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STANDING COMMITTEE ON WATER RESOURCES

(2023-24)

SEVENTEENTH LOK SABHA

MINISTRY OF JAL SHAKTI – DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION

'Glacier Management in the Country – Monitoring of Glaciers / Lakes Including Glacial Lake Outbursts leading to Flash-Floods in the Himalayan Region'

[Action Taken by the Government on the Observations / Recommendations contained in the Twenty Third Report (Seventeenth Lok Sabha) of the Standing Committee on Water Resources]

TWENTY SIXTH REPORT

LOK SABHA SECRETARIAT

NEW DELHI

December, 2023 / Agrahayana,1945 (Saka)

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Presented to Lok Sabha on 11.12.2023

Laid on the Table of Rajya Sabha on 11.12.2023

LOK SABHA SECRETARIAT
NEW DELHI

December, 2023 / Agrahayana,1945 (Saka)

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3. Shri Nihal Chand Chauhan
4. Shri Bhagirath Choudhary
5. Shri Chandra Prakash Choudhary
6. Shri Guman Singh Damor
7. Dr. Heena Vijaykumar Gavit
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26. Shri V. Vijayendra Prasad
27. Shri Arun Singh
28. Sant Balbir Singh
29. Shri Pramod Tiwari
30. Dr. Anbumani Ramadoss*
31. Vacant**

* Dr. Anbumani Ramadoss, MP (Rajya Sabha) has been nominated to the Committee w.e.f. 24 November, 2023.

** Consequent upon his resignation from Rajya Sabha, Dr. Kirodi Lal Meena, ceased to be Member of the Committee *w.e.f.* 6th December, 2023

SECRETARIAT

1.	Smt. Suman Arora	-	Additional Secretary
2.	Shri Ajay Kumar Sood	-	Director
3.	Smt. Shanta B. Datta	-	Under Secretary
4.	Shri Gaurav Jain	-	Assistant Committee Officer

INTRODUCTION

I, the Chairperson, Standing Committee on Water Resources (2023-24) having been authorized by the Committee to submit the Report on their behalf, present the Twenty Sixth - Report on the Action Taken by the Government on the Observations/Recommendations contained in their Twenty Third Report (Seventeenth Lok Sabha) on 'Glacier Management in the Country – Monitoring of Glaciers / Lakes Including Glacial Lake Outbursts leading to Flash-Floods in the Himalayan Region'.

2. The Twenty Third Report of the Committee was presented to Lok Sabha and laid in Rajya Sabha on 29 March 2023. The Action Taken replies of the Government to all the recommendations contained in the Report were received in this Secretariat on 01 August, 2023.

3. The replies of the Government were examined and the Report was considered and adopted by the Committee at their sitting held on 06.12.2023.

4. An analysis of the Action Taken by the Government on the Observations/Recommendations contained in the Twenty Third Report (Seventeenth Lok Sabha) of the Committee is given in Annexure-II.

New Delhi
06 December, 2023
15 Agrahayana, 1945 (Saka)

Parbatbhai Savabhai Patel
Chairperson
Standing Committee on Water Resources

CHAPTER I

REPORT

This Report of the Standing Committee on Water Resources (2023-24) deals with the action taken by the Government on the Observations/Recommendations contained in the Twenty Third Report on 'Glacier Management in the Country – Monitoring of Glaciers / Lakes Including Glacial Lake Outbursts leading to Flash-Floods in the Himalayan Region'.

2. The Twentieth Report was presented to Lok Sabha on 29.03.2023 and was laid on the Table of Rajya Sabha on 29.03.2023. The Report contained 15 Observations/Recommendations.

3. Action Taken Notes in respect of all the 15 Observations/Recommendations of the Committee have been received from the Government. These have been examined and categorized as follows: -

(i) Observations/Recommendations which have been accepted by the Government (Chapter II):

Recommendation Nos. 2,5,6,7,8,9,10,12,13,14 and 15

(Total – 11)

(ii) Observations / Recommendations which the Committee do not desire to pursue in view of the Government's replies (Chapter III):

Recommendation Nos. NIL

(Total – NIL)

(iii) Observations / Recommendations in respect of which replies of the Government have not been accepted by the Committee (Chapter IV):

Recommendation Nos. 1,3, 4 and 11

(Total – 04)

(iv) Observations / Recommendations in respect of which final replies of the Government are still awaited (Chapter V):

Para Nos. NIL

(Total – NIL)

4. The Committee desire that replies to recommendations made in the Chapter-I of this Report may be furnished to the Committee expeditiously.

5. The Committee will now deal with action taken by the Government on some of their Observations/Recommendations that require reiteration or merit comments.

A. Need to Check Emission of Black Carbon

(Recommendation No. 1) (Para No. 2.3)

6. The Committee had learnt that very few studies had been conducted by different organizations/ institutes in the country to assess the adverse effects of atmospheric pollution on the Himalayan glaciers. A study conducted by National Centre for Polar and Ocean Research and Space Physics Laboratory at their Himansh station in Lahaul-Spiti region had revealed that the total Suspended Particulate Matter (SPM) showed significant variations with dominance of mineral dust components therein (~67%). It had also been stated that the black carbon reportedly contributes (~4%) to near surface composite aerosol mass concentrations and also absorbs more light and emits infra-red radiation that increases the temperature. Hence, an increase in Black Carbon in the high Himalayas is stated to contribute to the faster melting of glaciers. The Committee recommended that with a view to assess the extent and scope of adverse impact of atmospheric pollution including black carbon on the fragile and sensitive Himalayan glacier system, the Department of Water Resources, River Development & Ganga Rejuvenation in consultation with the Ministry of Environment, Forest & Climate Change and other concerned Ministries/Departments/Agencies should commission a research work/project for comprehensive examination of this aspect and submit the research findings within a time-bound period.

7. The Department in its action taken note has replied as follows:

"Black carbon (B.C.) aerosols accelerate glacier melting in the Himalayas. Black materials absorb more light and emit infrared radiation that increases the temperature. So, an increase in black carbon in the high Himalayas will contribute to the faster melting of Himalayan glaciers. National Centre for Polar and Ocean Research (NCPOR) has informed that several studies in the Himalayan region have focused on observations and the character of B.C. particles in the ambient air. However, though there are many B.C. observatories in low altitudes (<2000 masl) and the plains, only a few studies have characterized B.C. at high altitudes in the Himalayas, particularly in India. The deposition of light-absorbing aerosols on snow or ice can lead to the darkening of the surface, which would enhance the absorption of solar radiation and significantly reduce the surface albedo. Such phenomena could result in positive forcing that can accelerate snow and ice melt in high altitudes. One of the measurements in the high Himalayan glacier (Chandra) basin shows a significant concentration of B.C. (mean BC ~ 168 ng m^{-3}). It contributes nearly 4% to near surface composite aerosol mass. A recent study shows that the concentration of black carbon increases in summer(0.01-4.62 µg / m^3) drastically. However, in the foothill, the black carbon concentration is much higher 796 µg / m^3 (Parbati), 416 µg / m^3 (Hamata) and 432 µg / m^3 (Beas). A multi-layer simulation of snow albedo demonstrated significant changes in snow albedo (2.5–9.0%) due to light-absorbing aerosols in this region. In the long run, changes in the atmospheric composition of the high Himalayas will affect rain and snow precipitation patterns. However, the sources of B.C. reaching in the Himalayan region are complex and remain uncertain due to a lack of field and reliable data.

WIHG has two (02) observational sites for black carbon monitoring near the glacierized basins (Gangotri Glacier). Further, WIHG is also looking at aerosols and dust in the snow and ice samples from glacier sites to understand their impact on snow and glacier melting and albedo changes".

8. The Committee having noted during the examination of the subject 'Glacier Management in the Country – Monitoring of Glaciers / Lakes Including Glacial Lake Outbursts leading to Flash-Floods in the Himalayan Region, that Black Carbon in the Himalayas is stated to contribute to the faster melting of glaciers, categorically recommended that a research work / project for comprehensive examination to assess the extent and scope of adverse impact of atmospheric pollution including black carbon on the fragile and sensitive Himalayan glacier system be commissioned. However, the Department through its Action Taken Replies has apprised the Committee that though there are many Black carbon observatories in low altitudes (<2000 masl) and the plains, only a few studies have characterized Black Carbon at high altitudes in the Himalayas, particularly in India. Furthermore, the Department has itself stated that the sources of Black Carbon reaching in the Himalayan region are complex and remain uncertain due to a lack of field and reliable data. Taking into account the Department's own admission that there is a lack of field and reliable data on Black Carbon concentration in ambient air of Himalayas which can affect rain and snow precipitation, the Committee reiterate their recommendation that Department of Water Resources, River Development and Ganga Rejuvenation in consultation with other concerned Ministries/Departments should commission a comprehensive research programme to understand the problem of Black Carbon in the Himalayas including its sources of origin and submit the research findings within a time-bound period. The Committee would like to be apprised of measures taken in this regard within three months of presentation of this Report.

B. <u>Need to set up Separate Dedicated Mountain Hazard and Research Institute</u>

<u>(Recommendation No.3) (Para No. 2.5)</u>

9. The Committee observed gaps and deficiencies in glaciology research and monitoring of the glacial lakes and water Bodies in the Himalayan region. The Committee noted that Geological Survey of India (GSI) had not conducted specific studies on estimated volume loss of glaciers between 1950 and 2020 and also not projected any estimate of loss by the year 2100. Further, there was no comprehensive information about the volume loss of glaciers in the Indian Himalayan Region. The Committee further noted that the Ministry of Environment, Forest & Climate Change had not conducted any study or awarded any project on warming of Himalayan glaciers. The Committee were informed by the DoWR, RD & GR that Central Water Commission (CWC) had not issued any advisory to the concerned local Governments regarding the anticipation of floods caused by avalanches/cloudburst landslides in the Himalayan region. Further, there was also no specific information available on stretches of the Himalayans where the danger of melting of glaciers and consequent Glacial Lake Outburst Flood (GLOF) are most severe. Moreover, no study on temporal changes in glacial lake number and their

extent had been carried out by Indian Space Research Organization (ISRO) and GSI. The Committee also took cognizance of the fact that no study has been carried out by GSI, ISRO and DST to critically analyse the enlargement and origin of glacial lakes near human settlements and their potential cause for a lake outburst.

Taking into consideration the aforestated gaps / deficiencies in the glaciological, hydro-materiological and hydro-geological research relating to Himalayan glacier system, the Committee were of the considered view that there is an need for setting up an over arching organisation at the national level which could coordinate with various Ministries / Departments / Agencies/ Research Institutes engaged in handling different hydro-geological and hydro-materiological hazards including glacier related hazards for having an integrated approach in collecting and collating information / data on Himalayan glaciers and also the research findings at one place and to maintain a reliable database that could be accessed easily by all agencies and also for issuing early warnings and alerts regarding potential multi hazards to the stake holders and public. In this regard, at the behest of the Committee, various Ministries/ Departments/ research agencies had given their suggestions and offered solutions for effective management and monitoring of glaciers in the country in a coordinated manner as under:-

(i) The Department of Science and Technology had suggested that there is a need for single coordinating agency to coordinate with various other agencies having mandates to handle different hydrometerological and hydrogeological hazards. It had also suggested that to deal with the disasters like cloudburst, GLOF, landslides etc. in an integrated manner, a multi hazard warning system may be put in place through a real-time coordinating mechanism wherein one agency may be entrusted with the responsibility of continuously monitoring and issuing warnings and alerts to authorities, stakeholders and public;

(ii) The MoEF&CC had suggested that the responsibility for coordination of all activities on the Himalayan glaciers should rest with a single identified nodal coordinating agency within Government of India, such as for e.g. National Security Council Secretariat (NSCS), which is already coordinating with various Government agencies in various studies, including impact of engineering technologies on the glaciers. Such an agency would need to be given an appropriate war time mandate because of recurrence of GLOF, Cloudburst, landslides etc. by allocating the subject through allocation of business.

(iii) The Ministry of Earth Sciences had suggested that a network of fully equipped and integrated monitoring systems supported by a set of field stations in critically important glaciered basins is required for monitoring glaciers and glacier bound hazards. The systems should be automated with real-time access to data to modelers to create a potential early warning system on glacio-hydrological hazards from

time to time, based on hazard potential coupled with geographical information system tools downstream activities and population vulnerability along with open access to ground-based meteorological, hydrological and glacilogical data from the entire region to achieve the target. ISRO can contribute by using high resolution and near real time satellite remote sensing to monitor glacial lake and water bodies in development of a reliable database.

(iv) Defence Geoinformatics Research Establishment set up under agegis of DRDO had suggested that an integrated approach for debris flow and GLOF risk management coupled with systematic risk assessment study of the region is imperative to curtail risks of glacial hazards. An inclusive approach with all stakeholders is recommended to understand GLOF phenomenal behaviour by creating ground and remote sensing based inventory of benchmark moraine dammed lakes and monitoring changes on a regular basis along with an effective early warning mechanism to monitor GLOF hazards in order to minimize the risk of such hazards.

Apart from above suggestions / solutions offered by various Ministries/Departments/organisations, the NDMA "Guidelines on Management of Glacial Lake Outburst Flood (GLOF)" had proposed that the Ministry of Jal Shakti (MoJS) be designated as the nodal Ministry and Central Water Commission (CWC) as the nodal agency for management of GLOF. These Guidelines further proposed that a national level Centre for Glacial Research, Studies and Management (CGRSM) be established by the MoJS under the umbrella of the National Institute of Hydrology (NIH), Roorkee as a premier centre with state-of-the art facilities, which would eventually grow into a national centre of excellence. Keeping in view the suggestions / solutions offered by various Ministries / Departments / Agencies, the Committee urged upon the Department of WR, RD&GR to carefully study the same and prepare a comprehensive concept paper / cabinet note subsuming the solutions/suggestions in consultation with all the Ministries / Departments / Agencies, so as to evolve a consensus on the structure mandate and modalities of the proposed national level apex research organisation viz. CGRSM for placing before the Union Cabinet for their consideration. The Committee would like to be apprised of the action taken in this regard within three months of presentation of the Report.

10. The Department in its action taken note has replied as follows:

"A Steering Committee under the chairmanship of Secretary, DOWR, RD & GR, Ministry of Jal Shakti has recently been formed to look into all these issues. The Steering Committee would act as an over arching organisation at the national level which can coordinate with various Ministries / Departments / Agencies/ Research Institutes engaged in handling different hydro-geological and hydro-meteriological hazards including glacier related hazards for having an integrated approach in collecting and collating information / data on Himalayan glaciers and also the

research findings at one place and to maintain a reliable database that can be accessed easily by all agencies and also for issuing early warnings and alerts regarding potential multi hazards to the stake holders and public".

11. The Committee note from the Action Taken Replies of the Department that a Steering Committee under the Chairmanship of Secretary, Department of Water Resources, River Development and Ganga Rejuvenation (Ministry of Jal Shakti) has recently been formed which would act as an arching organization for Glacier Management. However, the Committee are of the view that it is way short of what the National Disaster Management Authority (NDMA) "Guidelines on Management of Glacial Lake Outburst Flood (GLOF)" have proposed. The said Guidelines have suggested that a national level Centre for Glacial Research, Studies and Management (CGRSM) be established by the Ministry of Jal Shakti under the umbrella of the National Institute of Hydrology (NIH), Roorkee as a premier centre with state-of-the art facilities, which would eventually grow into a national centre of excellence. Considering the vast mandate suggested by the Guidelines of NDMA for comprehensive management of Glaciers, the Committee urge the Department to take note of these Guidelines and make concerted efforts for establishment of CGRSM. The Committee would like to be apprised of the steps taken by the Department in this regard.

