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ESTIMATION OF EXPOSURE OF THE REPUBLIC OF MOLDOVA TERRITORY TO THE OCCURRENCE OF CERTAIN NATURAL RISKS

166.02 ENVIRONMENT PROTECTION AND RATIONAL USE OF NATURAL RESOURCES

Abstract of doctoral thesis in geonomical sciences

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Torrential rains, average and maximum intensity of torrential rains, torrential rain duration, precipitation amount, torrential rains frequency, quantitative-temporal gradation of torrential rains, pluvial floods, landslides, exposure degree, losses, impact, estimation, risk, hazard, Geographic Information Systems, digital maps.

PURPOSE AND OBJECTIVES OF RESEARCH

Actuality of the topic. The adjustment of some regional normative acts according to EU acts through a series of Directives on the correct management of Natural Risks is a condition for the realization of complex researches on the exposure of the Republic of Moldova territory to the occurrence of certain groups of natural risks, which have a major impact on the population and the national economy. The importance of the issue approached in our study lies in the negative effects of torrential rains during the warm semester of the year, floods triggered by them and landslides that occur in the background of the current climate change. Thus, the study was determined by the necessity to estimate the exposure of the Republic of Moldova territory to the occurrence of mentioned natural risks.

Purpose of the paper: estimation of the exposure of the Republic of Moldova territory to the occurrence of torrential rains, floods triggered by them, and landslides.

Research objectives:

- identification of natural phenomena as risk generating sources with frequent occurrence on the republic territory;
- elaboration of databases for the period of study;
- processing of statistical data describing the spatio-temporal occurrence of torrential rains, floods triggered by them and landslides;
- establishing the spatio-temporal variability of mentioned risks;
- calculation of the main torrential rains parameters in the warm semester of the year for the period of study, with their quantitative-temporal gradation (≥ 30, ≥ 50, ≥ 100 and ≥ 150 mm in 24 hours and less);
- estimation of exposure of the Republic of Moldova territory to the spatio-temporal occurrence of the mentioned risks;
- development of a set of digital maps based on GIS reflecting areas with different degrees of exposure towards mentioned risks;
- elaboration of measures to prevent, reduce and combat the negative effects of the mentioned risks in accordance with the degree of vulnerability of the republic territory in administrative-territorial aspect, reflected by the value of the losses incurred for each individual risk.

METHODOLOGY OF SCIENTIFIC RESEARCH

This study has been realized with modern means of work, using statistical methods and tests, as well as GIS techniques. The primary data describing the regime of torrential rainfall, floods triggered by them, and landslides, as well as the losses caused by them, used in the study,

were systematized, processed, graphically and cartographically rendered using statistical programs – Statgraphics, Instat Plus and ArcGis. The use of these methods and programs allowed us to estimate the exposure of the Republic of Moldova territory to the spatio-temporal occurrence of the mentioned risks and to develop a set of digital maps reflecting areas with different degree of territorial exposure in the administrative-territorial aspect of each risk, as well as towards the range of risks studied.

Scientific novelty of the achieved results derives from the actuality of the topic and for the first time it represents a complex study on estimation of the exposure of the Republic of Moldova territory to the risk of torrential rains in the warm semester of the year, the floods triggered by them and landslides in the administrative-territorial aspect of the 1985-2015 period.

As a result of the study we have established and developed:

- the main torrential rains parameters in the warm semester of the year for the 1997-2015 period;

- digital maps regarding the exposure degree of the republic to the average (**i**) and maximum (**I**) intensity of torrential rains (1997-2015);

- digital maps regarding torrential rains with quantitative thresholds ≥ 30 and ≥ 50 mm, as well as the complex map of numeric cases distribution with maximum diurnal precipitation with thresholds ≥ 30, ≥ 50, ≥ 100 and ≥ 150 mm, fallen during 24 hours and less (1997-2015);

- digital maps reflecting the exposure degree of the republic territory in the administrative-territorial aspect towards the risk of torrential rains in the warm semester of the year, the floods triggered by them and landslides, as well as the complex map of the exposure of the territory to the mentioned risks, with the specification of share of each individual risk (1997-2015);

- concrete measures to prevent, reduce and combat the negative effects of the risks mentioned in accordance with the exposure degree of the republic territory in the administrative-territorial aspect, shown by the value of the losses incurred for each risk.

Important scientific issue solved. The estimation of the exposure of the Republic of Moldova territory to the risk of torrential rains in the warm semester of the year, the floods triggered by them and landslides in the administrative-territorial aspect for the 1985-2015 period was made for the first time and concrete measures for preventing, reducing and combating negative effects of mentioned risks were established.

Theoretical significance. An estimation of the exposure of the Republic of Moldova territory to the risk of torrential rains in the warm semester of the year, the floods triggered by them and landslides in the administrative-territorial aspect was made for the first time, together

with the development of a set of digital maps based on GIS that reflect areas with different exposure degree of the republic territory to the mentioned risks.

