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20. Agricultural Programs in the Danube Delta and the Danube Flood Plain

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Abstract: The two geographical units, i.e. the Danube Delta and the Danube Floodplain, are the largest wetlands in Romania, being flooded permanently or periodically, partially or totally. Over time, they have also been used by agriculture, as pastures or even as arable lands, but on small areas. A change in the use of the two wetlands occurred in 1945 when the new political power aimed at increasing the arable area at any cost to 10 million hectares. For this purpose, programs for the drainage and agricultural development of the two wetlands were drawn up periodically. As far as the Danube Delta is concerned, these programs remained, with only a few exceptions, on paper alone; however, in the Danube Floodplain, an area of over 400,000 hectares was drained at high costs, with disastrous consequences for the environment and inefficient results in terms of agriculture. This paper tackles these issues and presents the results obtained.
Keywords: Danube Delta, Danube flood plain, Agricultural Programs

INTRODUTION

Agriculture (besides fish and reed) has been present since immemorial times in the Danube Delta. Meat has been produced here, for the population's needs, but also for the export; moreover, vegetables and fruits have been produced for domestic consumption. Thus, except for bread, the Delta has been sustainable for its inhabitants in terms of food production. During the totalitarian communist regime – obsessed with the increase of any arable land area – the Danube Delta was one of the most available resources. Organized in dammed enclosures for the exploitation of reed with water level regulation, the Delta was the best-suited area that could be turned into a real granary. However, from all the programs, only the Pardina enclosure, with an area of more than 28,000 hectares, was drained and rendered to agriculture.

The Danube Floodplain had another fate. Despite the opposition of some of the most famous specialists in the field, including Gh. Ionescu-Sisesti or Grigore Antipa, this floodplain was impounded (non-submersible) over a length of around 1,100 km; behind the dikes, an area of approximately 420 thousand hectares was drained and equipped for agriculture. The costs of the agricultural equipment in the Danube Floodplain, including the related objectives, were estimated at approximately $ 14 billion (Hâncu et al., 2009). Despite these expenses, excess moisture was not eliminated. The 111 drainage stations threw over the dam the accumulated water, without preventing the infiltrations through the dikes. The agriculture practiced in drained enclosures was far from the projected parameters (Hâncu et al., 2009) and at present, the rehabilitation projects for the areas equipped for irrigation in the Danube Floodplain represent a priority.

MATERIAL AND METHOD

The material used is mostly a bibliographic and research retrospection of the agriculture from the Danube Delta, where Professor Lup A., conducted studies on the results obtained in the Delta, in terms of agriculture. There are also presented the latest agricultural development programs in the Danube Delta and the achievement stages. The research method is specific to economic research, i.e. material collection, and selection, processing, synthesis, conclusion and proposals.

RESULTS AND DISCUSSIONS

The Danube Delta and agriculture

During the command economy, after the bankruptcy of reed exploitation, the agricultural vocation of the Delta was rediscovered; this would become, among other things, the last source of arable land growth, i.e. one of the agricultural obsessions of the totalitarian regime. To this end, the former embankments performed in order to grow reed were well suited to becoming polders, where intensive agriculture could be practiced. Some of these were to be drained (the reed was to be plucked) and then equipped for irrigation. The drained areas were to become large state-owned agricultural enterprises producing grain and industrial plants, but also raising livestock (cattle and sheep). Not less than 218.3 thousand ha was planned to enter the agricultural circuit, of which over 50% were already embarked. The first and ultimately the only drained area was Pardina, with a total area of 28,970 ha.

It is noteworthy that the programs and equipment for agricultural use in the Danube Delta only dealt with the actual Delta area, i.e. 430 thousand ha (fig. 1), and not with the Danube Delta Biosphere Reserve, with an area of 580 thousand ha (fig.2).

Along with fishing and reed cultivation, the interest in agriculture had been manifested since the early 1950s. Thus, in 1953, upon the request of the Council of Ministers, the *General Study for the Integral Equipping of the Danube Delta* was elaborated; it addressed the main activities of the Danube Delta: fish farming, agriculture, reed cultivation, and forestry, trying to find a balance between them, since, implicitly, there was a competition among these activities. Logically, over time, each sector had tried to prove its own benefits.

