Cost Reimbursable Subaward Agreement – Non-U.S. Nongovernmental Modification

Prime Institution ("Virginia Tech")	Subrecipient Institution ("Subrecipient")
Name: Virginia Polytechnic Institute and State University Address: Office of Sponsored Programs North End Center, Suite 4200 300 Turner Street NW Blacksburg, VA 24061	Name: Rectors and Visitors of the University of Virginia Address: 1001 N. Emmett Street Charlottesville, VA 22903-4833 DUNS # 065391526
Cooperative Agreement Number: AID-OAA-L-15-00001 FAIN: AIDOAAL1500001 CFDA Number: 98.001 CFDA Title: USAID Foreign Assistance for Programs Overseas	Subaward Number: 451364-20006A Project Period of Performance: 10/15/2018 – 11/15/2021 Project Title: Assessment of Invasive Alien Species Distribution in the Chitwan-Annapurna-Landscape (CHAL) Region, Nepal
Awarding Agency: U.S. Agency for International Development (USAID) Federal Award Date: November 25, 2014 Total Amount of Federal Award to Virginia Tech: $18,180,447 R&D: Yes	Amount Funded This Action: $52,000.00 Total Funded To Date: $187,458.00 Modification No: 02 Effeective Date of Modification: November 2, 2020

Modification (s) to Original Terms and Conditions

The purpose of the modification is to:

- Incorporate a supplemental Statement of Work, Budget, and Budget Justification as Attachment 5A.
- Based on the revised Budget, provide funding in the amount of $52,000. Total funded to date: $187,458.
- Extend the Subaward Period of Performance to November 15, 2021.

Except as provided herein, all other terms and conditions of this Subaward Agreement remain in full force and effect.

By an Authorized Official of VIRGINIA TECH:	By an Authorized Official of SUBRECIPIENT:
Trudy Riley Digitally signed by Trudy Riley Date: 2020.11.25 08:37:01 -05'00'	Stewart Paddison Craig 1 Digitally signed by Stewart Paddison Craig 1 DN: o=University of Virginia, ou=UVA Standard PKI User, email=spc4bj@virginia.edu, cn=Stewart Paddison Craig 1 Date: 2020.12.09 11:53:32 -05'00'
Trudy M. Riley Associate Vice President for Research and Innovation, Sponsored Programs	Date
	Stewart P. Craig Executive Director, Office of Sponsored Programs
	Date

IPM IL: Assessment of Invasive Alien Plant Species Distribution in the Chitwan Annapurna Landscape (CHAL) region, Nepal, with the Application of Satellite Imageries

Period of Performance: October 1, 2020 through November 15, 2021

Dr. Madhav Marathe, University of Virginia Program Leader

Principal Investigator: Prof. Pramod Kumar Jha, Central Department of Botany, Tribhuvan University, Kathmandu, Nepal

Co-Principal Investigator: Dr Madhav Marathe and Dr Abhijin Adiga, Biocomplexity Institute, University of Virginia, VA, USA

Background

The project entitled "Assessment of Invasive Alien Species Distribution in the Chitwan Annapurna Landscape (CHAL) region, Nepal with the Application of satellite Imageries" started in May 2018 with the following objectives:

- To map the habitat distribution of major IAS between 1990 and 2019.
- To identify the high potential spatial location for the most common IAS through Geo-information based multi-criteria analysis.
- To draw a trend of distribution of IAS over time and develop the linkage of IAS distribution and climate change as a proxy indicator.
- Ecology and management of major Invasive Alien Plant Species (IAPS).

Description

In this project, seven invasive alien plant species (Ageratina adenophora, Parthenium hysterophorus, Lantana camara, Mikania micrantha, Chromolaena odorata, Eichhornea crassipes and Ipomea carnea ssp fistulosa) and four crops (maize, finger millet, buckwheat and cauliflower) were undertaken for ecological, biological, agronomical, and vehicle movement was strictly restricted, which hindered our field work.

High resolution imageries of years 2010 and 2011 were availed on 12 December 2019, and we were able to validate distribution results of five invasive species using satellite imageries before lockdown in March 2020. The distribution of invasive species Parthenium and Ageratina still need field verification. Collaborators Dr. Marathe and Dr. Adiga are employing a new approach of deep learning to develop species distribution and we would validate the results in Nepal. Encouraged by the results on Mexican beetle (Zygogramma bicolorata) and rust (Puccinia abrupta var. partheniicola) on Parthenium hysterophorus in restricted transects, we have planned to map its occurrence and distribution in the CHAL area, and intend to conduct distribution projection using Maxent model with the help of Ms. Seerjana Maharjan and Dr. Adiga. To convince the policy makers in Nepal, we intend to generate important data on impacts of invasive species on native ecosystem.

