

NMHS-FINAL TECHNICAL REPORT (FTR)

Demand-Driven Action Research Project Grant

NMHS Reference No.:	NMHS/2015-16/LG-05
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Date of Submission:	3	0	0	9	2	0	1	9
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BIODIVERSITY ASSESSMENT THROUGH LONG-TERM MONITORING PLOTS IN INDIAN HIMALAYAN LANDSCAPE

Project Duration: from (01.04.2016) to (30.09.2019)

Submitted to:

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Submitted by:

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NMHS-Final Technical Report (FTR)
Demand-Driven Action Research Project

DSL: Date of Sanction Letter

3	1	0	3	2	0	1	6
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DPC: Date of Project Completion

3	0	0	9	2	0	1	9
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Part A: Project Summary Report

1. Project Description

i.	Project Reference No.	NMHS/2015-16/LG-05					
ii.	Type of Project	Small Grant		Medium Grant		Large Grant	√
iii.	Project Title	Biodiversity Assessment through Long-term Monitoring Plots in Indian Himalayan Landscape					
iv.	State under which Project is Sanctioned	Under BTG "Conservation and Sustainable Use of Biodiversity"					
v.	Project Sites (IHR States covered)	<p>(1) Great Himalayan National Park (Himachal Pradesh) (2) Valley of Flowers National Park (Uttarakhand) (3) Neora Valley National Park (Darjeeling, West Bengal) (4) Dzongri (West Sikkim) (5) Kyongnosla Alpine Sanctuary (East Sikkim) (6) Tawang district (Arunachal Pradesh) (7) Namdapha National Park (Arunachal Pradesh)</p> <p>Maps are attached (BSI Annexure I)</p>					
vi.	Scale of Project Operation	Local	√	Regional		Pan-Himalaya	
vii.	Total Budget/ Outlay of the Project	3.43712 Crore					
viii.	Lead Agency	Botanical Survey of India, Kolkata, West Bengal					
	Principal Investigator (PI)	<p>Dr. B.K. Sinha Scientist-F Botanical Survey of India, Kolkata, West Bengal</p> <p>Dr. Kailash Chandra Director Zoological Survey of India, Kolkata, West Bengal</p>					

	Co-Principal Investigator (Co-PI)	<p>Dr. S.S. Dash Scientist-E Botanical Survey of India, Kolkata, West Bengal</p> <p>Dr. K.A. Subramanian Scientist-E Zoological Survey of India, Kolkata, West Bengal</p> <p>Dr. Vikas Kumar Scientist-E Zoological Survey of India, Kolkata, West Bengal</p>
ix.	Project Implementing Partners	<p>1. Botanical Survey of India, Kolkata, West Bengal</p> <p>2. Zoological Survey of India, Kolkata, West Bengal</p>
	Key Persons / Point of Contacts with Contact Details, Ph. No, E-mail	<p>Dr. B.K. Sinha Botanical Survey of India, Kolkata, West Bengal Contact No.: 033-23214050 E-mail: drbks2004@yahoo.co.in</p>

2. Project Outcome (*Botanical aspect*)

- 2.1. Abstract:** Recent studies on climate-change-induced impacts in Indian Himalayan Region raised many questions which need to be resolved through participatory scientific activities and development of strategies for long term monitoring and rehabilitation of the ecosystem. To address this issue the project was initiated to generate a baseline data and to establish permanent plots for future long-term monitoring. We have selected 7 study sites in 5 Indian Himalayan Region (IHR) states and established 437 monitoring plots. Exhaustive information on floristic composition was compiled from both primary and secondary sources on vegetational structure, of the respective experimental sites. The methods were standardised to develop protocols for future monitoring activities. Economically important, threatened and invasive alien species were also documented to facilitate appropriate conservation strategies. The findings provided in the present report are the first of its kind in IHR on plant resources, their ecology, with high scientific utilitarian value. Another significant mandate of the project was to disseminate the scientific outcome of the project among all the stake holders particularly in the local grass-root level. To achieve this target, we exposed the different stake holders to various informative lectures and interactions sessions with subject experts, on field training and by providing comprehensible publications on project outcomes. Besides, the project outcomes lay a path for further extensive ecological studies, which are duly recommended.