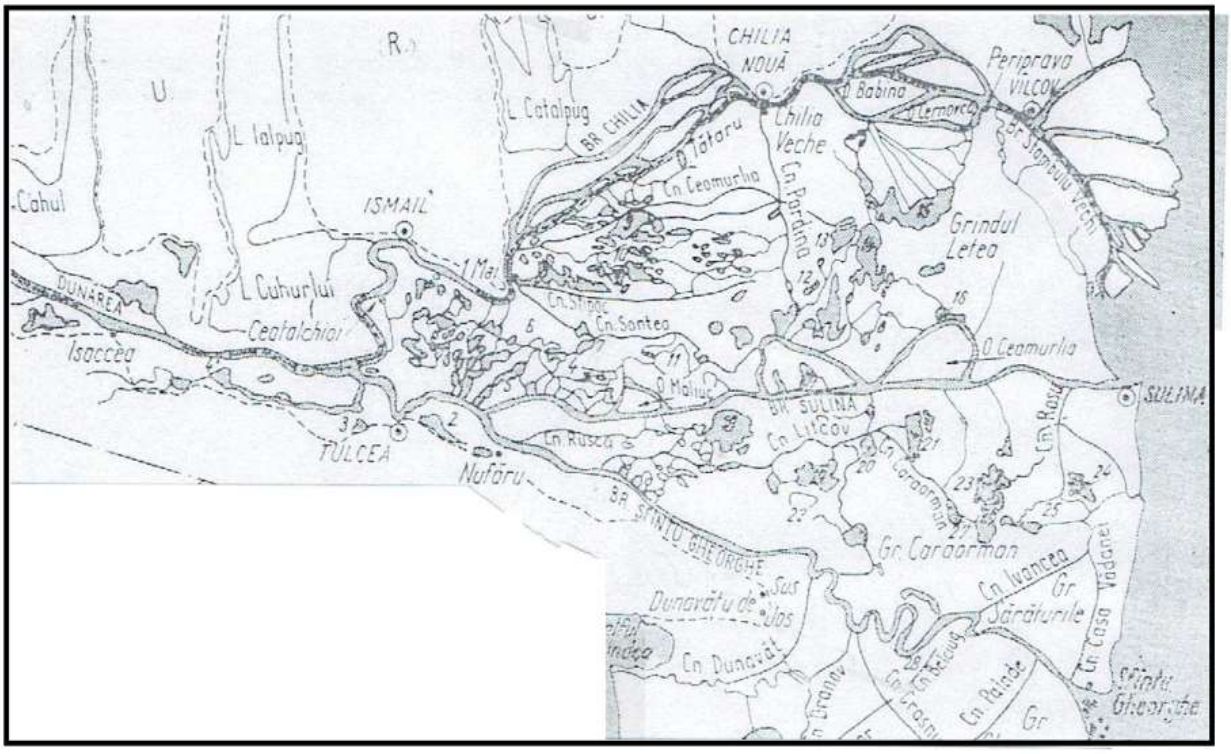


Figure 1. The Danube Delta (Source: Botzan et al., 1991)

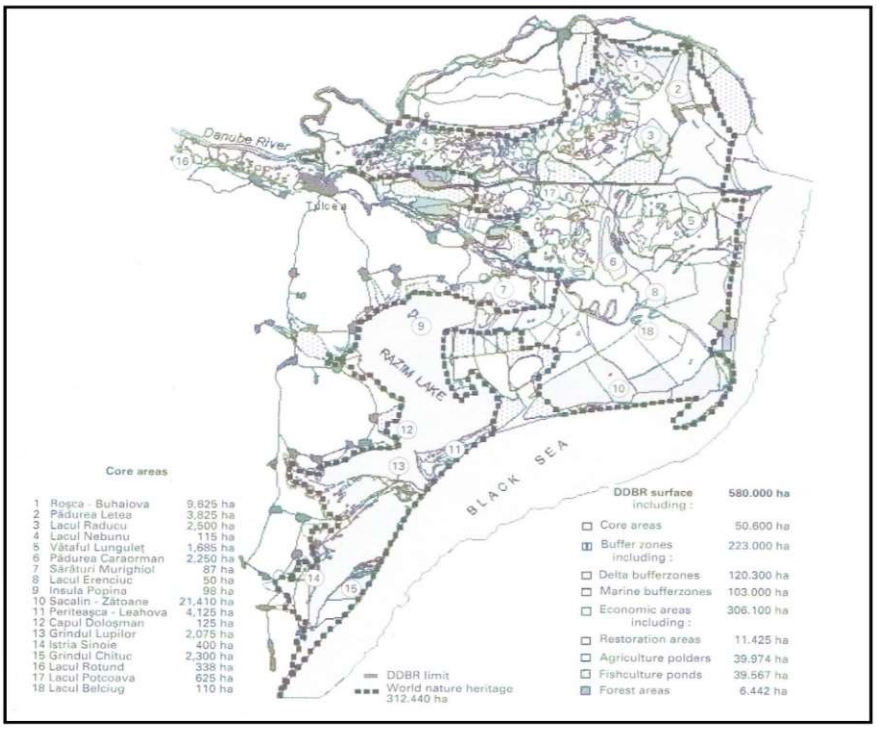


Figure 2.The Danube Delta Biosphere Reserve (Source: DDNI, 2010)

