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Zemtsov, Stepan and Baburin, Vyacheslav and Koltermann, Klaus and Krylenko, Inna and Yumina, Natalia and Vladimir, Litvinov

RANEPA, Lomonosov Moscow State University

15 December 2014

Stepan P. Zemtsov[1]*, Vyacheslav L. Baburin[2], Klaus P. Koltermann[2], Inna N. Krylenko[3], Natalia M. Yumina[4], Vladimir Yu. Litvinov[5]
[1*] Senior scientist, Institute of applied economic research, The Russian Presidential Academy of National Economy and Public Administration, Prospect Vernadskogo 82, 119571, Moscow, Russia
Tel. +7 495 6294386, fax. +7 495 6290000, e-mail: spzemtsov@gmail.com
[2] Professor, Faculty of Geography, Lomonosov Moscow State University, Leninskiye Gory 1, 119991, Moscow, Russia
Tel. +7 495 9392238, fax. +7 495 9328836, e-mail: info@geogr.msu.ru
[3] Senior scientist, Faculty of Geography, Lomonosov Moscow State University, Leninskiye Gory 1, 119991, Moscow, Russia
Tel. +7 495 9392238, fax. +7 495 9328836, e-mail: info@geogr.msu.ru
[4] Scientist, Faculty of Geography, Lomonosov Moscow State University, Leninskiye Gory 1, 119991, Moscow, Russia
Tel. +7 495 9392238, fax. +7 495 9328836, e-mail: info@geogr.msu.ru
[5] Student, Faculty of Geography, Lomonosov Moscow State University, Leninskiye Gory 1, 119991, Moscow, Russia
Tel. +7 495 9392238, fax. +7 495 9328836, e-mail: info@geogr.msu.ru
* **Corresponding author** (e-mail: spzemtsov@gmail.com)

SOCIAL RISK AND VULNERABILITY ASSESSMENT OF HAZARDOUS HYDROLOGICAL PHENOMENA IN RUSSIA.

ABSTRACT. Methods and results of social vulnerability and risk assessment are presented in the article. It is explored if modified methodology of the United Nations University (World risk index) can be used on different scale levels: regional, municipal and settlement. It was estimated that, despite the low value of the World risk index for Russia, southern coastal and mountain regions have high values of the risk index for hydrological phenomena because of higher frequency of the hazardous events, higher population density, and high social vulnerability. The Krasnodar region (in the south-western part of Russia) was chosen for a detailed analysis. A municipal risk index was developed, and municipal districts in the Kuban river mouth were identified as territories with the highest risk. For verification of the index results, the percentage of vulnerable people was estimated based on opinion polls. The results can be used in further risk calculation for other hazardous phenomena.

KEYWORDS: social vulnerability, hazardous hydrological phenomena, risk assessment, Russian regions, coastal areas.

INTRODUCTION

Hydrological phenomena (floods, storm surges, ground water level rise, etc.) are one of the main natural hazards in Russia [Miagkov, 1995; Petrova, 2006; Shoygu et al., 2010; Koronkevich et al., 2010; Gladkevich et al., 2011]. More than 10 million people, or 7.2 per cent of the population, are exposed [Ministry of Finance, 2011], and the area affected by flooding covers over 0.5 million km^2, or 2.9 per cent of Russian territory [Taratunin, 2008]. Meanwhile, natural hazards assessment is quiet developed in Russia, the assessment of flood impact on the socio-economic development is only infrequently considered in publications [Petrova, 2006; Baburin et al., 2009; Gladkevich et al., 2011; Zemtsov et al., 2012]. And the focus in this works is on the assessment of potential economic damage [Baburin et al., 2009], while in the similar studies in other European countries social vulnerability is more often reported [Birkmann 2007; Fekete, 2010; Fuchs et al., 2012, Birkmann et al., 2013]. The main gap for Russian studies from our point of view is a lack of works dedicated to the social vulnerability of regional and local communities.

Social risk denotes as a product of hazardous event occurrence probability and potential social losses (e.g. injuries or destruction of social networks). The primacy of the economic risk assessments persists in the Russian academic and administrative tradition, partly due to the orientation of the Russian statistics on accounting of the material assets. The nonmaterial parts of the national wealth (people, knowledge, social networks, etc.) are much more difficult to evaluate. However, social losses can be even higher than economic damage of fixed assets and infrastructure [Zemtsov et al., 2013].

The main purpose of the work is to estimate the potential influence of hazardous hydrological phenomena, especially floods, on society, using vulnerability assessment techniques. ‘Vulnerability’ is a universal category for such purposes, because any territorial system (ecological, technological or social) has its own level of resistance to disaster risk, and vulnerability is “the degree of damage that can be expected depending on the characteristics of an ‘element at risk’ with respect to a certain hazard” [Fuchs et al., 2011].

The work is based on the methodology, which was developed in the United Nations University Institute for Environment and Human Security (UNU-EHS) and represented in the World Risk Report [World Risk Report, 2011]. Despite the low value of the risk index for Russia (0.0383), the socio-economic risk of hazardous phenomena is unevenly distributed on its territory [Petrova, 2006; Gladkevich et al., 2011]; there are a number of areas with high and very high value of risk and vulnerability. One of the technical hypotheses is that the ‘World Risk Index’ (WRI) methods can be effectively applied on sub-national and intra-regional levels.

The authors have been able to modify the existing techniques for use at the regional and municipal levels, as well as developed methods of verification and social risk assessment on settlement level.

MATERIALS AND METHODS

The framework of the World Risk Report [World Risk Report, 2011] was applied with some modifications. Due to the framework, the concept of ‘risk’ [Birkmann, 2007; Damm, 2010; Fuchs et al., 2012] consists of two components. The first component is ‘exposure’, or the amount of potential losses, and it involves an assessment of exposed area and affected population. The second component, ‘vulnerability’, is used to assess the system's ability to withstand flooding; it includes ‘susceptibility’ (evaluation of the system sensitivity to natural environment changes), ‘coping capacity’ (recovery abilities) and ‘adaptive capacity’ (ability to adapt to changes in long-term period).

Complex subindices, which evaluated each of the components through several indicators, were used on regional and municipal levels. An algorithm for constructing the integral index included several iterations: database compilation, its transformation to a matrix of normalized indicators, assessment of weights for each indicator, application of the final equation and its verification by correlation analysis.

The authors have assumed universality of identified indicators and its relations in the world index, because the aim of the article was to compare results of the methodology on different levels. We tend to use the same or similar indicators and weights on international (*WRI* – world risk index), regional (*RRIR* – regional risk index of Russia) and municipal (*MRI* – municipal risk index of Krasnodar region) levels, but in the result they were slightly different because of statistical disadvantages and some differences in the factors’ influence.

For comparison purposes, the gradations from the ‘World Risk Report’ also were used for every index. It was presumed that the WRI has the highest values for all indices. But ‘extremely high risk index’ group of regions were added, because some values in Russia were even greater than evaluated by the WRI.

The data of the Russian Federal State Statistics Service (Russian Federal State Statistical Service, 2012) were used. The study is the result of the model adaptation for the Russian statistics, which is more focused on the account of material assets; social ‘abilities’ of the community can be assessed mostly indirectly. Databases, consisting of relevant indicators according to the framework (Table 1) for 83 Russian regions and 14 coastal municipalities of the Krasnodar region in 2010, were created. The databases were integrated into a geographic information system (GIS) for further assessment.

The index of social risk (*R*) and vulnerability index (*Vul*) were calculated using the following equations:

$$R = NH \times Exp \times Vul \quad (1)$$

$$Vul = 0.33 \times (Sus + LCC + LAC) \quad (2)$$

where *NH* represents the natural hazard index [Gladkevich et al., 2011], *Exp* entails the exposure index, *Sus* stands for the susceptibility subindex, *LCC* denotes the lack of the coping capacity subindex and *LAC* represents the lack of adaptive capacity subindex.

Equations of linear scaling (‘max-min’) were used for normalization [Fekete, 2010].

It is essential to assess ‘natural risk’ (I_{NH}) on the regional level in Russia because of the great difference in intensity, duration, height and destructive power of hazardous hydrological phenomena in different regions. Russian regions were divided into groups according to a ‘flooding hazard index’[1] [Gladkevich et al., 2011].

The proportion of people, affected by flooding [Ministry of Finance, 2011], was multiplied by the subindex of population density, and the obtained index was considered as an ‘exposure’ component on regional level. Population density was taken into account because of a great difference of the indicator among different Russian regions.

Maps of observed and maximum potential flood areas in the Krasnodar region were developed on the municipal level. Evaluation of potential flood areas was based on the altitude [Zemtsov et al., 2012]. An ‘exposure index’ for municipal risk index was assigned to a proportion of people living in flood prone areas.

