



Floristic Diversity of Sunni Dam Catchment in North Western Himalayas

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Abstract: The present investigation was conducted during July- September, 2021-22 in the vicinity of proposed Sunni Dam which falls under Shimla and Mandi districts of Himachal Pradesh wherein the panchayats closer to the dam area were considered with objectives to document the floristic diversity in the dam catchment. The study revealed that overall, 20 trees, 21 shrubs and 21 herbaceous species were recorded from the study area. The floral enumeration revealed that the tree density was highest (62.67/ha) in village Parlog and lowest (41.33/ha) in Khaira. Among the shrub layer, the highest density was observed in village Parlog whereas lowest in Khaira. The Shannon diversity index for the tree was highest (2.2) in Parlog and lowest (1.66) in village Khaira. The shrub diversity index was highest (1.81) in Bathora and lowest (1.13) in Khaira. The herb diversity was highest (1.98) in Bathora and lowest (1.81) in Parlog. The area with the highest floristic diversity and density will have a greater risk of being affected after the dam construction. This study would be considered a supportive tool for compensatory afforestation planning as well as baseline for any further research in this area.

Keywords: Diversity, Dam, Species, Flora, Baseline, Afforestation planning

The planet Earth is bestowed with a substantial diversity of life form that forms a basic foundation for life to exist on Earth (Bhatt 2021). Biodiversity is one such gift of nature that is responsible for humans' survival on the planet. It is not only responsible for stabilizing the ecosystem but also contributes to strengthening the economy of the nation (Alfagham et al 2022). Floristic diversity regulates a lot of provisioning and supporting ecosystem services. It is a reflection of a healthy ecosystem as well as it influences the other biotic factors. It is a consequence of actions to environmental filtering (Zheng and Zheng 2022). The plant community plays an important role in the management of biodiversity as well as in environmental conservation (Galal et al 2021). Floristic diversity serves as the basis for the entire ecosystem. However, various developmental activities like dams, roads and highway construction are well known threats to biological diversity through habitat degradation (Chaudhari and Pathak 2022, Rajkumar and Ravipaul 2022). Thus evaluation of the number of species in a particular community is a significant factor in determining the biodiversity status of that region and indirectly also helpful in assessing the loss of floral diversity due to such activities. Hence, assessment of biological diversity was done in terms of numerous phytosociological parameters.

Himachal Pradesh being situated in the lap of the Himalayas has huge potential for hydro-power generation thus a lot of hydro-power projects and dams are being proposed continuously and hence affecting the native floral

diversity of the region. Therefore, keeping in view the above facts the present investigation was carried out around proposed Sunni dam in Himachal Pradesh situated in Indo-Himalayan region. The study aimed to assess the loss of native floral diversity due to submergence under proposed dam. Analysis of floral diversity of a region is helpful in protecting the native flora of a particular region. Keeping in view the above facts the present study was carried out with the objective to assess the floristic diversity of the region around the Sunni dam hydropower project.

MATERIAL AND METHODS

Study site: The present investigation was carried out in the Shimla and Mandi districts of Himachal Pradesh in order to assess the floral diversity around the proposed dam of the Sunni hydro-power project of 382 MW capacity. The dam is proposed in the inner lesser Himalayas between the Dhuala Dhar range in the south and the higher Himalayan range in the north. It is located in Himachal Pradesh at a longitude of 77°12' 39" E and a latitude of 31°14' 53" N. Sub-tropical type of microclimate prevailed in the region. The study area comprised community land of three village panchayats Bathora, Khaira and Parlog in close vicinity to the dam. The selected villages come under the jurisdiction of the Mandi and Shimla districts. Village Khaira is situated in the closest proximity of dam within 1 km followed by Parlog at 6.8 km and Bathora at a distance of 8.2 km (Fig. 1).

