basin areas for their flood

forecasting activities. Central Water Commission is working in close association with IMD and State Governments for timely flood forecast whenever the river water level rises above warning level. Flood Meteorological Offices (FMO) operated by IMD provide meteorological support to CWC for issuing flood warnings well in advance in respect of 153 river basins. CWC issues flood forecasts 6hrs. to 30hrs. in advance using QPF received from FMOs of IMD and in-situ hydrometeorological data.

The Hydro-meteorological support for the Flood Forecast activity of Central Water Commission (CWC) for 153 flood prone river sub basins in the country in the form of Hydromet Bulletin from IMD include:

a. Sub-basin wise Quantitative Precipitation Forecast (QPF) for next five days.

b. Sub-basin wise Probabilistic QPF for next five days.

c. Sub-basin wise Heavy rainfall warnings for day-1 to day-5.

d. Station wise recorded significant rainfall (≥5cm).

e. Sub-basin-wise past 24hrs realized areal average rainfall.

For Brahmaputra, Barak and other river sub-basin in the north eastern states, the Hydromet Bulletins are issued for 20 river sub basins as per the details given in table below:

S. No.	Sub-Basin
1	Barak at Silchar
2	Barak at Badarpurghat
3	Manu
4	Gumti
5	Dehung at Passighat
6	Lohit at Dholla
7	Brahmaputra at Dibrugarh
8	Buridihing at Khowang
9	Subansiri at Badatighat
10	Brahmaputra at Neamatighat
11	Dhansiri (S) at Golaghat
12	Brahmaputra at Tezpur
13	Jiabharali at NT road Xing
14	Dhansiri (N) at Rly Bridge
15	Kapili at Kampur
16	Brahmaputra at Guwahati
17	Manas/ Beki at N H Xing
18	Brahmaputra at Goalpara
19	Brahmaputra at Dhubri
20	Sankosh

In order to cater to the needs of Cyclone Warning Services and Marine weather services, there are seven established Warning Centers covering the east & west coasts of our country. Among these, three are Area Cyclone Warning Centres (ACWCs) located at Chennai, Mumbai and Kolkata and remaining four are Cyclone Warning Centres (CWCs) located at Ahmedabad, Thiruvananthapuram, Visakhapatnam and Bhubaneswar. Area of responsibility of ACWCs and CWCs is shown in the Table & Figure below.

Centre	**Coastal area***	**Maritime State/UT**
ACWC Kolkata	State: West Bengal UT: Andaman & Nicobar Islands	State: West Bengal UT: Andaman & Nicobar Islands
ACWC Chennai	State: Tamil Nadu UT: Puducherry	State: Tamil Nadu UT: Puducherry
ACWC Mumbai	State: Maharashtra & Goa	State: Maharashtra & Goa
CWC Thiruvananthapuram	State: Kerala & Karnataka UT: Lakshadweep	State: Kerala & Karnataka UT: Lakshadweep
CWC Ahmedabad	State: Gujarat UT: Dadra-Nagar Haveli-Daman-Diu	State: Gujarat UT: Dadra-Nagar Haveli-Daman-Diu
CWC Visakhapatnam	State: Andhra Pradesh	State: Andhra Pradesh
CWC Bhubaneshwar	State: Odisha	State: Odisha

*Coastal strip of responsibility extends upto 75 km from the coast line.

IMD has one of the best Early Warning Services in the world related for Cyclones. The best practices followed by IMD related to cyclone warning services follow:

IMD has demonstrated its capability to provide early warning for Cyclones with high precision. As a result, the vulnerable population gets evacuated from the damage prone areas in a timely manner to safe shelters thereby reducing the human death toll to a bare minimum, in the recent years. It is noteworthy that death due to cyclones has been reduced to less than 100 in recent years.

IMD has continuously expanded its infrastructure for meteorological observations, data exchange, monitoring & analysis, forecasting and warning services using contemporary technology. IMD uses a suite of quality observations from Satellites, Radars and conventional & automatic weather stations for monitoring of cyclones developing over the Bay of Bengal and Arabian Sea. It includes INSAT 3D, 3DR and SCATSAT satellites, Doppler Weather Radars (DWRs) along the coast and coastal automated weather stations (AWS), high wind speed recorders, automatic rain gauges (ARGs), meteorological buoys and ships.

IMD has a very effective Decision Support System for analyzing various observations at a single platform and predicting track and intensity of cyclones as well as the adverse weather like heavy rain and wind. IMD also utilizes storm surge and coastal inundation models and wave models output from Indian National Centre for Ocean Information Services (INCOIS), Hyderabad) for issuing storm surge warning.