C. <u>Need to provide sufficient budgetary allocations for Glacier Research</u>

<u>(Recommendation No. 4) (Para No. 2.6)</u>

12. The Committee learnt from the written submission of the Department of Water Resources, River Development & Ganga Rejuvenation that various Ministries/Departments dealing with the subject of glacier management / monitoring had allocated and spent a meagre amount for conducting research/studies in the field in the last 5 years. While on the one hand, the Committee found that studies such as temporal change in glacier origin and enlargement of glacier area were required for proper assessment and management of glaciers, on the other hand, the fund allocation is not sufficient to encourage such studies. The Committee believed that there was an urgent need to conduct various field-based studies on glaciers which may need adequate funding/budgetary support. As the challenges of managing and monitoring the glaciers movement / behaviour and mitigation of hazards arising therefrom are enormous, the Committee recommended the Government to allocate adequate budgetary resources to the concerned Ministries/Departments involved in the research in the field so as to meet their financial requirements and for ensuring that the activities related to research and monitoring of glaciers do not suffer due to shortage of funds.

13. The Department in its action taken note has replied as follows:

"As suggested by Committee, there is need to provide sufficient budgetary allocations for glacier research, to the concerned Ministries/ Departments. This is important as the study of Glaciers, its dynamics and associated hazards have implications on sustainable development, disaster risk reduction and strategizing

climate change adaptation measures. The budgetary support for carrying out studies has to be met through allocated budgets to different Organisations/Department.

Any requirement of additional funds for carrying out any specific studies in the field of glacier monitoring and management by the concerned Institutions may be placed before the Steering Committee which in turn would request for enhancement of budget to specific Department/Organisations.

In above context, MoES has informed that in view of the importance of glacier research in the country, an amount of ~ Rs. 30 crore has been earmarked for it by the Ministry of Earth Sciences during 2021-2026".

14. Regarding the recommendation of the Committee for providing sufficient budgetary allocations for Glacier research, the Department has apprised the Committee that any requirement of additional funds for carrying out any specific studies in the field of glacier monitoring and management may be placed before the Steering Committee which in turn would request for enhancement of budget to specific Departments/Organizations. However, the Committee find this whole process cumbersome and time consuming. In view of the challenges of managing and monitoring the glaciers, the Committee urge the Department to take steps for suitably amending the Allocation of Business Rules in order to empower the Steering Committee [pending the establishment of Glacial Research, Studies and Management (CGRSM)] with its own exclusive budgetary allocations so that the Steering Committee may itself provide necessary budgetary provisions to the agencies involved in glacier research and management work.

D. Need to preserve Green Cover in the Himalayan Region

Recommendation No.- 11 (Para No. 2.13)

15. Considering the strategic role and paramount importance of Himalayan glaciers which are literally known as "Water Towers of Asia" and owing to the fact that three major Indian river system are glacier fed which provide water security to the country for various uses like drinking water requirements, hydropower, industry, agriculture etc., the Committee were of the considered view that since green cover in the valleys adjacent to the glaciers is critical and acts as a buffer and would help in reducing the impact of climate change, the same should be protected / conserved. For this purpose, the Committee urged upon the Department of Water Resources, River Development & Ganga Rejuvenation to work in close cooperation with the Ministry of Environment, Forest & Climate Change and other concerned Ministries for evolving a comprehensive policy response so as to preserve the sensitive Himalayan glacier system.

16. The Department in its action taken note has replied as follows:

"The Steering Committee for Monitoring of Glaciers under the chairmanship of Secretary, DoWR, RD& GR has been constituted with an aim to develop a coordination mechanism among various ministries (viz., Ministries of Jal Shakti; Environment, Forest & Climate Change, Department of Space, Ministry of Earth Sciences, Ministry of Mines and Department of Science and Technology etc.) for efficient mobilization of resources for glacier related studies".

17. Having taken note of the importance of green cover in the valleys adjacent to the glaciers which acts as a buffer and help in reducing the impact of climate change, the Committee in their recommendation in the Twenty Third Report urged upon the Department to work in close cooperation with other concerned Ministries for evolving a comprehensive policy response so as to preserve the sensitive Himalayan glacier system. However, no specific reply has been furnished on the aspect of maintenance of green cover, though, it has stated that a Steering Committee for Monitoring of Glaciers with an aim to develop a coordination mechanism among various Ministries for efficient mobilization of resources for glacier related studies has been formed. The Committee, thus, once again, urge the Department to take necessary steps in coordination with other Ministries to protect the green cover in the valleys adjacent to the glaciers. The Committee would like to be informed of the steps taken by the Department in this regard within three months of presentation of this Report.

E. Need to Evolve Land Use Regulations

(Recommendation No. - 12) (Para No. 2.14)

18. The Committee were of the considered view that well laid down procedure / regulations for land use planning / zoning in the Himalayan States especially those area which are more prone and susceptible to landslides, LLOFs, GLOFs etc. would go a long way in mitigating the eventualities that arise in the event of disasters. The Committee were informed by NDMA that in their guidelines on management of GLOFs, they had *inter alia* recommended for constitution of a Committee to formulate specific land use zoning and building construction regulations under aegis of Ministry of Jal Shakti (MoJS). Further, the Committee noted that while a Uniform Code for the construction practices is contained in National Building Code of India (NBC 2016) published by the Bureau of Indian Standards (BIS) which comes under the Ministry of Consumer Affairs, Food & Public Distribution, as regards excavation, a policy on Sediment Management is at drafting stage under aegis of the Ministry of Jal Shakti. The Committee were of the view that regulating construction activities in GLOF/LLOF prone areas would go a long way in averting disasters and saving precious human lives. They, therefore, recommended that as suggested by the NDMA, the Department of WR, RD&GR should constitute a Committee to formulate specific land use zoning and building construction regulations expeditiously. They also recommended that the Department of WR, RD&GR should work in close coordination with BIS, so that NBC norms are adhered to strictly by all the people while constructing buildings in the region. The Committee would like to be apprised of the steps taken by the Department in this regard within three months of the presentation of this Report.

19. The Department in its action taken note has replied as follows:

"The Department of Water Resources, RD &GR has formulated "National Framework for Sediment Management (NFSM) which was launched by the Hon'ble Minister for Jal Shakti during the 1st All India Annual State Ministers Conference on Water held in Bhopal, Madhya Pradesh on 5th – 6th January 2023. The NFSM is available on the website of the Ministry for reference.

Indian Institute of Technology Roorkee (IIT, Roorkee) and the Water Resources Department, Bureau of Indian Standards (BIS), New Delhi, jointly organized a National Hybrid Seminar on "Glacial Lake Outburst Floods (GLOFs) and Landslide Lake Outburst Floods (LLOFs) Disasters in Himalayan Regions" on June, 2022, at IIT Roorkee. The seminar provided an opportunity for the exchange of ideas and knowledge between diverse groups of the scientific community concerned with the current issues related to Glacial and landslide lake outburst flood-related hazards and the development of standard codes for its mapping and modeling.

BIS is an apex organization in the field of National Standardization which is carried out through 16 Division Councils covering various areas of Standardization. Water Resources Department is one of such 17 Departments in BIS, and it deals with standardization and standards formulation in the area related to River Valley Projects and Ground Water. A committee has been formed in BIS on GLOF related matters.

Water Resources Division Council chaired by Chairman CWC in its 21st meeting on 6th March 2023 agreed to constitute a new Sectional Committee on the subject "GLOFs and LLOFs" and requested BIS to constitute Search Committee to define and propose the scope of the newly constituted Sectional Committee on Glacial Lakes Outburst Floods (GLOFs) and Landslides Lakes Outburst Floods (LLOFs).

In this direction, a Search Committee was constituted by BIS and the first meeting was held on 12 July 2023 to discuss scope and composition of the constituted Sectional Committee".

20. The Committee had recommended to the Department of Water Resources, River Development and Ganga Rejuvenation that they should constitute a Committee to formulate specific land use zoning and building construction regulations expeditiously. In this connection, the Committee have come to know from the Action Taken Replies of the Department that Bureau of Indian Standards (BIS) is an apex organization in the field of National Standardization which is carried out through 16 Division Councils covering various aspects of standardization. Water Resources Department is one of such 17 Departments in BIS. Furthermore, a Committee has been formed in BIS on GLOF related matters. The Committee further observe that Water Resources Division Council chaired by Chairman, Central Water Commission has agreed to constitute a new Sectional Committee on the "GLOFs and LLOFs" and requested Bureau of Indian Standards (BIS) to constitute a Search Committee to define and propose the scope of the newly constituted Sectional Committee on Glacial Lakes Outburst Floods (GLOFs) and Landslides Lakes Outburst Floods (LLOFs). In this direction, a Search Committee was constituted by BIS and a meeting was also held to discuss scope and composition of the Constituted Sectional Committee. The Committee welcome this step and at the same time urge the Department to come up with the regulations regarding the land use in the Himalayan States within a fixed timeframe.

F. Need to Strengthen Functioning of National Disaster Response Force (NDRF)

(Recommendation No.-13) (Para No. – 2.15)

21. The Committee noted that NDRF is specialized rescue and response force mandated to respond to national and man-made disasters. However, they were apprised of the fact that heavy equipments like earthmovers/ heavy drilling machines/ JCBs etc, do not form part of the equipment profile of NDRF and these equipments are provided by the local authorities with handlers at the incident site. Further, NDRF was also not equipped with modern muck cleaning instruments/equipments to deal with emergent situations such as the one that arose in Chamoli District in the State of Uttarakhand in the month of February 2021. The Committee were surprised to learn from the deposition of the representative of the NDRF that though roads were fine there was considerable delay on the part of rescue team in reaching the site at Reni in Chamoli District Uttarakhand where the disaster took place on 7th February, 2021, because of distance. The Committee noted that there is no dedicated air craft service available with NDRF for airlifting NDRF personnel and they are dependent on IAF/ private choppers provided by the States.

The Committee found that notwithstanding the fact that NDRF is a specialized rescue and response force, however, the constraints / problems such as mentioned above are required to be removed as they hamper the rescue efforts of NDRF at critical times. Since the State Governments many a time lack specialized skills and resources required to deal with the different kind of calamities either natural or man-made, so, reliance of NDRF on the State Governments on delivery of various kinds of equipments may not serve the purpose and even may hamper the timely and much needed rescue operations. The Committee were of the view that instead of depending on State Governments, it would be more advisable for NDRF to have its own dedicated inventory of modern search and rescue equipment. Further, for ensuring timely arrival of NDRF rescue teams at disaster struck locations and avert delays as witnessed in Chamoli incident, it should have its own fleet of aircraft and should not be dependent on the IAF/State Governments to provide choppers. Besides, recognizing the role of local community as a first responder during any calamity, the Committee feel that the NDRF should organize extensive training programmes for local people in all States in general and in particular for the States which are more vulnerable to natural calamities. The Committee were of the view that NDRF should work closely with the States and render them all possible assistance in raising and training their State Disaster Response Teams. The Committee urged upon the Department of Water Resources, River Development & Ganga Rejuvenation to take up the above-mentioned suggestions with the Ministry of Home Affairs/NDMA to streamline the working of NDRF.

22. The Department in its action taken note has replied as follows:

"National Disaster Response Force (NDRF) has been authorized 315 different kinds of equipment by GoI since its raising for attending various disasters. The equipment profile is presently in the process of upgradation/ review to meet the latest technology available world-wide for enhancing operational efficiency. This is a constant process.

However, heavy equipment like earth movers/ heavy drilling machines/ JCBs have not been consciously kept part of the inventory as these would be difficult to maintain on account of rare use and also cumbersome to carry at large distances thereby hampering quick movement of teams. Hence, it is desirable that such equipment are worked out for specific

contingency requirements and catered for by the district administration. Further, details of all such equipment are required to be updated on the web based India Disaster Resource Network (IDRN) for identification at the time of occurrence of disaster.

Under the present organizational set-up of NDRF, it is not feasible to maintain a dedicated fleet of aircraft which entails a huge paraphrenalia of manpower and resources. It is felt that the present arrangement of making air requisition to IDS and IAF through MHA is working very well and actions are well coordinated at all levels to ensure rapid deployment.

To improve upon the present system, it is proposed that more helipads may be identified in vulnerable areas for landing of bigger helicopters like MI-17 which can carry more number of Rescuers with equipment in a single sortie and operate in harsh weather conditions as well. Further, airlifting of NDRF Rescuers in case of mountain rescue and forest fire by IAF may be catered for. Besides, Airforce aviation may be made available for training exercise of NDRF personnel in mountain rescue and forest fire.

NDRF is regularly organizing extensive Disaster Management training programmes for local people, community volunteers, School staff/students & other stakeholders as per vulnerability profile by conducting following programmes:-

1. *Community Awareness Program (CAP)*
2. *School Safety Program (SSP)*
3. *DM training for SDRFs, Community volunteers i.e. JNVs, Nehru Yuva Kendra Sangathan (NYKS), AapdaMitra, National Cadet Corps (NCC), National Service Scheme (NSS), AkhilBhartiyaTerapanthYuvakParishad (ABTYP) & other stakeholders.*
4. *Mock Exercises on various themes as per vulnerability profile.*
5. *Promotion of weather-based Govt. forecast application (06) apps.*

The details of personnel trained by NDRF since its raising is mentioned below:

SN	***Event***	***No of Beneficiary***
1	*CAP*	*59,90,048*
2	*SSP*	*15,76,469*
3	*MEx*	*15,44,371*
4	*NCC*	*31,865*
5	*AapdaMitra*	*24,834*
6	*NYKS*	*12,345*
7	*JNVs*	*68,416*
8	*ABTYP*	*559*

NDRF is now developing e-content for imparting DM training to NSS Volunteers so as to expand the awareness level.

***a. Training**:*

- *NDRF is working closely with States/ UTs for capacity building of State Disaster Response Force.*
- *NDRF conducts Basic Disaster Management Course for SDRFs at NDRF BNs as per their area of responsibility.*

- *So far, NDRF has trained 22,371 personnel (Basic-19,830 & Advance- 2,541). Apart from this **252** (Chhattisgarh- 53, Bihar- 79 & Gujarat – 120) personnel are undergoing training in Basic DM Course.*
- *NDRF circulates Annual Training Calendar (Advance Courses) every year for SDRFs.*
- *In 2023, following courses are planned for SDRF (Details enclosed as Appendix-A):-*
    i. *Training of Trainers of Chemical, Biological, Radiological and Nuclear(TOT CBRN)*
    ii. *Master Trainers in Chemical, Biological, Radiological and Nuclear(MT in CBRN)*
    iii. *Training of Trainers in Medical First Response and Collapsed Structure Search & Rescue(TOT in MFR & CSSR)*
    iv. *Master Trainers in Medical First Response and Collapsed Structure Search & Rescue(MT in MFR & CSSR)*
    v. *Borewell Rescue Course*
    vi. *Training of Trainers Cadre(TOT CADRE)*

***b. Raising**:*

- *NDRF is constantly in touch with States/ UTs, where SDRF not yet raised.*
- *NDRF Unit Commandants remain in coordination with the authorities of States/ UTs and provide them all needful assistance.*
- *Recently NDRF has assisted A&N authorities for raising of SDRFs in terms of equipping, training and deployment.*
- *A "Vision Document" has been prepared by NDRF for SDRFs covering all important aspects reg. vulnerability, infrastructure development, HR strength, training, equipping, deployment & future vision for States. This document is helping the SDRFs as guide tool in capacity building.*

It is felt that the raising, training and equipping of SDRFs needs to be taken up in a timeline under the supervision of the SDMAs so that they are in a position to take up L1 & L2 disasters on their own and NDRF can focus on developing specialized skills".

