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INTEGRAL INDEX OF HAZARDS AND RISKS OF REGIONS OF THE RA IN THE CONTEXT OF SOCIO-ECONOMIC DEVELOPMENT

Assessing the socio-economic development opportunities of the regions of the Republic of Armenia, the assessment of the hazard, vulnerable elements and capacities typical of the given communities becomes especially important. Studying the existing connections between the dangers typical of Armenia and the vulnerability of territories, we notice that in the strategies, plans and programs for the socio-economic development of the regions, there are practically no quantitative assessments of the risks inherent in the territory, the calculation of financial resources required to eliminate or mitigate them, so the disaster risk management component is missing. Within the framework of this paper, we have developed special quantitative risk assessment scores that can serve as a

basis for quantitative risk assessment, then to justify risk management investments or to calculate financial and economic damage from possible disasters.

Keywords: *hazard, risk, vulnerability, capacity, disaster risk management, risk index*
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Introduction. Considering the socio-economic development opportunities of the regions of the Republic of Armenia, the assessment of the hazards (dangers) and vulnerabilities inherent in the given region is of particular importance. The damage caused by natural disasters is especially significant in Armenia: droughts ($ 6 million average annual damage) and overflows ($ 0.7 million average annual damage)[1]. The average annual damage caused by flow is $ 2.9 million. It is estimated that a catastrophe that occurs every 200 years will result in $ 12.2 billion in direct damage[2]. Studying the existing connections between the hazards typical of Armenia and the vulnerability of territories, we notice that the socio-economic development strategies, plans and programs of the regions almost lack quantitative assessments of the risks inherent in the area, calculations of the financial resources required to eliminate or mitigate them, it means that documents lack the disaster risk management component. For example, in some regions of Armenia in 2017-2025 the SWOT analysis of regional development strategies lists various risks as weaknesses, but does not include disaster risk mitigation mechanisms or the necessary financial and economic costs to be incurred in the event of the potential impact[3].

Literature review. Disaster risk assessment studies in Armenia are quite comprehensive and in the framework of various studies, reference is made to the risk assessments of almost all the most typical hazards of the Republic of Armenia. In particular, there are reports and researches of the RA Ministry of Emergency Situations, the State Academy of Crisis Management, the National Platform for Disaster Risk Reduction (ARNAP), the UNDP Armenia Office, the Asian World Bank. The training manual "Disaster Risk Management at the Local Level"[4] jointly developed by the Ministry of Emergency Situations of the Republic of Armenia and UNDP presents the components of Climate risk assessment and management mechanisms, also referred to the assessment of other factors related to Climate risk: ecosystems, garbage collection, environmental elements and other components. As a logical continuation of the study, UNDP assessed the

[1] Decision No. 281 of the Government of the Republic of Armenia on approving the National Disaster Risk Reduction Strategy of the Republic of Armenia գործող Action Plan for the Implementation of the National Disaster Risk Reduction Strategy, March 7, 2012. https://www.arlis.am/DocumentView.aspx?DocID=74651

[2] Asian Development Bank, Country Partnership Strategy: Armenia, 2014-2018. https://www.adb.org/sites/default/files/linked-documents/cps-arm-2014-2018-sd-02-hy.pdf

[3] See socio-economic development strategies of the RA regions., http://mtad.am/hy/marzerirazmavarutyun
See MES, UNDP, Disaster Risk Management at the Local Level, Training Manual, Yerevan 2009. http://library.cmsa.am/hy/items/view/322

[4] Ibid.