The subindices of vulnerability index, according to the framework (Table 1), consist of several parameters, which were assessed by selected indicators.

$$\begin{aligned} Sus^{reg} &= 0.1425 \times Sus^{reg}_{water\_source} + 0.1425 \times Sus^{reg}_{sewage} + 0.145 \times Sus^{reg}_{fragile\_dwell} + \\ &+ 0.1425 \times Sus^{reg}_{dependance} + 0.1425 \times Sus^{reg}_{subsist\_\min} + 0.285 \times Sus^{reg}_{GRP} \end{aligned} \quad (3)$$

where Sus^{reg} is a susceptibility subindex for the Russian regions; $Sus^{reg}_{water\_source}$ is a subindex of share of buildings without water source; Sus^{reg}_{sewage} is a subindex of share of buildings without sewage system; $Sus^{reg}_{fragile\_dwell}$ is a subindex of share of the population living in fragile dwellings; $Sus^{reg}_{dependance}$ is a subindex of dependency ratio (share of under 15- and over 65 - year-olds in relation to the working population); $Sus^{reg}_{subsist\_\min}$ is a subindex of share of population with incomes below subsistence minimum; Sus^{reg}_{GRP} is a subindex of Gross regional product.

$$\begin{aligned} Sus^{mun} &= 0.285 \times Sus^{mun}_{sanitation} + 0.145 \times Sus^{mun}_{fragile\_dwell} + 0.1425 \times Sus^{mun}_{subsist\_\min} + \\ &+ 0.1425 \times Sus^{mun}_{soc\_serv} + 0.285 \times Sus^{mun}_{own\_goods} \end{aligned} \quad (4)$$

where Sus^{mun} is a susceptibility subindex for the municipal districts of the Krasnodar region; $Sus^{mun}_{sanitation}$ is a subindex of length of improved sanitation per capita; $Sus^{mun}_{fragile\_dwell}$ is a subindex

[1] Index of hazard = 0.5*(duration of flooding) + 0.2*(maximum depth of flooding) + 0.1*(probability of flooding) + 0.1*(percentage of flooding area) + 0.1*(curve type of water discharge, which is forming riverbed). Curve of water discharge, forming riverbed, determines the danger of channel and floodplain rearrangement

of percentage of inhabitants in fragile dwellings; $Sus^{mun}_{subsist\_\min}$ is a subindex of population share with incomes below the subsistence minimum; $Sus^{mun}_{soc\_serv}$ is a subindex of population share of served by social services at home; $Sus^{mun}_{own\_goods}$ is a subindex of sales of own-produced goods, works and services per capita.

Susceptibility of a community depends on the state of infrastructure, housing condition, social protection of population and economic potential of the region (Table 1). Water supply and sewage (sanitation) system development was used as an indicator of the infrastructure parameter. Water networks provide access to drinking water while sewage networks regulate the outflow of heavy rainfall and reduce potential damage. Housing conditions is a more important parameter for this particular study than undernourished population, which is not common for all Russian regions; fragile dwellings are more prone to destruction. Socially vulnerable groups, which include elderly people and families with children, are more affected during floods. Extreme poverty was measured as a share of population with incomes below subsistence minimum, which varies from €95 to €270 per month between regions due to climate conditions. Gross regional product (GRP) per capita is an indicator of economically developed and independent regional society. It is highly differentiated throughout Russia; price indices (depended on climate condition) between regions were used for clarification of the indicator.

$$LCC^{reg} = 0.45 \times LCC^{reg}_{foreign\_invest} + 0.225 \times LCC^{reg}_{beds} + 0.225 \times LCC^{reg}_{physicians} + 0.1 \times LCC^{reg}_{insur} \quad (5)$$

where LCC^{reg} is a subindex for lack of coping capacity on regional level; $LCC^{reg}_{foreign\_invest}$ is a subindex of share of foreign direct investment in assets of the region; LCC^{reg}_{beds} is a subindex of number of beds per 10000 inhabitants; $LCC^{reg}_{physicians}$ is a subindex of number of physicians per 10000 inhabitants; LCC^{reg}_{insur} is a subindex of social and medical insurances per capita.

$$\begin{aligned} LCC^{mun} &= 0.225 \times LCC^{mun}_{unempl} + 0.225 \times LCC^{mun}_{budg\_reven} + 0.225 \times LCC^{mun}_{physician} + \\ &+ 0.225 \times LCC^{mun}_{publ\_protec} + 0.1 \times LCC^{mun}_{wage} \end{aligned} \quad (6)$$

where LCC^{mun} is a subindex for lack of coping capacity subindex on municipal level; LCC^{mun}_{unempl} is a subindex of unemployment rate; $LCC^{mun}_{budg\_reven}$ is a subindex of percentage of own revenues of local budgets; $LCC^{mun}_{physician}$ is a subindex of number of physicians per 10000 inhabitants; $LCC^{mun}_{publ\_protec}$ is a subindex of share of public order protection groups; LCC^{mun}_{wage} is a subindex of average monthly wages per capita.

Ability to recover (coping capacity) is linked to the efficiency of local authorities, development of health services, social relationships and material prosperity of a community. The following ratios can describe the effectiveness of authorities: ratio of income to expenses, percentage of foreign direct investment in assets, number of state employees per 1,000 people and subsidies per km of coastline. Unemployment rate and percentage of own revenues were used as indicators within the MRI, as well as proportion of participants in volunteer groups for the protection of public order, which was chosen to assess the development of social ties.

$$LAC^{reg} = 0.2 \times LAC^{reg}_{educ} + 0.2 \times LAC^{reg}_{female} + 0.2 \times LAC^{reg}_{forest} + 0.2 \times LAC^{reg}_{diversif} + \\ + 0.1 \times LAC^{reg}_{invest} + 0.1 \times LAC^{reg}_{educ\_expend} \quad (7)$$

where LAC^{reg} is a subindex for lack of adaptive capacity on regional level; LAC^{reg}_{educ} is a subindex of share of people without education; LAC^{reg}_{female} is a subindex of proportion of unemployment rates between female and male; LAC^{reg}_{forest} is a subindex of share of forest recovery; $LAC^{reg}_{diversif}$ is a subindex of diversification of labour market; LAC^{reg}_{invest} is a subindex of private investment per fixed assets; $LAC^{reg}_{educ\_expend}$ is a subindex of expenditure budget share of education and science.

$$LAC^{mun} = 0.25 \times LAC^{mun}_{high\_educ} + 0.25 \times LAC^{mun}_{flood\_infr} + 0.5 \times LAC^{mun}_{invest} \quad (8)$$

where LAC^{mun} is a subindex for lack of adaptive capacity on municipal level; $LAC^{mun}_{high\_educ}$ is a subindex of share of employed people with high education; $LAC^{mun}_{flood\_infr}$ is a subindex of observed /maximum flood area; LAC^{mun}_{invest} is a subindex of private investment per capita.

Adaptive capacity was estimated by level of education, gender parity, diversification rate of labour market, development of technical systems and investment attractiveness. Gender disparities exist, but they are not varying greatly between regions, except some traditional Muslim societies in the Northern Caucasus. Labour diversity is an important indicator of potential adaptation strategy. It was calculated by the Herfindahl – Hirschman index (I_{HH}), which can estimate the concentration rate:

$$I_{HH} = S_1^2 + S_2^2 + \ldots + S_n^2 \quad (9)$$

where S_1 represents the proportion of the most common sphere of activity (job); S_2 – the proportion of the next common job; S_n includes the proportion of the last common job. The technical systems capacity was estimated as a proportion between observed (before 2010) and maximum potential (based on the altitude with 0.05 probability) flooding areas. Private investment is an indicator of the attractiveness of the area and its potential for diversification.

Correlation matrixes for the indicators are shown in the tables 2 and 3. Low correlation between an indicator and the vulnerability index (less than 0.15) and between an indicator and vulnerability subindices (less than 0.3) was an important excluding criterion for our final selection (excluded indicators are represented in italics in Table 1). There were some exceptions for I_{LAC} (diversification of the labour market, private investment per fixed assets, and share of expenditure in the budget for education and science) because of its high value for future adaptation in case of flooding. Several indicators (length of improved water source per capita, population share of benefiting from social assistance, number of beds per 10,000 inhabitants, diversification of labour market) were excluded from the MRI for the same reasons[2].

The purpose of the last stage was to verify the method, using field data, collected in Slavyansk municipal district, which has the highest risk index in Krasnodar region. The area is located on the delta of the Kuban River at a height of 1-2 meters above sea level. Hazardous hydrological phenomena are regular, affecting the economy and threatening the health and lives of people.

Hazardous hydrological phenomena were classified into three groups, according to the degree of danger (j)[3] [Zemtsov et al., 2013]:

1. widespread process of ground water level rise (average probability for most of the settlements is 0.99);
2. flooding due to embankment dams breakage with medium level of danger (0.01);
3. catastrophic flooding after the breakout/overspill of the Krasnodar reservoir and destruction of earthen dams (0.001).

Exposed population were assessed by areas of flooding and density of population on them, which is more accurate assessment of exposure index in comparison with the MRI. The index of exposure declined from 0.7 to 0.3.

The questionnaire consisted of more than 20 questions about susceptibility and vulnerability of the people. Polls were representative by age and gender, 485 respondents participated in the survey in several local communities (settlements): Achuevo, Anastasievskoe, Prikubanskiy, Zaboyskiy, Urma and Derevyankovka.

