LANDSCAPE DIVERSITY INVESTIGATION
ALONG KAMCHIA RIVER

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Abstract: This paper presents a study on landscape diversity along the lower course of Kamchia River, including riverside forest ecosystems. The boundaries of natural and low anthropogenic landscapes were defined. Their distribution was described based on the degree of moisture and the presence of indicator plant species. The study was conducted through field surveys, observations of satellite images and extensive literature review. A landscape map which includes 1 class, 1 type, 6 genera and 12 species of landscapes was prepared.

Key words: riverside forests, longoz forest, moisture regime, plant indicators, Kamchia River

INTRODUCTION

The landscape diversity in Valley Longoza and relationships between landscape components were poorly studied. There are two maps published of the landscape diversity of the territory – Landscape map of Bulgaria in scale 1:500 000 (Velchev et al., 1992) and Landscape map of the Bulgarian Black Sea coast (Mishev, Popov, 1979).

This study was designed according to recent scientific theory about the interconnectedness of natural components. Existing NTC (natural-territorial complexes) in the region are differentiated based on the composition of species of the described plant communities which are used as indicators. For the studied landscapes the main natural factor of differentiation was moisture, the changes in this factor can be assessed by changes in the composition of species of plant communities.

The aims of this work were the following: determination of the landscape diversity along the lower course of Kamchia River; clarification of boundaries of individual NTC using the connection between the degree of humidity and species composition of plant communities; generating an original landscape map of the investigation region.
OBJECT

The object of the study were riverside landscapes along Kamchia River Valley – from the estuary to Goren Chiflik village. The studied territory is bounded on the east by Black Sea and Kamchiiski-Shkorpilovski beach line, on the west by Goren Chiflisk fault line and the end of the Valley known as Longoza. The north border goes along the foothills of Avren (Momino) Highland and the south boundary goes along the line between riverside forest landscapes and anthropogenic agricultural fields (Fig.1a). The valley is a part of Down Kamchia sedimentary basin – a tectonic structure seen as an edge decrease of Moesian tectonic plate (Dimitrov, Georgiev, 2005). According to climate regionalization of Bulgaria the territory is on the border of continental-mediterranean climate region (part of Varna climate region) and transcontinental region (part of Eastern Balkan region). The average annual temperature is 11.4 °C. The average annual rainfalls are 500-600 mm (Velev, 2002). The rivers of the studied territory are mostly rain nourished (about 40-45%). There is a maximum of the flow of water in winter-spring period and a minimum in summer and autumn (Yordanova, 2002). The soils are of intrazonal type represented by alluvial, alluvial-meadow and meadow-marsh soils. Following the classification of FAO (1988) the three subtypes are merged into one type – alluvial soils (Fluvisols) (Ninov, 2002). Alluvial-meadow soils dominate in the territory. In places they are combined with the other two types with no exact boundaries between them. The vegetation in the studied area has azonal character. The valley Longoza falls under the biogeographical region of Black Sea Coast which is a part of Balkan biogeographic subprovince (Asenov, 2006). The territory is also a part of the biome of summer green forests and bushes (Aestilignosa).

METHODS

The information obtained from the terrain research and mapping of natural components, allowed to divide the territory into types of landscapes with precisely defined borders. The vertical structure of landscapes is described according to a geophysical methodology (Petrov, 1990). There were phytocoenological descriptions made of the vegetation (Lyubenova, 2004). The species composition was analyzed for presence of plant species related to different regimes of moist habitats. Thus is created an information database, where indexing of landscapes is based on the level of moisture of habitats. In the differentiation of the described landscapes four taxonomic levels were used – class, type, genus and species. The class was determined by macrotopography of the territory, the type – in terms of moisture and degree of anthropogenization, the genus – in terms of morpho-lithology.
characteristics, soil type and plant communities, and the species – in terms of plant edificator species.

