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ORDINATION STUDY OF VEGETATION ANALYSIS AROUND WETLAND AREA: A CASE STUDY OF MANGLA DAM, AZAD KASHMIR, PAKISTAN

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Abstract

Present study was conducted at Mangla Dam for vegetation ordinal classification by applying multivariate analysis in order to find relationship between vegetation and their edaphic factors. Samples of soil and herbaceous vegetation were randomly collected by using 1*1 square meter quadrats. Total 37 plant species belonging to 17 families were identified. Canonical Correspondence Analysis as direct ordination technique was applied by using CANOCO software. Results of analytical tests revealed that concentration of micro and macro nutrients along electrical conductivity and pH in different soil samples were varying to a greater level in study area while *Cynodon dactylon* showed higher abundance over broad range of all edaphic factors concentration.

Key words: Canonical correspondence analysis; Herbaceous flora; Edaphic factors.

Introduction

Dams play an important role in serving mankind like providing supply of water for municipalities, agriculture and industries' function as well as contribute in electricity production (Rosenberg *et al.,* 2000; Anon., 2000). Globally nineteen percent electricity demand is fulfilled by the hydropower with help of dam whereas 1/3rd of the nation's get half of their electricity in the biosphere from the hydropower dam (Anon., 2000). But the dam building, maneuver particularly of large dams can intensely effect ecosystem and watershed (He *et al.,* 2004). Because dam's construction can transform the riparian vegetation and shore line in both the impoundment area and downstream regions (New & Xie, 2008). Riparian vegetation provides habitat to diverse type of flora and fauna (Beauchamp *et al*., 2007; Malik & Richardson, 2009).

Many studies have revealed that the vegetation around water bodies can be extraordinarily impacted by dam building which lead to habitat destruction ultimately extinction of indigenous species (Nilsson & Svedmark, 2002; Tealdi *et al.,* 2011; Urooj *et al*., 2015). An alteration related to dam building in ecosystem processes have become a key attention for research studies (Gordon & Meentemeyer, 2006).

In adding to the hydrological management, genetic characteristics of species, topographical setting, environment and climate, vegetation zonation, species composition before dam construction can govern the responses of the riparian vegetation to hydropower process (New & Xie, 2008). But there is no worldwide model for the measurable valuation of the interrelationship between riparian vegetation and hydrological management (Bombino *et al.,* 2006; Tealdi *et al.,* 2011). Classification of plants is very important in case of conservation practices, which depend upon scale of measurement. There is interrelationship between edaphic factors and vegetation and have reversible effects on each other. Like soil gives sustenance in term of nutrients, humidity, and in turn vegetation be responsible for soil cover protection, reduce the soil erosion and increase the nutrient in soil (Eni *et al.,* 2012). This interrelationship between soil and environmental factors can be studied with the help of multivariate techniques (Urooj *et al*., 2015). Canonical Correspondence Analysis (CCA) is direct ordination technique which is used by ecologist for studying relationship between flora and environmental factors (Li *et al.,* 2012; Ahmad *et al.,* 2014; Urooj *et al*., 2015).

Present study was aimed to analyze the effects of edaphic factors on classified herbaceous flora for their growth abundance and absence around dam vicinity by using ordination technique. Study area of present study is Mangla Dam (33.12 ºN, 73.39 ºE) which is located in the district of Mirpur, Azad Jammu and Kashmir, North East of Pakistan, downstream to district of Jhelum Punjab, Pakistan with elevation of 630 m. Study area was divided into two zones i.e. Zone–I and Zone-II based upon geographical elevation (Fig. 1).

Materials and Methods

Data collection was based upon random sampling by using the quadrat of 1x1 m by following Braun-Blanquet cover abundance scale. Randomly collected floristic data was recorded by the visual estimation of cover value of each species in every quadrat in percentage as given by Kent & Coker (1992). Total fifty quadrats were laid down. Zone-I consisted 30 quadrats and twenty quadrats were laid down in Zone-II. Soil samples were collected randomly along the vegetation collection from fifty quadrats at the depth of 6-10 cm.

