

CHAPTER – VI

Ministry of Earth Sciences

6.1 Unfruitful expenditure due to non-functional website

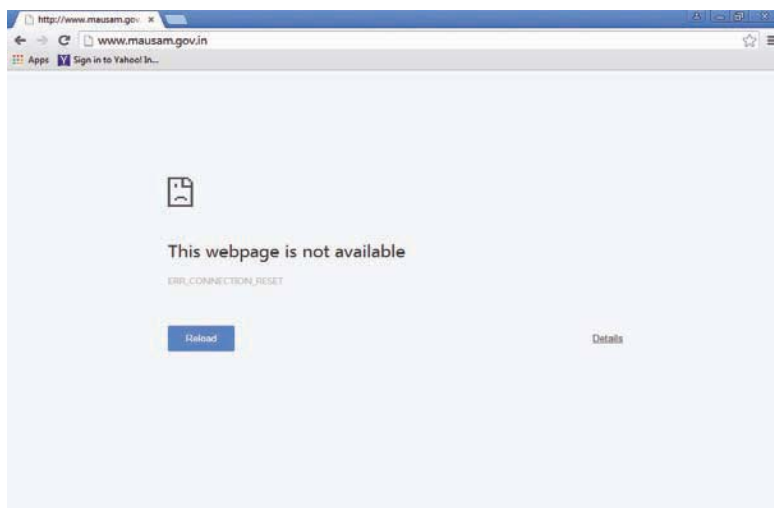
Content managed website developed by the Ministry of Earth Sciences at a cost of ₹ 2.27 crore remained non-functional since February 2012, resulting in unfruitful expenditure.

Subsequent to the re-organisation of the Ministry of Earth Sciences (MoES) after merging of India Meteorological Department (IMD) with the Department of Ocean Development and various other agencies, MoES planned (November 2006) to develop a content managed website for MoES and IMD with a view to provide real time data on atmosphere, weather conditions, weather forecast, agromet advisory, astronomical information, climate data, etc. in a user friendly manner so as to make IMD's website more useful and efficient. Tata Consultancy Services Ltd., Hyderabad (TCS) was selected (December 2007) for the project, as the firm had earlier (2002-03) developed a similar website for Indian National Centre for Ocean Information Services, Hyderabad (INCOIS), an autonomous body under MoES.

MoES instructed (November 2007) INCOIS to undertake development of the website of MoES/IMD. Accordingly, INCOIS signed an agreement (May 2008) with TCS for design, development, commissioning, hosting and maintenance of content on the website of MoES/IMD at a cost of ₹ 1.10 crore including taxes, to be paid in nine instalments. Hardware and software systems were to be provided by INCOIS. The project was to be completed within 33 weeks from the date of signing of agreement i.e. by January 2009. TCS was to provide warranty, operation and maintenance services for a period of three years from the date of completion of acceptance test.

Acceptance test of the website, named *www.mausam.gov.in*, was conducted (August 2010) by IMD and declared passed, subject to resolution of nine issues observed with reference to the agreed Systems Requirements Specifications (SRS). TCS resolved (September 2010) five of the nine issues and offered to take up the remaining issues as change request at additional cost. TCS also informed INCOIS that its support for the new website would be available till March 2011 and thereafter at extra cost. At the request of INCOIS, TCS extended the warranty support till April 2012.

However, though IMD/MoES received (July 2011) the source code, passwords, etc., problems in the website continued and it remained non-functional since February 2012. The matter regarding rectifying the pending issues in the website and warranty terms could not be resolved and remained under correspondence.



Status of website as of June 2015

MoES released a total amount (2007-08 to 2010-11) of ₹ 2.53 crore to INCOIS under the project, of which expenditure of ₹ 2.27 crore was incurred, including ₹ 1.17 crore towards procurement of systems and ₹ 1.10 crore as payment to TCS.

Audit observed lack of coordination between MoES and INCOIS on the matter of resolving the pending issues in the website as well as on agreed warranty terms. According to the terms of the agreement, TCS was to provide warranty support for the systems and software for a period of three years from date of acceptance of the website, i.e. upto August 2013. However, warranty was extended only till April 2012 and neither MoES nor INCIOS prevailed on TCS to enforce the actual terms of the agreement. In fact, INCOIS exited from the project after April 2012 in spite of issues remaining pending with regard to the project.

It was further noticed that hardware and software procured for the website development were also not maintained by IMD/MoES and were lying in disuse (August 2013) due to non-availability of air conditioned environment and lack of interest of IMD officials in maintaining the website and the hardware. As a result, TCS expressed its inability to re-deploy the website until the systems were made operational by IMD/MoES. The website remained non-functional as of May 2015, resulting in unfruitful expenditure of ₹ 2.27 crore incurred on procurement of systems and its development.

