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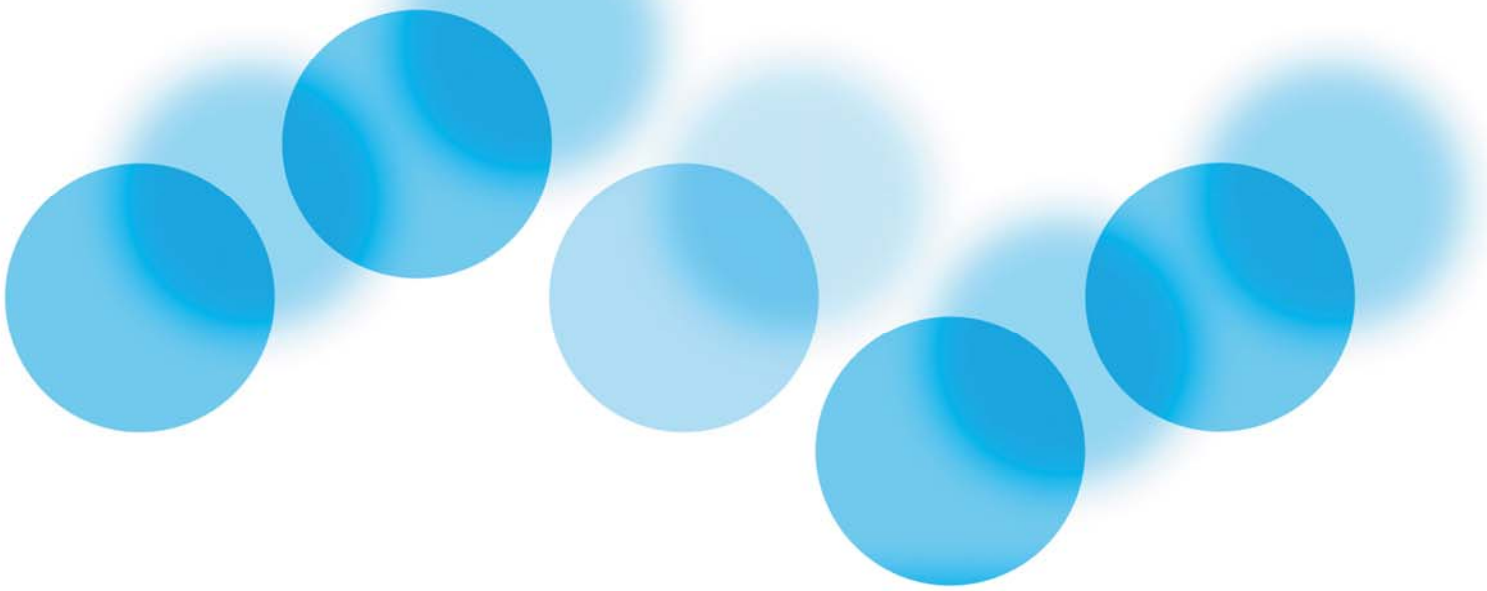
CASE STUDY: - "MONITORING AND ASSESSMENT OF NURIENT REMOVAL CAPACITY OF RIVERINE WETLANDS"

Final Report



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PREFACE

This assignment is directed at the implementing a small case study on estimation of nutrient removal capacities of wetlands that will contribute to the preparation of a Guidance Document to assist with the Water Framework Directive implementation.

The overall objective of this Component within the DRP's Phase 2 on "Monitoring Nutrient Removal Capacity of Wetlands" has been identified as:

To identify the benefits of wetlands as nutrient reduction/retention facilities and the contribution of wetlands in this role to the WFD Programme of Measures in Moldova.

The overall goal of the project was to propose measures for nutrient reduction due to the wetland restoration together with the development of the monitoring network for the quantification of the efficiency of the nutrient reduction. Involvement of local authorities allowed selection of sites for potential restoration and providing of recommendations for future efforts to reduce nutrient loads on water ecosystems through wetland restoration activities.

Specific objectives of the project were:

- To provide an assessment of nutrient sources in the region and quantify them, using statistical, scientific and other data on nutrient content in the components of environment and nutrient emissions in the region
- To identify main problems associated with the wetland nutrient removal capacities in the region and to estimate main pathways of nutrients in wetland areas.
- To evaluate options for nutrient reduction due to wetland restoration
- To select demo wetland restoration sites in the region
- To develop recommendations for monitoring program on nutrient reduction efficiency for wetland restoration and development of the network of wetland restored sites in the Yalpugh and Cahul river basins

The implementation of the assignment was addressed next issues: inadequate practices of nutrient management due to inappropriate agricultural practices in the region; insufficient study of the area, poor information on the quality of environment, water, soil and sediment quality and data availability; environmental degradation due to the high nutrient loads and erosion; deterioration of water quality of the rivers and artificial lakes; reduction of nutrients loads originated from different types of economy on water ecosystems; development of measures aimed at the wetland restoration in the region and prepare a list of project files, as well as; strengthening cross border cooperation towards reduction of nutrient loads and promote wetland restoration activity in the region.

The outputs and outcomes from this project will be utilized and further developed in the context of the development of the basin wide Danube River Basin Management Plan and implementation of the EU WFD in Moldova

The Project implementation will contribute to the development of a regional approach for to the elaboration of the river basin management plan, in line with the EU WFD and the country's commitments to the ICPDR.

Recruitment of local staff

Responsibilities of Moldovan team experts were assigned as follows:

Name	Position	Responsibilities
Dumitru Drumea	Team Leader	Overall project coordination and management Identifying sources of data, their processing and analysis. Selection of wetland restoration sites. Calculation of nutrient balance. Inception and final reports writing
Tatiana Belous	Local expert	Collecting and processing data on: agriculture, population, forestry and precipitation. Selection of wetland restoration sites.
Anghelina Covalenco	Local expert	Collecting and processing data on surface water, groundwater and wastewater quality Selection of wetland restoration sites.
Ciolacu Eugen	Local expert	Mapping of sampling and wetland restoration sites. Selection of wetland restoration sites.

