JUNIPER FORESTS OF BALUCHISTAN: A BRIEF REVIEW

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Abstract

Juniperus excelsa M. Bieb is the only conifer tree in Balochistan province of Pakistan. It is listed as a threatened tree by IUCN Red List in Pakistan. These forests and their associated plants and animals constitute a unique forest ecosystem; unfortunately, these forests in the northeastern region of Balochistan are degradating due to increased human population, poor regeneration, illegal cuttings, over grazing, agricultural land extension, canopy dieback, mistletoe attack, and periodic drought. Rehabilitation of these degraded forests land needs to be monitored over a long period of time with collaborative efforts and support from different related governmental organizations, as well as local inhabitants. Silvicultural practices and sustainable management must be adopted as tools for rehabilitation with floristic, ecological, and socio-economic interest. In the present study, the main objective is to indicate the major threats and recommend the appropriate silvicultural treatments in order to preserve and increase this species (*J. excelsa*) located in the Ziarat valley of Baluchistan. Under present conditions *J. excelsa* exhibits an adequate recruitment and does not face any immediate danger. However, if grazing does not stop in the future, *J. excelsa* may be replaced in better sites by more competitive species. In order to preserve an important component of the landscape such as *J. excelsa* stands and the integrity of ecosystem diversity, forest practice must imitate the impact of grazing and tree cutting in better sites. Intensive grazing must be avoided due to the negative effect upon the soil, juvenile seedlings, and microclimate. A forest management system that enables the original stands to survive and regenerate must be undertaken without delay. Moreover, the density of *J. excelsa* tree can be increased through specific silvicultural techniques such as the re-planting of drought tolerant exotic trees and Juniper.

Introduction

Juniper forests and their associated plants and animals constitute a unique ecosystem, in the arid mountains and harsh environmental conditions of Baluchistan province, Pakistan. These forests are considered to be one of the worlds largest and oldest and extremely slow growing, drought resistant, with poor natural regeneration. Therefore, they were often termed as a "living forest fossil"(Sheikh, 1985). According to Kew Herbarium classification there are 54 species of junipers occurring in North America, Europe, North Africa, West Asia and Central Asia and South Asia. Six of these including *J. excelsa* are found in a mixture in northern Pakistan (Farjon *et al.,* 1992). Balochistan has one of the largest remaining tracks of pure *J. excelsa* forests in the world that has global significance. They encompass an area approximately 141,000 hectares between elevations 2000-3350 m in almost pure forms while *Fraxinus xanthozoiledus* which are also found very rarely particularly along the stream beds (Beg, 1966). The most extensive (100,000 hectares) and the best known examples are found in the Ziarat and Zarghun range near Quetta. The other big blocks of juniper forests are in Herboi hills of Kalat district and northern part of Pakistan. Yet its distribution is comparatively confined to a small area (Atta, 2000a). Most of the juniper forests have an open canopy and can attain a height of 20m and has the ability to grow on shallow and stony soils in severe environments (Fisher *et al.,* 1995; Fisher, 1997).

Juniper woodlands provide construction materials and fuel wood, grazing pasture, conserve soil erosion, increase soil fertility by adding humus and other inorganic nutrients. It recharges the underground water, increases water table as snowfall and rainfall percolate into the soil, reduce the aridity by transpiration, purify the air by addition of oxygen and improve microclimate of the area. In addition, these forests also have recreational, scenic, tourist and climatic moderating values not only for local population but also for the inhabitants of the entire country as well as the world at large. They are the habitats to a variety of families, genera and species of living organisms and regulate multiple natural processes. The local populations obtained non- woody products such as decay resistant and aromatic woods, barks for roofing, pharmaceutically important berries and medicinal plants for traditional treatment. These forests as part of the global forest vegetation also play a vital role in storing amounts of carbon in its biomass and soils (Johannesburg Summit, 2002).

