Earthquake Risk Scenario Simulation at the Dam and Hydropower Plant Vidraru from Romania and Its Consequences on Energy and National Security

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Abstract: - A disaster-type event manifested by an earthquake at a dam and a high power hydropower plant, has a very low manifestation likelihood, but the gravity can be catastrophic with a powerful impact over the flood of the area followed by human lives loss, changing and altering the environment hence losing the facility of producing electricity. Such an event can bring extreme damage for the population, society and the state by losing the involved infrastructures, generating extreme prejudice for the energetic and national security. For this reason, the authors have simulated an 8 magnitude on Richter scale earthquake risk scenario at the dam and hydropower plant Vidraru with an impact over the installations of the strategic energy purpose. The final purpose of the paper is to find ways to protect the population in case of the dam-breaking situations, flooding of the downstream areas, and damaging the infrastructures and to allow the intervention for the evacuation in safety conditions and return to a normal state (resilience).

Key-Words: - earthquake, risc scenario, disaster, dam-breaking, hydropower, power plant, energy security, national security.

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1 Earthquake Risk Scenario Simulation

The seismicity of Romania is dominated by the Vrancea source, located in the central-east part of the country, in the convergence point between the East-European Plate and Moesic and Intra-Alpine Subplates. The collision of these plates caused a few tens of millions of years ago the detachment of a lithospheric block which is now immersed in the mantle. The block originates from an old tectonic plate cold and rigid enough compared with the surrounding mantle, being difficult to melt, which makes possible the production of earthquakes at intermediary depths (between 90 and 180 km, usually) where, normally, the temperature and ductility conditions would make such thing impossible. The earthquakes from this depth range can have magnitudes Mw>7, and can be felt strongly on 50-60% of the Romanian territory, as well as in The Republic of Moldova, Ukraine and Bulgaria. The earthquake constitutes the natural risk of which unpredictable manifestation can cause a large number of victims among the population, significant material loss, as well as a powerful psychological and social impact and the returning to a normality state requires an important effort (financially), carried out over a long period of time. On the 1st of August 2024, at 23:45 an 8-magnitude

on Richter scale earthquake was recorded, experienced especially in Vrancea, Arges and Brasov counties.

The earthquake caused damage to the installations of the strategic objective Vidraru Dam and Vidraru Hydro Power Plant, [1].

2 The Description of the Energetic Objective

2.1 Construction and Architecture

Vidraru Dam is located in the keys of the Arges River, approximately 6 km north of Capataneni village, on the North side of Arefu commune (Figure 1). The access to the up-side of the Vidraru Dam (canopy) and to the Hydro Power Plant Vidraru is provided by DN7C Capataneni-Vidraru Dam road, and the objective is placed on this communication path, DN7C, between km 56,6 and 61,7, a road with a lane on a direction, having a width of about 3 m per direction.

The access to the downstream leg of the Vidraru Dam is made by a branch in front of the Valley of Stan, which crosses with a viaduct at 694 meters above the sea elevation.

The access to the Vidraru Dam can be made on 16 access routes, as follows: *entrance no. 1*, located on the up side of the dam (canopy), on the East side - intended for the access of its own staff and *entrances 2-15,* located at different odds of the dam, on the East and West sides – intended for the own staff in the dam galleries.

Built between the ages 1960-1966 with the purpose of producing electricity, for irrigation and avoiding floods, the hydro energetic complex arranged on the Arges River is represented a hydropower plant (named Gheorghe Gheorghiu-Dej until 1989) and an ensemble of 14 downstream micro hydropower plants which develops an energy production of 350 million kWh. The main plant is located in a gallery dug 130 m below the Arges river bed and it was designed so that the hydro power plant can be controlled from afar, from Bucharest. It has an output of 220 MW and an energy production capacity of 400 million kWh per year, in average rainfall conditions. The regularization of the flow of the Arges river (and tributaries Topology, Valsan, Cernat, Doamnei, Valley of Stan, Limpedea) also contributes to the increase of the irrigated areas in the Arges basin by about 100 000 hectares and the prevention of floods in the Arges territory – allowing agriculture to be carried out on large areas that would otherwise have been affected by floods.