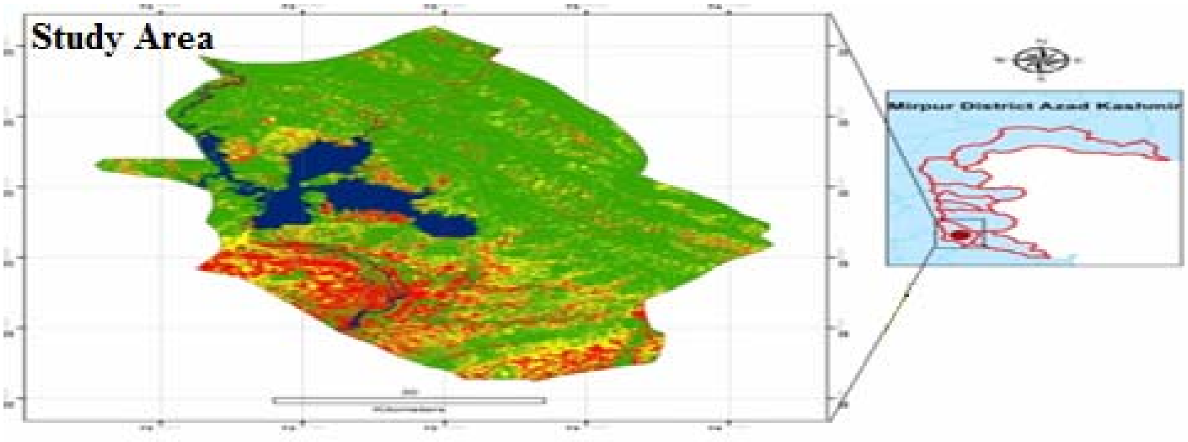

Fig.1. Study area map.

Physicochemical Analysis: Before analysis except soil moisture and organic matter all soil samples were dried overnight and pulverized and sieved by using sieve of 2 mm size. For soil moisture, 5 grams of each soil sample before drying were weighed by using digital weighing balance was recorded as initial weight. Then weighed samples were placed in air dried oven for 24 hours at 105 ºC and weighed again after drying, as final weight. Following formula was applied for the calculation of moisture content of the soil (Allen, 1974).

$$\text{Moisture (\%)} = \frac{\text{Loss in wt. on drying (g)}}{\text{Initial sample wt. (g)}} \times 100 \qquad (1)$$

After calculating soil moisture same samples were used for calculating organic matter (OM). Those samples were ignited in furnace at 360 ºC for 2 hour. After that weight was again noted. Loss in weight of samples during ignition was calculated as OM (Nathan & Gelderman, 2012).

$$\text{OM (\%)} = \frac{\text{Loss in wt. on ignition (g)}}{\text{Initial sample wt. after drying (g) x}} \times 100 \qquad (2)$$

Soil texture of 100 g dried soil was analyzed by using Octagon Digital Sieve Shaker instrument. Soil pH and EC were measured by preparing extract in 1:2 ratios. Two macronutrients (P and K) essential for plant growth were analyzed. Potassium was extracted by mixing of 1g dried, crushed soil sample in 10 ml ammonium acetate. Then solutions were shaked for 5 minutes and filtered out. Each filtrate was analyzed on an atomic absorption spectrophotometer at 776 nm. Soil samples of study area had equal or greater pH than 7.4, that's why Olsen sodium bicarbonate method was used. 1g dried crushed each soil sample was mixed with 20 ml $NaHCO_3$ (0.5 molar) and were mixed for 30 minutes. Blue color was appeared in filtrate upon adding of an ammonium molybdate-sulfuric acid solution and then an ascorbic acid solution and measured with colorimeter at 882 nm (Nathan & Gelderman, 2012). Four micronutrients Zinc, Iron, Copper and Manganese were analyzed. 1 g meshed and sieved soil from each collected soil sample was digested in 12 ml of freshly prepared aqua regia (containing acid solution of 9 ml HCl and 3 ml HNO_3 in 3:1 ratio). Digestion was progressed on hot plat at 80ºC for 2 hour. The digested samples were allowed to cool and filtered out and raised up by volume, by adding distilled water up to 50ml. These digested samples were then used for selected micronutrients analyses by using Atomic Absorption Spectrophotometer (Ehi-Eromosel *et al.,* 2012).

Ordination method for data analysis: For analyzing the relationships CCA technique was applied by using Canoco 4.5 version. CCA was based upon two matrix i.e. P × N1 (Species value); P × N2 (Environmental gradient) (Jia *et al*., 2007). Where environmental gradient in present study was included soil pH, EC, Moisture, Organic matter, available Potassium, Phosphorus, Zinc, Ferrous, Manganese and Copper.