Component analysis of the collected data [Fekete, 2010] was conducted to identify the most related and valuable questions (Table 4). According to the answers of the selected questions, the percentage of weakly, less and most vulnerable people was estimated (Table 5). This proportion was called vulnerability index. 41.5% of the total population in Slavyansk district can be attributed to the group of the most vulnerable. This proportion will be used as an index of social vulnerability (V^5) for medium flooding; the sum of the percentages for most and less vulnerable (57.5%) will be used as a social vulnerability index for catastrophic flooding.

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[2] Correlation analysis between indicator and indices can be used with certain limitations due to the small number of cases (14 municipal districts)

[3] Probability of disasters was estimated according to frequency of the disaster in analogue territories

For further social risk assessment, the authors proposed an equation for financial estimation of social risk. We supposed that social risk can be divided into two categories: 'victims', who are potential victims injured during a flooding, and 'lost' people, who are potential victims killed during an event.

$$D^{Social}{}_{L} = \sum_{i,j}\left(E_{ij} \times V_{ij} \times V^{Victims}{}_{ij} \times coeff^{Victims}{}_{L}\right) + \sum_{i,j}\left(E_{ij} \times V_{ij} \times V^{Lost}{}_{ij} \times coeff^{Lost}{}_{L}\right) \quad (10)$$

where L is an approach for financial estimation: L_1 is proposed by the authors and L_2 is used by EMERCOM; E is a number of exposed people in a settlement *i,* according to the degree of danger (*j*); $V^{(5)}$ is the social vulnerability index (in shares); $V^{Victims}$ is the 'normative' share of 'victims' (0.02 if j=2 (medium flooding) or 0.05 if j=3 (catastrophic) [EMERCOM, 2007]); $coeff^{Victims}$ is an indicator of an average health losses per one person[4]; V^{Lost} is the 'normative' death rate (0.05 if j=2; 0.1 if j=3 [EMERCOM, 2007]); $coeff^{Lost}$ is a financial estimation of a statistical life loss value[5]. The proposed method can be called as a "real loss for society", because it corresponds to all direct (e.g. lost possible future profits, taxes, etc.) and indirect (e.g. previous education and health expenditure, future demographic losses, etc.) losses in financial terms[6] in comparison with EMERCOM method, which only used for family compensation issues.

RESULTS AND DISCUSSION

1. REGIONAL RISK INDEX OF RUSSIA

Overall exposure subindex within the WRI for Russia is 0.094, but most of the territories have a very low exposure index value (Fig. 1). The lowest exposure values are typically found in regions with the lowest population density (except Magadan region and Republic of Saha); the opposite is true for the Northern Caucasus regions.

The susceptibility index (Fig. 2) within the RRIR is much higher than it is within the WRI (0.21), and comparison between them is impossible because of the lack of the 'nutrition' parameter. It is much less distributed than the exposure index: only most economically and socially developed Moscow, Saint-Petersburg, oil-production Khanti-Mansiysky and Yamalo-Nenetsky regions and three of the most underdeveloped (the republic of Tyva, the republic of

[4] L_1 is a share of an average health insurance coverage in the USA, adjusted for gross domestic product difference between the USA and Russia (≈€ 5,000 per capita, Guriev 2010), and L_2 is an average free medical insurance coverage for dismemberment in Russia (≈€ 1,200 per capita)

[5] L_1 is an average value of life insurances in the USA, adjusted for gross domestic product difference between the USA and Russia (≈€1.5m per life lost [Guriev 2010]), and L_2 is the loss of a family with respect to the primary earner (≈€ 50,000 per life lost [EMERCOM 2007])

[6] Monetization of life loss is debatable issue in literature [Mrozek & Taylor 2002; Viscusi & Aldy 2003], but it is one of the most reasonable approaches for comparing economic and social risks. The best way to assess anyone's value of life is only through his own assessment, which can be expressed as life and medical insurance [Guriev 2009]. If life insurance is common in society, it is hard for government or business to ignore safety rules

Altay, and the republic of Kalmikiya) were allocated. Most of the regions have a high and very high rate of the susceptibility subindex.

Low and medium values prevail in the lack of the coping capacity subindex (Fig. 3), and it coincides with its WRI value (0.597). Far eastern regions have the lowest values because of higher investment and higher indicators per capita.

The lack of the adaptive capacity subindex is the most regionally variable component. The lowest values are in the North (Fig. 4) because of the high rate of investment activity and tolerance. In traditional regions of southern Russia, the values are higher. The WRI value is 0.42.

The vulnerability index of Russia within the WRI is approximately 0.41 (Fig. 5). The high value of the index is the most common.

Most of the regions have a very low value of the RRIR (Fig. 6), except several southern territories. Southern coastal and mountain regions have the highest risk index because of their higher population densities, concentrations in river valleys and estuaries and higher social vulnerability in most of the cases. The highest risk values are common for Krasnodar, Saratov regions, the republic of Dagestan, the republic of Northern Ossetia and the republic of Kabardino-Balkaria.

Two versions of the RRIR, before and after exclusion of some indicators due to correlation analysis, were compared. The coefficient of correlation between two versions of the RRIR is 0.99. The index is stable, which can be interpreted as a form of verification.

2. KRASNODAR MUNICIPAL RISK INDEX

Krasnodar region was chosen for a more detailed analysis as one of the regions with the highest RRIR (0.12). The region, especially its coastal zone, is one of the most exposed to hazardous hydrological phenomena in Russia. The research was devoted to a social risk assessment of coastal municipalities of Krasnodar Region. Due to their unique geographical position, coastal areas have a higher concentration of hazards; however, since they can perform a variety of functions, they have a higher concentration of population and economic activity.

Potential flooding and observed flooding areas are shown on Fig. 7. Further approbation of the method shows the highest risk index in coastal municipalities along the mouth of the Kuban River (Fig. 8).

The groups with the lowest index (0.02 to 0.05) are located in highly developed areas and urban districts of the southern coast of the Krasnodar region. The potential damage of hydrological events in the region is related to high intensity and high velocity of water flow. If data on hazards were available, these territories might have a higher index. The foothills and mountainous area have lower populations and the area is less prone to flooding; they also have rather low values of vulnerability, which is associated with well-developed coping capacities.

Large cities (Sochi, Novorossiysk, Gelendzhik, Tuapse) in this area have the necessary infrastructure (e.g. health services), economic potential (e.g. high budget revenues and wages) and social ties for the prevention and elimination of consequences of natural disasters.

"Middle" index municipalities are located in areas that have larger flood areas than the previous group and also have a high level of vulnerability. The area is located between the delta of the Kuban River and the northern part of the Caucasus.

Areas with the highest index are both the most exposed and the most vulnerable to flooding. Floods can cover large areas and have long durations. The flatland areas, located in the delta of the Kuban, are mainly utilized for agriculture. For the rural plains, single level buildings near the river are typical complicating the ability to adapt to the consequences of floods. The Krymsk district is one of the most vulnerable ones as the area has one of the highest indices of sensitivity, which is associated with a high proportion of socially disadvantaged groups. The coping capacity of regions is generally low due to the low economic potential. Socio-economic system of Temryuk district, due to the high volume of private investment in port infrastructure, intended to increase the degree of economy diversification.

Correlation between two integral indices (before and after exclusion of indicators) is approximately 0.97.

3. FIELD-BASED TECHNIQUE OF SOCIAL VULNERABILITY ASSESSMENT

During the last stage, the main objective was an evaluation of social vulnerability and potential social damage for the Slavyansk municipal district with the highest risk rate, using the 'field' data.

The social vulnerability index for the Slavyansk municipal district (0.58), based on opinion polls, corresponds to the MRI (0.59). For purpose of verification, the social vulnerability index for each settlement was compared with the percentage of positive answers for several questions and arithmetic mean between them (Fig. 9). Most of the citizens are unaware and are not prepared for flooding events.

Potential social damage was financially estimated (Table 6). The total social damage for a 'middle' scenario is about 11.1 million euro and 272 million euro – for catastrophic scenarios. Economic damage according to the preliminary authors' results [Zemtsov et al., 2013] is about 4.3 million euro in a 'medium' scenario and 142 million euro in catastrophic. In our case, social losses from death and health problems can be similar or even higher than economic damage. This is the main reason for developing a system of protection, warning and evacuation more accurately.

CONCLUSION

Despite of all the difficulties connected with data collection, the discussed method can be used for vulnerability and risk assessments on different scale levels. If the methodology of the WRI was based on known maximum and minimum indicators (like the Human Development Index), it could become a much more useful instrument. A comparison between the integral indices at different levels is possible, but with a number of known limitations. For instance, indicators for normalization (maximum and minimum value) were chosen for each level separately. The similar indicators may have a different meaning on different scale level. The same weights, used on every level for comparison reasons, is debatable.

It is also important to mention that our work were dedicated for risk assessment in 2010, and it is not possible to forecast or use the results for previous periods. The indicators of infrastructure are quite stable in time in contrast to social and economic indicators, which can change greatly during one year. But the presence of many indicators is an advantage of the integral indices; they will not be highly changed because of the low influence of each indicator on the final index.

The results of the first stage of the work (Regional Risk index of Russia (RRIR) assessment) are important for regional politics. It highlights the existing problem areas in terms of natural and socio-economic risks.

