

# Chapter 9

## Awareness of Biological Diversity and Endangered Plant Species and Ecological Education



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### 1 Introduction

The word “Endemic” comes from the Greek word *endemos*. Endemism is the presence of a species in a particular region, which can extend from a few square metres to a continent. However, usually, in practice, the term refers to a native species of limited distribution in a particular geographical area or habitat (Kaya and Aksakal 2005).

Worldwide, biodiversity is declining and current trends could have adverse consequences for humanity. Loss of biodiversity threatens the functioning of ecosystems and, hence, the provision of goods and services to people. Biodiversity and the ecological services it helps provide are being depleted progressively every day by human actions and decisions. To mitigate the impacts of such global environmental problems, global networks of protected areas of conservation importance are being built and international agreements, strategies, policy and normative documents for

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nature protection have been prepared. All of these highlight the importance of environmental education.

Biodiversity is the sum total of all of the plants, animals, fungi, and microorganisms along with the communities and ecosystems of which they are a part (Rozenzweig 1995; Gaston and Spicer 2004). The Convention on Biological Diversity (CBD) defines biodiversity as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD 1992). Globally, plant biodiversity is threatened by habitat destruction, over-exploitation, agricultural practices and climatic changes. It is also affected by evolutionary processes and socio-cultural changes, including the loss of related local knowledge (Guarion et al. 1995; Hunter and Gibbs 2007; Hawkes et al. 2000). Species losses, and other declines in biodiversity, outcome from four major causes, namely: (i) direct exploitation; (ii) habitat loss and degradation; (iii) introduced species; and (iv) extinction cascades (Gaston and Spicer 2004). Water deficit is the main natural hazard facing Jordan in addition to potential for periodic earthquakes. The main issues related to the environment in this country comprise the limited natural freshwater resources, deforestation, overgrazing soil erosion, desertification and pollution (IUCN-ROWA 2014).

The Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) was established in 2012 to provide a mechanism recognised by both the scientific and policy communities to synthesise, review, assess, critically evaluate and deliver relevant knowledge generated worldwide. Current membership includes 126 governments, along with academia, scientific organisations, non-governmental organisations and indigenous communities. The platform operates under the auspices of UNEP, FAO, UNDP, and UNESCO, administered by UNEP. IPBES Deliverable 2(c) is the Global Assessment on Biodiversity and Ecosystem Services, which addresses the status and trends with regard to biodiversity and ecosystem services and their impact on human well-being, as well as the effectiveness of responses, including the strategic plan and its (Aichi) biodiversity targets.

The purpose of this chapter is to present a brief overview of environmental education about biological diversity and awareness of endangered species and their protection in Bulgaria, Jordan, Turkey and Pakistan (Lyubenova et al. 2017).

## **2 Awareness of Biological Diversity and Endangered Species in Jordan**

The flora of Jordan is rich, diverse. Jordan's 2622 species of vascular plants represent 1% of the world flora. However, Jordan's flora shows an alarming trend of degradation and loss due to land conversion and habitat destruction, over exploitation, overgrazing and other anthropogenic and environmental threats. In particular,

these problems affect around 485 species belonging to 330 genera and 99 families that are medicinal, aromatics, herbs and spices (Oran 1994; Al-Esawi 1998). These plants have been used, locally, in folk medicines for human and animal care. They generate income for resource-poor people, especially women, who are involved in most of the collection, processing and marketing of medicinal plants.

Jordan embraces four bio-geographic regions, namely: the Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian (Al-Esawi 1998). The four regions include 13 vegetation types, which provide the natural habitats for over 4000 species of fauna and flora from the terrestrial, marine and freshwater. Human activities are causing major impacts and so the monitoring of particularly endangered plants is a fundamental requirement for guiding the management and conservation of species and habitat. The number of endangered plant species has increased due to changes in land use, farming, clearing, road construction, buildings, mining, and rural harvesting of edible wild plants such as *Gundelia tournefortii* L. and medicinal plant such as *Artemisia herba alba*, *Teucrium polium* L., *Paronychia argentea*, *Matricaria aurea* (loef). Schultz. Bp. and *Ziziphora tenuior*. Pastoral communities are well aware about the use of plants for treating the ailments of animals, such as: *Teucrium polium*, *Peganum harmala*, *Hypericum* spp., *Retama raetam* and *Varthemiai phionoides* (IUCN-ROWA 2014). However, *Gundelia tournefortii* L. is considered as a cash crop that most pastoralists collect and thus, it has quickly become endangered. The loss of habitat is the prevalent driver of extinction, and it is important to understand current risk (Dirzo and Raven 2003). In order for medicinal wild plants to survive in their natural ecosystems, suitable conservation practices must be adopted and awareness created among the people who inhabit these lands (Roa et al. 2014).

