

Forest-Rangeland Ecotones in the Highlands of Balochistan, Pakistan

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The juniper and chilghoza forests in the highlands of Balochistan are important parts of the ecosystems providing numerous ecosystem services and livelihoods to communities. These forests grow at high mountain areas under arid and semi-arid climatic conditions, and harbour unique assemblages of flora and fauna. At different altitudes, these ecosystems exhibit clear ecotones of forest and rangelands. Overgrazing, removal of vegetation for fuelwood, overexploitation of non-timber forest products, and lack of policy and regulations are affecting both the ecosystems. The interface between the forest and rangeland ecosystems is little understood. Further studies are required on the various ecotones in Balochistan.

Keywords: Balochistan; chilghoza pine; forest-rangeland ecotone; juniper

Introduction

Pakistan extends over an area of 80 million hectares of which rangelands occupy around half of the area located mostly in arid and semi-arid regions and forming the major land use type. Around 80% of the land area of Balochistan is rangeland (Ahmad and Islam 2011). In Balochistan, animal production is heavily dependent on grazing resources; the rangelands support 22 million heads of small ruminants providing more than 80% of the feed requirements, and are a significant socio-ecological factor in pastoral livelihoods. The rangelands also provide ecosystem services like carbon sequestration, fuelwood for household energy, nutrient cycling, biodiversity and wildlife habitat, and ecotourism. Unfortunately, in Balochistan these vital natural resources have attracted only limited attention from researchers and very little policy support (Ahmad et al. 2012), and millions of pastoralists remain highly vulnerable to poverty.

Rangeland degradation is a major issue in Balochistan causing environmental problems, ecosystem instability, threats to floral and faunal biodiversity, adaptive changes in traditional pastoral livelihood patterns, including migration routes, and increased vulnerability of poor pastoral communities (Ahmad and Islam 2011; Ahmad et al. 2012). Climate change is now accepted as a reality, with increasing concentrations of greenhouse gases in the atmosphere being a major factor. The predicted scenarios could lead to changes that are significant for

pastoralists, including changes in the length and timing of the plant growing season and changes in the amount and seasonal pattern of precipitation. Rangeland-based adaptation strategies, such as seasonal grassland reserves, revival of traditional grazing systems, and development of forage reserves, are likely to benefit vegetation and soil carbon sequestration and have the potential to play a role in both adaptation to and mitigation of climate change.

Rangelands, particularly in mountain areas, are a major source of fuelwood for household energy. Traditional household energy needs in remote mountain areas are generally met from rangelands as forests are scanty. Small to large shrubs are collected by the pastoral communities for cooking and heating. In the mountains of Balochistan, *Artemisia* is the major species collected for fuel. There are no statistical data describing the actual fuelwood requirements from rangelands, but it is clear that the pressure on rangelands for fuelwood has increased tremendously over the past 20 to 30 years. In Balochistan, contributing factors include the political unrest and recent outmigration of pastoral communities. The people living in the mountain rangelands are particularly vulnerable to climate change and have adopted strategic initiatives such as outmigration and changes in traditional animal production systems. Nomadic and transhumant livestock production systems in Balochistan have evolved over centuries; they involve transboundary seasonal movements of herds and flocks between the downstream plains and the mountain valleys and uplands, from Sindh province to Afghanistan (FAO 1983). There has been a decrease in the relative proportion of the mobile livestock population over the last four decades as a result of changing land use and increasing population, but they still constitute more than half of small ruminants and contribute substantially to the household economy of mountain people through sale of livestock, hides, and wool.

There are different types of pastoral systems operating in Balochistan, but availability of livestock feed round the year is a major issue in all of the systems and mobility is a crucial factor. Pastoralists are compelled to use opportunistic grazing early in the season when grass is not at the optimal growth stage, which has a detrimental impact on both productivity and ecology (Ahmad et al. 2012). Mobile herds and flocks are rarely provided with full immunization despite their higher potential to spread diseases through seasonal migration. Similarly, livestock health, production services, marketing systems, and capacity building are mostly out of the reach of landless mobile herders. Economic and food security opportunities can be supported by strengthening pastoral livelihoods through promotion of, and appropriate policy support for, appropriate forage and energy technologies and capacity building of pastoralists for resource-based value chain development for adapting to and mitigating climate change. This paper deals with current state of the forest–rangeland interface, especially in semi-arid tracts of Balochistan, major management issues, and the way forward.