23. The Committee have been apprised that under the present organizational setup of NDRF, it is not feasible to maintain a dedicated fleet of aircraft and the present arrangement of making air requisition to Integrated Defence Staff (IDS) and Indian Air Force (IAF) through Ministry of Home Affairs (MHA) is working very well and actions are well coordinated at all levels to ensure rapid deployment. However, it has been further stated that in order to improve the present system, more helipads may be identified in vulnerable areas for landing of bigger helicopters like MI-17 which can carry more number of rescuers with equipment in a single sortie and operate in harsh weather conditions as well. Further, airlifting of NDRF rescuers in case of mountain rescue and forest fire by IAF may be catered for. Besides Air Force aviation may be made available for training exercise of NDRF personnel in mountain rescue and forest fire. Further regarding the raising, training and equipping of State Disaster Response Forces (SDRFs), it has been proposed that it needs to be taken up in a timeline under the supervision of the State Disaster Management Authorities (SDMAs). Having taken into account the above suggestions, the Committee once again urge the Department to take up the above-mentioned suggestions with the Ministry of Home Affairs to improve the functioning of NDRF.

Appendix-A

ADVANCE COURSES PLANNED FOR SDRFs IN TRAININGCALENDARFORTHEYEAR-2023

S/N	AME OFTHE COURSE	BOREWELL Rescue	MT inMFR &CSSR	TOTCBRN	TOTCADRE	ToTin MFR&CSSR	TOTCBRN	ToTin MFR&CSSR	BOREWELL Rescue	MT in MFR&CSSR	TOTCADRE	MT in MFR&CSSR	TOTCADRE	ToTin MFR&CSSR	BOREWELL Rescue	BOREWELL Rescue	ToT inMFR &CSSR	MT inCBRN	BOREWELL Rescue
	Duration (Weeks)	03days	01 Week	04Weeks	01 Week	05Weeks	04Weeks	05Weeks	03days	01 Week	01 Week	01 Week	01 Week	05Weeks	03days	03days	05Weeks	02Weeks	03days
	Schedule	09.01.23 to 11.01.23	06.02.23 to 11.02.23	20.02.23 to 18.03.23	20.02.23 to 04.03.23	27.02.23 to 01.04.23	01/05/23 to 27/05/23	01/05/23 to 03/06/23	08/05/23 to 10/05/23	08/05/23 to 13/05/23	19/06/23 to 24/06/23	10/07/23 to 15/07/23	21/08/23 to 26/08/23	04/09/23 to 07/10/23	04/09/23 to 06/09/23	09/10/23 to 11/10/23	06/11/23 to09/12/23	04/12/23 to16/12/22	18/12/23 to 20/12/23
	Institute	10TH BNNDRF	NDRF, Academy	05 BNNDRF	NDRF, Academy	07TH BNNDRF	05 BNNDRF	07TH BNNDRF	10TH BNNDRF	NDRF, Academy	NDRF, Academy	NDRF, Academy	NDRF, Academy	07TH BNNDRF	06TH BNNDRF	10TH BNNDRF	07TH BNNDRF	05TH BNNDRF	05TH BNNDRF
1.	WestBengal	-	-	-	-	-	-	6	-	-	7	5	-	5	4		5	-	-
2.	Uttarakhand	6	2	3	0	3	1	-	-	-	-	-	-	-	-	-	-	2	-
3.	Rajasthan						-	-	7	8	-	-	-	-	-	-	-	8	-
4.	Maharashtra	2	6	4	4	6	6	6	4	6	6	6	6	6	6	6	6	4	6
5.	Jammu& Kashmir	0	2	2	2	2	2	2	-	2	2	2	2	2	-	-	2	2	-
6.	Punjab	2	-	-	-	-	-	-	4	-	-	-	-	-	5	-	-	-	5
7.	Bihar	2	-	5	5	5	-	3	-	-	3	-	-	3	-	-	3	-	-
8.	Himachal Pradesh	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

9.	Tamilnadu	2	5	4	2	5	5	5	3	-	-	3	5	5	-	5	5	3	-
10.	Andhra Pradesh	-	-	-	-	-	10	10	7	9	10	10	10	12	10	13	12	7	13
11.	Karnataka	2	5	5	2	2	9	1	4	4	1	2	6	-	4	5	-	3	5
12.	Uttar Pradesh	10	5	10	10	10	-	-	-	-	-	4	3	6	3	2	6	4	3
13.	Tripura	-	-	-	-	-	-	-	1	1	2	-	1	-	1	2	-	-	1
14.	Assam	4	4	4	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	Arunachal Pradesh	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	Jharkhand	4	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Haryana	3	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-
18.	Ladakh	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
19.	A&N	-	2	-	2	-	-	-	-	-	--	-	-	-	-	-	-	-	-
Total Allotment		42	42	50	42	50	36	40	33	33	34	35	36	42	36	36	42	36	36

- Totalallotment-701Seatsareallotted

CHAPTER II

OBSERVATIONS/RECOMMENDATIONS WHICH HAVE BEEN ACCEPTED BY THE GOVERNMENT

Para No. 2.1

NEED TO MONITOR INDIAN HIMALAYAN REGION

Glaciers are important components of the hydrological cycles of the Indian Himalayan region as these are the source of three large river systems, i.e. the Indus, the Ganges, and the Brahmaputra, which provide water for millions of people in the country and accordingly, the Hindu Kush Himalayan Region (HKH) is rightly described as 'Water Towers of Asia'. Thus, the river systems and associated groundwater form a significant water resource for the country. The Himalayan glaciers ensure water availability even in post-monsoon period as the base flow of the glacial stream, besides ground water contribution in the river system of perennial rivers. As such, glaciers are very important for water security of the country. The Committee were informed that as per the inventory published by the Geological Survey of India (GSI), there are as many as 9775 glaciers in the Indian Himalayan Region (IHR). Further, a total of 1306.1 cubic km of ice volume (about 1110 cu. km of water) is locked up in glacierised basins of Indus, Ganga and Brahmaputra, although specific information about separate volume of ice and snow water is not available. It has also been informed that the thinning of Himalayan glaciers has been accelerated in the recent years, resulting in a significant rise in glacier melt, including sediment load, in yearly runoff and altered hydrological behaviour in the mountain region and downstream. The Committee observe that close and frequent monitoring of glaciers, glacier discharge, glacial lakes and prospective glacial lake outburst floods in the Himalayan region have become vital and critically important as never before for not only determining the current status as well as future responses of glaciers and glacial lakes, but also for predicting and mitigating the potential hazard disasters that may arise in future.

Reply of the Government

Monitoring of Glaciers in the Himalayan region is important for formulating climate change adaptation strategies, as its dynamics manifests the impact of climate change at regional and global scales. It also provides inputs on glacial mass balance which is crucial for sustainable water resources management.

Several initiatives have been taken by various Department and Organisation as mentioned below with an aim to monitor glaciers, glacier discharge, glacial lakes and prospective glacial lake outburst floods in the Himalayan region.

Ministry of Earth Sciences (MoES) through its autonomous Institute, the National Centre for Polar and Ocean Research (NCPOR) has been monitoring six glaciers in the Chandra basin (2,437 km^2 area) in western Himalaya since 2013. A state-of-the-art field research station 'Himansh' established in Chandra basin and operational since 2016 for conducting field experiment and expeditions to glaciers. The glacier inventory prepared by NCPOR for the Chandra basin shows that it has lost about 6% of its glacial area during last

20 years and 2.4 to 9 meter water equivalent (m.w.e.) ice mass during 2013-2021. Annual rate of retreat of Chandra basin glaciers vary from 13 to 33 meter/year during last decade. NCPOR through various studies have found that the Indian Himalayan region is one of the climate change hotspots, showing more significant warming than the global average due to the elevation-dependent warming phenomenon. Glaciers have shown significant retreat and mass loss in the past few decades due to the warming climate.

Waldia Institute of Himalayan Geology (WIHG) has been engaged in glacier research over the past 30 years. The research activities for glaciology require a two-phase operational strategy. In the 1stphase, recognizing the crunch of trained manpower, special focus is placed on training young researchers, establishment of field stations equipped with the latest instruments and technologies to comprehend several aspects in this specialised field of glaciology at tough terrain. 2nd phase would bring out continuous long-term observations on representative Himalayan glaciers and utilize the generated data for management, planning, and policy-making for the societal benefit and sustainable development.

As part of the first phase, WIHG has developed a basic infrastructure over ten (10) glaciers spread across Uttarakhand, Ladakh and expertise on different aspects of glaciology for monitoring glaciers throughout the year. WIHG has produced over 100 research articles on different aspects of glaciology and more than 15 PhDs in different disciplines of glaciology. WIHG has sustained long-term multifaceted observations on representative glaciers and has established inter-linkages and dependence of glacier dynamics on climatic, hydrologic, environmental factors through integration. Glacier-seismicity linkages have also been established, with an integrated approach for the assessment of different hazards in the Himalaya-Karakoram.

Considering that the IHR has ~10000 glaciers, WIHG aims to have a holistic approach for integrated long-term research throughout the year on representative glaciers, create manpower through training programs in glaciology to fill the void of human resources in this specialized field. In the ongoing phase WIHG will move towards latest technologies including up gradation to automated instrumentation, expansion of observatories with real-time connectivity, implementation of artificial intelligence and machine learning for faster and accurate data assimilation and dissemination.

Further, a basin wise and basin wide approach will be adopted to monitor the glaciers, glacial lakes and associated hazards downstream using a network of automated weather stations, water level recorders, broadband seismometers, high-resolution satellite data and sirens for warning in real-time. For this purpose WIHG has already been awarded projects to develop early warning systems by DST for Dhauliganga Basin, Uttarakhand State Disaster Management Authority (USDMA), Uttarakhand Jal Vidyut Nigam (UJVNL) limited for Bhagirathi Basin at the initial stage.

This can be adopted by other knowledge partners, institutes and organisations for long-term monitoring under the glaciological program of the Department of Science and Technology (DST). Besides, the WIHG is also equipped with ultra-modern laboratory facilities, which are being upgraded for glacier research. This would help institutionalize glaciological research in the country.

Indian Space Research Organisation has informed that satellite data and its expertise could be made available, as required by the nodal agencies, for monitoring/ modeling purposes.

Geological Survey of India (GSI) carries out the glaciological studies of GSI include Glacier Mass Balance Studies, Glacier Regimen Studies, Glaciers& Climate Variability Studies for selected glaciers in the Himalayan Belt. GSI has conducted mass balance studies on 09 glaciers to assess volumetric changes on the glacier surface, and carried out secular movement studies on 81 glaciers to assess the recessional and advancement pattern of the glacier. Majority of Himalayan glaciers are observed melting/ retreating at varying rates in different regions. In the Indian Himalayan Region, studies indicate that the glaciers are retreating and losing their mass, except for some glaciers in the Karakoram.

Ministry of Environment & Forest & Climate Change has informed that under the National Action Plan for Climate Change (NAPCC), the Government is implementing the National Mission for Sustaining Himalayan Eco-system (NMSHE). The Mission aims to

a. understand scientifically the complex processes affecting this eco-system,

b. evolve suitable management and policy measures for sustaining and safeguarding theHimalayan eco-system including Himalayan glaciers; and

c. work with the states in the Indian Himalayan region in the implementation of scientifically derived policy measures.

Recognizing the scientific and technological inputs required for sustaining the fragile Himalayan eco-system, DST has been charged with the responsibility of implementing NMSHE.

In addition, the G.B. Pant National Institute of Himalayan Environment (GBPNIHE), an autonomous institute under MoEF&CC, is involved in strengthening local knowledge of environment; evolve and demonstrate suitable technological packages in the Indian Himalayan Region with a focus on improved livelihood options including socio-economic development of the Himalayan communities along with biodiversity conservation etc.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

Para No. 2.2

WARMING OF THE HIMALAYAN-KARAKORAM REGION

The Committee note that as per the information furnished by the Department of Science and Technology (DST), the Himalayan-Karakoram region is becoming warmer at a faster rate than global mean by 0.5 ^{0}C which will lead to local changes in hydrology in terms of rainfall and snowfall patterns, increased melting from glaciers and threat to the infrastructure due to increase in extreme events leading to disasters. The Committee are further informed by the Ministry of Environment, Forest & Climate Change (MoEF&CC) that smaller glaciers in the Himalayan region are more sensitive to climate change and their

shrinkage rate is stated to be higher than those of larger glaciers. Further, as per the World Meteorological Organization, average global temperature for 2015-2019 is estimated to be 1.1 degree Celsius above pre-industrial (1850-1900) level. According to the Ministry of Earth Sciences, in line with rising temperatures across the globe, all India mean temperature has risen by nearly 0.7 degree Celsius during 1901 to 2018. The Committee further note that as per the IPCC report 2021, the glaciers of Hindu Kush Himalayas (HKH) are shrinking and the snow cover has been getting reduced since the early 21st century and glaciers have also been thinned, retreated and lost mass since the 1970s. According to estimates made between 2006 and 2018, the global mean sea level is rising at a rate of around 3.7 mm/yr. Further in the long term, the melting of glaciers will also contribute to rising of the sea level and threaten to submerge some coastal cities in the country and in the short term, the sea level rise may cause the change in rainfall pattern and seasonal flooding in the coastal areas. The Committee while observing cataclysmic changes that are occurring in the Himalayan region / cryosphere, call for urgent, coherent and coordinated response to the evolving challenges posed by global warming & climate change.

Reply of the Government

National Centre for Polar and Ocean Research (NCPOR) has informed that in the context of global warming, most glaciers are melting and receding. However, in contrast, the glaciers of central Karakoram have surprisingly remained unchanged or slightly increased in the last few decades, known as the "Karakoram Anomaly". Studies show that the central and west Karakoram glaciers gained ice mass, while the eastern Karakoram glaciers lost ice mass in the past two decades. The increasing precipitation trend is leading to mass gains in the western and central Karakoram glaciers, whereas increasing temperature is causing ice mass loss in the eastern Karakoram glacier.

Snow during winter covers a large area (1.59 ± 0.15 million km^2) in the HKH region and ranges from 85% in the winter to approximately 10% in the summer. There is no significant trend in the mean Snow Cover Area for the HKH region. However, decreasing trends in Jhelum, Kosi, Gandaki, Manas and Chandra river basins were reported, with a statistically significant negative correlation with temperature.

Further, the future projections indicate that glacier melt contribution will increase at first as the glacier mass loss accelerates, followed by a decrease resulting from a significant reduction in the glacier volumes. Further, changing climate indicates more precipitation in the form of rainfall instead of snowfall. In general, the warming climate will lead to the increasing contribution of rainfall-runoff, long-term decrease in snowmelt and ice melt and early melting seasonal snow, which will alter the trend and timing of the hydrological regime of Himalayan rivers.

Wadia institute of Himalayan Geology (WIHG) has informed that most of the studies over central and western Himalayan glaciers indicate that the glaciers are in a general state of retreat/thinning. However, several glaciers in the Karakoram are reported to be advancing/thickening/surging. Several studies have reported the advancement/retreating of glacier snouts, changes in area-elevation as well as the velocity of glaciers based on remotely sensed data. These do not provide any insight on understanding the processes responsible for these heterogeneities.

Therefore, to comprehend the processes governing the dynamics and hydrology of glaciers in the Himalaya-Karakoram, utilisation of advanced techniques in conjunction with the real-time in-situ observations is need of the hour to gain scientific knowledge on better understanding by simulating the glaciological processes at different spatio-temporal scales.

For this purpose, WIHG has carried out several expeditions to the Karakoram region and initiated hydro-meteorological monitoring in Nubra Basin, Ladakh Himalaya and also in-situ monitoring of two (02) glaciers within the basin, apart from in-situ monitoring of two (02) glaciers of Zanskar Basin in Ladakh and eight (08) glaciers of Bhagirathi and Alaknanda Basins in Uttarakhand. Also, WIHG has also been pursuing studies for larger basins using remote sensing data in Himalaya-Karakoram region through various glacial and glacial-lake inventories and their temporal changes.