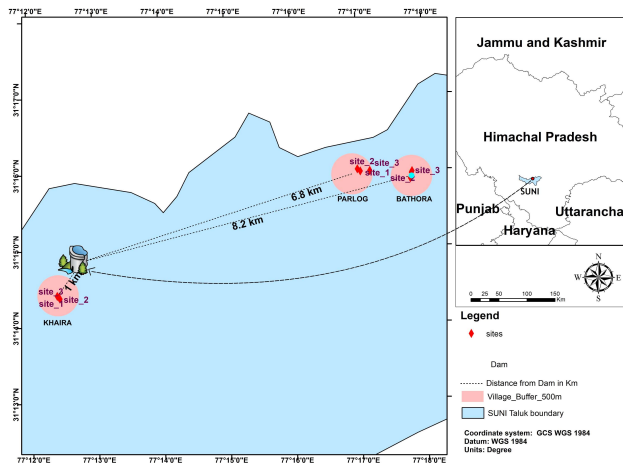


Fig. 1. Study area

Vegetation analysis: The field survey and assessment of floral diversity was carried out during the year 2022 from July to September in the vicinity of proposed dam. The species count methodology was employed for enumerating the species in the study area. The data was collected by marking 50 × 50 m plots in each village of study areas. Ten quadrats of 10×10 m for the enumeration of tree species, ten quadrats of 5×5m for shrubs and ten quadrats of 1×1m for herbs were randomly laid within the plots and plant community was studied for their quantitative character. The trees, shrubs and herbaceous vegetations were noted to keep an account of the floral composition of the plot

Density: Number of Individual of a species per unit area and is calculated Ghafari et al (2020).

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Total number of quadrats studied}}$$

Frequency: The degree of dispersion of an individual species in a community, i.e. chance of occurrence of species in each habitat is frequency (F) and expressed in per cent. The frequency was calculated (Raunkiaer 1934).

$$\text{Frequency} = \frac{\text{Total number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}}$$

Relative density: Relative density (RD) is per cent representation of a species in term of number of individuals relative to all other species in a community.

$$\text{Relative density (\%)} = \frac{\text{Number of individuals of a species}}{\text{Number of individuals of all species}} \times 100$$

Relative frequency

$$\text{Relative frequency (\%)} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100$$

Relative dominance

$$\text{Relative dominance (\%)} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

All the above three parameters of relative density, relative frequency and relative dominance were calculated using formulae given by Misra, 1968.

Importance Value Index (IVI): It reflects the sociological structure of a species in a community as it indicates its importance in the community. The importance value index was calculated using standard procedure given by (Curtis 1959, Kershaw 1973).

IVI = Relative frequency + Relative density + Relative dominance

Species diversity: the species diversity index was calculated using the following formula (Shannon and Weaver 1963)

$$\text{Species diversity} = H = \sum_{i=1}^S \frac{n_i}{N} \ln \frac{n_i}{N}$$

Where, s= number of species, n_i = the abundance of the n^{th} species.

N= the total abundance of each species

Concentration of dominance:

Concentration of dominance (cd) as per Simpson's index (Simpson 1949).

$$CD = \sum (N - N_i)^2$$

Where, n= the total number of individual particular species,

N= the total number of organisms of all species

RESULTS AND DISCUSSION

Phytosociological description of tree species: Overall 10 species were recorded in Khaira village (Table 1). Among trees *Leucaena leucocephala* has the highest tree density (10.33 ind/ha) whereas the lowest density (0.67 ind/ha) was of *Dalbergia sissoo*. Similarly, the frequency and total basal area were also highest for *Leucaena leucocephala* (43.33%, 1.032 m²/ha) whereas the lowest frequency (6.67%) was for *Dalbergia sissoo*. *Phyllanthus emblica* and *Phoenix sylvestris* has the lowest total basal area. Further, irrespective of the species, the total basal area was 3.292 m²/ha. The importance value index IVI was 75.51, 54.16 and 51.09 for *Leucaena leucocephala*, *Acacia catechu* and *Ficus palmata*, respectively.