2.2. Objective-wise Major Achievements (*Botanical aspect*)

S. No.	Objectives	Major achievements
1.	To create a geospatial and genetic database on the flora of Himalaya and the climate change induced impact on floral diversity of the region.	<ul style="list-style-type: none"> • The floristic assessment of selected project sites of IHR resulted in the documentation of 1,881 taxa of various plant groups such as Gymnosperms, Angiosperms, Pteridophytes Fungi and Algae. This includes an exhaustive collection of 476 taxa from Great Himalayan National Park (Himachal Pradesh), 317 from Valley of Flowers National Park (Uttarakhand), 356 from Neora Valley National Park (Darjeeling, West Bengal), 123 from Kyongnosla Alpine Sanctuary (East Sikkim), 137 from Dzongri (West Sikkim), 298 from Tawang district (Arunachal Pradesh) and 174 from Namdapha National Park (Arunachal Pradesh). All these taxa were listed along with their field collection number, latitude, longitude and altitude as geospatial database of the respective project sites (<i>BSI Annexure II</i>). • This floristic study revealed 131 new distributional records both at local and national level (<i>BSI Annexure III and IX</i>). • The study also recorded 44 threatened taxa and 19 invasive alien taxa from various monitoring sites (<i>BSI Annexure IV</i>). • DNAs of 41 plant species from IHR were barcoded with sequence information of <i>rbcl gene</i> and <i>ITS5a gene</i>, to facilitate the genetic database (<i>BSI Annexure V</i>). • Apart from the local floristic explorations, a exhaustive baseline information on the floral diversity within the established long-term monitoring plots were also documented (<i>BSI Annexure VI</i>). • An inventory of flowering plants of Indian Himalayan Region was compiled, resulting to enumeration of 11,157 no. of taxa, belonging to 2,359 genera and 241 families with their current accepted names and detailed distribution in Indian state. • Information on occurrence, altitude, date of collection, name of collector, collection number, accession number, habit and phenology were collected from 66,431 herbarium specimens collected from IHR states and lodged at Central National Herbarium (CAL) and various other herbaria used as a resource for preparing geo-spatial database and models depicting the trends of changes in phenology over the time.

2.	To establish long-term floral diversity monitoring plots across the Himalayan region.	<ul style="list-style-type: none"> • A total of 437 long-term floral diversity monitoring plots were established in the selected sites across the IHR, documented their baseline vegetation data (<i>BSI Annexure I and VI</i>). Of these, 79 were established in Great Himalayan National Park (Himachal Pradesh), 105 in Valley of Flowers National Park (Uttarakhand), 79 in Neora Valley National Park (Darjeeling, West Bengal), 30 in Kyongnosla Alpine Sanctuary (East Sikkim), 35 in Dzongri (West Sikkim), 52 in Tawang district (Arunachal Pradesh) and 57 in Namdapha National Park (Arunachal Pradesh).
3.	To develop long-term monitoring protocols for selected indicator taxa in the region and to develop appropriate methodology for propagation of individual species for conservation	<ul style="list-style-type: none"> • The two-way species analysis (TWINSPAN) on data collected from 13 sub-sites recognised a total of 188 indicator taxa from different study sites. This also includes 41 trees, 54 shrubs and 73 herbs. Some of the important indicator species that observed in more than one sub-sites were <i>Bambusa tulda</i>, <i>Rhododendron lepidotum</i>, <i>Rosa macrophylla</i> and <i>R. sericea</i> amongst shrubs; <i>Fragaria nubicola</i>, <i>F. vesca</i>, <i>Impatiens sulcata</i>, <i>Ophiopogon intermedius</i> and <i>Polygonum vacciniifolium</i> amongst herbs and <i>Abies densa</i>, <i>A. pindrow</i>, <i>Alnus nepalensis</i>, <i>Dipterocarpus retusus</i>, <i>Magnolia hodgsonii</i>, <i>Pinus wallichiana</i>, <i>Rhododendron arboreum</i>, <i>R. hodgsonii</i> and <i>Sorbus microphylla</i> amongst trees (<i>BSI Annexure VI</i>). • The methodology of selection and their ecological explanations as indicator taxa were provided in <i>BSI Annexure VI and VII</i>. • Monitoring protocols for both vascular and non-vascular plants in studied sites, were formulated and inferred (<i>BSI Annexure XI</i>), supported by several case studies (<i>BSI Annexure XII</i>).

4.	To develop local level capacity building among students, teachers and NGO's in long- term monitoring through training programmes and publications for awareness.	<ul style="list-style-type: none"> • Three interactive sessions for building awareness among the different stakeholders in the IHR were organized at Gangtok (Sikkim) during 2016-17; at Solan (Himachal Pradesh) during 2017-18 and at Itanagar during 2018-2019 respectively. An open structured interactive discussion were held among Forest department personnel, students, NGOs, native residents to infer the different perceptions on need for long-term monitoring of biodiversity in Indian Himalayan Region. <i>(BSI Annexure VIII)</i>. • All the stakeholders were imparted trainings on biodiversity, conservations and education through a series of lectures by project research staffs, forest officials, outside experts. <i>(BSI Annexure VIII)</i>. • The research findings of our project were disseminated among both scientific and non-scientific communities through participation in several seminars/conferences <i>(BSI Annexure IX)</i>. Research outputs were also published for knowledge sharing <i>(BSI Annexure IX)</i>.
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2.3. Outputs in terms of Quantifiable Deliverables* (Botanical aspect)