MoES accepted (May 2015) that the new website was non-functional and stated that efforts were being made to resolve the issue. MoES added that the final instalment due to TCS was still pending. However, as per terms of the contract entered between INCOIS and TCS, the contract amount of ₹ 1.10 crore has already been paid to TCS.

Thus, failure to coordinate effective delivery of the website and ensure proper maintenance of systems resulted in unfruitful expenditure of ₹ 2.27 crore as the website continues to remain inoperative for more than three years.

6.2 Installation and upkeep of meteorological observatories by Regional Meteorological Centre, Kolkata

Maintenance of observatories set up by Regional Meteorological Centre, Kolkata for collection of various types of meteorological data was inadequate. This, together with shortage of manpower, resulted in observatories lying defunct, shortfalls in carrying out prescribed inspections of observatories, non-rectification of defective instruments, inadequate geographical coverage of areas under the Centre and gaps in collection of meteorological data.

6.2.1 Introduction

India Meteorological Department (IMD) under the Ministry of Earth Sciences (MoES) is the national meteorological service of the country and the principal government agency in all matters relating to meteorology, seismology and allied subjects. The objectives of IMD are to make meteorological observations and provide current and forecast meteorological information for optimum operation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, off-shore oil exploration etc.; and to warn against severe weather phenomena like tropical cyclones, norwesters, dust storms, heavy rains and snow, cold and heat waves etc. which cause destruction of life and property.

Various meteorological data⁶⁸ are collected through different observatories and processed at data processing and forecasting centres, which are then disseminated to end users.

Regional Meteorological Centre, Kolkata (RMC) is one among six⁶⁹ regional centres under IMD. It is the nodal office for meteorological information pertaining to the

⁶⁸ Surface and upper air data, satellite data, hydro-meteorology data, agri-meteorology data, radiation, Ozone, electrical potential gradient pollution, Antarctica surface and radiation data and seismology data.

⁶⁹ RMCs have been set up at Chennai, Guwahati, Kolkata, Mumbai, Nagpur and New Delhi.

States/UT of Bihar, Jharkhand, Odisha, Sikkim, West Bengal and Andaman and Nicobar Islands. It is headed by a Deputy Director General.

RMC has established 1,643 observatories for collection of surface, upper air, hydrometeorologic, agrimeteorologic, seismological and radiation data. The number of observatories is given in Table 25.

Table 25: Details of observatories set up by RMC

Nature of observatory	Type of data disseminated	Number
Surface observatories	Surface data	81
Indian Air Force Station	Surface data	11
Agricultural Meteorological Observatories*	Agrimet data	8
Hydro-meteorological Observatories	Hydromet data	1,119
Pilot Balloon Observatories	Upper Air data	11
Radio Sonde/ Radio Wind	Upper Air data	6
Radiation Observatories	Radiation data	6
Seismological Observatories	Seismological data	8
Automatic Weather Station	Surface data	113
Automatic Rain Gauge	Hydromet data	275
Wind Finding Radar	Surface data	1
Storm Detection Radar	Surface data	2
Doppler Weather Radar (S-band)	Surface data	2
TOTAL		1,643

*Though Agricultural Meteorological Observatories have been established under the jurisdiction of RMC, the same are being directly controlled by IMD, Pune.

Budget allocation and actual expenditure incurred by RMC during 2010-11 to 2013-14 is given in the Table 26.

Table 26: Budget and expenditure of RMC from 2010-11 to 2013-14

(₹ in crore)

Year	Budget estimate			Actual expenditure		
	Plan	Non Plan	Total	Plan	Non plan	Total
2010-11	3.06	31.50	34.56	3.05	31.09	34.14
2011-12	2.81	30.02	32.83	2.81	30.01	32.82
2012-13	3.50	31.30	34.80	3.54	31.26	34.80
2013-14	4.14	33.66	37.80	4.02	32.25	36.27

It can be seen from the above table that nearly 89 to 91 per cent of the total expenditure was incurred on meeting non-plan expenditure.

6.2.2 Audit findings

Audit was conducted with a view to examine the extent of installation and up-keep of meteorological observatories by RMC during the period 2010-11 to 2013-14 and its impact on IMD's meteorological functions. Audit findings are discussed in the following paragraphs.

6.2.2.1 Shortage of scientific staff

Sanctioned strength and men-in-position of RMC during the last four years (2010-14) is given in Table 27.