Applicative value of the paper. Digital maps based on GIS that reflect areas with varying degrees of exposure to torrential rains, floods triggered by them and landslides, in the administrative-territorial aspect, can be used for the purposes of territory planning and efficient crisis management. The concrete measures for preventing, reducing and combating the negative effects of these risks, elaborated in accordance with the degree of exposure of the republic territory in the administrative-territorial aspect, shown by the value of the losses incurred for each risk, can be implemented in order to avoid losses of human lives and to reduce material losses.

Scientific results proposed for defence:

- main parameters of torrential rains in the warm semester of the year for the 1997-2015 period; digital maps on the exposure degree of the republic to the average (**i**) and maximum (**I**) intensity of torrential rains; quantitative-temporal gradation of torrential rains (≥ 30, ≥ 50, ≥100 and ≥ 150 mm fallen during 24 hours and less); digital maps on torrential rains frequency (≥ 30 and ≥ 50 mm), as well as the complex map of torrential rains frequency (≥ 30, ≥ 50, ≥ 100 and ≥ 150 mm) fallen during 24 hours and less; digital maps on the exposure degree of the republic territory, in the administrative-territorial aspect, to the risk of torrential rains, floods triggered by them and landslides, as well as the complex map of the exposure of the territory to the mentioned risks, with the specification of the share of each individual risk; concrete measures to prevent, mitigate and combat the negative effects of mentioned risks, determined in accordance with the exposure degree of the territory and expressed in terms of the value of losses incurred for each individual risk.

Implementation of scientific results. The scientific results obtained and the set of maps elaborated on the GIS basis, as well as the concrete measures to prevent, mitigate and combat the negative impacts of mentioned risks, are used in: elaboration of the landscaping and urbanization projects within the INCP „Urbanproiect", certified with Implementation Act of 2018; efficient crisis management by the General Inspectorate for Emergency Situations (GIES) in order to avoid loss of human lives and mitigate the material losses, certified with Implementation Act of 2018; teaching specialized courses in higher education institutions, certified with Implementation Act of 2018.

SUMMARY OF CHAPTERS

In **Introduction** the actuality and the importance of the approached issue are grounded; the purpose and objectives of the thesis are formulated, the scientific novelty of the obtained results, the theoretical importance and the applicative value of the research are described; implementation of results; publications within the research topic, structure and volume of the paper.

1. ANALYSIS OF RESEARCH STUDIES ON THE EXPOSURE OF THE REPUBLIC OF MOLDOVA TERRITORY TO THE OCCURRENCE OF CERTAIN NATURAL RISKS

In this section the necessity of complex estimation of the spatio-temporal exposure of the Republic of Moldova territory to the manifestation of natural risks, such as the torrential rains in the warm semester of the year, floods triggered by them and landslides for the 1985-2015 period is argued.

1.1. Terminology used in the study of hazards and natural risks at national and international levels

The terms that define different hazards and natural risks studied in the context of their acceptance and definition at international and national levels were selected, analyzed and exposed in the IDNDR Dictionary (1992) and the UNISDR terminology (2009) used in this study.

1.2. History of research studies on the exposure of the republic territory to the risk of torrential rains, floods triggered by them and landslides

A brief summary of the history of the current state of knowledge in the topic field chosen was carried out, based on detailed documentation, including the definition of fundamental concepts, the critical analysis of the national and international bibliographic sources. Scientific publications have also been analyzed, with particular attention being paid to recent scientific results in specialized literature on the exposure of the Republic of Moldova to the accurrence of natural risks: torrential rains, floods triggered by them and landslides [3, 4, 6, 7, 8, 9, 11, 12, 14, 18, 26, 27, 29, 30, 33].

As a result, it was found out that in the national specialized literature the natural risks mentioned are studied and analyzed more in terms of their genesis and less in terms of their impact on society and environment [2, 28, 31, 32, 34, 35, 36, 37].

2. INITIAL MATERIALS AND RESEARCH METHODS

2.1. Initial materials

The statistical databases collected from the archives of the State Hydrometeorological Service (SHS), Agency for Geology and Mineral Resources (AGMR), Agency for Land

Relations and Cadastre (ALRC), General Inspectorate for Emergency Situations (GIES) were used for conducting the proposed study:

- SHS – values of observations and meteorological measurements regarding the quantity and the spatio-temporal regime of the atmospheric precipitation at 13 meteorological stations (representatively located on the republic territory) for the 1985-2015 period, recordings of the pluviograms from 7 meteorological stations (representatively located on the republic territory) for the 1997-2015 period regarding the torrential rains in the warm semester of the year with a amount of 10 mm and more fallen within a short time, from a few minutes to a few hours, but no more than 24 hours;

- AGMR – the regime and occurrence of landslides for the 1985-2015 period;

- ALRC – the information on the evolution of the areas affected by landslides in administrative-territorial aspect for the 1985-2015 period;

- GIES – the value of material losses caused by torrential rains during the warm semester of the year, floods triggered by them and landslides in the administrative-territorial aspect recorded in the 1997-2015 period.