S. No.	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations made, if any, and Reason there of:
1.	Development of baseline geospatial and genetic database of 6 sites on the representative taxa focusing on endemic/ threatened/ invasive-aliens	Geospatial datasets generated (time series data with no. of sites and species)	Requisite base line information of the selected sites for floristic and ecological perspective were collected from all studied sites. <i>(BSI Annexure II to VI)</i>	None
2.	Identification of the indicator taxa for prioritization of biodiversity conservation in selected sites.		A total of 188 taxa of plant indicator species from 13 sub-sites and 7 sites, including 41 trees, 54 shrubs and 73 herbs, were identified and prioritised for further studies <i>(BSI Annexure VI)</i> .	None
3.	The establishment of long-term monitoring plots across ecosystems and habitat gradient in the 6 sites of Himalaya.	No. of plots established for long term monitoring	A total of 437 long-term floral diversity monitoring plots were established in the selected sites across the IHR, documenting their baseline vegetation data <i>(BSI Annexure I and VI)</i> .	None

4.	Capacity building of local stake holders in 4 IHR states.	Community groups trained (Nos.) Awareness camps/ programmes organized (Nos.) Publication of knowledge (No.)	Three capacity building training programmes were organized for local stakeholders. All the research staffs were also participated in several awareness campaigns and biodiversity camps (<i>BSI Annexure VIII</i>). Research findings were presented through 08 research presentations in various seminars, published one book, 26 research and popular articles. Five pamphlets. All these finding so prepared describing the project activities and floral diversity were distributed during different awareness programmes (<i>BSI Annexure IX</i>).	None
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(* As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. Strategic Steps with respect to Outcomes (*Botanical aspect*)

S. No.	Particulars	Number/ Brief Details	Remarks/ Enclosures
1.	New Methodology developed	Two long-term monitoring protocols were prepared for vascular and non-vascular plants.	<i>(BSI Annexure XI and XII)</i>
2.	New Models/ Process/ Strategy developed	NA	NA
3.	New Species/New records identified	A total of 131 new distributional records of Angiosperms, bryophytes and algae were identified.	<i>(BSI Annexure III and IX)</i>

S. No.	Particulars	Number/ Brief Details	Remarks/ Enclosures
4.	New Database established	<ul style="list-style-type: none"> • Primary data on floristic information of the selected studied sites were summarized. • An enumeration of flowering plants of Indian Himalayan Region (IHR) was compiled. This information contains current accepted names of 11,157 no. of taxa, belonging to 2,359 genera and 241 families along with detailed distribution in Himalayan states. 	(BSI Annexure II, VI and XII)
5.	New Patent, if any	NA	NA
	I. Filed (Indian/ International)		
	II. Granted (Indian/ International)		
	III. Technology Transfer(if any)		
6.	Others (if any)		

3. **Technological Intervention: Not applicable**

4. **New Data Generated over the Baseline Data (Botanical aspect)**

S. No.	New Data Details	Status of Existing Baseline	Additionality and Utilisation New data
1	A checklist of 11,157 flowering plants of IHR was prepared.	The existing information on the floral wealth (angiosperms) was restricted to ca. 7500 taxa.	The updated list will enrich the knowledge on the plant wealth of IHR and can be treated as a secondary source for future analyses.
2	131 New floristic records from the study sites were documented at both local and national level.	The new distributional records were authenticated basing on the published literature.	The new records were significant addition to the country as well as the protected areas, which enhances the conservation potentiality of the region.
3	Baseline vegetation information of the established plots.	Several of the studied sites were explored for vegetation data on ecological perspectives for the first time.	This baseline information will provide a base for further long-term monitoring of those ecosystems and for accessing the impact of climate change.

4	44 threatened taxa and 19 invasive alien plants from the studied sites were identified.	This documentation is a significant addition to the status of the threatened plants of the country.	The information on threatened plants can be used by conservation policy makers. Further vegetation studies can be focused on the invasive alien plants to study their expansion and its effect on the existing ecosystem.
5	Regeneration status of selected tree species of Neora valley N.P. and Namdapha N.P. was studied.	Such assessments were made for the first time from the localities.	The results will help in developing a systematic management plan which is required in the view of for conservation and sustainable utilization.

5. **Demonstrative Skill Development and Capacity Building/Manpower Trained** (*Botanical aspect*)

S. No.	Type of Activities	Details with number	Activity Intended for	Participants/Trained			
				SC	ST	Woman	Total
1.	Workshops	02	Awareness on floral diversity and their conservation	28	32	45	131
2.	On Field Trainings	02	-do-	28	32	45	131
3.	Skill Development						
4.	Academic Supports	04	Registered for PhD			01	04
	Others (if any)						

6. **Linkages with Regional & National Priorities (SDGs, INDC, etc)/ Collaborations**

S. No.	Linkages /collaborations	Details	No. of Publications/ Events Held	Beneficiaries
1.	Sustainable Development Goal (SDG)			
2.	Climate Change/INDC targets			
3.	International Commitments			
4.	Bilateral engagements			
5.	National Policies			
6.	Others collaborations			

7. **Project Stakeholders/ Beneficiaries and Impacts** (*Botanical aspect*)