Results

Total 37 herbaceous plants were recorded, belonging to 17 families. Dominant species were *Cynodon dactylon, Desmostachya bipinnata* and *Rhynchosia minima* in Zone-I whereas in Zone-II dominant species were *Cynodon dactylon, Croton bonplandianus, Desmostachya bipinnata* and *Brachiaria decumbens*. It was revealed from the analytical tests that concentration of micro and macro nutrients along electrical conductivity and pH in different soil samples varied to a greater level. In zone-I soil samples, pH ranged from 7.38 to 7.7, EC ranged from 0.83 to 1.47, Organic and moisture content ranged from 1.03 to 1.89% and 21 to 56% respectively. Whereas in zone-II, pH and EC were recorded 7.2-7.82 and 0.82-1.35 respectively in soil samples. Besides organic matter and moisture in soil ranged from 0.86-2% and 26-46% respectively.

In Biplot of CCA, correlation between all selected edaphic factors and species was built. Triangle indicated the individual species and arrow heads were showing environmental variable. Maximum change was shown by different length of arrows. Arrows lengths are proportional to the magnitude of change in direction of maximum change of these environmental variables. Longest arrow showed that it had influenced the growth of pointed species by arrow head. Phosphorous organic matter and Potassium have longest arrow which revealed the strong effect on growth of species which were present in Zone-I study area. *Oxalis corniculat* showed that it was frequently influenced by available Phosphorous as macronutrient in soil. Whereas *Cannabis sativa* had shown response to P but was not strongly affected. Another macronutrient (Potassium) greatly affected *Dichanthium annulatum*. On other side *Cynodon dactylon* was able to show its correspondence towards pH of soil (Fig. 2a). Arrow of soil moisture was small depicting less influence on species. Other species which were directed away from environmental variables were free from influence of these environmental gradients. Fig. 2(b) depicted that two micronutrients Cu^{+2} and Mn^{+2} have strong influence on plant species present in Zone-I study area. *Malvastrum coromendelianum* and *Dactyloctenium aegyptium* showed their correspondence toward Copper in soil. Whereas *Aristida adscensionis* and *Achyranthes aspera* show their correspondence toward Manganese (Mn^{+2}). Other two micronutrients were Zinc and Iron. But species are not seemed to be affected by these two micronutrients.

In Zone-II pH, Moisture and EC showed by longest arrow head indicating their strongest influence on species (Fig. 3a). *Heteropogon contortus* showed its correspondence to moisture and *Cynodon dactylon*, *Cannabis sativa*, *Artemisia scoparia* and *Amaranthus spinosus* showed that growth was influenced by electrical conductivity. Soil pH and available Phosphorous have shown great effect on the *Aerva javanica* and *Pupalia lappacea* species growth composition. Though organic matter indicated by small arrow head but specie *Croton bonplandianus* was influenced by organic matter and available Potassium in soil.

In Zone-II Manganese and Iron indicated by longest arrow depicted strong influence on species composition. However *Cannabis sativa*, *Brachiaria decumbens*, *Amaranthus spinosus* and *Parthenium hysterophorus* showed their correspondence to micronutrient Iron. Manganese showed by arrow influence on *Croton bonplandianus* and *Cynodon dactylon* whereas *Croton bonplandianus*, *Taraxacum officinalis*, *Cannabis sativa*, *Brachiaria decumbens*, *Amaranthus spinosus* and *Euphorbia hirta* corresponded to available copper in soil as micronutrient by showing growth. Growths of all other species which were directed away from the arrows were not influenced by the availability of Mn^{+2}, Cu^{+2}, Zn^{+2} and Fe^{+2} in soil of Zone–II (Fig. 3b).

