The Rufford Small Grants Foundation

Final Report

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

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. 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. 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	Anjana Giri
Project title	Biodiversity Conservation through Sustainable Forest management in the Balajhar Community Forest, East Nepal.
RSG reference	11877-1
Reporting period	14 months
Amount of grant	$ 6000
Your email address	anjanagiri@hotmail.com
Date of this report	

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
Analyse the floristic composition and structure of forest ecosystem			√	The objective was accomplished by sampling 24 forest plots during July-August and October-November. Intensity, frequency and scale of disturbance factors (e.g. selective logging, grazing and trampling) are responsible for change in forest ecosystems and species loss. These factors are often overlooked and fail to explain the influences of disturbances on species composition and forest structure. During the study, the forest was categorised into disturbed and regenerating by visually inspecting the site conditions and field measurement data on lopping and logging percentage, grazing intensity, trail and trampling coverage and regeneration pattern. Floristic composition and forest structure was analyzed by laying three nested circular plots of radii 2.5m, 5m and 10m for sampling seedlings, saplings and trees species respectively. The detail method and result are in the Annex 1.
Evaluate and compare the potential impacts of anthropogenic disturbances on regeneration of tree species			√	To obtain the data on the regeneration status of trees, seedlings less than 1 m in height were counted in the circular plots of radius 2.5 m. Six non- regenerating tree species were identified which need immediate conservation. The higher regeneration of plant species obtained in the present study is one of the good examples of community participation for the protection and management of forests, as this forest was previously a natural government forest and it was handed over to the community forest users groups only in 2009.
Determine the effect of forest disturbances on economically			√	Questionnaire survey and forest survey was conducted to fulfil this objective. Many economically important timber species and non timber forest products

important plant species				were once abundant in the area are difficult to find and some are already extinct from the forest. The result showed the effect of anthropogenic impacts on plant diversity. It further raised a serious question mark on the sustainability of the forest products.
Quantify current C pool in the vegetation			√	The objectives were accomplished by measuring the woody plants with diameter ≥ 5 cm at breast height and height > 1.3m in each plot. Regression model was utilised for the calculation of aboveground biomass of trees. Later, the biomass value was converted to C stock value. The observation in the quantity of C stored in two forest sites permits to appreciate that regenerating forest sites have potential to store more biomass C than the disturbed one.
Preparation of a comprehensive list of services provided to the community by forest ecosystem			√	Questionnaire survey and visual observation was carried out among the users group to prepare the list of ecological services provided by the forest. The requirements of the household fuel wood, grass, leaf litter are fulfilled by the disturbed forest sites and the nearby natural government forest.
Draw recommendation for forest management and conservation of economically important plant species			√	The outcome of the research results will be utilised by the Balajhar community forest users groups for the preparation of new guidelines. Increasing human settlement, forest fires, overgrazing and over harvesting of timber and NTFPs in the past are among the major reasons of biodiversity loss in the area. Lopping of the trees for fodder and fuelwood also inhibits forest regeneration and seed production. Sustainable looping practices should be implemented to get good seed production and natural regeneration of tree species. Plantation of non timber forest products and fodder trees in the arable land could decrease the dependency on forests which in turn increase the nutrient contents of soil, increase productivity of the arable land and provide fodder to

				livestock and for income generation of the local people, who depend on forest resources for their livelihood.

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

As the community members and user groups were very understanding, warm hearted and cooperative, there were no such difficulties or issues that arose during the study period.

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

Three most important outcomes of this research projects are;

