GEOECOLOGICAL RISK ANALYSIS FOR SUSTAINABLE DEVELOPMENT OF AGRICULTURE OF THE REPUBLIC OF MOLDOVA

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Abstract. This article is dedicated to particularities of the formation of geoecological risks, which needs to be considered for sustainable development of the agriculture of the Republic of Moldova. Special attention is dedicated to hydrometeorological and pedologo-geomorphological risks. Risks related to heavy showers, droughts, ravine erosion and landsliding processes are described more detailed.

Particularities of the natural resource potential of the Moldova’s territory have mainly predetermined the structure of its economy. Leading position is occupied by agriculture, which has contributed by 30% to PIB in 2009, while the products of agriculture and agricultural processing industry constitute 49%. Agricultural sector involves 28% of country’s population.

Highly fertile soils (70% of which are chernozems), climatic conditions are main factors to assure sustainable development of agricultural production in the Republic of Moldova and represent one of the spheres of economic activity of its population, main source of existence for the majority of its people.

National government specially attends to the development of the agro-industrial complex that is evidenced by the set of adopted documents. Thus, in 2000 National Strategy of Sustainable Development “Moldova XXI” was developed. At the end of 2008 National Strategy of Sustainable Development of the agro-industrial complex was adopted. This Strategy purposes increasing production of the ecologically safe products; conserving
natural resources, sustaining and improving the quality of the environment. It is complicated objective because natural resource potential serves as material base for agriculture. However, the former, as shown by recent studies, has been changed significantly and affected by substantial man-made impact.

Unfavorable phenomena and processes represent significant risk for the sustainability of Moldova’s agriculture; their frequency and intensity has a strong trend to increase in the last years.

Contrary to the existing opinion related to the favorability of the regional climate, such phenomena as heavy showers, hailstorms, frosts first in autumn and late in spring, extreme temperature, strong winds, droughts negatively impacts efficacy of agricultural production, contribute to important loses (for example, frost in April 2009 has lead to loosing of 80% of walnuts and 70% of stone fruit crops in the northern part of the country).

Main risk for the agriculture of the Republic of Moldova is represented by the humidity regime having been formed, which boils down to the alternation of heavy showers and long-lasting droughts (Constantinov et al., 2000; Константинова и др., 2005; Лассе, 1982).

![Fig. 1. Rainfall layer in the shower center, 26-Aug-1994](image)

Heavy showers (whose rainfall quantity can achieve 100 mm and even 300 mm in 24 h) determined by cyclone activity (Constantinov et al., 2000; Лассе, 1982) cause huge damages to the country. Thus, for example, the shower at August, 26, 1994, embraced the entire central part of the country (Boboc et al., 2004). It lasted 7,5 h, water layer exceeded 300 mm, while annual average is under 600 mm. Figure 1 represents the diagram of the
shower’s center, made using radar. Shower’s center embraced the area of more than 2000 sq.km being characterized by extreme unevenness in space.

As a result of this shower 29 persons died, 3137 houses were destroyed. Material damages achieved 78,8 mil. USD, which is quite significant amount to the country. It needs to be added that from many areas fertile soils were washed out, while in certain sectors important territories were flooded by water.

Losses caused just by inundations provoked by heavy showers in the last 20 years exceed 350 mil. USD (tab. 1)

Tab.1. Dangerous hydrometeorological phenomena on the territory of the Republic of Moldova identified by economic loses (thou. USD)

<table>
<thead>
<tr>
<th>Dangerous hydrometeorological phenomena</th>
<th>Date</th>
<th>Economic loses (mil. USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood</td>
<td>24-Aug-1994</td>
<td>300,0</td>
</tr>
<tr>
<td>Flood</td>
<td>6-Jul-1997</td>
<td>50,0</td>
</tr>
<tr>
<td>Strong wind</td>
<td>26-Nov-2000</td>
<td>31,6</td>
</tr>
<tr>
<td>Flood</td>
<td>18-Aug-2005</td>
<td>7,8</td>
</tr>
<tr>
<td>Flood</td>
<td>15-Mar-1999</td>
<td>4,0</td>
</tr>
<tr>
<td>Flood</td>
<td>Jun-2002</td>
<td>832,0</td>
</tr>
</tbody>
</table>

Source: International Disaster Database EMDAT-CRED, University of Louvain, Belgium

Archival materials, instrumental observation data, numerous publications emphasize regional particularities of drought occurrence. According to CRED data in 2007 because of the drought 210 thou. persons suffered damages. According to this indicator the Republic of Moldova has occupied second place after Macedonia.

