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Case Study

Assessment of Bio-sequestration potential of trees: A case study in sacred groves of Akhnoor and its environs, J&K, India

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Abstract

Sacred groves are lush, diverse virgin forests that have been safeguarded for generations by local communities due to cultural taboos and religious beliefs. These areas play a crucial role in preserving biodiversity. Many plant and animal species, which are now endangered elsewhere, continue to thrive in these sacred groves. The current study was conducted in the sacred groves of Akhnoor and its environs, J&K, to evaluate the diversity and carbon sequestration potential of the trees. In the study area, the average total growing stock, biomass, carbon, and CO_2 equivalent were 549.473m³/ha, 295.39 t/ha, 140.22 t/ha, and 513.84 t/ha, respectively. Among the tree species observed, Ficus religiosa had the highest average values for growing stock, biomass, carbon, and CO2 equivalent, followed by Ficus benghalensis. In contrast, Melia azedarach had the lowest values, with Grewia tillifolia coming in just above it. The paper highlights the potential of the sacred grove tradition as a tool for biodiversity conservation through community involvement. The aim of this study is to examine the role of sacred groves in the management and preservation of diverse ecosystem services and to propose an alternative approach for ensuring the sustainability of forests in areas surrounding human settlements.

Keywords: Biodiversity, Carbon dioxide equivalent, Carbon stocks, Sacred groves, Sequestration.

Introduction

Nature's method of sequestering carbon from the atmosphere is a technique for establishing atmospheric carbon dioxide equilibrium and preserving the global carbon cycle. Green plants possess a unique capacity to absorb carbon in the form of carbon dioxide as a raw material for food manufacture[1]. With 33% of the land area dedicated to forests, these ecosystems are crucial to the global carbon cycle, taking in around 25% of the annual emissions of carbon dioxide produced by humans. Therefore, through carbon-climate feedback, forests may either amplify or attenuate the rising trend in atmospheric CO_2 concentrations, affecting future temperatures[2].

Sustainable management of such terrestrial forest carbon stocks can contribute significantly to worldwide climate change mitigation initiatives. Protecting carbon stocks in existing forests and adding via afforestation and replanting contributed greatly to improving the terrestrial ecosystem's carbon sequestration capability and mitigating rising carbon dioxide concentrations in the atmosphere[3]. As a result, species richness, composition, and productivity vary greatly over space and time. The structural and geographical distribution of trees in forests, agroforests, social forests, sacred groves, and farmland trees assists in the development of management prescriptions to increase productivity and carbon stock[4].

Dedicated areas of vegetation in the name of regional deities or ancestral spirits are known as sacred groves (varying in size from a tiny cluster of a few trees to a vast forest stand covering several hundred acres). The removal of any living item from the sacred grove is forbidden, however dead logs and leaves are occasionally taken. This establishment is the best illustration of an indigenous traditional resource-use method that supports the preservation of biodiversity[5]. The maintenance of a variety of rare and unique species in the sacred groves as a result of centuries of customary protection of the groves makes them an excellent example of traditional cultural institutions supporting biodiversity conservation[6]. India is the country with the greatest number of sacred groves in the world, between 100,000 and 150,000, because of the country's diverse castes, religions, and ethnic groups, all of which are disappearing as a result of cultural shifts and pressure to exploit the groves natural resources[7]. However, except for a few in urban areas, the majority of sacred groves are rural. They act as a gene pool and provide ecological services such as a source of perennial water, the maintenance of local micro-environmental conditions, and assistance in biogeochemical cycles. In sacred groves, many threatened and endangered plant species can still be found[8]. As a result, they are the epicenter of ecological conservation research and policy concerning forest conservation and management at the state and national levels[9]. In several regions of the Himalayas, for the preservation of forests and sacred groves, various taboos have been used.

These can be enforced on an irregular basis and may be imposed on the population on the basis of their age, gender, or status[10]. Local communities have historically observed taboos out of fear of retaliation. To avoid conflict with traditional authority, even individuals who do not adhere to or believe in the social taboo practice avoid destroying sacred trees. While this practice fulfills traditional and cultural aims and aids in the conservation of natural resources in many parts of the world, it does not help the protection of biodiversity.