Juniper Area: In Balochistan juniper area is located in the northeastern region of Ziarat District. They occur at elevations between 2000-3,350 meters and geographically extend between Latitude 30° 18' N to 30° 30' N and

longitude 67° 54' E to 67° 57' E. The highest peak in the study area is Koh- Khalifat 3,475 m. The area is composed of irregular rugged ridges with steep terrains comprising several narrow valleys, running from east to west. The climate of the project area over the greater part is of dry temperate type (Champion *et al.,* 1965). The area is also characterized by extreme cold during winter and is refreshingly cool and pleasant in summer (Holdridge, 1947) .Snow falls from December to March and frosts are frequent (Khatak, 1963). Mean annual precipitation of is about 282 millimeter/yr is mainly received during winter in the form of snow (Ali, 1966; Ahmed *et al.,* 1990b) The highest snow fall of 82 centimeter reported in February 1977-1988. Some showers also occur in July and August.

Temperature extremes are characteristics feature of the climate with mean maximum temperature of 28°C in July and August and mean minimum temperature of -9 C° in January. The highest average relative humidity of 67% occurs December, while the lowest of 23 % in October. The average wind speed is 132 km/ hr. Winds are strong and quit common in September and October .Geological substrate include sedimentary rocks, ranging from Cretaceous to recent in age (Shah, 1964). Because of inadequate rainfall, only physical weathering of the rocks has occurred. About one third of the area is comprised of bare rocks where soil is either absent or confined to a very shallow lithosols. Over the rest of the area soil is shallow, light gray brown with a surface covering of gravels. Parent material in the area is shallow with limestone soil where erosion is common.

Forest degradation, threats and negative effects: The area of *Juniperus excelsa* forest in north-east Baluchistan has a long history of over exploitation and degradation. At present, there are some major threats indicating both humanitarian and natural pressures of degradation in different regions of the province, however, there are no statistics or quantitative data on its extent and severity. The factors that constrain the developing natural forests of Baluchistan are the lack and variability of rainfall in drought conditions which can not support the growth of the plant and seedlings. Other major factors such are illegal cutting for timber; selective felling of poles for graveyards and embankments, debarking of juniper trunks for thatching of hutments, branch cutting for fencing of agriculture fields and for hedges of sheepfolds are the main reason. Beside this low investment, unorganized tourism, lack of awareness, lack of co-ordination and experimental research especially on the seed germination, nursery raising and reforestation on the degraded sites are the major problems. Other factor that can account for the degradation and depletion of juniper ecosystems is low capacity of natural regeneration, however, Ahmed *et al.* (1989a) denied it. According to them increased human population pressure for fuel wood collection as need for domestic energy especially during the winter season, over grazing extensive forest clearing for cultivation without replanting, housing construction, uncontrolled recreational facilities and camping activities are responsible for forest degradation. These factors destroy not only the regeneration capacity, vegetation cover, but also make the soil material susceptible to soil erosion. Increase urbanization, recreation areas and climate change especially the effect of drought factors lead to degradation and a lack of juniper regeneration in many stands in Baluchistan.

The number of forestry specialists in Baluchistan is considered very low relative to the programs to be implemented in this area. These include inventory of forest areas, the evaluation, development and monitoring of activities. In other words, there are not enough qualified foresters to handle the forest expansion or reforestation programmes that the State would like to implement (Juniper conference, Kyerghistan, Atta 2000b).

Ahmed *et al.* (1989a) conducted an extensive study at sixty different locations of juniper track showing an average 50 seedling ha^{-1}. They indicated that at early stage juniper seedling required shade. They also concluded that despite some degraded stands due to various factors mentioned above the juniper forest in general, are not deteriorating in Ziarat District of Balochistan. Wardle (1969) also showed that low number of seedling do not necessarily mean that stand is deteriorating. However, prompt actions is necessary to promote regeneration in these forests.

During the last few decades over exploitation and excessive harvesting of wood and or non wood forest products, poor management, repeated fire, spread gaps of forest cover, overgrazing, land uses or other disturbances and extreme drought have brought a drastic change not only in vegetation composition and regeneration patterns but also increased the rate of soil erosion and decreased soil productivity (Atta.2000). Majority of the stands of juniper population looks like disturbed over mature, open, fragmented and less productive. Many areas have been overgrazed and replaced by *Artemisia* species, grasses, and other less desirable vegetation.

