

National Mission on Himalayan Studies (NMHS)

Project ID: NMHS/SG-2016/002/373

Sanction Date: 31.03.2016

Geomorphic characterization of flash floods and mass wasting in upper Ganga terrain of Garhwal Himalaya: role of climate - tectonic interaction in gradation processes

Annual Progress Report
for the period
from 01.04.2017 *to* 31.03.2018



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National Mission on Himalayan Studies (NMHS)

NMHS Progress Report

(Period from 01.04.2017. to . 31.03.2018.)

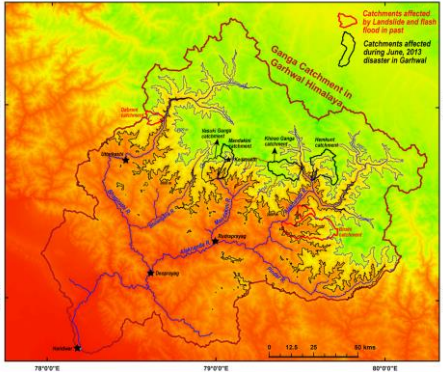
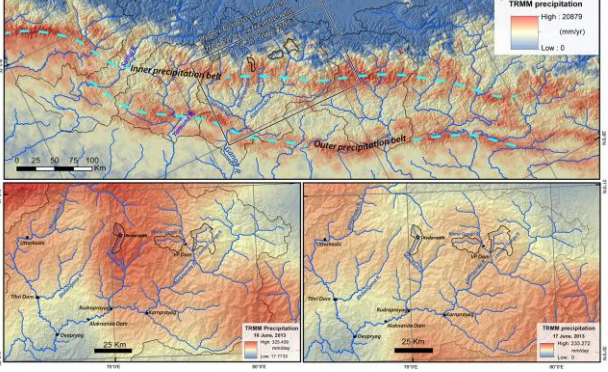




CSIR-National Geophysical Research Institute, Hyderabad

1. Project Information

Project ID:	NMHS/SG-2016/002/373	Sanction Date:	31.03.2016
Project Title:	Geomorphic characterization of flash floods and mass wasting in upper Ganga terrain of Garhwal Himalaya: role of climate - tectonic interaction in gradation processes		
BTG:	Rs. 49.20 Lakhs		
PI and Affiliation (Institution):	Dr. Anand K Pandey, CSIR- National Geophysical Research Institute Uppal Road, Hyderabad		
Name & Address of the Co-PI, if any:	Dr. Prabha Pandey, CSIR- National Geophysical Research Institute Uppal Road, Hyderabad		
Structured Abstract - detailing the current year progress [Word Limit 250 words]:	<ul style="list-style-type: none">• Thematic base maps regional geology (after GSI and Valdiya, 1980) are digitized.• The SRTM Digital Elevation Model for the Ganga catchment is generated for drainage classification and further morphometric analysis.• The critical catchments affected by GLOF and LLOF in past/present century are identified for detailed morphometric analysis (Fig.1).• Field mapping and characterization of ephemeral landform developed during 2013 Uttarakhand disaster have been mapped in some catchments (Fig. 1).• Effort is in progress to understand the role of extreme events on landscape growth in non-steady state drainage catchment, which are affected by frequent erosion and landscape modification in form of large landslides.• Some small catchments affected by cloudburst are analysed with the aim to scale up for larger catchment analysis (Fig. 2, 3,4,5).• The terrain analysis and erosion potential proxies are generated using spatial and along the drainage profiles in upper catchment (Fig. 7,8).		
Project Partner	Affiliations	Role & Responsibilities	
Name			
Partner 1	None		



2. Project Site Details

Project Site	Upper Ganga catchment
IHR States Covered	Uttarakhand
Long. & Lat.	78 ⁰ 30' - 79 ⁰ 45'E 31 ⁰ 00' - 30 ⁰ 30'N