As a means of preserving the essence of the natural world and preventing the extinction of species, nature conservation is always associated with habitat maintenance and restoration, which improves ecosystem services and safeguards biological diversity. It supports the upkeep of a robust and healthy ecosystem[11]. Thus, considering the significance of plants and natural sinks of carbon dioxide that play an important role in the carbon balance of the ecosystem and thereby the global carbon cycle, the current study was carried out in sacred groves of Akhnoor and its environs, J&K to assess the diversity and bio-sequestration potential of various tree species encountered in the study area.

Methodology

Study area: The study area, Akhnoor, is an ancient settlement located in the Shiwalik hill region of the Jammu District within the Union Territory of Jammu and Kashmir (Figure-1). Positioned between 32.87°N latitude and 74.73°E longitude, it lies at an elevation of 301 meters above sea level. Akhnoor is situated in the MairaMandrian Tehsil, on the right bank of the Chenab River, which flows into the plains near Kathar in the Khadhandhara Valley. It is bordered to the north and east by the Trikuta Range, Kali Dhar, and the Shivaliks. The climate in Akhnoor is humid subtropical, characterized by hot and humid summers and temperate to mild winters. Temperatures rise in March, peaking at around 45°C in April. The predominant soil type in the area is alluvial, which is loamy with minimal clay, moderate lime content, and high magnesium content. The region is covered with dense evergreen vegetation, featuring a variety of tree species including *Eucalyptus*, *Bambusa vulgaris*, *Mangifera indica*, *Albizia lebbeck*, *Ficus religiosa*, and *Alstoniascholaris*.

Data collection and analysis: Sacred groves within Akhnoor and its environs were selected and visited personally. The complete information on sacred groves is presented in Table-1. To create an inventory of tree species, field study was carried out at various locations, species within the boundary of the sacred groves were selected and all the necessary information about the tree species was collected and presented in Table-2. For the study, methodology of Forest Survey of India[12], Dehradun, was followed. Estimation of growing stock of the trees within the boundary of the sacred groves the data such as girth of the trees was used. Trees with a girth of less than 30 cmwere not considered for analysis. Volume estimation of trees was done by using a non-destructive method. The volume of individual tree species was estimated by using the respective allometric equation developed for various tree species of the Indian Himalayas[12]. For tree species for which the volume equation was not available, a general volume equation is used for those species. Data gathered after the calculation of volume for each tree species were arranged species-wise and then calculated for average volume. For the estimation of the biomass of encountered tree species, the volume obtained by using the volume equation was multiplied with species-specific gravity. The carbon content of each tree species was analyzed by multiplying the total biomass by a conversion factor of 0.475[13]. However, the carbon dioxide equivalent (CO_2e) was calculated by multiplying the total carbon by a conversion factor of 3.666[14]. Using Past 4.17 software, Hierarchical clustering analysis (HCA) was also performed.

Table-1: List of sacred groves encountered in the study area.

Name of the Sacred Grove	Name of the Deity	Place	Area (hectares)	Community	Number of Tree Species
Datti temple	Datti	Doomi	0.2 ha	Mahajan	7
Shamshan Ghat	-	Chandiya (Akhnoor)	0.12 ha	Brahman	5
Jia Pota Sun Temple	Goddess Durga	Akhnoor	0.05 ha	All	4
Guru Parshuram Mandir	Parshuram Ji	Akhnoor	0.12 ha	Brahman	3
Tirth Trimurti Mandir	Brahma, Vishu and Mahesh	Gurha Pattan	0.07 ha	All	2
Gauri Shankar Mandir	Lord Shiva	Akhnoor	0.05 ha	All	5
Kameshwar Mandir	Lord Shiva	Akhnoor	5.05 ha	All	14
Baba Lal Dayal Ji Mandir	Baba Lal ji	Akhnoor	0.15 ha	All	10

Dudhadhari Mandir	Baba Dudhadhari	Akhnoor	0.15 ha	All	3
Prachin Pandav Gufa	Lord Shiva	Akhnoor	0.07 ha	All	3
Radha krishna Mandir	Lord Krishna	Sumah	0.1 ha	All	11
Balle De Bagh	Baba Faiz Baksh	Akhnoor	0.4 ha	All	3
Baba Mathwar Temple	Baba Ballo Ji	Mathwar	3 ha	All	13
Showa Mata Temple	Goddess Showa	Bamyal	0.25 ha	All	21
Kufi Devsthan	Lord Shiva	Kufi (Akhnoor)	0.1 ha	All	3

Table-2: Tree species inventoried in sacred groves including their families, common name and economic importance.

