

Current state of Zarafshan tugay ecosystems and their protection

Aktualny stan ekosystemów tugajowych i ich ochrona

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Streszczenie. Tugaje są charakterystycznymi ekosystemami Azji Środkowej, będącymi pasmami zarośli lub lasów topolowo-wierzbowych, rosnących wzdłuż rzek. Antropopresja związana z hodowlą zwierząt, nielegalnym pozyskiwaniem drewna, wysypiskami śmieci i zmianą stosunków wodnych powoduje degradację tych cennych ekosystemów. Niniejsza praca przedstawia badania tugajów w dolinie rzeki Zarafszan w południowym Uzbekistanie, na odcinku od dystrybutorów wody w Ravatkhodzha do granicy obwodu Navoi. Na tym odcinku rzeki znajduje się duży obszar chroniony – Rezerwat Zarafszan. Opisano wyniki badań i obserwacji florystycznych, prezentujące najważniejsze gatunki drzew, krzewów i roślin zielnych obecnych w tugajach o różnym stopniu degradacji. Przedstawiono działania konieczne dla ochrony tych cennych ekosystemów.

Słowa kluczowe: tugaj, ekosystem, ochrona, gatunki charakterystyczne, degradacja

Key words: tugay, ecosystem, protection, characteristic species, degradation

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INTRODUCTION

The progress of civilization causing the variety of environmental problems affecting our entire world has reached a stage where the control of many negative phenomena is very important, but difficult. One of the example of recent trends in environmental protection is the investigation dealing with changes (mostly decreasing) in biological diversity.

Biological diversity, frequently defined as biodiversity, refers to the variety and variability among living organisms and the ecological complexes in which they occur. Items important for biodiversity are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, genes, and their relative abundance.

However, modern extinction rates are high, at 100 to 1000 times greater than background extinction rates calculated over the eras (Hamblen 2004, Hamblen, Speight 2004, Hamblen et al. 2011). Although new species appear (mostly within the group of microorganisms), existing species go extinct at a rate 1000 times that of species formation (Huber et al. 2002). The International Union for the Conservation of Nature estimates that 22% of known mammals, 32% of amphibians, 14% of birds, and 32% of gymnosperms (all well-studied groups) are threatened with extinction (Hilton-Taylor et al. 2008).

Ecosystems include all the species, plus all the abiotic factors characteristic for a region. When ecosystems are intact, biological processes are preserved. These processes include nutrient and water cycling, harvesting light through photosynthesis, energy flow through the food web, and patterns of plant succession over time. A conservation focus on preserving ecosystems not only saves large numbers of species (including non-charismatic species that do not receive public support) but also preserves the support systems that maintain life. Biodiversity on the level of ecosystem is especially important in the case of rare and specific biological units. Such ecosystems are present in some areas including the Central Asia. Species biodiversity and biodiversity of ecosystems are co-dependent – that diversity among species requires diversity of habitats, and vice versa. Habitat destruction has played a key role in extinctions (Ehrlich, Ehrlich 1981).

The protection of individual habitats and whole ecosystems is also important from the ecosystem services point of view. Ecosystem services – the economic benefits that nature provides to people – are gaining recognition in the research and policy communities as a means of better supporting sustainable resource management (Daily 1997). In the case of Central Asia such benefits include food, material for clothes, fuel, substrates for medicines, as well as, some cultural and social values, playing an important role in a sustainable development of the region.

It is widely known that man is able to alter the delicate balance in many areas. This phenomenon is especially visible in arid and semi-arid territories. Arid and semi-arid or subhumid zones are characterized by low rainfall per annum, periodic droughts and different associations of vegetative cover and soils. Drought has been a recurrent problem in Central Asian countries. Many ecosystems in Uzbekistan is under serious threat of desertification, water deficiency and degradation. The areas surrounding river valleys are crucial for solution of some ecological problems, hence, the investigations concerning the morphological and structural peculiarities, plant biodiversity as well as and climate projections will allow estimating the change in the floodplain areas in the immediate vicinity of river-beds. One can say that comprehensive studies of plant growing on beds of the rivers located at the territories where evaporation prevails precipitation and big daily and annual amplitude of temperature occurs is very important.

