

The Ecological Reconstruction of the Zaghen Tulcea Wetland and Its Evaluation

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Abstract-The wetland undergoing the ecological reconstruction is located in the east of Tulcea municipality and is marked on the map with the toponym "Lake Zaghen". The enclosure Tulcea-Malcoci-Nufărul was embanked in the 60s, in order to use the land for agricultural purposes. Due to the high level of groundwater and the intense evaporation (favored by the use of mechanised agriculture), the soil salinity tends to increase and agriculture can be practiced only with persistent irrigation. Additionally in the years 1970-72 works for dewatering of Lake Zaghen have been attempted, which were not completed with a canal which links the South of the lake and the Danube and has at each end two pumping stations, a reversible one at the Danube (for irrigation and dewatering) and a unidirectional one at the lake (for the desiccation of the lake). Farming activities in the area have been abandoned after 1990 due to soil salinity and lack of productivity. Lake Zaghen has been strongly affected by human intervention. Habitat deterioration is confirmed by studies and field observations and caused the population decline and the reduction of species diversity. The most endangered are the fish and bird species. The ecological reconstruction aims at restoring the natural balance through adequate technical and technological means, offering a long-term solution that will comply with the interests of the local population.

For this project have been contracted bank loans, European funds have been allocated, funds to state / local budget, foreign loans contracted guaranteed by State and other external sources. **Keyword**-wetland, ecological reconstruction, habitat, renaturation, protected area

I. INTRODUCTION

The term "wetland" defines a habitat where the soil is permanently saturated with moisture and extremely fertile, encompassing swamps, bogs, watermeadows and low-lying coastal areas. It provides sheltered warm waters, favoring fish hatcheries, and rich vegetation necessary for grazing and a large variety of wild animals. In many countries, wetlands constitute conservation areas, because besides that they present a rich biodiversity, they also contribute to the purification of wastewater. The Zaghen polder is located in Northern Dobrogea, east from Tulcea municipality, bounded by the eastern limit of the locality of Tulcea, the Tulcea arm of the Danube River on the northern side, and the regional road DJ 222C Tulcea – Malcoci. The region consists of the Tulcea – Malcoci – Nufărul area confined by dams, and is under the administration of the mayor of Tulcea, and the town of Nufărul. In the south there

are the hills of Tulcea and Mahmudia. From a hydrological standpoint, the area belongs to the hydrographic basin of the Danube, on the inferior course, down river from where the Danube branches into the two distributaries Chilia and Sfântu Gheorghe, and upriver from where it branches into the Sfântu Gheorghe distributary and the Sulina navigation channel. Lake Zaghen is located in Zaghen polder, east from Tulcea municipality, has a surface of 180ha and a volume of 937.000 mc. It is an area of embanked bottomland. Lake Zaghen is undergoing ecological reconstruction on 200 ha of its surface. The Zaghen polder is the outlet point of the streams Lipca and Băbăianu, that flow from the Tulcea hills. The embanked area where Lake Zaghen is located used to be the bottomlands of the Danube River, which was characterized also by floods, brooks, channels and depression areas. It is separated from the Danube by a flood embankment with a 1% insurance with the crest elevation at + 6,30 RMNS. The embankment is earth-filled and has been created in 1962. The crest width of the dam is 4 m, and has grass slopes with a 1 : 2 inclination, protecting an area of 2811 ha from flooding. The land is in the patrimony of the Tulcea Local Council, outside the city limits. Some grass lands have been rented in the past, but the contracts have not been renewed. Some of them are occupied illegally, and enclosed with light wooden fences, for animal husbandry, or through the extension to the lake of the houses in Orizont street, beyond the property limits. The proclaimed purposes of use (farming or grazing land) have been abandoned. The lands that "cannot be used for the purpose they have been set up for, are due to be integrated in the natural system of use by being subjected to the ecological reconstruction procedures determined by A.R.B.D.D." in agreement with the stipulations of the nr 18/1999 Act of the territorial fund and 82/1993 Act regarding the creation of the Danube Biosphere Reservation. The geology of the area was established after performing two drilling operations and analyzing the water and soil samples obtained. From a geological standpoint, the Tulcea municipality is located on the Triassic carbonate platform of the North-Dobrogea orogen. The Triassic carbonate platform lies on top of a pre-Alpine basement composed of crystalline formations (crystalline epimetamorphic schists). Daily on the hill Hora Tepe (the Monumentului hill) protrudes a pre-Alpine basement outcrop. The hills of the Tulcea municipality are composed of limestone, marno-limestone, lower/early Triassic sandstone folded on large areas in the chimeric tectogenesis. These rocks are exploited in the Bididia I and II and Trei Fântâni quarries and are used in civil and