In Bhatora village total of 15 tree species were observed out of which the highest density (14.67 ind/ha) was for *Grewia optiva*, whereas *Phyllanthus emblica*, *Pinus roxburghii* and *Jacaranda mimosifolia* has the lowest density (0.33 ind/ha) (Table 2). Further, the highest frequency (60%) was observed for *Leucaena leucocephala* and *Phyllanthus emblica* whereas the lowest was 3.33% for *Pinus roxburghii* and *Jacaranda mimosifolia*. The data pertaining to IVI revealed that a mixed community with codominance of *Grewia optiva* and *Leucaena leucocephala* with IVI values of 99.92 and 93.69 was observed. In Parlog village 14 tree species were

recorded out of which *Grewia optiva* has the highest density of 13 individual/ha, whereas the *Phoenix sylvestris* sowed lowest density (0.33/ha) (Table 3). The highest frequency and total basal area were observed for *Grewia optiva* (46.67%, 2.363 m²/ha) and the lowest (3.33%, 0.001 m²/ha) was observed for *Phoenix sylvestris*. The most dominant species *Grewia optiva* (80.10) followed by *Leucaena leucocephala* and *Ficus palmata* respectively (Fig. 2).

The vegetation analysis of tree species from the selected villages in the vicinity of the sunni hydro-power dam area revealed that among selected villages the highest number of tree species was in Bathora whereas the lowest in Parlog. The tree density was highest for village Parlog and lowest in Khaira. The total basal cover was highest in Bathora. Similar

study on phytosociological assessment of species has also been carried out in previous years wherein tree density of sub-tropical region ranges between 0.64-300 ind/ha (Sharma and Samant 2013, Kanwal and Joshi 2015, Dhiman et al 2020, Mohapatra et al 2020). However, the importance value index of tree species revealed that *Leucaena leucocephala*, *Acacia catechu* and *Ficus palmata*, *Leucaena leucocephala* and *Grewia optiva* were the most dominant communities in Parlog, Bathora and Khaira. The highest loss of trees was in Khaira and *Leucaena leucocephala* was the most affected community in study area.

Phytosociological description of shrub species:

The seven shrub species were recorded in the Khaira village (Table 4). *Lantana camara* has the highest density of

Table 1. Phytosociological description of tree species in Khaira village

Trees	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Acacia catechu</i>	6.67	30.00	0.693	1.45	15.56	15.12	23.48	54.16
<i>Bombax ceiba</i>	1.33	10.00	0.040	0.44	3.51	4.76	3.47	11.74
<i>Celtis australis</i>	2.67	13.33	0.097	1.33	6.10	6.85	2.56	15.51
<i>Dalbergia sissoo</i>	0.67	6.67	0.006	0.33	1.75	3.17	0.50	5.43
<i>Ficus palmata</i>	6.67	26.67	0.902	1.64	15.91	15.68	19.51	51.09
<i>Grewia optiva</i>	7.67	30.00	0.388	2.61	18.34	16.44	12.59	47.37
<i>Leucaena leucocephala</i>	10.33	43.33	1.032	2.37	25.10	23.78	26.63	75.51
<i>Phoenix sylvestris</i>	1.67	6.67	0.003	0.83	4.17	4.17	0.07	8.40
<i>Phyllanthus emblica</i>	1.00	6.67	0.007	0.50	2.63	3.17	0.57	6.38
<i>Toona ciliata</i>	2.67	13.33	0.125	1.33	6.93	6.85	10.64	24.42
Total	41.33	18.67	3.292	1.28	100.00	100.00	100.00	300.00

Table 2. Phytosociological description of tree species in Bathora village

Trees	D	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Ailanthus excelsa</i>	2.67	13.33	0.067	1.33	5.75	5.68	1.37	12.79
<i>Bauhinia variegata</i>	1.67	6.67	0.049	0.83	3.27	2.78	0.72	6.77
<i>Bombax ceiba</i>	2.67	20.00	0.064	0.89	5.13	7.87	0.86	13.86
<i>Butea monosperma</i>	1.33	10.00	0.015	0.83	2.90	4.13	0.31	7.34
<i>Ficus auriculata</i>	0.67	6.67	0.007	0.33	1.31	2.78	0.11	4.19
<i>Ficus palmata</i>	1.67	13.33	0.031	0.78	3.37	5.62	0.47	9.46
<i>Grewia optiva</i>	14.67	53.33	4.377	2.74	29.59	21.60	48.73	99.92
<i>Jacaranda mimosaeifolia</i>	0.33	3.33	0.001	0.33	0.76	1.45	0.01	2.22
<i>Leucaena leucocephala</i>	14.33	60.00	3.970	2.50	28.91	24.13	40.66	93.69
<i>Mallotus philippensis</i>	3.33	16.67	0.218	1.58	7.26	7.19	4.62	19.07
<i>Phoenix sylvestris</i>	1.67	10.00	0.023	1.17	3.40	3.92	0.25	7.57
<i>Phyllanthus emblica</i>	0.33	3.33	0.0003	0.33	0.65	1.39	0.003	2.05
<i>Pinus roxburghii</i>	0.33	3.33	0.004	0.33	0.63	1.23	0.03	1.89
<i>Syzygium cumini</i>	0.67	6.66	0.001	1.08	1.28	2.62	0.01	3.92
<i>Toona ciliata</i>	3.00	20.00	0.294	0.87	5.79	7.62	1.85	15.26
Total	49.33	16.44	9.122	1.06	100.00	100.00	100.00	300.00

