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Analysis of Socio-Economic Losses in Emergency Situations

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Abstract: This study proposes a new assessment methodology based on an integrated and modular approach, developed through the analysis of the advantages and shortcomings of existing methods for evaluating socio-economic losses in emergency situations. The proposed methodology allows for real-time data processing and adaptation to various types of emergencies.

Keywords: emergencies, economic losses, social damage, total damage, loss assessment, methodology, modular approach, time factors, real-time evaluation, recovery level.

Introduction: Emergency situations (ES) are unexpected events arising from natural processes and human activities that pose significant threats to the population, the economy, and the natural environment. Such situations negatively affect not only human life, but also economic sectors such as manufacturing, logistics, services, and infrastructure systems. Therefore, accurate and systematic assessment of the socio-economic losses caused by such events, as well as the development of measures to prevent and mitigate their consequences, is of paramount importance.

In recent decades, the acceleration of globalization and industrialization processes, ineffective resource management, and disruption of ecosystem balance have led to an increasing number of emergency situations. As a result, significant socio-economic losses have been observed across various social systems.

Due to the wide scope of emergency situations, the absence of an optimal methodology and insufficient practical mechanisms to assess their consequences remain among the major challenges. Currently, losses are often evaluated using approximate approaches, which leads to uncertainties in decision-making. From this perspective, the topic holds substantial scientific and practical importance.

Researchers and scientific works on the topic. A number of international and national scholars have conducted research in this field. In particular: Ulrich Beck, Burton, Kates & White, Howard Kunreuther, Islomov Sh.Sh., Mamarasulov A.H., Jurayev A.B., Karimov A.A., J. Smirnov, A. Ivanov, X. Abdullayev and others have contributed significantly. Their studies mainly focus on economic modelling and optimization of resource allocation in emergency management. However, scientific research dedicated specifically to identifying and analyzing socio-economic losses caused by emergency situations remains limited and insufficiently developed.

The objective of this research is to improve traditional methods of assessing socio-economic losses caused by emergency situations through their integration with modern methodological approaches.

Based on the research objective, the following tasks have been defined:

1. To study existing methods of assessing the consequences of emergency situations and analyze their advantages and disadvantages.

2. To introduce forecasting mechanisms based on mathematical modelling.

3. To develop proposals for practical implementation of the improved methodology.

Research methods. This study employs various scientific and practical approaches, including economic modelling, risk analysis, SWOT analysis, scenario-based assessment, GIS (Geographic Information Systems), and benchmarking. Several of these methods have been modified for improvement within the scope of the research.

Analysis and results. When emergency situations (natural, technological, or environmental) occur, they lead to different types of losses across various sectors. These losses may be classified as economic (financial, material), social (population, health, quality of life), and non-material (psychological, cultural, etc.).

The purpose of assessing and analyzing socio-economic losses in emergency situations is to determine the scale of damages, calculate restoration costs, properly allocate financing and insurance resources, and support decisions aimed at preventing and reducing future risks.

Stages of assessment

1. Data collection — gathering information about the affected area, population, infrastructures, and resources.

2. Classification of losses — dividing losses into economic, social, environmental, logistics, and other categories.

3. Determining the amount of damage — evaluating each type of loss (in monetary value or its impact on health and social life).

4. Preparation of reports and decision-making.

Economic damage refers to material and financial losses resulting from disruptions or complete cessation of economic resources, assets, and production processes due to emergency situations, including contamination by chemical, radiological, biological, or bacteriological substances.

Social damage encompasses harm to the population's life, health, social stability, and quality of life caused by emergency situations.

Integrated methodology for assessing socio-economic damage. Although various methods are used to assess socio-economic losses during emergencies, each has its strengths and limitations. From this standpoint, an integrated methodological approach combining economic and social damage assessment is examined. This methodology is practical for real-world analysis and enables comprehensive evaluation.

Purpose of the integrated assessment methodology. To jointly assess economic and social damage during emergency situations and provide an objective basis for decision-making.

Core principles of the methodology.