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hydrotechnic constructions and in concrete fabrication. In the Tulcea area we find dark grey types of soil and leaching black earth soil and to a lesser extent lito soil and carbonate black earth. These soils have a clay or clay-loam texture and have formed on Quaternary loess units, very sensitive to moisture. They consist of mineral material formed through rock decomposition and alteration, but also of organic matter derived from vegetation decay. Their thickness varies between 2 and 3.5 m. The soils are neutral to slightly alkaline (pH 6.5 – 7). Lake Zaghen is located in the Danube bottomlands, at the south-west end of the Danube Delta, on Quaternary deposits dating from late Holocene (qh₂) probably added on top of early Holocene (qh₁) or even Pleistocene deposits. The thickness of the Quaternary deposits from Lake Zaghen area is approximately 30-40 m, of which “the aleuritic complex” from late Holocene (qh₂) ranges between 5-8 m. The alluvia from late Holocene (qh₂) found around Lake Zaghen region are largely aleuritic (lutitic) belonging to an area of “river divagation” and were deposited at different stages of the changes in the river course. If 30-40 years ago Lake Zaghen had a 2 m depth (according to some old fishermen), at present its depth has greatly been reduced due to drainage works and the colmation with terrigenous material drifted from the neighboring higher land. From a seismic standpoint, the city of Tulcea region is situated in the macro-area with 7₁ intensity and a recurrence of 50 years. In the city of Tulcea area the peak ground acceleration for design/engineering is $a_g=0.16g$, for earthquakes having the mean recurrence interval $IMR=100$ years and the control period of response spectra $T_c=0.7$ sec. The area limitrophe to the Zaghen polder consists of current loose deposits intercalated with turf and slurry. On the land's surface, underneath the vegetal soil, its thickness ranging from 0.80m in F2 to 3.80m in F1, there is a crust of clay dust and dusty clay, soft /stiff plastic to hard plastic. Directly underneath this crust formed through atmospheric contact drying are the highly compressible layers of turf - with a thickness of 1.70m in F1 and 2.70 m in F2, followed by clay sand and silty sand. Through drilling the underground water has been intercepted in the form of infiltrations at 1.30-1.50 m depth and in the form of aquifer level (ascensional) at 6.30m, 6.10m depth respectively below the natural ground level. The infiltrations in the excavations will depend on the pluviometric regime of the season when the work will be performed. In a rainy season, water might be found at depths under 1 m below the natural ground level. The chemical analysis of the groundwater samples collected from drilling operations have shown that the waters in the area present a slightly carbonic aggression to concrete, according to the stipulations/regulations STAS 3349-83. To metals, the samples have proved to be highly aggressive, as outlined in I 14-76. *Special data* The maximum frost line is 80-90cm, according to STAS 6054/77. According to the NP 074/2002 regulations, the area is characterized by the following: Terrain conditions difficult terrains 6 points groundwater normal levels 2 points importance of construction reduced 2 points works neighboring regions medium risk - 3 points seismic (P100-92) zone C 1

point Total: 14 points. In conclusion, it can be said that the geotechnical risk of the location is MODERATE. The geotechnical category is 2. The optimal foundation depth, if not technologically determined, is conditioned by the frost line and will be with 0.10-0.20m above 0.80-0.90m, namely 1m below the natural land level. The foundation ground consists of clay dust or dusty clay, soft /stiff plastic to hard plastic. Below 1m, at very small vertical distances – 0.10cm in F2, there is a thick layer of turf. To avoid differential settlements, light construction works are recommended.

