Fenomene şi procese hidrice de risc

ENVIRONMENTAL TECHNOLOGICAL, HYDROLOGICAL AND CLIMATE RISKS, IN THE BASIN OF NISTRU RIVER AND POSSIBLE MITIGATION STRATEGIES

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ABSTRACT. - **Environmental technological, hydrological and climate risks, in the basin of Nistru River and possible mitigation strategies**. It's examined the impact of technogenical sources and natural risks on the basin of the Dniester river today and in view of climate change. Strategic approaches are proposed for improvement the general state of the environment, quality of surface waters, eco-protective and eco-productive potential of natural resources in the mentioned area based on optimal combination of activities and measures under pollution control strategies, eco-efficiency, prevent pollution source and restore ecosystems and natural ability to self-cleaning of small water reserves promoted by using the economic mechanisms of stimulation and constraint.

Key words: Dniester river basin, risks and natural hazards, climate change.

1. Introduction

The Dniester River is a trans-border river, crossing the territories of Ukraine and Moldova. It stems from the Carpathian Mountains, in Western Ukraine, at an altitude of 878 meters and is pouring into the Black Sea to the west of the ukrainian Odessa city. The total length of the river is 1362 km, of which 630 km cross the territory of Moldova. The annual average debit of the river is about 11 km3. In the river basin live about 10 million inhabitants: 3 million in Moldova and 7 million in the Ukraine. Dniester river satisfying about 54% of the water needs of the national economy of Moldova . The catchments basin of the river has a total area of 68 900 km2. The medium and the lower basin of the river occupies 19 070 km2 of the territory of Moldova which consist 28, 54% of the total basin and 56, 42% of the surface of the country. Both basin and aquatic artery are subject to an intense anthropogenic impact [1,2], which increases the risks of natural hazards: fluid, atmospheric and seismic risks.

The purpose of this work is to assess the technogenical impact and natural risks on the ecosystem of the Dniester River basin, including the perspective of climate change and identification of new approaches and directions of activity for the conservation and effective protection of the environment in the ecosistems of the river basin.

2. Materials and methods

In current research was used the following materials / data sources and methods:

- The characteristics of pollution sources of the Dniester River basin during the 1990-2007 years, performed by the State Ecological Inspectorate and industrial enterprises of the Republic of Moldova and Ukraine;
- Data from State Hydrometeorology Service of the Republic of Moldova about noxious concentrations in the air, atmospheric precipitation and surface water [3,4];
- Assessments from the National Strategy for Natural Risk Attenuation and Climate Change;
- Bibliographic sources indicated in the paper.
- Assessments of noxious emissions into the atmosphere are carried out in accordance with the EMEP methodology for inventory of sources of pollution [3,4].

3. Results and discussion

3. 1. Impact Factors

After examining the main sources and anthropogenic factors that impact negatively on the environment or the Dniester river basin was highlighted four main groups of sources of environmental risk: industrial, agricultural, energy production and communal services. These have a direct impact on the state of the environment and indirectly boost the risks manifested by natural characteristic in the Dniester basin area. More frequent take place series of fluid risks (flood, fluid soil erosion, landslides) and climate (high temperature oscillations, storms, wind erosion of soil). In the last three decades, under the technogenical and climate change impact increases the frequency and intensity of them. The consequences are felt strongly in the median and the lower basin of river. Over 19 000 km2 of this basin is in Moldova, forming about 57% of the country. In this area of the Dniester hydrographical network consists of 1685 water courses (rivers) with length between 10 and 300 km. The total length of the network is 8200 km and have a density of 0.46 km/km2.

3.2. Impact of natural hazards

The most frequent natural hazard that occurs in the basin of the Dniester are floods, disastrous impact being felt mostly on courses of internal rivers from basin. Floods caused by these large rivers are estimated at about U.S. $ 5 million / year [5]. These cause losses of animals, plantations, houses and other buildings and even human lives (flood from 1991 in the basin of river Raut caused 21 human

sacrifice, flood from 1994 in the basin of r.Calmațui – 29. In general floods, like these, in the period 1985-2000 killed 67 people). Material losses in the last 50-60 years caused by floods of small rivers are 5-6 times higher than those in large river basins. The level of protection against floods on small rivers didn't exist, or do not have a high degree of safety. From over 3,000 artificial accumulation of water (ponds) only 460 of existing ponds and lakes are functionally against floods. 659 localities in the country (from the total of 1583) are still in area of flood risk.