S. No.	Stakeholders	Support Activities	Impacts
1.	Gram Panchayats	Awareness through workshops and training programmes	Stakeholders were intimated about the plant diversity in relation to conservation and protection. The disbursed study materials among them were palatable for layman for floral identification and understanding their importance.
2.	Govt Departments (Agriculture/ Forest)	Awareness campaign and biodiversity camps	
3.	Villagers	Awareness through workshops and training programmes	
4.	SC Community		
5.	ST Community		
6.	Women Group		
	Others (Students)		

8. **Financial Summary (Cumulative)*: 1st April 2016 to 30th September 2019 (Botanical Survey of India)**

Tentative Expenditure as per our record (This may be changed after \reconciliation by PAO, BSI/ZSI, Kolkata)

S. No.	Financial Position/Budget Head	Funds Received	Expenditure/ Utilized	Balance
I.	Salaries/Manpower cost	87,85,600.00	87,83,355.00	2,245.00
II.	Travel	25,50,000.00	16,80,832.00	8,69,168.00
III.	Expendables & Consumables	27,00,000.00	20,43,221.00	6,56,779.00
IV.	Contingencies	13,50,000.00	13,33,536.00	16,464.00
V.	Activities & Other Project cost	9,16,804.00	8,84,398.00	32,406.00
VI.	Institutional Charges	-	-	-
VII.	Equipments	-	-	-
	Total	1,63,02,404.00	1,47,25,342.00	15,77,062.00
	Interest earned			
	Grand Total			

* Consolidated and audited Utilization Certificate (UC) and Year wise Statement of Expenditure (SE) are attached separately after reconciliation by PAO Kolkata (BSI/ZSI); ref. **Annexures**.

9. **Major Equipment/ Peripherals Procured under the Project** (if any): Not applicable**

10. Quantification of Overall Project Progress (*Botanical aspect*)

S. No.	Parameters	Total (Numeric)	Remarks/ Attachments/ Soft copies of documents
1.	IHR States Covered	05	<i>BSI Annexure I</i>
2.	Project Site/ Field Stations Developed	07 sites (13 sub-sites)	<i>BSI Annexure I, VI</i>
3.	New Methods/ Modeling Developed	02 (protocols)	<i>BSI Annexure XI</i>
4.	No. of Trainings arranged	02	<i>BSI Annexure VIII</i>
5.	No of beneficiaries attended trainings	131	<i>BSI Annexure VIII</i>
6.	Scientific Manpower Developed (Phd/M.Sc./JRF/SRF/ RA):	12	<i>BSI Annexure X</i>
7.	SC stakeholders benefited	28	<i>BSI Annexure VIII</i>
8.	ST stakeholders benefited	32	<i>BSI Annexure VIII</i>
9.	Women Empowered	46	<i>BSI Annexure VIII, X</i>
10.	No of Workshops Arranged along with level of participation	02 (one each in eastern and western Himalaya)	<i>BSI Annexure VIII</i>
11.	On field Demonstration Models initiated	NA	NA
12.	Livelihood Options promoted	NA	NA
13.	Technical/ Training Manuals prepared	NA	NA
14.	Processing Units established	NA	NA
15.	No of Species Collected	1881	<i>BSI Annexure II</i>
16.	New Species / New records identified	131 (new records)	<i>BSI Annexure III and IX</i>
17.	New Database generated (Types):	Floristic and vegetation data	<i>BSI Annexure II – VI, XII</i>

11. Knowledge Products and Publications by BSI:

S. No.	Publication/ Knowledge Products	Number		Total Impact Factor	Remarks/ Enclosures
		National	International		
1.	Journal Research Articles*	08	03	1.535	<i>BSI Annexure VIII</i>
2.	Books	01	–	–	
3.	Papers presented in Conferences/Seminars	08	–	–	
4.	Others (Pamphlets)	05	–	–	
5.	Others (Semi-technical articles)	05	–	–	

* Eight (08) Research Articles are communicated to various reputed Journal.

12. Recommendation on Utility of Project Findings, Replicability and Exit Strategy (*Botanical aspect*)

Particulars	Recommendations
<p>Utility of the Project Findings</p>	<p>One of the pioneer project findings is the updated floristic database generated through existing secondary and studied primary information. This database can be useful for future ecological modelling and phonological analysis. The inventory also provides lists of economically important, threatened and invasive alien plant species. This vast information can directly be utilized by the inhabitants of the Himalaya for their socio-economic upliftment and sustainable development. The established monitoring plots with associated data can be exploited for future ecological studies in answering the climate change issues. Local-level awareness and on-field trainings will empower the Himalayan stakeholders in participating in various conservation policies.</p>
<p>Replicability of Project</p>	<p>The field data generated through this project are of high replicability scope. The established plots were accurately plotted in GIS-based maps for their easy accessibility. Plot data included a list of 1881 plant species (tree, shrub and herb) along with the detailed vegetation data comprising plant species richness of study sites, diversity indices (<i>Shannon</i>, <i>Simpson</i> and <i>Evenness</i>), and basal cover for woody species, accompanied by density of different plant levels in each plots/sub-sites. For future monitoring of these established plots, two protocols for both vascular and non-vascular plants were standardized. The baseline information is also powered by several case studies on trees, climbers, orchids, plant life-forms, moss-associated diatoms and soil diatoms. These studies can also be replicated in other parts of IHR resulting more authentic cumulative inferences.</p>

