INDICATORS FOR LOSS OF BGBD ACROSS A GRADIENT OF LAND USE TYPES IN NILGIRI BIOSPHERE BENH MARK SITE, WESTERN GHATS, KARNATAKA

The research work carried out in the benchmark area, Koothy village of Somwarpet taluk is located in the Kodagu district of Karnataka. This benchmark area is situated very close to the Nilgiri Biosphere Reserve at the northern region and lies between $12^{0}40^{1}\ 03^{11}$ N–$12^{0}\ 42^{1}\ 19^{11}$ N and $75^{0}\ 47^{1}\ 10^{11}$ E–$75^{0}\ 79^{1}\ 14^{11}$ E. The annul rainfall of the area ranges from 2000 mm to 3500 mm. Most of the rainfall is drawn from southwest monsoon during June-August period. The temperature begins to increase from March to April with a mean daily maximum of 28.6^{o}C and a mean daily minimum of 17.8^{o}C. The temperature on some days might be as high as 32 to 35^{o} C during April or May. The daily lowest temperature of around 9^{o} C is recorded during the month of January.

Coffee and cardamom plantations cover major part of the study area. The natural forests are found in the periphery of the plantations, which are evergreen with varying levels of degradation. A few patches of *Acacia auriculiformis* plantations (monoculture) and grassy blanks are found adjacent to the forests. Rain-fed agriculture is practiced in the valleys with one paddy crop every year during the rainy season. Additionally, crops like chilly and short duration grain legumes are also grown in summer utilizing the residual moisture and sparse rainfall of northeast monsoon.

Land use / Land cover mapping

Satellite data (IRS -1D- LISS III data of the year 2000, path 98 and row 64) was interpreted to prepare land use/land cover map of the study area at 1:50,000 scale. Hybrid classification approach was adopted. A mask was created for almost non-overlapping classes (*viz*., agriculture areas and vegetated areas) obtained from unsupervised classification. The vegetated areas are further classified into forests, grasslands, coffee/cardamom plantations and forest tree plantations by supervised classification. The outputs obtained from unsupervised and supervised methods were merged to get the hybrid output. Classified output was draped over Digital Elevation Model (DEM) misclassified patches identified and necessary corrections were incorporated. Six land use – land cover types could be distinguished in the study area. They are natural forest, grasslands, acacia plantations, coffee plantations, cardamom plantations and paddy fields.

A 200 m grid was overlaid on the map and 60 intersection points were sampled for aboveground/belowground biodiversity studies. The sample points identified on the map were reached

in the field using handheld ***Garmin 12,*** Geographical Positioning System. A total of 60 sample points were distributed in two windows of size 6.4 sq km (4 x 1.6 km) and 0.8 sq km (0.4 x 2 km) so as to cover all the above said land cover types. Fifty-three sample points were distributed in the first large window and seven points in the second small window. Stratified sampling technique was adapted and two windows were selected, because the first large window that was selected did not have enough natural forests, grasslands and *Acacia* plantations. Hence, additional window in the study site was selected to cover the required land use types. The sample points were laid in the intersection point of the windows and were located in the ground using hand held ***Garmin 12*** GPS. These intersection points at which sampling could not be done due to the presence of a natural obstruction (presence of a tree, stone/water body etc.) were skipped and the next sampling was done in the next intersection point.

The physical properties of the soils of the study site are given in the table 1. The results indicate that the physical parameters *viz*., bulk density, clay, sand and silt contents did not vary significantly amongst the different land use types suggesting that these physical parameters are not influencing the below ground biodiversity in the study site.

Table 1: Physical properties of the soil in different land use types at Koothy, Western Ghats, Karnataka

PARAMETER	NF	GL	FP	CAP	COP	PF	F-test
Bulk density (g/cm)	1.20 ±0.14	1.42 ±0.15	1.41 ±0.17	1.17 ±0.13	1.270 ±0.17	1.21 ±0.14	NS
Sand (%)	61.69 +±4.96	60.83 ±6.05	62.73 ±6.28	61.17 ±4.62	61.09 ±9.48	60.18 ±7.63	NS
Silt (%)	26.35 ±2.9	23.17 ±5	23.93 ±5.47	24.28 ±3.75	25.10 ±4.59	23.60 ±2.58	NS
Clay (%)	14.06 ±5.77	16.97 ±7.6	14.13 ±5.61	14.14 ±4.98	13.88 ±6.98	16.10 ±5.76	NS

Table 2: Chemical properties of the soil in different ecosystem at Koothy, Western Ghats