In the following year, i.e. 1954, a group of researchers and specialists from different fields went to the Delta. In 1956, the first synthesis of knowledge emerged, and in 1958, the Academy developed a synthetic study on the delimitation of various Delta uses. Finally, in 1960, the Institute for Agricultural Studies and Design elaborated a Technical-Economic Memorandum on the Improvement Measures for the Agricultural Land in the Danube Delta. According to this document, 126 thousand ha were assigned to agriculture. At that time, 11,300 ha were embanked, 400 ha - drained and 803 ha - irrigated (Botzan et al., 1991).

The program for the development and full operation of the Danube Delta (1982).

The last adjustment regarding the economic use of the Delta's resources during the totalitarian regime was performed in 1983 through a special program that ranked priorities as follows:

- fish farming was to remain the main activity branch, developing both the equipped areas and the fishing in natural lakes, in free flood regime;
- agriculture was to be practiced with complex equipments, ensuring the necessary feed for fish and animal farming, for the consumption needs of the inhabitants, as well as some availability for delivery to the state fund;
- forestry would be mainly represented by the plantations of species growing rapidly in the shore-dike area;
- reed would be grown only in natural regime areas, ensuring raw materials for the production of cellulose;
- tourism would become an important economic branch;
- the systematization of the area and of its villages/towns, provision of facilities in order to improve the lives of the Delta inhabitants and their numerical growth (Lup, 2012).

In terms of agriculture, the program still included very ambitious objectives:

- increasing the agricultural area to 144 thousand ha. Of these 144,000 ha (assigned to agriculture), 93,635 ha were to benefit from land reclamation works (85,000 ha embanked, drained and irrigated; the remaining 50,365 ha would become grass lands by fixing and improving the sands) (Botzan et al., 1991);
- the livestock was planned to reach 20 thousand cattle; 350 thousand sheep; 120 thousand pigs and 350 thousand poultry.

Table 1. Land use in the Danube Delta in 1982 (Source: ISPIF)

Use	Area (hectar)
Fishing and fish and reed growing, nature reserves	315000
Forestry	20335
Agricultural (equipped and under natural regime)	66185
Constructions and land within build-up areas	4450
Danube branches	7820
Other areas (dunes, islets)	28510
TOTAL	442300

The program was approved by the Decree of the State Council no.92/1983. Prior to the elaboration of the last program (where the area assigned to agriculture was 144,000 ha), in the Danube Delta, agriculture was performed on only 66,185 ha (Table 1).
Moreover, in this case also, the media, including the cultural one, watched so that nothing would negatively influence the party and state leadership's decision to turn the Danube Delta into a granary.

In 1980-1981, a multidisciplinary collective of researchers from the Institute of Agrarian Economy of the Academy of Agricultural and Forestry Sciences elaborated the project of organizing Pardina area as a state-owned agricultural enterprise. The author of this paper took part in this project. The conclusions of the study included the following (fig. 3):

• In the irrigated phase, 11,0000 tones of grain and soybeans are obtained, with an increase by 82%, compared to the non-irrigated period. The value of the agricultural yield doubles (116% increase). The physical and value yield increase is due to irrigation, but also to the increase in the area cultivated with 2,200 ha (i.e. an increase by 10%).

• Expenditures are growing at a faster pace than the yield growth (an increase by 159%). The yield

increases 1.2 times and the expenses increase 1.6 times.

• The net income in the irrigated phase does not increase in the same way as the yield pace. While the latter increases 1.2 times, the net income increases only 0.3 times, i.e. four times slower, due to expenditures. The net income mass increases by 30% compared to the non-irrigated phase.• The incremental investments made between the non-irrigated phase and the irrigated phase, amounting to

528,820 thousand lei (i.e. 68%), lead to a corresponding physical and value yield increase; however, this does not lead to the increase in the net income in the same proportion.