II. CRITERIA FOR IDENTIFYING A WETLAND HYDROLOGICAL CRITERION

The area known under the toponym Lake Zaghen is a wetland ecosystem. In the last 100 years it has lost its lake characteristics, in the 60s-70s being described as a bog, and as a result of the dewatering operations performed in the 70s it has been downgraded to the swamp category due to the high water deficit and the colmation process. The reed has invaded practically the entire central part of the lake and large areas are completely dry during dry seasons, when water remains only in the channels. The normal hydrologic regime that depended on the Danube is no longer functional, due to the embankment of the Tulcea-Nufăru area. At present the water body is maintained through rainwater and riffles from Tulcea Hills. The temporary excess water is systematically moved to the Danube through the Bididia pumping station. In November 2008 measurements have shown that the water level at Zaghen is at 0.00m dMN, with 60cm below the Danube level. The supply of water is also sustained by the low ground level (under 1m dMN per perimeter and – 0.50m dMN at the center), the lakebed being supplied with groundwater as well. The springs that were observed in the 70s in the southern part of the lake, are no longer active at the surface. The current hydrologic regime enables soil moisture in periods of plant growth (spring).

III. THE CRITERION OF SUBSTRATE SATURATION

In order to develop wetland characteristics the soil must be saturated with water as deep as 30cm, for at least 2 weeks, during plant growth. At Zaghen the soil that was maintained for a long period of time in a state of saturation developed specific physicochemical properties: a specific sign is the lack of oxygen in the moisture saturated soil (anoxia), the oxygen being absorbed by roots, microbes and microorganisms, and its diffusion in soil becoming greatly reduced. The redox potential is high. The chronic lack of oxygen causes the accumulation of decomposed biological material (turf areas have been observed in the south) and the selective growth of vegetation that support such conditions.

IV. THE BIOLOGICAL CRITERION

This refers mainly to vegetation, the general rule being that of having over 50% of the dominant taxa of the hydrophytes category. The Zaghen area meets this criterion, including reed, cattail, scouring rush and the rich channel vegetation.

V. THE NATURAL BOUNDARIES OF THE WETLAND

Setting the boundaries of the wetland is based on the aforementioned criteria, which lend it the attributes that clearly distinguish it from the neighboring regions. The polder created through the embankment of the Tulcea-Nufăru area is no longer a wetland, but Lake Zaghen has withstood the pressure of the human impact and can still be identified and recognized as a wetland. In the polder area a similar region can be found near Murighiol. From comparing the maps from the last 150 years it has been observed that the surface of Lake Zaghen has been reduced by about 1/3 on the north-eastern side. Satellite snapshots can still capture the natural historical boundaries of the lake, because the lost surface is still saturated enough with moisture to be identified through color contrast. On the current cadastral map, "lake" Zaghen consists of the parcels 79 and 80, that can be easily recognized due to the channels of the perimeter. The wetland still "lives on" in parcel 81, 89, 90. The riparian area includes the parcels east of the lake, the ones from the subsiding tank and the ones in the south (parcel 77).

VI. THE STATE OF THE HABITATS

Lake Zaghen has not been a lake ever since in the 70s, the dewatering project was launched, with the intention of using the land for farming. The project was never finished, but the impact of the executed works has been disastrous for the wetland habitats. Even after the embankment of the Tulcea-Nufăru area (1962), the water was deep enough, so that the reed was present only along the borders. In the 50s the maximum depth was 2-3m, and in the 70s it became 0.6m. The systematic exploitation of the dewatering pumps from the Bididia station has made the normal retention capacity of the lake to drop at 0m dMN. Since in Tulcea the evaporation rate fairly matches the precipitation rate, in the years following the beginning of the dewatering project, a major water deficit has been recorded with a negative impact on the wetland habitats. The drainage channel of the waters from the hills located in the south of the city has led to an increased transport of solid material into the lake. Theoretical calculations estimate an annual rate of over 300 mc solid material that has reached the lake in this manner. Three siltations/ deposit cones/ debris cones/alluvial cones are clearly visible at the mouth of the channel, corresponding to the discharge locations this channel has had over the years. As a result of the colmation process and the systematic pumping of the temporary excess water, during dry season the reed covered surfaces have become dry, and the water level in the channels, where water is still present, has dropped to 0.5m. The reed growth has extended to the center of the lake, the birds being the most affected by the waterbody loss and shoal reduction (feeding area for waders/shorebirds).

