The Rufford Foundation
Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Santosh Kumar Rana Magar
Project title	Distribution and Niche Modelling of Highly Traded Prioritized Medicinal and Aromatic Plants of Nepal: Implication for Sustainability and Conservation
RSG reference	22528-1
Reporting period	2017-2018
Amount of grant	£4840
Your email address	rana.1.santosh@gmail.com
Date of this report	5th September 2018

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To create potential natural distribution map predicting the suitable geographic distribution area and niche (for both current (1990-2000) and future(2070)) of six highly traded prioritized Medicinal and Aromatic Plants (MAPs) of Nepal using different bioclimatic variables, topographic and land use land cover (LUC)				Potential natural distribution map predicting the suitable geographic distribution area and niche (for both current and future) of six highly traded prioritised medicinal and aromatic plants (MAPs) of Nepal is now produced using subset of explanatory variables among 19 bioclimatic variables, topographic and land use land cover (LULC).
Identify most important environmental variables in determining natural distribution of focal Species.				The model uses 19 bioclimatic variables, three topographic variables and land use land cover layers for initial calibration. Among them, based on the Pearson correlation (r) and Variance Inflation Factor (VIF), as well as considering MaxEnt result of Jacknife analysis, variable contribution in the model, and biological significance of the variables, we determined important subset of explanatory variables. The predictive environmental variables are species specific among i.e. nine temperature related and six precipitation related. Besides we used elevation in the model and tested LULC for the change in its habitat for different species under current scenario.
Identify the habitat suitability with the change in LULC.				The response curve from MaxEnt result indicates that the suitable habitat for six highly traded MAPs is

				grassland (cat. 6) except for *Dactylorhiza hatagirea*. The habitat suitability decreases as the LULC category shifts from grassland-needle leaved closed forest-snow /glacier for *Aconitum spicatum*; snow/glacier-bare area-needle leaved open forest for *Dactylorhiza hatagirea*; grassland-bare area-needle leaved open forest for *Nardostachys grandiflora*; grassland-bare area- needle leaved closed forest for *Neopicrorhiza scrophularifolia*; built-up area-needle leaved closed forest-scrubland-grassland for *Paris polyphylla*; and shrub land-needle leaved closed forest, needle leaved open forest- grassland for *Valeriana jatamansii*.
Predict the impact of climate change on the potential distribution and niche of MAPs based on GCMs under 4 different RCPs trajectories				I modelled the change in distribution and niche of MAPs based on GCMs under four different RCPs trajectories (RDP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5) predicted by IPCC (2013) for 2070 time period. Niche conservatism approach using ENMTools v1.3 was used to trace out the difference between the niches occupied by MAPs, as well as to estimate the future change in geographic range of MAPs through range and niche overlap; niche identity test indices D and I.
Blend the result of species distribution modelling approach with the field based information of availability, to assess vulnerability of the focal species and predict the sustainability of the harvest in wild in future.				The vulnerability of the MAPs was assessed by using IUCN Red List criteria 2001 (Baillie et al. 2004). According to the Criterion A3(c), we assessed IUCN categories for 2070: *Aconitum spicatum* will be NE (RCP 2.6) and VN (RCP 8.5) but will gain little suitability under RCP 4.5, 6.0; *Dactylorhiza hatagirea* will be NE (RCP 8.5) but gains suitability under other RCPs; *Nardostachys grandiflora* will NE (RCP 2.6), VN (RCP 6.0, 8.5) but