Figure 3. The facsimile of the project for organizing the yield from Pardina, in the Danube Delta (IEA)

The investment efficiency index decreases from 5.3% to 4.2%, and the recovery period increases from 18.7 to 24.2 years.
Why did not the authorities act forcefully in the Danube Delta, as happened in the Danube Floodplain? The answer to this question remains an enigma.
Despite the warnings that the land taken out from under the water would degrade (swamp formation, secondary salinity, aridization), hundreds of thousands of hectares were assigned to agriculture. This could be explained by the tacit acknowledgment that in the Delta the negative phenomena would have been much more difficult and more expensive to control. Moreover, we should not forget the failed attempts to embank, drain and use as permanent dry land some land areas from Mahmudia undertaken by the Dutchman Hangeveldt and from St. George branch undertaken by the Danish Ditgmer in 1895.

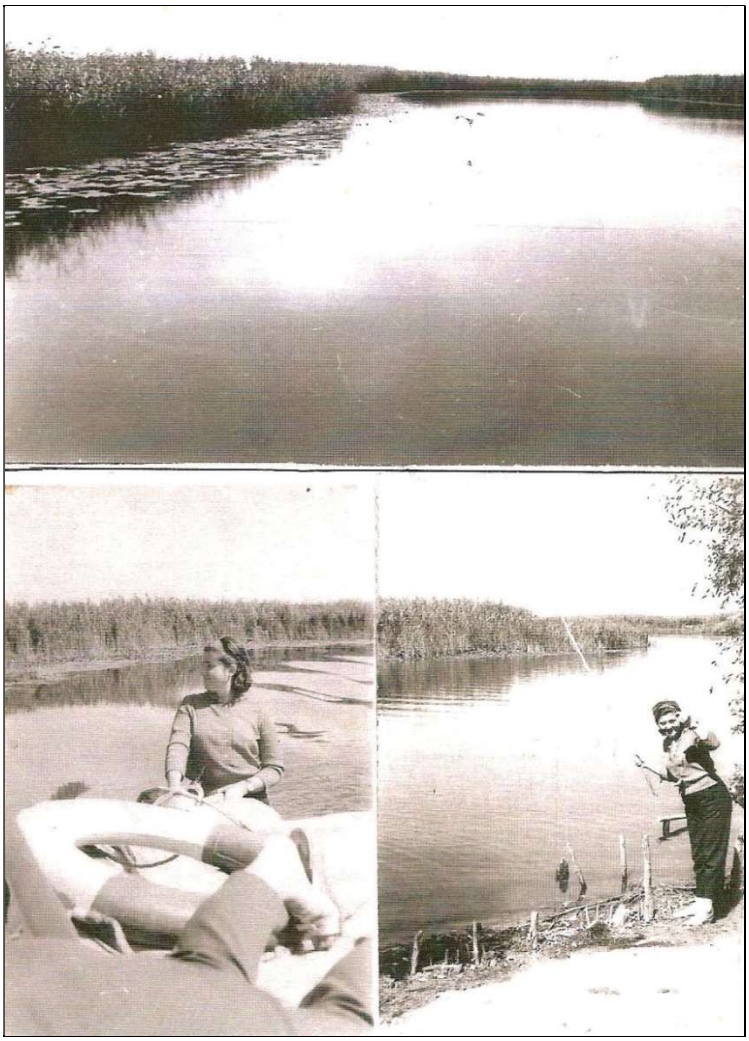


Figure 4. Civilized tourism could become one of the important economic resources in the Danube Delta (Photo: A.Lup)

Even more surprising is the recent proposal (2008) of the Institute for Studies and Design for Land Reclamation, i.e. that agriculture should be practiced in the Danube Delta not on 144 thousand ha, as the totalitarian regime wanted, but on 200,000-250,000 ha, so that the Delta would become an important area for the yield of corn, vegetables and sunflower. Considering that the Danube branches and forests amount to about 75,000 ha (out of 430 thousand ha), 70% of the remaining area, i.e. 355 thousand ha, would be drained and transformed into agricultural land. Let us hope, however, that these proposals will

not materialize and that agriculture will continue to be performed on 60,000-70,000 ha, subject to the restrictions imposed by the Delta's reservation status.

The case of the Danube Floodplain. The Danube Floodplain represented a special objective of Land Reclamation Programs. It was estimated that the drainage and embankment of the historical chain of lakes and ponds from the Danube Floodplain would transform it into a very fertile agricultural area that could increase the agricultural potential of state owned agricultural enterprises (by over 80%). It began with the construction of a 1,200-kilometer long, non-submersible dike; almost 432 thousand ha were drained, out of which 224 thousand ha (51,8%) were equipped for irrigation, field crops and rice (Hâncu et al., 2009).

