Baseline Report

Uttarakhand Decentralized Watershed Development Project (UDWDP)

Phase-II (GRAMYA) (IDA Credit No.5369-IN)

External Evaluation Consultancy

Sutra Consulting | SUSTAINABLE AND INNOVATIVE SOLUTIONS

Acknowledgement

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It is hoped that this study will assist WMD in further improving the quality of its projects, thereby ultimately benefiting villagers in the division. As is evident from the above, many individuals and organisations have made significant contributions to this study; however, the consultant remains responsible for any errors and omissions that it might contain.

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Abbreviations

ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AWP	Annual Work Plan
BA	Bachelors of Arts
BEF	Biomass Expansion Factor
BPL	Below Poverty Line
CartoSAT DEM	Cartosat-1 Digital Elevation Model
CBH	Circumference at Breast Height
CD	Change Detection
CS PRO	The Census and Survey Processing System (Software)
DBH	Diametre of Breast Height
DiD	Difference-in- Difference
DN	Digital Numbers
DPD	District Project Director
ESMF.	Environment and Social Management Framework
FF	Farmer Federation
FIGs,	Farmer Interest Group
FPO	Farmer Producer Organisation
FY	Financial Year
FYM	Farm Yard Manure
GIS	Geographic Information System
GPS	Global Positioning System
GPWDPs	Gram Panchayat Watershed Development Plan
HH	Household
ICAR	Indian Council of Agricultural Research
IGA	Income Generation Activity
IPM	Integrated Pest Management
IWMP	Integrated Watershed Management Programme
LAI	Leaf Area Index
LULC	Land Use Land Cover
LULUCF	Land Use, Land Use Change and Forestry
M&E	Monitoring and Evaluation
MDM	Minimum Distance to Mean
MIS	Management Information System
ML	Maximum Likelihood
MGNREGA	Mahatma Gandhi National Rural Employment Gaurantee Act
MWS	Micro Watershed
NDVI	Normalized difference vegetation index
NGOs	Non-Govenment Organisation
NRSA	National Remote Sensing Agency
NSS	National Sample Survey
OBC	Other Backward Caste

PDO	Project Development Objective
PME	Participatory Monitoring Evaluation
PMU	Project Management Unit
PoP	Poorest of Poor
PRA	Participatory Rural Appraisal
PRIs	Panchayati Raj Institution

1. Executive Summary

Uttarakhand Decentralized Watershed Development Project (UDWDP Phase-II) is built on the successful implementation of the first phase of the project by the Government of Uttarakhand through the Watershed Management Directorate (WMD)supported by the World Bank. The second phase of the project focuses largely on institutional and improvement in productive potential of the project area through various watershed treatment measures. The project development objective focusses on three primary areas of improvement; i) increasing the water discharge, ii) increasing the biomass, and iii) increasing the rain-fed area under irrigation. The project specifically aims at improved decentralized governance, gender equity and environmental sustainability by mobilizing and organizing the farmers in the watershed area focussing on women producers.

The key components of the project are

- **Component 1**:Social Mobilization and Participatory Watershed Planning
- **Component 2:** Watershed treatment and rain-fed area development
- **Component 3:** Enhancing livelihood opportunities including agri-business development
- **Component 4:** Knowledge management

The second phase of the project is being implemented in eight hill districts,comprising of Bageswar, Almora, Uttarkashi, Tehri, Dehradun, Pauri, Pithoragarh and Rudraprayag covering 523 panchayats with a target of 56,000 project beneficiaries.

The baseline study was undertaken between November 2016 to February 2017 as the first stage of evaluation, which would be followed by mid-term and end-term evaluation studies. The baseline study sets thebaseline benchmarkfor project results Indicators comprising of PDO level indicators and intermediate results indicators. Subsequent studies at the mid-term and end-term would compare the results with the baseline values, to understand the progress made by project in achieving targeted results. This report presents the baseline values of the results indicators and other relevant indicators related to the project interventions at the beginning of the project.

1.1Methodology

The evaluation design for Gramya-II is based on a quasi-experimental model, wherein suitable counterfactual group were established for comparison with the treatment group. A difference in difference method is used to do subsequent comparisons for treatment and control areas. The control or counterfactual units were geographically selected and were located in areas where no watershed development related activities had been conducted in the past 4 years. Control areas were selected from 4 different micro-watersheds from where 18 control Gram Panchayat(GPs) were drawn. A total of 54 treatment GPs and 18 control GPs were covered during the survey covering a total of 124 villages and 6474 households were covered as a part of the survey. The control samples havebeen selected purposefully by matching the physical variables and geographies into account.

The baseline study included both qualitative and quantitative methods and a set of 6 survey tools were administered. The quantitative survey tools included the micro-watershed level tool, the GP level tool, the village level tool and the household level tool. The qualitative tools included the Key Informant Interview schedule and the Focus Group Discussion schedule. The household data collection tool had comprehensive sections covering income, debt, savings, membership in community institutions, land use, asset ownership, social capital, etc. The GP schedule on the other hand focused on procedural details on implementation including levels of awareness, meeting schedules, nature of participation, monitoring processes followed, etc.

1.2. Summary of Baseline Findings

Table 1: Summary Results of Project Outcome Indicators

SUMMARY RESULTS OF PROJECT OUTCOME INDICATORS						
Project Outcome Indicators	**Unit of Measure**	**Baseline Study**				**Notes and Explanation**
		Project		**Control**		
1. Increase in water discharge	%	-		-		To be provided by hydrology agency / WAPCOS
2. Status of Bio Mass	MT/Ha	27.69		21.74		
3. Percentage area under rainfed condition	%	86.2		87.0		Percentage of rainfed area from total cultivable area
4. Increase in productivity in irrigated and rainfed crops ***(Note:Calculated for the reference period (2015-2016)***	Qtls/Ha					
Irrigated Crops		**Kharif**	**Rabi**	**Kharif**	**Rabi**	
Garlic	Qtls/Ha	-	24.1	-	23.3	
Cauliflower	Qtls/Ha		188.4		187.0	
Cabbage	Qtls/Ha		181.9		180.2	
Green Pea	Qtls/Ha	-	62.3	-	61.9	
Rainfed Crops		**Kharif**	**Rabi**	**Kharif**	**Rabi**	
Ginger	Qtls/Ha	86.9	-	85.7	-	
Maize	Qtls/Ha	15.3	-	14.9	-	
Wheat	Qtls/Ha	-	19.8	-	19.1	
Pigeon Pea	Qtls/Ha	7.8	-	7.0	-	
Finger Millet	Qtls/Ha	17.6	-	16.9	-	
Red Kidney Bean	Qtls/Ha	12.2	-	11.7	-	
Paddy	Qtls/Ha	22.8	-	21.3	-	

Table 2: Summary Results of Project Intermediate Outcome Indicators

SUMMARY RESULTS OF PROJECT INTERMEDIATE OUTCOME INDICATORS				
Project Outcome Indicators	**Unit of Measure**	**Baseline Study**		**Notes and Explanation**
		Project	**Control**	
1: Social Mobilization and Watershed Planning				
Intermediate Indicator 1: Percent of Participating HHs in the Gram Sabha meetings	%	67.2	58.0	
(ii) % of which are female	%	62.4	54.3	*Households where atleast 1 female member has attended Gram sabha meeting.*
Intermediate Result (Component 1) : Watershed Treatment and Rainfed Area Development				
Intermediate Indicator 2: Hydrological monitoring systems fully installed and functional in sample MWSs	%	-	-	To be provided by hydrology agency / WAPCOS
Intermediate Indicator 3: Targeted traditional natural water sources rejuvenated	%	-	NA	*baseline value is zero or not relevant for baseline*
Intermediate Indicator 4: Natural resource conservation techniques adopted in the targeted areas	%	-	NA	*baseline value is zero or not relevant for baseline*
Intermediate Indicator 5: Targeted farmers practicing soil moisture conservation and crop production technologies				
soil moisture conservation measures	%	28.4	27	*Percentage of farmers who are practicing any one soil moisture conservation measure*
crop production technologies[1]	%	13.3	11.7	*Percentage of farmers who are practicing any one one crop production technology*
Intermediate Indicator 6: Farmers organized into FIGs	No.	-	N.A	
Intermediate Indicator 7: Self-Sustained FFs	%	-	N.A	***Data to come from MIS, not relevant for baseline***
Intermediate Indicator 8: Vulnerable HHs covered by the	No.	-	N.A	***Data to come from MIS, not relevant***

[1] *Crop Production Technology: INM,IPM and improved post-harvest management technology*

SUMMARY RESULTS OF PROJECT INTERMEDIATE OUTCOME INDICATORS				
Project Outcome Indicators	**Unit of Measure**	**Baseline Study**		**Notes and Explanation**
		Project	**Control**	
Vulnerable Group activities under GPWDPs				***for baseline***

Table 3:Summary Results of Project Impact Indicators

SUMMARY RESULTS OF PROJECT IMPACT INDICATORS				
Project Outcome Indicators	**Unit of Measure**	**Baseline Study**		**Notes and Explanation**
		Project	**Control**	
Impact Area 1: Improvement in household Wealth / Welfare				
1. Annual Income of Household	Rs	1, 40,616	1, 41, 132	***Calculated for the period (2015-2016)***
2. Increase intake of nutritional (protein, vitamin) diet in households				
Per Capita consumption of Protein rich diet per day	gms	36.1	33.3	
3. Improved household access to water (Piped water connection in house)	%	62.3	66.7	
4. Percentage of Household taken debt (last year)	%	16	20	
Impact Area 2:Improved intensity of Agriculture and Allied sectors in the State				
5. Percentage of Farmers growingGinger and Garlicas high value crops	%	22.3	20.7	
6. Percentage of HH's owning livestock	%	79.8	78.3	
7. Days of local wage opportunities (Per household per year)	Number of days	191	190	
8. Local wage rates (Farm Government Wage current rate per day for year 2016-17)	Rs	172	172	
Impact Area 3: Empowerment and increase in Social Capital				
9. Increase in percentage of household in higher quartiles of empowerment score	%			
(Excellent) Q1	%	2	2	
Q2	%	63.7	65.7	
Q3	%	34	32.1	
(Poor) Q4	%	0.3	0.2	
10. Increase in percentage of household in higher quartiles of social capital score				
(Excellent) Q1	%	4.5	1.4	
Q2	%	52	43.4	

SUMMARY RESULTS OF PROJECT IMPACT INDICATORS				
Project Outcome Indicators	Unit of Measure	Baseline Study		Notes and Explanation
		Project	Control	
Q3	%	40.1	49.3	
(Poor) Q4	%	3.4	5.9	

1.3. Project Results

The project results are disaggregated across four broad components. The section below summarizes the observations against each of the result area.

Outcome Indicator One: Increase in Water discharge

The water discharge is calculated for 8 Micro watersheds through hydrological monitoring by an external agency. Measurement devices will be installed in each representative stream of the MWS. The location of establishment of these devices shall be done after reconnaissance survey. Water discharge will be calculated in Ltrs / Minute by recording water discharge once in every two days for the 8 MWS. The project is targeting to renovate drying sources and improve perennial sources so that water availability is improved. As part of the process during every GPWDP preparation water sources were identified. The baseline assessment has also captured both natural and artificial water resources in 54 GPs. A total of 201 water sources including natural streams, springs, boring, farm ponds, open wells, and check dams have been confirmed to be identified water source where rejuvination activities would be carried out. About 4 percent of the total water sources identified were such which has water available for nearly 12 months. Other sources would need rejuvenation efforts through the course of the project.

Outcome Indicator two: Increase in biomass

The second project development indicator is calculated on 38 sample MWS. The biomass estimation is done through an integration of field data with visually processed satellite image in all the 8 divisions viz. Almora, Pithoragarh, Bageshwar, Rudraprayag, Pauri, Dehradun, Tehri and Uttarkashi. The present study comprised of visual processing of pan sharpened image (LISS IV), to create a thematic map of the project area comprising of various stratified units viz. forest (Dense, Moderate, Open), waterbody, Land, agriculture etc. Additionally the image is processed for the calculation of vegetation index. The field estimation consists of laying of sample plots in different vegetation strata in order to achieve quantification of biomass in tonnes per hectare. The sample plots were used in conjunction with vegetation index to calculate the biomass value by correlating the two values using linear equation.Field sampling covers 12 MWS belonging to 7 divisions.

The overall biomassacross all districts in Tonnes is 4098995.1 and average across area is about 27.6 Tonnes/Ha. Rudraprayag and Pauri has a higher density of Biomass with about 34.9 and 33.4 Tonnes/Ha respectively. Other divisions were almost near to the overall average.

The average annual soil loss values varies considerably, the lowest average soill loss value of 250.88 $t^{-1}h^{-1}yr^{-1}$ has been estimated for Sarugad micro-watershed while the highest value of 748.63 $t^{-1}h^{-1}yr^{-1}$ was estimated in Dewangad micro-watershed

Outcome Indicator three: Percentage of area under rainfed conditions(Ha)

The unit of measurement of this indicator is the cumulative additional rainfed area under irrigation in Hectares. However, to measure change over a period of time percentage of area is calculated under rainfed conditions from the cultivable area of sampled households. Nearly 89 percent of the cultivable land in treatment area are rainfed and a similar pattern is in control as well.

Table 4: Percentage of Area under rainfed conditions

% of Area under rainfed conditions		
	Treatment	**Control**
Rainfed	88.7	87

Source: Household Survey, N (Treatment) =4862, N (Control) =756

Outcome indicator four: Increase in productivity in irrigated and rainfed crops

Project has a specific focus on improving crop production in rainfed areas and has related interventions to do the upgradation. The project targets to do productivity enhancement for major five high value irrigatedcrops and three major rainfed crops. Productivity values are calculated for specific crops by calculating the area in which crop is grown and production in specifc seasons. The average productivity values for the spcific crop is presented in Qtls/Ha.Crops grown in each division across three seasons are also detailed in the report. Based on the baseline findings the major five high value irrigated crop and three major rainfed crops are identified.In midterm and endline evaluation phase the identified crops would be tracked further for measuring changes in the productivity percentage. The production data captured is for the reference period of2015-16 through recall method as the baseline assessment year was 2016-17.

The major rain-fed crops in the surveyed areas include Maize, Paddy, Wheat, Pigeon Pea (Tur), Finger Millet, Ginger and Red Kidney Bean (Rajma). Other major crops in rainfed area include Potato, Soyabean, Mustard, Other Millets and Barley.The major irrigated crops include Garlic, Green Vegetables (Cabbage and Cauliflower) and Peas. The following table provides the productivity of the selected crops in the treatment and the control areas.

Table 5:Project Outcome Indicators –Productivity of irrigated and rainfed crops

Project Outcome Indicators	**Unit of Measure**	**Baseline Study**				**Notes and Explanation**
		Project		**Control**		
Increase in productivity in irrigated and rainfed crops ***(Note:Calculated for the reference period (2015-2016)***	Qtls/Ha					
Irrigated Crops		**Kharif**	**Rabi**	**Kharif**	**Rabi**	
Garlic	Qtls/Ha	-	24.1	-	23.3	
Cauliflower	Qtls/Ha		188.4		187.0	
Cabbage	Qtls/Ha		181.9		180.2	
Green Pea	Qtls/Ha	-	62.3	-	61.9	
Rainfed Crops		**Kharif**	**Rabi**	**Kharif**	**Rabi**	
Ginger	Qtls/Ha	86.9	-	85.7	-	
Maize	Qtls/Ha	15.3	-	14.9	-	
Wheat	Qtls/Ha	-	19.8	-	19.1	
Pigeon Pea	Qtls/Ha	7.8	-	7.0	-	

Project Outcome Indicators	Unit of Measure	Baseline Study				Notes and Explanation
		Project		Control		
Finger Millet	Qtls/Ha	17.6	-	16.9	-	
Red Kidney Bean	Qtls/Ha	12.2	-	11.7	-	
Paddy	Qtls/Ha	22.8	-	21.3	-	

1.4. Intermediate Result Indicators

The intermediate indicators through the course of time are expected to contribute to the achievement of the results. While the results on the intermediate indicatos are expeted to be zero in baseline however since the baseline was commissioned late by the project some influence on intermediate results can be seen. The values of the result indicators have been highlighted subsequently.

Component 1: Social Mobilization and Participatory Watershed Planning:

Participation in Gram Sabha:

UDWDP-II is based on the joint relationship among village communities-GP, WMD and NGOs and hence an improved functional efficiency of the institutions is envisaged in the process of project implementation. Gram sabha has an important role in discussing and approving all major decisions related to GPWDP, and ensuring inclusion and monitoring of GP and other implementers. There is therefore a special emphasis on ensuring higher participation of households in gram sabha meeting especially during the process of annual work plan approval and implementation. The data is supposed to be maintained in the MIS by project for each Gram sabha and Aam sabha meetings conducted for the purpose of project implementation. It is seen as a long term impact for improving overall gram saha functionality in this process. The study findings captures households participating in Gram Sabha meeting in last 1 year.The percentage is calculated from the sample households where any adult member have attended atleast one Gram Sabha Meetingin last 1 year.Overall participation of households in gram sabha meetings has come out to be about 67.2 percent in treatment and 58.0 percent in control.

Women participation was counted as households where at least one eligible women electoral participated among the sample households in at least one gram sabha during last year.There was no significant difference across control and treatment area as 58 percent of the control HHs and 67.2percent of the treatment HHs reported that at least one women member from their family attended the Gram Sabha meetings. Participation of female members seemed to be nearly similar in both control and treatment areas. The highest participation of members was noted in the district of Pithoragrah and the lowest in the district of Rudraprayag.Qualitative finding during the FGD also indicted that women participation in Gram Sabha meetings have been very significant especially in Dehradun and Bagheswar.

Component 2: Watershed treatment and Rain-fed area development

The second component particularly focuses on effective natural resource management through water source rejuvenation, soil moisture conservation and plantation activities. These activities are intended to ensure the effective use of natural resources.

Hydrological monitoring systems fully installed and functional in sample MWS

The external hydrology consulting agency, WAPCOS would install hydrological monitoring devices in 8 sample MWS in order to record water discharge in regular intervals. The water discharge information would start flowing in during the 6 monthly reporting stage.

Targeted traditional natural water sources rejuvenated

The project has targeted 1500 depleting water sources which are to be renovated. The GPWDP has details about all the targeted depleting sources which requires rejuvenation across 38 MWS. The baseline data collected through sample GP provides a list of water sources which have been identified for rejuvenation by the panchayat. During the baseline survey 309water sources have been identified

which are also mapped in GPWDP in 57 sample GPs. The quality of renovation activities and its progress would be further taken up during the 6 monthly regular monitoring process.

Natural resource conservation techniques practised in the targeted areas

Terraces with soil water conservation measures and vegetative boundaries are being promoted under the project at the village level. Since farmers may adopt more than one of these conservation techniques, adoption have been defined as adopting at least one among the many techniques promoted by the project. The conservation technique however is at village level and hence the intervention is mapped at the village level. The project MIS would give data on area coverd under plantation activities during 6 monthly monitoring cycle.

The baseline study looked at natural resources conservation techniques adopted by the targeted beneficiaries across the districts. It was found that construction of dry stone check dams and crate wire check dams along with river bank protection was adopted on a large scale to check soil erosion. The most significant plantation activity was undertaken in the district of Tehri district 2268.6 hectares of land has been brought under plantation, which the highest among all districts. Additionally, 929 water harvesting structures including farm ponds and community ponds have been constructed in the sample micro-watersheds visited.

Targeted farmers adopting soil moisture conservation practices and crop production technologies

There are several soil moisture conservation techniques promoted under the project. Crop production technologies has a series of production improvement measures that would help farmer in improving production and receiving fair price for their produce.Adoption is defined as farmers doing atleast one of the many technologies promoted under the project.

The project intended to capture soil moisture conservation measures practiced by farmers in atleast two seasons.The study shows that such practices are not very widely followed and only about 28.0percent of the farmers in the treatment area and 27.0 percent of farmers in the control area are using any one soil moisture conservation technology.Mulching and Napier are the two most comonly used ethods of moisture conservation. Mulching although reported by limited farmers.

Table 6: Percentage of HHs practising soil moisture conservation technology

Percentage of HHs where soil moisture conservation technologyis practiced (%)		
	Treatment	**Control**
Percentage of Households doing any one technology	28.4	27.0
Percentage of Households doing any two technology	21.7	19.6

Source: Household Survey, N (Treatment) =4010, N (Control) =628

Table 7: Percentage of HHs Practising crop production technology

Percentage of HHs where crop production technology is practiced (INM, IPM and Post Harvest Management) (%)		
	Treatment	**Control**
Percentage of Households doing any one technology	**13.3**	**11.7**

Source: Household Survey, N (Treatment) =4010, N (Control) =628

Crop production technology had a series of methods which farmers are practicing and the most common method used iscrop rotation and use of fertiliser. Among improved crop production technology the percentage was calculated for farmers practicing INM, IPM and Post harvest management practices which was overall as low as 13 percent in treatment and 11 percent in control areas. The package of practices are not widely used. Farmers usually use neem cakes, spray cow urine mixing with water and cow dung as measure of controlling pests.

Component 3:Enhancing Livelihood Opportunities

The third and fourth component of the Gramya II project includes enhancing livelihood opportunities and knowledge management and project coordination. These components are premised on the formation of various community based organizations such as Water User Groups(WUG), Farmer Federations(FF), Water and Watershed Management Committees(WWMC), Farmer Interest Groups(FIG) and WomenMahilaAam Sabha(MAS). These organizations have different objectives ranging from working with agribusiness support organizations and provide marketing support to farmers, implementing GPWDPs, mobilizing villagers and ensuring inclusion. Baseline figures for these organizations established are considered zero and numbers will be tracked during mid-line and end line. Eventual idea of the project is for community to sustain these groups without any handholding by Gramya II and same will be tracked in the future course of the project. Therefore, the baseline values for all intermediate indicators included in these two sections, has been taken as zero.

1.5. Impact Areas

Income and asset ownership; intensity of agriculture; and empowerment of project beneficiaries and social capital are three main impact areas to measure household welfare as a result of the project. The section below details out the impact areas.

1.5.1Intensification of agricultural allied activities: The project envisages that the watershed management practices institutionalized through the project along with the capacity building of beneficiaries would lead to improved intensity of the agriculture and the allied sectors in the state. This would be reflected through three primary areas of impact:a) Crop diversification, b) Engagement in allied agricultural activities and c) Overall improvement in wage rates through an overall increase in productivity.

One of the key objectives of the project is to make agriculture more profitable by providing farmers the technical knowledge and enhancetheir capacity to improve productivity rates.Crop diversification is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk. Crop diversification is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. One of the ways of enhancing return of farmers is to diversify the cropping pattern and move to high value crops in order to get better returns. Crop diversification is calculated as the number of farmers who are rowing high value crops and reported to be relatively newer crops as a results of lack of irrigation in last 5 years. This would help in tracking changes over a period of time to understand if availability of water and other project interventions has led to introduction and adoption of high value crops. The qualitative findings gave insights on the division specific high value crops which have been introduced in last 5 years for adoption by farmers. Ginger and Garlic seemed to be the most prominent crops used as a high value crop other than vegetable crops. It was found thatnear about 20-22 percent of the households in both the project and the control areas area cultivatedGinger and Garlic. Treatment seemed to little higher with 22 percent of the farmers growing Ginger. The major cultivation being recorded in the district of Dehradun.

Livestock and allied sector is one of the most significant sources of livelihood for the rural population in Uttarakhand. Based on the pattern of ownership it was seen that 79.8 percent of HHs in the treatment areas and 78.3 percent of HHs in the control area own livestock. Surveyed household possess average of 2Milch animals(cows /buffaloes) and 6 goats. Livestock on an average with goats and milch animals(cows / buffaloes) being the most owned livestock.

Table 8:Percentage of households owning livestock

Percentage of householdsowning livestock		
	Treatment	**Control**
Percentage of Household	79.8	78.3

Source: Household Survey, N=3753 (Treatment), N=571(Control)

Table 9*: Average livestock possessed*

Average livestock possessed				
	Milch Animals (Cows & Buffaloes)		Goats	
	Treatment	Control	Treatment	Control
Percentage of Household	2	2	6	6

Source: Household Survey, N=3753 (Treatment), N=571(Control)

Table 10: Percentage of households owning improved breed of cattle

Percentage of households owning improved breed of cattle		
	Treatment	Control
Percentage of Household	8	8

Source: Household Survey, N=473 (Treatment), N=72(Control)

But, the possession of improved breed of livestock is quite low with only 8 percent for both treatment and control households possessing improved breeds. This indicates that livestock farming is still dominantly based on traditional breeds and there is a potential for change.

The local wage earning opportunities in both the treatment and the control areas is extremely limited as the farmers mostly rely on subsistence agriculture. The local wage rate (farm Government rate) for work in agriculture sector was found to be Rs. 172 per day for both males and females in the treatment and the control areas. This was found to be above the minimum wage rate prevailing in Uttarakhand in the agriculture sector of Rs 157.69[2].

1.5.2 .Improvement in Income and Asset Ownership: The impact of increased agricultural productivity and livelihood opportunities can be felt on consumption and savings patterns of the benefitted households. It was found that the average annual household income covered in the treatment group was Rs. 1,40, 616 and that in the control group is slightly higher at Rs. 1,41,132. The highest average annual income was seen in Tehri division of Rs 1,52,300 and the lowest was seen in the district of Dehradun.

Tangible effect of increase in income is reflected in the consumption patterns of the household. Expenditure on food is one of the most vital heads in the consumption basket and increased intake of nutritious food including more protein and vitamin intake can be expected with an increase in income. The baseline findings revealed that the households in the treatment area fare slightly better than the households in the control areas in the consumption of protein and vitamin rich food. The per capita consumption of protein rich diet in the treatment area is 2 kg's per month and is 2.2 kg per month in the control areas. Per capita consumption of vitamin rich diet in the treatment area is 0.6 kg's per month in the treatment area

[2] *Uttarakhand Minimum Wage with effect from April 1, 2017 to September 30, 2017*

1.5.3 .Empowerment and increase in social capital: The final impact area is the empowerment of the communities and the increase in the social capital of the producers. The economic well-being of the producers and the community based organizations formed is envisaged to reflect in the improved empowerment of communities particularly of women. It is also expected that the institutions created would lead to stronger networks in the community and improve the resilience in the villages.

The baseline captured the perceptions of the surveyed population on aspects of togetherness, trust and social cohesion including conflict resolution, safety and attitude towards common property resources to compute a social capital score. The scores were divided into four quartiles with Quartile I representing excellent social capital scores and Quartile IV representing poor social capital scores. It was seen that in both the treatment and the control areas, the distribution was thin in the highest and lowest quartile and was concentrated in the second and the third quartile. The treatment areas registered a higher population with excellent social capital scores with 4.5 percent of the HHs in the highest quartile. In comparison, only 1.4 percent of the HHs in the control group were in the highest quartile.

A composite GP level index was created to measure the level of institutional capacity based on the implementation of the Gramya II project and the preparedness of the GP to take on the activities effectively. The index emphasizes on five major dimensions of due diligence, budget functionary, training and willingness, administrative capacity and inclusiveness. Budget functioning and administrative capacity were accorded the highest weightage based on their relevance in the functioning of the program at the GP level. The composite score was calculated by applying the weighted average of all the five dimensions. It was found that 21 percent of the GPs have performed excellent on all five dimensions and have attained the highest composite score. Only about 2 percent of the GPs had registered a poor score.

Introduction

2. Introduction

The mandate of the Watershed Management Directorate of Uttarakhand itself enshrines the holistic development of degraded and rain-fed areas of the state through integrated management of natural resources on a participatory basis. It seeks to achieve ecologically balanced income enhancement through increased livelihood opportunities, poverty alleviation, welfare of vulnerable groups including women and the landless, equity in benefit sharing and institutional strengthening through capacity building, utilising a sustainable watershed management approach.

The Watershed concept has been used extensively because of the importance of water balance in the study of ecosystems. Integrated watershed management covering an area from the highest point (ridge line) to the outlet is, therefore, the process of formulating, implementing and managing a course of actions involving natural and human resources in a watershed. It takes into account all the factors operating within the watershed.With time, the watershed management concept has evolved into a decentralized and participatory approach with financial autonomy for the PRIs, (legal institution under 73rd amendment), thereby improving and ensuring an efficient process delivery system. In watershed management, the decision making regarding uses and modification of all categories of lands and water within the watershed are made in an iterative process with participation of all stakeholders in the Gram Panchayats. The repeated coming together and discussion provides an opportunity to all stakeholders to balance diverse objectives for enhancement of productivity, not only of individually owned resources but also of common property resources, and to consider how their cumulative actions may ensure long term sustainable use of all the natural resources.

*The Gramya **I** project supported Government of Uttarakhand (GoUK) in improving agricultural productivity and rural livelihoods in the hill areas **by** enhancing natural resource management and strengthening the administrative capacity of the targeted GPs. Gramya II focuses on improved governance, environmental sustainability, and gender equality by: (a) building GP and VP capacity in planning, project management, financial management, safeguards, and social accountability; (b) managing natural and water resources in a sustainable manner by treating micro-watersheds; and (c) supporting women's participation in governance and livelihoods development.*

Since the last decade it has been realized that ensuring livelihood opportunities and food security for rural inhabitants is a must for a sustainable watershed management approach.A focus on increasing the productivity of rain-fed areas and ensuring livelihood opportunities for the poorest of the poor is the mandate of the project.

This approach is relevant for the state of Uttarakhand in which 85 % of the area is classified as hilly or mountainous. The State of Uttarakhand is characterized by mountainous terrains and ridges interspersed with fertile valleys, glaciers in the upper reaches which give rise to the major river systems that drain the Indo-Gangetic plains and rich forest resources. However, the mountainous terrain coupled with depleting forest cover, erroneous agricultural practices, increasing anthropological pressure etc. poses great problems in terms of erosion of top soil and worsening water regime.

It is in this background that the Gramya I was conceptualised and successfully implemented, which is now to be furthered with the second phase of the programme. The project intends to achieve its mandated objective by *increasing the efficiency of natural resource use and productivity of rain-fed agriculture by participating communities in selected micro-watersheds of the State of Uttarakhand.*

The seven year-long project consists of a 5-year project cycle for each target Gram Panchayat and is implemented in three phases, namely the preparatory phase (first year), the implementation phase (three years) and the withdrawal phase (fifth year).

The project will cover a total of about 2.638 lakh ha in the middle Himalayas, ranging from 700 m to 2700 m above sea level. A total of about 509 GPs spread across 8 districts, 18 blocks in both Kumaon and Garhwal regions of Uttarakhand will benefit from the project. About 3 lakh population comprising 55600 households will benefit from project interventions.

The project objective is to be achieved by (a) supporting sustainable natural resource management through treating watersheds comprehensively at micro-watershed level; (b) increasing productivity on arable lands through providing extension services; (c) increasing rural incomes through enhancing agribusiness development for target farmers and alternative livelihoods for vulnerable households; and (d) as needed, providing responses to eligible crises or emergencies in the target micro-watersheds.

The key components of the project are:

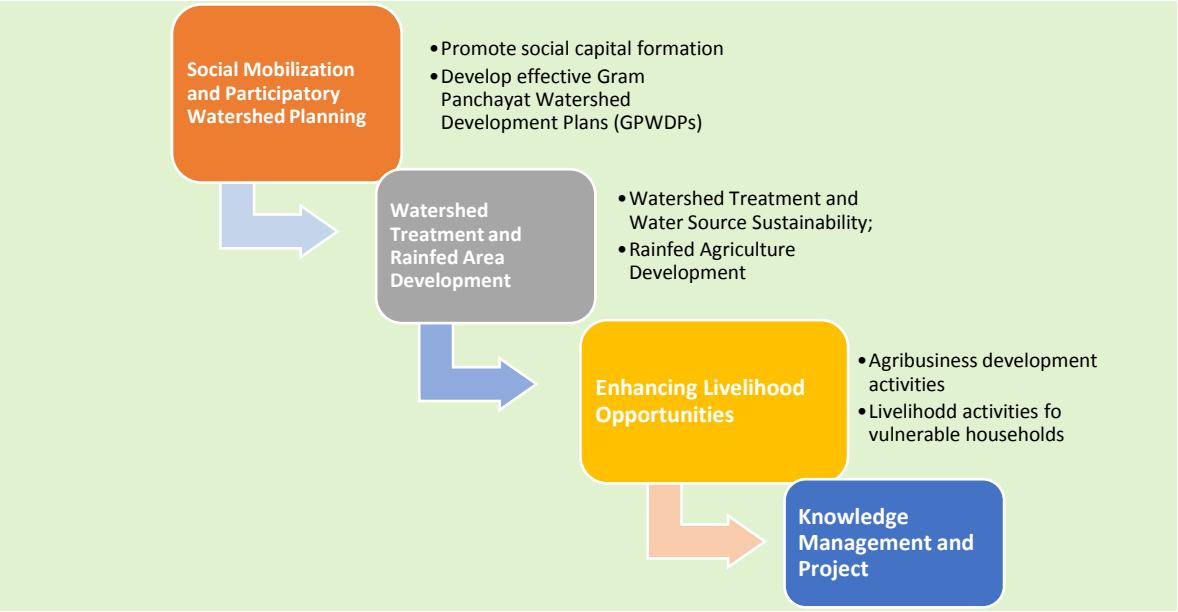
A. Social Mobilization and Participatory Watershed Planning: The component aims to promote social capital formation and develop effective Gram Panchayat Watershed Development Plans (GPWDPs) in order to map and plan for arable and non-arable land under the 82 selected watershed areas. These GPWDPs would undergo a participatory plan development process where communities will become aware of the budgets allocated to GP and the supporting activities under the budget in the plan. These plans would be supported by a comprehensive digital database and new decision-support tools. Treatment plans for the reserve forest and inter-GP areas would be included in GPWDPs with the participation of the VP.

B. Watershed Treatment and Rainfed Area Development: This component is one of the focused intervention areas under Gramya II project. Almost half of the project investment is for this component. Two major subcomponents under this are- (a) Watershed Treatment and Water Source Sustainability; and (b) Rainfed Agriculture Development. The interventions would be done to enhance catchment treatment and forestry activities and expand irrigated land coverage by converting the rainfed land to irrigated land. All of these treatment plans would be laid out under the GPWDP plans and the project would facilitate its effective management and implementation. Watershed treatment measures would be taken to increase productivity of field and horticultural crops grown in the watershed areas.

C. Enhancing Livelihood Opportunities: The activities under the subcomponent would support agribusiness development. The Gramya-I activities would also be consolidated under the component. Agribusiness development activities including formation and strengthening of farmer interest groups to create adequate market linkages for devising successful supply chain models. The group capacities would be built through agribusiness plan development and technical backstopping in supply chain. Vulnerable households identified under the project would be brought into separate livelihood groups to receive equitable benefits from the project. Under Gramya I consolidation activities, the damaged assets created in Gramya I would be renovated and agribusiness plans would be strengthened for 27 FFs.

D. Knowledge Management and Project: This component focuses on convergence with other Government departments in facilitative knowledge management. Convergence is facilitated in selected micro watersheds between IWMP, Department of Rural Development and WMD. In facilitating knowledge management at state, division, and local levels, WMD would establish a Centre of Excellence for Watershed Management.

Figure 1: Gramya II Project Components



The M&E framework of the project will facilitate: i) Results-based Management through timely analysis and feedback on relevant indicators; ii) Impact evaluation through measurement of Project Development Objective and specific performance indicators using appropriate baseline, mid-term and end-term surveys in project and control sites. The entire system of M&E has several components and will be managed by the Implementing Agency, MIS agency and external M&E agency.

2.1 Implementation mechanism

The implementation is based on the convergence of the efforts of three entities, namely, the village communities, the Watershed Management Directorate and the partner NGOs. The project outcome would be a culmination of the specific roles to be played by each stakeholder and their successful convergence and complementarity. The village community represented by the Gram Panchayat would be the main implementing body who would be responsible for planning and execution of all activities under the project. The WMD would provide technical know-how, overall coordination and all required assistance to the GP for successful implementation. The partner NGOs would be instrumental in carrying out social mobilization, providing technical assistance and undertaking project implementation and other activities as agreed to with GPs and WMD.

2.2 Context Setting

Uttarakhand as a state is bestowed with natural resources, with water resources (glaciers, natural streams, lakes) or forest in the Indo-Gangetic plain. The drainage system serves as a lifeline for the entire hydrological system for the state. Because of imbalances caused due to natural and man-made causes, Watershed Management Directorate has taken up the charge of implementing the second phase of Gramya II (Uttarakhand Decentralized Watershed Development Project)which is a continuation of Gramya I project (phase I) for watershed planning. The objective of the project is to increase agricultural production and increase land conversion from rain fed area to irrigated area.

Gramya I was implemented in Uttarakhand for a period of nine years from 2004-2012. The main objectives of the project were to have Participatory Watershed Development and Management, enhancing livelihood opportunities and strengthening institutions. The project promoted social mobilization and community driven decision making which is extended through Gramya II via formation of GPWDPs and their implementation through community members. Gramya I also emphasized on watershed treatment, village development, farming system improvement, value addition, marketing support, income generation activities for vulnerable groups and capacity buildings of Gram Panchayats and local community institutions. All of these activities of Gramya I is taken forward in phase two of the project by formation of various farmer groups such as Farmer Federations

and Farmer Interest Groups. Income generation activities are performed for all the farmer groups and vulnerable groups. In the later phase of Gramya II, marketing support and value addition will be provided for major crops of the state such that farmer receives value for money for the agricultural product.

Agriculture is the mainstay of the state including that of hilly districts in the state. The cropping pattern and practice of the state is mostly traditional agriculture. The region suffers from heavy soil erosion and significantly lower yields as compared to the national average. In the Kharif Season nearly 68 percent of the area is rain-fed and of the total area, the major part is under cereal and pulse production. While the total fruit production in the State is rain-fed and vegetable production is irrigated.
The Gramya II is being implemented in the eight hill districts of Bageswar, Almora, Uttarkashi, Tehri, Dehradun, Pauri, Pithoragarh and Rudraprayag. The location within the state of these districts is indicated below:

Figure 2: Coverage of Sample districts - Gramya II

**Map reproduced from the website of Watershed Management Directorate, Uttarakhand (http://www.gramya.in/projectarea.html)*

The villages covered as samples have already been detailed and discussed in the methodology section of this report. The eight hill districts as named above are distributed in both Kumaon (Almora, Bageshwar and Pithoragarh) and Garhwal (Uttarkashi, Tehri Garhwal, Dehradun, Pauri and Rudraprayag) regions of the state.The project covers 8 districts, 18 blocks, 509 GPs with a population size of 3 lakhs and 55600 households. Around 2.64 lakh ha in the middle Himalayas ranging from 700 m to 2,700 m above sea level will be treated by this project.

2.3 Project Development Objectives and Result Framework

The Project Development Objective (PDO) is to increase the efficiency of natural resource use and productivity of rain-fed agriculture by participating communities in selected micro-watersheds of the State of Uttarakhand.
The results framework clearly outlines four PDO level results indicators which would show progress for future results tracking.

- **Increase in water discharge:**Evaluation to be assessed in perennial water sources based on hydrological monitoring of eight representative Micro-watersheds in change in litres/ minute. This is to be measured by Hydrological Monitoring Impact Evaluation.
- **Increase in biomass:**Covers biomass produced in arable and non-arable lands and is to be measured by remote sensing and GIS based methodologies.
- **Increase in rain-fed area under irrigation:** The irrigation data will be collected from the field level to determine if annual targets and cumulative targets for areas under rain-fed agriculture have been achieved.
- **Increase in productivity in irrigated and rain-fed crops:** Increase in productivity of five high value irrigated vegetable/ fruit crops and three high value rain- fed crops are to be determined by field level data at state level.
- **Direct project beneficiaries and the percentage of which are female:**Calculated by households benefitted as a percentage of total vulnerable households in the target landscape disaggregated by male and female.

2.4 Purpose of baseline study

The current baseline study was taken up in the eight project districts on a sample basis with the objective of collecting, analysing and interpreting primary data from the field in order to arrive at existent values of indicators against which the achievement of the project implementation may be assessed. The major outline of activities undertaken in the baseline survey may be summarised as follows:

- Finalisation of a survey sample and survey design.
- Development of tools of data collection for collecting data at Household, Gram Panchayat, Revenue Village and Micro watershed level.
- Collection of data regarding the demographic, agriculture, health, hydrology, gender equity scenario, irrigation facilities, area under various crops, cropping pattern and production/ productivity, other livelihood options, water resources, land use, forest resources etc.
- Analysis of the data collected from the field and interpreting this to form the baseline values against which the achievements of the project may be measured during mid-term and end term survey.

Methodology

3.Methodology

At the inception stage the evaluation framework, key results and outcome objectives of the project were finalised. The focus of the baseline survey was to capture the pre-project measure of the key results or outcomes, impact areas and provide associated details to the project.

Evaluation design is based on the premise of comparing project samples at different time periods and will be surveyed during different timelines to understand the impact of the project interventions on outcome indicators. The results framework is considered to be a base to derive impact level indicators and set benchmarks for effect and outcome level indicators of the project till 2017.

3.1 Evaluation Design

The evaluation contributes in providing quantifiable information on programme benefits. It is based on the concept of comparing treatment and non-treatment areas and thus both project and non-project samples were surveyed to understand the effect of the project interventions on impact or outcome indicators.

3.2 Evaluation Framework

The Evaluation of the programme includes measurement of key indicators of the Project Development Objective (PDO) and intermediate project outcomes (results framework indicators) to establish benchmark values and subsequent evaluation phases. The baseline survey focused on benchmarking of these key indicators, and assessed the achievement of project results in terms of increase in water discharge levels, bio mass index, rainfed area under irrigation, increase in productivity and direct benefits received from project interventions. The baseline stage measure of these indicators would be compared with subsequent measures at the mid-term and end-term stages (in both project and control locations) to estimate project outcomes / results of the project. A few of the indicator values would be sourced from project MIS information to check project wide progress only for the sample micro watersheds.The evaluation design of the baseline survey focuses on measurement of key indicators of the Project Development Objectives (PDO) and intermediate project outcomes. While focus was laid on benchmarking values for these indicators, research tools were designed to gather more information about village development and social and empowerment indicators as well, which were not a part of the results framework. This additional information would aid in providing a holistic view of the overall impact of the programme during subsequent evaluation stages. The evaluation design has been framed to answer the following evaluation questions on outcome and impact indicators:

- Establish project baseline values for natural resource management practices, income levels and various sources of livelihood, employment sourcesof households under intervention, local development and operation and maintenance of community assets.
- Socio economic classification of the sample residing in the treatment area
- Establish attribution of the project activities in improving natural resource management, incomes and livelihoods, employment and job creation, empowerment and capacities of the GPs and villagers, local development and operation and maintenance of community assets.
- Identify the approaches and activities that are worked upon in meeting the project objectives and any deficiencies in planning and implementation or any unintended consequences of specific project activities.
- Identify equity issues and distributional impacts of project investments (the inclusiveness of project interventions and the distribution of benefits across different socio-economic groups, i.e.lower castes, landless, other vulnerable groups).
- Address the potential poverty impact of the project.
- Establish baseline figures for activities undertaken on common property resources versus those undertaken on private lands and arable versus non-arable lands.
- Assess the cost-effectiveness of innovative approaches adopted
- The quality of participatory processes and support to strengthening local self-government organizations particularly the Gram Panchayat
- Document mitigation measures taken in the GP to address the social and environmental issues as identified in the ESMF.
- The firm shall update the financial and economic analysis of project returns undertaken at the start of the project. This will be reflected in Endline figures.

3.3 Difference-in-Difference Approach

The assessment/evaluation of project outcomes is based on Difference-in-difference (DiD) model wherein project attributions are arrived at by taking difference of results in two stages of the project (baseline and mid-term/end-term or before and after) for both project and control areas; and then taking difference between the project and control groups.

The difference between the two measures (before and after) gives the incremental benefits “with the project” for project areas and “without the project” for control areas. The difference-in-difference of the incremental benefits between the project area and the control area, eliminates the effect of trend and unobservable characteristics of the results. One of the challenges with current methodology proposed by the project is the reduction in sample from baseline to midline. While in baseline the sample households selected would be based on simple random sampling method. In the midline the

same households from the baseline sample would be selected. During the midline while selection of 2780 households from 5560 households would essentially be done ona random basis but matching methods could be adopted to arrive at exact matched pairs for providing results.

3.4 Control groups for DiD

Selection bias arising out of selection of non-participants / controls groups has two principal components that affect evaluation measurements. The control samples were provided by the Department. The control samples were provided by WMD, where essentially there has been no watershed interventions in the last 4 years. The control sample has been selected purposefully taking physical variables of the geography into account and since it was a challenge to idenify locations without any watershed intervention the identified sample has a proximity towards treatment.
Sampling Size and Plan

The baseline survey was carried out in 8 divisions of the State (including a PMU model GP). A total of 38 MWS were covered across the 8 divisions. 54 GPs were in total covered as part of the treatment sample. Based on the ToR, the sample size was fixed at 10% for baseline (the total suggested sample and included 54 GPs, 108 Revenue village, 5486 Households and 8 Micro Watershed at baseline stage.) In order to compare the 'with' and 'without' project scenarios, a control group was proposed to cover at least 8 GPs, 16 Revenue Village (RV) and 988 Households (HH) from 4 MWS not included in the project area but adjacent and representative to the project area (MWS, GPs, RVs and HH which arenot directly exposed to project interventions nor havethey been part of any watershed development projects in the past 4 years).

Table 11*: Sampling Plan*

Type of Area	Division	Number of Micro watershed	Number of GPs	Number of Villages	Sample Households
Project	9	38	54	108	5,486
Control	9	4	8	16	988
Total			**62**	**124**	**6,474**

A stratified sampling was considered for the selection of sample. The first level of selection was across divisions.Therewere a series of discussions conducted during the inception stage to increase the control sample and to maintain the significance of results.
A stratified sampling technique is applied to select samples. The first stage of stratification is by watershed topography where samples are distributed across ridge, middle and valley ranges. The sample selection of GPs and villages was undertaken based on the following criteria:

- Selection of GPs/ RVs are representative samples and at least one GP falls under the three categories of valley (700-1200 meter), middle (>1200-2000 meter) and ridge (> 2000 meter).
- Selection of GPs/RVs is done in such a way that a maximum number of MWS are covered.
- GPs/RVs are selected where project activities were started at year one i.e. the baseline year (FY 2014-15).
- GPs are selected in a way that at least one GP falls in either categories of 0-1 km, 1-2 km and more than 2 km from a main road.

For the baseline survey, 8 divisions (8+ PMU-Model), 38 MWS, 72 GPs, 129 RV and 6474 HHs were covered. The sample covers both Control and Treatment. 5486 HHs fall under Treatment group and 988 fall under the Control HHs, 54 GPs are covered under Treatment and 8 GPs fall under Control. Treatment and Control GPs are distributed in Ridge, Middle and Valley zones. GPs selected for the Control group has no project intervention.
The non-project sample GPs are selected on the basis of observable features like population, area of the GP, remoteness / geography within the district, size of agricultural land, size of irrigated land, size

and number of MWS within the GP, number of villages in GP. Villages are selected by physical matching with villages selected under treatment within the GP on the basis of demography - size of the village, size of agricultural land, size of irrigated land, and population.
Sample 54 GPs were chosen out of 509 GPs where Gramya II is implemented. Below is the list of villages covered in Treatment and Control.

Table 12: Distribution of Villages as per Watershed Topography covered in survey

Divisions	Middle	Ridge	Valley	Grand Total
Almora	10	5	4	19
Bageshwar	5	-	11	16
Dehradun	6	3	1	10
Pauri	15	1	2	18
Pithoragarh	11	-	4	15
Dehradun-II(PMU-Model)	5	-	-	5
Rudraprayag	5	2	2	9
Tehri	10	3	10	23
Uttarkashi	3	1	4	8
Grand Total	70	15	38	123

Following table represents distribution of surveyed households :

Table 13**: Distribution of surveyed households across Divisions**

Divisions	Project	Control	Grand Total
Almora	890	239	1129
Bageshwar	902	76	978
Dehradun	482	102	584
Pauri	606	87	99
Pithoragarh	435	76	693
Dehradun-II(PMU-Model)	57	42	511
Rudraprayag	1115	75	1190
Tehri	532	11	543
Uttarkashi	467	280	747
Grand Total	5486	988	6474

3.5 Biomass and Soil Estimation

The project is envisaged considering theremote sensing and GIS based approach for estimation of sediment loss using the RUSLE model. It has been observed that soil, vegetation cover and topographic characteristics of an area also play a major role in rate of soil erosion, apart from the rainfall intensity and surface runoff. Therefore, given the variation of these characteristics within various sub areas of the catchment, it is desirable to identify smaller homogenous units of catchment for estimating the soil loss. RUSLE method will be followed as it is a simple approach to analyze soil losses and it can provide an accurate assessment of the soil loss over smaller surface areas.
It assumes a linear relationship between various parameters. This model is based on five parameters i.e. annual average soil loss, rainfall- runoff erosivity, soil erodibility, slope (length and steepness), and land cover management and conservation practice.

Landuse/ Land cover Mapping: The landuse / land cover map is generated by visual interpretation of LISS IV satellite data.

The landuse/ land cover map of three different periods is created for assessing the temporal variation of data. The use of LISS IV data for the study enables the creation of landuse/ landcover mapping on 1:10,000 scales.

Average Annual Soil Loss: Soil map of the study area will be provided by the concerned agency and it will be digitized using GIS package. This will be used in preparation of soil erodibility map.

Rainfall Erosivity: Rainfall data of 30 years will be used in creation of rainfall erosivity factor map.

Slope Factor: Topographic factors play a prominent role in soil erosion estimation and for this both slope length and slope gradient are very important.

Land Cover Management Factor: The ratio of soil loss observed from particular vegetation types are used to assess the land cover management factor.

Biomass Estimation: The quantification of biomass will be made in three stages, iebaseline, midterm and endterm. The quantification is done at the level of forest, pasture and fallow. The estimation is done using remote sensing technology by the use of NDVI. However since the NDVI technique is not completelty reliable, field based methods are also adopted for biomass estimation. The field based methods for estimation of forest and pasture is done using indirect measurements instead of the earlier suggested harvest method for pasture.

Soil Moisture Estimation: Soil moisture is a very important parameter for a variety of applications in hydrology and agriculture. Soil moisture is essential for agricultural studies given its significance in irrigation scheduling, plant stress and improving plant yield. Hence, quantification of soil estimation is required for better planning of agricultural management and hydrological applications.

Change Detection: From midterm onwards, when two season data is available, change detection of watershed will be carried out. This will be carried out by using supervised classification of LISS IV satellite images.

3.6 Study of Micro watershed

Geomorphologic study of micro-watershed

Geomorphology of an area reflects the past and present climate of any region. Different climates producesdifferent processes which in turn produce varying landforms. Climatic factors largely determine the nature and effectiveness of the various processes of weathering, transportation, and erosion. Climate creates precipitation, heat transfer, and winds in an area. If the climate of an area is warm or humid, chemical rock decomposition, gentle slopes and rock outcrops are rare; similarly, if the climate is dry, then mechanical rock decomposition, coarse soil fragments, rock escarpments are present, stream flow becomes irregular, and slope gradient increases.Likewise, climate influences the growth of vegetation. Thus, in a tropical climate, vegetation helps minimize erosion during torrential rains. The difficulty in using geomorphology to assess climate change is that geomorphic events may take up to hundreds of thousands of years to form. Further, human presence in an area greatly tampers with historical evidence and also current happenings. Therefore, the present geomorphology of the study area is not onlyreflective of the past and present climate but also reflects other aspects such as human interference with the landscape.

Geomorphic units are due to differential weathering of under laying formations. Volcanic, igneous, metamorphic and sedimentary rock formations form the underlaying rock formations.These landforms are the result of volcanic activities, followed by fluvial weathering. Natural vegetation played an important role in protecting the landforms from weathering. It can be concluded from the present geomorphic unit that the area falls in the climatic region of humid and hot.

River Morphology

Morphometric analysis of a drainage basin includes the quantitative measurements of the drainage basin characteristics and their expression in numerical terms to evaluate the drainage system. The quantitative analysis of drainage basins followed here is based on the methods given by Horton

(1945), Strahler (1953), and Chorley (1957) for linear aspects, the areal aspects using those of Schumm (1956), Strahler (1956, 1968), Chorley (1957), Miller (1953) and Horton (1932) and the relief aspects using the techniques of Horton (1945), Broscoo (1959), Melton (1957) Schumm (1954) and Strahler (1952). Basin area, perimeter, drainage and relief of the watershed are the basic parameters used to analyse the drainage morphometry of the watershed. A digitization of the drainage available in the survey of India toposheets was done, then edited and stored in layer of GIS database. Watershed area, perimeter and alleviation data of respective watershed is also documented for the purpose of analysis. The following are some of the important aspects of analysis and its interpretations.

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms (Agarwal, 1998; Obi Reddy et al., 2002). A major emphasis in geomorphology over the past several decades has been on the development of quantitative physiographic methods to describe the evolution and behavior of surface drainage networks (Horton, 1945; Leopold & Maddock, 1953; Abrahams, 1984).

The morphometric characteristics at the watershed scale may contain important information regarding its formation and development because all hydrologic and geomorphic processes occur within the watershed (Singh, 1992). Morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect of the characterization of watersheds (Strahler, 1964). GIS techniques are nowadays used for assessing various terrain and morphometric parameters of the drainage basins and watersheds, as they provide a flexible environment and a powerful tool for the manipulation and analysis of spatial information.

LISS III images and CartoSAT DEM are used for doing GIS and Remote Sensing analysis of the selected Micro-watershed. The object is to understand drainage pattern, relief and aspect of the Micro-watershed and generate landuse/landcover map of the watershed. Each map is further elaborated to understand the physiographic characteristics of micro-watersheds.

3.7 Data Used and Methodology

ASTER and CartoSAT (DEM) with 30m spatial resolution

Remote Sensing Data: LISS-IV Mx satellite imagery with 5.8m spatial resolution

Morphometric Analysis: Quantitative analysis has been done based on DEM & different morphometric parameters have been generated in GIS environment.

Land Use/Land Cover Map: Digitally, land use and land cover map have been prepared by using visual interpretation of LISS-IV Mx satellite imagery.

Linear Aspects: The linear aspects include stream number, stream order, stream length, bifurcation ratio of a given watershed.

Stream Orders: In the Strahler method all links with no tributaries are assigned an order of 1, and are referred to as first order. When two first order links intersect, the down slope link is assigned an order of 2 or second order. When two second order links intersect, the down slope link is assigned an order of 3 or third order rivulet, and so on. Only when two links of the same order intersect does the order increase. If a lower order river segment meets or joins the down rivulet it maintains the higher order. (Fig. River order map of selected watershed). Properties of the stream networks are very important to study the landform making process (Strahler, 2002)

Dendritic type -indicates the homogeneity in texture and lack of structural control.

Parallel drainage suggest that the area has a gentle, uniform slopes and with less resistant bed rock

Stream numbers: The number of streams of different orders within respective watershed and micro-watershed were counted and tabulated. The number of streams decreases as the stream order increases.

Bifurcation Ratio: The ratio between the number of the segments of a given order (Nu) to the number of segments of the next higher order (Nu+1) is termed the bifurcation ratio. By using Strahler's method the weighted bifurcation ratios were computed by taking consideration of actual number of streams that are involved in the ratios.

Ratio of the number of stream of any order to the number of stream of the next order (Schumn, 1956).

Rb = Nu / Nu+1

Where Nu – Number of stream of 'u' order Nu+1 – Number of stream of Nu+1 higher order
By using Strahler's method, the weighted bifurcation ratios were computed by consideration of actual number of streams that are involved in the ratios. Details are given in the following table. Bifurcation ratio gives an idea about the shape and underlying formation of the basin and helps in deciphering the run-off behavior of the watershed. A comprehensive analysis carried out at study area level revealed the past and present weather conditions along with texture of the under-laying topography.
Rb is generally between 2 and 4 in a tropical country. High Rb indicates steep dipping rock strata, where narrow valleys are confined between the ridges.

Variation in Rb represents a pronounced effect on the maximum flood discharge of the watershed. An elongated watershed with higher Rb would result in a lower but extended peak flow, whereas a circular watershed with low Rb produces sharp peak flow.Bifurcation ratios characteristically range between 0.9 and 2.3 for basins in which the geologic structures do not distort the drainage pattern (Strahler, 1964).

3.8 Image Classification

To understand the details on the landcover and landuse of the study area, remotely sensed data with the support of ground truth is needed. For that purpose a system approach is followed and landuse/ land cover maps of the study area were retrieved from the temporal remotely sensed data.

