COMPARATIVE ANALYSIS OF VEGETATION FROM ERODED AND NON-ERODED AREAS, A CASE STUDY FROM KASHMIR HIMALAYAS, PAKISTAN

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Abstract. Soil erosion negatively affects vegetation that brings deteriorating changes in the structure and composition of plant communities. Present study investigated the impact of soil erosion on vegetation along Jhelum valley road District Muzaffarabad, Azad Jammu and Kashmir. Phytosociological attributes were measured by using quadrat method. Geographical characters of each site were recorded including slope, aspect and elevation of eroded sites. Five sites were selected three were disturbed and two were used as control sites for general comparison. At disturbed sites Average Shannon diversity was 2.47; Simpson diversity was 0.94; Species richness was1.75; Evenness was 0.7. At control sites. Average Shannon diversity was 2.95; Simpson diversity was 0.97; Species richness was 2.02; Evenness was 0.72. Maximum similarity was 66.13 recorded between Control site 1 and Control site 2 while minimum similarity was 22.98 recorded between disturbed site 1 and Control site 1. There was a general trend of low diversity of trees and shrubs at disturbed sites as compared to control sites. Therophytes were dominant at disturbed site and regeneration pattern was high at disturbed sites. A total of 99 plants representing 91 genera belonging to 45 families were recorded from investigated area. The dominant family was Poaceae followed by Asteraceae, Lamiaceae and Rosaceae. At disturbed sites Shannon diversity was 2.47; Simpson diversity was 0.94; Species richness was1.75; Evenness was 0.7. At control sites Shannon diversity was 2.95; Simpson diversity was 0.97; Species richness was 2.02; Evenness was 0.72. At control sites, more diversity and richness was observed as compared to disturbed sites.
Keywords: *soil erosion, vegetation disturbance, vegetation regime, roadside vegetation pattern, Himalayas, anthropogenic impacts*

Introduction

The process of detachment of soil particles from soil surface and their deposition elsewhere is known as soil erosion. It reduces the productivity of soil in several ways; it decreases the water holding capacity, reduces the efficiency of plant nutrients, damage seedlings, decrease plant rooting depth, increase runoff and reduces its infiltration rates (Pimentel, 2006). Soil erosion has major effects on species composition, seed density and distribution of soil seed bank (Blaikie, 2016; Cheng et al., 2006). Soil erosion

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occurs when the soil is left exposed to rain energy. Raindrops hit bare soil with great energy and easily displace the soil particles from the surface. In this way raindrops remove a thin layer of soil from land surface and generate sheet erosion (Oldeman, 1997). Rainfall energy is the cause of erosion from bare land, occurring when the soil lacks protective vegetation cover. The main cause for erosion is due to deforestation, improper treatment of catchment and other anthropogenic activities (Mahabaleshwara and Nagabhushan, 2014).

During erosion process organic matter and essential plant nutrients are detached and soil depth is reduced. These changes not only reduce vegetative growth but also reduce the presence of precious biota and overall biodiversity and soil loss (Pimentel et al., 1995). Eroded soil carries away very important plant nutrients such as nitrogen, phosphorous, potassium and calcium. Typically, eroded soil contains about 3 times more nutrients than are left in the remaining soil (Lieskovský and Kenderessy, 2014; Pimentel, 2006). Vegetation or plant cover reduces the soil erosion, its effectiveness depending upon the height and continuity of canopy, density of ground cover and root density. Forests are most effective in reducing erosion because of their canopy and dense grass (Zuazo and Pleguezuelo, 2009). The Plant cover protects soil against erosion by reducing water runoff (Puigdefábregas, 2005; Rey, 2003). Soil erosion is a physical stress affecting vegetation development and also is controlled by the response of vegetation (Shihong et al., 2003). Soil erosion can reduce soil water holding capacity and nutrients availability to inhibit the vegetation regeneration and succession and decrease vegetation cover and species richness at any disturbed site (Guerrero-Campo and Montserrat-Martí, 2004). Soil erosion is not only a negative factor on vegetation, but it is also the driving force of vegetation development and succession at any disturbed site. Effect of soil erosion on vegetation begins at the formation and development of seed and runs through the whole process of plant growth through effects on seed availability, seed redistribution, seed germination. Seeds are the foundation stone of vegetation processes of colonization Different erosion environment has showed that soil erosion is main cause of reduced cover, decrease species richness and slowed succession (Guerrero-Campo and Montserrat-Martí, 2000; Zhou et al., 2016).

