Infrastructurely Complex Territories and Intersystem Accidents: Classification from Resilience View Point

Valery Lesnykh[1], Tatiana Timofeeva[2]

[1]RUDN University, Moscow, Russia
[2]The State University of Management, Moscow, Russia

doi: https://doi.org/10.21467/abstracts.93.59

ABSTRACT

Over past few decades the urbanization process has developed at a rather fast pace. The process leads to the formation of areas where not only the density of population, but also quantity and density of life support systems such as energy and fuel supply systems, water supply systems, transport and telecommunications systems, etc., increase significantly. Life support systems have not only complex structure and space distribution, but also are significantly connected by flows of energy, materials, information, etc. It is possible to speak about the formation of infrastructurely complex territories (ICT), the number and scale of which are constantly increasing. Life support systems, which are part of ICT, provide a high quality of life in all urbanization territories, but at the same time are sources of emergency and catastrophic situations, the consequences of which affect social, economic and environmental spheres. Accidents arising in ICT can have large-scale and long-term consequences, due to the possibility of intersystem failures (ISF), including their cascade development.

The problem of ISF research in infrastructurely complex territories is systematically reflected in the analysis of resilience of interacting life support systems. The report examines approaches to the classification of ISF in relation to the problem of ICT resilience level assessment**.** Resilience feature may have different content. For a complex object (construction, building, industrial facility), resilience is rather closer to the notion of stability, vitality, or vulnerability. For individual systems (environmental, organizational, technical, etc.), in addition to inherent features of individual objects listed above, resilience must necessarily include a recoverability feature. The greatest importance and content resilience has for interacting systems and, first of all, for critical infrastructures [1].

In the work [2], resilience refers to the ability of economy or society to minimize losses of income and assets because of shock events. The level of economy of country or region is proposed to be considered as a macro level of resilience, and the micro level is proposed to be used to indicate the vulnerability and ability of individuals, households and businesses to withstand shock events. The authors of the work [3] propose to consider economic regional resilience as independent object of researches, emphasizing the difference of similar concept for technical and environmental systems. The carried out analysis showed that the classification of ISF takes place mainly for individual life support systems. In the work [4] it is proposed the classification of cascade accidents in electric power systems. An approach to classification of cascade accidents is considered in oil pipeline systems, when initiating events of avalanche-like development of accident may be power outage, accident at pump station, etc. [5].

In this work, ISF are considered as part of the task of assessment and ensuring resilience of ICT. It is proposed to select the following indicators as the classification characteristics of ISF in ICT: place of ISF occurrence (initiating system) in ICT; number of systems involved in ISF; distribution of ISF in ICT area; scale of economic impact of ISF in ICT; scale of social consequences of ISF in ICT; nature of ISF resulting hazards; structure of ISF emergency processes development.

DOI: 10.21467/abstracts.93

According to uprising of ISF in ICT classification characteristics are related to classification characteristics according to ICT structure and can be classified according to the type of infrastructure system in which the triggering event occurred. The following types can be distinguished: accidents caused by power system failure; accidents caused by failure in gas supply system; accidents caused by failure in transport system; accidents caused by failure in water supply system; accidents caused by failure in communication system; accidents caused by failure in several systems at the same time.

By the scale of accident in ICT (number of systems involved in ISF) it is possible to distinguish: distributed ISF - failures occurred in 2-3 systems; macro-distributed ISF - failures occurred in 4-6 systems; mega-distributed ISF - failures occurred in more than 6 systems. According to the level of economic consequences, intersystem accidents in ICT can be divided into: microeconomic - consequences of ISF appear at the level of individual organizations; macroeconomic - consequences of ISF appear at the level of totality of organizations of several branches of economy or spheres of business; mesoeconomic - consequences of ISF appear at the level of individual branches of economy; megaeconomic - consequences of ISF are linked to national economy, several states or sectors of world economy. According to scale of social consequences, we will mark: local accidents - consequences affected groups of people; regional accidents - suffered communities of people in certain territories (area, region); interregional accidents - consequences are felt at national and intercountry levels.

If hazardous production facilities located in ICT are present in intersystem accidents, it is advisable to carry out classification according to nature of hazardous factors: ISF with forming chemically hazards; ISF with forming fire and explosive factors; ISF with forming biologically hazardous factors; ISF with forming hydrodynamically hazards; ISF with complex appearing of hazards. Analysis of happened ISF, as well as qualitative analysis of possible topologies of ISF development scenarios in ICT, allowed the authors to propose the following classification of ISF structure in work [6]: accidents with absence of branching; accidents with branching in systems; accidents with branching between systems; accidents with branching in and between systems. The necessity for carried out analysis and classification is connected with variety of ISF and need to choose methodological and model approaches to assessment of level resilience of ICT.

Acknowledgement: The abstracts were prepared with the support of the RFBR grant project "Development of theoretical foundations and practical methods for analyzing, predicting and evaluating security in intersystem interactions of critical infrastructures in urbanized areas" No. 20-010-00812A.

References

1. Theocharidou, M. et al. Resilience of Critical Infrastructure Systems: Policy, Research Projects and Tools. In Trump, B. D., Florin, M.-V., &Linkov, I. (Eds.). IRGC Resource Guide on Resilience (vol. 2): Domains of Resilience for Complex Interconnected Systems. Lausanne, CH: EPFL International Risk Governance Center.
2. Indexing Resilience: a Primer for Insurance Markets and Economies // SIGMA. №5, 2019, Swiss Re Institute – 54 p.
3. Simmie, J. and Martin, R. The Economic Resilience of Regions: Towards an Evolutionary Approach, Cambridge Journal of Regions, Economy and Society 3, 2010, 1, pp.27-43
4. Energy. Terms and definitions: Collection of standards (2005) - Moscow: STANDARTINFORM
5. Reliability of Energy Systems and Their Equipment. Volume 1 (1994) – Moscow: NEDRA.
6. Lesnykh, V. Petrov, V. and Timofeeva, T. Problems of Risk Assessment in Intersystem Failures of Life Support Facilities // International Journal of Critical Infrastructures, vol.12, No.3, 2016, pp.213-228.