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ASSESSING THE ROLE OF GRAVEYARDS IN NATIVE TREES CONSERVATION ALONG MODIFIED LANDSCAPES; A CASE STUDY FROM MANSEHRA, PAKISTAN

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Abstract

Remnant habitat patches can provide ideal space for conservation of native flora in agricultural and urban landscapes. Graveyards are ideals for such conservation actions if they are managed scientifically. Present study analyzed current status of the tree diversity and related issues of the graveyards from Tehsil Mansehra for their utilization in native tree conservation. Random sampling was made through 35 vegetation stands covering 35 graveyards occupying 35 Union Councils. Total 56 species including 35 trees and 21 shrubs, belonging to 46 genera and 31 families were documented from study sites including 44 naturally growing and 12 planted species. Total 2645 mature trees and 2532 regenerating trees were counted, and 14 tree species shows high rate of regeneration. Presence of noxious invasive tree Broussonetia papyrifera and Ailanthus altissima however stipulated the active management of such remnant habitats because of severe invasion threats. Involvement of the local communities can effectively result in utilization of the graveyards as steppingstones and functional corridors in rapidly intensifying urban areas and agricultural lands. Such approach can be applied to other areas for identification and utilization of remnant habitats in plant conservation.

Keywords*: Conservation; Graveyards; Habitat corridor; Remnant patches; Biodiversity*

Introduction

Aggressive deforestation and agricultural practices led to dramatic habitat loss worldwide in the past centuries and densely populated sites was affected more [1]. Due to agricultural expansion the natural habitat of the species is reduced rapidly throughout the globe [2]. Habitat loss is more common in tropics where fragmentation is rapid than other areas [3]. With increasing demand of crops, it is an alarming issue to compensate the crops and reduce the habitat loss and to conserve biodiversity along the crop fields and agricultural sites [4]. In urban area green spaces play vital role in maintaining natural environment by lowering temperature [5], controlling contamination [6], reducing the ratio of CO_2 from environment [7], reducing stress [8], provide recreation and built natural environment [9] and have considerable biodiversity. Shrinkage of such green places in urban area disturbed the ecological balance [10]. Graveyards are the only green spaces in agricultural and compact urban landscapes and have the territory of native flora [11, 12] and can managed differently from parks [13]. These sites are

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conserved by local communities considering ritual believes [14], sacred forest patches [15], acting as connecting corridor for the surrounding biodiversity [16] and hosting native endemic and endangered plant species [17]. These are the most protected sites that have various types of habitats [18], but their biological importance has not been taken under consideration thouroghly [19]. These sites are marked by wall boundaries or fenced off in some areas and are away from animals or anthropogenic activities and have various undiscovered and unknown plant species [20] and can protect extinct in wild or threatened species of a specific area [21], and old tree can be seen here [22].

In compact urban spaces graveyards can be managed and designed properly similar to parks to protect and support the native flora and fauna [23, 24] and many trees can be planted like ornamental plants *Cupressus spp.*, etc. along with native plants [25]. Cemetrobotany (study of plants of graveyards and their ecological values) is now an emerging trend in botany and various researchers explore the diversity and ecological values of graveyards globally, Loki *et al.* [1], Ullah *et al.* [26], Kamran *et al.* [27], Aziz [28], Molnar *et al.* [12], Molnar *et al.* [19], Shah *et al.* [29], Siddiqui *et al.* [30], Otves *et al.* [31], Khan *et al.* [32], Rutkovska *et al.* [33], Ruch *et al.* [23], Rahman *et al*. [34], Hussain *et al.* [35] and McBarron *et al.* [36]. Our findings correlate the graveyards and biodiversity conservation in compact urban and agricultural landscapes where they are acting as green spaces, natural connecting corridors and steppingstones and have native and key stone species.