78.33 individual/ha, whereas lowest was of *Berberis lyceum* (2.67 ind/ha). Moreover, the species abundance was highest (16.03) for *Lantana camara* and was lowest 1.50 for *Agave Americana*. Moreover, IVI values revealed that *Lantana camara* was most dominant species with an IVI value of 167.21. In Bathora village 13 shrub species were recorded (Table 5) and *Lantana camara* was the highly dens community with 41.67 individual/ha, whereas *Agave cantala*, *Opuntia monacantha* and *Punica granatum* (0.67/ha) has the lowest density. The IVI value revealed a mixed associated community of *Lantana camara*, *Adhatoda vasica* and *Murraya koenigii* was most dominant species with IVI value of 71.18, 70.24, 58.20, respectively. In Parlog village total of 14 species were recorded (Table 6). The highest density of 54.00 ind/ha was observed in the case of *Lantana camara* whereas *Punica granatum* recorded the lowest (0.67 ind/ha). The data pertaining to IVI revealed that mixed associated community of *Lantana camara* and *Adhatoda vasica* was

recorded with IVI value of 95.48, 70.57, respectively.

The phytosociological assessment of the shrub species revealed that among the selected villages the highest number of shrub species were in village Parlog, whereas the lowest in Khaira. Further, village Parlog have the highest shrub density, whereas lowest in Khaira. A similar study regarding the phytosociological assessment of species has also been carried out wherein it was reported that the shrub density of sub-tropical areas ranges between 0.2-500 ind/ha. (Kanwal and Joshi 2015, Dhiman et al 2020) However, the importance value index of tree species indicated that *Lantana camara*, *Adhatoda vasica* and *Murraya koenigii*, *Lantana camara-Adhatoda vasica* and *Cynodon dactylon*, *Cenchrus ciliaris* and *Saccharum spontaneum* were the most dominant communities recorded from village Parlog, Bathora and Khaira, respectively. Thus, it can be concluded from the present investigation that greater loss of shrubs was associated with village Parlog and *Lantana camara* and

Table 3. Phytosociological description of tree species in Parlog village

Trees	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Ailanthus excelsa</i>	4.67	20.00	0.140	2.50	7.33	7.69	2.71	17.73
<i>Bombax ceiba</i>	3.33	16.67	0.271	1.78	5.09	6.54	5.39	17.02
<i>Dalbergia sissoo</i>	4.33	23.33	0.504	1.94	7.03	9.13	3.81	19.97
<i>Eriobotrya japonica</i>	2.67	10.00	0.214	0.89	3.76	3.45	2.77	9.97
<i>Ficus auriculata</i>	3.33	20.00	0.042	1.89	5.77	7.80	1.09	14.66
<i>Ficus benghalensis</i>	2.00	6.67	0.021	0.67	2.84	2.48	0.30	5.63
<i>Ficus palmata</i>	8.33	26.67	0.253	2.11	13.06	10.28	4.86	28.20
<i>Grewia optiva</i>	13.00	46.67	2.363	2.77	20.62	17.97	41.51	80.10
<i>Leucaena leucocephala</i>	11.33	33.33	1.283	3.47	18.47	13.00	30.34	61.82
<i>Mallotus philippensis</i>	2.67	13.33	0.033	2.17	4.57	5.02	1.11	10.71
<i>Phoenix sylvestris</i>	0.33	3.33	0.001	0.33	0.47	1.15	0.00	1.62
<i>Phyllanthus emblica</i>	0.67	6.67	0.001	0.67	0.97	2.48	0.01	3.46
<i>Syzygium cumini</i>	2.00	13.33	0.047	1.00	3.32	5.44	1.03	9.80
<i>Toona ciliata</i>	4.00	20.00	0.246	2.28	6.70	7.56	5.06	19.32
Total	62.67	18.57	5.419	1.75	100.0	100.00	100.00	300.00

