

Memorandum of Understanding

Work plan for the collaboration

Under the project

**INTEGRATED STUDIES OF HIMALAYAN
CRYOSPHERE USING SPACE BASED INPUTS (ISHC)
(2016-2019)**

between

Cryosphere Sciences Division (CSD)
Geo-Sciences, Hydrology, Cryosphere Sciences and Applications Group
(GHCAG)
Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area
(EPSA)
Space Applications Centre (ISRO)
AHMEDABAD-380015

AND

Department of Remote Sensing & GIS,
University of Jammu, Jammu

Signed on this day August, Year 2017

BACKGROUND:

Himalayan cryosphere consists of seasonal snowpack, permanent snowpack and glacier ice occurring in the high altitudes of Himalayan mountainous system. Annual Snow fall and glaciers of the Himalayan region together make a vital natural resource of fresh water which feeds the Indian rivers flowing in northern India. The great northern plains of India sustain on this perennial melt of snow and glaciers meeting the water requirements of agriculture, Industries, domestic sector even in the months of summer when large tracts of the country go dry. Therefore, assessment and monitoring of snow and glaciers is very much important for nation's growth and water resources management especially in view of climate change. In addition to above, Himalayan snow and glaciers also govern the Indian monsoon system and through their high albedo controlling the global radiation budget.

Because of importance of Himalayan cryosphere in global climate change studies, in regulating the supply of fresh water to all the major Indian rivers, the scientific studies of Himalayan cryosphere are of paramount importance.

The seasonal snowfall in Himalayas begins in winters in the Northern Hemisphere. Permanent snowfields receive snow almost throughout the year. Since the snowfall is a dynamic phenomenon which requires monitoring, the orbiting satellites provide a quick coverage of snow cover in Himalayas. The satellites include both the near polar and geostationary. Mapping and monitoring of seasonal snow cover can be best done by remote sensing because of a large area coverage and multi-temporal datasets. Therefore, remote sensing can provide faster information on accumulation or ablation of snow cover than any other conventional means.

Remote Sensing has played a very important role in Himalayan glacier studies. One of the major reasons for this is that Himalayas have a very rugged topography. The Himalayan terrain is also very harsh climatically and accessibility in the remote part of Himalayas is a major problem. Therefore, ground studies in Himalayan terrain are very difficult to be carried out. Satellite remote sensing provides multi-temporal coverage of remotest part of Himalayas and help in understanding the dynamic nature of Himalayan glaciers. The synoptic view provided by satellite images help in faster mapping and monitoring of glaciers. Moreover, the interaction of EMR with snow and glaciers provide retrieval of some parameters which cannot be obtained by any other means for entire stretch of Himalayas in a very short time.

In view of the above characteristics of Himalayan terrain and its cryospheric elements, Space Applications Centre (SAC) has been contributing to the development of methods/techniques for extraction and dissemination of reliable and quick information from remote sensing data pertaining to snow and glaciers of the Himalayas for last more than two and half decades. The Centre has been instrumental in developing remote sensing based techniques, models and methods to generate a large amount of digital database and maps to understand the state of Himalayan cryosphere. There is no contemporary technique which provides this information to the nation in a very short span of time and for a large area. Apart from this SAC has contributed in capacity building and trained more than hundred professionals across the country on processing and use of remote sensing based information on Himalayan snow cover and glaciers.

SAC has conceptualized and developed techniques for Himalayan glacial inventory, glacial mass balance, monitoring glacial extents, snow pack characterization, snow and glacier melt runoff modeling, estimating hydro-power potential for micro-hydel sites, estimation of peak discharge

due to bursting of moraine dammed glacial lakes. SAC has developed algorithm to extract snow cover from AWiFS and IMAGER sensors onboard Resourcesat-1/2 & INSAT 3D satellites. Satellite remote sensing has taken a fast leap forward with the availability of microwave Radar data from RISAT-1 satellite. This data has enhanced the capability of orbiting satellites in monitoring of glaciers.

SAC has successfully completed projects sanctioned jointly by Ministry of Environment, Forests and Climate Change (MoEF&CC) & Department of Space in two phases.

In order to continue generation of valuable information on snow and glaciers and to understand the Himalayan cryosphere in a better way, a project has been formulated and approved at SAC. This project on “Integrated studies of Himalayan cryosphere using space based inputs” has been approved by Space Applications Centre, Department of Space, Government of India under the ‘Remote Sensing and Meteorological Applications Projects (RSMET)’ funded by DOS. The project is to be executed by SAC during 2016-2019 time frame.