Table 27: Sanctioned strength and men-in-position in RMC

Year	Sanctioned strength			Men-in-position					
	Scientific	Technical	Administrative	Scientific	Percentage shortfall	Technical	Percentage shortfall	Administrative	Percentage shortfall
2010-11	657	237	197	447	32	186	22	122	38
2011-12	657	237	197	419	36	179	24	118	40
2012-13	531	221	180	372	30	156	29	103	43
2013-14	531	221	179	353	34	137	38	105	41

The reduction in sanctioned strength from the year 2012-13 was due to transfer of metrological observatories located in Agartala, which were formerly under RMC, to administrative control of Regional Meteorological Centre, Guwahati.

Scientific and technical manpower of RMC are entrusted with the work of taking observations, inspection and maintenance of instruments, ensuring data reliability, processing of scientific data and communicating the same to various user agencies. It can be seen from the Table 27 that there was considerable shortage of scientific/technical manpower to the extent of 22 to 38 *per cent* of the sanctioned strength in each of the four years. RMC recruited 19 Scientific Assistants (SA) during 2013-14. However, the additional recruitments did not serve to increase the manpower as vacancy increased to 34 *per cent* in 2013-14 from 30 *per cent* in 2012-13. RMC did not take action to recruit scientific staff in other scientific/technical cadres. Shortage of scientific and technical manpower adversely affected the discharge of functions of RMC, as brought out in the subsequent paragraphs.

RMC stated (August 2013) that existing scientific staff was also compelled to perform administrative work which further led to severe hampering of scientific work. MoES accepted (June 2015) the audit observation.

6.2.2.2 Surface observatories

Meteorological parameters are measured in surface observatories, which are manned observatories. Besides taking observations, work in these observatories also includes scrutiny of meteorological data, rainfall analysis, self recording instruments, chart data tabulation work, meteorological data exchange, verification of collected automatic weather station data, etc. Surface observatories can be both 'departmental' and 'part time' observatories, depending on the nature and frequency of measurements to be taken; and whether these are manned by departmental staff or by part time staff. Departmental observers not only take observations but also scrutinise meteorological data, rainfall analysis, chart data, conduct tabulation work, meteorological data exchange, verification of collected automatic weather station data etc. Part Time Observers are trained by departmental officials from time to time.

(i) Inadequate distribution of surface observatories

According to the standard brief document of IMD, surface observatories were, as far as possible, to be located in each district. Of 119 districts in five States and one UT under the jurisdiction of RMC, 81 manned surface observatories (including 'departmental' and 'part time' observatories) were set up in 63 districts. Area wise distribution of observatories as of December 2014 is shown in Table 28.

Table 28: Number of observatories operational as of December 2014

Sl. No	Name of the State/ Union Territory	No. of districts in State/UT	Area (sq.km)	No. of observatories established	Number of districts covered	Area covered (sq.km)	Percentage of the State's/UT area covered	No. of defunct observatories	No. of operational observatories	Area (sq.km)
1	Bihar	38	94,793	14	13	40,699	43	3	11	32,849
2	Jharkhand	24	95,617	8	7	44,254	46	3	5	29,843
3	Odisha	30	1.56 lakh	22	19	1.09 lakh	70	0	22	1.09 lakh
4	Sikkim	4	7,096	5	3	5,930	84	0	5	5,930
5	West Bengal	20	88,752	26	18	82,229	93	3	23	75,153
6	Andaman and Nicobar Islands	3	8,249	6	3	8,249	100	0	6	8,249
	Total	119	4.51 lakh	81	63	2.90 lakh	64.30	9	72	2.61 lakh

It can be seen from table 28 that:

- Out of total 119 districts in the five States and one UT under the control of RMC Kolkata, only 63 districts were covered by surface observatories, indicating coverage of only 53 *per cent*.
- Of the total geographic area of 4.51 lakh sq km., area of 2.90 lakh sq km. was covered. Therefore, area of 1.61 lakh sq. km. representing 36 *per cent* of the total area of the six States/UT, was not covered for measurement of meteorological parameters.
- Nine observatories were inoperative. Audit observed that these observatories were not operational for periods as long as two to 34 years (2015). The reason cited for non-operation of these observatories was non-availability of observers. Status of these defunct observatories is given in Table 29.

