Anthropogenic Changes of Priamurje (Russia) Biodiversity

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Abstract: The retrospective analysis is focused on anthropogenic factors, which have formed modern biodiversity and caused crucial ecological problems in Priamurje.

Zusammenfassung: Eine retrospektive Analyse anthropogener Faktoren auf die Biodiversität und die ökologischen Probleme der Region Priamurje (Russland) wird vorgestellt .

Key words: Priamurje, ecological functions of forests, ecosystem degradation, forest resource use, bioindicators, rare species, agro-landscapes.

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Introduction

Compared to other Russian Far Eastern territories the Amur Basin occupies not only the vastest area but also has a unique geographical position as being a contact zone of the Circumboreal and East-Asian areas, the two largest botanical-geographical areas on our planet. Such contact zones usually contain peripheral areals of many plants as a complex mosaic of ecological conditions allows floristic complexes of different origin to find a suitable habitat.

The analysis of plant biodiversity dynamics seems necessary as the state of biodiversity determines regional population health and welfare.

The Russian part of the Amur Basin possesses over 4500 vascular plants, i.e. 36% of the Russian flora. Nearly 1/3 of the Far Eastern flora may be of use for different purposes (timber, medicinal, nutrition, forage, technical, etc.)

Most of regional population depends on timber resources, conditions of natural forage lands, game and other bioresources in the Amur Basin and the basins of big Amur tributaries, resources of edible and medicinal fungi and plants. Besides, biodiversity conditions serve as indicators of biosphere functions of the vegetation cover in the Amur Basin, which include such functions as environment-forming, biostation, water-protection, water-regulation, anti-erosional, permafrost-stabilizing, cultural (esthetic, educational, spiritual).

Our research was focused on revealing current conditions of the vegetation cover affected by fires and timber felling.

Methods

The field research was undertaken in three natural-historical fratries: coniferous-broad-leaved forests, spruce and fir forests and larch forests. The monitoring was carried out at permanent and temporary sites in the Amur valley, in the valleys of the Amur biggest tributaries (the Amgun, Anui, Khor, Bikin, Bira, Bureyza rivers) and in such divines as the Sikhote-Alin, Myao Chan, Badzhal and Mevandzha mountain ranges. Reactive test-indicators in plant communities were selected as possible to signal the impact of certain factors on the vegetation cover.

Such qualitative and quantitative parameters as plant number, occurrence, vitality, etc. were used to select bioindicators.

The following criteria of plant species importance for biodiversity conservation were studied: taxonomic representation; species phyto-geographical importance; biocenotic function based on the role of each plant species in phytocenoses; a conservation index that indicates the degree of destruction risks for the rare plant coenopopulation, etc.

The described indicators were used to assess the conditions of plant formations that suffered various types of anthropogenic disturbance.

Results and Discussion

One of the crucial anthropogenic factors that damage biodiversity is extensive timber harvesting of clear-felling type, when most productive woods are cut.

Data on round-timber export to China show the intensive growth of timber harvesting in the region: it was 5-10% at the end of 1990-ies and 50% at the beginning of this century. Just in one year 2 million 590 thousand m^3 of round timber were exported from Primorsky Krai and 5 million 155 thousand m^3 of round timber were exported from Khabarovsky Krai. At the same time according to the Russian State Statistics Committee data 4.4 million m^3 of commercial timber were exported from Khabarovsky Krai, i.e. 800 m^3 less than round timber. It means the amount of illegal felling and timber export. Illegal timber harvesting, which includes timber felling for export and for local consumption as well left in the forests, in Primorsky Krai was estimated as nearly 1.5 million m^3 (KOTLOBAI 2009).

30% of the timber flow from Primorsky krai to China is formed of hard-wood species: oak, ash and elm and 70% of timber are harvested in Primorsky Krai illegally under the pretence of improvement felling or sanitary measures. Although felling of *Pinus koraiensis* is forbidden, hundreds of thousands of m^3 of this species are exported under the name of "common pine". In the last hundred years Korean pine forests decreased 70 times (from 554 thousand hectares to 8 thousand hectares).