The Vidraru Dam has a 166.6 m height, an up-side of the dam (canopy) of 307 m and a thickness of the up side of the dam (canopy) of 6 meters. The arch of the dam includes 22 vertical columns joined by expansion joints, and each column is divided into 2 m high slats. For the construction, 480 000 cubic meters of unarmed, waterproof concrete, the B600 brand, were required The body of the dam is located inside the slopes of the Plesa and Vidraru mountains, being crossed by 9 horizontal galleries from which the integrity of the dam is controlled and measured. The communication between the galleries is made either with the two interior elevators or on the exterior access routes. The Vidraru Dam falls under the "A" category of exceptional importance, and at the time of its inauguration, it was the fifth in Europe and the ninth in the world between similar constructions, [2].

Fig. 1: Top view of Vidraru Dam

2.2 Technical Description

The Vidraru hydro power plant uses the Arges River hydro power potential, on a sector of 28 km length, located between Cumpana and Oiesti, with a total fall of 524 meters. For obtaining an important installed power, the waters of a river basin with an area of 745 km^2 are captured (Figure 2).

The average flow captured at the outlet for ensuring the operation of the power plant includes the flow of the Arges River of 7.2 m^3 /s and the flows captured from the neighboring basins: Topolog, Valsan, Cernat, Doamnei, Valley of Stan, Limpedea, totaling 12,2 m^3/s, meaning a total flow rate of 19,7 m^3/s.

The scheme of the power plant includes the following: *concrete arch dam, artificial lake and secondary captures; water plug; the gallery adduction; castle of balance; forted shaft; underground power plant with 4 vertical Francis turbines; the running gallery, connected on the riverbed of the Arges River through a running channel.*

The Vidraru Dam: *a height of 166,6 m; a length of the upside of the dam (canopy) of 307 m; the slender*

construction of the dam, with a thickness of 25 m at the base and 6 m at the up side of the dam (canopy); it includes 22 vertical plots monolithic by expansion joints, each plot is divided into 2 m high blades; for the construction of the dam it was used 480 000 m^3 of unarmed concrete, waterproof, B600 brand; the dam body, recessed in the slopes of the Plesa and Vidraru mountains, is crossed by horizontal galleries where the measuring and control devices are located to track the state of the construction; the communication between the galleries is done on the access routes outside the dam or with the help of the two elevators existing inside it, [2].

Hydropower plant: *the hydropower plant, with a flow rate of 90 m^3/s, is located on the right bank of the Arges River, north of the Capataneni village, in a cavern located at 104 m below the level of the Arges River and it includes the cavern of the machinery room of 75 m length, 16 m width and 34 m height, continued with the boxes of high voltage transformers; the hydropower plant is equipped with 4 Francis turbines with 56.5 MW vertical axis coupled with 61 MVA hydro alternators and 7 single-phase transformers of 40 MVA; the main access of the staff and equipment is made by a vertical shaft of 7.2 m diameter, continued with a horizontal gallery on a length of 123 m; the hydropower plant is equipped with 4 synchronous, vertical hydro-generators for direct coupling with the Francis turbine, for maximum power at 56.5 MW coupling.*

- technical characteristics: *apparent power: 61 MVA; active power: 55 MW; the power factor: 0,9; nominal voltage: 10,5±5% kV; frequency: 50 Hz; rated speed: 428,6 rot/m in; starting speed: 760 rot/m in.*
- energetic parameters: *installed power 220 MW; average electricity production 400 GWh/year; total gross fall 324 m; average flow rate captured 19,7 m^3/s; installed flow 90 m^3/s; Francis turbines used with vertical shaft 4 x 56,5 MW,* [2].

Fig. 2: Front and side view of Vidraru Dam and hydropower plant Vidraru

2.3 Damage

On the 6th of July 1974, the Vidraru Dam recorded significant damage during an operation test, producing an artificial flood of 600 m^3/second downstream, electricity supply disruptions in the area and the partial destruction of a bridge, and 2 people lost their lives in this tragic event.

Fortunately, the damage from 1974 is the only notable failure recorded at the dam, the high-magnitude earthquake that occurred in 1977 not affect it at all, [2].

3 Context

The triggering of the earthquake with an 8 magnitude on the Richter scale, from the 1st of august 2024, at 23.45, involves at the moment of the earthquake in the focal area a break on a distance of several tens of km, with an average displacement on the surface of the source of 1-2 m. The seismic waves emitted by the source will generate accelerations of over 0.1 g on an area including about half of the country's territory. This area represents the high-risk area. The duration of the event is several seconds, but in a location on the surface of the earth can vary from 30 to 60 s (in the latter case being about the duration of the movement of the soil felt by the population in that location). In the situation of large shocks, landform changes, changes in the river basin regime, which can affect biodiversity on a local scale, occurs. Significant damage is possible across the entire critical infrastructure ensemble which can create jams and obstacles in the post-event action system. In assessing the probable seismic hazard, the flood zone is the downstream of the dam area that could be flooded in the event of a malfunction or uncontrolled release of water and is usually, much larger than the surface for a normal water flow.