In the 70s the water supply of the lake came also from 12 springs (south of the lake), which held a constant temperature of 15-16 °C almost year-round, which had a positive effect on the population of some bird species,

among which the wild duck, the northern lapwing, the wagtail, the grasshopper warbler, the coot, the bearded reedling, species that find shelter in the reed and cattail layers. The cattail clusters at the edge of the waterbody offered good conditions for early nesting birds.

The habitats encountered at Zaghen are: *-natural, partially altered by people:* reed beds, parks of water willows, water meadows. *-anthropic, naturalized:* drainage channels. *-anthropic:* farming lands, groups of individual agricultural settlements and houses (without legal status), infields. The natural regeneration capacity has been outbalanced by the human impact even in those areas where wildlife seems preserved. The major consequence of this was the decrease of the biodiversity and the reduction of the species populations, except for the marsh vegetation that invaded the lake. Systematic studies have been done only for bird species that used the region as nesting, feeding and rest area. They have been strongly affected by human interference in the area, but have not left the region entirely, although the habitat destruction has accelerated in the last 40 years. On the other hand, the lack of maintenance works for the central area of the lake has led to the reed invasion in that part. Specialists suggest the reed to be reaped or burnt regularly to avoid its degradation, to keep the nutrient balance and avoid the colmation process. The region is located on the migration route of birds and belongs to the avifauna special conservation area of national interest. Signs of pollution are visible (alluvia transported by streams, animal and household waste), but the regeneration capacity limit has not yet been reached, and this aspect will be kept under control after the ecological reconstruction procedures. As part of the main objective for the habitat restoration is the necessity of reconstructing the connection to the Danube, which will ensure water transport and biological material directly from the river. The secondary objectives are the following: the decolmation of the channels and other major areas to alter the waterbody: heed ratio, in favor of the former. Reducing human presence and interference in the area (including through the evacuation from illegally occupied spaces) by creating protection corridors (the width of which will inevitably be less than that stipulated in the regulations due to the close vicinity to the urban area). Reconsidering the human presence in the area and redirecting it towards leisure, educational, research, maintenance and wildlife conservation activities.

VII. FAUNA

Local invertebrate species are the protozoa, ringed worms, leeches (*Hirudo medicinalis*), snails (gastropods), shells, spiders, myriapods, diurnal and nocturnal butterflies and numerous insects: gadflies, mosquitoes, wasps, bumblebees, ants, woodboring beetles, great silver beetles, May beetles, dragonflies, bush-crickets, crickets, mole crickets, grasshoppers. The vertebrates here are represented by numerous species of fish, batrachians, reptiles, birds, and mammals. Up until two years ago fishing could be practiced Lake Zaghen's channels, the fish species including the European perch (*Perca fluviatilis*), the common bleak

(*Alburnus alburnus*), the carp bream (*Abramis brama*), the sunfish, the northern pike (*Esox lucius*), the common carp (*Cyprinus carpio*), the European weather loach (*Misgurnus fossilis*), the crucian carp (*Carassius carassius*). Batrachians include the marsh frog (*Rana ridibunda*), the edible frog (*Rana esculenta*), the European tree frog (*Hyla arborea*). The local reptiles are the dice snake (*Natrix tessellata*), the European green lizard (*Lacerta viridis*), the sand lizard, the European pond turtle. The mammals in the area are the European mole (*Talpa europaea*), the European hedgehog (*Erinaceus europaeus*), the European brown hare (*Lepus europaeus*), the black rat (*Rattus rattus*), the house mouse (*Mus musculus*), the common vole (*Microtus arvalis*), European souslik (*Citellus citellus*), the lesser mole rat (*Spalax leucodon*). In the area, numerous previously domesticated animals also live in the wild.

