Original Articles

Multivariate approach to the classification and ordination of the forest ecosystem of Nandiar valley western Himalayas

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ABSTRACT

Questions: Does the vegetation composition of the forests of Nandiar Valley correlate with climatic, topographic and edaphic variables? Is it possible to identify plant communities through indicator species in relation to environmental gradients? Can this approach of classification and ordination will be helpful for conservation planning?

Location: Forests of Nandiar Valley, Moist temperate Western Himalayas Pakistan.

Methods: Eighty stands were selected for quantitative and qualitative characteristic of vegetation between an elevations of 525–3817 m. Species composition was recorded by using 400 m long transects. GPS, climatic, edaphic and topographic data were recorded for each sampling site. The relationship between habitat types, species composition and distribution along with climatic, edaphic and topographic variables were analyzed using TWINSPAN, Cluster analysis and DCA ordination.

Results: Sum 325 vascular plants species belonging to 97 families were recorded. Diversity index and species richness was maximum in the moist temperate zone. Classification and ordination showed that the variance in species data was 7.07. Two-ways indicator species analysis classified the vegetation into eight plant communities. Indicator species analysis revealed that slope aspect, wind speed, temperature, dew point, wet bulb, pH, organic matter and phosphorous were the strongest parameters ($p \leq 0.05$) determining plant community composition and indicator species in each habitat. The results also show the strength of the environment – species relationship using Monte Carlo procedures. DCA ordination grouped different species having similar habitat and habitats having common species.

Conclusions: The multivariate analysis of the vegetation along with environmental variables of Nandiar valley confirmed the indicators of each sort of vegetation communities/microclimatic zones which could further be used in conservation planning and management not only in studied area but also in the adjacent regions as well as in the areas exhibit similar sort of climatic, edaphic and topographic conditions.

1. Introduction

Phytosociology is the study of biocoenosis from a botanical perspective and is concerned with plant communities, their relationships, structure, composition, distribution, development and the short-term processes modifying them (Poore, 1955). Phytosociological surveys help in planning, management and the use of natural resources (Ahmad and Khan, 2004; Mashwani et al., 2011). Its aim is to achieve a sufficient empirical model of vegetation using plant species combinations that characterize univocally vegetation units which may express largely abstract vegetation concepts or actual readily recognizable vegetation types (Weber et al., 2000). Phytosociology is based on associations (Haq, 2015). Habitat of species describes the environment over which a species is known to occur and the type of community that is formed (Whittaker et al., 1973). Ecological niche is the set of biotic and abiotic conditions in which a species is able to persist and maintain stable population sizes (Wiens and Graham, 2005; Whittaker et al., 1973).

It is useful to collect data to describe the population dynamics of each species in different abiotic conditions (Haq et al., 2015a). Present
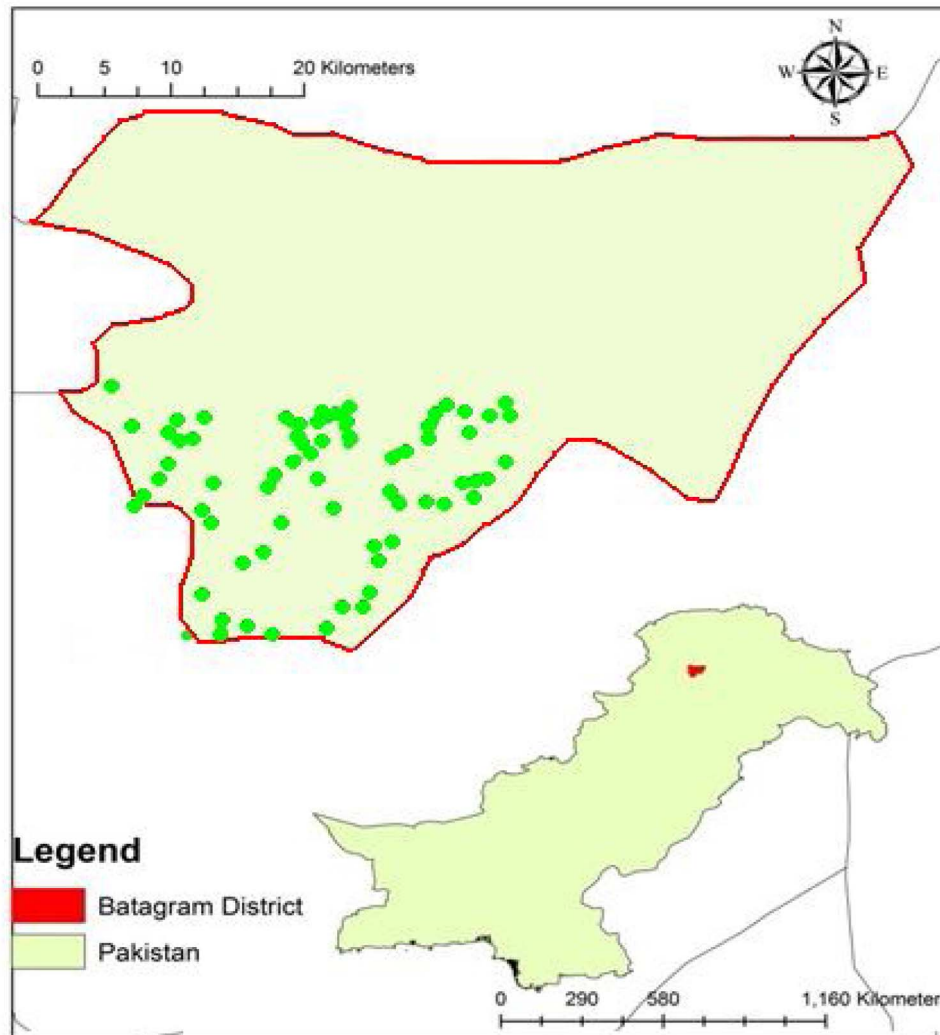