Ministry of Environment & Forest & Climate Change has stated that in August 2022, India has submitted its updated Nationally Determined Contribution (NDC) to United Nations Framework Convention on Climate Change (UNFCCC). The mitigation targets in terms of reduction of emission intensity and share of non-fossil fuels in total electricity generation installed capacity have been enhanced. Subsequently in November, 2022, India has submitted its Long-term Low Carbon Development Strategy to reach net-zero by 2070.India's action on climate change is guided by the National Action Plan on Climate Change, (NAPCC), which is the overarching policy framework and comprises national missions in specific areas of solar energy, enhanced energy efficiency, water, agriculture, Himalayan ecosystem, sustainable habitat, green India, human health and strategic knowledge on climate change. The implementation of these national missions is being anchored by concerned Ministries and Departments with each mission having its own sector specific action plan. The National Mission on Sustaining Himalayan Eco-system (NMSHE), inter-alia, aims for strengthening of research and capacity building in thematic areas viz. Himalayan glaciology, hydrology, biodiversity, sustainable agriculture, wild life protection and conservation, etc. At the State level, 34 States/ Union Territories (UTs) have prepared their State Action Plans on Climate Change (SAPCC) in line with NAPCC taking into account the State specific issues relating to climate change.

In addition, the Department of Science and Technology (DST) has also set-up Centres of Excellence at various institutions under NMSHE and National Mission on Strategic Knowledge for Climate Change (NMSKCC) for studying the impact of climate change across country including Himalayan Region.

In the context of sea-level rise, MoEF&CC under the Integrated Coastal Zone Management Project (ICZMP) has demarcated the hazard line along the entire coastal belt of the country, including the intertidal areas. The hazard line is indicative of the shoreline changes, including the sea level rise due to climate change and is a projection of impact due to sea level rise, and shoreline changes over a long period of time viz. over 100 years. This line is to be used by the Coastal State agencies concerned as a tool for disaster management for the coastal environment, including planning of adaptive and mitigation measures. The Government also seeks to conserve and enhance mangroves and corals through promotional and legal measures. The mangrove cover in the country is rising and has increased between 2017 and 2021.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO. 2 (Para No. 2.4)

Need for Overarching Apex Body for Glacier Management

The Committee note that Glaciers are important components of the hydrological cycles of the Indian Himalayan region as they are the source of the three large river systems of India i.e. the Indus, the Ganges, and the Brahmaputra, which provide water for millions of people in the country. However, they note that there are plethora of Ministries/Departments/Institutions with different mandates for dealing with hydro-meteorological and hydro-geological hazards of Himalayan glaciers. While the glaciers are surveyed and their detailed inventory is maintained by the Geological Survey of India, Ministry of Mines; the Ministry of Environment, Forest and Climate Change looks into all matters related to climate change including its impact on the glaciers. The Department of Science & Technology is involved in conducting research on glaciers and the National Centre for Polar and Ocean Research (NCPOR) under the Ministry of Earth Sciences has done some studies on the Himalayan cryosphere. Besides, the Defence Geo-Informatics Research Establishment under aegis of Defence Research & Development Organisation (DRDO) carries out work on avalanche forecasting, and the Indian Space Research Organization coming under the Department of Space, looks after the National Natural Resources Management System and provides valuable inputs by way of remote sensing. Further, the Department of Water Resources, River Development & Ganga Rejuvenation is tasked with flood-control management and the Central Water Commission has been mandated for monitoring glacial lakes. Apart from different Ministries/Departments/Agencies, glaciological studies and other cryospheric research is carried out by a number of researchers from various research and academic institutes across the country.

The Committee are of the considered view that given the strategic role and importance of glaciers as a vital national resource, there is a critical and imperative need as never before, to formulate new strategies for combating the challenges posed by the climate change and global warming in the glacier management especially glaciers movement, glaciers surge, Glacial Lake Outburst Flood (GLOF), Landslide Lake Outburst Flood (LLOF) and cloud burst in mountainous regions. In this regard, the role of planners, scientists and academicians assumes critical importance in devising, developing and implementing suitable measures for studying, monitoring and providing early warning response to reduce the potential glacier related risks. Fragmented research and studies by various Departments/Institutions/Agencies in this regard will not yield desired results / outcomes and also may not necessarily convert into actionable steps. The Committee, therefore, recommend that there is need to set up a single nodal agency for bringing out synergies among various Government Departments/Ministries involved in glaciological research and monitoring to achieve desirable results. Such an agency should be entrusted with the responsibility of coordinating the activities of all the Departments/Agencies involved in Himalayan Glaciers monitoring and research work. Besides, this agency should be given well-defined and delineated mandate by suitably amending the Allocation of Business Rules. The Committee urge upon the Department of Water Resources, River Development & Ganga Rejuvenation to play a lead role in this regard so as to take the matter to its logical conclusion for setting up of the institution and apprise the Committee about the steps taken by it within three months of presentation of this Report.

Reply of the Government

Department of Water Resources, River Development & Ganga Rejuvenation has constituted a Steering Committee for monitoring of glaciers(a copy of order of constitution of the committee attach at **Annexure-III**). The objective of Steering Committee is –

i. To initiate systematic mapping of glaciers/glacial lakes, monitoring glacial changes/melting and glacial lake outburst floods.

ii. To consolidate the glacier and glacial lake information collected by different agencies of the Government and make it available on GIS based web-portal.

iii. To develop a coordination mechanism among various ministries (viz., Ministries of Jal Shakti; Environment, Forest & Climate Change, Department of Space, Ministry of Earth Sciences, Ministry of Mines and Department of Science and Technology etc.) for efficient mobilization of resources for glacier related studies.

iv. To help building bridges among other research groups and academia for studies on glaciers.

v. To develop trends and predictions for behaviour of Himalayan glaciers in the context of climate change and their likely impact on hydrology.

vi. To develop capacity through workshops, awareness and trainings programs on snow and glacier aspects.

The Committee will meet quarterly to advise and review the progress on the methodologies suggested for monitoring of glaciers.

The first meeting of the Steering Committee for Monitoring of Glaciers was held in the National Institute of Hydrology, Roorkee on May 02, 2023. The meeting was chaired by Secretary, WR, RD & GR, Ministry of Jal Shakti, Gort. of India. Minutes of the meeting is attached **at Annexure-IV**

The above constituted Steering Committee under the chairmanship of Secretary, DoWR, RD & GR will act as an overall Arching Apex Body for Glacier Management.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.5 (Para No. 2.7)

Need for Revival of Springs in the Himalayas

The Committee note that the Niti Aayog Report of 2018 (Report of Working Group-I on Inventory and Revival of Springs in the Himalayas for Water Security) had warned that almost 60 per cent of water sources in the Indian Himalayan region are on the verge of drying up. The Ayog has proposed launching a National Spring Water Management Programme for the Himalayan Region. The Committee are happy to note that in compliance with the suggestions of the NITI Ayog, the Department of Water Resources, River Development & Ganga Rejuvenation has created a database of springs existing in the

mountainous regions of India, especially in Indian Himalayan region (total 12 states) by compiling all information already available with Survey of India (SoI), Central Ground Water Board (CGWB), National Remote Sensing Centre (NRSC), State Governments, Non-Governmental Organizations (NGO's) and other organizations. The database compiled was analyzed to create a Spring Geographical Information System (GIS) which is available as web based service in Survey of India G2G portal. While appreciating the steps taken for creation of database, the Committee urge upon the Department to take necessary steps for the revival of springs in the Himalayan region as millions of people depend only on Springs for their drinking, domestic, and agricultural water needs. The Committee would like to be apprised of the steps taken by the Department in this regard within three months of the presentation of this Report.

Reply of the Government

NITI Aayog's report on "Inventory and revival of springs in Himalayas for water security" highlighted the urgent need to take up a national level initiative focused on rejuvenation, restoration and management of Himalayan springs. On the recommendations of NITI Aayog, rejuvenation of springshed, in the lines of management of watershed, has been incorporated as a new activity in the Watershed Development Component under Pradhan Mantri Krishi Sinchayee Yojana (WDC-PMKSY). The continuation of Watershed Development Component (WDC-PMKSY) has been allowed by Government of India on 15.12.2021 as 'WDC-PMKSY 2.0' for the project period of 2021-2026..

Further, Guidelines for New Generation Watershed Development Projects (WDC-PMKSY 2.0) published by Dept. of Land Resources, Ministry of Rural Development covers implementation strategy and road map for springshed rejuvenation.

The steps being taken by Central Ground Water Board on springs revival and management in the country are -

1. "Spring Cell" has been created in 11 Regional offices of CGWB, where springs form a major source of drinking water supply.

2. CGWB has prepared a draft policy on "The Protection of Catchment Area of Springshed / Watershed".

3. Springshed Management in the Hilly areas of North Eastern Region has been deliberated during the State level workshop held on Success Stories of NAQUIM Studies and PMKSY-HKKP-GW Schemes in NER, organized on 24 January 2023.

4. Under National Aquifer Mapping 2.0, the revival of Springshed have been undertaken in AAP 2023-24.
   Springshed Mapping in Dalai District, Tripura,
   Kohima District, Nagaland,
   Imphal East District, Manipur,
   and Aizwal District, Mizoram

5. A Pilot study is being taken up by CGWB in association with NIH aiming to ascertain the efficacy of use of State-of-the-art technologies for spring mapping and sustainability of springs through suitable interventions in Pratapnagar, Bilangana blocks of TehriGarhwal district and Ukhimath block of Rudraprayag district, Uttarakhand (2023-24). By using DEM, Point cloud and ORI of Manu Project in Bilangana CD block of TehriGarhwal District and Ukhimath CD block of Rudraprayag District and drone mounted LiDAR data of Pratapnagar Block, TehriGarhwal district, spring identification and demarcation of springshed will be carried out by SoI and will be shared with CGWB.

6. CGWB in association with National Institute of Hydrology (NIH), Roorkee will carry out validation of SoI data, identification of vulnerable spring and suggest implementable plans for rejuvenation of springs, which will be executed by concerned State department.

NRSC/ ISRO has informed that available relevant thematic geospatial datasets can be shared for springshed management by concerned departments.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-6 (Para No. 2.8)

Need to have Data Sharing Agreements

The Committee note that though India has entered into treaty / agreement for water sharing / sharing of hydrological information with its neighbouring countries, however, there is no specific Agreement/Treaty with neighbouring countries for sharing of glacier related data for large-scale modeling and runoff evolution. The Committee are of the view that in order to design / devise a comprehensive and coordinated strategy that could effectively address both the risk of glacier related outburst floods and water management challenges, regional cooperation is the need of the hour. Since the threat posed by the melting/retreating of Himalayan glaciers transcends the national boundaries of the Himalayan nations, the Committee are of the considered view that in order to formulate / devise an effective and comprehensive response to the threat posed by melting of glaciers and for mitigating potential hazard situations, regional cooperation for seamless sharing of hydrological information / data on glacier movement / behavior is very much warranted. The Committee, therefore recommend the Department of Water Resources, River Development & Ganga Rejuvenation to take up the matter with the Ministry of External Affairs so as to have some kind of bilateral/multilateral Agreement with neighboring Himalayan countries for sharing of information / data on the changing state of glaciers and the threats posed by them. The Committee would like to be apprised of the steps taken by the Department in this regard within three months of the presentation of this Report.

Reply of the Government

There exists an Expert-Level Mechanism with China on trans-border rivers since 2006. Various issues relating to trans-border rivers are discussed with China under the ambit

of this Institutionalised Expert-Level Mechanism as well as through diplomatic channels. It has been informed by Ministry of External Affairs that India intends to remain engaged with China on the issue of trans-border rivers to safeguard our interests. A separate agreement on glacier data involving China is not recommended at the current juncture.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-7 (Para No. 2.9)

The Committee observe that there are various constraints / problems even at the national level in data-sharing relating to glaciological research. The Committee understand from the submissions of the Director, Wadia Institute of Himalayan Geology, that there are many obstacles in using the data especially the high-resolution data because they need specific permission from concerned authorities before their use. Besides, different Ministries have different protocols for data collection and their sharing. The Committee are of the view that since glaciology is a wide ranging and diverse field, research in this area necessitates requirement of data from a wide range of sources, institutions, and authorities. All information pertaining to glaciers need to be gathered at one place so as to enable its easy access and sharing by researchers and other stakeholders so that they accomplish their stated research goals. The Committee, therefore, recommend the Department to take up this issue with concernedMinistries/Department/Agencies/Institutes for setting up a common data sharing platform under the aegis of a single nodal agency so as to enable seamless exchange of data by various researchers / stake holders.

Reply of the Government

Department of Water Resources, River Development & Ganga Rejuvenation has constituted a Steering Committee for monitoring of glaciers. The objective of Steering Committee is to initiate systematic mapping of glaciers/glacial lakes, monitoring glacial changes/melting and glacial lake outburst floods and to consolidate the glacier and glacial lake information collected by different agencies of the Government and make it available on GIS based web-portal.

The objective of setting up a common data sharing platform under the aegis of a single nodal agency so as to enable seamless exchange of data by various researchers / stake holders would be fulfilled by above constituted Steering Committee.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-8 (Para No. 2.10)

Need to strengthen Network of Monitoring Stations

The Committee note that there is a severe shortage of meteorological and monitoring stations in the Indian Himalayan region. Presently the Defence Geoinformatics Research Establishment (DGRE) has set up three Mountain Metrological Centres (MMC) for avalanche study and the Wadia Institute of Himalayan Geology (WIHG) has five meteorological and discharge stations located in the high altitude regions (~3800 m asl), most of them being of

conventional type. The Central Water Commission (CWC) has set up 46 meteorological observation stations in the Himalyan region (1000m above msl) and out of these, only 35 are telemetry based stations. Apart from the above, 16 new telemetry based meteorological observation stations are proposed (1000m above msl) to be set up in the Himalyan region, which is under various stages of implementation. As regards Uttarakhand, which is very vulnerable to landslide induced and glacial lake outburst floods, the Committee find that CWC has only 6 (4 Level + 2 Inflow) flood forecasting stations. Explaining the reason for this, DoWR, RD & GR has stated that CWC issues level forecasts at identified locations and inflow forecasts for identified Dams/ Reservoirs/ Barrages for providing advance information based on the request from the respective State Governments. Hence, based on request from Government of Uttarakhand at present there are only 6 flood forecasting stations. While citing the constraints in making accurate and timely forecast by conventional systems due to tough terrain and flashy nature of rivers in Uttarakhand, the Department stated that for flood forecasting by rainfall-runoff mathematical modelling, sufficiently representative and temporal distribution of real-time rainfall would be required from Indian Meteorological Department (IMD).

The Committee further note that Himalayan glaciers and glacial lakes are not being monitored / observed on a scale on which they should have been due to their remote location and difficulty in accessing them. The strategic importance of glaciers in ensuring water security and the frequent occurrence of several extreme hydro-meteorological events in the recent past due to climate change resulting in abnormal flood like situations damaging human lives and infrastructure, has underlined as never before, the urgency of constant monitoring of the glaciers and glacial lakes. The Committee believe that in order to have effective and seamless monitoring of Himalayan glaciers and glacier-bound risks, a comprehensive network of field stations in highly important glaciered basins supplemented by integrated monitoring systems is the need of the hour. The Committee thus urge upon the Department to make concerted efforts to set up a network of high altitude meteorological and discharge stations covering more glaciers and watersheds in the Himalayan region. Besides, the Committee call upon the Department to work in close liason with the WIHG and explore the technical feasibility of converting their meteorological and discharge stations in the high altitude regions into Automatic Stations which will be of great use in enabling observation at a high time resolution to be received in real time. The Department should also work in close collaboration with the IMD with a view to ensuring real time rainfall forecast systems for a State like Uttarakhand which frequently becomes victim of various mountainous hazard events. Further, the Committee call upon the Department to reconsider its extant policy of setting up flood forecasting station only on the request from the concerned State Governments, and should become proactive and itself identify the vulnerable locations in collaboration with the respective State Governments, where Forecasting Stations are needed to be set up.