The vegetation of Himalayas is highly disturbed by landslides and erosion and this phenomenon is mostly linked with diverse human activities, such as the construction of roads and buildings and removal of forests. An overall erosion impact from earthquakes is comparatively minimal mainly because these events are relatively rare. Natural phenomenon that caused erosion such as exceptional rains, earthquakes and glacial lake outburst flooding in the high Himalayas are common (Shrestha, 1997). The objective of the current study were to assess the impact of soil erosion on vegetation degradation in the investigated area, to investigate the causes of soil erosion and effects of environmental factors influencing the vegetation and compare the species diversity on eroded and control sites.

Material and Methods

This study was conducted to study impact of erosion along roadsides. Study area lies in district Muzaffarabad, the capital of the state of Azad Jammu and Kashmir situated between 34.24° latitude and 73.22° longitude in north-east of Pakistan (*Fig. 1*). The climate of the area falls under sub-tropical and humid type and varies considerably. The maximum temperature of the area recorded in the summer is 40.0 to 47.5°C and

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minimum is 28.0 to 37.5°C respectively. The maximum temperature of the area recorded in the winter is 15.0 to 21.5°C and minimum is −3.0 to −1.0°C. The average annual precipitation of the district is 1511 mm. Maximum rain fall recorded in the month of July as 288.03mm whereas minimum rainfall recorded in the month of October as 36.21mm. Average relative humidity value with maximum value 76.81% and minimum value is 44.57% (PAK-MET, 2012).

Figure 1. *Map of Study area and satellite imagery of the sampling sites*

This study was designed to assess vegetation cover of 3 disturbed sites and two undisturbed sites were selected nearby the disturbed site to act as control sites for comparative analysis. Quadrat method was used for vegetation sampling. The vegetation was sampled in three layers i.e., trees, shrubs and herbs. Quadrat size used for trees layer was 10×10, for shrubs layer 5×5 and 1×1for herb layer (Fosaa, 2004). The diversity index for all the three layers tree, shrub and herb at each site was computed by Shannon-Wiener information index and dominance by Simpson's index (Ahmed et al., 2006). The vegetation data was quantitatively analyzed for abundance, density, cover and frequency. Altitude, latitude and longitude of each selected sites were recorded by using a Garmin 200 global positioning system (GPS). The Multivariate ordination techniques were applied for statistical analysis of the results. Data was subjected to PCA and Cluster analysis (Ter Braak and Smilauer, 2002).

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Results

A total of 99 species representing 91 genera belonging to 45 families were recorded. The major contributors of local flora included *Poaceae* with 11 species, followed by *Asteraceae* with 9 species, *Lamiaceae* with 6 species, *Rosaceae* had 5 species. *Cyperaceae* and *Fabaceae* with 4 species each, *Amaranthaceae*, *Verbeneceae*, *Euphorbiaceae*, *Malvaceae* and *Polygonaceae*, *Pteridaceae* with 3 species whereas *Apocynaceae*, *Brassicaceae*, *Oleaceae*, *Salicaceae*, *Lythraceae*, *Anacardiaceae*, *Solanaceae* and *Rhamaceae* were represented by 2 species. The remaining families had single representative (*Table 2*). At disturbed sites the dominant species according to their Importance value were *Arundo donax* (12.22) and *Justicia adhatoda* (10.94), Aristida *purpurea (7.01), Xanthium strumarium* (7.01), *Euphorbia hirta* (9.08) (*Table 1*). At control sites the dominant species were *Pinus roxburgii* (2.79), *Ficus palmata* (2.00), *Indigofera heterantha* (3.13), *Zanthoxylum armatum* (2.15), *Conyza bonariensis* (8.12) and *Cynodon dactylon* (7.72). Therophytes were the dominant life form class having a percentage of 29.2% and Microphylls with a percentage of 35.3. At disturbed sites average Shannon diversity was 2.47; Simpson diversity was 0.94; species richness was 1.75; evenness was 0.7. At control sites average Shannon diversity was 2.95; simpson diversity was 0.97; species richness was 2.02; evenness was 0.72. Maximum similarity was 66.13 recorded between control site 1 and control site 2 while minimum similarity was 22.98 recorded between disturbed site 1 and control site 1 (*Table 3*).