1. Economic and social damages are calculated separately and then integrated.

2. Each type of damage influences the overall assessment through specific coefficients.

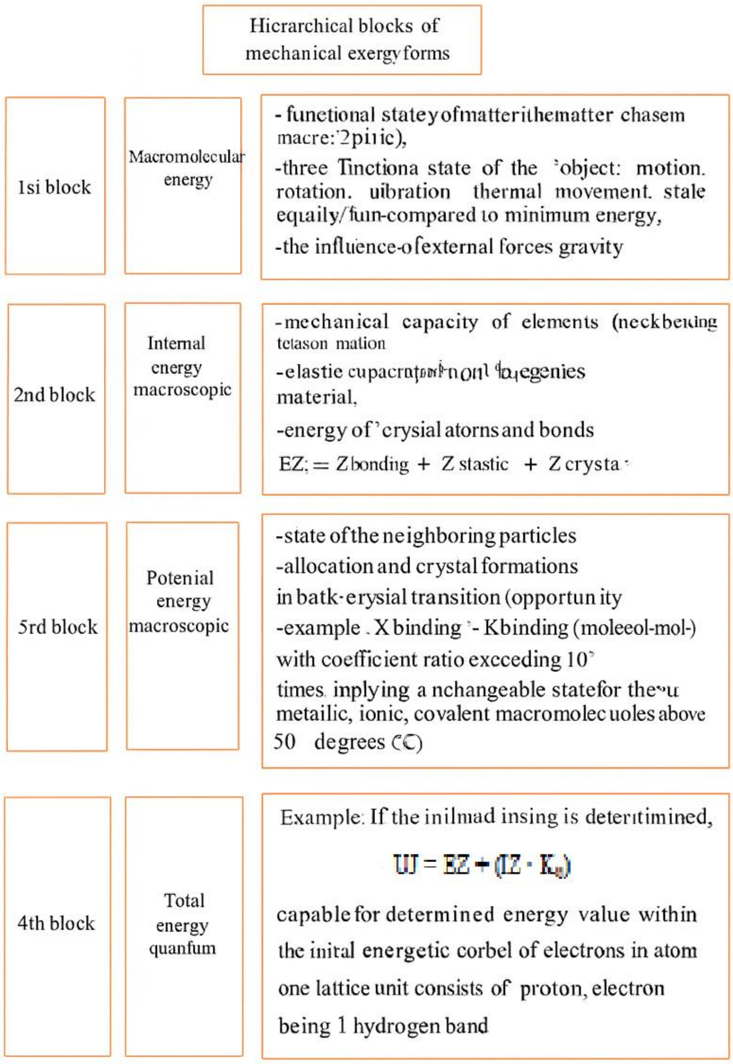
3. Quantitative and qualitative indicators are considered jointly.

4. The results provide balanced information for decision-making.

The methodology consists of the following stages:

Интеграциялаштан баҳолаш методикаси методикаси босқичлари

1-босқич	Маълумотларни йиғиш	-фавкулодда вазият юз берган худуд ҳақидаги маълумотлар; -зарар кўрган иқтисодий объектлар, аҳоли, инфратузилма; -жароҳатланган, ҳалок бўлган, кўчирилганлар сони; -ишлаб чиқариш тўхтаган вақт, қайта тиклаш харажатлари.
2-босқич	Иқтисодий зарарни ҳисоблаш	-моддий активлар йўқотилиши (бунга бинолар, ускуналар, маҳсулотлар киради); -ишлаб чиқаришдаги узилишлар; -қайта тиклаш ва таъмирлаш харажатлари; -давлат ва хусусий секторнинг зарарлари; Формула: $EZ = Z_{moddiy} + Z_{ishlab} + Z_{tiklash} + Z_{tiklanmchi}$
3-босқич	Ижтимоий зарарни ҳисоблаш	-ижтимоий зарар таркиби: -ҳалок бўлганлар ва жароҳатланганлар сони; -соғлиққа етган зарар (муолижа харажатлари); -эвакуация, ижтимоий инфратузилманинг ишламаслиги; -ишсизлик, таълим ва тиббиёт тизимидаги узилишлар; $iz = (n_{halok} \cdot k_1) + (n_{jarohat} \cdot k_2) + (n_{kochgan} \cdot k_3) + (z_{sogliq} + z_{ishsizlik})$ бунда, k_1, k_2, k_3 — аҳамият коэффициентлари (масалан, ҳалок бўлганлар учун 100, жароҳатланганлар учун 50 каби), n — сони, z — пул қийматидаги зарар.
4-босқич	Умумий комплекс йўқотишни ҳисоблаш	Ёки: Агар ижтимоий зарар пул қийматида эмас, нормалаштирилган шаклда бўлса: $UJ = EZ + (IZ \cdot K_{ij})$ бунда, K_{ij}—ижтимоий зарарни иқтисодий зарарга айлантириш коэффициенти (таҳлилчи ёки давлат органлари томонидан белгиланади; масалан, 1 ижтимоий балл = 500 000 сўм).



