

VULNERABILITY TO WATER SCARCITY IN MOLDOVA: LIKELY THREATS FOR FUTURE DEVELOPMENT

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Abstract. The present paper analyses vulnerability to water insufficiency for population and economy in the republic of Moldavia, taken into consideration through its impact on the aquatic resources. The worsening of the present situation expected in the near future will extend the areas with water insufficiency on the highly vulnerable regions. If the present situation will continue its dynamics without modifications, then the problem of available water will become a problem for the nation's development. To anticipate this effect, the paper examines several types of measures, and lists some of the basic recommendations.

1. Water, global environmental change, and economy

Securing equal access to natural resources and development possibilities for future generations is a major concern that mankind is facing at present. This concern has numerous facets depending on various natural and economic conditions on the globe. For Moldova, one of the main concerns (declared, among others, as priority directions by the government) consists in promoting economic development and reducing poverty [10]. Achieving those goals is considered, because of the importance of agriculture and agricultural processing industry in national economy, through rehabilitation of Moldavian villages [6], and, implicitly, through promoting sustainable agriculture. Due to the effects of climate change, pressure on water resources and water management will be exacerbated [2], and securing water resources for sustainable use (including, agriculture) may be a problem.

On the one hand, recent studies undertaken on the continental and country level, in spite of various methodologies, show constant trends of warming and drying up of the country's territory that varies in degree but not in direction of change [1,8,12]. Naturally-induced changes are manifested through redistribution of precipitation among seasons in such a way that decreases its amount in the vegetative period; rising temperature that causes increased evapotranspiration;

increasing risk, severity, frequency, and area where droughts occur; and increasing risk, frequency, and severity of extreme weather events (like heavy showers) [11].

During the past 17 years, Moldova has been facing effects of the economic transition from a planned socialist to market economy. The transition's impact has direct and indirect consequences on availability of water resources. Direct consequences are caused by diminished investments in water-related activities that have led to almost total decline of irrigation, failure of irrigation systems and decrease in the number and retaining capacity of reservoirs. For instance, irrigated area has decreased by more than 80 times in 5-6 years and now it constitutes just 1.7% of the previously irrigated area (according to the data of the government agency "Apele Moldovei"). Indirect impact is being manifested through changes in land use (for instance, cutting forests) and in agricultural practices (intensification of grazing on the grasslands, reduction of soil protection measures due to financial failure) that contributed to diminishing share of lands with high capacity for infiltration, thus increasing runoff.

Due to these double effects of economic changes, even under the constant climate, availability of surface water resources (as well as of groundwater) would have diminished since the beginning of the economic crisis. Future projections show that real water resources will diminish even more drastically. Thus, already by 2020s, availability of average surface water resources of the big rivers will diminish by 18-25% and of the local rivers by 26-37% depending on the scenario of greenhouse gases emissions (A2 or B2) [12]. These changes contribute to reducing water quantity and quality and, at the same time, increase water demand in agriculture, industrial and domestic use, as well as they extending the area where additional use of water (for example, for irrigation) must change from desirable to mandatory. The changes will lead to an increasing load on the water resources regardless of the direction of the evolution of the national economy.

Natural and anthropogenic factors within the last decades both contribute to diminishing available water resources. Only natural reclaiming of wetlands from previously drained areas is a result that has, among negative effects of the transition period, been positive: it contributes to conserving biological diversity and increases the quantity of water resources, but at the same time, wetlands occupy the most productive agricultural lands.

On the other hand, Moldavian economics has become more agrarian in recent years and depends on the two main sources of income: a local and export-oriented agriculture and food industry (more than 65% of exports) and remittances (27% of GDP; first country in Europe and 2nd in the World [4]). Russia has been the main economic partner of Moldova and its major target for export of agricultural products, but consecutive closing of its market for Moldavian export forces Moldova to seek new more exigent markets and to be more competitive. In

order to achieve this goal rehabilitation and extension of irrigated agriculture is becoming urgent.

As a result of recent changes in economy as well as the thermo-pluvial regime, productivity of main crops, wheat and corn, has been decreasing in the last years by almost 5% and 3% every year, respectively. At the same time, use of water for irrigation has been decreasing by 9% annually, and the volume of water used for watering of every hectare of actually irrigated fields has been decreasing by 8% every year. In addition to these dramatic data, with under use of irrigation capacity, relative losses of water for irrigation have increased from 13% ten years ago to more than 25% at present.

