Using of mobile flood protection on the territory of the Moldova as possible protection of the community

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Abstract. The Moldova is facing an increased incidence of floods. For these reasons, the involvement of state in flood protection is rising. Despite the fact that the Moldova is not a member of the European Union, its government follows legislation on prevention, risk assessment and flood protection which is closely connected with landscape. The article deals with the possibilities of using mobile flood barriers in this territory as possible protection of the community.

1. Introduction

Floods are one of the most common and common natural disasters. They can cause both life and animal losses, as well as losses on property and the environment. Countries across the globe are tackling different flood protection, which has become a very topical issue in recent years. This is due to the frequent occurrence of spring and lightning floods, global warming and anthropogenic interference in watercourses. Flood protection means measures to prevent and prevent damage to floods, carried out mainly by systematic prevention and implementation of preparatory measures within the municipality's preparedness for floods.

One of the countries facing the floods is Moldova. A part of the preventive measures in the flood protection area is the construction of mobile flood protection barriers ("FPB") in pre-selected locations. For the purposes of the article, the community is understood to mean the population living in the territory of Moldova and having some relations with each other.

2. The territory of Moldova

Moldova is located in an area with average annual rainfall of approx. 520 mm / year. The problem is the great unevenness of the distribution of these precipitations, as well as the insufficient retention capacity of the landscape (only 10% of Moldavia is covered with forests) [1]. The network of Moldavian rivers consists of two larger rivers - the Dnieper and the Prut, which flow into the lakes near the Danube and are connected with the Black Sea. There are 57 lakes and 3,500 ponds and reservoirs in Moldova [7][9].

Even though Moldova is not a member of the EU, it is subject to legislation on prevention, risk assessment and flood protection, similar to the EU member states. The issue of flood protection in Moldova is dealt with under the laws (eg, the Water Act No. 272/2011, provides a legal framework for the management, protection and efficient use of surface and groundwater, etc.) and European directives (eg the Floods Directive No 2007/60 / EC of 23 October 2007, etc.). The other legal regulation governing Moldova in the area of flood protection is "Commission Decision 2014/762 / EU of 16 October 2014 (hereinafter referred to as" the Decision ") laying down rules for Decision No
1313/2013 / EU of the European Parliament and of the Council Union Civil Protection Mechanism and repealing Commission Decision 2004/277 / EC, Euratom 2007/606 / EC, Euratom, in relation to the Civil Protection Module. An important module is Module 16 - Flood Control and Propagation. The task of this module is to consolidate existing (existing) facilities built up in recent years, or to build new barriers to prevent flooding from rivers, water tanks and rising waterways [5] [7] [9].

On the basis of the research (Study), the most vulnerable areas of the flood and identified for the FPB installation are: Vadul lui Vodă (suburb Chisinau) and Soroca (see Figure 1. Map showing vulnerabilities. Vadul lui Vodă is a suburb of Chișiănau. It is located on the right side of the Dniester River with a population of 5,295 people. The village is an important place for tourism. Close to the village there is an airport that is popular for landing and tourist flights and a large number of tourist resorts with forest park and beaches. [7] The Soroca district is located in the northeast of Moldova with a population of 95,000 by 2016. The administrative district of Soroca is the city of the same name located on the right side of the Dniester. The town of Soroca is a very interesting and popular place for tourism and recreation not only for the locals but also for tourists [2][4] [6].