Aristida- Themeda- Cyperus Community was located in Subri at an altitude of 815 m and was classified as a disturbed site having a total of 22 species. The slope of the stand was about 30^0 to 60^0 (class 2). The site was located at east facing aspect. The dominant species were *Aristida purpurea* having IVI value of 35.08 followed by *Themeda anathera* having IVI value of 32.62 and *Cyperus exaltatus* having IVI value of 26.15. The codominant species was *Arudo donax* having IVI values of 23.75. Simpson and Shannon diversity values of community were 0.91 and 2.19 respectively, species richness; 1.20, species evenness; 0.70 and maturity index was 41.81 (*Table 2*). In the community 5 seedlings of *Alianthus altissima* and 1 seedling of *Pistacia integerrima*, 1 seedling of *Dalbergia sissoo* and 1 seedling of *Mallotus philippensis* were recorded.

Table 1. *Importance Value Index (IVI) recorded from the investigated area*

No.	Botanical name	Site 1	Site 2	Site 3	Site 4	Site 5	Av. IVI
1	*Acacia arabica*	0	0	0	5.54	3.124	1.73
2	*Achyranthes aspera*	0	0	0	5.18	0	1.03
3	*Adiantum venustum*	0	0	7.9	0	5.861	2.75
4	*Adiantum caudatum*	0	0	8.2	0	0	1.64
5	*Ajuga bracteosa*	0	3.25	10.31	1.58	0	3.02
6	*Alianthus altissima*	0	0	0	3.68	6.283	1.99
7	*Amaranthus viridis*	0	0	4.8	4.13	2.959	2.37
8	*Aristida purpurea*	35.08	0	0	0	0	7.01
9	*Arundo donax*	23.75	29.74	0	7.62	0	12.22
10	*Avena sativa*	0	0	0	7.66	1.58	1.84
11	*Bauhinia variegata*	0	0	0	3.6	0	0.72
12	*Berberis lycium*	0	0	0	4.37	7.767	2.42
13	*Bidens pilosa*	12.41	7.02	5.97	0	7.046	6.48
14	*Callicarpa macrophylla*	0	8.39	0	0	0	1.67

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15	*Calotropis gigantea*	0	0	3.86	0	0	0.77
16	*Cannabis sativa*	0	0	2.3	0	6.584	1.77
17	*Capsella-bursa pastoris*	0	0	0	3.16	3.823	1.39
18	*Carissa opaca*	0	0	6.24	3.25	0	1.95
19	*Celtis eriocarpa*	0	0	0	1.28	0	0.25
20	*Chenopodium album*	0	6	3.33	5.61	7.198	4.42
21	*Cichorium intybus*	0	4.85	2.06	2.79	2.198	2.37
22	*Cirsium arvense*	0	7.09	0	1.8	3.132	2.40
23	*Conyza bonariensis*	8.47	6.17	6.87	11.6	7.523	8.12
24	*Cynodon dactylon*	0	13.79	6.07	4.28	14.472	7.72
25	*Cynoglossum lanceolatum*	5.66	4.85	2.3	4.13	6.254	4.63
26	*Cyperus exaltatus*	26.15	6.68	0	0	0	6.56
27	*Cyperus rotundus*	18.47	0	0	0	0	3.69
28	*Dalbergia sissoo*	0	0	0	2.91	0	0.58
29	*Desmodium elegans*	0	0	0	6.04	3.186	1.84
30	*Dichanthium annulatum*	0	3.42	6.2	5.29	0	2.98
31	*Diospyros lotus*	0	0	0	1.51	0	0.30
32	*Dodonaea viscosa*	11.33	15.49	6.79	0	11.242	8.97
33	*Duchesnea indica*	0	7.53	0	5.49	13.535	5.31
34	*Echinochloa colona*	0	0	0	4.8	0	0.96
35	*Elaeagnus umbellata*	0	0	0	4.5	0	0.9
36	*Eleocharis indica*	0	4.51	0	0	0	0.90
37	*Equisetum debile*	0	0	0	0	3.286	0.65
38	*Erioscirpus comosus*	0	6.34	0	0	0	1.26
39	*Euphorbia hirta*	0	6.85	13.22	0	2.497	4.51
40	*Euphorbia prostrata*	6.3	7.26	1.92	2.94	3.943	4.41
41	*Ficus palmata*	0	0	0	2.73	7.299	2.00
42	*Grewia villosa*	0	0	0	2.86	4.676	1.50
43	*Heteropogon controtus*	8.09	0	0	0	0	1.61
44	*Hibiscus rosa sinensis*	0	7.67	0	0	0	1.53
45	*Indigofera heterantha*	0	0	0	12.51	3.179	3.13
46	*Ipomoea eriocarpa*	0	4	0	0	0	0.8
47	*Jasminum officinale*	0	0	3.86	3.53	0	1.47
48	*Justcia adhatoda*	0	0	45.39	0	9.322	10.94
49	*Lantana camara*	0	0	10.07	0	0	2.01
50	*Lepidium bidentatum*	0	0	2.53	0	0	0.50
51	*Mallotus philippensis.*	0	0	0	5.46	1.559	1.40
52	*Malvastrum corommandelianum*	0	0	7.01	5.01	6.155	3.63
53	*Maytenus royleanus*	0	0	13	7.2	6.448	5.32
54	*Melia azedarach*	0	0	0	3.56	5.48	1.80
55	*Mentha royleana*	0	4.51	0	4.28	2.812	2.32
56	*Micromeria biflora*	0	0	9.98	3.59	6.9	4.09
57	*Morus alba*	0	0	0	3.33	3.146	1.29
58	*Myrisine africana*	0	0	0	5.5	0	1.1
59	*Nepeta erecta*	0	6.68	5.13	3.42	8.06	4.65
60	*Oenothera rosea*	9.72	4.85	2.3	3.04	7.142	5.41

