Benefitting from Geoinformatics: Estimating Floristic Diversity of Warwan Valley in Northwestern Himalaya, India

Akhtar Hussain MALIK\textsuperscript{1} \textsuperscript{\textcopyright}http://orcid.org/0000-0003-2734-157X; e-mail: ecoakhtar@gmail.com
Irfan RASHID\textsuperscript{2} \textsuperscript{\textcopyright}http://orcid.org/0000-0002-5214-1919; e-mail: irfangis@gmail.com
Ajaiz Hassan GANIE\textsuperscript{3} \textsuperscript{\textcopyright}http://orcid.org/0000-0002-8890-8050; e-mail: aijazku@gmail.com
Anzar Ahmad KHUROO\textsuperscript{4} \textsuperscript{\textcopyright}http://orcid.org/0000-0002-0251-2793; e-mail: anzarak@gmail.com
Ghulam Hassan DAR\textsuperscript{4} \textsuperscript{\textcopyright}http://orcid.org/0000-001-9653-1401; e-mail: profdar99@gmail.com

\textsuperscript{1}Centre for Biodiversity and Taxonomy, Department of Botany, University of Kashmir, Hazratbal Srinagar 190006, Jammu and Kashmir, India
\textsuperscript{2}Department of Earth Sciences, University of Kashmir, Hazratbal Srinagar 190006, Jammu and Kashmir, India
\textsuperscript{3}Department of Botany, University of Kashmir, Hazratbal Srinagar 190006, Jammu and Kashmir, India
\textsuperscript{4}Mahatma Gandhi Chair on Ecology and Environment, Centre for Biodiversity Studies, Baba Ghulam Shah Badshah University, Rajouri, 185234, Jammu and Kashmir, India


\textcopyright Science Press and Institute of Mountain Hazards and Environment, CAS and Springer-Verlag Berlin Heidelberg 2015

\textbf{Abstract:} The Himalaya harbor rich floristic diversity which is of immense scientific interest and socio-economic importance. In this study, floristic diversity of a remote alpine valley has been studied based on information extracted from remotely sensed satellite data along with field surveys undertaken during 2008-2014. Analysis of vegetation information from satellite data revealed that ~75\% of the area is covered with natural vegetation which comprises lush green coniferous forests, alpine pastures and alpine scrub lands. With inputs from vegetation information extracted from satellite data, comprehensive field surveys were planned to document the floristic diversity of the region. Analysis of species composition showed a total of 285 plant species, belonging to 191 genera in 60 families. Of these, 250 species are herbs, 14 shrubs, 2 sub-shrubs and 19 trees. The dicotyledons are represented by 240 species, monocotyledons 30, gymnosperms 04, and pteridophytes 11 species. Asteraceae is the largest family with 35 species. During the present study, 5 species (\textit{Corydalis cashmeriana}, \textit{Hippophae rhamnoides}, \textit{Primula minitissima}, \textit{Saussurea sacra} and \textit{Inula orientalis}) have been recorded for the first time from this Himalayan region. The study demonstrates the benefits of geo-informatics in floristic studies, particularly the robustness of remotely sensed data in identifying areas with potentially high species richness, which would be otherwise difficult in a complex mountainous terrain using traditional floristic surveys alone. The present study is expected to provide baseline scientific data for cutting edge studies relating to long term ecological research, bioprospecting, possible impacts of changing climate on vegetation and sustainable use of plant resources in this Himalayan region.

\textbf{Keywords:} Floristic diversity; Northwestern Himalaya; Remote sensing; GIS; Vegetation sampling

\textbf{Received:} 22 January 2015
\textbf{Accepted:} 9 June 2015
Introduction

Of the various ecological problems faced in modern times, the loss of biodiversity is one of the most serious global concerns. The unprecedented rate of species extinction, mainly driven by unbridled human activities, is fraught with grave economic and ecological consequences. The global diversity of biota on the planet is, however, so vast that only 1.7% of it is scientifically known (Dar and Farooq 1997; Dar et al. 2014). This poses problems in assessing the taxa that are lost. Given such a perilous state of affairs, taxonomic inventory of biodiversity has gained much urgency worldwide (Khuroo et al. 2008). Globally, there is a scientific consensus that taxonomic documentation is the first step in assessment, conservation and sustainable use of biodiversity (Khuroo et al. 2007; Dar et al. 2001).