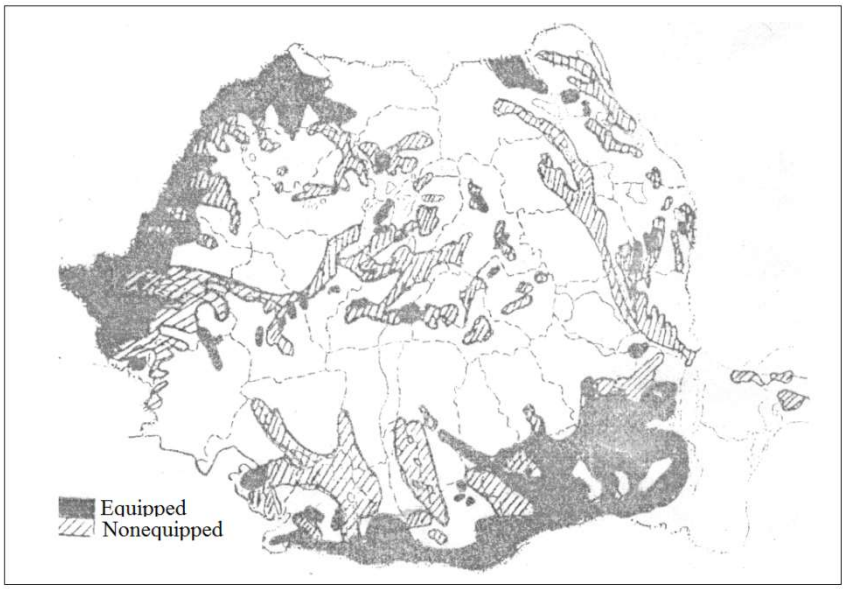
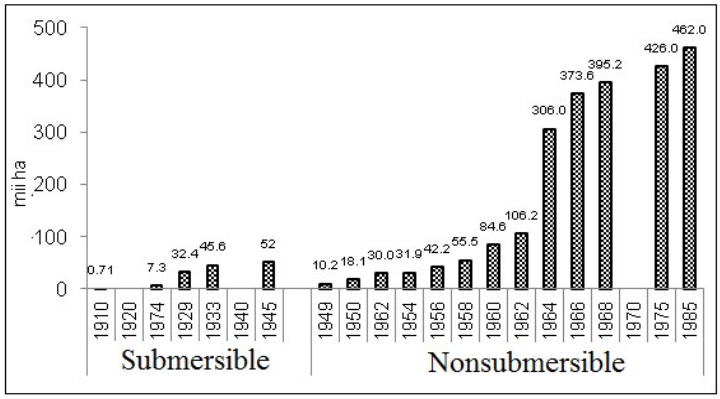


Figure 5. Lands affected by excess moisture in Romania and the status of the works performed by 1990 (Source: D.G.E.I.F.C.A.)

Table 4 The area (ha) equipped with drainage systems in 2003, compared to the 1985 program (Source: AGR.1 IF/31.12.2003 – SNIF S.A.)

No. crt.	County	Program (1985) thousand ha	Achieved (2003) thousand ha	Share %	No. crt.	County	Program (1985) thousand ha	Achieved (2003) thousand ha	Share %
1	Alba	18.4	7.7	41.8	22	Hunedoara	28.5	14.6	51.2
2	Arad	251.5	224.2	89.1	23	Ialomița	192.1	182.5	95.0
3	Argeș	43.8	33.3	76.0	24	Iași	49.3	42.1	85.4
4	Bacău	8.2	3.6	43.9	25	Maramureș	47.1	27.2	57.7
5	Bihor	170.9	166.6	97.5	26	Mehedinți	39.5	37.2	94.2
6	Bistrița-Năsăud	23.0	10.0	43.5	27	Mureș	76.2	13.8	18.1
7	Botoșani	12.4	10.3	83.1	28	Neamț	14.5	10.9	75.2
8	Brașov	89.8	77.0	85.7	29	Olt	121.1	75.3	62.2
9	Brăila	290.2	268.1	92.4	30	Prahova	65.0	49.8	76.6
10	Buzău	141.6	127.6	90.1	31	Satu Mare	239.8	232.9	97.1
11	Caraș-Severin	44.9	28.6	63.7	32	Sălaj	21.8	14.3	65.6
12	Călărași	240.4	171.7	71.4	33	Sibiu	27.5	28.5	103.6
13	Cluj	27.6	4.6	16.7	34	Suceava	69.4	44.9	64.7
14	Constanța	15.6	15.1	96.8	35	Teleorman	130.0	99.1	76.2
15	Covasna	54.6	37.7	69.0	36	Timiș	441.6	438.8	99.4
16	Dâmbovița	113.0	64.3	56.9	37	Tulcea	97.4	40.0	41.1
17	Dolj	128.2	142.5	111.2	38	Vaslui	59.8	41.7	69.7
18	Galați	71.5	59.2	82.8	39	Vâlcea	14.5	13.0	89.7
19	Giurgiu	125.3	90.2	72.0	40	Vrancea	55.2	50.1	90.8
20	Gorj	11.7	9.2	78.6	41	Mun. București	49.8	58.6	117.7
21	Harghita	38.7	21.3	55.0		**Total**	3761.5	3084.9	82.0

