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Species richness from cropland to forest in Ghunsa valley, eastern Himalaya

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Abstract

Objective: Species richness is the number of total species present in an ecological community which is widely used to measure biodiversity. The main aim of this study was to study variation in species richness along land use types, from cropland to forest.

Methods: This study was carried out in Ghunsa valley, Kanchenjungha Conservation Area of Eastern Himalaya during 2012. Four land use types, namely cropland, meadow, exploited forest and natural forest were selected at each of five elevational bands starting from 2,200 m above sea level at Sekathum to 3,800 m asl at Rambuk kharka, Taplejung. A total of 70 transects, having 25 m × 2.5 m size, were laid and the vascular plant species found within each transect were recorded twice.

Results: Altogether 360 species of vascular plants belonging to 257 genera and 95 families have been documented. Among them, 25 species belongs to pteridophytes, 7 species of gymnosperms and 328 species of angiosperms. One-way ANOVA showed the total species richness (including all groups) was significantly different ($F_{3, 66}$= 7.494, p=0.000) in different land use types.

Conclusion: Species richness was significantly different in different land use types. Species richness was found highest in exploited forest.

Keywords: ANOVA, Biodiversity, Kangchenjungha, Land use types

Introduction

Species richness is the number of total species present in an ecological community. It is the widely used measure of biodiversity, which is assumed to be a simple and easily interpretable indicator of biological diversity. Species richness varies along elevation, latitude as well as change in land use types [1]. Among them light, temperature, rainfall, canopy cover, snow cover and topography are major factors. Human disturbance is the main cause of change in land use type, which severely threatens the biodiversity. People harvest plants for timber, fodder, firewood, and so on. At high level of disturbance, due to human impacts like deforestation, many species are at risk of extinction. Disturbance favors the growth of herbaceous species rather than woody species [2]. Herbaceous species was found higher in openland than forest whereas tree species found more in undisturbed natural forest. The main objective of this study was to study variation in species richness along land use types, from cropland to forest.

Materials and methods

The study was carried in Ghunsa valley, Kanchenjunga Conservation Area (27°24'- 27°57' N latitude and 87°39'- 88°12' E longitude) in eastern Himalaya during 2012. This area falls on the temperate and subalpine zone. KCA harbors 844 species of plants, 279 species of birds, 83 species of insects and 23 species of mammals [3].

Study design

Study sites were selected at five different elevational bands from Sekathum (2,200 m asl) to Rambukkharka (3,800 m asl) at an interval of 400 m. At each elevational band, four different land use types (cropland, meadow, exploited forest and natural forest) were selected. Two transects having size 25 m ×2.5 m were laid on each land use type at an interval of 50 m horizontal distance by employing quasi-experimental sampling design [4]. The study area was visited twice in the year of 2012, to collect data from the field. One-way analysis of variance (ANOVA) and Kruskal Wallis test were used to significant test.

Results

A total of 360 species belongs to 257 genera and 95 families were recorded from the study area. Among them, 25 species were pteridophytes, 7 were gymnosperms and 328 species were angiosperms. Herbs with 242 species dominate over woody species, which comprise 118 species (shrub 82, tree 36 species). One-way ANOVA showed the total species richness (including all groups) was significantly different ($F_{3, 66}$=7.494, p=0.000) in different land use types. Tukey HSD test showed that the species richness in cropland was

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significantly different from rest of the land use types (meadow, exploited forest and natural forest) (Figure 1). But the species richness is similar among meadow, exploited and natural forest. Similarly, among the selected four land use types, exploited forest had highest α-diversity (i.e. mean±s.d., 33.72 ±11.034 species per transect) followed by meadow (31.67±10.318), natural forest (29.35±8.713) and least species in cropland (18.43±7.988).

