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Journal homepage: www.rangeland.ir

Full Length Article:

Diversity of Plants and Animals in Mountain Ecosystems in Tajikistan

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Received: 20/09/2013
Accepted: 20/11/2013

Abstract. Tajikistan is a hotspot of plant and animal species diversity and endemism and is important for the conservation of biodiversity on a global scale. The country is located at a biological crossroads. Species from Central and Northern Europe, Central Asia, the Middle East, and North Africa mingle here with endemics found nowhere else. The richness of Tajikistan's biodiversity shows up at the genetic, species, population, and ecosystem levels. There are many relic and endemic species, with most of the components of biodiversity vulnerable to anthropogenic factors. Proximate threats such as poaching, overfishing, illegal logging, and overgrazing are causing irreversible damage to biodiversity in the Tajikistan hotspot. Threats stem from economic and social problems, the lack of environmental awareness, poor management and enforcement capabilities, and the lack of transboundary cooperation. Conversion of land use, from biologically complex uses, such as mixed-crop agriculture, to less complex uses, such as mono-crop agriculture, has also reduced biodiversity. An example of the problem of biodiversity loss is simplification of agriculture systems. When a mixed-crop and livestock farm is converted to a single-crop enterprise, the landscape has lost ecological niches. International donors have provided considerable support to help resolve some of these issues. Funding opportunities exist, particularly in promoting transboundary cooperation, training conservation professionals, building environmental awareness and demonstrating the benefits of sustainable resource use. Close cooperation across borders will be required for conservation of unique and threatened ecosystems in the Central Asian region. An analysis of the present status of biodiversity conservation in Tajikistan and the constraints to successful implementation of the National Action Plan is presented here. Problems and prospects are discussed.

Key words: Romit reserve, Pamirs, Lakes, Glaciers birds, Fish, Reptiles

Geographical setting

Tajikistan, the smallest Central Asian country, is landlocked, but it is one of the world's centres of origin of cultivated plants and has a special role in the conservation of mountain biodiversity.

There is a big influence of climate, and the interaction between elevation and climate is pronounced. The climate changes drastically according to elevation. Tajikistan's climate is mostly continental but areas where subtropical and semiarid climates prevail are also found, with some desert areas. The Fergana valley and other lowlands are shielded by mountains from arctic air masses, but temperatures in that region still drop below freezing for more than 100 days a year. In the subtropical south western lowlands, which have the highest average temperatures, the climate is more arid, although some sections are now irrigated for farming.

At Tajikistan's lower elevations, the average temperature range is 23 to 30°C in July and -1 to 3°C in January. In the eastern Pamirs, the average July temperature is 5 to 10°C, and the average January temperature is -15 to -20°C. The average annual precipitation ranges between 700 and 1,600 mm for most of the republic. The heaviest precipitation is at the Fedchenko Glacier, which averages 2,236 mm per annum, and the lightest in the eastern Pamirs, which averages less than 100 mm per annum. Most precipitation occurs in winter and spring. Summers are hot and dry in many places, which limits water supply in some upland regions that might otherwise be used for transhumance.

Tajikistan shares its boundaries with Uzbekistan and Kyrgyzstan to the west and north, Afghanistan to the south, and China to the east (Fig. 1) and is characterized by the prominence of mountains and rivers.

Fig. 1. Tajikistan is the smallest Central Asian country. It is bordered by four countries

Mountains include the towering ranges of the Pamir and Tien Shan containing peaks ranging from 1300 to 7,495 m a.s.l. The Pamirs are the source of several torrential rivers that have carved out gorges and canyons. There are 947 rivers longer than 10 km. The longest among these are the Amu Darya, the Syr Darya, the Zeravshan, the Vakhsh, and the Panj. Tajikistan also contains numerous lakes, among which the biggest is the saline Lake Karakul (in Eastern Pamir) with a total area of 380 km^2. The freshwater Lake Sarez (in Western Pamir) is the deepest (490 metres) and has an area of 86.5 km2. The Hissar-Alay (Southern Tien Shan) ridges are central to Tajikistan geography, with numerous mountains exceeding 5,000 m a.s.l in height. Dushanbe, the capital city, is situated in the Hissar Valley at the foothills of the Hissar Mountains. The Tajikistan Mountains are noted for their glaciers, probably the largest in Asia. The Fedchenko Glacier is the largest in the Pamir (77 km long and 1,700–3,100 m wide), the Zeravshan Glacier is also noteworthy. The topography is heavily dissected as shown by the relief map (Fig. 2) and this makes it difficult to accurately map the fragmented vegetation types. There are no extensive unfragmented areas of rangeland, unlike

the extensive steppes in China, Kazakhstan, and the Russian federation.

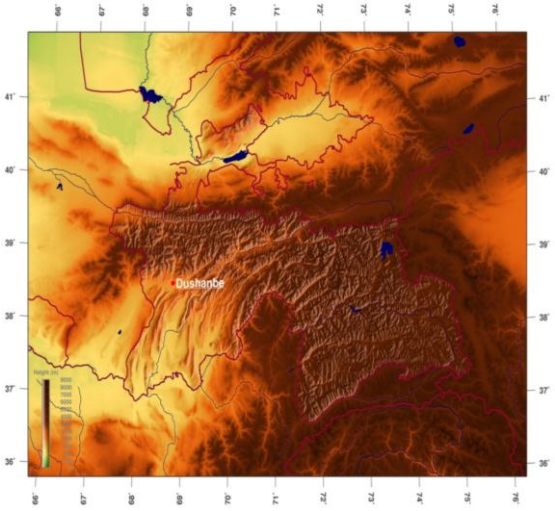

Fig. 2. Shaded height and relief map of Tajikistan. The darkest areas are the highest and are the major centres of biodiversity within this landlocked country. Transboundary cooperation is essential to conserve dwindling populations of threatened species

Biodiversity features

The flora and fauna of Tajikistan contain more than 23,000 species of which approximately 1,900 are endemic. Rare and endangered mammals include various gazelles (*Procapra spp.*), the Argali (*Ovis ammon*), Snow leopard (*Panthera unica*), Peregrine falcon (*Falco peregrinus*), Paradise flycatcher (*Terpsiphone paradise*), Mountain goose (*Anser indicus*), Menzbier's marmot (*Marmota menzbieri*), Siberian ibex (*Capra siberica*), and others. The Bukhara red deer (*Cervus elaphus*), the Persian gazelle (*Gazella subgutturosa*), and the Markhor (*Capra falconeri*) are also listed in the Tajikistan Red Data Book as vulnerable species. A number of birds are equally endangered, including several species of waders, birds of prey, pheasants, cranes, plovers, pigeons, and swifts. Nearly half of the flora and fauna species of the mid-mountain ecosystems are considered endangered. The flora and fauna of Gissaro-Alai are rich in diversity and contain a number of endemic Central Asian montane species. There are 1200 vascular plant species in Ramit Reserve (see below) with a high number of endemics often localized to specific mountain ranges. The typically Central Asian composition of the Gissaro-Alai flora is expressed in the predominance of Fabaceae (especially *Astragalus spp.*), Asteraceae (especially *Cousinia spp.*), Brassicaceae, Poaceae, Lamiaceae, and various wild onions (*Allium spp.*), while the diversity of ferns, horsetails, sedges, and willows is very limited.