Study area

Mansehra is the district of Kpk, Pakistan containing three tehsils and covering 4,579 km^2 areas and lies under Sino-Japanese region phytogeographically [37]. Tehsil Mansehra have 1301 km^2 areas, consist of 36 Union Councils and are surrounded by District Abbottabad, District Battagram, Tehsil Balakot and Tehsil Oghi (Fig. 1). Climatic condition varies due to variation in precipitation pattern and maximum rain fall occurs from June to August. During winter severe cold and snowfall occurs on mountains. Average rainfall is 72 inches per annum and temperature varies from 2 to 38°C [38].

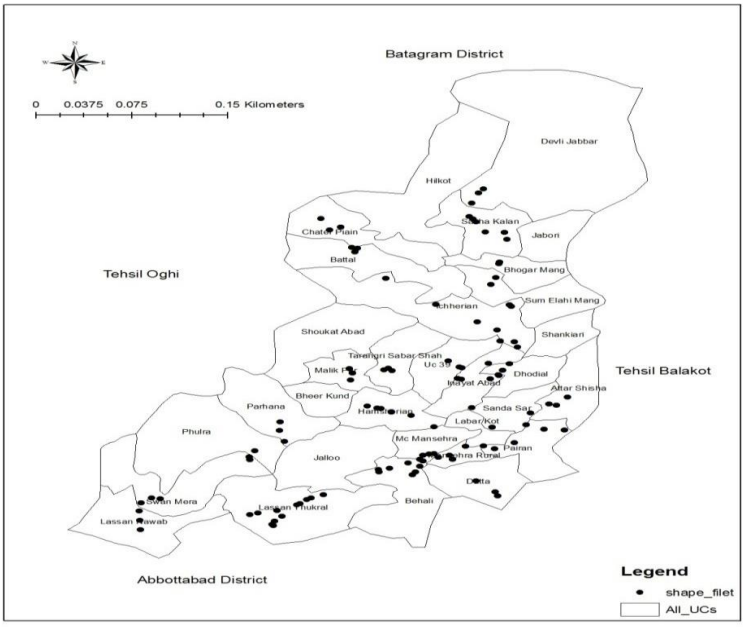

Fig. 1. Spot representing the most populous sites of Tehsil Mansehra having old graveyards

Material and method

Total thirty-five graveyards were selected each from one union council of Tehsil Mansehra having elevation range of 700 meter to 1688 meter. Study was carried out during April- August 2019. A quadrate size of 10m×10m was drawn from each graveyard as taken by Andrabi *et al.* [39] and by using GPS (Garmin Etrex) device, GPS coordinates (Latitude, Longitude and Altitudes) were taken and written in handbook and local names of species, total number of tree species and their regeneration status were counted and DBH of largest species were measured by inch tap.

Associated shrubs diversity and threats like invasive species, grazing and fragmentation were recorded. Data regarding protection measure, plant usage and plant cutting trends from graveyards were collected via semi structured questionnaires.

Data of overall 35 stands were gathered on MS Excel and number of mature and immature individuals of each tree species was calculated and regeneration status was calculated as:

$$\text{Regeneration status of a species} = \frac{\text{Total number of regenerted individuals of a species}}{\text{Total number of mature individuals of that species}}$$

Regenerated tree and mature tree species were compared to check the future of native tree in that area.

Results

Fifty-six species including 35 trees and 21 shrubs belonging to 46 genera and 31 families were recorded. Among them 92.8% (52 species) were angiospermae while 7.1% (4 species) were gymnospermae. Genus *Rubus* and *Zizyphus* had 3 species (each) followed by *Berberis*, *Morus*, *Pinus*, *Prunus* and *Pyrus* having 2 species (each) while other having only one species. Maximum species were belonging to family *Rosaceae* (10 species) followed by Moraceae and Oleaceae (4 species each), Myrataceae and Rhamnaceae (3 each), *Berberidaceae*, *Cuperssaceae*, *Fabaceae*, *Salicaceae*, *Pinaceae* and Rutaceaehaiving 2 species each (Fig. 2).