Although satellite monitoring of forest management started in 2007-2008 failed to identify most of illegal felling, it improved land monitoring information on the impact of timber harvesting on the water regime of small rivers of the Ussuri River and the lower Amur River basins.

It was found out that if an abies-and-spruce forest on the mountain slopes of 1500 hectares undergoes 36-75% felling, the spring, summer and annual runoff of small rivers in the forest vicinity increases. The spring river runoff is usually 30 mm and exceeds the summer runoff. Due to the increase of the spring runoff the overall annual runoff also increases. 75-100% forest felling in the same area makes the spring runoff increase and the summer runoff decrease. The annual runoff depends on the ratio of seasonal runoff differences. In all cases reported river runoff fluctuations increased in all the seasons, except the spring runoff in the abies-and-spruce forests cut 35-75% (KIM 1988).

The lower mountain areas with the slope steepness of 15-25% are covered with coniferous and coniferous-and-broad-leaved forests. Felling intensity here is usually 35-75%. If annual felling reaches 20 km^2, the annual river runoff and all its components will increase. The runoff both in spring and summer increases by 15-20 mm and the annual runoff increases by 30 mm (KIM 1988, SHIROKOVA 1973).

Thus, it has been proved that principal felling in the low mountain landscapes, mostly covered with coniferous-and-broad-leaved forests, affects the annual river runoff and its components much less compared to mid-mountain steep areas covered with spruce and abies-and-spruce forests. The impact of principal felling on the river runoff increases with the elevation of felling sites. (SCHLOTGAUER 2008).

In coniferous-and-broad-leaved forests with drainage area less than 500 km^2 the river runoff decreases in spring and sharply drops (up to 50 mm) in summer. The spring runoff decrease has been also registered in other landscapes, which suffered extensive commercial timber harvesting. Thus, intensive felling on vast areas negatively affects the annual river runoff in general. The more area undergoes intensive felling the bigger negative changes of river water regime and runoff decrease are caused. Intensive felling in mountain areas and dramatic reduction of forest-covered areas of river basins in low-elevation landscapes worsen the runoff and water regimes of small and medium rivers and deplete water resources of bigger rivers in the region.

Changes of the water regime and temperature increase by 1.8° C, registered by the climatologists in Priamurje, negatively affect coniferous forest conditions. *Piceae ajanensis* and *Abies nephrolepis* dying off continues. At the end of the previous century the regeneration of *Pinus pumila, P. koraiensis* and productivity and vitality of sprouts decreased (NOVOROTSKY 2008; BUDZAN & BUDZAN 1999).

That is why nowadays vast areas of middle-mountain and valley parts of the Russian Priamurje are covered with secondary forest formations interchanged with patches of meadow-shrubbery and half-grown forests. Felling of edificatory, primarily coniferous species causes destruction of sphagnum, lichen, fungi and vascular plant species, as they are highly dependant on the canopy-forming species. In larch-fir and pine-fir forest formations of the Sikhote-Alin Mountain Range degradation of many plant populations is observed, for example: most hygrophilous selaginella: *Selaginella tamariscina* and sphagnum: *Hippopterygium japonicum, Discelium nudum, Hondaella caperata, Targionia indica, Actinothuidium hookeri, Cryphaea amurensis,;* lichen: *Coccocarpia palmicola, Leptogium burnetiae, L. hildenbrandii, Lobaria pulmonaria, L. retigera, Sticta limbrata, Lethariella togashii, Parmotrema arnoldii, Punctelia rudecta, Pyxine sorediata, Hypogymnia hypotrypa, Asahinea scholanderi, Menegazzia terebrata;* fungi: *Grifola frondosa, Polyporus umbellatus, Hericium coralloides, Laricifomes officinalis, Sparassis crispa, Ganoderma lucidum, Cortinarius violaceus, Laetiporus silphureus*, etc. Areals of numerous fungi and such vascular plants, which form a symbiosis with tree species, as *Gastrodia elata, Epipogium aphyllum, Boschniakia rossica* and some others, have been reduced. However, the majority of plants, lichen and fungi are registered in the Russian Red Book or the Red Books of the Far Eastern regions. They, like *Panax ginseng, Popoviocodonia stenocarpa, Dioscorea nipponica, Paeonia lactiflora, Adonis amurensis, Bergenia pacifica* and some others are valuable nutritional, medicinal and adornment resources of Far Eastern forests.