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61	*Olea ferrugenia*	0	0	0	2.65	3.339	1.19
62	*Otostegia limbata*	0	0	7.73	0	0	1.54
63	*Oxalis corniculata*	0	10.08	9.65	7.03	10.934	5.57
64	*Parthenium hysterophorus*	0	15.6	2.96	6.99	3.579	5.82
65	*Persicaria barbata*	0	6.34	0	5.01	3.106	2.89
66	*Phlomis tuberosa*	0	6.04	0	0	0	1.20
67	*Phyllanthus fraternus*	0	6.68	4.47	1.93	0	2.61
68	*Pinus roxburghii*	0	0	0	9.11	4.876	2.79
69	*Pistacia integerrima*	0	0	0	0	3.88	0.77
70	*Plantago lanceolata*	0	0	0	2.31	0	0.46
71	*Populus alba*	0	0	0	3.83	3.995	1.56
72	*Pteris cretica*	6.72	0	0	0	2.344	1.81
73	*Punica granatum*	17.24	0	7.26	5.86	6.053	7.28
74	*Pyrus pashia*	0	0	0	3.15	3.558	1.34
75	*Rhus cotinus*	16.74	0	3.39	5.7	0	5.16
76	*Rosa macrophylla*	0	15.83	0	3.74	0	3.91
77	*Rubus ellipticus*	0	7.67	0	5.95	0	2.72
78	*Rubus fruticosus*	10.79	0	0	12.21	3.326	5.26
79	*Rumex hastatus*	10.79	0	0	0	1.726	2.50
80	*Rumex nepalensis*	0	4.92	0	3.16	4.865	2.59
81	*Saccharum spontaneum*	0	0	0	0	4.892	0.97
82	*Salix alba*	0	0	0	1.88	4.505	1.27
83	*Setaria pumila*	0	5.19	3.89	5.89	6.048	3.02
84	*Solanum nigrum*	0	5.83	2.16	0	2.05	2.00
85	*Solanum viriginianum*	0	0	1.92	0	0	0.38
86	*Sonchus asper*	6.3	0	1.26	3.27	0	2.25
87	*Sorghum halepense*	0	0	0	0	3.572	0.71
88	*Stellaria media*	0	0	4.27	0	0	0.85
89	*Tagetes minuta*	0	4.17	10.38	0	0	2.91
90	*Taraxacum officinale*	0	0	2.3	1.8	4.432	1.70
91	*Themeda anathera*	32.62	0	3.89	0	0	7.30
92	*Trifolium repens*	0	5.36	0	6.4	0	2.35
93	*Verbascum thapsus*	0	4.34	1.03	0	0.787	1.23
94	*Verbena tenuisecta*	0	0	4.1	4.17	1.946	2.04
95	*Woodfordia fruticosa*	0	0	6.71	0	0	1.34
96	*Xanthium strumarium*	7.19	24.76	9.89	0	3.602	9.08
97	*Zanthoxylum armatum*	0	0	7.26	3.5	0	2.15
98	*Ziziphus jujuba*	10.79	0	0	3.04	2.666	3.29
99	*Ziziphus oxyhylla*	0	0	7.26	4.24	2.519	2.80