<p>Site Maps</p>	 <p>Fig. 1: The study area/catchments affected by GLOF and LLOF in upper Ganga catchment.</p>	 <p>Fig. 2: Annual TRMM Precipitation over Himalaya with the extreme precipitation during 16 & 17 June 2013 causing flashflood in Upper Ganga catchment.</p>
<p>Site Photographs</p>	 <p>Fig. 3: Composite landslide along Madhyamaheshwar Ganga. Note the lake formed at landslide toe due to blockade</p>	 <p>Fig. 4: Comparing annual and extreme events (stream power) sediments discharge along the Kedarnath river section.</p>
	 <p>Fig. 5: Gohna landslide along Birhi Ganga.</p>	 <p>Fig. 6: Outreach at the Gohna Intermediate school about Natural Hazards in Himalaya in Birhi Ganga catchment</p>

3. Project Activities Chart w.r.t. Timeframe [Gantt or PERT]

PROJECT ACTIVITIES	WORK UNDERTAKEN Year: 01.04.2017 to 31.03.2018				OUTPUT
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Literature survey and study	continuing	continuing	continuing	continuing	New algorithms of terrain analysis are being explored.
Procurement of workstation, laptop	-	Workstation			Installed with the Arc GIS software for data processing

Recruitment of project staff	Two Project Assistant (PA-I & III) are recruited with Rs. 15,000 and 28,000 per month fellowship during May, 2017.		2 Project Asst. recruited.
Thematic base map and Terrain data preparation in GIS mode	<ul style="list-style-type: none"> SRTM DEM with 90 m and 30 m resolution data processed for entire study region Terrain Data preparation for the Glacial catchments and two LLOF type catchment are in progress 	<ul style="list-style-type: none"> Various terrain analysis algorithms and techniques are explored and developed TRRM precipitation data for June 2013 has been acquired and processed for analysis. Regional 2-D drainage characterization is in progress to identify zones vulnerable to focused erosion and landslides. 	Progressing as scheduled
Field work	<ul style="list-style-type: none"> Fieldwork was carried out during May-June 2016 along Bhagirathi and Mandakini river sections. Fieldwork carried out along Madhyamaheswar and Birhi Ganga catchments during Nov, 2017. 	<ul style="list-style-type: none"> Carried out field survey along Birhi Ganga during Dec 2016. Also carried out GPR survey at the landslide toe to map shallow subsurface geometry 	Trained a couple of trainee and Ph.D. students in field and GIS/ RS technique of terrain analysis
	Dabrani debris flow site and catchment along the Bhagirath river is uninhabited and inaccessible and therefore will be explored through remote sensing and GIS method only.		
Sampling		<ul style="list-style-type: none"> 2 Sand sample collected from old landslide lake for OSL dating near Gohna Tal landslide zone. 	Other sites have to be explored.
OSL Dating		<ul style="list-style-type: none"> Sand was not bleached and therefore did not yield luminescence ages. 	

4. Financial and Resource Information

Note: A separate bank account is expected to be opened for NMHS Project as per the provision of Direct Beneficiary Account (DBA) as laid out by the Govt. of India and also facilitate the audit of accounts. The interest earned out of the NMHS project funds should be reported clearly in the utilization certificate.

Total Grant:	49.20 lakhs	Grant Received Date:	Rs.25,72,400/-
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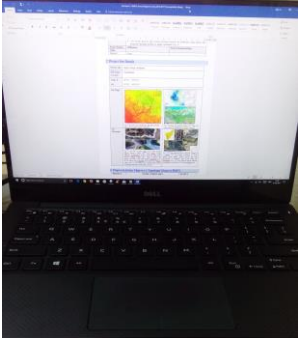
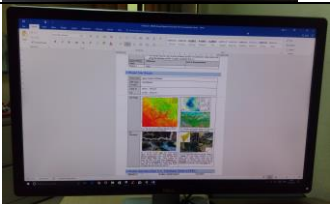


Project Partner(s)	Affiliations/ Institution	Budget Allocated to	Work Done
Partner 1	CSIR-NGRI, Hyderabad	CSIR-NGRI	CSIR-NGRI

