

**IMPACT OF DISTURBANCES ON THE STRUCTURAL DIVERSITY OF THE PLANT COMMUNITY PRESENT IN THE NANTA FOREST AREA, KOTA DISTRICT, RAJASTHAN**



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**ABSTRACT**

The present paper describes the impact of disturbance on the structural diversity of the plant community present in the Nanta forest area, Kota district, Rajasthan. Two sites (protected vegetation site and non-protected site) were selected for comparison of the disturbances. It was observed that the non-protected site has higher levels of disturbances that affect the vegetational structure of the forest. A higher level of disturbances in the non-protected vegetation site has resulted in lower species richness, density, and basal area in comparison to protected vegetation sites. The disturbance factors observed at the nonprotected site are overgrazing, cutting, and clearing forest for pathways etc, whereas in the protected site presence of stumps of trees / mutilated plants has been noticed. Disturbance level in the nonprotective site is 100%, whereas a 28.57% disturbance level was calculated in the protective site. In terms of diversity and distribution, the protected site is richer in diversity, but in the non-protected sites diversity index is low, specifying the poor state of species diversity and higher levels of disturbances.

**Keywords:** Nanta, Diversity, Disturbance, Overgrazing, Plant community.

**1. INTRODUCTION**

Forest disturbances are not easy to determine, but they can be assessed by studying the interrelationship between biotic and abiotic factors and their environment. One of the most accepted definitions was given by Brokaw *et al.*, (1985) who stated that “disturbance is any relatively discrete event in time that disrupts community or population structure and ecosystem functioning, which consequently changes resources or substrate availability and the physical environment”. Abiotic factors such as fire, earthquake, soil erosion, and landslides, as well as biotic factors like insects, animal grazing, disease, and anthropogenic activities, are responsible for forest disturbances. The environmentalists and ecologists focused on the forest’s unprecedented rate of destruction. Disturbances due to people living adjacent to nearby protected forest areas are also taken into consideration. Local communities residing near the protected areas of the forest depend on forest products for their household and they harvest large biomass, resulting destruction of the forest (Davidar *et al.*, 2010). Due to deforestation, we are losing 10.6 million hectares of forest per year worldwide (FAO, 2015) and are responsible for the major destruction of flora and fauna diversity. The pressures exerted on natural communities of plants and animals are immense and increasing. Anthropogenic pressure has a greater impact on the destruction of the forest than the changing climate in a large geographical area. The urban

straggling has fragmented the natural habitat of plants, and for the sake of development, humans keep away themselves from the floral wealth (Rathore *et al.*, 2023). Although forest products are harvested at a large scale in tropical dry forests, there has been limited action planning for evaluating ecological impact. Natural disturbances as well as biotic pressure both are responsible for changing the dynamics of the ecosystem significantly at regional and local scales (Sapkota *et al.*, 2009). Disturbance has variable impacts on different vegetation strata. Thus, it is essential to know the impact of various aspects of disturbance on individual species (Simberloff, 2001)

### Study area

The present study has been carried out in the Nanta forest area, which is located in the Sakatpura forest range in the forest division of Kota. Nanta is situated at 25.21525° latitude and 75.8311° longitude and falls under Ladpura Tehsil of Kota district, Rajasthan (Figure-1).