If the causes of the disastrous flooding in the basins of small rivers are rainfalls, then for large rivers as Dniester and Prut are characteristic spring floods. The relatively low losses from floods of border rivers, Dniester and Prut, are determined by existence of infrastructure and capacities to prevent danger by inter-state communications. However, there is a risk of catastrophic floods in case of mistakes in infrastructure control, in particular at one or more of the four main dams (Dubasari, Costesti - Stinca, Vatra, Dnestrovsk). Thus, in summer of 2008, after huge quantities of rainwater in the Carpathian mountains, the water leakage from the Dnestrovsk dam was increased several dozen times, which led to huge floods in the river downstream of the dam. Floods of the river Dniester in couple with Prut river upstream and downstream of the dam Costesti - Stinca in the same year caused damage for population and the national economy estimated at 120 mil. USD.

A strategy for mitigation this risk must take into account the probability of intensified storms and torrential rain as a result of climate change.

Rainfalls and floods increase hydrological soil erosion. Moldova's annual losses in agricultural production caused by this erosion in couple with the wind are valued at 40 million USD per year. Landslides take out annually from usage about 1000 hectares of agricultural land, bringing estimated losses between 1,5-3 million USD [5]. Taking into account these losses and the probability of increasing the risk of climate change in Moldova, are elaborated some strategic actions to prevent and mitigate the consequences of natural disasters and hazards, but their implementation is difficult.

3.3. Sources of anthropogenic impact

a. Industrial sources. In the economic systems of Moldova and Ukraine, Dniester river basin represent an economic complex characterized by a high concentration and diversity of industrial enterprises with a potential of environmental risk: extraction of minerals, chemical and oil industry, machine building, food processing , radio electronics etc. Most of the companies with high environmental risks lies in the upper part of the basin, in the Lvov and Ivano-Francovsk region of the Ukraine, where Dniester forms 70% of the flow. Another powerful industrial complex is located in the lower basin - Chisinau, Tiraspol,

Bender cities from Republic of Moldova. On the entire course of the river are located many smaller cities where are also located many potential environmental risk enterprises, including big plants such as the metallurgical factory from Râbnita (in Moldova, on the left side of the Dniester) with a productivity of 1 million tons / year of steel, cement factories near the city Kameneț - Podolsc (Ukraine), Râbnița and Rezina cement factories (Moldova, the right side of the Dniester) with a productivity between 0.5 - 1 million tons / year cement each. On the Raut river, the main tributary of the Dniester river in Moldova, are located some important industrial centres such as the city of Balti and Orhei. They produce enormous quantities of waste. Overall industrial sources from Dniester river basin eliminated in atmosphere are 1000-2000 kt/ year CO_2, 1,0 kt/year SO_2, 0,5 kt/ year NOx etc. Through precipitation the soil reach: sulfur compounds (S) -152 kg/ha, nitrogen compounds (N)-172 kg/ha in the North area; 333 kg/ha nitrogen compounds and 289 kg/ha sulfur compounds in the central area; 278 kg/ha sulfur compounds, 112 kg/ha NOx nitrogen compounds in the south. These leads to acidification and damage of water ecosystems.

b. Impact of technological damage. Also are recorded cases of technological disastrous damage to river. As an example a serious crash occurred in 1983 at the factory of potassium fertilizers in Ukrainian city Stebnic located on the upper course of the Dniester. There has been broken the dam of its sewage lake. In the river flows 4.5 million m3 of waste with a concentration of about 250 g/l, mainly chlorides and sulphates of potassium, sodium, magnesium and other salts, and heavy metals. River water was unusable for several weeks. Following this accident was modified, qualitatively and quantitatively, the salt in water of the Dniester. So after two months of the crash, mineralization in river water entering the territory of Moldova was 2 g/l, including chlorides 0,8-0,9 g/l. In the downstream of city of Soroca mineralization was about 1 g/l. These changes attenuated slowly during more than 1 year.