Project Staff Information:

S. No.	Name	Qualification	Designation	Fellowship/ Wages paid	Remarks
1.	K Sravan Kumar	M.Sc. (3 yr experience)	Project Assistant -III	28,000/ per month+HRA	4.5.2017 Registered for Ph.D.

		in GIS)				
2.	J Thirupati	B.Sc.	Project Assistant -I	15000/ per month+HRA	17.5.2017	-

5. Equipment and Asset Information

S. No.	Equipment Name (QTY)	Details (Make/ Model)	Cost	Date of Installation	Photograph of Equipment	Lowest Quotation, IF NOT Purchased
1.	Workstation with 22" monitor (1 no)	HP Z840	3,60,518.00	10.08.2016		Lowest
2.	Laptop (1 no)	Dell XPS 13 DINO	1,37,340.00	20.01.2017		Lowest
3.	Dell Monitor (1no)	Dell ultrasharp 32 Ultra HD Monitor	1,36,400.00	25.01.2017		Lowest
4	Workstation computer	Lenovo 710	Data and Image processing	4,54,300.00		Lowest
5	Laser Printer	HP	Printer & Scanner	53,750.00		Lowest

6. Expenditure Statement and Utilization Certificate

Please update the annual Expenditure Statement and Utilization Certificate (UC) periodically.

Expenditure Information:

S. No.	Financial Position/Budget Head	Funds Sanctioned	Expenditure (April 2016- March 2018)	% of Total cost
I	Salaries/Manpower cost	13,20,000.00	4,33,820.00	32.86%
II	Travel	6,00,000.00	3,31,402.00	55.23%
III	Expendables & Consumables	5,00,000.00	2,52,400.00	50.5%
IV	Contingencies	1,00,000.00	2025.00	0.02%
V	Activities & Other Project cost	6,00,000.00	00	-
VI	Institutional Charges	3,00,000.00	00	-
VII	Equipment	15,00,000.00	11,42,318.00	76.15%
	Total	49,20,000.00	21,81,965.00	44.35%
	Interest earned	64,582.00	-	-
	Grand Total			

Period	Expenditure Statement	Utilization Certificate (UC)
Annual 2017-2018	Attached	Attached

7. Project Beneficiary Groups

Beneficiary Groups [Capacity Building]	Target	Achieved
No. of Beneficiaries with income generation:	Not applicable	
No. of stakeholders trained, particularly women:	None	
No. of capacity building Workshops/ trainings:		Carriedout
No. of Awareness & outreach programmes:	Outreach to local village	Carriedout awareness and outreach program at Gohna Intermediate school in Birhi Ganga catchment
No. of Research/ Manpower developed:	2	One is registered for Ph.D. with Osmania University.

8. Project Progress Summary (as applicable to the project)

Description	Total (Numeric)	Description
<i>IHR States Covered</i>	1	Uttarakhand
<i>Project Site/ Field Stations Developed:</i>	6 catchments affected by GLOF and LLOF in recent past (Fig 1)	Mandakini / Kedarnath section, Khirroi Ganga, Laxman Ganga, Birahi Ganga, Madhmaheshwar Ganga and Dabrani river catchments
<i>No. of Patents filed (Description):</i>	None	None
<i>Article/ Review/ Research Paper/</i>	1 1 (Communicated on methodology)	Dimri et al., 2017. Cloudbursts in Indian Himalayas: A review. Earth-Science