STUDY AREA

The investigations were carried out in the Zarafshan River valley. Zarafshan River (length 877 km) is the third longest river in Central Asia. Its name, "spreader of gold" in Persian, refers to the presence of gold-bearing sands in the vicinity of upper part of the river. Zarafshan River rises on the fringes of the Pamir Mountains in Tajikistan, after about 300 km entering Uzbekistan, where turns west-to-north-west, flowing past the ancient city of Samarkand, passing Bukhara before it is lost in the desert beyond the city of Karakul. The area of investigation was performed in part of Zarafshan River valley located in Uzbekistan from distributors of water in Ravatkhodzah of the Samarkand region to borders with Navoi region.

The area of Zarafshan State Reserve was a part of Zarafshan River Valley. The Zarafshan State Nature Reserve is situated in the south-eastern part of Samarkand region. Its extends from the Chapan-Ata mountain upstream along the right bank of the Zarafshan river to the Pervomayskaya dam. The nature reserve consists of two separate parts, the distance between them being 300 m. The width of each part is 100–140 m and the average length is 47 km. The most widespread soils are alluvial-flood lands and inundated-alluvial.

RESULT AND DISCUSSION

Nowadays the biodiversity of plants in the Zarafshan valley begin to be endangered. Deficiency of water in summer months, as well as salinization and change of the hydrological mode of the river Zarafshan are observed. The agriculture use (mainly pastures), illegal cutting, fires and contamination lead to considerable changes in the

vegetation cover. Some plants growing earlier in these territories were reduced or completely disappeared.

The plant form characteristic for Uzbekistan river valleys is tugay forest. Tugay is defined in a broad sense as the recessive vegetation, including forests, bush communities and meadows, relying on flood and phreatic water along river banks, piedmont springs and lake shores in the desert and semi-desert plains in the middle of Asia. In a narrow sense it refers to riverine forests composed mainly of the two poplar species *Populus euphratica*, *Populus pruinosa* and *Eleagnus* spp. associated with shrubs (*Tamarix* spp.) and herbaceous species, distributed along rivers in Asian deserts (Tian 1991).

Tugay habitats occur in semi-arid and desert climates in the central Asian region and are highly sensitive to changes in water supply, such as abstraction for irrigation, and other anthropogenic effects on the environment. In this regard, considering ecological fitness of plants of tugay forests in Uzbekistan, their state, rational use, studying of theoretical regularities of a sustainable development and preservation, there is a requirement of investigations of these habitats, which extended in flood plains of the rivers and need of development of practical recommendations for production.

In current conditions, in the territory of the tugay forests are allocated three types of dominating vegetation: woody, shrubby and grassy (Bakhiev et al. 2008). The earlier investigations distinguished three sharply isolated parts depending on the distance from the river (Sedov 1959, Andreyev 1981). These parts were also described by Breckle (2002). The part locating in nearest vicinity to the river occupies a narrow strip along the operating or old bed of the river.

In last few years a series of expeditions was organized to study tugay habitats. The floristic investigation were carried out, 500 sheets herbarium was prepared, pictures were made and all collected material was compared with the data available from 50–60 years. In the research area the existence 267 species of plants belonging to 131 genera and 61 families. The collected herbarium was contributed to herbarium fund of the Department of Botany and Plant Physiology of Samarkand State University.

Our research showed that the rivers located in a flood plain of Zarafshan alluvial plains are populated with many species of plants pioneers. On sandy soils mainly occurs *Typha pallid* Pobed., whereas on the clay – *Calamagrostis dubia* Bunge. In the association of water vegetation the dominating species of the genus *Typha*, *Calamagrostis* or *Phragmites* were observed. *Saccharum spontaneum* L. prevails in flooded places, and in less humid areas other species – *Equisetum ramosissimum* Desf., *Glycyrrhiza glabra* L., *Erianthus purpurascens* Anders., or *Typha elephantine* Roxb. were more frequent.