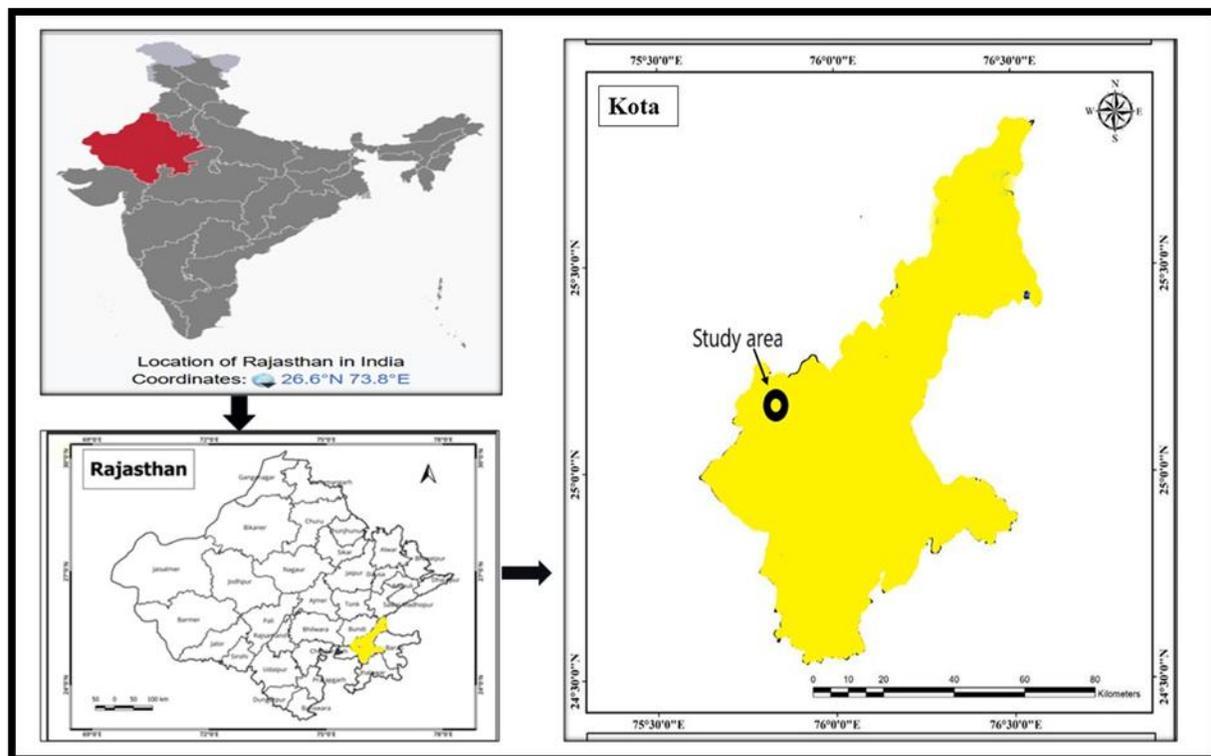


Figure 1: Map of the study area

## 2. MATERIAL AND METHOD

### (1) Sampling design & data collection:

Two sites were taken into consideration, one is a protected vegetation site, and the other is a non-protected site. To determine the flora of protected vegetation site and non-protected site, sampling is done separately using quadrats of different sizes for trees, shrubs, and herbaceous plants. The standard size of the quadrates for sampling trees; shrubs, woody climbers + saplings, and herbs + seedlings taken are 100 m x100 m (10000 m<sup>2</sup> or 1 hectare), 10 m x10 m (100 m<sup>2</sup>), and 1m x1m (1 m<sup>2</sup>) respectively.

**(2) Phytosociological analysis of vegetation:**

The vegetation data were quantitatively analysed for frequency, density, and basal area following Mueller-Dombois and Ellenberg (1974) and Magurran (1988). Basal areas of the trees and shrubs were expressed as m<sup>2</sup>/hectare and herbs as cm<sup>2</sup>/m<sup>2</sup>.

$$\text{Basal area} = \pi r^2 \quad \text{where, } \pi = 3.14$$

$$\text{D(density)} = \frac{\text{Number of aboveground stems of species counted}}{\text{Sample area (ha)}}$$

$$\text{F(frequency)} = \frac{\text{The number of plots where that species occur}}{\text{Total number of plots}} \times 100$$

**(3) Diversity indices:**

(a) The index of the dominance of the community was calculated by Simpson's Dominance index (Simpson, 1949) as

$$\text{Simpson index} \quad D = \sum (ni/N)^2$$

(b) The diversity index (H) was computed by using Shannon-Wiener information Index (Shannon & Wiener, 1949). This index takes into consideration the number as well as the relative abundance of species. This index measures diversity by the following formula:

$$\text{Shannon-Wiener information Index} \quad H = -\sum pi * \ln (pi)$$

where H = Shannon-Wiener Index, ni = number of species, N = total number of individuals

**(4) Calculation of disturbance level:**

Disturbance level was calculated using various parameters such as mutilated plants/stumps, presence of livestock, broken closer wall, path of peddlers, invasive species, bare ground and rocks, and soil erosion.