ABBREVIATIONS

CTSNP	Complex Territorial Scheme for Nature Protection
BAP	Best Agricultural Practice
DANUBIS	Nutrient Management in the Danube Basin and its Impact on the Black Sea
DRB	Danube River Basin
DRP	Danube Regional Project
EU	European Union
WFD	Water Framework Directive
GIS	Geographical Information System
ICPDR	International Commission for the Protection of the Danube River

MAFI	Ministry of Agriculture and Food Industry
MENR	Ministry of Ecology and Natural Resources
RBMP	River Basin Management Plan

1. INTRODUCTION

The necessity of the development of the project was based on information on the water quality in regard to nutrient in the southern part of Moldova. Case-study regions are located in the most vulnerable zone of the country with great water scarcity. Water resources are extremely limited and desiccation of Yalpugh and Cahul wetland areas led to strong deterioration of natural ecosystems in the region.

On the base of project results one could estimate actual nutrient loads on water ecosystems and identify main sources of pollution with the nutrients. The balance needs a lot of data. Partially these data were obtained during sampling campaign organized by experts from the “ECOS”, Regional Center for Strategic Environmental Studies. Hydrometeo Service (national reference lab for the Danube Convention) performed analysis of collected samples. Sampling stations in the frame of the study did not repeat those included in transnational monitoring network for the Danube basin. Results from local statistics often do not correspond to the reality (no data on fuel consumption, waste management, harvesting of the biological resources like fishing, cutting of trees, reed belts, etc). Existed data on population do not include migration capacity, real incomes of the people and thus create difficulties in estimation of nutrient fluxes from localities through consumption of different goods. Estimation of animal breeding is also a problem, because of lack of relevant statistics.

There is no monitoring on ground waters in the region. Several data were obtained from the Sanitary- Epidemiological Service, which performs analysis for drinking water sources. These data are also limited and do not cover all localities (only 30-35% of all localities are included in the network). This Service measures mainly mineral forms of nitrogen. Phosphorus in the ground waters is not measured and some data were obtained in the frame of actual study. This data did not show any alarm picture on phosphorus in the ground waters, which could be explained by high alkalinity of soils, waters and rocks in the region, small precipitations (<350 mm/year), etc.

The basins of the Yalpugh and Cahul rivers cover around 4300 km^2. Cathment areas of these rivers are located in Moldova and lakes Yalpugh and Cahul, in which they discharge, in Ukraine. Around 200000 people live in the basins of the rivers dealing mainly with the agricultural activity (grape cultivation, orchards, perennial crops). According to the statistical data around 80% of basin area is under different types of agricultural activities. Average application of fertilizers is around 10 kg/ha of nitrogen and around 1 kg/ha of phosphorus.

Irrigation lands used to be developed in the middle of 70^{th} in the valley of the Yalpugh river, but high TDS content did not allow to use constructed facilities for irrigation and actually irrigated lands in the area are practically absent.

Waste water facilities exist in relatively big settlements in the area like Comrat (20.000 people), Taraclia (12.000 people), Vulcanesti (12.000 people), Ceadir-Lunga (10.000 people). Industrial waste waters (mainly from food processing industry) are treated on municipal facilities and then are released to the Yalpugh river. Data on emissions of waste waters in the region are often contradictory and quality of emissions is monitored by labs without certificate, these labs do not participate in the interlaboratory studies, etc. in addition to it private households, especially in rural areas are not included in the statistics and their discharges are not known. Urban population is connected to sewer system on the level of 30-40%. Rest part of urban population use mainly septic tanks. There are no waste water treatment facilities in rural localities, where main part of population of the region lives.

2. PROJECT BACKGROUND AND EXISTING NUTRIENTS-RELATED INFORMATION

High nutrient loads and their consequences are recognized as one the most severe problems in the region together with the water scarcity. Nutrient reduction measures and monitoring on theirs' efficiency are main priority for local environmental authorities. Running project on control of nutrients from agriculture indicated some measures, which could lead to the reduction of nutrient loads.

Pre-requisite for the developing of the nutrient reduction policy for the region of Lower Danubian lakes (Yalpugh and Cahul basins) is to prepare a balance of nutrients cycling in environment and on the base of sampling campaign data, data from statistical and literature sources to calculate nutrient loads, which could be removed through wetland functioning (stock in vegetation, bottom sediments, alluvial soils, sediment retention, etc). Also the improved nutrient monitoring should be developed in the Yalpugh and Cahul river basins for the support of future policy-making aimed at sustainable development of the region.

First nutrient balances in the region were developed in the frame of the Haskoning and nutrient balance studies, performed in the middle of 90th. The target years for them were 1988 and 1992. Statistical data, which were the basis for these studies could not reflect all changes in nutrient balances after the Soviet era. Nutrient reduction capacities of wetland areas were tried to be estimated in the frame of mentioned projects, but it did not allow estimate nutrient removal capacities of wetlands.

On the basis of different efforts for estimation of nutrient reduction capacities of wetland areas a number of important issues were identified for recent study. Most important could be next: what was the impact of recent economic changes on nutrient cycling in wetland areas; what data are needed for calculation of nutrient loads, which could be removed by wetlands; how to use water, soil, sediment and vegetation data on nutrient content for calculation of nutrient removal

capacities of wetlands; how should monitoring on efficiency of wetland restoration for nutrient reduction should organized in future.

Recent study is based on the detailed data collection from statistical sources on nutrient consumption in the region, content of nutrients in the components of environment, results of sampling campaign, etc

Nutrient-related information on the Cahul and Yalpugh river basins is presented in Annex 1

3. METHODOLOGY

Traditional methods for assessing environmental quality in the wetland areas were used for estimation of nutrient loads and identification of its part reaching water ecosystems. Material accounting included assessing of statistical data on:

- agriculture: application of mineral and organic fertilizers, animal breeding, collection of livestock, land use in the basin, etc;
- industry: production of nutrient content goods, emissions with nutrient content (energy production, fuel consumption, etc);
- background information on water, soil, sediment vegetation quality, atmospheric precipitation, results of the sampling campaign
- consultation meetings with local authorities
- municipal data on waste water treatment,
- literature data on content of nutrients in different waste produced in private households, etc

Material accounting allowed calculation of stocks of nutrients in different parts of wetland areas, identify and quantify main issues of the pollution problems and allowed planning of certain actions aimed at wetland restoration and nutrient reduction.

3.1 EVALUATION OF THE RESULTS OF THE SAMPLING CAMPAIGN

In the frame of the project water quality was evaluated from monitoring network and sampling campaign. Samples have been collected from main water bodies – Comrat, Congaz and Taraclia. In addition to it water samples were collected from main river in upper – 2 stations, middle – 2 stations and lower Yalpugh, Cahul river was sampled in the lower part on 2 stations (see map 1). Sampling was performed in May and October 2006. The results of sampling campaign are presented in annex 1.