<p>Exit Strategy & recommendations</p>	<p>The methodology followed for conducting the research activities in the project was mostly based on previously standardized ones, particularly in establishing long-term monitoring plots and gathering their associated information. Yet, several improvements were accomplished and suggested in the protocols. It is suggested that <i>trail/transect</i> method should be selected instead of aerial grids, depending on the topography and accessibility of the remote locality of IHR. Large scale circular plots are recommended as advanced over small scale square plots. Different gradients of site selection must be cleared prior to the plot data collection. It is also recommended to conclude any ecological inference after analyzing a wide range of data for deducting a valid sequitur.</p>
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(PROJECT PROPONENT/ COORDINATOR)
(DR. B. K. SINHA, Sci. F, BSI)

(PROJECT CO-PRINCIPAL INVESTIGATOR)
(Dr. S.S.Dash, Scientist E, BSI)

(HEAD OF THE INSTITUTION)
(DR. A.A. MAO, Director, BSI)

Place:
Date:/...../.....

Template/Pro forma for Submission**NMHS-FINAL TECHNICAL REPORT (FTR)**

Demand-Driven Action Research Project Grant

NMHS Reference No.:	NMHS/LG-2016/0011
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Date of Submission:	3	0	0	9	2	0	1	9
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**BIODIVERSITY ASSESSMENT THROUGH LONG-TERM MONITORING PLOTS
IN THE INDIAN HIMALAYAN LANDSCAPE**

Project Duration: from (01.04.2016) to (30.09.2019).

Submitted to:

Er. Kireet Kumar

Scientist 'G' and Nodal Officer, NMHS-PMU

National Mission on Himalayan Studies, GBPNIHESD HQs

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NMHS-Final Technical Report (FTR) template

Demand-Driven Action Research Project

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Part A: Project Summary Report

1. Project Description

i.	Project Reference No.	NMHS/LG-2016/0011					
ii.	Type of Project	Small Grant		Medium Grant		Large Grant	✓
iii.	Project Title	Biodiversity Assessment through Long-term Monitoring Plots in the Indian Himalayan Landscape					
iv.	State under which Project is Sanctioned	1) Himachal Pradesh 2) Uttarakhand 3) Sikkim 4) West Bengal (Darjeeling & Kalimpong) 5) Arunachal Pradesh					
v.	Project Sites (IHR States covered) (Maps to be attached)	(1) Great Himalayan National Park, Himachal Pradesh (2) Valley of Flowers, Uttarakhand (3) Kyongnosla Alpine Sanctuary, Sikkim (4) Gnathang plateau (East District), Sikkim (5) Neora Valley National Park, West Bengal (6) Tawang district, Arunachal Pradesh (7) Namdapha National Park, Arunachal Pradesh.					
vi.	Scale of Project Operation	Local		Regional		Pan-Himalayan	✓
vii.	Total Budget/ Outlay of the Project	₹ 1,63,02,404.00 for ZSI (in Cr)					
viii.	Lead Agency	Botanical Survey of India, Kolkata					

Annexure- IX

	Principal Investigator (PI)	Dr. Kailash Chandra, Scientist – G (Director, ZSI)
	Co-Principal Investigator (Co-PI)	Dr. Vikas Kumar, Scientist- D
ix.	Project Implementing Partners	Botanical Survey of India, Kolkata
	Key Persons / Point of Contacts with Contact Details, Ph. No, E-mail	<p>Dr. Basudev Tripathy, Scientist- D Officer-in-charge, Technical Section, Zoological Survey of India, Kolkata (HQ) Email: tripathvb@gmail.com Mob: (+91) 9477942292 Project Co-ordinator, NMHS Himalayan Biodiversity Project, ZSI, Kolkata</p>

2. Project Outcome

2.1. **Abstract** (not more than 500 words) [it should include background of the study, aim, objectives, methodology, approach, results, conclusion and recommendations).