Tugai thickets are formed by species of the genus *Populus*, *Salix* and *Elaeagnus*. Creepers are represented by *Clematis orientalis* L. and *Cynanchum sibiricum* Willd. On more saline places *Halimodendron halodendron* Pall and different species of *Tamarix*

were present. Also two interesting species of grasses – *Cynodon dactylon* (L.) Pers., and *Imperata cylindrical* (L.) Raeusch. were found out.

Cogongrass (*Imperata cylindrical*) is considered to be one of the ten most troublesome and problematic weedy species in the world. This species found throughout tropical and subtropical regions, generally in areas disturbed by human activities, is very invasive. Cogongrass is a major impediment to reforestation efforts in southeast Asia, the number one weed in agronomic and vegetable production in many parts of Africa, and is responsible for thousands of hectares of lost native habitat in the southeastern U.S. (MacDonald 2004). *Cynodon dactylon* is a grass that originated in the Middle East. It is an abundant invasive species (Farsani et al. 2012). Development of these grasses create peculiar ecological conditions.

In some places located in a flood plain of the river tugay thickets goes up to as much as 2–3 m tall. Such riverine bushes are 4–5 years old and form a dense thickets of *Calamagrostis epigejos* (L.) Roth., and *Phragmites communis* Trin. Rapid expansion of perennial grasses such as *Calamagrostis* species has been observed in many damaged forests and in open deforested areas (Gloser, Glöser 1996).

It is easy to notice along the river the groups of trees differing in age. In such areas photophilous *Calamagrostis epigejos* (L.) Roth., *Typha angustifolia* L., *Tamarix ramosissima* Ledeb., *Halimodendron halodendron* Pall., begin to die out and being replaced by *Glycyrrhiza glabra* L., *Apocynum scabrum* Russan., and *Clematis orientalis* L., which are able to develop faster. In the places where the oldest trees grow, herbal plants died out almost completely.

In the Zarafshan State Reserve the most common species of wood were poplars (*Populus pruinosa* Schrenk, *Populus diversifolia* Schrenk), and willows (*Salix wilhelmiana* MB, *Salix songorica* Andersson). Small bush layer is characterized mainly by *Halimodendron halodendron* Pall, an interesting species which has been used as forage in northwestern China for a long time. The recent investigations suggest the potential of this plant as a source of functional food ingredients and provide support data for its utilization as forage as well (Wang et al. 2012). Dwarf shrub *Apocynum scabrum* Russan is also very common plant in this area. Plants belonging to *Apocynum* genus offer opportunities as fibre and medicinal plants (Thevs et al. 2012).

The area of Zarafshan State Reserve is characterized also by wide occurrence of grassy and herbal plants representing by *Erianthus ravennae* L., *Trifolium pratense* L., *Calamagrostis epigeios* L. Roth., *Phragmites communis* Trin., *Cynodon dactylon* (L.) Pers., *Poa bulbosa* L., *Sorghum sudanense* (Piper.) Stapf., *Plantago lanceolata* L., *Taraxacum officinale* Wigg., *Polygonum persicaria* L., *Chenopodium setorinum* L., *Glycyrrhiza glabra* L., *Clematis orientalis* L., *Dodartia orientalis* L. Also herbal creepers such

as *Calystegia sepium* (L.) R.Br., *Convolvulus arvensis* L., *Cynanchum sibiricum* Willd., *Cuscuta lehmaniana* Bge. were found.

Our researches showed that nowadays in a desert zone of a flood plain of the Zarafshan River different formations of poplars completely disappeared. They were replaced by vegetation cover composed of perennial herbs such as *Erianthus ravennae* L., *Phragmites communis* L., *Glycyrrhiza glabra* L., *Alhagi pseudoalhagi* Boiss. sometimes with single specimen of big bush *Eleagnus orientalis* L. In some places it is possible to meet plants belonging to genus *Tamarix*. Between bushes perennial plants (form a dense cover *Cynodon dactylon* (L.) Pers., and *Aeluropus littoralis* (Gouan.) Parl.