Sampling campaign was organized in order to cover the gaps for background data. There are 2 stations on Yalpugh river, where only water quality is monitored twice per year. Actual sampling campaign included collection of samples of sediments from the river and water bodies, alluvial soils in wetland areas, soils from watershed, vegetation, atmospheric precipitations. Analysis of collected materials was performed in the Hydrometeo Service lab, authorized for TNMN in the frame of the ICPDR. This laboratory participates in the interlaboratory studies and performances for nutrients for last 5 years were satisfactory.

3.2 EVALUATION OF THE STATISTICAL DATA

Statistical data included analysis of national and local statistics, plans for social and economical development of the region, use of nutrient content goods, etc. That target year for these data was period of 2004 – 2005. Statistical data on emissions of nutrients with waste waters were obtained from local WWTPs laboratories. Partially samples from these labs were parallel analyzed in the Hydrometeo Service lab. The results showed satisfactory results (>75% of collected samples gave comparable results).

Input of diffuse sources on nutrient loads, reaching wetland areas was estimated on the base of statistical data on fertilizers application, production of organic wastes, which are used as fertilizers or stocked in an unorganized manner under open space. Estimation of nutrient loads is based on the content of N and P in organic wastes and volumes of these wastes obtained from statistical sources.

Statistical data on nutrient emissions from population not connected to the sewer system in the region practically do not exist. Any collection of organic wastes in the rural settlements is not developed and a lot of organic wastes are stocked in ravines, river banks, suburbs of localities, etc. These dump sites are not included in the statistics, but could present a significant impact on nutrient loads reaching wetland areas.

3.3 CONSULTATION MEETINGS WITH LOCAL AUTHORITIES

Main goal of the consultation meetings with local authorities was estimation of the capacities of local institutions in implementation of wetland restoration activities and nutrient reduction measures associated with wetland restoration activities. For these purposes around 25 local authorities: head of regional environmental Inspectorate, experts of regional environmental Inspectorate, local branches of the “Apele Moldovei”, mayors of the villages, etc were contacted in the frame of the project. Main question for discussions was expectations of local authorities of wetland restoration activities and their willingness to restore wetlands, vision on implementation of nutrient reduction measures, etc

Local authorities expressed great concern on high concentration of nutrients in the waters (surface and shallow). They also expressed a commitment to introduce nutrient reduction measures and contribute to wetland restoration activities in the region. A short presentation of the project results was made at the end of November in Comrat in regional environmental Inspectorate on the role of wetlands in nutrient reduction and results of the project.

Local authorities also informed on the plans of planting of the green zones in the wetland areas near town of Comrat. They reported that around 20% of planted trees reach 3 year old and that overgrazing is main problem in the wetland areas. Another concern of local environmental authorities in regard to wetland is deepening of the Yalpugh river bed (1-1,2 m) in its upper part for avoiding of floods.

3.4. INTEGRATED DATABASE AND GIS IN THE REGION

The development of an integrated database-GIS for the Yalpugh and Cahul rivers is vitally needed for strengthening capacities of local institutions to harmonize the national reporting system compatible with the European one. Actually GIS is practically not developed in the region and used maps are from the Soviet era edition of 1969 with upgrading in the mid of 80th. Scanned versions of these maps were used for actual project.

4. NUTRIENT BALANCES FOR THE YALPUGH AND CAHUL BASINS

Nutrient balances were calculated on the base of data from national and regional statistical sources, scientific data obtained from different reports and articles, sampling campaign developed in the frame of actual project.

4.1 METHODS USED

The results of the sampling of main natural components together with the sampling of runoff from different types of the landscapes gave information for the calculation of the fluxes of nutrients in environment of the case-study area.

Data on water quality were obtained based on the national statistics for the monitoring stations and sampling campaign during the study. At the same time this information was strongly incomplete, because key natural water ecosystems for this study are not included in the national environmental monitoring network. For the resolving of this gap the water and bottom sediments sampling was undertaken. Special attention was paid to the bottom sediments in

lakes and Yalpugh and Cahul rivers, because the amount of nutrients accumulated here is the stock of these elements in the system and strongly influences on the state of theirs' balance.

4.2 METHODOLOGY OF ANALYSES

Several analyses of the soil, water, liquid part of the bottom sediments were performed in the frame of the study. Mineral forms of nitrogen and phosphorus were determined. Standard methodology was used for these purposes. Samples were collected during the field trips. Surface waters were collected in the winter, spring, summer and autumn period. Statistical data from different institutions and scientific reports were also used for the completion of the data.

Bottom sediments were collected during spring and summer periods. Liquid phase was received after rotation of the sample under 700 rotations per minute. Than the sample was analyzed as water sample according to the standard methodology.

Water and bottom sediment samples were collected at the beginning of the water body, in the middle part and near the barrage. The results were summarized and average meaning was calculated.

5. NITROGEN AND PHOSPHORUS BALANCES

This chapter presents the results on the estimation of the nutrient balances in the case-study region. Based on them total amount of nitrogen and phosphorus entering and leaving ecosystems have been calculated. For these activities it was necessary to use the data on the use pattern of different goods, land use, waste disposal and production, to make a set of estimations based on the results of sampling campaign in the frame of the project for last period.

5.1 ESTIMATION OF NITROGEN AND PHOSPHORUS REMOVAL BY WETLANDS

5.1.1 Quality of surface water.

Characterization of water quality

Data collected

The registered yearly average concentrations of N-NH4, N-NO2, N-NO3, P-total in the Yalpugh river during the last 12 years are presented in Annex 1 The data were obtained through monitoring programme by Hydrometeo Service.

Surface water quality

According to the estimation the water of the Yalpugh and Cahul rivers do not correspond to drinking quality standards (GOST-2874-82 "Drinking water") in terms of mineralization, pH, DO, chlorine, sulfates, oil compounds, N-nitrite and N-nitrate, silicon, ferrum. In many cases, the concentration of some components were higher then adopted limits. The exceeding concentration rates (indicated in brackets) were indicated for sodium (1.2 - 2.0 times), BOD (1.1 - 2.5), phenols (4 - 9), organoclorine pesticides, NH4 (1.3 - 1.5), copper (6 - 7), zinc (8 - 12).

According to the multi-annual statistics the average concentrations of SS in the Yalpugh river are fluctuating mainly in limits 2500 - 5000 mg/l (9800 - 11000 mg/l).