				gains little suitability under RCP 4.5; *Neopicrorhiza scrophularifolia* will be NE (RCP 2.6, 4.5), EN (RCP 6.0) but gains slight suitability under RCP 8.5; *Paris polyphylla* will be NE (RCP 2.6, 4.5, 8.5) and VN under RCP 6.0; *Valeriana jatamansii* will be NE (RCP 2.6, 4.5, 6.0) and EN under RCP 8.5. The abbreviated IUCN categories are NE: Near Threatened, VN: Vulnerable; EN: Endangered. The area projected under current and future scenario are just the predicted suitable area but not the actual distribution area.
Implement the results for the conservation and sustainability of MAPs and benefits of local people.				The broader scale to implement result is to make policy through the government bodies. So my approach is to share the outcomes publicly through a manuscript, workshop and conference so that different concern bodies use the result to implement in their respective areas. We are preparing manuscript for submission.
Aware people for the domestication of the highly traded MAPs in current or future predicted region evaluating its niche				Based on the projected geographical distribution and suitable habitat of MAPs, Trade zone, we will organised a result sharing workshop to aware local people for its domestication and conservation. It is tentatively planned to conduct in Jumla (western Nepal), as well as one of the district in Central Nepal.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

The main difficulties are unfavourable weather, lack of sufficient occurrence points. We planned to cover entire geographical distribution area of focal MAPs from eastern, central and western region but became able to gather occurrence points from Taplejung, Sankhuwasabha, Panchthar, Illam, Phidim; Rasuwa, Manang, Mustang, Kaski, Myagdi, Gorkha; Bajhang, Bajura, Darchula, Mugu, Jumla. I have to cancel proposed visit to Humla and Dolpa, Solukhumbu because of bad weather and inaccessible air route. Even, I was frequently obstructed by flood and landslides while travelling to my different study area. Due to which my tentative field visit was extended. We were thankful to Associate Prof. Dr. Suresh Kumar Ghimier, Prof Dr.

Krishna Kumar Shrestha and Dr. Sailesh Ranjitkar, as well as Mr. Mukti Ram Poudyal and Ms. DeepJyoti Chapagain who provided the previously collected occurrence points from the region where I couldn't visit.

3. Briefly describe the three most important outcomes of your project.

- Produced a fine scale current potential distribution map of 6 highly traded MAPs for Nepal at landscape level (Figure 1)
- Predicted the changes in suitability level of the six highly traded MAPs in current and future climate scenarios (CCSM4 of four different RCPs; RCP2.6, RCP4.5, RCP 6.0, RCP 8.5) (Figure 2) along with its simulated contraction-stability-expansion (Figure 3).
- Assessed the vulnerability of six highly traded MAPs based on suitability area projected under current and future (2070)-CCSM4 climate change scenario of four different RCPs (Table 1).

Table 1: Vulnerability assessment of six highly traded MAPs based on projected current and future (4 RCPs) suitability areas. The projected area is the baseline suitability but not actual distribution area.

Part 1

MAPs	**Current (1990-2000)**	**Future (2070)**						**Standard IUCN categories / CAMP**
	RCP 2.6				**RCP 4.5**			
	Suitability area	**Suitability area**	**% change**	**IUCN status**	**Suitability area**	**% change**	**IUCN status**	
Aconitum spicatum	14606	10365	-29	NE	15014	2.793	LC	V
Dactylorhiza hatagirea	15905	25642	61.22	LC	21233	33.5	LC	EN
Nardostachys grandiflora	24580	24047	-2.17	NE	24824	0.995	LC	R camp
Neopicrorhiza scrophularifolia	30003	27287	-9.05	NE	23881	-20.4	NE	V
Paris polyphylla	23147	19029	-17.8	NE	19640	-15.1	NE	V
Valeriana jatamansii	23330	18878	-19.1	NE	18173	-22.1	NE	V camp

Part 2

	RCP 6.0			RCP 8.5			
	Suitability area	% change	IUCN status	Suitability area	% change	IUCN status	Standard IUCN categories / CAMP
Aconitum spicatum	15817	8.293	LC	9446	-35.3	VN	V
Dactylorhiza hatagirea	29619	86.23	LC	15816	-0.56	NE	EN
Nardostachys grandiflora	14384	-41.5	VN	15397	-37.4	VN	R camp
Neopicrorhiza scrophularifolia	9697	-67.7	EN	33418	11.38	LC	V
Paris polyphylla	14857	-35.8	VN	19299	-16.6	NE	V
Valeriana jatamansii	20087	-13.9	NE	10722	-54	EN	V camp