The official simulations and the resulting data claim that if the Vidraru Dam (450 million tons of water) were to fail, the flood would cause the following damage: *it submerge the Arefu, Corbeni and Iasi Valley communes in 4 minutes; it will submerge the hydropower plant and Albestii de Arges commune in 13 minutes; the Argeseana House cabin, the ruins of Radu Negru fortress and the Capataneni-Ungureni and Capataneni-Pamanteni villages would disappear under the water; the flood will arrive in 20 minutes at Danului Valley and Curtea de Arges, which will be submerged under 25 meters of water; the flood will arrive in the Baiculesti village in 30 minutes, Merisani in 41 minutes, Budeasa in 53 minutes,*

Bascov in 66 minutes and Pitesti 72 minutes, which will be submerged under 12 meters of water, [2].

The final purpose is to protect the population in case of the control infrastructure damage and in the extreme case, of breaking the dam and flooding the downstream areas, enabling the intervention for the purpose of safe evacuation. Therefore, in such a situation, it will be applied the measures established by the „National concept of post-seism response" regarding the triggering of specialized response operations by activating the coordination and management of intervention centers, integrating operational capacities, collective knowledge, capabilities and resources of authorities, institutions and organizations that make up the National Emergency Situations Management System at national, county and local level, in order to protect life, property and the environment, limiting and removing the effects of a disaster caused by a major impact earthquake and returning to a normality state. The leadership of the forces in the field will be carried out, with a focus on supporting the viability of the informational-decisional flow at the intervention coordination and management centers level and adjusting the operational actions in terms of emergency transmission to the population of the actions that will be taken and their continuous, regular and focused communication through the most viable means of information. When the level of gravity established by the authorities has been reached or there is a danger of reaching it, the committee of the local public authority within which the emergency situation occurred is activated and the specific defense plan is implemented. If, as a result of specific real-time assessments, the possibilities of the created situation management committee are exceeded, the county committee and, if case, the Ministerial Committee and the National Committee shall be activated. The management of operational intervention operations in the event of a specific emergency situation occurring shall be carried out by the authorities legally invested with attributions and responsibilities regarding the conception, planning, organization and control in the respective field, and, by the prefect, the mayor and the heads of economic operators and public institutions. In the event of an emergency situation, the Defence Plan will be implemented (activated) in whole or in part, depending on the created situation.

The prefect and sub-prefect, mayor, head of the professional public service for emergency situations, heads of the autonomous regions, national societies and administrations/companies with attributions and responsibilities in the field, as well as representatives of the local civil society shall refer the matter to themselves and shall initiate from the headquarters of the respective institutions the necessary actions regarding the alerting and the intervention in case of an emergency according to the local and county Defense Plan.

The National Committee for Emergency Situations is the inter-institutional body consisting of ministers or state secretaries appointed by them and heads of central public institutions or persons with designated decision-making rights who, under the management of the prime minister, ensure the adoption of the strategic decisions necessary to manage the emergency situations produced in the event of a major impact earthquake in Romania. In order to ensure adequate training of the population in case of a major impact earthquake, to ensure an integrated, coordinated and organized response, as well as to ensure a reasonable time horizon for the return to a normal state, the National Committee for Emergency Situations coordinates the activity of central and local public administration authorities, institutions and organizations represented on emergency situations committees in the areas of action, prevention, preparedness, response, investigation / assessment and restoration / rehabilitation.

The Local Committee for Emergency Situations organizes, coordinates, and controls actions and measures to prevent, prepare, protect and intervene against the effects of a specific emergency situation. It collaborates with specialists and representatives of institutions and organizations with attributions and responsibilities in the management of emergency situations in the specific areas of competence and with the County Committee for Emergency Situations of the county. The Local Committee for Emergency Situations declares, with the consent of the prefect, the state of alert on the territory of the respective administrative-territorial unit, which refers to the immediate implementation of action plans and measures to prevent, warn the population, limit and remove the consequences of the emergency situation. Depending on the emergency situation created, the prefect may propose the establishment of a state of emergency, in case of calamities that make necessary the prevention, limitation or removal, as appropriate, the consequences of some disasters.