The TDS exceeds the standards for chlorine in 1.7 times for drinking, sulfates till 3.1), sodium up to 14.1 and mineralization up to 3.2 times. Average concentration is in the limits of 2 g/l.

5.1.2. Groundwater quality (deep wells)

The Moldavian hydrogeological basin includes itself the following water-bearing horizons (complexes): baden-sarmatian, carbon-silurian and congerian.

The mineralization of waters varies from 0.5 g/l till 2.5 g/l with the most frequent concentration 1.5 g/l. The hardness varies from 0.3 to 1.5-2.0 mg-equivalent/l. The concentration of different forms of nitrogen is approximately the same as for previous geological structures: nitrate does not exceed 25-30 mg/l, nitrite - 2 mg/l and ammonium - up to 1.5-2.0 mg/l.

Fluoride and heavy metals are determined on the low levels.

5.1.3 Groundwater quality (shallow wells)

The general picture of the shallow groundwater quality is painful and very anxious. At the district level between 70 and 90% of investigated wells used by population for drinking aims give water of unacceptable quality. In the overwhelming majority of cases, nitrates determine the MAC - exceeding situations. In the majority of villages the maximal nitrate concentrations reach several hundred milligrams per liter, in some settlements going up to 1500-2000 mg/l.

In the majority of wells the water is highly mineralized. The share of wells with MAC-exceeding values of TDS ranges from 45 to 60% in the studied basins. The maximal absolute values of TDS in many villages go up to 2500-5000 mg/l and in some locations even up to 7500-8000 mg/l. An important part of this mineral content is provided by chlorides and sulphates, whose concentration exceed MAC in 15-30% of investigated wells. In some cases chlorides exceed 1000-1500 mg/l while sulphates go up to 5300 mg/l.

5.2 NUTRIENT STOCK IN VEGETATION

On the base of measurements of total dried biomass in the floodplains of Yalpugh and Cahul rivers one could make a conclusion that reed biomass in the artificial lakes is on the level of 30 tons per ha. Congaz and Taraclia lakes are covered by the reeds with total area of 30-35%. This means that total biomass of reed is around 16500 tons.

Average nitrogen concentration in the dried biomass is 23200 mg/kg and 2820 mg/kg. This means that total amount of nitrogen stoked by water vegetation is around 700 kg per ha and around 85 kg of phosphorus. This means that for the artificial lakes amount of nutrients stocked in vegetation is 385 tons of nitrogen and 46,8 tons for phosphorus.

Terrestrial vegetation biomass is around 2 tonns per ha. Avarege content of nitrogen in dried biomass is around 18000 mg/kg and phosphorus - 6900 mg/kg. Total area of meadow vegetation is around 600 000 ha. This means that total biomass of grass vegetation is around 1200 000 tons. Thus total amount of nutrients accumulated in the dried biomass is around 40000 tons for nitrogen and around 1600 tons for phosphorus.

Agricultural vegetation estimated as cropped biomass is around 3 tons pe ha. Content of nutrients in agricultural areas is approximately same as for meadow grass vegetation (fertilizers practically are not used). This means that approximately same amount of nutrients, which is accumulated in grass vegetation, is removed due to the agricultural activities.

6. NUTRIENTS INPUT FROM ANIMAL FARMING

Total input of feed into the sub-process "Farm" (public and private sector of agriculture) can be estimated as 1850 t N + 350 t P for the region.

Table Output from Livestock Farming

Source	Process of destination	Amount, t/region		N-, P-fluxes, t/region*a	
		Yalpugh river	Cahul river	Yalpugh river	Cahul river
Manure	Agricultural soil	156498 + 46450	57488 +79750	1257 (N) 292 (P)	759 (N) 196 (P)

Gaseous losses, farm	Troposphere			332 (N)	268 (N)
Percolation, farm	Groundwater			200 (N) 50 (P)	120 (N) 30 (P)
Animal products	Industry	23 516	16 882	348 (N) 37 (P)	279 (N) 31 (P)
Direct discharges of manure	Surface waters	-	-	-	-

Animal products. The removal on nitrogen and phosphorus by producing animal biomass was estimated basing on slaughter statistics and N-, P-concentrations in the concerned products. The total removal of nitrogen and phosphorus by producing animal biomass (in public and private sector) can be estimated as 620 tons N + 70 tons P for both basins.

Manure. The amount of produced manure was calculated according to the average annual number of livestock and average physiological amount of excreta. Data concerning the public sector of agriculture are presented in the table 4.2. However the amount of manure applied on agricultural soil in the public sector was lower than the produced manure. The difference was partly lost during storage and partly stocked.

Table. Manure produced in the public sector

Livestock	**Assumed excretion rate,t/cap per year**	**Yalpugh basin**		**Cahul basin**	
		Number livestock	**Manure, t**	**Number livestock**	**Manure, t**
Cattle	9	15 895	143 000	10 214	92 000
Pigs	1.6	29 611	47 000	19 319	31 000
Sheep	0.7	17 873	12 500	12 061	8 400
Poultry	0.02	155 900	3 118	82 866	1 657
Horse	9	490	4 400	425	3 800
TOTAL	20,32	119769	210 000	124885	136 850

The primary data and calculation of N-, P-fluxes from manure produced in the areas in the public sector are presented in the table 4.3.

Table. N-, P-fluxes from manure produced in the public sector

Livestock	Content in manure*, %		Yalpugh river basin		Cahul river basin	
	N	P	N-flux, t/region*a	P-flux, t/region*a	N-flux, t/region*a	P-flux, t/region*a
Cattle	0.39	0.12	558	172	359	110
Pigs	0.57	0.15	270	71	177	47
Sheep	0.92	0.16	115	20	77	13
Poultry	2.22	0.40	69	12.5	36	6.6
Horse	0.35	0.08	15	3.5	13	3
TOTAL			1 027	279	613	180
Note:* - data from CTNPS, 1991						

Data concerning the amount of manure originating from the private sector of agriculture are presented in the following table . The same excretion rates were assumed.