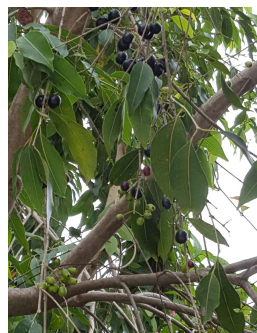
Table 4. Phytosociological description of shrub species in Khaira village

Shrubs	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Agave americana</i>	3.00	20.00	0.012	1.50	2.25	12.56	0.14	14.95
<i>Berberis lycium</i>	2.67	16.67	0.003	1.67	1.98	10.17	0.04	12.19
<i>Berberis vulgaris</i>	6.67	6.67	0.083	3.33	4.27	3.03	0.85	8.15
<i>Carissa carandas</i>	5.33	20.00	0.033	1.78	4.00	11.69	0.32	16.01
<i>Lantana camara</i>	78.33	50.00	7.443	16.03	58.73	30.52	77.96	167.21
<i>Murraya koenigii</i>	23.67	36.67	1.336	6.13	17.51	21.86	12.97	52.35
<i>Zanthoxylum armatum</i>	15.00	16.67	0.529	5.56	11.25	10.17	7.72	29.14
Total	134.67	23.81	9.439	5.14	100.00	100.00	100.00	300.00

Adhatoda vasica were the most affected community recorded from the study area.



A. *Gravia optiva*



B. *Syzygium cumini*



C. *Acacia catechu*



D. *Phyllanthus emblica*



E. *Leucaena leucocephala*



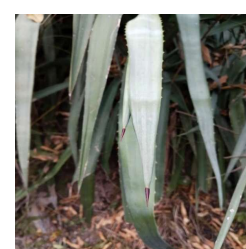
F. *Ficus auriculata*

Phytosociological description of herbaceous species

The survey of herbaceous species was also conducted in selected villages of dam catchment. The vegetation analysis of herbaceous species of Khaira village revealed that 12 herbaceous species. Out of the total species *Cynodon dactylon* has highest (190.25 ind/ha) density whereas the lowest (0.83 ind/ha) was for *Bambusa bambos* (Table 7). The IVI value revealed that mixed associated community of *Cynodon dactylon*, *Cenchrus ciliaris* and *Saccharum spontaneum* was with the IVI value of 90.84, 44.84, 44.49, respectively. The total of 18 species were recorded in Bathora village, among different species, the highest density of 74.50 ind/ha was for *Parthenium hysterophorus* whereas



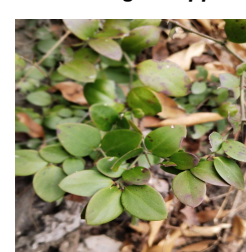
A. *Adhatoda vasica*



B. *Agave spp.*



C. *Punica granatum*



D. *Carissa carandus*

Fig. 2. Tree species recorded in the study area

Fig. 3. Shrub species recorded in the study area

Table 5. Phytosociological description of shrub species in Bathora village

Shrubs	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Adhatoda vasica</i>	38.67	23.33	2.209	17.56	22.85	11.82	35.58	70.24
<i>Asparagus racemosus</i>	3.67	6.67	0.001	3.67	2.21	3.41	0.03	5.65
<i>Berberis vulgaris</i>	14.33	13.33	0.135	7.17	8.97	6.07	4.81	19.86
<i>Agave cantala</i>	0.67	3.33	0.001	0.67	0.45	1.45	0.03	1.93
<i>Dodonaea viscosa</i>	4.33	6.67	0.004	2.17	2.37	3.92	0.04	6.33
<i>Euphorbia royleana</i>	9.33	20.00	0.106	2.75	5.55	9.25	3.07	17.87
<i>Lantana camara</i>	41.67	40.00	1.259	10.36	24.35	20.13	26.71	71.18
<i>Murraya koenigii</i>	28.00	40.00	0.839	7.00	16.78	19.99	21.43	58.20
<i>Opuntia monacantha</i>	0.67	3.33	0.001	0.67	0.45	1.45	0.04	1.93
<i>Punica granatum</i>	0.67	6.67	0.003	0.33	0.45	2.90	0.14	3.48
<i>Vitex negundo</i>	7.33	10.00	0.023	2.44	4.24	4.76	0.66	9.66
<i>Zanthoxylum armatum</i>	18.00	23.33	0.447	7.67	10.68	11.96	7.07	29.71
<i>Ziziphus mauritiana</i>	1.00	6.67	0.010	0.50	0.67	2.90	0.38	3.95
Total	168.33	15.64	5.038	4.84	100.00	100.00	100.00	300.00