By preprocessing of satellite images, geometrically and radiometrically corrected images were used for further analysis. Digital Image Classification is the process of assigning pixels to classes (Campbell and Wynne, 2011) where "data are transformed into information" (Jenson, 1986). Generally, for any kind of classification, multispectral images are used and hence these type of classifications are considered to be an information extraction process that analyses the spectral signatures and then assigns pixels to categories based on similar signatures (Sabins, 1987). Therefore, image classification can be considered an important part in the field of remote sensing, image analysis and pattern recognition. In fact, classification is considered only an intermediate step in an elaborate analysis in which the classified data form one of the several data layers in GIS (Campbell and Wynne, 2011). However, the actual multispectral classification may be performed using a variety of algorithms (Jenson, 1986)

In this study, the basic classification methods used were unsupervised and supervised classification. A standard method of landuse classification is followed with suitable modification for the retrieval of landuse/ land cover map/ classification of the study area. It is a step wise approach and the following steps are followed to retrieve temporal landuse/ land cover map of the study area.

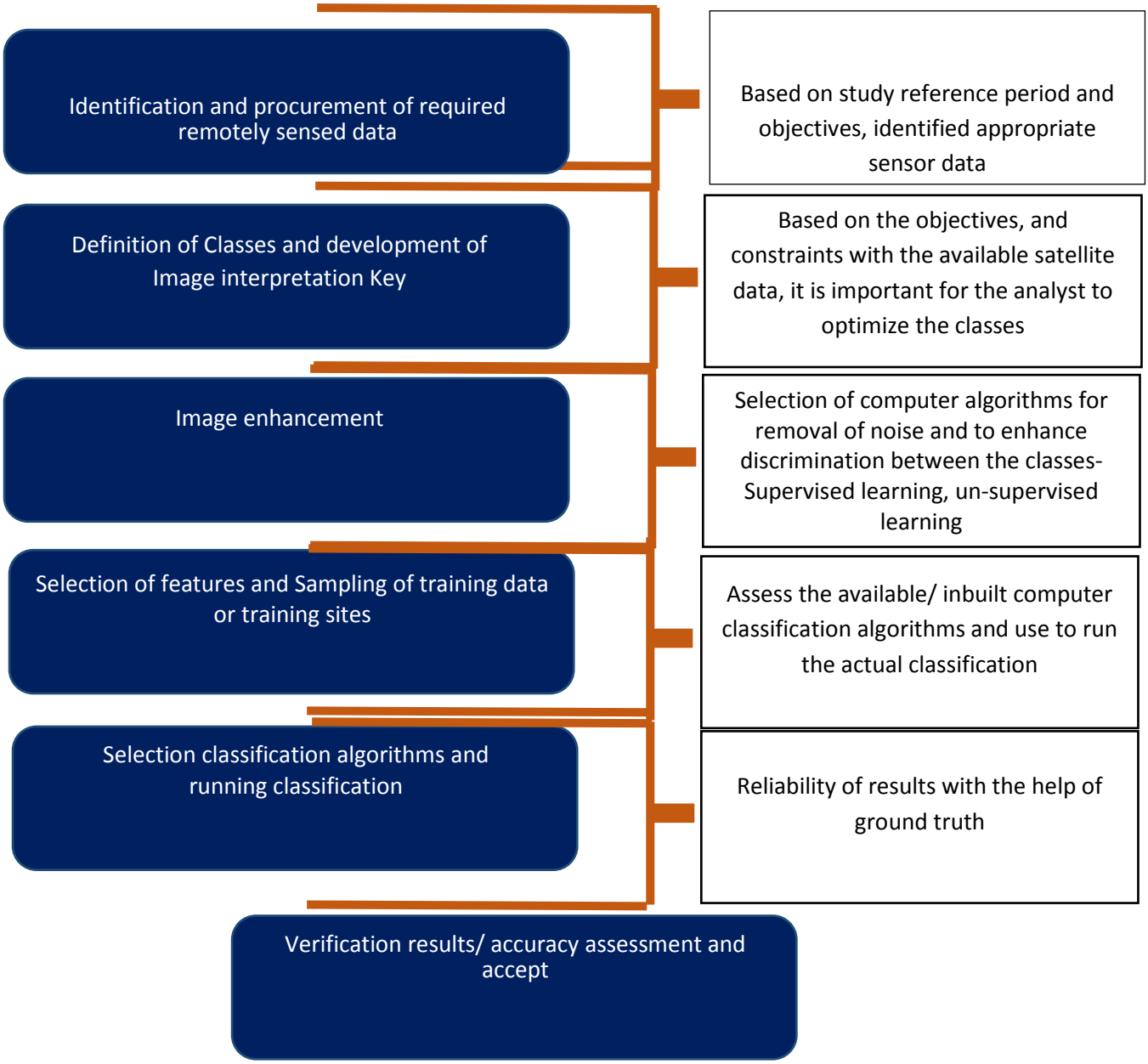
Supervised classification of an image is done with computer classification algorithms. The selection of an algorithm is done based on the number of training sites used/ applied and type of data used as input. After the training sample sets have been defined, classification of the image can be carried out by applying a classification algorithm. Several classification algorithms exist in the software and compared the following classifier.

a) **Minimum Distance to mean classifier:** The basis for the Minimum Distance to Mean (MDM) classifier are the cluster centres. During classification the Euclidean distances from an unknown pixel to various cluster centres are calculated. The unknown pixel is assigned to that class to which the distance is least.One of the flaws of the MDM classifier is that pixels that are at a large distance from a cluster centre may be assigned to this centre. This problem can be overcome by defining a threshold value that limits the search distance.
A further disadvantage of the MDM classifier is that it does not take the class variability into account - some clusters are small and dense while others are large and dispersed. Maximum likelihood classification takes class variability into account.

b) **Maximum Likelihood classifier:** Maximum Likelihood (ML) classifier considers not only the cluster centre but also its shape, size and orientation. This is achieved by calculating a statistical distance based on the mean values and covariance matrix of the clusters.
The statistical distance is a probability value: the probability that observation x belongs to a specific cluster. The pixel is assigned to the class (cluster) to which it has the highest probability. The assumption of most ML classifiers is that the statistics of the clusters have a 'normal' (Gaussian) distribution. For each cluster, so-called 'equiprobability contours' can be drawn around the centres of the clusters. Maximum likelihood also allows the operator to define a threshold distance by defining a maximum probability value. A small ellipse centred on the mean defines the values with the highest probability of membership of a class. Progressively larger ellipses surrounding the centre represent contours of probability of membership to a class, with the probability decreasing away from the centre.

c) **Runningactual classification:** Maximum likelihood classifier is used for actual classification. Bands of spectral region, visual (green, red) and Infra-red region (near infrared and mid-infra red region) are used/ considered while running actual classification.

Figure 3:Running classification



In unsupervised classification, the computer separates the pixels into classes (Sabins, 1987) without any direction from the analyst. The main objective behind unsupervised classification is to automatically categorize all pixels in an image into land cover classes and themes through some algorithms in the image processing software. The multispectral images are usually used to perform this classification and the spectral pattern present within the data for each pixel is used as the numerical basis for categorization. The spectral pattern referred here is not all the geometric in character but are basically the different combinations of Digital numbers (DN) based on their inherent spectral reflectance and emittance properties. It is basically an analytical procedure based on clustering of similar classes using certain algorithms on the basis of spectral signature (Richards and Xia, 2006). In other words, unsupervised classification is the definition, identification, labeling and mapping of these natural classes.

Although, for unsupervised classification, detailed prior knowledge is not required, a basic knowledge about the region is required to interpret the meaning of the clusters produced from the classification process. Therefore, a prior knowledge about the area was obtained from ancillary data and a pilot survey. Based on this knowledge, the number of categories desired was specified and then classification algorithm was run.

In this case the standard deviation varied from 1.25 to 2.00 along the Principal Axis so that any data correlation could be removed. To preserve the color scheme associated with the interpretation of RGB the Approximate True Color option was used. This produced an average image colour for each of the classes as opposed to producing a gray scale output. Maximum Iterations at a high number such as 35 may allow the process to take more time but it doesnot limit the accuracy described by the Convergence Threshold (0.995). The maximum iteration is usually set high so the convergence threshold will be reached first and the process will complete. The Convergence threshold is actually the percentage of pixels that do not change classes between successive iterations. The Convergence threshold and Maximum Iterations prevent the process from potentially becoming caught in a loop.

The pixels were identified for each cluster of specific spectral signature and they were grouped into land cover categories: water, shadow, deciduous forests, scrubland, wasteland, agriculture, ToF. It should be noted that pixels that do not fall within any class were classes as ‘unclassified’ as per Joseph, 2007. Here the pixels or clusters that were shadow area were also classed under the “Unclassified”. The classes that result from unsupervised classification are spectral classes as they are solely based on the natural groupings in the image values. Then these 256 image values were recoded into 7 classes. The most important thing to be noted here is that theidentity of these spectral classes was initially unknown until they were compared with some form of reference data and field knowledge.

The classified thematic layer manifests a salt and pepper appearance due to inherent spectral variability encountered by a classifier when applied on pixel-by-pixel basis (Liliesand and Kiefer, 2009). Therefore, the necessity of smoothing the classification arose but this post classification smoothing of algorithms were operated on the basis of logical operations rather than simple arithmetic computations. After the classification, there was a salt and pepper effect with some of the classes and therefore the clump and eliminate operation was used to make the image look good and it smoothed out the classes to give a better appearance. Finally the Land use Land Cover (LULC) mapping was done.

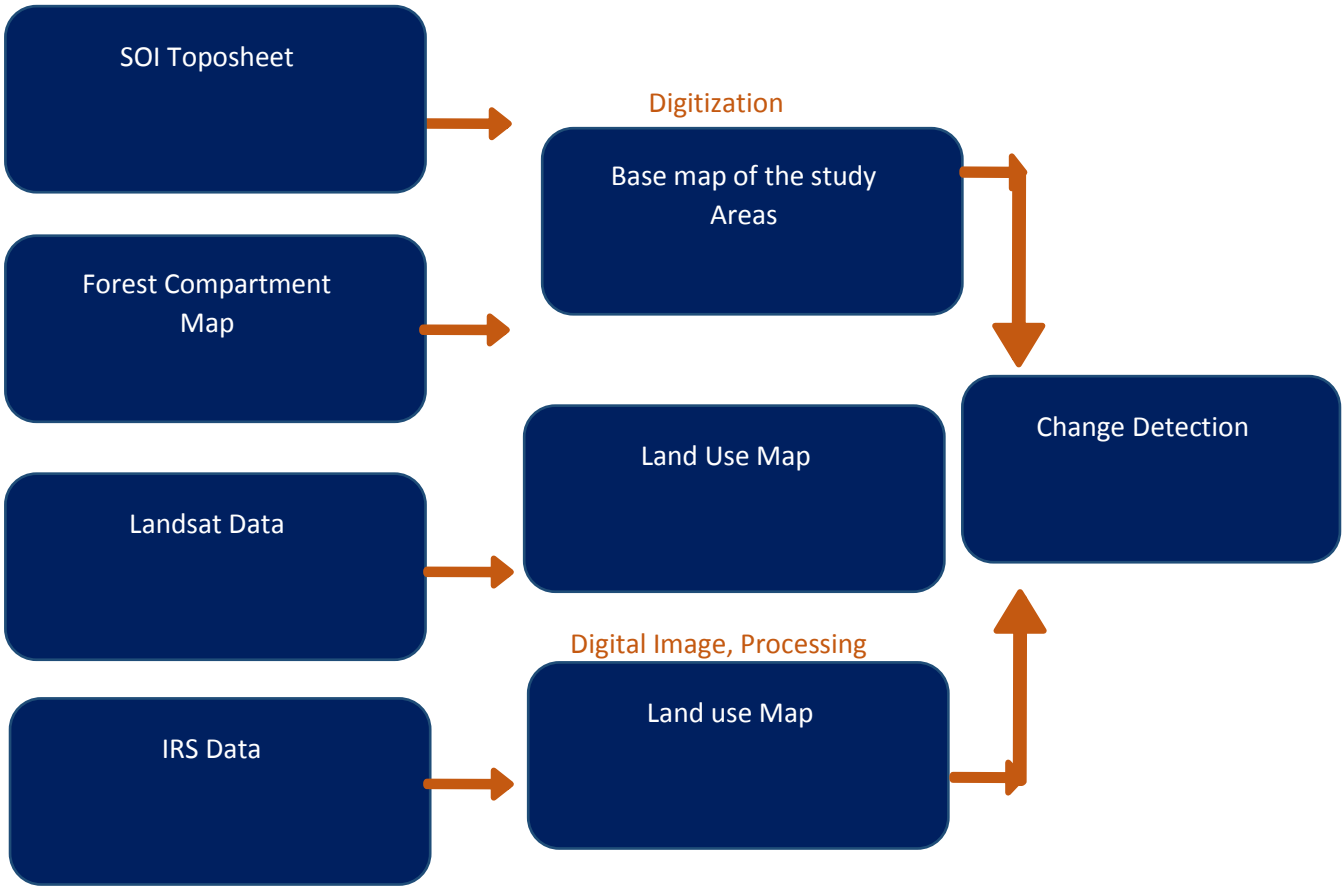
3.9 Data Analysis

Monitoring landuse/ land cover change

Remote Sensing methods can be used to monitor changes within and between many types of different vegetation cover and land use types. The objective for mapping land use change is to:

Identify the areas of deforestation/reforestation, monitor the canopy status and monitor the land use change including agriculture pattern, area under water body, predict future change based on the past trend of change and provide input to sustainable forest development.
Changes have been occurring on the earth's surface from time to time as a result of various activities including shifting cultivation, permanent cultivation, logging, grazing along with clearing of forests and most importantly, development in terms of urbanization. So the systematic investigation of such environmental dynamics has to be undertaken to know the present status and trend of changes for sustainable, ecological, agricultural and developmental strategies. Therefore, it can be said that change detection (CD) provides the formation of natural resources alteration and the trend of changes. This information is of immense use not only in formulating plans for development but also in assessing the vulnerability of vegetation cover to climate change. Technically, change detection is a method to compare spatial representation of two points temporally by controlling all variances caused by differences in the variables that are not of interest (Green et al. 1994). The basic premise in using remotely sensed data for change detection is that changes in the objects of interest will result in changes in reflectance values or local textures that are separable from changes caused by other factors such as differences in atmospheric condition, illumination and viewing angles, and soil moistures (Deer, 1995).

Figure 4:Methodology for change detection



Change detection has been applied in different application areas, ranging from monitoring afforestation programs, watershed impacts, land salinity, urban extension/ sprawl, desert extension, flood, wetland, and recently to co-relate the changes with global warming and climate change. In the current study change detection is divided into two main groups, namely; Vegetation Index Differencing and Post Classification methods.

Vegetation Index Differencing: The method is applied to analyse the amount of change in vegetation versus non-vegetation by computing Normalized Deference Vegetation Index (NDVI), and spectral bands used are NIR and Red (visual).

NDVI = (NIR – Red)/ (NIR + Red)

Satellite remotely sensed data used for the study is capable in providing only the canopy density or top canopy of the forest cover. Field forest enumeration has been done with the help of field inventory, which is conducted on sample basis (quadrate). Tree volume has been estimated based on the tree inventory data. Standard literature available on biomass mostly relates to the variability of individual biomass to the variety of diameter at breast height. Also, the stand density influences on spatial biomass fluctuation, or rather the allometric relations, is neglectable (Baskerville, 1965). The most common way to calculate biomass is by using mathematical models in the form of:

M = a * D b

M = Biomass [T/ha]

a; b = Scaling coefficients

D = Diameter at breast height [cm] per ha

In this formula only DBH is taken into consideration under the assumption, that the height of a tree is related to its basal area. The diameter and height of the trees were used to calculate the standing woody biomass of the vegetation by using the following non-power mathematical function referred by Dr. Ravindranath's paper.

M= (8.32 * BA) – 1.69

Where BA : Basal Area [m2/ha]

The data collected from the field sample enumeration is the basis for calculation of Importance Value Index (IVI), Species richness and Diversity. This phyto-sociological analysis is also done to get a clear picture of the present condition/ status of the forests of the study area.

This approach is generally used for rapid assessment of changes in biomass irrespective to landcover and landuse.Based on the above methods, the following eight micro-watersheds have been assessed and documented by the MWS characters.

3.10 Methodology for Field Estimation

i. Layout of Sample Plots

Three different sizes of square sample plots were laid for recording trees, shrubs, saplings, herbs and seedlings as indicated below:

i) 20 m x 20 m (0.04ha) : for tree vegetation

ii) 3 m x3 m : for shrubs and saplings

1 m x1 m: for herbs, grass andseedlingsEnumeration for trees was done by laying 0.04 ha central plots, enumeration of shrubs and saplings was done by laying subplots of 3 m x 3 m and enumeration was done for herbs and seedlings by laying subplots of 1m x 1m. Layout of the plots is shown in(Annexure I)

ii. Measurement of Biophysical Parameters

Biophysical parameters constituted description of physical parameters of the terrain like Elevation, Slope, Aspect, Rockiness, Humus of soil, Compactness of soil, Soil depth, Soil erosion, Crop composition, Canopy storey, Top canopy height, Regeneration status, Invasion of weeds, Drivers of degradation, and measurement of biological aspects of vegetation like crop composition, diversity index, dominance of species, above ground biomass, etc. Important biophysical parameters of the landscape were measured by visiting the forest type groups of the landscape. Laying of the sample plots were done adopting the methodology suggested in proposal 5.2.1. submitted earlier. Efforts were made to visit the sample plots. Descriptions of methods for studied parameters are described ahead.

iii. Frequency

It is the frequency of occurrence of a species in a given sample area and was calculated as:

$$\text{Frequency} = \frac{\text{Number of quadrates in which the species occured}}{\text{Total number of quadrates studied}} * 100$$

iv. Density

It is the count of the number of individuals of a species within a quadrate. This data was converted to numbers of individuals per hectare.

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Total area of quadrates studied}}$$

v. Basal Area

The Diameter at Breast Height (DBH) at 1.37 m for trees and collar diameter for Shrubs were recorded for converting it into basal area. Basal Area = π r2, where r (radius).

Vi Importance Value Index (IVI)

IVI is used to express the ecological success of any species on a given site. It uses three characteristics viz., Relative Frequency, Relative Density and Relative dominance/ Relative Basal Area and is calculated as described below.

IVI=Relative Frequency (RF) +Relative Density (RD) +Relative Basal Area (RB)

$$\text{Relativefrequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all thespecies}} \times 100$$

$$\text{Relativedensity} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100$$

$$\text{Relativefrequency} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all thespecies}} \times 10$$

Vii Diversity Indices

Enumeration of biodiversity was done using Shannon-Wiener diversity index. (Shannon & Wiener, 1949), which is calculated using formula:

$$\sum_{i=1}^{s} pi \ln pi$$

Where, H´ is Shannon-Wiener index of species diversity, pi is the proportion of ith species and s is the number of individuals of all the species, ln is the natural logarithmic value.

Viii Bole Biomass

For the purpose, only trees with Diameter at Breast Height (DBH) of more than 10 cm were taken into account. The Diameter and Height of trees were recorded during field survey. Volume of the tree was calculated using volume equations developed for the species at local or regional level, whichever was available and applicable; the calculated volume was multiplied by its specific gravity to obtain bole biomass i.e. merchandable volume. Bole Biomass (Tonnes or Megagram, Mg) = Merchandable volume of the Tree x Specific Gravity.

Ix Aboveground biomass

Aboveground biomass was calculated by multiplying the Bole Biomass with Biomass Expansion Factor (BEF). Aboveground biomass = Bole Biomass x BEF. Where, BEF was taken from IPCC Good Practice Guidance for LULUCF (2003).

Tools used in the Baseline Survey

Primarily four tools were used for collection of field data. The four tools have been provided in Annex 1.2. and are described as follows. The four levels of tools those were used during the survey were:

Table 14*: Survey Tools*

Quantitative Tools	Qualitative Tools
1. Micro Watershed Level Tool 2. GP Level Tool 3. Revenuew Village Level Tool 4. Household Level Tool	Key Informant Interview FGD Tool

3.11 Carrying out Household Survey

Household listing sheet formed the basis for sampling of households in a village and thus was a vital component in carrying out the survey. In every village, household listing was first taken out from the GPWDP conducted by inviting a group of key persons (Pradhan,RVC,etc.) who were educated and well informed about village dynamics. Information about number of households in a village and name of head of each household was noted down from gram pachayat/village councils register records. Information on parameters such as caste, gender of head of a household, landholding, and disability status of a member in a household was collected based on unanimously agreed responses from the group of key persons. Sample households were then selected from the list such that ratio equivalent to caste distribution ratio at district level was maintained.

Further, households were also segregated based on three categories, namely poorest of the poor, poor and others. This was done to ensure that all income groups were appropriately represented by the sample. As there exists no universal definition of poorest of the poor and it could vary from village to village based on how a particular community considers someone as PoP, the group of key persons were queried about this in every village. Besides incomes as criteria for deciding PoP, several other factors were noted down. An attempt to select sample households in a ratio equivalent to ratio of total number of HHs present in each of the aforementioned categories in a village was also made. It was ensured that there is representation of women headed, disabled and landless households in the sample.

i. Household Questionnaire

The tool is very comprehensive and is divided into 10 sections. The tool has been designed to acquire information from the head of a household about everybody who is part of the household. Household roster provided information on education level followed by economic characteristics of the household (including assets and amenities section). A complete section is dedicated to Agriculture and Production, seeking details regarding crops grown, quantity produced and marketing extension services. The tool also has a Membership in community institutions section which mainly focused on assessing various institutions that the members of a household are a part of, mainly FIGs, FFs, VGs, WWMC, Water User Groups. A separate section is on income generation, expenditure, saving, debt and food security. One complete section is dedicated to Land Use Practices to understand cropping systems and methods of cultivation followed by details regarding Livestock Ownership and fodder details. Social Capital, and Social Cohesion were also gauged through the questionnaire follwed by Women Empowerment section focusing on their role in agriculture, access to serives, safety perceptions, decision making power and independence of women in a household. The last section focused on training requirements of the household members.

ii. Administering Household Tool

Households as selected after household listing procedures were covered in each of the sample villages. The researchers, upon approaching a household, explained the survey and took consent from the respondents before starting the survey. In most cases, researchers interviewed the head of the household. In some cases, where a household was found to be locked or unattended, replacement of a household was chosen as an option to carry out the survey operations smoothly. A standard protocol for replacement has been followed throughout execution of the field survey where each household was visited at least twice before replacing it with another similar profile household (A,B,C Category).

iii. Village Schedule

The village schedule was designed to capture an array of information on the village profile, starting with basic information on demographic details. It has helped in providing useful information

regarding the presence of basic infrastructure, educational institutes and health facilities in the village. Other sections seek details regarding sources of irrigation, sources of drinking water present in the village, presence of community institutions at village level. The tool also captures livestock inventory of the village, fuel and fodder requirement, income generation activities and market facilities. The last section of the tool captures progress of activities identified under GPWDP.

iv. GP Schedule

The Tool at GP level captures the administrative capacity of the Gram Panchayat. This provides basic information regarding meeting schedules, participation level in community institutions, procedural awareness amongst participants, monitoring procedures carried out at GP level and annual audits conducted. GP Schedule also has the Gram Panchayat Empowernment Index which captures parameters such as due diligence, inclusiveness, training and willingess, Budget Functioning, and Administrative Capacity of the Gram Panchayat.

v. MWS Schedule

The micro watershed tool captures details regarding formation of microwatershed development, operational status of WWMCs, various natural resource conservation techniques adopted and progress of interventions taking place at microwatershed level.

3.12 Procedure for carrying out MWS schedule

Information was collected from Micro watershed office.

i. Data Collection

The Baseline survey was conducted in close coordination with the Watershed Management Directorate(WMD) and Deputy Project Directors(DPD). From the initial phase, it was ensured that the survey activities at Village, GP, MWS level takes place in the presence of Gram Pradhan, Account Assisstants and Women Motivators. A regular contact with DPDs had been maintained throughout the duration of the survey.

ii. Team Structure

The team involved in carrying out the baseline survey consisted of the following members: Program Manager, Field Manager, Data Manager, Division Supervisors, Internal Village Supervisors, Field Researchers, Data Executives and Data Entry Operators. The project has been managed primarily by three members of the team comprising of Project Manager, Division Managers and Data Managers. The Program Manager was responsible for overall execution of the assignment with support from his team members. The Division Manager supported the Program Manager and was responsible for overall execution of all field tasks in all project states. He provided support to field team members and ensured all survey activities are completed as per plan within deadlines. Field researchers, being familiar with region and local dialect of the communities they live in, were recruited from every division The Data Manager designed CS PRO software for double data entry of questionnaires.

3.13 Processes followed during the survey

A number of processes took place after the inception stage of the project to ensure quality of the tools used and to provide comprehensive training to the field staff deployed. Each of the processes has been described below.

i. Composition of field research teams

Division level supervisors were recruited based on the their past technical and geographical experience. The recruitment of field survey supervisors and researchers for the assignment was completed after the finalization of tools

Sutra Consulting stressed upon the following protocol for recruitment of the team:

- There cannot be deployment of any team members other than those who are trained and selected. If required to be replaced they can only be replaced from trained members
- There would be complete profiles, CVs, contact details and passport photographs of the

survey team

- Division managers will manage the survey team and will report to the Field Manager on the daily activity of the team and completion of targets on a daily basis through a self-designed tracking sheet for each team.

The field researchers have been recruited based on three criteria; i) Experience and qualification, ii) Location familiarity and iii) Work with the field survey coordinator earlier. Surveyors were selected from the sample divisions to ensure smooth functioning in interaction with households, familiarity with location of villages, local language and culture. An attempt has been made to provide training to more researchers than actually needed so as to have replacements. Researchers were selected and assesed on the basis of their performance during the training sessions, both in the classroom and in the field. The trainings were conducted by core team members with the support of the supervisors.
Apart from Field Managers and Division supervisors, internal team members were also engaged in quality monitoring from the beginning of the survey. It ensured that process is adhered to and flow of activities was smooth along with quality monitoring.

ii. Pre-testing of tools

Pre-Testing was carried out in Thatyur and Vikasnagar division. The core team of Sutra along with the state supervisors visited one village in each divsion and covered two households in each of the villages, alongwith Gram Pradhan, Account assisstants and Motivators to assess the situation.
The pre-testing was undertaken to ascertain the following aspects of the research tool:

- Relevance of the questions used in the tool
- Whether the language used in the question is easy enough to capture the mandated response even if the researcher is unable to probe properly
- Appropriateness of coded response
- Time taken to complete each section in the tool
- Sections seeking assumptive responses such as extent of recall period used so as to check accuracy and reliability of the information.
- Checking style of questioning of a particular type of question which may elicit politically correct responses and not a thoughtful response. These questions,related to household consumption and well being, may provide either over reported or under reported information from the poorest of the poor families
- Time taken to complete the entire schedule
- Feasibility of interviewing different stakeholders under one schedule such as in a household schedule where sections on consumption targets interviews with women in the household.

iii. Translation of tools

The translation of tools was done in Hindi from English. It was a strict necessity to thoroughly comprehend the original (source) message and field test it before finalizing the translated versions of the questionnaire. The first draft translation was reviewed during the supervisors training and rectified after that. This second draft was again reviewed by bilingual individuals not connected with the survey, to verify the correctness of the translation – both words/phrases and structuring of the sentences. The third draft was reviewed during the training program of the supervisors and field researchers & also from experience of the piloting of the tools.

iv. Training of Supervisors and Surveyors

Training of supervisors and surveyors was conducted in Dehradun for a duration of 7 days followed by field exposure. Training commenced in the presence of Project Director, Neena Grewal and WMD officials The purpose of this training was to understand the purpose of the tools, technical concepts involved and to discuss with them strategies to be adopted to overcome challenges. Role play excercises were conducted for difficult sections in the questionnaire.
Trainings were composed of two major components – Classroom Training and Pilot Testing. The researchers were trained adequately on the context, techniques and use of survey tools. A short training manual was also designed for this purpose which includes conceptual issues on research,

overview of the project processes and institutional arrangement, basics of field research, sample selection, field guides of do's and don'ts, explanation on using various instruments, guidelines on taking field notes and other research planning and management issues.

v. Quality Assurance

Field supervisors along with the internal team member were responsible for data collection and quality assurance. All data collected during the survey was checked for consistency at the field level and necessary corrections were immediately incorporated. Each day, after completion of the field survey, the supervisors did a manual scrutiny to identify incomplete questionnaires and redundant observations and had them rectified. In addition, 5 percent of the questionnaires were checked by the internal project team members during monitoring visits to field locations.

vi. Data Entry and Analysis

To enter the data from household, village, GP and MWS questionnaires, one software package was developed in CS Pro. The software was designed with operator controlled mode based on the nature of questions in survey tools. The following activities have been done with regard to the preparatory phase of the software testing:

- Range and validation rules were decided and included in each applicable cell of the software.
- The range and validation rules were ratified by taking feedback from all supervisors.
- Multiple testing exercises were conducted on the software with a small set of completed questionnaires in order to check all validations at different points in the software.

Data entry operators and supervisors were trained before the data entry work started. Data from all the questionnaires was entered directly to MS-Excel. For the purpose of minimizing the scope of errors and to improve data quality, double data entry option was availed of in which the same data was entered twice by different data entry operators. Later, the two sets of similar data were compared to identify unmatched values. The final dataset has been produced after correction of all such unmatched errors.

Indicators for Qualitative Assessment

Qualitative assessment was drawn to derive heterogeneity of impacts and hence was developed based on the following principles

Thematic Areas for assessing dimensions of Inclusion, Participation, benefits from project, heterogenity of impacts:

- Knowledge on project intervention
- Awareness of GPWDP and its importance
- Community feedback on inclusive plans for landless and transhumant population
- Feedback on identification process of the poorest and their inclusion in the programme.
- Need assessment process on technology transfer and community feedback on its significance
- Feedback on RVC (Revenue Village Committes) including all prioritized plans in GPWDP
- Feedback from women on purpose of Women aam sabha's
- Role played in providing women level proposals
- Participation in PME, role foreseen, role played and areas of improvement (need for project support)
- Need for Water conservation structures created and changes foreseen
- Challenges on productivity enhancement (traditional approaches)- Crop specific experiences
- Community feedback on road towards income improvement (and related changes)
- Pathway of change towards Drudgery reduction (access to fuel wood, water availability.
- Impact on migration
- Community feedback on changes foreseen in biodiversity conservation
- Best practices adopted for productivity enhancement (technology adoption/ traditional practices)
- Cropping pattern and cropping cycle- effect of climate changes
- Need for convergence with existing departments for persistent issues in scaling up livelihood
- Capacity building needs of GP and other community groups if any
- How impacts are distributed across different social groups

- Distributional impacts on households in ridge , middle and lower ranges
- Distributional impacts on type of farmer households
- Distributional impacts on type of poorest households identified through PRA
- Programme implementation challenges
- Stakeholders expected to have an important role in the governance mechanism of the project at panchayat level
- Capacity assessment of WWMC and GP for implementing watershed plans
- Need for grievance redressal system
- System of fund flow and inputs in the programme

Profile of Sample Covered

4. Profile of Sample

4.1 Micro Watershed Profile

Project Development Objective is to increase the efficiency of natural resource use and productivity of rain-fed agriculture by participating communities in selectedmicrowatersheds of the State of Uttarakhand.Gramya II is focusing on microwatershed treatment of 220,000 ha of non-arablelands, which would enhance agricultural productivity on 40,000 ha of adjacent arableland. Micro-watersheds serve as a common unit for comprehensive planning and demonstration among GPs as they work within confined hydrological area. 82 Micro watersheds were covered under Gramya II covering 509 GPs covering 263,837 ha. For the Baseline, 38 Micro watersheds were sampled such that they cover maximum number of villages. Micro watersheds are picked from Ridge, Middle and Valley terrain. GPs fall under these micro watersheds and the allocation is as below:

Table 15: Sample GPs covered

Watershed Topographical Division	Project GPs	Control GPs
Middle	29	14
Ridge	10	1
Valley	15	3
Total	54	18

Out of the total 38 MWS, 8 sample MWS were analysed using secondary information and interpretation of remotely sensed data. Brief information regarding the location, geomorphology, drainage, land use/ land cover, slope and aspect are discussed as follows:

i. Location details of MWS

The eight MWS were sampled from the eighty two micro watersheds under project intervention to calculate all GIS based indicators except the indicator related to Biomass (done for 38 MWS). The summary of MWS identity and location are indicated in the Table 1 of Annexure II

ii. Geomorphological and drainage features

The sample Micro-watersheds were analysed based on both secondary data as well as interpretation RS data in order to capture the essence of the general geomorphological features of the MWS. All of the sample MWS shows geomorphological features characteristics to mountainous regions and are criss crossed by numerous drainage stream. For each of the sample MWS, the major geomorphological features, drainage density and numbers of streams of under orders (I to VI) are summarised in Table 3 of Annexure II

iii. Land Use classification

The GIS based land use classification is done for 8 MWS classifying total land area into Arable Land, Barren Land, Dense Forests, Open Forests, Settlements, Shrubs and Water. It is to be noted that the arable area is high in case of most MWS, with Loharkhet having the lowest (9.29 %) and highest Arable land in Sidiyagarh (62.70 %). The Barren Land is below 5 % in all MWS except Sidiyagarh (24.93 %) and Silogi (18 %). Forest Cover is high across all MWS except Sidiyagarh (11.38 %). Highest Forest cover is noted in Loharkhet (85 %) and Sarugarh (82 %). Settlements are mostly below 1 %. (Refer Table 3 and Table 4 of Annexure)

iv. Slope and Aspect

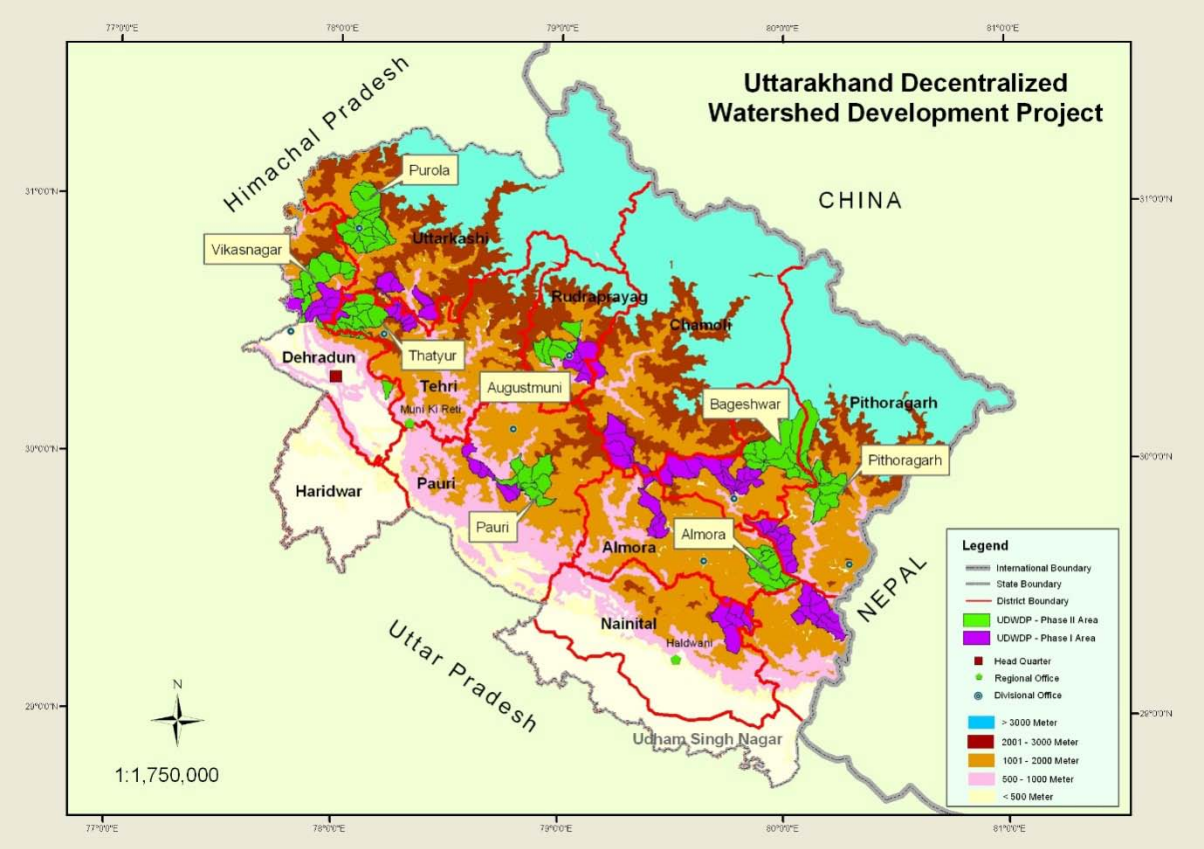
The percentage of the total land falling under each slope and aspect class for all sample MWS are summarised in the following two tables. It may be noted that owing to the mountainous terrain of all the sample MWS, the percentage of land falling under very steep slope (>25 %) is uniformly high across all samples MWS and ranges from 29.34 % to 65.77 %.

District Profile

v. Disaggregation of districts across terrain

The current baseline report is based on data collected from sample villages in all the 8 district in which the Gramya – II is being implemented, namely, Bageswar, Almora, Uttarkashi, Tehri, Dehradun, Pauri, Pithoragarh, Rudraprayag. The location within the state for the mentioned districts is indicated below in the following

Figure 5:Project coverage of UDWDP II



*Map reproduced from the website of Watershed Management Directorate, Uttarakhand (http://www.gramya.in/project area.html)

The villages covered as sample have already been detailed and discussed in the methodology section of this report. The eight hill districts as named above are distributed in both Kumaon (Almora, Bageshwar and Pithoragarh) and Garhwal (Uttarkashi, Thatyur/ TehriGarhwal, Dehradun, Pauri and Rudraprayag) regions of the State. In the following sections, a short overview regarding the location, demography, physiography, climate, land use, agriculture, livestock assets etc. have been outlined.
The district of Bageshwar is the easternmost among all these districts and shares its eastern boundary with Nepal. Towards its west are the districts of Bageswar (north-west and west) and Almora (south-west). The westernmost districts are Dehradun and Uttarkashi. Dehradun shares its western boundary with the state of Uttar Pradesh and has Himachal Pradesh to the North. The North westernmost district of Uttarkashi shares its western boundary with Himachal Pradesh and has China towards the North. Towards the South of Uttarkashi and east of Dehradun, the other Garhwali districts of Pauri, Tehri and Rudraprayag are located. The location details of the districts are summarised in Table 7 of Annexure II

4.2 Socio – economic profile of the sampled households

i. Caste wise distribution

A large part of the sample is from the general category, with a nearly similar nature of distribution in treatment and control areas. Almost half of the households (54%) are from the general caste category.

The Scheduled tribe has the lowest representation in the sample and has mostly appeared in Dehradun district. A large proportion of OBC households reside in Uttarkashi which can be seen both in treatment and control regions.

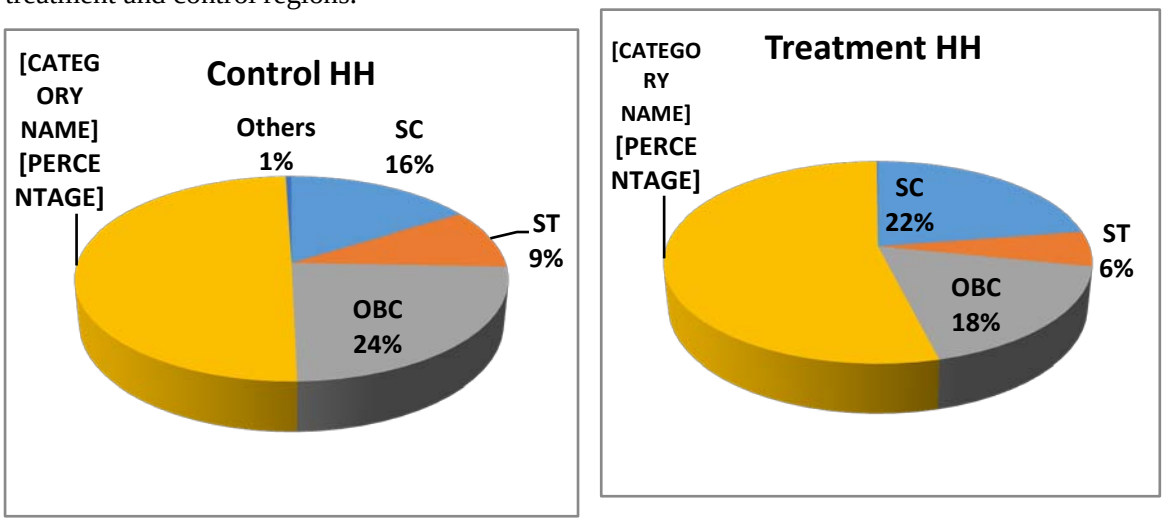


Figure 6:Caste wise distribution of sampled households (control and treatment)

One third of the sample in treatment were from scheduled caste. Rudraprayag, Dehradun and Uttarkashi had a higher proportion of representation of SC population in the sample - about 25-35 percent.

Table 16: Caste Distribution of Sample (% of Total Households)

Districts	Control				Treatment			
	SC	ST	OBC	General	SC	ST	OBC	General
Almora	17.7	0.9	0.0	81.5	26.0	0.2	3.4	70.4
Bageshwar	2.6	0.0	1.3	96.1	16.3	1.2	1.2	81.3
Dehradun	21.6	2.0	2.9	73.5	35.9	55.0	5.8	3.3
Dehradun-II (PMU-MODEL)	2.4	0.0	0.0	97.6	89.5	0.0	0.0	10.5
Pauri	24.1	0.0	0.0	75.9	10.4	0.3	2.0	87.2
Pithoragarh	13.2	13.2	42.1	31.6	16.5	2.8	33.8	46.8
Rudraprayag	10.7	0.0	0.0	89.3	25.9	0.7	3.3	70.0
Tehri	18.2	0.0	81.8	0.0	18.0	1.1	80.1	0.8
Uttarkashi	18.6	1.8	68.2	9.6	34.3	0.2	62.1	3.4

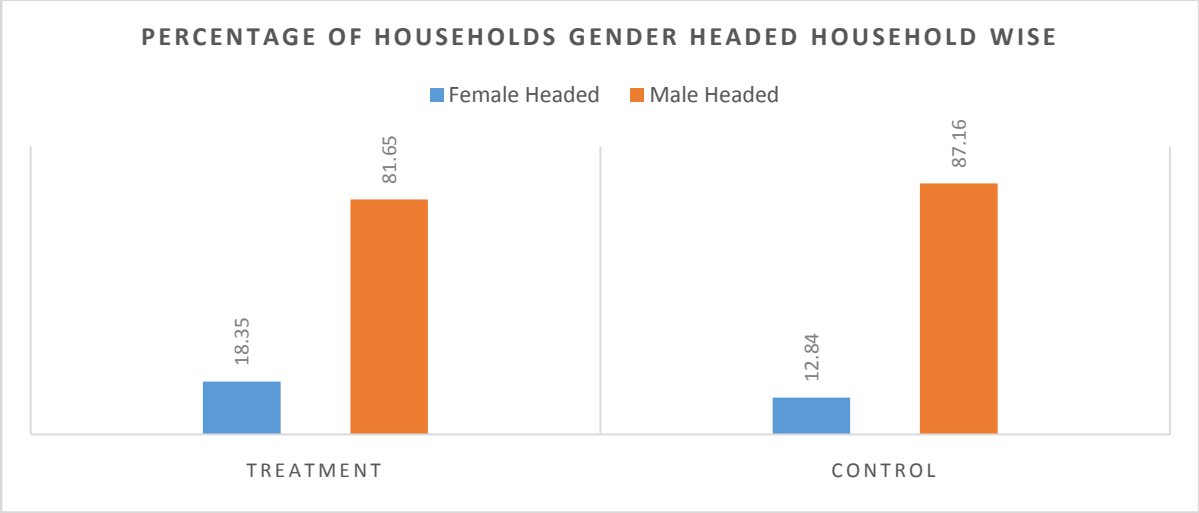
Source: Household Survey, N=5567(Treatment), N=907 (Control)

ii. Family size and family head

The average family size in the sample is about 5 members per family which is fairly similar in both treatment and control areas. The 2011 NSS 68th round of survey also gives similar data where the average family size was about 4.5 in rural region and 4.1 in urban region. A distribution across gender of head of household indicates that about 1/5th of the sample households in treatment area has women heads and little lesser in control region. The overall treatment sample consisted of about 18 percent female headed households which also follows the persisting pattern gender based disaggregation of households in Uttarakhand.[3]

[3] *NSS 68th Round Survey Uttarakhand: About 18 per cent of the households in the rural and 16 per cent in urban areas were headed by females. The average household size of the female headed households was 3.0 in rural areas and 3.7 in urban areas*

Figure 7: Genderwise distribution of Household



iii. Age distribution and Education

Age specific distribution of the sample population shows that nearly 60 percent of the population belong to working group which is between 15-64 years. Sample population was divided in three age groups as children/infant (0 – 14 years), working age (15 – 64 years) and old (65 years and above). The overall distribution of the working members in the age groups of 15-64 forms the major proportion of the population and the pattern appears similar in treatment and control.

Table 17*: Age Distribution*

District	Control			Treatment		
	Child (0 to 14 yrs)	Working (15 to 64 yrs)	Old (65 and above yrs)	Child (0 to 14 yrs)	Working (15 to 64 yrs)	Old (65 and above yrs)
Almora	19.2	66.0	14.8	23.5	64.3	12.1
Bageshwar	23.5	66.1	10.5	22.0	66.3	11.7
Dehradun	23.0	69.4	7.6	24.9	66.8	8.3
Dehradun-II (PMU-MODEL)	29.3	63.5	7.2	20.2	73.0	6.8
Pauri	18.6	69.0	12.4	20.0	67.6	12.4
Pithoragarh	19.4	66.7	14.0	23.4	65.5	11.0
Rudraprayag	26.4	67.2	6.5	24.7	67.6	7.7
Tehri	21.4	68.6	10.0	23.1	69.6	7.3
Uttarkashi	24.7	69.3	6.0	27.8	66.3	5.9

Source: Household Survey, N=5567(Treatment), N=907 (Control)

A distribution by educational profile of members shows almost similar profile across treatment and control area. About one fourth of the population are illiterate/ have not undergone any formal schooling. Percentage of individuals (around 8 %) having higher degree in gradutaion and above is lesser in proportion.

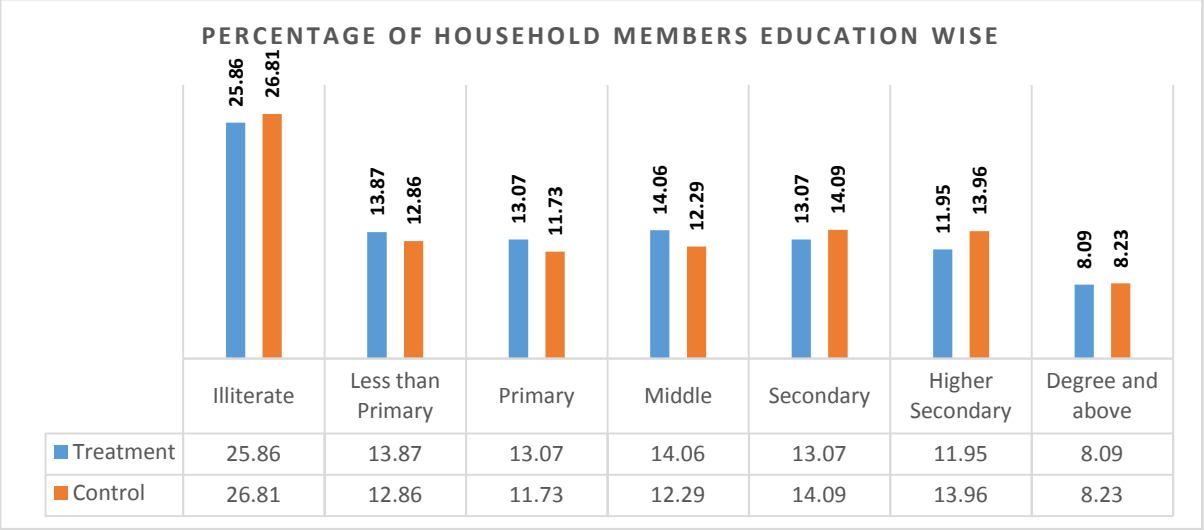


Figure 8: Education wise distribution of household members

Iv House ownership

The majority of households covered in both treatment and control (96.84 % and 97.66 % respectively) reported of owning a house and residing in the same. The sample distribution indicates that about 82 percent of the sample are marginal farmers with less than 2 Ha landholding. However, most of them had own house.All the sampled control households in Bageshwar, Pithoragarh, Rudraprayag and Tehri district reported that they own the house in which they are currently residing. The lowest value reported was 92.7 percent of treatment households in the Dehradun district.

Table 18: Percentage of household owning house

District	Control	Treatment
Almora	96.12	98.76
Bageshwar	100.00	97.66
Dehradun	99.02	92.74
Dehradun-II(PMU-MODEL)	97.62	100.00
Pauri	95.40	97.84
Pithoragarh	100.00	98.82
Rudraprayag	100.00	97.56
Tehri	100.00	97.37
Uttarkashi	94.29	99.57

Source: Household Survey, N=5567(Treatment), N=907 (Control)

Information on type of dwelling was obtained for 3 types of housing categories - Kuchha (non - cement concrete i.e. stone/ wood/ mud), Semi Pucca (partially cement concrete) and Pucca (wholly cement concrete). In the case of all the control households across districts, a majority (60.32 %) dwelt in completely cement concrete houses, 25.6 % resided in houses which were partially constructed of cement concrete and the remaining 14.06 % of households resided in non-cement concrete houses. The district-wise distribution of households residing in different types of houses (expressed as percentages of total sampled households) are indicated below:

Table 19: Percentage of household by type of house

District	*Kutcha*		*Semi Pucca*		*Pucca*	
	Control	Treatment	Control	Treatment	Control	Treatment
Almora	14.22	11.80	42.24	38.20	43.53	50
Bageshwar	7.89	17.37	19.74	27.62	72.37	55.01
Dehradun	37.25	21.16	13.73	29.46	49.02	49.38

Dehradun II (PMU Model)	9.52	5.26	11.90	3.51	78.57	91.23
Pauri	11.49	16.42	35.63	30.68	52.87	52.90
Pithoragarh	21.05	11.82	25	32.86	53.95	55.32
Rudraprayag	5.33	5.87	16	18.34	78.67	75.79
Tehri	9.09	16.17	27.27	22.56	63.64	61.28
Uttarkashi	17.86	16.70	9.29	10.06	72.86	73.23

Source: Household Survey, N=5567(Treatment), N=907 (Control)

V Basic amenities: Electricity, Water and Sanitation

Water facility, toilets and electricity forms the gamut of basic amenities for the household and defines the socio economic condition of the household in the intervention and non-intervention regions. Overall, a majority of the households (93.72 %) seemed to be equipped with electricity in their homes

Table 20:Percentage of HH having electricity

District	Control	Treatment
Almora	95.69	94.94
Bageshwar	94.74	95.10
Dehradun	99.02	96.27
Dehradun-II(PMU-MODEL)	92.86	94.74
Pauri	94.25	95.52
Pithoragarh	98.68	92.43
Rudraprayag	98.67	94.40
Tehri	90.91	93.61
Uttarkashi	78.21	88.87

Source: Household Survey, N=5567(Treatment), N=907 (Control)

(91.13% of control households and 94.19% of treatment households). It is noteworthy that the power situation in rural Uttarakhand, especially in the hill districts has greatly improved over the last few decades. As per secondry sources the State seems to be well equipped with energy sources as most of the (around 96%) rural households in Uttarakhand are electrified by Uttarakhand Power Corporation Limited as per Energypedia, 2017[4].

The access to toilets also seems to be fairly adapted in the state as overall more than 80 percent of the households seemed to be owning toilet, with only Uttarkashi lagging behind.77.28 % of the respondent households in treatment sample have access to toilets. The toilets that were being used by these households were reported to be of both of modern flush toilet type (49.3 %) and local pit type (50.7 %). The district-wise information regarding access to toilets and the types of toilet used by households are indicated below:

Table 21: Percentage of households having access to functional toilets

District	Percentage of households with access to functional toilets	
	Control	Treatment
Almora	87.93	80.56
Bageshwar	89.47	87.53
Dehradun	89.22	72.61
Dehradun-II (PMU-MODEL)	97.62	94.74
Pauri	88.51	82.75

[4] https://energypedia.info/wiki/Energy_Situation_Uttarakhand,_India#cite_note-5

Pithoragarh	86.84	83.69
Rudraprayag	77.33	79.95
Tehri	72.73	71.99
Uttarkashi	52.50	40.47

Source: Household Survey, N=5567(Treatment), N=907 (Control)

The sampled households belong to hilly rural areas and the percentage of people with access to functional toilets is uniformly high, ranging between 72% (treatment households in Tehri) to as high as 97.6% (PMU Model). The only district where a relatively lower percentage of respondent households reported having access to toilets is in Uttarkashi.

Although the percentages of the respondent households accessing each kind of toilet varies largely across districts, the overall percentage of households (all districts put together) accessing each type of toilet is comparable, as indicated earlier in this section. The major reason for non-access to toilets was reported as the presence of dysfunctional toilets or absence of toilets as a whole in all sampled districts.

Table 22: Percentage of households having access to various type of toilet

District	Percentage of HH having flush toilets		Percentage of HH accessing pit toilets	
	Control	Treatment	Control	Treatment
Almora	36.76	34.17	63.24	65.83
Bageshwar	38.24	47.46	61.76	52.54
Dehradun	53.85	52.29	46.15	47.71
Dehradun-II (PMU-MODEL)	63.41	87.04	36.59	12.96
Pauri	76.62	49.70	23.38	50.30
Pithoragarh	46.97	44.35	53.03	55.65
Rudraprayag	74.14	67.01	25.86	32.99
Tehri	87.50	59.01	12.50	40.99
Uttarkashi	14.97	21.16	85.03	78.84
Total	34.5	38.7	43	38.6

Source: Household Survey, N=5567(Treatment), N=907 (Control)

4.3 Occupational profile

Uttarakhand is an agriculture and horticulture dominant state and therefore occupational distribution shows that a majority of the households are into farming. Theoccupation of the household members was segregated into the categories of agriculture, agricultural/ farm labour, non-farm labour, services, business and other occupations. As all the districts under the study are hill districts and have a major subsistence agriculture dependent rural population, most of the households reported agricultural activity as their primary occupation. The nature of agriculture therein is subsistence in nature with most households (83%) having marginal landholdings (below 1 hectare). The members of the households themselves take part in the agricultural operations and the requirement for additional farm labour is low. It is evident from baseline sample assessment that both in the case of control as well treatment households, most of the respondents reported agriculture as their primary occupation (72 % for control households and 77 % for treatment households). Majority of the landless householdare engaged in non-farm activities (12 % for control and 11 % for treatment households). 15 % of the control households and 17 % of treatment households reported of being engaged in salaried jobs.
As most of the districts are popular tourist destinations of religious and trekking interest, small and medium businesses catering to lodging, travel, food and other needs of tourists are common.

4.4 Farmer category (landholding size)

Distribution by landholding size indicates that majority (83%) in the sample household belong to marginal farming category. The average landholding size decreases further in the hill districts owing to the poverty and adverse climatic and topographical conditions.

Table 23:Percentage og ahaopusehol;d by Land holding size

District	Percentage of Household by landholding Size	
	Control	Treatment
Landless	17	13
Marginal	80	83
Small	4	4
Large	0	1

Source: Household Survey, N=5567(Treatment), N=907 (Control)

Water Discharge

5. Water Discharge

5.1 Methodology

Water discharge will be accurately measured through Hydrological monitoring methods. Direct measurement of discharge of water has a high spatial variability influenced by land features, soil characteristics, and land slope and rainfall intensity. WAPCOS has been empanelled to install hydrological monitoring instruments to capture water discharge at particular frequency for the sample micro watersheds.

