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GIS TECHNOLOGY APPLICATION FOR DETERMINATION OF POTENTIAL ZONES OF ACCIDENTS ON MAJOR PIPELINES

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The author has collected and systematized data, determining factors causing accidents on major pipelines. The analysis of these data has found practical application in the establishment of GIS project maps of zones of potential accidents on major pipelines. The purpose of these maps is to identify potentially dangerous areas of pipelines, which are exposed to geodynamic factors, and timely warning of possible catastrophic consequences.

Predictive estimation of the risk of accidents on major pipelines is a necessary element of the design and building of engineering constructions. However, as a rule, the problem of accidents on major pipelines is analyzed from the engineering aspect only: at the design and construction stage hydraulic, thermal and mechanical calculations are performed [1]. Thus, seismic-tectonic factors are practically not taken into consideration. Moreover, there is no direct guidance on taking into account the interdependent influence of man-made and tectonic factors.

The paper tries to generalize the accumulated extensive geological, geophysical and seismological data related to the conditioning of accidents on linear constructions on the territory of Belarus. GIS project was created on the basis of collected and systematic geological, geophysical and geodetic data, determining factors of accidents on major pipelines of Belarus. It reflects possible occurrence of accidents (POA) on major pipelines.

The analysis of information on the accidents showed that the probability and density of accidents is primarily influenced by such factors as the activity of tectonic faults, the proximity to power lines, the type of salinity of subsurface water.

The selection of these factors is explained by the following:

– the fact of confinement of accidents on oil pipelines in Belarus to tectonic faults for more than 70% [1];

– electromagnetic fields generated by power lines and current leakage increase corrosion processes to a large extent;

– electrolyte properties of mineralized fracture water are enhanced under the influence of power lines, which leads to intense chemical corrosion [2].

The composed GIS project takes into account these three factors, and it is aimed at identifying the areas of possible occurrence of accidents (POA) on major pipelines.

The layout of GIS project has been created using technology ArcGIS9.3.1. The geodatabase consists of the attribute tables containing the necessary data, raster images and layers. Working with maps of different qualities initially involved converting paper maps into electronic bitmapped images and binding them to a single coordinate system. WGS1984 in the Mercator projection has been chosen as this coordinate system. The final look and feel of maps carried out in the layout. The proposed approach to the identification of POA areas in Belarus includes 2 stages.

Stage 1. The selection of POA zones prone to interdependent influence on the possibility of an accident near power lines and the type of salinity of subsurface water.

At first two groups of territories were distinguished according to the degree of influence of electromagnetic waves from power lines using the map of the main power grid of Belarus (table 1).

Table 1 – Selected groups of territories subject to the influence of power lines

№ of group	Characteristic
1	A three-kilometer area around the intersection of power lines, a three-kilometer zone under 750 kV power lines
2	A three-kilometer zone under 330kV power lines

Further, two types of areas, which are exposed to power lines, were deposited in layers on the salinity map [3] to highlight the interdependent impact of power lines and water salinity using the opportunities of ArcGIS9.3.1.

Four major degrees of salinity of subsurface water (fresh and slightly salty, brackish, salty water and brine) were singled out in separate layers on the map using the tools of ArcGIS9.3.1. Thus, comparing these layers with their zones of influence of power lines there can be identified areas with varying degrees of interdependent impact of power lines and water salinity on the occurrence of accidents. The following areas were identified (table. 2).

Table 2 – The degree of interdependent impact of power lines and water salinity on POA

Groups of territories which are exposed to power lines / Water salinity	№1	№2
Fresh and slightly salty water	Weak	Weak
Brackish water	Weak	Relatively moderate
Salty water	Relatively moderate	Moderate
Brines	Moderate	Strong

The result of the first stage is a map created using GIS technology, showing interdependent influence on the possibility of an accident near power lines and the type of salinity of subsurface water (fig. 1)

It should be noted that the map can be effectively used in the design of various underground engineering constructions to assess the risk of metal corrosion.

Now let us consider the second stage: the selection of POA zones on the basis of seismotectonic zoning of Belarus PES [4] and interdependent influence of power lines and water salinity.

With ArcGIS 9.3.1 on the same principle as that in the first stage we combine the map of seismotectonic activity in Belarus and the maps of interdependent influence of two factors on POA: the proximity to power lines and the type of salinity of subsurface water.