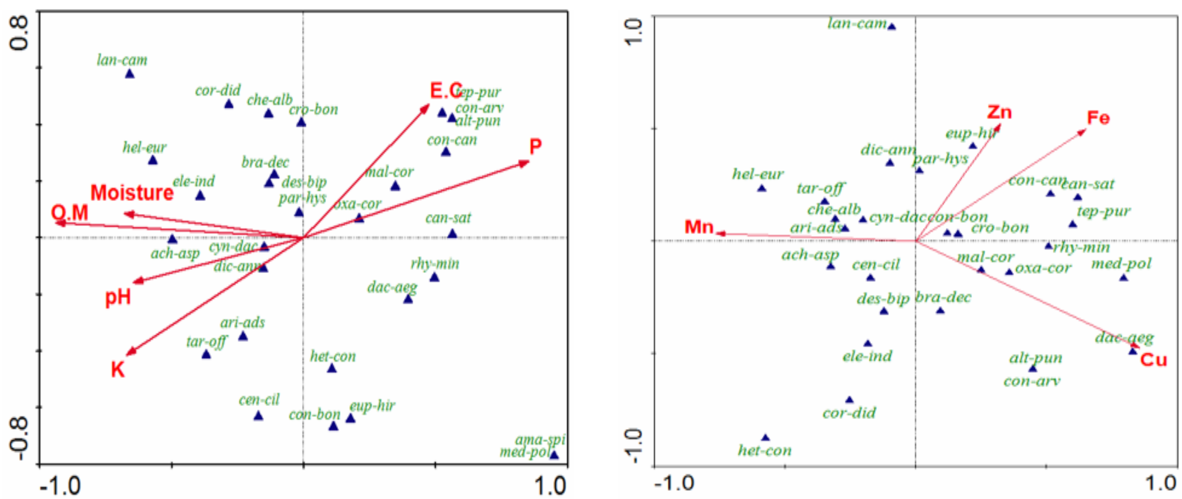

Fig. 2. Biplot between flora and soil parameters in Zone-I.

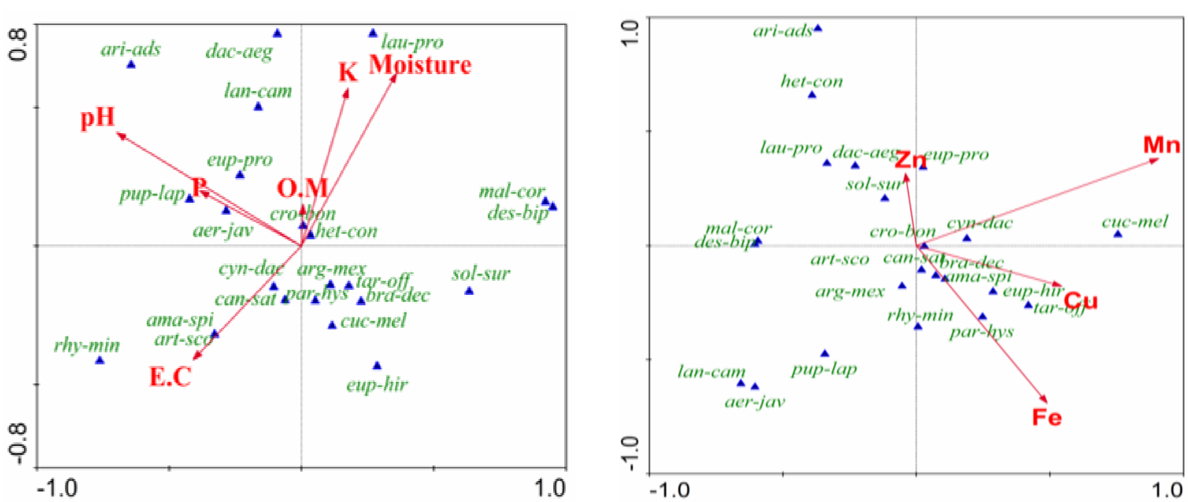

Fig. 3. Biplot between flora and soil parameters in Zone-II.

Discussion

Texture of soil found around Mangla dam was sandy loam and some places were also loamy. According to the Donahue *et al*. (1983) soil texture is one of the main and important soil property which has main function of water holding capacity and aeration, which regulates the soil fertility.

Organic Matter is another parameter to measure soil fertility. In results it has been assessed that all soil samples were containing the satisfactory amount of organic matter ranging from minimum 0.94 up to maximum 1.62 % of organic matter. This quantity in percentage of organic matter in soil of study area indicates that this percentage is favorable for the plant growth because it contribute to add more concentration of minerals and nutrients in soil for plants abundance. Many studies on effect of organic matter on plant growth stated that the abundance and richness of plant species in soil due to the marked effect of soil quality and organic matter (Leszczyńska & Kwiatkowska-Malina, 2011; Benedetti *et al*., 1996; Yin *et al.,* 2002). All soil samples had alkaline pH ranging from 7.4-7.68. At 7-7.5 range, all minerals and nutrients in soil are easily available to plants. But at 7.6-8 range, available nutrients in soil could easily available for plant growth, except zinc, manganese and boron. These particular micronutrients which are very essential for plants are becoming less available at 7.6-8 soil pH. However, at 8.1 and beyond this pH, no micronutrient could available along the Phosphorous (macronutrient) in soil to plants. There is negative relationship between pH ad EC studied by Regassa (2005). If pH of soil is higher than EC gets less and less nutrients will be available in soil. Many beneficial microorganisms are found in soil at 6-8 pH. Some kind of nitrogen fixing bacteria help in conversion of atmospheric nitrogen in to nitrites and nitrates. For ecological studies multivariate techniques are considered to be the best methods for the floral classification based on the abundance and species response towards their environmental gradients. As reported by Greig-Smith (2010) that the similar environmental condition and species, bring together much closer by inhabiting less dimensional space as compare to dissimilar ones.