5.2 Water Resource Inventory

The GPWDP made under Gramya-II maps all natural water soources and its perriniality acorss divisions. During the sampe survey both natural and artificial water resources were identified at GP level such as Natural Stream (Naulla, Gadera, Dhara), Springs, Boring, Open Well, Tube Well and Check Dam/ Water Harvesting Structure from GPWDP of sample GPs visited. Atotal 201water resources are identified across 54 sample GPs out of which only 4 percent of the sources were such that wateris available throughout the year. The hydrological moitoring data will provide a detailed inventory of the perennial sources which is done by an external agency WAPCOS

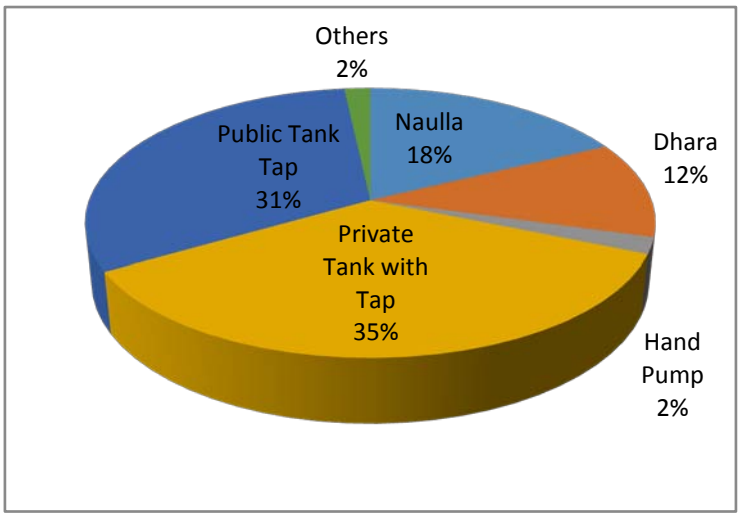
Table 24: Natural Water resource inventory

Sl. No.	Type of Source	Water Available for more than 6 months a year	Water Available for more than 9 months a year	Water Available for 12 months	Nu,ber of water resources identified in sample GPs
1.	Natural Stream(Naulla, Gadera, Dhara)	151			151
2.	Springs	32			32
3.	Boring / Tube Well	-	08		08
4	Open Well	-		10	10
	Total	183	08	10	201

Source: GP Survey, N=54(Treatment)

5.3 Drinking water sources

Figure 9: Primary source of drinking water



One of the objective of watershed development under Gramya-II is greater water accessibility for households in the course of the project. Source sustainability measures shall help families meet their domestic needs including that of drinking water. Baseline figure indicates that 68 percent of the households in treatment area have access to piped water supply. However, in practice many rural water supply systems are dysfunctional (Bank) which signifies there dependency on other sources of water such as on natural streams of water mostly Naulla or Dhara. These households are also dependent on community based water supply systems as communities in Uttarakhand now choose water supply service because of decentralization in functionaries. One third of households in control and treatment are dependent on private tanks and the other third on public tanks for drinking water.

30 percent of households in treatment are dependent on Naulla and Dhara which implies the need to travel to these sources for drinking water and other domestic needs. Women in these households spent a lot of time in fetching water from other sources. 30 percent of the households in the treatment have to trudgelong distances to collect water for household needs.

Integrated into the project are a host of initiatives to reduce trudging by forming WWMC, WUG and constructing various water storage structures.Number of natural water bodies across state has dried up exposing families of acute water crisis especially in summers. 73 % of the households in treatment and 83% of the control face water scarcity at least for the duration of one to three months.

Biomass

7. Biomass

In the present study for Baseline survey, biomass estimation is done for 8 micro watersheds of Uttarakhand i.e. Silogi, Dewangad, Sidiyagad, Utrasu, Lathiyagad, Loharkhet, Paligad and Sarugad. Methodology used for the calculating biomass is based on integration of field data with interpretation of visually processed satellite image for all the three stages of baseline, midterm and end term.

The estimation is done using remote sensing technology by using Normalized Differentiated Vegetation Index (NDVI). However, since the project requirement is estimation of biomass in terms of ton ha^{-1}, field based biomass estimation is being proposed by laying plots. The field based method for estimation of forest and pasture is done using indirect measurements instead of earlier suggested harvest method for pasture. From the mid-term onwards when two season data is available change detection of watershed will be carried out. This will be carried out by using supervised classification of LISS IV satellite image.

Classification of satellite images were done by hybrid method, taking help of both visual as well as digital processes. Both digital and visual interpretation is affected by the presence of clouds and their shadows, heterogeneity in the distribution of land use, land cover over the study area, minimal details identified from the classifications, and number of classes. These limitations are faced while classification of objects and that is why interpreter experience play an important role for Land use and land cover classifications. Statistically, digital classification is more accurate as compared to visual interpretation.

7.1 Methodology

i. Biomass Estimation Using Remote Sensing

The present proposal focuses on biomass estimation using remote sensing, it is an attempt to couple ground based vegetation quantification with the satellite remote sensing. In the present study pan sharpened LISS IV image of October-November, 2013-14 were used. The image was procured by WMD from NRSA. The satellite image was classified using spectral charteristics into different land cover type's viz. forest, water body, built up, agriculture and barren land etc. Tonal and textural variation plays a major role in the creation of land cover type map. From the field a large number of quadrants were laid to study the biomass availability and species distribution. The field data was also used as ground truth to differentiate between various vegetation compositions. The field base sampling has provided with the quantification of biomass in terms of th^{-1}.

The field values were later evaluated with reference to NDVI values. The correlation of field sampled values with NDVI values helps in the development of regression equation to assess biomass in terms of NDVI values using satellite image. The observed biomass values will serve as baseline value for estimation of change in biomass owing to project intervention.

ii. Digital Image Processing:

Digital image processing consists of image classification and NDVI calculation.

Image Classification:

Image classification consists of supervised classification of satellite image by providing training sets based on spectral characteristics representative of different classes. The field survey carried out during the field biomass estimation provides the information on spectral characteristics of different strata and in turn these help in defining training sets for image classification.

Vegetation Index

The vegetation index is the ratio of NIR and RED band is used to assess the information on biomass and LAI (canopy cover) of vegetation. The NDVI (Normalized Differential Vegetation Index) value

range in between -1 to + 1, here the negative value indicates water, bare land etc. whereas positive value is indicative of vegetation. The NDVI value is calculated by using the following formula:

$$NDVI = \frac{IR - R}{IR + R}$$

Here IR and R denotes infra red and red bands respectively.

The NDVI image of various micro-watershed has been provided in Annexure-1

iii. Biomass estimation: Field based method

The field sampling for biomass study was aimed at quantification of biomass in terms of t h-1, Field study was carried out in the month of March to July, 2017. Out of a total of nineteen development blocks seven blocks belonging to six divisions were selected for sampling. Out of seven, two blocks (Kalsi, Jaunpur) were selected from Garhwal, while remaining five (Agustyamuni, Ukhimath, Ekeshwar, Dhauladevi and Pokhra) were from Kumaon region. The attitudinal variation between the sampled Gram Panchayats ranges from 700 meter to more than 3500 meters.

7.2 Sampling

In all of the studied blocks the vegetation was studied by laying out of number of quadrants of specified sizes. In accordance with proposed methodology ground sampling was carried out by laying sample plots using quadrant sampling method developed by Mishra (1968) in different vegetation strata. Quadrants of 25*20 m, were laid out for measurement of tree species and for the study of shrub and herb quadrant size of of 5*5 m and 1*1 m were used respectively. Total of 80 quadrants of size 20X20 meter for trees, 5X5 meter for shrubs and 1X1 meter for herbs were laid out in different strata. On the basis of the field data, standing biomass stock was calculated for individual sites. The GPS coordinates of the plot has been listed out in Annexure-3.

For the measurement of tree biomass volumetric equations developed by FSI, 1996 were used. The herb and shrub biomass was calculated as ratio of tree biomass (Technical Paper, India's Forest and Tree cover: Contribution as a Carbon Sink, ICFRI). The quantitative measurements of plant parameters in these plots of size 25X20m for tree and 5X5m for shrub and saplings were used to measure girth at breast height (for trees) and height of individual plant. The mean CBH (circumference at breast height) and height for each species for a girth class was used in the regression equation to get an estimate of biomass for that girth class. The obtained value was multiplied by the density of trees in that girth class. The girth class values were summed up to obtain the biomass value of the sampled plot. Similarly biomass for agro-forestry and shelterbelts areas was estimated.

It has been observed that the sampled biomass in different micro-watershed varied widely along different strata. The minimum surveyed biomass value of 0.34 was recorded from Ekeshwer block of Pauri, it belongs to the Agro- forestry whereas the maximum observed value of 258.343 th-1 was recorded from Jaunpur block of Thatyur, belonging to dense forest.

Figure 10-13 shows the laying of quadrant and biomass enumeration process.

Figure 10- ***Laying of Plot in field***

Figure 11- Recording of field Measurement

Figure 13- Enumeration of Herbs and Shrub species

Figure 12:Biomass status in the field

Biomass Estimation

Observation:

The biomass stock in the project area was calculated on the basis of extrapolation of the sampled field biomass value. In order to extrapolate the field biomass value a regression equation was developed by correlating the sampled biomass value and NDVI value. Fig 5 shows the correlation of biomass and NDVI value (out of 80 values only 76 plots were used and 4 were discarded due erroneous value).

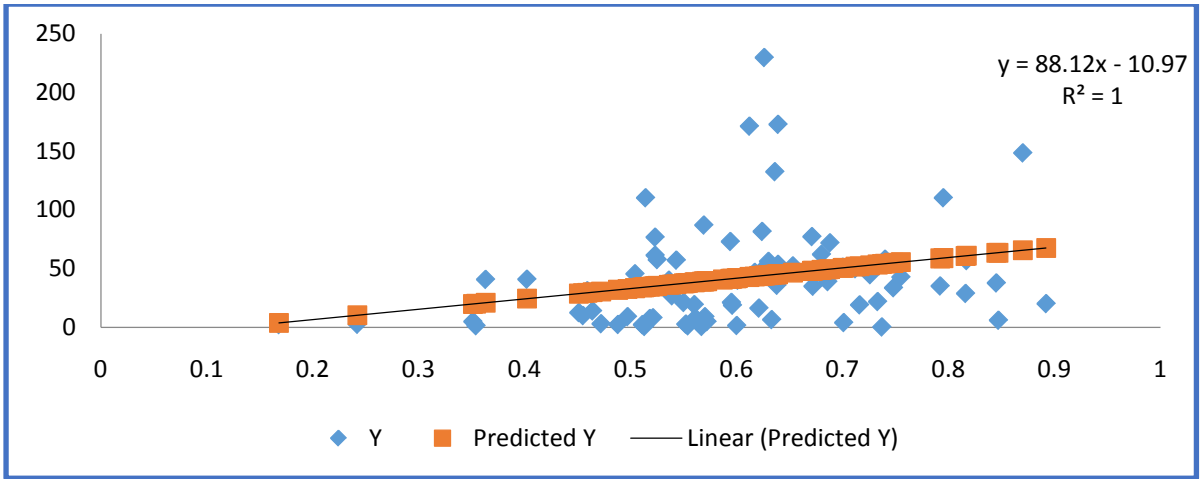


Figure 14- Correlation of NDVI and Biomass

It has been observed that the highest average biomass value of 40.49 t h-1 has been recorded from Chandol micro-watershed of Ekeshwar block in Pauri whereas The lowest average biomass value was recorded from Patalgad micro-watershed of Janupur block in Thatyur. Figure-6 provides the average biomass of different micro-watershed.

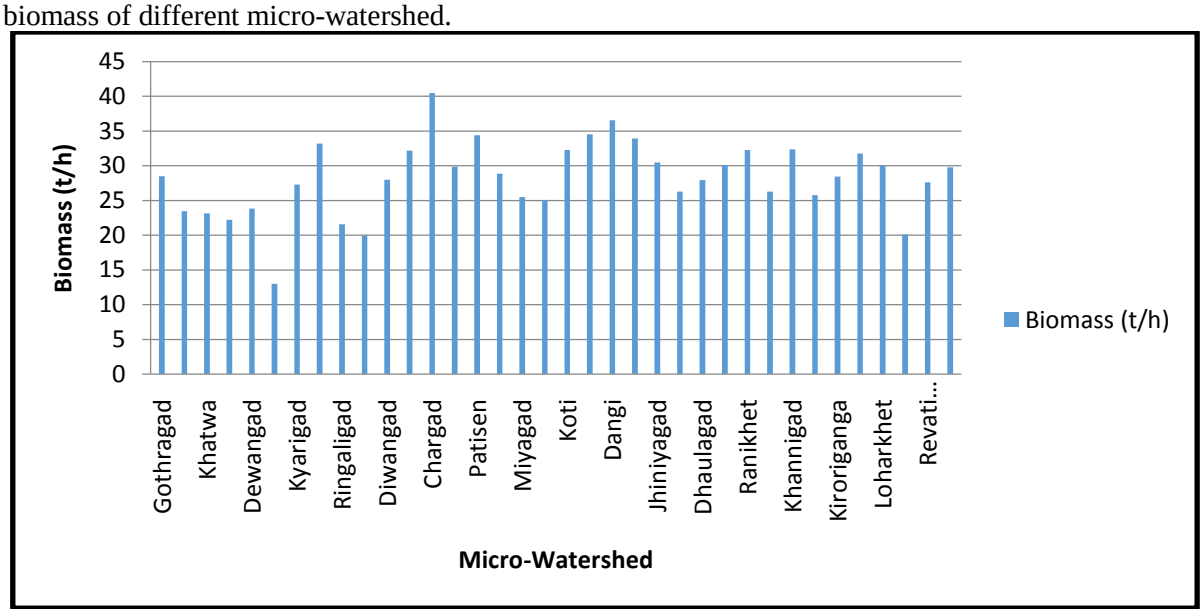


Figure 15*: Average biomass distribution*

Biomass Status:

A total of 36 micro-watersheds belonging to eight development blocks were analyzed for estimation of available biomass. The biomass estimation consists of processing of the satellite image in lab and field sampling to estimate the available biomass in t h-1. The total estimated biomass value in five micro-watersheds of Deharadun encompassing a total area of 21002.98 ha is 504421.75 Metric tons.Annexure-4 provides the biomass map of different micro-watersheds.

The overall Biomass across project and control sites is nearly similar.

Table 25: Biomass status (Project & Control)

Project Outcome Indicators	Unit of Measure	Baseline Study	
		Project	Control
Increase in biomass	Tonnes/Ha	27.69	21.74

Table 26- Biomass status in various micro-watershed

Sl. No.	Development Block	MWS Name	Avg. Biomass (t h^{-1})	Tree Biomass (t h^{-1})	Herb + Shrub Biomass	Total Biomass (t h^{-1})
1.	**Dehradun Division**					
1.	Chakrata	Gothragad	28.51	28.0798	0.4212	77737.942
2.	Kalsi	Kalsi	23.45	23.1022	0.3465	69918.95
3.	Kalsi	Khatwa	23.13	22.7810	0.3417	143312.96
4.	Kalsi	Aragad	22.25	21.9123	0.3287	47510.56
5.	Kalsi	Dewangad	23.83	23.4754	0.3521	165941.33
2.	**Thatyur Division**					
6.	Jaumpur	Patalgad	13.01	12.8099	0.1921	20676.01
7.		Kyarigad	27.31	26.9033	0.4035	76968.03
8.		Paligad	33.20	32.6990	0.4905	196861.96
9.		Ringaligad	21.59	21.2632	0.3189	47600.72
10.		Tunethagad	19.93	19.6330	0.2945	44993.52
11.		Mandigad	26.02	25.6369	0.3904	59036.86
12.		Diwangad	27.99	27.5692	0.4135	52268.98
13.		Pantwarigad	32.19	31.7072	0.4756	61125.91
3.	**Pauri Division**					
14.	Pokhra	Chargad	40.489	39.8817	0.5982	112952.04
15.	Ekeshwar	Silogi	29.867	29.4190	0.4413	127929.41
16.		Patisen	34.408	33.8919	0.5084	233283.66
17.		Chandol	28.883	28.4498	0.4267	77710.69
4.	**Uttarkashi Division**					
18.	Mori	Miyagad	25.50	25.1175	0.3768	115842.55
19.	Purola	Moltadi	25.07	24.6900	0.3704	45978.84
20.	Naugaon	Koti	32.28	31.7997	0.4770	94381.30
5.	**Rudraprayag Division**					
21.	Ukhimath	Rawanganga	34.54	34.0219	0.5103	142367.18
22.	Agastmuni	Dangi	36.55	36.0017	0.5400	108286.02
23.		Uttarshu	33.92	33.4142	0.5012	123043.06
6.	**Pithoragarh Division**					
24.	Berinag	Jhiniyagad	30.488	30.0307	0.4505	38359.27
25.	Munsiyari	Patligad	26.282	25.8878	0.3883	85815.88
26		Dhaulagad	27.926	27.5071	0.4126	71460.62
27.	Didihat	Lathiyagad	30.114	29.6623	0.4449	64314.17
28.		Ranikhet	32.267	31.7829	0.4767	132152.70
7.	**Bageshwar Division**					
29.	Kapkot	Saran gadhera	31.786	31.3089	0.4696	392102.65
30.		Loharkhet	29.967	29.5172	0.4428	409307.07
31.		Gogina	20.096	19.7946	0.2969	382914.21
32.		Revati	27.631	27.2165	0.4082	126564.26

Sl. No.	Development Block	MWS Name	Avg. Biomass (t h^{-1})	Tree Biomass (t h^{-1})	Herb + Shrub Biomass	Total Biomass (t h^{-1})
		Ganga				
33.		Kheti	29.763	29.3166	0.4397	78188.021
8. Almora Division						
34.	Dhauladevi	Bhanwargad	26.265	25.8710	0.3881	102906.48
35.		Khannigad	32.380	31.8943	0.4784	44520.36
36.		Galligad	25.771	25.3844	0.3808	80031.32
37.		Kiroriganga	28.440	28.0134	0.4202	138754.29

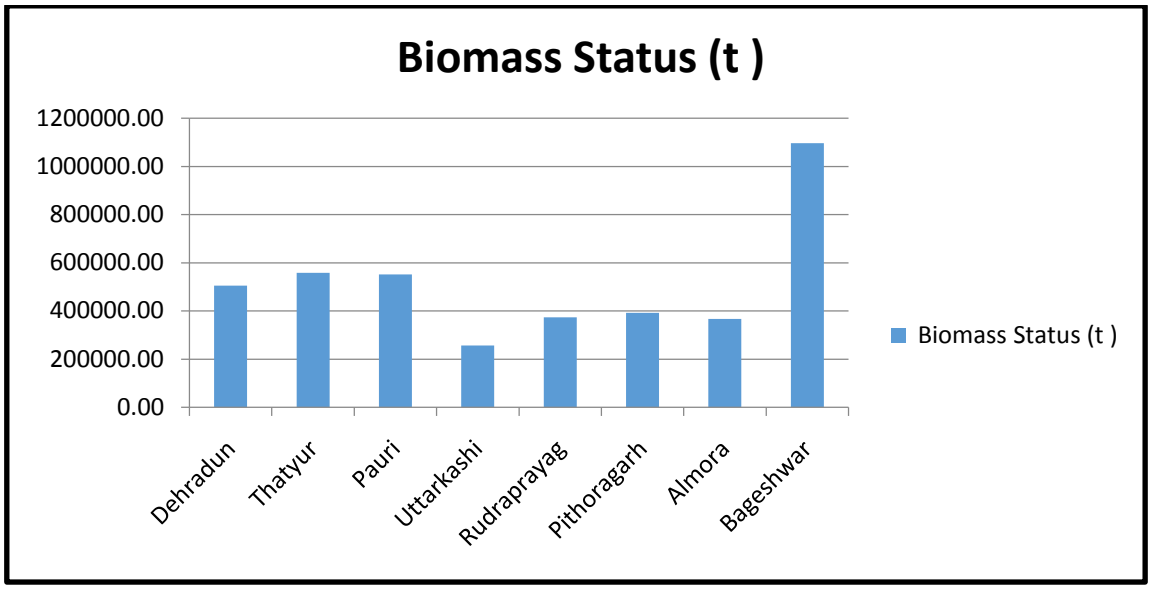
7.3 Divisional Biomass Status:

Division biomass status of the studied MWS has been mentioned in the table- 3. It has been observed that the total biomass availability in all the eight divisions is 4.04 Million tons. It was observed that per unit (Ha) biomass availability is highest in Rudraprayag division while it is lowest in Deharadun division. The total biomass availability is highest in Bageshwar and lowest in Uttarkashi.

Table 27*: Overall Biomass Status*

Division	Area (Ha)	Biomass (t)	Average Biomass (t/h)	Total Biomass (t)
Dehradun	21002.98	504421.75	24.02	4098995.16
Tehri (Thatyur)	20796.252	558528.50	26.86	
Pauri	16543.46	551875.81	33.36	
Uttarkashi	9300.63	256202.69	27.55	
Rudraprayag	10711.62	373696.27	34.89	
Pithoragarh	13313.60	392102.65	29.45	
Almora	13277.27	366212.46	27.58	
Bageshwar	43034.54	1095955.03	25.47	

Table 28*: Division-wise biomass status*



7.4 Species Diversity and Richness

Vegetation survey was conducted in accordance with the vegetation sampling process and methodology as described in section 2.2.3. The diversity index for different vegetation classes were assessed using the total number of tree, shrubs and herbs and their abundance. The diversity index is an effort to integrate both affluence and abundance into a single value. Here Shannon-Weiner diversity index was used to calculate the species diversity.

This index is based on the relationship between numbers of individuals of a species to the total number of plants within a sample.

$$H' = -\sum pi \ln pi$$

Here pi is number of individual of one species divided by total number of plants and 'ln' is the natural logarithm to base e.

In the present study estimation of Species diversity and richness was done separately for tree, shrub and herb. Details of the diversity index and species richness are provided in below table.

Table 29: Diversity index and species richness

Division	Micro-watershed	Block	Vegetation Type	Diversity Index	Species Richness
Dehradun	Kalsi	Kalsi	Tree	1.458	6
			Shrub	1.73	10
			Herb	1.539	13
	Aragad	Kalsi	Tree	0.29	2
			Shrub	1.22	6
			Herb	1.37	7
	Khatwagad	Kalsi	Tree	0.92	4
			Shrub	0.64	2
			Herb	1.19	4
Thatyur	Paligad	Jaunpur	Tree	1.38	5
			Shrub	0.93	4
			Herb	0.41	4
	Kyarigad	Jaunpur	Tree	1.32	5
			Shrub	1.17	4
			Herb	2.02	9
Rudraprayag	Dangi	Augustmuni	Tree	1.51	10
			Shrub	1.05	6
			Herb	1.70	7
Pauri	Chargad	Pokhra	Tree	0.91	4
			Shrub	1.09	5
			Herb	1.55	5
	Patisen	Ekeshwar	Tree	0.84	7
			Shrub	0.84	4
			Herb	0.64	3
Almora	Bhanwargad	Dhauladevi	Tree	0.83	5
			Shrub	1.47	10
			Herb	1.83	9
Bageshwar	Loharkhet	Kapkot	Tree	1.48	8
			Shrub	1.20	6
			Herb	1.48	5
	Gogina	Kapkot	Tree	1.62	6
			Shrub	1.18	4
			Herb	1.60	7
			Tree	1.04	4

Division	Micro-watershed	Block	Vegetation Type	Diversity Index	Species Richness
	Saran Gadhera	Kapkot	Shrub	0.18	3
			Herb	1.05	3

7.5 Estimation of Soil Erosion

The degradation of agricultural land due to soil erosion is a global phenomenon and this result in loss of vital nutrient from the soil resulting into increased runoff and thus contributing to decrease in water availability for plants. In view of the present objective of soil conservation at micro-watershed level, it was desirable that study of soil loss must be done to identify the soil loss over smaller area. The use of RUSLE model for soil loss estimation has been advised in view of the above mentioned objective of identification of small areas for soil loss.

Keeping in view of the above project objective a study involving Revised Universal Soil Loss (RUSLE) has been carried out to assess the potential soil loss and to identify priority area for project intervention in eight micro-watersheds belonging to various divisions of Uttarakhand.

The land water interactions are taking place through their respective cycles and it has been observed that these two processes plays important role in controlling and modifying the other. The process of soil erosion is initiated by detachment of soil particles due to erosion by rainfall. The detached sediments gets deposited in rivers, streams etc.. Thus the process of soil loss is of great concern as it lead to decrease in soil fertility and also causes a decrease in the capacity of the reservoir and degradation of water quality. Several models were developed to quantify the sediment yield, Out of these USLE (Universal Soil Loss Equation) was the most widely used model. Initially it was developed for cropland Wischmeier and Smith (1965), later it was adopted to other landuse also.

The USLE model was later revised in 1990 and 2000 to the Revised Universal Soil Loss Equation (RUSLE). It has been observed that soil, vegetation cover, topographic characteristics along with rainfall intensity and surface runoff of an area play a major role in rate of soil erosion. The RUSLE model assumes a linear relationship between various parameters. This model is based on five parameters i.e. annual avg. soil loss, rainfall- runoff erosivity, soil erodibility, slope(Length and steepness), and land cover management and conservation practice. It is a hybrid model combining both process based and index equation whereas USLE was an Index based model. RUSLE is basically depicted as a linear formula:

$$A = RKLSCP$$

A= average annual soil loss
R= rainfall-runoff erosivity factor
K= soil erodibility factor
LS= slope length and steepness factor
C= cover management factor
P= support practice factor

Methodology:

The rainfall data was collected from IMD by WMD and later shared with SUTRA for processing. The daily rainfall data from 1985 to 2015 acquired on a 0.25 degree spatial resolution was used for preparation of rainfall erosivity map.

The landuse map was created using PAN merged LISS IV satellite image data of a spatial resolution of 5 meter. The satellite image was digitally processed to prepare landuse map of the micro-watersheds. The soil map was prepared using 2.5 Million soil map of the study area. The slope and length map was prepared using cartosat DEM of 30 meter resolution. It was later processed to create LS map on 5 meter resolution.

Rainfall erosivity factor (R)

The rainfall erosivity factor (R) map is prepared using the formula presented by Wischmeier and Smith in the year 1978 for calculation of kinetic energy. The formula is as mentioned hereunder

$$E = \sum Ei = \sum_{i=1}^{N} 210.3 + 89 \log_{10} Ii$$

Here E is the total kinetic energy of rainfall (t m ha-1- cm-1), Ei is the rainfall kinetic energy of the i_{th} increment per storm (mt ha-1cm-1), Ii is the average intensity of rainfall during the i_{th} increment for each storm (cm ha-1), and N is the total number of discrete increment.

Soil erodibility (K) factor

The K factor is an expression of the soil texture, organic matter, structure and permeability. The soil map is prepared using SLUSI map on 1:50000 scale. The K factor for each soil class has been assessed on the basis of K-value nomograph.

Slope Length Steepness Factor

LS factor is the expression of topography on the soil detachment. It is used to quantify the effect of slope length and steepness on soil loss. The LS factor for each of the micro-watershed was computed using the Cartosat DEM.

a. **Slope LengthFactor:**Slope length is defined as the distance from the point of origin of overland flow to the point where either the slope gradient decreases enough that deposition begins or to where the flow connects to a river system (Wischmeier and Smith, 1978). The slope length factor (L factor) is dimensionless because it is simply a ratio of the horizontal length of the actual field plot divided by the unit field plot length, raised to the exponent m. The L factor is defined as:

$$L = (\frac{\lambda}{72.6})^2$$

Here- λ = horizontal projection of slope length;
72.6- feet is the standard unit plot length;
Exponent m is the variable slope length exponent. (Renard et al. 1997)

b. **Steepness Factor (S Factor)**
Slope angle is the expression of slope length only. The original equation for expressing the slope steepness factor, S, was introduced by Wischmeier and Smith (1978) as:

$$S = (65.41\ X\ Sin^2\theta) + (4.56\ X\ Sin\theta) + 0.065$$

Here θ represent slope angle in degree.

Cover Management Factor (C)

The cover management factor is important parameter of RUSLE having considerable effect on the soil erosion. It ranges from 0 to 1, with 1 being the most likely degradable area on the basis of land cover. C value is based on the combined effect of land cover and roughness, below ground biomass etc. The increasing cover characteristic has a considerable effect on C values which shows considerable decrease owing to increase in land cover and biomass.LISS IV pan merged satellite image of 5 meter resolution was used for creation of land-use map. Table below shows the C values for different land cover classes.

Table 30- **Factor for various land-use classes**

Land Cover Type	C Values
Dense Forest	0.008
Open Forest	0.40
Moderate Forest	0.04
Snow Cover	0.01
Barren Land	1.00
Water Body	0.00
Agricultural Land	0.03
Fallow Land	1.00
Built Up	0.50

Conservation Practice Factor (P)

The P factor is manifestation of supporting practices aimed at soil conservation. The support practice includes contouring, vegetation buffer strips and terracing. It is the ratio of soil loss with specific support practice. The present study assumes the parameter P as 1.

7.6 Findings

Rainfall Erosivity Factor Map

It has been mentioned in section 3.2.2 that rainfall erosivity is calculated on the basis of kinetic energy, however due to unavailability of storm wise rainfall data for the computation of rainfall erosivity factor (R); the relationship between seasonal value of R and average seasonal (June–September) rainfall has been used as defined by Ram Babu et al. (2004).

$$R = 71.9 + 0.36\,X$$

The rainfall erosivity factor (R) map is prepared using the 0.25 degree gridded rainfall data of India. The rainfall erosivity factor map was created using IDW method of interpolation.

Study of the rainfall pattern in all the zones highlights the highest rainfall intensity in eastern part of the state while the central and eastern part receives lesser rain. It has been observed that the annual average rainfall is highest in Loharkhet micro-watershed of Bageshwar division while the lowest annual rainfall has been observed in Silogi micro-watershed of Pauri division. The rainfall erosivity map is shown in Annexure 5

Soil Erodibility (K) factor

The K factor value for different soil class has been referenced from K-value nomograph. The K-factor map of different micro-watershed has been provided in figure 16-23.

The K factor map has been prepared with reference to 1:2,000,000 soil map prepared by National Atlas and Thematic Mapping Organization (NATMO). In view of the availability of 1:50000 soil map the same may be updated to get better accuracy.

Figure 16:

Figure 17: Dewangad K - Factor Map

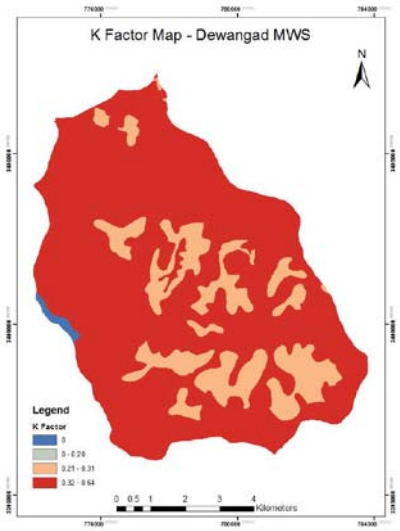


Figure 18: Lathiyagad K - Factor Map

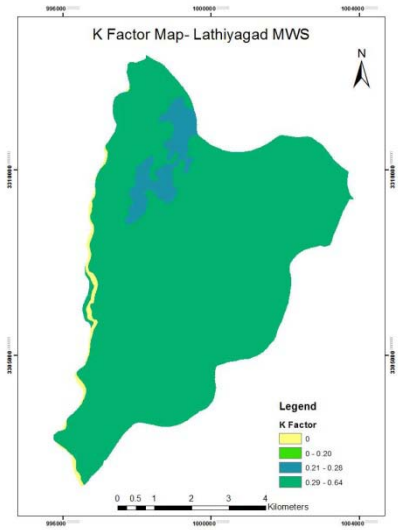
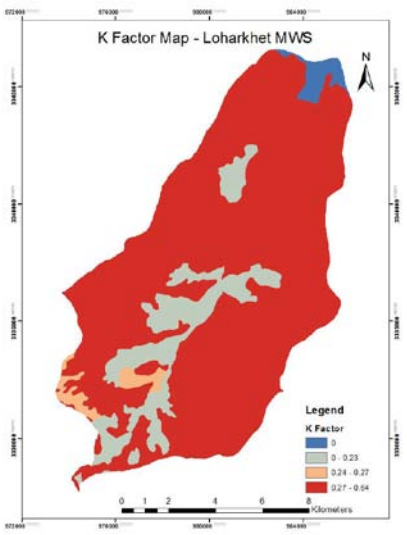


Figure 19: Loharkhet K-Factor Map

Figure 20: Paligad K - Factor Map



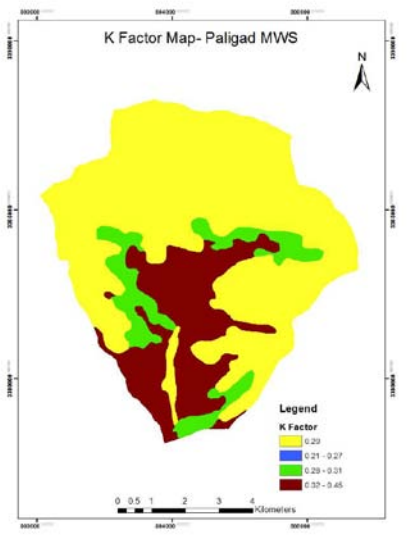


Figure 21: Sarugad K - Factor Map

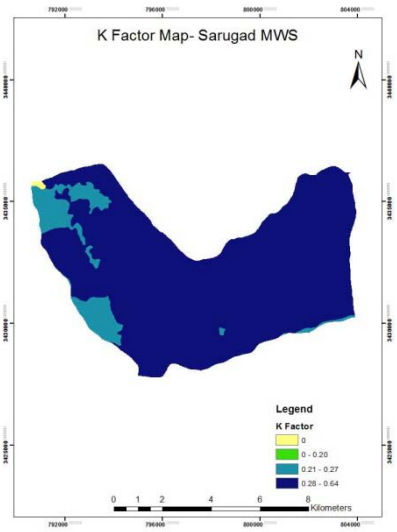


Figure 22: Sidiyagad K - Factor Map

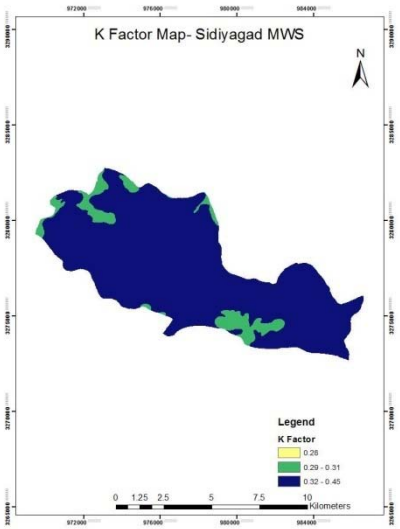


Figure 23: Silogi K - Factor Map

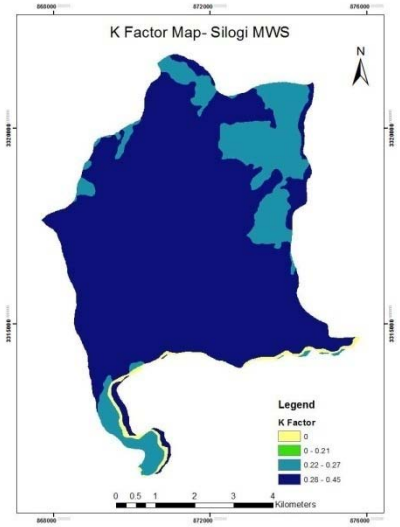
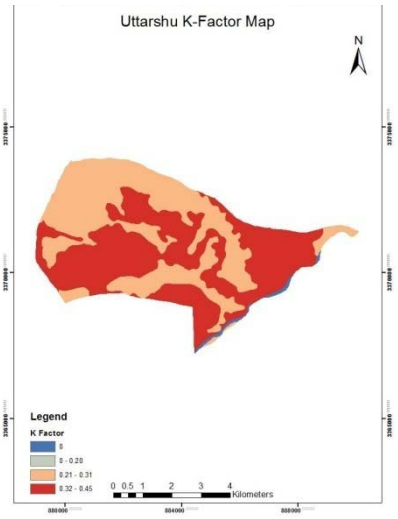


Figure 24:Uttarshu K - Factor Map



LS Factor Map:

The LS factor map was created using the C++ program for LS factor calculation (Van Remortel et al. 2004). The LS factor was calculated on the basis of slope length and steepness map created from DEM. The observed LS value confirms to the fact that LS value are high on ridges while lower on valleys. The lowest LS factor value of 29 has been observed in Sidiyagad and Silogi micro-watershed whereas the highest value of 46 has been reported from Uttarshu. The LS factor map of various micro-watersheds is shown in figure 16 to 23.

Figure 25: LS Factor Map Dewangad

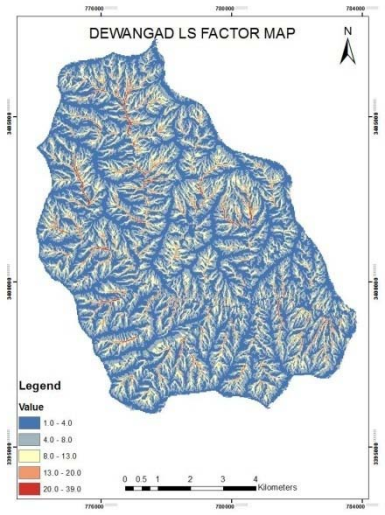


Figure 26: LS Factor Map Lathiyagad

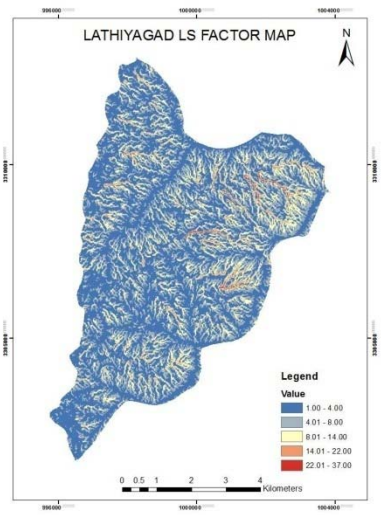


Figure 27: LS Factor Map Paligad

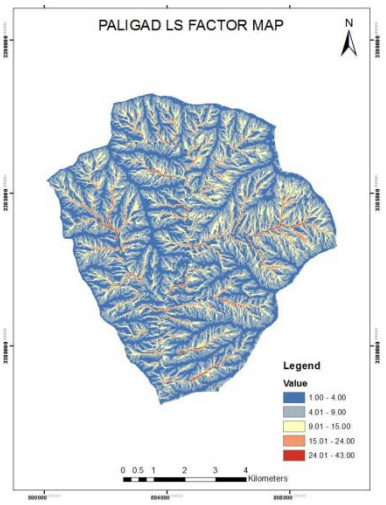


Figure 28: LS Factor Map Sarugad

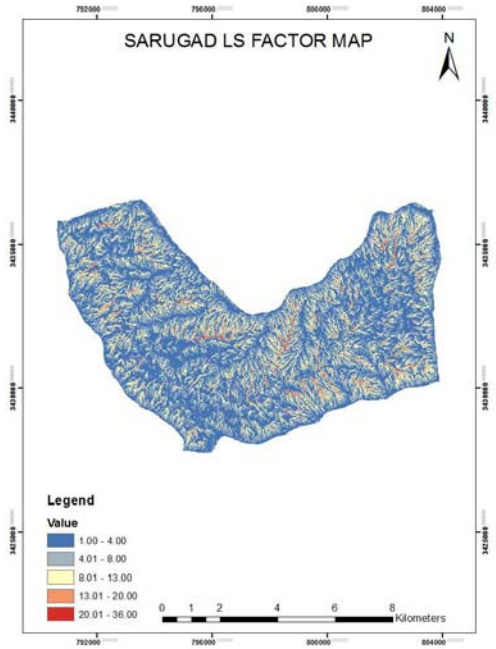


Figure 29: LS Factor Map Sidiyagad

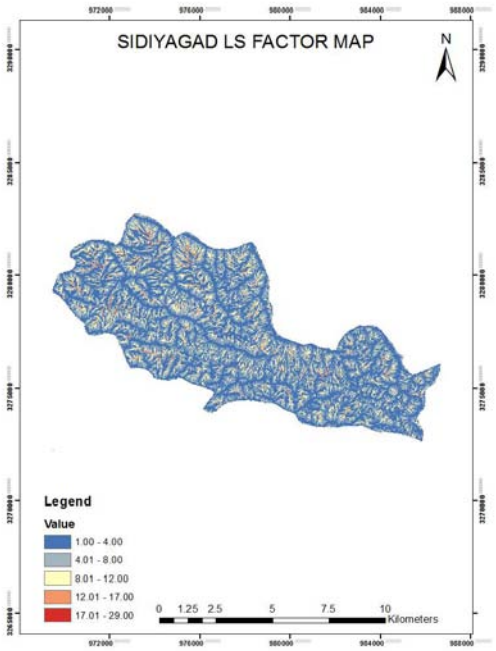


Figure 30: LS Factor Map Silogi

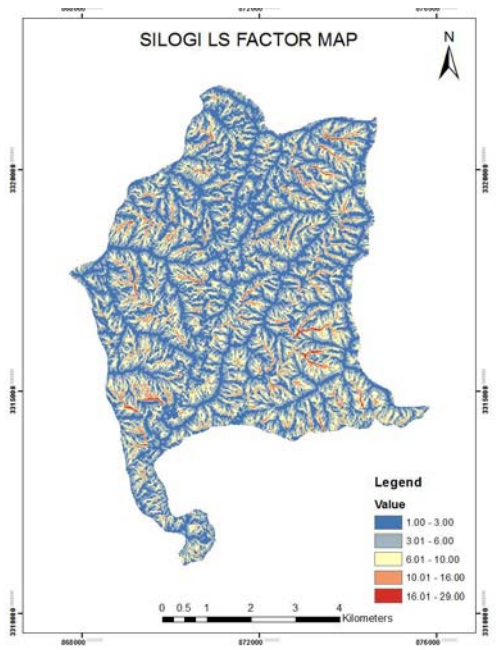
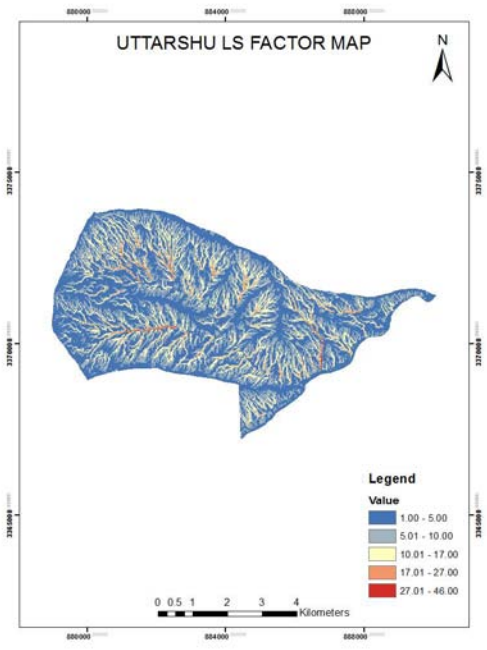


Figure 30: LS Factor Map Uttarshu



Factor Map:

Landuse Map Creation:

The landuse/landcover map was prepared using the LISS-IV, PAN merged image of resolution 5 meter. The landuse map was created by using hybrid classification method (Shila, H, N. and Ali, R, S. 2010, Offer, R. and Arnon, K. 2011), whereby the satellite image was classified using digital classification and later on visual method to identify the shadow zones and to assign them to suitable class. Digital image processing or digital signal processing is the process of applying various algorithms to process the digital images of Satellite with the help of computer. It has advantage over visual interpretation of analog satellite data due to wider range of algorithms to digital data and provides more clarity on data one used for landuse/ land cover classification of the study area. It was later updated using visual method to correctly assign the pixels to their respective class.

The classification was done using supervised classification method using maximum likelihood method. The maximum likelihood method allocates the pixels to suitable class on the basis of probability value of the pixels. Maximum Likelihood (ML) classifier takes into account shape, size and orientation of the cluster along with the distance from the centre. This is achieved by calculating a statistical distance based on the mean values and covariance matrix of the clusters.

The objective was to classify each MWS in the principal classes of Agriculture, Water bodies, Bare Land, Dense Forest, Moderate Forest, Open Forest, Built-up etc.

Methodology

In supervised classification, the computer separates the pixels into classes based on the operator provided representative samples of land cover classes called training sets. It determines each class on what it resembles most in the training set. The multispectral images are usually used to perform this classification and the spectral pattern present within the data for each pixel is used as the numerical basis for categorization. The spectral pattern referred here is not at all the geometric in character but they are basically the different combinations of Digital numbers (DN) based on their inherent spectral reflectance and emittance properties which are characteristics for each class. It is basically an analytical procedure based on clustering of similar classes using certain algorithms on the basis of spectral signature.

The pixels were identified for each cluster of specific spectral signature and they were grouped into land cover categories: water, shadow, deciduous forests, scrubland, wasteland, Agriculture, ToF. It should be noted that pixels that do not fall within any class were classes as ‘unclassified’ as per Joseph, 2007. Here the pixels or clusters that were shadow area were also classed under a separate class “Shadow”. The classes that result from unsupervised classification are spectral classes as they are solely based on the natural groupings in the image values afterwards these 256 image values were recorded into 7 classes.

The classified thematic layer manifests a salt and pepper appearance due to inherent spectral variability encountered by a classifier when applied on pixel-by-pixel basis (Liliesand and Kiefer, 2009). Therefore, the necessity of smoothing the classification arose but this post classification smoothing of algorithms were operated on the basis of logical operations rather than simple arithmetic computations. After the classification, there was a salt and pepper effect with some of the classes and therefore the clump and eliminate operation was used to make the image look good and it smoothed out the classes to give a better appearance. Finally the Land use Land Cover (LULC) mapping was done.Apart from the above classes owing to hilly terrain a considerable part of the study area is affected by shadow. The shadow was classified as a different class and later on using visual interpretation these shadow areas were assigned to their respective classes.

The classified map showing the prominent land-use class in each micro-watershed is shown in figure 30-37.

FigurFigure 31: Dewangad Landuse Map

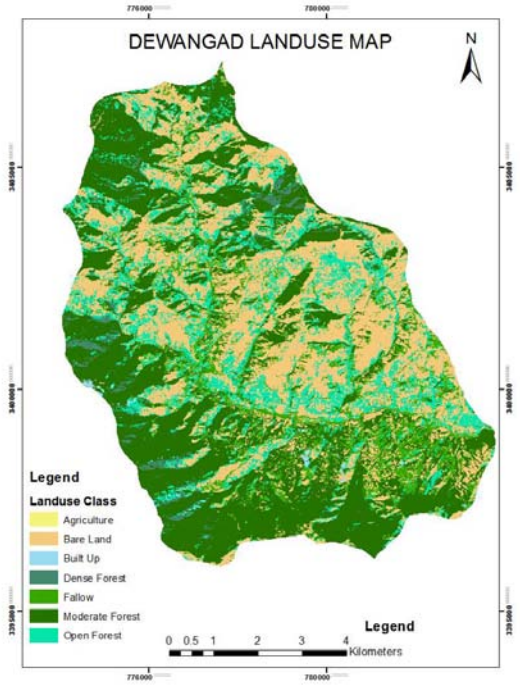


Figure 32: Lathiyagad Landuse Map

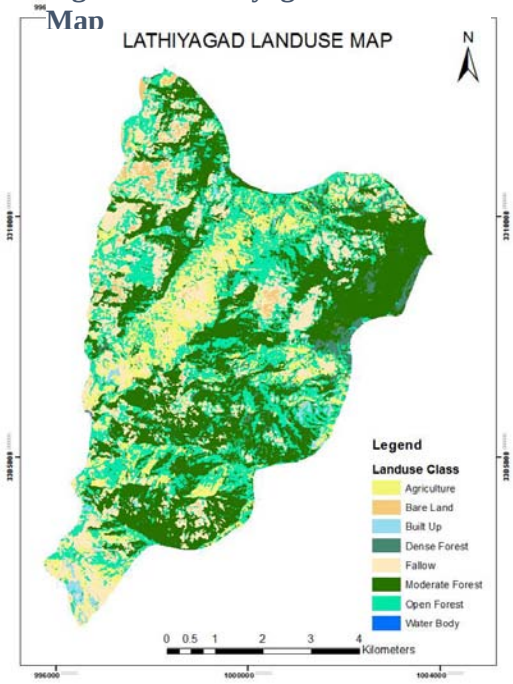


Figure 33: : Loharkhet Landuse Map

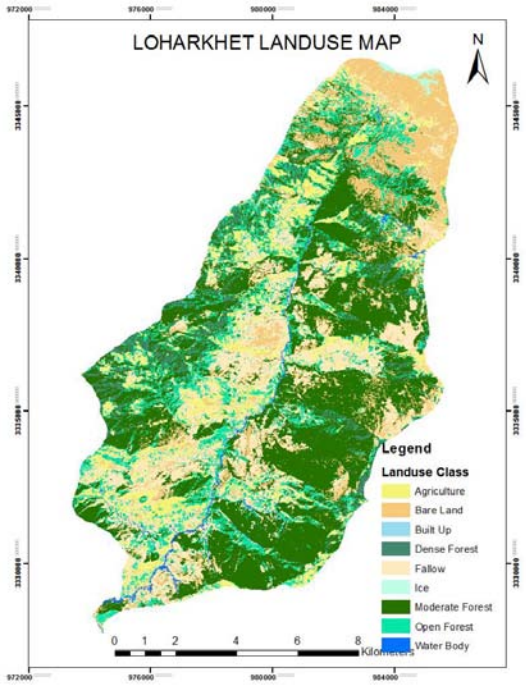


Figure 34: Paligad Landuse Map

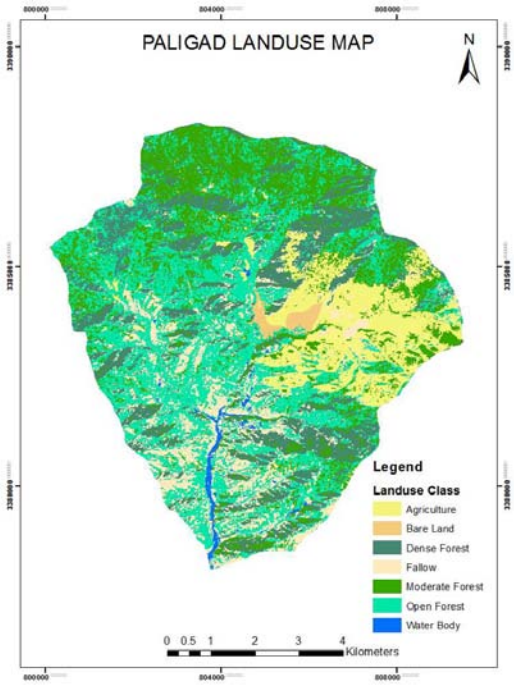


Figure 35: : Sarugad Landuse Map

Figure 36: Sidiyagad Landuse Map

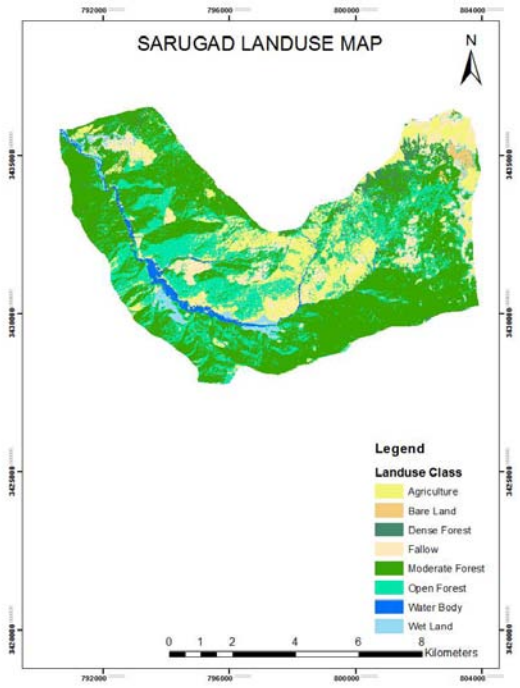


Figure 37: Silogi Landuse Map

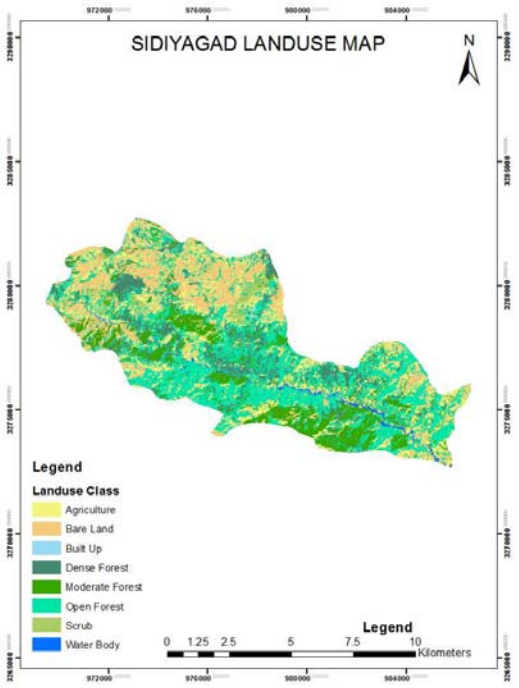
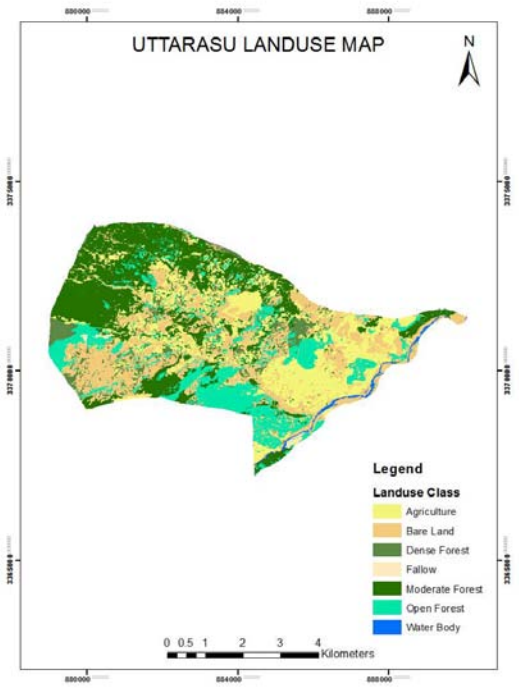
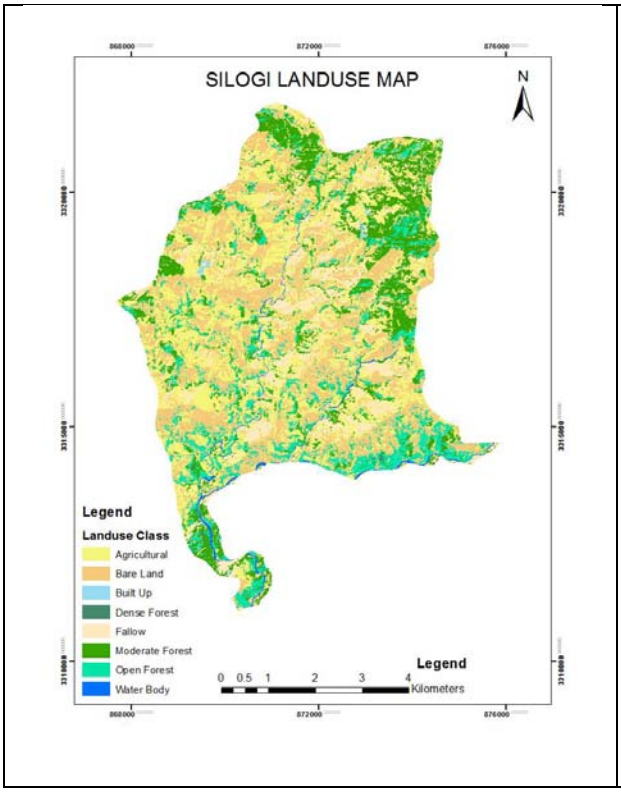


Figure 38: : Uttarshu Landuse Map





It has been observed that the highest forest cover is recorded in Sarugad micro-watershed of Uttarkashi division whereas the lowest forest cover has been recorded in SIlogi micro-watershed of Pauri division. The land-use/land-cover statistics of the various micro-watersheds is presented in Annexure 6 table- 6-1to 6-8.

Soil Loss Estimation:

The soil loss map was created with the help of RUSLE model as described in Section (A= R*K*L*S*C*P). This can be accomplished using map calculator tool. The enclosed soil erosion map from figure 38 to figure 45 define the annual average soil loss potential of various micro watersheds. The highest annual soil loss value of 11053.61 t^{-1} $h^{-1}y^{-1}$has been observed in Dewangad micro-watershed while the lowest value of 5902.87 t^{-1} $h^{-1}y^{-1}$ have been observed in Silogi micro watershed. The average annual soil loss values varies considerably, the lowest average soill loss value of 250.88 $t^{-1}h^{-1}yr^{-1}$ has been estimated for Sarugad micro-watershed while the highest value 0f 748.63 $t^{-1}h^{-1}yr^{-1}$ was estimated in Dewangad micro-watershed.