The IUCN species conservation programme and commission have been assessing the conservation status of species, subspecies, varieties, and selected subpopulations on a global scale for the past 50 years in order to highlight taxa threatened with extinction and to promote their conservation at all levels. The Jordan's Royal Botanic Garden (RBG) has led the assessment of Jordanian plants including more than 1000 plant species. The Red List of the Jordanian Flora aims to support the creation of conservation strategies that will both help protect Jordan's plant diversity and serve as a reference for future studies and monitoring programmes.

Increased public awareness is critical for biodiversity conservation and sustainable land use. Public awareness about the endangered plants of Jordan was initiated through the media, farm visit, interviews, schools and courses on biodiversity included in biology curricula at Jordan universities. Mass media, workshops and school activities were used to introduce the importance of dryland agro biodiversity to a large public audience (Abbass 2001). At the level of schools, painting competitions were launched to attract children who had an interest in conserving the environment and biodiversity. A collaboration with a rural theater team also helped expand awareness of biodiversity and the conservation of endangered plants.

For the future: regional as well international cooperation programmes for conservation and protection of the endangered and endemic plants are needed for the exchange of germplasm between countries to help minimize the loss of targets species and also restore them when conditions are suitable, especially in countries

exposed to wars. Endangered plants can be conserved at a gene bank for long time ( $-70\text{ }^{\circ}\text{C}$ ) through collection of their seeds or cuttings. Governments can also help by promoting and establishing nature reserves and then monitoring them to keep the species from outside influences. Biosafety guidelines and biodiversity action plans are essential within countries' legislation. The conservation and sustainable use of the important medicinal plants in Jordan's nature reserves requires strict regulations for both the grazing and the collection of plants. The National Biodiversity Strategy and Action Plan (NBSAP) proposed a series of priority objectives and actions that are presented according to five themes involving most sectors of society. These include: (i) protection of biological resources; includes endangered species; national red list; and protected areas, and (ii) building a biodiversity-oriented society, which includes economic valuation of biodiversity; legislation, institutional structures, public awareness and participation.

### **3 Awareness of Biological Diversity and Endangered Species in Bulgaria**

Bulgaria has a well-developed network of protected areas that cover nearly 5% of the country's territory. From Bulgaria's Protected Areas Act, one management objective for national and natural parks, reserves, maintained reserves and protected areas is carrying out educational activities in the field of ecology and environmental protection (Protected Areas Act 2007).

Of course, education is an important element of nature protection and of global importance. Commitments on this issue have been included since the earliest international conventions, such as the: Convention on the Protection of the World Cultural and Natural Heritage (1972), Convention on the Conservation of Wild European Flora and Fauna and Natural Habitats (1979) and Convention on Biological Diversity (1993).

The necessity for environmental education has been recognized in Bulgaria since the adoption of the Ordinance on the Conservation of Nature (1936) with the active cooperation of the Union for the Protection of the Homeland (1929) and the nature conservation societies and organisations included therein. The normative legal documents including Nature Protection Act (1967), Protected Areas Act (1998), continue this tradition and educational activities remain an integral part of the management objectives of protected areas in Bulgaria.

Education for Sustainable Development is a next stage in the development of eco-education, where environmental issues become equally important with socio-economic development issues. Formally, it has emerged since the United Nations Conference on Earth Issues (1992). Its subsequent implementation is set in the: Agenda 21 for Action on Sustainable Development of the Planet (1992), Johannesburg Plan for the Implementation of Agenda 21 (2002) and Global Plan of Action for Education for Sustainable Development (2014).

Protected areas play an important role as natural learning laboratories in achieving the goals of sustainable development education. They foster appropriate education through formal education, extracurricular activities and non-formal education that promotes knowledge in the field of ecology and environmental protection. This learning approach, which applies active and experiential learning and uses nature as an educational tool, is thought effective.

Non-formal education became part of the international discourse on education policy in the late 1960s and early 1970s. It can be seen to be related to the concepts of recurrent and lifelong learning. Non-formal education is any organised educational activity outside the established formal system, whether operating separately or as an important feature of some broader activity, that serves identifiable learning clienteles and learning objectives (Coombs and Ahmed 1974).