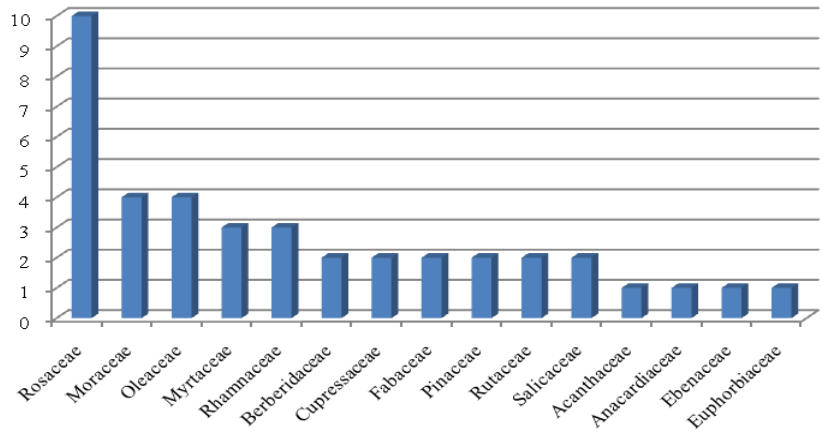

Fig. 2. Families' vs number of species

Total 2645 trees species individuals were recorded from all 35 quadrates drawn in study area, among them *Olea ferruginea*was found with maximum number of individuals (611) followed by *Ailanthus altissima* (385) and *Broussoneti apapyrifera* (263). Less than ten individuals of species recorded were *Salix tetrasperma, Prosopis juliflora, Prunus armeniaca, Thuja orientalis, Fraxinus excelsior, Zizyphus mauritiana, Pinus wallichiana, Platanus orientalis, Juglans regia, Parrotiopsis jacquemontiana, Pyrus pseudopashia* and *Prunus persica* (Fig. 3).

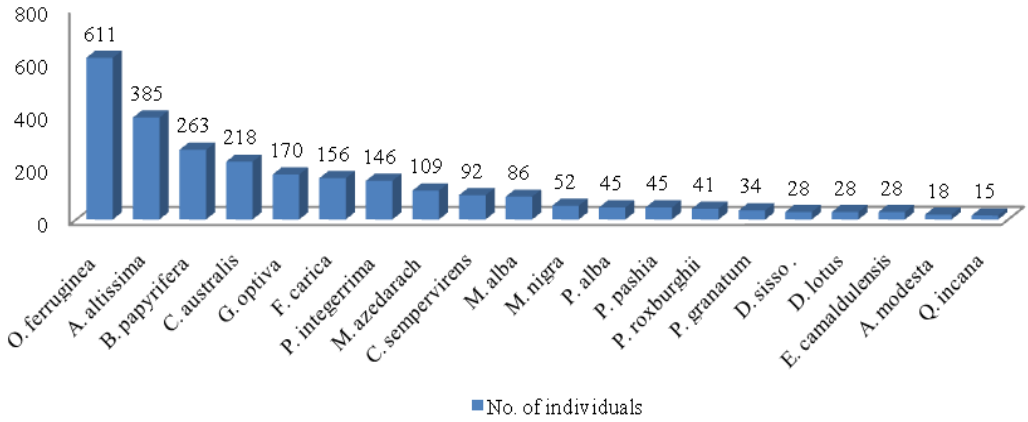

Fig. 3. Some trees vs number of counted individuals

Twelve species (21.42%) out of 56 were found to be planted in the area while 44 species (78.58%) were naturally growing. Majority of the planted species were belonging to genus *Prunus* and family *Rosaceae* and *Myrtaceae*. Among the planted species five were planted as ornamental purposes.

Twenty-two species with edible fruits belonging to fourteen genera and ten families were recorded. Family *Rosaceae* have maximum species (7) followed by *Rhamnaceae* and *Moraceae* (3 spp. each) while gunus Rubus have maximum number of species. Among them five species were planted while seventeen were naturally growing species.

