



**International Journal of Plant & Soil Science**  
4(5): 437-444, 2015; Article no.IJPSS.2015.043  
ISSN: 2320-7035



SCIEENCEDOMAIN *international*  
[www.sciencedomain.org](http://www.sciencedomain.org)

## Phyto-sociological Assessment of Sacred Groves in Kathmandu, Nepal

Laxmi Joshi Shrestha<sup>1\*</sup>, Mohan Devkota<sup>1</sup> and Bhuvan Keshar Sharma<sup>2</sup>

<sup>1</sup>Department of Botany, Amrit Campus, Institute of Science and Technology, Tribhuvan University, Kathmandu, Nepal.

<sup>2</sup>Department of Natural Resource Management, Phokhara University, Kathmandu, Nepal.

### Authors' contributions

This work was carried out in collaboration between all authors. Authors LJS and MD designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author BKS managed the literature searches, analyses of the study performed and identified the species of plant. All authors read and approved the final manuscript.

### Article Information

DOI: 10.9734/IJPSS/2015/13350

#### Editor(s):

(1) A. Mujib, Department of Botany, Hamdard University, India.

#### Reviewers:

(1) Anonymous, University of Alabama at Birmingham, USA.

(2) Pramod Medhi, Department of Botany Pandu College, Pandu Guwahati, Assam, India.

Complete Peer review History: <http://www.sciencedomain.org/review-history.php?iid=777&id=24&aid=6932>

Original Research Article

Received 13<sup>th</sup> August 2014  
Accepted 31<sup>st</sup> October 2014  
Published 14<sup>th</sup> November 2014

### ABSTRACT

Phyto-sociological studies were conducted in Bajrabarahi and Pashupati Sacred Groves of Kathmandu, Nepal for the comparative analysis of tree species diversity in the year 2012-2013. Concentric circular plots with radius of 20m were used to collect necessary information along four and eight parallel transects in Bajrabarahi and Pashupati Sacred Groves, respectively. Similarity Index showed that more than 57% tree species are shared by both the groves whereas Maturity Index showed that Bajrabarahi Sacred Grove has more mature trees (33.9) than Pashupati Sacred Grove (26). Based on Importance Value Index three different forest types, namely - Schima-Pyrus, Myrsine-Persea and Quercus-Myrsine, were identified in Pashupati Sacred Grove whereas, Bajrabarahi Sacred Grove incorporated only one forest type of Neolitsea cuipala. The Shannon-Weiner Species Diversity Index, Evenness and number of tree species of Pashupati Sacred Grove was higher than that of Bajrabarahi Sacred Grove, whereas the canopy coverage of Bajrabarahi Sacred Grove was higher than Pashupati Sacred Grove. Local community initiations are more effective management system than the government management system for tree diversity conservation, in sacred groves of Kathmandu.

\*Corresponding author: E-mail: [himalayanforum@gmail.com](mailto:himalayanforum@gmail.com), [joshi.laxmi.shrestha@gmail.com](mailto:joshi.laxmi.shrestha@gmail.com);

**Keywords:** Bajrabarahi; pashupati; diversity index; similarity index; maturity index.

## 1. INTRODUCTION

Sacred groves have very long and diverse history in human cultures and had shown ancient link between peoples and their environments, as a result sacred groves are conserved primarily for spiritual reasons across the world. Harming the forest is forbidden by tradition and it is typically believed that any alteration of the forest, such as cutting wood for construction or firewood, hunting animals or other forms of resource extraction, will result in negative consequences to the person taking the resources and this is the main reason that leads towards the conservation of biodiversity of sacred groves [1,2,3]. Sacred groves have been defined as a patch of religious forest that are rich in biodiversity and are conserved by local people on the basis of their cultural and religious belief and taboos [4]. Sacred groves are universal human phenomenon not connected with any specific religion or world view, but they have a very strong religious context and influenced by traditional local beliefs [5]. Sacred groves have been shown to have a major effect on conservation, ecology and environment due to the special precautions and restrictions taken by the community. As a result of limited human activity due to taboos and prohibitions, sacred groves frequently possess old growth vegetation, integrated nutrient cycling with high soil fertility and many ecologically and socially valuable plant species [6]. So, sacred groves have been proved as the repositories of rare and endemic species as the remnant of the primary forest left untouched by the local inhabitants [7]. Societies have been practicing in conserving the environment of these sacred groves through traditional and stewardship practices for long time and have complement the more recent approaches to protected area management based on scientific knowledge [6]. It is increasingly clear that social context plays a major role in the success of conservation of sacred grove.