The variety of landscapes ranges from foothill semi-deserts to alpine meadows, combined with characteristic mountain forests. Foothills (below 1800-2000 m a.s.l) are occupied by ephemeroid sagebrush communities (*Artemisia diffusa, A. sogdiana, Poa bulbosa, Carex pachystilis*), which are replaced at higher levels by herbaceous low herb ephemeroid communities (*Poa bulbosa, Carex pachystilis, Phlomis thapsoides, P. bucharica*). Spectacular red tulips (*Tulipa micheliana*) form the characteristic aspect of ephemeroid spring vegetation. In the middle mountain belts, characteristic grasslands are dominated by *Prangos pabularia, Ferula spp., Inula macrophylla, Crambe kotschyana,* and *Paraligusticum discolor*. Grass meadows are widespread at higher elevations of the Zaravshan, and Gissar ranges, and fescue (*Festuca alaica*) is a dominant bunchgrass species. Subalpine meadows begin at 3100–3400 m a.s.l, with fescue, *Poa relaxa, Puccinella subspicata, N. cocanica,* and *Nepeta podostachys.* The steppe grasses of this ecoregion grow alongside wild fruit and nut forests, including wild stands of such trees as walnut (*Juglans regia*), maple (*Acer semenovii, A. turkestanicum)*, pistachio (*Pistacia vera*), hawthorn (*Crataegus turkestanica, C. pontica*), mountain ash (*Sorbus tianschanica*), pear (*Pyrus korshinskyi, P. regelii)*, almond (*Amygdalus communis, A. bucharensis*), prune (*Prunus ferganica, P. sogdiana*), cherry (*Cerasus mahaleb*), and apple (*Malus sieversii)*. Common shrubs include various species of *Rosa*,

Cotoneaster, *Lonicera*, *Caragana*, *Colutea*, and *Rhamnus*. Juniper forests grow at the higher altitudes of the mountain ranges dominated by three species of juniper (*Juniperus turkestanica*, *J. seravschanica*, *J. semiglobosa*), complexed with maples, almonds, and roses. The valleys of mountain rivers house riparian forests with such dominant trees as poplars (*Populus spp.*), ash (*Fraxinus sogdiana*), willow *(Salix spp.*), birch (*Betula spp.*), jidda (*Elaeagnus spp.*), *Tamarix spp.* and shrubs such *as Hippophae rhamnoides*, *Berberis sphaerocarpa* and *B. interregima*. The most common mammals in this ecoregion's forests are wild boar (*Sus scrofa*), and various species of rodents and shrew; Indian porcupine (*Hystrix leucura*) is found at lower altitudes. Predators include wolves (*Canis lupus*), red fox (*Vulpes vulpes*), weasel (*Mustela nivalis*), ermine (*M. erminea*), marten (*Martes foina*), badger (*Meles meles*), otter (*Lutra lutra*), Turkestan lynx (*Lynx lynx*), and Tien Shan bear (*Ursus arctos*). Species more common to the juniper forests and higher altitudes include marmots (*Marmota*), tolai hares (*Lepus tolai*), Turkestan red pikas (*Ochotona rufescens*), juniper voles (*Microtus juldaschi*), and Siberian roe deer (*Capreolus capreolus*). The diverse list of the Gissaro-Alai birds of prey includes vultures (*Aegypius monachus*, *Neophron percnopterus*), Lammergeier (*Gypaetus barbatus*), eagles (*Haliaetus leucoryphus*, *Aquila chrysaets*, *A. heliaca*, *Hieraetus fasciatus*), buzzards (*Buteo rufinus*), hawks (*Accipiter nisus*), eagle owl (*Bubo bubo*), and various small owls. Other characteristic bird species include chukar partridge (*Alectoris chukar*), Himalayan snowcock (*Tetraogallus himalayensis*), northern goshawk (*Accipiter gentilis*), wagtail (*Motacilla spp.*), golden oriole (*Oriolus oriolus*), titmice (*Parus spp.* and *Remiz spp.*), sparrows (*Passer spp.*), shrikes (*Lanius spp.*), spotted flycatchers (*Muscicapa spp.*), eastern turtle dove (*Streptopelia orientalis*), rock pigeon (*Columba livia*), wood pigeon (*Columba palumbus*), and thrush nightingales (*Luscinia luscinia*). There are many rock birds such as rock nuthatch (*Sitta neumayer*), wall creeper (*Tichodroma muraria*), and pied wheatear (*Oenanthe pleschanka*).

At higher altitudes, one can also see woodpeckers (*Picus spp.*), finches (*Carpodacus spp.*), Eurasian hawfinch (*Coccothraustes coccothraustes*), white-winged grosbeak (*Mycerobas carnipes*), Himalayan tree creeper (*Certhia himalayana*), black redstart (*Phoenicurus ochruros*), greenish warbler (*Phylloscopus trochiloides*), cuckoos (*Cuculus canorus*), nutcrackers (*Nucifraga caryocatactes*), and Stewart's buntings (*Emberiza stewarti*). The venomous snake species Central Asian viper (*Vipera lebetina*) and cottonmouth (*Agkistrodon halys*) are also found in this ecoregion. Non-venomous snakes include the water snake (*Natrix natrix*), rat snakes (*Coluber spp.*), and blind worm snake (*Typhlops vermicularis*). A number of lizard species (skinks, geckos, agamas) are characteristic for the mountain forests, including Himalayan rock agama (*Stellio himalayanus*), legless glass lizard (*Ophisaurus apodus*), and Asian snake-eyed skink (*Ablepharus pannonicus*).

The list of endangered and protected mammal species in Gissaro-Alai includes several species of wild ungulates. The wild sheep, or Bukhara urial (*Ovis vignei bocharensis*), and markhor goat (*Capra falconeri*) occur in the southern spurs of the Gissar range that is part of Uzbekistan (Kugitang, Baisuntau, and Babatag mountains). Common leopard is extinct in the region, but the snow leopard still lives in the Gissar mountain range. The ecoregion is the most arid area inhabited by lynx and brown bear (*Ursus arctus isabellinus*), striped hyena (*Hyaena hyaena*) is rare and was sighted decades ago.

Brief overview of the major ecosystems

The major ecosystems in Tajikistan consist of forest, high mountain habitats, dry mountains, shrub land, steppe, semi-desert, and wetlands. The vegetation changes from steppe communities in the west to semi-desert and desert habitats in the south. Towards the east, the land rises above the plains with several peaks above 5,000 m a.s.l, and is enveloped by broadleaf and coniferous forests, subalpine and alpine meadows, and glaciers and snowfields. Arid open woodlands form on dry, rocky slopes in the eastern and southern districts made up of juniper (*Juniperus spp.*) and pistachio (*Pistacia spp.*) species. Lowland forests are found on the floodplains and low river terraces, generally growing on alluvial, swampy, or moist soils. Very few lowland forests have been preserved although some stands remain. High mountain meadows are dominated by herbaceous species. About 1,000 vascular plant species are found in the high mountains and half of these are endemics. Alpine mats, formed by dense low-lying perennial plants, cover the terrain on the upper slopes of mountain systems. Unique communities of cliff and rock vegetation are distributed throughout the high mountains. Approximately 80% of the plant species found in rock and scree communities on limestone ridges are endemic. Wetland ecosystems are found throughout and include river deltas, marshes, swamps, lakes, and streams in alpine regions. A variety of lakes are scattered throughout Tajikistan from small alpine lakes to significant bodies of water with highly specific fish fauna. The marshes are particularly important for waterfowl. Alpine meadows, wetlands, and grasslands are used intensively for livestock grazing in the summer throughout the region, with a resultant decline in plant species diversity. Other ecosystems, even forested ones, provide seasonal grazing for livestock and are therefore classified as rangelands (Strong and Squires, 2012). The total area of rangelands and pasturelands is 3.9 million hectares and represents over 80% of the country's agricultural land. The largest areas of rangeland, 60% of the total rangeland area, are found in Khatlon and RRS (a region near to Dushanbe). Much of the rangeland is in hilly and mountainous areas at altitudes above 2000 m a.s.l. Traditionally, these rangelands have formed the basis of Tajikistan's livestock sub-sector and have been used for centuries in ways that utilize the various altitudinal bands via the system of transhumance grazing (Table 1). In recent times, much of the rangeland at lower elevation (1500 m a.s.l) has been used for year round grazing by village-based households whose access to more distant pasturelands has been restricted by changes to land tenure arrangements and a breakdown of infrastructure, including roads, bridges, and travelling stock routes, and whose needs have been affected by population increases that have resulted in households owning as few as 2–5 livestock per household.