**3. RESULTS AND DISCUSSION**

In protected vegetation sites total tree density was recorded 16.10 ind/ha where as in non-protected vegetation sites it was 4.9 ind/ha. The same results were shown by many researchers where anthropogenic disturbances and rapid deforestation resulted in low tree diversity with low density in non-protective areas (Bhuyan *et al.*, 2003; Tripathi *et al.* 2010; Hossain *et al.*, 2013). In shrub layer total density was recorded 259.33 ind/ha in protected vegetation sites, in non-protected site it was 141.33 ind/ha. Shrub density (ind/ha) and basal area (m<sup>2</sup>/ha) were higher in both sites as compared to trees among individuals having cbh > 10.5 cm (Table: 1). In protected vegetation sites total herbs density was recorded 86.61 ind/m<sup>2</sup>, whereas in non-protected

vegetation sites it was 12.88 ind/m<sup>2</sup> recorded (Table: 1). The tree density values declined as disturbance levels increased, the shrub and herb densities were highest in the least disturbed forest, but the number of young regenerating individuals (saplings and seedlings) increased from high to low-disturbed forests, indicating that forest fragmentation hampered regeneration (Tiwari *et al.*, 2019). The lower values of the total basal area of tree and shrub in disturbed experimental sites (1.517 m<sup>2</sup>/ha.) in comparison to protected vegetation (2.69 m<sup>2</sup>/ha.) indicate that the stem density in non-protected sites is significantly affected by the perturbations caused by humans. In the same way, reduction in total density and basal area in non-protected experimental sites (12.88 ind/m<sup>2</sup>, 10.357 cm<sup>2</sup>/m<sup>2</sup>) in comparison to protected control sites (86.61 ind/m<sup>2</sup>, 73.441 cm<sup>2</sup>/m<sup>2</sup>) of the herbaceous layer is also due to a higher level of disturbance in non-protected sites. Due to deforestation, soil erosion prevails on this site more over the other activities like animal grazing, and clearing areas by humans for making paths for walking, therefore the herb seedlings cannot survive for long.

**Table 1: Phytosociological parameters of different growth forms in the protected and on non-protected vegetation sites. (ind=individuals, ha=hectare, m=meter)**

Parameter Habit ↓	Density		Basal area		Species richness	
	Protected vegetation	Non- protected vegetation	Protected vegetation	Non- protected vegetation	Protected vegetation	Non- protected vegetation
<b>Tree</b>	16.10 (ind/ha)	4.9 (ind/ha)	0.772 (m <sup>2</sup> /ha)	0.097 (m <sup>2</sup> /ha)	35	8
<b>Shrubs, woody climbers &amp; saplings</b>	259.33 (ind/ha)	141.33 (ind/ha)	1.924 (m <sup>2</sup> /ha)	1.420 (m <sup>2</sup> /ha)	45	12
<b>Herbs &amp; seedlings</b>	86.61 (ind/m <sup>2</sup> )	12.88 (ind/m <sup>2</sup> )	73.441 (cm <sup>2</sup> /m <sup>2</sup> )	10.357 (cm <sup>2</sup> /m <sup>2</sup> )	163	28

Diversity indices of vegetation in protected and non-protected sites have been calculated (Table: 2). Diversity indices provide significant data about the rarity and commonness of the species in a community. The Tree species diversity of the protected vegetation stand is high (H=2.78), in comparison to the non-protected stand (H=1.68). The same results are shown in the shrub layer (H=3.39) and herbaceous layer (4.37) where species diversity is high in the protected sites in comparison to non-protected sites of the shrub layer (H=1.98) and herbaceous layer (3.19). These values indicate that the protected sites are more diverse and richer in diversity and not dominated by few species. It also specifies the poor state of species diversity in non-protected sites (Dey & Akther, 2020). In general, species diversity correlates positively with microclimate, soil moisture, nutrient availability, and disturbance (Bhuyan *et al.*, 2003). Few studies indicated

an increase in diversity in response to short-term disturbances (Pitkänen, 2000; Peltzer *et al.*, 2000; Roberts & Zhu, 2002) prevailing in protected vegetation sites.