[Abbreviation: IUCN categories – NE: Near Threatened, LC: Least Concerned, VN: Vulnerable, EN: Endangered, R: Rare]

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

The current project is purely scientific that aims to generate knowledge required for the implication for sustainability and conservation of six highly traded MAPs. Therefore, local communities were less involved in this project. Besides, local people were used just to gather occurrence points and some trade related information. Through scientific approach, a fine scale projected map of habitat suitability for different six highly traded MAPs under current and future climate change scenario were produced. This map is a baseline data for government bodies, conservationists, policy makers to implement for the sustainability and conservation. The knowledge generated by this project was disseminated among colleagues, students, scientist, and academics through general talks but is remain to disseminate among local communities, traders.

5. Are there any plans to continue this work?

This project is the initiation in the field of conservation of MAPs. I was able to work with my research group at Kunming, China. The main result that we gained from this project is, the habitat, ecology, spatio-temporal distribution and trade status that contribute the local people's household economy. We were able to find the possibility of implementing the MAPs for domestication/cultivation in the projected suitability area. So, the next step of this project will focus on increasing the awareness among the local communities/people-traders, conducting workshop among stakeholders. Besides these, for the next stage we plan to assess the trade value of the MAPs and produce a manual book.

6. How do you plan to share the results of your work with others?

I am writing a scientific manuscript based on the result from this project. Besides, the knowledge generated from this project was shared among my colleagues through a group talks. Besides, we are planning to conduct a result sharing workshop among local communities, people, traders, students in different regions of Nepal. Out of which, we already conducted a small result sharing programme in Jumla, Nepal by one of our team member.

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

The RF grant was used to work in the field for 4 months including. Besides we used the grant for buying GPS and topographic maps used for the project. After gathering the occurrence points, most of the work was done in the Kunming institute of Botany, CAS, Kunming, China.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Transportation cost	720	720	0	This includes some local transportation in hilly areas. We tried to use road transportation as far as possible.
Assistant cost 4*26*20	1500	2080	-580	We need to hire additional assistant to complete the field visit within the designated time due to remoteness of the area and weather problem.
Local helper	500	300	+200	For different sites, we need to hire local people to get the occurrence area.
Principal Investigator (months*cost: 14*40)	560	560	0	I tried to cover my airfare from institution to Nepal within this cost during field visit.
Stationary cost	500	250	+250	We generally used notebooks, printed datasheet etc. that reduces the cost
Food and lodging cost	500	370	+130	We just used this cost for main investigator, where the research assistant used their own cost.
Topographic maps	50	50	0	
GPS	70	70	0	We bought one GPS and other used from my institution.

Miscellaneous	440	440	0	This money was used more in medical expenses and some extra cost.
Total	4840	4840	0	

9. Looking ahead, what do you feel are the important next steps?

The important next step are:

- DNA barcoding of prioritized MAPs of Nepal.
- It is essential to start domestication of highly traded MAPs in the projected suitability area.
- Need policy makers for strong implementation of the work.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did The Rufford Foundation receive any publicity during the course of your work?

Yes, the Rufford Foundation logo was used in the result sharing programme at Jumla, Nepal. It has been extensively used in Flex and maps produced during the project period.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Santosh Kumar Rana Magar (Principal investigator)
Role: As a principal investigator, the main role are field arrangement, data collection, data analysis, report production/submission.

Hum Kala Rana (Research assistant)
Role: She had actively participated during field visits, data collection, GIS map making, data analysis, report writing.

Chandra Mohan Gurmachan (Research assistant)
Role: He had actively participated during ethnobotany/socio-economic Survey, field visit, conducting result sharing programme and monitoring of selected focal species including Data analysis in Western Nepal.