Table 1. Main rangeland types in Tajikistan, areal extent, and season of use

Attribute	Season of Use			
	Winter	Spring-Autumn	Summer	All Year
Altitude (m a.s.l)	500-1,200	900-1,500	2,200-3,400	500-1,200
Use months	Nov-Mar	Mar-May, Sept-Nov	June-Aug	Jan-Dec
Use days	120-150	90-110	80-90	300-330
Total area (ha)	699,000	675,000	2,081,000	400,000[+]
Percentage of total rangeland area	18	18	54	10
Distance from villages (km)	0.8-1.4, 4-5	1.2-1.8, to 30	200-600[a]	<1

[a]6-8 weeks per year are spent travelling between winter and summer pastures

Biological importance of the rangelands

Tajikistan is a hotspot of plant and animal species diversity and endemism that is important for the conservation of biodiversity on a global scale. The country is located at a biological crossroads. Species from Central and Northern Europe, Central Asia, the Middle East, and North Africa mingle here with endemics found nowhere else. The mountain landscapes of Tajikistan contain 0.66% of the world's animal diversity and 1.8% of the plant diversity, including wild relatives of domestic animals and cultivated plants. The high levels of landscape diversity in the uplands are largely the result of the temporal-spatial variability in the region. The unique geology and terrain, consisting of three major mountain chains separated by valleys and plains, permit a variety of different microclimate, soil, and vegetative conditions, resulting in a broad range of landscapes and unusually high levels of species diversity for the temperate zone. Climatic conditions are very diverse, with precipitation ranging from more than 1200 mm per annum in the wettest areas, to less than 200 mm per annum in the Zeravshan and Pyanj deserts.

The rangelands of Tajikistan are occupied by people of several ethnic groups and there are several autonomous regions. Parts of the region are border areas that are strategically important to Tajikistan's security. The rangelands comprise extremely diverse physical, hydrological, and ecological systems as well as an array of different rural communities and production systems. The rangelands also contain geographically remote areas characterized by extreme diversity in environments, and it is in these areas that there is most hope for conserving intact ecosystems (Fig. 3).