This situation has reached a zenith in 2007: the drought being faced by Moldova is the most severe in the last 60 years. Total losses, according to the preliminary estimations made by the Government, run up to USD 1 billion (about 1/3 of GDP). But even in these severe conditions, productivity of wheat in regions where irrigation has been maintained (like in Stefan Voda) has achieved 0.4 t/ha, almost twice the country's average in normal years. In such a way, impact of water-related activities on Moldovan economy is obvious.

The water issue has become crucial for the prosperity of the economy and population's well-being. Moreover, economic effects of water scarcity represent just an aspect of the broader issue of national security [3], thus becoming a problem that is a subject to international organizations' concern.

2. Adaptation

Our analysis is based on the previous work, where regions of vulnerability and their role for national economy and population's well-being were identified [5]. Regions of vulnerability were designated to determine territories that are not critically exposed to currently "normal" droughty conditions, but those that will very likely be vulnerable to conditions of extreme droughts. Vulnerability has been classified in three types, depending on the main activity, and sensitivity of the categories of population: urban, rural, and complex vulnerability (Figure 1).

Water scarce areas are already experiencing effects of water deficit and are extremely sensitive to droughts. Regions of vulnerability do not necessarily suffer from water deficit; however, high demand for water combined with decreasing water availability makes them very sensitive to the changes likely to occur in the near future. It is extremely important to manage and make attempts to prevent the expected crisis, because areas both actually and potentially scarce in water are very significant for national economy and well-being of the country's population.

Projections of the moisture conditions and assessment of economic activities in the future make us expect that demand for water will be higher. At the same time, in rehabilitating past water use practices, losses of water will be higher as

well because inefficiency of the old practices will be accentuated under a more arid climate.

During the last 17 years, the government has not been paying attention to irrigation issues. Small farmers, left on their own, have no possibility to pay for water. This problem can no longer be ignored. It demands concern of governmental officials and international organizations. Planned activities include extending use of the limited water in agriculture and economic activities. In absolute terms, it will not be as large as before the crisis because of implementing new irrigational techniques and new crops, but, in relative terms, due to diminishing water resources, water use is expected to be more intensive.

The solution is represented by sustainable water use and a stable water supply. However, one main factor should be borne in mind: due to changes, especially climatic, some areas have started recently to experience insufficient water; some others will experience it in the near future (10-15 years). There has been evidence in four of such “vulnerable” regions; three of them (partly) are experiencing vulnerability because of water scarcity. Special attention should be paid on the zones of intersection of water scarce area and regions of vulnerability because here “natural” deficit of water is overlaid over the high load and intensive use of it. These areas (regions of vulnerability and zones of intersection) represent the main threat for future development of national economy from the standpoint of water supply.

As shown in our previous work [5], **Central Region** concentrates complex and diversified activities of national economy; on its territory, the most important population node is located. Water for all industry and the population is supplied by many local reservoirs and large transfers of water from Moldova’s second largest reservoir (Dubasari Reservoir on Dniester River). Probable water scarcity will have direct impact on many economic branches, and this effect will be multi-directional and exceedingly complex. This region is characterized by *complex vulnerability* of its population, agriculture, and economy to likely changes.

Industrial activity of **Southern Transnistria region** has an important potential, which is somewhat thwarted by economic and political conditions. At the same time, the region has more secure water supply for industrial and urban domestic water use than the previous one in short-term perspective thanks to the Dniester River and deep aquifers. Agriculture and rural activities seem to be significantly more exposed to likely crisis than cities. Therefore the region is characterized by *rural vulnerability*.

On the one hand, the importance of focusing water policies mainly on these regions consists in the fact that they will pass through the threshold from more or less favorable to unfavorable thermo-pluvial conditions in the near future. This threshold is very complex and is not related just to the water demand, watering or