(a) Population structure

The population structure of tree species was distributed in six different patterns. The species in the 1st pattern have sufficient individuals in sapling classes (2-10cm) and gradually decreasing in the higher tree size classes (reverse J curve pattern) showing good reproduction and recruitment. The second pattern indicates bell shape pattern and illustrated that the regeneration was sporadic. The third pattern showed species occur only in the lower DBH class (2-10cm and 10-20 cm) and absent in the rest. In the fourth pattern the lower DBH class (2-10cm) is absent and is only found in DBH class between 10-20cm. The larger gap between sapling and higher tree classes suggested that the species have not been reproducing well since longer time due to anthropogenic disturbances like illegal cutting, grazing, fodder collection, forest fire, etc. The fifth pattern showed species in the lower DBH class (< 10cm) and absent in the rest. These plant species are economically important for their fruits. Illegal harvesting of fruits as well as whole trees have hampered the regeneration of these species since longer time. Presently all these species are found in the regenerating forest. The sixth pattern represents those plants having DBH class > 20 cm and rest of the lower DBH class is absent. In general, trees in this group are arranged in a declining order having no saplings and pole size tree predicting the species are on the way to local extinction. While analysing the results, the trees that fell under 4th and 6th patterns did not show frequent reproduction. Thus, it can be interpreted that those trees (*Dalbergia latifolia*, *Grewia subinaequalis, Michelia champaca*, *Lannea coromandelica*, *Alstonia scholaris* and *Bombax ceiba*) are on the way to local extinction causing change in the species composition of the forest ecosystem. On the whole, the result of all tree population distribution patterns indicated that increasing human population with increasing demand of fodder, fruits, fuelwood and timber causing illegal and selective cutting of trees in the middle and higher DBH classes.

(b) Regeneration status

The distribution of seedlings and saplings in any forest shows the regeneration status of that forest. The tree species were categorised into two groups based on the number of seedlings and saplings present in the study site

Group “I” = species with ≥1 seedlings
Group “II” = species with no seedling at all

In the regenerating forest site, 7370 seedlings/ha and 1799 saplings/ha were recorded from 25 tree species. The highest seedling and sapling density was recorded for *Shorea robusta*. *Mallotus*

philippensis, Cassia fistula and *Albizia lebbeck* are found only in the seedling stage. While *Sterculia villosa* is only in the sapling stage. *Lannea coromandelica* and *Grewia subinenqualis* have no seedlings and saplings. The mature tree stage of *Emblica officinalis*, *Cassia fistula* and *Albizia lebbeck* were absent, while the seedling stage of the same were encountered.

In the disturbed forest site, 5562.6 seedlings/ha and 410 saplings/ha were recorded from 21 tree species. The highest seedling density was contributed by *Holarrhena pubescens* (2887.5 seedlings/ha). Similarly sapling density was highest for *Shorea robusta* (167.2 saplings/ha).The higher sapling density of *Holarrhena pubescens* indicates that the species grows well in the disturbed forest sites. The distribution and density of seedlings and saplings indicate the future status of the forest. Coming to the conservation priorities, the tree species in group "II" category (*Lannea coromandelica* and *Grewia subinenqalis*, *Bombax ceiba*, *Lannea coromandelica* and *Alstonia scholaris*) should be given priority for conservation. Overall the regeneration pattern of dominant tree species is satisfying. This is an indication of good community participation for the protection and management of forests, as this forest was previously a natural government forest and it was handed over to the community forest users groups only in 2009.

(c)Vegetation C stock

Preventing deforestation is recognised as one of the important measures to reduce climate change effect in a short period of time. This is gaining international attention among scientific communities regarding carbon negotiation mechanisms including REDD (reduced emission from deforestation and forest degradation) and REDD+ (including forest enhancement and sustainable management). Community forest programme in Nepal is considered as one of the most successful forest management schemes. Because of this reason, the government and non-government organisations are paying attention to include the community forestry programme in the REDD+ mechanism. Regarding this, estimation of forest C stock in the community forest is required to know the carbon trading mechanism and to make understand the importance of CF among users group. The research result showed that significantly higher biomass C stock was observed in the regenerating sites (47.6±4.8 Mg ha^{-1}) than disturbed forest sites (34.4±3.9 Mg ha^{-1}). In case of tree biomass C stock, no significant effect of forest disturbances were observed. But in the sapling layer, significantly higher biomass C stocks were recorded in the regenerating forest sites (34.7±3.9 Mg ha^{-1}) than disturbed sites (13.3±3.6 Mg ha^{-1}). The lower biomass stock in the disturbed sites could be due to forest disturbances such as trampling and livestock grazing which has hampered the growth of sapling. Forest management activities play a key role to make a forest land from sink to source condition of the atmospheric CO_2 and *vice versa*. The increment of biomass C stocks in the sapling layer of the regenerating forest sites also justifies the results. Overall, the observation in the quantity of C stored in two forest sites permits to appreciate that regenerating forest sites have potential to store more biomass C than disturbed forest site. In this context, replanting of tree species, adoption of longer rotation between harvesting and control over disturbances could be taken as an options to increase the biomass C stock and to maintain the biodiversity of the region. The result further helps to regulate global climate and motivates users group towards better forest management activities.