The importance of sacred groves in the conservation of biodiversity has been recognized long time back [1,8,9]. It has been believed that sacred groves have been protected due to deity of that grove and removal of even a small twig is supposed to be a taboos.

Nepal is rich in its ethnic diversity so there are diverse human societies with different religious

customs, myths and beliefs [10]. Nepalese societies are intricately interconnected with their religion and customs and have been practicing generation old religious traditions by establishing various sized sacred groves devoted for their deities. Understanding the values of sacred groves among various ethnic groups, Government of Nepal has identified and categorized religious forests as one of the forest types in its Forest Act 1992. Nepal's Forest Act (1992) has defined a religious forest as "a forest area that has been legally handed over to a legally registered religious group, community or organization to carry out and continue traditional religious activities by sustainably utilizing its resources as described in its management plan". In Nepal, sacred groves have received considerable attention, to conserve small patches of forest from socio-cultural and religious perspective but now a day they are facing severe threats and are losing its biodiversity rapidly. According to the statistics of Department of Forest (2013), only 36 sacred groves covering an area of 2056 ha, have been legally registered in Nepal which clearly indicates that the role of sacred groves is still unrecognized system in biodiversity conservation. There are inadequate conservation policies and plans of Government of Nepal towards conserving the plant diversity possessed by sacred groves. Sacred groves of the Kathmandu valley, a capital city of Nepal, have also remained overlooked in the past and have never been studied in detail to assess their role in biodiversity conservation. Therefore, this paper is aimed to assess tree diversity of Pashupati and Bajrabarahi Sacred Groves of Kathmandu Valley and to evaluate the effectiveness of different management systems applied for biodiversity conservation of sacred groves.

