Estimation of wetlands contribution to possible climate change in Moldova.

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The biggest rivers in Moldova are Dnister river (total length - 1352 km, length within Moldova's boundaries-630 km; the average annual flow-10700 mln.m^3) and Prut river (total length - 976 km, length within Moldova's boundaries-695 km; the average annual flow - 2900 mln.m^3). In springtime Dnister river has a flow of 44.4% of the annual flow; in summer time - 25.5%, in autumn-time-16.0%, in wintertime 14.1%. These data for Prut river are - 39.1%; 33.5%, 12.3% and 15.2% respectively.

Altogether, there are more than 3000 rivers, permanent and temporary streams. Out of them 7 have length of about 100 km; 247 - 10 kilometers, others- less than 10 kilometers. The density of rivers network varies from 0.8 km/km^2 to 0.2 km/km^2. Within last decades the hydrographic network met drastic changes. As a result of land reclamation, over 70% of rivers and streams have been regulated. In summer time the flow volume of small rivers decrease substantially; sometimes they are completely dried up. There are also 57 lakes on the territory of Moldova with total surface area 62.2 km^2. Besides natural lakes, there are nearly 3000 ponds and accumulation reservoirs.

Wetlands in the Moldovan part of the Danube river basin practically have not remained, except lower Prut river area. Several significant wetlands remained in the Dnister river basin: Copanka-Tolmaz; Ataci-Golosnita, Salas, Cuchurgani, and Goian bay. Spatial distribution of remained wetlands in Moldova among other ecosystems has been significantly changed due to anthropogenic activity. The largest remaining wetland areas belong to the Prut river and Dnister river floodplains (table 1).

Table 1. Wetland areas in the floodplains of the main rivers in Moldova

River	Wetland areas (ha)	Desiccated areas in the floodplains (ha)	Wetland areas protected from flooding (ha)
Dnister	68100	39000	38700
Prut	64200	20000	21700
Reut	21400		6400
Bic	12000		4600
Botna	10500	5000	7500
Cogilnic	11300		5900
Yalpugh	10700		1400
Total	198200		86200

Altogether the total surface area of floodplains of all rivers in Moldova constitutes 250000 ha and among them 200000 ha are under intensive agriculture. At the end of 50th the percentage of wetland areas, which was out of agricultural activity consisted about 74%, or 155800 ha, while at the end of 80th it was reduced to 20%. Total surface of

desiccated lands was 155800 ha. The depth of ground water in the wetlands varies from 0 to 2 m. The surface areas with different depth of groundwater in spring-summer period are presented in table 2.

Table 2. The level of groundwater in the wetland areas in Moldova

The depth of groundwater level in wetland areas (m)	Wetland areas with a certain groundwater level (ha)	% to the total wetland area
> 2	62500	25
1,5 – 2,0	37500	15
1,0 – 1,5	107500	43
0 – 1,0	42500	17

The most changeable among wetlands are swamps. Spatial distribution of swamps throughout the Moldova is: total surface area - 17200 thousand ha, including: in the forestry areas - 400 ha; adjacent to water bodies - 2100 ha; reserved - 9400 ha.

Large desiccation of the wetlands in Moldova was held in the middle of 70th. These lands have been widely involved in intensive agricultural activities: irrigation, use of mineral (200 kg/ha of a.s. of N and P) fertilizers, organic fertilizers (8-10 tons per year), and pesticides (mainly copper sulfate 15-16 kg/ha/year). Great negative impact on swamps and shallow water bodies results from eutrophication due to fertilizers application. It caused the reducing of plant species and their communities, changes in swamp vegetation etc. Previous intensive agricultural practice has strongly influenced the state of biodiversity in wetland areas and rivers itself. Currently applying of mineral and organic fertilizers, and pesticides also has strongly reduced for last 5-7 years.

Annual level of evaporation in Moldova constitutes 750 mm in the northern part: 850 mm in the central part and 900 mm in the southern part. Normally the level of water covering wetland areas from middle of March to middle of April (spring flooding) constitutes 0,5–1 meters. In this period the evaporation process is quite insignificant and virtually all water percolates into the underground horizons. Evaporation is responsible for the water loses during the hot summer period and impacts all water bodies, including those shallow waters, which are mainly responsible for the feeding of big rivers - Prut and - Dnister (till 60-70% of their flow during the summer period).

Alteration of hydrological regime along with flow change and available humidity will impact on precipitation, erosion and circulation of organic matters and nutrients. This in turn will influence on plant primary production, species competition and biodiversity. All these ties are extremely vulnerable and as a consequences of temperature or precipitation change could occur favorable conditions for sudden plant diseases or massive insect's reproduction.

Climate changes will definitely exert influence on wetlands and their ecosystems because such abiotic factors as temperature, evaporation and precipitation determine basic biogeographical zones and a small change even of one critical factors (e.g. temperature, precipitation, evaporation, or soil structure etc.) could cause sharp regional changes what in turn will effect on biogeographical structure of plant and on biodiversity typical for certain areas. Along with difficulties because of time shortage in ecosystems enlargement or displacement such problems could arise because of anthropogenic or

natural barriers that will prevent ecosystems migration so far climatic zones will displace. So, there is a great hazard that in some cases flora and fauna will migrate insufficiently fast to survive in alternating conditions.