All of the involved bodies have the obligation to: *execute the provisions (orders) of The County Committee for Emergency Situations, regarding the implementation of protection and intervention actions; provide for The County Committee the forces and material means required to carry out the protection and intervention actions,* [2].

Factual situation:
Following the 8 degree Richter scale earthquake that affected the Vidraru Dam, in the area of the water inlet, on the left slope, infiltration flows appeared. A few minutes later, the decreasing of the pressure in the forced pipe was found.

When assessing the post-disaster situation, it was found: *the cracking of the armor of the adduction gallery upstream of the flat valve on an area of about 0.5 m; the flooding of the underground oil household; 25 m^3 alluvium.*

4 Risk Level Assessment

The risk scenario assessment: Natural Disaster Vidraru Dam – Human Lives loss / Material damage / Infrastructures loss / Losing the facility to produce electricity, [3].

Sequential scrolling
NATURAL DISASTER VIDRARU DAM:
NATURAL HAZARD / ANTHROPIC HAZARD → PHYSICAL DESTRUCTION OF THE DAM → FLOOD → HYDROPOWER PLANT, VILLAGES, COMMUNES AND CITIES FLOODED → HUMAN LIVES LOSS | INFRASTRUCTURES LOSS | LOSING THE FACILITY TO PRODUCE ELECTRICITY → EXTREME DAMAGES → SOCIETAL INSECURITY → ENERGETIC INSECURITY → NATIONAL INSECURITY AND INSTABILITY

The causes and effects are described in Table 1.

Table 1. Causes and effects

Causes:	**Effects:**
- seismic activities; - natural disasters; - poor/wrong dam design from a seismic point of view; - lack of critical energy infrastructure protection; - lack of risk scenarios assessment and their materialization.	- human lives lost; - flooded hydropower plant; - flooded villages, communes and cities; - losing the facility to produce electricity; - extreme damages; - societal insecurity; - energetic insecurity; - national insecurity and instability.

a) Establishing the likelihood

Score and time of establish the likelihood

	Score level	LIKELIHOOD	Time
X	1. Very low	It has a very low likelihood of occurring. Normal measures are required to monitor the evolution of the event.	over 20 years
	2. Low	The event has a low likelihood of occurring. Efforts are needed to reduce the likelihood and/or mitigate the impact produced.	16 – 20 years
	3. Medium	The event has a significant likelihood of occurring. Significant efforts are needed to reduce the likelihood and/or mitigate the impact produced.	11 – 15 years
	4. High	The event has a likelihood of occurring. Priority efforts are needed to reduce the likelihood and mitigate the impact produced.	6 – 10 years
	5. Very high	The event is considered imminent. Immediate and extreme measures are required to protect the objective, assessment of a safe location of the impact as necessary.	1 – 5 years

b) Establishing the gravity

The vulnerabilities and capability assessment are described in Table 2.

Table 2. The vulnerabilities and capabilities assessment

THE VULNERABILITIES AND CAPABILITIES	LEVEL
1. Poor/wrong dam design from a seismic point of view;	**Very low**
	Low
	Medium
	High
	Very high
2. The flooding risk of the hydropower plant, villages, communes and cities following the earthquake;	**Very low**
	Low
	Medium
	High
	Very high
3. Lack of critical energy infrastructure protection and risk scenarios assessment and their materialization.	**Very low**
	Low
	Medium
	High
	Very high

The impact analysis are described in Table 3.

Table 3. Impact analysis

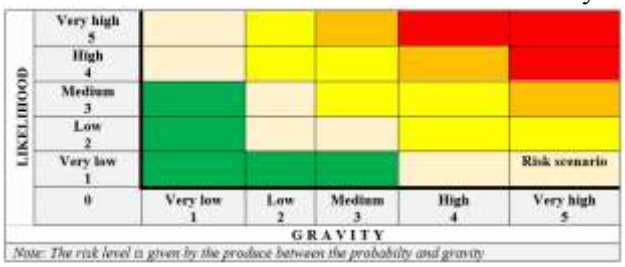
IMPACTS	LEVEL
Human lives loss and generating the societal insecurity state [3].	**1. Very low**
	2. Low
	3. Medium
	4.High
	5. Very high
Major damages caused by lack of facility to produce electricity; generating the state a energy and national insecurity	**1. Very low**
	2. Low
	3. Medium
	4. High
	5. Very high
Major damages to environment	**1. Very low**
	2. Low
	3. Medium
	4. High
	5. Very high
Powerful social impacts	**1. Very low**
	2. Low
	3. Medium
	4. High
	5. Very high