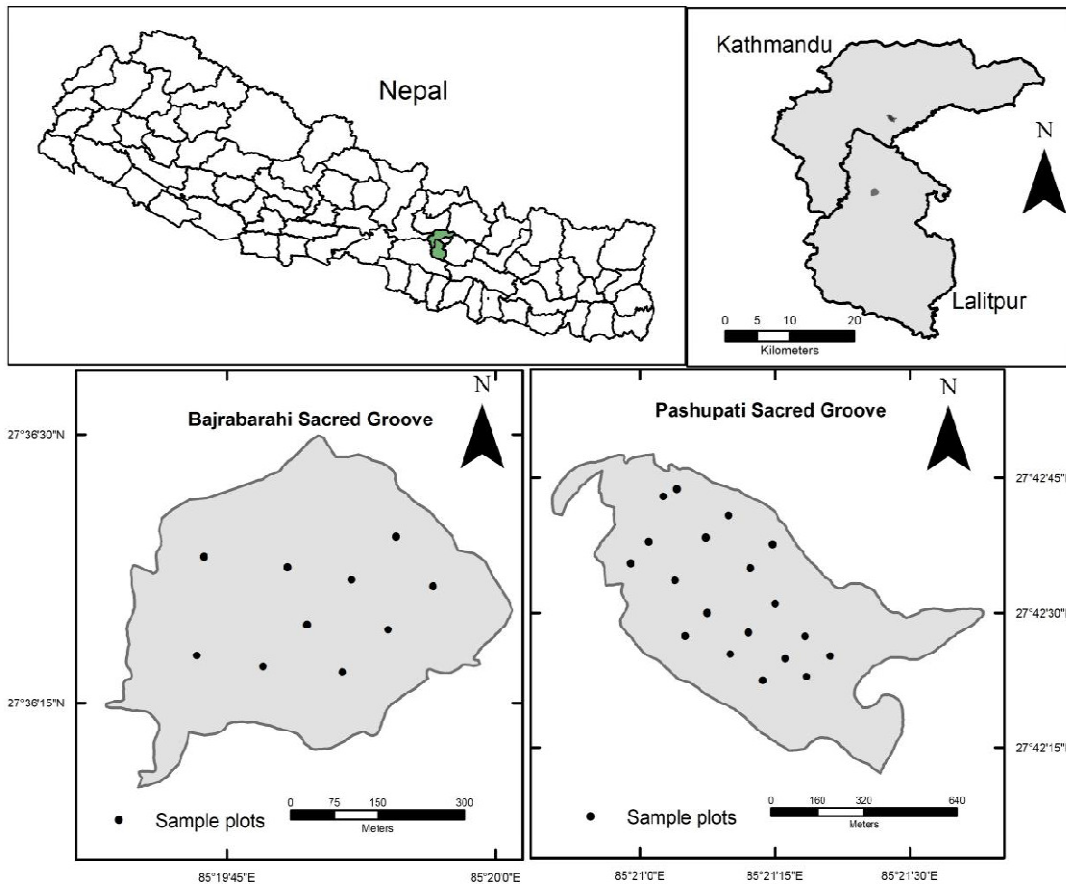
### 1.2 Study Sites

The sacred grove, popularly known as Bajrabarahi Sacred Grove (BSG) (named after its presiding folk deity "Bajrabarahi") is located at south-east corner of Kathmandu Valley, in Chapagaun Village Development Committee (VDC) of Lalitpur district at an elevation of 1440 m between 27°36'15.88" to 27°36'24.62" N, and 85°19'40.58" to 85°19'50.59" E, covering 18.29 ha area (Map 1). The forest represents 900 years old relict vegetation consisting of evergreen and deciduous trees [11]. Major tree species found in the grove are *Schima wallichii*, *Castanopsis*

*tribuloides*, *Albizia lebbeck*, *Alnus nepalensis*, *Choerospondias axillaris*, *Neolitsea cuipala*, *Myrica esculenta*, *Myrsine semiserrata*, *Pyrus pashia*, *Quercus glauca* and *Zizyphus incurva* [12]. Joytidaya Sangh, a local social organization has undertaken management responsibility of the sacred forest since 1994, after the grove has been handed over to this organization from Ministry of Forest and Soil Conservation (MoFSC). Current forest management practices include public awareness programs, appointment of forest guards, barbed wire fencing around the boundaries, and construction of walking trails, public trails and parking lots. Money generated by parking lot is used for various conservation activities.

elevation of 1,300 m covering 83.55 ha area. Pashupati area is renowned as one of the most sacred places in Hindu religion and is inscribed as world heritage site by UNESCO in 1979. This sacred grove is the centers of pilgrimage and is a centre of faith of all Hindu devotees. The forest represents 1400 years old relict vegetation consisting of evergreen and deciduous trees [11]. Pashupati Area Development Trust (PADT), a government organization, has undertaken management responsibility of this grove. About 85 tree species were recorded from PSG dominated by *Schima wallichii*, *Rapanea capitellata*, *Acer oblongum*, *Fraxinus floribunda*, *Osmanthus fragrans* and *Quercus glauca* [13]. Currently, PADT is contributing to manage the forest by awareness programs, appointing forest guards, fencing around the boundaries, replanting the lost tree species, and controlling grazing and human movements inside the grove.

Pashupati Sacred Grove (PSG) is located in the suburb of Kathmandu City between 27°42'25" to 27°42'36" N, and 85°20'12" to 85°21'29" E at an



Map 1. Location of study area

## 2. MATERIALS AND METHODS

Data for comparative assessment were collected from circular plots made in parallel transects (n=4 in BSG and n=8 in PSG) of 150 m apart from each other traversing north-south direction with the help of Google earth image. Plots were constructed at 100m interval in each transects. Distance between quadrates varied with the size of unit to be sampled, but was always a minimum of 50 paces apart. Plots were laid down 25 m inside from the forest margin to reduce the edge effect.

Concentric Circular Sample Plots (CCSPs) were used to collect the field data [14]. The central point of CCSP was identified by using Geographic Position System (GPS) incorporated already identified coordinates from Google Earth images. The circles of a CCSP with different radii and diameter thresholds were centered at the same point. The outermost plot was used for tallying bigger trees, whereas inner plots were used for measuring trees belonging to smaller size classes, respectively.