Prabin Bhandari (Research assistant)
Role: He had actively participated during field visit and data collection from Eastern Nepal

Shanta Budha Magar
Role: She had actively participated during field visit and data collection from Central Nepal

The work wouldn't have been possible without the support of local people: **Umesh Pokharel** (East Nepal), **Min Gurung** (Central Nepal), **and Surendra Rawal** (West Nepal).

12. Any other comments?

I find the RSG very helpful for developing research career in the field of conservation. I am thankful for my RSG project referees for their valuable supports and recommending my RSG project. I am also grateful for the suggestions/advise from my RSG advisory members.

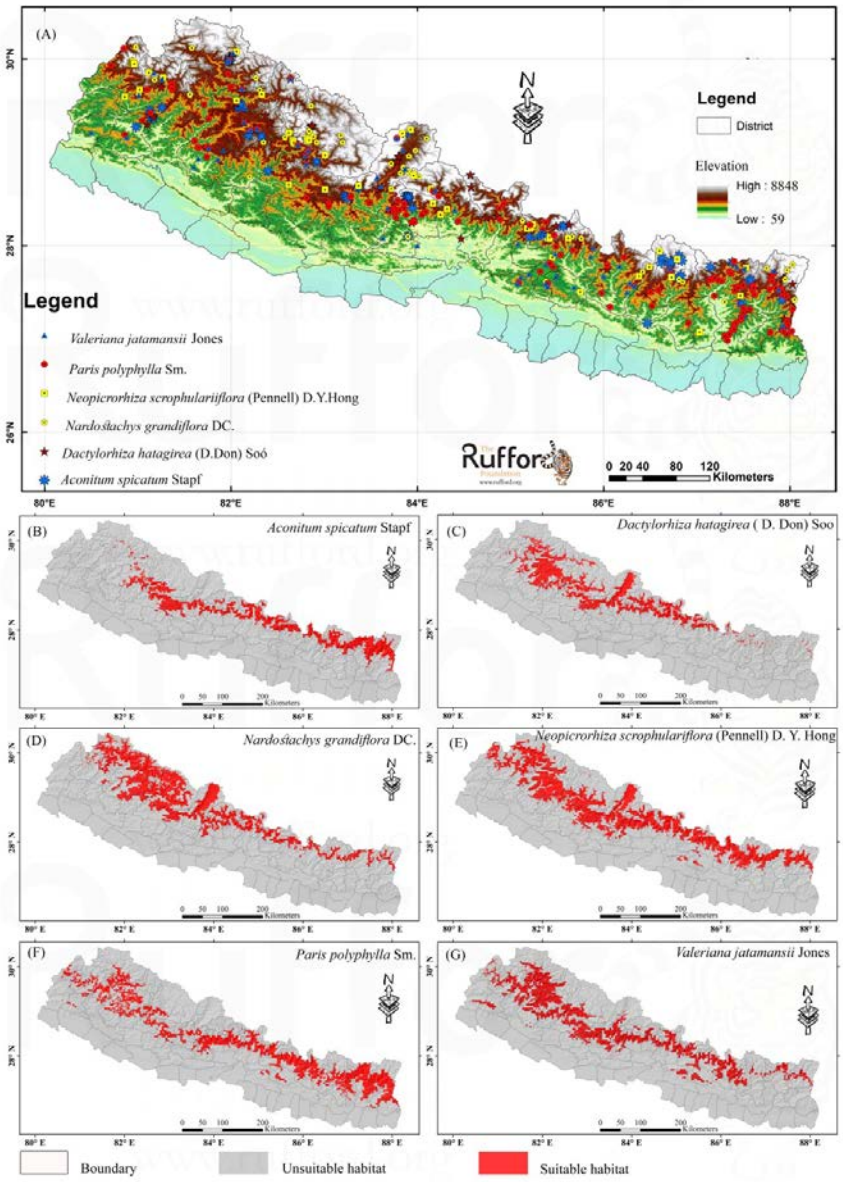

Figure 1- Current habitat suitability of 6 highly traded MAPs: A) Geographical occurrence of 6 MAPS, B) *Aconitum spicatum Stapf,* C) *Dactylorhiza hatagirea* (D.Don) Soo, D) *Nardostachys grandiflora* DC, E) *Neopicrorhiza scrophulariflora* (Pennell) D. Y. Hong, F) *Paris polyphylla Sm*., and G) *Valeriana jatamansii Jones*.