The species with maximum circumference was recorded and considered as oldest species of the area. Out of 35 localities, 14 had *Olea ferruginea*, followed by *Celtis australis* (5 localities), *Morus alba* (3), *Ailanthus altissima* and *Pinus roxburghii* (2) while all other were found in one graveyard as an oldest tree.

Regeneration

Total 2532 regenerating trees individual were counted from all study sites. Among them maximum regeneration status counted was of *Olea ferruginea* having 496 individuals followed by *Ailanthus altissima* (310) and *Broussonetia papyrifera* (300), while less than two regenerating individuals of some species found were *Callistemon citrinus, Fraxinus excelsior, Juglans regia, Pyrus pseudopashia* while zero regeneration status of *Pinus wallichiana, Platanus orientalis, Parrotiopsis jacquemontiana, Citrus acida* and *Prunus persica* were counted from study area (Fig. 4).

Species with status difference more than 1.0 has more regenerating individuals. These are 14 species among them maximum regeneration difference is shown by *Quercus incana* (3.3) and *Populus alba* (2.1), while species having difference between 1.0 to 1.05 shows less difference between mature and regenerating individuals like *Grewia optiva, Punica granatum and Pyrus pashia*. Seventeen species have fewer regenerating individuals than the mature trees showing the value less than 1.0 while 5 species have zero regenerating individuals (Fig. 5).