Bulgarian biota ranks among the most species-rich in Europe, especially relative to the country's size. More than 3100 *algae* species from 580 genera, 15 classes and seven divisions have been discovered so far. The *bryoflora* contains 754 species, of which 34% are of conservation importance (Critically Endangered, CR – 18; Endangered, EN – 25; Vulnerable, VU – 124 and Near Threatened, NT – 20). *Pteridophytes and seed plants* (incl. neophytes) are 4100 species of which 270 are Balkan, and 174 are Bulgarian, endemics (Golemansky 2015). As Erika p-Konya advises list 801 Red-list species, of which: Extinct, EX – 1; Regionally Extinct, RE – 12; CR – 208, EN – 297, VU – 204 and NT – 79. Overall, this constitutes 19.5% of the national flora. So far, 340 neophytes have been registered in Bulgaria, 16 in the period 2009–2013. More than 770 Bulgarian species (around 21% of the flora) are medicinal plants. The number of plants used frequently in traditional and official medicine is 220 species.

Animals recorded in Bulgaria amount to 30,359 species from 28 types and 75 classes but this is only 50% of the estimated total animal diversity. The list includes 27,000 invertebrates (about 85% are insects). There are 75 vertebrate species, the best studied group, which include 97 species of mammals, 409 birds, 37 reptiles, 19 amphibians, and 219 Black Sea and fresh water fish. Bulgaria is home to 33 of Europe's 35 species of bat. The large mammal fauna, with 23 species, is also among the richest in Europe. It includes the wolf (*Canis lupus lupus*), brown bear (*Ursus arctos*), badger (*Meles meles*), two species of marten (*Martes martes* and *M. foina*), three species of polecat (*Mustela evarsmanni*, *M. putorius* and *Vormela peregusna peregusna*), three species of deer (*Dama dama*, *Cervus elaphus* and *Capreolus capreolus*), and three marine mammals (*Dolphinus delphis*, *Phocaena phocaena relicta* and *Tursiops truncatus ponticus*). A fourth marine mammal, the Black Seamonk seal, a local form of the Mediterranean monk seal (*Monachus monachus*), is presumed extinct. The Bulgarian herpeto-fauna ranks third in Europe in species richness after Spain and Greece. There are 1200 endemic animal species (790 Bulgarian and 410 Balkan endemics). More than 780 cave species occur in Bulgaria, of which 110 are typical troglobionts.

For the conservation of this biodiversity, the 'Red Data Book of Republic of Bulgaria' has been published in three volumes: for plants and fungi, for animals, and for natural habitats. Organisms are divided into several categories depending on their status: disappeared, threatened, vulnerable, etc. The book presents the

need for regeneration and restoration of the Bulgarian flora and fauna. As elsewhere, point of this initiative is to increase public awareness of the state of flora and fauna. For example, the latest edition of the *Red Data Book of Republic of Bulgaria's Volume. 2: Animals*, lists 442 species: EX (Extinct) – 30, CR (Critical) – 87, EN (Endangered) – 107, VU (Vulnerable) – 137, NT (Not threatened) – 14, Least Concern (LC) – 42 and Data (DD) – 25. Fungi and fungus-like species are much less studied but, so far, over 4900 species have been recorded from a predicted total of 20,670. In the last 5 years, five volumes of '*Fungi in Bulgaria*' have been published with original data for more than 470 species. The Red List of fungi in Bulgaria contains 215 species of ascomycetes and basidiomycetes, which are: CR – 37, EN – 105, VU – 40, NT – 14 and DD – 19 (Peev 2015; Lyubenova et al. 2017).

Specific work related to biodiversity conservation is guided by the National Strategy for Biodiversity Conservation (NSBC 1998). Bulgarian legislation for biological diversity includes the following Acts: the Environment Protection Act (2002), the Biological Diversity Act (2002), the Medicinal Plants Act (2000), the Forestry Act (2011), the Fisheries and Aquaculture Act (2005), the Hunting and Game Protection Act (2000), the Genetically Modified Organisms Act (2005) and so on. The Bulgarian ecological legislation is fully harmonised with European legislation. According to the Bulgarian Biological Diversity Act, in Bulgaria, there are legally protected: 1057 endangered species: 595 species of vascular plants and 443 species of animals.