Name of species	Name of the family	Common name	Importance
Acacia catechu (L.f.) Willd.	Fabaceae	Khair	Medicinal, Fodder and Fuel wood
Acacia nilotica Linn.	Fabaceae	Babul	Timber, Fodder and Fire wood
Adina cordifolia (Roxb.) Hook. F. Ex Brandis	Rubiaceae	Kadamb tree	Sacred and fuel wood
Aegle marmelos L.	Rutaceae	Bilan	Timber, Fuel wood, Fodder and religion
Albizia lebbeck L.	Fabaceae	Shirish tree	Medicinal value
Alstoniascholaris L.	Apocynaceae	Satpatra	Ornamenmtal and shade tree
Annoma squamosa L.	Annonaceae	Sitaphal	Fruits and medicine value
Azadirachta indica A.Juss	Meliaceae	Neem	Medicinal and fuel wood
Bombax ceiba Linn.	Malvaceae	Simbal	Medicinal and fuel wood
Butea monosperma (Lam.) Taub.	Fabaceae	Palash tree	Rubber, resin, dye, fodder and medicine
Cassia fistula Linn.	Fabaceae	Golden shower tree	Ornamental and fuel wood
Cassia siamea (Lam.)	Fabaceae	Kassod tree	Ornamental and medicinal use
Casuarina equisetifolia L.	Casuarinaceae	Saru	Ornamental
Citrus limon L.	Rutaceae	Lemon	Fruits and fuel wood
Citrus medica L.	Rutaceae	Kimb	Fruits and fuel wood
Dalbergia sissoo Roxb.	Fabaceae	Shisham	Timber, fuel wood and Medicinal
Emblica officinalis Gaertn	Phyllanthaceae	Amli	Fruits, Fodder, Timber and Medicinal
Eriobotya japonica (Thunb.) Lindl	Rosaceae	Loquat	Fruits and Fuel wood
Eucalyptus citriodora Linn.	Myrtaceae	Safeda	Timber, Fuel wood and Essential oil
Ficus benghalensis L.	Moraceae	Bargad	Religious, fuel wood and fodder

Ficus elasticaRoxb.	Moraceae	Rubber tree	Ornamental and Medicinal use
Ficus palmataForssk.	Moraceae	Wild fig	Medicinal value and poultice
Ficus racemosa L.	Moraceae	Rumbal	Fuel, wood, fodder and medicinal
Ficus religiosa Linn.	Moraceae	Peepal	Religious, fuel wood and fodder
Ficus virens W.T. Aiton	Moraceae	White fig	Medicinal, fodder and fuel wood
Grevillea robusta A. Cunn. Ex R. Br.	Protaceae	Silver oak	Fire wood, timber and shade tree
Grewia optiva Drumm. exBurret.	Malvaceae	Bimal	Fodder, fibre and fuel wood
Grewia tillifolia Vahl	Malvaceae	Dhaman	Fodder and fuel wood
Jasminum sambac (L.) Aiton	Oleaceae	Jasmine	Ornamental
Lannea coromandelicaMerr.	Anacardiaceae	Jingini	Fodder and fuel wood
Leucaena leucoephala (Lam.) de Wit	Fabaceae	Subabul	Firewood, fiber and fodder
Mallotusphillippensis (Lam.) Mull. Arg	Euphorbiaceae	Kumkum tree	Dye and fuel wood
Mangifera indica L.	Anacardiaceae	Mango	Fruits, timber. Religious and cash crop
Melia azedarach L.	Meliaceae	Drek	Medicinal and fuel wood
Moringa oleifera Lamk.	Moriangaceaea	Drumstick tree	Medicinal value
Morus alba Linn.	Moraceae	Toot	Fruits, fodder, timber and medicinal
Platanus orientalis L.	Platanaceae	Chinar	Timber, fuel wood and shade tree
Polyathialongifolium L.	Annonaceae	False ashoka	Ornamental and medicinal
Psidium gujava L.	Myrtaceae	Amrud	Fruits and Fodder
Putranjivaroxburghii Wall.	Putranjivaceae	Jipota tree	Religious, fuel wood and Fodder
Roystonea regia (Kunth) O. F. Cook	Areaceae	Royal palm	Ornamental
Shorea robusta Roth.	Diptercarpaceae	Sal tree	Timber, Fuel wood and Fodder
Syzygiumcumini L.	Myrtaceae	Jamun	Fruits, Medicinal and Fuel wood
Tectona grandis L.f.	Lamiaceae	Sagwan	Timber and Shade tree
Terminnalia arjuna Roxb.	Combrataceae	Arjun tree	Timber and Medicinal
Terminalia belliricaRoxb.	Combrataceae	Baheda	Medicinal value
Terminalia chebula Retz.	Combrataceae	Harad	Medicinal value
Thevetia peruviana (L) Lippold.	Apocynaceae	Yellow oleander	Flowers, fodder and fuel wood
Toona ciliata M Roemer.	Meliaceae	Tuna	Timber and shade tree
Ziziphus marutiana Lam.	Rhamnaceae	Ber	Fruits, fodder, medicinal and fuel wood