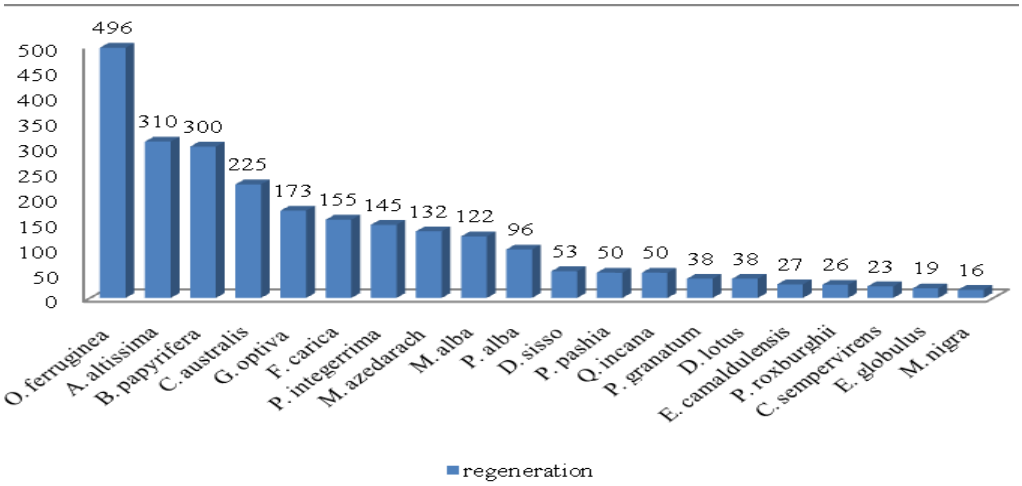

Fig. 4. Regeneration Status of 20 max tree species

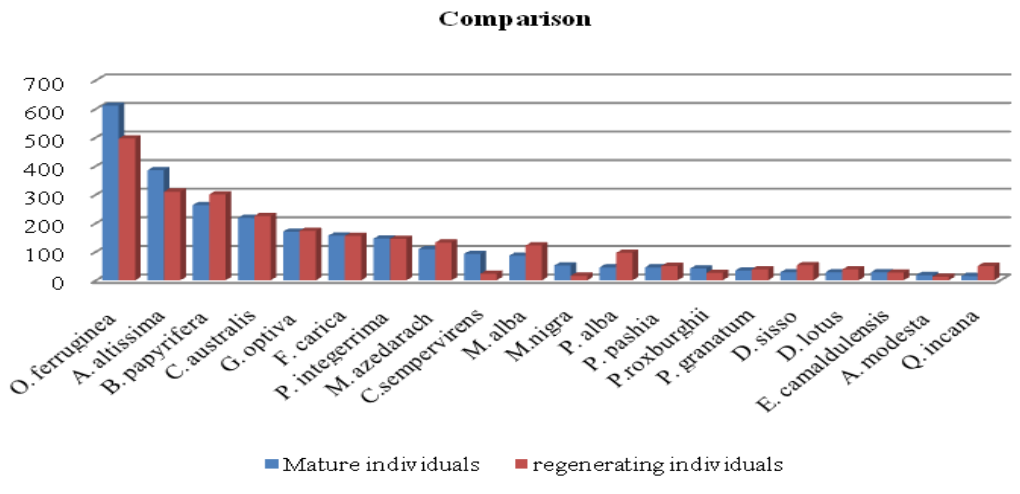

Fig. 5. Comparisons of mature and regenerated tree individuals

Threats to graveyard's floral diversity

Nine invasive species were recorded belonging to seven families. Three species were belonging to family Asteraceae. Only two invasive trees found were *Broussonetia papyrifera* and *Ailanthus altissima*, one shrub *Adhotida vasica* while other six species were herbaceous invasive including *Cannabis sativa*, *Parthenium hysterophorus*, *Lantana camara*, *Xanthium strumarium* and *Tagetes minuta*.

In fifty four percent graveyards there were no human exploitation recorded while fort six percent were used for various purposes. Among them maximum usage purpose was as fuel (30% graveyards), followed by edible fruit and multi purposes (15% each), thatching (13%), fodder (11%), medicinal (09%) and fencing purposes (07%) (Fig. 6).

Forty eight percent graveyards were fragmented while fifty two percent were un-fragmented. Fragmentation was due to passing link roads (4 graveyards), pathways (11) and

school buildings (2). Six-time fragmentation were found in 2 graveyards followed by five time in 2, four time in 2, three time in 4, two time in 4 and one time in 3 graveyards (Fig. 7).