risks at the local level. The "Risk Management at the Local Level"[5] practical manual already clearly defines the structure of all components of local Disaster risk management: hazards, vulnerabilities and capacity assessment mechanisms. Later ARNAP used this methodology in the process of developing community risk reduction plans[6]. The report of the UNDP Armenia office on "Disaster Risk Assessment and Management Situation in Armenia" presents the state of disaster risk reduction rocesses in Armenia, existing risk assessment methodologies, capacity assessmpents of the country-specific hazard descriptions studied the activities of organizations and actors involved in the disaster risk assessment (RIS) process, the existence of strategies and programs to reduce risks[7]. The reports of the "Risk Management Program at the Local Level in Ararat Region" project show that Disaster risk assessment and management processes have been implemented in Armenia since 2009. This report presents the natural hazard identification and assessment, vulnerability and capacity assessment of the natural hazards inherent in the Ararat region, the training and awareness-raising processes for the population in response to emergencies, and the implementation of small-scale disaster prevention measures. The study notes that capacity-Vulnerability assessment processes are closely linked to socio-economic issues[8]. Of particular importance is the fact that disaster risk assessments have been carried out in urban communities, in particular, "Disaster Risk Reduction in Urban Communities" published by the Armenian Red Cross Society, study presents the mapping of hazards, vulnerabilities and capacity of hazards in urban areas of Armenia. "The Armenian Red Cross Society's Disaster Risk Reduction in Urban Communities" study provides a map of risk, vulnerability and capacity mapping in urban areas of Armenia[9].

It can be mentioned that in 2009-2020 disasterr research conducted in Armenia during the past year has laid a solid foundation for disaster risk assessment and management processes. However, as for the links between these surveys and the socio-economic development of the country, we can say that in most surveys there is no clear quantitative assessment of risks. This fact makes it difficult or almost impossible to include the existing Disaster risk assessments in community and regional development programs and plans. Therefore, this study refers to the introduction of quantitative risk assessment methodology, and as a result, special scores have been developed, which will allow to quantify the risk, calculate the financial and economic impact of the risks on the community or region.

[5] See UNDP, Local Risk Management, Practical Manual, Yerevan 2012. http://library.cmsa.am/hy/items/view/321

[6] See ARNAP, settlements studied by RMLL methodology. https://www.arnap.am/?page_id=4203

[7] See UNDP Armenia, Disaster Risk Assessment and Management Situation in Armenia, Report, Yerevan 2010. http://library.cmsa.am/hy/items/view/320

[8] See also here, p. 12.

[9] Armenian Red Cross Society, Disaster Risk Reduction in Urban Communities, Survey, Yerevan, 2014. http://library.cmsa.am/hy/items/view/323

Research methodology. This part of the study is based on international standards and best practice, in particular the International Committee of the Red Cross and Disaster Risk Management (DRR) methodology, which includes[10]:

- Assessment of Hazards
- Assessment of Vulnerability
- Assessment of Capacity

Within the framework of the research, primary-secondary data on hazards, vulnerabilities and capabilities were collected, research and analysis, individual expert survey, survey of community leaders within the framework of questionnaires. The hazard analysis was carried out in two directions: the analysis of the actual registered emergencies and cases, and the risk analysis of hazards historically typical of the same areas, the incident information. Primary data on disaster risk management (hazard, vulnerability, capacity) were analyzed based on surveys, expert opinions, and responses to community leader questionnaires. Secondary data on registered emergencies were received from the Ministry of Emergency Situations of the Republic of Armenia, as there was no open access to such data. Based on the letter, the Ministry provided the emergency situations registered in all the communities of the Republic of Armenia during the last 4 years (2017-2020), which caused financial and economic damage, except for the city of Yerevan. For the analysis, the data of the RA Statistical Committee, the RA Real Estate Cadastre Committee, the RA National Platform for Disaster Risk Reduction were studied, as well as community passports, strategies and other official publications, including World Bank and Asian Bank reports on disaster risk management. International experience has been studied in order to obtain the risk index, various ratios calculated. The numbers are based on decades of statistics. The calculation of the disaster risk assessment model of Armenia is based on the data of the current 4 years. To get a model they used a five degree risk matrix. The matrix is based on the amount of direct financial and economic damage caused by emergencies (disasters) in all regions of the Republic of Armenia, expressed in AMD. The amount of financial and economic damage was determined by the maximum loss of cases recorded in all years. The risk level scale contains 0-5 degrees. Moreover, 0 is the complete absence of a state of emergency, a catastrophe due to the given danger in the given region, and 5 is its maximum manifestation. 5 is the region with the greatest damage, 1 is the least. Classification 1-5 was performed by the method of data normalization bringing the required range. The authors used Minimax normalization method for the calculation. The following formula was used $X'=a+(X-Xmin)/(Xmax-Xmin)*(b-a)$ - Tte more damage, the more class, and the less damage, the less class. The highest observed damage is class 5, the least observed damage for each disaster is class 1[11].