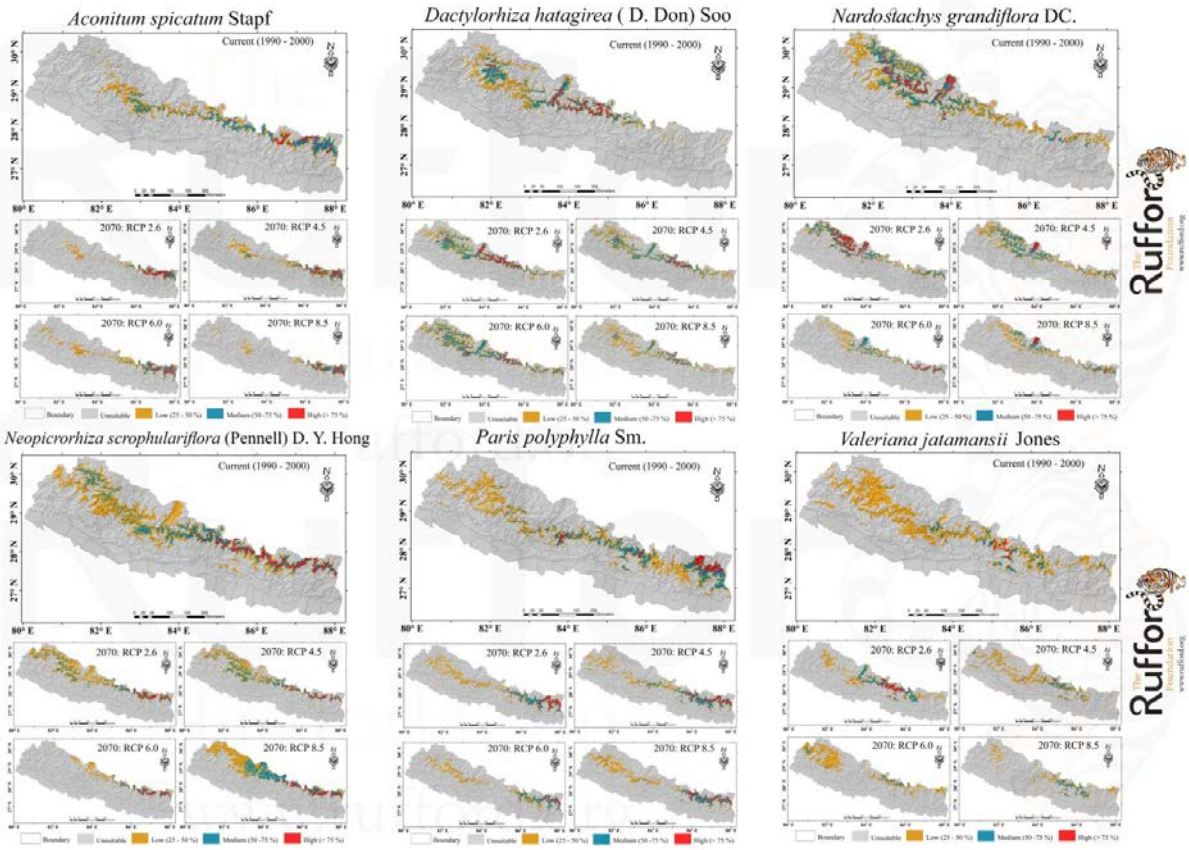

Figure 2 - Predicted suitability level of the 6 highly traded MAPs in current and future climate scenarios (CCSM4 of 4 different RCPs; RCP2.6, RCP4.5, RCP 6.0, RCP 8.5).