Adlumia asiatica, Panax ginseng, Lilium callosum, Ilex rugosa, Ephedra monosperma, Macropodium pterospermum , etc., and all in all 170 fungi and vascular plant species are under the threat of extinction (SCHLOTGAUER 2007).

In Priamurje intensive timber felling and fires that followed destroyed northern populations of relict filicoid and orchid species: *Liparis makinoana, Epipogium amphyllum, Gastrodia elata, Ponerorchis pauciflora, Oreorchis patens, Platanthera freynii*, and others. Populations of *Taxus cuspidata, Paeonia oreogeton, Gagea nakaiana*, etc. became fragmented or their areals were "poked with holes".

Distribution areas of medicinal plants such as *Aralia elata, Panax ginseng, Schisandra chinensis, Eleutherococcus senticosus* were also fragmented (Fig. 1).

The decrease of the biostation function of coniferous and broad-leaved forests caused the reduction of the game feeding base and threatened the existence of the northern population of

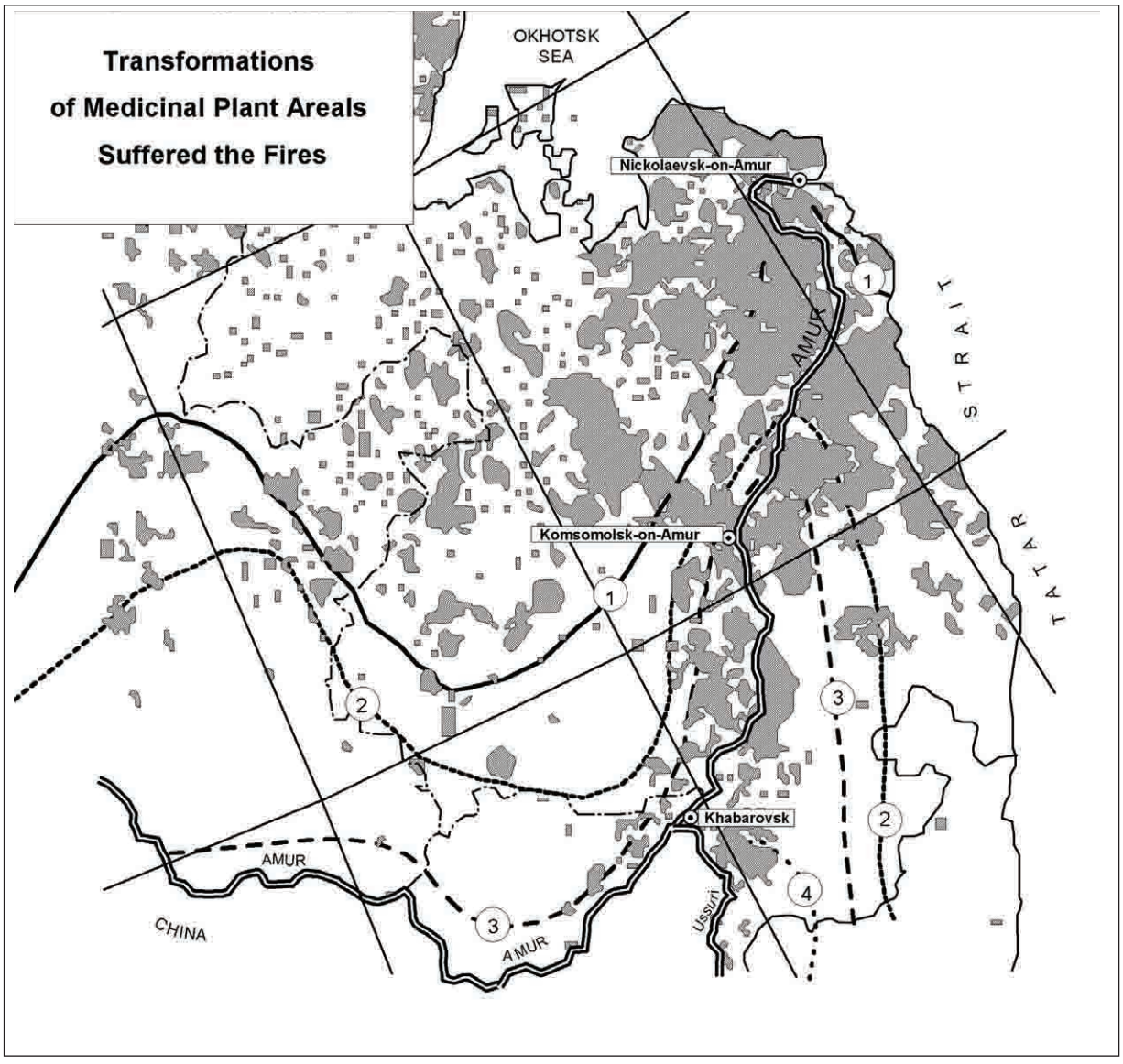

Fig. 1: Transformation of medicinal plant areas having suffered from fires.

Panthera tigris altaica and some other species of the Red Books of the Russian Federation (2008) and Khabarovsky Krai (2008) like: *Prionailurus euptilura*, *Nemorhaedus caudatus*, *Mustela altaica raddei*, *Grus japonensis*, *Terpsiphone paradisi*, *Eurystomus orientalis* and others.

Prerequisites for a high biological diversity originally inherent in flora and fauna are determined by landscape variety, peculiar natural conditions, geographical specifics of forest massifs and play a unique regional biogeographical role in the sustainable functioning of Amur ecosystems. However various anthropogenic processes restrict their development. Moreover, anthropogenic factors nowadays prevail over evolutional and historical ones. Genetic bridges, which secured continuous exchange of the genofond between the ecosystems and their components, are breaking. Ecosystems are loosing most of their components, thus becoming less resistant to the external pressure. It takes them little time to degrade to a lower organizational level, as their biodiversity and component functions decline.