The CCSP consist of four circular plots: plot with the radius of 20 m (area:1257.1 m<sup>2</sup>) all big size trees with DBH ≥30 cm were measured; plot with the radius 15 m (area: 707.1 m<sup>2</sup>) trees with DBH 20.0 cm to 30.0 cm were measured; the third plot with the radius 8 m (area: 201.1 m<sup>2</sup>) trees with DBH from 10.0 cm to 20.0 cm were measured; and fourth plot with the radius 4 m (area: 50.2 m<sup>2</sup>) trees with DBH from 5.0 cm to 10.0 cm were measured. Percentage canopy cover of the plots were measured with the help of a Spherical Densiometer, 20 m away from the center at four cardinal directions and one at the plot center. The height and DBH (diameter at breast height) of trees (woody plant with single bole, >5 cm DBH and >1.3 m height) were measured with the help of Vertex IV with Transponder T3 and DBH tape, respectively.

Importance values index (IVI) of individual trees species available in the particular vegetation were calculated by adding the relative values of frequency, density and dominance. Relative dominance of trees was determined by calculating the basal area. Name of each forest type was determined by ordering the Importance values of each tree species recorded.

Similarity index was calculated to compare similarity between two sacred groves by using Sorensen's index of similarity [15]. The similarity

index is the ratio of total common species and total number of species in both sacred groves.

Maturity of the forest was identified by using maturity index [16]. Maturity index was the ratio of sum of frequencies of individual species in the habitat and total number of species in the habitat.

The Shannon-Weiner species diversity index was calculated by using the following formula:

$$H = - \sum_{i=1}^s (p_i)(\log p_i)$$

- H = Shannon index of species diversity
- P<sub>i</sub> = Proportion of total number of individual of species I
- S = Number of species

Evenness was calculated by dividing Shannon-Weiner diversity index with the log value of total number of species found in the area.

## 3. RESULTS AND DISCUSSION

From the phyto-sociological analysis, only one forest type was recognized in the BSG dominated by *Neolitsea cuipala* having highest IVI (111.3). Among the tree species *Schima wallichii* was reported to have maximum height of 35 m and the maximum DBH of 111 cm. Whereas, the average tree height was 18.6±12.7 cm and the average DBH of tree was 36.6±19.44 m (Tab. 1) and the average tree density per ha was 430. The canopy cover of this grove was 90.8%. In this sacred grove a similar type of study carried out by IUCN (1996) has also reported only one forest type dominated by *Neolitsea cuipala* having 30 tree species with the density of 348 per ha. Same study also reported *Neolitsea cuipala* incorporated highest number of stem per ha with maximum DBH 114 cm and *Schima wallichii* having maximum height of 38 m [12].

