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MODELLING POTENTIAL DISTRIBUTION OF *TAXUS WALLICHIANA* IN PALAS VALLEY, PAKISTAN

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Abstract

Desktop modelling software in combination with Geographical Information Systems (GIS) has led species distributions modelling and proving a very powerful tool. DOMAIN model was used to produce potential distribution map of *Taxus wallichiana* in Palas valley. A similarity index cutoff of 0.95-1 was used to define core habitat of the species. Overall accuracy of the predictive model was 87.2%. Potentially areas identified of spatial distribution of *Taxus wallichiana* through modeling process can be used for its *in situ* conservation.

Introduction

Modelling potential species distributions has become a very powerful tool in recent years. Potential distribution mapping of plant species is within reach of many botanists now through the advent of desktop modelling software and Geographical Information Systems (GIS) (Carpenter *et al*., 1993; Skov, 2000). Mapping potential distributions of species requires environmental data at an apt scale and accurately geo-referenced collection data, from the management point of view; predicting rare, threatened or vulnerable species distribution can prove particularly valuable in countries like Pakistan where vast areas remain unexplored. Palas valley contributes a sizeable list of plants that are endemic, threatened or vulnerable thus making a well suited area to model distribution of such species.

Taxus wallichiana Zucc., is found in temperate forests of Asia ranging from Afghanistan through the Himalayas to the Philippines with elevation range of 1500-3500 m. It is small to medium-sized tree, with red 'berries' (seeds covered by arils), valuable for Taxol extraction (Phillips *et al*., 1998). It is used in preparation of anticancer drugs, in addition to other medicinal uses in Ayurveda and Tibetan Medicine. In 1995, *Taxus wallichiana* was listed in Appendix II of CITES (Schippmann, 2001). This study is an attempt to model its spatial distribution in Palas valley.

Methodology for modelling procedure

Palas Valley (Fig. 1) covering an area of 1400 km^2 elevation ranging from 700m to 5200m is maintained in a relatively pristine condition and retains a great deal of its natural characteristic. The valley centering on 35º'N Latitude and 71º15'E contains the most extensive and best-protected areas of natural forest in the Western Himalayas and Hindu-Kush Mountains of Pakistan. The valley also supports world's most important population of endangered Western Tragopan (*Tragopan melanocepahalus* - IUCN vulnerable). Rafiq (1996) provides the best account of the flora of Palas Valley.

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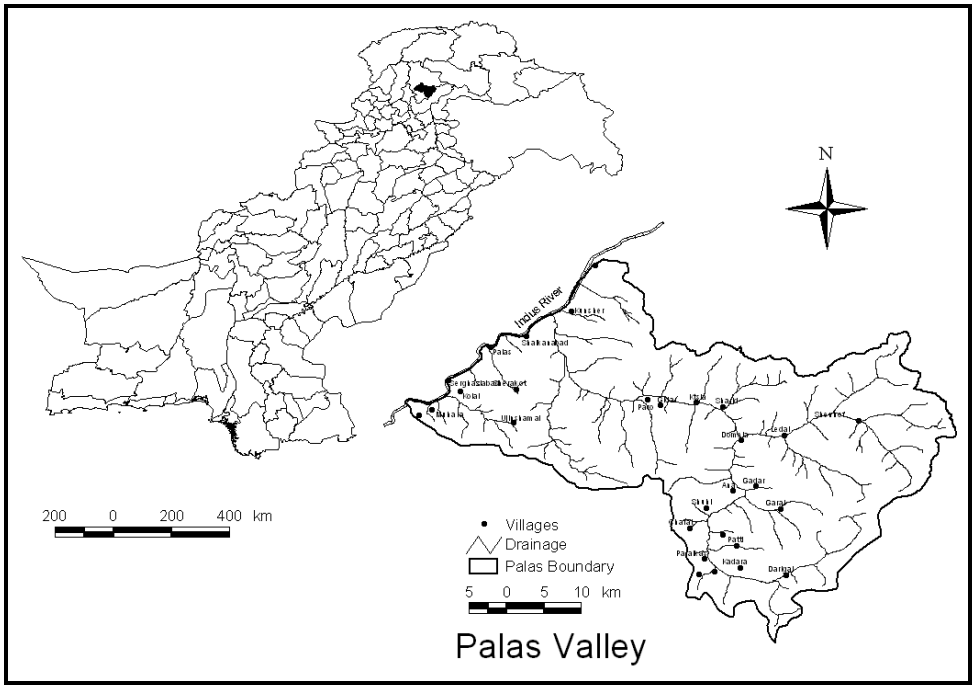

Fig. 1. Location map of Palas Valley.

The species occurrence data (n = 39) was based on data collected from Palas valley during 2004-2006. Garmin® Etrex® GPS (Global Positioning System) was used to record geographic coordinates of each sampling plots in WGS-84 datum. Environmental dataset (Table 1) comprised of 16 variables. Terrain derived variables were extracted from digital elevation model (DEM) of the study area and spectral variables were extracted from Landsat Thematic Mapper (TM) image acquired in September 1992.