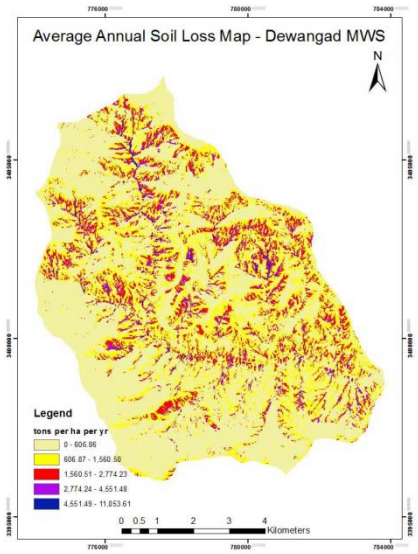


Figure 39: Dewangad Soil Loss Map

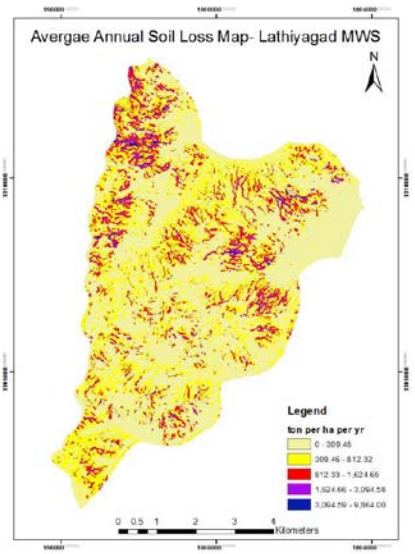


Figure 40: Lathiyagad Soil Loss Map

Figure 41:: Loharkhet Soil Loss Map

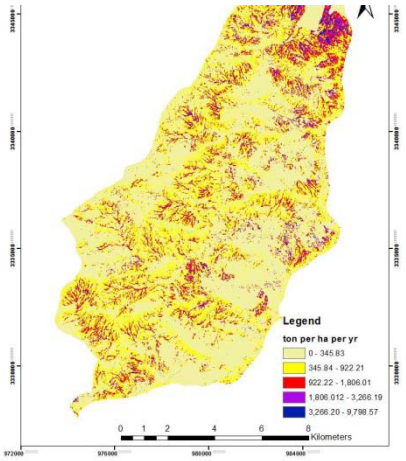
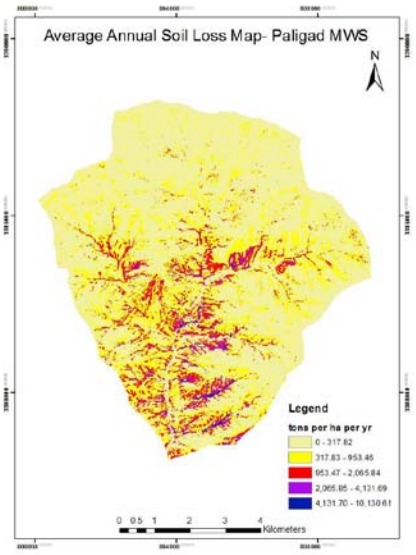
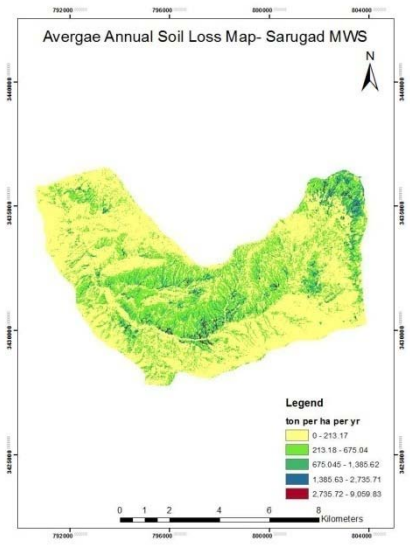


Figure 42: : Paligad Soil Loss Map





:Figure 43: Sarugad Soil Loss Map

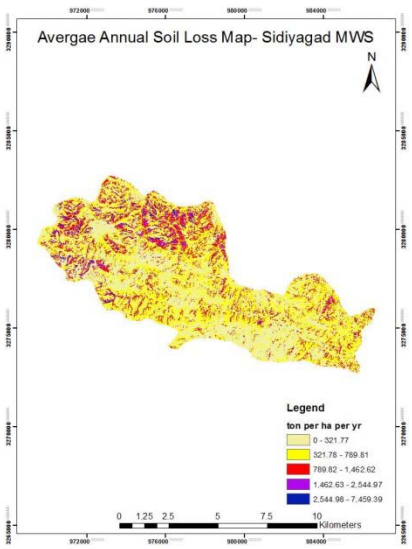


Figure 44: Sidiyagad Soil Loss Map

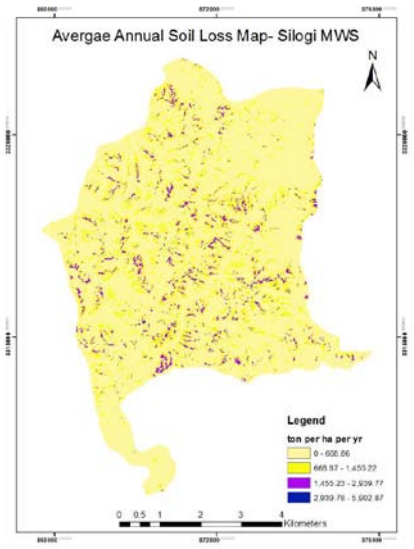


Figure 45: Silogi Soil Loss Map

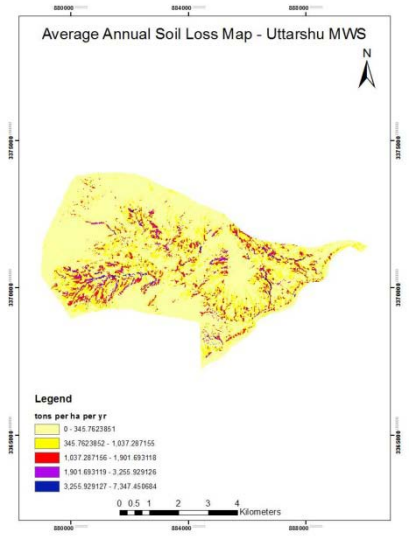


Figure 46: Utarashu Soil Loss Map

Agriculture and Crop Production

8.Agriculture & Crop Production

8.1 Area under Irrigation

The project recognises that imporvement in agriculture intervention has a direct bearing on the positive changes in income and welfare of agriculture dependent families which is almost 80 percent of the population in the project area. The primary purpose of the project is to improve the income levels and quality of life of the village communities by enhancing the productivity of rain fed area.Project has built in interventions to address challenges of irrgation so that subsequently land can be converted to irrigated/ partial irrigation. It is expected that with better access to water through water conservation techniques, more cultivation area will be arable and move from being purely rain-fed to irrigated. Two of the crucial project development objectives highlights on the progress of the project pertain to the increase in area under irrigation and the resultant productivity.

8.2 Rain-fed and Irrigated agriculture

The primary survey data was used as the key source for estimating the cultivable area under irrigation and crops grown in three different seasons. Project intends to increase the area under some irrigation measure and introduce high vaue crops which are completey rain dependent.Availability of water in rabi season would help introduce newer varieties of crops will be having a direct impact on the income accrued by the producers.

In the state of Uttarakhand, the agriculture is predominantly rain-fed. Primary sample survey indicates that among the total cultivable area about 86.2 percent of the area is dependent primarily on rain. The irrigation facilities are mostly concentrated on the plain and valley regions, with the hilly regions still dependent mostly on rain –fed agriculture.

Table 31:Percentage of area under rainfall conditions

Percentage of Area under rainfed conditions		
	Treatment	**Control**
Rainfed	86.2	87.0

Source: Household Survey, N(Treatment)=4862, N (Control) =756

The primary survey data revealed that, the total acreage of land under rain fed cultivation is significantly higher than that of land under partial irrigation sources. The finding holds true across the three major cropping seasons and in both the treatment and the control areas.

A meagre 11 % of the net sown area of the hilly districts have irrigation facilities. (SAPCC, 2014). The household sample survey also reveals a similar pattern both at the state and district levels. The net sown area under irrigation measures is about 8.9 percent in treatment and 7.7 in control.

Table 32:Percentage of Net Sown Area (Land in Hectares) under partial irrigation

Percentage of Net Sown Area (Land in Hectares) under partial irrigation		
	Treatment	**Control**
Average	8.9	7.7

The primary data revealed that more than 85 percent of the total land during the Kharif season and at least 70 percent of the total agricultural land during the Rabi season are used for growing crops which are rain-fed in nature. The trend is similar in both treatment and control areas. Agricultural land where mostly irrigated crops are grown, range from 13 to 30 percent of the total agricultural land across the cropping seasons and across the treatment and the control areas. Across divisions Pauri, Pithoragarh and Uttrakashi has nearly 90 percent of land dependent on rain for agriculture.

Cropping intensity is about 154.2 percent across division as per primary data and appeared to be the highest in Pithoragarh district and lowest Pauri at about 144.5 percent

8.3 Conversion of Rainfed area into Irrigated area

Increasing productivity in rainfed areas through enhanced management of soilmoisture and supplemen tal irrigation where small water storage and management is feasible is one of the major focus under Gramya II which will bring more rainfed areas under irrigated area.

The expansion of cropped areas will be through

- Investing in irrigation (irrigation scenario).
- Increasing annual irrigation water supplies by innovations in systemmanagement,
- developing new surface water storage facilities, and
- increasing groundwater withdrawals and the use of wastewater
- Increasing water productivity in irrigated areas and value per unit of water byintegrating multi ple uses—including livestock and domestic use—in irrigated systems

This initiative has been implemented from the inception of the Project and till date, the rainfed area conversion into irrigated area is depicted in the Table below along with the final area conversion from rainfed to irrigated, after factorization is considered.Thus till date 274.14 Ha of rainfed are has been brought under irrigation with total water holding capacity of 24488 Cum.

Table 33: Percentage of Net Sown Area (Land in Hectares) under partial irrigation

Sl. No.	Activity	No. / Km.	Water holding capacity (Cum)	Irrigation potential (Ha.)	Average Water holding capacity (Cum)	Average Irrigation potential (Ha.)	Total Water holding capacity (Cum)	Total irrigation potential (Ha.)	Remarks	Final irrigation potential (Ha.) considered
1	Rain Water Harvesting tank	1589	2.5 cu m	0.01-0.05	2.50	0.03	3973	47.67	One third of irrigation potential for Rainwater harvesting Tank	15.89
2	Irrigation tank	255	15 cu m	0.2-0.3	15.00	0.20	3825	51.00	Total irrigation potential of Irrigation tank	51.00
3	LDPE Tank	12	20 cum	0.25-0.35	20.00	0.30	240	3.60	Total irrigation potential of LDPE tank	3.60
4	Irrigation channel (Km.)	34	70-100 It/sec	5-6	0.00	5.50	0	187.00	Thirty percent of irrigation potential of Irrigation channel	56.10
5	Irrigation Pipeline (Km.)	20	70-100 It/sec	3-4	0.00	3.50	0	70.00	Total irrigation potential of Irrigation pipeline	70.00
6	Tanks with solar pump	3	20 cum	3-4	20.00	3.50	60	10.50	Total irrigation potential of Tanks with solar pumps	10.50
7	Village Pond*	149	70-180 cu m	0.3-0.6	110.00	0.45	16390	67.05	Total irrigation potential of village ponds	67.05
	TOTAL						24488	**436.82**		**274.14**

8.4 Productivity for Rain-fed and Irrigated crops

Agriculture is the mainstay and most of it is subsistence in nature with about 83 percent of farmers having landholdings less than 2 Ha(Source: Primary household level survey results). The major food crops grown the state are Paddy, Wheat, Finger Millet, Maize, Pulses and horticulture crops (ICAR, 2017)[5]. While, baseline results also indicated these two to be major crops grown additionally. Other multi-seasonal green leafy vegetables,Potato, Soyabean, Barley, pulses and oil seeds were also found to be prominent crops during Baseline.

This indicator is calculated for selected cropsin rain-fed and irrigated area across the three cropping seasons. The productivity values of crops presented are selected among the list of other Crops grown by households during baseline. The selection of these crops is based on the propensity of farmers gowing the crop and focus of Gramya II for crop diversification and production improvement. The high value irrigated crops include Ginger, Garlic, Green Vegetables and Peas and the high value rain-fed crops include Maize, Wheat, Pigeon Pea, Finger Millet and Red Kidney Beans. (Source: Primary Household Survey)

Table 34:Productivity of irrigated and rainfed crops

Project Outcome Indicators	Unit of Measure	Baseline Study			
		Project		Control	
4. Increase in productivity in irrigated and rainfed crops ***(Note:Calculated for the reference period (2015-2016)***	Qtls/Ha				
Irrigated Crops		**Kharif**	**Rabi**	**Kharif**	**Rabi**
Garlic	Qtls/Ha	-	24.1	-	23.3
Cauliflower	Qtls/Ha		188.4		187.0
Cabbage	Qtls/Ha		181.9		180.2
Pea	Qtls/Ha	-	62.3	-	61.9
Rainfed Crops		**Kharif**	**Rabi**	**Kharif**	**Rabi**
Ginger	Qtls/Ha	86.9	-	85.7	-
Maize	Qtls/Ha	15.3	-	14.9	-
Wheat	Qtls/Ha	-	19.8	-	19.1
Pigeon Pea	Qtls/Ha	7.8	-	7.0	-
Finger Millet	Qtls/Ha	17.6	-	16.9	-
Red Kidney Bean	Qtls/Ha	12.2	-	11.7	-
Paddy	Qtls/Ha	22.8	-	21.3	-

[5] http://www.icar.org.in/files/state-specific/chapter/116.htm

The primary data collected through the interviews of the sampled farmers and producers in the treatment and the control areas, were used for the estimation of the productivity of specific crops. Apart from the disaggregation of the data at the level of the intervention (treatment and control), analysis also entailed looking into the productivity of the crops in specific cropping seasons.

Some of the crops are grown exclusively in one cropping season and some others are cultivated over the course of the three cropping seasons. The above table indicates that treatment and the control values are nearly similar because of the proximity to the treated area in the control. The data of on average crop productivity is in almost following similar trends as per secondary data recorded for the State average for the year 2015. Furthermore, varietal differences, terrains, rainfall and irrigation patterns also play significant role in slight deviations in the crop production data which leads to increasing or decreasing trends compared to State average figures or in control regions. It is also observed that during baseline survey, project and control values of crop don't show much significant difference which might be attributed to physiology of the area and similar landholding, areas near to same watershed premises.
Wheat which is a rain-fed crop,the productivity in the treatment and the control areas ranged from 19.8 quintals per hectare to 19.1quintals per hectare in Rabi in treatment and control area. But, apart from Maize and Wheat among the rain-fed crops, the productivity of other rain-fed crops such as for pigeon peais lower ranging between 7.0 to 7.8quintals per hectare.The following are some of the other important crops grown during theseason by sample farmers in the region.

Table 35Productivity of some other irrigated and rainfed crops

	Unit	Treatment			Control		
Irrigated Crops		Kharif	Rabi	Zaid	Kharif	Rabi	Zaid
Black Gram	Qtls/Ha		7.4			6.9	
Rainfed Crops		Kharif	Rabi	Zaid	Kharif	Rabi	Zaid
Potato	Qtls/Ha	94.1	92.1		92.2	90	
Soyabean	Qtls/Ha	13.1			12.2		
Mustard	Qtls/Ha		8.2			7.4	
Other Millets *(Pearl Millet)*	Qtls/Ha	14.1			13.4		
Barley	Qtls/Ha		11.9	-	-	11	

Inferences:

Productivity of crops cannot be understood in isolation from the propensity of the farmers of the state to produce the crop. It has already been established in the previous section that rain-fed agricultural crops is the mainstay of Uttarakhand and the highest produced rain-fed crop is Paddy and Wheat in terms of perentage of farmers growing it. Nearly 70 percent of the respondents from across the 8 districts responded that they cultivated Wheat. Maize is the second highest cultivated crop with nearly 17 percent of the respondents cultivating it. Primarily, Maize is cultivated as a Kharif crop. About 2-3 percent of the sampled population produced Ginger, Garlic and Pigeon peas while 4-6 percent of the population produced Peas, Green Vegetables (Cabbage and Cauliflower) and Red Kidney Beans. The production of Wheat and Maize among rain-fed crops and Garlic and Green Peas among irrigated crops were recorded in majority of the districts.

The findings drawn from the primary data collection shows that the productivity of irrigated crops like of Cabbage, Cauliflowerare higher even if grown by less farmers. The average productivity of a crop

like Ginger cultivated by just around 2 percent of the surveyed farmers is about 82 quintals per hectare for ginger and that of cabbage and cauliflower produced by 5 percent of the farmers with a productivity of 180 quintals per hectare. This indicates that there is a potential for farmers and producers to increase their productivity and income by bringing in more land under cultivation for irrigated crops and by diversifying cropping practises.

The Gramya II interventions aims at improving yields and crop diversification for resilience. The lower productivities shown in the hill districts are due to combination of multiple reasons, including natural resource scarcity, unfavourable growing conditions, lack of irrigation facilities, unimproved agricultural inputs and lack of awareness regarding improved varieties. Production details of (2015-2016) given by Agriculture Statistics of Uttarakhandalso gives similar trend where productivity appears to be similar as per the sample assessment.

Agricultural practices adopted by households

One of the major economic impacts of the project can be gauged from the income accrued through increase in production. Income augmentation through agriculture can be done by-

- Intensifying production of existing crops
- Diversifying into new crops

The intensification of production is an important component in the project which includes introduction of package of practices, use of fertilizers, pest management, introducing irrigation system, adopting post-harvest techniques and farm mechanisation. Diversification can be done by doing multi cropping or inter-cropping wherein varieties of combinationcrops can be introducedin a limited land. Therefore, adoption of improved agricultural practices is central to the long term impact of enhanced income and productivity.

Understanding of the Indicator: This indicator tries of capture the number of farmers who are practicing and used any one soil conservation method or improved crop production methods in at least two cropping seasons. Adoption is defined as any one technology adopted from the basket of technologies promoted under the project. The agricultural technologies and improved practises promoted include use of improved and high yielding variety seeds, seed treatment, soil testing-based application of fertilizers, weed control, carrying out all cultural practices at the optimum stage of crop, bio-fertilizers and use of vermi-compost etc.

Finding: Improved soil conservation technology included Mulching, Napier, Terracing Diversion Drains, Bunding, Trenching etc. While few of the measures are crop specific it has been found from the household primary survey that mulching is the most commonly used method for soil moisture conservation.Mulching primarily in rainfed maize cropping is done using sunhemp green manure. Dry leaves are used for the purpose of mulching in organically grown ginger. That is why the percentage of farmers adopting any one techology among the five is seen on a higher side. Terracing is a traditionally practiced as a soil erosioncontrol measure and hence other technology such as practice of doing bunding, trenching and a combination of more than one technlogy is seen to be low. Other than terracing farmers are also using Napier cultivation to do soil conservation which is seen as the second most adopted technology.

Table 36: Percentage of farmers practicing soil moisture technology

Percentage of farmers practicing soil moisture technology		
Number of Technology used	Control	Project
Any one	28.4	27
Any two	21.7	19.6
Any three	2.0	0.5
No Use	47.9	52.9

The are nearly half of the farming households in treatment area which are not practicing any of the INM and IPM methods. As far as crop production technology is concerned, farmers use various

methods to ensure that crops get right inputs in righttime for enhancing production. There has been instances narrated during qualitative assessment where farmers have spoken about convergence activities by other departments in providing high yielding variety seeds, demonstrations on line sowing etc. During the baseline survey it was found that use of fertiliser and undertaking crop rotation is the most commonly used method of ensuring better crop production. INM and IPM methods are seen to be practiced very less. Few of the IPM practices followed are setting farm fields/residual crop on fire, spreading of decomposed FYM, burning of cowdung cakes and applicationof ash on standing crops.

Table 37: Percentage of farmers practicing crop production technology (INM and IPM)

Percentage of farmers practicing crop production technology (INM and IPM)		
Number of Technology used	**Control**	**Project**
Any one	13.3	11.7
Any two	1	1
All three	0	0
No Use	85.7	87.3

Out of the three improved crop production technology a very high percentage i.e about 87% of the farmers in treatment area seemed to be not adopting any of the methods.

Inference

It is seen that the instances of farmers adopting at least one improved crop production technology and soil conservation technology is high in both treatment and the control areas. However, those are traditionally used methods.This indicates that there is a certain level of sensitization existing among the farmers which could be leveraged to help them adopt newer gamut of technologies and improved practises. The understanding is that a mix of complementary technologies would be most beneficial in improving the productivity for the farmers.

The primary data collected revealed that the most common forms of improved technology adopted by farmers in the treatment and the control areas included shift in cropping practises, use of fertilizers, use of water harvesting technologies, use of mechanised farm implements and soil conservation methods. Fw of the INM practices followed are application of Farm Yard Manure (FYM) and spreading of Farm Yard Manure (FYM).The following section discusses each of these aspects in detail:

8.5 Cropping practices

Cropping practices play an importat role in retaining the soil quality for better productivity. In case of continuous cropping, nitrogen becomes a deficient nutrient. Therefore, when the frequency of cropping is increased, higher rates of nitrogen fertilizer, manure or frequent inclusion of legume crops in the rotation are required to maintain high crop yields. As a system of cropping many farmers were observed to be following mixed cropping. A higher proportion of farmers of about 64 percent are also doing mono cropping. The choice of cropping system also affects the quality of soil, increasing the relevance of cropping system. Owning to the vivid topography and diverse agro climatic endowments and small landholdings of farmers hilly areas practice mixed cropping while in plain areas monocropping is practised. However, because of small landholding and scattered plots in hills majority of the farmers practice mono cropping.

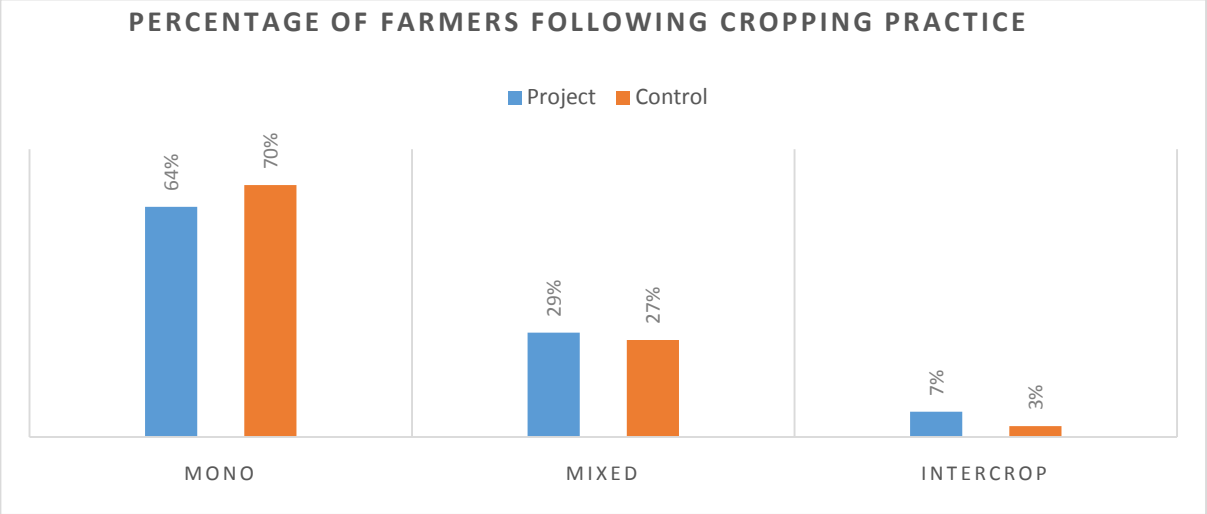


Figure 47: **percentages of households following different cropping practices**

While intecropping allows for better resource use efficiency as compared to monocropping but not many household are found to be practicing that. It is observed that very less percentage of farmers practice intercroppin. Few farmers also intercrop pigeon pea and groundnutresulting in higher yield of either of the crops. Promotion of different cropping systems including horticulture/ medicinal plants along with traditional agriculture crops may be promoted among the farmers who have restricted themselves to only mono cropping/ double cropping.

8.6 Fertilizer use

The use of a variety of fertilizers is high in both the treatment and the control areas.Majority of the farmers are using farm yard manure and about one fourth of the farmers are using chemical fertliser. 81.0 percent of the respondent households in the treatment area and 75 percent of the respondent households in the control area use farm yard manure for their cultivation practises.

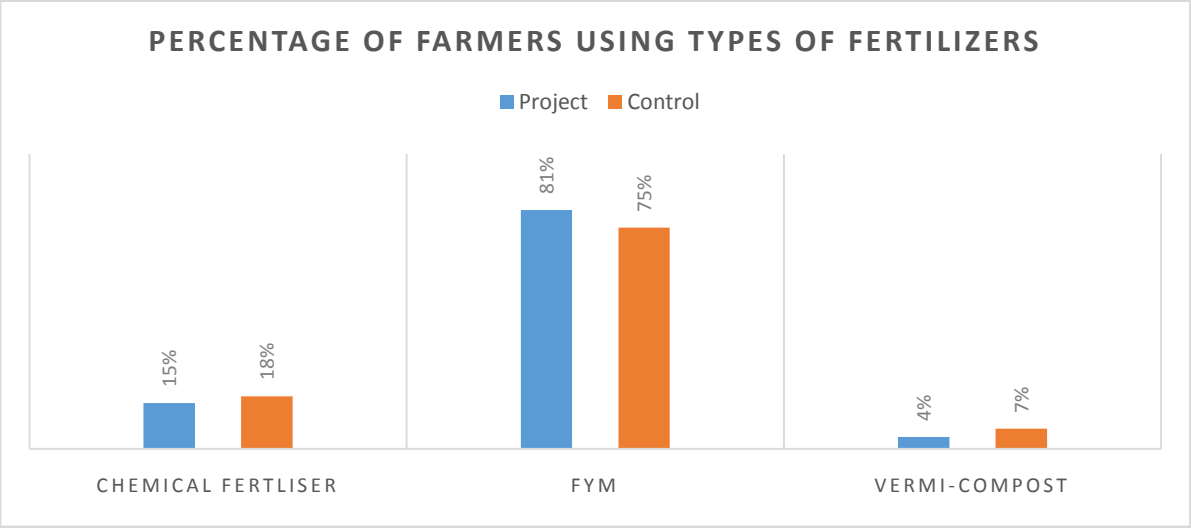


Figure 48: **Percentages of households using different types of fertilizer/ manure**

Most of the farming households across treatments reported farm yard manure as their primary option for fertilization of their agricultural lands. The use of chemical fertilizer is already low due to limited accessibility and remoteness of region coupled with easy availability of FYM from household livestock. The predisposition of the villagers in using organic manure as their primary option may be well utilised to promote other forms of organic agricultural practices including but not restricted to vermi –composting, bio-composting etc.

8.7 Pest Management

Pest management techniques are used to predominantly aid in the cultivation of crucial crops like Maize and Wheat.It is seen from the primary survey that while practice of IPM as a improved technology is less, majority (about 60 percent) of farmers are not using pesticides in the treatment area.

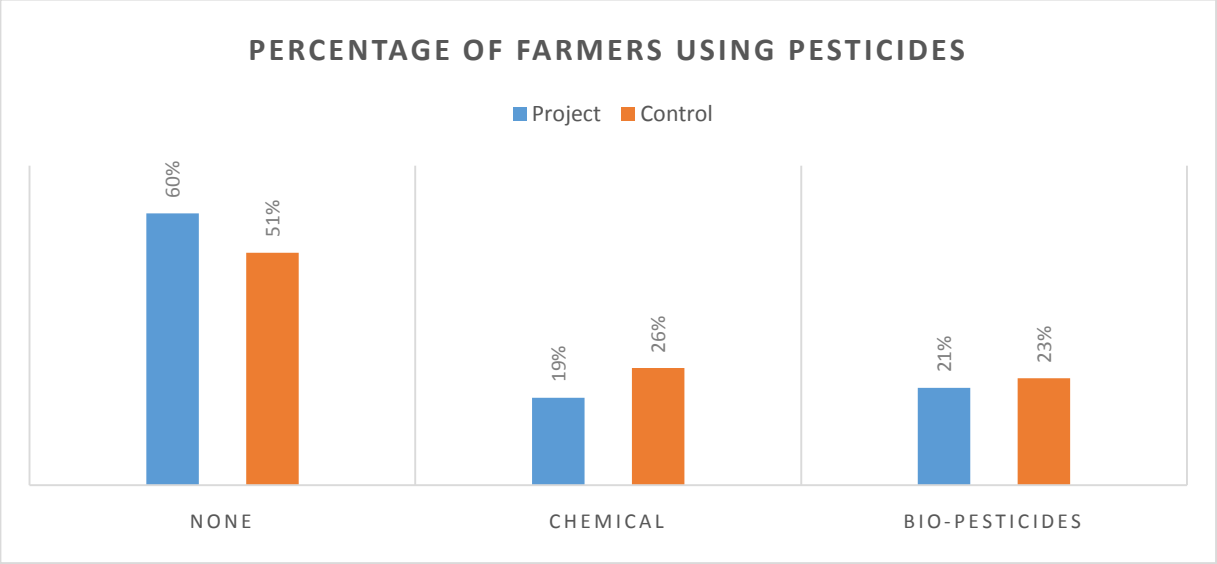


Figure 49: **Percentages of households using different types of pest control options**

It is interesting to note that most of the farmer families reported not using any measures for pest control. Farmers did not seem be very much aware of the integrated pest management practices and are dependent on own judgement of use of quantity of pesticide application to be done for different crops. Bacillus thuringiensis is the most commonly used in Dehradun, Uttarkashi, Tehri division. Neem based pesticides is practiced commonly in almost all divisions

8.8 Water harvesting techniques

Improved irrigation practises could go a long way in improving the productivity of agriculture. Water harvesting technique improve the water retention capacity of the soil and also allow for additional sources for irrigation. Various water harvesting techniques such as rain water harvesting in ponds/ tanks and also roof rain water harvesting are prevalent in the sampled districts. It was seen that 20.4 percent of the sampled households in the project and the control areas followed at least one method of water harvesting.

Maximum households harvested water in ponds and tanks. Roof rainwater harvesting by means of installation of roof structures, drainage pipes and ground pit for storing were observed in 20.4 % treatment households and 8.85 % control. Further promotion of roof rain water all over project area would be beneficial for the farmers who are primarily dependent on rainfall for agriculture.
Even though there were indications of water harvesting techniques being taken up, qualitative discussions revealed that many farmers were still disadvantaged by the lack of water availability for farming.

"Water is always inadequate in our village for cultivation. In this situation, whatever little we manage to cultivate is spent on consumption. What remains to be sold? Because of lack of irrigation there are crops which we have stopped growing such as potato and colocasia"

Focus Group Discussion, Block Dhauladivi, District Almora

8.9 Post Harvest Management

Post harvest management is critical for higher value realisation. However, knowledge of proper post harvest management and infrastructure for the same are limited in the remote hilly districts. Crop

specific basic post harvest management practices such as drying, sorting, grading and packaging improves value realisation. However, baseline figures reported that about half the sample households are not using any post harvest manageent technique. About 17-18 percent farmers are using grading and sorting methods in their own ways.

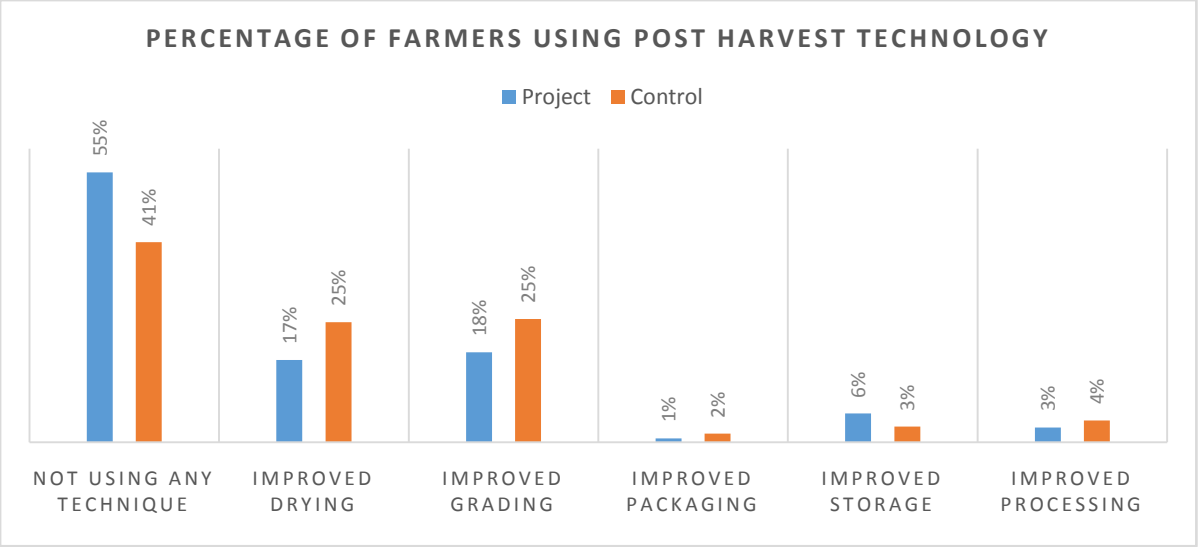


Figure 50: **Percentages of households adopting different types of post-harvest techniques**

With more than 50 percent of the respondents not relying on any form of post-harvest management practice, it is difficult to get the best market value of the crops. This finding could also be used to explain the relatively less development and augmentation of the value chain of various high value crops. Less than 5 percent of the population surveyed had adopted other techniques like storage, processing and packaging.

The farmers have harvested mustard crop before it reaches to full ripening stage. The crop has been harvested in green stage because harvesting of fully matured crop results in considerable loss of the grain due to shattering. The farmers then collect the harvested plants and make a pile of these on threshing floor.

Drying is primarily used for food grains for storage using leaves of Akharot (Juglans regia Linn.), Bithon (a tree of Neem family) or Tun (Toona ciliata M. Roem.) have been used. The leaves of these plants have been taken and kept under the sun for one day. Then the dried leaves are crushed and mixed in the food grains. The food grains are kept in storage structures.

8.10 Soil moisture conservation practises

The baseline assessment captured the current practcies on soil moisture conservation methods used by farming households. Techniqus such as Napier grass cultivation, mulching, diversion of drainage lines, farm bunding, trench making etc. In all the sample households across districts put together, 27 percentof the control households and 28.4 percentof the treatment households were practicing at least one of the aforementioned techniques of soil and moisture conservation.

Less than 15 percent of the sampled households in both the treatment and the control areas of Pithoragarh use atleast one soil moisture conservation method. The treatment areas in the PMU Model, Tehri district and Rudraprayag have about 22-24 percent of the respondents using soil conservation techniques in control and treatment respectively. The lowest usage of soil moisture conservation technique was found in Dehradun followed by Uttarkashi. The usage of soil moisture conservation techniques among the control households was the lowest in the district of Uttarkashi.

8.11 Risk Management Practices

The rural agricultural community in India faces multiple risks in varying magnitudes pertaining to agricultural production and output (Mathur and Singh, 2005)[6]. The magnitude of risk is even higher for small and marginal farmers and gets further constrained in backdrop of less favourable production environment, both physical (climate variability, soil erosion, erratic rainfall, lack of irrigation facilities etc.) as well as market related (variable prices, volatile markets, lack of storage options). The target population of Gramya II are vulnerable to increased risk owing to primary dependence on land resources, primarily rainfed agriculture, soil erosion, extreme climate conditions, small landholdings and lack of trainings and awareness pertaining to improved agricultural practices.

To assess the requirement of the target population for training and awareness in risk management practices, the existing practices were recorded during household survey. Among all the samples households, around 89.83 % of the households reported practicing farming as a livelihood option (at least one member practiced farming). Out of these farmer households, only 3.3 % households (3.07 % control and 4.36 % treatment households) reported having availed crop insurance, similarly, only 3.2 % farmer households (3.07 % control and 4.02 % treatment households) reported adopting any kind of risk management instruments.

The highest percentage of households adopting any risk management instrument in farming activities was reported from Almora district, which was mostly for crop insurance. The percentages of farming households practicing/ adopting risk management and availing crop insurance are low across districts and treatments. The percentages of households practicing various risk management options such as selling at minimum support price declared by the agriculture department, availing electronic spot exchange, availing price stabilization funds, selling produce in commodity markets, contract farming and availing farm insurance was found to be very low.

It is to be noted that none of the practices/ instrument adopted are widespread and represents lower than 1 % of the sampled households who practice agriculture. The vulnerability of these villagers are further aggravated by lack of awareness opportunities and therefore lower adoption of risk management instruments, including crop insurance. The Gramya II besides aiming at intensifying agriculture and strengthening natural resource bases also aims at increasing resilience of the farmers by means of providing opportunities through awareness, training and information sharing.

Table 38 : Percentage of HH's Practising Crop Risk Management Practices

District	Control	Treatment
Almora	5.1	6.1
Bageshwar	2.1	3.5
Dehradun	3.7	4.9
Dehradun-II (PMU-MODEL)	3.8	4.8
Pauri	3.2	3.7
Pithoragarh	1.2	2.1
Rudraprayag	3.4	3.9
Tehri	3.1	4.2
Uttarkashi	2	3
Average	**3.07**	**4.02**

[6] *Mathur, V.C. and Singh, N.P., Management of Risks in Agriculture: A Synthesis, Agricultural Economics Research Review Vol. 18, pp 149-155, 2005*

Table 39:Percentage of HH's Practising Crop Insurance

District	Control	Treatment
Almora	5.1	6.4
Bageshwar	2.1	3.9
Dehradun	3.7	5.1
Dehradun-II (PMU-MODEL)	3.8	5.3
Pauri	3.2	3.8
Pithoragarh	1.2	2.6
Rudraprayag	3.4	4.1
Tehri	3.1	4.6
Uttarkashi	2	3.4
Average	**3.07**	**4.36**

8.12 Farm Level Institutions, Training Needs and Capacity Building

Gramya II aims at improving livelihoods of the targetted households in project landscape by double pronged approach of intensification of rain – fed agriculture as well as promotion of alternative livelihoods. Thus trainings and capacity building programmes related to both on farm and off farm livelihood options are envisaged. It is therefore necessary to encapsulate training availed by these households and trainings they would like to go through that are useful. The percentage of households who had received at least one training regarding livelihood and the percentages of male and female household members (as compared to total number of members in all sample households) in each district is indicated below:

Table 40: Percentage of household received atleast one training

Percentage of household received atleast one training						
District	%of HH received at least onetraining		%atleast on male member attendedtraining from each HH		%atlest on female memberattended training from each HH	
	Control	Treatment	Control	Treatment	Control	Treatment
Almora	11.46	21.98	7.44	11.46	4.02	10.52
Bageshwar	8.24	11.7	5.91	6.9	2.33	4.8
Dehradun	22.2	23.92	16.8	18.2	5.4	5.72
Dehradun II (PMU-MODEL	21.05	24.4	14.56	15.3	6.49	9.1
Pauri	11.11	13.8	6.66	7.2	4.45	6.6
Pithoragarh	39.01	44.74	25.97	30.01	13.04	14.73
Rudraprayag	6.81	8.33	3.47	4.81	3.34	3.52
Tehri	18.23	20.7	10.19	12.23	8.04	8.47
Uttarkashi	10.28	12.14	6.27	6.8	4.01	5.34

The highest percentage of households to have received at least one training is reported from both control (44.74 %) and treatment (39.01 %) of Pithoragarh district. Around 23.92% of the treatment households of Dehradun district, 21.98 % of treatmenthouseholds of Almora district and 20.7% of treatment household of Tehri district also reported to have received training regarding on farm and off

farm technology to enhance livelihood. Except Pithoragarh, the proportion of household members trained is low and there is an immediate need to train the villagers such that spectrum of livelihood options are available.

Training needs were identified for both on farm and off farm activities. The sampled household members were inquired regarding their interest in trainings related to basic farming techniques, offfarm livelihood options and enhanced agricultural production technology.

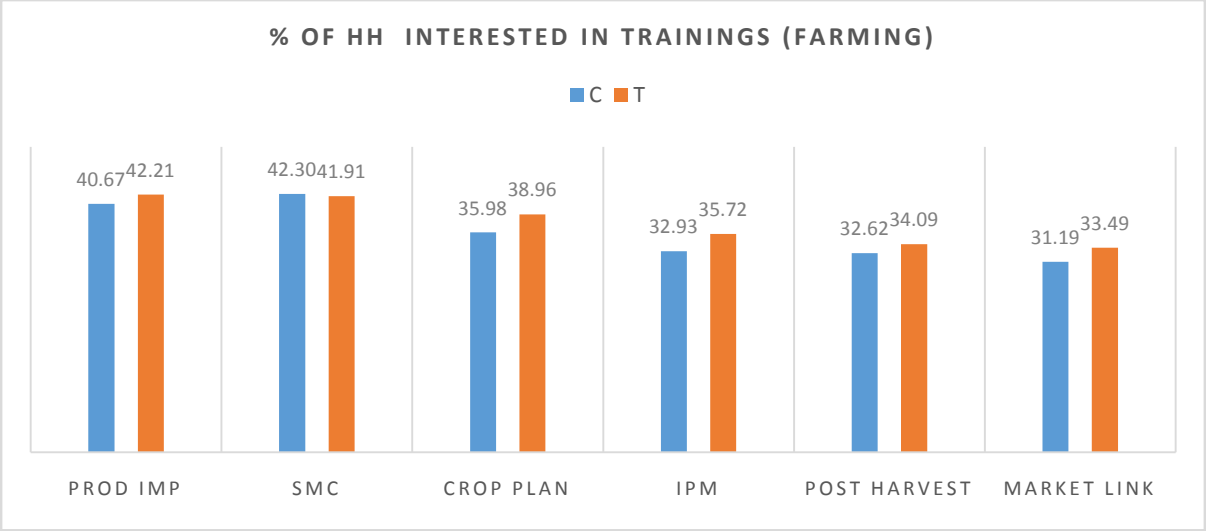


Figure 51: **Percentage of sampled household interested in different training (basic farming technology)**

Legend: Prod Imp – Production Improvement; SMC – Soil Moisture Conservation; Crop Plan – Crop Planning; IPM – Insect and integrated pest management, disease management; Post Harvest - Harvesting and Packing techniques; Market Link – Market Linkages

All of the sampled households expressed interest in receiving trainings in basic farming techniques as well as advance agriculture production techniques. Around 40 % to 42 % of the sampled household members expressed interest in receiving training on production improvement, soil and moisture conservation; around 31 % to 39 % households expressed interest in receiving training pertaining to market linking of farm products, post-harvest grading and packaging and integrated pest management.

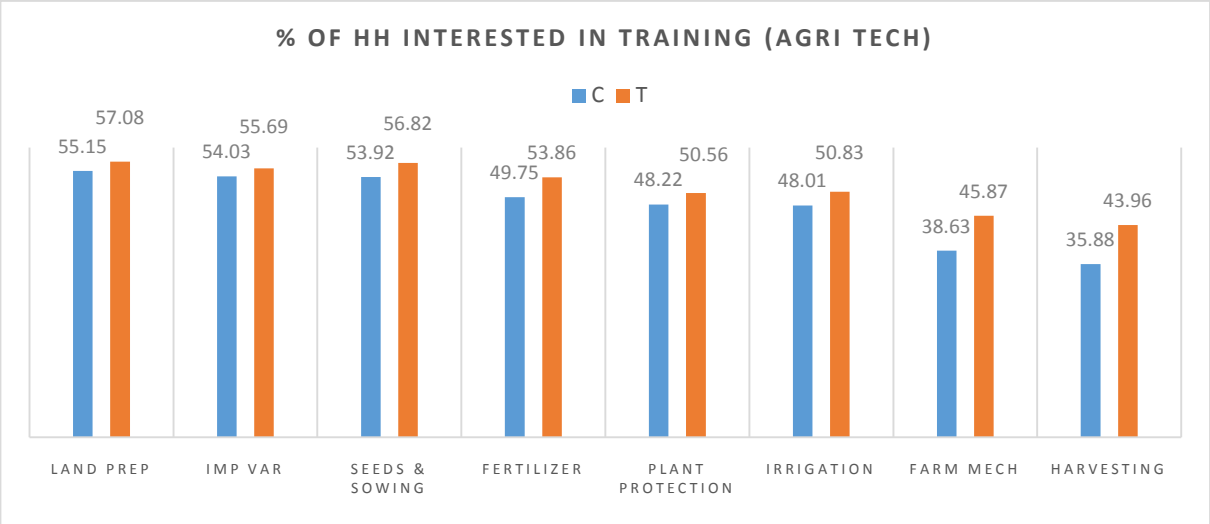


Figure 52: **Percentage of households interested in receiving trainings on agricultural production technology**

Legend: Land Prep – Land Preparation; Imp Var – Improved Varieties; Farm Mech - Use of Farm implements and machinery; Harvesting – Harvesting of produce

The households were also inquired regarding their interest in receiving trainings pertaining to advanced agricultural production technologies such as land preparation, improved varieties of crops, seed identification and sowing techniques, fertilizers and manures, protection of crops, irrigation techniques, farm mechanisation and harvesting techniques. As with basic farming techniques, the respondent households showed medium to high interest in trainings pertaining to improved agricultural production techniques.

Although the percentage of households/ members received training is low, community seems to be aware of how trainings could improve their livelihoods both regarding farming and non-farming options. The Gramya II also aims at strengthening agriculture as well as promotion of non-agricultural livelihood options. In addition to technical inputs and investments in these regards, the training and capacity building of villagers in their discipline of interest would greatly enhance their livelihoods.

8.13 Agri-business

Uttarakhand state has 26 principal market yards, 31 sub-market yards and 27 weekly markets for marketing of agricultural produce which are regulated effectively in 11 districts of the state. However, majority of the districts of this state is located in hilly region, but the principal markets are largely located in the plain regions. Although, the entire hill region is covered under the provision of Agricultural Produce Market Act, 1964; despite this, the major hill markets are still non-functioning. As far as the farmer's perception about the prevailing marketing system and practices is concerned, majority of the farmers were satisfied with the weighment, grading, cleanliness and, information sharing, at local markets & Mandies. But these farmers have also expressed their dissatisfaction on the account of cold storage facilities and the exploitative practices of traders and management of the markets especially during the rainy season in the agricultural markets of Uttarakhand. It may be inferred that the hilly regions of the state require special attention on the marketing interventions and infrastructure due to difficult terrains and limited bargaining and handling capacity of the growers resulting from lower size of holding and lack of resources.

8.13.1 Households selling Produce

Marketed surplus and prices received by farmers for agricultural commodities has been a significant concern in Uttarakhand during the recent years. Poor efficiency in the marketing and in adequate marketing infrastructure are the likely causes of not only high and fluctuating consumer prices but also a reason for reaching lower share of the consumers' rupee to the farmers. The following Table presents the percentage of Households selling produce (all crops).On an average 31.5% (27.8% Control and 35.2% treatment)of households reported the sale of crops.

Table 41: Percentage of Household Reporting Selling of Produce (all crops)

District	Control	Treatment
Almora	26.9	37.2
Bageshwar	31.8	31.8
Dehradun	33.1	42.1
Dehradun-II (PMU-MODEL)	27.5	34.4
Pauri	23.4	36.2
Pithoragarh	27.1	32.3
Rudraprayag	24.3	27.4
Tehri	25.3	32.2
Uttarkashi	31.1	43.1
Average	**27.8**	**35.2**

Source: Household Survey, N=5567(Treatment), N=907 (Control)

In terms of quantity of Produce sold, the average comes upto 2129.06 quintals (Control 1914.4 quintals and 2343.7 quintals).At present the marketable quantity is on the lower side.

Table 42: Quantity of Produce sold (Qtls**)**

District	Control	Treatment
Almora	1538.4	1672.7
Bageshwar	2189.0	1749.9
Dehradun	2677.7	2898.0
Dehradun-II (PMU-MODEL)	1920.9	2782.9
Pauri	1822.9	2528.7
Pithoragarh	2027.7	2516.2
Rudraprayag	1479.1	2050.1
Tehri	1722.8	1960.0
Uttarkashi	1851.3	2934.8
Average	**1914.4**	**2343.7**

Some of the Problems faced by farmers in marketing produce are;

1. Low marketable surplus of Agricultural goods

The number of small and marginal farmers is more in Uttarakhand. These farmers hardly produce for the market. The market, therefore, depends more on big farmers. The output of these few big farmers will have to reach different markets. The net result is that the quantity of agricultural goods available will be inadequate in relation to the demand.

2. Producer does not determine the price

In the case of consumer and industrial goods, it is only the producer who determines the basic price of the product. He is also sure of his margin.In contrast to this, the producer of agricultural goods does not know the price at which his produce would be sold to the ultimate consumer. It is not something decided by the farmer. It is only the intermediaries who determine the final price in marketing agricultural goods. The grower, in fact, is not sure of his revenue also.

3. Lack of storage

Agricultural goods are easily perishable. Their production is also seasonal. But they are demanded throughout the year. This means that agricultural goods need to be stored in warehouses so that they can be made available at the right time in the market.The farmers, who are the producers of agricultural goods, may not have their own storage facilities. This is in contrast to the situation in consumer and industrial goods marketing where the producers have their own warehouses.Absence of storage forces the farmers to sell their produce at the earliest. Sometimes, they sell at a very low price in the market. Thus, the farmers, as the producers, get a very low or even no profit.

4. Problems in Transportation

Most of the villages have poor roads. This leads to delay in the produce reaching the market.Although trucks are increasingly used in transporting perishables, the cost of transportation is generally very high. As a result, the farmers get a very low return on their output.

5. Long chain of middlemen

Agricultural goods, perhaps, have the longest chain of middlemen. There are a number of intermediaries in the market like the wholesalers, brokers, commission agents, retailers and so on.The agricultural goods pass through all these people before they reach the ultimate consumer. As it passes through each individual, the price increases. So, it is only the consumer who is finally made to bear the burden. Thus, the high price paid by the consumer does not reach the grower. It is pocketed only by the market intermediaries.

6. Malpractices in the market

In the market, the intermediaries indulge in a number of undesirable practices to make quick money at the cost of the producer and the consumer. Such malpractices are considered a major problem in marketing agricultural goods.

7. Lack of Market Information

The poor and illiterate farmers have no access to methods of gathering information about the market for their agricultural goods.

8. Inelastic demand

The demand for agricultural goods is not influenced by a fall or rise in their price. As a result, the producer will suffer because of fall in the price during bumper harvest.

9. Lack of Grading

Standardization enables the producer of consumer or industrial goods to get the right price for his products. Standardization has no relevance for agricultural goods. But they can be graded according to their size, shape and so on. But in the market, little importance is given for grading the produce and as a result the producer gets the same price for different varieties of goods.

10. Bulky nature

The bulky nature of agricultural goods necessitates packing. Otherwise, they cannot be taken to various market centres. This job has to be done manually and it involves labor. Gunny bags, bamboo baskets etc., are the materials used for packing.

8.13.2 Place of sale

Marketing system plays a crucial role in agricultural sector as efficient functioning of agricultural markets is supposed to add to the welfare of producers as well as consumers. An efficient agricultural marketing system helps in the optimization of resource use, output management, increase in farm incomes, widening of markets, growth of agro-based industry, addition to national income through value addition, and employment creation (Garg, 2010). The issues and concerns in marketing mainly relate to the performance (efficiency) of the marketing system, which depends on the structure and conduct of the market (Acharya, 2006). Agricultural marketing system in the country presently is marked by fragmented supply chain, dominated by multiple market players which results into high wastages thus, adversely affecting efficient marketing (GOI, 2013).

This requirement becomes much more intense in difficult terrains and remote areas. Larger part of Uttarakhand is characterized by a difficult terrain, undulating topography, remote and inaccessible villages, sparse population, tiny land holdings, agriculture based economy and weak infrastructure; the topographical, infrastructural and environmental constraints do not allow proper utilization of resources available in the inner parts of this fragile region (Tuteja, 2013). Development of the hills is primarily linked to the development of agriculture and its allied activities as the mountainous region of the country has tremendous potential for cultivation of many high value added and rare commodities. Uttarakhand is such state with dominance of agriculture and dependence of about 70per cent of the population on agriculture. The consumption of large marketable surplus available with farmers is outside the state and it further adds to the losses due to lack of proper infrastructure in form of cool chains, pack houses, mechanized grading and packing machinery, efficient transportation/connectivity, markets, etc. (Tuteja 2013). Uttarakhand Krishi Utpadan Mandi Parisad (UKUMP), is the nodal agency for agricultural marketing in Uttarakhand which has created a network of markets for marketing of agricultural produce in the state.

Marketing of agricultural produce in Uttarakhand is still in a nascent stage as most of the districts in hills still lack a functional regulated marketing system that adds to the backwardness of a potentially lucrative state in terms of horticulture and grain production. The aggregate level evidences have been validated with the field level realities at farmers' fields during the baseline.The farmers sale their produce through the local trader in an average of 41.3% households (Control 40.4% and Treatment 42.2%) while 55.1% households (Control 55.6% and Treatment 54.6%) sell their produce at local market.This is due to accessibility to the local market haat.Only a meagre 2.6% (Control 2% and Treatment 3.2%) sell their produce at Market Yard at Block/District Level

Table 43: Place of sale of crops

Place	% of Household selling crop in following sources (all crops)	
	Control	Treatment
Local Trader Approaching Farmer	40.4	42.2
Local Market Haat	55.6	54.6
Market Yard at Block/District Level	2	3.2

Source: Household Survey, N=5567(Treatment), N=907 (Control)

8.13.3 Average Price of Sale

Mandis are the market places mainly concerned with the buying, temporary storage and selling of farm producers. Mandis provide the market place for farmers thereby giving assurance of returns (though the rate of returns would be varying on future conditions).In Mandis, one can know the correct demand of the farm products as you are dealing with fairly large quantities of items. Hence there are chances for better realization of prices. This is much suitable for big farmers However middlemen have a large margin of profit, hereby eating into the returns of farmers.

Small farmers dealing with small quantum of produce and vegetables can sell them in the locality (local market /Haat) by themselves easily. The following table depicts the average price of crops sold at local market and Mandi, both for Control and treatment groups. There is very negligible price difference in Treatment and Control groups with the farmers in Treatment groups negligibly better placed.

Table 44: Average price of crops

Crops	Average Price at which Sold (Rs/ Quintal)			
	Control		Treatment	
	Local Market /Haat	Market Yard at Block/District Level (Mandi)	Local Market /Haat	Market Yard at Block/District Level (Mandi)
Garlic	1500.00	1750.00	1520.00	1750.00
Cauliflower	1900.00	2100.00	1930.00	2100.00
Cabbage	1950.00	2050.00	1950.00	2050.00
Pea	2500.00	2750.00	2520.00	2750.00
Ginger	1850.00	2100.00	1900.00	2100.00
Maize	1325.00	1500.00	1350.00	1500.00
Wheat	1525.00	1750.00	1550.00	1750.00
Pigeon Pea	4225.00	4500.00	4250.00	4500.00
Finger Millet	1550.00	1700.00	1570.00	1700.00
Paddy	1400.00	1550.00	1420.00	1550.00
Black Gram	4425.00	4550.00	4450.00	4550.00
Potato	700.00	850.00	730.00	850.00
Soyabean	2500.00	2700.00	2540.00	2700.00
Mustard	3350.00	3500.00	3370.00	3500.00
Barley	1225.00	1350.00	1235.00	1350.00

8.13.4 Marketing Extension Services

This extension approach is the need of the hour as the farmers are shifting from subsistence to profitable farming. Reddy and Jaya (2002) reported that this approach has advantage over conventional model as itenable since the farmers will get optimum/higher returns from their enterprises due to involvement in the marketing, available basket of package' of practices suitable to their farming situation, proper data recording and sufficient IT support.

It is evident from the following Table that only 7 per cent of the respondents (Control 5.9% and Treatment 8%) have received any form of market extension services. The slightly higher percentage of treatment groups having received market extension services are due to the early start of Project interventions.

Table 45: Market extension services received

Market Extension services received		
District	**Control**	**Treatment**
Almora	6.3	8.9
Bageshwar	5.8	7.9
Dehradun	6.4	8.1
Dehradun-II (PMU-MODEL)	6.5	8
Pauri	6.1	7.4
Pithoragarh	5.8	7.8
Rudraprayag	5.8	8
Tehri	5.3	7.7
Uttarkashi	5.4	7.9
Average	**5.9**	**8**

LIVESTOCK & ANIMAL HUSBANDRY

9. Livestock & Animal Husbandry

9.1 Livestock ownership

Livestock sector has a major contribution in income augmentation of the rural population perticularly in hilly districts.. Livestock rearing is the second most important occupation of the rural population in 8 divisions. Those who are engaged in rearing livestock are doing it in small scale because of lack of value addition and marketing infrastrctur and linkage for the products accrued from livestock rearing. Most of the dairy products are consumed locally, and do not receive suitable prices mainly due to lack of market and cold storages.'[7]

Goat/ Sheep and Milch cow are the most owned livestock in treatment as well as control. This applies to both traditional and improved variety of these cattle. 79.8% the households in project area and 78.3% of households in control area owns livestock.Only 7.8% of the households in treatment and 9.7% in control own improved variety of livestocks.This clearly indicates that traditional variety still dominates livestock rearing as compared to improved varieties.