Example of application:

Assume that as a result of an explosion, two factories were completely burned down (resulting in 1.2 billion UZS in losses), production was halted for five days (causing 300 million UZS in economic losses), reconstruction costs amounted to 500 million UZS, six people were killed, twelve people were injured, 300 families were relocated, and damage to public health was estimated at 80 million UZS in socio-economic losses.

The task is to calculate the total economic damage.

Economic damage:

EZ = 1,2 bil + 0,3 bil + 0,5 bil = 2 bil sum

Social damage (based on coefficient):

IZ = (6 × 100) + (12 × 50) + (300 × 10) + (80 mil)

IZ = 600 + 600 + 3000 = 4200 (ball) + 80 mil sum

If 1 point is assumed to be equal to 500,000 UZS:

IZ = 4200 × 500 000 = 2,1 bil sum + 80 bil sum = 2,18 bil sum

Total loss: TL = 2 billion + 2.18 billion = 4.18 billion UZS

Although the integrated assessment model is well structured, it still has several shortcomings. In particular:

Based on the analysis of the existing integrated assessment model, the following limitations can be identified:

The previous model evaluated economic damage (ED) - destruction of buildings, equipment, production downtime, and recovery costs - and social damage (SD) - fatalities, injuries, displaced population, and health-related impacts. Afterwards, the total loss (TL) was calculated.

However, the coefficient K_{ij}, used in the model for combined evaluation, is determined subjectively.

Problem: Each region, country, or organization may calculate this coefficient differently. This results in non-universal assessments and, in some cases, may even serve political or financial interests. Consequently, the damage may be incorrectly evaluated.

Challenges in assessing social damage:

- Difficulties in monetizing social impacts such as psychological stress, lower living standards, and mental health deterioration.
- Time factor not considered - the duration of damage or recovery period is not included.
- No real-time applicability - the model is static.
- Lack of universality - the same assessment structure is applied to natural, technological, and biological hazards.
- Recovery process not included - the model does not calculate required recovery resources.

To eliminate these shortcomings of the previous model, the following improvements are proposed:

- Introduction of an objective scoring (point-based) system.
- Inclusion of damage duration and recovery probability.
- Development of separate modules for each type of emergency.
- Integration with automated real-time information systems.
- Inclusion of the recovery process in the assessment model.

1. Replacing coefficients with a standardized point-based system:

A unified scale is developed, assigning normative points and economic equivalence values for each social indicator.

Social indicator	Score	Equivalent (sum)
1 person killed	100	10 000 000 sum
If 1 person is seriously injured	50	5 000 000 sum
1 if the family is evacuated	10	1 000 000 sum
If the school closes in 1 day	5	500 000 sum

These scores are reviewed annually based on analysis and Social Security Prices.

1. The duration of the loss is taken into account and in what term it will recover.

For each loss we apply the loss = Z × T × R formulaThese scores are reviewed annually based on analysis and Social Security Prices.