<i>Publication:</i>	development) 2 under preparation	Reviews, 168, 1–23. http://dx.doi.org/10.1016/j.earscirev.2017.03.006
<i>New Methods/Modellings Developed (description in 250 words):</i>	<p>We are carrying out terrain characterization using watershed concept based on spatial (2-D) and linear morphometric parameters defining effect of slope/gradient, cumulative runoff and erosion potential of different channel in analogous terrain GIS and numerical methods using MATLAB.</p> <p>The method is numerically intensive and have high degree of reproducibility.</p> <p>The terrain results are being analyzed with local geology and field observations.</p> <p>Chi (χ) analysis intend to identify the zone of high erosion potential based integral function of position in the channel network in a bedrock catchment (after Perron and Royden, 2013)</p> $\chi = \int_{x_b}^x \left(\frac{A_0}{A(x)} \right)^{\frac{m}{n}} dx$ <p>Where A_0 is drainage area, A is the upstream drainage area, m/n are non-integral constants corresponding to the slope at the upstream location 'x' and the 'x_b'.</p>	<p>Fig. 7: Ksn index analysis of Mandakini R. along the upper catchment. Note the zone with >400 Ksn index is affected by mass wasting during June, 2013 flash flood.</p> <p>Fig. 8: Chi analysis of Kedarnath valley cross section shows erosion prone area in mid region of valley</p>
<i>No. of Trainings (No. of Beneficiaries):</i>	-	-
<i>Workshop:</i>	-	-
<i>Demonstration Models (Site):</i>	(attach maps about location & photos)	Fig. 1,2,3,4,5,6,7,8,9
<i>Livelihood Options:</i>	Not applicable	
<i>Training Manuals:</i>	Not applicable	
<i>Processing Units:</i>	Not applicable	
<i>Species Collection:</i>	Not applicable	
<i>Species identified:</i>	Not applicable	
<i>Database/ Images/ GIS Maps:</i>	Many	<p><u>Spatial</u>: DEM, Hill shade, Slope, Slope aspect, Relief, Drainage, Drainage density, Catchments, Geology, Regional structure,</p> <p><u>Along the river profile</u>: profile, SL index, Ksn, Chi index, stream power index ---etc for the glacial catchments.</p>

Note: Photos/ maps should be attached in high quality in compatible formats viz., JPEG, .JPG, .PNG, .SHP, etc. along with a suitable figure legend/ caption.

9. Project Linkages (with nearby Institutions/ State Agencies)

S. No.	Institute/ Organization	Type of Linkages	Brief Description
	None		

10. Additional (publication, recommendations, etc.)

Time Period	Publications (Research Papers, Information Material, Policy drafts, Patents, etc.)
Annual [2016-2017]	Dimri, A.P., Chevuturi, A., Niyogi, D., Thayyen, R.J., Ray, K., Tripathi, S.N., Pandey, A.K. , Mohanty, U.C., 2017. Cloudbursts in Indian Himalayas: A review . Earth-Science Reviews, 168, 1–23. http://dx.doi.org/10.1016/j.earscirev.2017.03.006
2017-2018	<ul style="list-style-type: none"> Jaiswara et al (communicated) Hypsometry and stream-length gradient index of channel as proxy to delineate zone of active erosion: MATLAB functions for extracting parameters from Digital Elevation Model (DEM)- to ‘SoftwareX’. (example - Fig. 9) Pandey et al., (MS under preparation) Landscape growth in Higher Himalayan terrain: role of extreme events, precipitation, flash flood and mass wasting in Upper Ganga catchment (Example Fig. 2,7,8)

11. Project Concluding Remark

Kindly update the following Progress Parameters for the Reporting Period:

Project Objectives	Project output against each objective	Progress made against Monitoring Indicators (specified in Sanction Letter)	Remarks
Geo-referenced maps on different themes that include litho-tectonics / geology, landforms, digital elevation model, slope, relief, drainage pattern, and various morphometric parameters computed from above thematic spatial and vector dataset generated by extensive field mapping and numerical simulations.	70% The highlighted items are completed. Other derivatives and analysis are in progress.	Monitoring in comparison to the baseline information to be provided by the proponent.	Numerical simulation shall be attempted in last depending on the amount of data generated and constraint obtained from the study.
Data base on various factors affecting localization in varying case scenario like GLOF and LLOF type gradation process.	60%	Geo-referenced Maps and Geomorphic Factors on the selected themes viz., geology, landforms, digital elevation model, slope, drainage pattern, etc. (Nos.).	The highlighted thematic maps are prepared.
Dating of at least 2 old landforms to build geological history and recurrence, where possible.	20% Unsuccessfully dated two OSL samples from Birahi ganga.	Status and assessment reports for varying case scenarios (Nos.).	Samples were not bleached due to poor exposure during sediment transport.
Recommendations for disaster risk deduction for important human settlements through analysis of habitation with the landform.	30%	Long-term Thematic datasets and cross-correlation patterns of GLOF, LLOF, etc. (Nos)	Overlay analysis with the habitation is inprogress
		Dating of old landforms to form geological history of the selected sites along with communities engaged in monitoring program (Nos).	Unable to do due to sampling constrains from different generations of landslide

