Template/Pro forma for Submission

NMHS-Himalayan Institutional Project Grant

NMHS-FINAL TECHNICAL REPORT (FTR)

Demand-Driven Action Research and Demonstrations

NMHS Grant Ref. No.:	GBPNI/NMHS-2017-18/SG 26

Date of Submission:	0	4	0	1	2	0	2	3
	d	**d**	**m**	**m**	**y**	**y**	**y**	**y**

PROJECT TITLE (IN CAPITAL)

Bringing back the real green: Eradicating invasive species and restoring ecosystems through community participation

Project Duration: *from* (**28.03.2018**) *to* (**31.12.2021**).

***Submitted to*:**

Er. Kireet Kumar

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***Submitted by*:**

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GENERAL INSTRUCTIONS:

1. The Final Technical Report (FTR) has to commence from the start date of the Project (as mentioned in the Sanction Order issued by NMHS-PMU) till completion of the project duration. Each detail has to comply with the NMHS Sanction Order.
2. The FTR should be neatly typed (in Arial with font size 11 with 1.5 spacing between the lines) with all details as per the enclosed format for direct reproduction by photo-offset printing. Colored Photographs (high resolution photographs), tables and graphs should be accommodated within the report or annexed with captions. Sketches and diagrammatic illustrations may also be given detailing about the step-by-step methodology adopted for technology development/ transfer and/ or dissemination. Any correction or rewriting should be avoided. Please provide all information under each head in serial order.
3. Any supporting materials like Training/ Capacity Building Manuals (with detailed contents about training programme, technical details and techniques involved) or any such display material related to project activities along with slides, charts, photographs should be brought at the venue of the Annual Monitoring & Evaluation (M&E) Workshop and submitted to the NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora 263643, Uttarakhand. In all Knowledge Products, the Grant/ Fund support of the NMHS should be duly acknowledged.
4. The FTR Format is in sync with many other essential requirements and norms desired by the Govt. of India time-to-time, so each section of the NMHS-FTR needs to be duly filled by the proponent and verified by the Head of the Lead Implementing Organization/ Institution/ University.
5. Five (5) hard-bound copies of the Project Final Technical Report (FTR) and a soft copy of the same should be submitted to the **Nodal Officer, NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora, Uttarakhand**.

The FTR is to be submitted into following two (02) parts:

Part A – Project Summary Report

Part B –Detailed Project Report

In addition, the Financial and other necessary documents/certificates need to be submitted along with the Final Technical Report (FTR) as follows:

Annexure I **Consolidated and Audited Utilization Certificate (UC) & Statement of Expenditure (SE)**, including the interest earned for the last Fiscal year and the duly filled GFR-19A (with year-wise break-up).

Annexure II	**Consolidated Interest Earned Certificate**
Annexure III	**Consolidated Assets Certificate** showing the cost of the equipment in Foreign/ Indian currency, Date of Purchase, etc. (with break-up as per the NMHS Sanction Order and year wise).
Annexure IV	**List of all the equipment, assets and peripherals** purchased through the NMHS grant with current status of use, including location of deployment.
Annexure V	**Transfer of Equipment** through Letter of Head of Institution/Department confirming the final status of equipment purchased under the Project.
Annexure VI	**Details, Declaration and Refund of any Unspent Balance transferred through Real-Time Gross System (RTGS)/ PFMS in favor of NMHS GIA General**

NMHS-Final Technical Report (FTR) *template*

Demand-Driven Action Research Project

DSL: Date of Sanction Letter

2	8	0	3	2	0	1	8
d	d	m	m	y	y	y	y

DPC: Date of Project Completion

3	1	1	2	2	0	2	1
d	d	m	m	y	y	y	y

Part A: Project Summary Report

1. Project Description

i.	Project Grant Ref. No.:	GBPNI/NMHS-2017-18/SG 26						
ii.	Project Category:	Small Grant	✓	Medium Grant		Large Grant		
iii.	Project Title:	Bringing back the real green: eradicating invasive species and restoring ecosystems through community participation						
iv.	Project Sites (IHR States/ UTs covered) (*Location Maps attached*):	Himachal Pradesh (Bandla, Palampur 32^0 08' 15.42" 4 N lat., 760 33' 06.406" E long) (Appendix 07)						
v.	Scale of Project Operation:	Local		Regional	✓	Pan-Himalayan		
vi.	Total Budget:	46,08,000/- (In Cr)						
vii.	Lead Agency:	CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur-176061 (HP).						
	Lead PI/ Proponent:	Dr. Sanjay Kr. Uniyal, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176061 (HP).						
	Co-PI/ Proponent:	Dr. Rakshak Kumar, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176061 (HP).						
viii.	Implementing Partners:	Village Forest Development Society Bohal-Odi, Palampur-176061.						

	Key Persons (Contact Details, Ph. No., E-mail):	1. Mr. Dagu Ram, President Village Forest Development Society Vill. Bohal, P.O Bundla, Palampur-176061, Mob: 88940516352 2. Ms. Mallika Devi, Member Village Forest Development Society Vill. Bohal, P.O Bundla, Palampur-176061

2. Project Outcomes

2.1. Abstract/ Summary (not more than 250-300 words)

***Background*:** Invasive species are today a serious threat not only to biodiversity but also to the livelihood of communities. Their far-reaching impacts are visible on ecology, economy and health of the region they invade. Today even the pristine mountain areas such as the Himalaya are bearing the brunt of invasive species. Bohl, Mandai, and Odi villages of the Palampur forest division of Himachal Pradesh are well known as the base for the Palampur Water Governance Initiative (PWGI) and the spread of these *Lantana camara*, *Eupatorium adenophorum* and *Parthenium hysterophous* is a cause of concern.