3. Problems of bagging and mobile barriers

Part of anti-flood measures is the ability to cope with unwanted water leakage into areas that need to be protected from flooding. Types of mobile flood protection include sandbags or FBP. The most widespread mobile flood protection is classical sacks with an inert mix such as sand, gravel, soil, etc. Sandbags can be used to build dams, seal doors, windows, ventilation spaces, canals, etc. The effectiveness of the dike built from sacks is greatly increased by foil. There are currently many types and types of FBP on the market. The flood protection barriers are divided according to the type of construction (supporting frame, chamber concept, filling mixture) and used material (steel, aluminium, plastic, glass, cloth and wood). [2]

Table 1. Comparison of bag system with internal mixture and FPB shows a comparison of so-called bagging versus FBP. Based on the comparison made for the installation of flood protection facilities in Moldova, FBP were selected. [3]

| parameter            | Sacks with internal mixture | Mobile flood barriers          |
|----------------------|----------------------------|--------------------------------|
| Speed of installation| TIME                       | CONSUMING                      |
|                      | The lengthy sand filling and the need to construct the pyramid layout in the open spaces | QUICK                         |
|                      | READY TEAM                 | Immediate installation, a system of modules that connect to each other, will allow quick installation. Unlimited barrier length and shape. |
| Practice             | The need for a whole team of people who are gradually filling, carrying and sacking. | SOME PERSONS                  |
|                      | PICK AND FILLING EQUIPMENT | simple laying, about 5 people   |
| Filling              | It is NOT NEEDED or WATER (flood) - it is |                                 |

Figure 1. Map showing vulnerabilities [4][5].
material
Sacks must be filled with mixtures, the need for filling equipment.

Disposal
HYGIENIC AND NUCLEAR FOR TIME AND WORKING FORCE
Inappropriate hygienic conditions, need for more workforce.

Performance
WORKING - The need for a filling device and a team of people who are gradually filling, carrying and sacking.

Disassembly and disposal
NON-HYGIENIC, NUCLEAR FOR TIME AND WORKING FORCE
Inappropriate hygienic conditions, the need for more workforce

Stability
LIMITED STABILITY - Especially for higher barriers, the bags need to be layered into a pyramid, which is material and space-intensive. Limited barrier height.

Permeability
PERVIOUS
Bags pass through water throughput.

4. Analysis of the appropriate mobile flood protection
The choice of the appropriateness of the FPB has been taken into account in accordance with the Decision. Based on this, the technical parameters, criteria and description were set for the selection of FPB, see Table 2 [1].

| Criterion          | Description                                                                 |
|--------------------|-----------------------------------------------------------------------------|
| Price              | The total cost of an FPB does not exceed the total value of 380 000 Euro.    |
| Protective height  | Ability to cover water up to a minimum height of 1000 mm.                    |
| Length             | Construction of FPB with a length of 1000 meters.                           |
| Intervention       | Ability to simultaneously interfere with at least 2 locations in the areas (in the case of the Study it is a place of the village of Vadul lui Voda and the city of Soroca). |
| Transport          | Easy transportability of FPBs, including all accessories (hand pallet trucks and forklifts) on lorries from the place of storage to an endangered flood site.  |
| Installation       | Rapid construction and installation variability without the use of stationary anchor points, base pads, foundation belts, easy disassembly, no specific grounding requirements (high load-bearing capacity). It must be possible to install on different terrain, including unpaved surfaces (gravel, dirt, grass, asphalt, concrete, etc.) on a flat weight basis. Possibility of parallel construction (building on multiple sections with subsequent interconnection). FPB must limit leaks at the point of contact of the bottom of the FPB and the terrain. Construction interval is set at 1000 meters / 15 persons / 1 hour |
| Shape variability  | Shape variability of FPB - straight sections, arcs, possible solutions by combining individual types of FPB. The FPB parts must be connected to an unlimited length while retaining the ability to retain water. The FPB must be stable even when the sealing elements are punctured / broken. |
| Construction       | In order to ensure the FPB maintenance, the structure is specified on the support structure, the type of support frame. |
| Lifetime           | Minimum 10-year FPB lifetime (excluding sealing elements) for installation and repeatable use of FPB core components. FPB resistant to abrasion and mechanical
damage (e.g. floating objects). FPB resistant to floating objects. FPB must perform its function at temperatures of -10 to +50°C.
Possibility to perform simple screening controls, without the need to involve other entities. Regular maintenance of FPB does not require the intervention of a supplier or manufacturer of FPB and can be performed by a trained user.