Reply of the Government

Indian Meteorological Department has informed that IMD is already having a well established weather monitoring network. To enhance the same for Himalayan Region, a Project 'Integrated Himalayan Meteorology Programme (IHMP) is being implemented in the Western & Central Himalayan region covering four States/UTs namely, Jammu Kashmir &Ladakh, Himachal Pradesh, Uttarakhand and Sub Himalayan West Bengal to augment the observational network and fill the data gap areas in the region. Under this program, state of

art meteorological systems are to be deployed over the mountainous region to establish the dense observational network through commissioning of 10 Doppler Weather Radars (DWRs) in the Himalayan region. Out of ten (10) radars, nine (9) DWRs have been installed each at Kufri, Jot &Murari Devi in Himachal Pradesh, at Mukteshwar&Surkanda Devi in Uttarakhand, at Leh&Sonmarg in Ladakh and at Jammu and Banihal Top in Jammu & Kashmir. Installation of DWR at Lansdowne in Uttarakhand is under process.

The details of the same are given in Table below;

S.No.	Name of Station	DWR type	Commissioned on
1	Srinagar (Jammu & Kashmir)	X-Band, Polarimetric	01-05-2015
2	Mukteshwar (Uttarakhand)	X-Band	30.09.2020
3	Sonmarg (Ladakh)	Transportable X-Band	26.10.2020
4	Kufri (Himachal Pradesh)	X-Band	07.12.2020
5	Leh (Ladakh)	Transportable X-Band	28.10.2021
6	Jammu (Jammu & Kashmir)	X-Band	24.08.2021
7	Surkanda Devi (Uttarakhand)	X-Band	28.03.2022
8	Banihal Top (Jammu & Kashmir)	X-Band	01.09.2022
9	Jot (Himachal Pradesh)	X-Band	31.12.2022
10	Murari Devi (Himachal Pradesh)	X-Band	21.01.2023
11	Lansdowne (Uttarakhand)	X-Band	To be Commissioned

Existing observational network AWS/Agro-AWS/ARG in Himalayan States are given in the Table below;

S.No.	State	AWS	ARG	Agro-AWS
	Jammu & Kashmir	23	14	4
	Ladakh	10	-	-
	Himachal Pradesh	22	66	4
	Uttarakhand	25	21	3
	Sub-Himalayan West Bengal & Sikkim	10	11	2

The details of future plan for enhancement of observational network under ACROSS Project (2021-2026) are given in Table below;

S.No.	State	AWS	ARG	ASG	Agro-AWS	Surface Observatory
	Jammu & Kashmir	11	20	14	4	-
	Ladakh	10	1	10	1	-
	Himachal Pradesh	20	24	21	4	-
	Uttarakhand	42	22	11	6	15
	Sub-Himalayan West Bengal & Sikkim	06	06	03	4	-

(AWS: Automated Weather Station, **ARG**: Automated Rain Gauge, **ASG**: Automated Snow Gauge**)**

In addition to these, action for further enhancement of observational network for Himalayan regions under Integrated Himalayan Meteorology Project is in progress. Under this scheme installation and commissioning of AWS/ARG/HAWOS will be carried out over Himalayan Region for betterment of weather monitoring. Details of the same are given in Table below.

The Proposed Observational Network for Himalayan Region and North-eastern States

In Western Himalayan Region, following is the proposed network:

State	CSWDRS	HAWOS	AWS/ARG/SG	M-AWS	SFO
J & K	4	5	75	5	NIL
HP	4	0	65	5	NIL
UK	4	3	75	5	15
SHWB	NIL	1	15	NIL	NIL
TOTAL	**12**	**09**	**230**	**15**	**15**

CSWDRS: Compact Severe Weather Detection Radar Systems, HAWOS: Heliport Automated Weather Observation Systems

Proposed Observational Network Integrated Meteorological Services for Northeastern Region

State	DWR	AWS/ARG/SG	MR	WL	AWOS/HAWOS
Arunachal Pradesh	2	35	NIL	NIL	8
Assam	2	50	3	3	2
Meghalaya	0	30	NIL	NIL	1
Nagaland	1	30	1	1	1
Manipur	1	30	0	0	1
Mizoram	1	30	0	0	1
Tripura	0	30	1	1	2
Sikkim	1	35	0	0	2
TOTAL	**8**	**270**	**5**	**5**	**18**

MR-Microwave Radiometer, **WL**-Wind Lidar, **HAWOS**-Heliport Automated Weather Observation Systems.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-9 (Para No. 2.11)

Need to bring Smaller Glaciers under the purview of Monitoring

The Committee note that as per the inventory of GLs/WBs prepared in 2011, there are 2028 GLs/WBs having size more than 10 ha including 477 GLs/WBs having size more than 50 ha in Himalayan Region of Indian River Basins. Presently, Central Water

Commission is monitoring 95 GLs/WBs lying in India having size more than 50 Ha on monthly basis during monsoon season (June to October) every year. The Committee are of the view that it is just not enough to cover only large water bodies/glacial lakes as the smaller glaciers are also more vulnerable to climate change which accelerates their melting and thereby pose potent threat, the fact which has been corroborated by the statement of the representative of the DoWR, RD & GR during the course of oral evidence, wherein he has stated that even a smaller mass of ice or water can be troublesome as witnessed in Chamoli incident which occurred in the State of Uttarakhand in early months of the year 2021 which was non monsoon period. The Committee, therefore, recommend the Department of Water Resources, River Development & Ganga Rejuvenation to take necessary steps to bring smaller water bodies/glacial lakes under their purview for monitoring not only during monsoon period but throughout the year. They also urge upon the Department to collaborate with National Remote Sensing Centre (NRSC) for updation of their 2011 inventory of GLs/WBs which was based on the satellite imageries data of Advanced Wide Field Sensor (AWiFS) of the Indian Remote Sensing Satellite, Resourcesat-2 collected during the period May-Nov, 2009.

Reply of the Government

The number of Glacial Lakes/ Water Bodies being monitored by CWC has been increased from 477 to 902 from June 2022 onwards. The size of these 902 GL/WBs being monitored now covers those with areas more than 10 ha whereas earlier the minimum size covered was 50 ha. A few lakes of size less than10 ha have also been included. The details of the same is as under:-

• 477 Glacial Lakes and Water Bodies, having water spread area greater than 50ha which have been included from the inventory of Glacial Lakes & Water Bodies in the Indian Himalayan region using satellite data of the year 2009 prepared by NRSC

• 385 Glacial Lakes, having spatial extent greater than 10 ha, which have been taken from the inventory of Glacial Lakes & Water Bodies in the Indian Himalayan region using satellite data of the year 2009 prepared by NRSC.

• 57 Glacial Lakes, which have been listed as high priority lakes, as per Synthesis report on GLOF hazard and risk across the Indian Himalayan Region prepared by Swiss Agency for Development and Cooperation (SDC) for NDMA.

High resolution multi-spectral and microwave (SAR) images at 10 m resolution from foreign satellites have been used. The use of Microwave (SAR) images have helped in detecting Lakes even in cloud conditions. Initiative has also been taken up to utilise Indian satellite data. The data of RISAT 1-A has also been utilised. Open-source cloud computing platform, has been used for processing and analysing of these large satellite imageries. Processing &analysing of these satellite images and computation of water spread area has been automized.

2. First Order Hazard Assessment

To assess the potential impact of the lakes in the downstream area, a First order hazard assessment has been undertaken by CWC. The methodology adopted is similar to that recommended in the NDMA Guidelines on GLOF. Initially, 8 lakes have been identified by CWC for first order assessment in 4 States/UTs (HP, Uttarakhand, Ladakh, J&K). These were common, in the 3 studies i.e. firstly 56 lakes identified by SDC as high priority lakes in

6 States/UTs in their "Synthesis report on GLOF hazard and risk", secondly, report of Ranking Studies of Lakes by NRSC (Ganga & Indus Basin) in the Indian Himalayan Region and thirdly, monitoring reports of 902 lakes monitored by CWC every month from June to October. The results of the same have been shared with NDMA for their observations/assessment.

The detailed report for First Order Hazard Assessment is under preparation which will be shared with expert agencies like NIH, NRSC and other stakeholders for deciding collaborative future course of action on few high prioritized lakes.

Further, as a part of National Hydrology Project (NHP), NRSC/ISRO has prepared inventory of 28,043 glacial lakes (greater than 0.25 ha) using resources at LISS-IV satellite data for entire catchment areas of Indian Himalayan river basins (Indus, Ganga and Brahmaputra). Basin-wise glacial lake atlases and consolidated atlas were prepared and web published for download (https://www.nrsc.gov.in/Atlas_Glacial_Lake). The glacial lakes' database for Indus, Ganga and Brahmaputra basins are shared with CWC/ MoJS, and will be useful for CWC to monitor even smaller sized glacial lakes.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-10 (Para No. 2.12)

Need to have robust Early Warning System

The Committee observe that the recent spike in incidents of mountainous hazards / disasters viz. GLOF, LLOF, snow avalanches, cloud bursts and landslides have underlined the paramount importance of having a robust early warning system. The Committee understand that these mountainous hazards should not be viewed in isolation as single and stand alone incidents but should be seen as interconnected to potential multiple disasters having a cascading impact. However, most of the present day warning systems are not capable of dealing with these kinds of disasters as these are designed for making forecasts only for single disaster. The Committee recommend that the Department should take initiative in this regard and in consultation with other Government agencies like NDMA, Indian Meteorological Department and respective State Governments, particularly the State Government of Uttrakhand for evolving a multi-hazard risk assessment approach so that a Multi-Hazard Early Warning System coupled with real-time coordinated mechanism be set up under the aegis of a single nodal agency for regular monitoring and issuing of hazards / disasters warnings to all stakeholders in respect of potential mountainous hazards.

Reply of the Government

IMD is already having a well established Early Warning System which comprises of surface and upper air observational network including satellite and radars, high resolution numerical models, forecast decision support systems and advanced disseminations tools.

IMD follows a seamless forecasting strategy. The long-range forecasts (for the whole season) issued are being followed with extended range forecast issued on every Thursday with a validity period of four weeks. To follow up the extended range forecast, IMD issues short to medium range forecast and warnings daily valid up to next five days with an outlook

for subsequent two days. The short to medium range forecast and warning at district and station level are issued by State level Meteorological Centres (MCs)/Regional Meteorological Centres (RMCs) with a validity of next five days and are updated twice a day. The short to medium range forecast is followed by very short range forecast of severe weather up to three hours (nowcast) for all the districts and 1,171 cities and towns. These nowcasts are updated every three hours.

Forecast is issued for 36 meteorological sub-divisions from National Weather Forecasting Centre, IMD HQ and is updated four times a day. The forecasts and nowcasts are issued at District Level and Station Level by State Level Meteorological Centres and Regional Meteorological Centres.

Accordingly, forecast and warning services for Western Himalayan Region are covered by Meteorological Centre(MC) Srinagar (for Jammu Kashmir &Ladakh), MC Simla (for Himachal Pradesh), MC Dehradun (for Uttarakhand), MC Gangtok (for Sub Himalyan West Bengal &Sikkim) and Regional Meteorological Centre (RMC) Guwahati (for North East India).

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 finalised in collaboration with National Disaster Management Authority (NDMA) and is already implemented successfully for cyclone, heat wave, thunderstorm and heavy rainfall. Work is in progress to implement the same for other severe weather elements.

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 colour to be alert and be prepared to take action whereas red colour signals to take action.

In addition to this, from National Weather Forecasting Centre (NWFC) two bulletins are issued on daily basis based on 0830 1430 HRS observations respectively for supporting mountain weather services. These bulletins are disseminated to MC Srinagar, MC Simla, MC Dehradun & SASE Joshimath through Email and are uploaded in the IMD website also. These bulletins contain the synoptic situation responsible for the weather activities as well as forecast and warning for seven days for Kashmir, Ladakh and Gilgit& Jammu divisions of J&K Ladakh, High hills as well as lower hillls regions of Himachal Pradesh and Garhwal as well as Kumaon regions of Uttarakhand.

To upgrade the forecasting capabilities throughout the country including Himalayan Region, various programs are being implemented in IMD under the umbrella scheme “Atmosphere &Climate Research-Modelling Observing Systems & Services (ACROSS)” of the Ministry of Earth Sciences (MoES) namely viz. Atmospheric Observation Network (AON), Upgradation of Forecast System (UFS), Weather & Climate Services (WCS) and Commissioning of Polarimetric Doppler Weather Radars (PDWR).

Atmospheric Observations Network (AON)

- Sustenance and Augmentation of observational networks comprising of Doppler Weather Radars (DWRs), Automatic Rain Gauges (ARGs), Automatic Weather Stations (AWSs), Upper Air, Surface and Environmental Observatories etc. Improve upon the spatial and temporal density of Radar observational network, particularly over the regions with large data gaps in the country.
- To improve and upgrade weather and climate services over north-eastern region by establishing additional state of art surface and upper air observatories for real time observations.
- Sustenance & Establishment of Multi processing, computing and communication facilities for Satellite Meteorological Applications.

Upgradation of Forecast System (UFS)

- Upgradation and sustenance of Communication Systems for Data and Product transmission.
- Development of an advanced Operational Forecast System, Delivery System for Forecast and other services.
- Conduct of special campaign for improving Cyclone, Thunderstorm and Fog forecasting through provision of additional observations.
- Integrated Himalayan Meteorological Programme for Western & Central Himalayas.
- Capacity Building, Outreach, Planning and sustenance of specific process related observing systems over India.

Weather & Climate Services (WCS)

- Setting up of District Agro-Met Units (DAMUs) at all the districts complimentarily with existing AMFUs in the country for extension of Agromet Advisory Services (AAS).
- Major upgradation of Meteorological facilities at all airports through commissioning of State-of-art Integrated Aviation Weather Observing Systems (AWOS), HAWOS, Microwave Radiometers, Doppler LIDARs, Wind Profilers etc to support Aeronautical MET Services.
- Establishment of a state-of the-art Climate Data Centre with integrated advanced Climate Data Services portal for rendering national and regional climate services.
- To upgrade the training infrastructure and facilities to enhance the capacity of the training establishment.

This project covers the services for the country as a whole including Himalayan regions. Major plans along with expected outcome from this programme follow:

Future Plans

i. Development of an advanced operational forecast system.

ii. Upgradation and sustenance of communication systems for weather services.

iii. Capacity building & outreach etc.

Expected Outcome

- Upgradation of the existing Visualisation Platform & Decision Support System, which would enable the weather forecasters in India Meteorological Department to analyse a huge volume of data and various other products and inputs more efficiently and within the given time frame.
- The proposed system is planned to incorporate all the latest technological developments available in the field of Information Technology as well as 3-dimensional visualization capability.
- A forecast dissemination tool which will enable the inclusion of more user friendly textual & graphical products as well as videos are also envisaged to be procured under this programme.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-12 (Para No. 2.14)

Need to evolve Land Use Regulations

The Committee are of the considered view that well laid down procedure / regulations for land use planning / zoning in the Himalayan States especially those area which are more prone and susceptible to landslides, LLOFs, GLOFs etc. will go a long way in mitigating the eventualities that arise in the event of disasters. The Committee were informed by NDMA that in their guidelines on management of GLOFs, they have *inter alia* recommended for constitution of a Committee to formulate specific land use zoning and building construction regulations under aegis of Ministry of Jal Shakti (MoJS). Further, the Committee note that while a Uniform Code for the construction practices is contained in National Building Code of India (NBC 2016) published by the Bureau of Indian Standards (BIS) which comes under the Ministry of Consumer Affairs, Food & Public Distribution, as regards excavation, a policy on Sediment Management is at drafting stage under aegis of the Ministry of Jal Shakti. The Committee are of the view that regulating construction activities in GLOF/LLOF prone areas will go a long way in averting disasters and saving precious human lives. They, therefore, recommend that as suggested by the NDMA, the Department of WR, RD&GR should constitute a Committee to formulate specific land use zoning and building construction regulations expeditiously. They also recommend that the Department of WR, RD&GR should work in close coordination with BIS, so that NBC norms are adhered to strictly by all the people while constructing buildings in the region. The Committee would like to be apprised of the steps taken by the Department in this regard within three months of the presentation of this Report.