Aim: The proposal therefore targets eradication of invasive species from the area and restoration of degraded ecosystem using multipurpose native species by involving local communities.

***Methodology/Approach**:* The methodologies used were standard procedure which includes, field surveys, sampling, social interactions, eradication Programs, and restoration of the area.

***Results/ Outcomes*:**

- Invasive species eradicated from 10 ha area through two eradication drives, involving three villages. Plantation of grasses for ensuring fodder availability to the villagers and checking erosion carried out on two by involving villagers in plantation drives. Four awareness camps/drives were also conducted.

- The forest was found to be heavily infested with the obnoxious weed *Ageratina adenophora*. The distribution revealed maximum density (53.27 individuals/m2) and frequency (86.36%) of *A. adenophora* at the disturbed site compared to the undisturbed site.

- The distribution of seedling and saplings revealed a non-significant pattern between the disturbed and undisturbed sites.

- Overall seedling, sapling and tree density was higher at the undisturbed site (12727, 3240, and 1190 individuals/ha, respectively) as compared to the disturbed site (10000, 2440, and

950 individuals/ha; respectively.

- The soil pH, bulk density (BD) and available sodium (Na) reported higher values at the disturbed site, while values of organic matter (OM), available nitrogen (aN), available phosphorus (aP), available potassium (aK), available calcium (Ca) and available magnesium (Mg) were higher at the undisturbed site.

Conclusions Altered species composition and distribution in the 'Bohal spring-shed' forest has been observed. Soil properties differed significantly between the disturbed and undisturbed sites. The disturbed site was heavily infested with *Ageratina adenophora*, which would undoubtedly have an impact on the distribution of native species. The disturbance has resulted in altered vegetation assemblages in the current area, which may have an impact on the ecosystem services provided by this community managed forest. Furthermore, the long-standing quid pro quo relationship between stakeholders appears to be deteriorating and requires immediate attention. Community involvement in decision making and awareness programs focusing on sustainable forest management should be effectively implemented. Long-term ecological monitoring of the forest should be prioritized, with a focus on alien species.

Recommendations/ Way Forward with Exit Strategy*:*

- Any conservation and management program, particularly in the Himalaya, should include communities as primary participants.
- The current study site represents a typical Himalayan landscape, the approach taken here has implications for the larger Himalayan region.
- Residents will be inspired to manage resources because the eradication of noxious weeds benefits the local residents by providing various services which provides with the livelihood requirements.
- The plantation meets the livelihood needs of the resident communities (fuel, fodder, timber, medicine, and so on), providing self-motivation for their conservation.

2.2. Objective-wise Major Achievements

S#	Objectives	Major achievements (***in bullets points***)
1.	Identification of areas under heavy infestation of invasive species	Areas of infestation identified. Sampling conducted as well as co-ordinates were noted. Locations mapped.
2.	Awareness creation amongst the local communities	Four awareness drives have been conducted, which involved thirty women.

3.	Removal of invasive species by involving stakeholders	Two eradication drives have been carried out covering 10 ha area which was cleared of *Eupatorium* invasive species.
4.	Restoration of degraded sites.	Two plantation drives were initiated where *Penisettum* spp. were planted.

Note: Further details may be summarized in DPR Part-B, Section-5. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

2.3. Outputs in terms of Quantifiable Deliverables*

S#	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations, if any, & Remarks thereof:
1.	Maps showing areas under heavy infestation of invasive species	Areas of infestation identified. Sampling conducted. Locations mapped.	Three villages have involved. Invasive species eradicated from 10 ha area through two eradication drives.	
2.	Field-based model for restoration of ecosystems for continued flow of ecosystem services	10 ha area cleared of invasive species, and *Pennisetum* spp. were planted, which involve thirty women.	Plantation of grasses for ensuring fodder availability to the villagers and checking erosion carried out by involving villagers in plantation drives.	
3.	Ecosystem management through involvement of village communities in >10 villages	Four awareness camps/drives were conducted	Four awareness camps/drives were conducted.	
4.	Climate proofing	Eradication of	Eradication and	

	through manage ment of green cover	*Eupatorium* from the 10ha area. Plantation of native species	plantation drives ensure the conservation of resources	

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

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

S#	Particulars	Number/ Brief Details	Remarks/ Attachment
1.	New Methodology/ Technology developed, *if any*:	01	Trust building and presenting the ownership of the project to the local communities helped reaping the benefits. Their involvement right from of the beginning of the project and a bottom-up approach was of immense help.
2.	New Ground Models/ Process/ Strategy developed, *if any*:	-	-
3.	New Species identified, *if any*:	-	-
4.	New Database established, *if any:*	01	Baseline vegetation information provide a base for further long-term monitoring of those ecosystems.
5.	New Patent, *if any*:	-	-
	I. Filed (Indian/ International)		
	II. Technology Transfer, *if any*:		
6.	Others, *if any*	-	-

Note: Further details may be summarized in DPR Part-B, Section-5. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

3. New Data Generated over the Baseline Data

S#	New Data Details	Status of Existing Baseline	Addition and Utilisation New data
1.	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.
2.	Regeneration status of selected tree species of a community managed '*Bohal spring-shed*' forest in the Palampur tehsil (Kangra) 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.

Note: Further details may be summarized in DPR Part-B. Database files in the requisite formats (Excel) may be enclosed as annexure/ appendix separately to the soft copy of FTR.