Table 4.5. Manure produced in the private sector

Live-stock	Number livestock		Manure, t		N-flux, t/region*a		P-flux, t/region*a	
	Yalpugh river basin	Cahul river basin	Yalpugh river basin	Cahul river basin	Yalpugh river	Cahul river	Yalpugh river	Cahul river
Cattle	1 831	4 070	16 500	36 650	64	143	20	44
Pigs	2 157	6 468	3 450	10 350	20	59	5	15.5
Sheep	32 407	38 367	22 700	26 850	209	247	36	43

Poultry Horse	140 000 112	129 633 356	2 800 1 000	2 600 3 200	62 4	58 11	11 1	10.5 2.5
TOTAL	176507	178894	46 450	79 650	359	518	73	116

It was assumed that the whole amount of manure produced in the private sector was applied to land. However 20% of the nitrogen was assumed to be lost during the storage.

Thus the total amount of manure applied to agricultural land in the case-study regions (both from public and private sector) was estimated as 2000 tons N + 400 tons P for the whole region.

7. NUTRIENTS INPUT FROM AGRICULTURAL SOIL

Manure. About 55.000 tons manure from public sector and private sector were applied on agricultural soil in **Yalpugh and Cahul river basins**. The nutrient content of this amount of manure which was applied on agricultural soil (in public and private sectors) was estimated as 440 tons N + 70 tons P in both case-study areas.

Deposition. An average rate of atmospheric deposition of 3.8 kgN/ha and 0.35 kgP/ha per year was assumed basing on the average concentration of N and P in atmospheric precipitations in this region and average annual rainfall during the last decade. Thus the total nutrient input on agricultural soil by deposition was 205 tons N + 19 tons P the region.

N-fixation. The flux of nitrogen induced by the N-fixation activity of symbiotic and non-symbiotic micro-organisms was estimated as around 1 100 tons..

Mineral fertilizers. The whole amount of mineral fertilizer applied on agricultural soil within the reference case-study areas is very low and on the base of annual application the load of N for in the region could be estimated as **200 tons and for P as 20 tons.**

Crops 1. The total nutrient removal with harvested crops was derived from the harvest statistics and nutrient concentrations in different crops. The output from agricultural soil with crops was estimated as 4100-4700 tons N and 620-780 tons P in the region.

Percolation, agriculture. According to literature data nitrogen percolates into groundwater even from non-fertilized soil. That is why we have considered the percolation separately from non-fertilized soil and applied fertilizers.

Percolation from non-fertilized soil (assuming a percolation rate for arable soil and perennial plantations of 6.5 kg/ha and for grassland 2 kg/ha per year):

in the region of Yalpugh and Cahul rivers: 590 tons

Supplemental percolation, from application of mineral fertilizers (assuming a percolation rate of 15% from the fertilizers (as N) applied on arable land and perennial plantations, and 4% - from fertilizers applied on grassland):

442 from arable (2 946 tons*0.15) + 38 from perennial (254 tons*0.15) + 31 from grassland (777 tons*0.04) = 511 tons;

Supplemental percolation, from application of manure (assuming a percolation rate of 25% of N from manure applied on arable land and perennial plantations, 10% of N from manure applied on grassland, and an intermediary value of 15% for the manure applied in the private sector):

400 tons;

Thus the total agricultural percolation of nitrogen can be estimated as 1068 tons in Yalpugh river basin and 508 tons in the Cahul basin.

It was assumed that less than 1% from the phosphorus applied on agricultural land as fertilizer percolates into groundwater. For the case-study regions that means a flux of 5-10 tons P/year.

Denitrification, agricultural soil. Basing on the literature data the following average denitrification rates were assumed: for arable land - 9.5 kg/ha per year, for perennial plantations - 24 kg/ha, for grassland - 4 kg/ha, for irrigated soil - 33 kg/ha.

According to these data the total amount of N-losses by denitrification from agricultural soil in the case-study region was estimated as 1450 tons.

Gaseous losses of N-compounds, agricultural soil. Assuming that 20% of the total amount of N contained in manure applied on agricultural soil are lost we can estimate this quantity as approximately 400 tons.

The N-loss of mineral fertilizer is assumed by 15-20% and taking into account very small volumes of their actual applying this factor can be neglected.

Erosion, agriculture. The natural and antropic features of the region make it very susceptible to water erosion. The relief is rather fragmentated; 90% of the arable land have a slope exceeding 1 degree. The precipitations fall mostly in summer time and are highly intensive. The granulometric composition of soils also conditions the washing out of soil particles. The part of

perennial crops supporting erosion (Zea mais, sunflower) is rather high on the watersheds (till 65% of all agricultural lands in the case-study region).

The mentioned particularities determine very active erosional processes in the region. According to the estimations of local experts (CTNPS, 1991) 18 tons of soil per year are washed away from a hectare of arable land due to water erosion. For orchards and vineyards this amount is estimated as 12.5 tons/ha per year. Assuming for grassland a value of 2 tons/ha per year we may estimate the total quantity of soil washed away from the agricultural land. For both Yalpugh and Cahul river basins this amount exceed 700 000 tons of soil, which means an annual loss of about 1400 tons N and 700 tons P.

Another important part of the nutrient load to surface water with the runoff originates from the agricultural soil. A coefficients of 30% for N and 20% for P were assumed due to poor storage conditions and agricultural practices. The resulting loss of nutrients can be estimated as 205 tons N + 9,5-10,5 tons of P.

Stock, agricultural soil. On the base of analysis performed during the study one could estimate the average amount of nutrients in the 1-meter layer of agricultural soil as 20 tons N and 19 tons P per hectare. So the agricultural stock of nutrients is 1,080,000 tons N and 1,000,000 tons P for each case-study region.

8. NUTRIENT INPUT FROM FORESTRY

Timber. All forests in studied areas have the status of non-exploitable resource, having an exclusively protective function. Therefore only maintenance and regeneration wood cutting is permitted.

The average biomass of trees is 80-90 m3/ha. Recalculated in dry weight, that means 24 000 - 28 000 tons or a nutrient stock of 1000-1100 tons N + 30-35 tons P.

The average concentration of total nitrogen in the soil aeration zone (0-500 cm) of forest soils is about 0.08% (Bondarchuk, 1981), the concentration of phosphorus - 0.07% (Moldavian soils, 1984). Thus the amount of nutrients is considered to be about 60 t N/ha and 55 t P/ha and the nutrient stock of soil on wooded area of the region can be estimated as 440 000 tons N + 400 000 tons P.

8. NUTRIENTS IN GROUNDWATER

Infiltration, surface water. The infiltration rate from water bodies to groundwater is estimated by local hydrologists at 300-400 litres per year per m2 of the water body. Total area of water

ecosystems in the region is around 1500 ha. So the volume of infiltrated water can be estimated at 400 000 - 600 000 m3/year, what means 2-3 tons N and very insignificant for P.