Level of of gravity

	Level	GRAVITY
	1. Very low	The event produces a minor disturbance in the activity, without material damage.
	2. Low	The event causes minor material damage and limited disruption to activity.
	3. Medium	Injuries to staff, and/or certain losses of equipment, utilities and delays in providing the service.
	4. High	Serious staff injuries, significant loss of equipment of installations and facilities, delays and/or interruption of service provision.
X	5. Very high	The circumstances are catastrophic resulting in deaths and serious injuries to staff, major losses to equipment, installations and facilities and termination of service provision.

c) Risk level calculation

The risk matrix between Likelihood and Gravity



CALCULATED RISK LEVEL	
LEVEL	SCORE
Very low	1 – 3
Low	4 – 6
Medium	7 – 12
High	13 – 16
Very high	17 – 25

d) Risk treatment

The risk assessment are described in Table 4 (Appendix).

Proposed measures is next:

A. Technical measures (urgent);
B. Organisational measures;
C. Measures to prevent emergency situations arising from an earthquake;
D. Operational measures.

The vulnerabilities after treating the risk are described in Table 5.

Table 5. The vulnerability after treating the risk

VULNERABILITY	Identified	After applying the measures
1. Poor/wrong dam design from a seismic point of view; 2. The flooding risk of the hydropower plant, villages, communes and cities following the earthquake; 3. Lack of critical energy infrastructure protection and risk scenarios assessment and their materialization. [3].	**1. Very low**	**1. Very low**
	2. Low	**2. Low**
	3. Medium	**3. Medium**
	4. High	**4. High**
	5. Very high	**5. Very high**

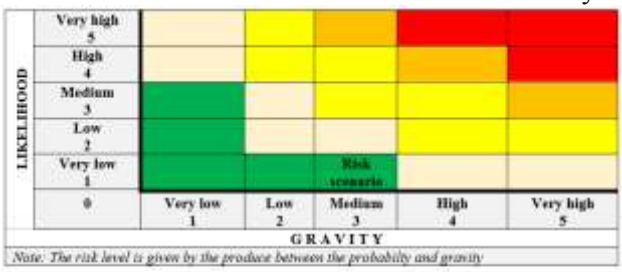
e) Recalculating the gravity of the consequences

Level of Gravity

	Level	GRAVITY
	1. Very low	The event produces a minor disturbance in the activity, without material damage
	2. Low	The event causes minor material damage and limited disruption to activity
X	3. Medium	Injuries to staff, and/or certain losses of equipment, utilities and delays in providing the service.
	4. High	Serious staff injuries, significant loss of equipment of installations and facilities, delays and/or interruption of service provision.

f) The risk level after the application of the reduction measures

The risk matrix between Likelihood and Gravity



CALCULATED RISK LEVEL	
LEVEL	SCORE
Very low	1 – 3
Low	4 – 6
Medium	7 – 12
High	13 – 16
Very high	17 – 25

5 Conclusions

Following the simulation of an earthquake with 8 magnitudes on the Richter scale, from the 1st of August 2024, at 23.45, on the dam and the hydropower plant Vidraru, the authors evaluated The risk scenario: Natural Disaster VIDRARU DAM– Human Lives loss / Material damage / Infrastructures loss / Losing the facility to produce electricity

Almost all stages of this disaster scenario have been sequentially scrolled: Natural hazard / Anthropic hazard → Physical destruction of the dam → Flood → Hydro power plant, villages, communes and cities flooded → Human lives loss | Infrastructures loss | Losing the facility to produce electricity → Extreme damages → Societal insecurity → Energetic insecurity → National insecurity and instability.

The results of the risk scenario:

- *establishing the likelihood:* ***1. Very low****;*
- *establishing the gravity:* ***5. Very high****;*
- *calculated risk level:* ***2. Low.***

The results of the risk scenario after treating the risk by reduction measures:

- *establishing the likelihood:* ***1. Very low*** *(it remains the same);*
- *establishing the gravity:* ***3. Medium****;*
- *calculated risk level:* ***3. Very low.***

The following measures have been taken:

- ***4*** *technical measures (urgent);*
- ***9*** *organisational measures;*
- ***9*** *measures to prevent emergency situations*

arising from an earthquake;
- ***53** operational measures.*

Regarding the relationship with the public and the mass media, the integrated and unitary production of the governmental public message is the attribute of the Chancellery of the Prime Minister.