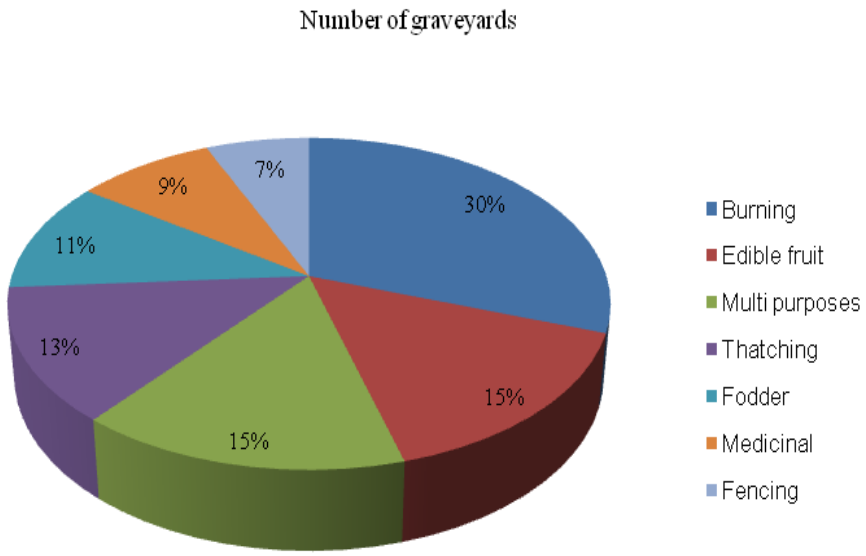

Fig. 6. Percentage of graveyards and usage of species

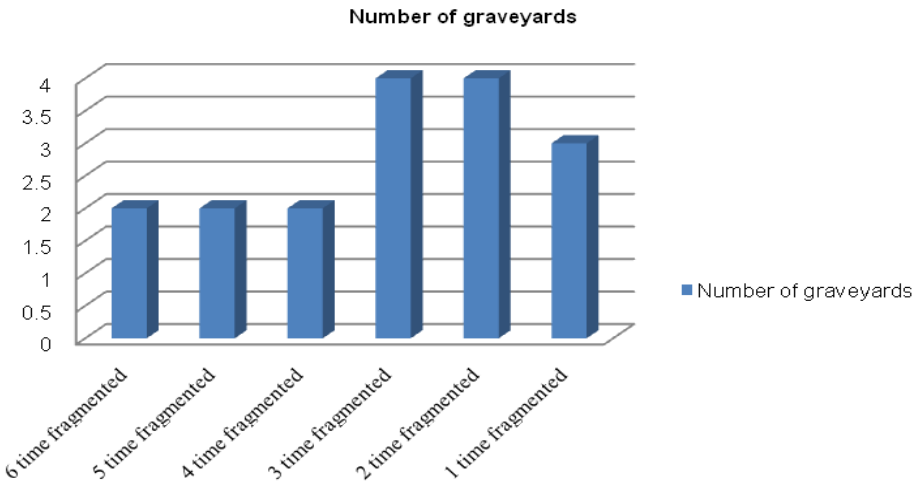

Fig. 7. Fragmentation status along number of graveyards

Fifty seven percent sites were found away from browsing and grazing activities by animals while forty-three graveyards were found directly grazing or browsing.

Graveyards administration

Out of 35 burial sites 68% were owned by communities (shamilat) while single person was the owner of other 32% graveyards. Fifty five percent graveyards were protected by wall around them 5% by fencing while other 40% were not protected by their surroundings. Plantation status: In 30 % graveyards various plant species were planted while in 70% there was not a single individual that was to be planted.

Table 1. Botanical name families' local name habitat status and native and exotic plants