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

The study site was the community forest and without the consent of community members, the project could not have been fulfilled. During the field survey four members of Balajhar community forest were involved for data collection and were trained for forest inventory work. Questionnaire

survey was conducted among the community forest users groups to check their knowledge on forest management activities and to teach the importance of biodiversity and natural resources. After analysing the first field data a meeting was conducted with the community members to discuss about the status of the forest. The major achievement of the research is to include the results during the preparation of upcoming new Balajhar community forest management guidelines. The local FM radio helped to disseminate our research activities and results to the local listeners.

5. Are there any plans to continue this work?

Yes, I am planning to continue the research and conservation activities. The research result provided baseline data on plant diversity, population structure, and regeneration of tree species and carbon stock of trees. High valued plants are likely to get extinct from the forest. Conservation and protection of these species is in dire need. Plant conservation programme will be launched to protect the species from extinction. Moreover, present research has generated baseline information regarding the C pools of different intensity of utilized forests. In the ecosystems, soil is the main pool of carbon. The sequestered C in the soil stays for a longer period. The study on Soil C, nutrient pools and In-*situ* CO_2 flux measurements will be carried out to obtain a clear picture on C dynamics of forest ecosystem.

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

The research results have already been shared among Balajhar community forest users group. I will submit the research report to the concerned government and intergovernmental organisation who are working in that area so that it can be used as a guideline for the management of anthropogenic impacted forest ecosystems. The research results will further be shared with scientific communities through conferences and publications.

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

Funding from RSG was used for 14 months for the data collection, data analysis, report preparation and dissemination of results to the community forest users groups. The project was completed on time and every component went as scheduled.

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
Vehicle hire and fuel costs during the field work	1550	1470	80	Due to the hike in fuel price.
Researcher field allowances (Lodging and food)	3100	3150	50	
Hiring field assistant	810	840	30	
Purchase of literature and maps	150	150		
Workshop/meeting	300	300		
TOTAL	6000	6000	Exchange rate:1 £ sterling=NRs 128	

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

We have already submitted the research report to the community forest members and to Nepal Academy of Science and Technology (NAST). We are planning to disseminate the result to the government organization especially to 'President Churia Conservation Programme'. At the mean time I am preparing the manuscript for the publication in the international journal. I am also planning to disseminate the results to the scientific communities by giving presentation in the international and national scientific conferences.

Our future aim is to conduct awareness programme to the community forest members, users groups and stakeholder who are involved in the forest management activities for the conservation of highly vulnerable species (results obtained from this study) by proving experimental education training programme on seed collection, germination, in-situ conservation, propagation, planting, monitoring and regeneration.

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

We constantly acknowledged RSG during the research work. I had used the logo in the report which I had submitted to the Community forest members. I will acknowledge RSG in the scientific publication as well as international and national conferences.

11. Any other comments?

I am pleased to get the funding from RSG, as this was our major resource to conduct this research activity. The objectives would not have been carried out without this support. This grant played a major role for biodiversity conservation and to provide scientific insights. I am very much grateful and am hoping for the same continuous support from RSGF in the upcoming years.