This damage has caused a serious ecological problems and big losses for the economies of Ukraine and Moldova. Aquatic biodiversity has suffered a lot, both in quantity and quality.

c. The impact of agriculture. A large part of the basin of Dniester is used in agricultural production. Share of this party in Moldova is around 70%. The intensive agriculture, which was practiced here a few decades didn't promote environmentally friendly methods of agricultural farming, plastic irrigation methods and other, based on excessive concentration, monocultures system, non-founded ecological irrigation. Thus, during 1970-1990 area of irrigated lands in Moldova increased from 120,000 ha to 300,000 ha. Around 200,000 hectares of these lands are located in the basin of the Dniester. Simultaneously were attracted into agricultural circuit the large area of protection zones and areas of pasture from

meadows of river which caused an additional loss of biodiversity in the basin. These factors have negatively affected the ecological status of the basin, causing negative changes in soil quality, surface water and groundwater changes which hardly diminish. Soil erosion has reached a loss of 40 t/ ha/year. As a result of water pollution from industrial sources and agricultural activities the water quality of the river are in continuous degradation. (fig. 1,2) [1].

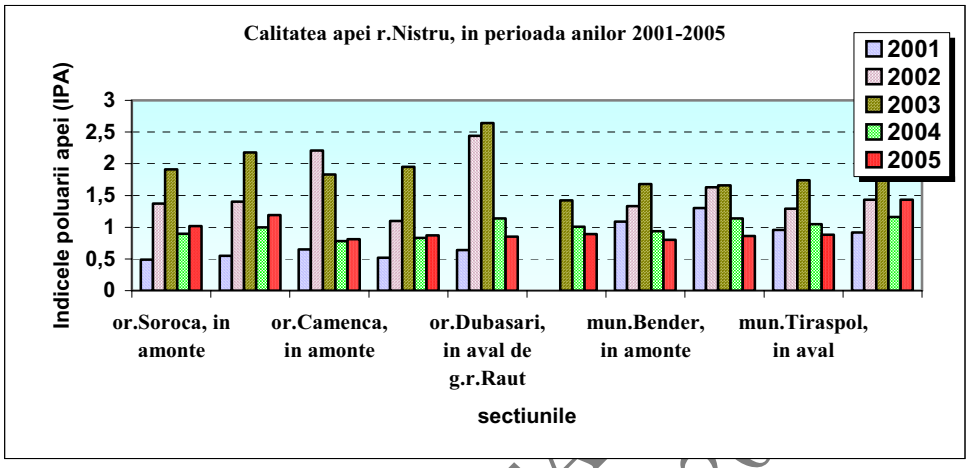

Fig.1. Water quality of the Dniester river in 2001-2005

As a result of such a state of surface waters from the bottom of the Dniester river basin, state characterized by lack of progress, and despite of the protective measures that were undertaken, is needed to change traditional approach to environmental protection only from the positions with the principle "pollution control" called also "end of pipe." It should be developed action plans for sectors with high potential for pollution: industry, energy, communal, agricultural, based on double efficiency (environmental and economic) and “pollution prevention in source". With the interest of increasing the level of protection of water using the "polluter pays" principle will be more effective when shared with other mechanisms of economic incentives and coercive towards preventing pollution in source. For developing and putting into action of such activities will be needed to update the inventory of sources of environmental risk and classified them based on the necessary preventive measures in parallel with the classification after the impact character. Staggering the sources after priority require a monitoring of the impact produced by each group of sources on the ecological status of the hydrological network.