Most of the territories in Russia have a very low exposure index, which cannot be interpreted as a direct positive fact because of high difference of natural hazards on intraregional level. The highest exposure values are typically found in regions with high flooding hazards (mountain and permafrost territories) and with the highest population density (including Central, Privolzgskiy, Southern and Northern Caucasus federal districts).

Most of the Russian regions have high and very high rates of the susceptibility subindex in comparison with other countries, which is not surprising because of low value of economic development. The subindex is only low for the richest Moscow, Saint-Petersburg, oil-production Khanti-Mansiysky and Yamalo-Nenetsky regions. Fortunately, low and medium values prevail in the lack of the coping capacity subindex, which can be interpreted as a result of a good system of preparedness. The highest rates are common for the least developed Northern Caucasus regions. The lack of the adaptive capacity subindex is high for most regions, which is connected with low investment activity and social diversification. As a result, most of Russian regions have high and very high rates of vulnerability, except the most developed (Moscow, Saint Petersburg and Kaluga region) and oil and mining less populated regions. That is why any natural disaster event can become a social catastrophe in Russia.

Most of the regions have a low value of the integral risk index. Southern coastal and mountain regions have the highest risk index because of their higher population densities, concentrations in river valleys and estuaries and higher social vulnerability in most of the cases. The highest risk values are common for Krasnodar, Saratov regions, the republic of Dagestan, the republic of Northern Ossetia and the republic of Kabardino-Balkaria.

On the second stage, the policy priorities of EMERCOM for improving the protection of citizens and their property in Krasnodar region have been determined. However, the approach cannot be applied to calculate real damages, and overestimation of the index approach is dangerous. Indices can smooth out many disparities and hide real problems. The disadvantage of the approach is the dependence on existing statistics.

Both external (MRI) and internal (component analysis of opinion polls) techniques can quite accurately determine the value of vulnerability for local communities, but the second approach is preferred for risk assessment. Conducted field research allowed identifying the lacking knowledge of the population with regard to hazardous hydrological phenomena.

One of the important results of the work was an estimation of economic and social risks in equivalent measures. Our calculations show that social risk can be higher even in financial values. Social risks can be underestimated in comparison with economic risks due to low ‘value of life’, which in turn will continue to negatively affect the vulnerability and especially, coping capacity in Russia, because of lesser attention of local authorities to the protection of citizens.

ACKNOWLEDGEMENT

This work was supported by grant 14-37-00038 of the Russian scientific fund. The authors are grateful for provision of additional materials, constructive comments and consultations to assistant professor M. Goryachko, researcher D. Magritsky and students of the department of economic and social geography of Russia: S. Bedratiy, A. Zhidrov, V. Makeeva, N. Moskvitina, A. Novozhilova, A. Pestich, F. Sleznov, A. Snezhko, I. Timofeev, M. Fadeev.

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APPENDIX

Table 1. Parameters of vulnerability for each level of assessment

	Susceptibility subindex

	Public infrastructure	Housing conditions	Nutrition	Poverty and dependencies	Economic capacity
WRI	28.5%	–	14.5%	28.5%	28.5%
	Population share without access to improved sanitation. Population share without access to improved sanitation	No (Share of the population living in slums)	Share of the population undernourished	Dependency ratio. Extreme poverty population living with USD 1.25 per day or less (purchasing power parity)	GDP per capita (purchasing power parity). Gini index
RRIR	28.5%	14.5%	–	28.5%	28.5%
	Share of buildings without water source. Share of buildings without sewage system	Share of the population living in fragile dwellings	No	Dependency ratio (share of under 15- and over 65 - year-olds in relation to the working population). Share of population with incomes below subsistence minimum	Gross regional product (*Index of prices). *Gini index*
MRI	28.5%	14.5%	-	28.5%	28.5%
	Length of improved water source per capita. Length of improved sanitation per capita	Percentage of inhabitants in fragile dwellings	No	Population share with incomes below the subsistence minimum. *Population share of benefiting from social assistance.* Population share of served by social services at home	Sales of own-produced goods, works and services / people

Lack of coping capacity subindex (I_{LCC})

	Government and authorities	Disaster preparedness	Medical services	Social networks	Material coverage
WRI	45%	–	45%	–	10%
	Corruption Perception Index. Good governance (Failed States Index)	No	Number of beds per 10000 inhabitants. Number of physicians per 10000 inhabitants	No	Insurances
RRIR	45%		45%	–	10%
	The ratio of income to expenses. The share of foreign direct investment in assets of the region. *Number of state employees per 1000 people*.	*Subsidies per km of coastline*	Number of beds per 10000 inhabitants. Number of physicians per 10000 inhabitants	No	Social and medical insurances per capita
MRI	45%		45%		10%
	Unemployment rate. Percentage of own revenues of local budgets	No	*Number of beds per 10000 inhabitants.* Number of physicians per 10000 inhabitants. Share of public order protection groups		Average monthly wages per capita

Lack of adaptive capacity subindex (I_{LAC})

	Education	Gender equity	Environmental management	Adaptation strategies	Investment
WRI	25%	25%	25%	–	25%
	Adult literacy rate. Combined gross school enrolment	Education gender parity. Share of female representatives in parliament	Water resources. Biodiversity. Forest and agricultural management.	No	Public health expenditure. Life expectancy at birth. Private health expenditure
RRIR	20%	20%	20%	20%	20%
	Share of people with high education. Share of people without education	Proportion of unemployment rates between female and male	*Water resources*. Share of forest recovery	Diversification of labour market	Private investment per assets. Expenditure budget share of education and science
MRI	0.25	–	25%	–	50%
	Share of employed people with high education	No	Observed /Maximum flood area	*Diversification of labour market*	Private investment per capita

Source: World Risk Report (2012). Indicators, excluded after verification, are shown in italics.

Table 2. Correlation matrix for RRIR

		1	2	3	4	5	6	7	9	10	11	12	13	14	15	17	18	19	20	21	22	23	24	25	27	29	30	31	32	34	36

15	14	13	12	11	10	9	7	6	5	4	3	2	1
Budget of social and medical insurances per capita	Number of physicians per 10000 inhabitants	Number of hospital beds per 10000 inhabitants	The cost of subsidies per kilometre of coastline	Number of government employees per 1000 people	The share of foreign direct investment in the fixed assets of the region	The ratio of income to expenses	Gini index	Gross regional product	Share of population with incomes below subsistence minimum	Dependency ratio	Share of the population living in fragile dwellings	Share of the buildings without improved water source	Share of the buildings without sewage system
-0,29	0,1	-0,12	0,09	0,23	-0,07	0,16	-0,21	-0,37	0,51	0,38	0,17	0,95	1
-0,4	0	-0,17	0,16	0,19	-0,14	0,19	-0,3	-0,45	0,52	0,45	0,21	1	0,95
0,32	0,18	-0,06	0,28	0,38	0,2	-0,13	0,07	0,16	0,17	-0,23	1	0,21	0,17
-0,72	-0,13	-0,24	-0,15	-0,36	-0,11	0,2	-0,46	-0,73	0,09	1	-0,23	0,45	0,38
-0,1	0,29	0,04	0,35	0,27	-0,08	0,03	-0,37	-0,36	1	0,09	0,17	0,52	0,51
0,64	0,02	0,08	-0,2	0,33	0,16	-0,11	0,56	1	-0,36	-0,73	0,16	-0,45	-0,37
0,35	-0,13	0	-0,07	0,02	0,06	-0,26	1	0,56	-0,37	-0,46	0,07	-0,3	-0,21
-0,27	0,16	0,12	0,04	0,1	0,1	1	-0,26	-0,11	0,03	0,2	-0,13	0,19	0,16
0,31	0,37	-0,08	0	0,28	1	0,1	0,06	0,16	-0,08	-0,11	0,2	-0,14	-0,07
0,54	0,4	0,06	0,07	1	0,28	0,1	0,02	0,33	0,27	-0,36	0,38	0,19	0,23
-0,16	-0,07	0,13	1	0,07	0	0,04	-0,07	-0,2	0,35	-0,15	0,28	0,16	0,09
0,16	0,4	1	0,13	0,06	-0,08	0,12	0	0,08	0,04	-0,24	-0,06	-0,17	-0,12
0,4	1	0,4	-0,07	0,4	0,37	0,16	-0,13	0,02	0,29	-0,13	0,18	0	0,1
1	0,4	0,16	-0,16	0,54	0,31	-0,27	0,35	0,64	-0,1	-0,72	0,32	-0,4	-0,29
0,15	-0,29	0	0,38	0	-0,01	-0,24	0,13	0,09	-0,01	-0,38	0,1	-0,32	-0,33
-0,44	-0,36	-0,17	0,44	-0,04	-0,2	-0,01	-0,2	-0,35	0,25	0,25	0,4	0,31	0,1
0,17	-0,16	0	0,2	0,06	0,18	-0,12	0,22	0,22	-0,22	-0,38	0,27	-0,27	-0,3
0,63	0,48	0,33	0,11	0,62	0,15	-0,03	0,14	0,35	0,1	-0,54	0,4	-0,11	-0,02
-0,17	0,02	0,28	0,29	-0,04	-0,06	0,08	-0,16	-0,1	0,03	0,09	-0,08	-0,19	-0,17
-0,51	-0,35	-0,35	0,01	-0,28	-0,22	0,13	-0,19	-0,19	-0,11	0,28	-0,34	0,1	0,04
0,42	0	-0,05	-0,09	0,22	0,23	-0,02	0,4	0,85	-0,26	-0,52	0,19	-0,3	-0,26
0,08	0,06	0,01	0,08	0,1	0,17	0,05	0,11	-0,01	-0,03	-0,03	0,15	0,06	0,11
0,85	0,39	0,12	-0,03	0,63	0,27	-0,12	0,28	0,65	-0,09	-0,71	0,39	-0,32	-0,23
-0,23	-0,15	-0,08	0,2	-0,28	-0,02	0,08	0,23	-0,06	-0,03	-0,03	-0,05	-0,1	-0,21
-0,16	-0,19	-0,04	0,38	-0,13	0,16	-0,09	0	-0,24	-0,06	0,06	0,11	-0,17	-0,21
-0,39	0,09	-0,17	0,23	0,13	-0,07	0,09	-0,26	-0,6	0,62	0,53	0,37	0,91	0,87
-0,5	-0,84	-0,66	0,24	-0,29	-0,45	-0,25	-0,01	-0,22	0	0,25	-0,05	0,24	0,12
-0,17	-0,3	-0,19	0,09	-0,13	0,04	-0,05	0,09	0,01	-0,14	-0,04	0,2	0	-0,12
-0,56	-0,48	-0,51	0,29	-0,11	-0,27	-0,1	-0,14	-0,49	0,34	0,46	0,28	0,7	0,57
-0,3	-0,34	-0,13	0,5	-0,22	0,02	-0,02	0,02	-0,27	-0,01	0,09	0,19	-0,07	-0,19

