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# *THE SPECIFICS OF APPLICATION OF LANDSCAPE AND HYDROLOGICAL ANALYSIS ON THE PERMAFROST TERRITORY OF WESTERN SIBERIA*

*SUMMARY. To carry out the landscape and hydrological analysis, the researcher collects information on the area. The information concerns the hydrological regime of the territory, the meteorological characteristics and different maps. The collection of such information is not a paramount one for a researcher from the European part of the Russian Federation, as this area is well studied (in terms of landscape and hydrologic analysis), and there are long and representative series of observations from meteorological and hydrological stations. When testing the landscape and hydrological analysis method on the territory of Western Siberia (especially on the permafrost area), collection of meteorological and hydrological information is time consuming. It is a high priority problem for seemingly an insignificant coverage area with meteorological stations and hydrological posts. The use of different calculation methods and the method of analogy will give not sufficiently representative material. In this connection, the sources of information on the area (very often they are unique ones) are scientific papers of different universities and research of industrial research institutes. The author of the article attempts to highlight the collection of all possible sources of information for the landscape and hydrological analysis in the permafrost area of Western Siberia.*

*KEY WORDS. Landscape and hydrological analysis, runoff formation complex, permafrost, photo interpretation.*

Landscape and hydrological analysis allows taking into account the role of both natural and anthropogenic runoff formation complexes. Runoff formation complex (RFC) is a part of the river catchment, presented as a set of natural components, characterized by the relative homogeneity and determining the parameters of the hydrological cycle in the area [1]. This definition is very close to the classic definition of the landscape.

An important property of RFC as a system is its resistance to external influences. To study the landscape and hydrological systems, it is necessary to evaluate the circumstances in which the normal interaction of the components will be broken and, consequently, the stability of the system resource is exhausted. The core of the system is the same flows of matter and energy between its components. For example, the existence of the catchment includes: operation of water facilities; biota; geomorphological factors, climatic and geo-biochemical processes, climatic events. Complex combinations of these and other components form a whole variety of natural

systems in a state of dynamic equilibrium of matter-energy exchange. Natural or technogenic change in one of the components of the complex leads to a chain reaction of changes in all possible links and a dynamic equilibrium is established as a result of self-regulation in the different structure of the real-balance energy flow [1]. The entire natural system can be significantly transformed.

Continuous permafrost (CP) is the key factor that contributes to the specifics of the natural state of natural ecosystems and the characteristics of their response to any sort of technogenic impacts. The experience of development of the first fields in the north of Western Siberia has shown that, without taking into account all the nuances of landscapes permafrost due to the presence of CP, the construction of gas field facilities leads, as a rule, to the emergence of various kinds of environmental stress situations at the time of resettlement. And the further operation of the presence of environmentally critical areas can threaten and the reliability of the gas field and gas transportation facilities.

The research that highlights the landscape–hydrological method was initiated in the 30s of the 20th century by V.G. Glushkov, who first used a complex approach to the study of the conditions of runoff. However, this method was not widely used in the researches of that time and it was replaced by a static one-way hydrological approach that allows obtaining quicker results that are less accurate. This approach was investigated and used by V.I. Rutkovsky, B.V. Polyakov, L.K. Davydova, S.D. Murayevsky, M.I. Lvovich, P.S. Kuzin [1]. The results of the above-mentioned researchers were laid as the basic principles of geographic and hydrological direction.

In the 1960-1970s studies on this subject were presented in the works by A.I. Subbotin, E.S. Zmiyeva (the study of Moscow Region), N.I. Koronkevich (the study of the water balance and its alteration under the influence of anthropogenic burden), G.N. Petrov (landscape and hydrological zoning of the Middle Volga Region), N.A. Solntseva, I.S. Sosedova (development of techniques of landscape–differentiated analysis of the water balance). The volume "Landscape and Water", dedicated to the research methodology and characteristics of the water regime in a variety of geographical conditions [1] can be considered as the research outcome.

Since the early 1980s the focus of the landscape research and hydrological method was made on small watersheds as the initial link of the drainage system. The researches were conducted by A.N. Antipov (calculation of the water balance of the basin and valley biogeocenosis geosystems—in the foothills of the Western Sayans and Lower Irtysh), A.I. Subbotin, A.S. Fedorovsky (identifying characteristics of water resources for the mountain rivers of the south of the Far East), L.A. Bezrukov and others. At this stage, the studies of specific regions of the USSR were carried out; the human impact on water resources was assessed.

At the present stage of development of the landscape and hydrological analysis several groups of methods for the study of human impact on water bodies have been formed: statistical, water–balance, methods of mathematical and physical modeling, method of the active experiment. The development of landscape and hydrological areas has led to the emergence of the idea of landscape planning watershed so that the river flow regime could meet its natural state or be optimized [1].