VIII. THE AVIFAUNA

After reviewing the research studies performed in the area before 1980, we have reached to an impressive number: 89 species had been identified, representing more than a quarter of the total number of species observed in the Danube Delta. The avifauna potential of Lake Zaghen is truly impressive, but so is its decline. Today birds are still present in the region, especially nesting bird species. Shorebirds, however, have lost their feeding grounds while the birds of passage have lost the resting grounds. The conservation regime of the Danube Delta avifauna ROSPA0031 that includes Lake Zaghen represents another strong argument in favor of the ecological reconstruction.

IX. FLORA

Among the woody plants present are the white willow (*Salix alba*) and the black poplar (*Populus nigra*). On the surface of the former settling tank a population of saltcedar (*Tamarix ramosissima*), a plant well-known for its healing properties, has grown rapidly. Reed species like the common reed (*Phragmites communis*) occupy the central basin and stretch even north and east, beyond the channels from the lake perimeter. Besides reed we find common bulrush (*Typha latifolia*), true bulrush (*Scirpus lacustris*), arrowhead (*Sagittaria sagittifolia*), flowering rush or grass rush (*Butomus umbellatus*), cowbane (*Cicuta virosa*), fineleaf waterdropwort (*Oenanthe aquatica*), purple loosestrife (*Lythrum salicaria*), water mint (*Mentha aquatica*), marsh euphorbia (*Euphorbia palustris*) stinging nettle (*Urtica dioica*), three-parted beggar-ticks (*Bidens tripartitus*), marsh sow-thistle (*Sonchus paluster*), the marsh thistle (*Cirsium paluster*), the common water-plantain (*Alisma plantago-aquatica*), soft rush (*Juncus effusus*), the water soldier (*Stratiotes aloides*). Inside the channels, where the water is deeper and contains more oxygen, the flora is richer and specific to this type of habitat: tape grass (*Vallisneria spiralis*), the curly-leef pondweed (*Potamogeton crispus*), frogbit (*Hydrocharis morsus-ranae*), spiked water-milfoil (*Myriophyllum spicatum*), soft hornwort (*Ceratophyllum submersum*), common duckweed (*Lemna minor*), and the

Spirogyra algae. The sandy land areas are covered with grass and other plant species characteristic of the steppe.

X. THE FUNCTIONS OF THE WETLAND

a) Hydrological functions:

the Zaghen region collects the high floods/waters and alluvia from Tulcea valley, stores water that replenishes the groundwater levels, maintains a beneficial wet environment during dry seasons, regulates temperature in seasons of extreme temperatures, serves as protection for farming lands against floods.

b) Biogeochemical function:

retains and recycles nutrients (nitrogen, phosphorus), mineralizes organic pollutants (denitrification), enables a natural and efficient carbon cycle, maintains the surface layer of the soil in an anoxia state.

c) Ecological functions:

habitat for plants and animals (reproduction area for fish, nesting, feeding and resting grounds for birds); an essential habitat for migratory birds, reservoir of genetic resources and biodiversity, the aquatic macrophytes and microbes are necessary for the decay of organic waste (including vegetation) and nutrient recycling, the underwater macrophytes regulate the microbial metabolism and biogeochemical cycles.

d) Socio-economical functions:

ecotourism, education, leisure activities (unexplored until now), the creation of new work opportunities by making use of traditional occupations (fishing, reaping the reed for construction work, collecting plants), habitat for a population that finds itself at a disadvantage because of the technological progress, but which is also very well adapted to the delta environment, the natural purification area for household waste.

These functions of the wetland are only partially and in an uncontrolled manner explored today, but this process can become more efficient through the ecological reconstruction that will add value to the area.