lowest (0.83 ind/ha) for *Bambusa bambos*. The IVI value revealed *Parthenium hysterophorus* and *Saccharum spontaneum* were most dominant species respectively (Table 8). In village Parlog total of 14 species of herbs were observed and the highest density (79.92 ind/ha) was observed for *Cynodon dactylon* whereas the lowest density (4.50 ind/ha) was for *Mentha sylvestris*. The IVI value was higher for *Parthenium hysterophorus*, *Cynodon dactylon* and *Saccharum spontaneum* in Parlog (Table 9) (Fig. 4).

The phytosociological assessment of the herbaceous species revealed that highest number of herbaceous species

was in village Bathora, whereas lowest in Khaira. Further, village Khaira have the highest herb density, whereas the lowest in Bathora. Similar study regarding the phytosociological assessment of also reported that the herb density of sub-tropical area ranges between 2-500 ind/ha (Sharma and Samant 2013, Shah and Mir 2019, Singh et al 2019, Singh and Devi 2020). However, the importance value index of herb species revealed that *Cynodon dactylon*-*Cenchrus ciliaris* and *Saccharum spontaneum*-*Parthenium hysterophorus* and *Saccharum spontaneum*-*Parthenium hysterophorus*-*Cynodon dactylon*, and *Saccharum*

Table 6. Phytosociological description of shrub species in Khaira village

Shrubs	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Adhatoda vasica</i>	31.33	30.00	3.858	10.47	20.00	15.23	35.33	70.57
<i>Asparagus racemosus</i>	7.00	13.33	0.037	1.75	5.31	6.41	2.53	14.25
<i>Berberis vulgaris</i>	9.00	6.67	0.161	4.50	1.98	3.85	3.16	8.98
<i>Desmodium elegans</i>	10.33	6.67	0.032	5.17	2.59	5.13	0.71	8.43
<i>Ipomoea carnea</i>	2.67	3.33	0.001	2.67	0.99	1.28	0.03	2.30
<i>Lantana camara</i>	54.00	53.33	6.715	9.22	27.64	22.06	45.78	95.48
<i>Lonicera angustifolia</i>	13.00	3.33	0.125	13.00	3.83	2.56	3.29	9.68
<i>Murraya koenigii</i>	15.67	30.00	0.313	5.93	13.89	13.76	4.56	32.22
<i>Punica granatum</i>	0.67	6.67	0.003	0.33	0.54	3.70	0.03	4.27
<i>Rubus ellipticus</i>	12.00	10.00	0.047	4.00	9.68	5.56	0.42	15.65
<i>Vitex negundo</i>	19.67	13.33	0.089	9.83	8.86	6.07	2.30	17.23
<i>Woodfordia fruticose</i>	6.67	13.33	0.004	3.33	2.91	6.27	0.13	9.30
<i>Zanthoxylum armatum</i>	5.33	10.00	0.098	1.78	0.99	2.56	1.62	5.17
<i>Ziziphus mauritiana</i>	1.00	10.00	0.013	0.33	0.81	5.56	0.11	6.48
Total	188.33	15.00	11.496	5.17	100.00	100.00	100.00	300.00