In Tyumen Region V.M. Kalinin, S.I. Larin, I.M. Romanova are involved in the landscape–hydrological study. The work [1] considered the southern area of Tyumen Region and small rivers under anthropogenic influence (the Balakhley, the Ashtalyk, the Yemurtla, the Begila, the Aremzyanka). To perform calculations of the runoff from the catchment of each RFC with special formulas, a series of special maps was constructed (land use map, the map of slopes, soil map). The joint analysis of these maps can build a map of runoff formation complexes [1]. This kind of work (by the method proposed by V.M. Kalinin and others in 1998) was carried out for the territory of the Ishym Plain by V.V. Kozin, G.S. Koshcheyeva and others [2]. The tested method of landscape and hydrological analysis for the territory of the Polar oil and gas field was also applied by A.A. Yuzhakov. In his work he carried out the RFC allocation of the Yuredeyyakhi to forecast changes in the river flow, taking into account the construction of all the designed projects in the basin, and the potential for oil pollution in the case of emergency [3].

A.N. Antipov in this scientific works pointed out three main regions of the works: Minusinsk Basin (the south of Krasnoyarsk Territory); the valley of the Lower Irtysh (Tyumen Region), the south coast of Lake Baikal (Irkutsk Region). The theoretical and understanding of the landscape and hydrological organization of the territory as a pre-defined hierarchy of hydrological systems of different types and spatial level developed by A.N. Antipov in the relation to the conditions of Siberia methodological can be considered as the result of the study [4].

N.V. Goroshko explored the territory of the Upper Ob basin (to the town of Barnaul, within which the Altai Mountains and the lowlands are located). As a result, 13 major RFC differing in magnitude annual run rate have been allocated, and practically the varying runoff formation role of landscapes has been confirmed [5].

The analysis of scientific works in terms of landscape–hydrological analysis showed that this method has undergone broad testing for the European part of Russia and the South of Tyumen Region. The presence of permafrost factor in the northern regions causes a significant change in the implementation of the calculations for the purposes of landscape–hydrological analysis. The problems of maps construction is solved by the interpretation of remote sensing data–aerial photos (AP) and satellite images (due to the insufficient development of the transport network in the territory of permafrost zone it is difficult to carry out field certification of the results). The description is carried out with the help of wide range of GIS: MapInfo, ArcGIS, EasyTrace and others. In connection with wetland of permafrost in Western Siberia, the problem of correct landscape interpretation of various types of marshes arises. Methods of AP landscape interpretation of polygonal, hilly, oligotrophic, mesotrophic and eutrophic swamps of Western Siberia are presented in the works by L.I. Usova [6]. Based on the results of landscape interpretation, the author offers the method of typological mapping of marshes as well as line grids mapping for draining marshy waters of large scale.