The Medicinal Plants Act regulates activities concerning the preservation and use of medicinal plants, the liabilities of physical persons and legal entities and governmental and local authorities for conservation of biological diversity and resources of medicinal plants. The general purpose of this act is to provide conditions for the long-term sustainable use of medicinal plants across the whole territory. About 61 medical species are protected by the Biological Diversity Act, which introduces a system of protected areas with six categories under [International Union for Conservation of Nature](#) (IUCN) and defines the interactions between the institutions responsible for their management.

At the end of 2016, Bulgaria had 1012 legally designated protected areas in six categories (National Parks – 3, Natural Parks – 11, Strong Reserves – 55, Managed Reserves – 35, Protected Places – 564 and Landmarks – 344); that is 5.2% of country's territory. The law has also imposed management plans. The Natura 2000 Network in Bulgaria covers 4,105,320 ha or 34.4% of the territory. This network includes 119 Special Protection Areas (22.7% of the territory) and 233 Special Areas of Conservation (30% of the whole territory). By the share of the national land area given to National Natura 2000 Network, Bulgaria ranks third in the European Union after Slovenia (35.52%) and Croatia (34.80%). The National Ecological Network comprises sites of the European Natura 2000 sites (Special Areas of Conservation under the Habitats Directive and Special Protection Areas under the Birds Directive) and protected areas which may be included in or may be outside the Natura 2000 area (Lyubenova et al. 2017).

Bulgarian environmental education is controlled by the standards set for the secondary school curriculum, which are seen as a mechanism for management and regulation of the general education system. They propose a normative curricula for each respective class. This curriculum decomposes the goals (the expected results), in terms of a “core of learning content – knowledge (concepts, laws, theories), skills, relationships” (Tsanova 2007).

For example, Chap. 3 (paragraph 22) of the Pre-school and School Education Act regulates standards for civic, health, environmental and intercultural education (Pre-school and School Education Act 2016). An important step towards regulating ecological education in Bulgaria is Ordinance No. 13 on Civil, Health, Ecological and Intercultural Education. In this normative document, environmental education is defined as: “aimed at the formation of ecological culture, ecological awareness and ecological behaviour in their mutual relation with a view to knowledge of environmental laws, protection, improvement, management and reasonable use of natural resources as well as protection of the natural environment and ecological equilibrium”. Ordinance No. 13 regulates the framework requirements for the results of education in the field of environmental education for pre-school and school education – by degrees and stages. Expected results are in areas of competence: Water, Soil, Air, Energy and Climate, Biodiversity, Society and the Environment (Ordinance No. 13 2016). In Ordinance No. 5 of 30 November 2015 on general education, paragraph 3 (3) reads: “Supporting sustainable development principles, including ecological, economic and social dimensions and aiming at outlining a long-term vision for society, is through training on different subjects and aims to build a personal responsibility for sustainable future.” (Ordinance No. 5 on general education 2015; Ordinance No. 5 on Pre-school Education 2016). The Comparative Review of the Standards for Different Degrees and Stages regarding the opportunities for environmental education of students represents this as a set of knowledge, skills and attitudes to be developed within the general education of students (Table 9.1).

The conclusions drawn from this analysis of the curriculum to the end of the first high school in the context of environmental culture, environmental awareness and environmental behaviour are:

- The centre is knowledge of environmental law, protection, improvement, management and reasonable use of natural resources;
- The central concern is the preservation of the natural environment and the ecological balance;
- Science knowledge is used to formulate a problem (including environmental), acquire new knowledge, explain natural processes and phenomena, make substantiated conclusions on issues related to natural sciences;
- The features of natural sciences as part of human knowledge include nature study as a major feature;
- Natural sciences and technologies form in a certain way our material, intellectual and cultural environment;

**Table 9.1** Analysis of the integration place for the endangered plant species knowledge in Bulgaria of the students by degrees and stages

Level of education	Knowledge integration possibilities for endangered plant species	Class
Basic level of education, initial stage	<b>Environment</b> Areas of competence: Natural diversity The man and the healthy Lifestyle	3–4 class
	<b>The man and the society</b> Area of competence: The man and his Environment	3–4 class
Basic level, lower secondary level	<b>Biology and health education</b> Area of competence: Organism-environment	7 class
Secondary education, first high school stage	<b>Biology and health education</b> Areas of competence: Multicellular organism Biosphere Observations, experiments, research	10 class
Secondary education, second high school stage	<b>Biology and health education</b>	12 class

- The scientific explanations, the identification of scientific problems, the scientific explanation of natural processes and phenomena, the use of scientific data and evidence can also be applied in an ecological context;
- The centre is to discuss issues related to natural sciences and sharing ideas; and
- The appearance is individual, public and global: natural resources, environment, risk.

