



Identification of species with optimum land use planning for enhancing water availability to sustain livelihood in Chitwan-Annapurna Landscape (CHAL), Nepal.

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Introduction

- Land use practices- balancing ecosystem- maintenance of water supply services to watersheds of concern.
- On the other hand- land use planning- integral role- sustainable conservation and management of catchment specific resources.
- Intricate relationship -vegetation and water cycle in a micro-catchment- define-> water cycle in the basin which again refines the growth and productivity of the plant species.
- Topography, soil characteristics, vegetation and climate<-> interact-determine the types, intensities, and locations of runoff production and the transport of sediments, chemicals, and organic debris in a landscape.

- Prediction of the resulting changes in vegetation patterns, water quality and runoff production requires an accurate, explicit representation of the relationships between hydrology, vegetation and climate (Wigmosta et al., 1994).
- Vegetation- important role in the amount of retention-both in terms of interception and transpiration.
- Effect of interception on retention- more significant- when precipitation comes in low intensity.
- Momentarily, land/cover use practices are unorganized in most river basins of Nepal.
- Although, the target for maintainance-40% (fixed) of forest resources- made by polices of Nepal-there often lacks the mechanism for sound delineation- to achieve balanced ecological function of nature.

Methodology and Study Area

- Four specified watershed- two in each Tanahun and Kaski district.

Watershed	Area	Landuse type
Chhabdi Khola watershed, Tanahun	Area= 28.411 sq. km Stream length= 19.73 km Drainage density= 0.694	57.3% BLCF; 8.87% BLOF; 33.7% Agriculture; 0.14% Built-up area
Guhe Khola watershed, Tanahun	Area= 2.275 sq. km Stream length= 1.68 km Drainage density= 0.738	46.48% BLCF and 53.53% Agriculture
Gharmi Khola watershed, Kaski	Area= 2.958 sq. km Stream length= 1.72 km Drainage density= 0.581	16.48% BLCF; 5.44% BLOF; 0.30% Shrubland; 1.09% Grassland; 76.68% Agriculture
Bhoti Khola watershed, Kaski	Area= 6.036 sq. km Stream length= 3.86 km Drainage density= 0.639	1.87% NLCF; 8.87% NLOF; 21.86% BLOF; 10.1% BLCF; 0.19% Shrubland; 0.31% Grassland; 56.8% Agriculture

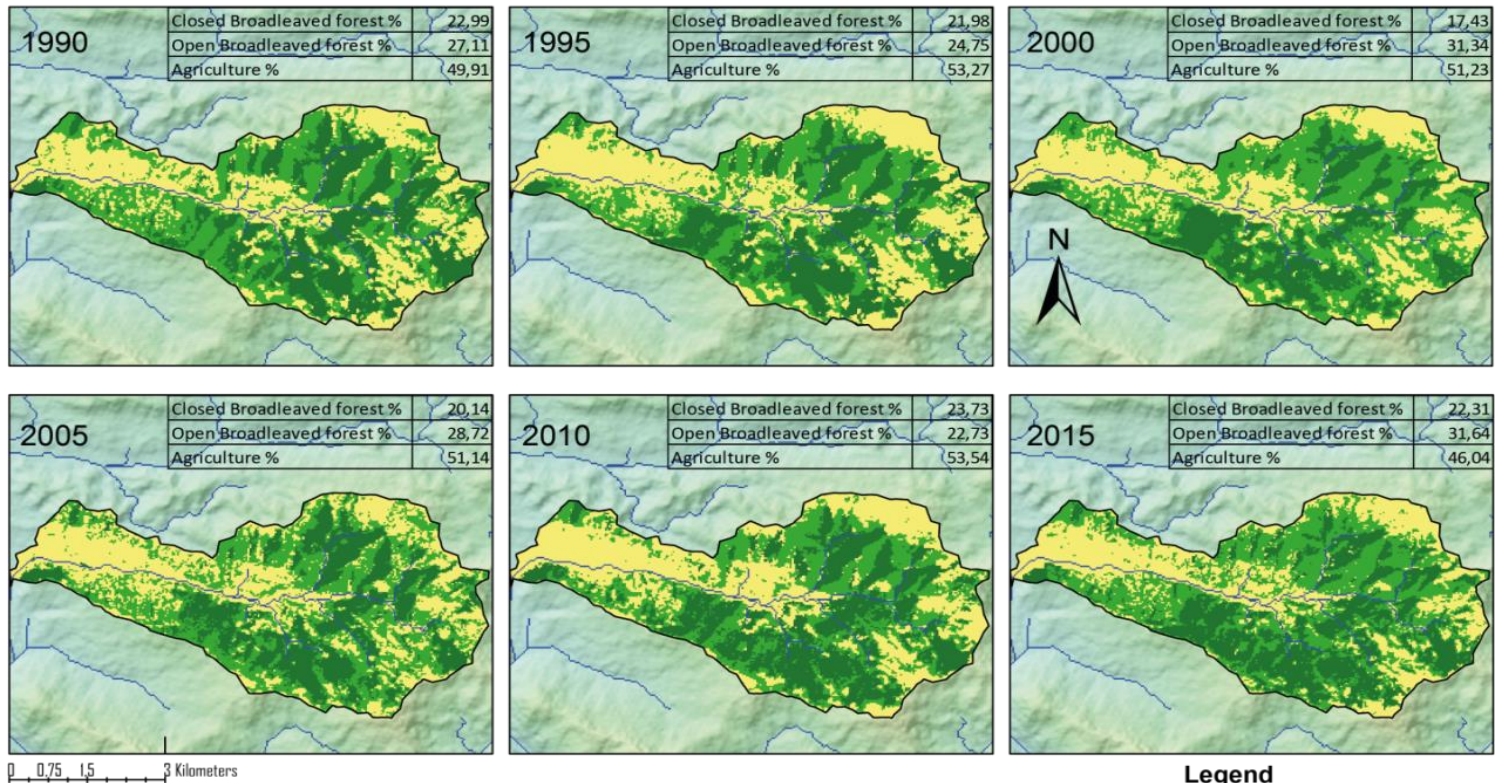
BLOF= Broadleaved Open Forest; BLCF= Broadleaved Closed Forest; NLOF= Needle Leaved Open Forest; NLCF= Needle Leaved Closed Forest