Table 46: Percentage of HHs owning improved breed of cattle

Percentage of HHs owning improved breed of cattle		
	Treatment	**Control**
Almora	5	3
Bageshwar	12	7
Dehradun	4	4
Dehradun-II (PMU-Model)	9	11
Pauri	6	9
Pithoragarh	28	19
Rudraprayag	8	12
Tehri	13	0
Uttarkashi	6	10

On an average, per household ownership comes out to be 4 livestocks in both treatment and controlarea with a higher percentage of farmers owning traditional varieties. Farming communities seemed to be owning more goats than cattle's in comparison.

Table 47Average number of livestock owned

Average number of livestock owned		
	Treatment	**Control**
Average number of Livestock owned	5	4
Average number of Improved Breeds	2	1
Average number of Traditional varieties owned	4	4

[7] *(Sati, 2016)*

Table 48:Average no of goats owned

Average number of Goats owned		
	Treatment	**Control**
Average number of Livestock owned	5	6
Average number of Improved Breeds	4	4
Average number of traditional varieties owned	6	6

Table 49:Average no of milch cows owned

Average number of Milch cows owned		
	Treatment	**Control**
Average number of Livestock owned	2	2
Average number of Improved Breeds	2	1
Average number of Traditional varieties owned	1	1

9.2 Source of Income from Livestock

Livestock rearing through various means enhances income of rural households. Various products received from these livestock include milk production, ghee, wool, poultry meat, and other poultry products such as eggs. 58 percent of the sampled population in the treatment area and 54 percent of the population in the control areas are enagaged in livelihood activities from livestock farming. The NSSO 70th round data put the figure at around 48 percent.

54 percentof the households in treatment and 48 percentin control are involved in sale of milk as one the source of income generation activities however the income from this activity may not be very significant in terms of contribution to household economy. This signifies nearly half of the households are in the capacity of milk consumption and sell off the remaining quantity in market for income generation. However, close to 2% of the households are involved in poultry meat as a product from these animals. Similarly, only 2% of the households receive other poultry products such as eggs. These figures stand for both treatment and control.

9.3 Fodder source for livestock

To understand the stress on various natural resources because of grazing, information was gathered from sampled households regarding the source of fodder for their livestock. The respondent households collected fodder either from their own agricultural land (fodder species grown alongside other crops), provided from agricultural residue, reserved forests, van panchayat, common revenue land plantations. Some households also reported buying fodder from market.

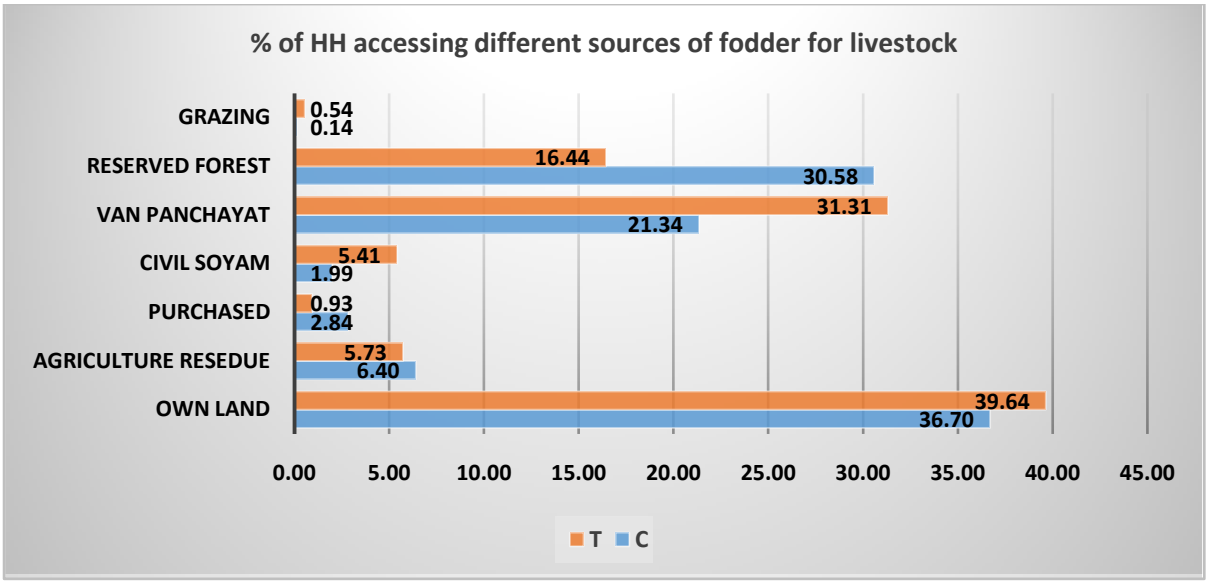


Figure 53: percentages of sampled households by their major source of fodder collected for livestock

The above figure reveals that only a very few households (0.54 % treatment households and 0.14 % control households) practice open grazing in pastures whereas most households collect fodder from different sources and bring to their homesteads for consumption of livestock. Maximum households (36.70 % control households and 39.64 % treatment households) grow fodder species in their own landholdings alongside other agricultural crops. A considerable proportion of the households identified either reserved forests (30.58 % of control households and 5.73 % of treatment households) or Van panchayats (21.34 % of control households and 31.31 % of treatment households) or both as their major source of fodder. Around 6.4 % of control households and 5.73 % of treatment households depended on agriculture residue (straw/ husk) for fodder.

The village common property resources include trees outside forests. This clearly indicates that majority of dependence is on natural vegetation in form of trees and shrubs/ herbs either from the forest or vegetation outside forest boundaries.

Table 50: Percentage of sample household accessing different sources of fodder (district-wise)

Table 18: Percentage of sample household accessing different sources of fodder (district-wise)						
District	Source of fodder for livestock (percentage of sample HH)					
	Forests		Pastures		Village CPR	
	Control	Treatment	Control	Treatment	Control	Treatment
Almora	56.29	45.69	2.13	2.59	41.58	51.72
Bageshwar	67.15	65.79	4.23	4.21	28.62	30
Dehradun	59.96	71.49	4.98	4.98	35.06	23.53
Dehradun-II(PMU-MODEL)	64.91	83.33	0	0	35.09	16.67
Pauri	63.02	62.76	7.79	8.05	29.19	29.19
Pithoragarh	64.43	64.47	1.32	1.2	34.25	34.33
Rudraprayag	74.25	76	0	3.4	25.75	20.6
Tehri	66.17	66.17	4.74	3.38	29.09	30.45
Uttarkashi	52.68	52.68	1.43	2.36	45.89	44.97

There is a high dependence of the households on community forests and trees outside forests for domestic purposes and fodder for livestock. Gramya II among other things aims at increasing biomass production from forested lands (fuel and fodder along with timber). This would benefit the local people who are highly dependent on forest resources for their domestic fuel and fodder sourcing. Identification and promotion of non-conventional energy use for domestic purposes may also be done to reduce absolute dependence on fire wood.

9.4 Fodder requirement for livestock

The average quantity of fodder required per household annually was reported as 35.92 quintals (35.23 quintals average for control households and 40.14 quintals average for treatment households), which is accessed from the various sources as discussed above. On an average, in a household about 2 members in a family go out of home or spend time to collect fodder. Qualitative assessment states that these members are mostly women members of family. Average time taken by the member is about 163 minutes a day which is about 2 ½ hours a day at the minimum. Three months in a year mostly fodder collection is done and stored for the entire year other than ongoing fodder collection activities. April, May and June are three months in the plains when people collect and store fodder for the entire year Other than this fodder cultivation such a Napier grass is also grown in backyard of house to ensure regular avaiability of fodder.

Only around 2.84 % of control households and 0.93 % of treatment households purchased parts of their fodder requirement from the market or other villagers. The interventions of Gramya II in intensifying agriculture and enhancement of forest biomass would directly increase availability of fodder, as maximum households are dependent either on their landholdings or forests (reserved forests/ van panchayat) for collection of fodder. This would in turn also reduce the cost incurred by households who need to buy fodder owing to low availability of fodder from other sources. The average time spent to acquire fodder would also reduce with increased availability, thereby enabling household members, especially women to utilise their time better.

Participation in the Programme & Institution Building

10. Participation in the Programme and Institution Building

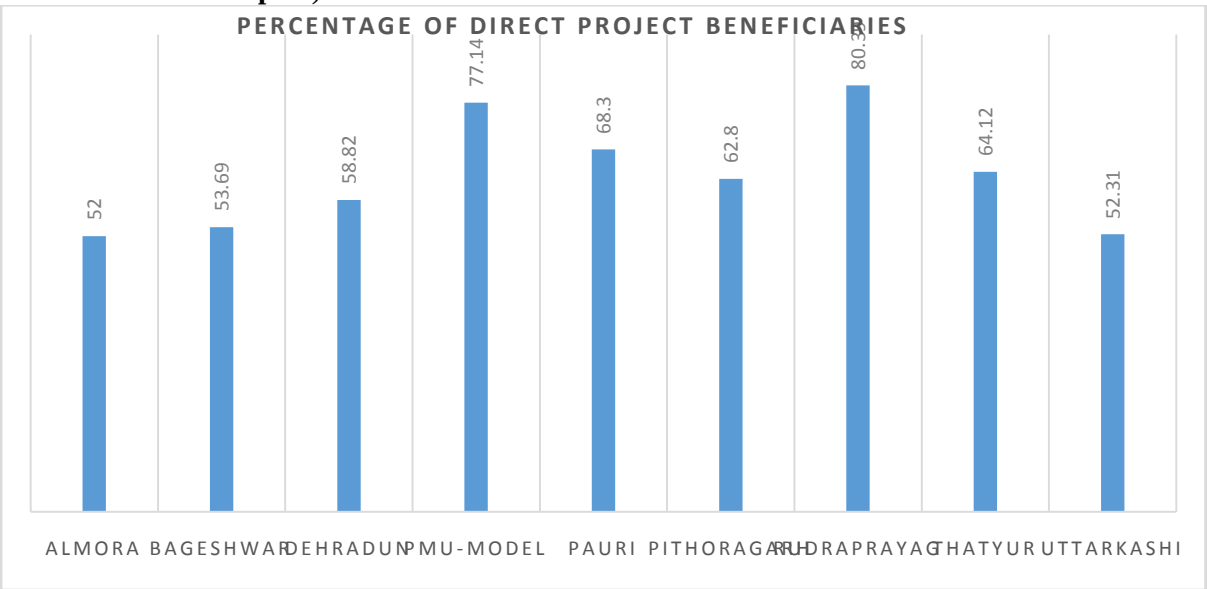
10.1 Direct Project Beneficiaries

It was assumed that all the members of the sampled households who are included in any of the beneficiary institutions namely, Vulnerable groups (VG), Farmers' Federation (FF), Farmers' Income Groups (FIG), Watershed and Water Management Committee (WWMC) and Water Users group would be direct beneficiaries of Gramya – II project. The project would be directly tracking project beneficiariesto estimate inclusion of members under various interventions. Community were consulted during the period of survey and they seemed to be very much aware about project intervention.

Around 60 % of the members of the sampled households across the districts are estimated to be directly benefitted by the project in the treatment households. The percentage of female beneficiaries to the total number of direct beneficiaries across districts (sample of entire state) is around 72.6 %.

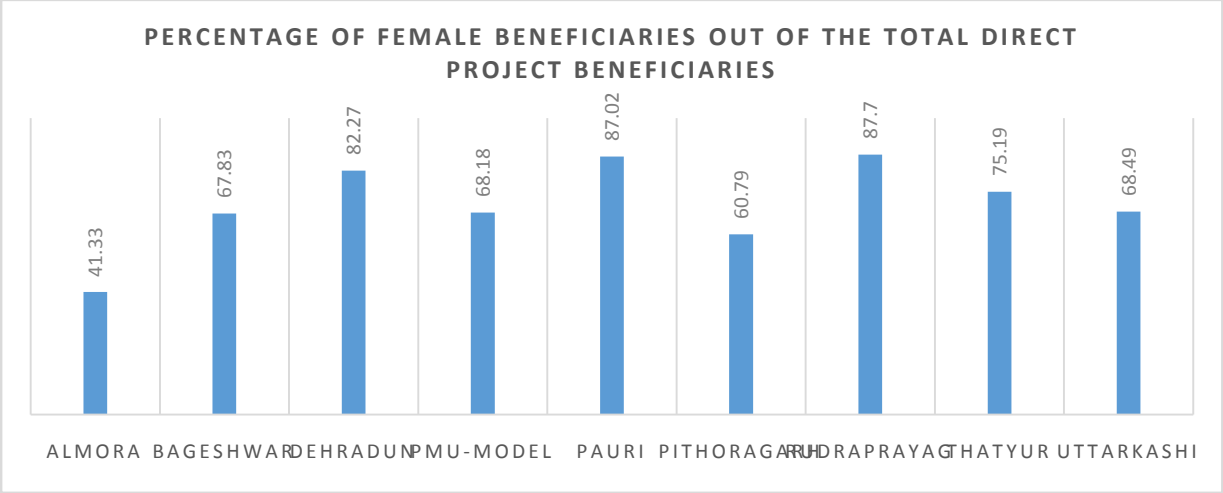
The following figure indicates the percentage of direct beneficiaries as compared to the total individuals (all members of sampled households) sampled, in all the eight sample districts and the model PMU for the treatment areas.

Figure 54: **Percentage of individuals to be directly benefited by Gramya - II (as compared to total individuals sampled)**



As indicated in the above figure, the highest percentage of direct project beneficiaries are reported among the total sampled individuals of Rudraprayag district)80.39 (%, followed by the PMU – Model household members)77.14 .(%The lowest percentage was reported from Almora district)52 .(%The percentage of female project beneficiaries to the total project beneficiaries, district-wise, as calculated from the household sampling, is indicated below.

Figure 55:Percentage of female project beneficiaries)in Gramya II



The highest percentage of estimated female project beneficiaries were reported in Rudraprayag district (87.7 %), followed by Pauri Garhwal district (87.02 %). The lowest percentage of female beneficiaries were reported from Almora district (41.33 %).

10.2 Participation in Gram Sabha

Participation of sampled households in Gram Sabha

Gramya II follows a bottom up approach in terms of implementation of the project as all the components have decentralization in their genesis. This section reports level of participation of the sampled households in gram sabha meetings. Across all the districts, 58.0% of the control households reported at least one member participated regularly in gram sabha and 67.2% of the control households reported at least one female member of the household regularly participating in Gram Sabha meetings. In case of the treatment households sampled across districts, 62.4% of the households reported at least one female member attending gram sabha and 54.3% of female households reported at least one female member attending gram sabha on regular basis.

10.3 Institution Building

Institutions established

Various community based organizations such as Farmer Federations(FF), Water and Watershed Management Committees(WWMC), Farmer Interest Groups(FIG) are being formed under the project. These organizations have different objectives ranging from working with agribusiness support organizations and provide marketing support to farmers, implementing GPWDPs, mobilizing villagers and ensuring inclusion. Baseline figures for these organizations established are considered zero and numbers will be tracked during mid line and end line. The particpation leves and quality of paricpation would be assessed during midline and endline phase.

Impacts

11.1 Impact Area 1: Improvement in household wealth / welfare

i. Income

The per capita annual income of Uttarakhand state has been on a steady rise over the last decade. The State Directorate of Economics & Statistics estimated the per capita annual income to have grown by 12.05% between the financial years 2012-13 and 2013-14 and by 11.49% between the years 2013-14 and 2014-15. Although, the per capita annual income of Uttarakhand estimated at 115,632 INR for the year 2014-15 is higher than the national average of 86,879 INR, the economy of hill districts is plagued by multiple problems.

These include degrading agriculture due to lack of irrigation facilities, marginal land holdings, dependence on rain fed agriculture, soil erosion, erratic rainfall, lack of irrigation facilities, lack of alternate livelihoods, lack of marketing facilities and marketing malpractices. (SAPCC, 2014) Another looming adversity impacting the rural areas of these hill districts is distress migration. Due to the limiting factors regarding agriculture and constrained livelihood options, rural people are forced to migrate to nearby urban areas both within and outside the state. This leads to abandonment and further degradation of conditions in the remote villages.[8]

Household level monthly income has been calculated for establishing baseline values for comparison. It is one of the indicators for impact that is expected to flow through the results chain by way of increased agricultural production and productivity, reduced input costs, additional avenues for income generation, and value chain up-gradation for farmers.

The average monthly income per household in the control villages is found to be Rs. 11,718 in the treatment areas as against Rs. 11,761 in the control villages.

Table 51: District level average monthly income (in Rs.)

Average Monthly Income (in Rs.)		
	Treatment	**Control**
Almora	11279	10905
Bageshwar	10800	14286
Dehradun	10150	11064
Pauri	11443	12391
Pithoragarh	12031	11975
Dehradun-II(PMU-MODEL)	10507	10319
Rudraprayag	12782	13556
Tehri	12524	10281
Uttarkashi	12273	10681
Total	**11718**	**11761**

The highest average monthly income in the treatment area was registered in the district of Rudraprayag with Rs. 12,782. The average monthly income in the control areas of Rudraprayag was even higher at Rs. 13,556. In the control areas, the highest average monthly income was noted in the district of Bageshwar with a figure of Rs. 14,286 per month. The lowest average monthly income in the treatment areas was registed in the district of Dehradun with an income of Rs. 10,150 per month. Tehri registered the lowest monthly average income in the control areas where the income was Rs. 10,281. These divergences can be explained by different occupational profiles of the sample as well as education levels which have a bearing on access to livelihood opportunities across divisions.

The agriculture income as a share of total household income is about 54% for Uttarakhand, followed by income from livestock (18%) (Ranganathan, 2015)[9].The baseline survey also indicates a similar share of income through agriculture sources. This is intune with the NSSO, 70th round data which states that across the country 48% of the total share of household monthly income comes from agriculture and 12% comes from livestock.

[8] *(Venkatesh, 2016)*
[9] *http://www.iegindia.org/ardl/Farmer_Incomes_Thiagu_Ranganathan.pdf*

Given the primacy of agriculture in generating household incomes, the interventions pertaining to livelihood enhancements proposed under Gramya II project including formation and strengthening of FIGs and FFs, development of agri-business plans and marketing strategies, is well-targeted and is poised to significantly contribute to household income enhancement. Likewise, the already meaningful contribution of businesses in household income lays the ground for additional handholding through project activities in the area of micro-enterprise development for the farmers. With higher incomes, it is expected that distress migration will be arrested at least partly, with local livelihood opportunities available to people.

ii. Local Employment opportunities and Wage Rate

Majority of farmers in the state of Uttarakhand fall into the category of marginal farmers which is also ratied by our baseline survey where about 83 percent of the household are marginal farmers. The very low size of landholding means that the need for external labour is minimal, with most household members involved in farm activities. Accordingly, the percentage of farm labour is very low in both treatment and control, i.e. 1.4% and 1.3% respectively. The baseline survey has found that 50% of the households in treatment and 52% in control practise primarily agriculture for income generation.

Not surprisingly, people have turned to non-farm labour in the absence of on-farm labour demand. A look at the figures gathered from samples shows that 11.5% in treatment and 12% in control report their main occupation to be non-farm labour. As per an analysis of the 70th round of NSSO data, the share of non-farm labour in a typical farming household's total income in the state is 5%. While it is expected that existing government schemes such as MGNREGA would absorb much of the demand for wage labour in the absence of demand for agricultural wage labour, the Gramya-II intervention enables households to partake in income generation activities by getting involved in the implementation of GPWDPs, wherein households are involved from the incubation stage till the time the proposed sites are prepared for utility.

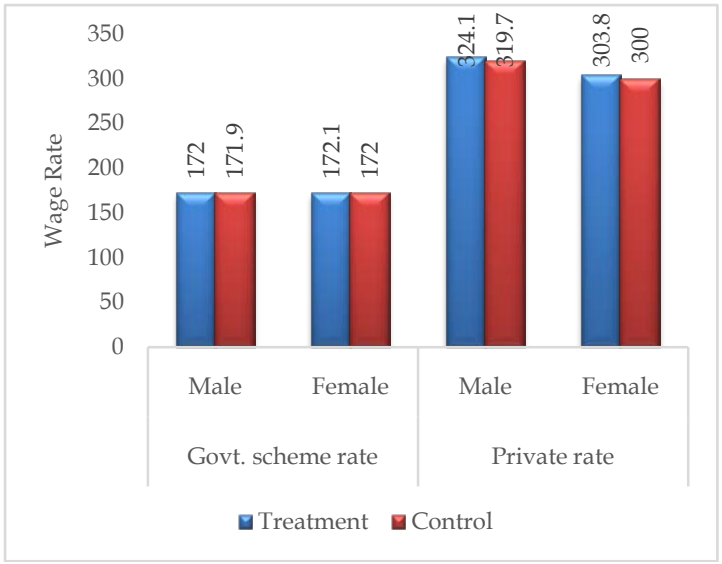


Figure 56: Farm labour wage rate

It is to be noted that access to regular non-farm jobs is also positively correlated to individual and household characteristics such as education and landholdings[10]. Accordingly, the intervention with its focus on empowering marginal groups through collectivization efforts (FIGs, FFs) coupled with the focus on involving the community in local construction, in addition to developing off-farm means of income generation is likely to address the twin problems of limited livelihood opportunities, and economic vulnerability amongst marginal farmers.

The wage rate for both men and women in the treatment and the control areas was found to be Rs. 172.According to the Annual Report of the Ministry of Labour and Employment (2016-17), the minimum wage rate for unskilled and semi-skilled labour is Rs. 200 and Rs. 231 respectively. This shows that the wage rate in the study areas is slightly lower than the number obtained from the secondary data. Private rates for farm labour are on the higher side as compared to government rates. There is also a remarkable difference in wage rate for male and female, wage rate of male being 6% higher than the female in both treatment and control groups.

[10](Lanjouw & Shariff)

iii. Average Indebtedness of Households

Only 16% of the households in treatment and 20% in control took loans in the last year. One of the major reasons for being in debt is for buying assets such as land, livestock and other household durables. This clearly indicates that farmers do not receive adequate returns after crop sales to provide for inputs towards the next crop cycle and purchase more land to increase production.

Figure 57: Purpose of loan

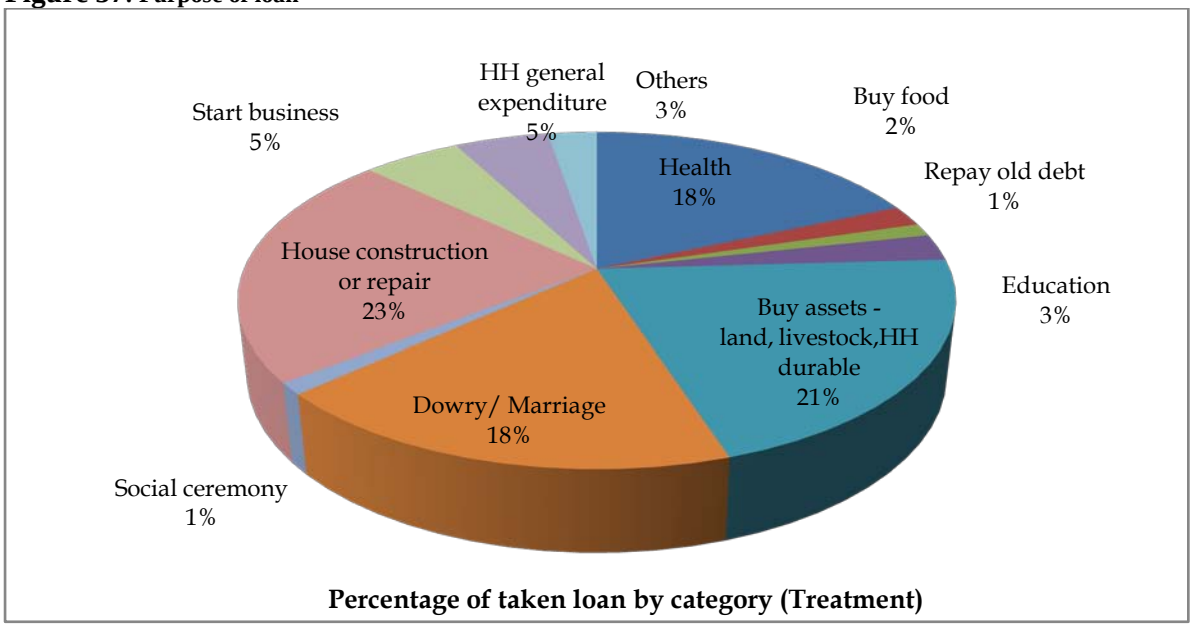
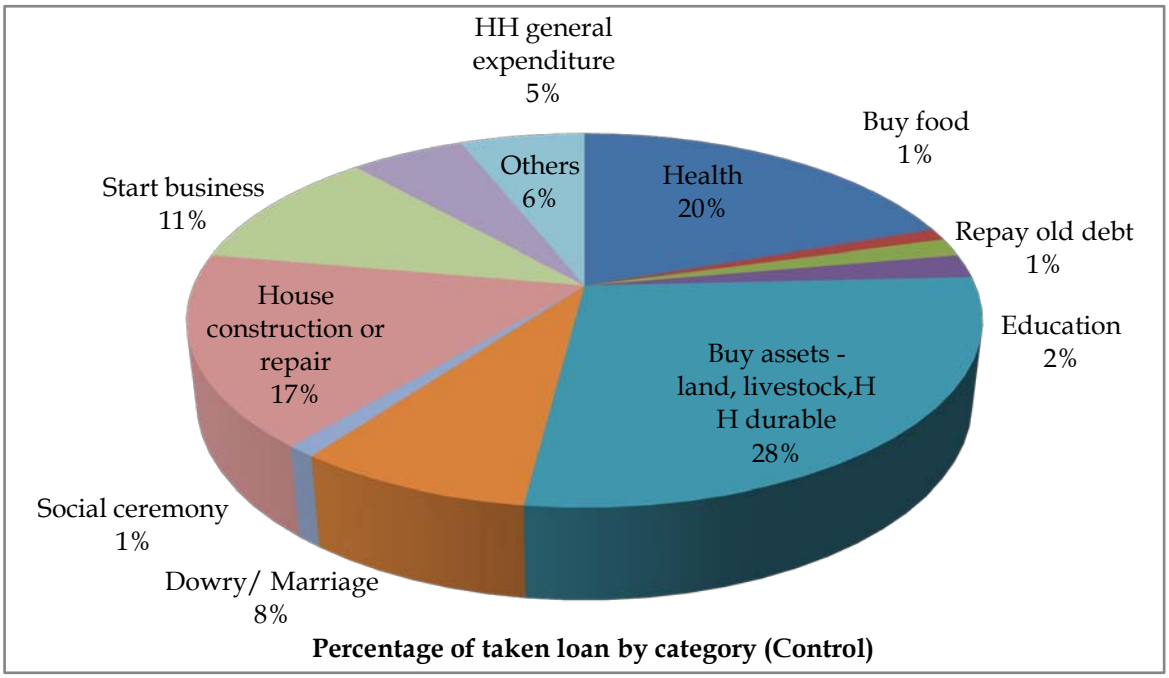
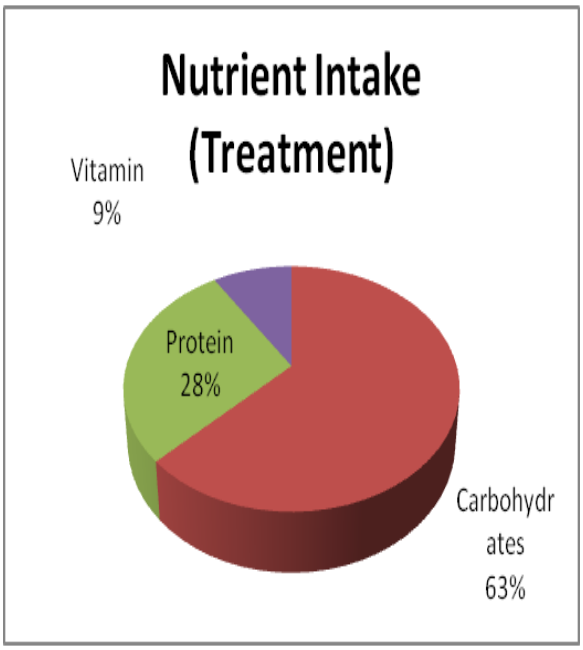


Figure 58: Purpose of loan – Control



ConsumptionFigure 59: Share of Carbohydrate, Protein and Vitamin Intake



iv. Household consumption

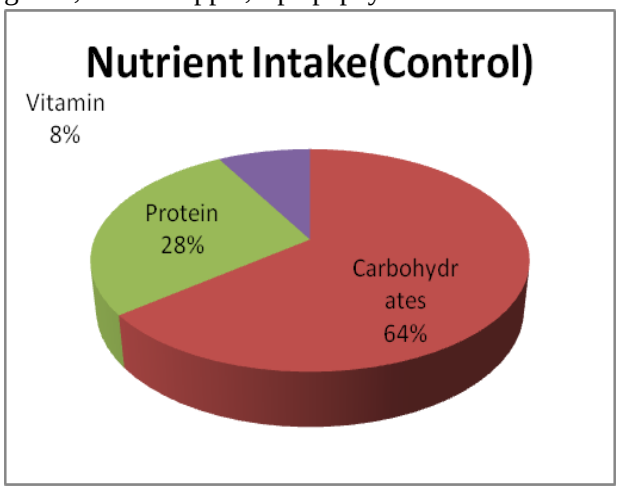
This section reflects on food consumption in terms of food basket and nutrient intake of sampled households in the state of Uttarakhand. This also brings out the economic ability of the household to access a variety of food. The food basket has been calculated by a simple count of food groups that a household consumes in a month while the nutrient consumption is calculated by the aggregate of quantity consumed in various food groups.

Food groups are mainly divided into Carbohydrates, Protein, Oil and Fat, Vitamin Rich Vegetables and Tubers, Vitamin Rich Fruits and Spices and Condiments. Food rich in these nutrients are classified below:

Carbohydrates: Rice, Wheat, Maize, Millet, Sugar, Bread and other root vegetables

Protein: Pulses and their products, Milk, Milk products, Egg, Fish, Chicken, Mutton

Vitamin Rich Vegetables, Tubers, Fruits: Vegetables such aspumpkin, carrot, squash, sweet potato, dark green leafy vegetables (spinach and other such vegetables). Fruits such as ripe mango, apple, guava, custard apple, ripe papaya

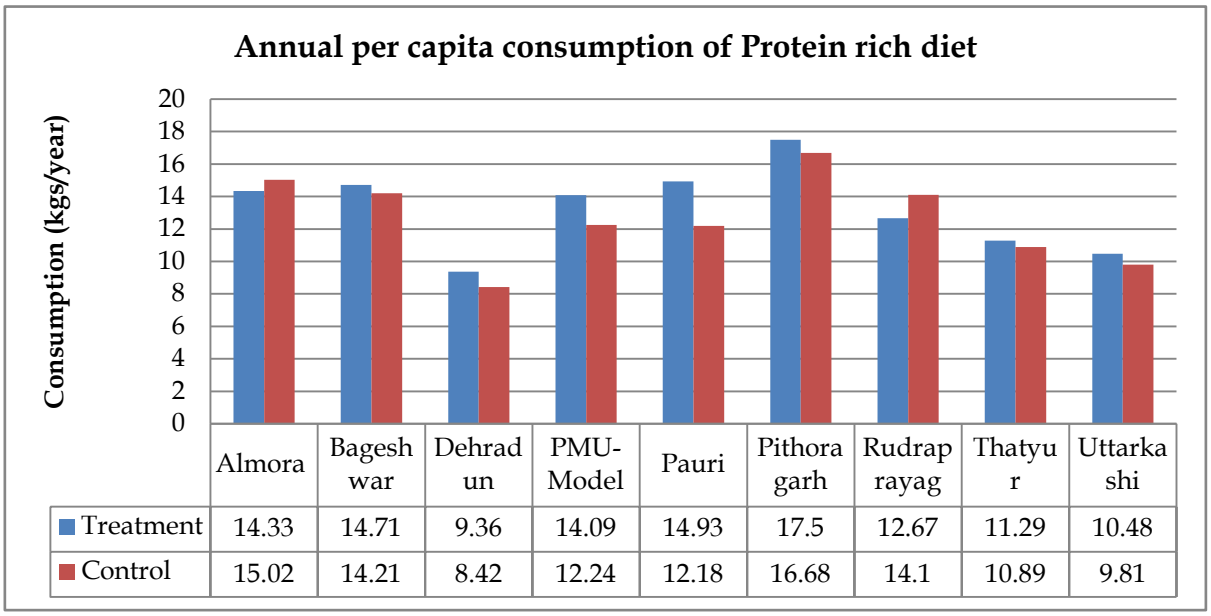


Carbohydrates form the major part of nutrient intake among households surveyed, followed by proteins and vitamins in both Treatment and Control areas. This is tune

Wheat and rice are frequently consumed foods, generally eaten on a daily basis. Milk and sugar are consumed 20 days a month while leafy vegetables and pulses are consumed 15 days in a month.

Data regarding nutrient intake was collected for a complete household and not member wise. Acess to protein rich food items has been seen as indicative of an increase in the economic bearing of the family allowing them to access more food groups.

Following table shows annual per capita consumption of protein rich diet in the treatment and control areas across the study divisions.



	Almora	Bageshwar	Dehradun	PMU-Model	Pauri	Pithoragarh	Rudraprayag	Thatyur	Uttarkashi
Treatment	14.33	14.71	9.36	14.09	14.93	17.5	12.67	11.29	10.48
Control	15.02	14.21	8.42	12.24	12.18	16.68	14.1	10.89	9.81

Figure 60Annual per capita consumption of a protein rich diet

It is seen that the per capita annual consumption of a protein rich diet comes to 13 kgs in the treatment areas and 12 kgs in the control areas. Roughly this amounts to a per day consumption of about 36 grams of protein rich diet by an individual in a day. The NSSO 66th round data on nutrition status in India had revealed that the average per capita protein rich diet intake in the state of Uttarakhand is 67 grams per day. The findings are lower than the secondary figures because the sample is restricted only to a rural population in some of the remotest blocks of Uttarakhand. While milk and pulses are consumed fairly regularly in the study areas, the frequency of consuming protein rich food items like eggs and poultry is limited.

The midline and the end-line data collection will look into whether the frequency of the consumption of protein rich food items as gone up along with an increase in the quantity of pulses, milk and eggs consumed in a month.

11.2 Impact Area 2: Improved intensity of Agriculture & Allied sectors in State

i. Increase in diversification

With improved access to water sources in the last 2 years, communities have added new crops to the basket. Consultations with farmer groups indicated that in the last 2 years, green peas, ginger, turmeric, all season cauliflower, garlic and in plains such as Dehradun, Rajma (Pulse)and Fresh Beans (Vegetable) have been introduced or cultivated on a large scale.[11]

22.3 percent of farmers in treatment and 20.7 percent of farmers in control are growing high value crops such as ginger and garlic.15.2 percent of farmers in treatment and 12.2 percent of farmers in control are growing potatoes, which is the most comonly grown vegetable across the sample. Apart from potatoes, leafy vegetables, peas and onions are also grown.

[11] *FGD/Community Consultations in all Divisions.*

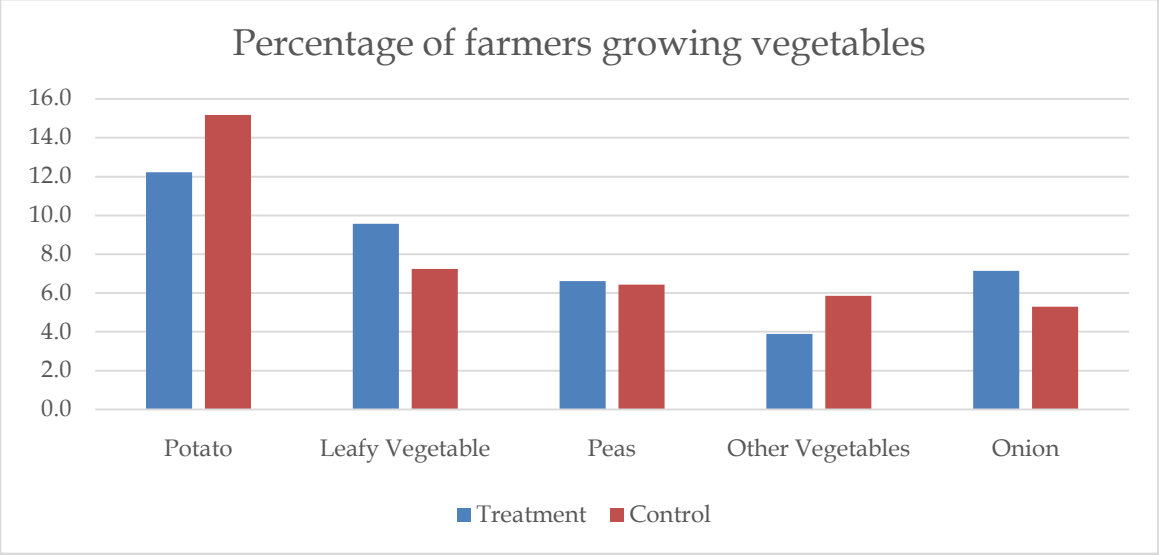


Figure 61: Percentage of farmers growing vegetables

ii. Improved livelihood from allied sector (Dairy, livestock rearing and pisciculture)

Largely communities are dependent on agriculture however, because of lack of water there is a higher focus on improving livestock and other allied activities. The baseline figures reveal that on an average each surveyed HH in the treatment and the control areas possess at least 4 livestock with goat being the most commonly owned livestock followed by cattle.

58 percent of the farmers in the treatment area and 54 percent of the farmers in the control areas are engaged in dairy, livestock rearing and related activities. Among them, nearly 54 percent of the HHs in the treatment area and 48 percent of the HHs in the control areas, were engaged in the sale of milk as an income earning activity. While, there is a dependence on livestock rearing as an income earning activity, it is not the mainstay of income generation for most families. Qualitative discussions revealed that in many cases sale of milk was secondary to consumption at home. Additionally, the lack of established value chains for milk and marketing of milk based products does not leave the activity remunerative for many livestock owners. Therefore, it is often seen as an additional source of income and not the primary source of income. This is in tune with the findings of the NSSO 70th round data where only 2.7 percent of the HHs owning livestock described it as their primary source of income.

Another reason which could explain the lack of complete dependence on agricultural allied activities is that only 8 percent of the HHs in the treatment and the control areas own an improved variety of milch cattle. With nearly half the livestock owners depending on milk sale for income, this is a limting factor. This indicates that the remuneration from allied activities might not be as high and could result in a cycle of debtedness and below par productivity.

Impact Area 3: Empowerment and increase in Social Capital

11.3 Impact Area 3: Social Capital Index

Social Capital remains a contested concept till this time as there is no standard definition. The World Bank defines Social Capital as 'Institutions, relationships, and norms that shape the quality and quantity of a society's social interactions. Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together'[12]. It is an important impact indicator to capture as it broadly defines the capacity of the community to co-operate, resolve conflicts, ease transactions and dealings and facilitate upliftment and inclusion. The Social Capital score was

[12](Hans)

calculated for all the households covered under treatment and control separately, based on various parameters grouped under multiple dimensions. A total of 9 parameters were considered under dimensions of 'Togetherness and Trust' and 'Social Cohesion'. The perceptions of households are reflected in the social capital score

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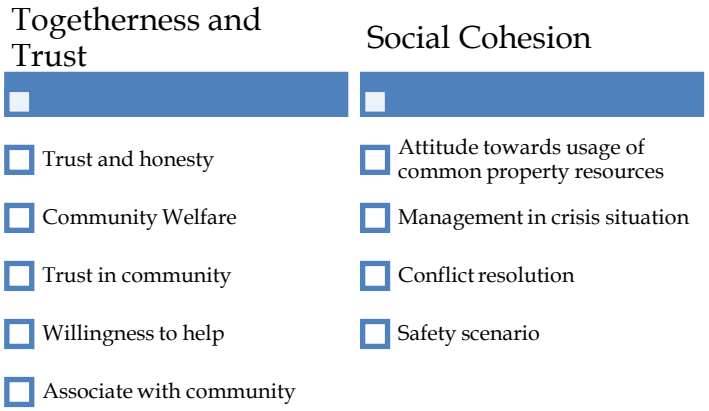


Figure 62: Social Capital Dimensions and Parameters

Scores are divided into four quartiles where Quartile I represents percentage of households that have scored Excellent, Quartile II represents households scoring Good, Quartile III represents percentage of households scoring Adequate and Quartile IV represents households that have scored poorly on the social capital front.

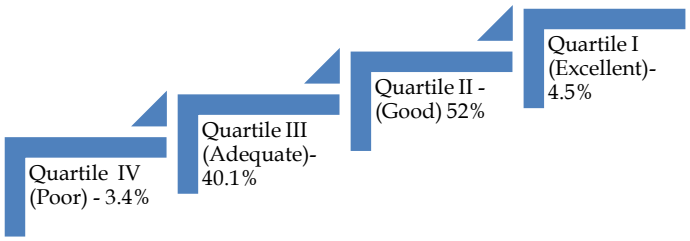


Figure 63: Social Capital Score – Treatment

52 % of the households have scored Good Social Capital while 40.1% of the households have scored Adequate on the score in the Project area. The two extremes of Excellent and Poor have very few households. These households will be tracked in midline and end line to observe the movement of households from Quartile IV ->Quartile III -> Quartile II -> Quartile I.

Distribution of households in four quartiles is similar to the households in treatment. 49.3 % of the households in control score adequate which gives enough room for these households to move to higher quartiles

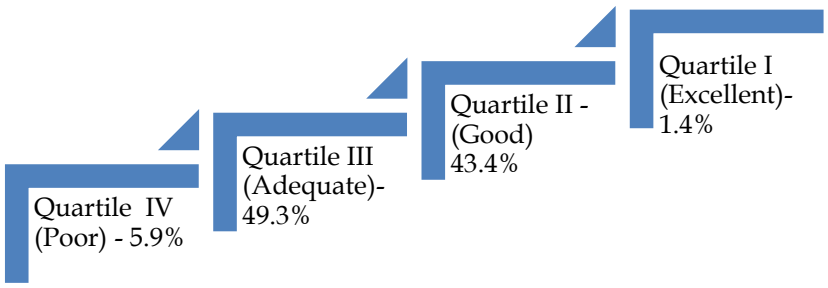


Figure 64HHs Social Capital Score - Control

11.4 Impact Area4:Women Empowerment

Gramya II has been very particular about its female beneficiaries and in providing opportunities at various stages of GPWDP implementation to empower women. Women's opinions were captured to calculate the women empowerment score. The Women Empowerment score was calculated for all the households covered under treatment and control separately based on various parameters grouped under multiple dimensions. A total of 24 parameters were considered under dimensions of 'Mobility', 'Women's role in agriculture', 'Decision making', 'Access to services' and 'Safety'. Perceptions of women are reflected in the Women Empowerment Score.

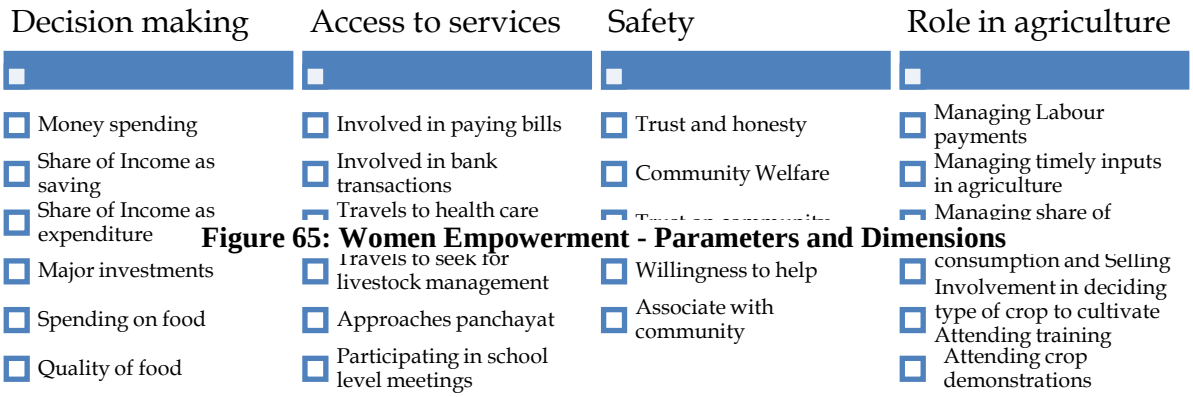


Figure 65: Women Empowerment - Parameters and Dimensions

Scores are divided into four quartiles where Quartile I represents percentage of households that have scored Excellent, Quartile II represents households scoring Good, Quartile III represents percentage of households scoring Adequate and Quartile IV represents households that have scored poorly on Social Capital front.

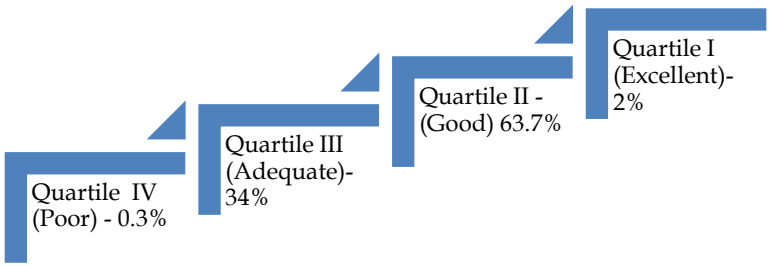


Figure 66: Women Empowerment Score – Treatment

63.7 % of women have scored Good on the Empowerment front while 34% have scored adequate in Project area. Similar is the trend in Control sample where 65.7% of the women have scored good while 32.1% have scored adequately in the Empowerment score. It will be interesting to track the impact indicator during midline and end line so as to see the shift in percentage of women feeling more secure, in their increased participation in agriculture and decision making.

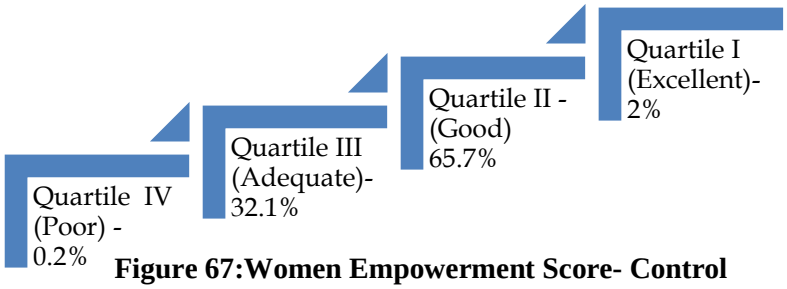


Figure 67:Women Empowerment Score- Control

i. Understanding dimensions of women empowerment

One of the key impact areas of the project is the empowerment of women by building their capacity as producers and farmers. There are numerous studies to substantiate the role of women in the agricultural economy. Globally, the discourse on feminization of labour is also gaining traction. The engagement of more women in agriculture is often seen in areas where the males migrate to urban centres in search of non-farm based income avenues. But, even in the face of such large scale engagement, women still struggle to get acknowledged as farmers and are often given very limited set of responsibilities in the production domain. The reasons behind such practises and belief systems, range from the inability of women to own land in rural areas to issues with credit access.

The baseline data also points towards the same. It was seen that only 26 percent of women individually owned land assets and around the same proportion of women owned livestock and agricultural implements. Even though, the other women responded to have joint ownership of these assets, qualitative discussions revealed that these were mostly token practises with decision making mostly in the hands of the male members.

Role in Agriculture: It is important to examine the role of women in agriculture in the light of the ownership patterns discussed.
The following figure gives an indication of the various agricultural decisions that women could be asked to take. Green indicates that a majority of women are regularly consulted for the decisions, yellow indicates that they are sometimes consulted and red indicates that they are rarely or never consulted.

Treatment		Control
	Attending trainings and agricultural inputs provided by any project	
	Attending any crop demonstration meetings conducted in the village	
	Decisions on type of crop to be produced	
	Decisions on share of production for home consumption and market	
	Managing timely inputs to be given to agriculture and horticulture produce	
	Managing Labour Payments	

Figure 68:Role of women in taking agricultural decisions
It is seen that overall, the control sites have a larger proportion of women regularly consulted on most agricultural decisions.

30 percent of women in the treatment areas and 37 percent of women in the control area said that they were regularly consulted for the type of crop to be produced. 29 percent of women in the treatment

area said that they were regularly consulted for managing the inputs for horticulture and agricultural production. An equal proportion of women in the treatment area said that they were also regularly consulted to decide the share of produce that should be sold in the markets. In the control areas, 35 and 36 percent of women were regularly consulted for these activities. About 38-39 percent of women in the treatment area and 32-35 percent of women in the control area said that they are sometimes consulted about these processes. It is fair to say that there is an increased involvement of women in the production based decisions related to agriculture though it is not as regular as it should be. Most of the women are ocassionally and not regularly consulted on production and marketing related activities, which needs to be addressed through the course of the project.

It was seen that though women were involved in the production process, they had a very limited opportunity to upskill themselves and learn better crop production methods and technologies. 43 percent and women in the treatment areas and 50 percent of women in the control said that they had never attended any trainings or learnt of any agricultural improvement inputs provided through the Gramya II project. On a similar vein, 38 percent of the women in the treatment areas and 37 percent of the women in the control area had never attended any crop demonstration meeting which was conducted in the village. About 30 percent of the women said that they had sometimes attended these meetings but had never followed up. The proportion of women who had regularly attended trainings and crop demonstrations in the treatment areas was 26 and 27 percent respectively.

This indicates that just about a quarter of the female population has been accessing training and upskilling opportunities in the treatment area. This leaves a huge opportunity for the project to involve more women in the training process so as to empower them through better capacity building on agricultural practises and entrepreneurship.

Income and Consumption based decisions: One of the major aspects leading to a higher gender empowerment score is the increased role of women in deciding how their earned money is to be spent. Less than 22 percent of the women across the project and control sites stated that they have never been consulted on any spending related decision. The following figure exhibits the decisions in this domain that are most commonly taken by women in the treatment areas and the ones where women are sometimes consulted. Green indicates that maximum number of women are regularly consulted for the decisions and yellow indicates that maximum women are sometimes consulted.

Treatment		Control
	Decisions of amount of income to be spent on purchasing adequate food	
	Decisions on spending on protein and vitamin rich food for the family	
	Decisions on share of income to be used as savings	
	Decisions on regular expenses at home	
	Decisions on major investments to be made at home	

Figure 69: Decision-making roles of women in usage of income

It is seen that the control sites perform better across all the five decision areas with the majority of respondents claiming that they are regularly consulted for these decisions. It also goes on to explain why a larger proportion of women in the control areas come under the 'Good' quartile of the Gender Empowerment Index as compared to women in the treatment areas.

11.5 GP Institutional Capacity Index

Context

Gram Panchayat plays a very important role in devolution of power and decentralization of governance. This becomes particularly relevant in connection to planning and implementation of watershed development and management projects, where GP is considered as the unit for planning, implementation and monitoring of project activities. GPWDP is a bottom up approach wherein the whole process of need analysis, preparation, implementation and monitoring is done by Gram Panchayats.

In the case of the Gramya projects, a considerable amount of time and effort is spent on GPWDP preparation, as this stage summarizes the GP scenario, including both available resources and further needs, which lays the foundation to the way forward. The planning process brings the community together, united by common cause for development and helps in capacity building of community based organizations (FPOs, User Groups, WDC etc.). As the onus of preparation lies with the community, accountability and responsibility of GPWDP implementation is also realized by the community during the process. The objective of this exercise is to strengthen GPs by forming relevant user groups which takes Gramya –II ahead in terms of implementation.

Community members have already received training in financial management and technical knowledge which has gradually and steadily increased their administrative capacity. The activity promotes social capital formation within the GP to build momentum for handling resources and continue with the implementation of GPWDP.

In this context, it is important to measure the level of institutional capacity of the GP and check what an activity like GPWDP and the Gramya–II project as a whole would be achieving. GP Empowerment Index is an index designed to measure progress in the multi-dimensional aspects of GP empowerment. The index emphasizes five major dimensions of due diligence, budget functionary, training and willingness, administrative capacity and inclusiveness. All of these dimensions are assigned varying weightages, depending on the importance of the dimension. The methodology of development and application of the index and the findings thereof are discussed in details in the sub sections to follow.
It is pertinent to point out here that some studies in the Indian Subcontinent and Asia in general have been using similar indices to measure decentralization of power, empowerment of marginalized groups/ women, good governance, people's perception of benefits received etc. A pan-India study (Alok 2012) uses similar measures to compare extent of devolution of power and localized governance across sample GPs in all States and UTs. The first stage of the study involves the shortlisting of the states and UTs that pass all five criteria mandated by the Constitution, namely:

- Establishment of state election commission [article 243 K],
- Holding regular panchayat election [article 243 E],
- Reservation of seats for SCs/STs and women [article 243 D],
- Establishment of state finance commission at regular intervals [article 243 I], and
- Setting up of district planning committees [article 243 ZD].

The second stage of the study involved calculation of indices by assigning scores to all indicators including the five indicators reflecting mandatory provisions of the Constitution. The indicators were used to measure the six major dimensions of Framework, Functions, Finances, Functionaries, Capacity Building and Accountability. The dimensions were also assigned weights according to their order of importance. The "score" obtained under each indicator were compiled dimension-wise and weighted. The weighted values were then compiled to arrive at the devolution index for each GP.

Another study by ICRISAT(Bossuet and Dar 2013) conducted in India collected primary data to examine change over time on key gender-related health, nutritional and institutional indicators in order to ultimately measure women's empowerment. The indicators used to measure nutrition were dietary diversity, anthropometry, dietary recall, health and sanitation, whereas the women's empowerment was measured by Labour participation, Social network, Time allocation, Assets,

Gender attitudes and norms and Decision making. The indicators were weighted according to their importance and clubbed to give index value per village.

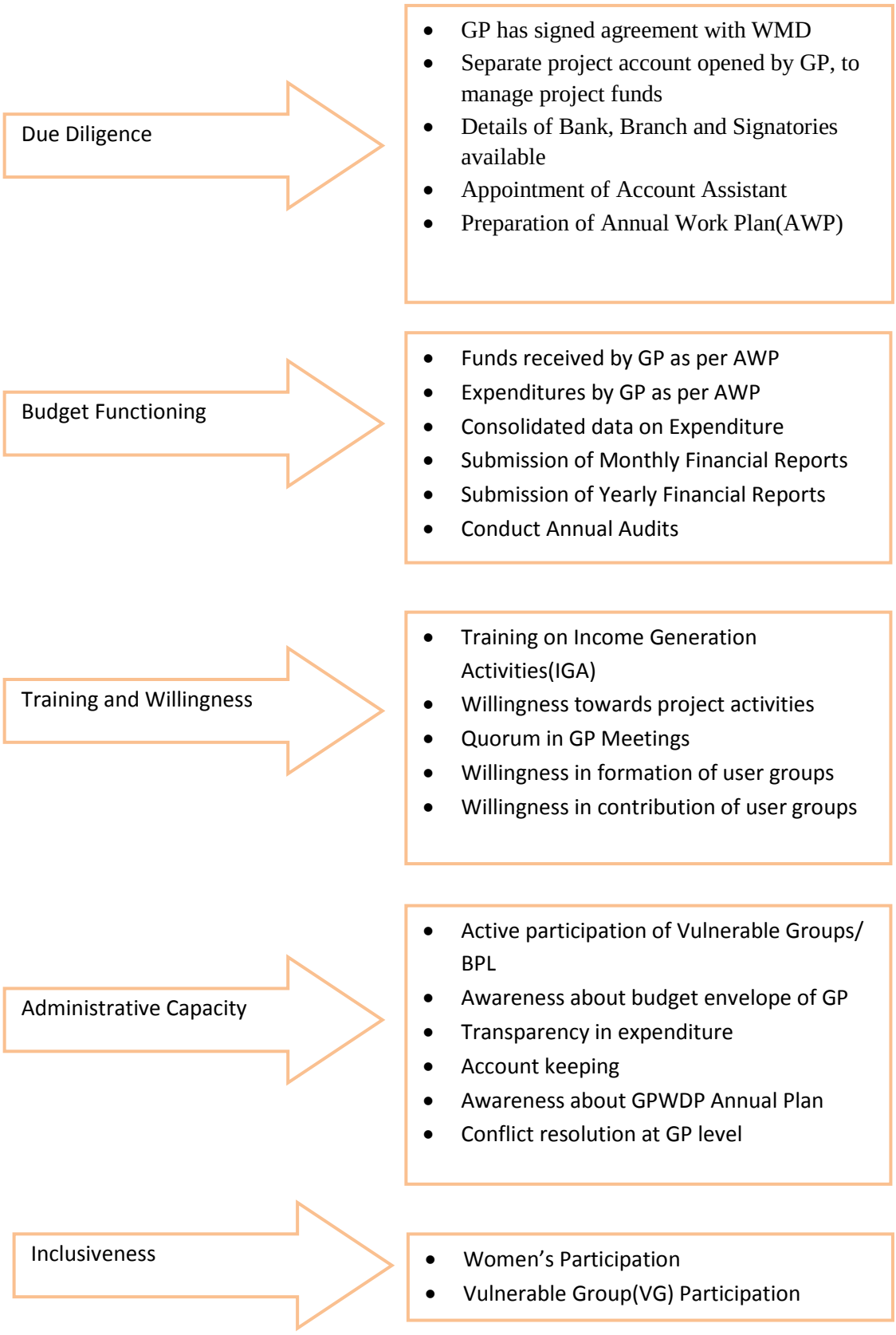
Methodology

A rigorous consultation with the project team was carried out and a total of 24 parameters were finalized which have an impact over project implementation and were considered non-negotiable for the project to be successfully handled by GP. The indicators were categories under five subgroups namely (1) Due Diligence; (2) Budget Functioning; (3) Training and Willingness; (4) Administrative Capacity (Accountability and Transparency); and (5) Inclusiveness

The performance under each subgroup, except for Administrative Capacity, is calculated through binary scores. So, each correct answer receives 1 point and the incorrect one receives 0 points. The fifth dimension is that of Administrative Capacity (Accountability and Transparency) whose indicator is on a five-point scale of Improvement, viz, Excellent, Good, Moderate, Below moderate and Poor. Marks are assigned and the respective marks are five, four, three, two and one for excellent, good, moderate, below moderate and poor. If the performance of an indicator is excellent it may get a maximum score value of 1 whereas if the performance is poor the score value is 0.2. The aggregate of marks for each dimension is based on the number of indicators covered which varies with each dimension. Finally, the weighted aggregation of five dimensions is computed for each GP.