Unfortunately, expected results about endangered species are lost in this educational process. For example, there are only two themes (one in the 7th and one in the 10 class) of current content where endangered plant species are mentioned. In the 7th class, knowledge of the rules of conduct in protected areas are presented, which does address endangered species.

However, in addition to the standard class-lesson forms of organising the learning process, extracurricular activities are also used successfully. During excursions, students experience natural objects and endangered plant species, perceiving them in their entirety, acquiring broad experiences related to nature, collecting rich visual material, which they can then use in the classroom (Asenova and Yotovska 2014). Observing different ecosystems and their great diversity of species leads to a better understanding. Students recognize the need to preserve the environment and to preserve its integrity. Outdoor work (including eco-paths) or other projects organised by various nature conservation organisations also contribute to this learning. Many



learning tools have been created that can be applied successfully in formal education (Black Sea box, Danube package, etc.; Asenova et al. 2012; Miteva et al. 2009, 2012; Yotovska et al. 2016). Some include knowledge about protected plants and other endemic species. By discussing life problems and their involvement in different projects, a positive and proactive attitude towards the environment may be formed. As for non-formal education in sustainable development, some serious work with an ecological focus being done on the development of: training programmes of different duration in protected areas. These are being prepared in a logical relationship with each other and are tailored to the participants' age so providing tools for non-formal education for sustainable development; and mechanisms for evaluating the quality of educational activities (Yotovska et al. 2015; Bancheva et al. 2016).

Today, according to state requirements, the curricula of almost all bachelor's degree programmes in Bulgarian universities include "Ecology and Environmental Protection" as a general-purpose course. This also provides information on the ecosystem role of biodiversity, its status and conservation, and the types of threats to species (Table 9.2).

Student enrolment is higher for universities offering the specialty 'Ecology and Environmental Protection'. A Faculty of Ecology and Environmental Protection has been established at the Forestry University, while in other universities, such as the Sofia University, there are separate departments. For example: Department of Landscape Ecology and Nature Conservation at the Geography and Geology Faculty; and Ecology and Environmental Protection in the Faculty of Biology. There are also Master's courses in the faculty of Biology such as "Biological Resources and their Protection", "Biodiversity and Conservation", "Environmental Legislation", "Environmental Impact Assessment", etc.

A Master's programme in Ecological Education has been active in the Faculty of Biology, Sofia University "Kl. Ohridski" for 15 years. This "Pedagogue-Master of Environmental Education" is interdisciplinary and provides specialised training in both ecology and education. This Master's degree contributes to the general professional development of teachers and priority attention is paid to the problems of ecology, ecological education and upbringing. The qualification of graduates of this Masters programme allows them to carry out specialised activities in all types of secondary schools (compulsory and extra-curricular), as well as various nature conservation organisations, reserves, visitor centres, and so on.

**Table 9.2** Analysis of the bachelor's degree programmes in Bulgaria's 51 accredited universities

Indicator	Bulgarian universities
Bachelor's degree programmes "ecology"	21
Bachelor's degree programmes in Bulgarian universities include "ecology and environmental protection"	43

## 4 Awareness of Biological Diversity and Endangered Species in Pakistan

Pakistan is a diverse geographical region ranging from Arabian sea in the south to its northern mountains, which have peaks above 8000 m from sea level. Due to its diverse biomes, Pakistan has rich biodiversity which includes 180 mammals, 700 birds and 540 fish species (Anonymous 2019b). Unfortunately, massive destruction of habitat due to the cutting of forest for energy consumption, furniture making and urbanisation has adversely affected Pakistan's endemic species.

Pakistan is a land of over 5700 diverse plant species. Out of these, 405 plants are endemic plant species from 43 families (Anonymous 2011). According to a 2011 report published in Dawn News (a well-known newspaper of Pakistan), 703 species are endangered (Anonymous 2011). This report also highlighted the plant species that no longer exist in Pakistan. These plants include: *Allium gilgiticum* (Gilgit), *Arabidopsis brevicaulis* (Hunza valley), *Asparagus gharoensis* (Sindh), *Bruguiera gymnorrhiza* (Indus delta), *Cousinia matifeldi* (Chitral), *Nepeta schinidii* (Chitral), *Pedicularis caeruleoalbescens* (Chitral), *Saxifraga duthei* (Baltistan), *Scaveola plummerii* (Sindh coast), *Scaveola taccada* (Sindh coast), *Sonneratia caseolaris* (Indus delta) and *Taraxacum chitralicum* (Chitral).

