

4.1.2 Glaciers

1.0 Subject Matter: *(about importance of glacier in state water resources and impact of climate change on glacier)*

- **Annexure : Location of glaciers on map**
 - Glacier area (Total)
 - Minimum and maximum length
 - Glacier classification (type of glaciers)
 - Snout location (altitude)

2.0 Availability and Utilizable Water

Table A3 is for glacial melts within the State Boundary which is a vital input for Chapter 9.

A3. Inflow from Glacial Melts of the Basin/Sub-basin within the State Boundary: (MCM)		REMARKS
Basin A/ Sub-basin		
Basin B/ Sub-basin		
Basin C/ Sub-basin		
TOTAL		

3.0 Issues and Challenges

- *Reduction in size of glaciers and snow cover may be mentioned.*
- *Monitoring of glacier due to inaccessibility, tough terrain and weather condition may be included.*

4.0 Problem Root Cause Analysis for issues and challenges:

- *Climate change or general rise in atmospheric temperature is the main cause of shrinkage of glacier/snow cover besides other factors linked with anthropogenic activities.*
- *Change in precipitation (snow) pattern together with aspects, slope conditions and debris cover etc could be other causes of shrinkage of glacier.*

5.0 Governance / Management of Glacier:

- a. Institutions governing / managing / monitoring the resources and Institutional structure: **(monitoring agency)**

GSI, WIIHG, NCOAR Goa, Universities, State Remote Sensing Centre, Space Application Centre, Ahmedabad, NRSA, Hyderabad, State Irrigation Department, CWC, DST, MoEF&CC, GBPNIHESD, etc

- b. Areas of Peoples/Private Participation/NGO if any

NGOs may contribute in awareness programmes of climate changes.

- c. Schemes & Financing for monitoring [Relevant tables on Water Financing and Economics may be looked into Chapter 7 and filled up with appropriate data/information]

Ministry of Water resources, Ministry of Science and Technology, State councils of Science and technology, Dept of Space, MoEF&CC, etc

6.0 Constraints in Measurement, Monitoring and Data collection/ Management

- i. *No man-power is deputed for measurement and monitoring, except discharge measurement in downstream for hydropower projects.*
- ii. *Inaccessibility to glacier, tough terrain and weather condition.*
- iii. *Lack of trained manpower.*
- iv. *Lack of standard infrastructure and logistics.*
- v. *No centralized data base centre.*
- vi. *Lack of meteorological stations.*
- vii. *Measurement and monitoring only by academic institutions.*
- viii. *Only project mode studies, no long term programs for glacier monitoring*
- ix. *Limited knowledge about dependence of mountain people on glaciers*

7.0 a) Bench Marking, if any

b) Performance Indicators: (for comparison across State/District/Basin)

Indicator	Unit	District -1	District-2	District -3
Change in number of glaciers	numbers			
Change in snow cover	In km ² / m ²			
Change in accumulation area	In km ² / m ²			
Change in ablation area	In km ² / m ²			
Average change in snout position	In meter (+) positive (-) Negative			
Change in Precipitation over last 10 to 20 years	In cm/mm			
Change in ratio between accumulation and ablation	ratio			
Change in flow /melt water	cumecs			

8.0 Reforms undertaken / being undertaken / proposed, if any

9.0 Road map of activities / tasks proposed for better governance with timelines and agencies responsible for each task / activity

Activities	Agency responsible	Time frame	Outcome
Glacier mapping	State Remote Sensing Agencies	Annual	Areal data on glacier distribution

ANNEXURE

- Summary table of glacier

State	No. of Glaciers	Total surface area of glacier	Approx. Ice volume	Major Rivers	Snow line (altitude)

(Glacier distribution in Himalayan region based on Glacier inventory (GSI, 2009))

- Present status of glaciers in numbers in state

District/ Basin	<2km ²	2-5km ²	5-10km ²	10-15 km ²	15-20 km ²	>20km ²
1						
2						
3						

- Change in number of glaciers in last 20-25 years

District/ Basin	Unit Km ² /m ²	2000	2005	Change in 5 year %	2010	Change in 10 year %	2015	Change in 15 year %	Last 2 yrs	Change in 17 year %
1										
2										
3										

- Reduction or Shrinkage of glaciers in numbers and percent wise across the State in last 20-25 years

District/ Basin	<2km ²	2-5km ²	5-10km ²	10-15 km ²	15-20 km ²	>20km ²

	Nos.	%	Nos.	%	Nos.	%	Nos.	%	%	Nos.	%	Nos.
1	60	30	30	20	20	15	10	5	10	5	8	3
2												
3												

- Change in snow cover in last 20-25 years

District/Basin	Unit Km ² /m ²	2000	2005	Change in 5 year %	2010	Change in 10 year %	2015	Change in 15 year %	Last 2 yrs	Change in 17 year %
1										
2										
3										

- Change in Accumulation area

District/Basin	Unit Km ² /m ²	2000	2005	Change in 5 year %	2010	Change in 10 year %	2015	Change in 15 year %	Last 2 yrs	Change in 17 year %
1										
2										
3										

- Change in Ablation area

District/Basin	Unit Km ² /m ²	2000	2005	Change in 5 year (%)	2010	Change in 10 year (%)	2015	Change in 15 year (%)	Last 2 yrs	Change in 17 year (%)
1										
2										
3										

- General Change in Snout position of glaciers

District/Basin	Unit In meter	2000	2005	Change in 5 year (%)	2010	Change in 10 year (%)	2015	Change in 15 year (%)	Last 2 yrs	Change in 17 year (%)
1										
2										
3										

- Change in ratio between accumulation and ablation

District/Basin	Unit Ratio	2000	2005	Change in 5 year (%)	2010	Change in 10 year (%)	2015	Change in 15 year (%)	Last 2 yrs	Change in 17 year (%)
1										
2										
3										

- Precipitation (Snow fall) Basin/District wise

District/Basin	Precipitation	Discharge from glacier basin in cumec/ cusec	% of precipitation enters into glacier basin
1			
2			
3			

- Change in Precipitation district/basin

<i>District/ Basin</i>	<i>Unit mm/ cm</i>	<i>1995- to 2000</i>	<i>Change in 5 year (%)</i>	<i>2000 to 2005</i>	<i>Change in 5 year (%)</i>	<i>2005 to 2010</i>	<i>Change in 10 year (%)</i>	<i>2010 to 2015</i>	<i>Change in 15 year (%)</i>	<i>Change in Last 2 yrs</i>	<i>Change in 17 year (%)</i>
1											
2											
3											

- Basin wise availability of water from glacier basin (time scale to be specified as per need)/ Sediment load to be added

<i>District/ Basin</i>	<i>Availability In cumec/ cusec *</i>	<i>Utilizable In cumec/ cusec *</i>
1		
2		
3		

*** Cubic meter per second or cubic feet per second**

- Mapping of glacial lakes (basin wise)

<i>District/ Basin</i>	<i>Number of glacial lakes</i>	<i>Size of lakes/ area In sq km</i>	<i>Change in size of lakes/ annual</i>	<i>Potential risk of GLOF in terms of downstream population</i>
1				
2				
3				