4. Demonstrative Skill Development and Capacity Building/ Manpower Trained

S#	Type of Activities	Details with number	Activity Intended for	Participants/Trained			
				SC	**ST**	**Women**	**Total**
1.	Workshops	-	-	-	-	-	-
2.	On-Field Trainings	04 awareness drives have been conducted	Local stakeholders		30	30	30
3.	Skill Development	-	-	-	-	-	-
4.	Academic Supports	03	School children	-	-	-	100
	Others (if any)	-	-	-	-	-	-

Note: Further details may be summarized in DPR Part-B. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

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

S#	Linkages /collaborations	Detail of activities (No. of Events Held) *	No. of Beneficiaries

1.	Sustainable Development Goals (SDGs)/ Climate Change/INDC targets addressed	-	-
2.	Any other:	-	-

Note: Further details may be summarized in DPR Part-B, Section-6. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

6. Project Stakeholders/ Beneficiaries and Impacts

S#	Stakeholders	Support Activities	Impacts in terms of income generated/green skills built
1.	Line Agencies/ Gram Panchayats:	Municipal Council, Palampur (Informal guidance. Ensures flow of services and amenities to residents.)	Awareness and knowledge building
2.	Govt Departments (Agriculture/ Forest/ Water):	State Forest Department, HP; HP Irrigation and Public Health (Intellectual and informal guidance. It has the mandate of conserving and managing natural resources).	Appraisal of work, direct dialogue with communities, especially women
3.	Villagers/ Farmers:	03 villages (People realized the implications of invasive species)	Support activities led to development of the various ecosystem services which provide with livelihood requirement
4.	SC Community:	-	-
5.	ST Community:	03 villages namely *Bohal, Mandai,* and *Odi* are inhabited by the agro-pastoral *Gaddi* community.	Knowledge building and leadership of women
6.	Women Group:	30 women's group involved	Took leadership in planning, implementing activities
	Others, *if any*:	04 Awareness programs has been conducted. (People realized	Awareness and knowledge building among the

		the implications of invasive species)	residents

Note: Further details may be summarized in DPR Part-B, Section-6. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

7. Financial Summary (Cumulative)

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

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

S#	Name of Equipment	Quantity	Cost (INR)	Utilisation of the Equipment after project (Appendix 07)
1.	Global Positioning System (Garmin E-trex)	02	21490 × 2= 42980	For field surveys in the Himalaya
2.	DRR (RAM)	01	4490	For data analyses and information retrieval
3.	LCD Projector (Epson)	01	64676	For on-site awareness and capacity building programmes
4.	Display Screen (LG)	01	49999	For display, popularization and dissemination
5.	Voice Recorder	02	10000× 2=20000 (7000× 2)	

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

9. Quantification of Overall Project Progress

S. No.	Parameters	Total (Numeric)	Remarks/ Attachments/ Soft copies of documents
1.	IHR States/ UTs covered:	01	Himachal Pradesh- A west Himalayan state that lies between 30°22′ N to 33°12′ N and 75°47′ E to 79°04′ E. Almost 27% of the geographical area of the state is under forest. Close to 3600 flowering plant species are reported from the state that not only support the wildlife but also human populations that are dependent on it.
2.	Project Sites/ Field Stations Developed:	01	One Site, 32^0 08’ 15.42” 4 N lat., 760 33’ 06.406” E long
3.	Scientific Manpower Developed (PhD/M.Sc./JRF/SRF/ RA):	02	Junior Project Fellow (M.Sc.), Field Assistant (B.Tech.)
4.	Livelihood Options promoted	-	-
5.	Technical/ Training Manuals prepared	-	-
6.	Processing Units established, if any	.... (Attach photos)	-
7.	No. of Species Collected, if any	61	Sampling was carried out in the area using quadrats and a total of 61 plant species were encountered.
8.	No. of New Species identified, if any	-	-
9.	New Database generated (Types):	-	-
	Others (if any)	09	Field photographs of the activities and coordinates

			of the areas where eradication has been carried out. (Appendix 07)

Note: Further details may be summarized in DPR Part-B. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

10. Knowledge Products and Publications:

S#	Publication/ Knowledge Products	*Number*		*Total Impact Factor*	*Remarks/* Enclosures
		National	International		
1.	Journal – Research Articles/ Special Issue:		01	1.2 Cite score	Appendix 07
2.	Book – Chapter(s)/ Monograph/ Contributed:				
3.	Technical Reports:				
4.	Training Manual (Skill Development/ Capacity Building):				
5.	Papers presented in Conferences/Seminars:				
6.	Policy Drafts/Papers:				
7.	Others, if any:				

Note: Please append the list of KPs/ publications (with impact factor, DOI, and further details) with due Acknowledgement to NMHS. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

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

Particulars	Recommendations
Utility of the Project Findings:	Stakeholder involvement for eco-restoration programmes. A framework for invasive species removal and propagation of native species.

Replicability of Project/ Way Forward:	Since the present area represents a typical Himalayan landscape, the approach followed here has implications for wider Himalayan region and therefore, replicable. Any conservation and management programme, especially in the Himalaya, should involve communities as prime members.
Exit Strategy:	Please describe the Exit Strategy of the project, self-sustaining and benefitting the stakeholders and local community: Since the eradication of noxious weeds benefits the local residents by providing various services, residents will be inspired to manage resources once the project is completed. The plantation serves the livelihood requirements of the people (fuel, fodder, timber, medicine etc.); which will be a self-motivation for their conservation.

(**PROJECT PROPONENT/ COORDINATOR**)

(Signed and Stamped)

(**HEAD OF THE INSTITUTION**)

(Signed and Stamped)

Place: ……..

Date: …../……/……

PART B: DETAILED PROJECT REPORT

The Detailed report should include an Executive Summary and it should have separate chapters on (i) **Introduction**, (ii) **Methodologies/Strategy/Approach**, (iii) **Key Findings and Results**, (iv) **Overall Achievements**, (v) **Project's Impacts in IHR** (vi) **Exit Strategy** and Sustainability, (vii) **References**, and (viii) **Acknowledgements** (acknowledging the financial grant from the NMHS, MoEF&CC, GoI).