According to Smith *et al*. (1997) in an applied science such as silviculture, in the absence of total knowledge we are always condemned to act on the basis of thoughtful judgment. In order to achieve sustainability in forest management, ecologists have to understand the historic forces that have shaped forest ecosystem and work with mechanisms by which ecosystems sustain themselves Kohm and Franklin, (1997). A major factor which determined the structure and character of forest ecosystems to a great extent is the disturbance. The best way to create a definite stand structure to imitate the disturbance that creates that structure in natural forests is to carryout a quantitative vegetation analysis (Smith *et al.*, 1997). Moreover, Drafis (1989) claims that a forester analyzes the previous growth history and dynamics in order to estimate the future

development before the application of any silviculture operation. It is the easiest way to choose the correct siviculture treatment in order to deliberately guide forest structure to a direction which will best serve the management goals. Except for the traditional management goal of timber production an objective which siliviculture serves is the preservation of some locally or globally important ecosystems or species.

In the present study, the main objective is to indicate the problems of juniper forests degradation, its form and causes and suggest efforts for rehabilitation, and to recommend the appropriate silvicultural techniques in order to preserve and to increase *J. excelsa* forests located in Ziarat district of Baluchistan.

Fig.1. Juniper stand overgrazing

Fig. 2. A Juniperus Stand with a cut Stump

Fig.3. Juniper tree with fungal attach *Pyroformes domidofii*

Fig. 4. A juniper tree with Die-back.

Fig. 5. A juniper tree with Dwarf mistletoe (*Arceuthobium oxycedri*)

Fig. 6. Brooms of Dwarf mistletoe (*Arceuthobium oxycedri*)

1. Seed characteristics and regeneration: Zaman *et al.* (1968) studied juniper barriers in Ziarat area. According to Ahmed *et al* (1989b), over mature trees produced low quality seeds. In addition only 13 to 31% seeds contain embryo in which most of them are not viable due to abortion in early stage of development. In addition most of the seeds produced are destroyed by birds, rodents, borers, drought and soil erosion. However despite these factors, juniper trees produced large amount of barriers which provide a balanced seedling size structure which needs to be maintained with a proper management plan (Ahmed *et al.,* 1989a).

Atta (2000a, 2004) mentioned that the hard seed coating, premature death of embryo, the impact of arthropods on cones and seeds, and low seed germination are the main causes of decreased natural regeneration of juniper forests. Garden and Fisher (1994) stated that human disturbance, grazing pressure, fires and climate change are the factors that could lead to poor regeneration of juniper woodlands on the Arabian Peninsula. This is true as natural regeneration is a feature of forest trees in their natural habitats and requires suitable environmental conditions for seed production, germination, and growth (Margolis and Brand, 1990). Some researcher attribute the low capacity of the natural regeneration in juniper forests to biological stress caused by specific seed sucking insects damaging cones (Hajar *et al*., 1991). Other reports accuse tourism, stating that unplanned activities and development of forest sites for recreational purposes have reduced the capacity for regeneration, produced solid waste problems and polluted forest water resources (IUCN, 2008). In general, harsh climatic conditions limit forestry potential and restrict regeneration once forests are degraded (Sheikh, 1985). Similar situation was experienced by Ahmed *et al.* (1990a) at juniper forest of Rodhmollazai, Balochistan, where due to extensive logging, overgrazing, soil erosion and extremely low patchy ground flora, no regeneration was recorded.

2. Overgrazing: The nurse vegetation on the ground that protects the young seedling in their early stage of development are destroyed by grazing animals. According to Ahmed *et al* (1989b) young seedling and smaller juvenile juniper plants with their sharp aciculate leave, would probably not be grazed, but they could be damaged, smashed or killed by animal ponderous tread or trampling. In addition, in an extreme drought

condition goats may uproot young juniper seedling. Deteriorating impacts of goat grazing on natural vegetation has been discussed by many workers. These works always allow and recommend other domestic animals due to their way of grazing. Therefore goat grazing should be either keep strictly under control, minim or should be banned in these forest. However sheep and other domestic animal may be recommended for control grazing since they do not uproot plateable vegetation.