Table 7. Phytosociological description of herbaceous species in Khaira village

Herbs	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Adhatoda zeylinica</i>	17.67	28.33	0.091	6.33	3.66	13.66	3.24	20.55
<i>Bambusa bambos</i>	0.83	3.33	0.001	0.83	0.22	1.80	0.05	2.07
<i>Cannabis sativa</i>	34.00	15.00	0.354	14.83	5.55	6.43	6.42	18.40
<i>Cenchrus ciliaris</i>	81.33	21.67	1.242	41.17	15.52	9.74	19.57	44.84
<i>Cynodon dactylon</i>	190.25	35.00	5.736	59.33	33.11	14.13	43.61	90.84
<i>Martynia annua</i>	11.42	21.67	0.060	4.50	2.03	7.47	1.11	10.60
<i>Oxalis corniculata</i>	17.50	11.67	0.021	5.00	4.53	6.31	0.86	11.70
<i>Parthenium hysterophorus</i>	8.75	5.00	0.078	5.83	2.26	2.70	3.18	8.15
<i>Rumex hastatus</i>	7.75	5.00	0.023	5.17	2.01	3.57	1.01	6.60
<i>Saccharum spontaneum</i>	106.08	25.00	0.766	40.33	18.89	11.28	14.33	44.49
<i>Sida cordata</i>	24.50	10.00	0.041	16.33	6.35	6.27	1.76	14.39
<i>Tinospora cordifolia</i>	9.17	16.67	0.033	1.83	1.10	4.76	0.16	6.02
<i>Urtica dioica</i>	25.17	26.67	0.152	9.50	4.76	11.88	4.70	21.35
Total	534.42	17.31	8.598	16.23	100.00	100.00	100.00	300.0

spontaneum were the most dominant communities recorded from village Khaira, Bathora and Parlog. This indicates greater loss of herbaceous layer was associated with village Bathora and *Parthenium hysterophorus* were the most affected species.

Status of species diversity and concentration dominance of different plant species

The Shannon diversity index (h') for the tree species was highest in Parlog village (2.2) whereas the lowest (1.66) was in village Khaira. However, the highest shrub diversity (1.81)

Table 8. Phytosociological description of herb species in Bathora village

Herbs	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Achyranthes bidentata</i>	14.50	5.00	0.038	9.67	4.72	3.23	0.83	8.78
<i>Adhatoda zeylinica</i>	8.83	6.67	0.023	8.83	2.60	3.82	0.47	6.89
<i>Bambusa bambos</i>	0.83	3.33	0.001	0.83	0.22	1.67	0.01	1.90
<i>Cenchrus ciliaris</i>	50.08	18.33	0.582	28.17	15.54	10.52	10.94	37.00
<i>Cynodon dactylon</i>	20.33	3.33	0.089	20.33	5.29	1.67	1.50	8.46
<i>Dactyloctenium aegyptium</i>	12.83	11.67	0.157	3.67	3.34	5.83	2.66	11.83
<i>Dicanthium annulatum</i>	6.67	8.33	0.027	2.67	2.17	5.38	0.59	8.14
<i>Erigeron annuus</i>	11.33	15.00	0.016	7.67	3.54	8.88	0.34	12.76
<i>Eupatorium adenophorum</i>	2.50	8.33	0.001	1.00	1.05	5.21	0.03	6.16
<i>Martynia annua</i>	5.00	8.33	0.005	4.17	1.46	4.65	0.10	6.22
<i>Mellisa officinalis</i>	6.17	3.33	0.007	6.17	2.26	2.08	0.17	4.51
<i>Mentha sylvestris</i>	3.33	3.33	0.003	3.33	0.87	1.67	0.06	2.59
<i>Mirabilis jalapa</i>	5.50	5.00	0.009	3.67	2.02	3.13	0.22	5.36
<i>Oxalis corniculata</i>	17.50	8.33	0.015	7.00	6.42	5.21	0.36	11.99
<i>Parthenium hysterophorus</i>	74.50	28.33	2.764	26.17	24.03	16.87	60.88	101.78
<i>Saccharum spontaneum</i>	65.67	20.00	1.009	32.83	19.90	11.80	18.72	50.41
<i>Sida cordata</i>	11.08	11.67	0.118	9.50	3.46	6.73	2.03	12.23
<i>Urtica dioica</i>	4.83	3.33	0.005	4.83	1.26	1.67	0.08	3.00
Total	321.50	9.54	4.869	10.03	100.13	100.00	100.00	300.0