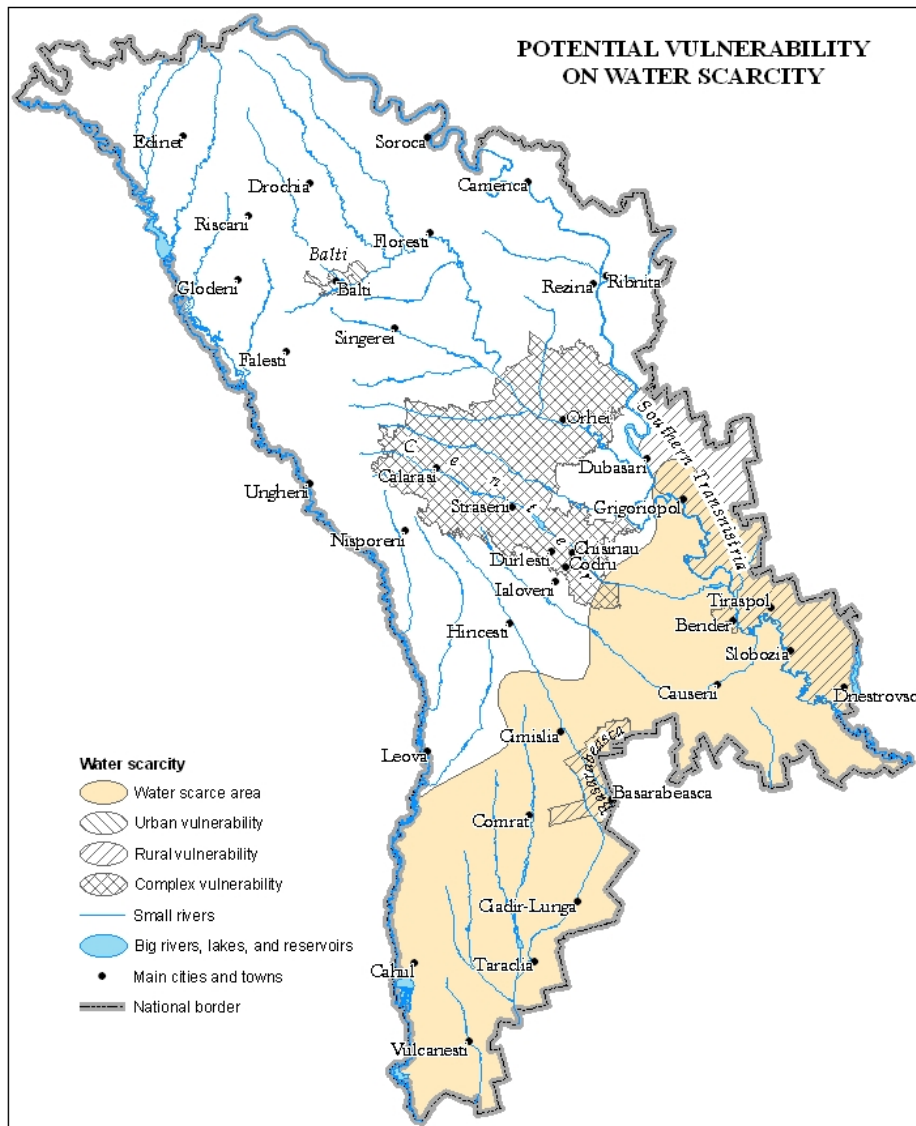


Fig. 1 - Potential vulnerability to water scarcity [5]

industrial use; it is much broader (for instance, it relates to the biological efficiency of climate [11]).

On the other hand, we do not expect that in the near future water scarce areas will embrace all the regions of vulnerability: the western part of central region and Balti region seems not to experience water deficit problems. However, it will extend over the territories with relatively low vulnerability in the eastern part of the country. If some indicators of water scarce area and regions of vulnerability [5] will be added, the new region will include 45% of country's territory, more than half of the towns and 36% of villages, more than 2/3 of the urban population (almost 80% if we include Balti as well, which is still vulnerable) and 44% of rural population, as well as forests, pastures, orchards, and arable land more than 40% each, and almost 70% of country's vineyards. In such a way, very important parts of the country's population and lands will be affected to a certain extent by water scarcity. Therefore, we can say that Moldova is very close to a threshold of the entire country being threatened. After passing this threshold, a totally new approach to climate change mitigation policy will need to be adapted.

Because rural activities (including agriculture and food processing industries) seem to represent the biggest concern of governmental policies and the main factor of revitalization of national economy, adaptation to new conditions to prevent and diminish negative effects of global environmental change is very important. And, regardless of their focus, adaptation policies should take in consideration effects on the rural people, in order to diminish their sensitivity to the policies and changes. Two types of adaptation should be considered: passive and active adaptation. In terms of their relation to villagers' way of life, the latter has two sub-categories that require special attention.