Fig. 1. Map of District Battagram showing stands location.
The remaining area is Allai vallley.

external factors and historical plant geography are responsible for the determination of a plant community (Poore, 1955). The availability of suitable habitat determines the species distribution patterns in habitat structure where ecogenesis and phylogenesis interact in a complex manner to shape current species distributions (Thorpe et al., 1994; Ali et al, 2014).The presence or absence of vegetation is controlled by environmental variables (Hoveizeh, 1997; Leonard et al., 1988).

Exploring and understanding the association of biotic and abiotic components of an ecosystem and the variation in species diversity and species richness along environmental gradients are critical branches of ecological research (Tavili and Jafari, 2009). In mountainous regions slope aspect, slope angle, altitude, soil pH, organic matter and electrical conductivity show the greatest effects on species diversity, species richness and community structure (Khan and Ahmad, 2015; Ullah et al., 2015). In terms of identifying the effects of environmental variables on vegetation the multivariate analytical programs can help ecologist to discover structure in vegetation data sets and enable to analyze the effects of environmental variables on whole group of species in more efficient way (Khan et al., 2012; Haq et al., 2015b).

Statistical programs has reduced the complexity of data by classifying the vegetation data and correlating it with environmental variables (Khan et al., 2013). Classification and ordination also overcomes problems of comprehension by summarizing the multidimensional field data into small number of dimensions and bringing the species having similar habitats and stands having common species (Haq et al., 2015a).

Such approaches have, however rarely been used in Pakistan (Ahmed, 1976; Jabeen and Ahmad, 2009; Saima et al., 2009; Khan et al., 2013; Shaukat et al., 2014; Khan et al., 2015; Haq et al., 2015a,b).

The aim of the current study is to achieve an empirical model of vegetation using plant species composition to characterize vegetation types in the area. Most of the Himalayan regions like Nandiar valley has not been studied previously therefore the study was proposed, to explore the species diversity and vegetation structure on the basis of climatic, edaphic and topographic factors. The study contributes to wider efforts to systematically describe the plant communities of the mountainous regions using a phytosociological approach supported by the robust statistical analysis which will form the basis for strategic conservation planning.

2. Study area

Nandiar valley, is located in Khyber Pakhtunkhwa Province of Pakistan between 34° 33′ and 34° 47′N and 72° 55′ and 73° 14′ E (Haq, 2010, 2011, 2012, 2015). It is bounded by Allai valley in the north, Siran valley in the east, Konsh and Agror valleys in the south, Black mountain and Indus River in the west (Ahmad et al., 2010). The altitudinal range of Nandiar valley is from 525 m at Thakot to 3817 m above mean sea level at Malkisar (Haq et al., 2011, 2012). The vast variation in altitude, slope aspect, disposition of mountain ranges and prevailing wind currents reveal that the climate vary from sub-tropical