The normalization formula outputs ranges, that is, a range of damage sizes [a, b] that corresponds to, say, class 2, and thus is calculated for all hazards. That is, as a result of the above operation, we have such a table for each hazard.

[10] UN & ICRC, Hazard, Vulnerability and Capacity Assessment. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2016/06/3-HVCA-Manual-in-English.pdf

[11] Data normalization. https://wiki.loginom.ru/articles/data-normalization.htm

Range 1 [a1:a2]	class 1
Range 1 [a2+1AMD:a3]	class 2
Range 1 [a3+1 AMD:a4]	class 3
Range 1 [a4+1 AMD:a5]	class 4
Range 1 [a5+1դ AMD:a6]	class 5

The calculation was performed as follows: The financial and economic size of the emergencies and hazards caused by the disasters in each region was separated into monetary units and compared to the population living in the given region[12].

Analysis. The aim of the study is to develop indicators for the regions of Armenia, which will show the degree of economic damage from natural disasters. In order to determine the financial and economic damage caused by the emergency situations registered in different communities of Armenia, the matrix with the mentioned 5-grade classification was first compiled (Table 1).

Table 1

The amount of damage caused by recorded emergencies in 2017-2020 (thousand AMD)[13]

	Aragatsotn	*Ararat*	*Armavir*	*Geghar-kunik*	*Lori*	*Kotayk*	*Shirak*	*Syunik*	*Vayots Dzor*	*Tavush*
Strong wind		42414	13921	53905	17102	32274.0	215410	7500	2496	
Lightning					5730	5863				
Hail	2393465	42648		855726	12200	163372	3350426	60726	183120	384065
Heavy rain				2850	720	400		59331	90	
Landslide								2500	3004	
Mudslides							144951			
Heavy snow				1194		436				
Frostbite	222126	178013		2500			237501	93060	347256	
Drought	108942									
flood			6914			504				
Rockfall				640	650				625	
Damage caused by biogenic pests and wildlife				5600	15523					
Flow								60000		
Fire				2800	4730	2559		209500		8499

In order to compile the analysis matrix, the following 14 emergencies were identified, due to the maximum financial and economic damage (Table 2).

[12] Population, Demographic Handbook of Armenia (2020), armstat.am/file/article/nasel_01.01.2020.pdf

[13] The table was compiled by the authors based on the data of the letter N 02 / 11.1.2 / 3851-2021 provided by the RA Ministry of Emergency Situations.

Table 2

Dangers of emergencies classification by nature[14]

Natural hazards	*Human-made hazards*	*Socio-biological hazards*
Strong wind	Fire	Damage caused by biogenic pests and wildlife
Lightning		
Hail		
Heavy rain		
Landslide		
Flow		
Mudslides		
Heavy snow		
Frostbite		
Drought		
flood		
Rockfall		

Then the regions were classified according to the degree of risk depending on the extent of the damage (Table 3)[15].

Table 3

Regional disaster risk classification[16]

Emergency, - type of disaster	*Aragatsotn*	*Ararat*	*Armavir*	*Geghar-kunik*	*Lori*	*Kotayk*	*Shirak*	*Syunik*	*Vayots Dzor*	*Tavush*
Strong wind	0	2	1	2	1	2	5	1	1	0
Lightning	0	0	0	0	1	1	0	0	0	0
Hail	4	1	0	2	1	1	5	1	1	1
Heavy rain	0	0	0	1	1	1	0	2	1	0
Landslide	0	0	0	0	0	0	0	1	1	0
Mudslides	0	0	0	0	0	0	1	0	0	0
Heavy snow	0	0	0	1	0	1	0	0	0	0
Frostbite	4	3	0	1	0	0	4	2	5	0
Drought	1	0	0	0	0	0	0	0	0	0
flood	0	0	1	0	0	1	0	0	0	0
Rockfall	0	0	0	1	1	0	0	0	1	0
Damage caused by biogenic pests and wildlife	0	0	0	1	1	0	0	0	0	0
Flow	0	0	0	0	0	0	0	1	0	0
Fire	0	0	0	1	1	1	0	3	0	1