Other necessary details/ Supporting Documents/ Dissemination Materials (*New Products/ Manuals/ Standard Operating Procedures (SOPs)/ Technology developed/Transferred, etc, if any*) may be attached as Appendix(ces).

1 EXECUTIVE SUMMARY (not more than 2–3 pages)

Spread of invasive species such as *Eupatorium adenophorum* has threatened the status of forests in the Bohl, Mandai, and Odi villages of the Palampur forest division of Himachal Pradesh. This has not only limited flow of services to the Palampur town but has also affected the livelihood of the villagers. Recognizing this, the above titled project is being implemented with the objectives i.e. identification of areas under heavy infestation of invasive species, awareness creation amongst the local communities, removal of invasive species by involving stakeholders, and restoration of degraded sites. The work was initiated by inducting a manpower and consultations with Prof. RK Kohli, Hon'ble VC, Central University, Punjab. During the reporting period, nine field surveys were conducted to the study area for confidence building, awareness creation, identification of invasive species, and recording co-ordinates of invasive infested sites in the forests. Consequently, four awareness drives were carried out on Biodiversity Conservation & native species. A total of 50 plots that correspond to 350 quadrats were sampled. These include 50 quadrats for trees, 100 for shrubs, and 200 for herbs. Nested inside each tree quadrat were two shrub quadrats, each of which in turn had two nested quadrats for herb.

61 vascular plant species were recorded from the studied forest. Of these, 36 are herbs, 15 shrubs and 10 tree species. These plant species belong to 33 families. Amongst the families, Asteraceae and Rosaceae were the dominant, followed by Poaceae and Fabaceae. The forest was found to be heavily infested with the obnoxious weed *A. adenophora.* The distribution revealed maximum density (53.27 individuals/m2) and frequency (86.36%) of *A. adenophora* at the disturbed site compared to the undisturbed site (13.89 individuals/m2 and 67.86%, respectively). Overall seedling, sapling and tree density was higher at the undisturbed site (12727, 3240, and 1190 individuals/ha, respectively) as compared to the disturbed site (10000, 2440, and 950 individuals/ha; respectively. Later an eradication plan was prepared by involving the Village Forest Development Society, Bohal. Ten hectare of forest land was cleared of *Eupatorium adenophorum*. In the eradicated land, *Penisettum* spp. were planted. It is an important fodder species. In the process, school children were also involved in the activity.

2 INTRODUCTION

2.1 Background (max. 500 words)

Spread of invasive species is a global contemporary issue that has serious implications on ecosystems, economy and health. This not only affects ecosystem services but also the livelihood of the dependent communities. More than 40% of the threatened plants are a result of ill-effects of invasive species (Wilcove et al. 1998). Controlling *Eichhornia crassipes*, in the seven African countries, annually costs between $ 20- 50 million (Mc Neely 2001). At the same time, health hazards posed by some of the invasive species are also obvious (Aneja et al. 1991).

Today, even the pristine mountain areas such as the Himalaya are under threat of invasive species. Recent estimates from Himachal Pradesh, one of Himalayan states, reveal presence of 500 alien plant species in the state. Alarmingly, 34% of these have naturalized while 29% are invasive (Jaryan et al. 2013). *Lantana camara, Eupatorium adenophorum* and *Parthenium hysterophous* are the most common invasive species in the state that have the potential to spread fast with detrimental consequences on native ecosystems. Their spread has resulted in diminishing services of the nature and associated livelihood implications.

Bohl, Odi, and Mandai villages of the Palampur forest division, Himachal Pradesh are well known for the Palampur Water Governance Initiative (PWGI) (Banyal 2010-11 to 2024-25). An initiative that ensures water supply to the town of Palampur. These villages lie in the catchment area (ca. 286 ha) of Bohl spring water recharge zone. Local people depend on surrounding forests known as Bheerni forest for grazing, fuel wood and fodder needs. These forests also form the recharge zone of Bohl spring. Bohl spring is the oldest and purest source of drinking water for Palampur municipal council. Presently it is classified as “Protected forest” formally under the ownership & control of the Forest department. Recently, community forest protection strengthened with the formation of Village Forest Development Society (VFDS) as a part of Palampur Water Governance Initiative (PWGI).

In the recent years, spread of *Eupatorium adenophorum* and *Lantana camara* has raised concern amongst the villagers in the area. Common pastureland and fallow land have been ruined by these species. They are now proliferating into the forests thereby threatening the regeneration of native species and water flow from Bohl spring. This is a serious issue that has multifarious ramifications.

2.2. Overview of the major issues addressed (max. 500 words)

The major problem identified in the region is spread of invasive species that is altering the ecological processes, the services rendered by the forests and an increased burden on local community. Maintaining the flow of ecosystem services, biodiversity and health of the ecosystem are of utmost importance and much desired. This not only has implications for the livelihood of the resident population but also for the downhill populations.

2.3 Baseline Data and Project Scope (max. 500 words)

In the recent years, spread of *Eupatorium adenophorum* and *Lantana camara* has raised concern amongst the villagers of Bohl, Odi, and Mandai villages of the Palampur forest division, Himachal Pradesh. These forests also form the recharge zone of Bohl spring. Bohl spring is the oldest and purest source of drinking water for Palampur municipal council. Presently it is classified as "Protected forest" formally under the ownership & control of the Forest department. Recently, community forest protection strengthened with the formation of Village Forest Development Society (VFDS) as a part of Palampur Water Governance Initiative (PWGI). The spread and quantification of the above mentioned species was not yet available from the study area, and so was the information on vegetation and soil characteristics. The project scope, therefore included vegetation quantification and managing invasive species through community participation of the above mentioned villages.