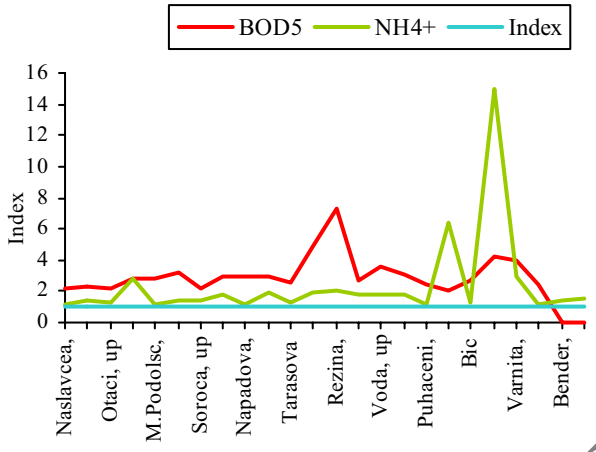

Fig. 2. Water quality of the Dniester river from Naslavcea to Olanesti

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d. The impact of the energy sector. On the upper Dniester where it enters in Moldova, was built the dam of the ukranian hydroelectric station (SHE) Novo-Dnestrovsk. Dam and station operation have seriously affected the ecological state of the river. The average water temperature in the river decreased by 2 ^{0}C. The impact of this phenomenon caused disappearance of species hidrobionts, led to a succession of valuable species of fish with others without important nutritional and economical value. Fish productivity of the river was reduced more than 30 times.

In the middle and lower part of the river are located accumulation tanks of SHE Dubasari and Moldavian Thermoelectrically Station (CTEM). Against the positive role of regulating flow of water and preventing flooding, they have a negative environmental impact. Dam of SHE Dubasari, among others, have a negative geological impact –it stopped movement of stones from river bottom.

In the lower part of the river is situated Cuciurgan lake, which from 1965 became the cooling lake for CTEM. CTEM has a strong negative environmental impact on river and lake because causes the oscillations of water level and temperature during a day, and as a result increase water turbulence. A problem that occurs during time is mineralization of water in lake, which has increased from 0,6 g/l in 1960 to 1,1 g/l today. This water can not be used for agricultural irrigation any more.

Furthermore, the unmentioned sources are strong factors of air pollution in the basin. Only CTEM annually drop in atmosphere about 7 kt/year NOx and 8 kt/year SO_2. These changes in quality of environmental components jeopardises the basin ecosystem and human health. For reducing the existing hazards is required a comprehensive approach to basin management at the intergovernmental cooperation.

e. The communal sector. Environmental situation remains tensioned and because of the degradation of cleaning water stations or lack of them in the small towns which intensive pollute Dniester tributaries. Currently does not work 3 / 5 of the cleaning water stations in Moldova. As a result, about 8 million m3 of wastewater are insufficient cleaned or not cleaned at all and communal and industrial waters are discharged annually into the Dniester. The quality of surface water in the basin of the Dniester river in Moldova is supervised by six specialized monitoring stations, data provided by them demonstrates the continuing degradation of water quality.

4. Impact of climate change

Forecasts of climate change impacts on ecological status of the Dniester river basin. Among the five key issues that relate to the vulnerability of ecosystems, highlighted in the Forth Report of the Assessment group of international experts on climate change, is noted that climate change will intensify the effects of anthropogenic pressure on ecosystems such as un-rationally use of natural resources, degradation of natural habitats, etc., which will cause the progressive reduction of biological diversity. According to the same source during the XXI century about 20-30% of the global biota and between 1-80% at the regional level will be under risk of disappearance. In case if will not take effective measures for preventing and mitigatation of these risks, will substantially decrease the potential of natural and human adaptation to the risks such as changes of

temperature, precipitation, alien species invasion, appearance of diseases considered new or considered dissapeared [6] . These and other forecasts are projected on the ecosystem and environment of the lower Dniester too.

The forecast of effects of climate change presented in the First National Communication of the Republic of Moldova within the United Nations Convention on climate change (2000) involve expansion in Moldova of periods of semi arid climate with periods of arid climate starting from 2010-2039.