34	32	31	30	29	27	25	24	23	22	21	20	19	18	17
Vulnerability index	Lack of adaptive capacity index	Lack of coping capacity index	Susceptibility index	Exposure index	Natural hazard index	Share of expenditure in the budget for education and science	Private investment per fixed assets	Diversification of the GRP structure	Diversification of the labour market	Share of recovered forest	Water resources	Proportion of unemployment rates between female and male	Share of employed people without education	Share of employed people with high education
0,57	-0,12	0,12	0,87	-0,21	-0,21	-0,23	0,11	-0,26	0,04	-0,17	-0,02	-0,3	0,1	-0,33
0,7	0	0,24	0,91	-0,17	-0,1	-0,32	0,06	-0,3	0,1	-0,19	-0,11	-0,27	0,31	-0,32
0,28	0,2	-0,05	0,37	0,11	-0,05	0,39	0,15	0,19	-0,34	-0,08	0,4	0,27	0,4	0,1
0,46	-0,04	0,25	0,53	0,06	-0,03	-0,71	-0,03	-0,52	0,28	0,09	-0,54	-0,38	0,25	-0,38
0,34	-0,14	0	0,62	-0,06	-0,03	-0,09	-0,03	-0,26	-0,11	0,03	0,1	-0,22	0,25	-0,01
-0,49	0,01	-0,22	-0,6	-0,24	-0,06	0,65	-0,01	0,85	-0,19	-0,1	0,35	0,22	-0,35	0,09
-0,14	0,09	-0,01	-0,26	0	0,23	0,28	0,11	0,4	-0,19	-0,16	0,14	0,22	-0,2	0,13
-0,1	-0,05	-0,25	0,09	-0,09	0,08	-0,12	0,05	-0,02	0,13	0,08	-0,03	-0,12	-0,01	-0,24
-0,27	0,04	-0,45	-0,07	0,16	-0,02	0,27	0,17	0,23	-0,22	-0,06	0,15	0,18	-0,2	-0,01
-0,11	-0,13	-0,29	0,13	-0,13	-0,28	0,63	0,1	0,22	-0,28	-0,04	0,62	0,06	-0,04	0
0,29	0,09	0,24	0,23	0,38	0,2	-0,03	0,08	-0,09	0,01	0,29	0,11	0,2	0,44	0,38
-0,51	-0,19	-0,66	-0,17	-0,04	-0,08	0,12	0,01	-0,05	-0,35	0,28	0,33	0	-0,17	0
-0,48	-0,3	-0,84	0,09	-0,19	-0,15	0,39	0,06	0	-0,35	0,02	0,48	-0,16	-0,36	-0,29
-0,56	-0,17	-0,5	-0,39	-0,16	-0,23	0,85	0,08	0,42	-0,51	-0,17	0,63	0,17	-0,44	0,15
-0,07	-0,06	0,23	-0,26	0,46	0,17	0,19	0	-0,04	0,05	0,22	0,03	0,28	0,15	1
0,66	0,45	0,5	0,41	0,27	0,22	-0,3	-0,03	-0,18	0,06	0,07	-0,18	0,2	1	0,15
0,14	0,8	0,06	-0,24	0,3	0,33	0,22	0,08	0,13	-0,15	-0,04	0,11	1	0,2	0,28
-0,36	-0,24	-0,45	-0,08	0,04	-0,24	0,72	0,3	0,16	-0,32	-0,08	1	0,11	-0,18	0,03
-0,18	-0,3	-0,04	-0,11	0,31	0,17	-0,11	-0,02	-0,03	-0,07	1	-0,08	-0,04	0,07	0,22
0,23	0,03	0,45	-0,02	0,06	-0,02	-0,3	-0,19	-0,05	1	-0,07	-0,32	-0,15	0,06	0,05
-0,31	0,05	-0,12	-0,43	-0,22	-0,02	0,46	0,02	1	-0,05	-0,03	0,16	0,13	-0,18	-0,04
-0,04	-0,21	-0,08	0,1	0,06	0,02	0,11	1	0,02	-0,19	-0,02	0,3	0,08	-0,03	0
-0,48	-0,14	-0,41	-0,34	-0,1	-0,16	1	0,11	0,46	-0,3	-0,11	0,72	0,22	-0,3	0,19
0,14	0,31	0,16	-0,06	0,25	1	-0,16	0,02	-0,02	-0,02	0,17	-0,24	0,33	0,22	0,17
0,12	0,12	0,19	-0,01	1	0,25	-0,1	0,06	-0,22	0,06	0,31	0,04	0,3	0,27	0,46
0,74	0	0,2	1	-0,01	-0,06	-0,34	0,1	-0,43	-0,02	-0,11	-0,08	-0,24	0,41	-0,26
0,73	0,27	1	0,2	0,19	0,16	-0,41	-0,08	-0,12	0,45	-0,04	-0,45	0,06	0,5	0,23
0,47	1	0,27	0	0,12	0,31	-0,14	-0,21	0,05	0,03	-0,3	-0,24	0,8	0,45	-0,06
1	0,47	0,73	0,74	0,12	0,14	-0,48	-0,04	-0,31	0,23	-0,18	-0,36	0,14	0,66	-0,07
0,34	0,33	0,37	0,08	0,85	0,58	-0,19	0,06	-0,22	0,02	0,29	-0,12	0,43	0,51	0,43

36	RRIR	-0,19	-0,07	0,19	0,09	-0,01	-0,27	0,02	-0,02	0,02	-0,22	0,5	-0,13	-0,34	-0,3	0,43	0,51	0,43	-0,12	0,29	0,02	-0,22	0,06	-0,19	0,58	0,85	0,08	0,37	0,33	0,34	1