According to the IUCN's *Red List*, 18 plant species are globally endangered (Anonymous 2019c), while 12 higher plant species were reported threatened by the World Bank's 2016 collection of development indicators (Anonymous 2019d). Pakistan is one of those countries where people know very little about endemic and endangered species or their ecosystem role. Unfortunately, research on endangered plants by Pakistan's scientific community is also very limited and, as the IUCN notes, little information is available about the endangered plant species of Pakistan. However, field studies of *Astragalus gilgitensis* (Alam and Ali, 2009) and *Cadaba heterotricha* Stocks (Abbas et al. 2010) place them in the Critically Endangered category and Endangered categories respectively.

Alam and Ali (2010) also indicate the number of endangered plant species in Pakistan but only for 8 of 19 taxa. 19 flowering plants were awarded IUCN Red List status at national (Anonymous 2001) and regional level (Anonymous 2003) using the IUCN Red List's categories and criteria (Anonymous 2008). Of this 19, 16 were from Gilgit and Baltistan (Alam 2009), one was endemic to Sind Province (Ali and Khan 2009), and two were restricted to the coastal area of Karachi (Ali 1972). Alam and Ali's (2010) work categorizes the data as follows:

### (I) Collected Threatened Taxa

#### (a) Critically Endangered (CR) Taxa

- (i) *Tanacetum baltistanicum*
- (ii) *Haplophyllum gilesii*
- (iii) *Berberis pseudumbellata* subsp. *gilgitica*
- (iv) *Astragalus clarkeanus*

- (v) *Asperula oppositifolia* subsp. *baltistanica*
- (vi) *Androsace russellii*
- (b) Vulnerable (VU) Taxa
  - (i) *Rhodiola saxifragoides*
  - (ii) *Aconitum violaceum* var. *weileri*,
- (II) *Uncollected Taxa*
  - (a) Extinct (EX) taxon
    - (i) *Asparagus gharoensis* Blatter:
  - (b) Regionally extinct (RE) taxa
    - (i) *Scaevola taccada* (Gaertn.) Roxb
    - (ii) *Scaevola plumierii* (L.) Vahl
  - (c) Possibly extinct
    - (i) *Saxifraga duthiei* Gandogar
    - (ii) *Plantago baltistanica* Hartmann
    - (iii) *Mattiastrium karakoricum* Podlech and Sadat,
    - (iv) *Elymus russellii* (Meld.) T. A. Cope,
    - (v) *Consolida schlagintweitii* (Huth) Munz,
    - (vi) *Christolea mirabilis* (Pamp.) Jafri,
    - (vii) *Arabidopsis brevicaulis* (Jafri) Jafri,
    - (viii) *Allium gilgiticum* Wang and Tang

Hussain et al. (2010) reported on the endangered plants of Karachi, the largest city of Pakistan at the coast of Arabian Sea. Their report recognises: 18 threatened tree species, 11 threatened shrub species, 29 threatened under shrub species, 11 threatened woody climbers, seven threatened herbaceous climber species and 59 threatened herbaceous plants, a total of 135 threatened plant species. These plants, classified as vulnerable, rare, extinct, endangered, invasive and intermediate, are listed in Table 9.3.

**Table 9.3** Distribution of different endangered plants of Karachi, Pakistan

	Total	Vulnerable	Rare	Extinct	Endangered	Invasive	Inter- mediate
Tree	18	12	2	1	1	2	0
Shrubs	11	6	4	0	1	0	0
Under shrub (threatened)	29	19	7	3	0	0	0
Woody climbers	11	3	6	2	0	0	0
Herbaceous climber	7	4	2	1	0	0	0
Herbaceous plants	59	22	25	6	3	0	2
Total	135	66	46	13	5	2	2