At a national level, public communication is ensured by the principle of a single voice, according to the provisions of GD no. 548/2008 regarding the approval of the national strategy for communication and public information for emergency situations, through the specialized structures of the Ministry of Internal Affairs to which the contribution of all the component institutions is added.

Communication on operational aspects is usually done through the action commander, intervention commanders and designated staff of communication and public information centers.

The national centre for communication and public information will provide telephone lines intended only for communication with the public, equiped with staff able to communicate in the minority language, as well as in a language of international circulation, as appropriate.

For the relationship with embassies regarding the situation of affected foreign citizens located on the territory of Romania, The National Centre for communication and public information will provide a telephone line separated from those designated for the communication with the public, which will be communicated in a timely manner through the Ministry of Foreign Affairs.

In order to achieve an adequate, efficient, effective and in accordance with the needs generated by the disaster response, the County Committee for Emergency Situations, through the structures at the county level, involved in the management of the emergency situation, will implement the decisions of the National Committee for Emergency Situations approved by the Department of Emergency Situations of the Ministry of Internal Affairs.

Regarding the structures involved, the National Emergency Situations Management System, through its components and, the overcoming of the national response capacity, in cooperation with international bodies, executes a complex response action after a major impact earthquake, mainly for:
- rescue of victims, providing emergency medical assistance/qualified first aid;
- limit the effects;
- ensuring the continuity of the work of the Government, central and local public authorities and the functioning of critical infrastructure;
- successive return to social and economic normality, [2], [6], [7].

The elements of strategic action in the event of a major impact earthquake are made up of the decision-making elements, the main authorities and the authorities/institutions which provides support functions.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Nicolae Daniel Fita came up with the idea of simulating a risk scenario on the Vidraru dam, an 8-degree earthquake on the Richter scale, and helped evaluate the risk scenario.
- Sorin Mihai Radu he accurately described the position and structure of the Vidraru dam: construction and architecture, technical description, damage.
- Sorina Daniela Stanila showed the exact context of the earthquake risk scenario and the possible damage caused and of course resilience.
- Mila Ilieva Obretenova has made contributions to the risk scenario assessment.
- Aurelian Nicola has made contributions to the risk scenario assessment.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of Interest

The authors have no conflicts of interest to declare.

APPENDIX

Table 4. Risk treatment

THE VULNERABILITY AND/OR CAPABILITY
1. Poor/wrong dam design from a seismic point of view; **2. The flooding risk of the hydropower plant, villages, communes, and cities following the earthquake;** **3. Lack of critical energy infrastructure protection and risk scenarios assessment and their materialization.**
PROPOSED MEASURES
A. Technical measures (urgent): [4], [5] 1. Reconsolidation of the dam to withstand up to magnitude 9 on the Richter scale; 2. Major investments in the protection and securing of critical infrastructure related to dam and hydropower plant; 3. Predictability of natural disasters (relations with state institutions in the field of emergency situations); 4. Assessments of the seismic risk. B. Organisational measures: 1. Identification of the decision-making, coordination and control authorities/institutions in case of an earthquake and the assuming the roles and responsibilities of these in the sectors thei incur; 2. In order to achieve clear, timely and efficient public communication and information, the principle of a single voice will be used at the county level and it will be designated annually, in a normality state, a unique voice through the public relations officer of the County Emergency Situations Inspectorate; 3. Drafting and updating the rules of organization and operation of the County Center for Management and Coordination of the Intervention with the establishment of the duties of representatives of all structures involved in the management of risk types; 4. Establishing the general mode of action of all emergency structures/institutions in order to achieve the management, coordination and control of human and material resources in order to protect life, property, and the environment, limiting and removing the effects of a disaster caused by an earthquake with major impact and returning to the normality state; 5. Updating the locations of the operational bases established in times of normality by the county committee for emergency situations and ensures the periodic updating of the established seating positions for the location of the bases operations and county and local public authorities will support their organization; 6. Creating the framework to use the available informational, human, financial, and material resources efficiently, effectively and in accordance with the established objectives; 7. Identifying and monitoring potential sources that may generate emergency situations; 8. The special program for the Vidraru Dam is carried out at the registration at the seismic station of an earthquake with a magnitude over 4 on the Richter scale; 9. The special program consists of performing a tranche of measurements, immediately after registering an earthquake with a magnitude over 4 on the Richter scale, and then daily until the situation is clarified, at the following devices: *all of the direct and inverse pendulums; the infiltration sources from the dam's galleries I and II, the characteristic sources from the valve house and in the bottom gallery no.2; the deformetric vaults in gallery VIII; detailed visual observations on the downstream parameter, slopes and the perimeter of the recess and in the dam galleries.* C. Measures to prevent emergency situations arising from an earthquake: 1. Informing the population about the sources of risk that may generate emergency situations and coordinating the preparation of the population on prevention, protection and intervention in emergency situations; 2. Informing the population about the understanding of threats that have a potential negative impact on communities in case of an earthquake to increase the resilience of communities; 3. posting on the websites of the County Prefecture/Inspectorate for County Emergency Situations the general and specific recommendations necessary to protect the health of the population; 4. Preparing public authorities to be able to intervene on the basis of their own response plans at the manifestation of a type of risk; 5. Permanent training of the intervention staff on knowledge of the content of the cooperation plans, as well as of the specific intervention procedures for the removal of the negative effects generated by a major impact earthquake; 6. Update of programmatic documents and emergency situations response, protection and intervention plans; 7. Verifying the viability of the actions established by conducting exercises in the normality state; 8. Preparing the conditions for the restoration and rehabilitation of the objectives (areas) affected by a major impact earthquake; 9. The attributions of the emergency cell at the Vidraru Dam level in the pre-disaster period: *it*