2.2. Research methods used

In this study, the methods and means used for the processing, analysis and interpretation of the main parameters of the torrential rains, floods triggered by them and landslides are argued. The statistical programs (Excel, Statgraphics, Instat Plus and ArcGis) used for the systematization, processing, graphic and cartographic interpretation of the primary databases used in the study were exposed and argued. The use of the interpolation method (IDW) has been argued and materialized in producing the spatio-temporal distribution maps of the parameters values of the main torrential rains, as well as the calculated losses caused by the risks studied.

3. ESTIMATION OF EXPOSURE OF THE REPUBLIC OF MOLDOVA TERRITORY TO THE OCCURRENCE OF CERTAIN NATURAL RISKS

3.1. Estimation of exposure of the republic territory to torrential rains in the warm semester of the year

3.1.1. Spatio-temporal variability of atmospheric precipitation in the warm semester of the year

Peculiarities of spatial variability of atmospheric precipitation: monthly maximums; absolute monthly; absolute maximums of the warm semester and annual absolute maximums were established based on our investigations for the 1985-2015 period and are reflected in tab. 3.1.

Thus, for the period of study the spatio-temporal variability of the maximum monthly absolute precipitation amounts on the republic territory in the warm semester is characterized by a distribution similar to the distribution of the maximum monthly amounts [19, 20].

Table 3.1

Maximum and absolute amounts (mm) of monthly, semestrial and annual precipitation

Statiile	Maximum monthly precipitation amounts in the warm semester							**Absol. monthly max.**	Record year	**Absol. max of warm sem.**	Record year	**Absol. annual max.**	Record year
	IV	**V**	**VI**	**VII**	**VIII**	**IX**	**X**						
Briceni	127	135	221	330	202	177	138	**330**	2003	703	2010	**960**	2010
Soroca	86	106	205	221	353	186	122	**353**	2004	582	1995	**850**	1996
Falesti	88	148	249	256	155	240	128	**256**	2002	614	1991	**777**	1996
Balti	81	120	246	197	126	173	102	**246**	1985	562	1991	**741**	1996
Cornesti	103	161	239	145	161	235	174	**239**	1985	562	1991	**922**	1996
Bravicea	77	143	300	164	165	200	160	**300**	1985	648	1985	**757**	1985
Chisinau	61	143	200	168	201	215	172	**215**	1996	555	1991	**734**	2010
Baltata	66	123	201	122	180	140	121	**201**	2001	547	1989	**650**	2001
Leova	77	231	168	202	195	231	145	**231**	1991	677	1990	**773**	1991
Comrat	84	142	164	253	135	169	85	**253**	2002	517	1997	**679**	2012
Ciadir-Lunga	72	177	164	131	129	166	75	**177**	1991	537	1997	**691**	1997
Cahul	70	207	160	203	148	288	89	**288**	2013	659	1997	**716**	1997
St. - Voda	87	148	152	207	121	140	91	**207**	2013	481	1997	**680**	2004

3.1.2. Main parameters of torrential rains in the warm semester of the year

Based on data from processed pluviograms from 7 meteorological stations for the 1997-2015 period (warm semester of the year), the main parameters of the torrential rains were determined – their intensity, duration, amount and frequency, according to which a number of 331 rains with the amount of 10 mm and more fallen in a limited time, but not more than 24 hours, were identified. Also, the average (**i**) and maximum (**I**) intensity of torrential rains in the warm semester of the year were calculated according to formulas:

$$i = \frac{P, mm}{T, \min} \qquad (3.1.2.1)$$

$$I = \frac{P\max., mm}{T, 10\min} \qquad (3.1.2.2).$$

It is extremely important to have knowledge on the intensity of torrential rains, because this parameter reflects the amount of pluvial spillages that triggers other associated natural hazards. On the basis of the average (**i**) and maximum (I) intensity data of torrential rains, digital maps were developed reflecting the regional peculiarities of torrential rains occurrence together with the exposure degree of the republic territory to the mentioned indices.

As a result of the analysis of the average intensity distribution map (**i**) of the torrential rains (fig. 3.1), there were revealed territories with a different risk exposure degree: low (**i** <0,20 mm/min); medium (**i** = 0,20 – 0,24 mm/min); high (**i** > 0,24) [25].