In order to determine and evaluate the response of species towards their environmental parameters prevailing in study area, Canonical Correspondence Analysis (CCA) was used to assess the species response to environmental variables along with species ranking. The main advantage in this ordination technique as reported by Mohler (1981), that is, samples cluster does not influence the relative position of species and accurate response can be achieved by showing abundance. The occupation of an area by natural flora indicated the health of soil and mode of adaptation with flora and edaphic factors (Zhang *et al*., 2011).

In present study species showed response to soil pH in form of distribution over the study area, around Mangla dam. Three species (*Malvastrum coromendelianum, Solanum surrattense, Desmostachya bipinnata*) found in Zone-II showed negative response against high pH value. The abundance/growth of these species declined with increasing soil pH value. However, there were some species whose abundance was decreased with decreasing pH in soil (Gough *et al*., 2000).

Conclusions

It has been concluded from revealed results that existing herbaceous vegetation around Mangla dam was comprised of 37 species which belonging to 17 families. The most abundant species found everywhere around the dam area was *Cynodon dactylon*, which showed growth at wide range of every selected and analyzed soil environmental variable. Response of species towards environmental gradients was varied from species to species which was analyzed by direct ordination technique CCA. Available Potassium, Phosphorous, Electrical conductivity and organic matter impart greater influence as edaphic factors on species existence and abundance in zone-I of study area. While species in zone-II greatly respond to soil pH, EC and moisture along macronutrients by showing growth and richness in diversity. But existing vegetation around Mangla dam is facing lot of problems due to direct and indirect developments like Housing scheme; Dam extension; Agricultural practices. Due to such encroachment edaphic factors may be changed, and ultimately less concentration of nutrients could be available to existing flora. Besides, human encroachment acts as contributing factor towards habitat loss of prevailing vegetation.

References

Ahmad, S.S., R. Murtaza, R. Shabbir, M.N. Ahmad and T. Shah. 2014. Environmental diversification and spatial variations in riparian vegetation: A case study of Korang River, Islamabad. *Pak. J. Bot*., 46(4):1203-1210

Allen, S.E. 1974. Chemical analysis of ecological materials. Blackwell scientific publications, Oxford. London. pp:12

Anonymous. 2000. *Dams and Development: A New Framework for Decision-Making*. World Commission on Dams (WCD). Earth scan press, London, UK.

Beauchamp, V.B., J.C. Stromberg and J.C. Stutz. 2007. Flow regulation has minimal influence on mycorrhizal fungi of a semi-arid floodplain ecosystem despite changes in hydrology, soils, and vegetation. *J. Arid Environ.,* 68: 188-205.

Benedetti, M. F., W.H. Van Riemsdijk, L.K. Koopal, D.G. Kinniburgh, D.C. Goody and C.J. Milne. 1996. Metal ion binding by natural organic matter: from the model to the field. *Geochim. Cosmochim. Acta*., 60(14): 2503-2513.

Bombino, G., V. Tamburino and S.M. Zimbone. 2006. Assessment of the Effects of Check-Dams on Riparian Vegetation in the Mediterranean Environment: A Methodological Approach and Example Application. *Ecol. Eng.,* 27: 134-144.

Donahue, R.L., R.W. Miller and J.C. Shickluna. 1983. *Soil: An introduction to soil and plant growth* (5th ed). New Dehli: Prentice-Hall of India Private Limited.

Ehi-Eromosel, C.O., A.A. Adaramodu, W.U. Anake, C.O. Ajanaku and A. Edobor-Osoh. 2012. Comparison of three methods of digestion for trace metal analysis in surface dust collected from an E-waste recycling site. *Nat. Sci*., 10(10): 42-47.