Annex 1

Overview of the study site

Balajhar Matiyarba Community Forest (BMCF) covers an area of 199,91 ha within ward numbers 7,8 and 9 of Hariharpur VDC of Dhanusha district. The community forest was established in 2009 (Nepali calendar: 2066 BS), for the management of forest and other natural resources of the area and allows the degraded natural forest to regenerate by protecting it through participatory approach. The study site is bordered with Jalad Khola in the east and North, Daldali Khola in the west and cultivated land in the south. The community forest is protected and managed by users group. There are 472 households with the population of 2673 (male 1396 and female 1276). The vegetation of the study site comprises of *Shorea robusta* forest, deciduous riverine forest and tropical mixed broadleaved forest. *Shorea robusta* is the dominant species which is accompanied by *Terminalia* sps., Acacia catechu, *Aegle marmelos*, *Nyctanthes arbor-tritis*, *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Syzyzium cumini* etc. Shrub vegetation is dominated by *Murraya koenigii*, *Phoenix humilis*, *Mimosa rubicaulis*, etc.

Methods and Methodology

Land use classification

The forest is classified as disturbed and regenerating forest by visually inspecting the site conditions, through giving emphasis on forest disturbances such as litter raking, lopping and logging percentage, trial coverage, grazing intensity, trampling coverage and regeneration pattern. The gradient of forest disturbances was used for the assessment of vegetation structure, regeneration pattern and carbon stocks.

Experimental design

A transect survey was carried out systematically across the study sites to collect the primary information from the forest sites. Fourteen and nine permanent forest plots were placed in the regenerating and disturbed forest sites respectively. The forest plots were laid down considering vegetation, intensity of forest utilization, site condition and topography. The sampling was done with the help of 3 nested circular plots of radii 2.5m, 5m and 10m for seedlings, saplings and trees respectively.

Forest Inventory

All trees with DBH > 10 cm and height >1.3 m were recorded within the circle of radius 10m. Vegetation with DBH 5-10 cm and height >1.3 m were measured within the circular plot of radius 5 m. Plant species <5 cm DBH and height >1.3 m were recorded within the circle of radius 2.5 m. Similarly, to obtain the data on the regeneration status of trees, seedlings less than 1 m in height were counted in the circular plots of radius 2.5 m. Tree height was determined using a Suunto-clinometer while, a DBH tape was used to record the diameter of trees.

Analytical method

Analysis and evaluation of vegetation dynamics in two different forest sites were made by computing the collected information on basal area (BA), tree height, density (D) and relative density (RD); frequency (F) and relative frequency (RF); dominance (Dom), importance value index (IVI) and regeneration status.

Results

Floristic structure

The present study dealt with tree and shrub species only. A total of fifty one species of tree and shrub specimens were collected from the regenerating and disturbed forest sites of BMCF (Table 2). The identified specimens belong to 47 genera and 28 families. Fabaceae represents the largest family having 6 genus followed by Anacadiaceae (genus 4), Rutaceae (genus 4), Euphorbiaceae (genus 2) and the rest contained a single genus each. The genus Terminalia was represented by 3 species, Zizyphus by 2 species, and 44 genus contained a single species. In general, trees contributed to 81% of the floristic composition of the total collection from the study sites.

Diameter at breast height (DBH)

In the regenerating forest sites, the distribution of tree species in 2-10cm DBH class is 1799 individuals/ha (82%), 374 individuals/ha (17%) in 10-20 cm DBH and 19.6 individual/ha (1%) in 20-40 cm DBH. Similarly, in the disturbed forest sites, the number of stems in lower DBH class (2-10 cm) is 410 individuals/ha (59%), in 10-20 cm DBH is 233 individual/ha (33.6%) and in 20-40 cm DBH is 49 individual/ha (7.4%). In general, *Shorea robusta* is the only species that is dominant in all the DBH

class (Figure 1). While comparing the forest sites, the distribution of higher DBH class trees were noted in the disturbed forest sites. Absence of higher girth trees (above 35cm DBH) indicated that there was an anthropogenic pressure.