IMD has a well-defined Standard Operation Procedure for monitoring & forecasting the cyclones and issue related warning. The Cyclone Warning Division (CWD) at IMD, New Delhi acts as a Regional Specialised Meteorological Centre (RSMC) for monitoring, predicting and issuing warning services on tropical cyclones developing over north Indian Ocean. It also carries out research on track, intensity, landfall and adverse weather associated with cyclones like heavy rainfall, gale wind and storm surge monitoring and prediction.

There have been improvement of about 25% in track & intensity forecast of cyclone in recent five year (2016-21) compared to previous five years (2012-16).

IMD issues forecasts and warnings related to extreme weather events and share the same with Disaster Management Authorities as well as general public through various platforms for necessary preparedness and to support mitigation measures.

While issuing the warning suitable colour code is used to bring out the impact of the severe weather expected and to signal the Disaster Management about the course of action to be taken with respect to impending disaster weather event. Green color corresponds to no warning hence no action is needed, yellow color corresponds to be watchful and get updated information, orange color to be alert and be prepared to take action whereas red color signals to take action.

IMD is implementing Impact Based Forecast (IBF) which gives details of what the weather will do rather than what the weather will be. It contains the details of impacts expected from the severe weather elements and guidelines to general public about do's and don'ts while getting exposed to severe weather. These guidelines are finalized in collaboration with National Disaster Management Authority (NDMA) and is already implemented successfully for cyclone, heat wave, thunderstorm and heavy rainfall.

In case of cyclone forecast, to support the Disaster Management Authorities, there are continuous efforts towards vulnerability assessment & resilience building related to cyclones. Towards this, the Government of India (GoI) has initiated the National Cyclone Risk Mitigation Project (NCRMP) with a view to address cyclone risks in the country. The overall objective of the Project is to undertake suitable structural and non-structural measures to mitigate the effects of cyclones in the coastal states and UTs of India. National Disaster Management Authority (NDMA) under the aegis of Ministry of Home Affairs (MHA) will implement the Project in coordination with participating State Governments and the National Institute for Disaster Management (NIDM). The Project has identified 13 cyclone prone States and Union Territories (UTs), with varying levels of vulnerability.

Though there has been noteworthy decrease in death toll due to cyclones in recent years, containing damage and economic loss associated with cyclones is still a challenge. Various structural measures with multi-institutional support at national and state level are required to reduce damage due to cyclones.

(c) - (d) There has been a noteworthy decrease in death toll due to cyclones in recent years. The details of people killed due to cyclone storms, floods and heavy rains during 2010-2021 as provided by National Crime Records Bureau (NCRB) are provided in Annexure-I.

(e) Yes Sir. In collaboration with World Meteorological Organization (WMO), Geneva, IMD has commissioned the South Asia Flash Flood Guidance System (SASIAFFGS) on 23 Oct 2020 for catering flash flood guidance services to South Asian Countries viz. India, Bangladesh, Bhutan, Nepal and Srilanka. Hydromet division of IMD viz. Regional Centre (SASIAFFGS) provides location specific flash flood guidance alerts every 6 hours up to watershed level (One lakh approx.). **The system is not a predictive tool for forecasting of flash floods. It only provides guidance for vulnerable watersheds.** These alerts are in the form of **threats with 6 hour of lead time** and **risks with 24 hour lead time** by integrating near real-time gauge observations along with the satellite, IMD Radar rainfall estimates and NWP outputs and value added flash flood guidance is provided to the stakeholders.

During Flood Season 2022, India Meteorological Department issued the Flash Flood advisories with a validity of 24 hours for 5 such events that occurred in the North eastern Region of the country.

(f) FFGS has been effectively used for issuing Flash Flood advisories during the ongoing Flood season 2022. North Eastern States have received multiple very heavy rainfall spells. Based on the FFGS model and value addition from the meteorologists at IMD, operational Flash flood advisories were issued about 24 hrs in advance in the form of colour coded flash flood risk.

