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Method for Selecting the Ranking Criteria for Monitoring Stations of the Status of Spatially Distributed Systems and for Defining the Priority of their Location

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***Abstract* — This work considers the issue of selecting the criteria for ranking of the stations used to monitor the status of spatially distributed systems and the processes within such systems, as well as for establishing the priority for locating such stations. The paper offers a SWOT-based method intended to classify all criteria with regard to internal and external opportunities and threats and to overlay on one another iteratively the results of SWOT analyses in order to generate a unified set of criteria. The criteria, so obtained, are compared with regard to the available databanks and GIS maps, and only those criteria that are supported by the information being sufficient for their evaluation are sorted out. The criteria, so selected, are fit for further multi-criteria optimization of a network of monitoring stations with the use of systems analysis methods; they ensure better accuracy, validity, reliability and information value of such optimization results. The functionability of the method has been demonstrated by the example of designing the network of the surveillance monitoring stations for the surface water quality in line with the objectives of the EU Water Framework Directive.**

Keywords* — *monitoring stations location; spatially distributed system; multi-criteria optimization; SWOT analysis; EU Water Framework Directive

I. Introduction

A great role in industrial and environmental management belongs to complex space-distributed systems such as electric power systems (including power lines), transport systems (including street-and-highway traffic systems and their infrastructure), river systems (including cascade hydropower stations) within such systems, and so on [1-5]. Data simulation and prediction, as well as establishing the rules for managing the status and the processes existing within such systems, both on a long-time and short-time basis, require a great scope of surveying at different stations under various monitoring programs: regular, general, surveillance, background, scientific, operational, investigative, critical, etc. The quality of managing the course of processes depends on the accuracy and completeness of the monitoring-resultant data, and the quality of such data, in turn, depends on the adequacy of location of the monitoring stations.

There are different special approaches, techniques and monitoring station deployment standards for each field and each class of spatially distributed systems. Normally, we define a certain set of optimization criteria, then such set of criteria is analyzed according to one of the well-known methods of multi-criteria systems analysis (such as Saati hierarchy analysis method, minimax method, spatial analysis method, dynamic programming method, VICOR method, Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) and so on) [5-14]. However, the common disadvantage of such methods is the significant subjectivity in for choosing a set of different-level criteria, where such methods are to be later applied to.

So, the development of a universal method for defining a set of basic criteria needed to choose the best locations for the monitoring stations of the status of spatially distributed systems and the processes running therein, with due regard to the monitoring program specifics and the specifics of such systems, is of utmost importance. A solution of such problem would allow to reduce the subjectivity level, thereby increasing the accuracy, validity, reliability and information-value of the monitoring data.

II. Method

Normally, functioning of all complex spatially distributed systems is determined by the influence of two groups of factors: internal factors (the status of the systems per se) and external factors (anthropogenic load, nature use, environmental impact, etc.). The key issue essential for a complex system management is to ensure stability of such system against various disturbances and factors. So, the influence of such factors can be either positive (contributing to the system's stability), or negative (destabilizing the system). Such approach to systematization of factors is used in SWOT-analysis [15-17].

In the present-day practical economy, SWOT-analysis is one of the best known and commonly used high-quality methods of strategic analysis and criteria selection. It is the strategic analysis which is the most important phase of developing the effective strategy for deployment of monitoring stations; such analysis is to yield an accurate estimate of internal resources and opportunities as to the condition (and

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