The solution of non-submersible dikes belonged to Engineer A. Saligny, although, in 1929, a ministerial council agreed with naturalist Gr. Antipa, who pleaded for the submersible dikes that continued until after

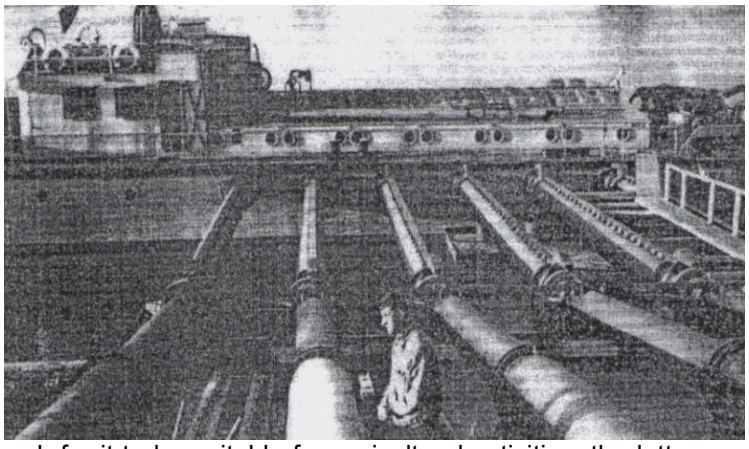


the Second World War. However, in 1945, the Improvement Council of the Ministry of Agriculture (MA) finally noticed, without any doubt, the inappropriate results (during the exploitation period, the submersible dikes were overrun by floods and flooded the agricultural lands behind them; however, the new regime wanted exclusive agricultural exploitation). Thus, it was decided to pass to non-submersible dikes (Figure 6).

Figure 6. The evolution of embanking along the Danube flood plane

In the period 1948-1983, in the Danube Flood plain, 53 areas, including the two major Danube islands (Balta Braila and Balta Borcei) were dewatered. As a result of the non-submersible embankment and drainage of the Danube Floodplain, the agricultural area grew by almost 184 thousand ha and the arable land by about 273 thousand ha, but the lakes, ponds and especially the forests disappeared. From 95,000 ha of pond forests, there remained only 6,269 ha, i.e. 6.6%. Regarding the disappearance of the forests from the Danube Floodplain, the current director of the National Institute for Studies and Land Reclamation Designs has recently stated that the embankments and drainages performed in the Danube Floodplain reduced the forest area by no less than 15 times (Hâncu et al., 2009). Moreover, these works also affected wood quality (which is more expensive than any grain); an apologist of the former regime said that "instead of reed beds and stump willow forests, endless fields of corn and sunflower stretch now towards the horizon". As for the quality of stump willows and pond wood, the photos presented below, taken by forester Stoiculescu, are eloquent.

Preparing the Danube Floodplain for agricultural exploitation. The embankments performed in the



Floodplain were not enough for it to be suitable for agricultural activities, the latter requiring a sufficiently drained land. In the new conception, periodic floods were excluded; thus, the drainage had to be integral and permanent. Therefore, from 1951 to 1952, floating powerful pumping stations were built along the Danube in order to irrigate the drained area, as well as the higher terraces (Figure 7).

Figure 7. The floating pumping station from Modelu, Călărasi County, built in 1964 (Source**:** I.S.P.I.F.)