Results and Discussion

The current study examined a total of 15 sacred groves in Akhnoor town and its environs. The complete information regarding the history, religious importance, tree species encountered, area of sacred groves, etc. from 15 sacred groves was collected personally. The sacred groves identified belong to different communities and clans, belonging to Hindus and Muslims.

The details about tree species existing in the sacred groves, growing stock, biomass, carbon content, and carbon dioxide equivalent were also studied as presented in Table-3. The data collected from the sacred groves showed50 species with 345 tree individuals belonging to 39 genera and 24 families. The tree species encountered in the study area were *Acacia catechu*, *Acacia nilotica*, *Adina cordifolia*, *Aegle marmelos*, *Azadirachta indica*, *Bombax ceiba*, *Dalbergia sisoo*, *Emblica officinalis*, *Ficus religiosa*, *Ficus virens*, *Grewia optiva*, *Mangifera indica*, *Mallotusphilippensis*, *Melia azedarach*, *Putranjivaroxburghii*, *Terminalia arjuna* and many more.

These days, sacred groves have become vital because they are repositories of genetic and flora variety that need to be maintained. Species that were formerly common outside the grove are now rare and found only in these locations. Sacred groves provide an unbreakable connection between the past and the present in terms of culture, biodiversity, religious and ethnic heritage[15]. Varying in size from a few trees to dense forests covering extensive tracts of land, sacred groves act as an ideal center for biodiversity conservation.

The study conducted by Sharma and Kour in the sacred groves of rural areas of block Vijaypur, found that out of a total of six tree species, *Dalbergia sissoo* was the most dominant followed by *Eugenia jambolana*[16]. In a study conducted by Priya and Sharma reported a total of 71 tree species from 60 sacred groves they studied. The most common and revered tree species in the study area is *Ficus religiosa*, which is present in every sacred grove[17].

Growing stock, biomass, carbon, and CO_2 equivalent (CO_2e)

Among the various sacred groves studied, the maximum average growing stock was found for *Ficus religiosa* (186.79±136.16m^3/ha) followed by *Ficus benghalensis* (184.59±134.14m^3/ha), whereas least in case of *Melia azedarach* (0.003±0.01m^3/ha) followed by *Grewia tillifolia* (0.01±0.00 m^3/ha).

The study area had an average growing stock of 549.473m^3/ha, biomass of 295.39t/ha, carbon of 140.22t/ha, and CO_2 equivalent of 513.84t/ha. The elevated biomass observed in the sacred groves was primarily attributed to the presence of a high number of old and mature tree species, which have been preserved undisturbed due to their religious significance and aesthetic appeal.

Values of biomass, carbon, and CO_2 equivalent varied among various tree species that are encountered in the study area. Maximum average biomass, carbon, and CO_2 equivalent was reported in the case of *Ficus religiosa* (95.16±70.41 t/ha), (45.20±33.45t/ha) and (165.71±122.63t/ha) respectively, followed by *Ficus benghalensis* i. e. biomass (93.69±68.31 t/ha) carbon (44.50±32.44 t/ha) and CO_2 equivalent (163.13±118.92 t/ha). Apart from these species, the other major carbon-sequestrating species reported in the study area were *Tectona grandis*, *Ficus racemosa*, *Emblica officinalis,* and *Terminalia arjuna*.

The minimum average biomass, carbon, CO_2 equivalent was reported in the case of *Melia azedarach* (0.003±0.004 t/ha), (0.001±0.002 t/ha) and (0.003±0.007 t/ha) respectively, followed by *Grewia tillifolia* i.e. biomass (0.01±0.00 t/ha), carbon (0.004±0.00 t/ha) and CO_2 equivalent (0.01±0.00 t/ha).