Figure 4, 5 & 6 - Result sharing programme by Chandra Mohan Gurmachhan at Jumla, Nepal.

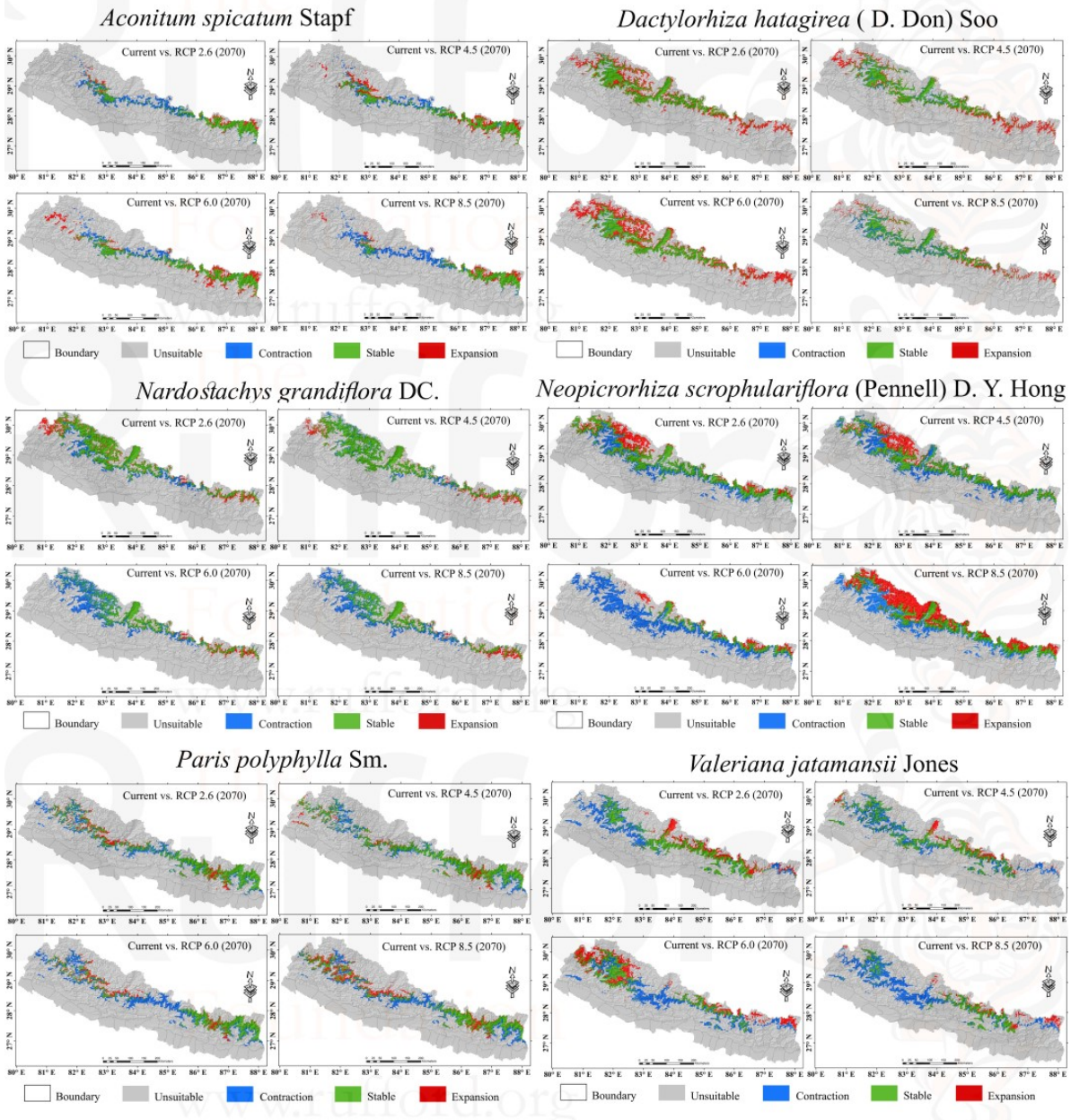

Figure 3 - Climate change simulation for contraction-stability-expansion of six highly traded MAPs under current and future (2070; CCSM4, 4 RCPs) climate change scenarios.