Reply of the Government

The Department of Water Resources, RD &GR has formulated "National Framework for Sediment Management (NFSM) which was launched by the Hon'ble Minister for Jal Shakti during the 1st All India Annual State Ministers Conference on Water held in Bhopal, Madhya Pradesh on 5th – 6th January 2023. The NFSM is available on the website of the Ministry for reference.

Indian Institute of Technology Roorkee (IIT, Roorkee) and the Water Resources Department, Bureau of Indian Standards (BIS), New Delhi, jointly organized a National Hybrid Seminar on "Glacial Lake Outburst Floods (GLOFs) and Landslide Lake Outburst Floods (LLOFs) Disasters in Himalayan Regions" on June, 2022, at IIT Roorkee. The seminar provided an opportunity for the exchange of ideas and knowledge between diverse groups of the scientific community concerned with the current issues related to Glacial and landslide lake outburst flood-related hazards and the development of standard codes for its mapping and modeling.

BIS is an apex organization in the field of National Standardization which is carried out through 16 Division Councils covering various areas of Standardization. Water Resources Department is one of such 17 Departments in BIS, and it deals with standardization and standards formulation in the area related to River Valley Projects and Ground Water. A committee has been formed in BIS on GLOF related matters.

Water Resources Division Council chaired by Chairman CWC in its 21st meeting on 6th March 2023 agreed to constitute a new Sectional Committee on the subject "GLOFs and LLOFs" and requested BIS to constitute Search Committee to define and propose the scope of the newly constituted Sectional Committee on Glacial Lakes Outburst Floods (GLOFs) and Landslides Lakes Outburst Floods (LLOFs).

In this direction, a Search Committee was constituted by BIS and the first meeting was held on 12 July 2023 to discuss scope and composition of the constituted Sectional Committee.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

Comment of the Committee
(Please see Para No. 20 of Chapter I of the Report)

RECOMMENDATION NO.-13 (Para No. 2.15)

Need to strengthen functioning of National Disaster Response Force (NDRF)

The Committee note that NDRF is specialized rescue and response force mandated to respond to national and man-made disasters. However, they were apprised of the fact that heavy equipments like earthmovers/ heavy drilling machines/ JCBs etc, do not form part of the equipment profile of NDRF and these equipments are provided by the local authorities with handlers at the incident site. Further, NDRF is also not equipped with modern muck cleaning instruments/equipments to deal with emergent situations such as the one that arose in Chamoli District in the State of Uttarakhand in the month of February 2021. The Committee are surprised to learn from the deposition of the representative of the NDRF that though roads were fine there was considerable delay on the part of rescue team in reaching the site at Reni in Chamoli District Uttarakhand where the disaster took place on 7th February, 2021, because of distance. The Committee note that there is no dedicated air craft service available with NDRF for airlifting NDRF personnel and they are dependent on IAF/ private choppers provided by the States.

The Committee find that notwithstanding the fact that NDRF is a specialized rescue and response force, however, the constraints / problems such as mentioned above are required

to be removed as they hamper the rescue efforts of NDRF at critical times. Since the State Governments many a time lack specialized skills and resources required to deal with the different kind of calamities either natural or man-made, so, reliance of NDRF on the State Governments on delivery of various kinds of equipments may not serve the purpose and even may hamper the timely and much needed rescue operations. The Committee are of the view that instead of depending on State Governments, it would be more advisable for NDRF to have its own dedicated inventory of modern search and rescue equipment. Further, for ensuring timely arrival of NDRF rescue teams at disaster struck locations and avert delays as witnessed in Chamoli incident, it should have its own fleet of aircraft and should not be dependent on the IAF/State Governments to provide choppers. Besides, recognizing the role of local community as a first responder during any calamity, the Committee feel that the NDRF should organize extensive training programmes for local people in all States in general and in particular for the States which are more vulnerable to natural calamities. The Committee are of the view that NDRF should work closely with the States and render them all possible assistance in raising and training their State Disaster Response Teams. The Committee urge upon the Department of Water Resources, River Development & Ganga Rejuvenation to take up the above-mentioned suggestions with the Ministry of Home Affairs/NDMA to streamline the working of NDRF.

Reply of the Government

National Disaster Response Force (NDRF) has been authorized 315 different kinds of equipment by GoI since its raising for attending various disasters. The equipment profile is presently in the process of upgradation/ review to meet the latest technology available world-wide for enhancing operational efficiency. This is a constant process.

However, heavy equipment like earth movers/ heavy drilling machines/ JCBs have not been consciously kept part of the inventory as these would be difficult to maintain on account of rare use and also cumbersome to carry at large distances thereby hampering quick movement of teams. Hence, it is desirable that such equipment are worked out for specific contingency requirements and catered for by the district administration. Further, details of all such equipment are required to be updated on the web based India Disaster Resource Network (IDRN) for identification at the time of occurrence of disaster.

Under the present organizational set-up of NDRF, it is not feasible to maintain a dedicated fleet of aircraft which entails a huge paraphrenalia of manpower and resources. It is felt that the present arrangement of making air requisition to IDS and IAF through MHA is working very well and actions are well coordinated at all levels to ensure rapid deployment.

To improve upon the present system, it is proposed that more helipads may be identified in vulnerable areas for landing of bigger helicopters like MI-17 which can carry more number of Rescuers with equipment in a single sortie and operate in harsh weather conditions as well. Further, airlifting of NDRF Rescuers in case of mountain rescue and forest fire by IAF may be catered for. Besides, Airforce aviation may be made available for training exercise of NDRF personnel in mountain rescue and forest fire.

NDRF is regularly organizing extensive Disaster Management training programmes for local people, community volunteers, School staff/students & other stakeholders as per vulnerability profile by conducting following programmes:-

6. Community Awareness Program (CAP)
7. School Safety Program (SSP)
8. DM training for SDRFs, Community volunteers i.e. JNVs, Nehru Yuva Kendra Sangathan (NYKS), AapdaMitra, National Cadet Corps (NCC), National Service Scheme (NSS), AkhilBhartiyaTerapanthYuvakParishad (ABTYP) & other stakeholders.
9. Mock Exercises on various themes as per vulnerability profile.
10. Promotion of weather-based Govt. forecast application (06) apps.

The details of personnel trained by NDRF since its raising is mentioned below:

SN	Event	No of Beneficiary
1	CAP	59,90,048
2	SSP	15,76,469
3	MEx	15,44,371
4	NCC	31,865
5	AapdaMitra	24,834
6	NYKS	12,345
7	JNVs	68,416
8	ABTYP	559

NDRF is now developing e-content for imparting DM training to NSS Volunteers so as to expand the awareness level.

c. Training:

- NDRF is working closely with States/ UTs for capacity building of State Disaster Response Force.
- NDRF conducts Basic Disaster Management Course for SDRFs at NDRF BNs as per their area of responsibility.
- So far, NDRF has trained 22,371 personnel (Basic-19,830 & Advance- 2,541). Apart from this **252** (Chhattisgarh- 53, Bihar- 79 & Gujarat – 120) personnel are undergoing training in Basic DM Course.
- NDRF circulates Annual Training Calendar (Advance Courses) every year for SDRFs.
- In 2023, following courses are planned for SDRF (Details enclosed as Appendix-A):-
  vii. Training of Trainers of Chemical, Biological, Radiological and Nuclear(TOT CBRN)
  viii. Master Trainers in Chemical, Biological, Radiological and Nuclear(MT in CBRN)
  ix. Training of Trainers in Medical First Response and Collapsed Structure Search & Rescue(TOT in MFR & CSSR)
  x. Master Trainers in Medical First Response and Collapsed Structure Search & Rescue(MT in MFR & CSSR)
  xi. Borewell Rescue Course
  xii. Training of Trainers Cadre(TOT CADRE)

d. Raising:

- NDRF is constantly in touch with States/ UTs, where SDRF not yet raised.
- NDRF Unit Commandants remain in coordination with the authorities of States/ UTs and provide them all needful assistance.

- Recently NDRF has assisted A&N authorities for raising of SDRFs in terms of equipping, training and deployment.
- A “Vision Document” has been prepared by NDRF for SDRFs covering all important aspects reg. vulnerability, infrastructure development, HR strength, training, equipping, deployment & future vision for States. This document is helping the SDRFs as guide tool in capacity building.

It is felt that the raising, training and equipping of SDRFs needs to be taken up in a timeline under the supervision of the SDMAs so that they are in a position to take up L1 & L2 disasters on their own and NDRF can focus on developing specialized skills.

Appendix-

ADVANCE COURSES PLANNED FOR SDRFs IN TRAININGCALENDARFORTHEYEAR-2023

S/N	AME OFTHE COURSE	BOREWELL Rescue	MT inMFR &CSSR	TOTCBRN	TOTCADRE	ToTin MFR&CSSR	TOTCBRN	ToTin MFR&CSSR	BOREWELL Rescue	MT in MFR&CSSR	TOTCADRE	MT in MFR&CSSR	TOTCADRE	ToTin MFR&CSSR	BOREWELL Rescue	BOREWELL Rescue	ToT inMFR &CSSR	MT inCBRN	BOREWELL Rescue
	Duration (Weeks)	03days	01 Week	04Weeks	01 Week	05Weeks	04Weeks	05Weeks	03days	01 Week	01 Week	01 Week	01 Week	05Weeks	03days	03days	05Weeks	02Weeks	03days
	Schedule	09.01.23 to 11.01.23	06.02.23 to 11.02.23	20.02.23 to 18.03.23	20.02.23 to 04.03.23	27.02.23 to 01.04.23	01/05/23 to 27/05/23	01/05/23 to 03/06/23	08/05/23 to 10/05/23	08/05/23 to 13/05/23	19/06/23 to 24/06/23	10/07/23 to 15/07/23	21/08/23 to 26/08/23	04/09/23 to 07/10/23	04/09/23 to 06/09/23	09/10/23 to 11/10/23	06/11/23 to09/12/23	04/12/23 to16/12/22	18/12/23 to 20/12/23
	Institute	10TH BNNDRF	NDRF, Academy	05 BNNDRF	NDRF, Academy	07TH BNNDRF	05 BNNDRF	07TH BNNDRF	10TH BNNDRF	NDRF, Academy	NDRF, Academy	NDRF, Academy	NDRF, Academy	07TH BNNDRF	06THBNNDRF	10TH BNNDRF	07TH BNNDRF	05THBNNDRF	05TH BNNDRF
1.	WestBengal	-	-	-	-	-	-	6	-	-	7	5	-	5	4		5	-	-
2.	Uttarakhand	6	2	3	0	3	1	-	-	-	-	-	-	-	-	-	-	2	-
3.	Rajasthan						-	-	7	8	-	-	-	-	-	-	-	8	-
4.	Maharashtra	2	6	4	4	6	6	6	4	6	6	6	6	6	6	6	6	4	6
5.	Jammu& Kashmir	0	2	2	2	2	2	2	-	2	2	2	2	2	-	-	2	2	-
6.	Punjab	2	-	-	-	-	-	-	4	-	-	-	-	-	5	-	-	-	5
7.	Bihar	2	-	5	5	5	-	3	-	-	3	-	-	3	-	-	3	-	-
8.	Himachal Pradesh	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

9.	Tamilnadu	2	5	4	2	5	5	5	3	-	-	3	5	5	-	5	5	3	-
10.	Andhra Pradesh	-	-	-	-	-	10	10	7	9	10	10	10	12	10	13	12	7	13
11.	Karnataka	2	5	5	2	2	9	1	4	4	1	2	6	-	4	5	-	3	5
12.	Uttar Pradesh	10	5	10	10	10	-	-	-	-	-	4	3	6	3	2	6	4	3
13.	Tripura	-	-	-	-	-	-	-	1	1	2	-	1	-	1	2	-	-	1
14.	Assam	4	4	4	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	Arunachal Pradesh	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	Jharkhand	4	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Haryana	3	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-
18.	Ladakh	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
19.	A&N	-	2	-	2	-	-	-	-	-	--	-	-	-	-	-	-	-	-
Total Allotment		42	42	50	42	50	36	40	33	33	34	35	36	42	36	36	42	36	36

- Totalallotment-701Seatsareallotted

<u>Comment of the Committee</u>
(Please see Para No. 23 of Chapter I of the Report)

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-14 (Para No. 2.16)

Need for both Union and States to work in tandem

The Committee observe that though a revised National Disaster Management Plan has been prepared for addressing the disasters likely to happen in Himalayan region like landslides, cloudburst, GLOF etc., no specific Disaster Management (DM) Plan has been prepared by the NDMA for the Himalayan States, though the State of Uttrakhand has developed its own State Disaster Management Plan (SDMP) and the updation of the same is in progress. Further, the Committee note that no manual and Standard Operating Procedure (SOP) has been developed by NDMA to deal with the emergent situations arising out of floods including flash floods Cloudburst, Glacier Outburst and Avalanches. It has been informed by NDMA that only guidelines in respect of the subjects viz. disaster management for Management of floods (2008), Urban floods (2008), Glacial Lake Outburst and Floods (GLOFs) (2020) & Landslide & Snow Avalanche (2009) have been prepared and issued defining the roles, responsibilities of different Ministries & States, while the SOPs & Manuals to tackle hazards/ disaster are to be prepared by the concerned nodal agencies.The Committee are of the view that preparation of guidelines by NDMA with regard to various calamities is a welcome step, but the need of the hour is that it should be ensured that these guidelines are implemented in true spirit and in the right earnest by all the concerned stakeholders at the ground level. The Committee are of the considered opinion that it is high time that role of State Governments particularly in the Indian Himalayan Region need to be adequately recognized and they should be made active partners and engaged proactively in monitoring and research of glaciers and issuance of warning in the wake of disasters. Thus, the Union Ministries/Department should work in close cooperation and coordination with the State Governments in order to strengthen their efficacy, capacity building and implementation of the SDMP. The Committee also urge upon the Ministry of Home Affairs/NDMA to improve and streamline their functioning and tone up their Disaster Management Apparatus, so as to anticipate and provide quick response to the impending glacier related and other disasters in the Himalayan region.

Reply of the Government

In order to to improve and streamline the functioning of NDMA and tone up their Disaster Management Apparatus, so as to anticipate and provide quick response to the impending glacier related and other disasters in the Himalayan region, several initiatives as mentioned below have been taken-.

(i) National Disaster Management Authority (NDMA) prepared the revised National Disaster Management Plan (NDMP)-2019 as per provisions under the Disaster Management (DM) Act, 2005. Further, State Disaster Management Plan (SDMP) is to be prepared by the State Executive Committee (SEC) and shall be approved by the State Authority. Therefore, NDMA is not required to prepare State Disaster Management Plan (SDMP).

(ii) As per the provisions under the DM Act, 2005 NDMA already prepared Guidelines on management of disasters like floods, Glacial Lake Outbursts etc. However, manual and Standard Operating Procedures (SOP) are to be prepared by the concerned stakeholders taking into account the Guidelines issued by NDMA.