2. The duration of the loss is taken into account and in what term it will recover.

For each loss we apply the loss = Z × T × R formula, where: Z is the amount of damage, T is the time factor (in days, weeks), R is the recovery rate coefficient (0 is total non-recovery, 1 is frequent recovery

For example: a loss of 100 million soums lasts 7 days, if the probability of recovery is 0.7: loss = 100 million × 7 × 0.7 = 490 million soums

3. Integration with Real-time automatic assessment system. The methodology is adapted in such a way that at the moment of an emergency, information from local authorities, the Ministry of emergency situations, hospitals, and other information systems is automatically collected and uploaded to the model.

4. Replacement of modules in the model depending on the type of emergency. The situations in aavkulad differ from each other. According to him, the model will have a modular approach.3. Integration with Real-time automatic assessment system. The methodology is adapted in such a way that at the moment of an emergency, information from local authorities, the Ministry of emergency situations, hospitals, and other information systems is automatically collected and uploaded to the model.

5. Replacement of modules in the model depending on the type of emergency. The situations in aavkulad differ from each other. According to him, the model will have a modular approach. Each module has its own damage indicators and coefficients.

6. Introduction of a complete recovery cost analysis for economic loss. Not only material damage, but all stages of the recovery cycle (project, construction, infrastructure restoration, labor resources, retraining) are taken into account.

Final improved formula (simplified)

$UJ = \sum EZi + IZj \sum [(IZ_j \cdot V_j \cdot T_j \cdot R_j)]$

in this: EZ_i-types of economic damage, IZ_j-type of social damage, V_j - its economic equivalent, T_j-duration, R_j – degree of recoveryin this: EZ_i-types of economic damage, IZ_j-type of social damage, V_j - its economic equivalent, Tj-duration, R_j – degree of recovery

Practical example 5 people were killed → 100 × 5 = 500 points = 50 mln, 10 people were injured → 50 × 10 = 500 points = 50 mln, 100 families were moved → 10 × 100 = 1000 points = 100 mln / this situation lasts 10 days, recovery coefficient: 0.6 trace = (50 + 50 + 100) mln × 10 × 0.6 = 1200 mln

If the economic loss is: 800 crore, the total loss is = 800 + 1200 = 2 crore. Through the improved integrated methodology presented in the study, it is possible to effectively organize post-emergency recovery strategies, funding pathways, insurance funds and social protection programs.

As a result of the data and threats obtained in the study, we can conclude the following.

In aavqulad situations, it causes great damage to the economic and social spheres. Creating a clear and quick assessment system for these losses increases our country's ability to effectively deal with emergencies.

Traditional methods have disadvantages in assessment, such as subjectivity, disregard for the time factor, and incomplete coverage of social harms. Therefore, to improve the models:

- implementation of objective scoring system;
- taking into account the duration of damage and the degree of recoveryIn aavqulad situations, it causes great damage to the economic and social spheres. Creating a clear and quick assessment system for these losses increases our country's ability to effectively deal with emergencies.

Traditional methods have disadvantages in assessment, such as subjectivity, disregard for the time factor, and incomplete coverage of social harms. Therefore, to improve the models:

- implementation of objective scoring system;
- taking into account the duration of damage and the degree of recovery;
- develop separate modules suitable for each type of emergency,
- it was necessary to introduce mechanisms for automatic reception and rapid analysis of information in real time. Therefore, in the study, the integrated approach methodology used in the assessment of economic-social damage in emergency situations was tacimilized and its advantages were proven. This approach makes it possible to more accurately assess economic-social losses and serves as an important basis for making the necessary decision for the country and the public.

Recommendations

1. Standardized assessment systems should be implemented for evaluating the socio-economic impacts of technogenic emergency situations.

2. Information systems should be improved and automated to ensure the timely and accurate collection of essential data.

3. When assessing social losses, the psychological impacts, healthcare-related consequences, and the influence on social networks must be considered, and their corresponding economic equivalents should be clearly identified.

4. Separate and adaptable methodologies must be developed for each type of emergency situation, taking into account their specific characteristics and dynamics.

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