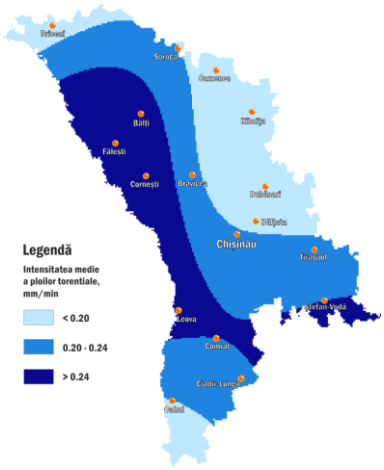

Fig. 3.1. Exposure of the Republic of Moldova territory to the risk of medium intensity (i) torrential rains (low, medium and high)

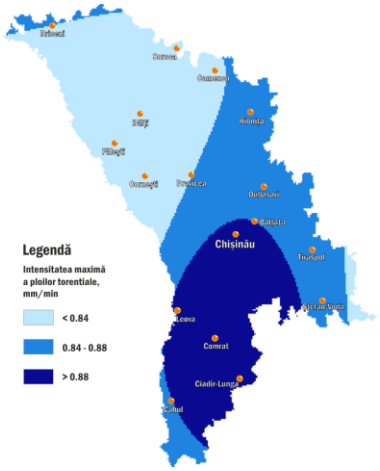

Fig. 3.2. Exposure of the Republic of Moldova territory to the risk of maximum intensity (i) torrential rains (low, medium and high)

As a result of the analysis of the maximum intensity distribution map (I) of the torrential rains (fig. 3.2), there were also revealed territories with different risk exposure degree: low (**I** <0,84 mm/min); medium (**I** = 0,84 – 0,88 mm/min); high (**I** >0,88 mm/min).

As a result of the analysis of torrential rains in the warm semester of the year at the 13 meteorological stations, their frequency with different quantitative gradation was determined in ≤ 24 hours (tab. 3.2, fig. 3.3, 3.4, 3.5).

Table 3.2

Frequency of torrential rains with maximum diurnal amounts exceeding thresholds of 30, 50, 100 and 150 mm in the warm semester of the year (1985-2015)

Thresholds	**Briceni**	**Soroca**	**Balti**	**Falesti**	**Cornesti**	**Bravicea**	**Chisinau**	**Baltata**	**Leova**	**Comrat**	**C-Lunga**	**Cahul**	**Stefan-Voda**	**Total cases**
≥ 30 mm	39	34	29	40	43	35	31	29	37	23	37	26	39	**442**
≥ 50 mm	16	9	11	13	15	13	10	10	9	6	10	14	10	**146**
≥ 100 mm	1	0	0	1	0	1	0	2	0	0	0	1	1	**7**
≥ 150 mm	0	1	0	0	0	0	0	0	2	0	0	0	0	**3**

The data in the tab. 3.2 reflects the presence of torrential rains with quantitative thresholds ≥ 30 mm and ≥ 50 mm at all analyzed meteorological stations and the number of cases for each station. Torrential rains with thresholds ≥ 100 and ≥ 150 have a major flood risk only at local level, because the number and area affected is insignificant.

Based on the data in tab. 3.2 digital maps were developed for the spatio-temporal distribution of torrential rains with the ≥ 30 mm and ≥ 50 mm thresholds, with the highest frequency and potential flood risk for the entire territory of the republic (Fig. 3.3, 3.4). Also, based on the data mentioned above, a complex map of the torrential rains frequency ditribution with thresholds ≥ 30, ≥ 50, ≥ 100 and ≥ 150 mm (fig. 3.5) was developed reflecting areas with different degrees of exposure to the mentioned risk.