Table 3. Correlation matrix for MRI

		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
1	Length of water pipe networks	1,00	0,13	-0,20	0,36	-0,37	0,49	-0,46	0,54	-0,53	-0,22	-0,89	0,09	-0,78	-0,13	0,33	0,17	-0,58	0,68	0,63	0,59	0,11	0,69	0,32
2	Length of sewer system	0,13	1,00	-0,38	-0,31	0,05	0,22	-0,48	-0,20	0,16	-0,05	0,15	0,69	-0,13	0,46	-0,13	0,32	-0,20	-0,05	-0,02	-0,20	-0,10	-0,40	0,15
3	The share of the inhabitants in fragile dwellings	-0,20	-0,38	1,00	-0,01	0,03	-0,14	0,01	-0,06	-0,38	0,09	0,00	-0,39	0,24	-0,25	-0,29	-0,11	0,61	-0,04	-0,13	0,32	0,40	0,18	0,13
4	The share of the population with incomes below the subsistence minimum	0,36	-0,31	-0,01	1,00	-0,09	0,57	-0,34	0,61	-0,28	0,18	-0,53	-0,03	-0,55	0,02	0,31	-0,10	-0,28	0,30	0,27	0,51	0,66	0,41	0,03
5	The share of the population benefiting from social assistance to pay for housing services	-0,37	0,05	0,03	-0,09	1,00	-0,41	-0,19	-0,25	0,45	-0,30	0,45	0,26	0,18	0,59	-0,08	-0,03	0,32	-0,25	-0,23	-0,24	0,37	-0,37	-0,37
6	The share of the population served by the departments of social services at home for senior citizens and disabled	0,49	0,22	-0,14	0,57	-0,41	1,00	-0,52	0,64	-0,44	0,40	-0,56	0,02	-0,65	-0,21	-0,02	-0,14	-0,49	0,31	0,23	0,62	0,46	0,40	0,47
7	Sales of own-produced goods, works and services / people	-0,46	-0,48	0,01	-0,34	-0,19	-0,52	1,00	-0,49	0,23	-0,05	0,46	-0,31	0,73	-0,42	-0,15	0,04	0,35	-0,33	-0,31	-0,46	-0,69	-0,27	-0,08
8	Unemployment rate	0,54	-0,20	-0,06	0,61	-0,25	0,64	-0,49	1,00	-0,53	0,45	-0,72	-0,18	-0,77	-0,20	0,13	-0,07	-0,51	0,19	0,14	0,71	0,49	0,63	0,33
9	The share of own revenues of local budgets	-0,53	0,16	-0,38	-0,28	0,45	-0,44	0,23	-0,53	1,00	0,02	0,64	0,36	0,42	0,60	0,20	0,11	0,14	-0,19	-0,07	-0,81	-0,26	-0,77	-0,57
10	Number of hospital beds per 10000 inhabitants	-0,22	-0,05	0,09	0,18	-0,30	0,40	-0,05	0,45	0,02	1,00	0,06	-0,16	0,00	-0,20	-0,18	0,01	0,03	-0,28	-0,27	0,09	0,19	-0,16	0,24
11	Number of physicians per 10000 inhabitants	-0,89	0,15	0,00	-0,53	0,45	-0,56	0,46	-0,72	0,64	0,06	1,00	0,15	0,85	0,23	-0,30	0,02	0,61	-0,66	-0,59	-0,77	-0,30	-0,86	-0,34
12	Share of participants in voluntary groups of population for the protection of public order	0,09	0,69	-0,39	-0,03	0,26	0,02	-0,31	-0,18	0,36	-0,16	0,15	1,00	-0,02	0,77	-0,04	0,63	-0,08	-0,28	-0,23	-0,36	-0,02	-0,57	-0,06
13	Average monthly wages per capita	-0,78	-0,13	0,24	-0,55	0,18	-0,65	0,73	-0,77	0,42	0,00	0,85	-0,02	1,00	-0,08	-0,30	0,08	0,79	-0,61	-0,55	-0,71	-0,46	-0,69	-0,28
14	Share of employed people with good education	-0,13	0,46	-0,25	0,02	0,59	-0,21	-0,42	-0,20	0,60	-0,20	0,23	0,77	-0,08	1,00	0,08	0,41	-0,10	-0,14	-0,09	-0,35	0,22	-0,51	-0,30
15	Maximum / Observed flood area	0,33	-0,13	-0,29	0,31	-0,08	-0,02	-0,15	0,13	0,20	-0,18	-0,30	-0,04	-0,30	0,08	1,00	-0,38	-0,15	0,58	0,72	-0,21	0,01	0,22	-0,72
16	Diversification of the labour market	0,17	0,32	-0,11	-0,10	-0,03	-0,14	0,04	-0,07	0,11	0,01	0,02	0,63	0,08	0,41	-0,38	1,00	-0,07	-0,29	-0,32	-0,11	-0,23	-0,34	0,38
17	Private investment per people	-0,58	-0,20	0,61	-0,28	0,32	-0,49	0,35	-0,51	0,14	0,03	0,61	-0,08	0,79	-0,10	-0,15	-0,07	1,00	-0,43	-0,39	-0,41	0,04	-0,45	-0,35

18	Municipal Risk Index	0,68	-0,05	-0,04	0,30	-0,25	0,31	-0,33	0,19	-0,19	-0,28	-0,66	-0,28	-0,61	-0,14	0,58	-0,29	-0,43	1,00	0,98	0,40	0,15	0,63	-0,05
19	Exposure	0,63	-0,02	-0,13	0,27	-0,23	0,23	-0,31	0,14	-0,07	-0,27	-0,59	-0,23	-0,55	-0,09	0,72	-0,32	-0,39	0,98	1,00	0,24	0,08	0,54	-0,21
20	Vulnerability	0,59	-0,20	0,32	0,51	-0,24	0,62	-0,46	0,71	-0,81	0,09	-0,77	-0,36	-0,71	-0,35	-0,21	-0,11	-0,41	0,40	0,24	1,00	0,57	0,83	0,65
21	Susceptibility	0,11	-0,10	0,40	0,66	0,37	0,46	-0,69	0,49	-0,26	0,19	-0,30	-0,02	-0,46	0,22	0,01	-0,23	0,04	0,15	0,08	0,57	1,00	0,28	0,03
22	Lack of coping capacity	0,69	-0,40	0,18	0,41	-0,37	0,40	-0,27	0,63	-0,77	-0,16	-0,86	-0,57	-0,69	-0,51	0,22	-0,34	-0,45	0,63	0,54	0,83	0,28	1,00	0,31
23	Lack of adaptive capacity	0,32	0,15	0,13	0,03	-0,37	0,47	-0,08	0,33	-0,57	0,24	-0,34	-0,06	-0,28	-0,30	-0,72	0,38	-0,35	-0,05	-0,21	0,65	0,03	0,31	1,00

Table 4. The combination of answers for groups of people with different value of vulnerability

	The most vulnerable	Less vulnerable	The least vulnerable
Can you provide the safety of your life?	No	In part. Do not know	Yes
What is your age?	0-16; >66	56-65	> 16; < 56
How many years do you live in the area?	Less than 1; 1-5	5-20	> 20
Did you experience flood?	No	Once	More than once

Table 5. The distribution of the vulnerability groups

	Frequency	Per cent	Valid per cent	Cumulative per cent
The most vulnerable	192	40.5	41.5	**41.5**
Less vulnerable	74	15.6	16.0	**57.5**
The least vulnerable	197	41.6	42.5	100
Total	463	97.7	100	