identifies and monitors potential sources that can generate emergency situations; it organizes the collection of information and the informational-decisional flow; it analyses and endorses the plans for ensuring the human, material and financial resources necessary to manage emergency situations; it informs the County Committee for Emergency Situations, through the Inspectorate for Emergency Situations, as the case may be, about the states that may generate emergency situations and the imminent threat thereof; it informs employees of the sources of risk that may generate emergency situations; it coordinates employee training on prevention, protection and intervention in emergency situations and disasters; it shall draw up annual activity and intervention preparedness plans and risk analysis and hedging plan; it appoints the collective to lead actions to restore and rehabilitate the affected objectives (areas); it organizes teams of specialists to evaluate the effects and damages produced, in order to communicate them to those interested; it examines the causes of the emergency situation and sets out measures to prevent and limit the effects; it provides information to the population about the evolution and effects of the situation, the actions taken to limit them and the measures that are still needed; it establishes and pursues the distribution and use of material and monetary aid granted; it analyses the documentation regarding the granting of the necessary funds for the restoration works; it updates protection and intervention plans in emergency situations.

D. Operational measures: [6], [7], [8]

1. Informing the County Committee for Emergency Situations, regarding the potential states generating emergency situations and the imminent threat thereof;
2. With the first intervention measures, the commander of the intervention at the county level will be appointed, and all intervention forces will be ordered to pass on the cooperative communication channel;
3. The following types of missions: medical triage, medical evacuation, search-rescue, reception and routing of the forces arrived for support (reserve station area and access to the intervention area), fire limitation/extinguishing, etc, logistical support;
4. The participation with own assets and resources in the actions of protection, search-rescue, evacuation of the population and material goods, to limit and remove the consequences of the earthquake, management of emergency situations resulting from the effects of the earthquake (fires, CBRN accidents);
5. Activating the Red Intervention Plan directly at stage IV, with the possibility of moving to stage VI (allerting SMURD resources at the regional level), and the achievement of full operational capacity at the level of all sub-units of the inspectorate;
6. Activating the White Plan of county hospitals in the region to increase the capacity of taking over a high number of victims;
7. Informing the management of the General Inspectorate of Emergency Situations, Department of Emergency Situations and other structures on the measures taken by sending preliminary operational reports;
8. Notification of all authorities in the county that provide support in case of multiple victim accidents about the event and about communication on the dedicated cooperation channel;
9. Preliminary assessment of the effects of the earthquake and performing recognitions, including by airways;
10. Informing the population by mass media, radio or television and sending RO-ALERT warning messages to maintain a high degree of information of the population in order to avoid general panic, recommendations to ensure self-protection and disseminate first response measures;
11. Increasing the response capacity of intervention structures by requiring capabilities;
12. Convening an extraordinary meeting and identifying the elements necessary to establish the immediate action plan;
13. Implementation of own action plans in the event of earthquake-related emergencies;
14. Operationalization of command and control systems, operational centers and the coordination and management center of intervention by County Committee decision;
15. Organizing at the event site an advanced operational point and requesting representatives of public order structures at the national level;
16. Immediate and operational collection of data of interest and preparation of operational information to upper echelons;
17. Organization and arrangement of bases of operations;
18. Establishing the medical first aid/triage points, and the disaster camp, checking the information on the functioning of airports in order to organize possible support in evacuation and medical transport actions, as well as, transport of materials and intervention staff, as appropriate, by requesting the operationalization of available means of the Romanian air force;
19. Identification of accommodation spaces