Uncontrolled overgrazing refers to letting animals browse in forest land regardless of their species or the number of the maximum period in which the land can support such numbers. Animals eat the terminal of the young seedling, the small trees or the green twigs; This all results in malformation or stunted forms of the plant. If the numbers of effected trees are higher, this would reflect on the whole forest by lowering in its productivity and regeneration capacity. In addition due to destruction of vegetation of forest floor, forest land may be eroded, due to shifting of tap soil during rainfall. Overgrazing is major impediment to the regeneration of juniper forest and it is one of the main causes of die off and die-back (JAICA, 2002). The palatable shrubs, herbs and nurse plant have suffered and reduced to small, dense, individual clumps with poor infiltration which not only increase the soil erosion but also change the microclimatic condition, reduce soil fertility and expose the young juniper seedling to direct sunlight which create unsuitable environment for young seedling survival. Similarly, overgrazing and over extraction of green fodder, both lead to forest and land degradation through loss of vegetation and physical deterioration in the form of top soil compaction. It also reduce the porosity, fertility, productivity, reduce infiltration and increase soil erosion (National Action Plan Program of combating, desertification, India, 2003).

Ogden and Powell (1979) concluded that grazing may have caused the relatively sparse and patchy regeneration which increased the rate of mortality due to the increased competition in these patches. Sundquist (2008) addressed an additional possible adverse effect of overgrazing. According to him overgrazing in open forest results in replacement of grasses by woody shrubs. Fires in shrubs destroy the trees, while fires in grasses are harmless and restore the trees in a physical semiarid forest.

3. Illegal cutting: Forests provide a flow of benefits such as timber, non wood forest products, carbon sequestration and wildlife habitat (Lipper, 2007).However, threats such as over cutting of trees due to high pressure for fuel wood collection for domestic energy, charcoal for heating in winter and for cooking all over the year, lopping, debarking for hutments, selective timber for building construction and urban expansion *etc*. can result in the substantial reduction in this flow and ultimately the whole forests disappear.(El-Juhany *et al.*, 2008).

At present, juniper stock density is reducing at a very alarming rate. According to the working plan, (1961) the total standing volume of the juniper stock was 63 millions cubic feet, out of which approximately 27 millions cubic feet are now available (Atta, 2000). If the present state of overexploiting and harvesting is continued, this forest resource which is not only a rare genetic resource but also one of a natural heritage, would completely disappear within the next two or three decades (Khattak, 1963). To regulate or restrict this process, the federal government of Pakistan has provided the supply of natural gas to the communities' inhabiting in and around the Ziarat juniper forests of Baluchistan since the gas prices are not stable and increasing rapidly. Due to lack of implementation of law in remote areas people still are depending on forest for fuel wood. Wood cutting is likely to continue despite the existence of protection legalization. Unfortunately, in the past, the cutting was restricted to only few trees or even some branches and only at need, but now large areas of forests cover is clearing for expanding agriculture land or assibilation houses and economical enterprises. Urbanization started to place not only the forests but the agriculture land too. They begin as small scale then expand more and more via clearance to extensive cutting of trees, overgrazing or fire. There is an apprehension losing of the forests at the end (Aref and El-Juhany, 2000).

4. Die-back: Dieback is the top drying diseases of *J. excelsa* in many valleys, possibly due to continuing climate change, over maturation. The features of the deterioration of juniper forests can be seen in large areas. Most of the forests lost their trees and other areas stricken by die-back where many of their trees are partly or completely dead (Atta, 2000a). Die-back effects juniper trees and considers the main problems facing the forest lands not only in Pakistan but also in other parts of the countries. Fisher (1997) proposed four hypotheses for the decline of Arabian Juniper woodlands. The four hypotheses depend on climate change and were overgrazing, global warming, periodic droughts combined with long regeneration cycles and a long term increased in aridity.

It may also be due to change in forest margin. Due to cutting trees growing on forest margin are taken away in the beginning marginal trees normally grow in extreme condition providing safe guard to the trees growing in side the forest. Removal of these trees create sudden extreme condition for trees growing close to the inner margin which are not use to these situation resulting upper branches of the trees start dieing. Therefore it is important to save tree which are growing on the margin.