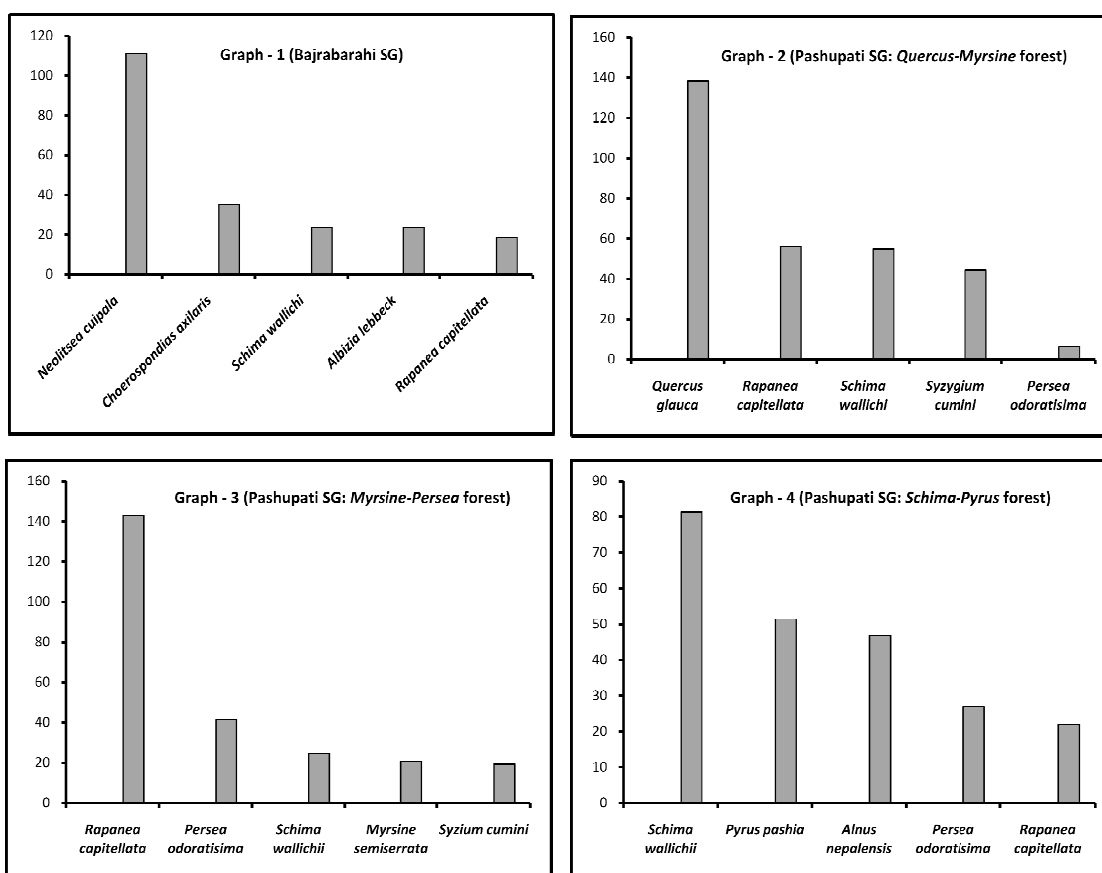
In PSG three forest types were identified namely, *Schima-Pyrus* forest, *Myrsine-Persea* forest and *Quercus-Myrsine* forest on the basis of importance value [17,18]. In *Schima-Pyrus* forest, *Schima wallichii* had the highest IVI (81.4) followed by *Pyrus pashia* (51.5). Similarly, in *Myrsine-Persea* (moist) forest *Rapanea capitellata* had the highest IVI (142.9) followed by *Persea odoratissima* (41.5) and in *Quercus-Myrsine* (mixed) forest *Quercus glauca* had the highest IVI (138.5) followed by *Rapanea capitellata* (56.2) [18; Fig. 1]. In this grove, the

maximum height of tree was 35 m (*Araucaria bidwillii*) and the maximum DBH of tree was 106 cm (*Choerospondias axillaris*). Similarly, the average tree height in this grove was 13.3±6.3 m and the average DBH of tree was 33.6±17.4 cm. The percentage canopy cover of this grove was 73.1%. Shrestha (2001) reported 24 trees species from only one forest type (*Myrsine-Schima*) with the density of 601 per ha, higher than present study having maximum tree height of *Schima wallichii* (18.6 m) from this grove. The study area covered by Shrestha in 2001 was only a part of entire grove thus the forest type identified was also only one. But the present study has covered the entire forest area of the PSG recording three forest types.

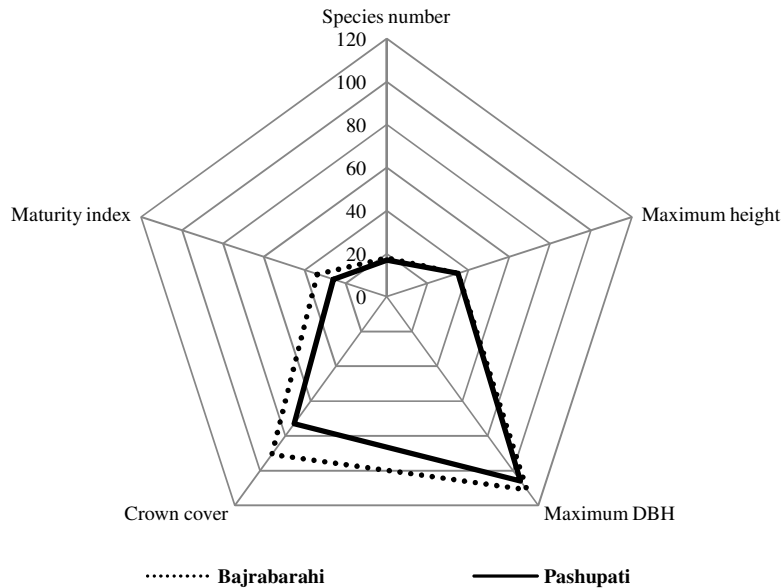
In Bajrabarahi Sacred Grove, 18 species of trees were recorded with the density of 430 tree per ha, Whereas, Pashupati sacred grove had 17 tree species with their per hector density of 533 stems. Both groves shared ten common tree species such as *Schima wallichii*, *Syzygium*