No	Botanical name	Local name	Families	Habit	Fruit	Status	Nt/Ex
1	*Acacia modesta* Wall.	Phulai	Mimosaceae	Tree	NE	WI	Nt
2	*Ailanthus altissima* Mill.	Drawa	Simaroubaceae	Tree	NE	WI	Ex
3	*Broussonetia papyrifera* (Linn.) L`Herit. ex Vent.	Shehtoot	Moraceae	Tree	NE	WI	Ex
4	*Callistemon citrinus*	Bottle brush	Myrtaceae	Tree	NE	Pl	Ex
5	*Celtis australis*	Batkalarh	Ulmaceae	Tree	NE	WI	Nt
6	*Citrus acida*	Khatti	Rutaceae	Tree	E	Pl	Ex
7	*Cupressus sempervirens* L.	Saroo	Cupressaceae	Tree	NE	Pl	Ex
8	*Dalbergia sisso* Roxb.	Taali	Papilionaceae	Tree	NE	WI	Nt
9	*Diospyros lotus* L.	Kala Amlok	Ebenaceae	Tree	E	WI	Nt
10	*Eucalyptus camaldulensis*	Gond	Myrtaceae	Tree	NE	WI	Ex
11	*Eucalyptus globulus* Labill.	Gond	Myrtaceae	Tree	NE	WI	Ex
12	*Ficus carica* L.	Anjir	Moraceae	Tree	E	WI	Nt
13	*Fraxinus excelsior* L.	Sum	Oleaceae	Tree	NE	WI	Nt
14	*Grewia optiva* Drum. ex Burret	Dhamn	Tilliaceae	Tree	E	WI	Nt
15	*Juglans regia* L.	Akhrot	Juglandaceae	Tree	E	Pl	Nt
16	*Melia azedarach* L.	Dhrek	Meliaceae	Tree	NE	WI	Nt
17	*Morus alba* L.	Sfed Toot	Moraceae	Tree	E	WI	Nt
18	*Morus nigra* L.	Kaala Toot	Moraceae	Tree	E	WI	Nt
19	*Olea ferruginea* Royle	Kahoo	Oleaceae	Tree	NE	WI	Nt
20	*Parrotiopsis jacquemontiana* (Dcne.) Rehder	pashorh	Hamamelidaceae	Tree	NE	WI	Nt
21	*Pinus roxburghii* Sargent	Cheerh	Pinaceae	Tree	NE	WI	Nt
22	*Pinus wallichiana* A.B.Jackson	Biarh	Pinaceae	Tree	NE	WI	Nt
23	*Pistacia integerrima* J. L Stewart ex Brandis	Kangarh	Anacardiaceae	Tree	NE	WI	Nt
24	*Platanus orientalis* L.	Chinaar	Platanaceae	Tree	NE	Pl	Ex
25	*Populus alba* L.	Safeda	Salicaceae	Tree	NE	WI	Nt
26	*Prosopis juliflora*	Velaiti keekar	Fabaceae	Tree	NE	WI	Ex
27	*Prunus armeniaca* L.	Khobani	Rosaceae	Tree	E	Pl	Nt
28	*Prunus persica* (L.) Batsch.	Arhoo	Rosaceae	Tree	E	Pl	Nt
29	*Punica granatum* L.	Drunna	Lythraceae	Tree	E	WI	Nt
30	*Pyrus pseudopashia*	Tanchi	Rosaceae	Tree	E	WI	Nt
31	*Pyrus pashia* Ham. ex D.Don.	Batangi	Rosaceae	Tree	E	WI	Nt
32	*Quercus baloot* Griffth.	Rein	Fagaceae	Tree	NE	WI	Nt
33	*Salix tetrasperma* Roxb.	Beens	Salicaceae	Tree	NE	WI	Nt
34	*Thuja orientalis* L.	Thuja	Cupressaceae	Tree	NE	Pl	Ex
35	*Zizyphus mauritiana* Lam.	Ber	Rhamnaceae	Tree	E	WI	Nt
36	*Adhatoda vasica*	Bhaiker	Acanthaceae	Shrub	NE	WI	Nt
37	*Berberis lycium* Royle	Sumbul	Berberidaceae	Shrub	E	WI	Nt
38	*Berberis vulgaris*	Timbur	Berberidaceae	Shrub	E	WI	Nt
39	*Cotoneaster numularia* Fisch. & Mey.	looni	Rosaceae	Shrub	NE	WI	Nt
40	*Dadonaea viscosa* L.Jacq.	Sanatha	Sapindaceae	Shrub	NE	WI	Nt
41	*Daphnae oleoides* Schreb.	Kutelaal	Thymelaeaceae	Shrub	NE	WI	Nt
42	*Debregeasia hypoleuca*	Chinjli	Urticaceae	Shrub	NE	WI	Nt
43	*Indigofera heterantha* Wall. ex Brand.	Kenthi	Fabaceae	Shrub	NE	WI	Nt
44	*Jasminum humile* L.	Chamba	Oleaceae	Shrub	NE	WI	Nt
45	*Ligustrum compactum*	Lingustm	Oleaceae	Shrub	NE	Pl	Ex
46	*Mallotus philippensis*	Kameela	Euphorbiaceae	Shrub	NE	WI	Nt
47	*Prinsepia utilis*	Phulwara	Rosaceae	Shrub	NE	WI	Nt
48	*Randia tetrasperma*	Gangeri	Rubiaceae	Shrub	E	WI	Nt
49	*Rosa alba*	Gulab	Rosaceae	Shrub	NE	Pl	Nt
50	*Rubus ellipticus* Smith.	Grachha	Rosaceae	Shrub	E	WI	Nt
51	*Rubus fruticosus*	Kanachi	Rosaceae	Shrub	E	WI	Nt
52	*Rubus ulmifolius*	pukana	Rosaceae	Shrub	E	WI	Nt
53	*Vitex negundo* L.	Merwanni	Lamiaceae	Shrub	NE	WI	Nt
54	*Zanthoxylum armatum* DC.	Timer	Rutaceae	Shrub	E	WI	Nt
55	*Zizyphus oxyphylla* Edgew.	Phitni	Rhamnaceae	Shrub	E	WI	Nt
56	*Zizyphus vulgaris*	Sinjli	Rhamnaceae	Shrub	E	WI	Nt

Abbreviations: Wl= Wild, Pl=Planted, Nt=Native, Ex=Exotic, In=Invasive, E= Edible fruits, Ne= non edible fruits.