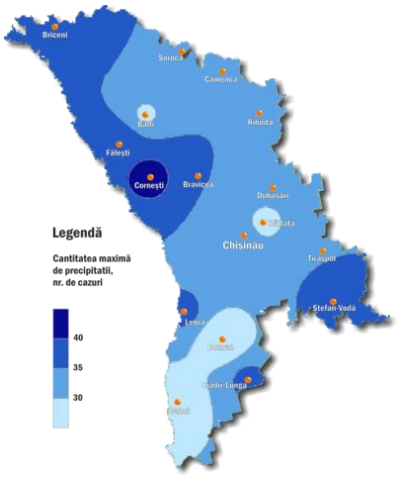

Fig. 3.3. Frequency of cases with a maximum diurnal precipitation of ≥ 30 mm

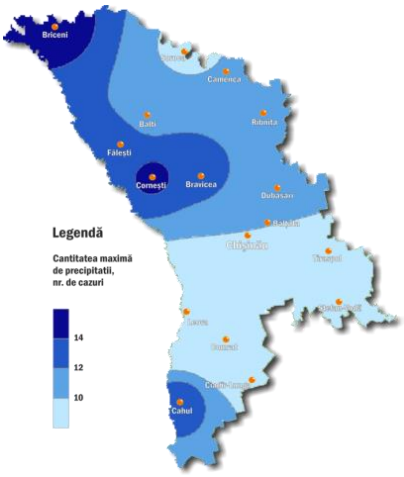

Fig. 3.4. Frequency of cases with a maximum diurnal precipitation of ≥ 50 mm

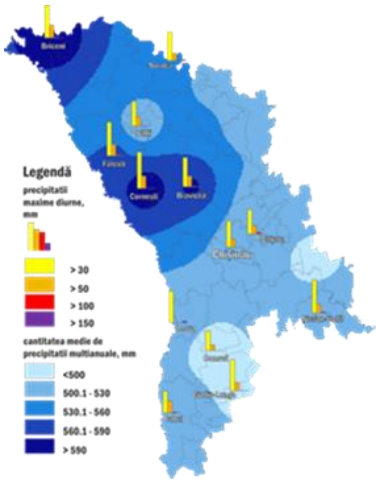

Fig. 3.5. Complex map of torrential rains frequency of ≥30, ≥ 50, ≥ 100 și ≥ 150 mm

3.1.3. Administrative territorial estimation of the losses caused by torrential rains in the warm semester of the year

In order to estimate the losses caused by torrential rains in the warm semester of the year in the administrative-territorial aspect, 730 torrential rains from the warm semester for the 1997-2015 period were recorded by GIES, the losses amounting 4.62 billion lei [24]. As a result of calculations made, the annual frequency of the analyzed rains with significant losses for the period of study varied from 8 to 122 cases on the Republic of Moldova territory (fig. 3.6).

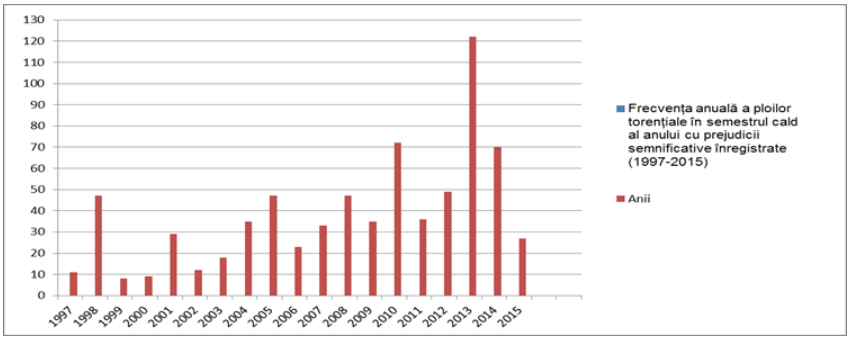

Fig. 3.6. Annual frequency of torrential rain in the warm semester of the year with significant losses recorded (1997-2015)

As a result of the analysis of the spatio-temporal variation of the value of losses caused by the torrential rains during the warm semester of the year for the 1997-2015 period, we can state

that the value of the losses varies significantly from one month to another, both at national level and apart for each administrative-territorial district, being determined by the variation of the main parameters of the torrential rains in the warm semester of the year [22].

The map exposed in fig. 3.7 reflects the degree of spatial exposure of the material losses value caused by the torrential rains in the warm semester of the year in the administrative-territorial aspect as follows:

- territories with high risk exposure degree (with losses over 500 mil. lei);
- territories with medium risk exposure degree (with losses between 100 and 500 mil. lei);
- territories with low risk exposure degree (with losses between 50 and 100 mil. lei);
- territories with very low risk exposure degree (with losses lower than 50 mil. lei).

Thus, the territories with a high risk exposure degree include ATU Gagauzia (1043,2 mil. lei) and Taraclia district (994,8 mil. lei).

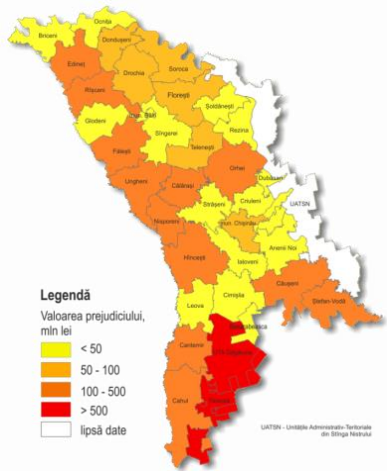

Fig. 3.7. Territory exposure to the risk of torrential rains in the warm semester of the year

Based on the analyzed data on the variation of torrential rainss in the warm semester of the year, including particular months, as well as the losses caused by them in the administrative-territorial aspect, we can state the following: the large number of torrential rains does not always cause maximum losses and vice versa, exceptional losses can be caused by a low number of torrential rainfall. Thus, the value of losses caused by torrential rains depends not only on the main parameters of these rains, but also on the influence of other physico-geographic factors [4].