Simpson’s diversity index is considered the best index to determine forest structure under different levels of disturbance. It reveals the relative abundance of various species and how they contribute to diversity as a whole. When Dominance (D) increases, diversity decreases (Sen, 2018). In protective sites a low Simpson’s index in all three layers in comparison to the non-protective sites, suggesting high species diversity and more evenness where no single species dominates the other. The high value of Simpson’s index in non-protective sites indicates low species diversity and high dominance, where few species are more dominant than others.

**Table 2: Diversity indices of vegetation in protected and non-protected vegetation sites of Nanta forest area.**

Parameters	Values	
	Protected sites	Non-protected vegetation sites
Simpson’s dominance index for trees (D)	0.096	0.218
Simpson’s dominance index for shrubs (D)	0.042	0.095
Simpson’s dominance index for herbs (D)	0.022	0.047
Shannon-Weaver index of diversity for trees (H)	2.78	1.68
Shannon-Weaver index of diversity for shrubs (H)	3.587	2.399
Shannon-Weaver index of diversity for herbs (H)	4.369	3.192

The disturbance factors observed at nonprotected sites are overgrazing, cutting, clearing forest for pathway etc, where as in protective site presence of stumps of trees / mutilated plants have been noticed. The disturbance level (100%) observed in the non-protective sites is higher than that in the protective sites (28.57%), which can lead to a negative impact on the species richness of the Nanta forest area. (Table 3). The tree species richness recorded in protected vegetation stands is 35, whereas in non-protected vegetation sites, only 8 species were recorded.

**Table 3: Parameters and disturbance levels present in protected and non-protected vegetation sites in the Nanta forest region.**

Parameters	Protected vegetation sites	Non-protected vegetation sites
Mutilated plants / stumps	+	+
Presence of livestock	-	+
Broken closer wall	-	+
Path of peddlers	-	+

Invasive species	+	+
Bare ground and rocks	-	+
Soil erosion	-	+
<b>Disturbance level</b> →	28.57%	100%

Disturbance is an important component in shaping forest species composition. Disturbances cause quick loss of tree cover, which has a knock-on effect on other living forms, reducing forest species diversity (Campbell *et al.*, 2017). As a result, declining tree species in a forest can have a negative impact on the forest's structure, function, and ecosystem services. Many species are not present in the experimental sites or present in an insufficient number due to the various anthropogenic factors. This condition has the potential to result in the gradual extinction of many forest species (Sanou *et al.* 2021). According to research undertaken in various parts of the world, the biological diversity of plants and other features of forest vegetation such as density, basal area, and species diversity decrease as the degree of disturbance increases (Cardelús *et al.*, 2019; Thakrey *et al.*, 2022).

It has been reported that the dry deciduous forests of central India are rapidly eroding as a result of intensified anthropogenic pressures, and they are rapidly transforming into dry deciduous scrub, savannah, and grasslands (Baboo *et al.*, 2017) and there has been observed grazing pressure of 0.43 ha per livestock and degradation of forest at the rate of 0.22 km<sup>2</sup> each year (Sagar & Singh, 2006). Undoubtedly, human activities disrupt forest structure and affect forest community composition, and if a forest is subjected to disturbance for a long period, it will eventually disrupt tree population structure as well (Arroyo-Rodríguez *et al.*, 2017; John, 2018).

#### 4. CONCLUSION

Environmental stress and human interference disturb the natural structure and functional composition of vegetation. Many times, vegetation recovers itself in due course of time but this process takes a very long time hence, intervention is required to accelerate the process of recovery of pre-disturbance vegetation. Knowledge of floristic characteristics is required before human intervention. Based on research findings, it can be concluded that the non-protected sites have higher levels of disturbance that affect the vegetational structure of the forest. Higher level of disturbances in the non-protected vegetation has resulted in lower species richness, density, and basal area in comparison to protected vegetation sites.

However, according to the "intermediate disturbance hypothesis," the highest species occur when the disturbance frequency is at an intermediate level, but in the present study area, the disturbance frequency is high. In terms of diversity and distribution, the protected site is richer in diversity, but in the non-protected sites diversity index is low, specifying the poor state of species diversity and higher levels of disturbances. The low value of Simpson's index in all three 3 layers (tree, shrub, and herb) in comparison to the non-protective site, suggests low dominance, high species diversity, and more evenness (no single species dominates the other) whereas the high value of Simpson's index in non-protective sites indicates low species diversity and high dominance, where few species are more dominant than others.

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