Kour and Sharma conducted research in the plains of district Samba, J&K, to evaluate the bio-sequestration potential of trees located outside forests, such as those in agricultural areas, along defensive ditches, beside connecting roads, and in sample plots within sacred groves[18].

Their findings indicated that sacred groves had the highest biomass value (257.13 t/ha) and carbon content (123.43 t/ha) compared to other areas, though these figures are lower than those reported in the current study.

It is because of the reason that sacred groves represent the unique fragments of the respective gene pool. Conservation of sacred groves may conserve the declining population diversity[19]. Thus, it is important to preserve these sacred groves to effectively manage the carbon stock. This will serve as a solid foundation for the incentive provided for the Reducing Emissions from Deforestation and Forest Degradation (REDD) mechanism and may aid in better understanding the viability of their use in a carbon credit system.

Hierarchical clustering analysis (HCA): Using Wards approach, to find the degree of similarity, two-way HCA was performed. The parameters have been clustered into two main clusters: cluster 1 comprises of carbon and biomass, whereas cluster 2 consists of carbon dioxide equivalent and growing stock.

The tree species under the study have also been clustered into broad clusters: cluster 1 is further divided into cluster 1.1 includes *F. benghalensis* and *F. religiosa*. Similarly, cluster 2 is further subdivided into two main clusters, cluster 2.1 and cluster 2.2, which further subdivided into sets and each set further comprises of tree species (Figure-2).

Table-3: Species wise growing stock, Biomass, carbon content and CO_2 equivalent of tree species in sacred groves

S.No.	Name of species	Growing stock(m^3/ha)	Biomass (t/ha)	Carbon (t/ha)	CO_2 equivalent (t/ha)
1	Acacia catechu (L.f.) Willd.	5.92±4.42	3.30±3.57	1.56±1.69	5.71±6.19
2	Acacia nilotica Linn.	10.36±6.52	5.78±3.64	2.74±1.72	10.04±6.30
3	Adina cordifolia (Roxb.) Hook. F. Ex Brandis	4.61±3.50	1.77±1.34	0.84±0.63	3.07±2.30
4	Aegle marmelos L.	5.3±2.60	4.53±2.18	2.15±1.03	7.88±3.77
5	Albizia lebbeck L.	10.35±6.52	5.79±3.65	2.75±1.73	10.08±6.33
6	Alstoniascholaris L.	3.83±3.79	2.11±2.09	1.00±0.99	3.66±3.62
7	Annoma squamosa L.	0.56±0.49	0.52±0.44	0.24±0.20	0.87±0.73
8	Azadirachta Indica A. Juss	3.49±1.40	1.93±0.77	0.91±0.36	3.33±1.31
9	Bombax ceiba Linn.	8.98±4.09	4.43±1.13	2.10±0.53	7.69±1.94
10	Butea monosperma (Lam.) Taub.	5.28±2.90	2.90±1.27	1.37±0.60	5.02±2.19
11	Cassia fistula Linn.	0.17±0.05	0.09±0.03	0.05±0.03	0.18±0.10
12	Cassia siamea (Lam.)	0.54±0.46	0.47±0.40	0.22±0.19	0.80±0.69
13	Casuarina equisetifolia L.	0.32±0.42	0.24±0.32	0.11±0.15	0.40±0.54
14	Citrus limon L.	0.70±0.63	0.62±0.55	0.29±0.26	1.06±0.95
15	Citrus medica L.	0.41±0.27	0.26±0.17	0.12±0.08	0.43±0.29
16	Dalbergia sissoo Roxb.	9.69±3.07	5.82±1.84	2.76±0.87	10.11±3.18
17	Emblica officinalis Gaertn	11.20±4.89	7.83±3.41	3.71±1.61	13.60±5.90
18	Eriobotya japonica (Thunb.) Lindl	0.53±0.51	0.29±0.28	0.14±0.13	0.51±0.47
19	Eucalyptus citriodora Linn.	0.08±0.12	0.08±0.10	0.03±0.04	0.10±1.46
20	Ficus benghalensis L.	184.59±134.14	93.69±68.31	44.50±32.44	163.13±118.92
21	Ficus elastic Roxb.	0.63±0.58	0.54±0.48	0.25±0.22	0.91±0.80
22	Ficus palmate Forssk.	2.46±1.05	1.13±0.48	0.54±0.23	1.98±0.85
23	Ficus racemosa L.	11.23±4.91	7.86±3.44	3.73±1.63	13.67±5.97
24	Ficus religiosa Linn.	186.79±136.16	95.16±70.41	45.20±33.45	165.71±122.63