Passive adaptation is the result of natural evolution of agricultural practices. It is more water intensive (if we speak about water use), but it is less time- and emotion-consuming, does not require radical changes in the way of life of the villagers, and is more economically efficient with minor changes at early phases of drastic changes. In addition, it is efficient to a certain extent at bigger but constant changes. But in long-term perspective and under the changes passing at least one threshold, it leads to the quick depletion of water resources.

As an eloquent example we can cite is currently occurring in the south-eastern part of the country. The first aquifer (perched groundwater) in the villages is depleting due to diminishing recharge capacity; people are experiencing lack of water for watering vegetable gardens – the activity traditionally practiced over the years. The solution was found in breaching the upper aquifer with a pipe and pumping water from the lower one. As a result: depletion rate of the perched groundwater has increased, there is enough water for watering so far, and nothing has changed in agricultural practices and people's way of life.

This type of adaptation can be recommended in the southern part of the country traditionally experiencing deficit and poor quality water resources, because their practices and way of life have evolved under the water scarce conditions.

Active adaptation is more water-efficient; however, it is cost-intensive and needs important investments. It gives better results in the longer perspective, but it is much more efficient if implemented under the conditions that pass through a certain threshold. However, in its relation to societal effect of likely changes, it is separated in two subtypes.

Socially passive adaptation, when applied to rural activities and agriculture, is based on introducing drought resistant cultivars of the same crops traditionally cultivated in the area as well as on implementing improved irrigation techniques in existing or recently irrigated areas. This subtype is relatively more cost-intensive than passive adaptation category, but it is based on improving current agricultural practices and has neither important, nor immediate effect on people's way of life.

Socially active adaptation is the most radical among the presented types, because it requires change, sometimes very drastic, of the villagers' traditional occupations. For instance, introducing completely new crops or agricultural techniques, which villagers are not familiar with or introducing irrigation in previously non-irrigated areas. The vulnerability of the population increases not just due to global environmental change, but additional contribution is made by policy measures, especially when they are applied in anticipation of future conditions that are not yet obvious to the locals. In addition to increasing financial costs, it creates tension among villagers, it is emotion-consuming and, if translated in financial terms, its total costs can be the highest among all the presented types (and even higher than initially planned). But in long-term perspective, if properly implemented, it promises the best results.

Active adaptation is more risky and more difficult to implement, but it is more recommended in the regions of vulnerability. It is especially important, because this type of adaptation, in order to be efficient, must embrace all aspects of people's (mainly villagers') everyday life. The best (but not fast) way is to start from education and pass through all the water related aspects. Implementation of active type adaptation through the entire water scarce region, especially in the regions of vulnerability, will result in increasing efficiency of water policy, will eliminate an important brake on Moldova's economic development, and will contribute to consolidating the base of sustainable development of the country.

3. Conclusions and recommendations

The recommendations with immediate and more distant goals in order to diminish vulnerability of economy and population to water issues can be adapted from experience of similar regions facing same problems. Drawing on the

recommendations elaborated for Bulgaria [7], the authors attempted to outline main measures (with emphasis on those absent in current practices and specific to local needs) that should be respected in order to eliminate likely threats for economic development of Moldova:

- Economy and mode of living:
 - Adaptation approaches should be carefully differentiated by type and by region; no single solution fits everywhere;
- Economy and agriculture:
 - Attention in national and regional economic planning should be paid to the vulnerability of the economy to water supply;
 - Planning in the agricultural economy should take into consideration crop pattern change with special attention to potential vulnerability of these measures;
 - Consideration should be given to the establishment of strategic food and water reserves;
- Water management planning:
 - Create scenarios of water use under the severe drought and water shortage conditions which prioritize water use (focusing on drinking water and irrigation),
- Irrigation agriculture management:
 - Irrigation systems should be re-created from the standpoint of and borrowing practices from more arid climates with special attention to minimization of losses of water (e.g. drip irrigation, special water storage systems etc.);
 - Prospective review of irrigative potential should be made;
 - Special attention should be paid on diminishing soil salinization, especially in the southern parts of the country;
- Ethics and politics of water:
 - Special attention should be paid on reassessing national traditions and search for new approaches for consolidation of water-saving culture and ethics;
 - Issues and problems of global environmental change should be part of public education.

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