RMC Guwahati issues weather forecasts and heavy rainfall warnings to various users of Central and State Govt. authorities including like State Disaster Management Authorities, District Authorities, NDRF, Power Sector, CWC, Railways etc. and are being disseminated through whatsapp, twitter, email, media (electronic and print) etc. Associated Flash Flood Bulletins have also been issued by RMC Guwahati on 15, 16, 17, 18, 20 and 21 May; 2, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 28 and 29 June; 31 July; 1, 27 and 31 August and 10, 24 and 25 October 2022. Impact Based Forecasts have been issued by RMC Guwahati:

Number of heavy rainfall warnings issued by IMD for Northeastern state of India

Month 2022	Assam	Nagaland	Manipur	Mizoram	Arunachal Pradesh	Tripura	Meghalaya
April	5	-	-	-	4	-	2
May	5	-	-	-	3	-	3
June	17	3	3	2	4	5	15
July	3	-	-	-	2	-	-
Aug	1	1	1	1	2	8	-
Sep	3	-	-	-	4	10	-
Oct	8	3	3	3	6	7	3

Very heavy and Extremely heavy rainfall warnings are also issued (2022) - 8, 9, 12-19, 27-29 June; 18-21 and 31 July; 1, 27 and 28 August and 3-5 September for Arunachal Pradesh sub-division; 3-19, 27-30 June; 13, 18-21, 24, 25, 28 and 31 July; 1, 27 and 28 August; 4, 5, 11 and 14 September for Assam and Meghalaya sub-division; 16-19 June; 3 July; 27 and 28 August and 11 September for Nagaland, Manipur, Mizoram and Tripura sub-division.

All advisoriesare sent through email, Whatsapp Groups, and Twitter to both National and State Disaster Management Authorities, MHA, Water Resource Department, Central Water Commission, Ministry of Transport, Prasar-Bharti and other concerned MC's & MO's including Ago-Meteorological Field Units /District Agro-Meteorological Unit.

(g) Flash Floods are rare events and it is difficult to quantify the accuracy of its forecasting system because of the lack of vital data for its validation. However the effectiveness of the system is evaluated on case to case basis during the flood season based on data available in public domain. Numerical Weather forecast with Radar and Satellite estimates of rainfall in conjunction with the Geomorphological conditions is used by SAsiaFFGS to delineate the locations with a potential of having Flash Flood in next 6 hours to next 24 hours. Accordingly, the Flash Flood Risks and Flash Flood Threats are being issued as per WMO standard color codes.

Annexure-I

State/UT-wise Number of Accidental Deaths due to Cyclone during 2011-2021

SN	State/UT	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Andhra Pradesh	8	12	8	41	0	3	1	7	0	3	0
2	Arunachal Pradesh	0	0	0	0	0	2	0	1	0	0	0
3	Assam	0	6	0	0	1	1	0	0	0	2	0
4	Bihar	22	5	1	1	0	4	5	3	0	0	0
5	Chhattisgarh	0	0	1	0	0	0	0	0	0	0	0
6	Goa	0	0	0	0	0	0	0	0	0	0	0
7	Gujarat	6	2	7	6	0	0	0	0	3	0	40
8	Haryana	6	0	1	0	0	0	0	0	0	0	0
9	Himachal Pradesh	0	0	0	0	0	0	0	0	0	0	0
10	Jharkhand	2	0	1	3	0	0	2	3	0	0	0
11	Karnataka	0	0	0	0	0	0	0	0	1	2	0
12	Kerala	0	0	0	0	0	0	113	1	0	0	0
13	Madhya Pradesh	4	6	2	2	1	0	0	0	0	0	0
14	Maharashtra	3	1	6	2	0	3	0	1	0	2	72
15	Manipur	0	0	0	0	0	0	0	0	3	0	0
16	Meghalaya	0	0	1	0	0	0	2	0	0	0	1
17	Mizoram	0	2	0	0	0	0	0	0	0	0	0
18	Nagaland	0	0	0	0	0	0	1	0	0	0	0
19	Odisha	0	0	1	0	0	0	0	6	14	0	0
20	Punjab	0	0	1	0	0	0	0	0	1	0	0
21	Rajasthan	2	1	2	0	0	0	0	0	0	0	0
22	Sikkim	0	0	0	0	0	0	0	0	0	0	0
23	Tamil Nadu	10	1	0	0	0	2	6	95	0	0	0
24	Telangana	-	-	-	0	0	0	0	0	0	0	0
25	Tripura	0	0	1	0	0	0	0	2	0	0	0
26	Uttar Pradesh	40	11	18	7	13	0	3	5	11	0	0
27	Uttarakhand	3	0	1	0	0	0	0	0	0	4	0
28	West Bengal	1	0	0	0	0	0	0	0	0	22	2
TOTAL STATE(S)		**107**	**47**	**52**	**62**	**15**	**15**	**133**	**124**	**33**	**35**	**115**
29	A & N Islands	0	0	0	0	0	0	0	0	0	0	2
30	Chandigarh	0	0	0	0	0	0	0	0	0	0	0
31	D&N Haveli and Daman&Diu @ +	0	0	0	0	0	0	0	0	0	0	1
32	Delhi UT	0	0	0	0	0	0	0	0	0	0	0

