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THE AGRO-ECO-SYSTEM OF AN AREA EQUIPPED WITH IRRIGATION FACILITIES – CASE STUDY: BRĂILA TERRACE

ABSTRACT

The paper attempts to make a quantitative and qualitative analysis of processes and phenomena determined by the interference of natural and human ecosystems, in the context of the sustainable development of the rural communities located in the area covered by the irrigation system of Brăila Terrace from the county Brăila. The methodology used is based upon the analysis and synthesis of information regarding the natural resources, as well as on the diagnosis analysis of the economic and social processes and phenomena from the rural communities located in an area equipped with irrigation facilities. The statistical data were completed with the information provided by studies and articles addressing the same subject.

Located in the North Bărăgan Plain, in the eastern part of Romania, the irrigation system Brăila Terrace covers a total area (designed and executed in the period 1969–1972) of 67,500 ha, out of which the net agricultural land area (recognized as public utility) totals 40,993 ha, and the net agricultural area for which subsidies are received totals 33,208 ha (only if the water supply demand implies the irrigation of at least 20% of a served consolidated area). The Danube is the water resource that feeds the irrigation system with a water flow of 53.24 m^3/s, representing about 2.7% of the minimum multi-annual water flow with a probability to ensure 97% and 0.9% of the multi-annual average flow. The water comes from the Danube and it corresponds to the STAS 9450/88 standards for the irrigation water. The higher mineralization of water from the desiccation system reveals the impact of agro-chemical substances on the water collected in the perimeter of the irrigation system Brăila Terrace.

The obtained results allow us to consider that the future development of the rural communities located in the area covered by the irrigation system Brăila Terrace represents the direct effect of using the potential provided by the local resources. Through the hydro-melioration and irrigation measures, the terrestrial habitat consists of agricultural crops and domestic animals, and the modifications produced in the structure of ecological systems are made for the purpose of local biodiversity preservation and responsibility towards people.

Key words: sustainable development, agro-ecological systems, crop irrigation.

JEL Classification: Q01, Q57.

1. INTRODUCTION

Starting from the premise that economic development takes place within certain ecological systems, at present the eco-development concept is increasingly used. This concept is defined as a complex relation established between the economic development and the natural environment, a special focus being laid on the adequate and rational utilization of natural resources, technology and management style.

In agriculture, the drought, even on short term, has a negative impact upon crop growth, upon yields and upon the harvest quality. The optimum conditions for the utilization of natural resources with maximum efficiency are obtained through a complex set of hydro-melioration works, for drainage-desiccation, irrigation and soil erosion control. For farmers, irrigation represents an input, which ensures optimum conditions for crop development, reliable and relatively stable high yields across years, as well the competitiveness increase of obtained products. For the environment, the non-rational use of land and irrigation water may lead to environmental disequilibria in time (air, surface, ground water and soil pollution).

The research need is justified mainly in the context in which the agro-eco-system located in the coverage area of an irrigation system represents a functional biosphere unit whose dynamics and structure is controlled by humans. This gives the agro-eco-system a trophic structure with lower diversity and a change circuit of substances and energy in terms of intensification or inhibition of certain processes, targeting increasingly high yields for meeting people's food needs.

As an anthropized eco-system, the agro-eco-system located in the coverage area of an irrigation system is differentiated from a natural eco-system by an increased energy consumption, by the use of other energy sources than solar energy, as well as by a flow of substances that does not take into consideration the natural bio-geo-chemical cycles. Its purpose is to obtain harvests of maximum productivity, through the correlation of agro-phyto-technical measures with the ensured water input.

The irrigated agro-eco-system exists as long as the humans' activity is manifested with higher or lower intensity, and the economic efficiency and the level of harvests in irrigated agriculture depend on the controlled supply of water in soil in the first place, according to crop requirements.

2. STATE OF KNOWLEDGE

The **ecosystem** is defined as a community of living organisms present in a given area, under interdependence relations between each other and with the environment, functioning as a unit. The ecosystem or the ecological system has no fixed limits, as its components are mobile and are materialized into trophic chains, as well as by flows of substance and energy introduced by the living organisms in the metabolism process. By its diversity of ecological systems, the environment ensures the existence of all living beings, of the human species implicitly.