In marshy places of tugay ecosystems present in Zarafshan River valley *Typha laxmanni* Lepech., *Phragmites communis* L., *Alhagi persarum* Boiss, *Alhagi kizghisorum* Schrenk, *Glycyrrhiza glabra* L. were found. In the tugay of an adyr (a belt of low, barren hills) zone partial distribution of formations of *Salix wilhelmsiana* M.B., *Hippophae rhamnoides* L., *Elaeagnus orientalis* L. was established.

Formations of the *Elaeagnus orientalis* L, *Hippophae rhamnoides* L. and *Populus* were also kept in the territory of the Zarafshan State Reserve, and also around a water distributors in Ravatkhodzhah, in Sarazm. In some places of these territories, where the anthropopressure was not really strong, partial degradation was observed, but in general the characteristic landscape of the tugay forest still existed. However, in the territory of Dzhabbay, Pastdargom, Akdarya and Ishtykhan regions, where intensive anthropogenic factor influenced the environment, the tugay forests are fragmented and strongly degraded (Photo 1).



Photo 1. General view of degraded tugay

Fot. 1. Ogólny widok na zdegradowany tugaj

It should be noted that for the last 50 - 60 years the area of the tugay forests in Uzbekistan were considerably reduced (Nihoul et al. 2003). In many places of the bed of the rivers are ploughed and used under crops. However, the existence of some characteristic tugay plants confirms that formerly the tugay forests were present in these territories. The accelerated reduction of the areas of the tugay forests and their degradation are connected also with using trees and bushes by local population as building material and for heating. The other threat for tugay ecosystems is cattle breeding. This leads to significant changes of vegetation cover towards domination of *Clematis orientalis* L. and *Rubus caesus* L. which has not been eaten by cattle. These plants become dominant species, carrying out a role of weeds (Photo 2).



Photo 2. *Rubus caesus* L. – dominating species in some degraded tugay forest

Fot. 2. *Rubus caesus* L. – gatunek dominujący w niektórych zdegradowanych lasach tugajowych

In addition, in places of the sparse and vulnerable vegetation of tugay ecosystems a large number of garbage tips appeared, what caused favourable conditions for development of ruderal plants. As a result of our researches 40 species the ruderal flora were collected. Among them the big spaces are occupied by species of the genus *Xanthium*, i. e. *X. spinosum* L., (especially extended) and *X. californicum* Greenc.

Each plant growing in the tugay forests is a part of a gene pool of flora of Uzbekistan. For the purpose of preservation of tugay a gene pool the Zarafshan and Baday-Tugay Reserves were organized. Both reserves receive serious help from the state. The long-term monitoring is carried out in these reserves which allowed us to define the main tendencies of natural and anthropogenic changes of tugay ecosystems (1985–2014).

CONCLUSIONS

Central Asia, which stretches from the Caspian Sea over Kazakhstan, Turkmenistan, and Uzbekistan to Northwest China (i.e. Xinjiang, Gansu, Qonghai, Inner Mongolia, Ningxia, Shanxi, and Shaanxi), and Mongolia, is largely covered by steppes, semi-deserts, and deserts. In such arid and semi-arid areas, ecosystems where water is the important factor controlling the environment and the associated plant and animal life, play the significant role. Hence, the vegetation of river valleys which undergoes important changes due to the natural or anthropogenic factors should be strongly protected.

The overall protected areas system of Uzbekistan covers most of the ecosystems and habitats present in the country, including the globally significant Tugay gallery forests. Relatively big number of domestic and international proposals dealing with the tugay forests is offered. The arrangements of these projects promote conservation of the unique ecosystems present in Central Asian river valleys

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