2.4 Project Objectives and Target Deliverables (as per the NMHS-Sanction Order)

Objectives	Deliverables
Identification of areas under heavy infestation of invasive species	Areas of infestation identified. Sampling conducted as well as co-ordinates were noted. Locations mapped.
Awareness creation amongst the local communities	Four awareness drives have been conducted, which involved thirty women.
Removal of invasive species by involving stakeholders	Two eradication drives have been carried out covering 10 ha area which was cleared of *Eupatorium* invasive species.
Restoration of degraded sites.	Two plantation drives were initiated where *Penisettum* spp. were planted.

3. **METHODOLOGIES/STARTEGY/ APPROACH –** *supporting documents to be attached.*

3.1 Methodologies used (max. 500 words)

The present study was conducted in the foothills of Dhauladhar mountain range in district Kangra, Himachal Pradesh (India) (Fig. 1). A community managed '*Bohal spring-shed*' forest in the Palampur tehsil (Kangra) was selected for the sampling (Fig. 2a). The forest encompasses an area of ~160 hectares and lies between 1700-2100 m altitudinal zones (Uniyal et al., 2020). This forest functions as the main recharge zone of Bohal Spring, which fulfills the drinking water needs of the downstream Palampur town. Three villages namely *Bohal, Mandai,* and *Odi* are located in its lower recharge zone and inhabited by the agro-pastoral *Gaddi* community. They depend on the forest for their daily biomass needs. Originally, the forest belonged to the village common land but now it is classified as a "Protected Forest", formally under the ownership and control of the forest department (Banihal, 2010). Since the

implementation of the payment for water services initiative in October 2010, the Village Forest Development Society (VFDS) is responsible for the management and conservation of this forest (GIZ, 2011). Field surveys, sampling, social interactions, eradication Programs, and restoration of the area

3.2 Data collected and Equipments utilized (max. 500 words)
Vegetation sampling was done using nested quadrats of 10 × 10 m (Tree), 5 × 5 m (Shrub), and 1 × 1 m (Herb) (Kunwar et al., 2020; Kumar et al., 2020).

A total of 50 plots that correspond to 350 quadrats were sampled. These include 50 quadrats for trees, 100 for shrubs, and 200 for herbs. Nested inside each tree quadrat were two shrub quadrats, each of which in turn had two nested quadrats for herb. From each quadrat, information on plant species and their number were noted. Physiognomic attributes like tree height (*h*), and circumference at breast height (*CBH*) were recorded using meter tape. The height of tree individuals greater than 2 m was estimated visually. The percentage cover of dominant alien species was visually estimated from individual quadrats. The presence and absence of disturbance in the form of livestock dung, trails, lopping signs, alien species, and fire signs were also noted in each of the 10 × 10 m plots. Individually, each of the disturbance indicator was scored on a numerical scale of 0 and 1; where 0 represents the absence and 1 the presence of disturbance (Kumar and Shahabuddin, 2005; Cardoso et al., 2013; Sahoo et al., 2020). The values were then summed up to get a final score for each plot. Sampling plots having a score ≤2 was classified as undisturbed and those with a score ≥3 was categorized as disturbed plots. The location of each plot was recorded using a Garmin *etrex* 20x global positioning system (GPS). Furthermore, three random soil samples were collected and mixed from each of the 10 × 10 m plots to form a composite soil sample. Soil samples were taken at depths ranging from 0 to 30 cm, where the majority of root zone activities occur (Kewlani et al., 2021; Kooch et al., 2021). In total, 50 well-labeled soil samples were collected in zip lock bags from the area. These were then air-dried at room temperature for physiochemical analysis of the soil.

3.3 Details of Field Survey conducted, if any (max 500 words)
Nine field surveys were carried out during the growing season in 2016 and 2017. Stratified random sampling was followed to cover all the vegetation types occurring in the area (Fig. 2b).

3.4 Strategic Planning for each activity with time frame (max. 200 words)
Sampling was carried out during the growing seasons so that the flora is well represented. Eradication programme of the invasive species was conducted during summers and later during autumn. The programme was planned in consultation with the local people. Data analyses were conducted at the laboratory, this included vegetation and soil.

4 KEY FINDINGS AND RESULTS – *supporting documents to be attached.*

61 vascular plant species were recorded from the studied forest. Of these, 36 are herbs, 15 shrubs and 10 tree species. These plant species belong to 33 families. Amongst the families, Asteraceae and Rosaceae were the dominant, followed by Poaceae and Fabaceae.

4.1. Species composition

The density of herbs varied from 0.02-53.27 individuals/m2, that of shrubs between 0.05-8.05 individuals/5m2, and those of trees between 0.05-11.50 individuals/10m2 (Table 1). The distribution of herbs and graminoids revealed a high density of *Ageratina adenophora* (53.27 individuals/m2) followed by *Oplismenus compositus* (16.09 individuals/m2) at the disturbed site, whereas *Apluda mutica* (29.71 individuals/m2) reported the highest density at the undisturbed site (Table 1). In the case of shrub species, *Berberis lycium* (3.86 individuals/ 5m2) and *Cotoneaster bacillaris* (8.05 individuals/5m2) had the highest density at the disturbed and undisturbed sites, respectively. With regard to trees, *Quercus leucotrichophora* dominated both the disturbed and undisturbed sites (4.40 and 11.50 individuals/10m2, respectively). Concerning species richness, a marked difference was observed (Table 2). The richness of herbs (34 species) and shrubs (13 species) was higher at the undisturbed site as compared to the disturbed site. On the other hand, tree species richness did not vary between the two sites (n=9 each in disturbed and undisturbed sites). Except for the species richness of shrubs, different indices of species diversity revealed a significant variation (p0.05) in the distribution of herbs and shrubs in disturbed and undisturbed sites (Fig. 3). The -richness (species richness), -diversity (Shannon diversity), and evenness of herbs were higher in the undisturbed site, whereas for shrubs, the same was higher in the disturbed site. There was no significant difference (p0.05) in the distribution of tree species between disturbed and undisturbed sites (Table 2).