		Vulnerability maps created through overlay and habitation analyses of Landforms and Geomorphic Factors (Nos).	
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Methodology (in brief):	<ul style="list-style-type: none"> The regional terrain analysis to identify the catchment affected by GLOF and LLOF in past century based on landform pattern. And during June 2013 extreme event the flashflood remobilized the glacial moraine from the glacial outwash along the high gradient streams and deposited them at the junction with the trunk streams (Fig. 2, 4). The sample catchments are extracted and its detailed morphometric analysis (spatial and linear-along the main stream) based on hydrological factors and drainage pattern are carried out (Fig. 7,8,9). Different morphometric parameters are derived from DEM and remote sensing images on above line using ArcGIS and MATLAB utilities and algorithms, modifying them to suit the objectives (Fig. 9).
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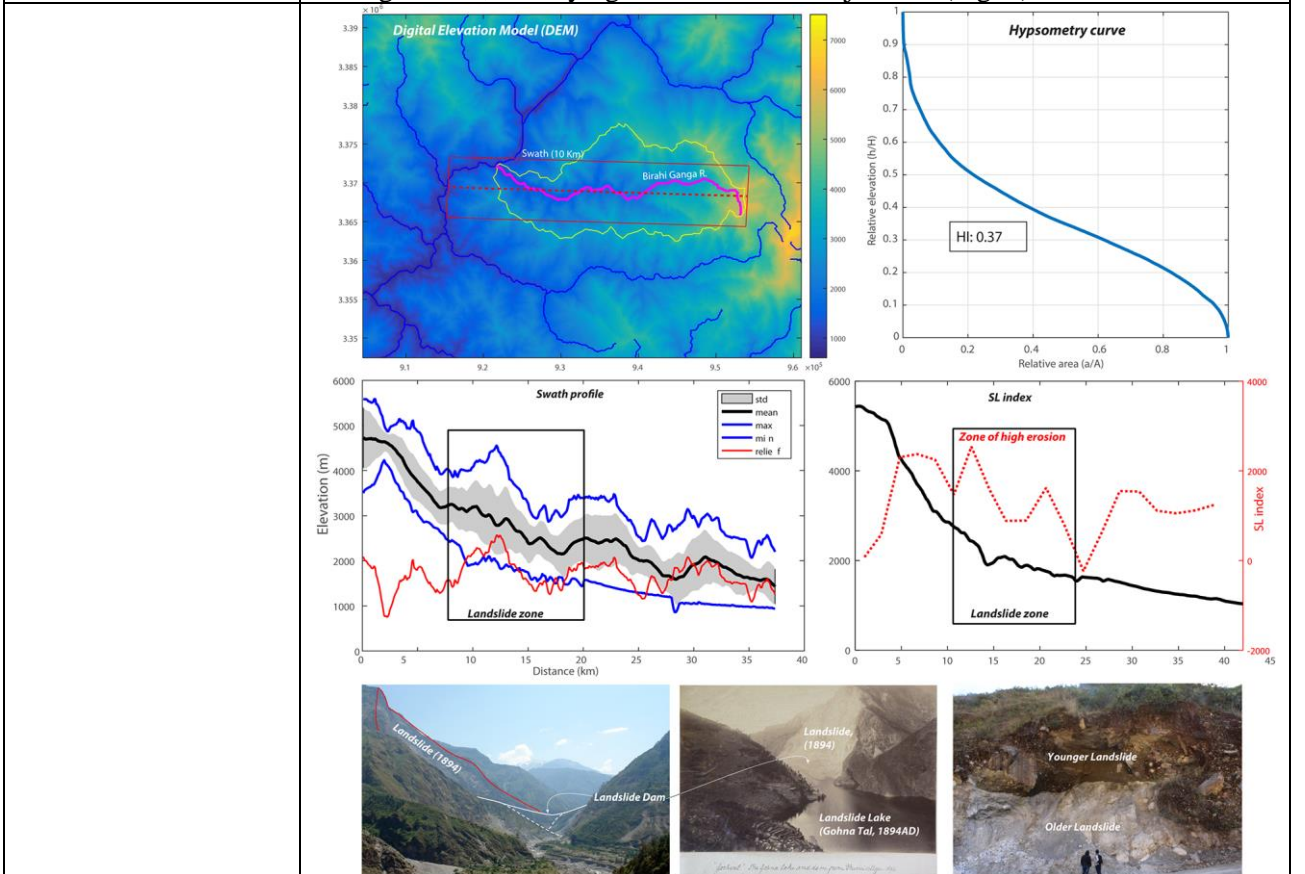