- ArcGIS 10.2.2- Analysis and preparation of land use classification map.
- Basis for classification- acquisition of satellite images; generated land use maps which depict four road category of natural land cover existed in studied watershed.
- LANDSAT 8 Imagery (1990, 1995, 2000, 2005, 2015), and various topographic maps and base maps.
- To estimate soil properties, soil organic carbon (SOC), bulk density, soil texture and soil moisture were calculated using their respective formulas.

Result

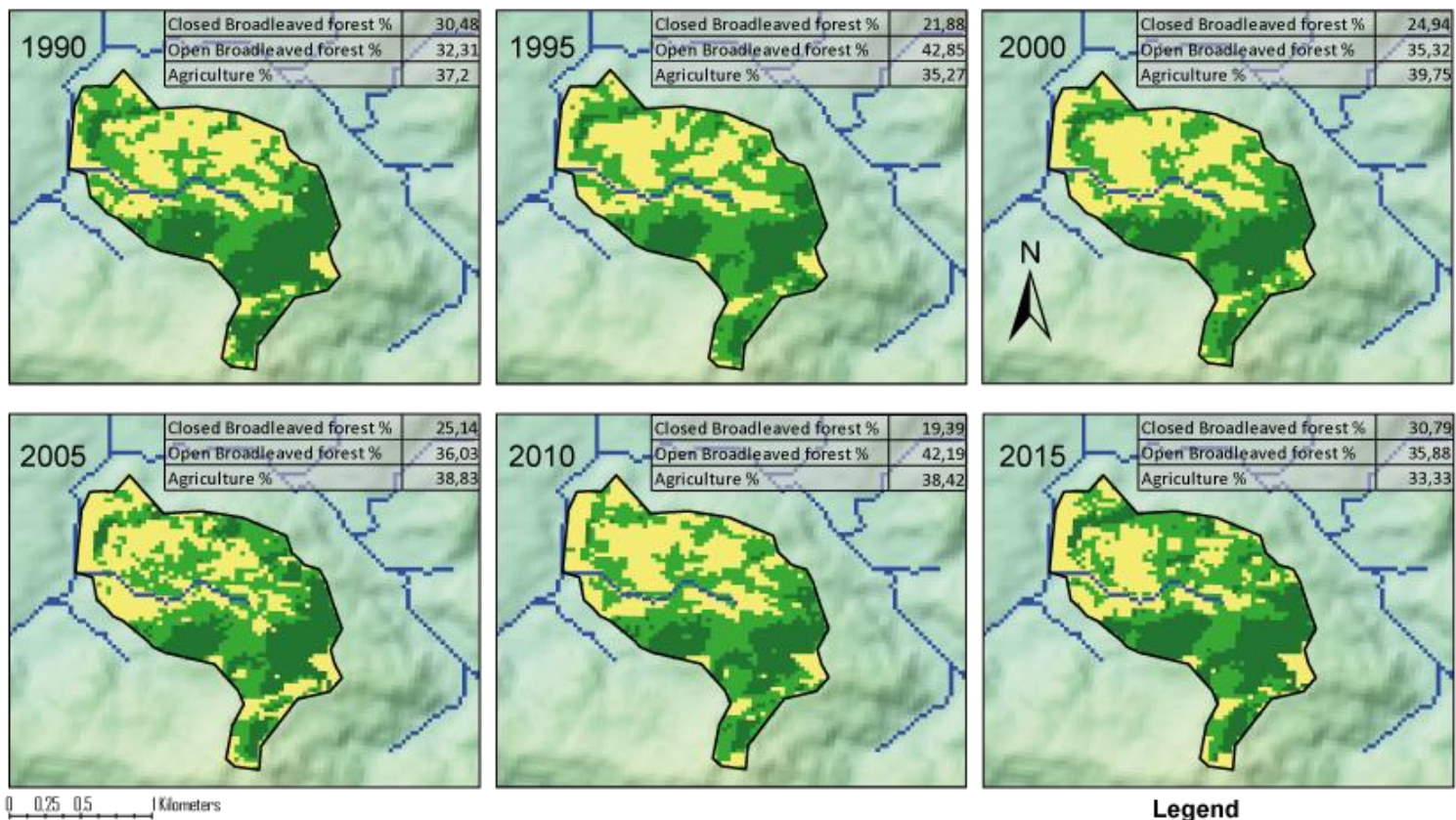
1. Land cover mapping in different years in different watersheds