25	Ficus virens W.T. Aiton	16.54±9.75	7.29±4.30	3.5±2.06	12.83±7.55
26	Grevillea robusta A. Cunn. Ex R. Br.	0.17±0.05	0.09±0.03	0.05±0.01	0.18±0.03
27	Grewia optiva Drumm. Ex Burret.	0.1±0.02	0.07±0.01	0.03±0.01	0.10±0.03
28	Grewia tillifolia Vahl	0.01±0.00	0.01±0.00	0.004±0.00	0.01±0.00
29	Jasminum sambac (L.) Aiton	0.28±0.15	0.13±0.07	0.06±0.03	0.21±0.10
30	Lannea coromandelica Merr.	0.29±0.16	0.13±0.07	0.06±0.04	0.21±0.14
31	Leucaena leucoephala (Lam.) de Wit	0.67±0.60	0.58±0.52	0.27±0.24	0.98±0.87
32	Mallotusphillippensis (Lam.) Mull. Arg	0.61±0.55	0.52±0.46	0.24±0.21	0.87±0.76
33	Mangifera Indica L.	5.5±2.62	4.57±2.22	2.17±1.05	7.96±4.59
34	Melia azedarach L.	0.003±0.01	0.003±0.004	0.001±0.002	0.003±0.007
35	Moringa oleifera Lamk.	0.24±0.27	0.17±0.21	0.08±0.09	0.29±0.32
36	Morus alba Linn.	0.53±0.24	0.29±0.13	0.13±0.06	0.47±0.21
37	Platanus orientalis L.	3.48±1.39	1.92±0.76	0.91±0.36	3.33±1.31
38	Polyathialongifolium L.	0.50±0.66	0.42±0.56	0.20±0.26	0.73±0.95
39	Psidium gujava L.	0.32±0.42	0.24±0.32	0.11±0.15	0.40±0.54
40	Putranjivaroxburghii Wall.	5.7±2.64	4.59±2.24	2.18±1.06	7.99±3.88
41	Roystonea regia (Kunth) O. F. Cook	0.55±0.70	0.47±0.60	0.22±0.28	0.80±1.02
42	Shorea robusta Roth.	4.2±1.32	3.95±1.26	1.87±0.59	6.86±2.16
43	Syzygiumcumini (L.) Skeels	0.15±7.86	0.11±5.11	0.05±2.42	0.18±8.87
44	Tectona grandis L.F.	19.3±19.35	9.31±9.37	4.42±4.45	16.21±16.31
45	Terminnalia arjuna Roxb.	10.4±3.55	7.28±2.48	3.45±1.17	12.65±4.29
46	Terminalia belliricaRoxb.	0.69±0.62	0.59±0.53	0.28±0.25	1.02±0.91
47	Terminalia chebula Retz.	0.64±0.57	0.55±0.49	0.26±0.23	0.96±0.84
48	Thevetia peruviana (L) Lippold.	0.42±0.12	0.25±0.07	0.12±0.34	0.43±1.24
49	Toona ciliata M Roemer.	8.45±4.25	3.61±1.79	1.71±0.85	6.26±3.11
50	Ziziphus marutiana Lam.	1.71±1.24	1.11±0.81	0.54±0.39	1.97±1.42