By analyzing the maps we can distinguish POA areas, i.e. we get the zoning of the territory of the Republic of Belarus with regard to the impact of three major interdependent factors on the stability of major pipelines. As a result, we can identify the following POA areas (table 3).

The GIS-project resulted in an interactive map of the territory of Belarus with dedicated zones of POA on major pipelines according to the degree of influence of geodynamic factors (fig. 2).

Table 3 – POA areas according to the degree of influence of geodynamic factors

The maximum expected earthquake magnitude (M max) in the areas of PES	The degree of interdependent impact of power lines and water salinity on POA			
	Weak	Relatively moderate	Moderate	Strong
≤3,0	Weak	Weak	Weak	Relatively moderate
3,1-3,5	Weak	Weak	Relatively moderate	Moderate
3,6-4,0	Weak	Relatively moderate	Moderate	Relatively Strong
4,1-4,5	Relatively moderate	Moderate	Relatively strong	Strong

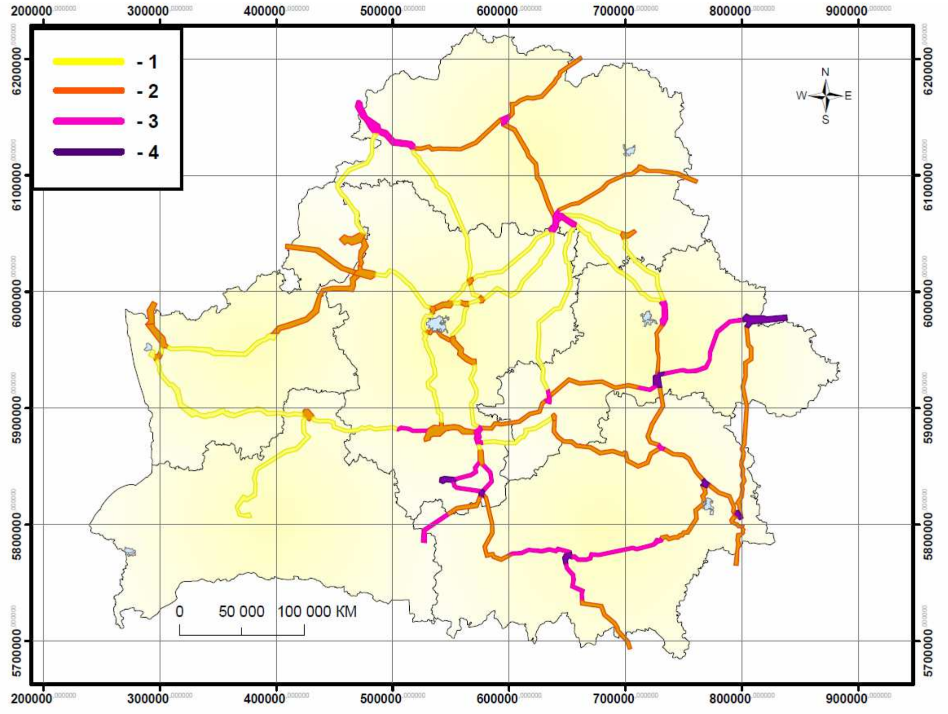

Fig. 1. Map of interdependent influence of power lines and salinity of subsurface water on stability of major pipelines:

1 - territory with a weak degree of interdependent impact of proximity to power lines and the type of salinity of subsurface water, 2 - territory with relatively moderate influence, 3 - territory with moderate influence, 4 - territory with a strong degree of influence