Based on Table 3, the hazard ratio was calculated, which assumes the amount of damage per capita in the Region. The results are presented in Table 4.

[14] The table was compiled by the authors according to the RA Statistical Committee by Emergency Situations Classification Methodology.

[15] https://wiki.loginom.ru/articles/data-normalization.html

[16] The table was compiled by the authors based on the data of the letter N 02 / 11.1.2 / 3851-2021 provided by the RA Ministry of Emergency Situations.

Table 4

Amount of Damage caused by disaster for per capita in the regions of the Republic of Armenia in 2017-2020 (AMD)[17]

RA region	*Amount of damage per capita (AMD)*	*Position*
Aragatsotn	21849	1
Shirak	17063	2
Vayots Dzor	11064	3
Gegharkunik	4063	4
Syunik	3588	5
Tavush	3231	6
Ararat	1025	7
Kotayk	819	8
Lori	266	9
Armavir	79	10

The classification of the results according to the degree of decrease has revealed that Aragatsotn region is the highest with that index, followed by Shirak, Vayots Dzor and other regions. The population of the mentioned regions bears the heaviest monetary burden of the damage caused by disasters and emergencies, for example, in Aragatsotn region the amount of damage suffered by one inhabitant per year is 21,849 drams in monetary terms.

Now we will find out how the amount of damage per person (AMD) will change if the risk level of each hazard in all regions increases by 1 class (Table 5).

The purpose of the calculation is that if the necessary steps are not taken in time to reduce the risk, the risk as a rule starts to increase over time. It is due to a number of subjective and objective reasons. For example, if there is a landslide area in the community, that area is a sown area, that is, it is irrigated, it is fertilized, etc. then sooner or later the risk of slipping on that slope will start to increase. The magnitude of the damage caused by the landslide will exceed the amount of resources spent on mitigation measures.

Table 5

Table of 1 degree of risk increase[18]

RA region	*Damage per capita (AMD)*	*Position*
Aragatsotn	35,771	1
Vayots Dzor	33,941	2
Shirak	18,466	3
Tavush	10,97	4
Syunik	9,231	5
Gegharkunik	6,819	6
Ararat	6,025	7
Kotayk	5,966	8
Lori	4,974	9
Armavir	3,423	10

As can be seen from Table 5, in the case of such a scenario, the loss / region ratio will increase significantly in all regions. In addition, Vayots Dzor (+1 position) and Tavush (+2 position) become significantly riskier. The reason for such a result is the hail damage in both regions. It turns out that if the risk class

[17] Ibid.

[18] The table was compiled by the authors as a result of relevant calculations.

for hail, which is typical for both regions, increases by 1: 1-> 2, then the amount of damage in those regions will increase by 2-2.5 times, therefore 2-2.5 times more means will be needed for compensation.

The essence of disaster risk management is to reduce those risks, so we have calculated the risk reduction index as the most important indicator to justify future investments in this area, as global experience has shown that prevention costs are much more effective and less than the cost of disaster relief (Table 6).

According to the table, we can mention that the effectiveness of risk reduction actions is high. As a result, the amount of danger in Armavir, Lori and Tavush regions will be 0, it means it will disappear. It is obvious that a significant positive trend will be observed in other regions as well. To highlight what has been mentioned above, let us consider the rate of increase and decrease of risk in the regions of Armenia.