Background: The biodiversity and ecosystem health of Himalaya has been increasingly threatened due to ongoing anthropogenic activities and Human induced climate change. Altitudinal shifts of vegetation are observed in many places and are estimated to be 80-200m per decade. Biodiversity of glaciers, snow fields and high altitude zones will be most adversely affected by these changes. **Objectives/ Aim:** To create a geospatial and genetic database with identifying potential indicator for climate change in Indian Himalaya, establishment of permanent monitoring plots for Himalayan Fauna, developing monitoring protocol for selected indicator taxa in IHR and to develop local level capacity among students, teachers and NGO's for long-term monitoring. **Methodology's:** Methodologies that were followed are followed as per standard procedure and varied as per individual taxa. **Approach:** We conducted our research through field surveys and laboratory identification methods and standard GIS and statistical analysis. **Results:**

1. An **online GIS based database** platform with public access on the records and distribution of faunal species in Indian Himalaya.
2. Generated a total of **45 distributional maps** for Himalayan fauna with new distributional localities so far in the Indian Himalaya including several species threatened, indicator, economically important and newly described species.
3. Present study in search for possible indicator species through climate envelope modeling of **40 species** has revealed 24 species to be decreased its climatic niche in the year 2050 due to the altered climate in the Himalaya.
4. Present study has collected 8036 specimens and 48 samples (soil and moss) from the five study sites of Indian Himalaya from which **1778 species were identified**.
5. **Two new genera, 20 species are described as new** to science along with **22 species** of different taxa are recorded for the **first time from India**.
6. **A book was published** on the monitoring protocol of fauna in the Indian Himalaya titled, "Toolkit for Long-Term Monitoring of the Faunal Resources in the Indian Himalaya".
7. Completed **three capacity building programs**.

Conclusion: Altogether, 1778 species were collected during present study, including maximum 782 species from NNP, followed by NVNP with 624 species, Tawang 346 species, GHNP 252 species and VoF 241 species. Most number of novel species were described from NNP (9), followed by VoF (6), Tawang (4) and GHNP (1).

Recommendations: Present study recommends further monitoring and continuing of the surveys on the established monitoring plots following the published methods from the current project and continuous monitoring of suggested taxa for possible indication of climate change.

2.2. Objective-wise Major Achievements

S. No.	Objectives	Major achievements (in bullets points)
	<p>1. To create a geospatial and genetic database on the fauna of Himalaya and the climate change- induced impact on faunal diversity of the region.</p>	<ol style="list-style-type: none"> 1. An online GIS based database platform with public access on the records and distribution of faunal species in Indian Himalaya. 2. Generated a total of 45 distributional maps for Himalayan fauna with new distributional localities so far in the Indian Himalaya including several species threatened, indicator, economically important and newly described species. 3. Present study in search for possible indicator species through climate envelope modelling of 40 species has revealed 24 species to be decreased its climatic niche in the year 2050 due to the altered climate in the Himalaya.
	<p>2. To establish long-term faunal diversity monitoring plots across the Himalayan region.</p>	<ol style="list-style-type: none"> 1. Present study has collected 8036 specimens and 48 samples (soil and moss) from the five study sites of Indian Himalaya from which 1778 species belongs to different taxa were identified. 2. Two new genera, 20 species are described as new to science along with 22 species of different taxa are recorded for the first time from India.
	<p>3. To develop long-term monitoring protocols for selected indicator taxa in the region.</p>	<ol style="list-style-type: none"> 1. A book was published on the monitoring protocol for the fauna of the Indian Himalaya titled, "Toolkit for Long-Term Monitoring of the Faunal Resources in the Indian Himalaya".

<p>4. To develop local level capacity building among students, teachers and NGOs for long-term monitoring through training programmes and publications.</p>	<p>1. Capacity Building Program:</p> <p>a) Three National Level Capacity Building Workshops on “Long Term Monitoring of Himalayan Biodiversity” for Stakeholders of Himalayan Region were organised. First Program was held at Gangtok, Sikkim on 29th and 30th March 2017. The second program was held at Solan, Himachal Pradesh on 23rd and 24th March, 2018. The third and last program was held at Itanagar, Arunachal Pradesh on 31st March and 1st April, 2019.</p> <p>b) Ministry of Environment, Forest and Climate Change, Government of India has formulated a novel Green Skill Development Programme (GSDP) for enhancing skills of Class X/XII pass/dropouts. A team of ZSI resource person have participated GSDP programme in BSI Sikkim to instruct the stakeholder on different aspects of Zoological studies, including systematic classification of Animal Kingdom, Biodiversity and its significance, collection and preservation of different zoological taxa, Wildlife conservation, different instruments being used in wildlife/ zoological surveys, wildlife acts through lecture and field demonstration.</p> <p>2. Gender Equality: The program conducted in Gangtok, 2017 were attended by 26% of female and 74% male members. The capacity building program conducted at Solan, 2018 was participated by 47% female and 53% male members. The program conducted at Itanagar, 2019 were attended by 55% of females and 45% male members.</p> <p>3. Communications: The ZSI-NMHS team also participated in Wildlife Week Celebration at M.G. Marg, Gangtok, Sikkim developing several events and displayed information on faunal diversity of Indian Himalaya and demonstrated the instruments to monitor them.</p>
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2.3. Outputs in terms of Quantifiable Deliverables*