Land cover of the Chhabdi Khola River Basin from 1990 to 2015 *Builtup area is not shown



- Mainly occupied by forest.
- Share of Broadleaved Forest peaked in 2000 with 41.68% while the share of Closed-broadleaved Forest was at its lowest.
- In contrast, the share of Closed-broadleaved Forest peaked in 2010 with 30.77% and the share of Broadleaved Forest was at its lowest with 31.35%.
- Very little correlation between the progression of years and the share of agricultural land.

Land cover of the Guhe Khola River Basin from 1990 to 2015 *Builtup area is not shown



Legend

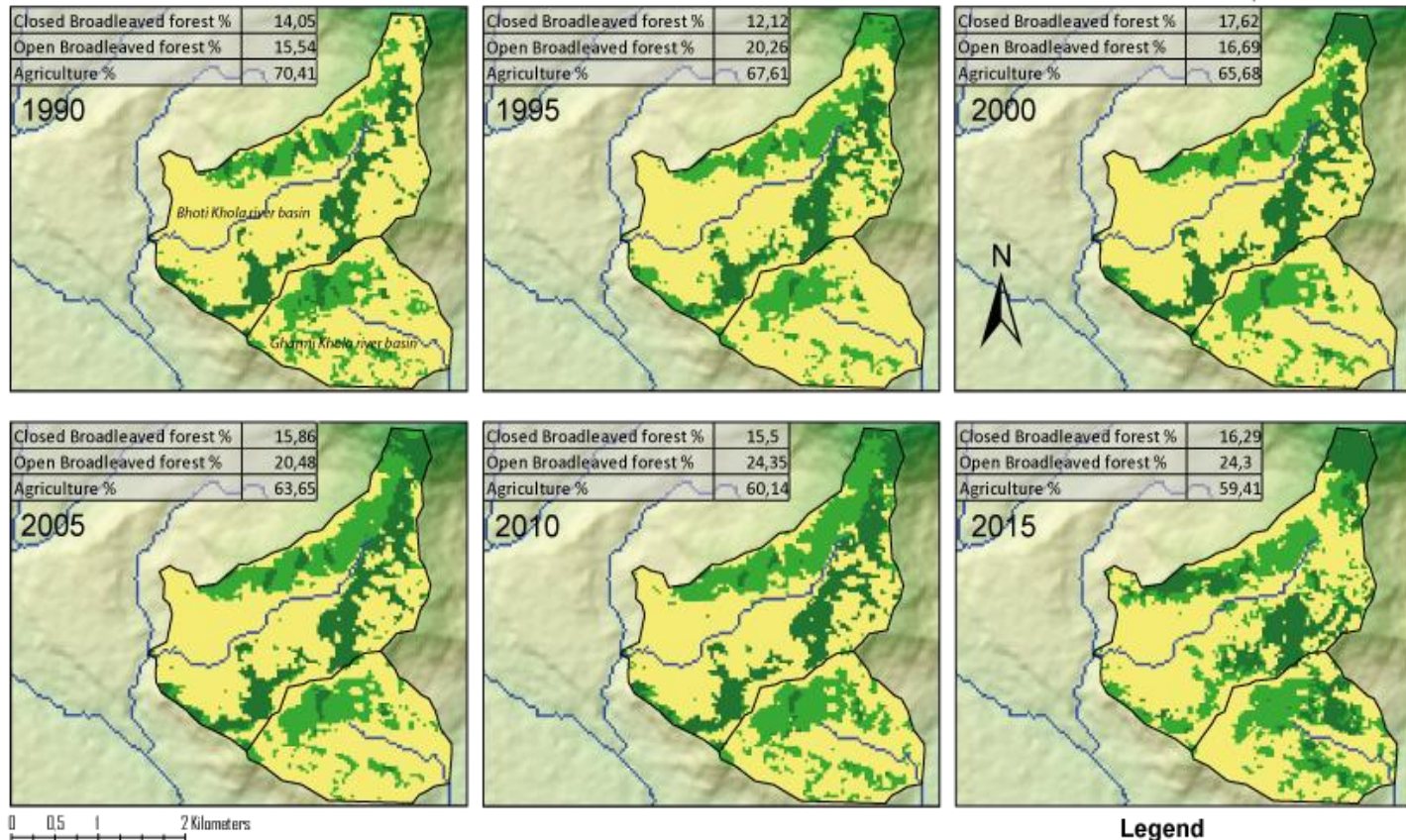
Land cover

- Closed Broadleaved forest
- Open Broadleaved forest
- Agriculture

- 60% covered by forest, a significant share of which are distributed in small patches of Open-Broadleaved Forest throughout the agricultural area.
- Closed-Broadleaved Forest- mainly concentrated in the southern part of the river basin.
- Big differences between two forests in 1995 and 2010, with the share of Open-Broadleaved Forest being approximately double than the share of Closed-Broadleaved Forest (42.85% Open-Broadleaved Forest vs. 21.88% Closed-Broadleaved Forest in 1995 and 42.19% Open-Broadleaved Forest vs. 19.39% Closed-Broadleaved Forest)