The floristic and vegetation studies are of prime importance in the present biodiversity-conscious world. In particular, the floristic studies and spatial distribution patterns of natural vegetation in a mountainous region can provide important inputs for conservation and bioprospecting of biodiversity. During the past two decades, geoinformatic tools have been increasingly used for generating spatial data on vegetation types and land use patterns (Kokaly et al. 2003; Zhang et al. 2003; Joshi et al. 2005). In practice, the applications of geoinformatics have been widely demonstrated in the fields of ecology, biodiversity conservation, and biogeochemical cycling (Romshoo 2004; Wang et al. 2010). Spatial database on vegetation types and status have been used in GIS environment for landscape and habitat analysis (Pauli et al. 2003; Rashid et al. 2010). Vegetation characterization using remotely-sensed data hence provides vital inputs in prioritizing areas for biodiversity conservation (Roy and Tomar 2000; Gairola et al. 2013; Rashid et al. 2013). Geoinformatics has, thus, opened up new frontiers in understanding distribution patterns of biodiversity and the disturbance regimes affecting it (McMahon et al. 2011).

The Himalaya, recognized as a global biodiversity hotspot (Mittermeier et al. 2005), vital taxonomic information about flora of its many regions is still not available. Jammu and Kashmir (J&K) in the Western Himalaya is one such region which has been recognized as floristically under-explored (Dar et al. 2001; Dar et al. 2014). Biogeographically, J&K comprises three distinct provinces: the subtropical Jammu, the predominantly temperate Kashmir and the cold-arid Ladakh. Owing to great variety of habitats all along these provinces, the region is very rich in floristic diversity. During the last two centuries, its flora has attracted the attention of many foreign and local botanists. Many of its plants are cited in the illustrious works of Hooker (1872-97) and Stewart (1972). In J&K, Jammu province possesses the greatest floristic richness. Several taxonomic studies dealing with floristic diversity of this province have been carried out over the last three decades. Sharma and Kachroo (1981) first of all published the Flora of Jammu and adjacent areas. Kapur and Sarin (1990) dealt with the flora of Trikuta hills, presenting a floristic account of the plants inhabiting these hills and the surroundings. Swami and Gupta (1998) published the Flora of Udhampur district, which is a useful treatise on the higher plants of this region. Bhellum and Magotra (2012) catalogued the flowering plants of Doda, Kishtwar and Ramban districts, dealing with floristic richness of these three adjacent districts in the Chenab Valley.

In India, the Himalayan state of J&K is recognized as one of regional hotspots of biodiversity. It has been rightly referred to as a ‘Terrestrial Paradise’ on the Earth (Vigne 1842). Being located at the intersection of Holarctic and Paleotropical Floristic Realms, and falling within the bio-region of Northwestern Himalaya, the region has varied topography along elevation range which offers great habitat heterogeneity and as such is gifted with teeming treasure-troves of plant diversity. The scientific studies on the floristic diversity of J&K started about two centuries ago. Many workers have contributed to floristic studies in various areas and on various groups of plants throughout this region (Stewart 1972, 1979; Sharma and Kachroo 1981-82; Kapur and Sarin 1990; Swami and Gupta 1998; Dar et al. 2002, 2014; Malik et al. 2010, 2011; Bhellum and Magotra 2012).

The Warwan Valley, a remote region located in the Jammu province of J&K has, however, been left floristically unexplored due to its isolation, difficult terrain and inaccessibility with scanty and