The analysis was performed using the multi-criteria pairing method of the Füller triangle, which was used for a number of criteria, namely 7. The method is used in the determination of weights with a larger number of criteria, where it is difficult to compare each other. Based on the use of this method, the coefficients were calculated, see Table 3.

**Table 3. Selected coefficients for the criteria [3].**

| Criterion     | Coefficient |
|---------------|-------------|
| 1. Price      | 0.18        |
| 2. Protective height | 0.25        |
| 3. Transport  | 0.03        |
| 4. Installation| 0.11        |
| 5. Shape variability | 0.07        |
| 6. Construction| 0.18        |
| 7. Lifetime   | 0.18        |

The next step was the assignment of values, see Table 4, which was then multiplied by the coefficients.

**Table 4. Assigning values to the criteria [3].**

| Numeric values | Symbol | Description |
|----------------|--------|-------------|
| 5              | X      | did not meet the criterion |
| 10             | ∞      | information not identified |
| 15             | √      | met the criterion |

The resulting values for individual barriers were calculated according to formula (1) [3].

\[
\sum_{n=1}^{7}(k_n \times h_n)
\]  

(1)

Where:  
k_n - coefficient from Table 3  
h_n - the numerical value of the criterion in Table 4.

The resulting values of each species are recorded, see Table 5.

**Table 5. Resulting values of individual types of barriers [3].**

| Flood protection barriers | Description                                                                 | Result |
|---------------------------|-----------------------------------------------------------------------------|--------|
| One-chamber               | construction type chamber design, used material strength PVC, filling material water, cylindrical type | 9.45   |
| Tubus                     | type construction of a chamber concept, tubes covered with polyester, tubular type | 9.65   |
| Filling with filler material | type with steel construction, material - covered with PES woven PVC, water or loose material | 8.2    |
| Bags                      | bags made of rubber-textile material, fitted with flanges for water filling and deaeration, filling material water | 8.2    |
| Barrier filling with flood water | polyethylene barrier, filling material flood water | 10     |
Filling without filling materials type of supporting structure, type of supporting frame, sealing rubber rim 13.9
Barrier carrier type of supporting structure, type of supporting frame, sealing foil, possibility of using wooden pallets 15

Based on the analysis that arose from the market survey offered by FPBs, the scale for their evaluation was set, see table 6.

Table 6. Set barrier rating scale [3].

| Range of values | Rating                                      |
|-----------------|---------------------------------------------|
| 5 – 10          | does not meet the conditions, cannot be used as a barrier at selected locations |
| over 11         | meets conditions, can be used as a barrier at selected locations               |

It is clear from the evaluation that a suitable type for the installation of FPB in the endangered territory of Moldova is the supporting structure, the type of support frame of the sealing foil or the sealing rubber rim.

5. Conclusion
This article provides a preview of flood protection issues related to mobile flood barriers (FPB) in the territory of Moldova. The article is based primarily on the Study, which dealt with the selection of FPB in the endangered community, Vadul lui Vodă (suburb of Chisinau) and Soroca. Based on the analysis, it was found that a suitable type of FPB for installation in endangered places in Moldova is the FPB of the supporting structure, the type of support frame of the sealing foil or the sealing rubber rim. FPB will serve Service of civil protection and emergency situations of the Republic of Moldova for the following purposes: protection against floods and storm water, protection of industrial buildings and family houses, enhancement of existing dams or rivers, regulation and collection of flood water. The FPB can be ambidexterous use for floods, not only at Vadul lui Voda and Soroca. The disadvantage is the possibility of incorrect installation of FPB. This option is unlikely for reasons of training (practical exhibitions of MPZ) 10 persons for 2 x 7,5 hours in the Czech Republic and 10 persons 2 x 7,5 hours in Moldova.

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