Land cover of the Bhoti- and Gharmi Khola River Basins from 1990 to 2015

*Builtup area is not shown

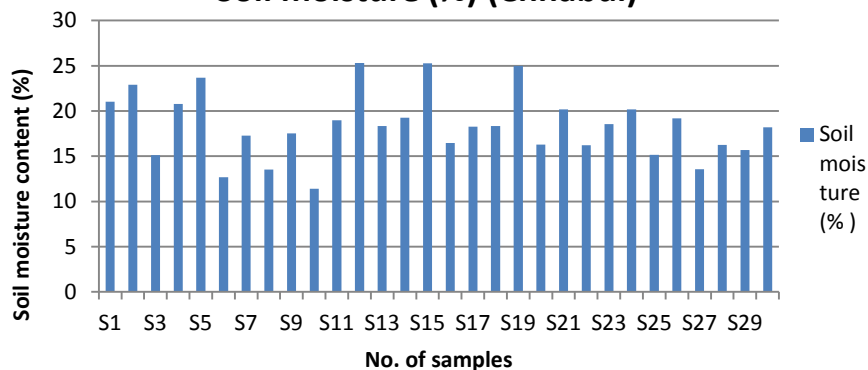


- Largely covered by agricultural land.
- Share of Closed-Broadleaved Forest seems to fluctuate although there is a slight of 2.24% increase from 1990 to 2015.
- Overall downward trend can be observed in agricultural area; share of agricultural land seems to be decreasing in each of five year interval.

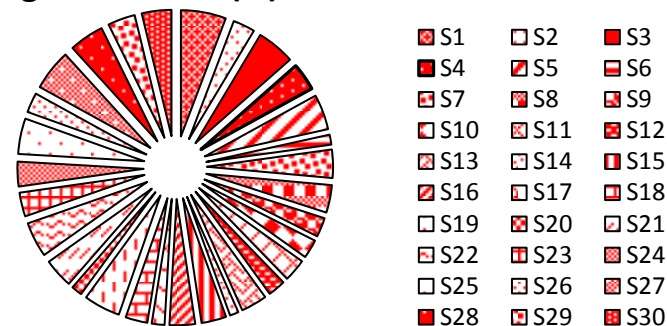
- Hydrological properties of soil
 - Total of 80 samples were taken based on soil samples taken from representative field sites.
 - Samples were taken as representatives of various land use types.
 - The sampling was done in such a way as to take replica for each of the land use category and which also maintained justifiable representation of all categories of land use along with the quite representing of slop type, aspect and other geographic features of the watershed.

- Chaabdi Khola Watershed

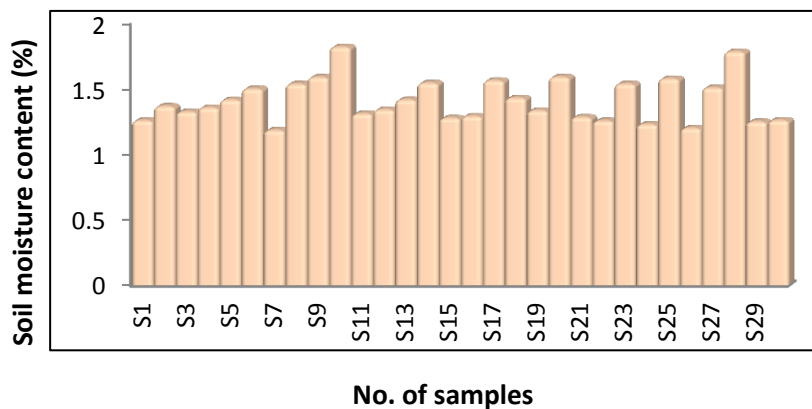
Soil moisture (%) (Chhabdi)



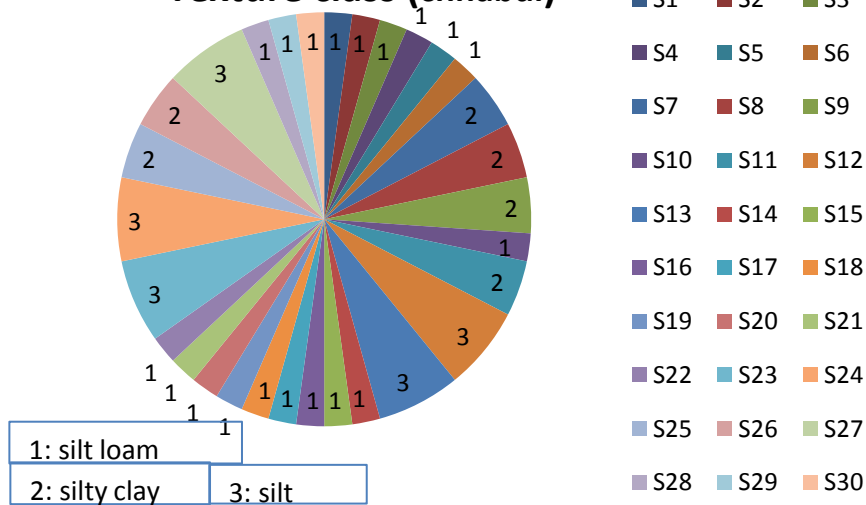
Soil Organic Carbon (%) Chhabdi



Bulk Density (gm/cm³) (Chhabdi)