Table 6

1 Degree Risk Reduction Table[19]

RA region	*Damage per capita (AMD)*
Aragatsotn	2,662
Ararat	392
Armavir	-
Gegharkunik	942
Lori	-
Kotayk	58
Shirak	2,506
Syunik	991
Vayots Dzor	5,320
Tavush	-

Table 7

Rate of risk reduction by 1 degree of decrease and increase[20]

RA region	*The pace of risk reduction by 1 degree*	*The pace of risk increase by 1 degree*
Aragatsotn	-88%	64%
Ararat	-62%	488%
Armavir	-100%	4233%
Gegharkunik	-77%	68%
Lori	-100%	1770%
Kotayk	-93%	628%
Shirak	-85%	8%
Syunik	-72%	157%
Vayots Dzor	-52%	207%
Tavush	-100%	240%

According to Table 7, if the risk is reduced by 1 degree, the amount of damage caused by the risk in Kotayk, Aragatsotn and Shirak regions will resume. In Ararat and Vayots Dzor regions it will be reduced by about half. In Gegharkunik and Syunik regions it will decrease distinctly. Cause of increasing the risk by 1 degree, the damage in Ararat, Armavir, Lori, Kotayk, Tavush, Vayots Dzor regions will not double but increase several times. It will have the least

[19] The table was compiled by the authors as a result of relevant calculations.
[20] Ibid.

impact on the Shirak region, where the risk of damage will increase by only 8% percent. The next step is to calculate the disaster risk inclination index, which aims to identify which region is most at risk for disaster or emergency. The index was also calculated so that we could compare the RA regions of according to the risk of disasters. The effectiveness of the disaster risk ratio is that the results obtained will allow when planning investment programs in the regions to determine in advance in which region it is expedient to implement it, where the risks are minimal. In addition, the results will help to understand to what extent, in principle, the budget allocations, in particular the risk mitigation funds, should be allocated. The regions according to the degree of disaster inclination, risk class, the weighted risk classes are presented below in Table 8.

Table 8

Regions according to disaster inclination level, risk class, weighted risk classes[21]

RA region	*Degree of disaster prone*	*Risk class*	*Weighted risk class*
Aragatsotn	0.21	3	0.64
Ararat	0.21	2	0.43
Armavir	0.14	1	0.14
Gegharkunik	0.57	1	0.57
Lori	0.50	1	0.50
Kotayk	0.50	1	0.50
Shirak	0.29	4	1.14
Syunik	0.50	2	1.00
Vayots Dzor	0.43	2	0.86
Tavush	0.14	1	0.14

The calculation of the index was carried out as follows: According to Table 1, financial losses were recorded in only 14 of the disasters; in Table 8, the degree of disaster inclination was calculated by comparing the number of disasters in the region to 14. The risk class has been calculated according to the average of the disaster classes. Combining these two indicators, the weighted risk class was calculated. It is a comprehensive indicator, which includes risk orientation of the region also risk class.

Conclusions. All the regions of the Republic of Armenia, without exception, have suffered direct financial and economic losses from various disasters. The most affected region is the region which is characterized by the diversity of disasters, such as Gegharkunik region. The regions not prone to various disasters are Armavir and Tavush. On average, Shirak region has the highest risk class, which is also the leader in the weighted risk class. Thus, changes in the risk class make a significant difference to the financial and economic consequences of the disaster. In particular, if the risk class is declining, the financial investments made to reduce it are more profitable and less than the financial resources required to eliminate the consequences, when we take into account the extent of the damage if not restrain it. By the way, if we look at the issue in terms of perspective planning, the costs of risk reduction are to some extent one-off, long-term costs, that is, a specific investment, and the elimination of consequences implies multiple costs over a period of time. For example, if the installation of anti-hail in the field solves the problem in local time, and in case

[21] The table was compiled by the authors as a result of relevant calculations.

the anti-hail station is not installed, the compensation for the damage will be considered as elimination after the hail. Due to the seasonality of the hail, it will be repeated often, so the cost of reimbursement in each season will exceed the cost of installing an anti-hail station. Disaster risk management models allow for significant changes in the socio-economic assessment processes of the regions, it is possible to assess to some extent the impact of potential hazards. It becomes possible to quantify the impact of potential threats, to include in the regional development plans specific concrete disaster prevention measures, to make justified investments. The resulting disaster risk reduction ratios provide an opportunity to justify the effectiveness of disaster risk reduction investments and justified costs.