Discussion

Graveyards are well preserved sites and have forest patches that are dense than other forest patches in urban areas [28]. Over all 97 such studies about graveyards have been made from different Subcontinents [1]. Beta diversity of graveyards of Bannu Kpk was conducted by Kamran *et al.* [27]. Rahman [40] reported 106 plant species from burial sites of Bangladesh and among them 49 species were used as ethnomedicinal purposes. Ali *et al*. [41] work on burial places of Malakand and reported 20 species of native trees. Rahman *et al*., [34], reported 49 species from cemetery of Bangladesh. Molnar *et al.* [12] studied the graveyards from Albania and reported 29 orchid species and Molnar *et al.* [19] reported 17 orchid species from graveyards of Turkey. Ecological values of graveyards were also studied by Löki *et al.* [42] from Turkish graveyards and reported 86 orchid species. Shah *et al.* [29] studied the ethnoecological values of graveyards from Lahore city. Siddiqui *et al.* [30] studied the garden and parks of Lahore as green spaces and reported 94 species.

Similar native trees were documented by various authers from different burial areas like *Azadirachta indica* and *Dalbergia sissoo* [34], *Morus alba, Acacia modesta* and *Melia azedrachta* [43], *Juglans regia, Ailanthus altissima, Olea ferruginea, Celtis australis, Platanus orientalis* and *Prunus armeniaca* [44], *Pistacia integerima, Punica granatum and Pyrus pashia* [45]. According to Rutkovska *et al.,* [33] many species like *Erigeron Canadensis* etc are planted in cemetery and according to Rahman *et al.* [34] various medicinal plants species are planted in graveyards. From the cemetery of Campbell town Sydney total 77 planted species were reported by McBarron *et al.* [36] and majority of planted species in graveyards were ornamental plants [46]. Twenty-nine ornamental species were reported by Rutkovska *et al.* [33]. Such plantation in graveyards encourages the native flora of the area.

Plant regeneration is a natural process and various native species like *Pistacia integerima, Olea ferruginea, Pyrus pashia etc.* similarly reported by Hussain and Ilahi [45] and 428 naturally growing species reported by McBarron *et al.* [36] from cemetery of Sydney and regenerating rate of invasive species like *Broussonetia papyrifera* etc. is faster than the native species [7].

Invasive species are a great problem for the conservation of native species [29] and these are introduced in graveyards by anthropogenic activities [33]. From burial grounds 49 invasive taxa were documented by Rutkovska *et al.* [33] while Andrabi *et al.* [39] reported maximum invasive taxa belonging to family Asteraceae from graveyards similarly. Browsing and grazing inhabit the budding of plants species in graveyards and suppress the bushes and tree diversity [19]. Construction works in different area cause the rapid destruction of biodiversity and only such green spaces are the hope of native tree conservation in cities [29]. Globally 32% earth is under pastures or crop lands and native coverage is disturbed by agricultural practices [47]. Graveyards are sites that can contribute to conservation of biodiversity [15].

Conclusions

Graveyards acting as remnant habitat patches in agricultural and compact urban landscapes are the model green spaces for biological conservation. Fifty-six plant species belonging to 31 families including 12 planted and 44 naturally growing species were reported from graveyards of Mansehra. There is significant ratio of regenerating individuals of tree species and, about fourteen tree species show more regenerating individuals than mature one.

Native tree diversity in the burial grounds, however, faces various problems like fragmentation, suppressing regenerating plants and invasion of invasive species like *Broussonetia papyrifera* and *Ailanthus altissima.* Old individuals of native species *Celtis*

australis, Olea ferruginea, Pistacia integerrima, Quercus spp. and *Morus spp.*, can be seen in graveyards and may be able to protect native tree diversity in agricultural and compact urban landscapes and can enhance the growth of key stone species. They should be managed scientifically by active participation of communities and local government for the future protection of native flora.

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