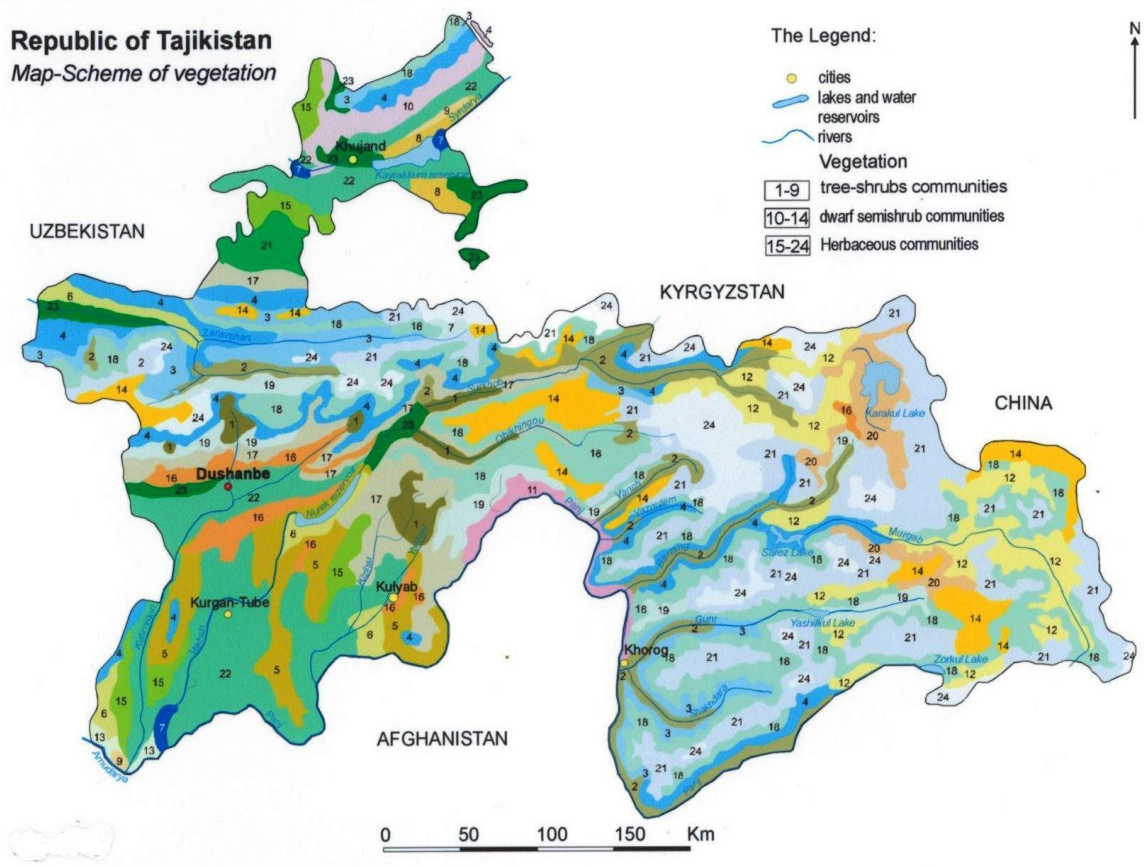

Fig. 3. Map scheme of Tajikistan vegetation

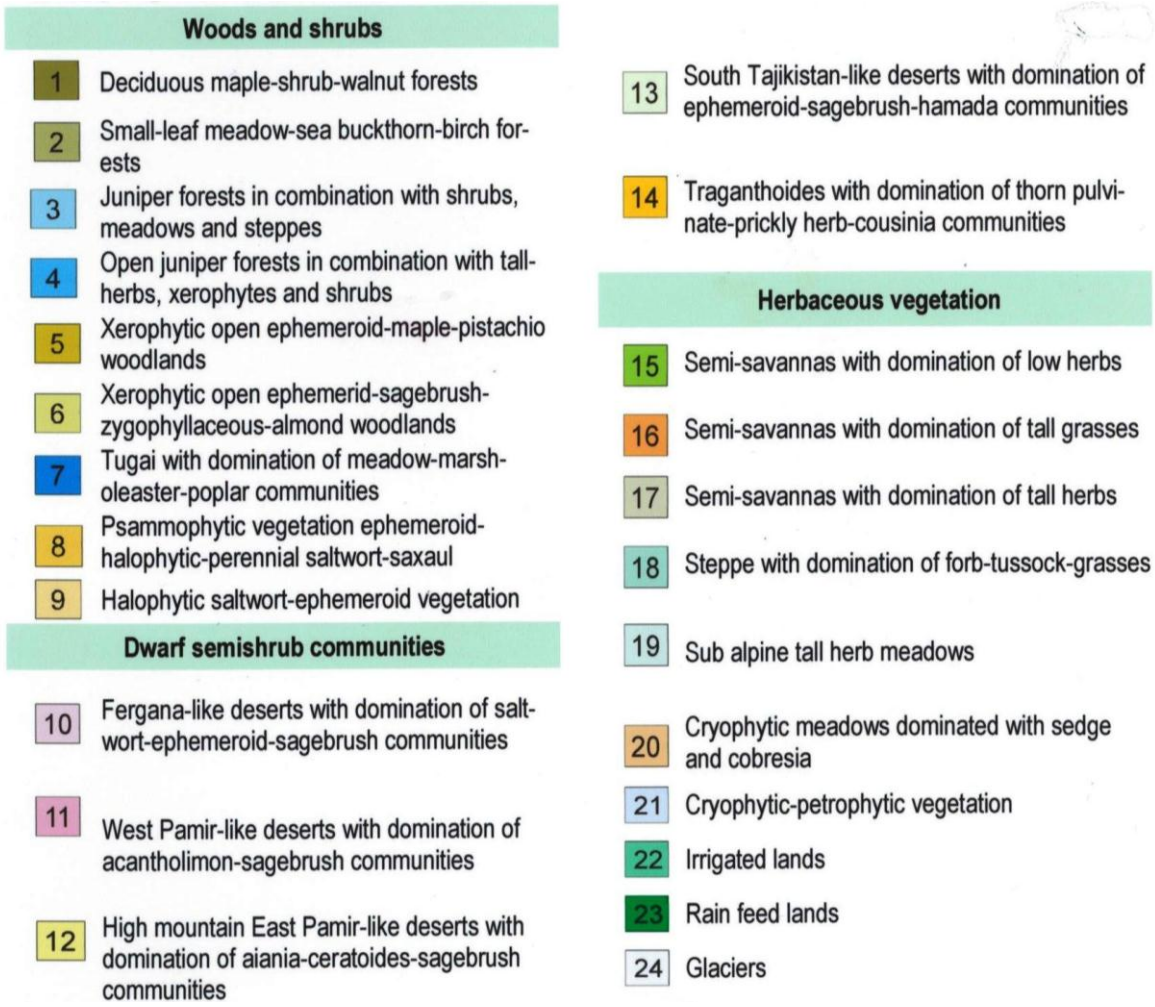

Fig. 4. Legend of Map scheme of Tajikistan vegetation

Transboundary aspects of central Asian biodiversity conservation

The richness of Tajikistan's biodiversity shows up at the genetic, species, population, and ecosystem levels (Ansgar, 2005). There are many relic and endemic species, with most of the components of biodiversity vulnerable to anthropogenic factors. Close cooperation across borders will be required for conservation of the unique and threatened ecosystems in the Central Asian region there are three interactive levels of biodiversity: the genetic, species, and ecosystem levels. The term biodiversity covers a large array of ecological complexity and is poorly understood. To most people, biodiversity is taken to mean species diversity. This erroneous interpretation leads to biodiversity being seen in a restricted way. Many people assume that biodiversity is found only on conservation reserves, or in remnant patches of native vegetation. The narrow species-focussed view of biodiversity gives rise to the notion that landscapes can be compartmentalised and that protection of remnant native vegetation is the primary action required for the conservation of biodiversity. This attitude does not take into account the majority of biodiversity and is leading to continuing loss of its essential elements, which affects the provision of ecosystem goods and services (see below).

People's attitudes to conservation and biodiversity protection

A number of studies (Lerman, 2012) and detailed PRA analysis (Kurbanova, 2012) indicate that poverty, land use rights, food security, and health and welfare

issues predominate in the thinking of rural people, including those living at high altitudes where biodiversity is most at risk (Jackson, 2012). The notion of land stewardship is poorly understood and rarely practised (Squires, 2012).

Why should Tajikistan worry about biodiversity?

Conservation and maintenance of biodiversity are important for four reasons: life support; economics; aesthetics and culture; and ethics. From an anthropocentric viewpoint, our survival depends on biodiversity as many of its elements provide the critical life support systems that make human life possible. These are the healthy, functioning ecosystems that maintain the atmosphere (including the air we breathe), regulate the climate, produce fresh water, form soils, cycle nutrients, and dispose of waste. Many people in mountainous areas obtain cultural identity, spiritual enrichment, and recreational activities from elements of biodiversity. Much of the 'sense of place' comes directly from biodiversity. Biodiversity also provides great economic returns, for example in the provision of food and fibre, medicines, control of pests, building materials, and crop pollination (Table 2).

Table 2. The benefits people obtain from ecosystem services

Provisioning Goods produced or provided by ecosystems	Regulating Benefits obtained from regulation of ecosystem processes	Cultural Non-material benefits obtained from ecosystems	Supporting Services necessary for the production of other services
- Food - Fuel wood - Timber - Fibre - Biochemical/medicines) - Genetic resources - Pollination	- Climate regulation - Flood regulation - Water purification - Carbon sequestration - Pest and disease regulation	- Spiritual - Inspirational - Aesthetic - Educational - Recreational	Soil formation and conservation Primary production Supporting biodiversity conservation

The economy is a subset of the environment and not vice versa, and our social systems must also work with the environment, not against it. Tajikistan's path to a sustainable future will not be easy as many issues must be dealt with (Squires, 2012). Sustainability can only be achieved when the country has an environment that supports the continued existence of all its component parts. At present, there is no accepted collective vision of what the people want Tajikistan's landscapes to look like and how they want them to function. One major consequence of this lack of vision is that there is no integrated approach to planning and acting for the future despite the development of the national action plan for biodiversity conservation following Tajikistan's accession to the convention on biodiversity in 2003.

Failure to develop and implement a collective vision will lead to continual tinkering on the fringes of the problem and will see future generations facing biotically impoverished landscapes with extensive areas needing remediation at vast cost. Many factors affect the biodiversity of plants and animals (including birds, fish, and insects). Habitat loss is a major one often characterized by vegetation fragmentation or the loss of connectivity in landscapes. The degree of fragmentation is a key indicator. Fragmentation of natural habitat disrupts ecological processes such as energy cycling, creates sub-populations of species, and isolates those sub-

populations from one another. Most fragmentation is due to overgrazing, opportunistic cropping, and other modifying practices

For ecosystems to persist there is a need to avoid habitat loss. Habitat change and loss can be extremely varied, ranging from logging of indigenous forest, especially in the alpine areas, conversion of rangeland to cropland, physical modification of river systems (reservoirs, hydroelectric, navigation), drying up of wetlands due to reduced water flows, pollution from agro-chemicals and industry, and direct damage from infrastructure development such as roads and tunnels and mining developments.

Institutional frame work relating to biodiversity conservation in Tajikistan

After the breakup of the Soviet Union in 1990, Tajikistan faced the challenge of building new governmental structures. New state institutions dealing with natural resources were created, while others were dismantled or reorganized. Various line ministries, forestry, water resources, agriculture, and some other agencies, also have jurisdiction over various aspects of natural resources. Ministries generally have regional divisions in each of the provinces within the country. State conservation agencies, however, often lack the funding and capacity to implement their mandates or to enforce legislation and international obligations. Conflicting policies in legislation and overlapping jurisdictions, in addition to a general lack of communication among governing bodies, hinder effective management of environmental resources and create significant contradictions in regulation. Transboundary cooperation on environmental issues is limited. Tajikistan has signed the majority of international conventions, including the Convention on Biological Diversity, Convention on Desertification and Drought, Wetlands of International Importance, Convention on International Trade in Endangered Species (CITES), and World Cultural and Natural Heritage, but does not have the capacity and finances to fulfil its international obligations. Following accession to the UN Convention on Biological Diversity and the approval of the National Strategy and Action Plan on Conservation and Sustainable Use of Biodiversity (Government Resolution № 392 of RT of 01.09.2003), the National Centre for Biodiversity and Bio-safety (NCBB) was established. This is the inter-agency coordination unit for assessing and protecting pasture biodiversity, but interagency coordination is not easy. There are severe budget constraints and a lack of properly trained staff.