Relict, endemic, peripheral, conservative, rare and originally few in number plant species, which are ecologically important and commercially valuable, are substituted in zoo-complexes by background, eurytopic, synanthropic or apt to synanthropization species. The new level of the zoo-complex balance tends to abrupt changes and cannot secure necessary stability. Thus many species either rapidly grow or decrease in number. The genetic diversity of many populations declines whereas their special and genetic isolation increases (VORONOV 2006).

It has been proved with the records of fire damage dynamics. If in 1921 the fire that damaged 10 thousand hectares was considered awful, at the beginning of the 21st century annual fires damage from 100 thousand to 1.5-5 million hectares. Catastrophic fires occurred only in dry years (1921, 1949, 1954, 1976, etc.), whereas nowadays they happen nearly every year (1998, 1999, 2000, 2001) or even twice a years in spring and autumn as was in 1998 and 2001 (GREK 2002). In the 19th century fires helped agriculture development (cutting farming, burning out haying sites) and their negative effect was the unfavorable change of plant species in limited areas. Fires today threaten biological diversity and even existence of coniferous-and-broad-leaved formations of the vegetation cover, and cause extinction of particular plants and animals. Smoggy air in cities and towns threaten health and life of people. Moreover, speaking about a possible ecological catastrophe in the Amur basin in general and about one of its criteria in particular, i.e. about river water pollution with phenols, besides industrial chemical pollution, coming from China, one should also mention annual burns of reedgrass meadows and swamps both in the Chinese and Russian parts of the basin (BAKLANOV & VORONOV 2010).

Multi-year statistical data show that most of fires are caused by men, 93% of fires in coniferous and broad-leaved forests in particular. Fire occurrence distribution data by weekdays reveal that 40% of fires during a week happen on week-ends and holidays. Moreover, 68% of fires start within 3-km zones along the roads and 10-km zones around cities and towns, frequented by citizens, who gather berries, mushrooms, medicinal herbs, ferns, etc. Many fires deep in the forest are caused by fishermen and hunters.