The following figure encapsulates Dimensions and Indicators for the GP capacity Index

Figure 70: Dimensions and Indicators of GP Empowerment Index



Each dimension has a scale depending on which ratings are decided. The ratings are on a percentage which is a standard procedure followed throughout the process. The highest weightage is carried by two dimensions which are (1) Budget Functioning (2) Administrative Capacity. Both of these dimensions carry importance because of their relevance in smooth functioning at GP level. The other two parameters which carry the next level of importance in the index are Due Diligence and Willingness. Due Diligence covers various parameters such as following norms, procedures, record keeping etc. These due diligence parameters are needed for hassle free functioning of GPWDPs. So is the willingness required from various community members involved at GP level. The last dimension covers inclusiveness with respect to women and vulnerable groups (VG). Both stakeholders are important contributors to the project. And that is why the dimension holds a placing in the index.

The composite score is calculated by applying the weightage average of all the five dimensions. Weightage for each of these dimensions is mapped to the scale.The table below describes the range values for each of these dimensions:

Table 52: Range value for each dimensions

Range value for each dimension							
Dimensions	**Scale**	**Excellent (Min 100%)**	**Very Good (Min 95%)**	**Good (Min 90%)**	**Fair (Min 80%)**	**Poor (Min 70%)**	**Very Poor (Less than 70%)**
Due Diligence	5	5	4.75	4.5	4	3.5	Less than 3.5
Budget Functioning	6	6	5.7	5.4	4.8	4.2	Less than 4.2
Willingness	5	5	4.75	4.5	4	3.5	Less than 3.5
Administrative Capacity	6	6	5.7	5.4	4.8	4.2	Less than 4.2
	Excellent(100% = 2) , Good(Min 50%=1), Poor (Less than 50% = 0)						
Inclusiveness	2	2		1		0	
Composite Score	5.25	5.25	4.98	4.72	4.2	3.67	Less than 3.67

Gram Panchayats(GPs) have been scored according to the scale mentioned above. They are then distributed based on the score they obtain in each of these dimensions and in the composite score. The frequency of occurrence of GP is then calculated for all the six ranges mentioned. Based on the frequency, percentage of GPs falling within the range is given a mention below:

Table 53: Percentage of GPs falling in the respective range

Percentage of GPs falling in the respective range							
+-	**Scale**	**Excellent (Min 100%)**	**Very Good (Min 95%)**	**Good (Min 90%)**	**Fair (Min 80%)**	**Poor (Min 70%)**	**Very Poor(Less than 70%)**
Due Diligence	5	75%	-	-	17%	-	7%
Budget Functioning	6	86.5%	-	-	11.5%	-	1.9%
Willingness	5	40.3%	-	19.2%	11.5%	5.7%	23%
Administrative Capacity	6	65.3%	-	-	21.1%	11.5%	1.9%
	Excellent(100% = 2) , Good(Min 50%=1), Poor (Less than 50% = 0) – Only for Inclusiveness						
Inclusiveness	2	Excellent (Min 100%)		Good(Min 50%=1)			Poor (Less than 50% = 0)
		61.5%	-	36.5%	-	-	1.9%

Percentage of GPs falling in the respective range							
+-	Scale	Excellent (Min 100%)	Very Good (Min 95%)	Good (Min 90%)	Fair (Min 80%)	Poor (Min 70%)	Very Poor(Less than 70%)
Composite Score	5.25	21.1%	25%	17.3%	19.2%	15.3%	1.9%

Below is the individual composite score for all the GPs:

Table 54Composite Score for all the GPs

Composite Score for all the GPs						
GP	Due Diligence(Max Score = 5)	Budget Functioning (Max Score = 6)	Willingness (Max Score = 5)	Administrative Capacity (Max Score = 6)	Inclusiveness (Max Score = 2)	Composite Score (Max Score = 5.25)
Soopi	4	6	2.5	4.4	0	3.95
Kiroli	4	5	3	4.4	1	3.89
Pothing	3	6	2.5	5.2	1	4.03
Dulam	4	6	2.5	5.2	2	4.32
Sama	4	6	3	4.4	1	4.14
Madam	4	6	2.5	6	1	4.44
Chaundungri	5	6	2.5	4.4	1	4.25
Dungara	5	6	2	6	1	4.54
Kabhari	5	6	5	6	2	5.25
Pali	5	6	4.5	6	2	5.15
Kaluta	3	5	4.5	6	2	4.48
Nainoli	5	6	4.5	6	2	5.15
Ara Salphar	4	6	4	5.2	1	4.55
Mohana	5	6	5	6	1	5.17
Vyasbhood	5	6	5	6	2	5.25
Kandora Baundur	5	6	5	6	2	5.25
Kandaal	5	6	5	6	1	5.17
Bijnu	5	5	5	6	2	5.00
Tilau	5	6	4.5	6	2	5.15
Dharkot	5	6	5	6	2	5.25
Halai	5	6	5	6	2	5.25
Era Malla	5	6	5	6	1	5.17
Kathuli	3	6	4	5	2	4.38
Simar	5	6	5	6	1	5.17
Chopra	4	6	5	6	1	4.96
Gadri	5	6	5	6	2	5.25
RainsoliTalli	5	6	5	6	2	5.25
Hokra	5	6	4.5	6	2	5.15
Malajhula	5	6	5	6	2	5.25
Khetbhagar	5	6	1.5	6	2	4.52
Bhejkhal/bhainskhet	5	6	3.5	6	2	4.94
Ranikhet	5	6	3.5	6	2	4.94
Dyokali	4	6	3	6	2	4.63
Chaka	5	6	5	6	2	5.25
Dangi	5	6	4.5	6	2	5.15
Kurchola	5	6	4	2	2	4.04

Composite Score for all the GPs						
GP	**Due Diligence(Max Score = 5)**	**Budget Functioning (Max Score = 6)**	**Willingness (Max Score = 5)**	**Administrative Capacity (Max Score = 6)**	**Inclusiveness (Max Score = 2)**	**Composite Score (Max Score = 5.25)**
Dadoli	5	6	4.5	5	2	4.90
Paudhi	5	5	5	4.2	2	4.55
Siyakempty	3	5	3.5	5.2	1	3.99
Kandajakh	5	6	0.5	5.2	2	4.11
Lalotna	5	6	5	6	2	5.25
Khera	5	6	1.5	4.4	2	4.12
Masrar	5	6	4	6	2	5.04
Pantwari	5	6	4.5	5.2	2	4.95
Tator	5	6	5	6	2	5.25
Bel	5	6	4.5	6	2	5.15
Koti Banal	5	6	5	5.2	1	4.97
Devdhug	4	2	4.5	5	1	3.60
Pokhari	5	6	4	6	1	4.96
Nanai	5	6	5	6	1	5.17
KandiyalGaon	5	6	4	5.2	1	4.76
Gadoli	5	5	5	6	1	4.92

Findings:

(1) Due Diligence – 75 percentage of the GPs covered fulfil the due diligence norms and are found to be excellent, based on the perception of the GP officials. 17% of the GP were rated fair while 7% have performed poorly in the due diligence dimension.
(2) Budget Functioning – 86.5 percentage of the GPs have done an excellent job in terms of submission of monthly and yearly audits, and other budget allocation activities. 11.5% of the GPs performed fairly while 1.9% performed poorly in the budget functioning head.
(3) Willingness – 40.3 percentage of GPs performed excellently under training and willingness while 19.2% GPs fall under the range of good, 11.5% GPs have done fairly while 5.7% have performed poorly and 23% of them performed very poorly. Under the willingness head, there is a lot of scope for improvement in the willingness and training. As the Gramya II progresses, the willingness of the community members will play an important role for sustainability.
(4) Administrative Capacity – 65.3 percentage of GPs performed excellently under administrative capacity head, while 21.1% of the GPs performed fairly, 11.5 percentage of the GPs performed poorly and 1.9 percentage of the GPs performed very poorly under this head.

21.1 percentage of GPs have performed excellently in the composite index which is a combined score of all the five dimensions. 25 percentage of the GPs have attained very good composite index while 17.3 percentage of GPs have attained good scores. 36.4% of GPs have attained below fair composite index.

As of now, which is the beginning of Gramya II, there is a scope for expansion of work and power at Gram Panchayat level. While some GPs have achieved the maximum in the empowerment index, a few have performed below average. The department can make guided efforts, especially in the Willingness aspect of the community members to make it a stronger dimension while the other dimensions work towards improving their indicators

Conclusion and Recommendations

12. Conclusion and Recommendations

The baseline stage cannot be used to comment on the effectiveness, the efficiency and the sustainability of the project, some critical insight can be gained on the relevance of the project and the activities outlined. These insights should be reflective of the road blocks and concerns on the field so that redressal and mitigating measures could be immediately taken to undertake course correction and ensure that the benefits of the project are correctly accrued.

The targeting of the project is seen to be relevant since the dependence on agriculture and allied activities has been clearly established along with a low income and asset ownership. The market linkages have been found to be inadequate and non-remunerative even in the face of increased crop diversification and uptake of high yielding variety crops. This necessitates further organization of farmer groups and transfer of knowledge on agri-business and entrepreneurship development which are the core of the project.

12.1 Situational Analysis

At the stage of the baseline, it has been estimated that about 60 percent of the sampled HHs are direct beneficiaries of the project. Women comprise of 72.6 percent of these project beneficiaries. The most beneficiaries were from the Rudraprayag district (80.4 percent) and the least number were found in Almora (52 percent).This data has been estimated from the primary survey conducted at the level of the Panchayats but will further be validated through the MIS data once it is available. Some of the other key findings at the level of the baseline are outlined below.

1. The biomass estimation was done in 8 sample micro watersheds through an integration of field data with visually processed satellite image. All 8 divisions were covered in the data collection process. The overall biomass in Tonns is 4098995.16and average across area is about 25.47Tonns/Ha. Rudraprayag and Pauri registered a higher density of Biomass with about 34.89and 33.36 Tonns/Ha respectively.
2. About 87 percent of the total cultivable land in the state is dependent solely on rainfed irrigation.
3. The major rain-fed crops in the surveyed areas include Maize, Wheat, Pigeon Pea (Tur), Finger Millet and Red Kidney Bean (Rajma). The major irrigated crops include Ginger, Garlic, Green Leafy Vegetables (Cabbage and Cauliflower) and Peas.

The highest productivity was seen in the Ginger cultivation with both project and control areas registering a productivity of 82 and 85 quintals per hectare in the 2015-16 period. Maize was cultivated through the three cropping seasons and in the treatment areas had a productivity in the range of 12-13 quintals/hectare in treatment area. The productivity of Maize in the control areas was slightly higher with a range of 17-22 quintals/hectare. The productivity of Finger Millets and Paddy was also significantly high with 17.6 quintals/hectare and 16.9 quintals/hectare registered respectively.

1. 22.3 percent of the farmers in the treatment area are cultivating high value crops which includes ginger and garlic. 12 percent of the farmers in the treatment area had started the cultivation of Potatoes which is the most common crop that farmers are adopting.
2. 79.8 percent of the respondents in the treatment area and 78.3 percent of the respondents in the control own livestock. Only 8 percent of the respondents owning livestock possess improved varieties of milch cattle.
3. 67.2 percent of the HHs in the treatment area had at least one member who had attended a Gram Sabha Meeting in the past member. 62.4 percent of these households had at least one woman from the family attending the Gram Sabha Meeting in the past year.
4. The average household monthly income in the treatment area for the year 2015-16 was found to be Rs. 11,718. In the control areas, the monthly income was almost similar at Rs. 11,761.

5. It was found that the per capita annual consumption of protein rich diet through consumption of milk, meats, eggs and pulses was 13 kgs in the treatment area. This meant that the per capita per day consumption of protein rich diet is about 36 grams per day.

12.2 Learnings from the Baseline

i. Lack of knowledge on post-harvest technologies

The baseline findings indicated a rather low level of usage of post harvest technologies in the treatment area. Nearly 56 percent of the HHs claimed that they have never adopted any post harvest technology to get a better price for their produce. There is hardly any technology being used for critical value chain enhancement steps like processing, packaging and storage. Less than 15 percent of the farmers in the treatment area use some sort of an improved drying and grading technology. This indicates that there is no value chain established for high value crops which could be a reason behind the less than remunerative returns for farmers. But, the lack of demand for the creation of value chains is the bigger problem which needs to be addressed. Only about 36 percent of the surveyed HHs indicated an inclination to get trained on post hervest technologies.

There is a need to create more awareness about the necessity of post harvest technologies and the way in which it leads to the realization of a better value for crops. Though relatively low, 36 percent of the surveyed HHs in the treatment area had expressed an interest in getting further training on post-harvest technologies which indicates certain willingness of the community to learn and adopt these practices at the earliest. There needs to be more awareness generation on post harvest technologies through trainings and demonstration visits.

ii. Lack of Market Linkages

The baseline findings indicate that due to lack linkages with aggregate markets the produce is often sold in low prices. While project has initited the process by bringing the ABSO agency on board, but in regions where new variety of seeds are provided there is a need to see end to end linkage so that farmers are convinced about the expected returns. It would essential to take lead farmers on exposure visits on such pilot initatives done in different regions so the FIG members can engage and particpate the project interventions.

iii. Further probing on training demands

It was noted that the respondents were more keen to get trained on advanced agricultural production technologies rather than training forimprovement of basic farming techniques. More than 54 percent of the respondents in the treatment areas demanded further training on land preparation, improved variety of seeds and sowing techniques. In contrast, just about 28.4percent of the respondents showed interest in soil moisture conservation techniques and 33 percent were interested in integrated pest management training. This finding is quite revealing in the context of the fact that 46 percent of the farmers claimed to engage in agriculture without using any sort of pest management technique. While remuneration through sale of crops was often expressed as a problem, training on market linkages was demanded by just about 32 percent of the respondents.

While, the demand for the training programs could be indicative of the real issues being separated from the problems which have been assumed, there is a need to further probe into the level of awareness of the farmers about the necessity of the various activities which are counted as basic farming practices. Lack of clear knowledge on aspects like pest management or post harvest technologies could be leading to lesser demand for training. At the same time, there is a substantial demand for trainings on agri-technologies including irrigation methods, use of fertilizers and plant protection. More than 48 percent of the respondents in the treatment areas have expressed the need for these trainings.

iv. Focus on livelihood enhancement through entrepreneurship development

The primary data collection figures establishing the baseline, were in tune with the secondary findings and revealed that 54 percent of the share of the HH income is from agriculture and 18 percent is from livestock rearing.

In the light of these findings, the average HH income in the treatment area is still below the average in the control areas and particularly low in high hill districts like Bageshwar and Pithoragarh. Therefore, the strategies for outreach and mobilization for the formation and strengthening of Farmer Interest Groups and Farmer Federations need to be well thought out and targeted in certain low income districts. It is to be understood that only the formation of these groups will not bring in the necessary upward spike in incomes and it needs to be augmented by trainings on development of agri-business plans and strategies for market linkages.

Entrepreneurship remains a weaker area in the treatment districts primarily due to lack of knowledge and support structures. The development of micro agri-enterprises will also generate jobs in the areas and could result in decreasing distress migration from the state.

V. Addressing debt and financial support through multiple action points

One of the major concerns seen in the treatment areas was the indebtedness of the farmers and the subsequent troubles faced during repayment. It was seen that 16 percent of the households had taken a loan in the past year with 21 percent of the loans taken for buying land, livestock and other HH durables. The qualitative discussions with the farmers revealed multiple dimensions to this indebtedness. On one hand, there was the concern of the sales of the farm produce being remunerative enough to invest in the next crop cycle. On the other hand, there were the concerns of paying off the debts because the loan amounts were inadequate or the returns were still below expectations. The third concern revealed by many farmers was the inability to get a loan for the purpose of investment.

This necessitates action and intervention on three fronts. Firstly, there needs to be a concerted attempt to make sure that the farmers get their due for their produce and the sales are remunerative enough for investment in the next crop cycle. The second action point should be to ensure that the investment is need based and is guided by scientific and logical identification of gaps and loopholes and is not intuitive or sporadic. It could happen that the loans taken are not being used correctly which is spiralling the debt cycle but is not addressing the specific concerns for which they are being availed.

The third front though less discussed is vital and concerns establishing more financial linkages along with market linkages. This is a critical peg in the cycle for strengthening supply chains and there is a necessity to look into the micro finance based support that is available to the farmers in the area. The formation of more FIGs and FFs with a savings component could also direct home based savings to these more institutional bodies which would allow for bigger sums to be be borrowed and a sharing of risk within the community.

vi.Addressing the willingness of the community to take part in project activities

One of the impacts being mapped in the improvement is the institutional capacity of Gram Panchayats to undertake budgetary and administrative work. The community based user groups are supposed to strengthen the GPs as the GPs will be critically involved in the handling of the resources and in the implementation of the GPWDP. The baseline findings revealed that 36.4 percent of the GPs still score below fair on the institutional capacity index. This indicates that there is still a lot of work to be done on improving the willingness of the communities to come together and work towards building the capacity of the GPs. The biggest loophole has been noticed in the willingness of the communities to get together to form user groups and give contributions as users of the services. The lack of

willingness also extends to being a part of project activities including participation in training activities. Below par participation in GP meetings is also a cause of major concern. There is also a need to look into the participation of vulnerable groups in the GP activities and ensuring transparency in expenditure and book keeping.

The project is still in its in nascent stage and there are enough inroads and time available to resolve the problem of willingness among communities. It has to be ensured that the community mobilization and organization activities are given enough time and thought and designed to speak to the issues faced by the targeted beneficiaries. The benefits of participation and the cost of non-participation should be clearly articulated and expressed tangibly in economic terms.

vii.Road Map for the Midline and Endline

In many of the places for result indicators the values of productivity of crops are higher in control areas compared to project areas which maybe due to other project nterventions in the control area by line departments. It has been suggested that the treatment sample will be halved at the point of the midline evaluation. Therefore, the consultants will undertake matching to retain the most relevant counterfactual pairs for the evaluation and control the contamination of other intervnetions The midline and the endline will track the project development, intermediate and outcome indicators and see the trajectory of change since the baseline. With the project having truly commenced in all operational areas, the findings of the mid term and end-term evaluation will be more reflective of the effectiveness of the program. The midline evaluation will also look into the sustainability components built into the project activities that allow to make the transfer the project to the community more feasible and fruitful.
The changes in the impact level indicators like average household income, per capita consumption of protein rich diet and increase in local wages will be mapped against the project activities, duration of engagement and membership in institutions formed. This will allow for differences in impacts within the treatment group to be mapped and the heteogenity of impacts can be understood. The land holding size and income levels will be mapped against productivity of crops and crop diversification patterns to clearly identify the causality of impacts.

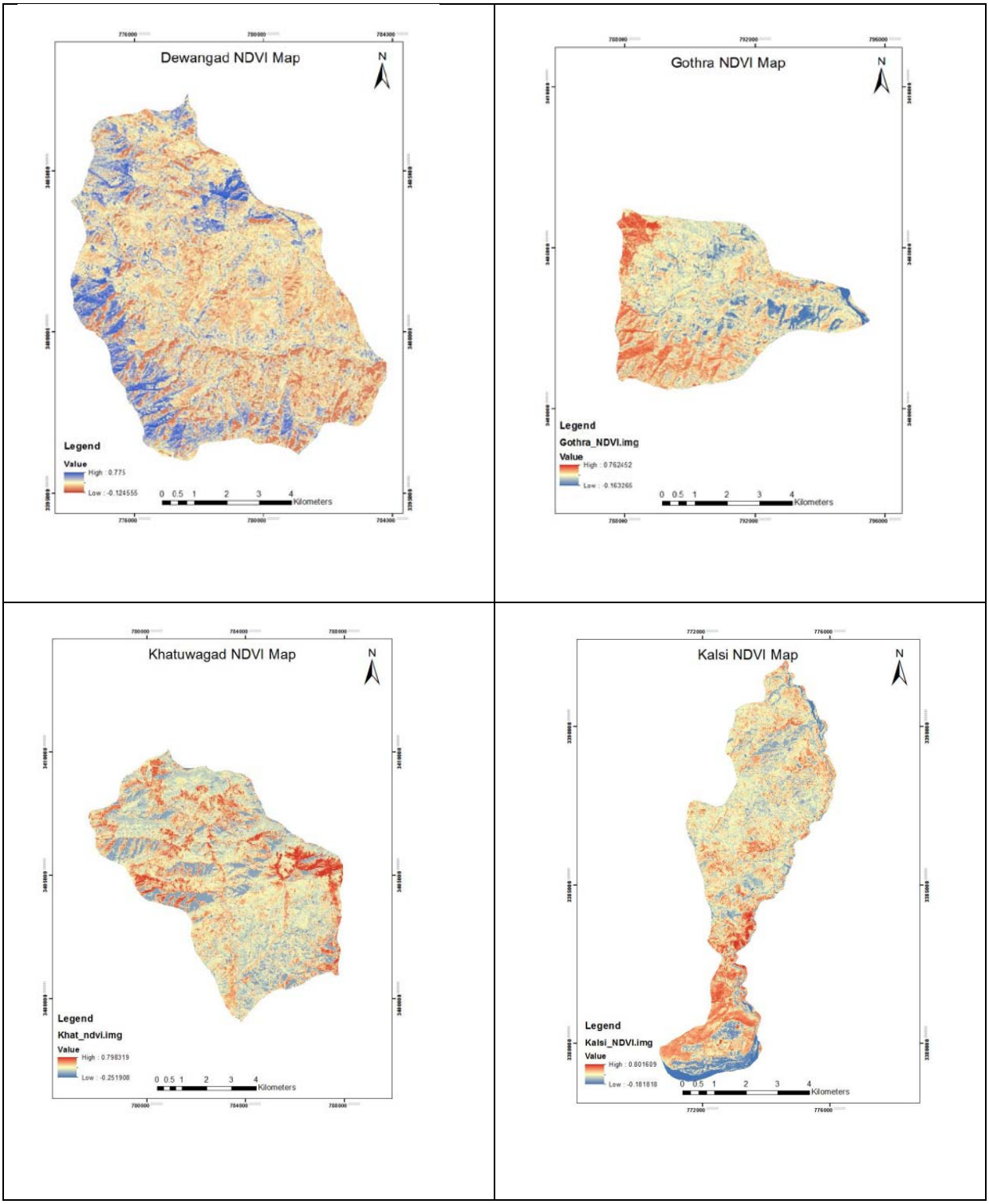
Qualitative investigations will look into the activities aimed at strengthening the value chain for selected commodities, nature of functioning of the farmers groups formed and the relevance of the trainings and demonstrations for the farmers. It will also look into the role and engagement of women in the project activities and the extent to which they have been involved in the day to day activities related to farming. The overall empowerment of women and the community members along with the institutional capacity development of the Gram Panchayats will be looked into at the level of the mid-line and the end-line.

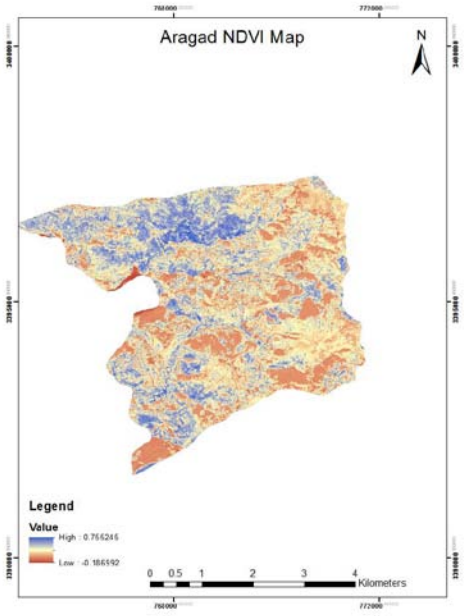
ANNEXURE

Contents

Annexure 1: NDVI Maps

1. NDVI images Dehradun division

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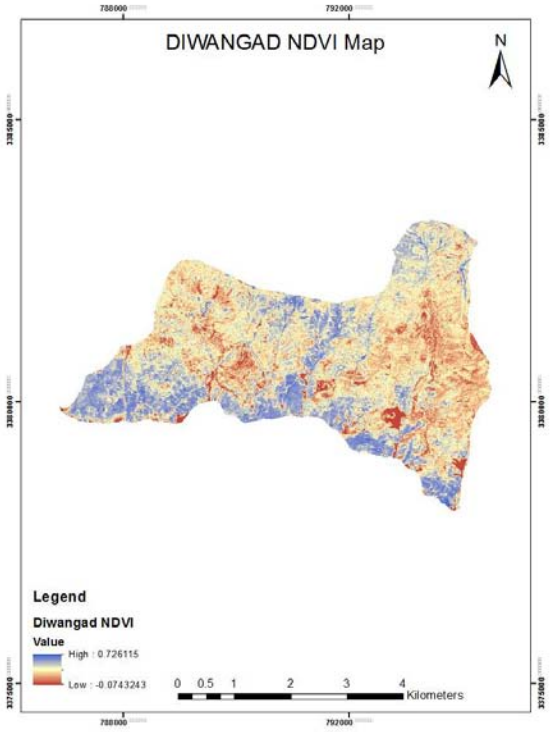

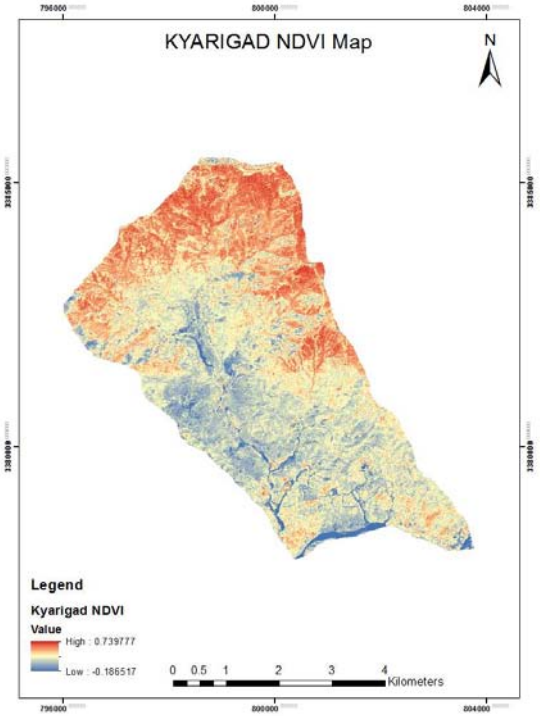

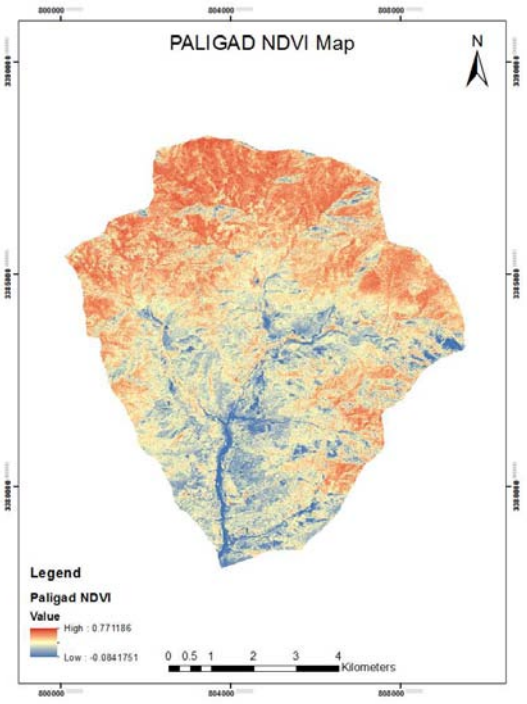

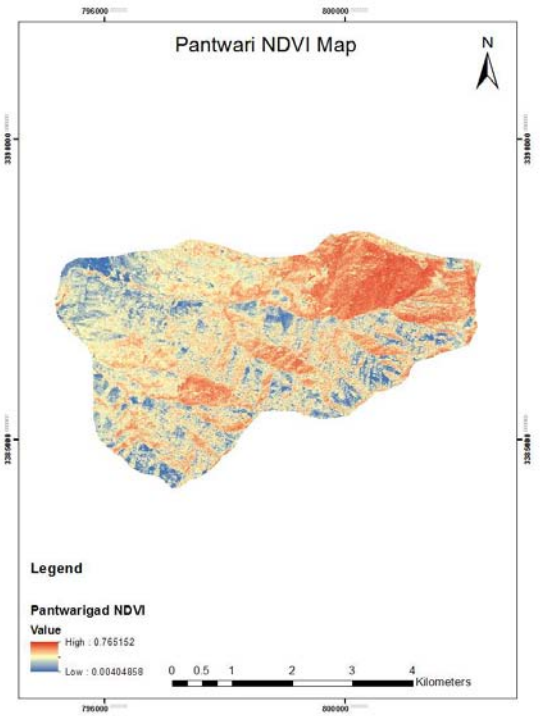

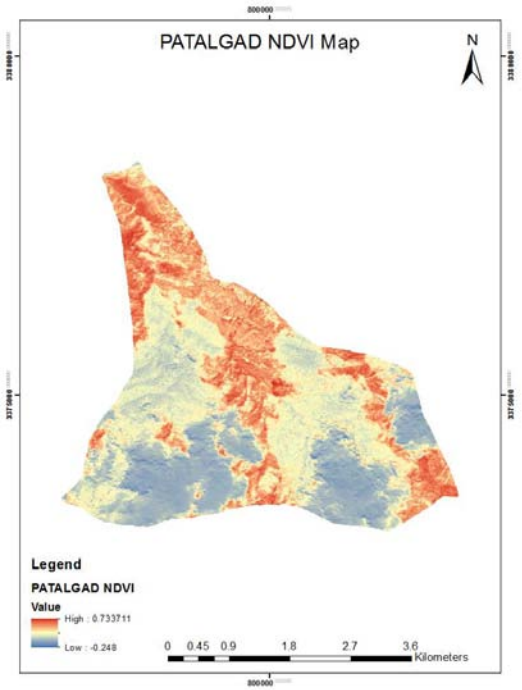
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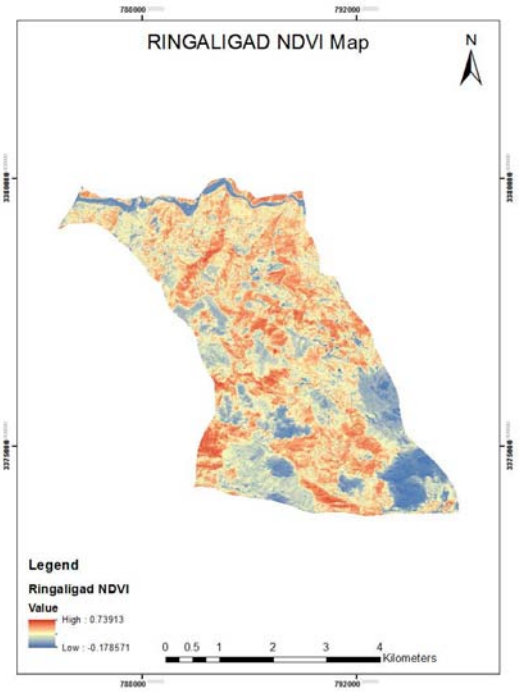
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Legend
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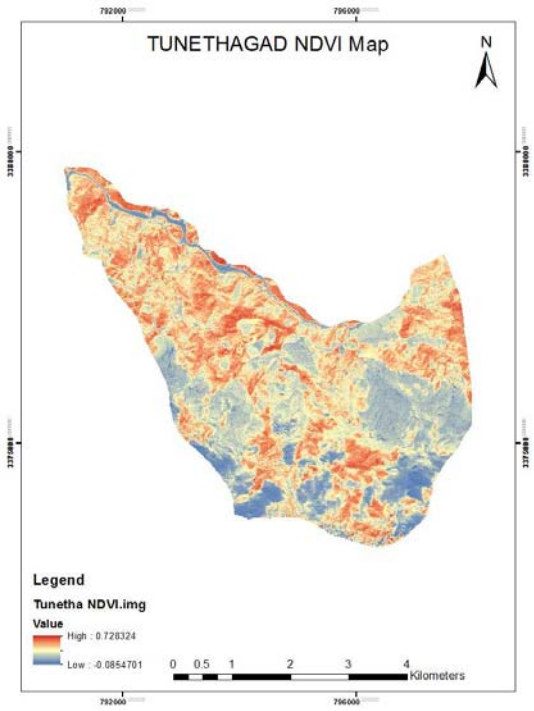
Kilometers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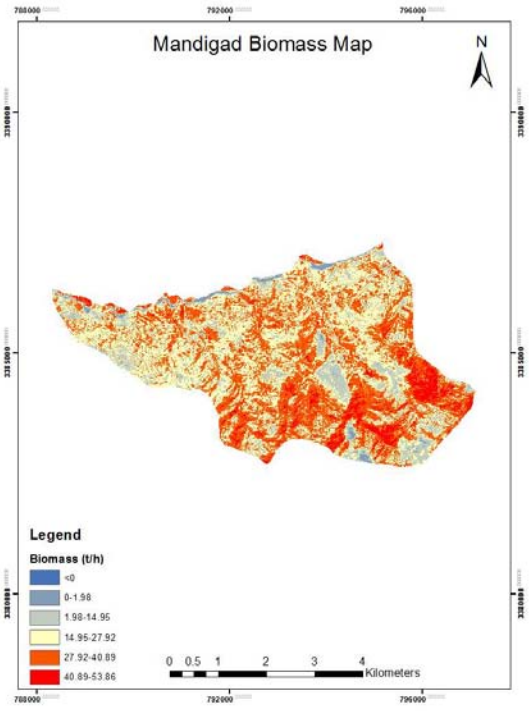
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Legend
Biomass (t/h)
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Kilometers

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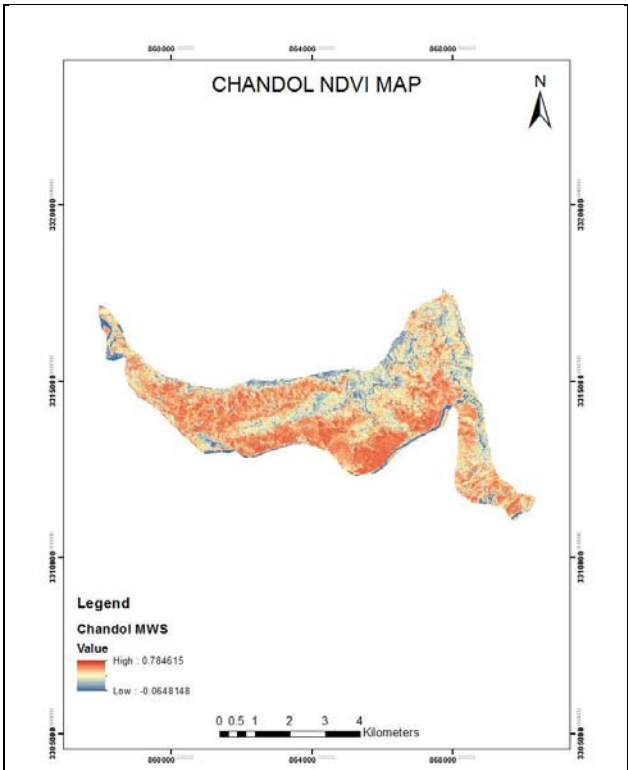

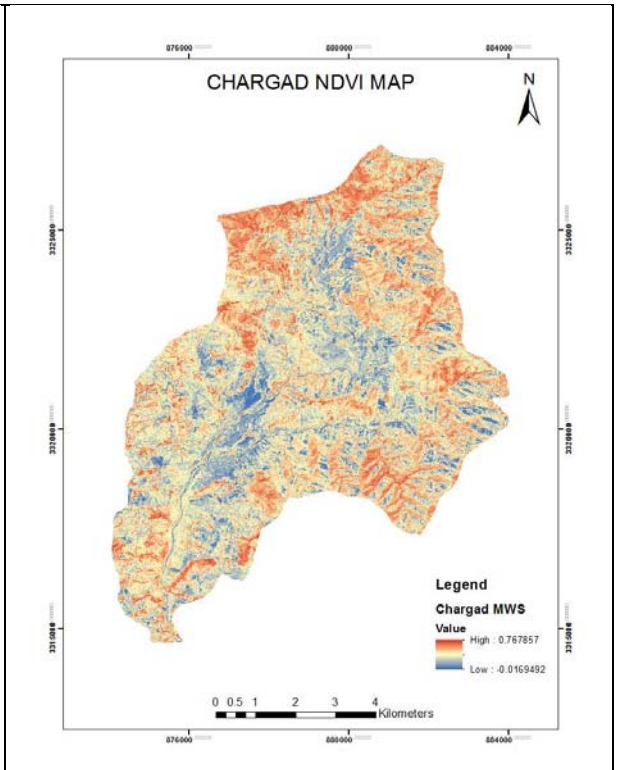

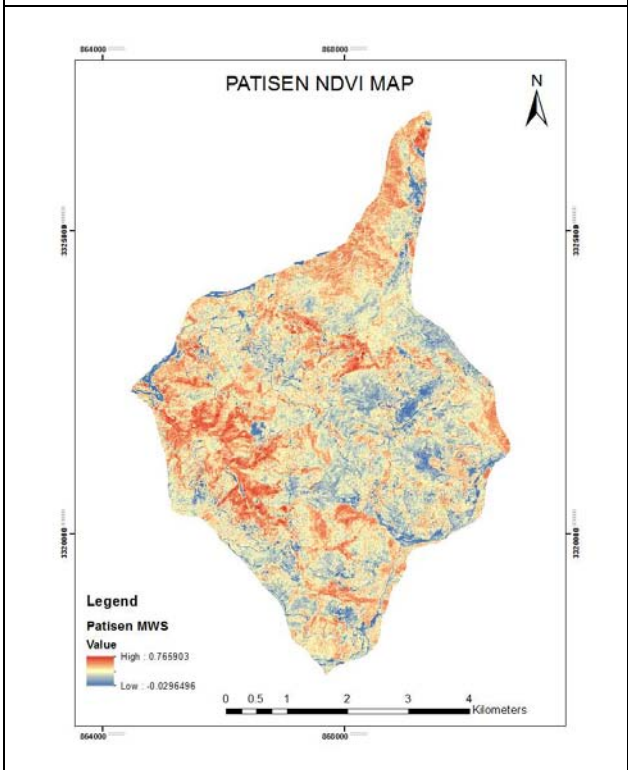

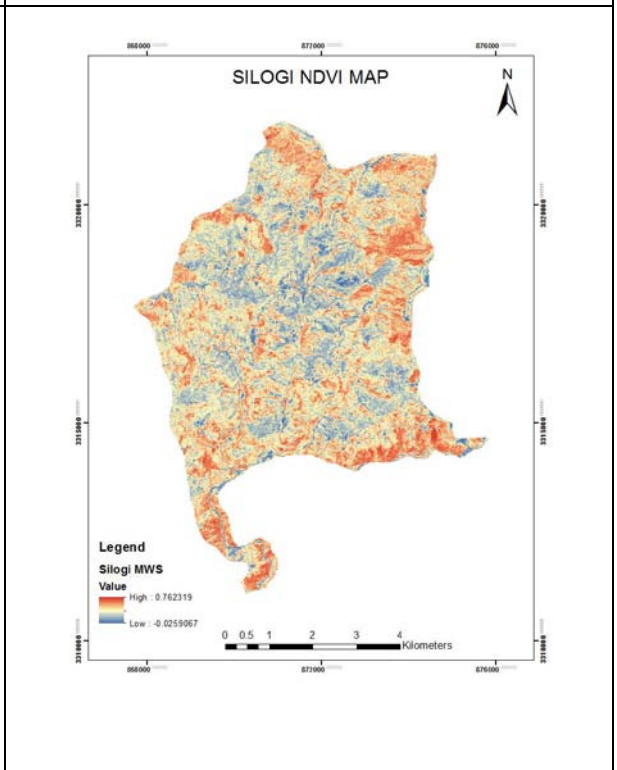

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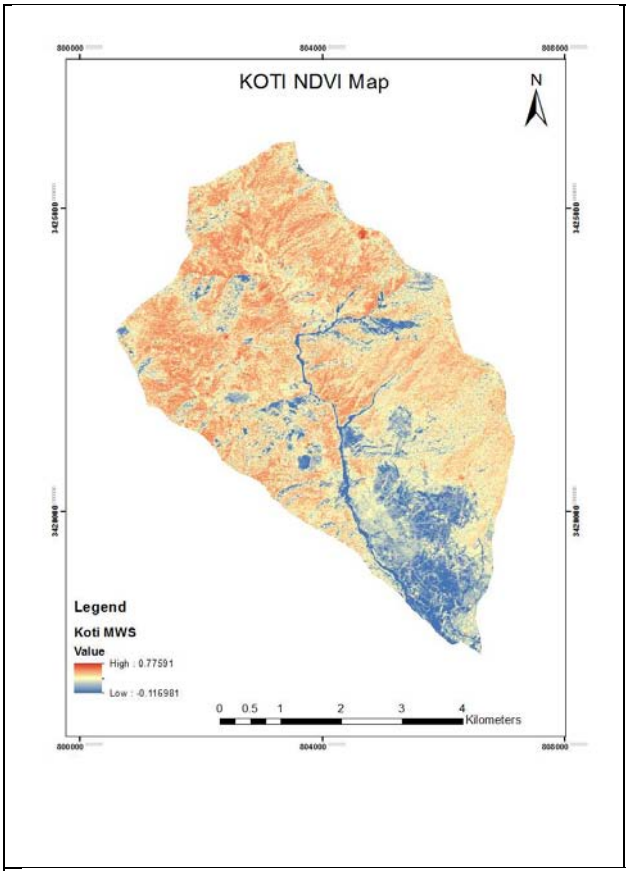

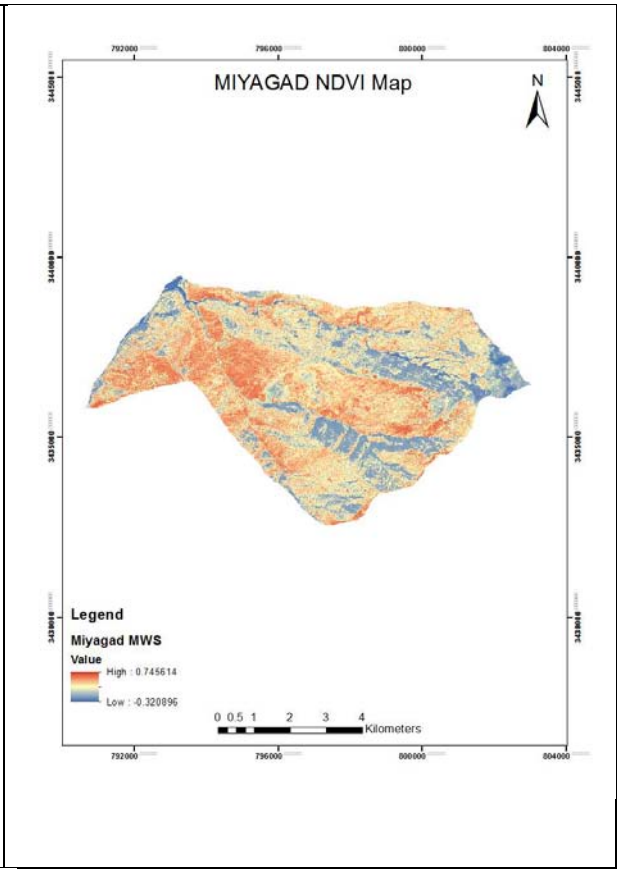

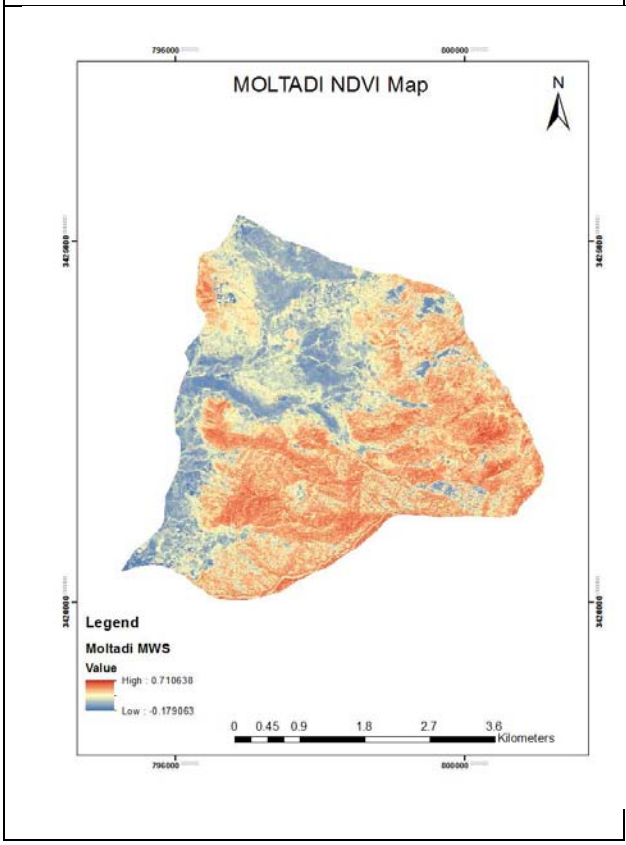

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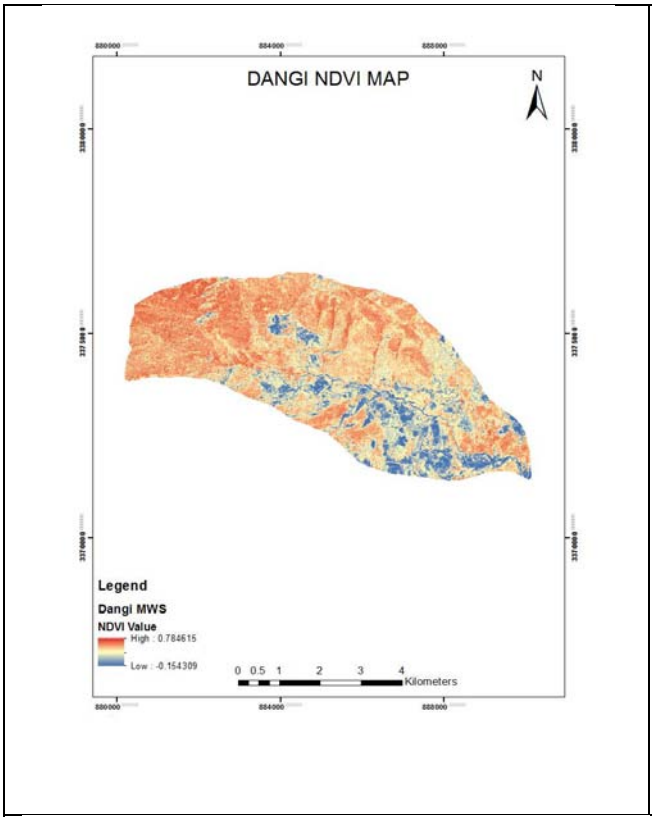

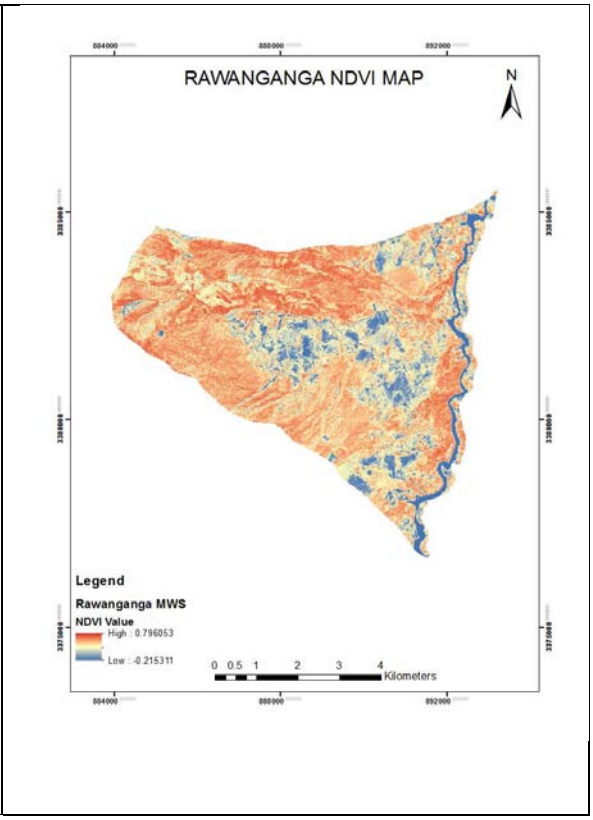

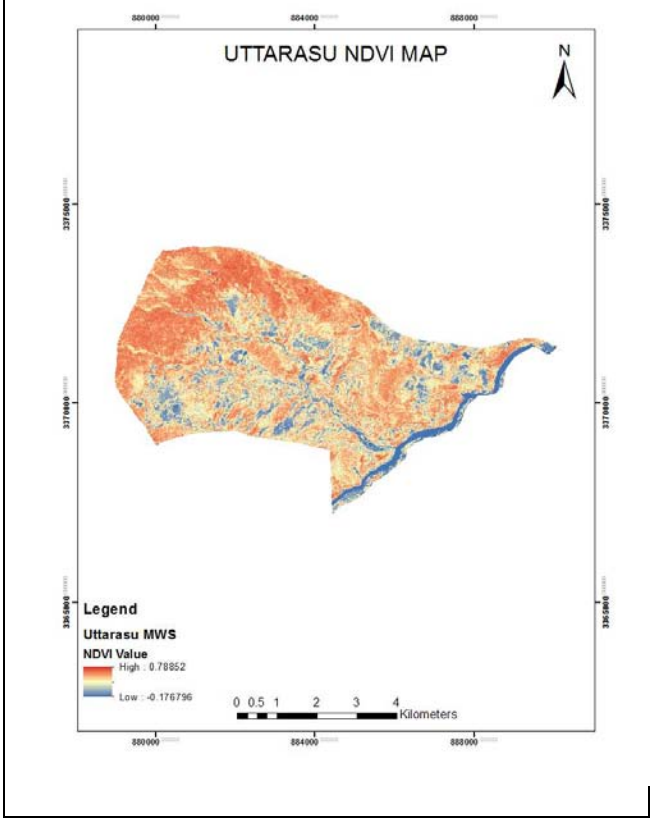

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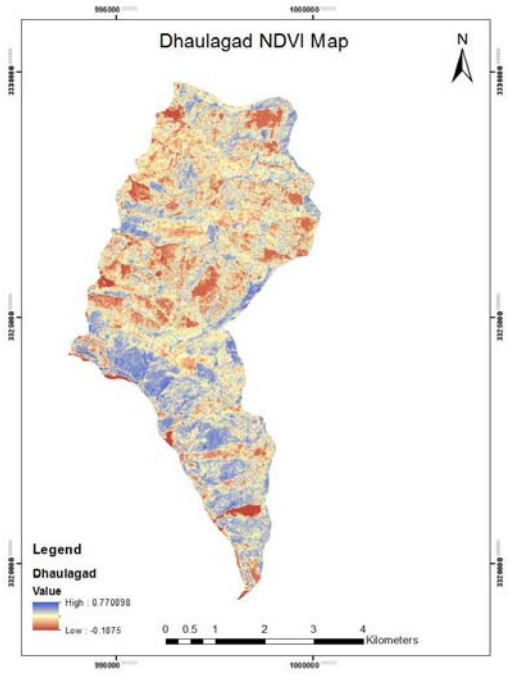
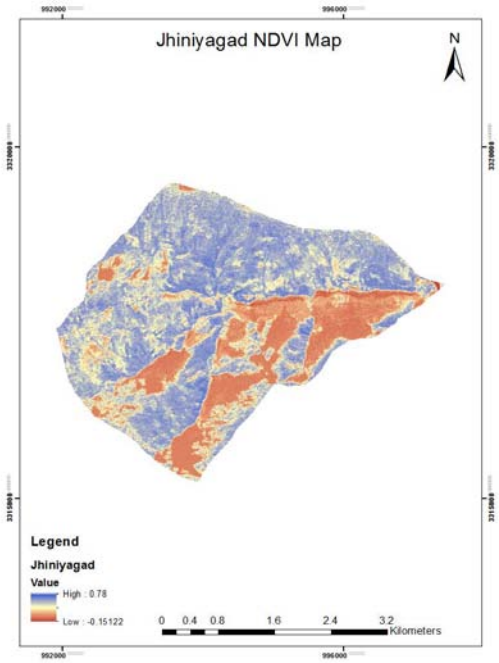
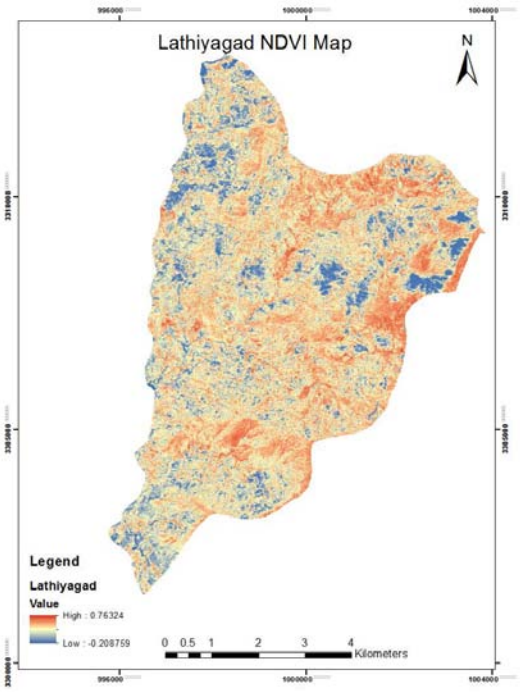
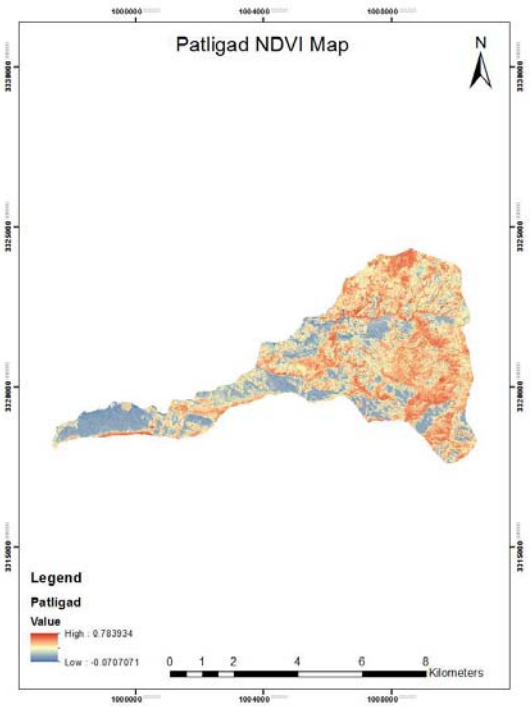
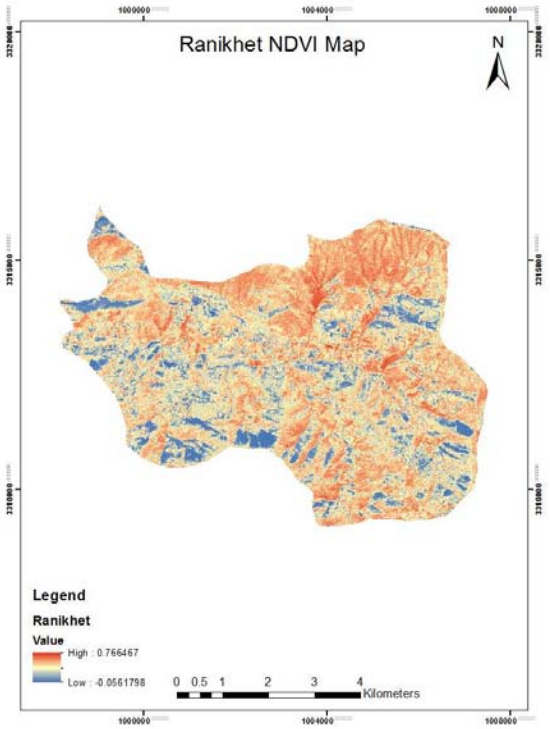
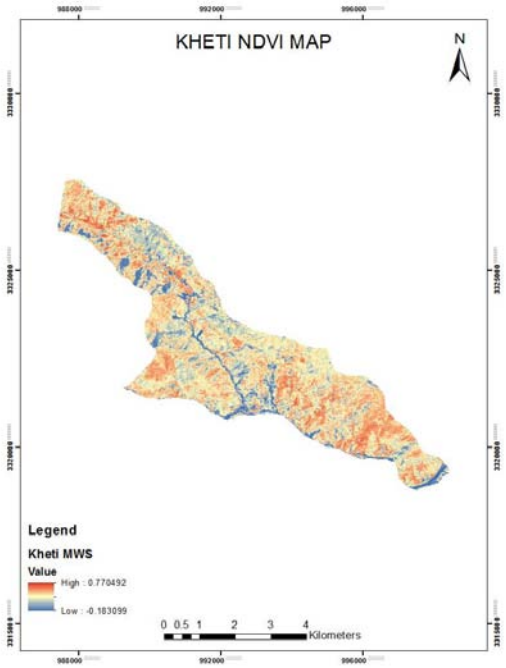