Table 9. Phytosociological description of herb species in Parlog village

Herbs	D (ind/ha)	F (%)	TBA (m ² /ha)	A	RD (%)	RF (%)	RBA (%)	IVI
<i>Achyranthes bidentata</i>	45.83	23.33	0.366	18.83	13.02	14.10	4.98	32.11
<i>Adhatoda zeylanica</i>	11.00	11.67	0.032	6.33	2.45	6.20	0.34	8.99
<i>Cannabis sativa</i>	8.83	3.33	0.058	8.83	1.57	1.71	0.46	3.74
<i>Cenchrus ciliaris</i>	46.83	13.33	0.688	22.33	9.66	7.05	6.24	22.95
<i>Cynodon dactylon</i>	79.92	11.67	3.164	22.83	14.18	5.98	25.26	45.42
<i>Dactyloctenium aegyptium</i>	9.33	6.67	0.024	4.67	2.59	3.70	0.33	6.62
<i>Erigeron annuus</i>	22.83	18.33	0.085	8.50	7.96	12.32	1.51	21.79
<i>Martynia annua</i>	5.33	10.00	0.004	5.33	1.61	6.13	0.05	7.80
<i>Mentha sylvestris</i>	4.50	3.33	0.007	4.50	0.80	1.71	0.06	2.56
<i>Oxalis corniculata</i>	8.75	5.00	0.007	5.83	1.55	2.56	0.06	4.17
<i>Parthenium hysterophorus</i>	51.50	21.67	3.017	16.00	18.48	14.53	48.69	81.70
<i>Saccharum spontaneum</i>	55.50	20.00	0.674	28.00	15.71	11.82	8.37	35.91
<i>Synedrella nodiflora</i>	27.42	15.00	0.186	17.67	9.57	9.61	3.53	22.71
<i>Urtica dioica</i>	4.75	5.00	0.015	3.17	0.84	2.56	0.12	3.53
Total	382.33	12.02	8.327	12.35	100.00	100.00	100.00	300

Table 10. Status of species diversity and concentration dominance of different plant species in the study area

Villages	Species diversity (h)			Concentration of dominance (cd)		
	Trees	Shrubs	Herbs	Trees	Shrubs	Herbs
Khaira	1.66	1.13	1.83	0.20	0.41	0.19
Bathora	1.79	1.81	1.98	0.21	0.18	0.16
Parlog	2.2	1.63	1.81	0.13	0.26	0.2
Mean	1.88	1.52	1.87	0.18	0.29	0.18

**A. *Mirabilis jalapa*****B. *Parthenium hysterophorus*****C. *Synedrella nodiflora*****Fig. 4.** Herbaceous species recorded in the study area

was in Bathora village whereas lowest (1.13) in Khaira. For the herb layer, the highest (1.98) diversity was in Bathora whereas the lowest (1.81) in Parlog. The highest value of simpson's index (0.21) for the trees was in Bathora whereas the lowest (0.13) was in Parlog. Simpson's value for shrubs was highest (0.41) in village Khaira whereas lowest (0.18) in Bathora. For the herb layer, Parlog has the highest value (0.20) whereas the lowest Simpson index (0.16) was in Bathora (Table 10). The diversity was highest for trees whereas it was lowest for shrubs. Similarly, the level of dominance was higher for shrubs and lowest for trees and herbs. Similar study regarding the phytosociological assessment of species was carried out, wherein reported that the tree species diversity ranged between 0.9-2.59, shrub species diversity ranged between 1.0-4.0 and the herb species diversity ranged between 0.9- 3.0. Further the dominance ranged between 0.13-0.40 for trees, 0.08-0.41 for shrubs and 0.03-0.40 for herbs (Mohapatra et al 2020, Dhiman et al 2020, Shah and Mir 2019, Singh and Devi 2020).

CONCLUSION

The vegetational analysis of the proposed Sunni hydroelectric project area revealed that overall, 20 trees, 21 shrubs and 21 herbaceous species were recorded from the study area. The area with the highest floristic diversity and density will have a greater risk of being affected after the dam construction. This study would be considered a supportive tool for compensatory afforestation planning as well as baseline for any further research in this area.

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