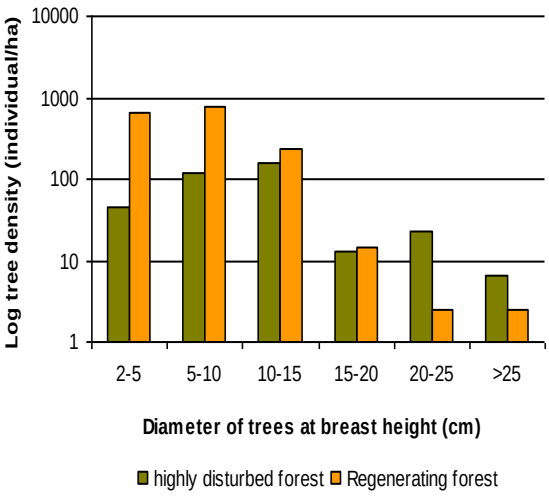

Figure 1. Diameter distribution of *Shorea robusta*

Basal area

The basal area of all tree species in the regenerating forest site was 8.7 m^2/ha. In which, *Shorea robusta* alone contributed the largest share of 5.4 m^2/ha. Remaining species occupied less than 1 m^2/ha. In the disturbed forest site, the total basal area was 7.16 m^2/ha, in which *Shorea robusta* has the biggest share (3.7 m^2/ha) followed by *Bombax ceiba* (1.7 m^2/ha). The total basal area is very low. It could be due to the distribution of lower DBH class trees which did not contribute to the total basal area of the forest.

Tree density

In the regenerating forest sites, the density of trees >2cm, >10cm and >20cm DBH were 1799.4 individuals/ha, 374.8 individuals/ha and 19.6 individuals/ha respectively. Regarding tree density >2cm DBH, *Shorea robusta* contributed 74.2% followed by *Buchanania latifolia* 7.7%, *Nyctanthus arbor-tritis*, 4.4%, *Lagerstroemia parviflora* 2.8%, *Syzigium cumini* 1.4% and *Emblica officinalis* 1.3%. Other tree species (*Acacia catechu*, *Adina cordifolia*, *Anogeissus latifolia*, *Bauhinia purpurea*, *Michelia champaca*, *Holarrhena pubescens*, *Semecarpus anacardium*, *Solena heterophylla*, *Sterculia villosa*, *Terminalia alata*, *Toddalia asiatica*) each shared <1% of the total tree density. In trees >10 cm DBH, *Shorea robusta* shared the highest tree density (65.4%) followed by *Lagerstroemia parviflora* (12.4%), *Buchanania latifolia* (7.1%), *Michelia champaca* (3.3%) and *Acacia catechu* (1.9%). Considering DBH >20cm, *Shorea robusta* and *Lagerstroemia parviflora* shared 37.2% and 25% of the total tree density respectively whereas, *Lannea coromandelica*, *Semecarpus anacardium* each shared 12.2%.

In the disturbed forest sites, the density of trees with DBH greater than 2 cm is 410 individuals/ha. The number of stems with DBH >10 cm was 223.5 individuals/ha and those with DBH >20 cm was 49.4 individuals/ha. In > 2cm DBH class, *Shorea robusta*, *Holarrhena* pubescens and *Anogeissus latifolium* alone contributed to 40.8%, 25.2% and 22.3% of the total density, respectively. Similarly,

Acacia catechu and *Garuga pinnata* each contributed 2.9% of the total density. Tree species namely, *Bombax ceiba*, *Dalbergia latifolia*, *Ficus hispida*, *Lannea coromandelica*, *Michelia champaca*, *Semecarpus anacardium* and *Tectona grandis* contributed only 7% of the total density. Concerning trees with DBH > 10 cm, *Shorea robusta* alone contributed 72.7%, followed by *Holarrhena pubescens* (7.5%), *Anogeissus latifolia* (6.2%) and *Michelia champaca* (4.5%). Tree species, *Garuga pinnata* and *Tectona grandis* each contributed 2.9% of the total density. Regarding trees with DBH class >20 cm, *Shorea robusta* contributed 57.3% and *Bombax ceiba* 21.5%. Three species, *Alstonia scholaris*, *Lannea coromandelica* and *Tectona grandis* each contributed 7.1% of the total density. The lower value obtained in the present study could be due to forest disturbances and selective logging of higher diameter trees. The result having predominance of tree density in the lower DBH class indicting that the forest was severely disturbed in the past. Overall, the regeneration potential of *Shorea robusta* in both the study sites is in the higher side indicating good recruitment of this species. The reason could be due to the combined effect of light intensity, increased soil temperature and reduced competition of nutrient which might support the regeneration of this species.