The other reason may be the effect of overgrazing and soil erosion which reduced the soil fertility, change microclimatic condition, increased direct evaporation of moisture from the ground surface, exposed bare rocks

which received direct sun light and warm-up quickly. Due to these reasons plant unable to provide nutrients and water to its upper branches. The problem of die-back in Baluchistan juniper forests still needs to be explored. However, it might be due to the attack of composite fungus or certain unknown study not such as genetic reasons (Ceisla *et al.*, 1998).

5. Forest fire: Forest fires occur due to either anthropogenic or natural causes. The majority of the fires around the globe are caused by human activity. Lightning is probably is the most natural cause of fire (WWF, 2000). They cause considerable loss of forest cover, alter the structure and composition of forests, opening up areas to invasions by fast colonizing alien species and threatened biological diversity. Forest fire can cause health hazards for the inhabitants as respiratory and other pollution related ailments such as asthma, bronchitis and pneumonia as well as eye and skin problems.

Forest fire in the region of north-eastern Baluchistan has become more frequent lately. They consider a major threat to the plant cover as a whole and especially the natural forests. Fire has distinct effects on species composition of the forest, as the sensitive plants such as the conifers which are rich in resins may disappear while the broadleaved trees that can resist fire remain. In addition fire kills young seedling and nurse plants. Note that forest fires historically are considered one of the elements of environmental equilibrium, and rarely accounted for the main causes of forest degradation. So the problem is with those forest fires that are mostly started intentionally by people for a purpose.

6. Diseases: Zakaullah and Badshah (1977) and Sheikh (1985) reported that diseases, low fertility, low viability, and slow rate of growth are responsible for low rate of regeneration in *Juniperus excelsa* forest. According to Atta (2000b, 2004) invasion of alien plant species, the attack of natural diseases and seed sucking insect's species have significant adverse effects on the health and productivity of these forests. Zakaullah (1978) reported that 33 % of largest trees are destroyed due to destructive fungi (*Pyroforms domedofii*). Similarly unique dwarf mistletoe (*Arceuthobium oxycedr*i) kills the host juniper trees from 2-4 % annually and reducing the seed quality and productivity (Atta, 2000b). This obligate parasitic seed plant of angiosperms which entirely dependent on their host plant (*Juniperus excelsa*) for protection, nourishment and reproduction and cause substantial reductions in host growth, extensive host mortality, and creating major adverse impacts on the health and productivity of forest Ecosystems. This distractive plant parasite has brought many drastic changes not only in the composition, structure and regeneration patterns but it may also damage our ecological, economical and environmental areas in the future.

The first report of A. *oxycedri* in the Ziarat Forest was presented by Beg (1973) who discovered this parasite in the Sasnamana Valley, the north east of Ziarat, as a part of Ziarat forest disease survey, initiated by Pakistan Forest Institute of Peshawar. A second report (Jamal and Beg. 1974) suggested that the parasite had been present in the area for some time but was overlooked because the aerial shoots mimic the foliage of its host plant. There are reports dating back to the 1920's which indicate that local residents of the area knew the existence of this plant and collected the aerial shoots to feed their livestock. However, they were not aware that plant was a parasite and capable of killing the juniper. The practice of using *A. oxycedri* shoots as fodder was mentioned by Zakaullah and Badshah (1977) who expressed concern that this practice might spread the parasite.

In Pakistan, *A. oxycedri* presently occupies a single area of approximately 7000 ha in the Chasnak and Sasnamana valleys. This represents less than 6% of the total area of juniper forests in Ziarat and adjoining areas. The Juniper dwarf mistletoes (*A. oxycedri*) in currently cover much of the headwaters of Chasnak and Sasnamana valleys in Ziarat juniper forests. The intensely of infection was more severe in Chasnak valley than Sasnamana valley. This is reflected in percent of infection and area Dwarf Mistletoe Rating (DMR) for the two valleys. In the infested portion of Chasnak valley an estimated 34% of trees are infected with a mean area dwarf mistletoe rating (DMR) of 1.68. By contrast an estimated 29% in the Sasnamana valley are infected with mean area (DMR) of 0.90. The reason for differences in infection rate may be related to forest conditions between the two valleys or the fact that dwarf mistletoe control program was conducted in Sasnamana valley between 1978 and 1983. Higher elevation range (2800-3000m) and south western aspects appeared to show the highest incidence of infection in both valleys.