Planning issues pertinent to rangeland biodiversity use, conservation, and functional activity, should be the responsibility of 'hukumats' (local government at district level), with the interagency coordination at the Ministry of Agriculture (MoA). There are units within the MoA related to grazing and biodiversity who are also assigned biotechnical activities as diverse as seed production and measures to ensure long-term sustainable use of forest biodiversity. The Ministry of Agriculture, together with the Pasture Trust, should join the NCBB to unite efforts to improve pasture biodiversity. The Committee for Land Management Geodesy and Cartography (CLMGC) handles land transfers and should do so according to the season of use and with proper cadastral registration. Such actions by existing state institutions could do much to improve the situation in Tajikistan's rangelands and pasturelands.

Further, there is no single coordination system between departments, and no common strategy to engage with pasture users in a meaningful way. Plant biodiversity, even as it relates to valuable forage species, weedy, and poisonous

plants, is neglected. Training systems and university level instruction are also quite divorced from practical pasture studies, especially in the species composition aspects of rangeland biodiversity. The important issue of preserving biodiversity as a part of grazing management, and assessment of the adverse effects of overgrazing on the biodiversity of rangelands, especially the impact of use on forest biodiversity, is often overlooked when short-term gains are uppermost in people's minds. Neither the forest authority (who benefit from leasing out the land), nor the livestock owner who needs access to better pasture, is sufficiently concerned to monitor the situation and regulate grazing pressure or entry and exit dates if overuse is detected.

Why Tajikistan's mountain ecosystems are so important?

Mountainous area such as those in the Pamirs and Alatai in Tajikistan, as well as other less well-known regions above 2500 m a.s.l, are biodiversity 'hot spots'. The reason for this is that the elevation of land areas leads to compression of climatic zones over short distances. A high conservation priority is ascribed to these areas, and they have a key role to play in global efforts to conserve biodiversity. In undisturbed areas within humid alpine areas, a substantial part of the regional flora and fauna can be found within a 1 km^2 patch (for plants, often within 100 m^2) and very few additional species are found if the survey is extended to the whole mountain range or to a regional scale.

Despite their importance, the alpine steppes and meadows of Tajikistan are suffering from conversion to cropland (most of which occurred after the collapse of the Soviet Union about 20 years ago). According to the soil research institute, there is a loss of about 10.7% of Soil Organic Carbon (SOC) content from steppe cultivated for 12 years. The concentration of SOC declined by 24.3% over 20 years after conversion to cropland. Soil N also declined, as did the proportion of water-stable soil aggregates (<1 mm) (Strong and Squires, 2012).

Tajikistan is a landlocked country and is one of the world's centres of origin of cultivated plants, thus it has a special role to play in the conservation of mountain biodiversity. As described above, the richness of biodiversity shows up at the genetic, species, population, and ecosystem levels (Table 3), and most of the components of biodiversity are vulnerable to anthropogenic factors. Tajikistan shares borders with five countries and is a globally significant centre of cultural diversity, where a number of ethnic groups, languages, and religions intermingle over a relatively small area. Close cooperation across borders will be required to conserve the unique and threatened ecosystems, and will also help to foster peace and understanding in this ethnically diverse region.

Table 3. Main components of biodiversity in Tajikistan

Components/Attributes	Number
Ecosystem types	12 types
Vegetation	20 types
Flora	9,771 species
Wild relatives of cultivated plants	1,000 species
Endemic plants	1,132 species
Plants listed in the Red Data Book of Tajikistan	226 species
Fauna	13,531 species
Endemic animals	800 species
Animals listed in the Red Data Book of Tajikistan	162 species
Agricultural crops	500 varieties
Domestic animals	30 breeds

More than 9,700 species of vascular plants have been found in Tajikistan and more than 1,100 of these are found nowhere else on Earth – reflecting one of the highest levels of endemism in the temperate world (Table 4). Tajikistan is also home to more than 13500 species of animals, including 385 species of bird, about 800 of which are endemic to the region, including four bird species. Twenty-two of the 46 reptiles in Tajikistan are endemic to the region. Fourteen species of amphibians are found in the region, of which two are endemic. More than 52 species of fish are found in the rivers and lakes, more than a third of which are found nowhere else.

Globally threatened species – those listed as vulnerable, endangered and critically endangered according to the IUCN Red List – are the primary focus in the Tajikistan Biodiversity Action plan for conservation at the species level. In all, 162 globally threatened species of animals and 226 plants were identified by the IUCN. The distribution of these species is being re-examined to determine important sites and corridors for conservation. Corridors are swathes of land that link sites on which there are key plant and animal species present in close enough proximity to allow migration from one to another. The distance between such sites depends on the mobility of the species or its means of dispersion. Corridors can also provide a refuge in the event of a disaster in one or other location.

Protected areas in Tajikistan: role in biodiversity conservation

Overview

Tajikistan has some protected areas mandated by law. Most nature reserves and national parks in Tajikistan are too small to guarantee long-term biodiversity conservation. Economic problems have resulted in an increase in poaching, illegal cutting of forest, and grazing in protected areas where the protection regime is not always enforced (Box 1). Reserve employees are underpaid and equipment and transportation are lacking. Buffer zones are often non-existent, so the effects of resource use and human pressure outside the reserves spills over the borders and impacts the protected ecosystems. Furthermore, the existing protected area system is not entirely representative of the full range of biodiversity in the country.

Almost 3 million hectares of the country's territory have been designated as natural reserves, national parks, site management areas, tourist and recreation zones, botanical gardens, or stations. The nature reserve Tigrovaya Balka lies along the Vakhsh river delta in southern Tajikistan and is characterized by tugai forests along the Vakhsh and Panj rivers; populations of Markhor and Bukhara red deer are conserved in Dashtijum reserve; and the argali is found and the bar-headed goose nests in Zorkul in south eastern Tajikistan, which includes the protected areas of Zorkul lake islands. The Romit Nature Reserve has practically lost its status as a valuable biodiversity refuge (see Box 1), or a reference?

Around 10% of the unique ecosystems of Tajikistan are situated outside the protected areas. Poor ecological education contributes to irregular use of biological resources. For example, more than 60 species of wild medicinal herbs are used by the population who have no idea that some of them are about to become extinct. New protected areas need to be created in regions where there are none, and corridors need to be created between existing protected areas. The protected status of sanctuaries, which have low levels of protection, need to be increased in areas that are important for the conservation of biodiversity and have endangered species and ecosystems. Management and planning in nature reserves needs to be improved by increasing the qualifications of nature

reserve staff and elaborating and implementing management plans.

Protecting sites alone will not be sufficient to conserve biodiversity in the long-term; conservation of landscapes large enough to allow the persistence of biodiversity must be anchored on core areas, embedded in a matrix of other natural habitat and anthropogenic land uses. A preliminary assessment of such landscapes within Tajikistan should be carried out to identify and delineate suitable sites based on the following criteria: coverage of representative sites, existence of large-scale intact biotic assemblages (all the living things within an environment: plants, animals, invertebrates, birds, and micro-flora and fauna), needs of wide-ranging (landscape) species, connectivity of habitats, and opportunities for maintaining ecological and evolutionary processes. Areas that should be considered include intact rivers and landscapes, natural mountain passes, known migratory corridors, and areas with spatial heterogeneity that could serve as stepping stones for many species. Other factors to be considered are the range of habitats represented, resilience to anthropogenic development scenarios, and the need to safeguard as yet unstudied areas that might harbour high levels of biodiversity or endemism. Remote sensing and GIS are important tools and the results of the initial studies in Tajikistan (and elsewhere) illustrate the value of such an approach (Akhmodov, 2008).