Like the ecosystem, the ***agro-eco-system*** represents the unit between all the organisms on an area covered by a certain crop and which are in interdependency relations with the physical environment, so that a certain trophic structure and a circuit of substances on the basis of a flow of energy and substance are created (Baicu, 1988).

In the agro-eco-system, a mostly high production is had in view, useful for people. For this purpose, all measures possible are taken in order to ensure the highest synthesis possible in order to obtain a large biomass amount. Generally, biomass is taken in a percentage of 30% up to 80% from the agro-eco-system under the form of harvest.

On the other hand, actions are also taken on the 1st order consumers (pests and phyto-patogens) in order to limit the use of biomass. The measures target the prevalence of a certain species of plants, which in fact represents the autotroph component. The heterotroph component is developed by the restructuring and decomposition of complex substances.

The agro-eco-system mainly comprises the following elements:

– inorganic substances (C, H, O, CO_2, H_2O, NH_4 etc.);

– organic compounds (proteins, carbohydrates, lipids, humic acids, etc.);

– climate (temperature, light, rainfall, etc.);

– the producers who produce food from simple inorganic substances, consisting of one or two crops and weeds – as undesired primary producers;

– macroconsumers, mainly animals, rodents, insects, acarians etc., which feed on a certain crop or other living organisms;

– microconsumers, heterotroph organisms, mainly bacteria and fungi, which decompose the complicated compounds created by plants or animals.

In order to obtain optimum conditions for maximum efficiency utilization of the natural resources existing in a certain area, humans intervene with a series of actions targeting both *crop breeding*, and the *improvement and development of land areas* for agricultural use.

Crop breeding is the agricultural science concerned with the creation of varieties and hybrids (through the genetics principles utilization) with higher productive features, which meet the humans' needs (Bîlteanu, 1988).

Land improvement based on a set of technical works, mainly land reclamation, targets the improvement of soil and hydrological conditions for the development of crops.

The hydro-meliorative development is meant to regularize the soil moisture. The following are included in this category:

– irrigations, which include water catchment, transport and distribution to crops;

– drainage and desiccation, for the purpose to collect and remove the water surplus from the agricultural land;

– soil erosion control, through a set of works and measures, provides for the prevention and control of the water or wind erosion process.

The area equipped with irrigation facilities represents the agricultural area on which irrigation works were executed for a controlled supply of water to agricultural crops, in order to increase average yields and ensure production independence from the weather conditions throughout the agricultural year, using the equipment and water resources available on the farm, except for the kitchen gardens and crops grown in greenhouses and under plastic tunnels. Only those agricultural areas are included for which the irrigation facilities can be used, regardless of irrigation having been or not applied on the respective area. The area equipped with irrigation facilities does not include the areas of dikes, of settling reservoirs, as well as the land covered by water pumping installations from the irrigation system. The linear details are an exception (channels, small dikes, etc.) under 1 meter wide, whose areas are included. The area equipped with irrigation facilities can be investigated, during the agricultural censuses, by the legal status of the agricultural holdings: individual agricultural holdings and legal entities.

The technology of water transport and distribution to crops implies a definite formula of execution of all agricultural works, in optimum agro-technical periods, in relation to the biological development stages, in order to obtain maximum yields with minimum costs.

The irrigation technique (Măgdălina, 1988) has the following forms:

– overhead sprinkler irrigation, consisting in water distribution through mobile pipelines under pressure and water application through sprinklers; it is practiced on land areas with uneven, unstable land or on sandy soils;

– surface irrigation, consisting in water supply through low pressure mobile pipelines and its distribution by furrows or ridges;

– drip (trickle) irrigation, consisting in water supply through pipelines under pressure and distributed by dripping to the plant roots;

– flood irrigation, consisting in water supply through open channels and distribution on parcels under continuous layer;

– underground irrigation system, by using underground pipelines.

The sprinkler irrigation system, operating "on demand", is on the first place as regards the current concerns of all experts from the most advanced countries in irrigation in agriculture. The contributions in this direction also have in view the possibility to easily adapt to the distribution networks in the differentiated application of irrigations in private farming, with a wide range of water/flow/volume/ pressure/time requirements.