Forest-Rangeland Ecotones

Ecotones

Ecotones or the forest-rangeland interfaces represent important biological processes. Many fundamental processes and functions occur at biological boundaries at different scales. A treeline is the boundary of the habitat in which trees are capable of growing. Beyond the treeline, they are unable to grow because of inappropriate environmental conditions. An ecotone is a transition area between two adjacent ecological communities or ecosystems. The timberline ecotone below the treeline represents the transition zone between continuous forest and rangeland (Solaimani and Shokrian 2011). Ecotones can influence the fluctuation of materials and energy in the landscape and can be early indicators of ecological reaction to environmental change (Di Castri et al. 1988). The determination and monitoring of ecotones plays an important role in understanding biodiversity distribution and conservation. Ecotones can be classified as ‘environmental’ or ‘anthropogenic’, resulting from natural or human-induced environmental transition over space (Walker et al. 2004). The transition with altitude from dense forest to the rangeland represents an ecotone gradient relating to increasingly harsh environmental conditions (Smith et al. 2003). Local scale environmental factors such as topographic complexity, geology, disturbance patterns, and biotic interactions also influence its relevance (Wu et al. 2007).

The forests of Balochistan

The juniper (*Juniperus excelsa*) and chilgoza pine (*Pinus gerardiana*) forests in the highlands of Balochistan are important ecosystems for the provisioning of ecosystem services and livelihoods to communities, but they are highly threatened. So far, no attempt has been made to analyse the interfaces and ecotones in these important ecosystems. The main objective of the present study was to define the main forest-rangeland ecotones in Balochistan, in the expectation that they will be studied in more detail for future conservation.

The study was carried out within timberline ecotones in the Suleman ranges near Zhob (31°37′10.13″ N, 69° 52′ 26.43″E) and in the Ziarat area (30°23′06.79″N, 67°43′40.90″E). The region has a Mediterranean climate, characterized by cold winters and hot dry summers. Annual rainfall varies between 250 and 450 mm with heavy spells of snowfall during winter.

Juniper woodland is the most common forest type in the high mountainous areas. The juniper and associated diversity of species constitute a unique ecosystem. These forests are considered to be among the world’s oldest; the trees are extremely slow growing and long lived (>3,000 years) giving rise to their local name of ‘living forest fossils’. Balochistan has approximately 141,000 ha of *Juniperus excelsa* forests, with approximately 86,000 ha in Ziarat and Loralai districts. *J. excelsa* typically grows as pure stands of open and multi-storied forest at an elevation of 2,000 to 3,000 masl (Sheikh 1985). These forests are an important

source of fuelwood for local residents and offer protection from soil erosion in the watersheds. They also serve as grazing lands, a popular place for tourists, and a source of various non-timber forest products such as bark for roofing, essential oils, and 'berries', which are used for flavouring and as a remedy for kidney and other diseases (Sarangzai et al. 2010). *Juniper excelsa* is the main tree species, alongwith *Fraxinus xanthoxyloides* and *Pistacia khinjuk*. The main shrubs are species of *Prunus*, *Cotoneaster*, *Crataegus*, *Ephedra*, *Caragana*, *Berberis*, and *Rosa*. The ground cover is mainly formed by *Stipa himalacia*, *Dichanthium annulatum*, *Artemisia maritima*, *Chrysopogon aucheri*, and *Cymbopogon* spp. The forests contain a high plant biodiversity (Figure 17).

Approximately 26,000 ha of the total area falls under chilghoza pine in Balochistan. These forests consist of open to dense stands of mature area that fall between the altitudes of around 2,100 to 3,500 masl and higher. Over-mature trees have dead tops and dead branches. The seed of *Pinus gerardiana* (pine nut) is used as a dry fruit and has high commercial value in both national and international markets. The seed harvest is the major source of income for the local people in the Suleiman mountains (Saeed and Thanos 2006). The broad-leaved associates are *Prunus amygdalus*, *Fraxinus xanthoxyloides*, and *Pistacia khinjuk*.

Wild olive forest and mixed scrub forest (*Acacia* and *Pistachio*) are found below the high-altitude chilghoza and juniper forests at 1,750 to 2,400 masl in the Shingher, Kaisaghar, and Speraghat hills in Zhob and Sherani districts, and the Torghar hills in Killa Saifullah District. In the Zhob area, the herbaceous component is dominated by *Cymbopogon jwarancusa*, *Chrysopogon aucheri*, *Tetrapogon villosa*, *Pennisetum orientale*, *Panicum antidotale*, *Stipa*, *Saccharum* species, and *Poa bulbosa*. Common shrubs in the understory include *Alhagi camelorum*, and *Caragana ambigua*.

Figure 17: Key species forming the forest–rangeland ecotone in Balochistan



Changing Trends of Ecotones

The major factors that have led to ecotone shifts in Balochistan are overgrazing by domestic livestock, vegetation removal, conversion of rangeland into agricultural land, and drought (Islam et al. 2004). Woody species and unpalatable grasses have encroached the central part of the upper and lower ecotones, and heavy grazing has inhibited establishment, survival, and growth of seedlings of trees and other palatable species.