Haq (2011) has reported on the critically endangered flora of District Battagram, Pakistan, finding 12 critically endangered plant species. Species suffering population decrease (%) were: (1) *Acer caesium* Wall (86%), (2) *Betula utilis* D. Don (98%), (3) *Cedrus deodara* Roxb. ex Lamb (98%), (4) *Opuntia dillenii* Haw (85%), (5) *Paeonia emodi* Wall. ex Hook. f (81%), (6) *Pistacea integerrima* (J. L. Stewart) Rech.f (93%), (7) *Populus alba* Linn, (8) *Quercus glauca* Thunb, (9) *Skimmia laureola* D.C (81%), (10) *Taxus baccata* L. Subsp. *Wallichiana* (Zucc.) Pilger (87%), (11) *Ulmus wallichiana* Planch and (12) *Viscum album* Linn. These, often significant, decrease in plant population was caused by habitat loss including area of occupancy, human exploitation of resources, the introduction of exotic taxa and pathogens (Haq 2011).

Pakistan has diverse topography and climatic conditions which create diverse ecosystems and habitats. Four of these are recognised as part of the Global 2000 list of most significant ecosystems. Unfortunately, Pakistan has no agency for ecological conservation and no action plan for landscape and land use; the consequence will likely be further ecological degradation and loss of biodiversity. Pakistan ranks among the top 10 countries that face severe biodiversity damage due to climate change and some animals and plant species are at risk of extinction. Meanwhile, the increasing cultivation of marginal lands for crops or animal production is also causing a threat to the wild flora. This is fuelled by factors that include rapid population growth, deforestation for fuel, wood, forage, illegal trade, over grazing, erosion, water logging, etc., which are causing major losses to specific habitats and, in turn, increased danger of habitat fragmentation and eventual extinction of species. Erosion of the genetic diversity of major crops is also very high in Pakistan.

The Climate Change Vulnerability Index 1 ranks Pakistan 16th in 2014 and thus one of the countries most affected by climatic changes, which result in 14 billion \$ loss per annum. Pakistan is always looking for sustainable development programmes and, in 1992, a National Conservation Strategy was developed at the request of the United Nation's Convention on Biological Diversity (UN-CBD). Such policies were also developed at Provincial and District levels. The threat of extinction to major parts of its flora and fauna forced Pakistan to sign and cooperate with the global community's environment related treaties (Anonymous 2015). These include: (i) Convention on Biological Diversity (CBD), (ii) Convention on the Conservation of Migratory Species (CMS), (iii) Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), (iv) Cartagena Protocol on Biosafety, (v) Nagoya Protocol on Access and Benefit Sharing, (vi) The United Nations Framework Convention on Climate Change (UNFCCC), and (vii) the Sustainable Development Goals.

The basis for Pakistan's national action plans for the conservation of biodiversity is Article 9 of the Constitution of Pakistan, which highlights the "right to life" for biodiversity. The Article's 18th amendment devolves biodiversity conservation to Provincial Governments but the Federal Government remains empowered to make International treaties. Other acts like Pakistan Environmental Protection Act (1997), Pakistan Trade Control of Wild Fauna and Flora Act, 2012 (CITES Act) and Access Benefit Sharing Bill (2012) have also been constructed. Similarly, a number of

“Biodiversity Policy Frameworks” have been launched and included in the National Conservation Strategy (NCS – 1992), Biodiversity Action Plan (BAP – 2000), National Environment Policy (2005), National Sustainable Development Strategy, 2012 (NSDS) and National Climate Change Policy (2012). All these programmes aim to promote sustainability and create awareness among people. However, political and economic instability has resulted in unsatisfactory progress on the Biodiversity Action Plan (BAP), 2000.

The BAP 2000 programme was formulated by a Biodiversity Working Group (BWG) which had representatives from government, civil society and experts of biodiversity and was approved by Pakistan’s Environmental Protection Council in 2000. Thereafter, a roadmap for BAP was overseen by BWG and a programme was launched with the help of provincial governments. This programme addresses: biodiversity awareness, gender, poverty, the biodiversity nexus, and also mainstream biodiversity concerns into national planning and policy processes for terrestrial ecosystems, individual habitats, species, forest ecosystems, inland wetland ecosystems, coastal and marine ecosystems, sustainable agriculture and agro-biodiversity, sustainable production and consumption and biosafety issues and challenges.