Any significant change in plant production and structure will lead to change in animal life (dispersion, structure, reproduction etc.) It could be seemed that their response to enriched CO_2 will be only positive because it contributes their growth. However it is not obligatory that such a response will be unified for all plant associations; accelerated growth of some plants could suppress the growth of others. Besides, very doubted seems to be the concept, that plants will absorb consequently enhanced amount of carbon dioxide. Increased competition between plants also will prevent improvement of such natural ecosystems like forests and meadows.

Through little research has been done on whole-forest responses to elevated CO_2 levels, there is no reason to believe that net growth occurs in forest ecosystem. However, regardless of how it influences total carbon storage, CO2 enrichment is bound to have an impact on ecosystems. In fact, the composition of plant communities will likely change as different responses to heightened CO2 result in some plants competing more successfully. Again, CO_2 enrichment would have other ecosystemswide effects. For reasons unknown, CO_2-enriched foliage contains less nitrogen, making it less palatable to herbivores. Certainly, plant response to higher CO_2 levels must be weighed against competitive responses to other climate variable, for instance, higher temperatures and altered precipitation patterns. One widely acknowledged effect of higher temperature is to shift the optimum growing range of plants toward higher latitudes. This can cause a rapid and large-scale reorganization of plant communities. If, because of higher temperatures, some forested areas shrunk and gave way to herbaceous or shrubby vegetation, it could result in a net carbon release to the atmosphere, easily overwhelming positive CO2 fertilization effects.

Animal species using plants for nutrition or as habitats also will be under threat. In turn, loss of biodiversity will threat natural ecosystem integrity what will have negative effect on ecology and economy. Change of foliage nutrition value may cause reduction of animal populations (consuments of a second and third orders) in limits of their habitats. Besides, enhanced CO_2 may impact at the time of plant growth and blooming what will violate the fertilization process.

Change of vegetation zones followed by climate change may also have severe consequences for dispersal, abundance and survival of animals. Fast changes along with existing urban and agricultural barriers could prevent availability of many animal species to come through from one zone to another. Moreover, rare and threatened species will be especially vulnerable to fast changes due to their narrow ecological niche. That’s why fast climate change will be definitely threat biodiversity.

Change in atmosphere content will impact on biomass enhance, alteration of vegetation content and organic matter what in turn will provoke unexpected changes in soil structure. As a result of increased temperature and change of precipitation within year whole ecosystems may displace northward, but it may be restricted by the land use patterns. It’s assumed that in general higher temperature will lead to creating of dryer climatic conditions. Droughts increase may induce such unfavorable processes in the soil like cessation of nutrients providing, salts accumulation and sharp reduction of soil fertility.

Generally , investigations of the climate change impact on wetlands, their ecosystems and biodiversity have been little or not at all performed in Moldova. However, on the base of manifold investigations fulfilled abroad it was shown that climate change may reduce stability of wetland ecosystems. New environmental conditions will contribute to appearance of plant and animal species with bigger competitive abilities. Alterations of native plant associations and forests may change living conditions for animals, especially amphibians, insects, reptiles and birds; change their range, including rapid extinction of certain species and alterate wildlife communities composition. Temperature optimums will influence the succession rate of fish and other aquatic organisms. The rate of species disappearance will depend on rapidity of climate warming and dispersion rate of the species. Those species that are more tolerable to dry conditions may partly replace the actual vegetation and thus change biological productivity of these lands. If normal biomass of the wetlands constitutes about 2 tones per ha (In: Rational use of wetlands, 1957), one can assume that climate change will reduce this till 1,8-1,9 tones. CO_2 consumption due to the photosynthesis is 7.9 mg of CO_2 per square decimeter per hour. The reducing of biomass on 4-10% can cause increase of CO_2 from wetland vegetation on approximately 0,02 mg/dm^2/hour. Considering, that wetland biomass covers about 50000 ha one can calculate that total emissions of CO_2 due to this factor will be:
50000 ha x 0,02 mg/dm^2/hour = 1 t of CO_2/hour.
If to take into account that the vegetation period in Moldova is about 180 days and lasts 12 hours per day total annual emissions roughly may be estimated as:
1000 tones of CO_2/hour X 12 hours X 180 days = 2160 tones of CO_2 per year

Climate change also will lead to the occurrence of new various plant and animal diseases. Temperature enhance may induce both the exceeding of adaptation abilities and extinction of species. Precipitation balance is important factor together with temperature acting on chemical composition and structure of soils.

Climate warming will be more expressed in the northern and temperate latitudes. Since individual species inhabited in wetlands have their temperature optimums, enhance of temperature by at least 1 C is expected to change species range. In the conditions of climate warming species range is expected to move northward (latitudinal). Well known also, that climate warming could contribute to northward shifts of the certain forest types. Besides, enhanced temperatures induce favorable conditions for pests and appearance of plant diseases. In Moldova forests are mostly planted and such type of forests are the most sensitive to climate change.

Alteration of species range is an extremely complicated process, which definitely lead to both extinction of certain species and colonization of new areas. As for wetland aquatic ecosystems, they are much more well adopted to the temperature conditions than terrestrial ones, however limits of their adaptation will depend on dissolved oxygen, fish and crustacean development cycles, feeding conditions etc.