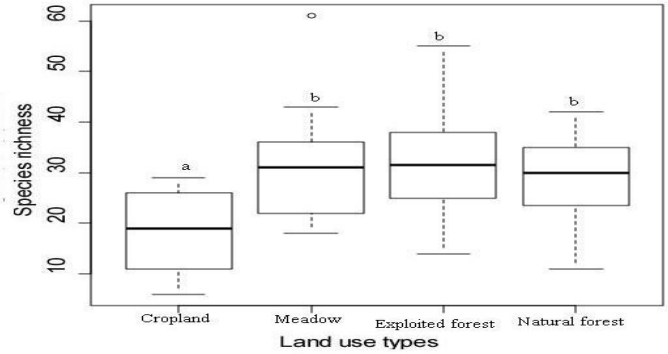

Figure 1: Boxplot showing relationship between total species richness and land use types. The boxes sharing same letters on top are not significantly different (Tukey HSD test)

Similarly, the Kruskal-Wallis test showed the species richness for all functional groups, pteridophytes (p=000), gymnosperms (p=0.033) and angiosperms (p=005) and life forms, herbs (p=0.023), shrubs (p= 0.000) and trees (0.000) also found significantly different among selected four land use types. Among the three functional groups, pteridophytes richness was found maximum (3.8±2.238) in natural forest (Figure 2). Similarly, gymnosperms and angiosperms were found maximum in exploited forest with value 1.22±1.478 and 29.39±10.393 respectively (Figure 2).

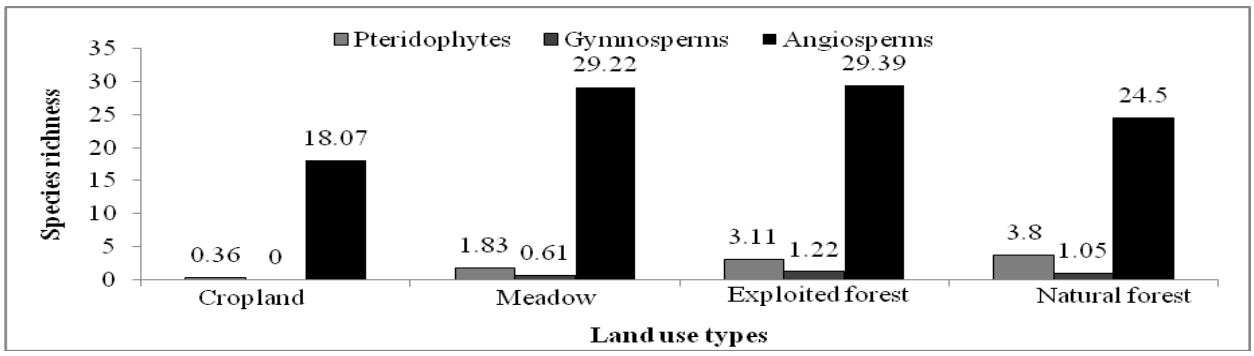

Figure 2: Relationship of mean species richness for different functional groups with land use types

Similarly, the species richness among different life forms, the herbaceous species richness was found maximum (25.72±7.85) at meadow (Figure 3), whereas shrub species (8.78±2.605) at exploited forest and tree species (3.75±2.918) found maximum at natural forest (Figure 3).

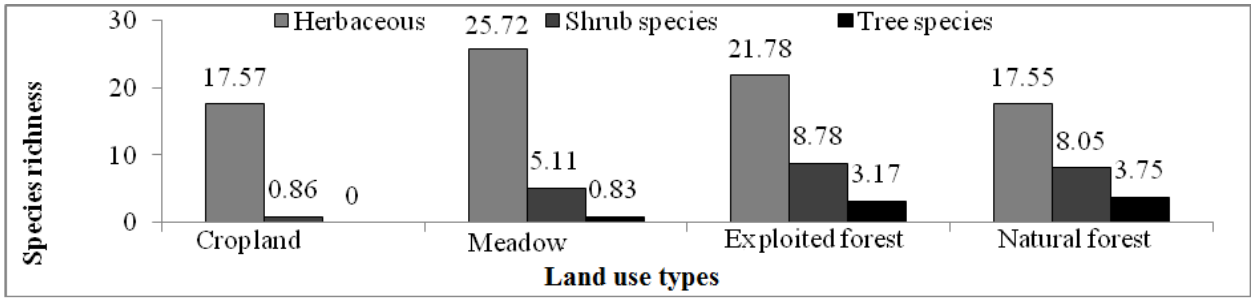

Figure 3: Relationship of mean species richness for different life forms with land use types