PARAMETER		NF	GL	FP	CAP	COP	PF
pH	0-10 cm	6.2 ±0.30^{a}	5.57 ±0.31^{c}	5.51 ±0.19^{c}	6.31 ±0.20^{a}	6.16 ±0.25^{a}	5.30 ±0.15^{c}
	10-20 cm	6.21 ±0.28^{a}	5.57 ±0.37^{c}	5.56 ±0.2^{c}	6.16 ±0.19^{a}	6.18 ±0.32^{a}	5.50 ±0.15^{c}
Org.C (%)	0-10 cm	3.77 ±0.92^{ab}	2.28 ±0.51^{c}	2.33 ±0.48^{c}	3.14 ±0.75^{ab}	2.79 ±0.88^{a}	1.11 ±1.05^{c}
	10-20 cm	2.59 ±1.26^{ab}	1.80 ±0.53^{c}	1.73 ±0.48^{c}	0.50 ±0.10^{ab}	0.47 ±0.11^{a}	0.32 ±0.16^{c}
Total-N (%)	0-10 cm	0.48 ±0.16^{ab}	0.29 ±0.06^{c}	1.73 ±0.48^{ab}	3.14 ±0.75^{a}	2.79 ±0.88^{ab}	1.11 ±1.05^{c}
	10-20 cm	0.37 ±0.12^{a}	0.28 ±0.07^{c}	0.34 ±0.08^{ab}	0.50 ±0.10^{a}	0.47 ±0.11^{ab}	0.32 ±0.16^{c}

The chemical properties namely, the pH, organic-C and the total-N that are indicated in the table 2 significantly differ from one land use type to the other even at different depths. The natural forests, cardamom plantations and coffee plantations, which are rich in the above ground biodiversity as indicated by their diversity indices for trees and shrubs might influence the soil pH congenial to most organisms. The organic-C and total-N are added thorough recycling of leaf litter continuously throughout the year in these ecosystems. But, significantly lower pH, lower org.-C and total-N are recorded in grasslands, acacia plantations and paddy fields. This is mainly attributable to the fact that diversified types of leaf litter as in the other ecosystems is not added as there is only one type of vegetation that may not add much litter to the soil during most of the year. Thus, there is a loss in belowground biodiversity de to lack of sufficient Org.-C and N required for the growth of organisms.

Table 3. No. of species of different functional groups of organisms across a gradient of land use types

PARAMETER	SEASON	N. F	GL	AP	CAP	COP	PF
VAM	PRM	27	24	22	19	23	16
	POM	31	27	26	26	25	13
Soil meso-fauna	PRM	27	13	14	27	25	12
	POM	19	12	16	23	21	16
Earthworms	PRM	-	-	-	-	-	-
	POM	8	8	6	1	11	8

The number of species of different functional groups of organisms across a gradient of land use types could be seen from the table 3. It was noted that the number of species of VA mycorrhizal fungi were higher in the post – monsoon season than in the pre-monsoon season except in the paddy fields. The number of species of meso-fauna was higher in most of the land use types in the pre-monsoon season compared to post-monsoon season except in acacia plantations and paddy fields. However, the number of species in grasslands, acacia plantations and paddy fields were lesser and it is pertinent to mention that in these land use types, the Org.-C was also lower compared to the other land use types. while the number of species of earthworms was higher in the post-monsoon season only. The important contribution from the Karnataka part of is that seasons also play an important role in diversity and loss of biodiversity.

Table 4. The diversity species of different functional groups of organisms across a gradient of and use types

PARAMETER	SEASON	N. F	GL	AP	CAP	COP	PF
VAM	PRM	4.41	4.20	3.99	3.57	3.80	3.36
	POM	4.59	4.45	4.26	4.08	4.04	3.01
Soil meso-fauna	PRM	2.86	2.49	2.10	3.38	3.72	2.13
	POM	2.86	2.78	2.16	3.53	3.62	2.90
Earthworm	PRM	-	-	-	-	-	-
	POM	2.97	2.59	2.54	3.50	3.65	2.90
Trees	PRM	5.60	-	-	5.20	4.90	-
Shurbs	PRM	3.90	2.30	1.40	3.50	2.80	-
Herbs	PRM	3.90	4.20	3.80	3.30	3.20	3.90

Further, the Shanon Weiner diversity index has clearly brought out that there is more diversity in VA mycorrhizal population density during the post-monsoon season compared to the pre-monsoon season (Table 4). There was more diversity in VA mycorrhiza in natural forests, coffee and cardamom plantations in which the pH was also near neutral congenial for growth of organisms so also the Org.-C and N while a lower diversity was observed in other land use types with lower pH and lower Org.-C and N in the soils. With regard to meso-fauna, the diversity was higher in the post-

monsoon season in most of the land use types compared to pre-monsoon except in coffee plantations. A similar observation as that of VA mycorrhiza was also seen in diversity of meso-fauna in relation to pH, Org.-C and N. The earthworms were found only in the post monsoon season as there was not enough moisture in the pre-monsoon season. Thus, it can also be concluded that moistur could also be one of the factors for loss in BGBD.

However, it is difficult to bring out any relationship between the above ground and belowground biodiversity. However, by and large VA mycorrhizal fungal diversity is higher where the aboveground is higher. But, the soil meso-fauna is neither influenced nor affected by the above ground biodiversity in the study area.

The above results carried-out in the first phase of the project clearly bring out the following reasons for the loss in biodiversity.

1. Soil pH
2. Loss in organic carbon
3. Soil nitrogen
4. However changes in seasons can also be good indicators of loss of biodiversity to some extent for certain period.
5. Soil moisture.