Table 29: Status of Defunct observatories

Sl. No	Name of the observatories	Defunct since
1	Darbhanga, Bihar	2008
2	Jamui, Bihar	1981
3	Arra, Bihar	1999
4	Hazaribagh, Jharkhand	Not available
5	Dumka, Jharkhand	Not available
6	Dhanbad, Jharkhand	1996
7	Sagar Island, West Bengal	2006
8	Bagati, West Bengal	2012
9	Krishnanagar, West Bengal	2013

- Except for Andaman and Nicobar Islands, no other State had 100 *per cent* coverage of working observatories. Jharkhand and Bihar had the lowest coverage of working surface observatories, at 31 and 35 *per cent* respectively. As a result meteorological observations over a vast area of 1.28 lakh sq.km. in the two States were not recorded.

Details of number of 'departmental' and 'part time' observatories set up in the States are given in **Appendix XIX**.

MoES stated (June 2015) that areas not covered by Automatic Weather Station (AWS) will be covered under ensuing scheme of AWS.

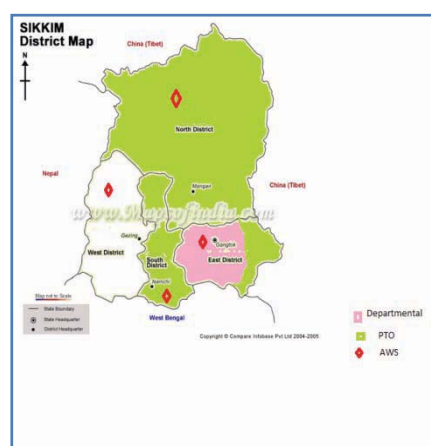
(ii) Distribution between 'departmental' and 'part time' observatories

Surface observatories mentioned in para 6.2.2.2 above have been classified under six classes as shown in Table 30.

Table 30: Classification and prescribed allotted work of observatories

Classification	Sub-classification	Prescribed allotted work	Number of observatories established
Class I	No sub-classification	Principal Climatological Station manned by departmental staff taking three to eight synoptic observations and communicating at least two sets of synoptic observations a day. In addition, such stations were equipped with a minimum of three autographic instruments for recording atleast three meteorological parameters viz pressure, temperature, wind and rainfall.	20
Class II	(a), (b), (c) & (d)	These are ordinary climatological stations at which observations are made at fixed times, including readings of extreme temperature and precipitation. II (a) & II (b) were to take and communicate at least two sets of observations daily. II (c) was to take atleast two sets of observations daily and communicate only one set of observations and II (d) was to take atleast two sets of observations daily and report them by monthly register. Class II (a) are manned by departmental staff and Class II (b) to II (d) are manned by part time staff.	II(a)- 9 II(b)- 43 II(c)- 1
Class III	(a) & (b)	III (a) was to take and communicate only one set of observations daily and III (b) was to take only one set of observations daily and report the same through monthly registers only.	0
Class IV	(a) & (b)	IV (a) was to take two sets of observations daily (excluding pressure) and report them through monthly registers and IV (b) was to take one set of observations daily (excluding pressure) and report them through monthly registers.	IV (a)- 3 IV (b)- 1
Class V	Precipitation Stations and are manned by part time observers.		
Class VI	(a), (b) & (c)	Climatological Stations for specific purposes which are not covered by Classes I to IV. These observatories are established for observations of a specific element or elements or for a particular requirement.	0
Classification not available			4 ⁷⁰
Total			81

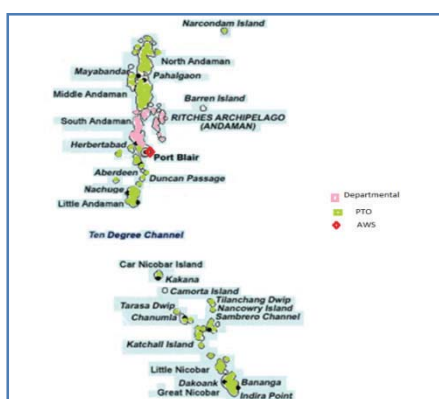
Sikkim and Andaman and Nicobar Islands are natural hazard (earthquake, landslide, cyclone) prone areas. Audit observed that these States/UTs were covered mostly by ‘part time’ observatories. There were two departmental (Class I) observatories in one district and three ‘part time’ (Class IV (a)) observatories in three districts in the State of Sikkim. Thus, Principal climatological stations were set up in only one district in Sikkim, representing only 13 per cent of the area of the State. Data collected from the two districts having Class IV (a) observatories was required to be communicated through monthly registers only.



Distribution of observatories in Sikkim

⁷⁰ Classification of two departmental observatories established at Hirakud (Odisha), Asansol (West Bengal) and two ‘part time’ observatories established at Sonapur, Daringbari (Odisha) was not available.