Box 1. Romit: A protected area in Varzob Raion

Romit Reserve (Park) is a mountain-landscape nature conservation area of 16,000 ha in the highest protection category. Romit has been recognised by the IUCN as a major biodiversity site and is a declared zone of international tourism. The main purpose of the reserve is to study and preserve mesophyllic forest, mountain-steppe, meadow ecosystems, and rare endemic species, including fauna and flora listed in the Red Data Book of Tajikistan. Despite the limited territory of the reserve, it is rich in diversity of species of flora and fauna. The Reserve has about 1500 higher flowering plants. The vegetation cover is quite diverse and consists mainly of shiblyak, deciduous forest, tall-grass (shroud) semi-savanna, mountain steppe, and alpine and sub-alpine meadows at some places along the upper boundary. Maple and juniper are the main forest-forming species. In addition, there are walnut (Juglans regia), Bokhara almonds (Amygdalus bucharica), Turkestan birch (Betula turkestanica), and many species of plants such as Allium rosenbachianum, halmon (Petilium Eduardii), and Allium suworowii. The highlands of the Varzob river basin are mainly savanna type steppe, with small areas of meadow pasture, and the alpine pastures of the Romit river basin are mainly sub-alpine meadows with steppe type tall-grass. Only 500 plant species, including 130 forage plants, have been recorded in the mountainous territory of the Varzob valley (Romit river basin or Kofarnihan) and in Varzob gorge, where there is regular intensive summer grazing. Unfortunately, due to intensive and unregulated grazing, the pastures are heavily contaminated with buzulnik, Rumehs, kotovnik tarragon, and wormwood (Artemisia spp.). This type of biodiversity is typical for the river basin of Varzob, the only difference is that in the river basin in the middle of Varzob, the large areas of floodplain are occupied by chinar (Pinus spp.) plantings, and willows (Salix spp.) grow in large areas of the floodplains. Romit is home to partridge (Alectoria kakelik), quail (Coturnix sotirnih), a large dove (Streptopelia orientalis), ringdove (Solimba palumbus), kestrel (Falco tinnunculus), golden eagle (Aquila chrysaetus), owl (Bubo vibo), splyushka (Otus ssors), ordinary starling (Sturnus vulgaris), Himalayan snow cock (Tetraogallus himalayensis), Himalayan merganser (Mergus merganser) and other birds. The mammals include a stone marten (Martes foina), ermine (Mustel erminea), weasel (Mustela nivallis), badger (Meles meles), wolf (Canis lupus), fox (Vulpes vulpes), lynx (Felix lynx isabellina), wild boar (Sus scrofa), Siberian ibex (Sarra sibirica), tolai rabbit (Lepus tolai), and long-tailed marmot (Marmota caudata). Reptiles include the viper (Vipera lebetina), copperhead (Ancistrodon halys caraganus), runner-coloured (Soliber ravergieri), patterned snake (Elaphe dione), and sand boa (Ehuh sp.). The rivers are home to fish such as the marinka (Schizothorax intermedius), trout (Salmo trutta oxianus), and Turkestan catfish (Glyptosternon reticulatum).

Species outcomes

In determining species outcomes, the Government of Tajikistan (GoT) should aim to improve or stabilize the conservation status of species and ultimately avoid extinctions. Threatened species, or species having a high probability of extinction, are the obvious targets for conservation in a given region. Species outcomes are defined, based on the conservation status of individual species, which are compiled in the IUCN Red Lists. The Red List is based on quantitative, globally applicable criteria under which the probability of extinction is estimated for each species. Species outcomes in Tajikistan should be centred on the 162 species of animals and 226 species of plants that are globally threatened (vulnerable, endangered, and critically endangered) according to the most recent IUCN Red List.

Most species are best conserved through the protection of the sites in which they occur. Sites are physically and/or socioeconomically discrete areas of land that need to be protected to conserve the target species. Sites are scale-independent, which means they can be very small or very large. The defining characteristic of a site is that it is an area that can be managed as a single unit. Sites can be any category of protected area, government land, or private farm. The main objective of defining important sites for conservation of threatened species is to identify areas where investments can be made to create protected areas or special conservation regimes, expand existing protected areas, and/or improve protected area management, all of which will help to prevent species extinctions and biodiversity loss.

International hunting is organized for Argali (Ovis ammon), Siberian ibex (Capra sibirica), Urial (Ovis vignei), and Tajik markhur (Capra falconeri). Overhunting of legal game species and poaching of rare species is widespread, especially in the mountain regions. Government agencies set quotas for game species without carrying out appropriate research on game numbers or population dynamics. Thus quotas are often too high to ensure that viable populations of game animals (mostly ungulates like argali and Siberian ibex) are maintained. In the last ten years, poaching alone caused a drop in numbers of argali and Siberian ibex by 50%. Nature reserves are neither equipped nor authorized to control poaching outside of protected areas. The limitations of enforcement capabilities also lead to uncontrolled hunting, for example of Snow leopards (Uncia uncia), within so-called protected areas (Jackson, 2012).

Measures to reduce poaching include building capacity (training, equipment, transportation) of existing services, inspection agencies, and NGO groups to patrol areas where poaching is prevalent. Harvesting of animal parts, such as horns and antlers, for oriental medicines, and Snow leopard (Uncia uncia) skins for decoration, threatens several endangered species. Poaching and unsustainable hunting are rampant in nearly all areas. Vipers (Vipera lebetina) have long been exploited for their venom, but have been hunted almost to extinction in the first decade of the twenty-first century.

The mountain forests of Gissaro-Alai play a crucial role in preventing wind and water erosion. During the past two centuries, much of the natural woodland in this eco-region has been cleared for fuel wood and overgrazed by an increasing number of domestic cattle, causing soil erosion (Akhmadov, 2008). Agriculture, grazing, forestry, extractive industries, building construction, and recreation have caused the greatest impact on these mountain ecosystems. Many foothill ecosystems have shown a marked decline in biodiversity.

The ungulates, wild sheep and goats, are the most affected by human influence in this ecoregion. Wild goats are

threatened primarily from traditional hunting by the local population, but they are also prized trophies for foreign hunters. In addition, the urial faces threats from loss of habitat and grazing land due to competition from flocks of domestic livestock, as the majority of land in the eco-region is used for sheep pasture, in some areas year round.

Synopsis of current threats to biodiversity

Endangered species are the first elements of biodiversity to disappear as ecosystems and natural conditions are altered. The biodiversity of Tajikistan is being lost at an alarming rate. On average, nearly half of the lands in the major biodiversity sites have been transformed by human activities. The plains, foothills, and subalpine belts have been the most heavily impacted. Native floodplain vegetation remains on only half of its original area, and only 2-3 percent of original riparian forests remain. Most natural old growth forests have been fragmented into small sections, divided by areas of commercial forests or plantations, as well as agricultural and developed lands. For Tajikistan as a whole, less than a quarter of the region remains in reasonable condition, while less than 10 percent of the original vegetation, including forests, can be considered pristine. Numbers of large native herbivores such as wild sheep, camels, and asses have dropped dramatically over the past century as have carnivores such as Red marmot (Marmota caudata), Muskrat (Ondatra zibethica), Fox (Vulpes vulpes), Badger (Meles meles), Snow leopard (Uncia uncia), and Wolf (Canis lupus), which is being over hunted and placed at risk. Data on reptiles, birds and fish are not easy to obtain, but doubtless many species have been lost or are in danger of extinction (at least locally).

Illegal logging, harvesting of fuel wood and the timber trade threaten biodiversity in the region's forests and lead to habitat degradation. While officially-sanctioned logging has actually decreased in some areas over the past few years, illegal logging persists. Illegal logging leads to a decline in species composition, forest degradation, and overall habitat loss, impacting a number of plant and animal species. Harvesting of fuel wood has increased nearly three times in some areas compared to even a decade ago as a result of energy shortages and the economic crisis. Fuel wood harvesting and consumption lead to forest degradation and the disappearance of certain species, and contribute to global warming. Rural populations are largely dependent on fuel wood for heating and cooking.