The most vulnerable aquatic resources to climate change are surface waters. In case of such scenarios is supposed reducing of water flow rates at the initial period of climate change by 2-20%, including about 14% reduction of Dniester flow in comparison with 1960-1990. At the next stage, after year 2040, the river flow could increase with about 27%, and the interior rivers with 30-50%. Serious changes are forecasted especially for biodiversity, for natural and anthropic ecosystems, as a result of considerable reduction of climate conditions for habitats. This will reduce capacity of forest habitats to maintain biodiversity, environmental protection and ensure it specific social and economic functions (supply of raw materials, energy, food, hunting resources, etc.). Is projected an increase of timber production of forests in the first decades with10-20% followed by 20-40% reduction of it production after the middle of the XXI century. The function of protection and economic role of forests on the territory of Moldova could decrease with 40-60%.

Also is projected increase of soil vulnerability to possible climate change. According to the models used in the report mentioned above CSIRO, MK2, Had cm2, ECHAM4 will be created conditions for intensification of the desertification process, wind and hydrological erosion, landslides. The risk of landslides, as well as of floods will become higher due to increasing volume of rainfall with 8,4-11,4%.Also will increase the frequency of torrential rains. Big variations of temperature will affect both natural phytocoenosis and agro phytocoenosis.

5. Conclusions

1. As a result of preventive study was established that degradation of environmental components in the Dniester river basin: soil, water surface, biological diversity continue as a result of technological impact, degradation of protection system, operation and development of industry, energy, agriculture and communal services of the national economy without taking into account all the environment requirements, environmental legislation, both by economic enterprises and population. Also degradation happens because of discharge in hydrologic network of large quantities of communal sewage and uncleaned partially or totally industrial waters, the irrational use in river basin of water resources, forests, soil and biological diversity at all, local and transboundary pollution of air in basin.

2. A disastrous impact on the ecological situation of the zone has had attracting into agricultural production of over 2 / 3 of the surface of area and degradation or even liquidation of protecting belts of river against winding, swamps draining, banks degradation, discharge of waste from household and livestock activities on the banks of small rivers or even in their water.

3. In case if will be not taking appropriate measures to stop the degradation process in short and medium terms they will enhance and accelerate under the impact of climate change and growth (also as result of climate change) of frequency, intensity and destructive potential natural and technological disasters. Dniester river basin ecosystem will lose a lot of it capacity of resistance to climate change and as result will weak the protection of the ecosystem for humans activity against the natural risks in condition of climate change.

4. For improvement the quality of water surface should be undertaken some measures for pollution preventing based on reduction of formation of pollutants in the source. Optimum combination of approaches, processes, activities and measures from strategies of pollution control, eco-efficiency, pollution prevention in source and restoring of ecosystems and natural ability of self-cleaning of small river water courses, promoted by economic stimulating and constraint mechanisms will improve the overall condition of environment as well as eco-protective and eco-productive potential of natural resources in the area.

5. Activities of protection and conservation of the natural potential of the Dniester river basin in conditions of global environmental changes should be integrative, taking into account the impact of all nocive and local degrading factors in complex, interaction between them and between them and changes in global environment. Activities of reduction pollution sources intake in the basin at the formation of global and trans-border phenomena (reducing greenhouse gas emissions, substances which destroy ozone etc.) through preventive approaches will have an important effect of maintenance of environment quality at the local level.

6. The lack of a single intergovernmental mechanism of protection and rational use of the Dniester river in general, of its eco-protective eco-productive and economical potential, in accordance with provision of "Convention on the protection and rational use of transboundary water courses and international lakes" and "The Water Framework Directive of the European Union" in conditions of a uncertain political and economic stability in the region in the last period don't bring an impulse to activities of improvement of status of biological resources and water river quality, state that is negatively reflected on the biological resources of the aquatic ecosystem and on its economical potential.

7. Another group of activities intended to improve ecological status in the basin of lower and medial Dniester is restoration of natural potential of biodiversity, landscape, capacity of self-cleaning of small river waters by extending

the area of natural micro ecosystems, number and area of natural protected areas, restoration and creation of protection zones and strip of watercourses in the basin, promoting organic farming, enhancing the role of environmental agro biodiversity. In particular is needed to create hydrological protected areas and restoration, at least partially, for ex. wetlands on the courses of Dniester and it tributaries.

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