Arundo-Xanthium-Rosa Community was located in Subri at an altitudinal range of 732m and was classified as a disturbed site comprising 37 species. The slope of the stand was about 0° to 30° (class 1). The site was located at west facing aspect. The dominant species of the stand were *Arundo donax* having IVI value of 29.74 followed by *Xanthium strumarium* having IVI value of 24.76, *Rosa macrophylla* having IVI

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value of 15.83. The co dominant species were *Dodonaea viscosa* and *Parthenium hysterophorus* having IVI value of 15.49 and 15.6 respectively. Average value of diversity recorded were 0.96 and 2.47, species richness; 1.61, species evenness; 0.68 and maturity index was 33.78 (*Table 1*) In the stand one seedling of *Populus alba* and *Dalbergia sissoo* and 2 seedlings of, *Morus alba* and *Acacia arabica* were recorded.

Justicia-Euphorbia-Maytenus Community was located in Lawasi at an altitudinal range of 740m and was classified as a disturbed site. It was. The latitude and longitude of the area were 34°22'501" N and 73°29'769" E comprises of 46 species. The slope of the stand was about 30° to 60° (class 2). The site was located at west facing aspect. The dominant species of the community were *Justicia adhatoda* having IVI value of 45.39 followed by *Euphorbia hirta* having IVI value of 13.22 and *Maytenus royleana* having IVI value of 13. The co dominant species were *Tagetes minuta*, *Ajuga bracteosa* and *Lantana camara* having IVI value of 10.38, 10.31 and 10.07 respectively. Average values of diversity index recorded in the community were Simpson's and Shannon diversity; 0.97 and 2.76 respectively, species richness; 2.46, species evenness; 0.72 and maturity index value was 32.39 (*Table 1*). Single seedling of *Melia azedarach*, *Grewia villosa*, *Dalbergia sissoo*, *Mallotus philippensis*, *Olea ferruginea*, *Celtis eriocarpa*, *Bauhinia variegata* were recorded in the area.

Indigofera-Rubus-Conyza Community was located in Sundgran at an altitudinal range of 760 m. and was classified as a control site. The latitude and longitude of the area were 34° 19'907" N and 073°30'299" E. Community comprises of 65 species. The slope of the stand was 0° to 30° (class 1). The site was located at east facing aspect. The dominant species of the stand was *Indigofera heterantha* having IVI value of 12.51 followed by *Rubus fruticosus* having IVI value of 12.21 and *Conyza bonariensis* having IVI value of 11.6. The co dominant species were *Pinus roxburgii* and *Avena sativa* having IVI values of 9.11 and 7.66 respectively. Average values of diversity index recorded for communities were 0.98 and 3.02, species richness; 2.06, species evenness; 0.74; and maturity index was 30.64 (*Table 2*).

Table 2. *Phytosociological parameters recorded from the investigated area*

Community	No. of species	Simpson diversity	Shannon diversity	Richness	Evenness	Maturity
Disturbed site 1	22	0.91	2.19	1.20	0.70	41.81
Disturbed site 2	37	0.96	2.47	1.61	0.68	33.78
Disturbed site 3	46	0.97	2.76	2.46	0.72	32.39
Average		0.94	2.47	1.75	0.7	35.99
Control site 1	65	0.98	3.02	2.06	0.74	30.64
Control site 2	59	0.97	2.88	1.98	0.70	39.41
Average		0.97	2.95	2.02	0.72	35.02
Average		0.95	2.71	1.88	0.71	35.50