Overgrazing and uncontrolled livestock grazing threaten the steppe, subalpine, and alpine ecosystems. A large proportion of the pasturelands in Tajikistan are subject to erosion. The number of sheep grazing on the winter ranges and steppes and semi-deserts has nearly tripled over the past two decades. Intensive grazing has resulted in reduced species diversity and habitat degradation. Secondary plant communities now occupy 80% of the rangelands in the subalpine belt. The alpine belt is slightly better preserved. Grazing of cattle in forested areas disturbs the undergrowth and creates competition for wild ungulates. Overgrazing is causing environmental damage over much of the Tajikistan rangelands (Fig. 5).

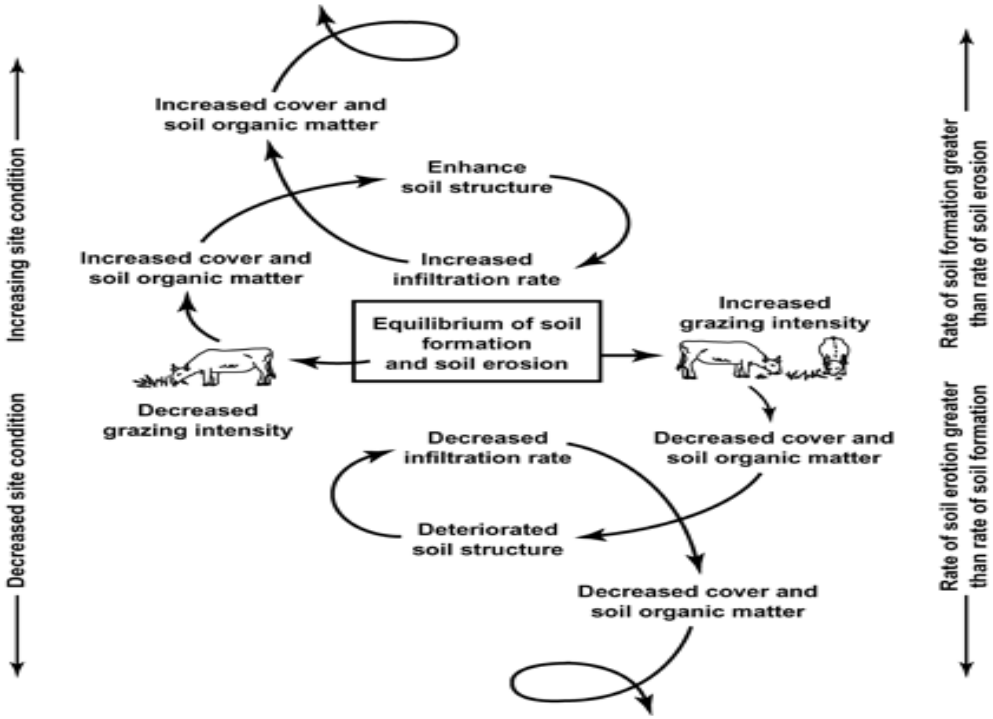

Fig. 5. Overgrazing affects more than just the livestock. Ecosystems go into decline and biodiversity is destroyed as soil and nutrients are lost and infiltration rates are reduced

Measures to reduce the impacts of overgrazing include developing sustainable rangeland management plans, enforcing restrictions on grazing in protected areas, and prohibiting grazing in damaged fields near rivers and on steep slopes. Furthermore, developing opportunities for alternative sources of income would reduce the need to keep large numbers of livestock in some rural communities (Strong and Squires, 2012; Lerman, 2012).

Pollution of rivers and wetlands is generally a result of run-off from human settlements, factories, farmland, and pastures. While the use of pesticides and fertilisers in commercial agriculture has declined significantly since 1990, there is still significant pollution from this source, especially from pesticides used in cotton fields. Manure from livestock is often dumped directly into rivers, altering the nutrient balance and causing eutrophication of lakes. Waste materials from timber production are also thrown into rivers at logging and processing sites. Erosion from farmland, pasture, and logged forests causes increased turbidity in many rivers. Pollution of wetlands and rivers impacts breeding birds and fish populations. Pesticides and fertilisers kill large numbers of invertebrates and make their way up the food chain to birds and even humans. Pollution has impacted freshwater systems in the lower reaches of the Amudarya River (a major river that empties (d) into the Aral Sea).

Root causes of biodiversity loss

A number of root causes lie behind the proximate threats to biodiversity (Fig. 5). These root causes can be broadly grouped into three categories: socioeconomic, political, and institutional.

Socioeconomic root causes

Poverty is perhaps the most significant of the socioeconomic root causes, leading to poaching, fuel wood consumption, illegal logging, overgrazing, and other threats. Poverty forces people to be dependent on natural resources and to use the resources unsustainably to meet their basic needs. The lack of public awareness

and public involvement in nature conservation is another reason why people are more likely to participate in poaching, overfishing, and other violations. Economically, the public has little incentive to conserve fuel wood, water, or other resources. Poor land use planning results in overgrazing, pollution of waterways, and inefficient infrastructure development.

Political root causes

Political root causes of biodiversity degradation stem from gaps and contradictions in legislation and the lack of a clear delineation of jurisdiction for enforcement agencies. Political and civil conflicts hinder cooperation on nature conservation, and military conflicts often result in increased forest fires, logging, poaching, and pollution. The lack of transboundary cooperation between countries hinders control of overfishing, illegal trade of timber and wildlife, and pollution of waterways.

Institutional root causes

Institutional root causes include ineffective administrative institutions and enforcement of legislation. Limited coordination among institutions and lack of communication results in duplication of efforts and misunderstanding. Insufficient knowledge of conservation issues among key stakeholders hinders environmental protection efforts. Gaps in protected area networks and poor protected area management lead to poaching, illegal logging, overgrazing, and other threats. Insufficient research and monitoring means that the extent of illegal logging, overfishing, and poaching is unknown, and long-term impacts on biodiversity are poorly understood.

International conventions on biodiversity, such as the Convention on Biological Diversity (CBD), UNCCD, CITES, and the Ramsar Convention on Wetlands, require member countries to provide adequate levels of protection to endangered species, ecosystems, and biodiversity overall. Although the Government of Tajikistan has signed the majority of conventions related to biodiversity, it lacks the means to implement them. Often officials responsible for convention implementation lack the necessary know-how to ensure compliance with convention regulations. Training programmes for conservation agencies and responsible officials are needed to create the capacity to implement the biodiversity conventions.