Rehabilitation Needed: Forest rehabilitation is a management strategy applied in degraded forest lands that aims at restoring the capacity of a forest to produce products and services. The rehabilitation of degraded forest land is often severely limited by a lack of spontaneous regeneration of tree and shrub species is severely limited (Teketay, 2004). The following points may be useful to be taken in account for successful rehabilitation action:

- To establish an independent authority responsible for planning supervision, evaluating and monitoring the care of the forest and development in Balochistan.

- Raising awareness for the public that supports the rehabilitation tailored to the needs of the local community, the needs and concern on conflicts of interest between stakeholders should be taken into account.
- It must be emphasized that the setting of any objective must be done with the involvement, the primary stake holders and have their full agreement.
- Encourage research into all disciplines related to forests, forest land and their conservation and rehabilitation.
- To stop the causes of degradation (e.g., prevent intensive cutting, grazing, fire; hunting and reduce *etc.* human access to the forests).
- Forest management plans that involve reduced human access to the forest must, therefore, include alternative means of achieving a sustainable livelihood for forest-dependent population (Lipper, 2007).
- To use native species in reforestation process, where appropriate. Include regeneration of degraded forest species.
- The rehabilitation of degraded forest land can be done by facilitating natural regeneration through measures such as protection from cornice disturbance, site stabilization or water management.
- Native species are adapted to the local environment and, may be less susceptible to stress, serious disease, and pest damage. Local people are more familiar with their native plants and have more uses for them (Evans, 1982).
- It is important to study the socio-economic impacts of land and vegetation degradation on local population, and carry out awareness raising activities in this domain and determine the cost of rehabilitation and presenting the findings to the decision makers.
- To extend forestry educational reform, promote forestry education and raise the quality and benefits of forestry education. To increase and improve the condition for forestry education and strengthen vocational forestry technical education.
- Monitoring, evaluating and sustainable management are the key issues in the success of the whole work and its different activities.
- Collaborate with the local community to improve the resource management on more scientific lines and to communicate the results of this integrated project to a wider research community and particularly to the donor agencies and decision-makers are the keys to the success of such projects.

Government Efforts toward Rehabilitation: Rehabilitation program for degraded sub Saharan land of Africa was presented by Taketay (2004). The Government of Balochistan has also laid down very clear guidelines, rules and regulation of the native vegetation. The objective of the forestry and range law and it's by laws to control and regulation was passed on the following.

a. Forests in fragile habitat susceptible to deterioration can not be exploited.
b. Forest areas in valley bottoms cannot be exploited for farming.
c. Areas with more than 40 parent slope cannot be cropped or cleared.
d. Areas used as control of send encroachment cannot be exploited.
e. Tree cutting and uprooting of plants in their native habitats for fuel were regulated. Only people with special permits from the Ministry of agriculture are allowed to cut the plants for specific needs.
f. Burning was completely forbidden in forest and range lands.

Silvicultural treatments: In the present condition *J. excelsa* exhibits an adequate recruitment and does not confront any immediate danger however, if grazing not stopped in the future. *J. excelsa* will be replaced in better sits, by more competitive species having greater site sensitivity. In order to preserve *J.excelsa, stands*, and forest practice must imitate the impact of grazing and illegal cutting in better sites. Uncontrolled grazing must be avoided due to sedative effect upon the soil (compacting, erosion). Moreover, through species silvicultural treatment the density of *J. excelsa* trees has to be increased.

First of all, in the cases where *J. excelsa* trees of small dimensions intermingle with other and species plant we must release sapling from competition through the gradual cutting of other species competitive shrubs/trees. In the case of *J. excelsa* group, the basic objectives are (A) to give the shaded juniper saplings enough light and growing space to grow adequately and develop into larger tree and (B) to stabilize, strengthen and enlarge these groups though the redistribution of growing space. This procedure may be accomplished in two successive steps according to the dimensions and the density of the groups.