*cumini*, *Myrica esculenta*, *Myrsine semiserrata*, *Choerospondias axillaris*, *Castanopsis tribuloides*, *Rapanea capitellata*, *Persea odoratissima*, *Celtis australis* and *Hymenodictyon orixense*. From the index of similarity (IS), more than 57% of tree species were found to be similar between BSG and PSG. Similarly, the analysis of maturity indices (MI) indicated that BSG forest incorporated more mature (MI = 33.9) trees than that of PSG (MI = 26.0). The BSG incorporated less number of stem (430 per ha) with higher crown cover than that of PSG (Fig. 2, Table 1).

Maximum dimensions of trees in terms of size and growth pattern have been reported from a community managed sacred grove of West Bengal, India [19]. Although, the present study was conducted in different physiographic region than West Bengal, India but showed the similar type of results regarding DBH and tree height from the studied groves.



**Fig. 1. Importance value of five major plant species in the study area, species are arranged in vertical axis, horizontal axis represented importance value**



**Fig. 2. Tree characteristics of the study areas**

**Table 1. Tree characteristics of the study areas**

| Characteristics/ Parameters | Bajrabarahi SG | Pashupati SG |
|-----------------------------|----------------|--------------|
| Average tree height (m)     | 18.6±12.7      | 13.3±6.3     |
| Average DBH (cm)            | 36.6±19.4      | 33.6±17.4    |
| Tree density (number/ha)    | 430            | 533          |
| Number of forest type       | 1              | 3            |
| Species Diversity Index     | 1.80           | 1.91         |
| Evenness                    | 0.62           | 0.67         |

The calculated values of Shannon-Weiner species diversity index were 1.80 and 1.91 for BSG and PSG, respectively. This indicated that PSG is most diverse than BSG in term of tree diversity. Similarly, Evenness value indicated that tree species of Pashupati Sacred Groves (0.67) were more evenly distributed than that of Bajrabarahi Sacred Groves (0.62).

The general ecological principle in the open canopy forest, stem per unit area is highest due to having more light in the ground. In this study, forest canopy coverage in BSG was high but the density was less, where as in PSG the canopy coverage is low and density was high. This result also matches with the general ecological principle.

Study conducted in four sacred groves of Manipur, India revealed that density–diameter distribution of woody species showed highest stand density and species richness in the lowest girth class and decreased in the succeeding girth

classes [4]. In current study, PSG incorporated higher tree density and their richness than BSG. Present study revealed that BSG has more mature trees due to community managed system supported by strong religious belief, taboos resembling the results of Manipur study. Sacred groves play a significant role in biodiversity conservation while studying the Lumbini Sacred Grove of Nepal [20]. Similarly, study of the mistletoe diversity in five sacred groves of Kathmandu Valley has concluded that the rich plant diversity of sacred groves has supported 45% mistletoe diversity reported from Nepal [21].

A study conducted to assess the strength and weakness of different management system in conserving sacred groves in India found that the plant diversity is well conserved in the area managed by local community [22,23]. The current result also supports that community managed BSG is well conserved than government managed PSG. A number of factors have been identified that are negatively affecting

the forest in PSG, during the study, such as - overgrazing, firewood collection, uncontrolled human access, burial ground, newly opened access road, access tracks, and lack of conservation awareness among the locals. The establishment of a deer park within the grove has been considered as a major cause of forest destruction [24] since 30% of trees were damaged by deer and 15% were dead or dying because of damage occurred by antlers and the study concluded that Mrigasthali (deer park) is a dying patch of forest.