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ՎԱՀԵ ԲՈՒԼԱՆԻԿՅԱՆ
Հայաստանի պետական տնտեսագիտական համալսարանի «Ամբերդ» հետազոտական կենտրոնի ավագ հետազոտող, տնտեսագիտության թեկնածու, դոցենտ

ԱՆԻ ՏԵՐՏԵՐՅԱՆ
Հայաստանի պետական տնտեսագիտական համալսարանի ֆիզդաստիարակության, արտակարգ իրավիճակների և քաղպաշտպանության ամբիոնի ասիստենտ, կառավարման ամբիոնի հայցորդ

ԴԻԱՆԱ ՄԱԹԵՎՈՍՅԱՆ
Հայաստանի պետական տնտեսագիտական համալսարանի միջազգային տնտեսական հարաբերությունների ամբիոնի ասպիրանտ

ԼԱԼԱ ԽՈՋՅԱՆ
Հայաստանի պետական տնտեսագիտական համալսարանի կառավարման ամբիոնի ասպիրանտ

ՀՀ մարզերի վտանգների և ռիսկերի ինտեգրալային համաթվի մշակումը սոցիալ-տնտեսական զարգացման համատեքստում.– ՀՀ մարզերի սոցիալ-տնտեսական զարգացման հնարավորությունները գնահատելիս առանձնակի կարևորություն է ստանում տվյալ մարզին և համայնքներին բնորոշ վտանգների, խոցելի տարրերի ու կարողությունների գնահատումը: Ուսումնասիրելով Հայաստանին բնորոշ վտանգների և տարածքների խոցելիության միջև առկա կապերը՝ նկատում ենք, որ մարզերի սոցիալ-տնտեսական զարգացման ռազմավարություններում, պլաններում և ծրագրերում գրեթե բացակայում են տվյալ տարածքին բնորոշ վտանգների վերաբերյալ քանակական գնահատումները, դրանց վերացման կամ մեղմացման ուղղությամբ պահանջվող ֆինանսական միջոցների հաշվարկները, այսինքն՝ բացակայում է աղետների ռիսկերի կառավարման բաղադրիչը:

Սույն հոդվածի շրջանակում մշակել ենք վտանգների քանակական գնահատման համաթվեր, որոնք կարող են հիմք հանդիսանալ վտանգների քանակական գնահատման, այնուհետև նաև ռիսկերի կառավարման ներդրումները հիմնավորելու կամ հնարավոր աղետներից ֆինանսատնտեսական վնասը հաշվարկելու համար:

Հիմնաբառեր. *վտանգ, ռիսկ, խոցելիություն, կարողություն, աղետների ռիսկերի կառավարում, վտանգի համաթիվ*
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Оценка интегральных индексов опасностей и рисков в марзах (областях) РА в контексте социально-экономического развития.– При оценке возможностей социально-экономического развития марзов (областей) Республики Армения особое значение приобретает оценка опасностей, уязвимых элементов и возможностей, характерных для данного марза. В процессе изучения существующих связей между типичными для Армении опасностями и уязвимостью территорий было выявлено, что в стратегиях, планах и программах социально-экономического развития регионов практически отсутствуют количественные оценки рисков, присущих территории, расчет финансовых ресурсов, необходимых для их устранения или смягчения, т.е. отсутствует компонент управления рисками стихийных бедствий.

В рамках данной статьи нами разработаны специальные количественные индексы и шкалы оценки рисков, которые могут служить основой для количественной оценки рисков, а затем и для обоснования инвестиций в управлении рисками или для расчета финансового и экономического ущерба от возможных бедствий.

Ключевые слова: *опасность, риск, уязвимость, потенциал, управление рисками стихийных бедствий, индекс риска*
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