Step 1: To prune the dense branches in the lowest stem part of some juniper tree in the case when under these trees are other *J. excelsa* sapling.

Step 2: To apply successive thinning in which the very suppressed and in any way damage trees of the group will be remove.

Step 3: The thinning severity must be very light and the tree removing (cutting) procedure has to be very gradual in order to avoid the abrupt impossibly cause a physiological shock. According to Ahmed *et al.* (1989a) shaded Juniper seedlings in Baluchistan failed to survive when canopy cover was removed.

Step 4: The density of groups has to be retained to such level so as to preserve the microhabitats level to favorable microclimate, adequate amount of nurse plant litter, improved soil condition and high soil fertility which are created under the *J. excelsa* groups throughout the whole process of thinning (Drafis, *et al.* 1989).

The benefit which will derive from the above mentioned silvicultural treatments is the preservation of a) an important component of landscape such as *J. excelsa* stands and b) integrity of ecosystem diversity, which is crucial for ecosystem stability and for the natural heritage conservation of the area and species.

Recommendations for conservation and Management: Establishment of net work of national parks and buffer zones throughout the juniper forestland is immediate concern. Legally this national park should be divided into three different zones.

A. Reserve: in which all economic activities must be prohibited
B. Preserve: in which limited tourist activities to be allowed
C. In which all the promotion regeneration activities such as seed germination, nurseries rising and tree planting trail should be conducted basis.

- Base on the right and obligations, local people to take great responsibility for forest management, offering them increased right in return for increased responsibility.
- Community members and rural farmers must be trained for nursery rising and plantation schemes along the water streams for timber, fuel and forage, in order to fulfill their own requirements.
- Selected watersheds should be completely fenced for ecological studies on natural recovery of degraded ecosystem.
- Grazing must be restricted to the specific areas of the forest *i-e* grazing not to be allowed in the tree regeneration block.
- Control mistletoe diseases by removing and burning of heavily infested trees and pruning of infested branches from highly infested trees. Investigations by university students should be encouraged.
- Promoting natural regeneration by seed as well as by layering system with indigenous tree species on the degraded sites and also provide alternate fuel on subsidized rates to the local population in order to save this unique biological heritage.
- Refill the gaps within the forestlands with the same prevailing native tree species. These may be growing slowly but their successful percentage will be high if they receive proper care. Same species should be planted on forest boarder as a wind breaker.
- Stop opening roads in the forestlands for recruitment activities. It is more beneficial to open success to the remote sites inside the forests in order to develop them and /or control fires.
- Restore the agriculture terraces that were degraded due to abandonment or as result of severity of rain. This is important to conserve and make use of the rain water in order to not leak away from trees and other plants.
- Intensify the informative programs in the media (TV, press, broadcast and others) about the importance of forests and the necessity of conserving them. Also, holding symposium and scientific meetings the development and conservation of the natural forests and it is of great benefit to invite experts in this field from inside and out side the country. University scientists should be involved with proper funding to solve various forest related problems.
- Define sites and name of the forests and fixing advising signboards near by them for restricting cutting, lighting fires and all other illegal actions. It is also important to produce maps for these forests to be lodged at the different related authorities to secure them against any encroachment.
- Develop the skills of the specialists on the field of planting trees through training programs under supervision of experts.
- Ensure enough measure for forest fires; as observation towers, water tanks, and all means of control fire, in addition to training the fire man to cope with such fires.

Conclusions

In conclusion, majority of the stands of juniper population looks like disturb, over mature, open, fragmented and less productive. Many areas have been overgrazed and replaced by *Artemisia* sp., grasses and other less desirable vegetation. It is concluded that despite the considerable anthropogenic disturbance, overgrazing and site conditions, *Juniperus excelsa* still has sufficient recruitment. Rehabilitation of the degraded forest land needs to be monitored over long period of time, collaborative efforts and support from different related universities departments/governmental sectors as well as local inhabitants. Silvicultural practices and sustainable management must be adopted as tools for rehabilitation with floristic, ecological and socio-economic interest. Consequently, if conservation and management scheme for *J. excelsa* forests were put into action soon, this unique heritage could be safeguarded for future generations.

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