Similarly, in Andaman and Nicobar Islands, though the coverage in terms of area was 100 per cent, there were six observatories in the UT, of which one was a departmental (Class I) observatory and five were ‘part time’ (Class II (b)) observatories. This indicated that meteorological data was collected only upto two times a day.



Distribution of observatories in Andaman and Nicobar Islands

MoES stated (June 2015) that AWS stations in Andaman and Nicobar Islands would be installed in future schemes.

(iii) Non-execution of MoU for ‘part time’ observatories

Considering the need for accurate and timely recording and reporting of synoptic observations⁷¹ for weather forecasting and climatological purposes, RMC was to establish part-time observatories in co-operation with Government/Semi-Government/ Autonomous

Agency/ Organisation/ Institution, defined as Co-operating Agency (CA). A Memorandum of Understanding (MoU) was to be executed between RMC/IMD and CA spelling out the activities to be performed and in token of having accepted the terms and conditions for each ‘part time’ observatory.

Audit observed that though 49 ‘part time’ observatories were established under RMC, no MOU was found on record in respect of any of the observatories. In the absence of MoU, various activities as prescribed in the model MoU were not carried out. The details of these activities are given in Table 31.

Table 31: Status of execution of terms and conditions contained in MOU

Major terms and conditions to be included in MOU	Audit observations
CA was to arrange recording of two synoptic observations daily without fail at 08-30 hours and 17-30 hours through their staff.	There was no record at RMC regarding receipt of real time data, twice a day from the ‘part time’ observatories.
CA was to appoint, from amongst the technical staff/teachers, an observer, preferably a graduate of science.	Of the 40 running ‘part time’ observatories, observers in 34 observatories possessed qualifications below matriculate, below graduate in Arts/Commerce, graduate in Arts/Commerce and Masters in Arts etc.87 per cent observers did not possess academic background in science.
The inspecting officer of RMC/IMD was to thoroughly train the observers in every item of work.	No formal training was imparted to the observers by inspecting officer of IMD/RMC.
CA was also required to arrange upkeep and maintenance of the instruments installed in the observatory enclosures.	There was no maintenance work including routine and preventive maintenance at any of the observatories. This was done only at the time of inspection.

⁷¹ A surface weather observation made at periodic times usually at three and six hourly intervals.

MoES accepted (June 2015) that copies of MoU were not available. Regarding qualification of observers and their training, MoES stated that it was difficult to get observers as per prescribed qualification but efforts were made to train the observers as per departmental requirements. However, in an earlier reply (August 2013) RMC had accepted that no formal training was imparted to the observers of 'part time' observatories. Regarding recording of meteorological observations, RMC added that met data was being received on real time over phone. In respect of maintenance of observatories, RMC stated that maintenance works were done during inspection tours⁷².

The reply of RMC indicates that no record of met data was being kept and maintenance works were carried out by RMC/IMD and not by the CA.

6.2.2.3 Automatic Weather Station

An Automatic Weather Station (AWS) is an unmanned meteorological station at which observations are made and transmitted through satellite automatically. As part of the overall meteorological application programme under the Indian National Satellite (INSAT), land based AWS were installed and commissioned throughout the country for collection of hourly meteorological data, which are vital for cyclone warning, flood warning and snow survey studies. As these are unmanned weather stations, security of these observatories is a critical aspect.

Poor maintenance of Automatic Weather Stations

RMC installed 113 AWS in the six States/UT under its jurisdiction during the period 2006-2015. For the purpose of maintenance and upkeep of AWS, IMD instructed (August 2010) RMC to establish a Regional Instrument Maintenance Centre (RIMC). Each RIMC was to supervise the work of respective State Instrument Maintenance Centres (SIMC) and Field Maintenance Units (FMU). The work of RIMC involved monitoring the station equipment, its operation and transmission of data, monitoring the data quality, liaison with SIMC and FMU for preventive maintenance/repair of equipment, overall maintenance and up-keep of all types of instrument etc.

Maintenance and upkeep work were classified broadly in two groups viz. preventive maintenance and corrective maintenance. While inspection on preventive maintenance was to be conducted once in four months irrespective of the fault at station, corrective maintenance was required to be undertaken by SIMCs in addition to preventive maintenance guidance for rectification of faults, replacement of faulty spares etc.

⁷² Inspection on preventive maintenance was to be done once in four months by Regional Instruments Maintenance Centre of IMD.

Though RMC stated that RIMC was established in November 2011, it did not provide details on the establishment of SIMC/FMU. As such, Audit could not verify existence of SIMC and FMU under RIMC/RMC.

The status of preventive maintenance of AWS by RIMC/RMC during 2013-15 is given in Table 32.