3.2. Estimation of exposure of the republic territory to floods triggered by torrential rains in the warm semester of the year

3.2.1. Peculiarities of spatio-temporal occurrence of floods triggered by torrential rains in the warm semester of the year

In the Republic of Moldova the main factor contributing to the floods is the torrential rains in the warm semester of the year which create favorable conditions for triggering hydrological hazards such as severe floods, sometimes catastrophic ones occurring in the rivers of the republic, especially in the small ones [1, 5, 7, 10]. The large floods accompanied by losses of human lives and enormous material losses are explained by the fact that traditionally the majority of the localities of the republic are situated in close proximity of watercourses [13, 16, 17].

3.2.2. Administrative territorial estimation of flood losses triggered by torrential rains in the warm semester of the year

The severe and frequent floods in the warm semester of the year for the 1997-2015 period caused significant material losses to the national economy and the population of the country, amounting to 150,5 mil. lei. According to the factological data analyzed and reflected in fig. 3.8 we can state that in the mentioned period the annual frequency of these floods varied from 0 to 12 cases [21].

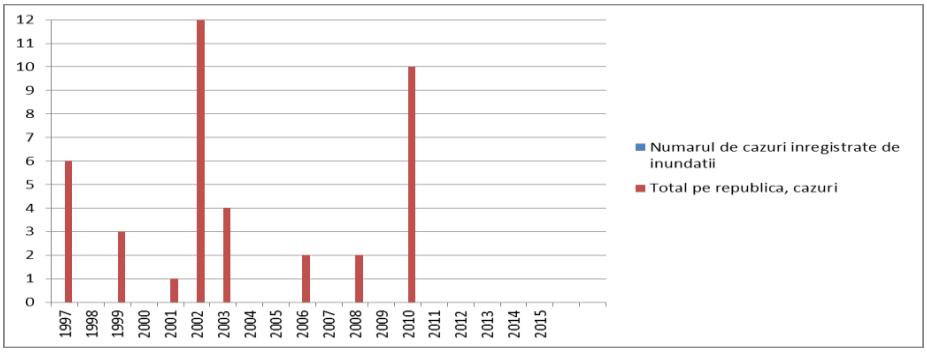

Fig. 3.8. The annual frequency of floods triggered by torrential rains in the warm semester of the year with significant losses recorded (1997-2015)

Based on the factual data processed and analyzed on the value of the losses caused by the 40 floods triggered by the torrential rains during the warm semester of the year in the 1997-2015 period, a map was developed reflecting the exposure degree of the republic territory in the administrative-territorial aspect to their risk (fig. 3.9):

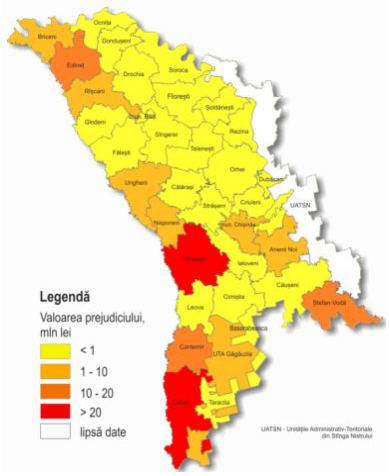

Fig. 3.9. Exposure of the republic territory to the risk of floods triggered by torrential rains

- territories with high risk exposure degree (with losses of over 20 mil. lei);
- territories with medium risk exposure degree (with losses between 10-20 mil. lei);
- territories with low risk exposure (with losses between 1-10 mil. lei);
- territories with very low risk exposure (with losses lower than 1 million lei).

3.3. Estimation of exposure of the republic territory to the occurrence of landslides

3.3.1. Peculiarities of spatio-temporal occurrence of landslides

As a result of the graphical and cartographic analysis and mapping of the materials collected from ALRC, areas affected by landslides in administrative-territorial aspect were

identified for 1985 and 2015 years, which are the first and the last year of the (1985-2015), reflecting the situation at the beginning of the study period and the current state (fig. 3.10).

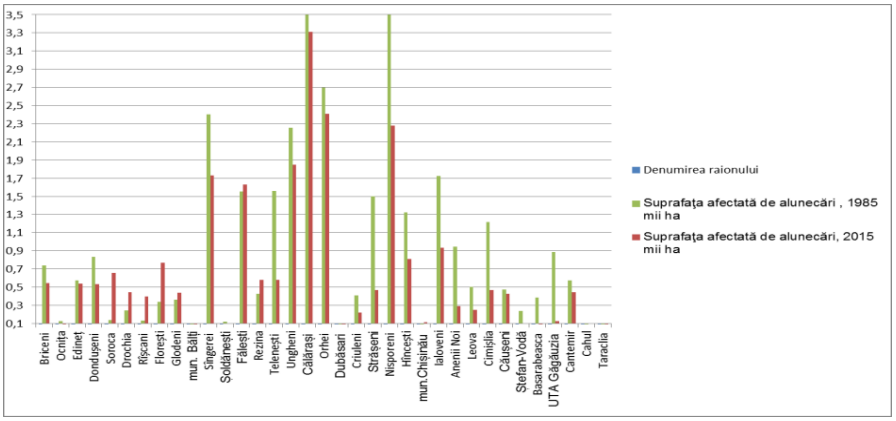

Fig. 3.10. Area affected by landslides for 1985 and 2015 years

According to the data of fig. 3.10 we can state that during the 1985-2015 period the area affected by landslides in the administrative-territorial aspect has broadly decreased. The reduction of the areas affected by landslides over the last 30 years is explained by several causes, mainly by the implementation of forestry ameliorative measures and technical fitting of lands.