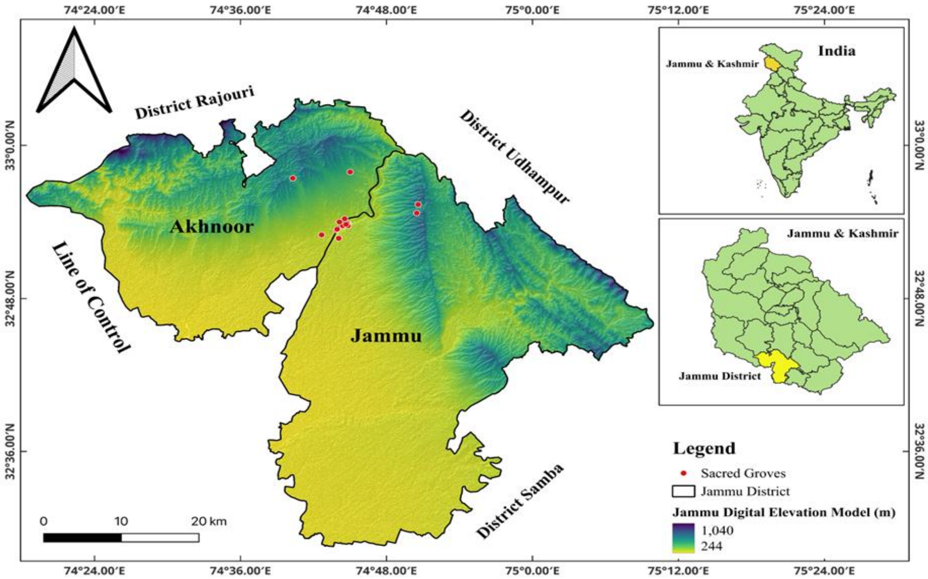

Figure-1: Location map of study area.

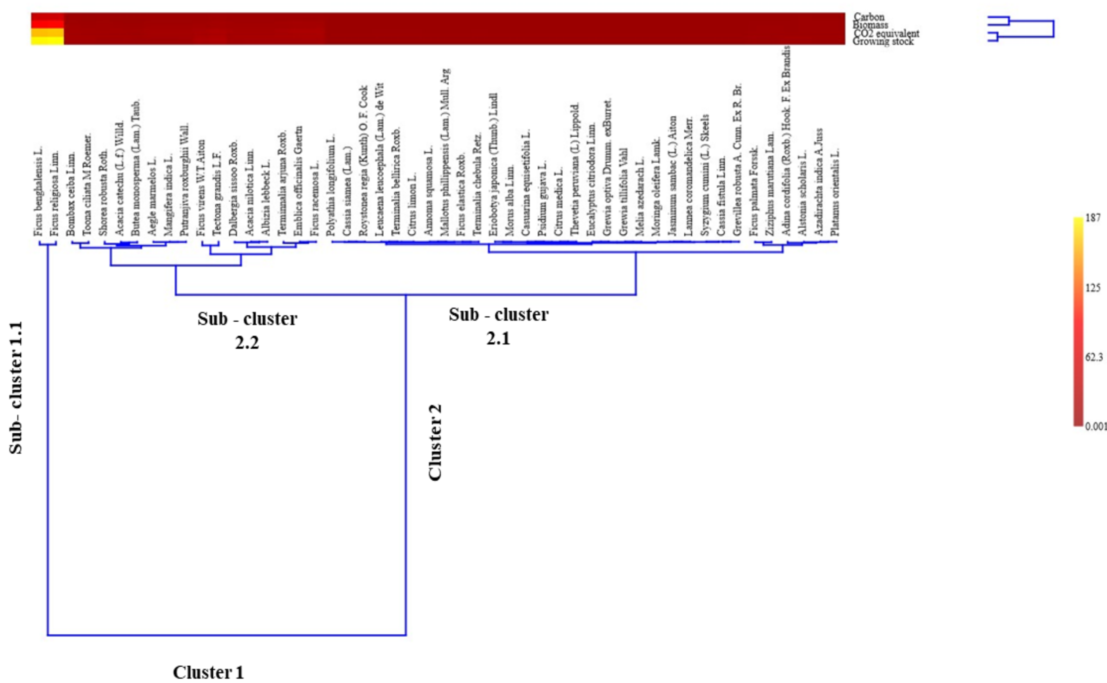

Figure-2: Two-way Hierarchical clustering analysis (HCA) for growing stock, biomass, carbon, carbon dioxide equivalent and different tree species.

Conclusion

Out of the 15 sacred groves studied, only a few were discovered to be protected, while others were under moderate to severe anthropogenic pressure as a result of several development projects in and around the sacred groves. For these kinds of activities, a very large number of tree species were supposed to be removed from the groves. The impact of modernization and education and growing disbelief in the traditional value system among the local communities has impacted the preservation of sacred groves. Because sacred groves have been maintained traditionally for so long, it is critical to document the biomass carbon store of such land usage. But there is no documentation of these effects. Therefore, the present study was a candid attempt to assess the bio-sequestration potential of trees in the sacred groves just to stress the importance of these areas as a sustainable system in terms of biodiversity, conservation of water and soil, and thereby, adaptation to climate change adaptation.