(schools, kindergartens, boarding schools, hotel spaces, gyms) that can serve as accommodation for the victims of natural disasters;
20. Requesting for the establishment of "emergency state" or, where appropriate, declaration of "alert state" by County Committee decisions;
21. Requesting operationalization of ROL II military hospital;
22. Intensifying response actions of public order structures to prevent deterioration of the climate of public order and safety;
23. Ensuring the monitoring of traffic in the area of intervention actions or access routes to them and the development of a transport schedule for the evacuation/receipt of material goods;
24. Ensuring the permanent informational-decisional flow;
25. Reinstatement of telecommunications networks and services and information technology necessary for the smooth operation of the decision-making act;
26. Supplementing the advanced point of operation with the command point because there is an increase in the number of 112 emergency calls that can lead to system overwork and blocking or, as the case may be, creating a waiting list;
27. Creating the request for human resources in support of those affected by moral and/or mental wear in order to be able to successfully perform the rotation of the intervention staff, an operation that raises the efficiency of the intervention actions;
28. Creation of the request regarding the material resources necessary to replace those affected by the accentuated wear based on the elaborated analyses;
29. Nominating a structure responsible for coordinating the O.N.G.s at the county level and managing volunteers and humanitarian aid. Unitary coordination of these entities is imperative because there is a risk of hindering community support activities in the absence of an organization of the O.N.G.s;
30. Analyzing with the representatives of the county structures and the administrator of the hydro-technical work the opportunity to notify, warn and alarm the population, institutions and economic operators willing downstream;
31. Requesting the estimated need to evacuate the population and the existing local possibilities;
32. Transmission of the specifications on self-evacuation and preventive evacuation of people, animals and material goods outside floodplains, based on the information provided by county structures;
33. Requesting/receiving from the territorial road structures data on the existence of blocked or damaged communication routes or other infrastructure elements;
34. Ensuring the participation or making available of the technical means necessary for the transport of persons, food and materials to the affected areas;
35. Transmission of the information provided by the economic operators regarding the adoption of the decision to interrupt the supply of electricity, and gas and ensure the communications in the flooded areas, for the prevention of electrocution, gas poisoning or other technological accidents;
36. Issuance of the emergency evacuation order;
37. Organizing the activity of population evacuation and coordinating the implementation of evacuation plans at the level of Territorial Administrative Unit/economic operator or even implementing the evacuation plan of the county;
38. Creating a special line, TEL VERDE type, with permanent activity, for the caregivers and for the persons affected by the emergency situation;
39. Searching for missing persons, installing bulletin boards and posting on specialized websites the lists and photos;
40. Participation of state, territorial and local administration structures in missions for receiving/collecting/distributing domestic humanitarian aid;
41. Application of sanitary-epidemic measures;
42. Regular transmission of data on water and food consumption restrictions in certain areas;
43. Carrying out public health measures and establishing any possible restrictions on the consumption of food, water, and feed. Ensuring safe access to water and support to ensure individual and collective hygiene for the victims of natural disasters or temporarily discharged persons;
44. Collection and identification of deceased persons and identification of spaces and arrangement of places for burial of deceased persons;
45. Informing the population about the measures taken and the protection measures to be taken;
46. Coordination of water and food insurance missions (after 72 hours);
47. Identification of victims, victims of natural disasters and drafting a missing persons situation;
48. Requesting /receiving and centralizing information and operational reports and subunits during/at the end of the intervention actions;
49. Participation in actions to assess the damage caused by the emergency situation;
50. Assessment of the state of critical infrastructures according to competence;
51. Identification of destroyed/damaged buildings belonging to the population, public authorities

and private operators;

52. Identification of the transport infrastructure elements (roads, railways, ports) that have been affected, respectively those that can be used in full or, if the case, those that can be used with certain restrictions for the purpose of maneeuvring forces and means;
53. Carrying out activities of consolidation, release of elements resulting from collapsed constructions, rehabilitation and restoration of the infrastructure and affected buildings, [9], [10], [11].