The anthropogenic development of the territory was examined in order to demonstrate that most of the landscapes in investigation area are natural or slightly anthropogenic, with preserved complicated natural relationships between its components. Information collected from the ground was compared with satellite images for verification of the terrain data (Fig. 1b).

The study used GIS cartographic methods to create a digital terrain model for more precise measurements, analysis and generation of maps, which best present the results of the study.

RESULTS

The analysis of collected information for the studied territory shows that the low altitude region has a weak vertical segmentation of the relief. For Longoza valley the most important factor in determining the boundaries of landscape units are humidity regime and plant communities formed. There is a significant homogenity of climate, soil and rock components.

Fig. 1. The investigated region (a – topographic base; b -satellite image)
Hydrological component of the studied territory is represented both by surface water of Kamchia River and groundwater. Groundwater level determines the composition of plant communities. According to Mishev, Popov (1979) main role in the formation of landscapes in different regions could be played by different factors and components, including the anthropogenic factor, each of which in time may lose and recover its primary importance. The anthropogenic factor is represented mainly by dams built to prevent flooding and dehydration of the border territory with agricultural areas.

On the basis of the data collected were determined 6 genera and 12 species of landscapes within the studied territory. They are presented in an original map of landscape diversity (Fig. 2).

(I – class landscape; A – type landscape; 1, 2,...3 – landscape genera; 1a, 1b,...5 – landscape species)

**I. PLAIN AND FOOTHILLY LANDSCAPES**

A. Hydromorphic and sub-hydromorphic provisional natural and low anthropogenic landscapes

1. River-valley, accumulation landscapes with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the riverside forest communities – Dense forest:

   1a. River-valley, accumulation landscape with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the riverside forest communities – Dense forest of ash (*Fr. oxycarpa*) and elm (*U. minor*).

   1b. River-valley, accumulation landscape with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the riverside forest communities – Dense forest of ash (*Fr. oxycarpa*), pedunculate oak (*Quercus pedunculiflora* C. Koch.) and hornbeam (*Carpinus betulus* L.).

   1c. River-valley, accumulation landscape with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the riverside forest communities – Dense forest of ash (*Fr. oxycarpa*), elm (*U. minor*) and maple (*Acer campestre* L.).

   1d. River-valley, accumulation landscape with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the riverside forest communities – Dense forest of ash (*Fr. oxycarpa*) and elm (*U. minor*) with the participation of lime (*Tilia tomentosa* Moench.), oak (*Quercus robur* L.) and maple (*A. campestre*).
clay soils and with the riverside forest communities – Dense forest of pedunculate oak (*Q. pedunculiflora*), ash (*Fr. oxycarpa*), turkey oak (*Quercus cerris* L.) and hornbeam (*C. betulus*).

2. River-valley, accumulation landscapes with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the agricultural fields and meadows with increased involvement of natural vegetation:

River-valley, accumulation landscapes with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the agricultural fields and meadows with increased involvement of natural vegetation of alder *Alnus glutinosa* (L.) Gaertn, white poplar (*Populus alba* L.) and white willow (*Salix alba* L.).

3. River-valley, accumulation landscapes with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the shrub communities of the transition of the forest:

River-valley, accumulation landscapes with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the shrub communities of the transition of the forest of hornbeam (*C. orientalis*), olive (*Ligustrum vulgare* L.), spindle tree (*Euonymus europaeus* L.), hawthorn (*Crataegus monogyna* L.), thorn (*Paliurus spinachristi* Mill.), etc.

River-valley, accumulation landscapes with quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the grassland – hydromorphic meadows:

4. River-valley, accumulation landscapes with the quaternary, alluvial deposits and alluvial, alluvial-meadow and alluvial-marsh, sandy and sandy-clay soils and with the grassland – hydromorphic meadows of *Ammophila arenaria* (L.) Link (Marram), *Leymus arenaria* (L.) Hochst, etc.