33	Jammu & Kashmir @ *	0	0	0	0	0	0	0	1	0	2	0
34	Ladakh @	-	-	-	-	-	-	-	-	-	0	0
35	Lakshadweep	0	0	0	0	0	0	0	0	0	0	0
36	Puducherry	10	0	0	0	0	0	0	0	0	0	0
TOTAL UT(S)		**10**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**3**
TOTAL (ALL INDIA)		**117**	**47**	**52**	**62**	**15**	**15**	**133**	**125**	**33**	**37**	**118**

As per data provided by states/UTs

Source: Accidental Deaths & Suicide in India

'+' Combined data of erstwhile D & N HAVELI AND DAMAN & DIU UT during 2011- 2019

'*' Data of erstwhile JAMMU & KASHMIR State Including LADAKH during 2011-2019

#' Newly carved State from Andhra Pradesh during 2014

'@' Data of newly created UT 2020

State/UT-wise Number of Accidental Deaths due to Flood during 2011-2021

SN	State/UT	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Andhra Pradesh	3	25	45	4	16	1	0	0	1	4	36
2	Arunachal Pradesh	0	8	0	0	0	0	0	6	0	0	0
3	Assam	61	79	72	75	196	28	7	15	100	18	6
4	Bihar	186	55	131	97	12	520	346	231	480	786	351
5	Chhattisgarh	11	10	3	10	1	11	1	10	10	14	5
6	Goa	0	0	0	0	0	0	0	0	0	0	0
7	Gujarat	50	37	61	21	57	17	23	4	16	35	22
8	Haryana	0	0	1	0	20	0	0	0	0	0	0
9	Himachal Pradesh	9	30	10	19	1	10	0	2	6	1	15
10	Jharkhand	3	2	1	0	2	0	3	7	4	1	0
11	Karnataka	6	17	11	8	6	0	0	13	38	11	21
12	Kerala	1	0	0	0	0	0	2	125	32	0	27
13	Madhya Pradesh	46	30	87	59	26	56	15	8	27	11	12
14	Maharashtra	111	55	185	35	47	96	49	51	190	64	155
15	Manipur	0	0	0	0	0	0	2	0	0	0	0
16	Meghalaya	0	0	0	9	0	0	1	1	0	1	0
17	Mizoram	0	3	0	1	0	0	0	0	0	0	0
18	Nagaland	0	0	0	0	0	0	0	0	0	0	0
19	Odisha	3	2	3	4	2	1	1	2	0	0	0
20	Punjab	0	0	0	0	0	0	0	0	1	0	0
21	Rajasthan	0	2	1	0	5	9	3	0	3	0	0
22	Sikkim	0	5	0	0	0	0	0	0	0	0	0
23	Tamil Nadu	18	4	6	0	249	2	0	0	3	0	1
24	Telangana	-	-	-	2	0	0	0	0	0	8	3
25	Tripura	0	0	0	0	0	0	0	1	0	0	0
26	Uttar Pradesh	47	24	66	66	188	22	39	24	28	0	0
27	Uttarakhand	14	15	13	2	0	0	1	0	9	4	2
28	West Bengal	5	8	1	0	12	0	3	0	0	0	0
TOTAL STATE(S)		**574**	**411**	**697**	**412**	**840**	**773**	**496**	**500**	**948**	**958**	**656**

29	A & N Islands	0	0	0	0	0	1	0	0	0	0	0
30	Chandigarh	0	0	0	0	0	0	0	0	0	0	0
31	D&N Haveli and Daman&Diu @ +	0	0	0	0	0	0	0	0	0	0	0
32	Delhi UT	3	1	0	0	0	0	0	0	0	0	0
33	Jammu & Kashmir @ *	8	8	3	129	6	1	0	0	0	1	0
34	Ladakh @	-	-	-	-	-	-	-	-	-	0	0
35	Lakshadweep	0	0	0	0	0	0	0	0	0	0	0
36	Puducherry	0	0	0	0	0	0	0	0	0	0	0
TOTAL UT(S)		**11**	**9**	**3**	**129**	**6**	**2**	**0**	**0**	**0**	**1**	**0**
TOTAL (ALL INDIA)		**585**	**420**	**700**	**541**	**846**	**775**	**496**	**500**	**948**	**959**	**656**