There were 54 floating pumping stations, such as the one in Figure 8; they all pumped water from the bottom to the top, sometimes up to heights over 200 m. Regarding the evacuation of the excess moisture from the Danube

Floodplain, this was assured by 111 stations with an installed flow of 142 mc/sec, all with a power consumption higher than the one required for irrigation (Botzan et al., 1991):

- the power installed in order to eliminate the excess moisture from the embanked floodplain was 0.17 kW/ha and the power consumed was 212 kWh/ha;
- the power installed for the irrigation of the field crops from the embanked areas was 0.16 kWh/ha, and the power consumed was only 200 kWh/ha.

Figure 8. Poplar logs (left) and willow forest (right) in the Danube Floodplain

The preparation for agriculture did not end there. The excess water resulting from precipitations and especially from the Danube infiltrations through the dike, and the water losses from the non-waterproof irrigation channels had to be collected in a network of channels, whereby it could be evacuated over the dike by means of the above-mentioned pumping stations.
Collecting excess water in the channels also posed a series of problems in terms of a minimum slope or lack of slopes. Despite all the difficulties inherent to such work, the authors of the above-mentioned material stated that the three necessary steps taken for agricultural exploitation (embankment, drainage and irrigation) had been completed and ultimately there had been created the main condition for the capitalization of the full potential of the floodplain, with higher fertility soils.
It was acknowledged later that the excess water from the Danube Floodplain was never effectively eliminated and that the floodplain was not prepared for agriculture properly. This acknowledgement would only come in 2008: "The drainage works together with the application of the entire complex of hydro-ameliorative measures were expected to be accomplished in 4 stages:

1. Embanking and draining surface water through main drainage channels;
2. Eliminating excess surface water by increasing the number of channels within the networks (collection, interception, etc.);
3. Draining water from soil and irrigating drained land;
4. Performing complementary works of surface drainage, rehabilitating the irrigation systems and improving saturated lands and sands.

Due to the partial accomplishment of the third stage (the tubular drainage was introduced only on 5% of the drained area) and the non-performance of the fourth stage, the following deficiencies were noted in the drainage systems:

- the occurrence of areas affected by excess moisture in humid periods, especially in depression areas, which account for almost 20% of the lands where such reclamation works had been performed;

- on some areas with mineralized groundwater, situated at shallow depth, due to the large evaporation-transpiration process, which created a water deficit of 200-300 mm annually in the soil, there occurred secondary soil salinization hambar processes, affecting especially the depression areas, where irrigation was applied without drainage (Hâncu et al., 2009).

The costs incurred by the land reclamation works performed in the Danube Floodplain and the results obtained. The investments in the hydro-amelioration of the Danube Floodplain were particularly high. In 2008, at the debate on the problems raised by the Danube Floodplain and the Delta, the following issues were mentioned:
"The embankment works performed on 1,158 km, the drainage of 418 thousand ha and the irrigation of 224 thousand ha represented an investment of about 2,200 million Euro, i.e. a specific investment of over 5,250 Euro/ha. Adding the costs incurred by the works performed for agricultural land preparation (deforestation, reed removal, initial water drainage, modeling-leveling, movable and immovable assets of the 400 agricultural farms, private property constructions, other infrastructure works and other assets), the total value was estimated at about 8.8 billion Euro or approx. 14 billion USD (Hâncu et al., 2009).
This financial and technical effort was not efficiently exploited precisely because of the constructive deficiencies that were recognized only after the general collapse of the socialist agriculture, but also due to inappropriate exploitation: large water losses in the network of non-waterproof channels, lack of fertilizers and even lack of the water pumping power. The data from Table 5 are conclusive The average yields are insignificantly superior to the country average; sometimes they are even lower; the losses are higher than those registered at the country level, especially in intensive crops such as corn, sugar beet, potato (Lup, 1997).

Table 5 The economic efficiency of the main crops on the land irrigated at a rate of 60%, compared to the country average, for the period 1986-1989 (Source: Statistical Yearbook of Romania,1990 and the Ministry of Agriculture and Department of State Agriculture)

Area	Average yield kg/ha	Value yield lei/ha	Expenses lei/ha	Profit/ losses lei/ha	Average yield kg/ha	Value yield lei/ha	Expenses lei/ha	Profit/ losses lei/ha
	Wheat				Corn			
Irrigated 60%	3073	5592	5237	355	3816	5827	7005	-1176
Country average	2957	5381	5244	137	3097	4728	5290	-562
	Sunflower				Soybean			
Irrigated 60%	1603	4955	4584	371	765	2493	3982	-1489
Country average	1652	5108	4589	519	983	3203	4271	-1068
	Sugar beet				Potato			
Irrigated 60%	23909	9097	10852	-1755	10167	9884	17130	-7246
Country average	19341	7761	8707	-946	13178	12391	15137	-2746