The spiritual beliefs of the local populations serve as the cornerstone for their dedication to safeguarding their local ecosystems and their will to take an active role in preserving sacred groves and other natural areas. The country's sacred groves need to have their management and legal status reviewed because human activity is causing them to progressively disappear. The small sacred patches of forests, as well as the local wildlife, must be preserved immediately, and the efforts of the local people must be recognized.

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References

1. Pandey, A., Dar, J. A. and Raha, D. (2023). A production function approach to estimate agricultural yield benefits of sacred groves: Evidence from sacred groves of Kachchh, Gujarat. Proceedings of the International Academy of Ecology and Environmental Sciences,13(3), 94-110 (2023)

2. Ahmed, J., Sharma, S., & Kumar, D. (2018). Quantitative Ethnobotanical Approach to Analyze Local Importance of Tree Species in North Western Himalaya: A Case Study of Ponda Watershed, J&K. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 88, 897-903.

3. Lee, K. W. K., Cheuk, M. L., Fischer, G. A., & Gale, S. W. (2023). Can Disparate Shared Social Values Benefit the Conservation of Biodiversity in Hong Kong's Sacred Groves?. *Human Ecology*, 51(5), 1021-1032.

4. Salunkhe, O., Khare, P. K., Sahu, T. R., & Singh, S. (2016). Estimation of tree biomass reserves in tropical deciduous forests of Central India by non-destructive approach. *Tropical Ecology*, 57(2), 153-161.

5. Ahmed, M., Sharma, V., & Dhiman, M. (2023). Sacred groves: the gene banks of threatened and ethnomedicinal flora, associated taboos and role in biodiversity conservation in the Peer Panchal range of North Western Himalayas, India. *Ecological Questions*, 34(3), 1-20.

6. Sen, S. (2020). Sacred Groves Of West Bengal: An Overview. *International Journal of Research and Analytical Reviews April*, 7(2).

7. Ormsby, A. A., & Bhagwat, S. A. (2010). Sacred forests of India: a strong tradition of community-based natural resource management. *Environmental Conservation*, 37(3), 320-326.

8. Bhat, A. H., Sharma, J., & Jaryan, V. (2019). Role of Sacred groves in carbon sequestration in Jammu and Kashmir. *International Journal of Scientific Research and Review*, 7(04).

9. Rawat, S., & Kumar, R. (2024). The enchanting flora of Chamba: Unveiling sacred and magico-religious plants in Himachal Pradesh. *Ethnobotany Research and Applications*, 28, 1-16.

10. Janaki, M., Pandit, R., & Sharma, R. K. (2021). The role of traditional belief systems in conserving biological diversity in the Eastern Himalaya Eco-region of India. *Human Dimensions of Wildlife*, 26(1), 13-30.

11. Ojha, R. (2022). Nature Conservation as Reflected in Hindu Theology and its Deviation in the Modern Days: A Discourse. *ASEAN Journal of Religious and Cultural Research*, 5(1), 1-5.

12. Forest Survey of India (1996). Volume Equations for Forests of India, Nepal, and Bhutan.

13. Singh, K., & Chand, P. (2012). Above-ground tree outside forest (TOF) phytomass and carbon estimation in the semi-arid region of southern Haryana: A synthesis approach of remote sensing and field data. *Journal of Earth System Science*, 121, 1469-1482.

14. Pandya, I. Y., Salvi, H., Chahar, O., & Vaghela, N. (2013). Quantitative analysis on carbon storage of 25 valuable tree species of Gujarat, Incredible India. *Indian Journal of Scientific Research*, 4(1), 137-141.

15. Sharma, S., & Devi, R. (2014). Sacred groves: traditional way of conserving plant diversity in Block Bhalwal of Jammu District (J&K). *International Journal of Science and Research*, 3(2), 239-242.

16. Sharma, S., & Kour, K. (2014). Tree diversity in rural area of block Vijaypur, Samba, J&K. *International Journal of Environmental Sciences*, 4(6), 1114-1120.

17. Priya, K. and Sharma, S. (2021). Carbon sequestration in sacred groves of Jammu district, J&K. *International Journal of Science and Research*, 10(10), 90-93 (2021)

18. Kour, K., & Sharma, S. (2017). Biosequestration potential of trees outside forest in the plains of District Samba, J&K, India. *Environment Conservation Journal*, 18(1&2), 127-135.

19. Waikhom, A. C., Nath, A. J., & Yadava, P. S. (2018). Above ground biomass and carbon stock in the largest sacred grove of Manipur, Northeast India. *Journal of Forestry Research*, 29, 425-428.