Identification of geosystem formative factors on the basis of field and remote sensing data

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In spite of all inconsistencies of various scientific interpretations, the term “landscape forming factors” mean in landscape science the properties of components which determine endogenous character and intensity of interaction. Among these important properties are climate, geological structure, relief, biotic and soil features. While researching a specific territory the main task of a researcher is to reveal a role of zonal and azonal factors in landscape structure differentiation as well as to determine dominant and subdominant factors for different hierarchical levels. The special task is to reveal individual and integral properties for each landscape component. Individual ones which determine regularities of structure organization of particular landscape components are the object of branch sciences of geography. Integral properties provide wholeness of natural geosystem is studied by landscape geography.

Decisions of stated tasks differ for various territories and depend of basic perceptions of researcher and selected methods of material collection and analysis. Development of methods of an objective estimation of factors which form the complex of environment conditions is an actual task of modern landscape science.

The stated aim is complicated because we need to extract hypothetical factors from huge number of properties which determine conditions of landscape components. Each component has its own characteristic time. Moreover, these properties inevitably need various methods of description and with various accuracy. The most optimal scheme of landscape factors search we can offer the way of consequent, step-by-step decreasing number of properties for each functional part of component. For example, soil can be described by the following properties: thickness of each genetic horizon, their color and texture. Similar functional parts for vegetation are separate layers of canopy characterized via species composition, height etc. Relief as the factor of moisture redistribution on various scales can be presented through relative elevation, slope and its form. Reflected solar radiation registered by satellite sensor is in fact momentary measurement of energy balance components, different spectral indices reflect biophysical properties of vegetation.

Joining this massif of data and using different methods of multidimensional statistical analysis, we can sequentially present each measured property or combination of properties through relief and remote sensing data characteristics. In simplest case this operation can be realized by step-by-step discriminant and factor analysis. Properties which discrimination statistically is not confident are excluded from further analysis. Eventually, few dozens of field measured properties are reduced to a few (5 to 6) independent factors. During this transformation a number of properties excluded from final system. These are the ones which variation in space is very specific or, only the determined in whole system part of this property can be determined. The properties that are described by independent factors are admitted as belonging to unified landscape system. The disadvantage of the offered method is selection of all initial properties on the basis of relief and remote sensing data and mapping via factor analysis only linear relations. Its advantage is visualization of any property and independent factors variation directly in cartographic form. This allows us to semantically control the obtained results and to make physical interpretation of independent factors through analysis of their connection with functional properties.

Decreasing of system dimension essentially possible using method non-parametric scaling. Using this method we do not need to use remote information as unified base. But the second way in more bulky although it provides the informative analysis. Results of proposed method are demonstrated on the example of searching landscape forming factors for southern taiga landscape of Walday Hill (Central Forest Reserve, 33º E, 56.2º N). It is based on 1150 field descriptions of 20 properties.

We have stated that all diversity of properties measured in situ, can be described by eight independent factors which reflect properties of landscape components in more than 30% cases. For example three variables of Munsell soil color charts (HUE, VALUE, CROMA) reconstructed in 50% cases. First factor determines 21.3% of total variation and leading for most of landscape components. It reflects redistribution of moisture depending on slope steepness on various hierarchical levels and determines development of raised peat bogs and forest bogs, main properties of soils, development of moss cover and pine distribution in space. Second by its significance factor (16.5%) also reflects moisture redistribution but through form of surface. It is closely connected with amount of sun radiation used for transpiration and biological productivity and sort of humus (soft or coarse). Third independent factor (14.5%) reflects succession stages. Maximum of factor corresponds to forests with highest biological productivity with spruce and birch domination. Fourth factor (12.5%) again connected with moisture redistribution and with degree of humus accumulation dependently of backwater moisture. It determines distribution of alder and elm trees. Fifth factor (9.5%) do not depend on relief, it determines development of thin podzoloc soil horizon hypothetically in places where ground water unloaded through carbonated moraine deposits. Here the low sparse forests with poor productivity appear. Sixth factor (7.9%) is connected with absolute elevation and determines thickness of humus layer and way of organic decomposition. All other equal the higher territories characterized by thinning of humus layer and more soft humus sort. Seventh factor (7.3%) is connected with soil texture and absolute elevation. The higher elevation is, the more dense soil forming rock. Thickness of humus and podzolic soil layers increases under grassy spruce-birch forests. At last the weakest eighth factor (5.7%) is connected with slope steepness at microlevel and determines the type of redox regime which influences the color of podzolic soil layer.

All factors with different weights determine states of various landscape properties. Their real state is a result of relatively independent forces. But generally relations resolve to multidimensional redistribution of moisture by relief, independent vegetation disturbances and various mineralization of ground water.

Stated relations allow to obtain landscape map with utmost possible portrayed genesis of landscape properties and to prepare basis for landscape forming processes modeling.

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