This project will take up the operational and R&D components like

- i) Glacier facies Mapping from RISAT MRS data (2013-15)
- ii) Monitoring of snowline at the end of ablation season(2015-18)
- iii) Monitoring the changes (advance/retreat) of glaciers between 2000/2001 and 2015/16/17/18
- iv) Snow cover mapping (2015-18)
- v) Snow and glacier melt runoff estimation (2015-18)
- vi) Snow depth estimation using.
- vii) Estimation of glacier ice velocity

This new proposal is aimed at comprehensive integrated study of various research elements of Himalayan snow and glaciers which require technique development so that in future these can be applied operationally for monitoring of Himalayan cryosphere, for societal benefits and to understand the impact due to climate change. Activities are also included to meet the long duration data requirement over Himalayan region.

Department of Remote Sensing and GIS, University of Jammu, has been associated with Space Applications Centre, ISRO Ahmedabad in earlier projects under various programs. In view of the expertise developed at Department of Remote Sensing and GIS, University of Jammu in handling and interpretation of satellite data for mapping of glaciers, a joint work has been planned under this project. Initially the collaboration is proposed for two years which can be extended for next four years after review of Budget and progress at the end of two years.

Objectives under proposed collaboration

- Monitoring the changes (advance/retreat) of glaciers in J & K state using recent LISS III data and other data available in open source. The glacier extents prepared earlier by SAC will be utilized for monitoring. A few glaciers need to be monitored at larger scale using high resolution data such as LISS IV/cartosat-1 & 2. Ground verification of glacier features needs to be done on atleast one glacier annually.
- Generation of database of glacial lakes of J & K state by automatic approach to be used in Disaster Management Program.

Study area: Snow and glaciated regions of J & K

	Task	Responsibility	Timeline
1	Generation of layer of glacier extents using recent LISS III data of J & K	University of Jammu	March 2018
	Comparing the glacier extents with layers prepared earlier by SAC in Phase II program for J & K.	University of Jammu	December 2018
2	Mapping and change detection of glacier extents using high resolution data of selected glaciers for parts of J & K.	University of Jammu	December 2018
3	Generation of database of glacial lakes of J & K	University of Jammu	March 2019
4	First field work for snout verification	University of Jammu	October 2017
5	Second field work for snout verification	University of Jammu	October 2018

Budget:

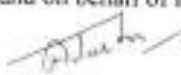
Head	(Rs. In Lakh)		
	2017-18	2018-19	Total
Services/Salaries of JRFs	3.5	3.5	7.0
Field work	1.5	1.5	3.0
Travel & Contingency	1.5	1.5	3.0
Overhead Expenses	1.5	1.5	3.0
Total	8.0	8.0	16.0

Terms of reference

- Satellite data to be provided by DOS. The data from open source to be downloaded by University of Jammu.
- Any publication out of this work to be brought by University of Jammu and SAC jointly.
- All outputs and maps to be displayed on VEDAS portal of SAC/ISRO.

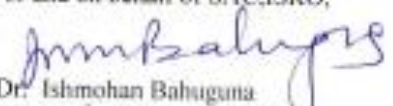
Parties

For and on behalf of Partner Institute


Prof. Avtar Singh Jasrotia
Department of Remote Sensing and GIS
University of Jammu, Jammu -180 006

For and on behalf of PARTY

For and on behalf of SAC,ISRO,


Dr. Ishmohan Bahuguna
Scientist/Engineer 'G' & Head,
Cryosphere Sciences Division (CSD)
Geo-Sciences, Hydrology and Cryosphere Sciences
and Applications Group (GHCAG)
Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area (EPSA)
Space Applications Centre (SAC) ISRO, Ahmedabad-15

Project Report

Integrated Studies of Himalayan Cryosphere using Space Based Inputs (ISHC), Space Application Centre (ISRO), Ahmedabad

Important aspects & progress made so far: Total 2274 glaciers covering approx. 19705.55 Km² area were monitored for the years 2000 and 2017 for Jammu & Kashmir Himalayan region. Out of 2274 glaciers, 243 glaciers having 3725.07 Km² area in 2000 and 3719.64 Km² in 2017 were retreating (retreat = 5.43 Km², 0.02%), 52 glaciers having 2794.66 Km² area in 2000 and 2836.52 Km² in 2017 area were advancing (advance = 41.56 Km², 0.21%) and 1979 glaciers exhibits no change.