Not only have the natural physical environmental conditions intervened in the irrigation technique, but also the organizational, political and social conditions. The agrarian structures, the production systems, the development level, the nature of economic and social relations, the investor's financial capacity, etc. are factors conditioning the irrigated agriculture and which determine the organization forms of irrigated areas and to a great extent even the technical design of the irrigation networks.

Until 1989, in Romania, as well as in other countries with command economy, the (sprinkler or surface) irrigation networks prevailed, with water distribution by rotation. Under the new agricultural framework, with policulture on small holdings and with the limitation of water and energy resources, the *irrigation with water* *distribution "on demand",* like in other countries as well (France, Italy, Spain), will acquire an increased focus, with extremely diversified and differentiated techniques, sprinkler irrigation prevailing. At the same time, *surface irrigation*, with *water distribution "by rotation",* can be prioritarily adopted in the dry areas, where large-sized holdings prevail in monoculture and where large areas of homogenous soils exist. All these have in view the creation of specific conditions for private agriculture, with water use on a dispersed basis in space and community.

In order to understand the wording *"on demand"* certain examples adapted to the countries with advanced agriculture must be investigated:

– in certain countries (such as Israel), the restrictive factor (water), as well as the lack of, and the high cost of skilled labour, led to the adoption of automation in the irrigation networks as well as to water use for fertilization, fight against pests, against temperature, this having also an implication in the ecology sphere;

– in other countries (such as Switzerland), the main problem had in view was the elimination of the constraints to farmers with regard to farmer's choice to dispose of the cropping techniques, organization of time, production system, the water distribution network with pipes under pressure making it possible to continuously have a water reserve in the irrigation reservoirs.

In Romania's conditions, the shift to these techniques makes it possible to solve up several problems with regard to the water flow and the economic aspect referring to the size of it at the end of the parcel, the introduction of water reservoirs that can provide the flow and pressure "*on demand*" having higher building-erection costs.

The shift from a system with open or closed collective pipes, specific to large-scale farming (for instance Ialomița-Călmățui, Sadova-Corabia etc.) to a modern system specific to parcel agriculture, with complex cropping plans requires great technological and financial efforts, but we must admit that it is extremely necessary under the new farming conditions.

The irrigation system for a certain crop implies a complex set of irrigation-specific technical concepts. The methodology used for the calculation of water consumption is the *soil water balance*. In order to determine the effective water consumption, the water reserve in soil is accurately determined from the beginning to the end of the vegetation period, with a strict evidence of the water amounts from rainfall and from irrigation. It is intended that the irrigation application does not exceed the moisture values over the capacity in the field, thus avoiding the water losses. The following contribute to soil water balance: *inputs* – all water supply sources – the water reserves at the beginning of the vegetation period, named initial reserve (Ri), sum of useful rainfall at the beginning of the vegetation period (P), water amount applied by irrigation, *i.e.* irrigation norm (M) and *outputs* – total water consumption (E + T), as well as the water reserve that remained in soil at harvesting, final reserve (Rf).

Thus the following relation is established:

$$Ri + P + M = C (e + t) + Rf$$

from which the water consumption is determined:

$$C (e + t) = Ri - Rf + P + M$$

The *number of irrigation applications* is established according to soil moisture evolution.

The moment of irrigation application depends on soil moisture diminution on the depth where the most part of radicular mass is found. The *irrigation norm*, *i.e.* the quantity of irrigation water applied (m^3/ha), is determined in relation to the thickness of the active layer of plant roots, to the apparent soil density, field capacity and the current soil water supply.

Under a rational irrigation system, the crops are provided with the strictly necessary water amounts for the normal development of their physiological processes, which are influenced by this production input. A rational irrigation system should be in line with: crop water requirements, physical-chemical properties of soil, hydrological situation and the local weather conditions.

The irrigation can be effected on a systematic basis (at certain moments with established norms) or only once (by submersion, with water resulting from snow melting, and by flooding, when the water covers the irrigable area only in the period of overflowing). The irrigation water sources can be the following: rivers, lakes, ground waters and other natural water sources. The water is supplied to the irrigated area through an irrigation system.

