Assessment of Spatial and Temporary Features of Distribution of Natural and Man-Made Emergency Situations on the Territory of Siberian Federal District

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Abstract. This paper dissects the current spatial and temporary distribution patterns of emergencies in constituent entities of Siberian Federal District. It dissects the economic, social and environmental situation in these entities. The article contains information about the spatial structure of natural and man-made emergencies which happened in Siberian Federal District is provided. The research presents a method to analyse subjects of Siberian Federal District for the first time. Methods of research includes information about transport, protection from natural disaster, environmental stress and others. The article gives information about natural and man-made emergencies from 2000 to 2013 years is given and is divided by different social situations in each regions.

1. Introduction
Due to their specific geographical location, population density, natural conditions and level of economic development, as well as the state of industrial facilities and infrastructure, constituent entities of Siberian Federal District differ in terms of hazard and risk of natural and man-made emergencies. Protecting both the population and areas of the district from emergencies of different origins is an increasingly urgent problem of society. In order to analyze the situation in constituent entities of Siberian Federal District associated with natural and man-made emergencies, it is necessary to analyze their impact on the economy, environment and population.

The subject of the study is the constituent entities of Siberian Federal District.

The scope of the study is natural and man-made emergencies, and the research methodology for these emergencies, with focus given to their impact on the economy, population and environment of Siberian Federal District.

The relevance of the study is associated with the fact of this research. Prediction and prevention of natural and man-made emergencies are extremely important due to deterioration of the environmental, social and economic situation in some regions in Russia. Siberian Federal District plays an important role in the national economic situation as regarding mining and industrial center. However, a number of production facilities, including oil and gas fields, coal mines, etc., can be a potential source of man-made emergencies. Some constituent entities of Siberian Federal District are highly susceptible to natural emergencies, such as natural fires, floods, etc. Therefore, protecting the population and areas of the district from emergencies is an increasingly urgent and important problem.
The scientific novelty: this is the first study to present objective information on the spatial structure of natural and man-made emergencies in the district; to investigate the spatial and temporal distribution of emergencies, and to divide the district into zones according to the degree of damage from natural and man-made emergencies.

The purpose of the study is to conduct a socio-economic assessment based on the impact of emergencies from different origins.

Objectives:
1. To provide a geographical description of constituent entities of Siberian Federal District.
2. To conduct a spatial and temporal analysis of recorded emergencies in the constituent entities of Siberian Federal District.
3. To conduct a social, economic and environmental analysis of the constituent entities of Siberian Federal District.

2. Research methodology
The research methodology includes create a map, comparative and descriptive, statistical and zoning methods, i.e. purely geographical methods.

Sources of factual information include reports and records of the Ministry of Emergency Situations of the Russian Federation (EMERCOM), and Federal State Statistics Service (ROSSTAT).

Siberian Federal District was established on May 13th, 2000. Siberian Federal District comprises 12 constituent entities of the Russian Federation: four republics (Altai, Buryatia, Tyva and Khakassia), three marches (Altai, Krasnoyarsk and Zabaykalsky), and five regions (Irkutsk, Tomsk, Kemerovo, Novosibirsk, Omsk). On January the 1, 2007, Taimyr (Dolgano-Nenets) Autonomous District and the Evenk Autonomous District were merged into Krasnoyarsk Territory. On January the 1, 2008, Ust-Orda Buryat Autonomous District became a part of Irkutsk Region. On March the 1, 2008, Chita Region and Agin-Buryat Autonomous District were merged to form Zabaykalsky Territory [8].

The importance of Siberian Federal District is reinforced by its special geopolitical position: the region is not only an integrating link between the Far Eastern economic region and the European part of the country, but also a “bridge” between foreign European countries and the Asia-Pacific region.

A lot of academic specialists from different countries are learning emergencies [1, 2, 3, 5, 9].

Natural disasters are the most unpredictable or leave out events. According to EMERCOM of Tomsk Region [7], more than 20% of all emergencies (natural, man-made and biosocial) are of natural origin, which indicates their frequency in this region.

Emergencies are distributed differently across Siberian Federal District. The greatest numbers of man-made emergencies within the period from 2000 to 2013 are recorded in Zabaykalsky Territory, Republic of Buryatia and Krasnoyarsk Territory. The least number of man-made emergencies for the same period occurred in Republic of Khakassia, Kemerovo and Novosibirsk regions.

The number of natural emergencies also varies greatly in the regions of Siberian Federal District. During the period under review, from 2000 to 2013, the greatest number of natural disasters was recorded in Krasnoyarsk Territory, Republic of Buryatia, Irkutsk Region, and Novosibirsk Region. The least number of natural disasters was recorded in Republics of Tyva, Khakassia and Altai. Importantly, during the period under review, the number of natural emergencies is much higher than the number of man-made emergencies in all regions of Siberian Federal District. This is important to note since natural emergencies are the most likely source of damage to the agriculture in any region.

A natural hazard is a natural phenomenon or process that might be a threat to life, as well as the health and well-being of people under certain conditions. A measure of risk is a magnitude, order or degree of damage that people will incur as a result of a known hazardous event in the natural environment in which they are somehow involved or which they provoke themselves, at a given (actual, real) level of preparation for this event [4].

A natural hazard can be predicted for certain areas, regions and countries. The prediction is based on a set of dangerous processes and takes into account the accumulate experience to reveal a dangerous background of economic activities [4].
Using the methodology developed in [4], the authors of this study assessed the risk of environmental resources management in the constituent entities of Siberian Federal District based on socioeconomic and environmental conditions of the entities by conducting the integrated territorial analysis and taking into account all natural hazards and risks.