Table 32: Status of preventive maintenance of AWS

Name of the State/ Union Territory	Number of AWS installed	Number of inspection to be conducted	Number of inspection actually conducted	Shortfall	Shortfall (in per cent)
Bihar	28	224	27	197	88
West Bengal	27	216	71	145	67
Odisha	37	296	11	285	96
Sikkim	4	32	9	23	72
Andaman and Nicobar Islands	1	8	0	8	100
Jharkhand	16	128	0	128	100
Total	113	904	118	786	87

It can be seen from Table 32 that

- Overall there was shortfall of 87 *per cent* in preventive maintenance of AWS by RIMC/RMC.
- No preventive maintenance work was done in Jharkhand and Andaman and Nicobar Islands.

RMC stated (May 2013) that 92 AWS were under Annual Maintenance Contracts and therefore no inspections were conducted. The reply of RMC is not convincing as no records of upkeep and maintenance of AWS by other agencies through AMC were kept. Audit scrutinised 11 inspection reports pertaining to maintenance of AWS in Bihar and 13 inspection reports pertaining to West Bengal on test check basis and found that:

Bihar

- The reports did not indicate the kind of inspection (preventive/corrective) conducted. There was no format of inspection and approval of competent authority on the reports was not obtained.
- In all the 11 AWS, solar panel and battery of AWS were reported to be either stolen or missing. In three AWS, Global Positioning System (GPS) and

pressure sensors were also reported to be stolen/ missing. Date of procurement and cost of the missing equipment was not available with RMC. In six reports, the enclosures of AWS were reported to be covered with long grass, iron angles were rusting and fencing and cables of wind sensors were broken, which indicated that general maintenance was poor.

West Bengal

- In five reports, there was no mention of status of preventive/corrective inspection. None of the reports were approved by the competent authority.
- During inspection of the AWS conducted between February 2013 and February 2015, eight AWS which were established between August 2006 and July 2011 were found to be defunct due to defective instrument. No action was taken to repair the instrument and get the AWS functioning as of May 2015.



AWS Raidighi-defunct due to inoperative instruments



AWS Kakdwip- defunct due to non-functional instruments



Thus, in spite of a prescribed mechanism for regular maintenance of AWS, the same were poorly maintained by RMC.

While accepting that maintenance of AWS was not done, MoES stated (June 2015) that this was due to shortage of staff and non-availability of spare parts. MoES also stated that inspections were not feasible due to shortage of staff. However, it assured that proper maintenance of the AWS would be done.

6.2.2.4 Pilot Balloon Observatories

Pilot Balloon Observatories (PBO) record and report information about upper winds on real time basis. Information provided by PBO is of vital importance not only for forecasting purposes but also for pilots in flying aircraft.

Inadequate data collection due to absence of infrastructure

There are 11 PBOs under the control of RMC at 11 locations⁷³. Of these, Audit visited three observatories⁷⁴ in West Bengal and Odisha. It was observed that while there were no prescribed instructions issued by IMD for maintenance and upkeep of upper air instrument, World Meteorological Organisation (WMO)⁷⁵ had circulated (2008) a Guide to Meteorological Instrument and Methods of Observation. Audit compared the performances of the PBOs with some of the best practices given in the Guide. The findings are discussed in Table 33.

Table 33: Performance of Pilot Balloon Observatories

Criteria for best practices	PBO Dum Dum, WB	PBO Bankura, WB	PBO Balasore, Odisha
Regular ascent was required to be taken twice a day at 0600 hrs and 1800 hrs respectively for taking upper air climatologic data.	No pilot balloon ascent was held for 184 days during the period April 2009 to April 2012 due to absence of balloons, hydrogen gas, etc.	No pilot balloon ascent could be held for 533 days during 2009-14 due to non-supply of proper size balloon, lantern, gas and obstructions by trees.	No pilot balloon ascent could be held for 338 days during 2009-13 due to absence of balloons, hydrogen gas, etc.
IMD was to issue suitable instruction manuals to each upper-air station for the proper use of equipment and interpretation of data.	No instructions manual was issued.		
All balloons should be kept in their original packing until required for pre-flight preparations. Wherever possible, balloons were to be stored in a room at temperature between 15 and 25 degree Celsius.	Balloons were stored in a non-AC room at temperature of 25-30 degree Celsius.	Balloons were stored in a room at temperatures varying from 10 to 44 degree Celsius.	Balloons were kept in the store room of the office at temperatures of 10-46 degree Celsius.
Inspections were to be carried out yearly by RMC and reports sent to the concerned PBO for follow up action.	Four inspections were conducted during 2008-15. The reports were not sent to PBO for follow up action.	Six inspections were conducted during 2008-15. The reports were not sent to PBO for follow up action.	Inspections were conducted every year during 2008-15. The reports were not sent to PBO for follow up action.