The present and prospective situation of the works performed in order to eliminate excess moisture. At the end of 1989, the National Land Reclamation Administration administrated 3.1 million ha with drainage facilities, 1,800 dikes on the Danube and 1,089.4 km on inner rivers. Keeping them in service by maintenance, repair and exploitation works is one of the strategic objectives but also an important objective of the current activity carried out by the Administration. However, the condition and operation of the drainage systems is inadequate. A committee of the Romanian Parliament found in 2009 the following:

- half of the drainage systems is not prepared for interventions in case of natural disasters;
- defective way of organizing maintenance and repairs;

- the channel network is invaded by vegetation;
- the maintenance and repair system for pumping stations is inadequate (Fig. 9);
- the program for the maintenance and inspection of pumping stations is not applied.

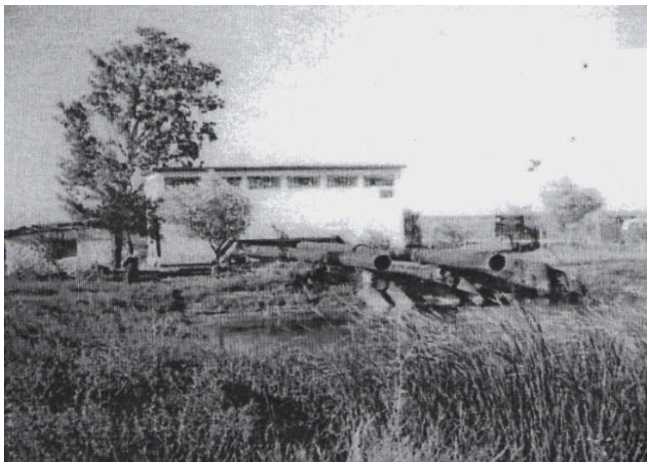


Figure 9. Draining station, Hârșova, Constanța (Photo: A.Lup)

For the future, the National Land Reclamation Administration plans to remedy these deficiencies and to perform works on another 300 thousand ha in order to obtain an area of 3,500 thousand ha (and not more than 5,300 thousand ha, as scheduled before 1990).

CONCLUSIONS

The Danube Delta is primarily a biosphere reserve, whose main resources (flora and fauna) can be economically assessed only by admiring it. Attempts to turn the Delta into a barn have failed at least until now. With a declining population of 14,000-15,000 inhabitants, the Delta provides the main products needed for the subsistence of this population and, at the same time, it produces, or could produce, commodities such as fish, reed, and wood.

The agricultural vocation of the Delta has been limited until recently to a system of self-supply with most agricultural products, except for bread.

Upon the presentation of the Reservation Management Project (1993), 19,000 cattle, 60,000 sheep and 45,000 pigs were declared as livestock. In fact, nobody will ever know the real size of the livestock grown in the Delta; moreover, it is not known how much fish it has and how much it is fished. The shift to aquaculture has not been successful, at least until now.

At present, there is a tendency to capitalize the Danube Delta's touristic potential; however, we are also faced with the leaders' tendency to capitalize it for purposes other than the touristic ones.

Drought, excess moisture and soil erosion affect over half of Romania's arable land. Unlike random temporal and spatial drought, excess moisture and soil erosion are phenomena that permanently diminish crops, make the land non-cultivable or irreparably damage the soil. The economic efficiency of combating excess moisture does not consist so much in the relatively modest yield increases but in the changes in land use, i.e. cultivable land with cereals, technical plants, forage, etc., instead of temporary pasture or marsh.

In order to increase largely and rapidly the yield per hectare, priority was given to irrigations, hundreds of thousands of hectares being drained in the Danube Floodplain, in particular. On drained surfaces, excess moisture was not mastered by drainage; thus, sloughing and salting occurred. The yields obtained with great expenses were far below the planned ones, and in more intensive crops (corn, sugar beet, potatoes) loses were recorded instead of profit. In the recent years, the rehabilitation programs of land reclamation works have given again priority to irrigation, without solving the water losses and drainage issues.

The fact that the Danube Floodplain, where large local and foreign commercial companies exploit hundreds of thousands of hectares of land, has again priority for rehabilitation raises questions about the official agricultural policy in terms of land reclamation.

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