The natural hazard factor is calculated by the formula [4]:

$$H_c = D(S^2/P)$$

(1)

where $D$ is the number of regionally hazardous natural processes; $S$ is the area of the region, km$^2$; $P$ is the population of the region, amount of people.

By the level of natural disaster risk, regions can be divided into five categories:

1) Negligible or very low risk;
2) Low risk;
3) Medium risk;
4) High risk;
5) Very high risk.

This categorization is based on the risk factor for natural disasters calculated by the formula:

$$R_c = \frac{H_c}{V_c}$$

(2)

where $H_c$ is the natural hazard factor; and $V_c$ is the protection factor for natural disasters.

Based on the calculated factor, the constituent entities under review were divided into the above categories by the level of risk from natural disasters (Table 1).

The telecommunication factor $T$ is calculated by the formula:

$$T = \frac{(T_{ph} + T_{mph} + T_{rd} + T_{v} + T_{int})}{P}$$

(3)

where $T_{ph}$ is the number of landline telephones; $T_{mph}$ is the number of mobile telephones; $T_{rd}$ is the number of radio sets; $T_{v}$ is the number of TV sets; $T_{int}$ is the number of Internet users; and $P$ is the population of the regions.

The transport factor $C$ was calculated by the formula:

$$C = \frac{(C_{r} + C_{a} + C_{w} + C_{l})}{(P + S)}$$

(4)

where $C_{r}$ is the length of railway lines in km; $C_{a}$ is the length of motor roads in km; $C_{w}$ is the length of waterways with active traffic in km and $C_{l}$ is the airlines factor (number of airports multiplied by 100 km – the minimum range of airlines).

The protection factor for natural disasters is calculated by the formula:

$$V_c = \frac{(B + P_j + T + C + W + L + K)}{(P_p + CHD + E)}$$

(5)

where $B$ is the gross regional product per capita; $P_j$ is the proportion of working-age population; $T$ is the telecommunication factor; $C$ is the transport factor; $W$ is the military resources factor; $L$ is the life expectancy rate; $K$ is the literacy rate; $P_p$ is the proportion of the population living below the poverty line; CHD is the infant mortality rate; and $E$ is the environmental stress factor (Table 2).

The calculation of the natural hazard factor showed the following: the highest factor was recorded for Zabaykalsky Territory (high natural hazard) and Republic of Buryatia (high natural hazard). These constituent entities are susceptible to natural hazard (high frequency of hazardous natural processes) due to their complex terrain, severe climate and other natural conditions. A low level of natural hazard was identified in Republic of Altai, Tomsk Region and Omsk Region.
Table 1. Classification of the Constituent Entities of Siberian Federal District by the Level of Risk from Natural Disasters.

| Constituent Entity | Negligible or very low risk | Low risk | Medium risk | High risk | Very high risk |
|--------------------|----------------------------|----------|-------------|-----------|----------------|
| Altai Republic     | +                          |          |             |           |                |
| Omsk Region        |                            | -        |             |           |                |
| Novosibirsk Region |                            |          | +           |           |                |
| Irkutsk Region     |                            | +        |             |           |                |
| Kemerovo Region    |                            |          | +           |           |                |
| Krasnoyarsk Territory |                        |          |             | +         |                |
| Zabaykalsky Territory |                      |          |             | +         |                |
| Altai Republic     |                            | +        |             |           |                |
| Republic of Buryatia |                        |          |             |           |                |
| Republic of Khakassia |                        |          |             |           |                |
| Tyva Republic      |                            |          |             |           |                |
| Tomsk Region       |                            |          |             |           | +              |

The highest telecommunication factor was recorded for the Krasnoyarsk Territory, Irkutsk Region, Omsk Region, and Altai Territory. These results suggest that these constituent entities have the best emergency notification systems, which can contribute to reducing the death rate.

The analysis of the transport factor in the constituent entities of Siberian Federal District showed the following: the highest factor was recorded for the Republic of Altai and the Zabaykalsky Territory. This factor demonstrates the coverage of the area with different transport routes relatively to the total area and overall population.

Table 2. The Protection Factor for Natural Disasters in the Constituent Entities of Siberian Federal District.

| Constituent Entity of Siberian Federal District | Vc   |
|-----------------------------------------------|------|
| Altai Republic                               | 0.434986 |
| Republic of Buryatia                          | 0.294721 |
Continuation of table 2

| Constituent entity of Siberian Federal District | Vc |
|-----------------------------------------------|----|
| Tyva Republic                                 | 0.21353 |
| Republic of Khakassia                         | 0.586857 |
| Altai Territory                               | 0.284375 |
| Zabaykalsky Territory                         | 0.398701 |
| Krasnoyarsk Territory                         | 0.808617 |
| Irkutsk Region                                | 0.536612 |
| Kemerovo Region                               | 0.70895 |
| Novosibirsk Region                            | 0.520546 |
| Omsk Region                                   | 0.642728 |
| Tomsk Region                                  | 0.836606 |

3. Conclusions
The integrated assessment of emergencies of different origins can be used to assess the situation in different regions and diverse features of a particular area. Damage from emergencies depends on such factors such as the population density, the area within a region, the development of agriculture, the complexity of the terrain, climatic conditions and other characteristics.

4. References
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