(iii) Members and Officers of NDMA visit States/UTs from time to time and interact with them to ensure that these guidelines are implemented at ground level. The same is also reiterated during various Regional conclaves, Workshops, Seminars, Review meetings etc.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.-15 (Para No. 2.17)

Public Awareness Programme

The Committee are pleased to note that various Government Departments/Agencies have taken a number of steps to educate and empower people in environment conservation and adoption of sustainable practices through trainings, demonstrations and dissemination of information in the Indian Himalayan Region. The Committee expect that the various training programmes initiated by the Ministry should not be a one time affair but should be sustained and held at regular intervals so that the momentum generated by these Programmes remains intact and do not lose the steam. It is not an exaggeration to mention that the natural calamities caused by climate change will exacerbate the livelihoods of the communities residing in mountains as well as downstream populations. Hence, there is a greater need not only to make people aware about the deleterious impact of global warming particularly in the Himalayan region but also launch programmes to impart knowledge and encourage them in adopting environmentally sustainable practices and support the local participatory planning for the development of this sensitive region. The Committee recommend that the Department should make all out efforts to launch a blitzkreig by involving print, electronic and popular media as well as social media and also the academia on a larger scale in creating public awareness about the consequences of global warming resulting in threat to the ecosystem, communities and infrastructure.

Reply of the Government

Various Organisations/ Departments regularly conduct training Programmes to impart knowledge and encourage stake holders in adopting environmentally sustainable practices in the emerging challenges of climate change and its impact on glaciers. For glacier monitoring and management, different kinds of capacities, including scientific, management, engineering and institutional skills are required. A comprehensive training in the understanding of natural processes and their complex interactions in glaciated high-mountain regions is required, including knowledge of the past and future developments at different temporal scales. Local mountain communities are not much aware about glacier hazard and its disastrous effects. Electronic and print media including social media will also be useful in the endeavour to create greater public awareness about climate change and related environmental issues. Some of the initiatives taken in this direction are-

WIHG is already involved in creating public awareness about different hazards in the Himalaya-Karakoram through lectures and mock drills at various public schools, colleges and vulnerable villages. Apart from this, WIHG encourages the visit of students from various

schools to its museum and laboratories to understand the orogeny of the Himalaya and related processes and hazards. A large number of master's students are also being trained and made aware of Himalayan Geology, Glaciers and related hazards through dissertations, summer and winter trainings.

MoEF&CC through its Environment Education Division Implements Environment Education Programme (EEP) under Environment Education Awareness, Research and Skill Development (EEARSD) Scheme to sensitize children/ youth, on issues related to environment and to motivate them to adopt sustainable lifestyle, through varied pedagogical initiatives like workshops, projects, exhibitions, campaigns, competitions, nature camps, summer vacation programmes, etc. This programme leverages on the key sectoral strength of Eco-clubs already formed under National Green Corps programme, in addition to targeting Youth Clubs and other such clubs/ units/groups formed under various programmes/ schemes of the Government. In addition, GBPNIHE has also been actively engaged in organizing public awareness programmes across the Himalayan States/UTs. These initiatives are also being synergized with the Mission Lifestyle for Environment (LiFE)."

List of Centre of Excellences under NMSHE and NMSKCC set-up by DST

S. No.	Title of the project	Name and address of PI	Mission
1	Vulnerability and Risk Assessment due to various Environmental drivers in a Climate Change Scenario over eastern India	Indian Institute of Technology (IIT), Kharagpur	NMSKCC
2	Mahamana Centre of Excellence in Climate Change Research	Institute of Environment & Sustainable Development, Banaras Hindu University	NMSKCC
3	DST's Centre of Excellence in Climate Modeling	IIT, New Delhi	NMSKCC
4	Centre of Excellence for Climate Change and vector borne diseases	National Institute of Malaria Research, New Delhi	NMSKCC
5	DST-Centre of Excellence in Climate Studies,	IIT, Bombay	NMSKCC
6	Climate Change Impacts on Coastal Infrastructure and the Adaptation Strategies	IIT, Madaras	NMSKCC
7	DST-ICRISAT Centre of Excellence on Climate Change Research for Plant Protection (CoE-CCRPP): Pest and disease management for climate change adaptation	International Crops Research Institute for the Semi-Arid Tropics, Telangana	NMSKCC
8	Strengthening the Existing Centre of Excellence in Climate Change: Divecha Centre for Climate Change	Prof. S.K. Satheesh, Divecha Centre for Climate Change, Indian Institute of Science, Bengaluru-560012, Karnataka State.	NMSKCC

9	Climate change impact mitigation for a climate resilient habitat	Dept. of Environmental Science, Tezpur University	NMSHE
10	Centre for Excellence in Climate Change	Department Earth Sciences, University of Kashmir, Hazratbal Srinagar, Jammu and Kashmir	NMSHE
11	DST's Centre of excellence on Water resources, Cryosphere and climate Change studies	Sikkim University, Gangtok, Sikkim	NMSHE
12	DST Centre of Excellence CoE on Climate Change Research DST-CoE-CCR	CSIR- NEERI, Nagpur, Maharashtra	NMSKCC

DGRE is imparting the awareness training on snow and avalanches to the Indian army, paramilitary forces, BRO etc. through various print and electronic media. The similar awareness programmes may be conducted for civil population residing in snow bound mountainous regions. Also an international training on mountain geohazard management was conducted in 2022 by DGRE, the similar training programmes be conducted in future to spread awareness in the society.

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

CHAPTER III

RECOMMENDATIONS/OBSERVATIONS WHICH THE COMMITTEE DO NOT DESIRE TO PURSUE IN VIEW OF THE GOVERNMENT'S REPLIES

NIL

CHAPTER IV

RECOMMENDATIONS/OBSERVATIONS IN RESPECT OF WHICH REPLIES OF THE GOVERNMENT HAVE NOT BEEN ACCEPTED BYTHE COMMITTEE

RECOMMENDATION NO. 1 (Para No. 2.3)

Need to check emission of Black Carbon

The Committee learn that very few studies have been conducted by different organizations/ institutes in the country to assess the adverse effects of atmospheric pollution on the Himalayan glaciers. A study conducted by National Centre for Polar and Ocean Research and Space Physics Laboratory at their Himansh station in Lahaul-Spiti region have revealed that the total Suspended Particulate Matter (SPM) showed significant variations with dominance of mineral dust components therein (~67%). It has also been stated that the black carbon reportedly contributes (~4%) to near surface composite aerosol mass concentrations and also absorbs more light and emits infra-red radiation that increases the temperature. Hence, an increase in Black Carbon in the high Himalayas is stated to contribute to the faster melting of glaciers. The Committee recommend that with a view to assess the extent and scope of adverse impact of atmospheric pollution including black carbon on the fragile and sensitive Himalayan glacier system, the Department of Water Resources, River Development & Ganga Rejuvenation in consultation with the Ministry of Environment, Forest & Climate Change and other concerned Ministries/Departments/Agencies should commission a research work/project for comprehensive examination of this aspect and submit the research findings within a time-bound period.

Reply of the Government

Black carbon (B.C.) aerosols accelerate glacier melting in the Himalayas. Black materials absorb more light and emit infrared radiation that increases the temperature. So, an increase in black carbon in the high Himalayas will contribute to the faster melting of Himalayan glaciers. National Centre for Polar and Ocean Research (NCPOR) has informed that several studies in the Himalayan region have focused on observations and the character of B.C. particles in the ambient air. However, though there are many B.C. observatories in low altitudes (<2000 masl) and the plains, only a few studies have characterized B.C. at high altitudes in the Himalayas, particularly in India. The deposition of light-absorbing aerosols on snow or ice can lead to the darkening of the surface, which would enhance the absorption of solar radiation and significantly reduce the surface albedo. Such phenomena could result in positive forcing that can accelerate snow and ice melt in high altitudes. One of the measurements in the high Himalayan glacier (Chandra) basin shows a significant concentration of B.C. (mean BC ~ 168 ng m^{-3}). It contributes nearly 4% to near surface composite aerosol mass. A recent study shows that the concentration of black carbon increases in summer(0.01-4.62 µg / m^3) drastically. However, in the foothill, the black carbon concentration is much higher 796 µg / m^3 (Parbati), 416 µg / m^3 (Hamata) and 432 µg / m^3 (Beas). A multi-layer simulation of snow albedo demonstrated significant changes in snow albedo (2.5–9.0%) due to light-absorbing aerosols in this region. In the long

run, changes in the atmospheric composition of the high Himalayas will affect rain and snow precipitation patterns. However, the sources of B.C. reaching in the Himalayan region are complex and remain uncertain due to a lack of field and reliable data.

WIHG has two (02) observational sites for black carbon monitoring near the glacierized basins (Gangotri Glacier). Further, WIHG is also looking at aerosols and dust in the snow and ice samples from glacier sites to understand their impact on snow and glacier melting and albedo changes.

Comment of the Committee
(Please see Para No. 8 of Chapter I of the Report)

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.3 (Para No. 2.5)

Need to set up separate Dedicated Mountain Hazard and Research Institute

The Committee observe gaps and deficiencies in glaciology research and monitoring of the glacial lakes and water Bodies in the Himalayan region. The Committee note that Geological Survey of India (GSI) has not conducted specific studies on estimated volume loss of glaciers between 1950 and 2020 and also not projected any estimate of loss by the year 2100. Further, there is no comprehensive information about the volume loss of glaciers in the Indian Himalayan Region. The Committee further note that the Ministry of Environment, Forest & Climate Change has not conducted any study or awarded any project on warming of Himalayan glaciers. The Committee were informed by the DoWR, RD & GR that Central Water Commission (CWC) has not issued any advisory to the concerned local Governments regarding the anticipation of floods caused by avalanches/cloudburst landslides in the Himalayan region. Further, there is also no specific information available on stretches of the Himalayans where the danger of melting of glaciers and consequent GLOF are most severe. Moreover, no study on temporal changes in glacial lake number and their extent has been carried out by Indian Space Research Organization (ISRO) and GSI. The Committee also took cognizance of the fact that no study has been carried out by GSI, ISRO and DST to critically analyse the enlargement and origin of glacial lakes near human settlements and their potential cause for a lake outburst.

Taking into consideration the aforestated gaps / deficiencies in the glaciological, hydro-materiological and hydro-geological research relating to Himalayan glacier system, the Committee are of the considered view that there is an need for setting up an over arching organisation at the national level which can coordinate with various Ministries / Departments / Agencies/ Research Institutes engaged in handling different hydro-geological and hydro-materiological hazards including glacier related hazards for having an integrated approach in collecting and collating information / data on Himalayan glaciers and also the research findings at one place and to maintain a reliable database that can be accessed easily by all agencies and also for issuing early warnings and alerts regarding potential multi hazards to the stake holders and public. In this regard, at the behest of the Committee, various

Ministries/ Departments/ research agencies have given their suggestions and offered solutions for effective management and monitoring of glaciers in the country in a coordinated manner as under:-

(i) The Department of Science and Technology has suggested that there is a need for single coordinating agency to coordinate with various other agencies having mandates to handle different hydrometerological and hydrogeological hazards. It has also suggested that to deal with the disasters like cloudburst, GLOF, landslides etc. in an integrated manner, a multi hazard warning system may be put in place through a real-time coordinating mechanism wherein one agency may be entrusted with the responsibility of continuously monitoring and issuing warnings and alerts to authorities, stakeholders and public;

(ii) The MoEF&CC has suggested that the responsibility for coordination of all activities on the Himalayan glaciers should rest with a single identified nodal coordinating agency within Government of India, such as for e.g. National Security Council Secretariat (NSCS), which is already coordinating with various Government agencies in various studies, including impact of engineering technologies on the glaciers. Such an agency would need to be given an appropriate war time mandate because of recurrence of GLOF, Cloudburst, landslides etc. by allocating the subject through allocation of business.

(iii) The Ministry of Earth Sciences has suggested that a network of fully equipped and integrated monitoring systems supported by a set of field stations in critically important glaciered basins is required for monitoring glaciers and glacier bound hazards. The systems should be automated with real-time access to data to modelers to create a potential early warning system on glacio-hydrological hazards from time to time, based on hazard potential coupled with geographical information system tools downstream activities and population vulnerability along with open access to ground-based meteorological, hydrological and glacilogical data from the entire region to achieve the target. ISRO can contribute by using high resolution and near real time satellite remote sensing to monitor glacial lake and water bodies in development of a reliable database.

(i) Defence Geoinformatics Research Establishment set up under agegis of DRDO has suggested that an integrated approach for debris flow and GLOF risk management coupled with systematic risk assessment study of the region is imperative to curtail risks of glacial hazards. An inclusive approach with all stakeholders is recommended to understand GLOF phenomenal behaviour by creating ground and remote sensing based inventory of benchmark moraine dammed lakes and monitoring changes on a regular basis along with an

effective early warning mechanism to monitor GLOF hazards in order to minimize the risk of such hazards.

Apart from above suggestions / solutions offered by various Ministries/Departments/organisations, the NDMA "Guidelines on Management of Glacial Lake Outburst Flood (GLOF)" has proposed that the Ministry of Jal Shakti (MoJS) be designated as the nodal Ministry and Central Water Commission (CWC) as the nodal agency for management of GLOF. These Guidelines further propose that a national level Centre for Glacial Research, Studies and Management (CGRSM) be established by the MoJS under the umbrella of the National Institute of Hydrology (NIH), Roorkee as a premier centre with state-of-the art facilities, which would eventually grow into a national centre of excellence. Keeping in view the suggestions / solutions offered by various Ministries / Departments / Agencies, the Committee urge upon the Department of WR, RD&GR to carefully study the same and prepare a comprehensive concept paper / cabinet note subsuming the solutions/suggestions in consultation with all the Ministries / Departments / Agencies, so as to evolve a consensus on the structure mandate and modalities of the proposed national level apex research organisation viz. CGRSM for placing before the Union Cabinet for their consideration. The Committee would like to be apprised of the action taken in this regard within three months of presentation of the Report.

Reply of the Government

A Steering Committee under the chairmanship of Secretary, DOWR, RD & GR, Ministry of Jal Shakti has recently been formed to look into all these issues. The Steering Committee would act as an over arching organisation at the national level which can coordinate with various Ministries / Departments / Agencies/ Research Institutes engaged in handling different hydro-geological and hydro-meteriological hazards including glacier related hazards for having an integrated approach in collecting and collating information / data on Himalayan glaciers and also the research findings at one place and to maintain a reliable database that can be accessed easily by all agencies and also for issuing early warnings and alerts regarding potential multi hazards to the stake holders and public.

Comment of the Committee
(Please see Para No. 11 of Chapter I of the Report)

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO. 4 (Para No. 2.6)

Need to provide sufficient budgetary allocations for Glacier Research

The Committee learn from the written submission of the Department of Water Resources, River Development & Ganga Rejuvenation that various Ministries/Departments dealing with the subject of glacier management / monitoring have allocated and spent a

meagre amount for conducting research/studies in the field in the last 5 years. While on the one hand, the Committee find that studies such as temporal change in glacier origin and enlargement of glacier area are required for proper assessment and management of glaciers, on the other hand, the fund allocation is not sufficient to encourage such studies. The Committee believe that there is an urgent need to conduct various field-based studies on glaciers which may need adequate funding/budgetary support. As the challenges of managing and monitoring the glaciers movement / behaviour and mitigation of hazards arising therefrom are enormous, the Committee recommend the Government to allocate adequate budgetary resources to the concerned Ministries/Departments involved in the research in the field so as to meet their financial requirements and for ensuring that the activities related to research and monitoring of glaciers do not suffer due to shortage of funds.

Reply of the Government

As suggested by Committee, there is need to provide sufficient budgetary allocations for glacier research, to the concerned Ministries/ Departments. This is important as the study of Glaciers, its dynamics and associated hazards have implications on sustainable development, disaster risk reduction and strategizing climate change adaptation measures. The budgetary support for carrying out studies has to be met through allocated budgets to different Organisations/Department.

Any requirement of additional funds for carrying out any specific studies in the field of glacier monitoring and management by the concerned Institutions may be placed before the Steering Committee which in turn would request for enhancement of budget to specific Department/Organisations.

In above context, MoES has informed that in view of the importance of glacier research in the country, an amount of ~ Rs. 30 crore has been earmarked for it by the Ministry of Earth Sciences during 2021-2026.