Base flow. The Yalpugh river valley is considered to be an area of discharging of shallow groundwater into surface waters (Cahul flow is very small and was not taken in calculation). According to the estimations of local experts the main part of alluvial complex is drained by the Yalpugh river. According to national statistics the shallow groundwater resources represents 3-4% of the total groundwater resources. The total groundwater resources in the case study regions are estimated at 5800 m3/day. So we could assess the contribution of shallow groundwater to the Yalpugh river as 30 000 m3/year. Considering an average concentration of nitrogen in shallow groundwater of 20-40 mg/l the local N-flux through base flow can lie in the range between 0,5 and 1 tons per year. The input of phosphorus into surface waters through base flow is insignificant.

The N-, P-fluxes were calculated assuming an average daily consume of water of 40 l/inhabitant for the population not connected to public water supply. However the estimation of average concentration of N and P in shallow groundwater is a difficult problem. The water table of freatic groundwater is generally 5-10 m deep and highly exposed to pollution, especially with nitrate. According to the information of the local water and health authorities in early 1990s between one third and two thirds of the individual wells provided nitrate-polluted water in the case-study region.

On the base of the results of the sampling campaign undertaken during 2005 – 2006, average range of concentrations of 20-40 mg N/l was assumed for the calculations of nitrogen flux from shallow groundwater.

260 000 inh * 40 l/inh * 365 = 37960000000 m^3 or around 65.000 tons of N for both case-study areas

The flux of P from shallow groundwater seems to be negligible.

Percolation septic tanks. 260 000 persons in the case study regions are not connected to sewerage and the waste water produced is disposed in septic pits. These pits are never isolated and their content percolates completely into groundwater. The nutrient loads into groundwater can be easily calculated multiplying the number of inhabitants by the specific emission factors for N and P:

260 000 inh * 3.3 kgN/year per inh = 800 tons N;
260 000 inh * 1.1 kgP/year per inh = 260 tons P;

In Moldova the waste water treatment plants ensure the common treatment of waste water from households and industry.

Run-off. This good correspond to the nutrient content in annual flow of Yalpugh river. The average yearly discharge into the Yalpugh river is 1 mln m3. The assumed concentrations are 6-7 mgN/l and 0.3-0.5 mgP/l. The resulting flux is 7-10,2 tons N + 0,5-1 tons P per year.

Based on estimation of nutrient balance in the region one could conclude that the content of nitrogen and phosphorus in sediments of the lakes located in the protected areas strongly depends on pollution coming from settlements and restoration of wetland areas can lead to the decreasing of nutrient loads till 20%. Main form of nutrient content in soils and sediments is organic, which consists around 90-95% of nutrient content in sediments. Main source of nutrients loads on environment is superficial runoff, which is responsible for around 80% of all nutrients reaching water ecosystems.. In the solid phase of bottom sediments of the studied lakes organic forms of nitrogen and phosphorus predominate and values increase from upper lake to lower one. The content of organic nitrogen and phosphorus varies from 2400 till 4200 mg/kg and organic phosphorus from 600 to 900 mg/kg.

Nitrogen presents in the soils prevailingly in an organic form, it makes 91-96%, and the organic phosphor makes on average of 62-84% of the total phosphor. Of the mineral nitrogen 65% is the share of the ammonium nitrogen.

In general, the share of the mineral phosphor is 2-4 times bigger than the share of the mineral nitrogen in the researched soils.

The biological accumulation of nutrients by vegetation is higher for aquatic (reeds), where the content of nitrogen and phosphorus is 420 higher than its content in the sediments. In the soils it depends on the agricultural crops grown on these territories and is 20-25% lower than for aquatic vegetation.

9. ROLE OF THE WETLANDS IN THE YALPUGH AND CAHUL RIVER BASINS

Studied region was strongly affected by massive irrigation of lands organized in the middle of 70th in the USSR. Wetlands in the flood plains of both rivers were practically totally changed and non affected areas in the valleys of the rivers practically do not exist. In addition to it upper part of the Yalpugh river is dredged and its bed is being deepened 1-1,5 meters for the protection from inundation. Total length of deepening works is around 25 km of the river.

Based on the results of consultation meetings with local authorities one could identify next roles of the wetlands in the region:

1. Agriculture. Agricultural activities are developed in the middle part of the Yalpugh valley and cover around 20% of the floodplain territory. Application of fertilizers is very low. According to the statistical data around 10 kg of N while phosphorus is practically not applied. Organic fertilizers application is also very poor. Main crops: sunflower – 15%,

mais – 25%, wheat – 10%, vegetables – 5%, rest of the lands (mainly in upper part till 50%) is used for pasture. Overgrazing affects development of meadow vegetation, where its biomass during summer period was around 20g/m2.

2. Irrigation. All hydro technical works in the middle of 70th were designated to the irrigation. Irrigation was stopped in the middle of 80th because of high mineral content in the surface water. Actual state of water bodies is strongly affected by siltation. According to the estimations around 50% of the Taraclia water body is loosed. Water bodies are used for fish farming activity (fito-fags and carp species). At the same time an unauthorized fishing is prospering in the region. Congaz and Taraclia lakes are also used for recreation purposes, but there are no plans for their management for these and other purposes. Actually total surface of wetland areas affected by desiccation in the Yalpugh river is around 90% and in Cahul around 60% of rivers floodplains. Actually there are no lands irrigated from the Yalpugh and Cahul rivers.

3. Development of the organic agriculture. Local authorities expressed theirs' strong commitment in the development of the organic farming in the region and in the wetland areas. At the same time there are no plans and programs to encourage local farmers for this.

4. Landscape planning. Trees planting campaign near big towns (Comrat, Congaz and Taraclia) in the wetlands (around 5-7% of total wetland areas) is organized annual. These efforts are often missed because of overgrazing and low public awareness. Only 5-7% of planted tress (mainly willow) reach 5 year age. Planting of green carcasses on the watershed is organized on the agricultural lands and relevant actions should also be developed in the wetlands lands used for agriculture. There are no nature protected sites in the region. Upper part of the Taraclia lake (around 500 ha) and lower part of the Yalpugh and Cahul rivers (around 1000 ha) at the confluence with the Yalpugh and Cahul lakes in Ukraine could be proposed as wetland and nature protected zones.