The landscape differentiation performed is based on ideas set out in the landscape classification of Velchev et al. (1992) and the expanded classification system of Velchev’s antropogenic landscapes (2010). The levels of moisture of different types of landscapes are assessed based on their floristic composition and the moisture of soil component. Landscape types 1a, b and c are characterized by polydominant forest ecosystems with moist and overmoist soils and diverse liana vegetation (*Smilax exelsa* L., *Periploca graeca* L., *Hedera helix* L., etc.). Landscape type 1 d is dominated by ash with the participation of elm and individual trees of lime, maple, etc.

There is no liana vegetation except sporadic existence of *Clematis vitalba* L. and *H. helix*, also the soil is with normal humidity. The landscape type 1 d – dense forest dominated by pedunculate oak, less ash and in places cerris oak and hornbeam is characterized by poor undergrowth and only in places liana vegetation beard and *C. vitalba* can be seen. Beyond the studied
territory, but still within Longoza valley, two borderline landscape species are described (type 5 and 6). One of them is type 5 – the natural landscape of psamophytic communities of *Artemisia maritima* L. var. *salina* Koch, *Eryngium maritimum* L., *Silene thymifolia* Sibth., *Crambe maritima* L., etc. on the quaternary, beach sediments (sands). The other one is type 6 – the highly anthropogenic, and marked by modified vegetation, landscape of agricultural areas with quaternary, alluvial deposits and alluvial, sandy and sandy-clay soils, presented by two types: 6a – agricultural land with annual crops and fields and 6b – agricultural areas with permanent crops (fruit orchards). The last two types of landscapes occur in the former places of natural oak forests and partly on the border areas of landscapes of dense communities. Antropogenization along the border of dense landscapes destabilizes them and violates their hydrological regime, but this effect is currently limited because of the economic retardation of the area.

**CONCLUSIONS**

The studied area is characterized by comparative monotony of natural components. The landscape-level differentiation of the genus and species of landscape in the region is influenced by variations in moisture regime, which affect the plant complexes. Anthropogenic factors are second in importance. By testing the characteristics of vegetation and other natural components a landscape classification and a map are proposed, which include 1 class, 1 type, 6 genus and 12 unique landscape types. Except on the base of natural features, landscapes are differentiated on the degree of anthropogenization, which is medium to low in this territory. In the past Longoza valley included
monotonous habitats, characteristic of wetlands (Bondev, 1991). Since 1970 in Bulgaria there has been reported a trend for global warming, seen in the reduction of annual temperature range, increasing of the minimum annual temperature, displacement of the upper limit of deciduous forests, tendency of increased deficits of soil and air humidity, earlier vegetation (7-15 days overtaking), etc. (Alexandrov, 2010). These climatic changes as well as activities related to water management in the region lead to habitat xerophytization which affects the described plant complexes and the development of new types of landscapes. Most pronounced differentiation in the landscape is typical for Longoza genus (1), of which 5 species are described. They are reflected in the legend based on the gradual reduction of the degree of moisture of the habitat. Types of landscapes have been described (1e) of Longoza Valley involving Q. cerris. They relate to habitat 91EO (Kavrakova et al., 2009) and derivative bush and grass landscapes.

The unique dense vegetation (habitat 91F0) is highly sensitive to deterioration of the water regime, which is a threat not only to its existence but also to the preservation of stability of natural complexes in Longoza valley.

REFERENCES

Velchev, A. 2010. The total classification system antropogeniziranite landscapes (lectures).
Изследването е свързано с описване на ландшафтното разнообразие по долното течение на река Камчия, включващо крайречните горски екосистеми. Въз основа на: обстойна литературна справка; теренни изследвания и анализ на сателитни изображения; отчитане на степента на овлажнение чрез наличието на индикаторни растителни видове, са определени границите на естествените и слабо антропогенизирани ландшафти и тяхното разпространение на проучваната територия. Създадена е ландшафтна карта, съдържаща 1 клас, 1 тип, 6 рода и 12 ландшафтни вида.

Ключови думи: крайречни горски екосистеми, лонгозни гори, степен на овлажнение, индикаторни растителни видове, река Камчия