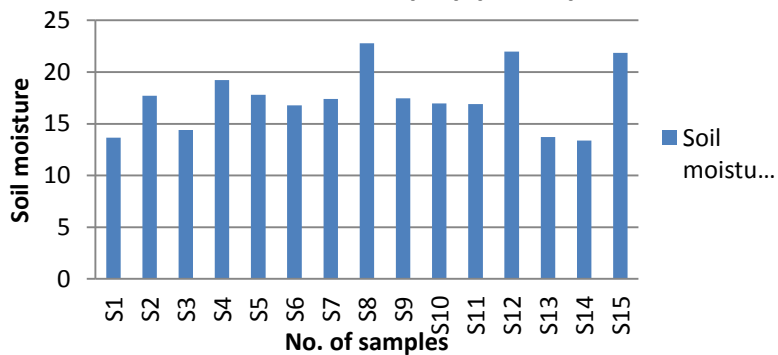
Texture class (chhabdi)



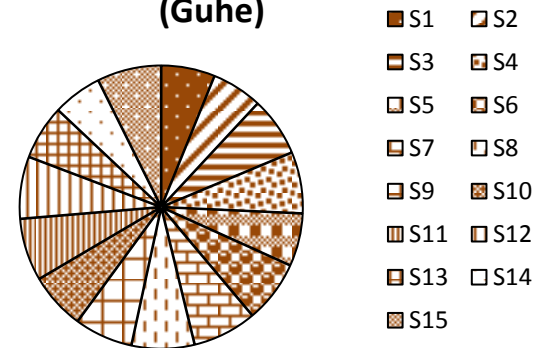
- Soil Moisture: Analysis shows that the Chhabdi Khole contains more moisture in the upper layer of soil with the average of 18.35%.
- Soil Organic Carbon(SOC): Carbon estimation was done through Dry Combustion method. SOC->0.69%.
- Bulk Density: Represents the compaction setting of the soil interims of occupancy/non-occupancy of structural pores. Average->1.41 gm/cu.cm.
- Bulk density found to be highest for compacted area near roadside than another land use.
- Texture: Average texture class in soil sample-> silt loam, silty clay and silt.

- Guhe Khola Watershed

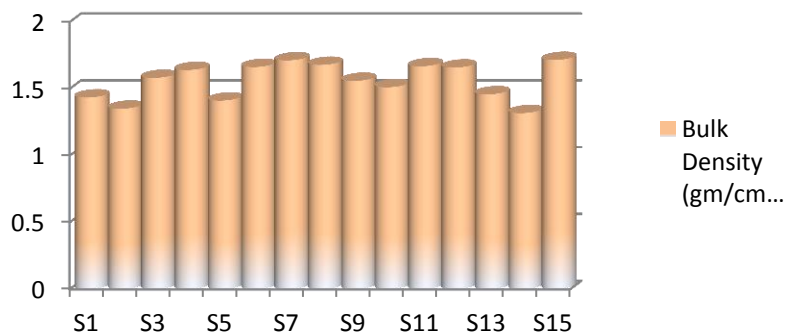
Soil moisture (%) (Guhe)



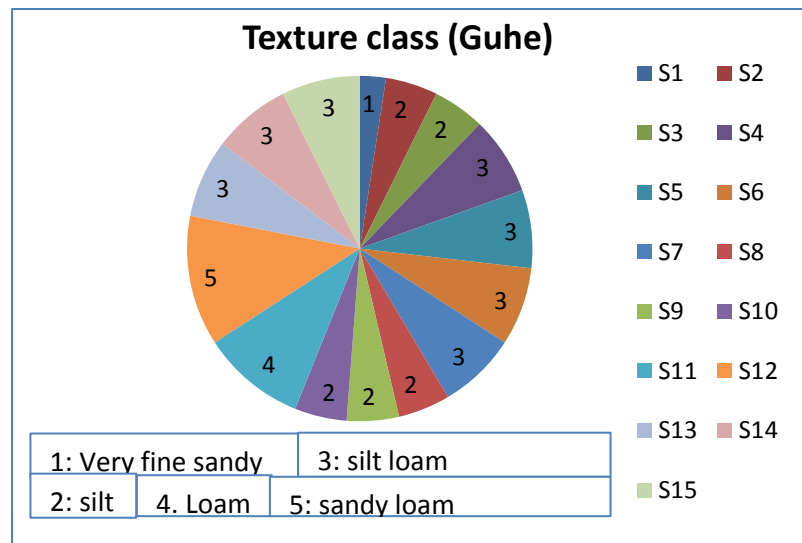
Soil Organic Carbon content (%) (Guhe)