Destructive geomorphologic processes (linear erosion and significant areas of the slopes prone to landslides) represent another regional natural particularity, which impacts efficacy of agricultural production in the country.

According to various sources in the Republic of Moldova there are up to 70 000 ravines. Their presence causes substantial difficulties in farming, in crop rotation. Distribution of ravines by administrative-territorial units is shown in figure 2. It is worthy of emphasizing that there is a trend of increasing the areas occupied by ravines. Analysis of the data for the last years confirms this trend (Sîrodoev et al., 2009) (fig. 3).

Along with ravines, landslides enjoy large distribution. At present in Moldova there are more than 15 000 actual landslides (Tcaci, Gheorghia, 1995), while total area of landslide lands reaches 500 thou. ha. Such a large distribution of landslides on relatively small plain country is caused by the specificity of natural conditions on the one hand, and intensive human economic activity on the other. On figure 4 there are given data on the degree to which administrative-territorial units of the country are affected by landslides.

Provision of the country’s inhabitants with agricultural lands by the end of XXth century constitutes just 0,55 ha/pers., inclusive arable land 0,4 ha/pers. To date the latter index remain unchanged (0,4 ha/pers.), although the population has decreased by 400 thou. pers., which would have increased the area of arable land by person. This situation is explained by large development of destructive processes as well as by withdrawal of agricultural lands for other needs.
Fertile soils represent the main natural heritage of the country; their particularity constitutes in the high level of anthropogenic change. Current state of soils in the Republic of Moldova is significantly influenced by nature management. Formation of vine plantations provided for special technology of tillage – plantaging.

Fig. 2. Affectedness of the territory of administrative-territorial units by ravines

Fig. 3. Area dynamics of the ravines developed on agricultural lands

During the long period of time (since 1960s) runoff regulation has been enjoying an important attention. As a result more than 3400 water reservoirs have been built. Their
construction was frequently made without proper consideration of regional particularities of the territory and river water regime; as a result, agricultural lands are frequently flooded.

Fig. 4. Affectedness of the territory of administrative-territorial units by landslides

In the second half of XXth century significant areas (about 25 thou. ha) have been terraced with the purpose of reducing slope locally and of fighting erosion by the means of planting here vineyards and orchards. This work has not been fully accomplished. Created terraces contributed to decrease of ravine advancing, however, surface runoff was transferred into ground one, which contributed to increasing of another destructive process—landslides.

New economic relationships have aggravated the problem with ration use and protection of soils by virtue of the fact that the areas under permanent crops consecutively decreased, while those under the tilled crops increased. Frequently, the latter were occupying slope surfaces that contributed to the extending of ravine network and surface erosion. Intensification of these and other destructive processes was caused by the way of land privatization. Small allotments do not allow implementing modern anti-erosion measures in the organization of agroecosystems.

Land privatization was accompanied, as well, by liquidation of the set of agricultural enterprises, users of innovative technologies, which usually took part from scientific production association and influenced the efficacy of the branch.
The country, from the point of view of humidification provision, as it was mentioned before, is located in the zone of insufficient humidity; therefore, agricultural efficiency requires irrigation, which had been largely used till the end of the past century. As a result of economic and social reforms, the area of irrigated lands has decreased by 19 times and in 2005 it constituted just 16 thou. ha. It is worthy of mentioning that at present small irrigation using small river’s, reservoir’s and pond’s water reserves prevails; however, the quality of these waters does not correspond to adopted standards due to the high mineralization. Using of these waters in irrigation leads to salinization and alkalization of soils.

Sustainable development of the Republic of Moldova’s agriculture is threatened to certain extent, besides natural processes and phenomena, by two more factors: desertification, which embraces significant part of the Republic of Moldova and is caused by high anthropogenic impact, and land fragmentation, appeared after privatization.

Specially prepared detailed information (prepared on the basis of the geoinformation systems, specialized data bases of the long lasting environment monitoring) about the particularities of process and phenomenon manifestation in space and time could contribute to diminishing negative impact of natural and anthropogenic factors on the analyzed economic branch; considering such information would have contributed to taking right decisions.

Significant hope for diminishing threats and risks for agriculture is linked to the creation of National Ecologic Network with multifunctional purposes (Андреев и др., 2001). This network along with solving a set of problems related to biodiversity conservation will lead to increase of slope stability, improving microclimate, soil protection, and, therefore, will contribute to reducing risks that influence ecological state of geocosystems, of their components and to provide for sustainable development of the agriculture of the Republic of Moldova.

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