Cynodon-Duchesnea-Zanthoxylum Community was located in Garhi dupata at an altitudinal range of 1199m and was classified as a control site. The latitude and longitude of the site were 34°15'867" and 73°34'650" respectively. Community comprises of 59 species. The slope of the stand was about 0° to 30° (class 1). The site was located at south facing aspect. The dominant species were *Cynodon dactylon* having IVI value of 14.472 followed by *Duchesnea indica* having IVI value of 13.535,

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Zanthoxylum armatum having IVI value of 11.608. The co dominant species were *Dodonaea viscosa* and *Oxalis corniculata* having IVI value of 11.242 and 10.932 respectively. Average values of diversity recorded for community were 0.97 and 2.88, species richness; 1.98, species evenness; 0.70 and maturity index value was 39.41 (*Table 2*).

Table 3. *Index of Similarity and Dissimilarity between the study sites*

Community	Disturbed site1	Disturbed site 2	Disturbed site 3	Control site 1	Control site 2	
Disturbed site 1	×	30.50	32.35	22.98	27.16	
Disturbed site 2	69.5	×	50.60	45.09	45.03	
Disturbed site 3	67.65	49.4	×	43.24	45.71	I.Ss
Control site 1	77.02	54.91	56.76	×	66.12	
Control site 2	72.84	54.97	54.29	33.88	×	
		I.Ds				

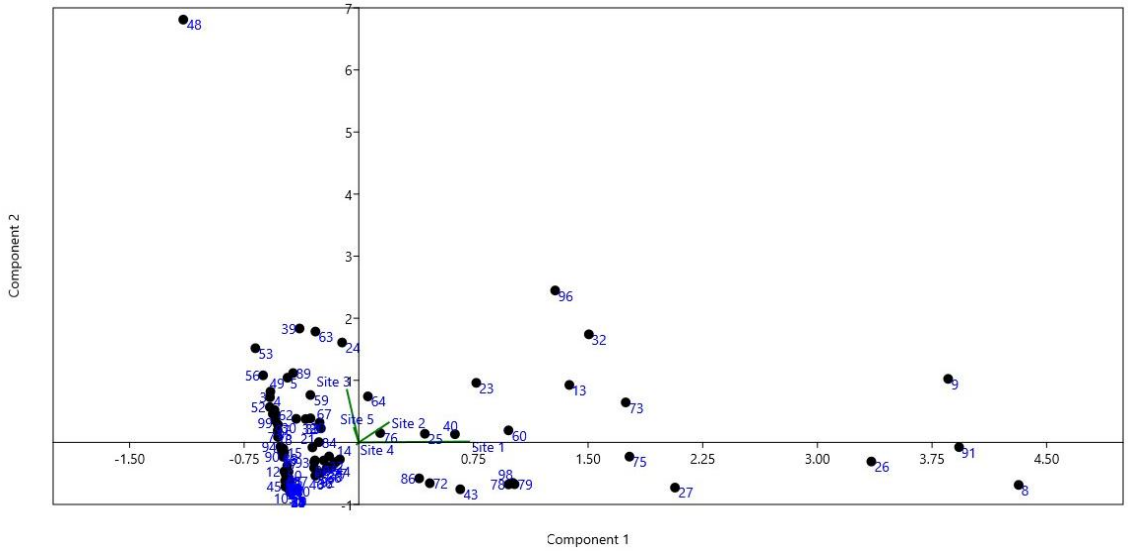

Figure 2. *PCA Bi plot of the studied communities from the study site (For corresponding numbers please see Table 1)*

PCA biplot showed representative species of the area separated away along the X-axis i.e. *Arundo donax, Aristida purpurea* representing their ultra-dominance in studied sites. *Euphorbia hirta, Heteropogan controtus, Matyenus royleana, Cynodon dactylon* were significantly correlated with the disturbed sites. *Justicia adhatoda was* significantly correlated with site 3 (*Fig. 2*). Cluster analysis grouped the data of disturbed and undisturbed sites in to the associations based on species correlation and dominance in communities. Cluster analysis had shown 5 associations of all communities (*Fig. 3*).