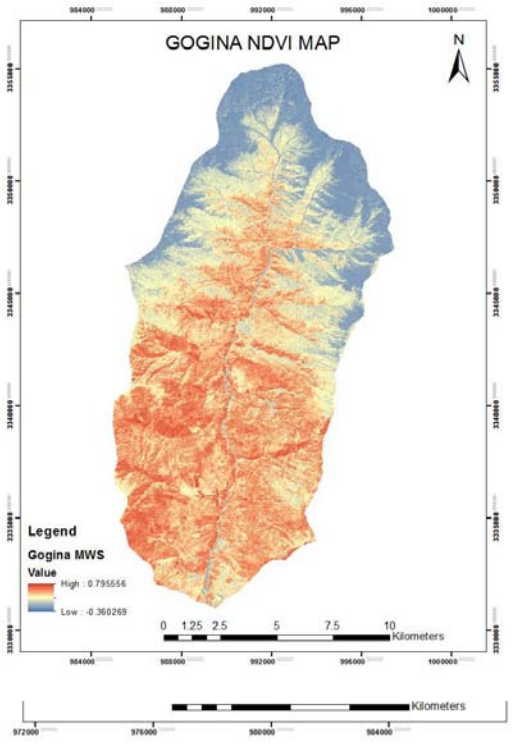


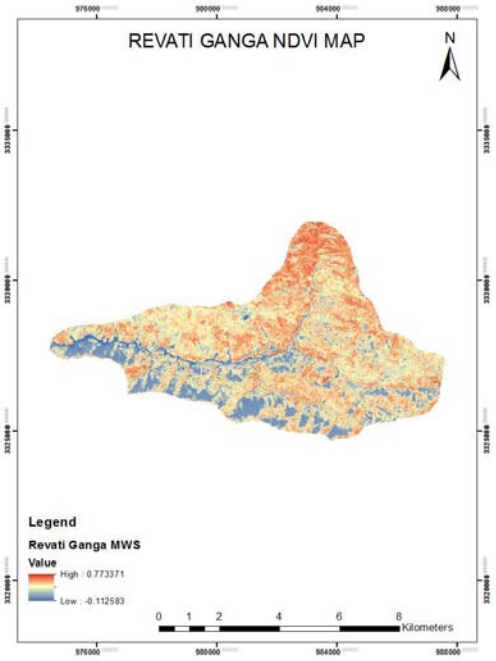


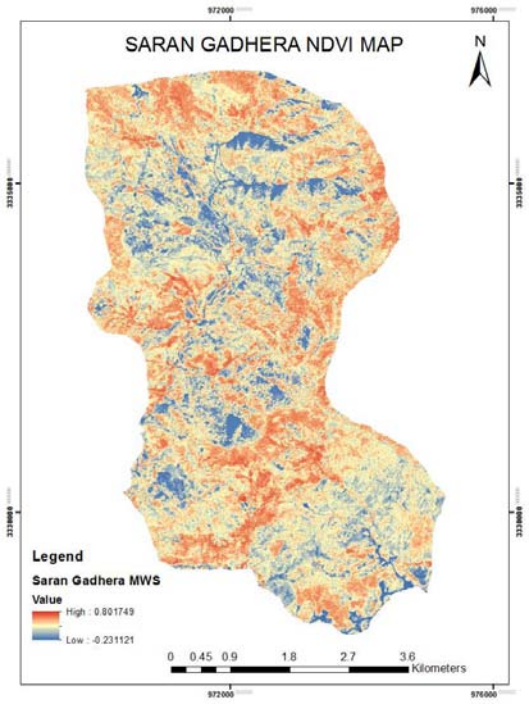




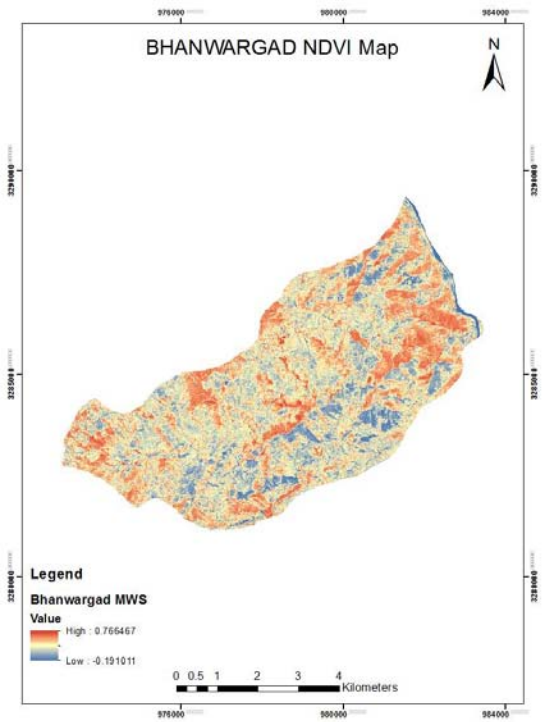
7. NDVI images Bageshwar division

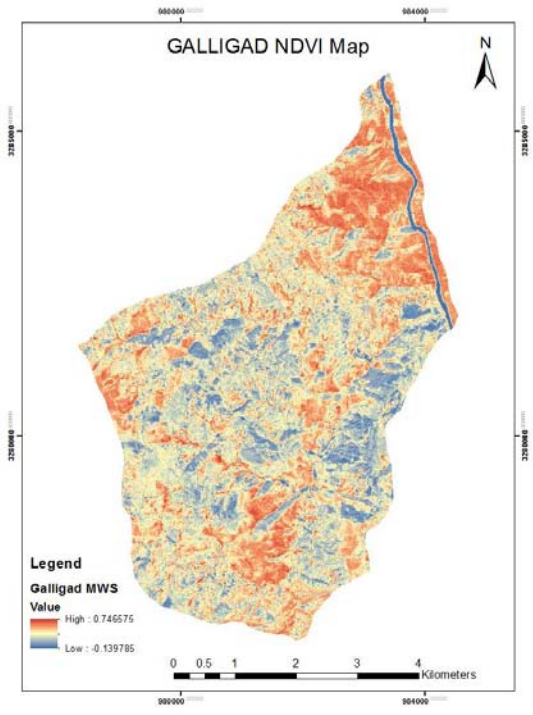

GOGINA NDVI MAP
N
Legend
Gogina MWS
Value
High : 0.795556
Low : -0.360269
0 1.25 2.5 5 7.5 10
Kilometers
Kilometers

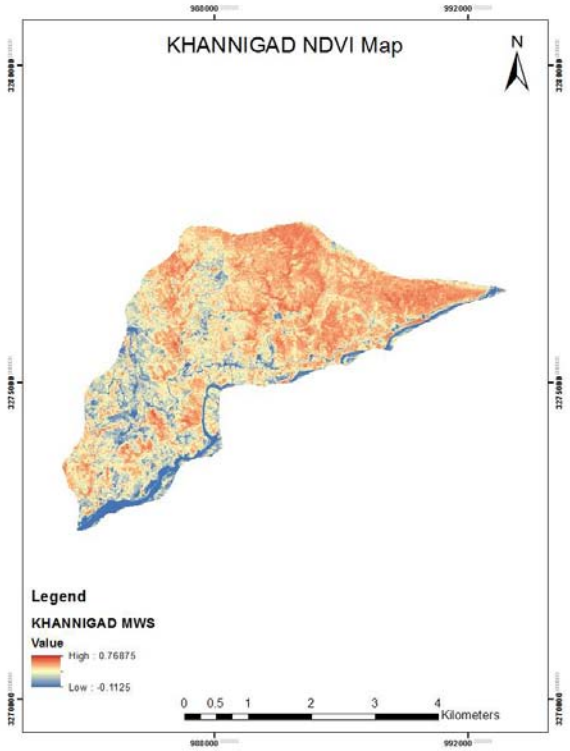

REVATI GANGA NDVI MAP
N
Legend
Revati Ganga MWS
Value
High : 0.773371
Low : -0.112583
0 1 2 4 6 8
Kilometers

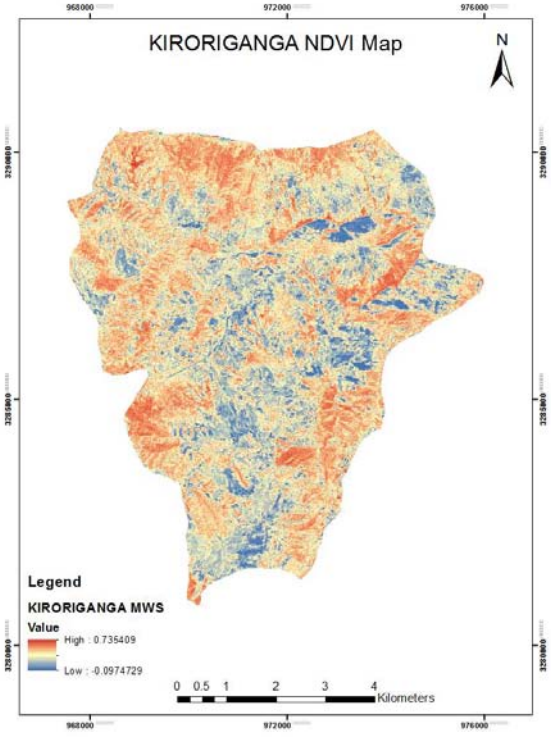


8. NDVI images Almora division






KHANNIGAD NDVI Map
N
Legend
KHANNIGAD MWS
Value
High : 0.76875
Low : -0.1125
0 0.5 1 2 3 4
Kilometers


KIRORIGANGA NDVI Map
N
Legend
KIRORIGANGA MWS
Value
High : 0.735409
Low : -0.0974729
0 0.5 1 2 3 4
Kilometers

Annexure 2: Details of MWS

Table 2: MWS Latitude and Longitude			
MWS name	**District**	**Latitude**	**Longitude**
Silogi MWS	**Pauri Garhwal**	29° 52' 48" N to 29°58' 12" N	78° 48' E 36" to 78° 54'0" E
Dewangarh MWS	**Dehradun**	30° 37' 24" to 30°45' 12" N	77° 50'36" to 77° 58' 12" E
Sidiyagarh MWS	**Almora**	29° 29' 24" to 29°34' 50" N	79° 51'36" to 80° 02' 24" E
Utarsu MWS	**Rudraprayag**	30° 22' to 30°27' N	78° 55' to 79° 042' E
Lathiyagarh MWS	**Pithoragarh**	29° 43' to 29°51' N	80° 06' to 80° 13' E
Loharkhet MWS	**Bageshwar**	29° 57' to 30°10'N	79° 53' to 80° 02' E
Paligarh MWS	**TehriGarhwal**	30° 28' to 30°36' N	78° 08' to 78° 13' E
Sarugarh MWS	**Uttarkashi**	30° 56' to 31°02' N	78° 01' to 78° 10' E

Table 3: MWS-Drainage Density, number of streams falling under respective Stream Order

Table 3: MWS-Drainage Density, number of streams falling under respective Stream Order				
MWS	**Geomorphology**	**Drainage density**	**Stream order**	**No. of streams**
Silogi	Falls under Nayar river basin, consists of denudational hills, fluvial terraces, periglacial lobes alluvial fans, mass wasting areas and present floodplain. Environmental Hazards are landslides, bank erosion, sheet wash, gully erosion, and deforestation.	4.3	I	2264
			II	986
			III	622
			IV	277
			V	310
Dewangarh	Occupies the central part of the elongated piggy back syncline Doon Valley and sits on loose unconsolidated coarse clastic Doon gravels derived from the Lesser Himalayas being deposited by Bindal and Rispana river systems during the Late Pleistocene and Holocene age	0.0019	I	1466
			II	831
			III	549
			IV	215
			V	0
Sidiyagad	Sidiyagad is situated on a ridge at the southern edge of the Kumaon Hills of the Central Himalaya range. It is surrounded by thick forests of pine and fir trees. Flowing alongside the city are rivers of Koshi (Kaushiki) and Suyal (Salmale).	0.0018	I	1808
			II	826
			III	759
			IV	290
			V	251
Utarsu	May be divided into two major Units the	0.0023	I	50182

Table 3: MWS-Drainage Density, number of streams falling under respective Stream Order				
MWS	**Geomorphology**	**Drainage density**	**Stream order**	**No. of streams**
	high Denudational mountains and the river valleys. Separated from Siwaliks by the Krol thrust (Main Boundary Fault) is the Lesser Himalayas (1500 to 2500 m high).		II	17782
			III	4617
			IV	5279
			V	0
Lathiyagarh	The southern sedimentary belt occurs south of the Almora-DudhatoliCrystallines and is called the Outer Sedimentary Belt. The northern sedimentary belt occurring north of the Crystallines is the Inner Sedimentary Belt. The Crystalline zone represents the divide between the two sedimentary belts constituting the Kumaon Lesser Himalaya.	0.002	I	1066
			II	484
			III	305
			IV	56
			V	104
Loharkhet	Comprises two broad physiographic divisions from north to south viz. Central Himalayan Zone (north of the Main Central Thrust) and Lesser Himalayan Zone (south of the Main Central Thrust). The area shows an extremely rugged topography characterised by precipitous hills and deep gorges with sharp variation in surface relief.	0.0022	I	2959
			II	1585
			III	740
			IV	485
			V	561
Paligarh	The physiography of the district is characterised by high mountain peaks, deep gorges and valleys. Drainage of the area is mainly controlled by the major perennial rivers like Bhagirathi, Bhilangana, Alaknanda and their tributaries like Bal Ganga and Dharma Ganga	0.0016	I	1101
			II	593
			III	402
			IV	222
			V	0
Sarugarh	The prevalent landforms are lateral moraines, end moraines, U-shaped glacier valleys, V-shaped fluvial valleys, river terraces and Denudational Structural Mountain. The landforms, mappable on the present scale, are Glacial Valley (GL), River Terrace (RT), Terrace (T) and Denudational Structural Mountain (DSM).	0.0021	I	1584
			II	851
			III	282
			IV	510
			V	0

Table 4: LULC Classification

Table 3: LULC Classification							
Name of MWS	Percentage of land under each land use						
	Arable	Barren Land	Dense Forest	Open Forest	Settlement	Shrubs	Water
Silogi	56	18	18	5	1	3	
Dewangarh	55.82	4.10	36.05	3.04	0.25		0.75
Sidiyagarh	62.70	24.93	11.38				0.99
Utarsu	43.84	0.24	43.39	10.04	0.98		1.51
Lathiyagarh	35.71	0.03	57.56	5.33	0.12		1.25
Loharkhet	9.29	5.09	68.40	16.57			0.65
Paligarh	34.10		62.28	2.92			0.70
Sarugarh	12.58	5.00	74.97	7.45			

Table 5: Percentage of land under Slope class

Name of MWS	Percentage of land under each slope class					
	Gently Sloping/Flat (0-3 %)	Moderately Sloping (4 - 7 %)	Strongly Sloping (8 - 11 %)	Moderately Steep (12 - 15 %)	Steep (16 - 25 %)	Very Steep (>25 %)
Silogi	7	52	37	3		
Dewangarh	0.38	1.48	3.41	5.81	31.65	57.25
Sidiyagarh	0.70	2.47	4.51	7.31	33.60	51.40
Utarsu	4.39	47.49	40.96	7.15	0.01	
Lathiyagarh	0.87	3.18	5.91	12.81	47.89	29.34
Loharkhet	0.31	1.26	3.09	5.72	26.55	63.07
Paligarh	0.28	1.08	2.76	4.94	25.17	65.77
Sarugarh	0.60	2.38	4.60	7.92	37.33	47.16

Table 6: Percentage of land under Slope class

Table 6: Percentage of land under Aspect Class	
Name of	Percentage of land under each aspect class

MWS	0-45 (NE)	45-90 (N)	90-135 (NW)	135-180 (W)	180-225 (SW)	225-270 (S)	270-315 (SE)	315-360 (E)
Silogi	10%	5%	9%	13%	13%	15%	17%	17%
Dewangarh	13.69%	13.11%	10.97%	8.49%	9.83%	12.83%	15.50%	15.57%
Sidiyagarh	14.24%	12.51%	8.32%	7.92%	12.08%	16.10%	15.53%	13.30%
Utarsu	13.20%	9.36%	2.62%	2.80%	6.01%	15.46%	27.83%	22.71%
Lathiyagarh	1.17%	5.70%	18.99%	34.14%	17.81%	10.04%	8.26%	3.90%
Loharkhet	9.22%	11.04%	13.79%	11.86%	13.45%	13.76%	12.29%	14.60%
Paligarh	9.70%	6.42%	8.51%	14.18%	14.68%	17.40%	15.87%	13.24%
Sarugarh	7.83%	8.56%	11.77%	15.63%	22.40%	15.19%	13.27%	5.35%

Table 7: Location of Districts

Name of District	Region	Headquarters	Latitude	Longitude	Geographical area (sq. km)
Almora	Kumaon	Almora town	29° N to 30° N	79° E to 81° E	3697.2
Bageshwar		Bageshwar town	29° 42' N to 30° 18' N	78° 28' E to 80° 90' E	2302
Pithoragrh		Pithoragarh	29º 27' N to 30º 49' N	79º 50' E to 81º 3' E	7090
Dehradun	Garhwal	Dehradun city	29° 57' N to 31° 2' N	77° 35' E to 79° 20' E	3088
Uttarkashi		Uttarkashi town	30º28' and 31º28'	77º49' and 79º25'	8016
TehriGarhwal		Tehri	30° N to 31°N	78° E to 79° E	3642
PauriGarhwal		Pauri	29° 26' N to 30° 19' N	78° 12' E to 79° 14' E	5329
Rudraprayag		Rudraprayag	29º 55' N to 31º 27' N	78º 54' E to 80º 2' E	1984

**area and coordinates sources from official district websites for each district, 2017.*

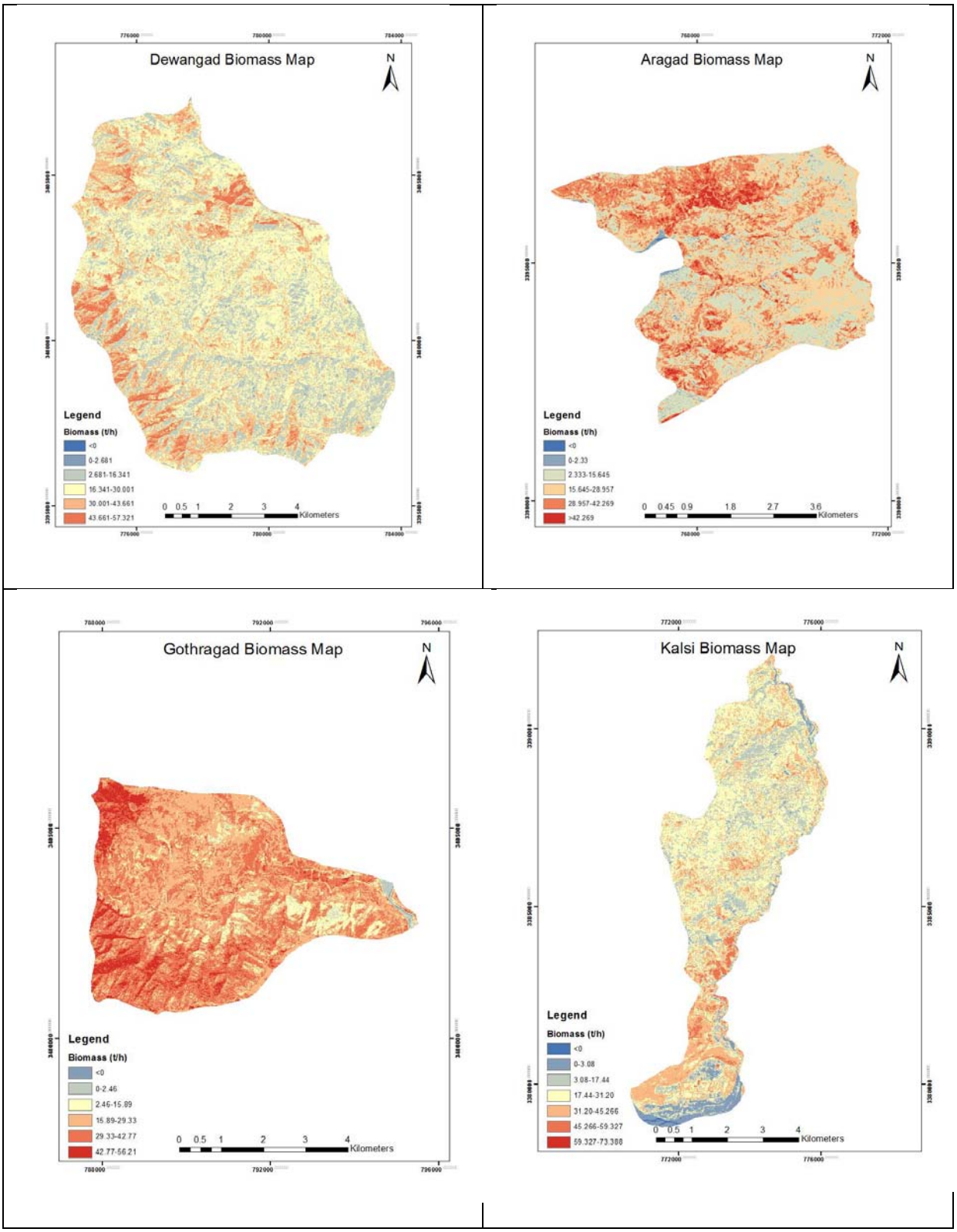
Annexure-3: GPS Coordinates of Plots

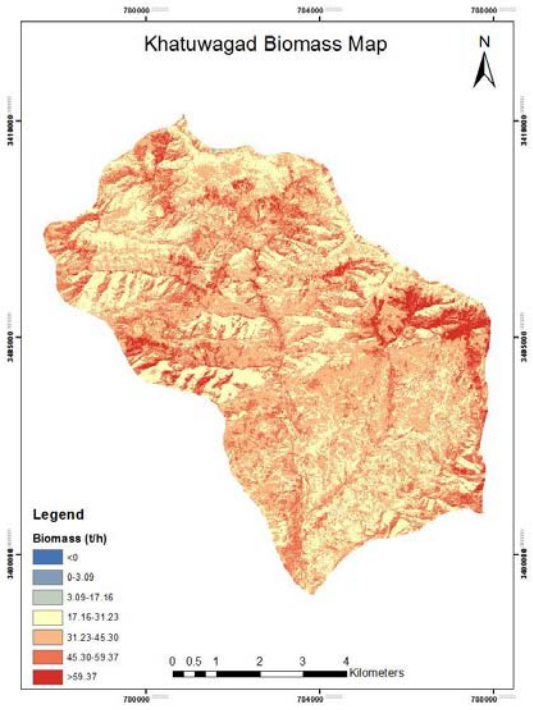
SL No.	Quadrant ID	Lat	Long	Altitude
1	Q1K	30.576	77.856	1105
2	Q2K	30.576	77.854	1154
3	Q3K	30.575	77.854	1171
4	Q4K	30.576	77.860	1180
5	Q5K	30.724	78.002	1718
6	Q6K	30.725	78.002	1713
7	Q7K	30.731	77.999	1604
8	Q8K	30.647	77.809	1817
9	Q9K	30.642	77.812	1505
10	Q10K	30.641	77.812	1533
11	Q11K	30.641	77.811	1489
12	Q12J	30.533	78.108	1690
13	Q13J	30.545	78.106	1637
14	Q14J	30.535	78.114	1659
15	Q15J	30.519	78.123	1548
16	Q16J	30.528	78.130	1474
17	Q17J	30.500	78.163	1224
18	Q18J	30.559	78.179	1676
19	Q19J	30.545	78.177	1545
20	Q20J	30.538	78.175	1450
21	Q21J	30.531	78.171	1410
22	Q22D	30.403	79.039	878
23	Q23D	30.414	79.048	1066
24	Q24D	30.414	79.050	1063
25	Q25D	30.413	79.044	1065
26	Q26D	30.409	79.035	1051
27	Q27D	30.429	79.019	1540
28	Q28D	30.435	79.018	1456
29	Q29D	30.434	79.013	1420
30	Q30D	30.430	79.022	1371
31	Q31E	29.916	78.783	1485
32	Q32E	29.914	78.782	1446
33	Q33K	29.913	78.784	1532
34	Q34K	29.915	78.785	1500
35	Q35E	29.922	78.792	1543
36	Q36E	29.937	78.803	1612
37	Q37E	29.952	78.821	1675
38	Q38E	29.954	78.826	1698
39	Q39E	29.946	78.818	1675
40	Q40E	29.944	78.816	1587
41	Q41E	29.966	78.852	1532

SL No.	Quadrant ID	Lat	Long	Altitude
42	Q42E	29.981	78.916	1768
43	Q43E	30.016	78.932	1892
44	Q44E	29.999	78.921	1923
45	Q45E	29.990	78.923	1805
46	Q46E	29.978	78.916	1761
47	Q47K	30.046	79.938	2063
48	Q48K	30.032	79.935	2092
49	Q49K	30.040	79.935	2087
50	Q50K	29.997	79.942	1688
51	Q51K	30.002	79.931	1277
52	Q52K	30.018	79.878	1432
53	Q53K	30.022	79.878	1543
54	Q54K	30.022	79.879	1593
55	Q55K	30.020	79.880	1574
56	Q56K	30.047	79.876	1989
57	Q57K	30.044	79.948	1880
58	Q58K	30.041	80.055	2094
59	Q59K	30.042	80.061	2080
60	Q60K	30.058	80.063	2042
61	Q61K	30.074	80.077	1980
62	Q62K	30.064	80.075	2009
63	Q63K	30.025	80.042	2179
64	Q64K	30.025	80.043	2198
65	Q65D	29.567	79.936	1733
66	Q66D	29.562	79.939	1785
67	Q67D	29.559	79.940	1826
68	Q68D	29.558	79.939	1773
69	Q69D	29.571	79.935	1745
70	Q70D	29.572	79.933	1739
71	Q71D	29.575	79.939	1634
72	Q72D	29.583	79.940	1524
73	Q73D	29.585	79.943	1478
74	Q74D	29.577	79.942	1613
75	Q75D	29.630	79.828	1984
76	Q76D	29.634	79.827	2062
77	Q77D	29.633	79.829	2061
78	Q78D	29.631	79.827	2000
79	Q79D	29.617	79.850	1973
80	Q80D	29.613	79.839	2095

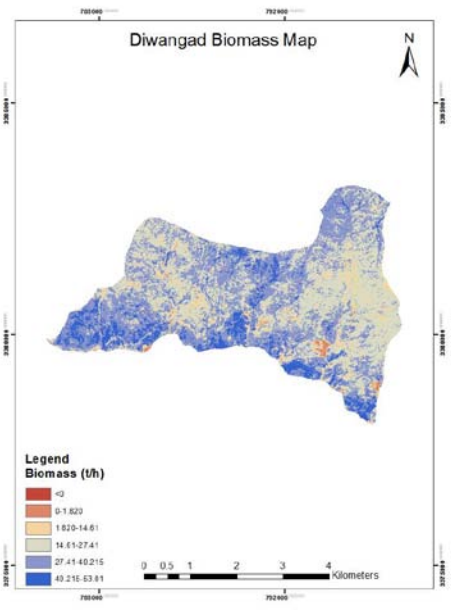
Annexure-4 Biomass Maps of Watersheds

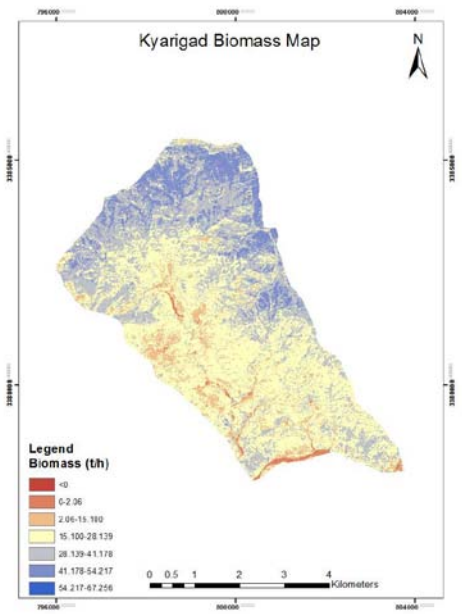
1. Biomass map of Micro-watersheds of Dehradun

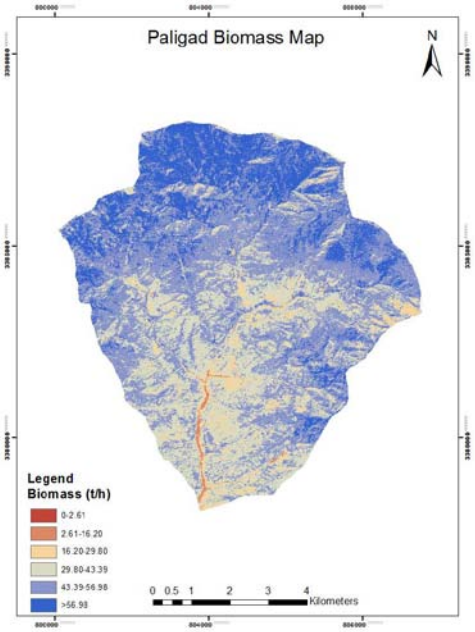


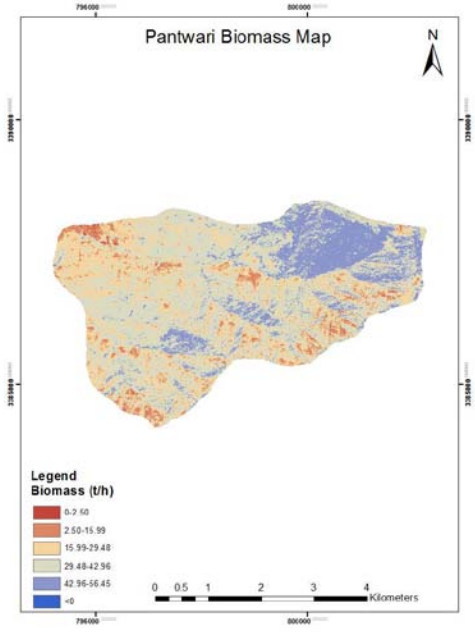


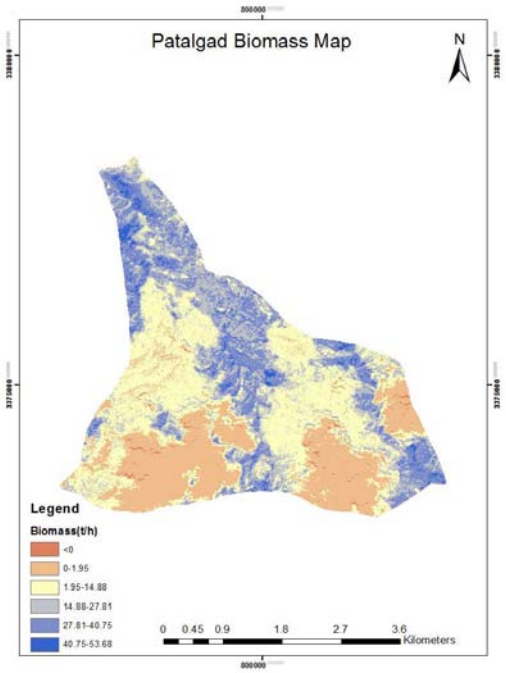
2. Biomass map of Micro-watersheds of Thatyur

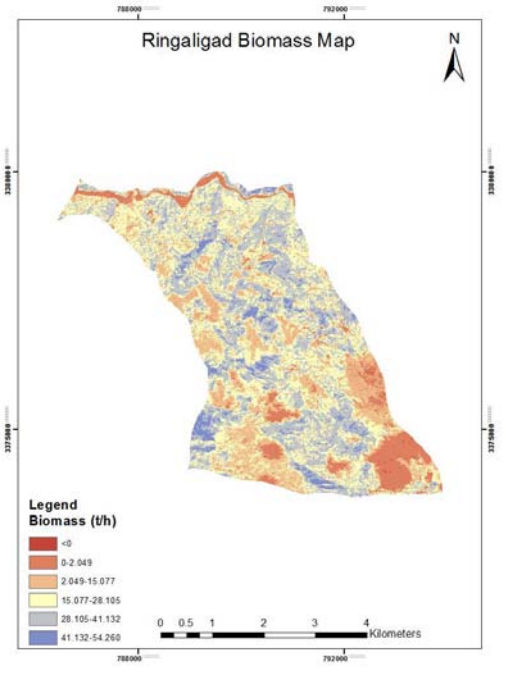


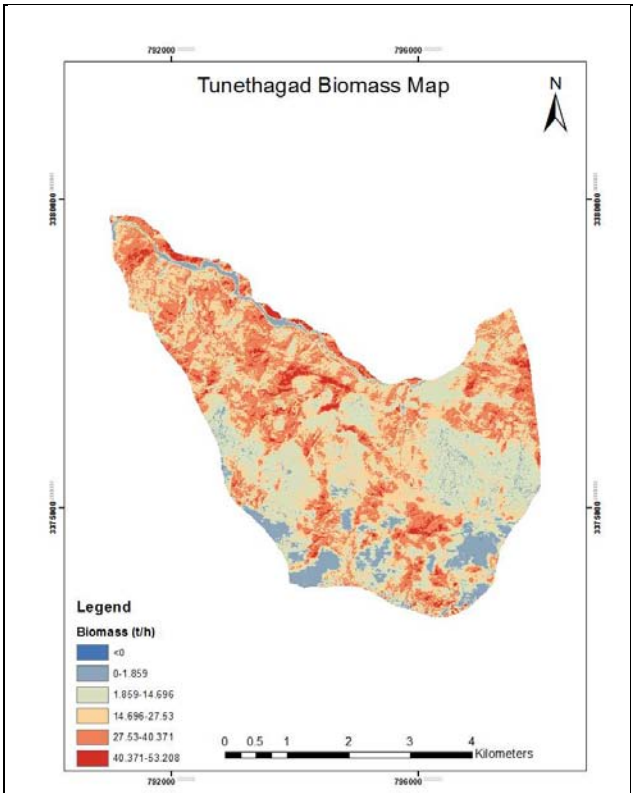


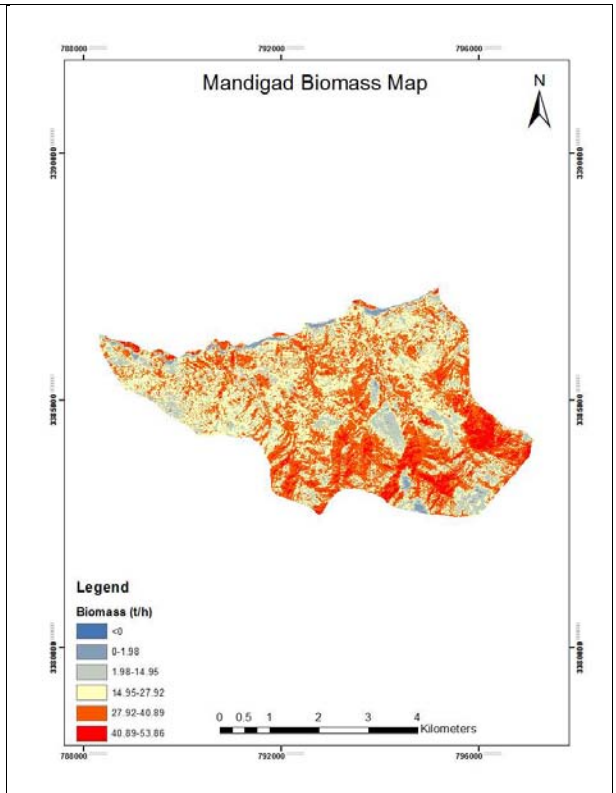

Paligad Biomass Map
N
Legend
Biomass (t/h)
0-2.61
2.61-16.20
16.20-29.80
29.80-43.39
43.39-56.98
>56.98
0 0.5 1 2 3 4
Kilometers

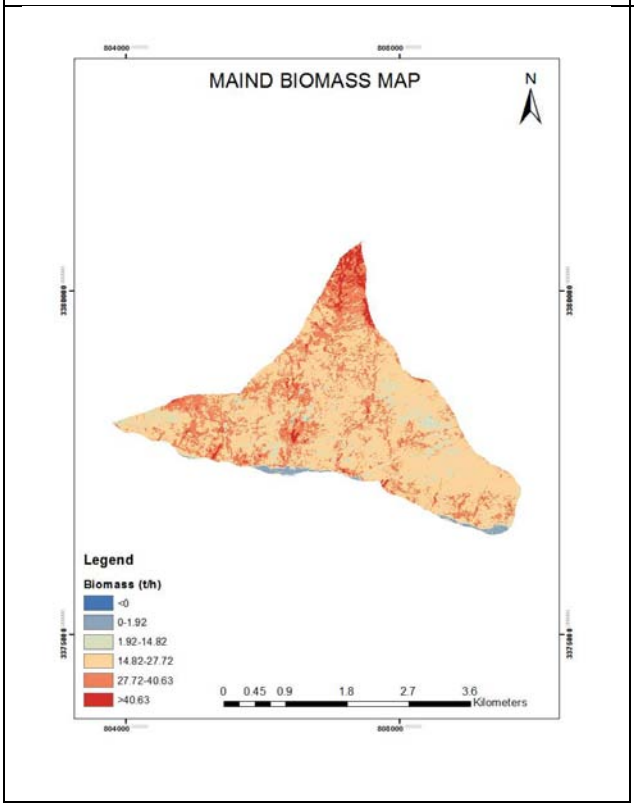

Pantwari Biomass Map
N
Legend
Biomass (t/h)
0-2.50
2.50-15.99
15.99-29.48
29.48-42.96
42.96-56.45
<0
0 0.5 1 2 3 4
Kilometers


Patalgad Biomass Map
N
Legend
Biomass(t/h)
<0
0-1.95
1.95-14.88
14.88-27.81
27.81-40.75
40.75-53.68
0 0.45 0.9 1.8 2.7 3.6
Kilometers

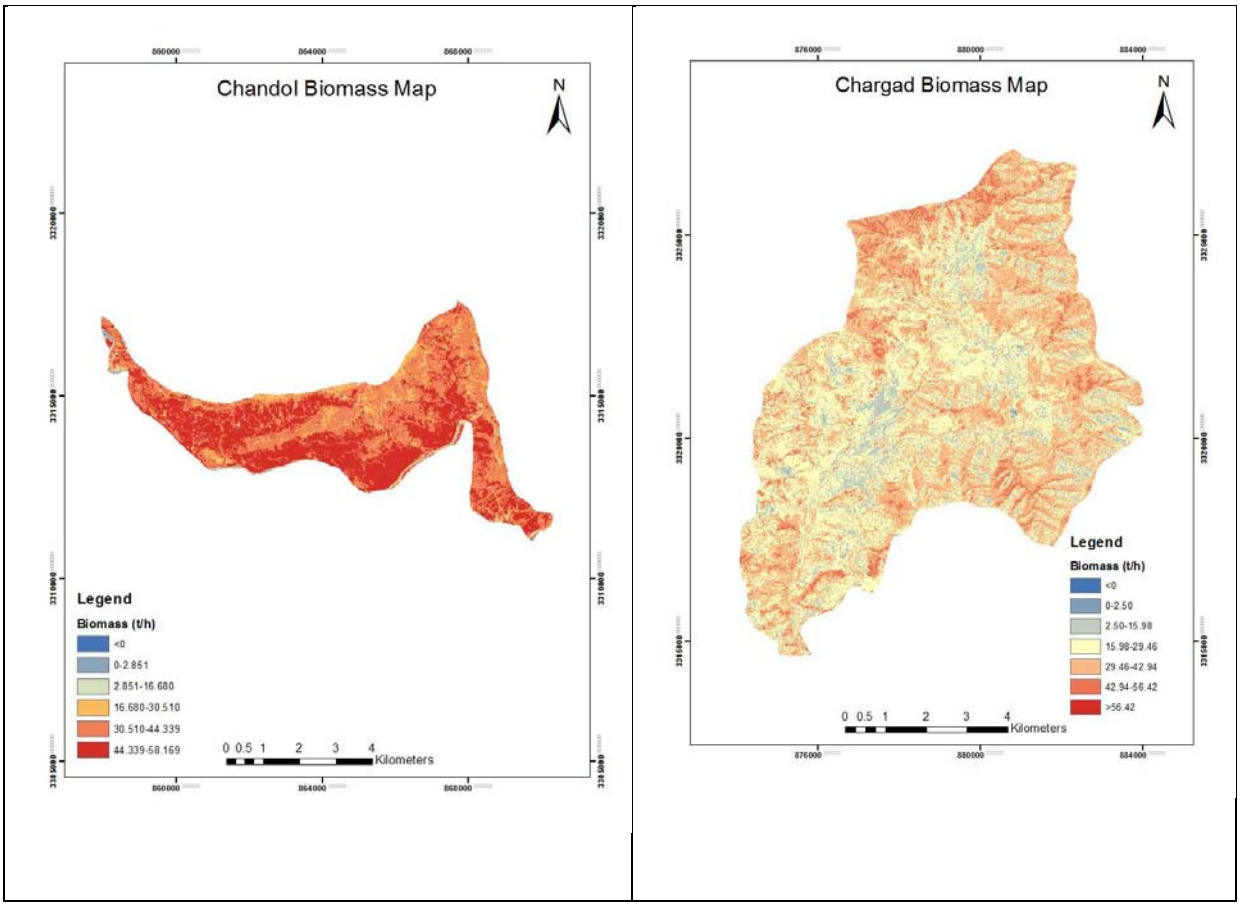

Ringaligad Biomass Map
N
Legend
Biomass (t/h)
<0
0-2.049
2.049-15.077
15.077-28.105
28.105-41.132
41.132-54.260
0 0.5 1 2 3 4
Kilometers

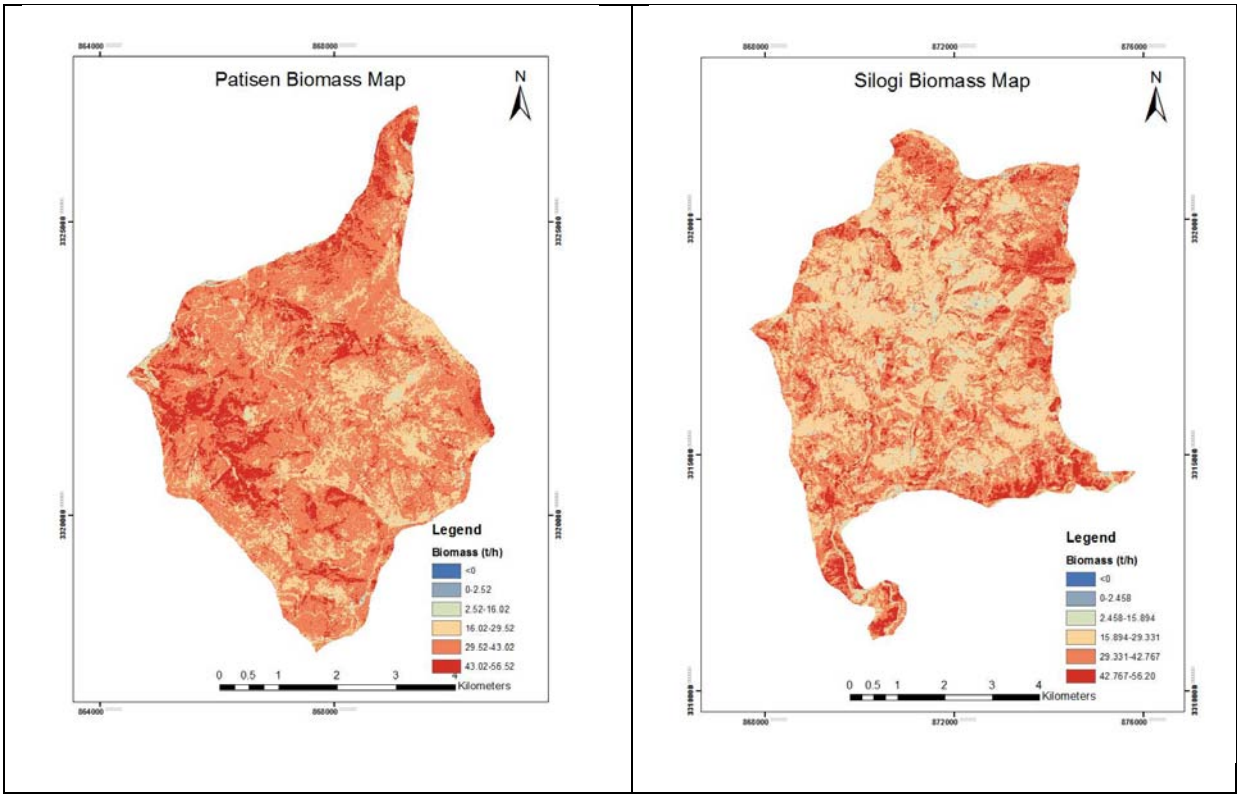

Tunethagad Biomass Map
N
Legend
Biomass (t/h)
<0
0-1.859
1.859-14.696
14.696-27.53
27.53-40.371
40.371-53.208
0 0.5 1 2 3 4
Kilometers


Mandigad Biomass Map
N
Legend
Biomass (t/h)
<0
0-1.98
1.98-14.95
14.95-27.92
27.92-40.89
40.89-53.86
0 0.5 1 2 3 4
Kilometers

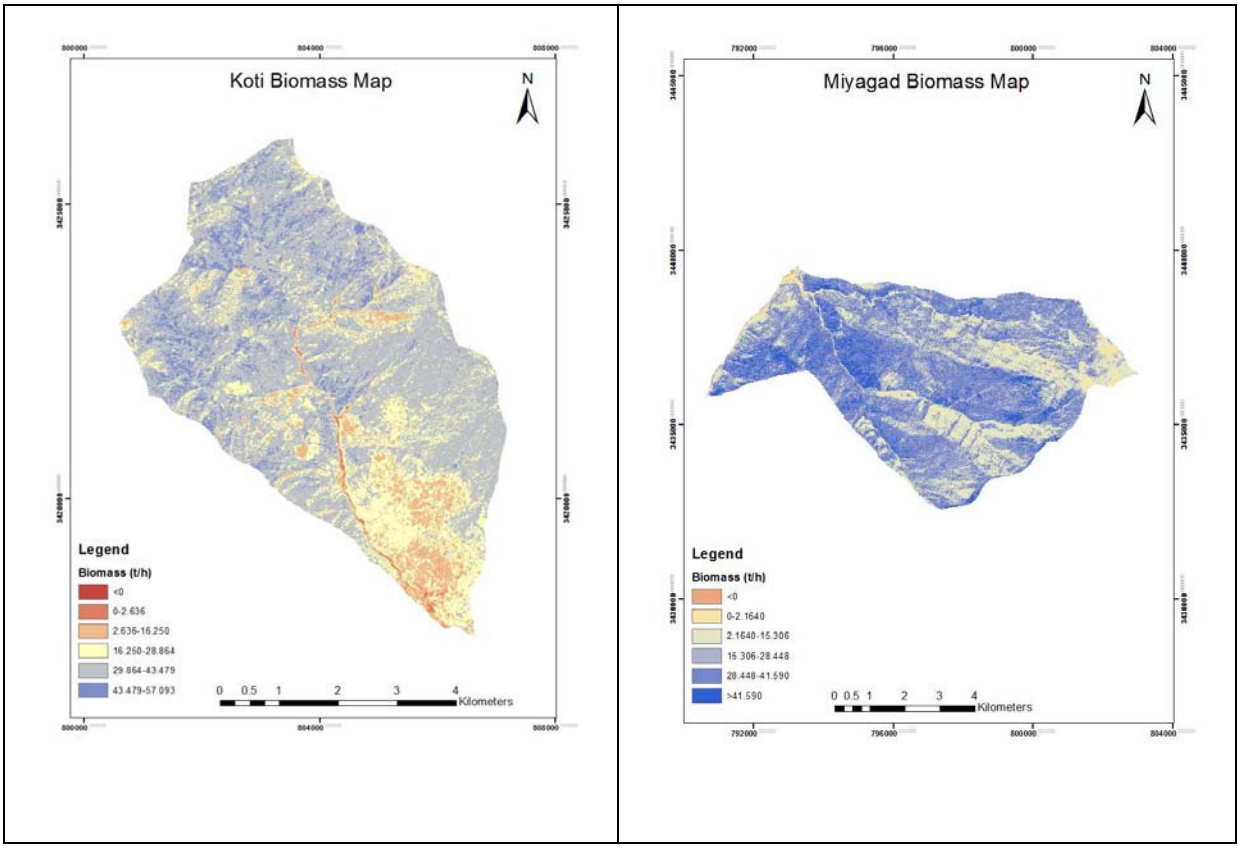

MAIND BIOMASS MAP
N
Legend
Biomass (t/h)
<0
0-1.92
1.92-14.82
14.82-27.72
27.72-40.63
>40.63
0 0.45 0.9 1.8 2.7 3.6
Kilometers

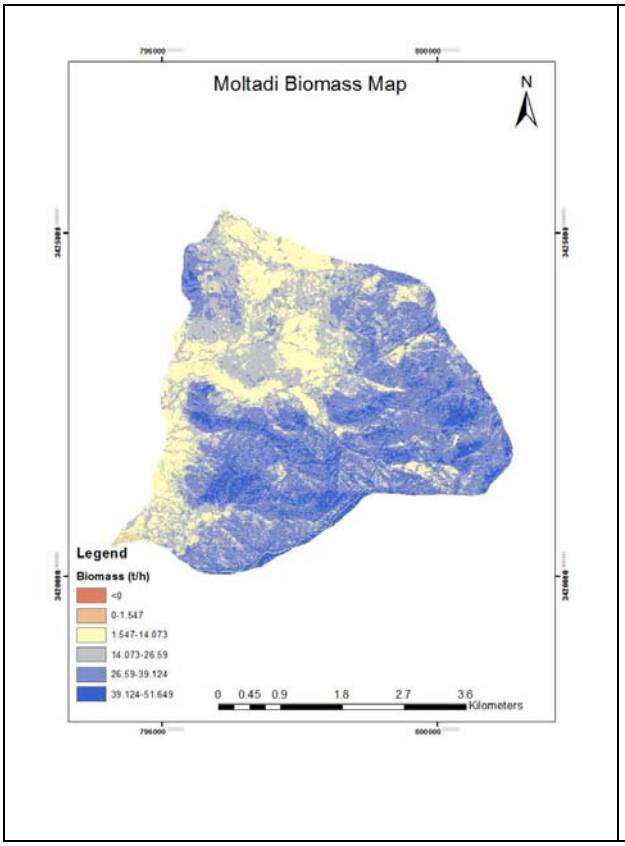
3. Biomass map of Pauri Micro-watersheds

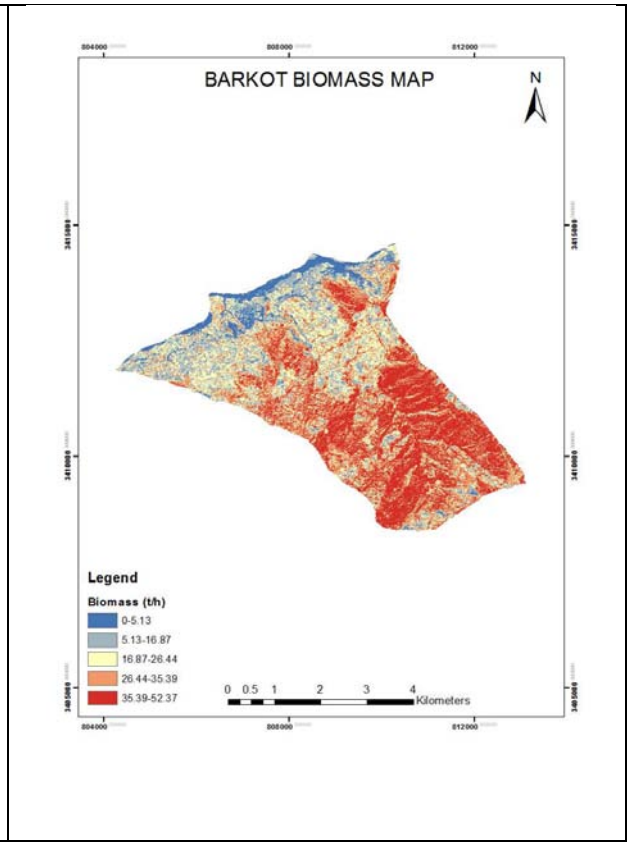




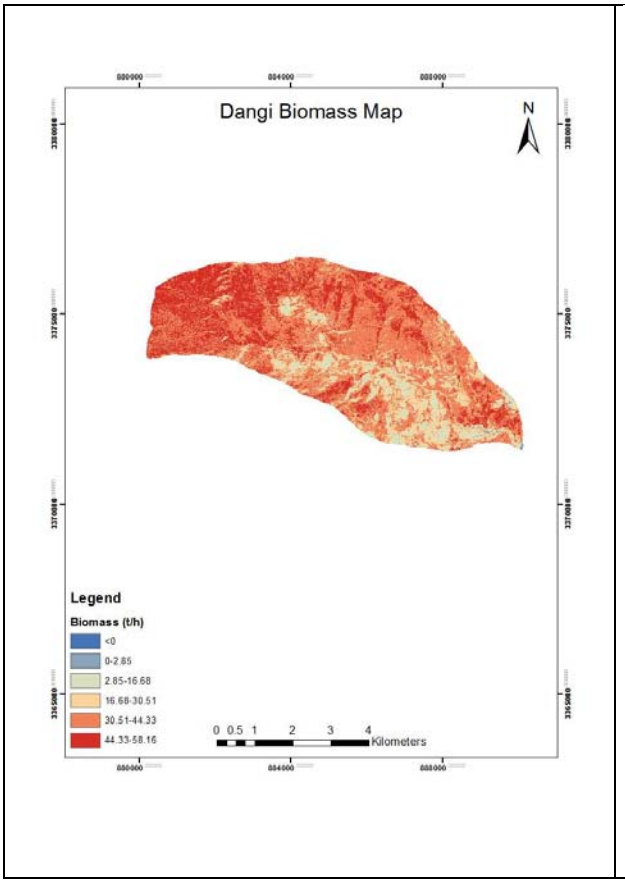
4. Biomass Map of Uttarkashi Micro-watersheds