Bulk Density (gm/cm³) (Guhe)



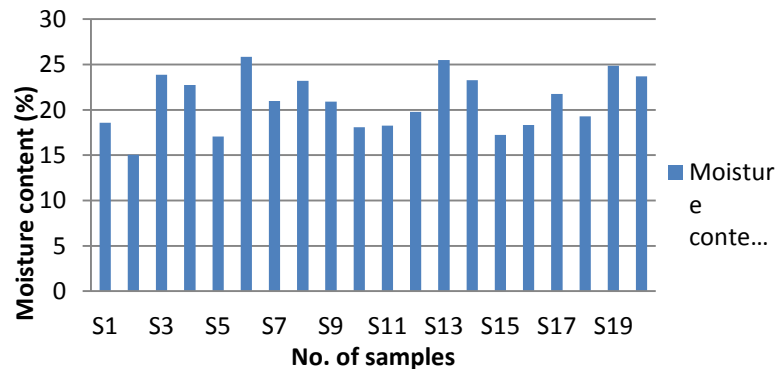
Texture class (Guhe)



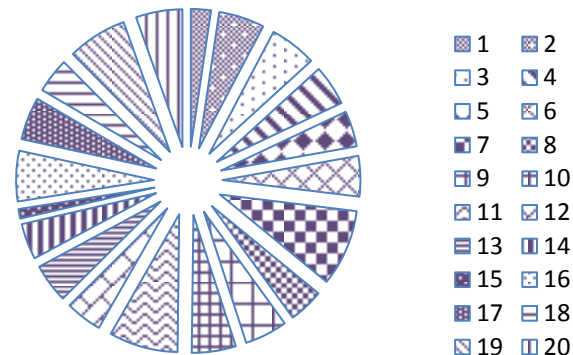
- Soil Moisture: Highest at S8 but the average was 17.47%.
- Soil Organic Carbon: Average 0.43%, lowest was 0.1351%.
- Bulk Density: Measure of bulk density ranged from 1.3 to 1.716gm/cu.cm. Average was found to be 1.55 for all samples.
- Texture: Major texture was attributed to silt loam.

- Bhoti Khola Watershed

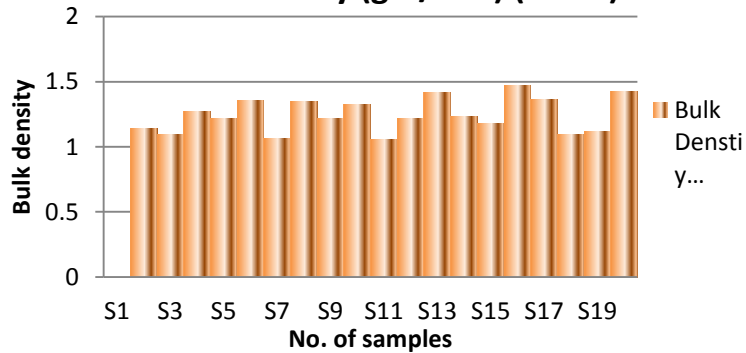
Moisture content (%) (Bhoti)



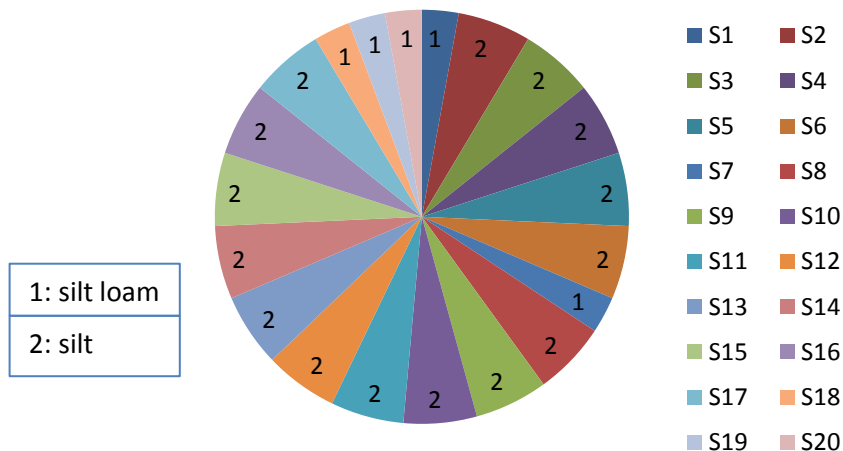
SOC (%) (Bhoti)



Bulk Denstiy (gm/cm³) (Bhoti)