Thus, no ascents were held in the three PBOs for prolonged periods, thereby indicating that upper air readings were not taken. Maintenance and storage of instruments at PBOs was also lax and the possibility of balloons not providing optimum results due to improper storage conditions could not be ruled out.

⁷³ Dum Dum and Bankura in West Bengal, Port Blair in Andaman and Nicobar Islands, Gangtok in Sikkim, Jharsuguda, Balasore, Bhubaneswar and Gopalpore in Odisha, Jamshedpur in Jharkhand and Bhagalpur and Gaya in Bihar.

⁷⁴ PBOs at Dum Dum, Bankura and Balasore.

⁷⁵ The World Meteorological Organisation (WMO) is a specialised agency of the United Nations, of which India is a member. One of the purposes of WMO is to coordinate the activities of its members in the generation of data and information on weather, climate and water according to internationally agreed standards. Technical Regulations adopted in each session of the World Meteorological Congress lay down the meteorological practices and procedures to be followed by WMO Members.

PBO, Bankura accepted (December 2014) that meteorological work was hampered due to irregular ascent during the period mentioned above. MoES stated (June 2015) that bad weather conditions and non-availability of hydrogen gas were main reasons for absence of ascents. Regarding storage of balloons, MoES stated that in India it was not possible to maintain the conditions suitable for their storage. It further stated that it could not carry out inspections as prescribed due to shortage of staff.

The reply of MoES did not describe constraints faced by it in procuring hydrogen gas. The reply regarding storage of balloons is to be viewed in light of the fact that requirements prescribed were basic storage conditions not requiring specialised infrastructure.

6.2.2.5 Hydro-Meteorological Observatories

For the collection of basic hydro-meteorological data viz. rainfall, temperature, humidity and wind for planning various river valley projects and flood control products, IMD/RMC set up hydro-meteorological observatories in the Himalayan catchments of northern rivers and other catchments where multipurpose river valley projects were being planned and executed. These observatories are manned by part-time staff and record mainly precipitation data and carry out flood forecasting, river basin studies and compilation of rainfall statistics for use in construction of dams, railways and road bridges, evaluation of snow-melt in Himalayan rivers and water balance and glaciological studies. The number of observatories depends upon the needs of the specific project. Expenditure on the observatories set up for projects undertaken on behalf of other organisations, is recovered from the sponsoring agency.

(i) Non-functional observatories

There were 1,119 hydro-meteorological observatories under RMC as of December 2014. Audit observed that 215 (19 *per cent*) observatories were not functional. Of these, 105 were non-functional due to unserviceable instruments and 41 observatories did not have required instruments. Cost of these unserviceable instruments was not found on record in RMC. Reasons in respect of the remaining 69 inoperative observatories were not on record.

MoES stated (June 2015) that the State authorities do not follow RMC's instructions to revive/reopen the defunct observatories timely and as per requirement. However, action taken, if any, by MoES in this regard was not informed.

(ii) Inadequate number of Flood Meteorological Offices

Under Hydromet observatories, RMC has established Flood Meteorological Office (FMO) in the catchments with the objective of collecting rainfall data, flood

forecasting and river basin studies, computing average annual precipitation, forecasting rainfall during monsoon, warnings against heavy rainfall, forecasting river catchment wise quantitative precipitation, etc. There are four FMOs under RMC located at Asansol and Jalpaiguri in West Bengal, Patna in Bihar, and Bhubaneswar in Odisha. The FMOs collect precipitation data from 155 'part time' observatories in West Bengal, Bihar, Jharkhand, Odisha and Sikkim to prepare their analysis.

Audit observed that though Andaman and Nicobar Islands have six perennial rivers⁷⁶, no FMO was established in these river catchments. As a result, catchment wise precipitation data from different islands of this UT was not collected. Further, only three observatories were set up in two districts in Sikkim, although the river Teesta and its major tributary, Rangeet almost flows right across the length of the State.

Audit further observed that considerable geographic areas were not covered in the States of West Bengal, Jharkhand and Odisha.

Absence of coverage of these areas indicated that the database on rainfall, annual precipitation, as well as forecasting rainfall during monsoon, warnings against heavy rainfall, etc. was incomplete.

MoES stated (June 2015) that the number of observatories for each FMO and river catchment was determined by experts. However, it did not provide basis for the absence of observatories in Andaman and Nicobar Islands and the number of observatories approved/established in Sikkim, Jharkhand, West Bengal and Odisha.