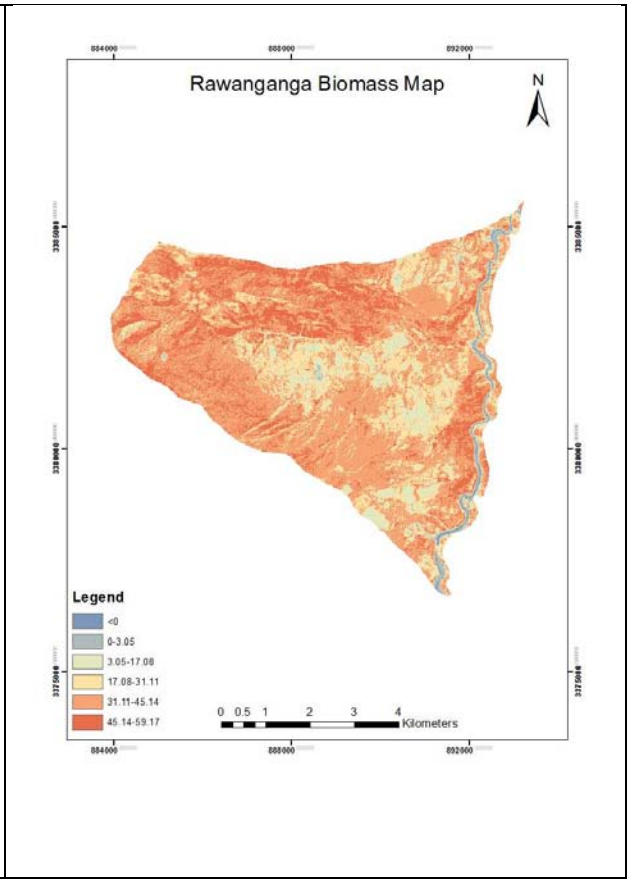


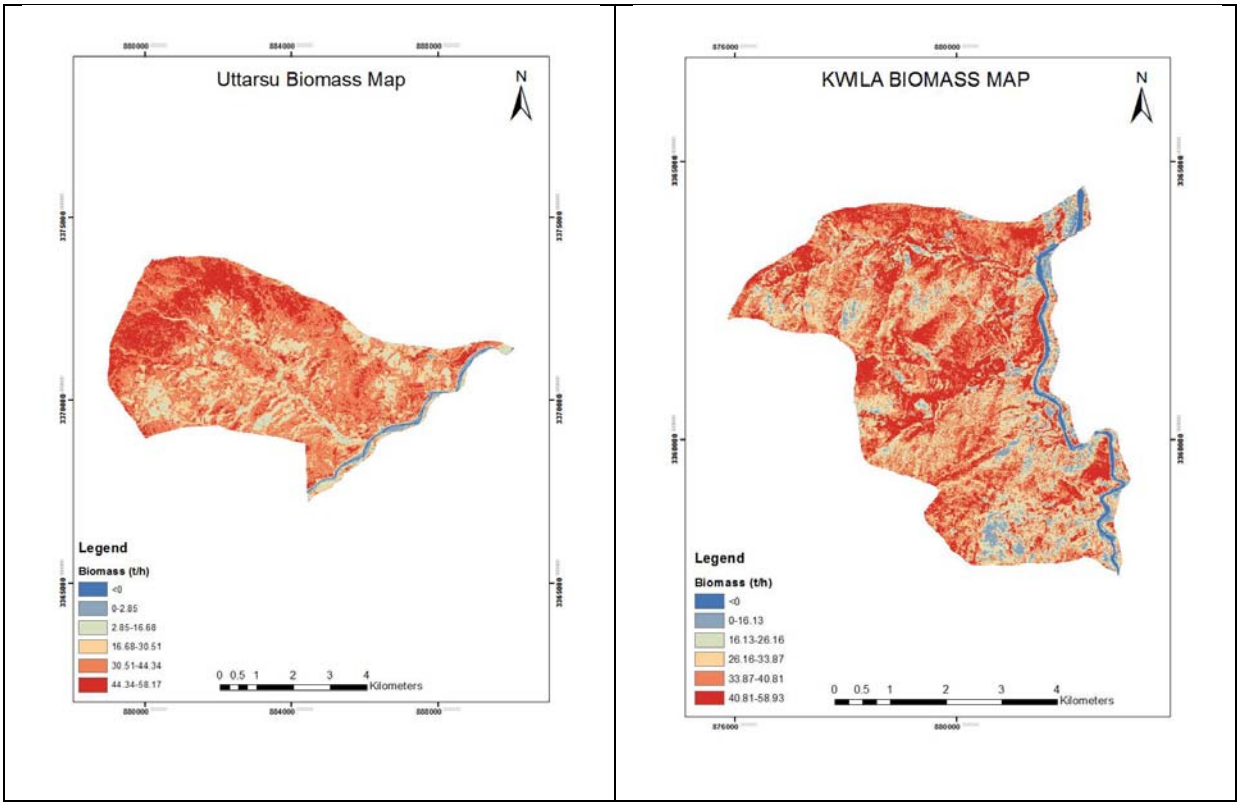




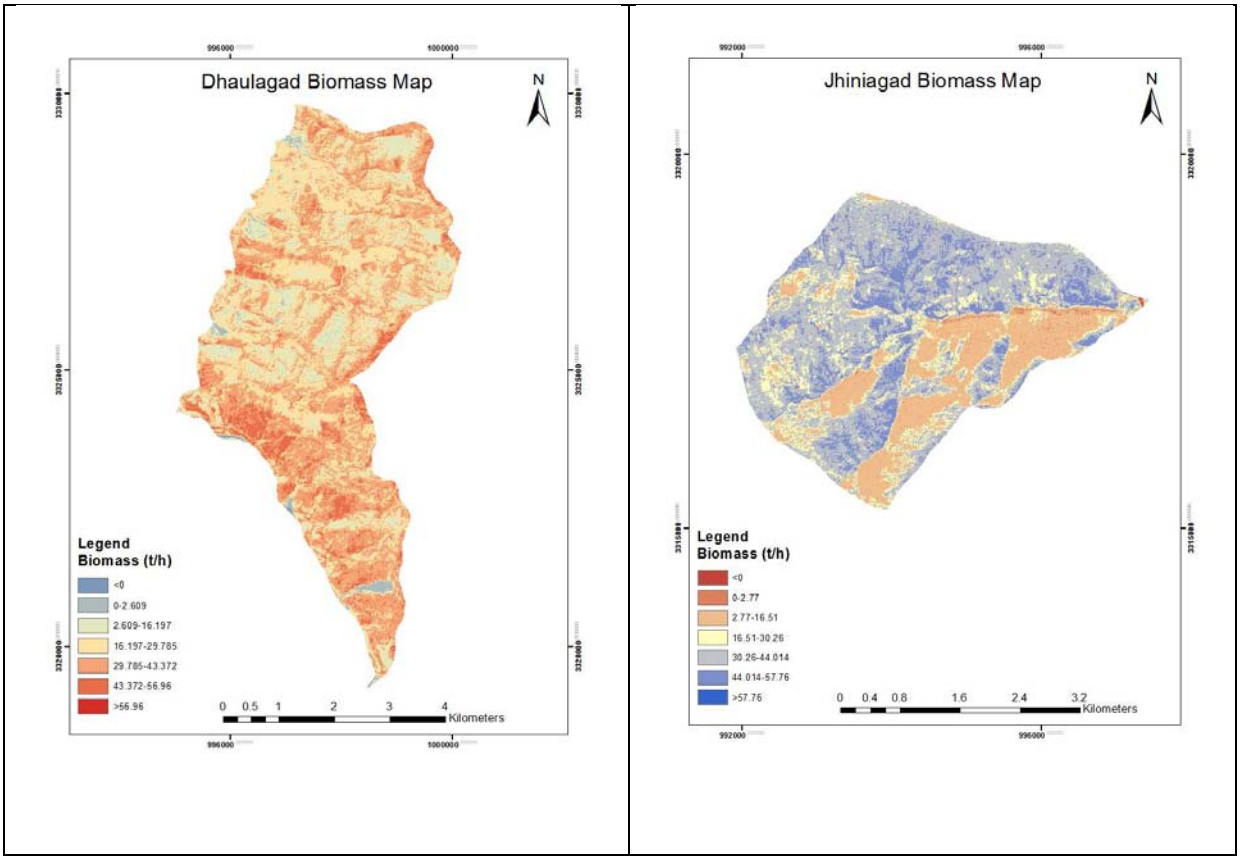
5. Biomass map of Rudraprayag Micro-watersheds

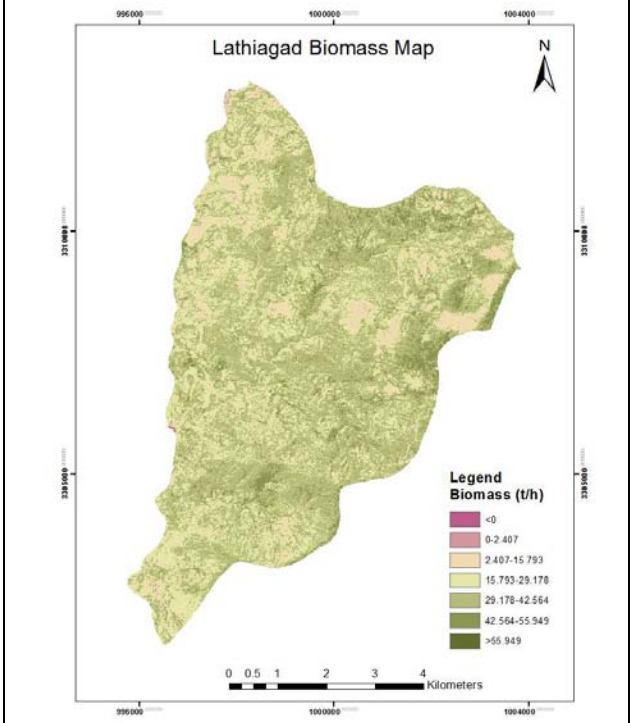


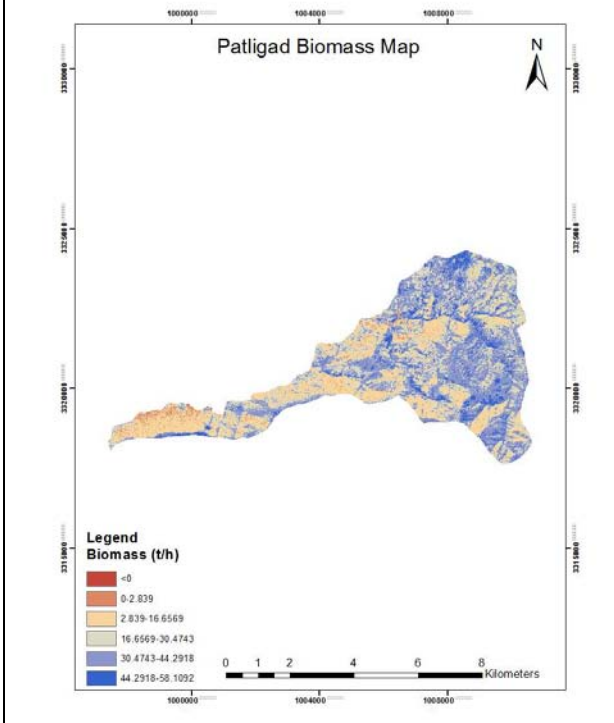


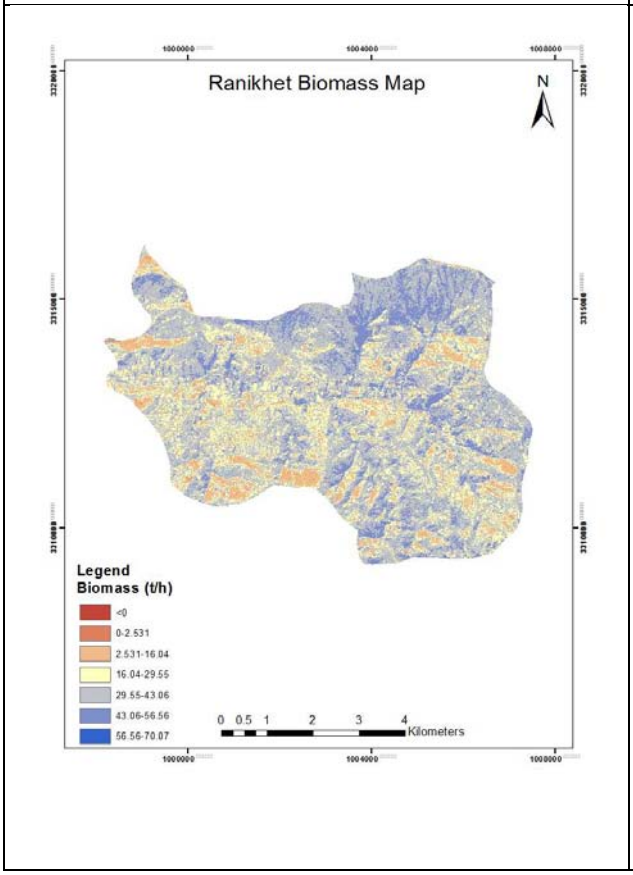


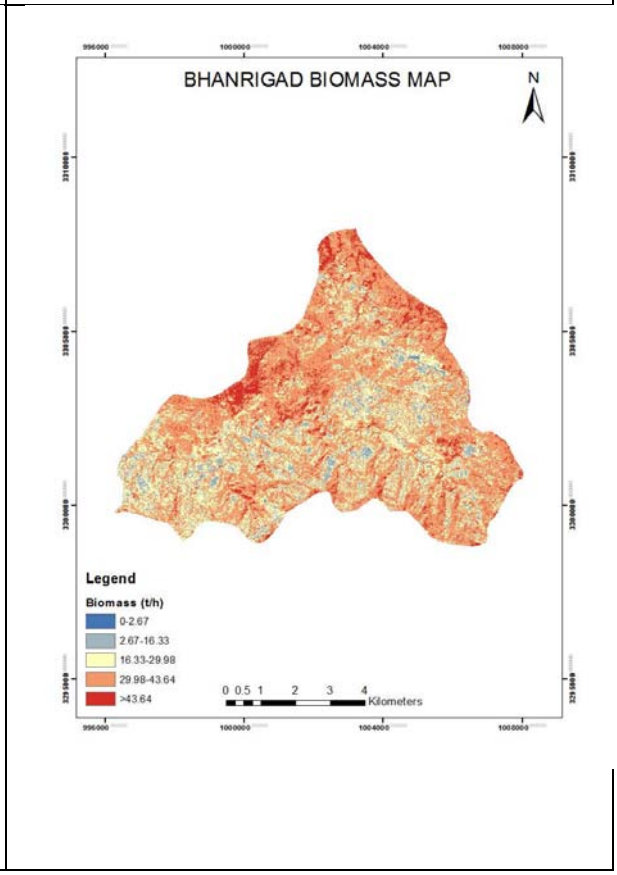
6. Biomass map of Pithoragarh Micro-watersheds



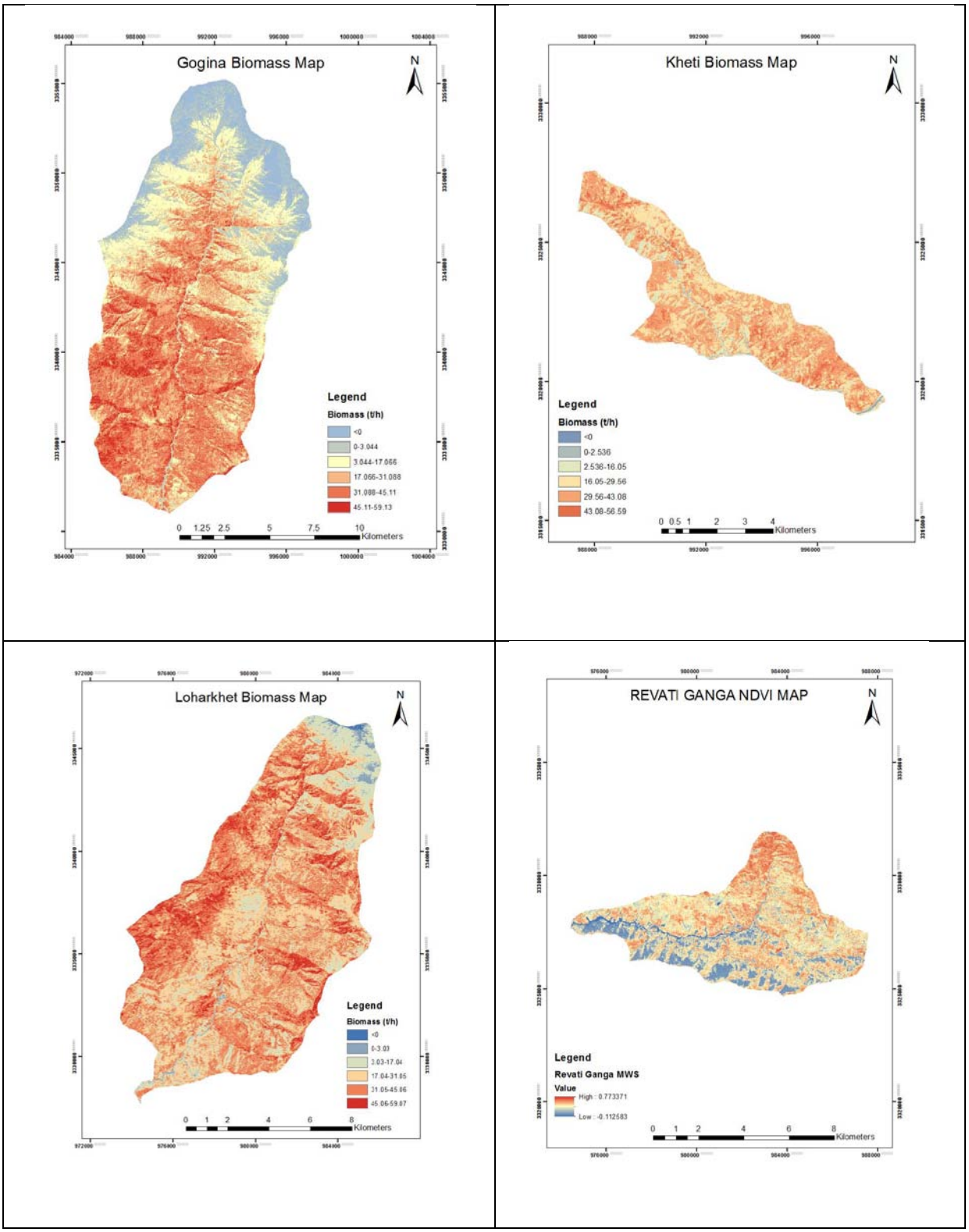

Lathiagad Biomass Map
N
Legend
Biomass (t/h)
<0
0-2.407
2.407-15.793
15.793-29.178
29.178-42.564
42.564-55.949
>55.949
0 0.5 1 2 3 4
Kilometers

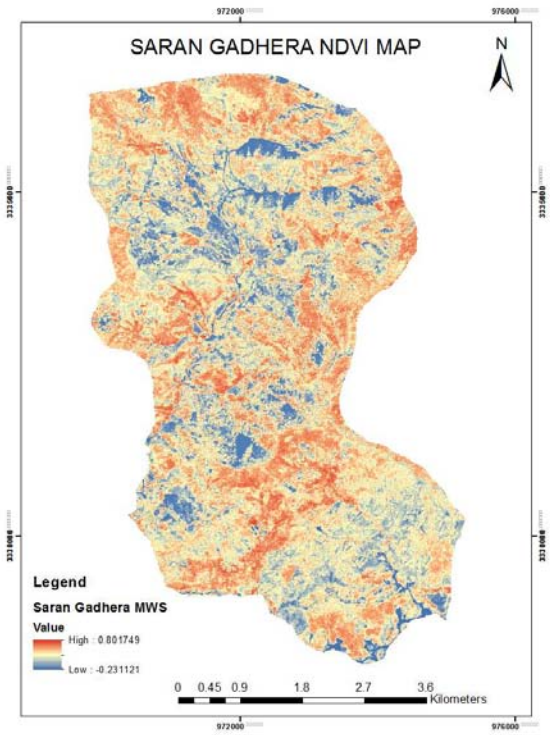

Patligad Biomass Map
N
Legend
Biomass (t/h)
<0
0-2.839
2.839-16.6569
16.6569-30.4743
30.4743-44.2918
44.2918-58.1092
0 1 2 4 6 8
Kilometers

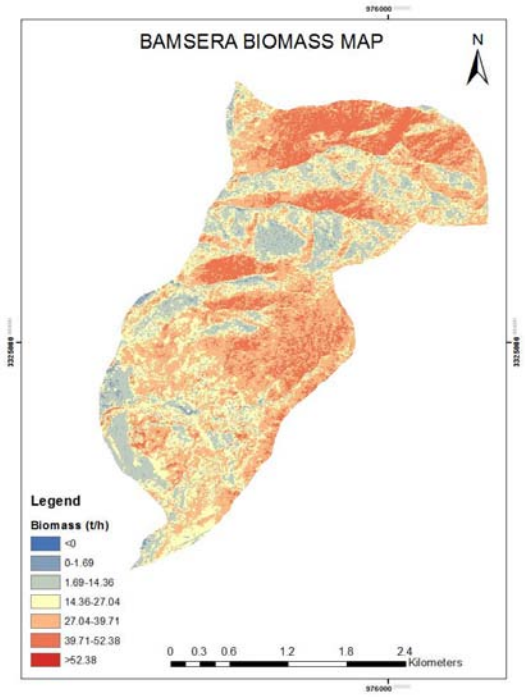

Ranikhet Biomass Map
N
Legend
Biomass (t/h)
<0
0-2.531
2.531-16.04
16.04-29.55
29.55-43.06
43.06-56.56
56.56-70.07
0 0.5 1 2 3 4
Kilometers


BHANRIGAD BIOMASS MAP
N
Legend
Biomass (t/h)
0-2.67
2.67-16.33
16.33-29.98
29.98-43.64
>43.64
0 0.5 1 2 3 4
Kilometers

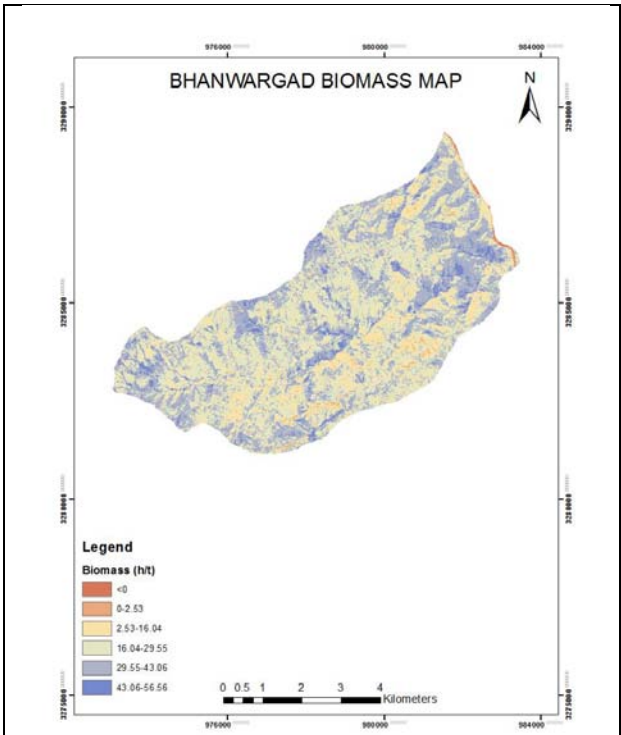
7. Biomass map of Bageshwar Micro-watersheds

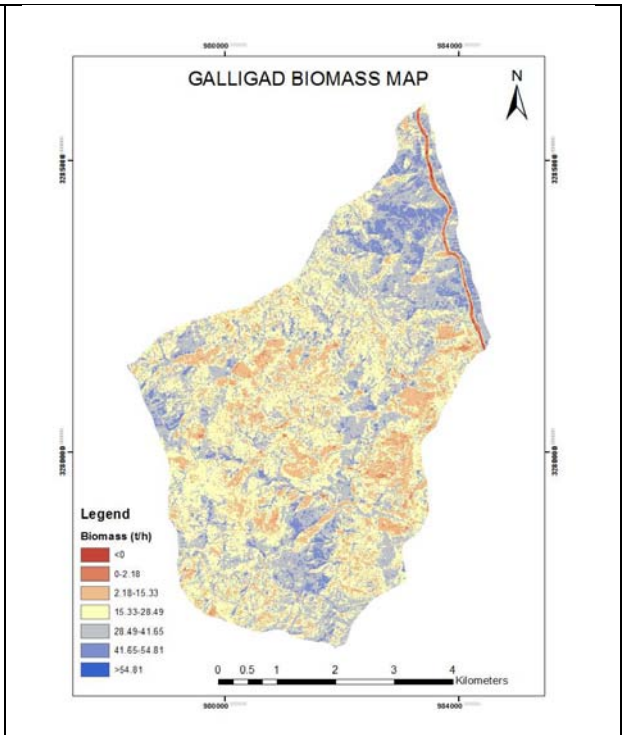


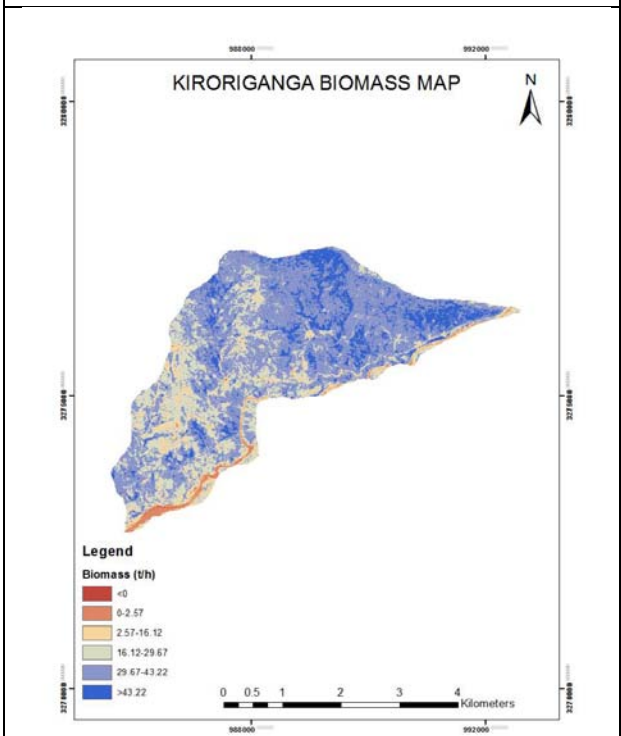


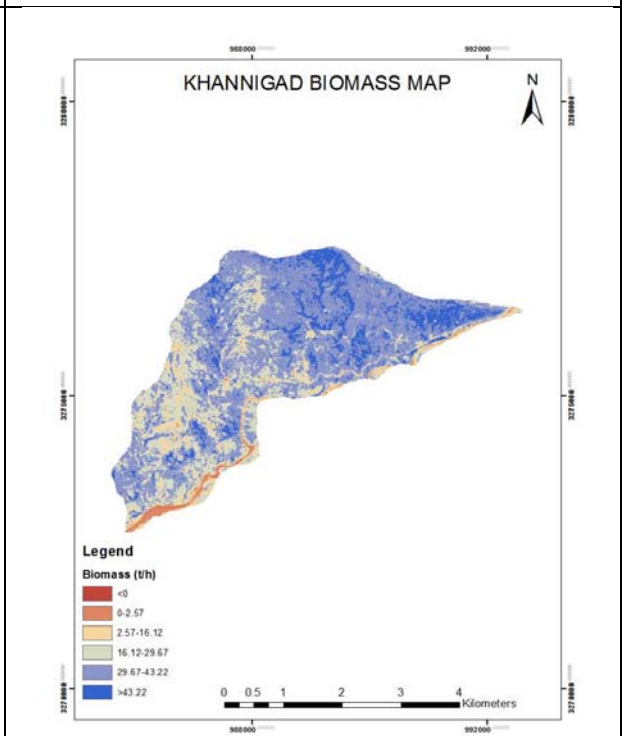


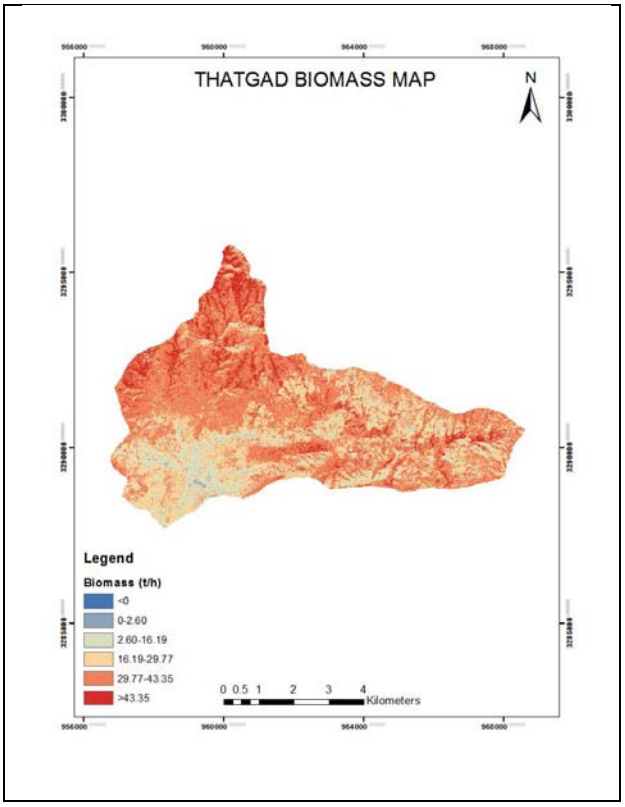
8. Biomass map of Almora Micro-watersheds


BHANWARGAD BIOMASS MAP
N
Legend
Biomass (h/t)
<0
0-2.53
2.53-16.04
16.04-29.55
29.55-43.06
43.06-56.56
0 0.5 1 2 3 4
Kilometers


GALLIGAD BIOMASS MAP
N
Legend
Biomass (t/h)
<0
0-2.18
2.18-15.33
15.33-28.49
28.49-41.65
41.65-54.81
>54.81
0 0.5 1 2 3 4
Kilometers


KIRORIGANGA BIOMASS MAP
N
Legend
Biomass (t/h)
<0
0-2.57
2.57-16.12
16.12-29.67
29.67-43.22
>43.22
0 0.5 1 2 3 4
Kilometers


KHANNIGAD BIOMASS MAP
N
Legend
Biomass (t/h)
<0
0-2.57
2.57-16.12
16.12-29.67
29.67-43.22
>43.22
0 0.5 1 2 3 4
Kilometers


THATGAD BIOMASS MAP
N
Legend
Biomass (t/h)
<0
0-2.60
2.60-16.19
16.19-29.77
29.77-43.35
>43.35
0 0.5 1 2 3 4
Kilometers

Annexure-5 Rainfall Erosivity Factor Maps

Figure 71: Rainfall Erosivity Map Dewangad

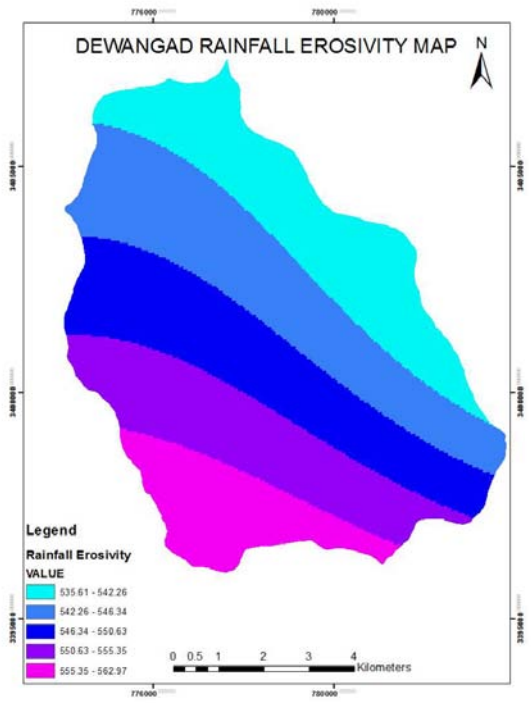


Figure 72: Rainfall Erosivity Map Lathiyagad

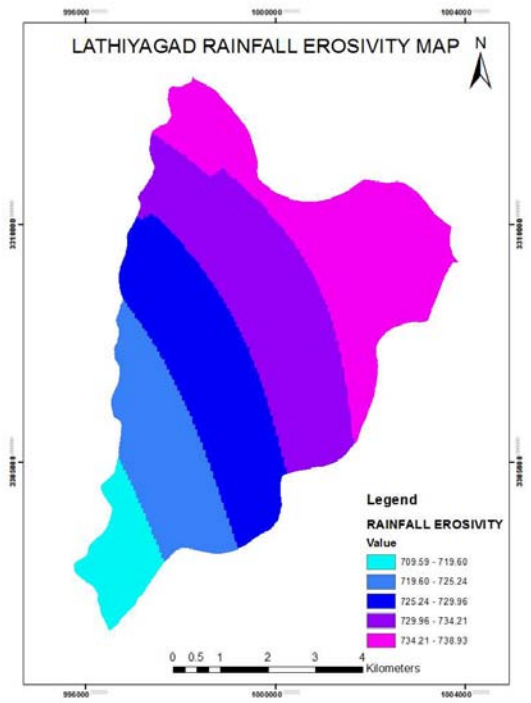


Figure 73: Rainfall Erosivity Map Loharkhet

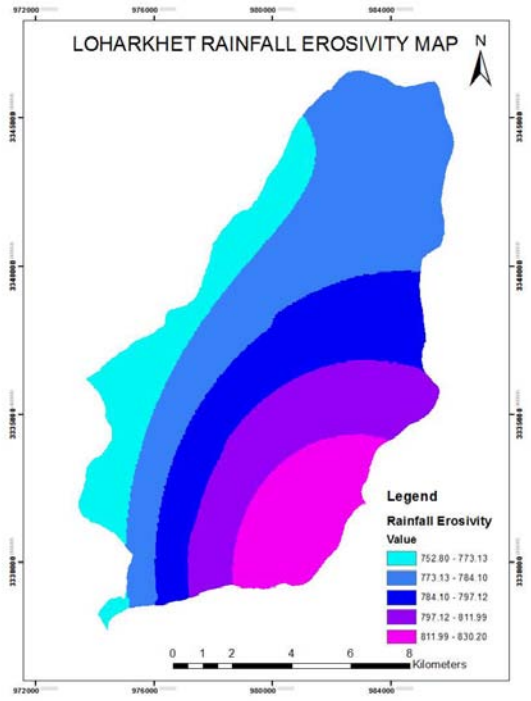


Figure 74: Rainfall Erosivity Map Paligad

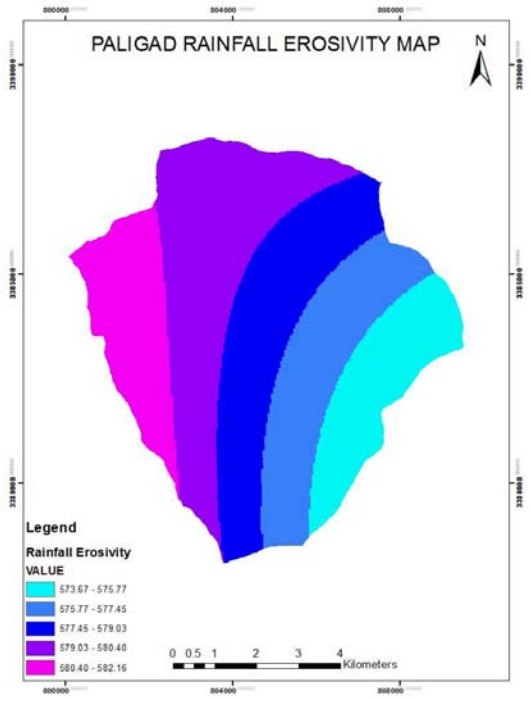


Figure 75: Rainfall Erosivity Map Sarugad

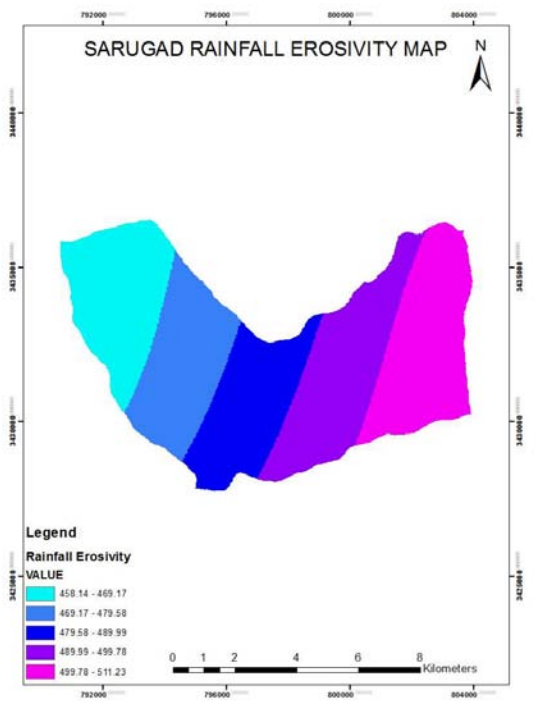


Figure 76: Rainfall Erosivity Map Sidiyagad

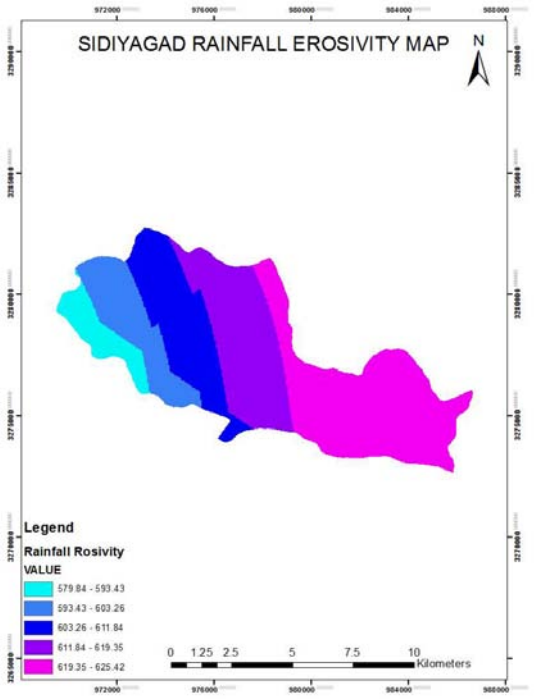


Figure 77: Rainfall Erosivity Map Silogi

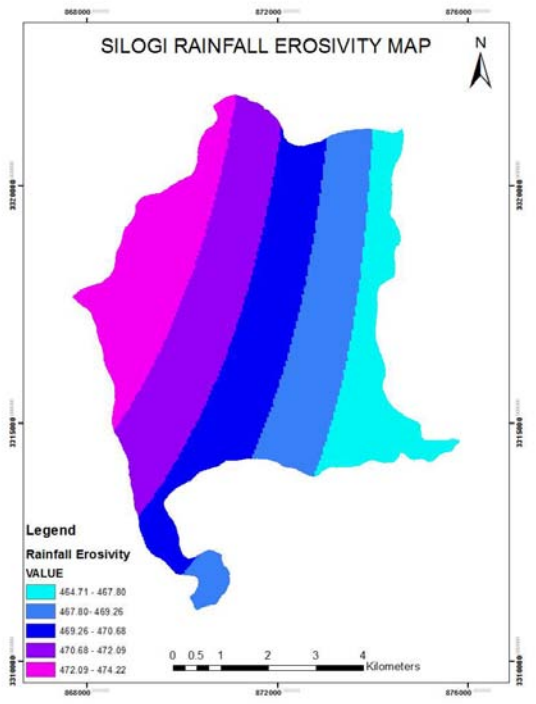
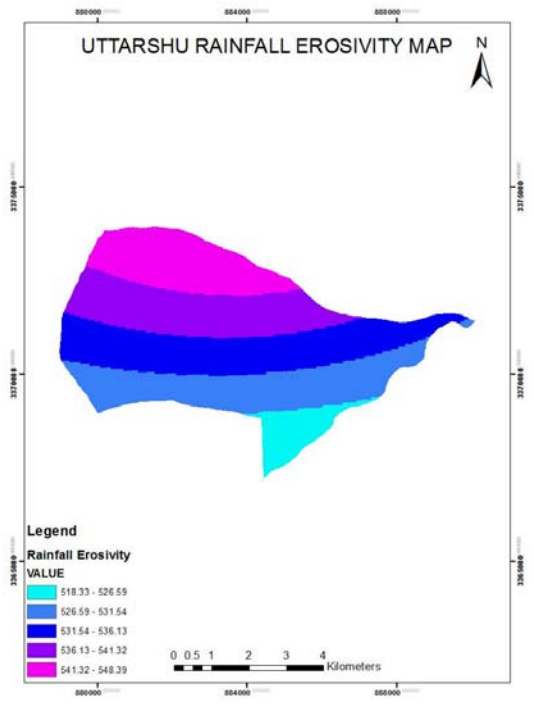


Figure 78: Rainfall Erosivity Map Uttarshu



Annexure-6 MWS wise Land use Land Cover Details

Table 55-(1): Land-use Status Lathiyagad

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
Lathiyagad	Moderate Forest	1670.463	35.78%
	Bare Land	924.145	19.79%
	Agriculture	632.3375	13.54%
	Water Bodies	0.765	0.016%
	Dense Forest	102.3625	2.19%
	Built Up	48.825	1.04%
	Open Forest	1289.388	27.62%

Table 6-2: Land-use Status Dewangad

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
Dewangad	Moderate Forest	2740.42	39.31%
	Fallow	713.075	10.23%
	Open Forest	1133.808	16.26%
	Agriculture	13.5625	0.19%
	Dense Forest	130.8325	1.88%
	Built Up	22	0.32%
	Bare Land	2217.883	31.81%

Table 6-3: Land-use Status Loharkhet

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
Loharkhet	Moderate Forest	4870.845	35.86%
	Fallow	2617.58	19.27%
	Open Forest	1984.27	14.61%

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
	Agriculture	1393.455	10.26%
	Water Body	98.235	0.72%
	Ice	40.38	0.30%
	Dense Forest	545.6025	4.02%
	Built Up	2.465	0.02%
	Bare Land	2031.723	14.96%

Table 6-4: Land-use Status Uttarasu

Micro-Watershed Name	Landuse Class	Area(Ha)	Area (%)
Uttarasu	Moderate Forest	1008.095	28%
	Fallow	12.43	0%
	Open Forest	607.58	17%
	Agriculture	855.125	24%
	Water Body	29.585	1%
	Dense Forest	239.77	7%
	Bare Land	864.8075	24%

Table 6-5: Land-use Status Paligad

Micro-Watershed Name	Landuse Class	Area(Ha)	Area (%)
Paligad	Moderate Forest	1277.585	21%
	Fallow	805.5325	14%
	Open Forest	1945.8125	33%
	Agriculture	731.0975	12%
	Water Body	29.585	0.5%
	Dense Forest	1048.4725	18%
	Bare Land	61.87	1%
	Water Body	56.9475	1%

Table 6-6: Land-use Status Sidiyagad

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
Sidiyagad	Moderate Forest	1030.685	13%
	Scrub	150.935	2%
	Open Forest	2724.6025	35%
	Agriculture	1331.205	17%
	Built Up	8.765	0.11%
	Dense Forest	967.3825	12%
	Bare Land	1482.935	19%
	Water Body	77.3525	1%

Table 6-7: Land-use Status Silogi

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
Silogi	Moderate Forest	683.18	15.95%
	Fallow	441.63	10.31%
	Open Forest	496.63	15.95%
	Agriculture	1355.12	31.63%
	Built Up	11.72	0.27%
	Dense Forest	10.30	0.24%
	Bare Land	1254.42	29.20%
	Water Body	42.83	1.00%

Table 6-8: Land-use Status Sarugad

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
Sarugad	Moderate Forest	3173.825	44.71%
	Fallow	526.67	7.42%

Micro-Watershed Name	Landuse Class	Area (Ha)	Area (%)
	Open Forest	1789.9975	25.22%
	Agriculture	1117.5375	15.74%
	Dense Forest	162.5325	2.29%
	Bare Land	187.8575	2.65%
	Water Body	140.3425	1.98%

Annexure-7 Agriculture Crop Production Tables

Table 7.1
Productivity Garlic

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	22.2	23.5
Bageshwar	22.4	23.1
Dehradun	31.4	32.0
Pauri	19.6	20.4
Pithoragarh	19.6	20.4
Dehradun II	30.9	31.4
Rudraprayag	20.6	21.4
Tehri	20.4	21.4
Uttarkashi	22.3	23.1
Grand Total	**209.4**	**216.7**
Average	**23.3**	**24.1**

Table 7.2 Productivity
Cauliflower

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	113.2	114.4
Bageshwar	159.1	160.2
Dehradun	270.1	271.7
Pauri	101.2	102.9
Pithoragarh	202.1	203.3
Dehradun II	269.6	270.7
Rudraprayag	160.3	161.8
Uttarkashi	220.1	221.9
Grand Total	**1495.7**	**1506.9**
Average	**187.0**	**188.4**

Table 7.3
Productivity
Cabbage

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	110.2	111.7
Bageshwar	147.1	148.9
Dehradun	260.1	261.9
Pauri	101.2	102.4
Pithoragarh	200.1	201.8
Dehradun II	258.1	260.7
Tehri	154.3	155.9

Uttarkashi	210.1	211.8
Grand Total	**1441.2**	**1455.1**
Average	**180.2**	**181.9**

Table 7.4
Productivity
Peas

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	56.3	57.0
Bageshwar	34.0	34.4
Dehradun	121.0	121.6
Pauri	72.0	72.5
Pithoragarh	47.0	47.4
Pmu-Model	0.0	0.0
Rudraprayag	0.0	0.0
Thatyur	32.8	33.2
Uttarkashi	70.0	70.3
Grand Total	**433.1**	**436.4**
Average	**61.9**	**62.3**

Table 7.5
Productivity
Ginger

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	84.2	85.7
Bageshwar	76.0	77.0
Dehradun	92.9	93.6
Pauri	80.5	81.7
Pithoragarh	85.7	86.3
Dehradun-II	93.2	94.6
Tehri	85.1	86.6
Uttarkashi	88.1	89.8
Grand Total	**685.7**	**695.3**
Average	**85.7**	**86.9**

Table 7.6
Productivity
Maize

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	10.3	10.7
Bageshwar	8.8	9.2
Dehradun	18.0	18.6
Pauri	11.9	12.5

Pithoragarh	15.8	16.3
Dehradun-II	18.8	19.3
Rudraprayag	13.8	14.3
Tehri	17.6	18.1
Uttarkashi	18.8	19.1
Grand Total	**133.8**	**138.1**
Average	**14.9**	**15.3**

Table 7.7
Productivity Wheat

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	18.5	18.9
Bageshwar	13.0	13.8
Dehradun	20.8	21.3
Pauri	18.3	19.6
Pithoragarh	21.2	21.9
Dehradun-II	21.9	22.7
Rudraprayag	19.4	19.8
Tehri	18.9	19.6
Uttarkashi	19.8	20.8
Grand Total	**171.8**	**178.4**
Average	**19.1**	**19.8**

Table 7.8 Productivity Pigeon Pea

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	6.2	7.2
Bageshwar	7.1	7.9
Dehradun	8.4	9.0
Pauri	8.0	0.0
Pithoragarh	6.4	7.1
Dehradun-II	8.0	9.4
Rudraprayag	6.0	0.0
Tehri	6.2	6.4
Uttarkashi	7.1	7.8
Grand Total	**63.4**	**54.8**
Average	**7.0**	**7.8**

Table 7.9 Productivity Finger Millet

Division	Control (Q/Ha)	Project (Q/Ha)

Almora	13.1	14.3
Bageshwar	14.3	14.8
Dehradun	21.0	21.7
Pauri	14.6	14.2
Pithoragarh	14.2	14.6
Dehradun-II	21.4	22.1
Rudraprayag	17.1	18.3
Tehri	17.1	18.3
Uttarkashi	19.6	20.3
Grand Total	**152.4**	**158.6**
Average	**16.9**	**17.6**

Table 7.10 Productivity Red Kidney Beans

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	10.1	10.8
Bageshwar	5.8	7.2
Dehradun	10.6	10.9
Pauri	11.7	11.7
Pithoragarh	16.1	16.5
Dehradun-II	10.2	10.7
Rudraprayag	12.1	12.5
Tehri	12.8	12.4
Uttarkashi	16.1	16.7
Grand Total	**105.5**	**109.4**
Average	**11.7**	**12.2**

Table 7.11 Productivity Black Gram

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	5.7	6.1
Bageshwar	4.2	4.9
Dehradun	9.3	10.0
Pauri	5.9	6.5
Pithoragarh	7.8	8.3
Dehradun-II	9.0	9.8
Rudraprayag	6.2	6.7
Tehri	7.5	8.0
Uttarkashi	6.0	6.5
Grand Total	**61.6**	**66.8**
Average	**6.8**	**7.4**

Table 7.12 Productivity Potato (Kharif)

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	76.5	78.1
Bageshwar	80.4	82.1
Dehradun	121.1	123.2
Pauri	42.1	43.1
Pithoragarh	148.9	152.9
Dehradun-II	120.4	122.2
Rudraprayag	54.0	55.6
Tehri	95.1	96.8
Uttarkashi	91.0	92.6
Grand Total	**829.4**	**846.5**
Average	**92.2**	**94.1**

Table 7.13 Productivity Potato(Rabi)

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	75.6	77.1
Bageshwar	81.3	82.6
Dehradun	118.2	120.6
Pauri	41.0	42.0
Pithoragarh	138.0	145.0
Dehradun-II	117.5	119.6
Rudraprayag	54.2	55.1
Tehri	96.2	97.8
Uttarkashi	87.6	89.0
Grand Total	**809.6**	**828.8**
Average	**90.0**	**92.1**

Table 7.14 Productivity Soyabean

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	9.6	11.0
Bageshwar	10.7	11.4
Dehradun	13.9	14.5
Pauri	0.0	0.0
Pithoragarh	13.1	13.9
Dehradun-II	13.1	14.1

Rudraprayag	11.3	12.1
Tehri	13.7	14.4
Uttarkashi	12.4	13.6
Grand Total	**97.8**	**105.0**
Average	**12.2**	**13.1**

Table 7.15 Productivity Other millets

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	13.6	14.1
Bageshwar	12.1	12.8
Dehradun	12.9	13.4
Pauri	12.7	13.2
Pithoragarh	14.7	14.8
Dehradun-II	12.0	12.9
Rudraprayag	16.0	17.0
Tehri	15.7	16.7
Uttarkashi	10.8	11.8
Grand Total	**120.5**	**126.7**
Average	**13.4**	**14.1**

Table 7.16
Productivity Mustard

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	6.6	7.5
Bageshwar	5.4	6.3
Dehradun	9.9	10.8
Pauri	6.7	7.3
Pithoragarh	10.8	11.5
Dehradun -II	9.0	10.0
Rudraprayag	5.8	6.8
Tehri	3.7	4.0
Uttarkashi	8.6	9.5
Grand Total	**66.5**	**73.6**
Average	**7.4**	**8.2**

Table 7.17
Productivity Barley

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	9.3	10.9

Bageshwar	8.3	9.2
Dehradun	11.3	12.1
Pauri	11.1	11.9
Pithoragarh	12.1	13.0
Dehradun-II	12.1	12.9
Rudraprayag	10.2	10.9
Tehri	12.2	13.1
Uttarkashi	12.3	13.2
Grand Total	**99.0**	**107.2**
Average	**11.0**	**11.9**

Table 7.18
Productivity Paddy

Division	Control (Q/Ha)	Project (Q/Ha)
Almora	16.3	17.9
Bageshwar	20.2	21.8
Dehradun	24.1	25.8
Pauri	14.5	15.9
Pithoragarh	15.4	16.9
Dehradun-II	25.7	26.8
Rudraprayag	18.1	18.9
Tehri	20.2	21.9
Uttarkashi	37.2	38.7
Grand Total	**191.7**	**204.6**
Avearge	**21.3**	**22.7**

Table 7.19 Percentage of sample households expressing interest in training pertaining to basic farming techniques

		% of sampled HH interested in various trainings (farming)								
Training in	**Treatment type**	**Almora**	**Bageshwar**	**Dehradun**	**PMU-Model**	**Pauri**	**Pithoragarh**	**Rudraprayag**	**Thatyur**	**Uttarkashi**
Production improvement	C	43.10	42.11	62.75	2.38	27.59	69.74	0	18.18	43.93
	T	59.44	50.22	65.35	14.04	44.94	66.90	4.79	29.89	50.32
SMC	C	56.90	42.11	65.69	0	27.59	72.37	0	18.18	36.79
	T	60.11	56.46	65.98	5.26	43.95	65.48	2.71	28.38	43.25
Crop Planning	C	57.33	42.11	48.04	2.38	28.74	72.37	2.67	18.18	19.29
	T	57.98	55.46	58.71	7.02	43.62	65.48	4.43	28.01	18.84
IPM	C	56.03	39.47	43.14	0	29.89	68.42	2.67	18.18	13.21

	T	53.71	49.78	57.88	8.77	38.81	64.30	4.34	21.62	15.42
Post-harvest	C	54.31	34.21	46.08	2.38	29.89	67.11	0	18.18	14.64
	T	52.47	48.55	56.02	3.51	36.65	62.65	2.26	21.62	12.85
Market linkages	C	50.86	32.89	46.08	0	28.74	67.11	0	18.18	13.57
	T	52.36	48.89	54.98	0	36.32	59.57	1.63	21.99	11.13

C - Control, T - Treatment

Table 7.20 Percentages of sample households expressing interest in training pertaining to advanced agricultural production techniques

		% of HH interested in training (Agri production tech)								
Training in		**Almora**	**Bageshwar**	**Dehradun**	**PMU-Model**	**Pauri**	**Pithoragarh**	**Rudrapryag**	**Thatyur**	**Uttarkashi**
Land Preparation	C	67.24	68.42	82.35	28.57	29.89	55.26	49.33	63.64	44.64
	T	60.11	74.83	73.65	59.65	59.04	59.57	38.84	46.24	50.54
Improved varieties	C	70.69	73.68	79.41	33.33	36.78	63.16	49.33	27.27	33.93
	T	59.44	71.83	76.14	35.09	57.88	63.36	40.47	44.74	37.69
Seeds & Sowing	C	68.53	75	77.45	35.71	33.33	67.11	50.67	54.55	33.93
	T	61.24	72.94	77.59	35.09	56.72	63.36	42.73	46.24	38.33
Manure and fertilizer	C	67.24	68.42	67.65	23.81	39.08	69.74	38.67	45.45	28.57
	T	61.46	74.28	73.44	26.32	51.08	63.59	36.22	41.17	34.26
Plant Protection	C	64.22	72.37	62.75	33.33	29.89	71.05	37.33	45.45	27.86
	T	59.44	71.71	67.22	33.33	51.24	60.99	29.36	37.78	32.33
Irrigation	C	58.62	69.74	65.69	40.48	37.93	71.05	41.33	18.18	27.86
	T	54.83	70.16	64.11	42.11	54.73	60.28	34.15	39.66	32.12
Farm mechanisation	C	45.69	67.11	60.78	21.43	27.59	65.79	20	27.27	21.07
	T	52.25	68.93	54.98	15.79	47.93	56.74	30.08	34.40	21.63
Harvesting	C	34.91	67.11	52.94	14.29	24.14	63.16	38.67	36.36	20.71
	T	48.65	66.48	49.79	17.54	44.94	55.56	30.71	32.14	22.06

Table 7.3: percentages of sample households expressing interest in training pertaining to non-agriculture IGA

District	**% of HH interested in training (IGA)**

	C	T	C	T	C	T	C	T	C	T
Almora	66.81	71.24	55.17	59.78	56.90	56.97	53.02	53.37	52.59	49.55
Bageshwar	94.74	83.85	89.47	80.29	93.42	79.73	80.26	75.84	75	73.50
Dehradun	90.20	86.72	78.43	75.73	74.51	77.80	71.57	71.78	67.65	64.73
PMU-Model	69.05	75.44	14.29	26.32	52.38	43.86	30.95	38.60	21.43	36.84
Pauri	70.11	63.18	33.33	48.59	49.43	57.38	40.23	50.58	37.93	47.26
Pithoragarh	31.58	47.75	11.84	26.24	22.37	17.49	19.74	16.55	15.79	22.70
Rudraprayag	68	64.95	20	29.00	52	50.95	41.33	34.87	36.00	37.58
Thatyur	63.64	62.03	63.64	39.29	45.45	48.31	45.45	36.28	27.27	30.64
Uttarkashi	79.64	71.52	56.79	54.60	65	52.68	46.43	38.54	36.07	29.34