Out of 2274 glaciers, 829 glaciers were having area less than 1 Km² for both the years 2000 and 2017. Out of 829 glaciers, 71 glaciers having 30.16 Km² area in 2000 and 24.69 Km² in 2017 are retreating, 3 glaciers having 1.09 Km² area in 2000 and 1.52 Km² in 2017 were advancing and 755 glaciers exhibits no change. Total 1445 glaciers were having area ≥ 1 Km² for both the years 2000 and 2017, and out of 1445, 172 glaciers having 3694.91 Km² area in 2000 and 3694.95 Km² in 2017 are retreating, 49 glaciers having 2793.57 Km² area in 2000 and 2835 Km² in 2017 were advancing and 1224 glaciers exhibits no change. 1445 glaciers were having area ≥ 1 Km² for both the years 2000 and 2017.

R&D work done: Project completed, presented and submitted successfully. The information was generated in the above said project are available in the Jammu University portal Geoportal: <https://www.jammuuniversity.ac.in/node/2285>

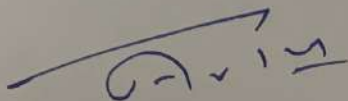
EXPENDITURE REPORTProject: **Integrated Studies of Himalayan Cryosphere using Space Based Inputs (ISHC)**Name of Participating Agency: **Space Application Centre (SAC), ISRO, Ahmedabad and
Department of Remote Sensing and GIS, University of
Jammu, Jammu**

Expenditure report for the period: Aug., 2019 to June, 2020

Certified that an amount of Rs. 6,00,000 received from SAC for the work connected with the "Integrated Studies of Himalayan Cryosphere using Space Based Inputs (ISHC), project to Department of Remote Sensing and GIS, University of Jammu, Jammu has been spent for the purpose for which it was sanctioned as under:

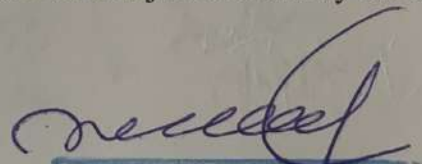
S.No.	Expenditure head	Amount (Rs.)
1.	Expenditure upto beginning of the quarter	6,00,000
2.	Expenditure during the quarter (Aug., 2019 to June, 2020)	
	Services	6,0,0000
	Total Expenditure	6,00,000
3.	Opening balance as at beginning of the quarter (Aug., 2019)	6,00,000
4.	Expenditure during the quarter (Aug., 2019 to June, 2020)	6,00,000
5.	New balance / amount required (2020-21)	-

The expenditure as above has been incurred as per rules and procedures of **University of Jammu** and has been properly accounted for in the books of accounts. The relevant records are retained in this organization and are audited/subject to audit by our auditors.



(Dr. A.S. Jasrotia)
Principal Investigator

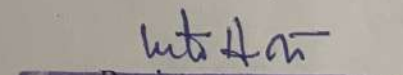
Prof. & Head
Deptt. of Remote Sensing & GIS
University of Jammu,
Jammu



Joint Registrar (Finance)
Joint Registrar
University of Jammu

17/8

17/08/2020



Registrar
Registrar
University of Jammu

17/8

17/08/2020

**UNIVERSITY OF JAMMU
STATEMENT OF EXPENDITURE**

Statement of expenditure incurred in connection with the research project entitled “**Integrated Studies of Himalayan Cryosphere using Space Based Inputs (ISHC)**” sanctioned by the SAC in favour of **Prof. A.S. Jasrotia, Department of Remote Sensing and GIS, University of Jammu, Jammu** w.e.f August,2019 to June, 2020.

Head	Unspent balance B/F from FY 2018-19	Grant received for FY 2019-20	Total grant available for FY 2019-20	Expenditure incurred during FY 2019-20	Balance	Grant required for FY 2020-21
Services	8,485	6,00,000	6,08,485	6,08,485	Nil	
Total	8,485	6,00,000	6,08,485	6,08,485	Nil	

A.S.

(Dr. A.S. Jasrotia)
Principal Investigator
Prof. & Head
Deptt. of Remote Sensing & GIS
University of Jammu,
Jammu

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Joint Registrar
University of Jammu

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