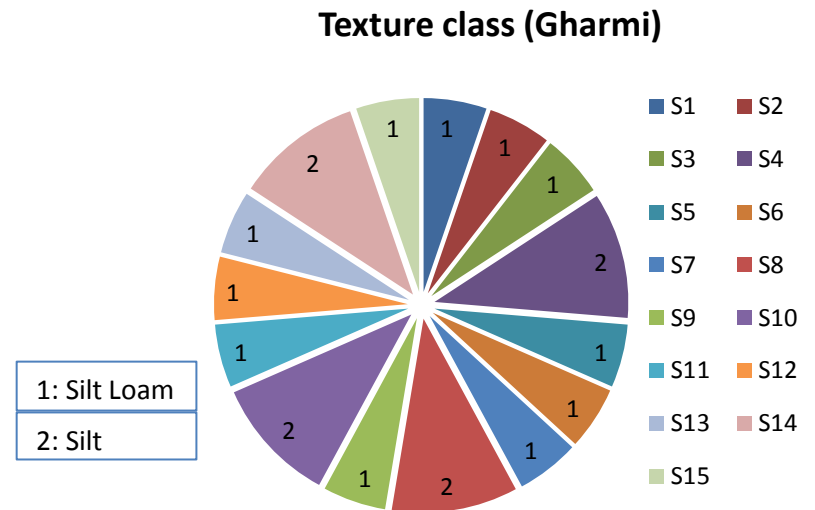
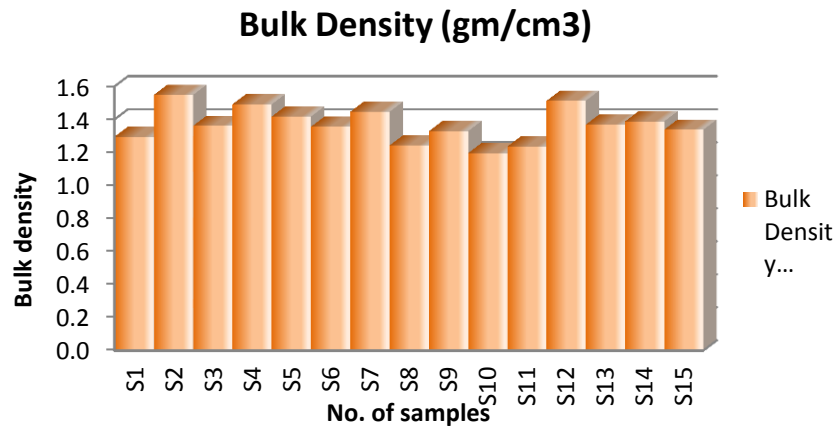
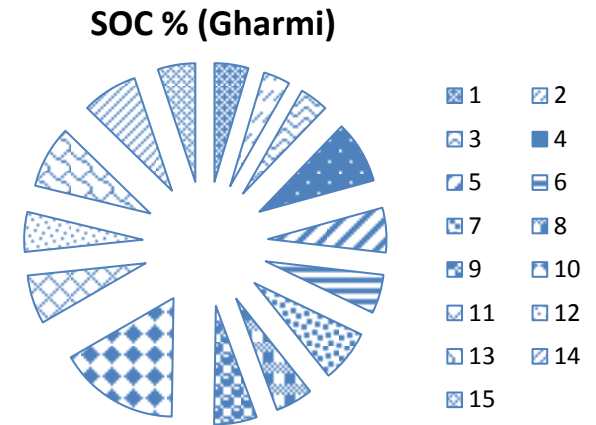
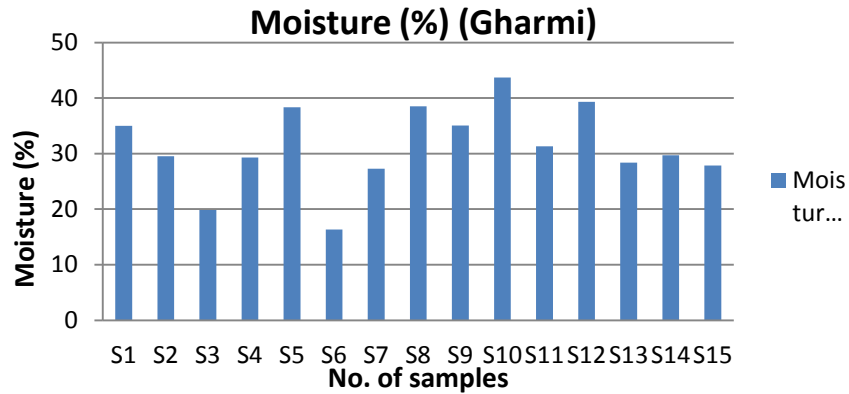


Texture class (Bhoti)



- Soil Moisture: With the average of 20.915%, maximum soil moisture was around the scattered trees, near bridge (river edge), orchard, lowland and otherside of river.
- Soil Organic Carbon: Value ranged from 0.258% to 0.987% with average of 0.59%.
- Bulk Density: Highest was at S16 and S20. Average 1.26 gm/cu.cm.
- Texture: Dominated by silt i.e. soil material contains 80% or more silt and less than 125 of clay material.

- Gharmi Khola Watershed



- Soil Moisture: Maximum soil moisture content was 43.715 for forest followed by shrubland with 31.29%. Average 31.29%.
- Soil Organic Carbon: Highest for forest, fallow land and some nearby roadside as well as some upland areas. Least in barren land. Average 0.519%.
- Bulk Density: 1.37 gm/cu.cm.
- Texture: More than 50% of silt loam.