4.2. Distribution patterns of dominant alien species

The forest was found to be heavily infested with the obnoxious weed *A. adenophora.* The distribution revealed maximum density (53.27 individuals/m2) and frequency (86.36%) of *A. adenophora* at the disturbed site compared to the undisturbed site (13.89 individuals/m2 and 67.86%, respectively) (Table 1). The abundance of *A. adenophora* was also higher (61.68/m2) at the disturbed site compared to the undisturbed site (20.47/m2). Further, the percentage cover of *A. adenophora* (disturbed site 55%, undisturbed site 25%) significantly varied (p≤0.05) between the disturbed and undisturbed sites (Fig. 4). It was observed that *A. adenophora* has influenced the distribution of native species in disturbed sites.

4.3. Regeneration potential of forest

The distribution of seedling and saplings revealed a non-significant pattern between the disturbed and undisturbed sites, while the recruitment class (trees) showed a significant difference in their distribution

in the two sites (p≤0.05; Fig. 5). In general, overall seedling, sapling and tree density was higher at the undisturbed site (12727, 3240, and 1190 individuals/ha, respectively) as compared to the disturbed site (10000, 2440, and 950 individuals/ha; respectively) (Table 3). At the disturbed site, the average tree girth (CBH) was 54.86±39.34 cm whereas the same was 51.27±38.40 cm in the undisturbed site. The density distribution curve also revealed a relatively higher number of individuals in the small girth class (young trees) at the undisturbed site than at the disturbed site. Girth-class distribution reported a higher frequency of young individuals in the undisturbed site as compared to the disturbed site (Fig. 6) revealing better recruitment in the undisturbed site in near future.

4.4. Soil properties, total biomass, and carbon content

Overall, soil properties varied significantly between the sites (Fig. 7; p≤0.05). Soil parameters namely soil pH, bulk density (BD), available nitrogen (aN), available potassium (aK), sodium (Na), calcium (Ca) and magnesium (Mg) showed significant variations between the disturbed and undisturbed sites, whereas organic matter (OM) and available phosphorus (aP) did not vary significantly between the two sites (p≤0.05; Fig. 7). The disturbed site had higher soil pH, BD, and Na values, while the undisturbed site had higher OM, aN, aP, aK, Ca, and Mg values. Simultaneously, total biomass and carbon content were higher at the undisturbed site than at the disturbed site (Table 4).

4.2 Major Activities/ Findings (max. 500 words)

Surveys

Species sampling

Invasive species eradication

4.3 Key Results (max. 500 words in bullets covering all activities)

Species composition presented

Soil characteristics deciphered

Invasive species population documented

Spread of species mapped

4.4 Conclusion of the study (max. 500 words in bullets)

Altered species composition and distribution in the 'Bohal spring-shed' forest has been observed. Soil properties differed significantly between the disturbed and undisturbed sites. The disturbed site was heavily infested with *Ageratina adenophora*, which would undoubtedly have an impact on the distribution of native species. The disturbance has resulted in altered vegetation assemblages in the current area, which may have an impact on the ecosystem services provided by this community managed forest. Furthermore, the long-standing quid pro quo relationship between stakeholders appears to be deteriorating and requires immediate attention. Community involvement in decision making and

awareness programs focusing on sustainable forest management should be effectively implemented. Long-term ecological monitoring of the forest should be prioritized, with a focus on alien species.

5 OVERALL ACHIEVEMENTS – *supporting documents to be attached.*

- Invasive species eradicated from 10 ha area through two eradication drives, involving three villages. Plantation of grasses for ensuring fodder availability to the villagers and checking erosion carried out on two by involving villagers in plantation drives. Four awareness camps/drives were also conducted.

- The forest was found to be heavily infested with the obnoxious weed *Ageratina adenophora*. The distribution revealed maximum density (53.27 individuals/m2) and frequency (86.36%) of *A. adenophora* at the disturbed site compared to the undisturbed site.

- The distribution of seedling and saplings revealed a non-significant pattern between the disturbed and undisturbed sites.

- Overall seedling, sapling and tree density was higher at the undisturbed site (12727, 3240, and 1190 individuals/ha, respectively) as compared to the disturbed site (10000, 2440, and 950 individuals/ha; respectively.

- The soil pH, bulk density (BD) and available sodium (Na) reported higher values at the disturbed site, while values of organic matter (OM), available nitrogen (aN), available phosphorus (aP), available potassium (aK), available calcium (Ca) and available magnesium (Mg) were higher at the undisturbed site

Publication:

Sharma, R., Uniyal, A., Rawat, G. S., & Uniyal, S. K. (2022). Dwindling status of a community managed forest in the Dhauladhar mountain range of western Himalaya. *Trees, Forests and People*, 8, 100254.

6 PROJECT'S IMPACTS IN IHR – *supporting documents to be attached.*

6.2 Socio-Economic impact (max. 500 words)

- Eradication of weeds and plantation of the native species serves the local inhabitants with various ecosystem services.

- The plantation serves the livelihood requirements of the people such as fuel, fodder, timber, food, medicine etc., and helps in the improvement of the ecosystem services.

6.3 Impact on of Natural Resources/ Environment (max. 500 words)

- Invasive plant species can hinder native plant growth and development as well as have an impact on ecosystem properties such as soil cover, nutrient cycling, fire regimes, and hydrology. As a result, eliminating weeds and plantation of the native species are the important steps towards the restoration of ecosystem.

