Territorial Potential Risk as a Comprehensive Fire Safety Indicator

Aleksey Ryzhenko

FS Academy of EMERCOM of Russia, Moscow, Russia

doi: https://doi.org/10.21467/abstracts.93.72

ABSTRACT

When assessing fire safety of industrial and social environment objects, many risk indicators are considered: risk of accident occurrence, risk of scenario development, risk of probabilistic development, individual risk, economic risk. In 2013, the program of certification of objects was launch, at which the passport of the object is form, where all necessary indicators characterizing the state of the object are specify. In 2018, this program received a "second breath" and entered a more difficult stage of certification of territories. At the same time, the task of systematizing all risk indicators in a single format to develop scenarios of possible development, scenarios of attracting forces and funds for localization and elimination of emergencies, as well as forecasting of possible consequences. Several approaches to systematizing risk indicators have been proposing as part of ongoing research. As the most successful indicator of potential-territorial risk is chose, which displays a risk map (risk field) with reference to the terrain surface (three-dimensional geographic information system taking into account surface roughness, as well as natural and artificial obstacles). **Features of model of an indicator**:

multi-layer, allowing to display both all indicators in layers simultaneously, and any of them separately as a separate field; roughness, binding of map isolines based on shadow mask to three-dimensional surface using three types of collisions to calculate social risk; flexibility to quickly change the positions of social, industrial and other zones to identify potential zones of damage; complexity, all risk indicators are presented in the form of one field with the specified criteria and restrictions of the type of unified traffic light model; detail, allowing to introduce models of risk assessment in case of destruction of buildings and structures (voxel model) for calculation of individual risk; scenario, a pyramid facet-hierarchical system is built, allowing to build adaptive horizontal and vertical trees of scenarios of emergency development and fires on objects of arbitrary type of complexity; adaptively, which allows to work both in evolutionary mode of correction of neighboring indicators of risk field grid, and in revolutionary mode, which allows to fundamentally change arbitrary layer as a whole.

Optimistic and pessimistic scenarios for the formation of intersection point values have been add to identify intersection points between forecast and statistical indicators of economic risk. During the development of the risk field model, the following problems were solve:

partially corrected non-connections during systematization of different risk models; the stages of generation of risk indicators in the form of a sequence of strata of one level (stratification model of management) are organized; added possibility of conversion of nodal points of non-uniform grid in affine coordinate system for binding of risk grid to matrix indicators; added a model for converting three-dimensional objects into a voxel-polygon model for combining neighboring objects (synthesis of similar risks), etc.

Since all source data for determining risk indicators are presented in the form of resources, the coordinating system uses a combination of two target hierarchical vertical trees (forward and reverse), where each level is defined by a facet of data. This model allowed many alternative solutions to be use in a single data and solution field. Interaction of trees is carried out using an interpreter, which allows with the help of a system of *n*-ar associative rules to build adaptive dependencies of adjacent risk indicators in autonomous mode (at

DOI: 10.21467/abstracts.93

the same time possible conflicts of strong differences defining artificial peak of partially smooth surface are eliminated).

As mentioned earlier. The developed model is use to form passports of territories of subjects of the Russian Federation when assessing complex fire risk indicators. The sequence of using the model functionality to add a map-bound risk field is as follows:

map zone of influence is defined: residential (red), industrial (yellow) and eco (green) zones are identified; a uniform grid is applied with zero matrix indicators of heights - indicators of potential-territorial risk; objects are identified - probabilistic sources of potential accidents, indicated on the terrain map, ambient space is detailed; fault scenario trees are generated for each object, indicators are applied for each branch, all possible scenarios are considered, from the most frequent (according to statistics) to the scenario with the worst consequences; for each scenario, a mathematical model of consequences is built, linear graphs of dependence of the damage factor on distance are built, individual risks are calculated to the maximum value with zero damage index; risk indicators are transferred to the social risk matrix; Map-bound scenarios are synthesized for the worst-case variant, BLEAVE (influence of neighboring objects), new extended-type scenario trees are formed; the obtained risk indicators are transferred to the cells of the potential-territorial risk matrix - a height map (affine coordinate system) is formed; using a shadow mask, the height matrix is converted into a risk field, superimposed on a cartographic basis (non-uniform grid based on isolines).

The received field is quite dynamic. Since you have built in a date-based source data key figure change system, you can track the sequence in which risk key figures are convert at each node or cell in the matrix. The effect of multi-texturing on the three-dimensional surface allows to superimpose the zones of damage of scenarios and the zones of risk of damage simultaneously in the same color range, which in command-staff exercises helps to justify decisions, as well as to predict possible consequences at the early stages of emergency development or fires. Now, scenarios of border territories are also being worked out, in which the target trees are four, and the intersections between development scenarios are controlled by a separate independent interpreter, which allows to cut off duplication of activities of the attracted forces and funds of border States.

Acknowledgements: The presented work is supported by the grant Russian Foundation for Fundamental Research, RFFR 18-07-00615 A "Development and integration of methods of local and systematic search based on matrix representation of non-numerical dependencies to effectively solve problems of meeting restrictions in poorly formalized subject areas."