2. Potential Vegetation Recommendation

- Successful and sustainable forest management-key-integrated watershed management and conservation.
- Tanahun district-elevated above 869m from sea level-temperature fluctuating between 25.8-2.2C- yearly rainfall about 2058 mm-comprises of lower tropical to sub-tropical vegetation types.
- Kaski district- situated at an altitudinal range of 450m- 891m-upper tropical to Trans-Himalayan vegetation types.
- Tanahun district-dominated by naturally hardwood species.
- Kaski district- dominated by coniferous species in most forest types.
- Considering all the factors- altitudinal and climatic variation-demand of local people- conservation status- economic return- social acceptability->

- *Shorea robusta*- lowest belt; *Acacia catechu*- lower river sides; *Bambax ceiba*- open pasture areas; *Dalbergia sisso*- private land; *Syziium cumini*- waterlogged areas; *Pinus roxburghii*- uppermost zone (Tanahun district).
- *Acacia catechu*, *Alnus nepalensis* and *Albizia procera*- lower river side and abandoned areas.
- *Gmelina arborea* and *Anogeisus latifolia*- private lands; *Quercus species*-natural forest; *Betula utilis*- gullies area; *Cupress torulosa*- upper most region (Kaski district).
- In terms of people's perception with output generation- non timber forest products- Baas (*Bambusa nutans*); Nigalo (*Drepanostachyum inter medium*); Lokta (*Daphne bhoola*); Pipal (*Ficus religiosa*); Chiraito (*Swertia sps.*); Cardamom and Cinnamom- recommended.

S.N	Species	Scientific name	Range of distribution (horizontal & vertical)	Ease of cultivation/propagation	Regeneration/rotation period	Ethno-botanic importance	Multipurpose uses	Economical return	Annual Industrial Demand in Nepal	Market value/ price	Royalty rate as % of market price	Social acceptance for promotion	Threat category/Conservation status	Quality improvement potential	Total Score (out of 60)j
1	Sal	Shorea robusta	3	3	1	4	4	5	5	5	5	3	3	3	44
15	Khayar	Acacia catechu	3	3	4	4	2	4	5	5	5	3	3	2	43
8	Simal	Bombax ceiba	2	5	4	4	4	4	3	3	3	4	3	3	42
24	Sisoo	Dalbergia sissoo	3	4	3	4	3	4	5	5	3	3	1	3	41
2	Asna	Terminali alata	3	3	2	4	3	4	4	4	4	3	3	3	40
16	Khote sallo	Pinus roxburghii	3	4	4	4	2	4	4	4	4	2	2	3	40
10	Jamun	Syzygium cumini	4	3	3	4	4	3	2	3	2	3	2	2	35
27	Dhupi	Cupressus torulosa	3	3	3	4	4	3	3	2	2	3	2	2	34
26	Bhoj patra	Betula utilis	3	2	3	4	3	3	2	2	2	2	4	2	32
6	Mahuwa	Madhuca indica	2	3	4	3	4	4	1	1	1	3	3	1	30
14	Champ	Michelia champaca	2	3	3	3	2	2	2	2	1	2	5	2	29
25	Utis	Alnus nepalensis	3	4	4	4	3	2	2	2	1	2	1	1	29
3	Karma	Adina cardifolia	2	3	4	3	3	2	2	2	1	2	1	2	27
11	Seto Sirish	Albizia procera	3	4	3	3	3	2	1	1	1	3	1	2	27
22	Bajhi	Anogeissus latifolia	3	3	3	3	3	2	2	2	1	2	1	2	27
5	Katus	Castanopsis indica	3	3	3	3	3	2	2	1	1	2	1	2	26
17	Khamari	Gmelina arborea	2	3	4	3	3	2	2	1	1	3	1	1	26
12	Lampate	Aesculus indica	3	3	3	3	3	2	2	1	1	2	1	1	25
21	Khasru oak	Quercus semecarpifolia	2	2	3	3	2	2	2	2	1	2	1	1	23
23	Jhigat	Lannea coromandelica	2	4	4	2	2	1	1	1	1	2	1	1	22
4	Chilaune	Schima wallichiana	3	4	3	2	2	1	1	1	1	2	1	1	22
7	Dabdabe	Garuga pinnata	2	3	4	1	2	1	1	1	1	1	1	2	20
9	Botdhairo	Lagerstroemia parviflora	2	3	3	2	2	1	1	1	1	1	1	1	19
20	Bajh	Quercus lanata	2	2	3	2	2	2	2	2	1	1	1	1	21
18	Laligurans	Rhododendron arboreum	2	2	2	3	1	1	1	1	1	2	2	1	19

Discussion

- Chhabdi Khola watershed-increment in closed broadleaved forest-after 2005; expect 2005 and 2010- open broadleaved forest cover- increased(mostly).
- Guhe Khola-closed broadleaved forest-increases(2015).
- Gharmi-Bhoti Khola- share of agricultural area-more.
- Soil properties were also specific to different watershed.
- After land use planning- determination of potential vegetation, along with recommended management practice and sustainability.
- Base for recommendation-> ease of cultivation, rotation period, ethno-botanic importance, multipurpose uses, economic returns, market value, annual industrial demand in Nepal, royalty rate as % of market price, range of distribution, threat category and conservation status.

Thank you!