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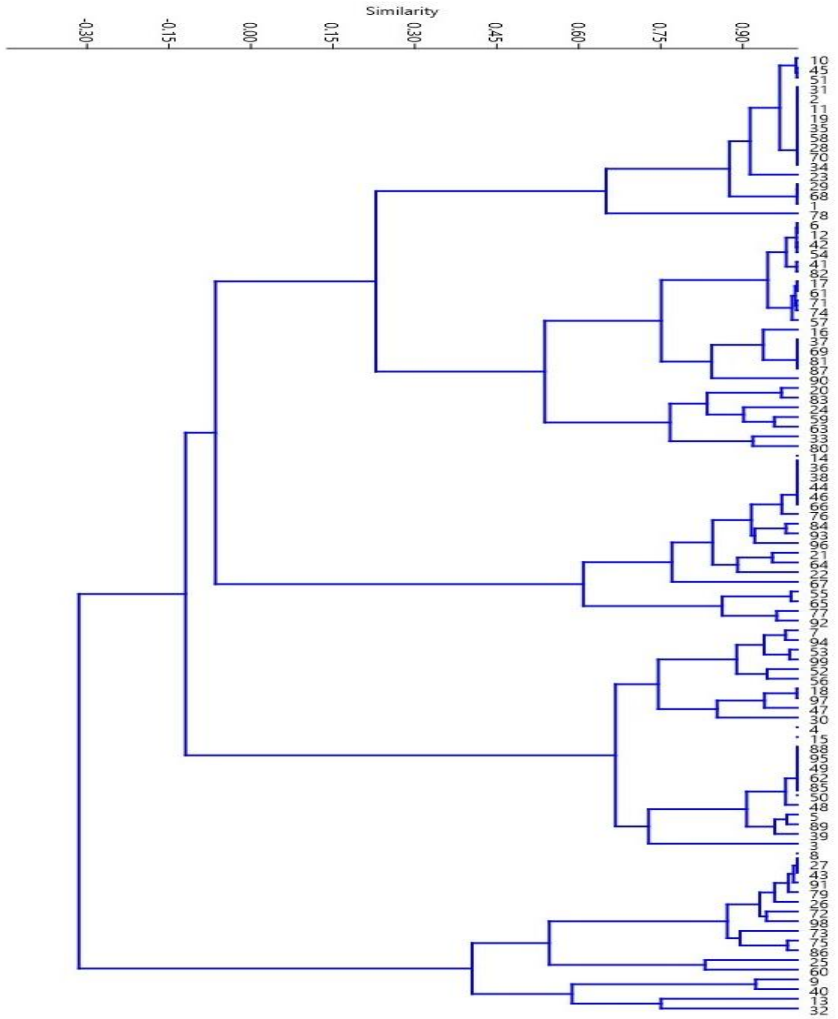

Figure 3. *Dendrogram showing Cluster Analysis of the studied communities (For corresponding numbers please see Table 1)*

Discussion

The study revealed that different factors affecting the vegetation of area like grazing, trampling, road construction, browsing and erosion. Soil erosion affecting vegetation development and also controlled by the response of vegetation (Shihong et al., 2003). Productivity of soil loss due to erosion because the top soil is removed, root depth reduced and plant nutrients like potassium, nitrogen, calcium are removed. When nutrients are removed by erosion then plant growth is stunted and overall productivity of soil decline. Due to erosion cover reduced, species richness decreased and succession slow down. Slope had negative impact on plant density and diversity, with increase in the degree of slope the recorded density and diversity was low in the area. At disturbed site 1 plant density and diversity low due to slope. Similar conclusion suggested by Walker et al. (2013) stating that slope and vegetation negatively relate to each other the less the slope the greater the density and diversity. On a steep slope erosion increase because the vegetation cover of annual plant decreases (Koulouri and Giourga, 2007). Aspect may also influence on soil erosion. On investigated area both aspects have same species so no clear differences were recorded. A slower recovery of vegetation and