During implementation, different stakeholders found it difficult to understand the concepts of biodiversity and its values. Therefore, a Biodiversity Directorate was established which suggested and launched thematic workshops to develop knowledge about biodiversity, increase understanding of the national BAP and develop training for using relevant tools and mechanisms. The main features and targets for 2020 of this programme are:

1. Creating awareness among people about biodiversity, conservation and sustainability
2. Integrating biodiversity values with poverty reduction and planning for national and local development
3. Integrating different stakeholders for sustainable resources management
4. Reducing the rate of biodiversity loss to near zero for all natural habitats
5. Promoting sustainable land use for areas under agriculture, aquaculture and forestry
6. Reducing pollution
7. Identifying invasive alien species and their pathways to prevent their introduction and establishment
8. Preventing the extinction of known threatened species
9. Maintaining the genetic diversity of cultivated plants and domesticated animals and their wild relatives to minimise genetic erosion
10. Enhancing and implementing relevant traditional knowledge, innovations and the practices of indigenous and local communities relevant to conservation and sustainable biodiversity
11. Applying scientific research and innovative technologies to biodiversity protection.

After implementing the national BAP programme, the following plant species have been targeted for conservation (Anonymous 2015).

1. Aconite, Atees (*Aconitum heterophyllum*) AJK, KP, GB
2. Alder (*Sharol Alnusnitida*) AJK, KP
3. Bakau (*Rhizophora mucronate*) Sindh
4. Chilghoza (*Pinus gerardiana*) Balochistan, GB
5. Costus, Kuth (*Saussurea costus*) AJK, KP, GB
6. Gugul (*Commiphora wightii*) Sindh
7. Himalayan May apple (*Podophyllum hexandrum*) AJK, KP, GB
8. Himalayan Yew (*Taxus wallichiana*) AJK, KP, GB
9. Indian Maple (*Acer caesium*) AJK, KP
10. Indian snakeroot (*Rauvolfia serpentine*) AJK, KP
11. Juniper (*Juniperus excelsia*) Balochistan
12. Kutki (*Picrorhiza kurroa*) AJK, KP, GB
13. Marsh orchid or Spotted Orchid (*Dactylorhiza graggeriana*) AJK, GB
14. Marsh orchid or Spotted Orchid (*Dactylorhiza hatagirea*) AJK, GB
15. Mazri (*Nannorrhops ritchiana*) Balochistan, KP, Punjab
16. Nag Chhatri (*Trillium govanianum*) AJK, Gb
17. Nepalese Alder (*Alnus nepalensis*) AJK, KP
18. Primrose *Primula* sp. AJK, KP, GB

Field results clearly reveal that plant species in Pakistan are under threat of extinction due to several socio-economic and environmental factors. The number of endangered species in Pakistan differs in data taken from various sources. Just 18 plants are listed by the IUCN; this clearly highlights the problem as regional studies reveal much higher number of endangered species in Pakistan. There is a dire need to control the endemic and endangered plant species of all regions followed by enlisting the plants to IUCN data base for better conservation. Recently, Pakistan launched its long term “*National Biodiversity Strategy and Action Plan for achieving Aichi Biodiversity Targets and Sustainable Development Goals (2017-2030)*” (Anonymous 2019e). This headlines the need for environmental education to raise public awareness of the biodiversity issues and a process of education has now begun for those directed to implement the plan.

## 5 Conclusion

This chapter dealt with the status of biological diversity in Jordan, Bulgaria, and Pakistan, its protection and also public education about their endangered species. The flora of Jordan, Bulgaria, and Pakistan is rich, diverse and includes many medicinal and aromatic plants as well as herbs and spices. Information about the biodiversity of Jordan, Bulgaria, and Pakistan as well as about its protection is (or should be) included at all levels of formal education – basic, secondary, higher, informal and non-formal, although the process is in its very early stages in some of these countries. In higher education, the focus of attention is the ecosystem role of biodiversity and its importance for the stability of the biosphere and effectiveness of

ecosystem functions, and its role in the provision and regulation of ecosystem service. The main goals of environmental education are consciousness raising and the development of ecological thinking.

Significant biological diversity at all levels – genetic, species and ecosystem, is considered valuable asset of Jordan, Bulgaria, and Pakistan. Biological diversity protection in these countries helps guarantee the preservation of ecosystem integrity and sustainable ecosystem functioning, providing sustainable ecosystem services to society. However, achieving this requires the creativity of environmentally responsible individuals, people who may be made empowered through active environmental education. This extremely important role for education can be realised through the improvement of the formal education courses and increased participation of different forms of non-formal education and voluntary activity that allows learners to gain hands-on experience in solving the real problems and cases.

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