Fig. 9: Output of MATLAB code for morphometric characterization of different catchments to identify the zone of erosion and landslide.

Major Research Achievements:	<ul style="list-style-type: none"> The Mandakini / Kedarnath valley, Khiroi Ganga and Laxman Ganga are explored extensively during field and through imageries. The GLOF infested catchments are not accessible for field work and therefore spatial terrain analysis using empirical relationship in bedrock channel is being explored. The morphometric parameters are derived on spatial and linear properties including Hypsometry, SL index, Ksn, Chi index and stream power analysis are carried out for above catchments. The extensive field work is carried out along Birhi Ganga and Madhyamaheshwar Ganga catchments, which suffered LLOF during past century. The results on landscape evolution and potential landslide zones is being identified in profile mode.
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	<ul style="list-style-type: none"> • The results are being compiled for these catchments. • The MATLAB code with manual is being developed for morphometric analysis of the catchment (Fig. 9; Jaiswara et al., communicated manuscript). • Review of cloud burst in NW Himalaya is compiled and some catchments are characterized for the geomorphic expressions of the same (Dimri et al., 2017, ESR).
Brief Conclusion - the current year progress – during the reporting period (point-wise):	<ul style="list-style-type: none"> • The extreme events have profound role in landscape evolution by gradational processes (erosion/landslide and sediment transportation during surface runoff) in comparison to the steady state conditions in high gradient glacio-fluvial terrain. • We choose east facing, west facing and south facing catchments of similar size in high gradient /relief terrain for analysis to rule out varying contribution of glacial melt. • The specific gradation events like erosion, deposition and debris remobilization zones can be clearly identified based on different terrain morphometric parameters.
Progress Achieved (%):	60%
Remaining work to be done:	<ul style="list-style-type: none"> • Finalization of terrain identifier based on morphometric parameters in glacial streams. • Terrain analysis and mapping of older landslides zones to characterize LLOF type region. • Integration of local geology to understand its influence on LOLF localization. • Spatial overlay analysis of results with zone of precipitation. • Finalization of numerical methodology for morphometric analysis and manual for user. • Overlay analysis of above geomorphic results with the habitation to understand vulnerability.

Submitted to:

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Submitted by:

Project PI (Signature):



Institution (Seal):

Dr. Anand K. Pandey
Scientist
National Geophysical Research Institute
(Council of Scientific & Industrial Research)
Uppal Road, Hyderabad - 500 007, INDIA.

Dated (dd/mm/yy): 14.06.2018

Please fill the NMHS Progress Report pro forma as applicable with respect to time and other requirements and return *via* post/ e-mail. In case of any query, please contact at: nmhspmu2016@gmail.com