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Discussion

Total species richness found to be highest in exploited forest also revealed the same result of Sharma (2012). In the natural forest only the competitive dominant species can survive but in exploited forest, light demanding as well as shady plants can coexist there. Whereas in the meadows due to the grazing of domestic animals, the species richness found lower than exploited forest [5]. While due to the presence of grasses as well as shrubs in medows, speceis richness was found higher than in natural forest and cropland. On the other hand due to the regular use, cleaned up vegetation and other anthropogenic disturbances the cropland has lowest species richness.

Pteridophytes species richness found highest in natural forest because they are shady plant and grow on moist places. Natural forest has high canopy cover due to presence of old as well as big trees [5] and moisture is positively correlated with canopy cover. So, due to high moisture, pteridophytes species was found highest in natural forest than other remaining land uses. Tree species richness decreased as the level of disturbance increased from natural forest to cropland [6]. On decreasing tree species, epiphytic pteridophytic species also decreases. The maximum gymnosperms species richness was found in exploited forest in mean comparison of overall data. But among the 7 total species of gymnosperms, namely *Abies spectabilis, Ephedra gerardiana, Juniperus communis, Juniperus indica, Juniperus recurva, Juniperus squamata* and *Larix griffithiana* found in this study, 6 species were found in natural forest except *Ephedra gerardiana.* Similarly, exploited forest and medow comprises 5 species excluding *Juniperus recurva, Juniperus squamata*. The higher number of gymnosperms found in natural forest.

Angiosperms species richness follows the usual pattern of total species richness along the different land use types. The angiospermic species richness nearly equal in exploited forest and meadow. In medow, herbaceous as well as shrub species found high due to high canopy openness [1]. On the other hand species richness low in natural forest may be due to presence of old trees with high canopy cover and lowest in cropland due to regular cleaned vegetation [6].

In this study, herbaceous species richness was found to be highest in meadow. It may be due to high canopy openness than forest. Herb species richness was higher in open canopy than close canopy. But due to the regular cleaned vegetation by digging, ploughing and other anthropogenic disturbances the cropland has lower species richness than meadow [6].

Shrub species richness was found higher in exploited forest. It also followed the usual result of total species richness because shrubs are understory vegetation of forest. The shrub species was found lower in undisturbed natural forest as well as highly disturbed land use types because shrub species found higher in moderate canopy [8]. In the meadow spineless plants browse by regular grazing of animals and mostly spiny species remains there. So, shrub species was found to be lower in meadow. The tree species richness was found higher in natural forest and highest tree species richness found in the primary forest of Central Sulawesi, Indonesia. The nearly equal tree species richness found in exploited and natural forest. But it is found lower in meadow and absent in cropland may be due to higher disturbances [12].

The other cause of change in species richness in different land use types may be due to the changes in different environmental factors. These environmental factors are temperature, moisture, soil pH, soil nutrients, and soil organic matter, canopy cover [2, 8]. The natural forest has high canopy coverage due to which low intensity of light reaches to ground, so it has high moisture content in soil. But in cropland, due to high openness maximum light reaches to ground and has low moisture content. So species richness decreases from forest to cropland [13].

Conclusion

This study analysed the species richness along the land use types in Ghunsa valley of Kanchenjunga Conservation Area, eastern Himalaya on the basis of two broad categories, functional group and life forms. From this study, it can be concluded that the species richness is significantly different in different land use types for all categories. Species richness found highest species richness in exploited forest.

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