6.4 Conservation of Biodiversity/ Land Rehabilitation in IHR (max. 500 words)

- Since native plants are adapted to local environmental conditions, they require far less water, therefore, conserving the most valuable natural resource of all, water.

- Plantation drives and eradication of the invasive species helps in conservation of soil, improves soil nutrient cycles and enhanced regeneration and as a result, helps in the conservation of Biodiversity.

6.5 Developing Mountain Infrastructures (max. 200 words)

6.6 Strengthening Networking in State/ UT (max. 200 words)

- Long term monitoring site provide baseline data for future comparison studies.

7 EXIT STRATEGY AND SUSTAINABILITY – *supporting documents to be attached.*

7.1 Utility of project findings (max. 500 words)

The study highlights the stakeholder involvement for eco-restoration programmes. Further, a framework for invasive species removal and propagation of native species is presented.

7.2 Other Gap Areas (max. 200 words)

How invasive species affect native fauna and alter ecosystem services that are critical for resident communities.

7.3 Major Recommendations/ Way Forward (max. 200 words)

Any conservation and management program, particularly in the Himalaya, should include communities as primary participants.

The current study site represents a typical Himalayan landscape, the approach taken here has implications for the larger Himalayan region.

The eradication of noxious weeds benefits the local residents by providing various services which provides livelihood requirements. Plantation of native multipurpose tree is suggested.

7.4 Replication/ Upscaling/ Post-Project Sustainability of Interventions (max. 500 words)

The work can be easily replicated. Confidence building and stakeholder involvement is key to it.

8 REFERENCES/BIBLIOGRAPHY

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9 ACKNOWLEDGEMENTS

We thank the Ministry of Environment, Forests and Climate Change; Government of India for financial support and GBPNIHE Almora (Uttarakhand), through project GAP-0235. We also thank CSIR-IHBT Palampur HP, State Forest Department, Municipal Council Palampur, and HP Irrigation and Public Health for their immense support.

APPENDICES

Appendix 1 – Details of Technical Activities
Appendix 2 – Copies of Publications duly Acknowledging the Grant/ Fund Support of NMHS
Appendix 3 – List of Trainings/ Workshops/ Seminars with details of trained resources and dissemination material and Proceedings
Appendix 4 – List of New Products (utilizing the local resources like NTFPs, wild edibles, bamboo, etc.)
Appendix 5 – Copies of the Supporting Materials like Manual of Standard Operating Procedures (SOPs) developed under the project
Appendix 6 – Details of Technology Developed/ Patents filled, if any
Appendix 7 – Any other

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Annexure-I

Consolidated and Audited Utilization Certificate (UC) and Statement of Expenditure (SE)

For the Period: 01-04-2018 to 31.12.2021

1.	Title of the project/Scheme/Programme:	GAP-0235 (Bringing Black the Real Green: Eradicating Invasive Species and Restoring Ecosystem through Community Participation)
2.	Name of the Principle Investigator & Organization:	Dr. Sanjay Kr. Uniyal CSIR-Institute of Himalyan Bioresource Technology, Palampur-176061, HP
3.	NMHS-PMU, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand Letter No. and Sanction Date of the Project:	GBPNI/NMHS-2017-18/SG 26, Dated: 28-03-2018
4.	Amount received from NMHS-PMU, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand during the project period (Please give number and dates of Sanction Letter showing the amount paid):	**₹1717893.00** (Including Bank Interest ₹23893.00)
5.	Total amount that was available for expenditure (Including commitments) incurred during the project period:	**₹1717893.00** (Including Bank Interest ₹23893.00)
6.	Actual expenditure (excluding commitments) incurred during the project period:	**₹1595403.00**
7.	Unspent Balance amount refunded, if any (Please give details of Cheque no. etc.):	**Nil**
8.	Balance amount available at the end of the project:	**₹122490.00** (Including Bank Interest ₹23893.00)
9.	Balance Amount:	**₹122490.00** (Including Bank Interest ₹23893.00)
10.	Accrued bank Interest:	**₹23893.00**

Certified that the expenditure of **Rs.1595403.00 (Rupees: Fifteen lakhs ninety-five thousand four hundred and three only)** mentioned against Sr. No. 6 was actually incurred on the project/scheme for the purpose it was sanctioned.

Date: 04-01-23

(Signature of Principal Investigator)

डॉ. संजय कुमार
प्रधान वैज्ञानिक
सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
पालमपुर-176061 (हि.प्र.)

(Signature of Registrar/ Finance Officer)

Finance & Accounts Officer
CSIR-Institute of Himalayan Bioresource Technology
Palampur - 176061 (H.P.)

(Signature of Head of the Institution)

निदेशक
सी.एस.आई.आर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
पालमपुर- 176061 (हि.प्र.)

OUR REF. No.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
NATIONAL MISSION ON HIMALAYAN STUDIES (GBP,NIHE)

Statement of Consolidated Expenditure

[CSIR-Institute of Himalayan Bioresource Technology, Palampur, H.P.]
(W.e.f. 01.04.2018 to 31.12.2021)

Statement showing the expenditure of the period
from Sanction No. and Date : GBPNI/NMHS-2017-18/SG 26, Dated:28-03-2018

1. Total outlay of the project : **₹4608000.00**

2. Date of Start of the Project : **01-04-2018**

3. Duration : **Three Years (Extension up to Dec 2021)**

4. Date of Completion : **31-12-2021**

a) Amount received during the project period :**₹1717893.00**(Including Bank Interest ₹23893.00)

b) Total amount available for Expenditure :**₹1717893.00**(Including Bank Interest ₹23893.00)

S. No.	Budget head	Amount received	Expenditure	Amount Balance/ excess expenditure
1	Salaries	672812.00	667795.00	5017.00
2	Permanent Equipment Purchased (Item-wise)	400000.00	251132.00	148868.00
3	Consumable	259981.00	268505.00	-8524.00
4	Travel	350000.00	396764.00	-46764.00
5	Contingency	11207.00	11207.00	0.00
6	Institutional Charges	0.00	0.00	0.00
7	Accrued bank Interest	23893.00	0.00	23893.00
8	**Total**	**₹1717893.00**	**₹1595403.00**	**₹122490.00**

Certified that the expenditure of **Rs.1595403.00 (Rupees: Fifteen lakhs ninety-five thousand four hundred and three only)** mentioned against Sr. No. 6 was actually incurred on the project/scheme for the purpose it was sanctioned.