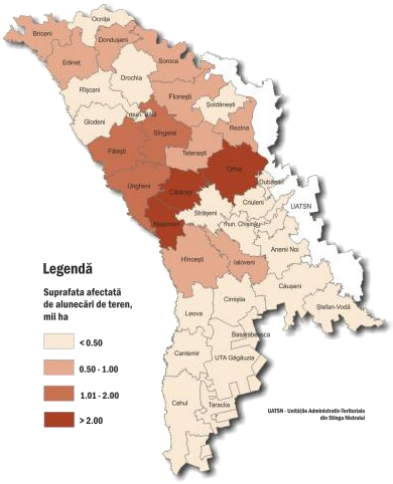

Fig. 3.11. Gradual distribution of areas affected by landslides in administrative-territorial aspect for 2015 year

Based on processed and analyzed factual data, a map was developed reflecting the gradual distribution of areas affected by landslides in administrative-territorial aspect for 2015 year (fig. 3.11):

- territories with high degree of landslides occurrence (over 2 thousand ha);
- territories with medium degree of landslides occurrence (1,01 – 2,0 thousand ha);
- territories with low degree of landslides occurrence (0,50 – 1,0 thousand ha);
- territories with very low landslides occurrence (less than 0,50 thousand ha).

3.3.2. Administrative territorial estimation of landslides losses

During the study period on the republic territory were recorded 71 cases of landslides with significant losses amounting to 66,2 mil. lei. The annual landslides frequency ranged from 0 to 28 cases.

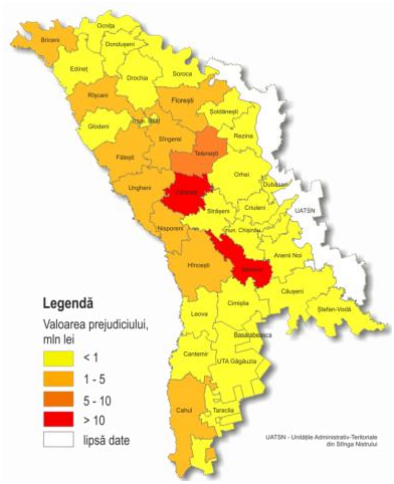

Fig. 3.12. Exposure of the Republic of Moldova territory to the risk of landslides

Based on processed and analyzed factual data, a map was developed (fig. 3.12) reflecting the exposure degree of the republic territory to the risk of landslides:

- territories with a *high degree* of risk exposure (with losses of over 10 mil. lei);
- territories with *medium degree* of risk exposure (with losses between 5-10 mil. lei);
- territories with *low degree* of risk exposure (with losses between 1-5 million lei);
- territories with *very low degree* of risk exposure (with losses lower than 1 mil. lei).

3.4. Complex estimation of exposure of the republic territory to occurrence of torrential rains, floods triggered by them and landslides

Based on the statistical data from the GIES archive on the value of the losses calculated for each category of risk (torrential rains, floods triggered by them and landslides), digital maps showing the exposure of the republic territory according to the share of the losses caused by each risk. Also, the complex map regarding the risk exposure of the country territory in administrative-territorial aspect (in percentages) was created, stating the exposure degree of each administrative-territorial unit (fig. 3.13).

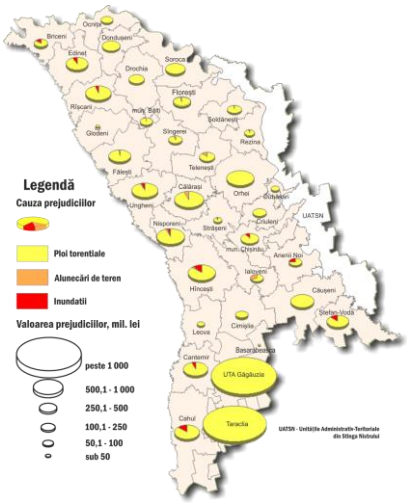

Fig. 3.13. Complex map of total lossess of the risks studied and the share of each risk

According to the information reflected on the complex map (fig. 3.13) regarding the exposure to studied risks of the republic territory in the administrative-territorial aspect, we can state the following: torrential rains affect practically all republic districts and the losses caused by them represent imposing sums compared to the losses caused by floods and landslides [25].