5. Flood control. Actually around 25 km of the Yalpugh river length in the upper part between Comrat and Congaz localities is affected by deepening of the river bed. Average volume of extracted material is around 1,5 m3/m of the river bed. At the same time flooding is not a danger for the region and these measures seem useless. That is why it was proposed to local authorities to stop these activities and thus assure flooding of wetlands with more water, which could cover wetland areas during spring and rain period.

Based on the experience from other projects one could assume that implementation of the organic agricultural practices, construction of green carcasses in the wetland areas, organizing of the recreational areas, etc could contribute to the nutrient reduction till 10-20% of actual loads. Water scarcity in the region is another issue, which could be partially improved trough wetland restoration activities. All these issues were discussed with local authorities and they welcome development of the management plans aimed at nutrient

reduction in the region. At the same time wetland restoration is not well known in the region as an option for nutrient reduction.

10. EXPECTATIONS BY THE PROJECTS

Actually water authorities in Moldova are developing Integrated River Management Plan for the Moldavian part of the Danube river basin. Environmental and other sectoral authorities expect management plan for the nutrient reduction in the region and thus improvement of water quality, overcoming of water scarcity, etc.

Analysis of expectations of the project is based on the consultation meetings with local authorities, NGOs, experts etc. Main conclusion is that local authorities expect that this project will contribute to the development of the plans for the social and economical development of the region. They expect that due to the nutrient reduction measures (including wetland restoration) the amount of nutrients reaching water ecosystems will reduce. They mainly rely on ground water sources for the development of the drinking water supply and expressed great interest in the overcoming of the water scarcity in the region. Improvement of the hydrological status of the rivers through wetland restoration and thus increasing of the water resources in the region was discussed as an option for social and economic development, especially drinking water supply network.

Organic agricultural practices are also recognized as a priority for the region. It was also mentioned that this will improve gender equity in the region allowing creation of more jobs for local population and larger involvement of women in social and economic activities. Rural tourism was also mentioned as a priority for local development. For these purposes local authorities talked about necessity for inclusion in plans for development of the region such nutrient reduction related issues as:

- development of the network of protected areas and green carcasses in the flood plains of the studied rivers
- reduction of animals grazing in the wetlands and creation of strictly protected sites (till 100 m2) for the observing of the vegetation recovery in the wetlands
- stopping of the deepening of the river bed and thus flooding of larger territories in the wetland areas
- construction of platforms for stocking of organic wastes in rural localities and organizing of the sanation of the territory of localities
- development of the network of construction wetlands for the processing of waste waters and composting of organic wastes

Presented nutrient reduction related issues could be a specific projects supported by local authorities.

Some of the projects to be implemented in the area of concern are the following:

1. Identification of the mechanism of sediment control by wetland areas. Overall Objective: To establish mechanism of sediment control towards promotion of wetlands restoration in the lower Moldovan part of the Danube river basin. Estimated cost 50,000 EUR

2. Creation of the green carcasses in restored wetlands. Overall Objective: To promote establishment of green carcass (Lower Prul Lakes- Cahul -Yalpugh) towards improvement of nutrient removal capacity in the lower Moldovan part of the Danube River basin. Estimated cost 500,000 EUR

3. Promotion of organic farming practices in wetland areas of the region. Overall Objective: To reduce nutrients input from agriculture on wetlands towards improvement conditions in natural habitats. Creation of network of pilot farms in the region and especially in the wetland areas. Estimated cost 500,000 EUR

4. Creation of nutrient removal platforms and production of the compost. Overall Objective: To reduce nutrient load in the watershed by improving organic waste collection system and composting. Create relevant network and facilities for composting and stoking of organic wastes in the region. Estimated cost 600,000 EUR

11. MOTIVATION FOR THE SPECIFIC PROJECTS IN THE AREA OF CONCERN

Main motivation for the development of the project is social and economic development of the region, which is the poorest part of Moldova. Development of the projects will allow creation of new jobs, attraction of the financial resources to the region as from local sources as well as from international Institutions. Further development of industrial facilities like refinery, transportation network linking oil terminal in Djurdjulesti with other parts of Moldova, storage for oil products etc will increase pollution loads including nutrients on environment.

So as agricultural activities predominate in the region and water scarcity is great issue of concern, local authorities in cooperation with central one are going to attract investments in organic farming, development of rural tourism, etc. That is why main motivation for nutrient reduction and wetland restoration seem to be overcoming of water scarcity, improvement of water quality and creation of facilities for rural tourism in the region

12. LEGAL AND INSTITUTIONAL BACKGROUND FOR THE WETLAND RESTORATION

Main institution responsible for the management of natural resources is Ministry of Ecology and Natural Resources (MERN). Ministry develops plans for environmental resources management.

State Ecological Inspectorate subordinated to the MERN performs ecological expertise and approves results of environmental impact assessment of certain projects, issues permits on environmental resources use, etc.

There exist no any special law on wetlands and also legal entity (institution) responsible for management of wetlands.

According to the Land Code, wetlands along with other lands are managed by local authorities on the territory of which they are situated and/ or economic entities which use the lands where wetlands are situated.

If the wetlands are situated in forest areas managerial responsibilities are shared between local authorities and State Forestry Agency MoldSilva like in cases with Lower Prut Lakes and Lower Dniester. MoldoSilva is an institution responsible for management of forestry resources and subordinates directly to the Government of Moldova.

However, in case wetland is situated on the territories protected by state, along with local authorities, managerial responsibilities are also shared with MENR (Lower Prut Lakes).

Recently (Oct 6 & Nov 24 2006), the Parliament of Moldova has approved in two readings a Draft Law (Nr. 2285) on insertion of modifications and addenda to be included into Law on Fund on Natural Territories Protected by State (Nr. 1538 as of 1998) concerning wetlands of international importance Lower Prut Lakes and Lower Dniester. This draft law proclaims Lower Prut Lakes and Lower Dniester as territories under protective regime to be generally supervised by the MENR. However, according to the draft law the managerial responsibilities as before are going to be shared between MENR, MoldSilva and local administrations/ economic entities. One could expect that future protected areas created in the Yalpugh and Cahul river basins will be under same procedure.