Comment of the Committee
(Please see Para No. 14 of Chapter I of the Report)

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

RECOMMENDATION NO.- 11 (Para No. 2.13)

Considering the strategic role and paramount importance of Himalayan glaciers which are literally known as “Water Towers of Asia” and owing to the fact that three major Indian river system are glacier fed which provide water security to the country for various uses like drinking water requirements, hydropower, industry, agriculture etc., the Committee are of the considered view that since green cover in the valleys adjacent to the glaciers is critical and acts as a buffer and would help in reducing the impact of climate change, the same should be protected / conserved. For this purpose, the Committee urge upon the

Department of Water Resources, River Development & Ganga Rejuvenation to work in close cooperation with the Ministry of Environment, Forest & Climate Change and other concerned Ministries for evolving a comprehensive policy response so as to preserve the sensitive Himalayan glacier system.

Reply of the Government

The Steering Committee for Monitoring of Glaciers under the chairmanship of Secretary, DoWR, RD& GR has been constituted with an aim to develop a coordination mechanism among various ministries (viz., Ministries of Jal Shakti; Environment, Forest & Climate Change, Department of Space, Ministry of Earth Sciences, Ministry of Mines and Department of Science and Technology etc.) for efficient mobilization of resources for glacier related studies.

Comment of the Committee
(Please see Para No. 17 of Chapter I of the Report)

(O.M. NO. Z-17013/1/2022-FM dated 01.08.2023)

CHAPTER V

OBSERVATION/RECOMMENDATION IN REPSECT OF WHICH FINAL REPLY OF THE GOVERNMENT IS STILL AWAITED

NIL

NEW DELHI
06 December, 2023
15 Agrahayana,1945 (Saka)

Shri Parbatbhai Savabhai Patel
Chairperson,
Standing Committee on Water Resources

ANNEXURE – II

[Vide Para 4 of the Introduction]

ANALYSIS OF ACTION TAKEN BY THE GOVERNMENT ON THE RECOMMENDATIONS/OBSERVATIONS CONTAINED IN THE TWENTY THIRD REPORT (SEVENTEENTH LOK SABHA) OF THE COMMITTEE

(i)	Total number of Recommendations/Observations	15
(ii)	Recommendation/Observations which have been accepted by the Government Recommendation Nos. 2,5,6,7,8,9,10,12,13,14 and 15	 Total – 11 Percentage– 73.33 %
(iii)	Recommendations/Observations which the Committee do not desire to pursue in view of the Government's replies Recommendation Nos. NIL	 Total – 00 Percentage – Nil
(iv)	Recommendations/Observations in respect of which replies of the Government have not been accepted by the Committee Recommendation Nos. Recommendation Nos. 1,3, 4 and 11	 Total – 4 Percentage – 26.66%
(v)	Recommendation/Observation in respect of which final reply of the Government is still awaited Para Nos. NIL	 Total – 00 Percentage – Nil

Annexure-III

Office Order of Constitution of Steering Committee

TE-16019/2/2023-E-II-MOWR

'81451/2023

No. TE-16019/2/2023-E-II-MOWR
Government of India
Ministry of Jal Shakti
Department of Water Resources, RD & GR

Shram Shakti Bhawan, Rafi Marg,
New Delhi, 09-03-2023

OFFICE ORDER

Subject: Constitution of Steering Committee for Monitoring of Glaciers.

Consequent upon approval of competent authority of Department of Water Resources, River Development & Ganga Rejuvenation, a Steering Committee is constituted for monitoring of glaciers.

2. The composition and terms of reference of the committee are given below:

Composition

S.No.	Designation & Addresses of Office held by the Members	Status
1.	Secretary, DoWR, RD & GR, Ministry of Jal Shakti, Govt. of India	Chairman
2.	Special Secretary, DoWR, RD & GR, Ministry of Jal Shakti, Govt. of India	Member
3.	Chairman, Central Water Commission (CWC), New Delhi	Member
4.	Chairman, Central Ground Water Board (CGWB), Faridabad, Haryana	Member
5.	Director, National Institute of Hydrology (NIH), Roorkee	Member
6.	Director, National Remote Sensing Centre, Hyderabad	Member
7.	Director, Indian Institute of Remote Sensing, 4 Kalidas Road, Dehradun	Member
8.	Director, Wadia Institute of Himalayan Geology 33, General Mahadev Singh Rd, Sewla Kalan, Majra, Dehradun	Member
9.	Commissioner, Indus, DOWR, RD & GR, Ministry of Jal Shakti	Member
10.	Commissioner, B&B, DOWR, RD & GR, Ministry of Jal Shakti	Member
11.	Prof. Shakil A Romshoo, (former Professor, Dept. of Earth Sciences, Kashmir University) Vice Chancellor, Islamic University of Sciences and Tech. Srinagar, J&K	Member
12.	Director, Defence Geo-informatics Research Establishment, Chandigarh (Earlier SASE)	Member
13.	Dr. Vijay Kumar, Scientist G, Ministry of Earth Sciences, New Delhi	Member
14.	Chief Engineer, Morphology & Climate Change Directorate Central Water Commission, R.K. Puram, New Delhi	Member
15.	Dr Sanjay K Jain, Scientist G, National Institute of Hydrology, Roorkee	Member
16.	Dr. S. S. Randhawa, Principal Scientist Officer, Himachal Pradesh Council for Science, Tech. & Env., Vigyan	Member

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	Bhawan, Shimla	
17.	Er. Kireet Kumar, Sc-G & Nodal Officer, NMHS, Govind Ballabh Pant 'National Institute of Himalayan, Environment' (NIHE), MoEF &CC	Member
18.	Dr. Nisha Mendiratta, Scientist, G and Advisor, DST, New Delhi	Member
19.	Representative not below the rank of Director from Geological Survey of India	Member
20.	Technical Expert Disaster Risk Management, SCA Himalayas project, SDC, Department of Science and Technology, Government of Sikkim, Vigyan Bhawan, Deorali, Sikkim	Member

Terms of Reference

i. To initiate systematic mapping of glaciers/glacial lakes, monitoring glacial changes/melting and glacial lake outburst floods.

ii. To consolidate the glacier and glacial lake information collected by different agencies of the Government and make it available on GIS based web-portal.

iii. To develop a coordination mechanism among various ministries (viz., Ministries of Jal Shakti; Environment, Forest & Climate Change, Department of Space, Ministry of Earth Sciences, Ministry of Mines and Department of Science and Technology etc.) for efficient mobilization of resources for glacier related studies.

iv. To help building bridges among other research groups and academia for studies on glaciers.

v. To develop trends and predictions for behaviour of Himalayan glaciers in the context of climate change and their likely impact on hydrology.

vi. To develop capacity through workshops, awareness and trainings programs on snow and glacier aspects.

3. The expenditure towards servicing of the Committee may be borne by NIH out of the grants-in-aid released to NIH by DoWR, RD & GR. The Committee will meet quarterly to advise and review the progress on the methodologies suggested for monitoring of glaciers.

Signed by Vinod Kumar Gupta
Date: 09-03-2023 10:18:58

(Vinod Kumar Gupta)
Under Secretary to the Government of India
Tel.No. 011-23711946

To

The Director, NIH for circulation of the order among the Chairman and Members of the Committee

Copy for information to:

Annexure-IV

Minutes of first Meeting of Steering Committee

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Minutes of the 1st Meeting of the Steering Committee for "Monitoring of Glaciers" held on 02 May, 2023 at National Institute of Hydrology, Roorkee

The 1st meeting of the Steering Committee for Monitoring of Glaciers was held in the National Institute of Hydrology, Roorkee on May 02, 2023. The meeting was chaired by Shri Pankaj Kumar, Secretary, WR, RD & GR, Ministry of Jal Shakti, Govt. of India. The list of the participating members is annexed.

2. Dr. Sudhir Kumar, Director, NIH welcomed all the members. He informed that a 'Centre for Cryosphere and Climate Change Studies' has recently been established at NIH. The Centre will look after the various studies related to snow/glacier. This Centre will coordinate and collaborate with other organisations working in the field of snow/glacier.

3. Chairman, in his opening remarks,emphasized on the importance of cryosphere and climate change studies in view of the need to assess the impact of climate change on Indus, Ganges and Brahmaputra system of rivers and also extreme events associated with hazards like flash floods, cloud bursts, etc. in the Himalayan region. The Centre is designed as a Nodal Centre for better coordination amongst the organizations/agencies working in the field of snow and glaciers to help develop a comprehensive assessment of hydrological cycle in the context of climate change to provide necessary inputs for policy formulation.He then asked the Member-Secretary to take up the agenda.

4. Dr. Sanjay Kumar Jain, Scientist G & Member-Secretary made a Power Point presentation highlighting the contribution of glaciers and cryosphere resource distribution in major Himalayan basins viz. Indus, Ganges and Brahmaputra. Dr. Jain also provided a glimpse of the studies undertaken by NIH in the field of cryosphere. He, further, elaborated the key issues and gaps of Himalayan region pertaining to snow and glaciers, and suggested to identify a lead organization to address those issues. He informed that a brain storming session was organised on 28th April 2023 at NIH to discuss various issues related to the snow/glacier and recommendations of the centre was also presented.

5. Members shared their perspective on snow/glacier and the following points emerged:

(i) Long term studies, both field based and space based, may be taken up in an integrated manner. As a number of organizations are involved in different aspects of cryosphere and climate change studies, they should be given the task to handle different activities as per the expertize with active communication and collaboration with the Centre. Some institutions could be made the nodal agencies for different aspects.

(ii) More instrumentation in Himalayan region is needed for expanding data collection. For comprehensive collation and management of data, the data available with differentstakeholderson glaciological studies may be shared with the Centre. For sharing and uploading of the data, NIH may create a suitable portal.

(iii) Snow cover areas in various basins may be estimated over the long-term historical record along with the trends of snow cover areas in different sub-basins at different

time steps (monthly/seasonal/annual), and in different elevation zones. This information may be continuously updated bringing out the trends.

(iv) Glacier inventory may be updated on annual basis with few parameters (glacier length change detection) using remote sensing multi-spectral data to know the yearly response of the glaciers. Number of glaciers and their areas may be estimated over the long-term historical record in different river basins. This information may be continuously updated bringing out the trends. Comprehensive glacier inventory may be prepared and updated every 5 years.

(v) Glacial Lakes and GLOF: Number of glacial lakes and their areas may be estimated over the long-term historical record in different river basins. Glacial lake inventory may be updated at an interval of 5 years but GLOF potential vulnerable lakes may be monitored on yearly basis and likely areas of submergence should be suitably identified and monitored. The GLOF potential lakes may be physically verified for ground truthing. Based on the data, risk assessment may be carried out and early warning systems developed.

(vi) Snow/glacier melt contribution for the basins of Himalayan region may be visualized in the context of climate change scenarios along with their impact on river flows using various modelling tools (SPHY, WinSRM, VIC, SWAT, HBV etc.). Such tools may be continuously used (with updated database) to model different hydrological components in Himalayan basins for validation and visualization.

(vii) Glacier regime/mass balance study: An accurate assessment of glacier mass balance is vital for understanding the vulnerability of glaciers due to climate change and the rates of glacier denudation The mass balance of Himalayan glaciers has been measured with different methods, from conventional to remote sensing and geodetic. For glaciers representing different regions of Himalayas, more field based mass balance studies may be undertaken. Hanging glaciers and areas prone to disasters because of such glaciers may also me identified and regularly monitored for taking remedial measures.

(viii) Permafrost: There is need to identify and map the permafrost area in the country and assess its impact on water resources.

(ix) Training and capacity: Training and capacity building programs,especially for the young scientists, may be devised to develop capacity in cryosphere and climate change assessments.

(x) There is a need of coordinating body like Program Advisory & Monitoring Committee on Himalayan glaciers to focus efforts towards developing a comprehensive assessment and also avoid duplication of effort.

6. It was decided to co-opt some more organisations in the Steering Committee. A representative from NDMA, New Delhi;MOEF & CC, New Delhi; SAC, Ahmedabad;NCPOR, Goa and NESAC, Shillongor Arunachal Pradesh may be included in the Steering Committee. Chairman emphasised the long term and important role likely to be

Annex

Sl. No.	Name & Designation
1	Shri Pankaj Kumar, Secretary, DoWR, RD & GR, Ministry of Jal Shakti, New Delhi
2	Shri A. K. Bajaj, Ex-Chairman, CWC
3	Dr. Sudhir Kumar, Director, NIH
4	Dr. Sanjay K Jain, Sc.'G' & Member Secretary, NIH
5	Shri A. K. Pal, Commissioner (Indus)
6	Shri S.K. Sinha, Commissioner (B&B)
7	Shri T.B.N. Singh, Member (EAST), CGWB, Faridabad
8	Shri RiteshKhattr, Dir., CWC
9	Shri B. Simhadri Rao, Sc/Er 'SG' & Head, WRAD, NRSC, Hyderabad
10	Dr. Praveen K. Thakur, Sc./Er 'SG' & Head, WRD, IIRS – ISRO, Dehradun
11	Shri Kireet Kumar, Sc.'G' & Nodal Officer, NMHS.PMU, GSP-NIHE
12	Dr. S. S. Randhawa, Principal Scientific Officer Himachal, Shimla
13	Dr. H. S. Negi, DGRE, Chandigarh
14	Shri Ajai Kumar, Director, GSI, Lucknow
15	Dr. Amit Kumar (WIHG), Wadia Institute of Himalayan Geology
16	Shri Shankar Kumar Saha, SE, IRI, Roorkee
17	Dr. M. K. Goel, Sc.'G', NIH, Roorkee
18	Dr. A. K. Lohani, Sc.'G', NIH, Roorkee
19	Dr. Manohar Arora, Sc.'F', NIH, Roorkee
20	Dr. P. K. Mishra, Sc.'D', NIH, Roorkee
21	Dr. Vishal Singh, Sc.'D', NIH, Roorkee

played by this Steering Committee. He suggested that possibility of development of a protocol to inventorize the cryosphere resources (snow & glaciers) annually or with suitable periodicity may be explored.

7. It was opined that the organisations working in the field of snow/glacier can be assigned different aspects of the task. Further, the work can be shared with different institutes/organisations for different regions/basins as the Himalayan region is very large and it may not be possible to cover it by a single organisation. Some more organisations can be added as found suitable and recommended by the members. It was discussed that a large number of researchers belonging to various research and academic institutions carry out research in glaciology and other cryosphere research areas. The research/studies carried out by these institutions have to be incorporated suitably in various tasks. Many of the State Governments do not participate directly as stakeholders and partners in the snow/glacier studies There is a need to take support from States in monitoring and management of glaciers. The distribution of tasks was proposed as follows:

Items	**Proposed organisations**
1. Data/Instrumentation	: CWC, GSI, State Agencies
2. Snow cover area	: IIRS, DGRE, SAC
3. Glacier inventory	: SAC, WIHG, HP Council
4. Glacial Lake & GLOF	: NRSC, CWC, NIH
5. Snow/glacier melt contribution	: NIH, IIRS, NRSC
6. Glacier regime/mass balance	: GSI, WIHG, NCPOR, Kashmir University

8. The Chairman emphasized collaborative approach among organizations to undertake studies for the Himalayan region. He further advised that the respective organizations come forward with a proposal to lead a particular work component, with respect to the key issues/challenges, as per their strength and expertise. He suggested that the items proposed to be covered by the different organisations may be formally sent to them for their consent and acceptance. He stressed upon the need of regular deliberations/meetings amongst the Steering Committee members.

9. In the end, a short film on snow/glacier prepared by NIH was also shown to the committee, which was appreciated by all. The participants supported the coordinated and collaborative approach for comprehensive assessment of impact of climate change on cryosphere, glaciers, snow and glacial lakes for various purposes.

10. The 1st meeting of the Steering Committee on Monitoring of Glaciers was concluded with a Vote of Thanks by the Member-Secretary.

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