Eni, D.D., A.I. Iwara and R.A. Offiong. 2012. Analysis of soil vegetation interrelationships in a south-southern secondary forest of Nigeria. *Int. J. For. Res.,* 2012:1-8.

Gordon, E. and R.K. Meentemeyer. 2006. Effects of dam operation and land use on stream channel morphology and riparian vegetation. *Geomorph.,* 82: 412-429.

Gough, L., G.R. Shaver, J. Carrol, D.L. Royer and J.A. Laundre. 2000. Vascular plant species richness in Alaskan arctic tundra: The importance of soil pH. *J. Ecol.*, 88: 54-66.

Gower, J.C. and D.J. Hand. 1996. *Biplots*. Chapman and Hall, London. pp. 277.

Greig-Smith, P. 2010. Quantitative Plant Ecology. Blackwell Scientific, Oxford.

He, D.M., W. Zhao and L.H. Chen. 2004. The ecological changes in manwan reservoir area and its causes. *J. Yunnan Uni.*, 26(3): 220-226.

Jia, X., J. Chenand and H. Wan. 2007. Application present situation of DCA, CCA, and DCCA ordination of grassland vegetation communities in China. *Chin. Agri. Sci. Bull.*, 23(12): 391-395.

Kent, M. and P. Coker. 1992. *Vegetation description and data analysis*. London, Belhaven press.

Leszczyńska, D. and J. Kwiatkowska-Malina. 2011. Effect of organic matter from various sources on yield and quality of plant on soils contaminated with heavy metals. *Ecol. Chem. Eng*., 18(4): 501-507.

Li, J., S. Dong, Z. Yang, M. Peng, S. Liu and X. Li. 2012. Effects of cascade hydropower dams on the structure and distribution of riparian and upland vegetation along the middle-lower Lancing-Mekong River. *Forest Ecol. Manag*., 284: 251-259.

Malik, A.U. and J.S. Richardson. 2009. Riparian vegetation change in upstream and downstream reaches of three temperate rivers dammed for hydroelectric generation in British Columbia, Canada. *Ecol. Eng*., 35: 810-819.

Mohler, C.L. 1981. Effects of sample distribution along gradients on eigenvector ordination. *Veg.*, 45(3): 141-145.

Nathan, M.V. and R. Gelderman. 2012. Recommended chemical soil test procedure. Available Online: http://www.agvise.com/wp-content/uploads/2014/06/Recommended-chemical-soil-test procedures-2012.pdf. Retrieved on December 28th, 2013.

New, T. and Z. Xie. 2008. Impacts of large dams on riparian vegetation: applying global experience to the case of China's three gorges dam. *Biod. & Conser.,* 17(13): 3149-31634.

Nilsson, C. and M. Svedmark. 2002. Basic principles and ecological consequence of changing water regimes: riparian plant communities. *Environ. Manag*., 30: 468-480.

Regassa, T. 2005. An Ecological Study of Vegetation around Lake Abijata. MSc thesis, Addis Ababa University School of Graduate studies. Available Online: http://etd.aau.edu.et/bitstream/123456789/444/2/TOLCHA%20REGASSA.pdf. Retrieved on 5th December, 2013.

Rosenberg, D.M., P. McCully and C.M. Pringle. 2000. Global-scale environmental effects of hydrological alterations: Introduction. *Bio Sci*., 50: 746-751.

Tealdi, S., C. Camporeale and L. Ridolfi. 2011. Modeling the impact of river damming on riparian vegetation. *J. Hydrol*., 396: 302-312.

Urooj, R., S.S. Ahmad, M.N. Ahmad and S. Khan. 2015. Ordinal classification of vegetation along Mangla Dam, Mirpur, AJK. *Pak. J. Bot*., 47(4): 1423-1428.

Wright, S.J. 1992. Seasonal drought, soil fertility and species density of tropical forest plant communities. *Trends Ecol. Evol*., 7: 260-263.

Yin, Y., C.A. Impellitteri, S.J. You and H.E. Allen. 2002. The importance of organic matter distribution and extract soil: solution ratio on desorption of heavy metals from soils. *Sci. Total Environ*., 287: 107-119.

Zhang, L., X. Mi, H. Shao and K. Ma. 2011. Strong plant-soil associations in a heterogeneous subtropical broad-leaved forest. *Plant Soil*, 347: 211-220.

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