Date: 04-01-23

(Signature of Principal Investigator)

डॉ. संजय कुमार
प्रधान वैज्ञानिक
जैवसंपदा प्रौद्योगिकी संस्थान
पालमपुर-176061 (हि.प्र.)

(Signature of Registrar/ Finance Officer)

Finance & Accounts Officer
CSIR-Institute of Himalayan Bioresource Technology
Palampur - 176061 (H.P.)

(Signature of Head of the Institution)

निदेशक
सी.एस.आई.आर-हिमालय जैवसंपदा प्रौद्योगिकी
पालमपुर- 176061 (हि.प्र.)

OUR REF. No.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
NATIONAL MISSION ON HIMALYAN STUDIES (GBP NIHE)

Annexure-II

Consolidated Interest Earned Certificate

Please provide the detailed interest earned certificate on the letterhead of the grantee/ Institution and duly signed.

Annexure-III

Consolidated Assets Certificate

Assets Acquired Wholly/ Substantially out of Government Grants

(Register to be maintained by Grantee Institution)

Name of the Sanctioning Authority: NATIONAL MISSION ON HIMALAYAN STUDIES (NMHS) G.B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD) Kosi-Katarmal, Almora - 263643, Uttarakhand, India.

1. Sl. No. _____
2. Name of Grantee Institution: CSIR-Institute of Himalaya Bioresource Technology
3. No. & Date of sanction order: GBPNI/NMHS-2017-18/SG 26, 28-03-2018
4. Amount of the Sanctioned Grant: INR 4608000/-
5. Brief Purpose of the Grant: For the procurement of the equipments.
6. Whether any condition regarding the right of ownership of Govt. in the property or other assets acquired out of the grant was incorporated in the grant-in-aid Sanction Order:

   _____
7. Particulars of assets actually credited _____ or acquired_____
8. Value of the assets as on

   _____
9. Purpose for which utilized at present

   _____
10. Encumbered or not

    _____
11. Reasons, if encumbered

    _____
12. Disposed of or not

    _____
13. Reasons and authority, if any, for disposal_____

14. Amount realized on disposal

_____

Any Other Remarks:

_____

_____

__

(PROJECT INVESTIGATOR) **(FINANCE OFFICER)**

(Signed and Stamped) **(Signed and Stamped)**

(HEAD OF THE INSTITUTION)

(Signed and Stamped)

Annexure-IV

List or Inventory of Assets/ Equipment/ Peripherals

S. No.	Name of Equipment	Quantity	Sanctioned Cost	Actual Purchased Cost	Purchase Details (Indent No.)
1.	Global Positioning System (Garmin E-trex)	02	525000	21490 × 2= 42980 (24000× 2) (22000× 2)	IHBT/2018/17425 IHBT/2018/21421
2.	DRR (RAM)	01		4490	
3.	LCD Projector (Epson)	01		64676	
4.	Display Screen (LG)	01		49999	
5.	Voice Recorder	02		10000× 2=20000 (7000× 2)	IHBT/2018/21432, IHBT/2018/17425
6.	Mosquito Catcher Racket	03		250×3=750	PO/IHBT/2020/18536/1

(PROJECT INVESTIGATOR) **(FINANCE OFFICER)**

(Signed and Stamped) **(Signed and Stamped)**

(HEAD OF THE INSTITUTION)

(Signed and Stamped)

Annexure-V

Letter of Head of Institution/Department confirming Transfer of Equipment Purchased under the Project to the Institution/Department

To,

The Convener, Mountain Division
Ministry of Environment, Forest & Climate Change (MoEF&CC)
Indira Paryavaran Bhawan
Jor Bagh, New Delhi-110003

Sub.: Transfer of Permanent Equipment purchased under Research Project titled "...." funded under the NMHS Scheme of MoEF&CC – reg.

Sir/ Madam,

This is hereby certified that the following permanent equipment purchased under the aforesaid project have been transferred to the Implementing Organization/ Nodal Institute after completion of the project:

1. GPS Garmin
2. LCD Projector, Epson
3. Display Screen, LG
4. Voice Recorder
5. DRR, RAM
6. ……
7. ……

Head of Implementing Organization:
Name of the Implementing Organization:
Stamp/ Seal:
Date:

Copy to:

1. The Nodal Officer, NMHS-PMU, National Mission on Himalayan Studies (NMHS), G.B. Pant National Institute of Himalayan Environment (NIHE), Kosi-Katarmal, Almora, Uttarakhand-263643

Annexure-VI

Details, Declaration and Refund of Any Unspent Balance

Please provide the details of refund of any unspent balance and transfer the balance amount through RTGS (Real-Time Gross System) in favor of **NMHS GIA General** and declaration on the official letterhead duly signed by the Head of the Institution.

Kindly note the further Bank A/c Details as follows:

Name of NMHS A/c:	NMHS GIA General
Bank Name & Branch:	Central Bank of India (CBI), Kosi Bazar, Almora, Uttarakhand 263643
IFSC Code:	CBIN0281528
Account No.:	3530505520 (Saving A/c)

In case of any queries/ clarifications, please contact the NMHS-PMU at e-mail: nmhspmu2016@gmail.com