Thus, the territories with different degree of exposure in an administrative-territorial aspect to the mentioned risks were pointed out in order to establish measures for mitigating the negative effects.

4. MITIGATION OF THE NATURAL RISKS EFFECTS ON ENVIRONMENT AND SOCIETY IN THE CONTEXT OF THE TERRITORIAL ARRANGEMENT OF THE REPUBLIC OF MOLDOVA

4.1. Measures to prevent, reduce and combat negative consequences of torrential rains and floods triggered by them on society and environment

The concrete measures to prevent, mitigate and combat the negative consequences of torrential rains and floods caused by them on society and environment have been established and structured according to the exposure degree of the republic territory to these risks in the administrative-territorial aspect. The full and complex implementation of the envisaged measures will contribute to the significant mitigation of the losses caused by these risks [12, 26].

4.2. Measures to prevent, reduce and combat negative consequences of landslides on society and environment

The study carried out in this paper aimed to establish concrete measures to prevent, mitigate and combat the adverse consequences of landslides, identifying the degree of exposure of the republic territory to this risk in the administrative-territorial aspect, shown by the value of the existing losses. Specific prevention and control measures, as well as adaptation measures, are included and substantiated in the doctoral thesis and other publications [15, 23].

GENERAL CONCLUSIONS AND RECOMMENDATIONS

General conclusions

1. As a result of the specialized literature study on the exposure of the Republic of Moldova territory to the occurrence of torrential rains in the warm semester of the year, floods triggered by them and landslides, it was found out that these risks at national level are studied and analyzed more in terms of genesis and less in terms of their impact on population, built space and urban infrastructure. This conditioned the necessity of estimating the exposure of the republic territory to the occurrence of the mentioned risks in an administrative-territorial aspect, with the determination of the exposure degree shown by the value of the losses caused.

2. For the first time with reference to the territory of the Republic of Moldova, we have calculated the average intensity (i) and the maximum intensity (I) of the torrential rains, thorough the elaboration of digital maps reflecting the areas with a high degree of territory exposure to the mentioned risks, which are triggering pluvial spillages and floods.

3. As a result of the frequency calculation of torrential rains with a different quantitative gradient fallen within 24 hours and less, digital maps on torrential rain distribution were developed for the first time, detailing the highest frequency ($\geq$ 30 mm and $\geq$ 50 mm) and

potential risk of flood for the entire territory of the republic, and also the complex map of the torrential rains distribution developed with the gradation ≥ 30, ≥ 50, ≥ 100 and ≥ 150 mm, reflecting areas with a different degree of exposure to mentioned risk.

4. As a result of estimating the exposure of the republic territory to the risk of torrential rains in the warm semester of the year, floods triggered by them and landslides in administrative-territorial aspect, a set of digital maps reflecting areas with a different exposure degree of the republic territory to these risks, shown by the value of the losses caused by each individual risk. Amounting the losses caused by these risks for the 1997-2015 period determined the elaboration of a complex map that reflects the total losses and the losses share caused by each risk apart.

5. The estimation of the exposure degree of the republic territory in the administrative-territorial aspect to the risk of torrential rains, floods triggered by them and landslides, has allowed us to set and substantiate measures to prevent, mitigate and combat the negative effects according to the exposure degree of the areas highlighted to these risks, represented by the value of the losses caused by each individual risk.

Recommendations

1. The results of the undertaken study on estimating the republic exposure to the risk of torrential rains in the warm semester of the year, the floods caused by them and landslides, as well as the measures set for preventing, mitigating and combating the negative effects in the administrative-territorial aspect will serve to elaborate specialized warnings and recommendations to inssure safety of the population, the material goods and the environment against these risks.

2. The use of digital maps on the exposure of the Republic of Moldova territory to the risk of torrential rains in the warm semester of the year, the floods triggered by them and the landslides, elaborated on the basis of the values obtained regarding the main parameters of the torrential rains, the material losses caused by the risks mentioned above, will contribute to the significant mitigation of their impact in the administrative-territorial aspect with effect on different fields of activity for the purpose of sustainable development of the national economy sectors.

3. The results of the study will serve as informational support for: taking operational measures to prevent, mitigate and combat the consequences of the risks mentioned by GIES; elaboration of PATN, PATR and PUG projects by INCP „Urbanproiect”; use in the process of teaching students and master students within the study programs of the Department of Biological and Geonomical Sciences of the State University „Dimitrie Cantemir” and other field academic institutions.

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37 CRED International Disaster Database –Universite Catholique de Louvain – Brussels – Belgium.

ESTIMATION OF EXPOSURE OF THE REPUBLIC OF MOLDOVA TERRITORY TO THE OCCURRENCE OF CERTAIN NATURAL RISKS

166.02 – ENVIRONMENT PROTECTION AND RATIONAL USE OF NATURAL RESOURCES

Abstract of doctoral thesis in geonomical sciences

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