Distribution modelling of *Taxus wallichiana* DOMAIN model was applied to the occurrence data. It uses point-to-point similarity metric (DOMAIN model) to quantify the similarity between sites (Carpenter *et al*., 1993; Skov, 2000). The DOMAIN model is easily implemented, performs well with limited site data and has been used successfully for distribution modelling (Carpenter *et al*., 1993; Guisan & Zimmermann, 2000; Skov, 2000; Funk & Richardson, 2002). Potential distribution grid for *Taxus wallichiana* was created and reclassified to values of zero for similarity index cutoff of 0–0.95 (unsuitable and similarity index cutoff of 0.95–1.0 for suitable), 'core habitat' was assumed to be locations between 95 and 100 percentile limits and those locations in potential distribution grid having value outside these limits were considered areas of 'marginal habitat' (Carpenter *et al*., 1993; Funk & Richardson, 2002). Cohen's kappa (κ) was used to assess the validity of model (Peterson, 2001; Stockwell & Peterson, 2001).

Table 1. Variables used for potential distribution mapping of *Taxus wallichiana*.

S. No	Variables	Source	Resolution (m)
	Terrain		
1.	Elevation	DEM	30
2.	Slope	DEM	30
3.	Aspect	DEM	30
4.	Potential annual solar radiation	DEM	30
5.	Upslope Catchment area	DEM	30
6.	Topographic Wetness index	DEM	30
7.	Surface curvature	DEM	30
8.	Profile curvature	DEM	30
9.	Distance to stream	DEM	30
10.	Distance to ridge	DEM	30
	Spectral		
11.	Soil adjusted vegetation index SAVI	Image processing	30
12.	TM Brightness	Image processing	30
13.	TM Greenness	Image processing	30
14.	Red (TM 3)	Landsat TM	30
15.	Near-IR (TM 4)	Landsat TM`	30
16.	Mid-IR (TM 5)	Landsat TM	30

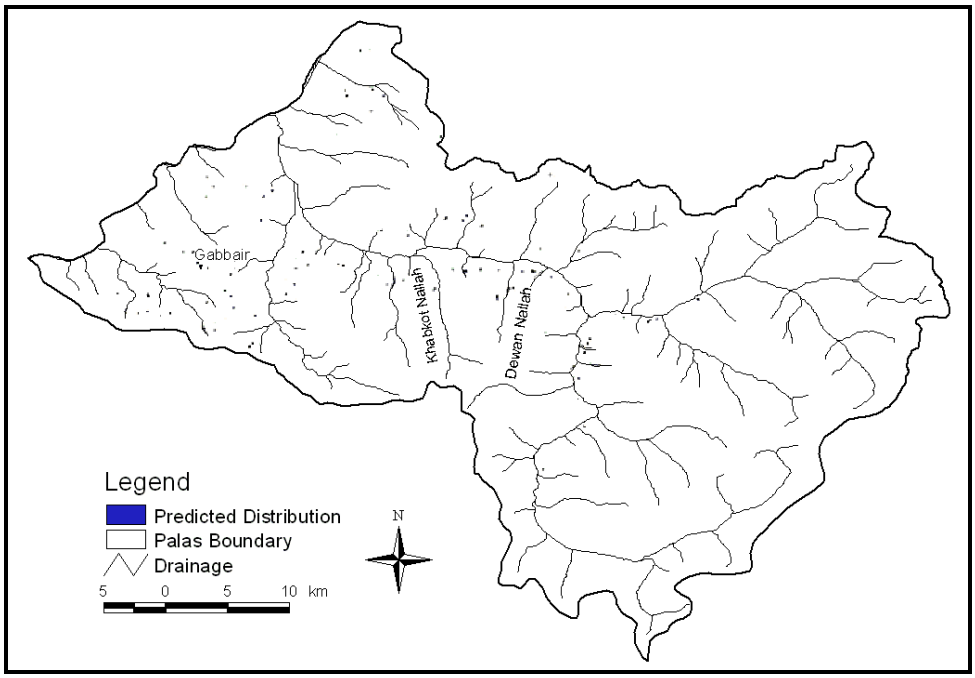

Fig. 2. Potential distribution map of *Taxus wallichiana* in Palas Valley.

Results and Discussion

The model exhibits that the distribution of *Taxus wallichiana* is scanty and patchy in Palas valley (Fig. 2). Total predicted distribution area at 95-100 percentile was 3334 hectares with an overall accuracy of 87.2% ($\kappa = 0.6258$, standard error of $\kappa = 0.18242$ and Z-score for $\kappa = 3.4306$). This species is concentrated chiefly towards the left bank of the Palas river Mushaga. Two areas where it can be expected include regions between Dewan and Khabkot Nallah and the Bar Ser area (Fig. 2). The results emphasize the usefulness of spatial modeling for mapping the potential distribution of *Taxus wallichiana* which showed restricted habitat. This information can be used to find areas suitable for its cultivation and management in Palas valley which is considered as one of the important diversity zone in Pakistan.

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