As per data provided by states/UTs

Source: Accidental Deaths & Suicide in India

'+' Combined data of erstwhile D & N HAVELI AND DAMAN & DIU UT during 2011- 2019

'*' Data of erstwhile JAMMU & KASHMIR State Including LADAKH during 2011-2019

#' Newly carved State from Andhra Pradesh during 2014

'@' Data of newly created UT 2020

State/UT-wise Number of Accidental Deaths due to Torrential rain during 2011-2021

SN	State/UT	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Andhra Pradesh	2	2	0	2	2	4	1	0	0	7	0
2	Arunachal Pradesh	2	0	0	2	0	0	0	0	0	0	0
3	Assam	0	0	0	0	0	0	0	0	0	1	0
4	Bihar	28	14	6	1	0	7	87	59	13	1	5
5	Chhattisgarh	0	0	0	54	0	62	63	0	0	0	0
6	Goa	0	0	0	0	0	0	0	0	0	0	1
7	Gujarat	14	72	11	45	45	5	78	0	1	0	0
8	Haryana	2	1	2	2	0	1	0	0	0	0	0
9	Himachal Pradesh	0	0	0	0	0	0	1	16	1	0	0
10	Jharkhand	28	8	0	5	2	41	4	8	3	10	12
11	Karnataka	32	0	1	0	0	0	0	3	6	2	10
12	Kerala	0	0	0	0	1	0	0	5	2	0	0
13	Madhya Pradesh	17	1	14	1	1	6	3	1	1	1	0
14	Maharashtra	1	4	3	6	3	7	4	3	5	5	8
15	Manipur	0	0	0	0	0	0	0	0	0	0	0
16	Meghalaya	0	0	0	0	0	0	3	0	0	6	0
17	Mizoram	0	0	0	0	1	0	0	0	0	0	0
18	Nagaland	0	0	0	0	0	0	0	0	0	0	0
19	Odisha	0	0	0	0	0	0	0	0	0	0	0
20	Punjab	0	0	0	0	0	0	0	0	0	0	0
21	Rajasthan	6	4	11	21	4	1	1	0	3	3	9
22	Sikkim	0	0	0	0	1	0	0	0	0	0	0
23	Tamil Nadu	1	0	0	0	2	0	13	0	5	1	2

24	Telangana #	-	-	-	3	6	0	0	0	0	0	0
25	Tripura	0	0	1	0	0	0	0	0	4	0	0
26	Uttar Pradesh	20	21	30	14	126	9	1	3	17	0	0
27	Uttarakhand	0	53	63	0	0	0	0	3	7	0	16
28	West Bengal	17	23	0	0	1	0	0	0	1	0	0
TOTAL STATE(S)		**170**	**203**	**142**	**156**	**195**	**143**	**259**	**101**	**69**	**37**	**63**
29	A & N Islands	0	0	0	0	0	0	0	0	0	0	0
30	Chandigarh	0	0	0	0	0	0	0	0	0	0	0
31	D&N Haveli and Daman&Diu @ +	0	0	0	0	0	0	0	0	0	5	0
32	Delhi UT	0	0	0	0	0	0	0	0	0	1	0
33	Jammu & Kashmir @ *	0	0	0	0	0	0	0	0	0	0	0
34	Ladakh @	-	-	-	-	-	-	-	-	-	0	0
35	Lakshadweep	0	0	0	0	0	0	0	0	0	0	0
36	Puducherry	0	0	0	0	0	0	0	0	0	0	0
TOTAL UT(S)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**
TOTAL (ALL INDIA)		**170**	**203**	**142**	**156**	**195**	**143**	**259**	**101**	**69**	**43**	**63**

As per data provided by states/UTs

Source: Accidental Deaths & Suicide in India

'+' Combined data of erstwhile D & N HAVELI AND DAMAN & DIU UT during 2011- 2019

'*' Data of erstwhile JAMMU & KASHMIR State Including LADAKH during 2011-2019

#' Newly carved State from Andhra Pradesh during 2014

'@' Data of newly created UT 2020

However for the year 2022 the figures are provided below as per the IMD reports.

YEAR	FLOODS AND HEAVY RAINS	CYCLONIC STORM	TOTAL
2022	804	0	804

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