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higher erosion rates are expected in southern and western than in northern and eastern direction. As a result, southern exposed slopes usually have a lower vegetation cover than northern exposed slopes (Zuazo and Pleguezuelo, 2009). Species diversity was negatively related to the soil erosion. Average Shannon diversity index recorded was 2.71 and Average Simpson diversity recorded was 0.95. At disturbed sites Shannon and Simpson diversity was low as compared to control sites. Higher diversity value shown by control sites (2.95) which is indicator of low disturbance and low diversity recorded at disturbed sites (2.47) showing more disturbances. Similar results drawn by Luo (1996) in Hetian Fujian that at disturbed sites diversity index low because vegetation cover low on eroded site and at control sites Shannon diversity index high due to increased number of species and also natural invasion increased. At disturbed sites average species richness was low (1.75) and at control sites average species richness was high (2.02). Similar results drawn by Uniyal et al. (2010) in Gharwal Himalaya that at disturbed sites richness was low due to high erosion intensity and other anthropogenic activities while at control site species richness was high which indicates the opening of canopies that favors the growth of plant species which gives overall stability to the communities. Results showed that at disturbed site 3 species richness increased as (2.46) due to invasion of non-native flora. Eroded site break the dominance of native species that creates a condition for fast growing invasive species to attain dominance (Tang et al., 2011). Species richness and diversity was low at site 1 with increasing altitude. Sher and Khan (2007) reported the similar findings that at high altitude cover remain low and species richness and diversity decreased with increased of altitude due to trampling, grazing and soil erosion in the area. The decrease in diversity and species richness at high altitude is due to the reduced growing season, low temperature and low productivity (Diemer and Körner, 1998). Average specie evenness recorded was 0.7. Specie evenness fluctuates between stands differently might be due to disturbance in the area (Fosaa, 2004). Higher species number was found at low disturbed areas and low species number was found at highly disturbed area (Erenso et al., 2014). High dissimilarity was recorded between control and disturbed sites (77.02). High dissimilarity is due to difference in level of disturbance, microclimatic condition and altitudinal range (Javed et al., 2006). Therophytes were the dominant life form which is the indicator of the subtropical zone; it was followed by Nanophanerophytes, Megaphanerophytes, Hemicryptophytes, Chamaephytes, Geophytes, Phanerophytes and Lianas. Life form classes are indicators of micro as well as macro habitat of the species (Guo et al., 2009). Therophytes are experts of occupying vacant niches as a result of disturbances (Pyšek et al., 2005). Leaf size classes showed that vegetation of the investigated area was dominated by Microphyll, indicating the impact of xeric conditions decreasing the leaf size (Kar et al., 2010). Low maturity index of plant communities showed unbalanced and heterogenous nature of local flora. This effect is also enhanced by anthropogenic disturbances or natural disturbances which inhibit the establishment of vegetation to reach a climax stage (Saxena and Singh, 1984). The vegetation attributes of both control and disturbed sites showed impacts overall disturbance in whole investigated area.

Regeneration capacity was also examined on investigated sites. High regeneration was reported at disturbed sites while on control sites no seedlings were found. At disturbed sites adjacent to control sites, the dominant trees were *Pinus roxburgii* and *Ficus palmata*. Joshi (1990) also reported the presence of *Pinus roxburghii* at the disturbed sites adjacent to control sites. Climatic factors and biotic interference also

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influence the regeneration of different species (Sen et al., 2008). Dominant grass species recorded from disturbed sites were *Aristida purpurea*, *Arundo donax*, *Cynodon dactylon*, *Themeda anathera*. These species help to stabilize the disturbed sites due to their dense cover. Vegetation restoration plays an important role for degraded ecosystem rehabilitation. Recovery after disturbance indirectly controls the soil erosion rates (Fenli et al., 2002). The establishment of grass species play a significant role in ecological restoration which have been successfully grown on degraded land (Török et al., 2008). Revegetation on eroded sites improves the soil aggregate stability by accelerating vegetation development (Burri et al., 2009).

Conclusion

Current investigation showed that *Arundo donax* and *Justicia adhatoda* were dominant species at site adjacent to control sites. *Ajuga bracteosa*, *Arundo donex*, *Cichorium intybus*, *Cirsium arvense*, *Conyza bonariensis*, *Cynodon dactylon*, *Cynoglossum lanceolatum*, *Dichanthium annulatum*, *Duchesnea indica*, *Euphorbia prostrata*, *Nepeta erecta*, *Oenothera rosea*, *Oxalis corniculata*, *Parthenium hysterophorus*, *Persicaria barbata* and *Rosa macrophylla* were common to both disturbed and undisturbed sites. Undisturbed sites had lower number of herb species as compared to disturbed sites. At disturbed sites, more shrubs and herbs were recorded due to open canopy as more light reached at forest floor sallowing more species to grow.

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