6.2.2.6 Radiation Observatories

There are six radiation observatories under RMC located at Patna in Bihar, Ranchi in Jharkhand, Bhubaneswar in Odisha, Kolkata in West Bengal, Tadong in Sikkim and Port Blair in Andaman and Nicobar Islands.

Idle instrument at Radiation observatory at Kolkata airport

Audit test checked records maintained at Radiation Observatory, Kolkata Airport. Radiation Division situated at Kolkata Airport takes observations on five parameters⁷⁷ of radiation at 10 minutes interval through data logger and sends the data to Radiation Head Quarters at Pune.

According to instructions of IMD (June 1999), inspection of each observatory was to be conducted once in a year. Each observatory was required to submit an operational status report on regular basis. Audit observed that no inspection of the

⁷⁶ Kalpong, Alexandra, Amrit Kaur, Danes, Galathea and Dogmar.

⁷⁷ (i) Diffuse Solar Radiation; (ii) Global Solar Radiation; (iii) Terrestrial Solar Radiation; (iv) Direct Solar Radiation; and (v) UVA Solar Radiation.

observatory was conducted during the period 2008-14. Audit further observed that six instruments⁷⁸ were defective since November 2009/ June 2012 due to which these were not being utilised. During the period 2008-13, the radiation observatory submitted four operational status reports. However, no action was taken to repair the defective instruments.

Audit made a comparison of the maintenance of instruments at Radiation Observatory, Kolkata with international best practices circulated by Commission for Instruments and Methods of Observations⁷⁹ (CIMO). According to CIMO guidelines, calibration and testing are inherent elements of a quality assurance programme. To assure the validity and relevance of the measurements produced by a meteorological sensor or system, some combination of calibration, laboratory testing and functional testing is needed. However, the instrument of Radiation Observatory, Kolkata airport was calibrated four to 10 years ago.

MoES accepted (June 2015) the observations and stated that action had been initiated to comply with the audit observation.

6.2.2.7 Radiosonde/Radiowind Observatories

Besides radiation observatories, upper air measurements are made with balloon borne radiometersondes⁸⁰ to measure the vertical distribution of infrared radiation flux and radiation cooling from surface upto a height of 20 km or more in the free atmosphere. The data is supplied to aircraft pilots for smooth and safe flights.

Inadequate data collection and dissemination

Audit scrutinised records of the Radiosonde/ Radiowind (RS/RW) Observatory operated by RMC at Kolkata Airport. The RS/RW Observatory is required to take readings twice a day through two RS/RW ascents, to have an efficient data collection. However, during the period 2009-14, data on only one ascent was taken by the Observatory, thereby resulting in inadequate data collection. Audit observed from monthly progress reports of RS/RW Observatory that three instruments were unserviceable for more than three to five years. No action was taken to repair/replace the defective instruments.

⁷⁸ Pyrgeometer, Radiometer, Pyrheliometer, Differential Pyranometer, Datalogger and Sky Radiometer.

⁷⁹ Commission for Instruments and Methods of Observations (CIMO) is an organ under World Meteorological Organisation to promote and facilitate international standardisation and compatibility of instruments and methods of observations to improve quality of products and services.

⁸⁰ An instrument used to measure infra red radiation, which is attached to the balloon that is released into the sky.

Thus, frequency of observations by the observatory was compromised due to improper maintenance of instruments at RS/RW observatory.

MoES stated (June 2015) that action was being taken to provide sufficient RS/RW instruments for regular observations.

6.2.3 Conclusion

Regional Meteorological Centre, Kolkata (RMC) faced shortage of scientific and technical staff, which affected its scientific work. As of 2013-14, there was shortage of 34 *per cent* and 38 *per cent* in the scientific and technical cadres respectively. RMC was unable to set up new observatories due to shortage of manpower. As a result, large geographical areas were left out of coverage.

Out of 81 surface observatories established by RMC, nine were not operational due to non-availability of observers. There was inadequate care of instruments in the observatories. Inspections were not carried out as prescribed. In the observatories where inspections were carried out, no follow up action was taken on the position reported. There was poor preventive maintenance in respect of the unmanned Automatic Weather Stations. There were also reports of thefts and defective instruments, which were also not addressed by RMC. Pilot Balloon Observatories were not provided with sufficient infrastructure for ascent of balloons. As such, there were long gaps in periodicity of data on upper winds. States having major rivers, such as Sikkim, West Bengal, Odisha and Andaman and Nicobar islands did not have enough coverage of Flood Meteorological Observatories.