#### 4. CONCLUSION

Management of BSG taken over by Jyotidaya Sangh and community conservation initiative has contributed more in conservation activities that has increased tree density per hectare. The paper identified that community involvement followed by strong religious beliefs has led towards biodiversity conservation in BSG compared to PSG despite of various protection measures adopted by the government for the conservation of the forest.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

- Gadgil M, Vartak VD. Sacred groves of Western Ghats in India, *Economic Botany*. 1976;30:152–160.
- Chandrakanth MG, Gilless JK, Gowramma V, Nagaraja MG. Temple forests in India's forest development. *Agro forestry Systems*, Springer. 1990;11(3):199–211.
- Barre RY, Grant M, Draper D. The role of taboos in conservation of sacred groves in Ghana's Tallensi-Nabdam District. *Social and Cultural Geography*. 2009;10(1):25–39.
- Khumbongmayum AD, Khan ML, Tripathi RS. Biodiversity conservation in sacred groves of Manipur, northeast India: population structure and regeneration status of woody species. *Biodiversity and Conservation*. 2005;15:2439–2456.
- Engel JR. Biosphere reserves as sacred places *Orion nature quarterly*. 1985;4:53-59.
- Ramakrishnan PS. Conserving the sacred: from species to landscapes. *Nature and Resources*. 1996;32:11–19.
- Anthwal A, Sharma RC, Sharma A. Sacred groves: Traditional way of conserving plant diversity in Garhwal Himalaya, Uttaranchal. *The Journal of American Science*. 2006;2(2):35-43.
- Haridasan K, Rao RR. Forest flora of Meghalaya. Bishen Singh and Mahendrapal Singh, Dehra Dun. 1985;1.
- Khan ML, Menon S, Bawa KS. Effectiveness of the protected area network in biodiversity conservation: A case study of Meghalaya state, *Biodiversity and Conservation*. 1997;6:853–868.
- Ingles AW. Religious beliefs and rituals in Nepal. Their influence on forest conservation. In: Halladay Patricia and Gilmour DA. (Eds.). *Conserving Biodiversity outside Protected Areas. The role of traditional agro-ecosystems*. IUCN, Gland, Switzerland, and Cambridge, UK. 1995;205-224.
- Mansberger JR. Ban yatra: A bio- cultural survey of sacred forest in Kathmandu valley. PhD thesis submitted to University of Hawaii, USA. 1991;330.
- IUCN. Forest resource information report of Bajrabarahi forest (Draft report), Nepal. 1996;1-23.
- Shrestha S. Ecological study of trees of Shleshmantak forest, Pashupati Development Area, Kathmandu, Nepal. M Sc dissertation submitted to the Central Department of Botany, Tribhuvan University; 2001.
- FRA/DFRS. Terai Forests of Nepal (2010 – 2012) Babarmahal, Kathmandu: Forest Resource Assessment Nepal Project/Department of Forest Research and Survey; 2014.
- Sørensen T. A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. *Biologiske Skrifter / Kongelige Danske Videnskabernes Selskab*. 1948;5:1-34.
- Pichi-Sermolli R. An index for establishing the degree of maturity in plant communities *Journal of Ecology*. 1948;36:85-90.
- Sharma BK, Chalise MK and Solanki GS. Vegetation type and wildlife occurrence in Baghmara Buffer zone Community forest, *International Multidisciplinary Research Journal*. 2012;2(2):52-65.
- Shrestha L, Devkota M. Forest types of Pashupati sacred grove, Kathmandu,

- Nepal, Journal of natural history museum. 2013;27:72-77.
19. Bhakat RK, Sen UK, Pandit PK. Role of sacred grove in conservation of plants West Mindapore District, West Bengal. Indian forester. 2008;134(7):866-874.
  20. Bhattarai KR, Baral SR. Potential role of sacred grove of Lumbini in biodiversity conservation in Nepal. Banko Jankari. 2008;18(1): 25-31.
  21. Devkota M. Sacred groves as sanctuaries for mistletoe conservation in Kathmandu Valley, Treetops at Risk: Challenges of Global Canopy Ecology and Conservation. (ed) Margaret Lowman, Soubadra Devy and T. Ganesh. Springer Science and Business Media, New York. 2013;405-414.
  22. Chandrashakara UM, Sankar S. Ecology and management of sacred groves in Kerala, India. Forest Ecology and Management. 1998;112:165-177.
  23. Sukumaran S, Jeeva S, Raj ADS, Kannan D. Floristic diversity, conservation status and economic value of miniature sacred groves in Kanyakumari District, Tamil Nadu, Southern Peninsular India. Turk J Bot. 2008;32:185-199.
  24. Shrestha S. Destroying a remnant sacred forest, Habitat Himalaya-Resources Himalaya Foundation Fact file. 2009;16(3):1-4.

© 2015 Shrestha et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*  
<http://www.sciencedomain.org/review-history.php?iid=777&id=24&aid=6932>