Objective 1

Assess the impacts of four invasive plant species (Parthenium hysterophorus, Lantana camara, Mikania micrantha and Chromolaena odorata) on native biodiversity/ecosystem.

Method: Vegetation analysis will be done using quadrate method and determining species density, frequency, coverage, and biomass by using standard methods and formula. Association of invasive species with native species will be noted, and impacts of invasion will be categorized for different bioclimatic zones in CHAL.

Expected Outcome: We have noted impact of Ageratina adenophora on native species in CHAL, and found changes in species composition and a decrease of important native plant species. With this new knowledge, we have planned this activity to quantify the significant negative impact of invasive plant species on important native plant species and nearby biota. This information will be important to convince policymakers to justify need of strategy document to manage invasive species in Nepal.

Objective 2

To validate and assess accuracy of the distribution pattern of the two major invasive alien plant species (Ageratina adenophora, Parthenium hysterophorus) between 1990, 2000, 2010 and 2019, and compare it with the results using high resolution imageries, and deep learning approach.

Method:

- Iso-clustering the imageries based on reflectance frequencies of the Digital Number (DN) in different wavelength (sensing bands) of sensors. The result of Iso-clustering will be narrowed down by using the supervised classification.
- Based on field training samples, supervised classification of imageries will be carried out.
- The result of supervised classification will be verified with the field survey and other ancillary information.
- Digital Elevation Model (30m x 30m spatial resolution acquired by ASTER Sensor) will be used for the topographical detail i.e. elevation, slope, aspect.
- Knowledge Based Engineer algorithm will be followed by putting hypothesis, rules, and variables selecting from iso-clustering, supervised classification, DEM, climatic parameters, Normalized Vegetation Index, and biological parameters, and will produce the species distribution map.
- The marked GPS location in the field will be superimposed with the classified map and accuracy level will be determined by using sufficient number of observations as per the requirement for statistical computation.

Expected Outcome: The outcome of the Knowledge-Based approach will be integrated with the terrain and produce the invasive plant species (Parthenium and Ageratina) distribution in spatial and temporal context. The trend of distribution pattern (spread pattern) from 1990 to 2019 will be determined. This will help in understanding invasion pattern of invasive species.

Objective 3

To map the distribution of Mexican beetle (Zygogramma bicolorata Pallister) on Parthenium hysterophorus.

Method: The Mexican beetle will be qualitatively and quantitatively surveyed through the well-designed grids in the CHAL area. Their presence and absence coordinates will be noted, and biological and climatic variables for the knowledge-based classification and mapping will be done. The distribution of Mexican beetle in CHAL area will be mapped and projection will be done by using Maxent model.

Expected Outcome: The Mexican beetle was first reported from Hetauda in CHAL area in 2009; however, no detailed information exists on its distribution. The research outcome will be distribution information of the biological control agent in CHAL, which will help in management of the noxious weed Parthenium. The varied degree of infestation on Parthenium hysteorphorus by the Mexican beetle in CHAL will be known.
The information generated may be used to develop distribution scenario through modeling.

Objective 4

To map the distribution of the pathogen Puccinia abrupta var. partheniicola on Parthenium hysterophorus, and determine its impact.

Method: The rust (Puccinia abrupta var. partheniicola) will be surveyed in the well-designed grids (10 km x10 km area) in CHAL area. Its intensity, presence, and absence coordinates will be recorded, and biological and climatic variables for the knowledge-based classification and mapping will be done.
At each site three random 2m x2m plots will be laid and the degree of infestation by Puccinia abrupta var

parthenicola and Zygogramma bicolorata in Parthenium hysterophorus will be measured by visual estimation. Ranking score will be given as follows: 0 – healthy individual, 1 – only few leaves infested without any apparent impact on growth, 2 – premature senescence of some leaves but not apparent impact on inflorescence; 3 – death of several leaves with apparent impacts on inflorescence but not senescence of plant; 4 – death or senescence of plant. Then cumulative value for each site will be calculated.

Expected Outcome: There was a complete outburst of the rust on Parthenium inside Kathmandu valley in April-May in 2019 and 2020, and visible impacts on the reproductive parts of the plant was seen. The proposed research outcome will be distribution and quantification of impact of rust. This information will help in management of Parthenium. The varied degree of infestation on Parthenium hysteorphorus by fungal control agent and their spread in CHAL will be known.
The information generated may be used to develop distribution scenario through modeling.

Objective 5
To share and disseminate knowledge and experience on biological invasion and its management using IPM.
Method: An international workshop on biological invasion and management will be organized in June 2021 to share knowledge and experience. This will be a good opportunity to share the USAID IPM IL research findings with international experts, researchers, and policy makers. Experts will be especially invited to share their knowledge, and requested to contribute the research/review articles for an edited book.
Policy brief will be prepared based upon existing status of biological invasion in Nepal, and international practices to control it.