Technical design of projects for wetland restoration is mainly assured by design institute “ACVAPROIECT” subordinated to the “Apele Moldova” which in turn is a subdivision of the Ministry of Agriculture and Food Industry. “ACVAPROIECT” is an institution responsible for design of all technical water-related projects. “ACVAPROIECT” prepares relevant proposals and submit them both to institutions like Academy of Sciences, universities etc. and local administrations for approval and implementation. Technical projects are discussed during public hearings with the invitation of the NGOs, concerned public, local authorities, etc

Actually in Moldova the percentage of protected areas has increased from 2,5% till 4,3% of national territory and target till the year of 2015 is - 7%. Local authorities expressed their readiness to extend nature protected activities in the wetlands and underlined that local MoldoSilva agencies could provide more trees for planting in the wetlands.

There are no protected areas in the Yalpugh and Cahul river basins. However, in 2001 the Parliament of Moldova approved Action Plan on Development of the National Ecological Network (Nr. 112 as of April 27, item A2) which relates to wetlands, as well.

In this regard wetlands as areas performing extremely important ecological functions are under a special interest of the central ecological authority of the Republic of Moldova. That is why, the potential of wetland restoration activities in the studied region in order to reduce nutrient loads was welcome by local authorities.

As wetlands belong to the local authorities (municipalities), they are responsible for maintaining of the lands according to the plans of their use. Local authorities approve plans for the land use and assure its implementation.

According to the Law on Water Protection Strips, green strips have to be planted near the rivers with the width of 50 m from both sides. In case of Yalpugh and Cahul rivers this law is poor implemented, because of natural conditions, which do not allow trees growing (high salt concentration in soils and waters, water scarcity, etc). Trees planting is responsibility of local authorities while MoldSilva has to provide general plan for afforestation and also planting materials.

Hydrometeo Service provides monitoring of the water quality of Yalpugh river at the its lower part and also Taraclia water reservoir. Cahul river is monitored in its lower part (Gavanoasa village). Sediment quality is monitored irregularly, and only in the frame of specific studies organizing by the Academy of Sciences and “ACWAPROIECT” Institute.

There are no plans for wetland management in Moldova approved by central authorities. Local authorities also do not have any document, which could regulate theirs’ specific managerial activities in the wetland areas. Relevant permits on land use in wetlands and other areas are issued by local authorities with approval from local environmental agency/ inspection (depends on administrative raion). According to obligations of Moldova to be fulfilled under implementation of EU WFD it is presumed that Integrated River Basin Management Plan will include wetland management issues and thus strongly contribute to wetland restoration activities.

Scientific research in wetland areas is also rather fragmentary. Nutrient removal capacities of wetland areas were estimated in the frame of the actual study. Obtained data on nutrient removal capacities of Yalpugh and Cahul wetlands are innovative for Moldova, and this research has to be continued and enlarged.

Ministry of Agriculture and Food Industry developed the concept for the promotion of organic farming. Wetland restoration activities as a potential for nutrient reduction are not mentioned in this concept. The Ministry of Agriculture in cooperation with the Ministry of Tourism and MERN developed a concept on rural tourism, which includes organizing of the visits in the protected areas located in wetlands. Main issue of these concepts is development of rural areas, protection of natural ecosystems, organizing of the territories, etc

Allocations for wetland restoration activities from state budget are very insignificant and relate mainly for the organizing of the monitoring, scientific research and supporting of the exitence of protected areas (located in the wetlands). Creation of national parks in the wetland areas is a

concern of authorities, but there is no consensus with land owners. There are no special financial allocations for compensation of the land costs in wetland areas for farmers.

Wetland areas could be included in the restoration activities only if they belong to the local public institutions. Potential of such lands is around 30% of all wetlands in the Yalpugh and Cahul areas. Mainly these lands do not present any agricultural value and are often used for grazing.

13. POTENTIAL FOR WETLAND RESTORATION IN THE YALPUGH AND CAHUL RIVER BASINS

Main aim of the project was identification of the potential of nutrient removal capacities of the wetland areas in Yalpugh and Cahul river basins. Analysis showed that actual state of floodplains in the basins of these rivers does not facilitate nutrient reduction function of wetland areas. First of all this happens due to overgrazing in the flood plains, hydrotechnical works performed in the 70th, lack of green protected carcasses, etc.

Studied wetlands are largerly used in agriculture in the lower parts of the rivers for cultivation of perrenial crops. Restoration of the upper parts of the water bodies could facilitate recovery of vegetation and thus contribute to the sediment transport, accumulation and stock of nutrients by vegetation, reducing evaporation and thus keep more waters in the lakes. According to estimations this could lead to 5-10% of nutrient reduction on water ecosystems due to wetland restoration.

On the base of the discussions with local authorities potential for wetland restoration is rather high, especially in the upper and middle part of the basin. Here the value of lands from agricultural point of view is rather insignificant and they are not distributed among farmers. So the owners of these lands are municipalities and significant financial contributions will not be needed.

Sites proposed for wetland restoration in the basins of Yalpugh and Cahul rivers cover around 2-3% of wetlands. That is why it is difficult to expect significant nutrient reduction at the moment. Nevertheless these sites could serve as a model for further activities in this domain and one could expect 10% of nutrient reduction in case of restoration of around 20% of wetlands in the case-study area. This target could be achieved in the nearest 5-7 years.

CONCLUSIONS

Main source of nutrient loads in the region is agricultural activity. This sector is responsible for around 90% of all nutrient loads in the region. That is why reduction of nutrient loads on water ecosystems should be organized in order to introduce best agricultural practices on the

watersheds and wetlands. Deterioration of wetlands could be limited trough stopping of deepening of the river bed, limitations on grazing, rising of public awareness, etc.

Local authorities expressed strong commitment for the wetland restoration activities. Wetland restoration issues have to be included in the developing IRBMP and nutrient reduction could reach the target of around 10% of all nutrient loads on water ecosystems coming from the watershed. Introduction of green carcasses on watersheds and in wetlands could increase the amount of nutrients stocked in vegetation, regulate sediment transport in the rivers floodplains and thus improve water quality in regard to nutrients of artificial lakes created on the Yalpugh river bed.

Institutional capacities of local authorities in wetland restoration are very limited due to the financial situation, but due a low agricultural value of upper and middle stream wetlands this issue does not seem a problem. At the same time technical capacities in order to estimate real effectiveness of nutrient reduction are also limited due to the lack of relevant equipment, poor statistic, etc.

Personnel of local institutions never had any training on wetland management and their awareness on this issue is very low. That is why their capacities to develop plans on wetland management and restoration is very limited. It is important to organize such training, because local authorities will play crucial role in the implementation of the management plans. Trees planting is organized as a public action and any plans, documents, legislation, etc on wetland management in Moldova are not developed.

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