S. No.	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations made, if any, and Reason thereof:
1.	Establishing Long-term Monitoring Plots in IHR	15 permanent plots established.	Two new genera, 20 species are described as new to science along with 22 species of different taxa are recorded for the first time from India.	Monitoring plots in Sikkim were not surveyed due to denied permission for the project.
2.	Develop Geo-spatial and Genetic database of fauna in IHR.	An online GIS based database platform with public access on the records and distribution of faunal species in Indian Himalaya. Genetic database for 58 species of various taxa with 450 sequences were generated and uploaded in BOLD database.	Database has distributional record of more than 30 thousand species from IHR. Total 77 barcode data from different species of IHR has been generated novel for the BOLD database.	
3.	Identifying indicator Taxa	40 species from various taxa were identified as possible climate change indicator for IHR.	40 Climate envelope model for future projections were developed.	
4.	Creating awareness and building capacity among stake holders	Three National Capacity Building Program, one awareness and one Skill development program was organized.	Capacity enhancement of 281 participants through study materials and discussions were conducted.	

(*) As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. Strategic Steps with respect to Outcomes (in bullets)

S. No.	Particulars	Number/ Brief Details	Remarks/ Enclosures
1.	New Methodology developed	Monitoring protocol developed for indicator taxa In IHR.	1 book published. Appendix 5
2.	New Models/ Process/ Strategy developed	40 future projection models developed for possible climate change indicator in IHR.	Annexure- 11
3.	New Species identified	2 Genus and 20 species of various taxa have been newly described from IHR.	Appendix 4
4.	New Database established	Geo-spatial Database on fauna of IHR established.	Annexure 12
5.	New Patent, if any		
	I. Filed (Indian/ International)		
	II. Granted (Indian/ International)		
	III. Technology Transfer(if any)		
6.	Others (if any)	22 species of various taxa has been reported for the first time from India	Appendix 4

3. Technological Intervention

S. No.	Type of Intervention	Brief Narration on the interventions	Unit Details (No. of villagers benefited / Area Developed)
1.	Development and deployment of indigenous technology	NA	NA
2.	Diffusion of High-end Technology in the region	NA	NA
3.	Induction of New Technology in the region	NA	NA
4.	Publication of Technological / Process Manuals	NA	NA
	Others (if any)	NA	NA

4. New Data Generated over the Baseline Data

S. No.	New Data Details	Status of Existing Baseline	Additionality and Utilisation New data
1.	Two Genus and 20 species new to science described	30,377 species/sub Species (Chandra <i>et al.</i> , 2018)	1033 species of different taxa were recorded for the first time from study sites in IHR. 22 species from various taxa were reported for first time from India. Appendix 4
2.	Future projection of 40 species as possible indicator for monitoring of climate change in IHR	No such data was available on the fauna of IHR.	Annexure- 11
3.	77 barcode data from different species of IHR has been generated novel for the BOLD database		Annexure 13

5. Demonstrative Skill Development and Capacity Building/ Manpower Trained

S. No.	Type of Activities	Details with number	Activity Intended for	Participants/Trained			
				SC	ST	Woman	Total
1.	Workshops		Students	-	-	45%	147
2.	On Field Trainings		Students	-	-	46%	15
3.	Skill Development		Students	-	-	68%	134
4.	Academic Supports		PhD candidate	-	-	-	3
	Others (if any)						

6. Linkages with Regional & National Priorities (SDGs, INDC, etc)/ Collaborations

S. No.	Linkages /collaborations	Details	No. of Publications/ Events Held	Beneficiaries
1.	Sustainable Development Goal (SDG)	Three National Capacity Building Program, one awareness program and one Skill development program was organized.	Capacity enhancement of 281 participants through study materials and discussions were conducted.	Students, Govt. Officers, Forest officials, Local stakeholders and NGOs.
2.	Climate Change/INDC targets	Three National Capacity Building Program, one awareness program and one Skill development program was organized.	Capacity enhancement of 281 participants through study materials and discussions were conducted.	Students, Govt. Officers, Forest officials, Local stakeholders and NGOs.
3.	International Commitments			
4.	Bilateral engagements			
5.	National Policies			
6.	Others collaborations	Three Students enrolled in PhD program	-	Students

7. Project Stakeholders/ Beneficiaries and Impacts

S. No.	Stakeholders	Support Activities	Impacts
1.	Gram Panchayats	Three National Capacity Building Program, one awareness program and one Skill development program was organized.	Enhanced knowledge on local fauna and its sustainable use.
2.	Govt Departments (Agriculture/ Forest)	Three National Capacity Building Program, one awareness program and one Skill development program was organized.	Enhanced knowledge on faunal diversity of IHR and their identification as well as survey methodologies.
3.	Villagers	Knowledge on the faunal diversity	Enhanced knowledge on

		of IHR was shared with the local residents of the villages near the study sites. They were also group discussions among the villagers and project personnel on the conflict and resource utilization of wild faunal resources of IHR.	faunal diversity of IHR and their identification as well as survey methodologies
4.	SC Community	Present study supported 51 individuals belonging to SC communities through 3 Capacity Building Program.	Enhanced knowledge on local fauna and its sustainable use. Enhanced knowledge on faunal diversity of IHR and their identification as well as survey methodologies.
5.	ST Community	Present study supported 34 individuals belonging to ST communities through 3 Capacity Building Program.	Enhanced knowledge on local fauna and its sustainable use. Enhanced knowledge on faunal diversity of IHR and their identification as well as survey methodologies.
6.	Women Group	Three National Capacity Building Program, one awareness program and one Skill development program was organized under the present study.	Enhanced knowledge on local fauna and its sustainable use. Enhanced knowledge on faunal diversity of IHR and their identification as well as survey methodologies.
	Others (if any)	Three Students enrolled in PhD program in UGC registered University	Three Doctoral candidates on exclusively IHR faunal groups will emerge as expert on their respective area of studies.