Catastrophic fires in 1998, which damaged over 4.5 million hectares of the forest fund (GREK 2002), were not only caused by consistent extremely dry seasons, but also by the enormous amounts of flammable materials left in the felling areas and insufficient infrastructure to remove them out of the forest.

Many forest managers predict possible extreme forest fire situations in Priamurje and point out that the forest fire protection system it its current state will not be able to adequately address them.

The impact of forest fires on the structure, dynamics and ecological state of taiga and coniferous-broad-leaved forest biodiversity significantly exceeds all other anthropogenic impacts.

Fires of various types and intensity produce different effects on the ecosystems. Monsoon climate and mountain specifics cause many environmental problems, such as soil erosion, formation of rock debris and digression successions on the plains, coupled either with the development of sod formed of thick roots of perennial gramineous plants, or with intensive swamping processes.

The logical succession of events in the ecosystem is as follows: timber felling and forest fires – decrease of forest-covered areas in the Amur Basin – decrease of primary forests – increase of secondary formations and areas covered with perennial gramineous plants – regular fires of dead grass in spring and autumn – smoke screening of large areas and toxic substance penetration into the soil – transportation of pyrogenic substances with the air flow, atmospheric precipitations and surface runoff into water ecosystems – eutrophication of water biogeocoenoses.

The analysis of rare and vanishing plants showed that 50 plant species need correction of their rarity status.

The decrease of a biostation function of coniferous-broad-leaved formations caused the decrease of the game fodder base and threatened the existence of the northern population of tigers.

When natural lands are used for agriculture, habitats of many species and hence regional biodiversity undergo inevitable changes caused by agricultural drainage, cattle grazing and pyrogenesis increase due to agricultural activities, etc. Land and natural resource use effects in the Zeya-Bureya plain and the Middle-Amur Lowland include the destruction of protective forest massifs and "islands", which otherwise prevent the soil from wind and water erosion, melioration of peat land, heavy machinery used against modern agricultural requirements.

Beginning from the 1990-ies plow lands tend to decrease and transform into wilderness. Unused lands start swamping and shrubbing. Insufficient material, technical and financial support of agriculture on the federal level results in the decrease of the number of companies and people engaged in farming.

However, weakening of agricultural activities in the Amur Basin did not much improve the regeneration of natural biodiversity, but aggravated negative processes that damaged traditional forest-steppe agro-landscapes, to which many flora and fauna species were adapted for centuries. Many of these plants and animals are the RF Red Book species. Such obvious processes as increasing erosion, surface washing-out and deflations undermine biodiversity of the Zeya-Bureya plain and the Middle-Amur Lowland. Low farming standards aggravate these processes. Uncontrolled use of toxic chemicals and fertilizers by Chinese farmers accelerates degradation of soil biota. Invasions of alien species also worsen conditions of agro-landscapes and adjacent forest massifs. Their number grows from year to year and now equals to over 400 plant species (ANTONOVA 2006).

One of the most evident tendencies of biodiversity changes in the forest-steppe and steppe zones of the Amur Basin is the ecological misbalance between agrarian landscapes and islands of forests composed of *Pinus sylvestris*, *Larix cajanderii*, *Betula*

platyphylla, B. daurica, Quercus mongolica. To preserve and regenerate natural biodiversity of open landscapes the interchange of elements of agro-landscapes and forest and meadow-bog biogeocenoses should be used more intensely to form the ecological carcass of the territory. Thus positive tendencies of conservation and regeneration of species and ecosystem diversity in forest-steppe and steppe areas of the Upper and Middle Amur Basin could be supported.

In Priamurje in general extensive and environmentally unfriendly timber harvesting completely destroys most productive forests and not attention is paid to their ecological and biotope functions, which are decisively important for biodiversity conservation and healthy living conditions of local population.

A serious problem in the social and economic sphere is that government officials and population as a whole underestimate the importance of primary (indigenous) forests for the sustainable development of the Amur Basin and comfortable existence of its population in complicated natural and climatic conditions of the region.

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