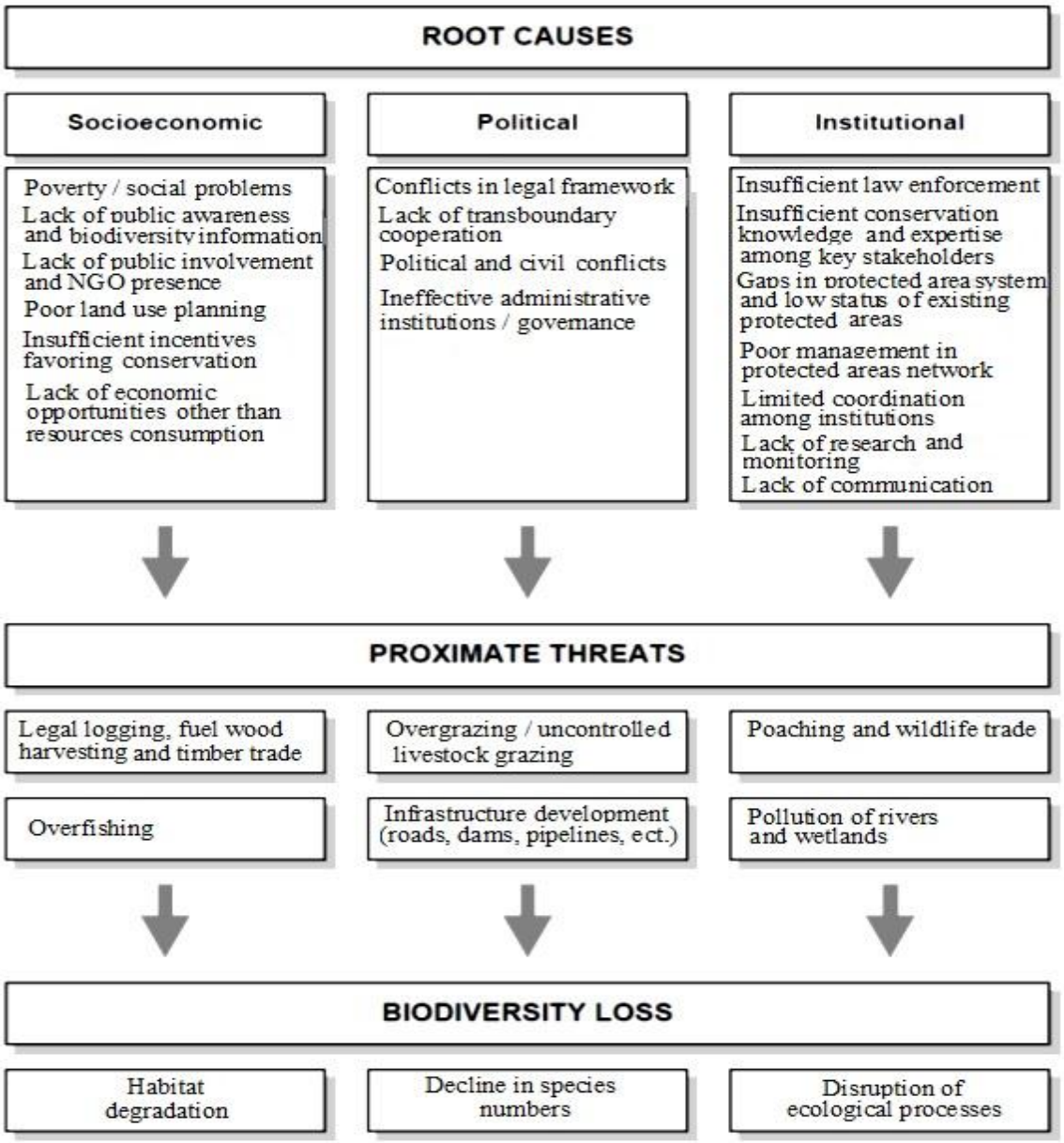

Fig. 6. Flow chart showing the relationships between elements contributing to biodiversity loss

Investments to demonstrate sustainable resource use

In order to reduce poaching, overgrazing, overfishing, and unsustainable fuel wood collection, new models of sustainable resource use need to be developed in areas where the pressures are greatest. Ways need to be developed for local communities to generate income in order to make them less dependent on natural resources. Examples of alternative income generation include ecotourism, sustainable collection and sale of medicinal plants and other non-timber forest products, and sustainable hunting and fishing. NGOs and other civil institutions can work with local communities to develop capacity for alternative livelihoods. Sustainable resource use also entails reducing the impacts of development on the environment and biodiversity. Civil society can play an important role in monitoring these impacts and providing objective information on pressing conservation issues. Finding ways for rural communities to benefit from nature conservation through sustainable resource use will boost local economies, helping reduce pressures on biodiversity.

Involving NGOs in planning and monitoring development projects will ensure that long-term economic endeavours take into account the consequences to biodiversity. Rural populations – those with a direct link to natural resource use – are generally the least informed on conservation issues. By focusing awareness strategies in target corridors, these rural communities will gain knowledge that will last a lifetime, empowering them to make informed decisions about their environment. Investments to demonstrate sustainable resource use might involve evaluation and implementation of models for sustainable forestry, water use, and rangeland management. It could start by identifying communities within the selected corridors that have the desire to participate in model projects. Steps are (i) build capacity in these model communities through training and technical support; (ii) elaborate guidelines for sustainable resource use and implement in model areas. Proximate threats such as poaching, overfishing, illegal logging, and overgrazing are causing irreversible damage to biodiversity in the Tajikistan hotspot. Threats stem from economic and social problems, the lack of environmental awareness, poor management and enforcement capabilities, and the lack of transboundary cooperation. International donors have provided considerable support to help resolve some of these issues. Funding opportunities exist, particularly in promoting transboundary cooperation, training conservation professionals, building environmental awareness, and demonstrating the benefits of sustainable resource use.

Acknowledgments

Thanks are due to support from GITEC-Consult, Cologne, who employed one of us (VS) during 2010/11 on an ABD/GEF Rural Development project, and to erstwhile colleagues, especially Dr. A. Madaminov, within the Project Management Unit in Dushanbe. Donaev Management Consulting employed one of us (NS), and their support and assistance is gratefully acknowledged.

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تنوع گیاهی و جانوری اکوسیستم‌های کوهستانی در تاجیکستان

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چکیده. کشور تاجیکستان به لحاظ تنوع زیستی گونه‌های گیاهی و جانوری بومی، در منطقه آسیا برجسته می‌باشد که حفاظت آنها در مقیاس جهانی تنوع زیستی دارای اهمیت خاصی است. این کشور در چهاراه بیولوژیکی قرار گرفته است. گونه هایی از اروپای مرکزی و شمالی، آسیای مرکزی، خاورمیانه و شمال آفریقا در ترکیب با گونه‌های بومی که در جای دیگری یافت نمی‌شود باعث اهمیت منطقه شده است. غنای تنوع زیستی تاجیکستان نشانی از تنوع در سطوح ژنتیکی، گونه‌ای، جمعیت و اکوسیستی دارد. گونه‌های بومی و باستانی زیادی در این منطقه است که در اثر عوامل انسانی آسیب پذیر هستند. تهدیدهای مهمی نظیر شکار در مناطق ممنوعه و حفاظت شده، ماهیگیری زیاد، ورود غیر قانونی و چرای شدید آسیب جبران ناپذیری بر تنوع زیستی تاجیکستان می‌رساند. ریشه این خطرات به مسائل اجتماعی و اقتصادی بر می‌گردد که موجب عدم آگاهی زیست محیطی، مدیریت ضعیف و توانایی‌های اجرایی پایین و نیز فقدان همکاری متقابل می‌شود. همچنین تغییر کاربری اراضی نظیر کشت مخلوط غلات و کاهش استفاده‌های ترکیبی نظیر کشاورزی تک محصولی موجب کاهش تنوع زیستی شده است. یکی از مشکلات کاهش تنوع زیستی ساده سازی سیستم کشاورزی است. وقتی که کشت ترکیبی تبدیل به کشت تک محصولی و پرورش یک گونه حیوان اهلی شده، بنابراین موجب از دست رفتن آشیانه اکولوژیکی می‌شود. کمک‌های بین المللی اثر قابل توجهی بر کاهش و حل این مشکلات دارد. فرصت‌های بنیادی بخصوص در راه ارتقاء همکاری‌های مردمی، آموزش متخصصان حفاظتی، افزایش آگاهی‌های عمومی نسبت به محیط زیست و نمایان ساختن فواید کاربرد منابع پایدار موجود است. همکاری نزدیک کشورهای حاشیه این چهار راه تنوع زیستی برای حفاظت از اکوسیستم‌های یک دست و در معرض خطر در منطقه آسیای مرکزی ضروری است. این مقاله اشاره به تجزیه و تحلیل وضعیت موجود، حفاظت تنوع زیستی در تاجیکستان و پیاده سازی موفق قوانین طرح ملی دارد. در نهایت مشکلات و دورنمای وضعیت تنوع زیستی در این کشور مورد بحث قرار می‌گیرد.

کلمات کلیدی: حفاظت رومیت، پامیر، دریاچه‌ها، پرندگان برفی، ماهی، خزندگان