XI. THE VALUE OF THE WETLAND

Although many years ago, wetlands were regarded as areas of discomfort (mosquitoes, moisture, unexploitable land) and have systematically went through land reclamation, nowadays the role of wetland ecosystems in preserving the water quality and biodiversity is better understood. Gaining the awareness that the right to a clean environment belongs to the public rights domain has been a step forwards, favoring the conservation of these areas. After being under anthropic pressure so severe that it could have led to its extinction, presumably followed by a period of falling into complete oblivion, the time has come for the Zaghen area to be discovered and explored for the benefit of the community. For the Tulcea municipality the area can be developed for its sanitary, leisure and esthetic values. The

close location to the Danube also makes it suitable for tourism and scientific research.

XII. PROJECT'S OUTLINE

Within the Tulcea-Malcoci-Nufărul embanked region, an area of about 200ha from the Lake Zaghen perimeter undergoes the ecological reconstruction. This aims at restoring the natural balance of the environment through adequate technical and technological means, offering a long-term solution that would also answer the local community's needs. This implies the following: enabling the water input from the Danube into lake Zaghen the restoration of a variety of natural habitats specific to wetlands facilitating the development of aquatic and terrestrial fauna and flora, the development of natural resources: fish, reed, cattail, wood, and establishing the adequate hydrologic regime. The creation of special recreation areas for the local people of the Tulcea municipality as well as for its visitors.

Setting up an inside tourist route consisting of a navigable channel for small boats; setting up along the banks characteristic tourist stops, fishery, wind mill, traditional fisherman houses, birdwatching facilities, workshops for exploring the natural resources (carpentry, spaces for the creation of trellis and other wood or cattail intertwining work and artisanship), tourist center, etc. Providing facilities for visitors to take part in local events and activities: sport fishing, non-motorized boating, exploration and understanding of the fauna and flora specific to the delta, landscape exploration with recording devices (cameras), cultural events, culinary events with local food, etc. Ensuring the necessary utilities and ways of access. Maintaining the current function as a buffer zone against the high floods of Tulcea valley, by preserving the existing polder, which must not affect the facilities area. The drainage system of Lake Zaghen and SP Bididia will be restored and activated, as well as the purification basin for torrential pluvial waters that come through the Valea Tulcei channel and the two reversible pumping stations. Additionally the adjacent areas of Lake Zaghen will undergo ecological measures like the removal of all inadequate dwellings and extensions. Based on the studies and observations made, the wetland area that had no economic relevance will be transformed into a leisure, education and research area, that will be added to the list of tourist attractions. The area will serve as a means of ecological education and raising awareness for children and students, and as a practical example of the development of a conservation area. The ecological objectives are the renaturation of the wetland and the restoration of biodiversity. From a technical standpoint the solution lies in the restoration of the hydrologic regime specific to floodplains. Coming back to the normal hydroperiods will result in the recovery of the wetland's functions: habitat for plants and animals specific to wetland habitat and reproduction area for fish habitat and reproduction area for water and shore birds source of biodiversity and genetic resources bio-corridor and genetic exchange biological production resuming the normal biogeochemical cycle of the elements settlement of sediments and toxic substances

(purification function) The habitat restoration is permitted in order to resume the long-term development process for the local economic, touristic and recreation resources of the wetland.

Scenario zero, of non-intervention would condemn the lake to advanced colmation in the next 30-40 years. The area presenting no interest anymore would be degraded by uncontrolled human interference. Because its natural purification capacity would be irreversibly damaged, the area would become another "rubbish dump" of the city. This process has actually already begun: Without intervention the colmation process will continue until the area's function to attenuate the floods collected through Valea Tulcei will be entirely compromised. Because the colmation area does not match the location of the floodplains (adjacent to inhabited areas), the output channels of the water will close, the water will longer longer in the same location, and the precession of pollutants will be reduced, the floodplains becoming "hotbeds for infections", in close vicinity to the inhabited area.

Minimal intervention scenario would imply only: taking sanitary measures to clean the area along with the removal of farms dealing with animal husbandry Correcting the channel in the Tulcea valley and creating a new output way towards the pumping station. This scenario ignores lake Zaghen's potential and the possibility for it to become a restored wetland and be explored as a natural environment. If there is no clearly outlined function of the area, the sanitation costs will not bring in return direct and explicit benefits.