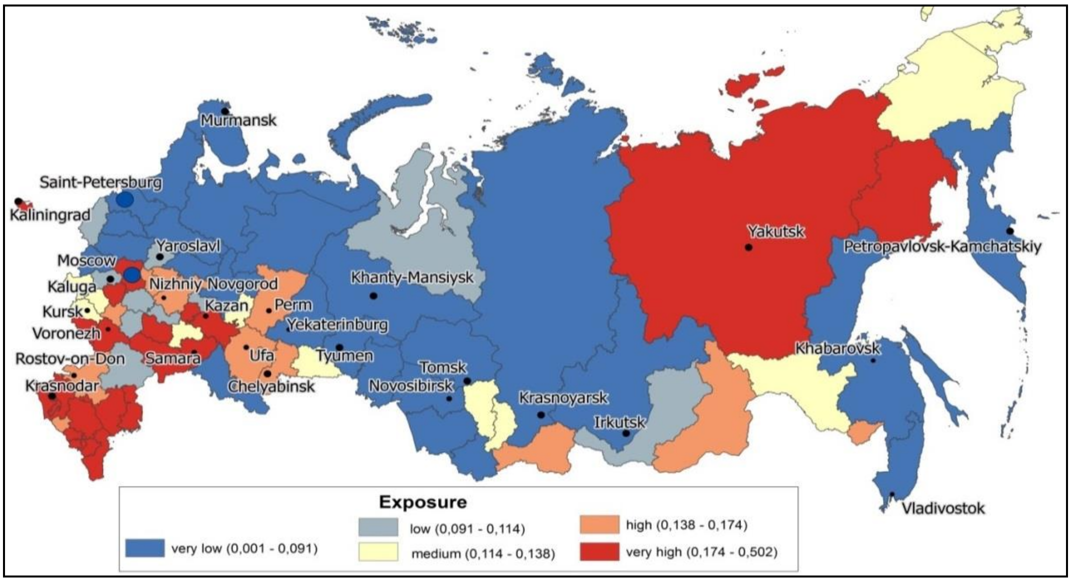

Fig. 1. Exposure index distribution in Russia in 2010

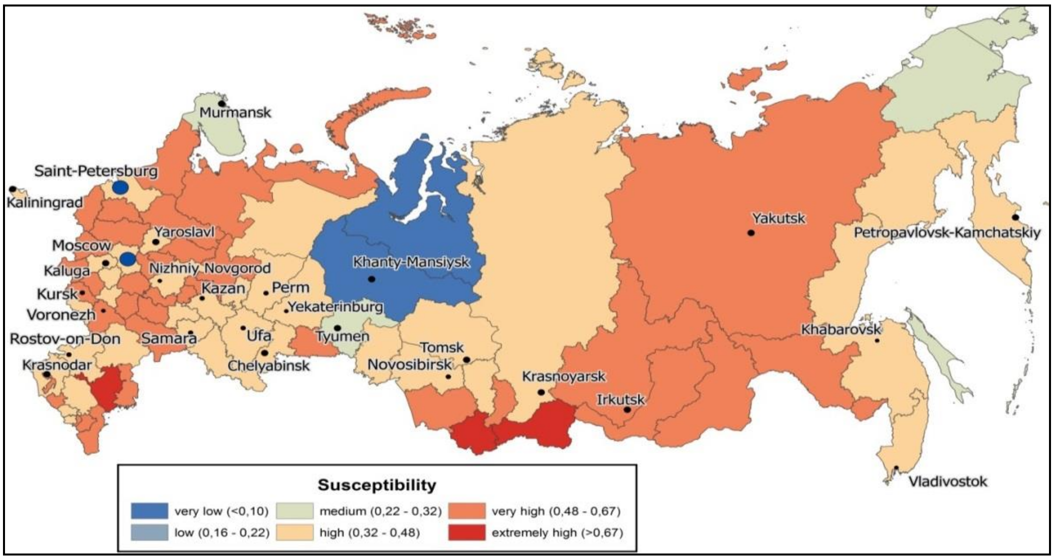

Fig. 2. Susceptibility subindex distribution in Russia in 2010

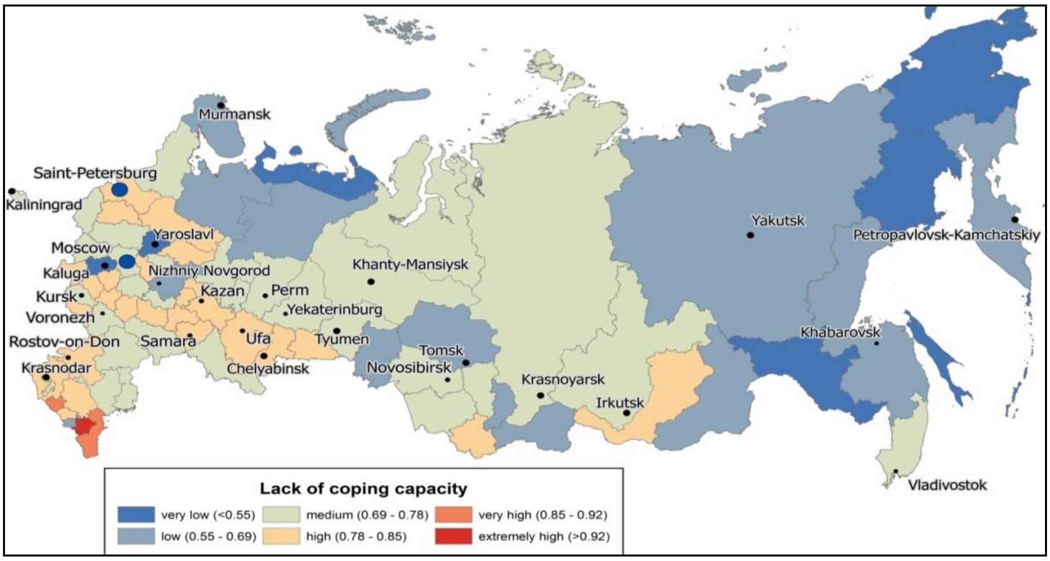

Fig. 3. Lack of coping capacity subindex distribution in Russia in 2010

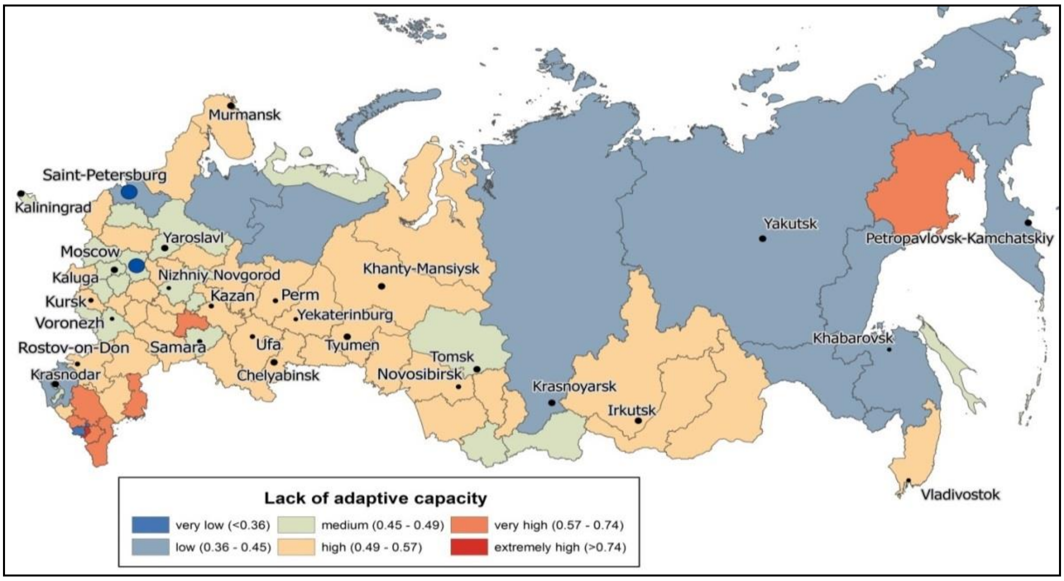

Fig. 4. Lack of adaptive capacity subindex distribution in Russia in 2010

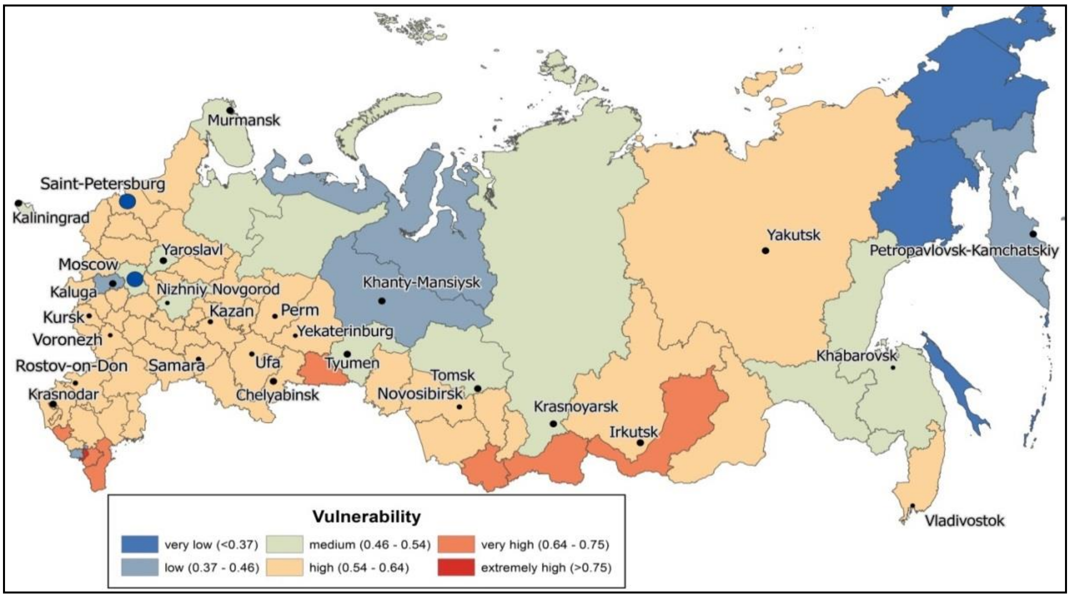

Fig. 5. Vulnerability index distribution in Russia in 2010

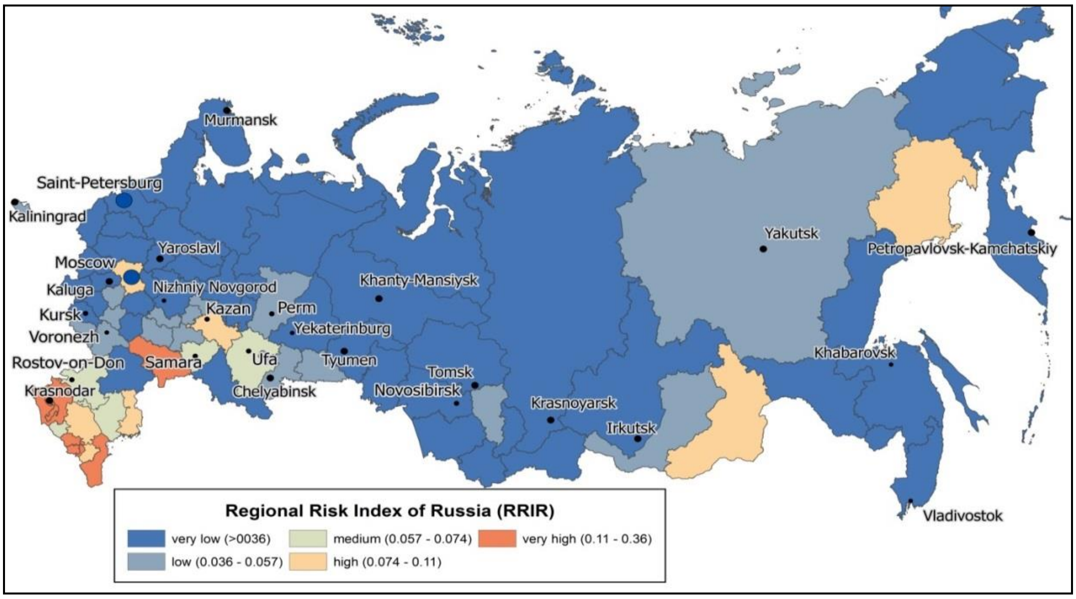

Fig. 6. Regional Risk Index of Russia in 2010

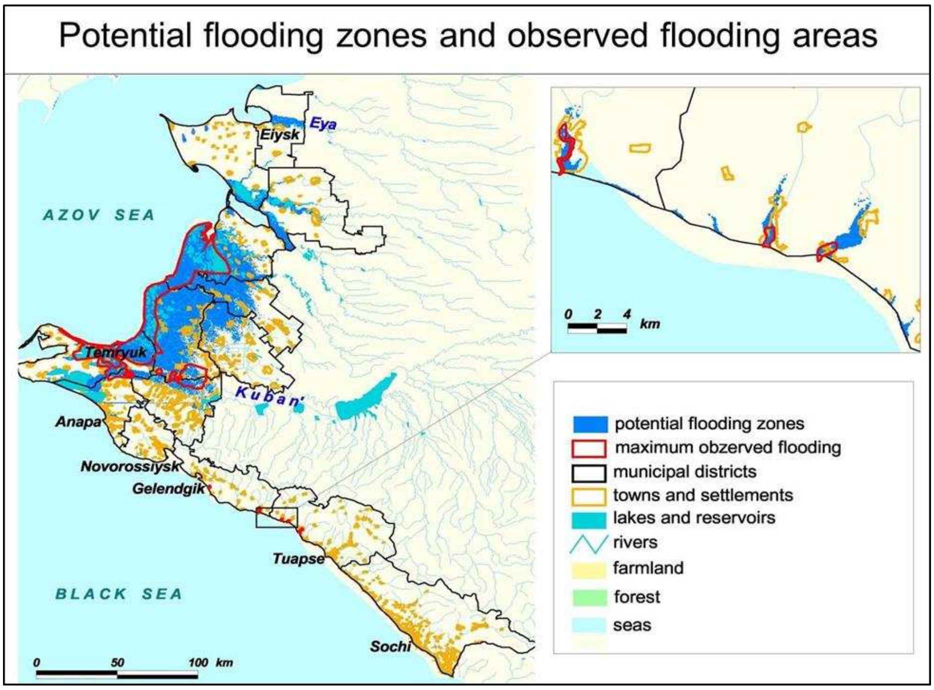

Fig. 7. Potential and maximum observed flooding zones on municipal level of Krasnodar region in 2010