Expected Outcome: An edited book on biological invasion and two policy briefs will be prepared.

International Travel:

- Visit to Virginia Tech, Blacksburg, USA for two weeks for finalization of book and research papers.
- Participation and presentation of research findings in TAC meeting organized by Virginia Tech and international organizations.

Activities: One-year time for the following activities to address above mentioned five objectives (starting from November 16, 2020).

SN	Activities	Months											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Field data collection (Impact study)	*	*			*		*		*			
2	Field data for Zygogramma distribution		*				*	*	*				
3	Field data for Puccinia infestation						*	*	*				
4	Field Validation and Accuracy Assessment		*			*			*				
5	Knowledge Based Classification			*	*			*	*				
6	Midterm reporting						*						

7	Distribution modeling							*	*				
8	International seminar/Workshop							*					
9	Manuscript editing for book								*	*	*	*	
9	Research manuscript to submission Journals									*		*	
10	Policy formulation meeting with												
11	Final reporting												*

University of Virginia
IPM Innovation Lab
Assessment of Invasive Alien Species Distribution in the Chitwan-Annapurna-Landscape (CHAL) Region, Nepal

$187,458

10/15/18-11/15/2021

Requested 10.20.20

Budget Item ID		Esc Factor	Unit Cost, $	Unit	YR 1 Units	Year 1 $	Yr 2 Units	Year 2 $	Total, $
a.	**Personnel**								
	Principal Investigator								
	Madhav Marathe	3	$ 375,000	% LOE	2.08%	7,813.00	1.25%	4,815.00	12,628.00
	Co PI								
	Abhijin Adiga	3	$ 107,400	% LOE	38.33%	41,170.00	8.33%	9,217.00	50,387.00
	Co PI								
	Srinivasan Venkatramanan	3	$ 92,000	% LOE	28.75%	26,450.00		-	26,450.00
	Student Wages								
	TBD	3		% LOE		-	100.00%	12,000.00	12,000.00
	Total Personnel					75,433.00		26,032.00	101,465.00
b.	**Fringe Benefits**								
	Madhav Marathe		28.40%	percent		2,219.00		1,363.00	3,582.00
	Abhijin Adiga		28.40%	percent		11,692.00		2,608.00	14,300.00
	Srinivasan Venkatramanan		28.40%	percent		7,512.00		-	7,512.00
	Total Fringe Benefits					21,423.00		3,971.00	25,394.00
c.	**Travel**								
	Domestic	3	$ 735	trip	1	735.00		2,500.00	3,235.00
	International	3	$ 4,415	day	1	4,415.00		4,000.00	8,415.00
	Total Travel					5,150.00		6,500.00	11,650.00
d.	**Equipment**								
	Total Equipment					-		-	-
e.	**Materials and Supplies**								
	Total Supplies					-		-	-
f.	**Contractual Services**								
	Total Contractual Services					-		-	-
g	**Subawards**								
	Total subawards					-		-	-
h.	**Tuition**								
	Total Tuition					-		-	-
i.	**Other Direct Costs**								
	Computer Services	3	$ 4,500	lot	1	4,500.00		-	4,500.00
	Publications	3	$ 1,000	lot	1	1,000.00		4,767.00	5,767.00
	Total Other Direct Costs					5,500.00		4,767.00	10,267.00
j.	**Total Direct Cost**					107,506.00		41,270.00	148,776.00
k.1	**Indirect Cost**		26.0%	Percent		27,952.00		10,730.00	38,682.00
k.	**Total Administrative Cost**					27,952.00		10,730.00	38,682.00
l.	**Total**					**135,458.00**		**52,000.00**	**187,458.00**

BUDGET JUSTIFICATION – University of Virginia

PERSONNEL

Madhav Marathe – Principal Investigator, will lead project direction and manage project goals. Funds are requested for .15 calendar months effort and salary support.

Abhijin Adiga – Co Principal Investigator, will be assist with overall project management and for supervision of project deliverables. Funds are requested for 1 calendar months effort and salary support.

Student hourly wages are also requested.

FRINGE BENEFITS

UVA will charge fringe benefits accordingly per their rate agreement.

OTHER DIRECT COSTS

Publications – Funds are requested to cover publication fees submitted to scientific journals.

TRAVEL

Domestic travel is budgeted for related professional conference. International travel is also budgeted for one trip to Nepal to meet and plan program activities with in-country collaborators. This will cover airfare, M&IE, lodging, visa, and other transport costs. Per diems paid will not exceed the allowable State department rates for the actual locations traveled to.

FACILITIES AND ADMINISTRATIVE COSTS

Facilities and Administrative (F&A) (Indirect/Overhead) Costs - The University of Virginia's “off campus” negotiated (Modified Total Direct Costs (MTDC) F&A rates with DHHS, per agreement of June 12, 2018 is 26%.