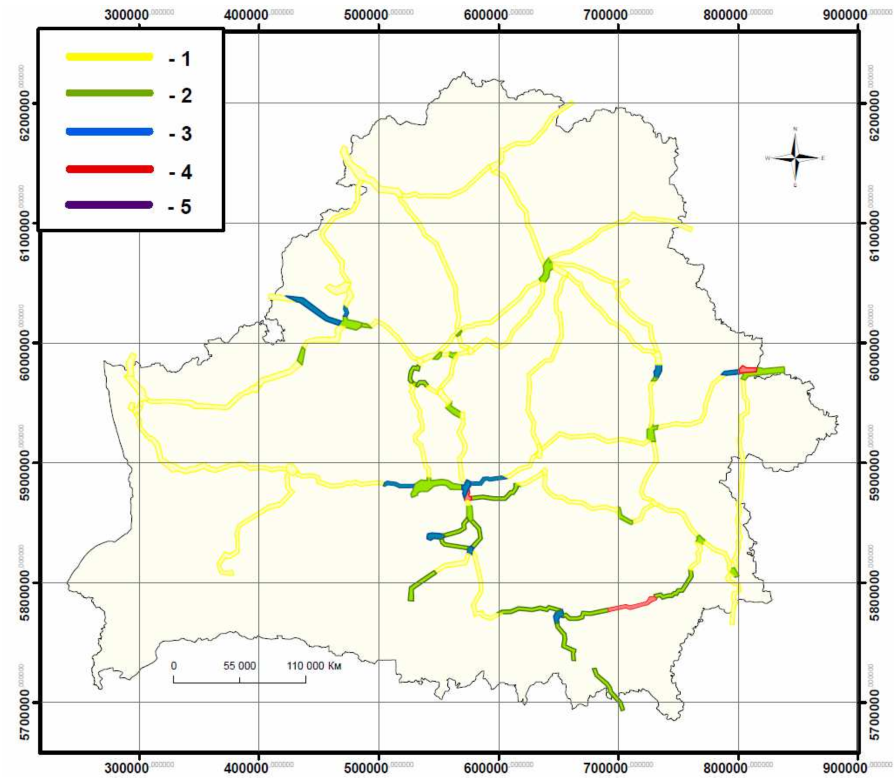

Fig. 2. Map of POA zone classification according to the degree of influence of geodynamic factors:

1-5 - the degree of influence of geodynamic factors in the areas of POA: 1 - weak, 2 – relatively moderate, 3 - moderate, 4 - relatively strong, 5 - strong

The analysis of the map (Fig. 2) shows that there is a number of areas of POA where the nature of influence is considerable. First of all these are the areas of the Starobin deposit and the Pripyat Trough, which are seismically active.

The completed study allows to form the original scheme for engineering and geological forecasting of potential occurrence of accidents in underground linear constructions. Accordingly, the construction reliability and safety increase. Timely installed geodynamic monitoring of dangerous areas, identified by means of GIS project, will enable timely detection of dangerous changes in seismic activity and prevention of possible consequences.

The possibility of connecting new map material and new databases suggests that the layout of GIS project can be effectively developed and used to conduct a comprehensive geodynamic monitoring of the territory of Belarus.

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HIGH-SPEED MILLING OF SPHERES

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The basic tendencies of development of machine tool industry and tool management are determined in the article and possibilities with regard to machining of spherical surfaces of parts are considered. Comparative analysis of methods of machining of spherical surfaces is carried out. The process of high speed milling of spherical surfaces of parts is described. The formula of the customizing the process of high speed milling of spherical surfaces with high productivity and quality.

Machine building is a key industry, because any other industry can not do without the use of its facilities for manufacturing of the necessary parts, products, equipment, etc. For example, in industries such as petrochemical, automotive and machine tool building parts with spherical surfaces: spherical bearings, tube ball valves, lifters, crank, etc. are widely used. There is the problem of processing such parts with a given capacity and required quality at the lowest possible production costs. Depending on these requirements, the technical process of manufacturing is developed, the equipment and cutting tools are selected.

The analysis of tendencies of development of machine building shows [1 - 3] that companies aim to use machine tools and instruments consisting of interchangeable structural modules, allowing you to adapt them quickly to the production of new products and new technological processes. An important factor in increasing the efficiency of production is the cutting tool, which share in the cost of metal on the one hand rarely exceeds 5%, but on the other hand, the choice of which depends strongly on the technological process parameters.

Comparison of methods of machining spherical surfaces. The analysis [4-7] shows that during the treatment of spherical surfaces of mechanical parts the processing methods either at special machines or using a special tool are mainly used. In the case of processing a wide range and large scale processing of spherical surfaces it is necessary to use special machines or to design additional tooling or a large number of special cutting tools, resulting in increased cost of machining parts. Moreover, the processing by the means of copy devices is not sufficiently accurate. But in order to produce a spherical surface with specific geometric characteristics a tool is needed with the same fixed characteristics, which are difficult and labour-consuming.

Let's calculate the normal time in the processing of spherical surfaces of the detail "Ball pin" for such methods of processing a spherical surface, as:

– shaped cutter method of cutting on universal lathe;
– cutter method of combining two innings on lathes;
– cutter with rotary fixtures and special machines;
– cutter method two spins on lathes using a special device.