8. **Financial Summary (Cumulative), ref. Annexure I.**

Total Project Expenditure (April 2016 – September 2019)				
Sl No.	Budget head	Amount received	Expenditure	Remaining Balance
1.	Salaries/ Manpower cost	₹ 87,85,600.00	₹ 87,62,602.00	₹ 22,998.00
2.	Travel	₹ 25,50,000.00	₹ 19,95,464.00	₹ 5,54,536.00
3.	Expendables & Consumables	₹ 27,00,000.00	₹ 27,00,000.00	₹ 0.00
4.	Contingencies	₹ 13,50,000.00	₹ 13,50,000.00	₹ 0.00
5.	Capacity building	₹ 9,16,804.00	₹ 9,08,857.00	₹ 7,947.00
	Total Rs.	₹ 1,63,02,404.00	₹ 1,57,16,923.00	₹ 5,85,481.00

* Please attach the consolidated and audited Utilization Certificate (UC) and Year wise Statement of Expenditure (SE) separately, *ref. Annexure 1.*

9. **Major Equipment/ Peripherals Procured under the Project** (if any)**

S. No.	Name of Equipments	Cost (INR)	Utilisation of the Equipment after project
1.	NA		
2.			

**Details should be provided in details (*ref Annexure III &IV*).

10. **Quantification of Overall Project Progress**

S. No.	Parameters	Total (Numeric)	Remarks/ Attachments/ Soft copies of documents
1.	IHR States Covered	5	Annexure- 9
2.	Project Site/ Field Stations Developed	7	Annexure- 9
3.	New Methods/ Modeling Developed	40	Annexure- 11
4.	No. of Trainings arranged	5	Appendix 3
5.	No of beneficiaries attended trainings	281	Appendix 3
6.	Scientific Manpower Developed (Phd/M.Sc./JRF/SRF/ RA):	12	Appendix 3
7.	SC stakeholders benefited	51	Appendix 3
8.	ST stakeholders benefited	34	Appendix 3
9.	Women Empowered	53%	Appendix 3
10.	No of Workshops Arranged along with level of participation	3	Appendix 3

11.	On field Demonstration Models initiated	2	Appendix 3
12.	Livelihood Options promoted	281	Appendix 3
13.	Technical/ Training Manuals prepared	1	Appendix 5
14.	Processing Units established	NA	NA
15.	No of Species Collected	1778 species of different taxa	Annexure 14
16.	New Species identified	20	Appendix 4
17.	New Genera identified	2	Appendix 4
18.	New Database generated (Types):	1	Annexure 12
	Others (if any) No. of species first time reported from India	22	Appendix 4

11. Knowledge Products and Publications:

S. No.	Publication/ Knowledge Products	Number		Total Impact Factor	Remarks/ Enclosures
		National	International		
1.	Journal Research Articles/ Special Issue:	9	19	SCI (IF) - 12.115 NAAS(IF) - 123.84	Appendix 2
2.	Book Chapter(s)/ Books:	15	-	NA	Appendix 2
3.	Technical Reports	-	-	-	-
4.	Training Manual (Skill Development/ Capacity Building)	1	-	NA	Appendix 3
5.	Papers presented in Conferences/Seminars	3	-	NA	Annexure 15
6.	Policy Drafts/Papers	-	-	-	-
7.	Others: (Popular Article)	1	-	NA	Appendix 2

* Please append the list of KPs/ publications (with impact factor and further details) with due Acknowledgement to NMHS.

12. Recommendation on Utility of Project Findings, Replicability and Exit Strategy

Particulars	Recommendations
Utility of the Project Findings	Further studies on faunal diversity on Himalayan Landscape
Replicability of Project	Yes. Possible and Recommended.
Exit Strategy	Projects has generated enough published documents implying and recommending further assessment of fauna in the Indian Himalaya and have recommended several species to monitor for identifying changes in Climate in Future which can help in sustaining benefitting the stakeholders and local community.

(PROJECT PROPONENT/ COORDINATOR)

(Signed and Stamped)



(HEAD OF THE INSTITUTION)

(Signed and Stamped)

डॉ. कल्पेश चंद्रा
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MoEF & CC, Govt. of India
बंगलूर / Kolkata

Place:

Date: 31.1.2019