Distribution and Niche Modelling of Highly Traded Prioritized Medicinal and Aromatic Plants of Nepal: Implication for Sustainability and Conservation

Team members:- Santosh Kumar Rana Magar, Hum Kala Rana, Chandra Mohan Gurmachhan, Pramod Sen Oli

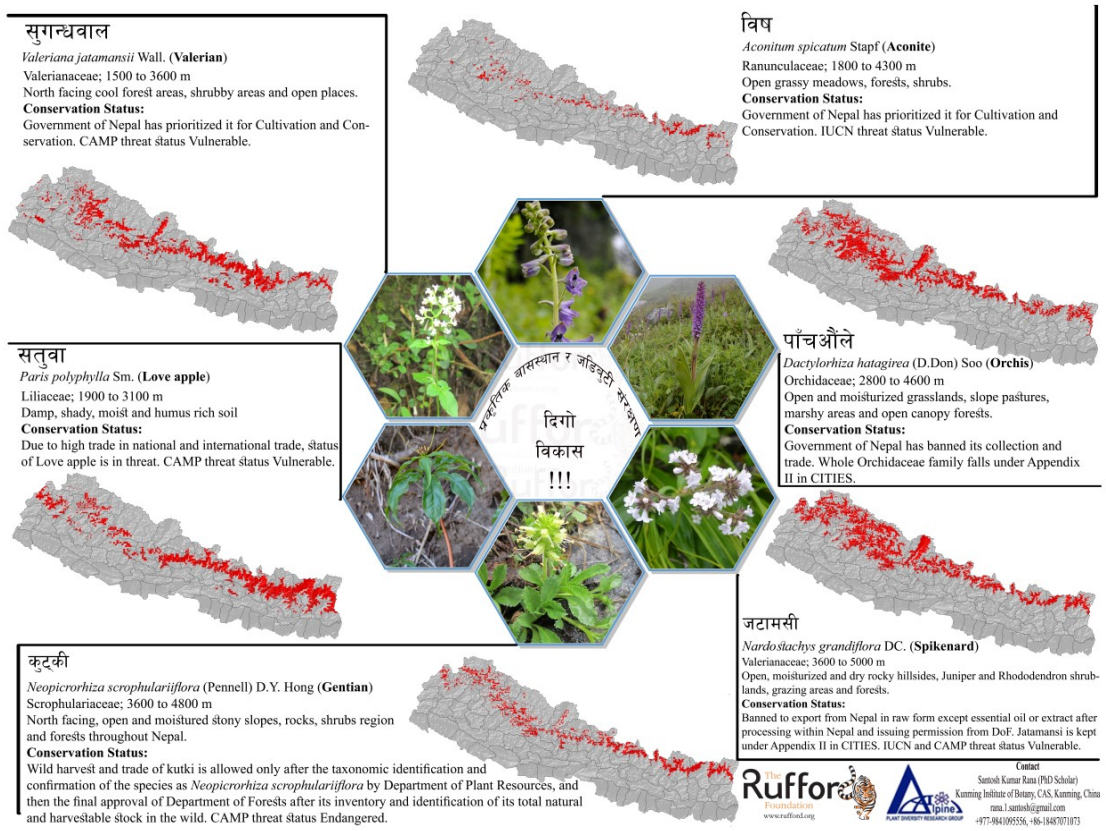

Figure 7: Flex print used for result sharing programme.