In the upper ecotones, local communities have converted rangeland into agricultural land by constructing stone walls, structures, and bunds to divert rainwater, collecting the silt and clay in the water, and using this to convert the bund into a piece of fertile land suitable for planting apple, apricot, and cherry. This encroachment has been aggravated by the government giving subsidies on electric tube wells by fixing the farmer's share at a 'flat-rate' of PKR 48,000 per year. The number of tube wells has increased at rates of 9% and 6% per annum for electricity and diesel-operated tube wells, respectively, over the last 35 years. The purpose was to encourage farmers to use groundwater for increased agricultural production and to increase consumption of electric power. The subsidy did help to expand irrigated agriculture in Balochistan, but it also promoted poor use of the scarce groundwater resources. Recent droughts combined with an annual lowering of the water table by around 6 m per annum have badly damaged horticulture in Balochistan and have contributed to increasing desertification in the area.

Increasing human and livestock populations in the province have put tremendous pressure upon the rangeland resources for providing fuelwood, water, forage, and recreation. The increase in demand for goods and services, coupled with prolonged and severe drought, has led to rangeland deterioration. Nevertheless, rangelands are still playing a vital role in the economy of the province through the provision of livelihoods to the rural communities. The rangelands provide forage for 33 million heads of livestock (projected population 2012) with an estimated monetary value of PKR 477 billion. Overall, plant species in Balochistan tend to be deficient in total digestible nutrients and in digestible protein and dry matter with respect to animal requirements (FAO 1983; Islam and Adams 2000; Ahmad et al. 2009)

As late as 1950, the vegetation cover in the province was more than 50%. However, the arrival of Afghan refugees in the early 1980s increased pressure on the rangeland health and productivity. Forest and rangeland vegetation near refugee camps was completely wiped out. According to UNHCR (2007), trees and bushes were completely uprooted on close to 175,000 ha of forest and rangeland. At present, there is still a downward trend in vegetation surface cover.

The major indicators of rangeland degradation are shifts in species composition, loss of biodiversity, reduction in biomass production, less plant cover, low ruminant productivity, and soil erosion (Ahmad et al. 2012). Perennial grasses and palatable shrub species are confined to some protected forest areas. The degradation of rangelands in Balochistan is site specific and depends on the existing vegetation, grazing pressure, grazing accessibility, human

population, availability of water, and tribal conflicts (Ahmad and Islam 2011). Highly palatable perennial grass species such as *Chrysopogon aucheri* are gradually being replaced by low palatable species such as *Cymbopogon jwarancusa* and shrubs like *Artemisia* spp. or *Haloxylon* spp. (Ahmad et al. 2000a). In many rangeland areas, these shrub species have again been replaced by unpalatable shrub species such as *Peganum harmala* and *Othonophsis intermedia*, accompanied by clear evidence of soil erosion. Regeneration of most forest and rangeland plant species depends on the production of viable seeds, patterns of seed dispersal, seed predation, seed bank dynamics, and the presence of suitable microsites and environmental conditions for germination and seedling establishment (Aguiar and Sala 1997; Russell and Schup 1998). At present, many natural plant species have very limited regeneration potential due to either heavy grazing or removal of vegetation for fuelwood, which badly hampers seed production, seed dispersal, and establishment of a soil seed bank (Ahmad et al. 2000a,b,c; Ahmad et al. 2007).

Shifts in the forest-grassland ecotone have been observed in many parts of the world, generally in the form of lowering of the treeline and/or reduction or complete loss of the timberline ecotone, with an abrupt change from forest to grassland. These shifts are attracting increased attention due to the implications for global carbon sequestration and land surface atmosphere interactions (Mast et al. 1997; Mather 2000). Transition zones or ecotones between biomes are predicted to be particularly sensitive areas to directional changes in climate. However, for many ecotones, there is little understanding of the key processes that allow dominant species from adjacent biomes to coexist in transition zones, and how differences in these processes affect species responses to changes in environmental conditions (Peters 2002).

Conclusion

In the Balochistan highland forest-rangeland ecotones, it is expected that less palatable shrub species will increase with increasing grazing intensity in the lower rangeland ecotones, and that forests at higher elevations will undergo a decline in diversity, mainly due to tree cutting for fuelwood collection, poorly managed collection of pine nuts and juniper berries, and limited establishment, survival, and growth of tree seedlings. In Balochistan, the ecotones between various ecosystems are not well demarcated or described. Detailed ecological studies are needed to understand the role of the different ecotones, the interfaces, and the shift over time, in order to develop appropriate management and conservation plans.

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