Maximal intervention scenario, the renaturation of the entire Tulcea – Nufărul area as a floodplain, is not feasible, because the embankment plays also a role in protecting the Tulcea municipality from flooding.

Feasible scenarios are compromises that must reach a balance between the need to restore the natural habitats and the interests of the urban community to develop this area. Therefore, the project has a different approach than the other renaturation projects from the Danube Delta. The close proximity to the city is a major advantage when it comes to develop the region as a tourist, recreational, educational and research attraction. Secondary scenarios and objectives can be described as follows: the rehabilitation of the pumping stations and dredging the channel between Lake Zaghen and the Danube, "ensuring the operation of reversible pumps at both stations" the downside of this is that pumping destroys the biological material, which comes from the Danube and is essential. Protecting the wetland with an embankment, in order to trace clear boundaries for the perimeter, to protect the banks and stabilize the specific hydrologic regime. Dredging a large area of Lake Zaghen to restore different habitat types: lake, bog, island, shoal.

The separation of the waters flowing from Valea Tulcei into Lake Zaghen and the creation of a separate discharge way into the Danube Modeling the wetland with islands and channels, diversifying the recovered dry land through planting Connecting Lake Zaghen to the other wet areas from the embanked region, in an integrated

system Conducting specialized studies for the identification of species and habitats that are in need of protection and relevant to the community

Setting up recreation facilities Setting up research and conservation facilities

XIII. THE CURRENT ECONOMIC SITUATION

the Zaghen area has a direct cost that can be estimated from the exploitation costs of the dewatering system (water pumping, building, equipment, hydrotechnic works amortization) the Zaghen area has also a hidden cost consisting of sanitation costs, irretrievable but necessary for the community's well-being the Zaghen area has indirect costs which represent losses arisen from the fact that the land and the natural resources have not been exploited the Zaghen area does not produce revenue (terrains have not been leased anymore because this leads to indirect losses through pollution, the beneficiaries of the hydrotechnic works do not pay taxes, those responsible for pollution do not pay taxes for the water that has been naturally purified by the wetland) the indirect benefits of the wetland location (influences on the urban microclimate, depolluting the pluvial waters containing urban pollutants in a natural manner, minor resource for work opportunities for the low-income population in the area) are hard to evaluate; they create a socio-economic value, without any influence on the financial prospects. The costs are greater than the financial benefits. It is advisable that for economic calculations to take into account the average economic value of the land is null (calculation value = 0), because the value of current ecological services is compensated by the operating costs. Options for investment may be limited to strict the renaturation (variant A) or an investment which can be expanded to develop the area of social functions (variant B). Variant A can be achieved by limited hydraulic works, with an investment of 7 200 000 euro, and by renaturation the value of ecological services increases (estimate 200 ha. x 3000 Euro / ha / year = 600 000 euros/ ha / year. Under the financial terms this the economic value is doomed to failure because society is not yet prepared to recognize and pay the price of services. The solution is the combination of ecological services with other services that the company is willing to pay. This intervention has effect on the economic value of the area. Its value will be 8.35 million euro (NPV), but enhances the financial effects only in particular conditions. Because of investment, financial NPV is negative, -2.35 million euro. The investment is economically justified, but only in conditions of unsustainable financial i.e. only in conditions of subsidies. In variant B, developed in this study, the development of area is complex, with a lot of direct and indirect effects. The beneficiary has the opportunity to obtain financial income from operating (sale or exploitation of land, area concession, access fees, taxes). If the area enters into a development process to exploit its natural potential and specificity we can set achievable objectives: Minimum value of leaseable land without infrastructure 10 euro / sqm; Average leaseable land with infrastructure minimum 30 euro/ sqm; Value of leaseable land with complete infrastructure 100 euro /

sqm. This potential develops and produces financial revenue. The 296 ha area, studied by the project can update its value as follows:- 60% as area protected by anthropogenic effects, 2 euro/ sqm.- 10% as area with permission for operating with minimal anthropogenic effects (Scientific Tourism, Education, Research), 10 euro / sqm.- The proportion of 12% as utility area (research, education, urban park), 20 euro / sqm.- 15% as dwelling area, 30 euro/ sqm.- The rate of 3% for commercial development, 100 euro/ sqm. Exploitable value estimated in this scenario is calculated as follows: 296 hectares x Σ (proportion* value of unit) = 15 764 000 euro. Option B has three versions, described in the text as variants I, II and III. The values of investments proposed by the project are:

Option I or II: 13 000 000 euro

Option III: 18 808 000 euro

Calculation assumptions for these variables are:- The projected period of 15 years;- Residual value of buildings and utility at the end of period is 60% from investment, in conditions to recovery the specific investment cost and obtain a 10% profit;- Residual value of hydraulic works, in the end, is 50% of investment;- The value of ecological services of wetland (180 hectares) is reconsidering to the internationally recommended value (10 000 euro/ year / ha for lakes and 20 000 euro / year / ha of ponds, swamps, delta);- Financial revenues are calculated from the amount of concessions (5% / year in land value and 10% / year in the amount of interest decorations);- Economic revenues are calculated as the sum between the value of ecological services, direct financial income and indirect effect on social economic development (calculated as 25% flat rate of direct financial revenue);- Operating costs are mainly related to the exploitation of hydro, other activities are covered by lease scenario.

Table 1 Comparison of variants (in constant prices):

	Variant I	Variant II	Variant III
Economic revenues	56156	83156	59941
Financial revenues	23325	23325	26353
Operating costs	9000	3000	6000
Loan cost	6500	6500	9404
Residual value of investment	7261	7261	10371
Land value	15764	15764	15764
Economic NPV 1-3-4+5+6-9	50681	83681	51864
Financial NPV 2-3-4+5+6-9	17850	23850	18276
Investment value	13000	13000	18808
- of which tourist amenities	7668	7668	9687

Source: own calculations

XIV. CONCLUSIONS

a) Economic analysis:

The benchmarks for this type of project, qualified as investment environment are:- Discount rate 5% (in real terms since the projections in this draft have been in constant prices)

- Financial IRR -0.1% (may increase up to max. 5%)-

Economic IRR 15.8%- reference period 15 years

The economic significance of the results of cost-benefit analysis is that the investment is justified as economic, but in financial terms it requires financing, including non-refundable grant form. This situation is relatively normal, because the largest share in investment is environmental intervention works (ecological reconstruction) that produce value in the first and only appearance in the socio-economic background financial value (net revenue, profit).

b) Sensitivity analysis

In terms of financial efficiency, the project is sensitive to market behavior. Market failure is taken into account, at least in the short term, considering the possible lasting effects of the current financial crisis.

The project remains desirable even in those circumstances, considering this is a restoration project of an area affected by anthropogenic intervention. Restoration of this area is a legal obligation.

c) Risk analysis.

Similar projects have been a success in Delta, nature showing a remarkable capacity for regeneration, if the human been removes the obstacles. In terms of risk, variant A and B are similar. A difference in this case are between versions 1 and , version for hydro works. Both are technically feasible, but variant 1 modify the type of ecosystem, while version 2 restoring the existing support.

d) Sources of investment financing

Funding source of investment will be in accordance with the law and consist in equity, bank loans, funds to state / local budget, foreign loans contracted or guaranteed by State grants and other sources of external funds legally constituted.

XV. REFERENCES

- 1) DANCHIV, AL: *Hidraulica Aplicată*, Ed. Universității București, 2002
- 2) DIMITRIU, MARIA: *Investments and risk*, Editura Margaritha, 2000
- 3) GHEORGHE AL., ZAMFIRESCU F., SCRĂDEANU D., ALBU M. *Aplicații și probleme de hidrogeologie*, Universitatea din București, 1983
- 4) MUTIAC V., IONESI L. *Geologia României*, Ed. Tehnică, București, 1974
- 5) UJVARI I. *Geografia apelor României*, Ed. Științifică, București, 1972