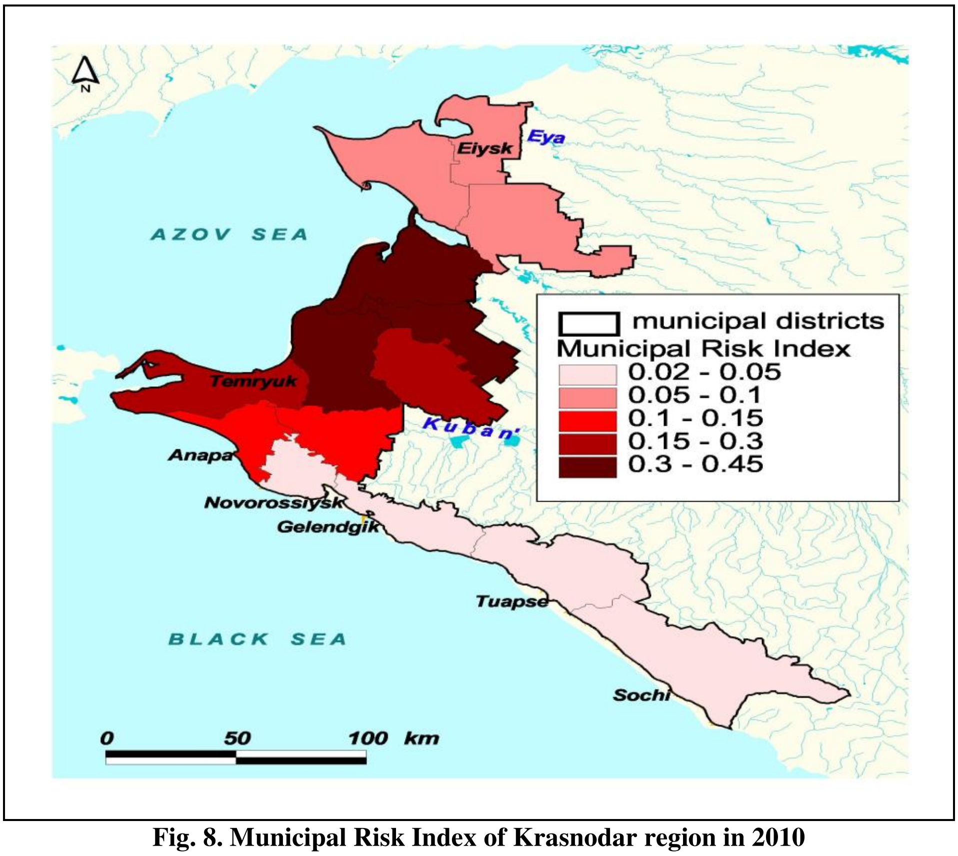

Fig. 8. Municipal Risk Index of Krasnodar region in 2010

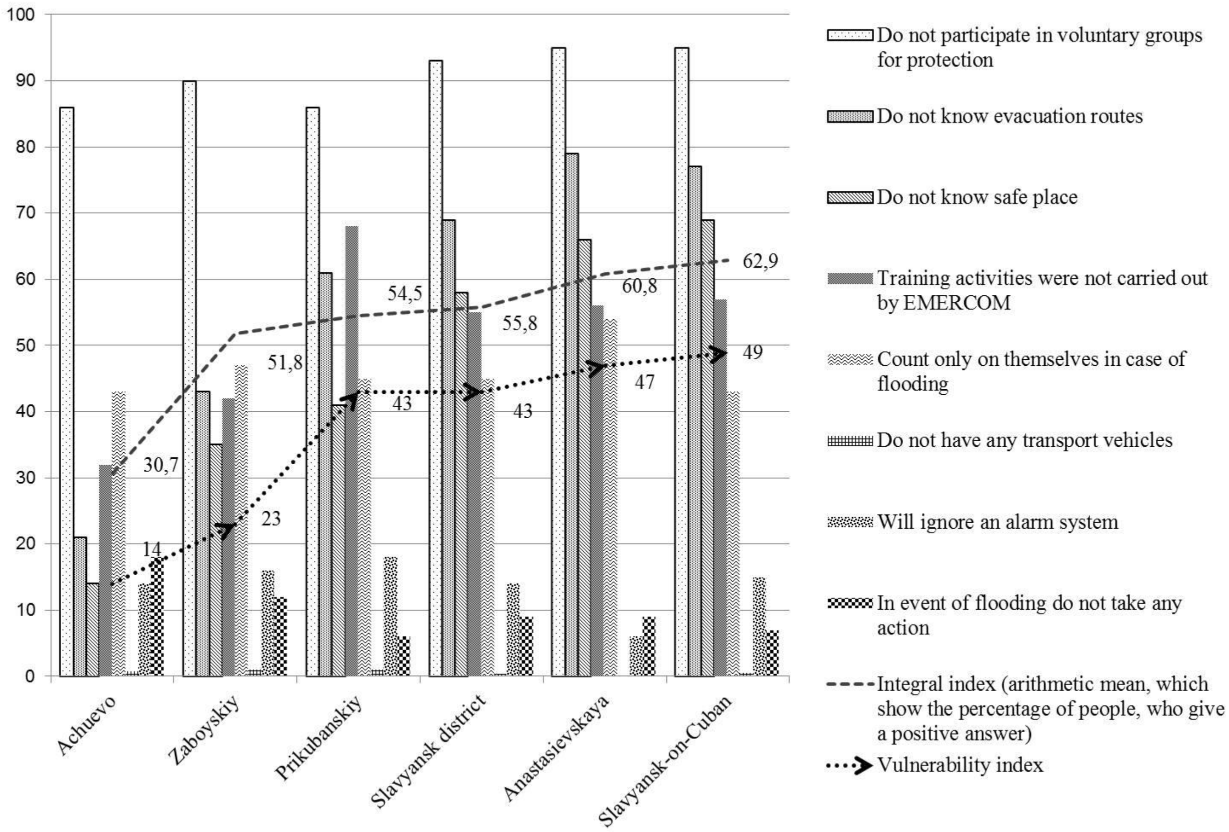

Fig. 9. Percentage of respondents by answers in settlements of Slavyansk municipal district, %

Table 6. Social risk calculations

		Medium flooding	**Catastrophic flooding**
Potential social loses (persons)	Exposed population	16481	60575
	Vulnerable people	6922	35134
	Victims	138	1757
	Deaths	7	176
Real loss for society (1000 €)	Victims	690	8785
	Deaths	10 500	264 000
	Total potential damage	11 190	272 785
	Annual social risk	111,9	272,8
Government estimation (1000 €)	Victims	165,6	2108,4
	Deaths	350	8800
	Total potential damage	515,6	10 908,40
	Annual social risk	5156	10,91