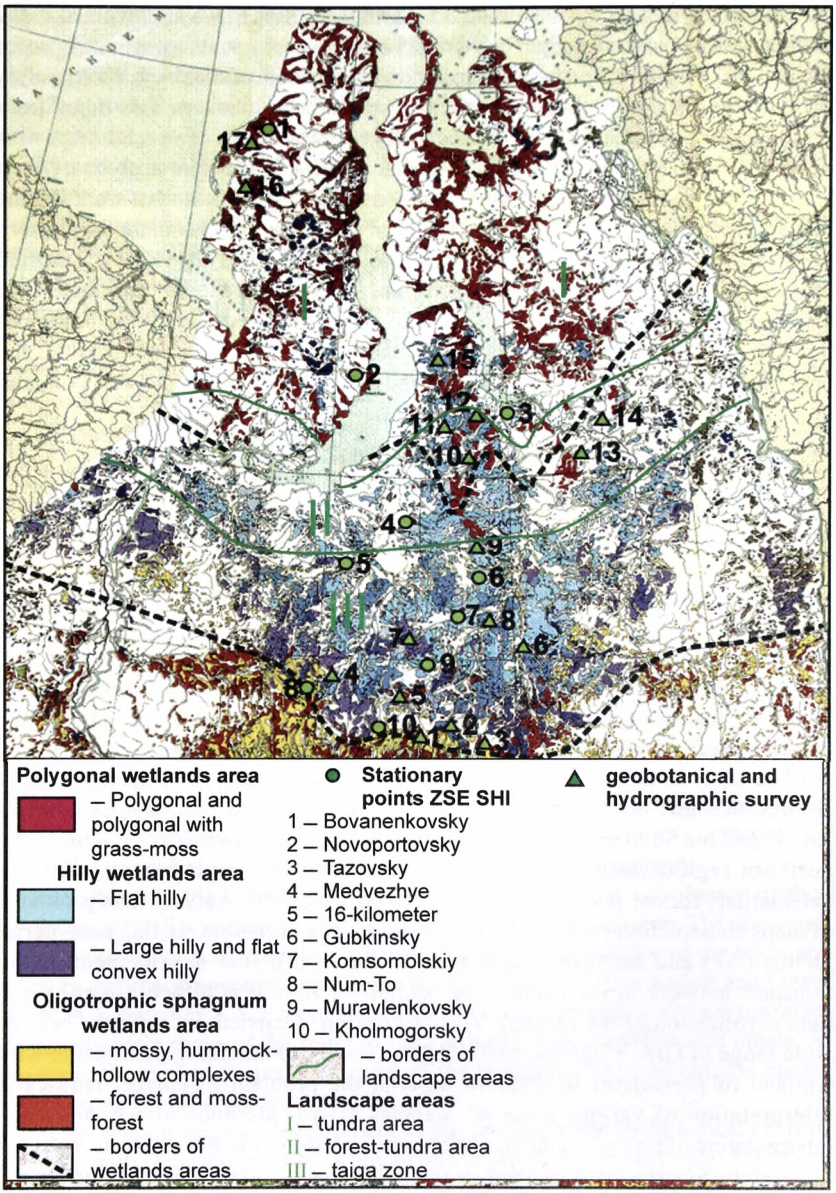


Figure 1: Typological map of wetlands (according to S. Novikov) and landscape areas [7].

Due to the lack of scrutiny of the territory of permafrost hydrology (especially the northern part) the problem concerning the way to obtain the values of hydrological parameters is an important one. Because of the scarcity of hydrological observations (up to the 1990s northernmost gauges were located on the lake Numto and at the moment two more gauges are equipped — New Port and Seyakha; and 10 hydrological stations are added — most located in large and medium-sized rivers—the Nadym, the Pur, the Taz, the Poluy, the Kazym) and specific physical and geographic conditions of the recommended method of analogy cannot be used. The use of formulas will give the unrepresentative material, as without specifying the constituent parameters the data cannot be used for the study area.

The materials of research expeditions in most cases are not published and are in the archives of various design and research institutes. Thus, a significant contribution to the hydrological study of permafrost was made by such design institutes as Giprotyumenneftegaz, YuzhNIIgiprogaz, TyumenNIIgiprogaz, Lengiprotrans and educational institutions: Tyumen State University, Tomsk State University, Leningrad Hydrometeorological Institute. However, these studies are not exhaustive as numerous researches, design and educational institutions, not having the necessary basic hydrological data to carry out their work, conducted and are conducting these surveys on their own. These studies cover narrow (departmental) objectives without taking into consideration the necessity to carry out complex studies.

The most complete and reliable data is gained from field work of the West Siberian Expedition of the State Hydrological Institute (WSE SHI) in the territory from the Siberian ridges to the Kara Sea (researches were conducted within the major hydrocarbon fields). Figure 1 shows the location of constant constructions laid by SHI [7].

The results of the work for 2009 were published in *Hydrology of Wetland Permafrost Zone of Western Siberia* monograph, in which a detailed description of the marshes is presented on the basis of geo-botanical studies of marshes and decoding of AP. The significant place in the book is given to the formation and calculation of runoff of small and medium-sized rivers; the characteristics of intra-marsh lakes, hydrochemistry of swamps, rivers and lakes, as well as of the human impact on water bodies of wetlands is analyzed.

Some necessary data for the purposes of landscape–hydrological analysis can be taken from *the Yamal–Nenets Autonomous Area Atlas*, compiled by scientists of the Tyumen State University with the support of the Yamal administration [8], which contains a series of maps devoted to surface water and climatic characteristics of the territory of the autonomous area. However, one should be aware that the maps, presented in this atlas, are small-scale and show the basic patterns of distribution of both climatic and hydrological characteristics of the territory due to the lack of density of the location of the meteorological, hydrological stations and observation posts.

The studies on the hydrography of large and medium-sized rivers of Yamal were conducted by V.A. Lezin [9]. This study provides information on the morphology and morphometry of the characteristic water levels and flows, the timing of floods, the

indicators of water availability and other resources. This information can be used for landscape and hydrological analysis of large and medium rivers of the autonomous area.

Thus, in the course of scientific papers on the application of the method of landscape and hydrological analysis in Western Siberia permafrost, the primary task is to collect and systematize representative data [10] on the hydrological characteristics of areas according to the characteristics of the terrain and climatic differences in the equation of the water balance from the territory of the South of Tyumen Region, for which this method was the most widespread. For example, in the permafrost zone in the first place there is the parameter of the snow stock of the territory, as there is the sustained melting of snow, and as a consequence — the change in the flow volume.

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