As a result, the agro-eco-system located on a coverage area of an irrigation system becomes a functional biosphere area whose dynamics and structure is controlled by humans in conformity with a certain target (mainly obtaining increasingly higher yields, for meeting their food needs). This provides a trophic structure to the agro-eco-system, with a lower diversity and with a changed circuit of substances and energy as regards the intensification or inhibition of certain processes. The agro-eco-system exists as long as humans' activity is manifested with a higher or lower intensity.

3. MATERIAL AND METHOD

At present, the eco-development concept is used on an increasingly large scale, starting from the premise that the economic development takes place within a certain ecological system. This concept is defined as a complex relation established between the economic development and the natural environment, with an increased focus upon the adequate and rational use of natural resources, technology and management style.

The paper intends to investigate the processes and phenomena determined by the interference of natural and human eco-systems in a given area equipped with irrigation facilities, where the anthropic activities led to the emergence of certain disequilibria in the environment in time, and the biodiversity preservation can be affected by the overexploitation of natural resources as a result of population's pauperization.

The informative material on which the paper was based includes reference scientific studies from the world and national literature. The irrigation water management analysis was based on information obtained from the following bodies: National Land Improvement Agency (NLIA), Regulation Office of the Land Improvement Organizations under the Ministry of Agriculture, Forests and Rural Development, the Ministry of Environment, etc., as well as on a series of statistical data at county level and governmental reports.

4. RESULTS AND DISCUSSIONS

4.1. Irrigated agro-ecosystems in Romania

Known and practiced even since ancient times, irrigation became a basic component of the cropping technology in the last decades, not only in the arid areas, where crops could not be grown in the absence of irrigation, but also in the sub-arid and humid areas.

In Romania, the first areas equipped with irrigation facilities for vegetables, the first rice paddy with irrigation facilities were near Timişoara, in the period 1718–1723 and the first development of the hydro-technical system Bega-Timiş, in 1728. The hydro-technical development works were extended throughout Banatului Plain, Crişurilor and Someşului river plains, Ierului Valley. In 1780 the Ipsilanti canal was built for defending the town of Bucharest against flooding, through the evacuation of the high waters of the Dâmboviţa river in Ciorogârla. In 1910 the Law on Land Reclamation in the Danube flooded area, modified in 1914 and 1925; the law provided for damming in with insubmersible dykes, an idea that was supported by Anghel Saligny in opposition with Grigore Antipa, who was in favour of a limited damming in of about 130,000 ha with submersible dykes, while the rest of the river plain remained under natural regime (Mărăcineanu, 1988).

After 1949, the socialist transformation of agriculture reorganized and developed the land reclamation activity, increasing the areas equipped with land reclamation facilities, with regularization of water courses, desiccation and drainage works, irrigations, development of agricultural land under slope, melioration of salty soils and amendment of acid soils, levelling and shaping the agricultural land areas, land clearing and cleaning. Thus, non-productive land areas could be introduced into agricultural use and certain natural phenomena with negative impact upon the agricultural land productivity could be prevented and controlled.

The land equipped with irrigation facilities (under large systems or under, small-scale local systems) comprises engineering works for water catchment, transport and distribution to crops on a controlled basis. Until the early ’90s, the land equipped with irrigation facilities exceeded 3 million ha (Table 1) out of the 14.8 million ha agricultural land and 9.3 million ha arable land, mainly located in the driest areas from the Romanian Plain, Dobrogea, Moldova Plateau (Fig. 1).

Table 1

Evolution of land areas equipped with irrigation facilities in Romania

Year	**1938**	**1950**	**1955**	**1960**	**1965**	**1970**	**1975**	**1980**	**1985**	**1989**
Area equipped with irrigation facilities thou. ha	15.4	42.5	93.1	199.7	229.9	714.6	1,437.3	2,221.8	2,873.9	3,109.0

Source: Lup, A., *Îmbunătățirile funciare în agricultura României. Retrospectivă istorică și perspective*, Revista „Economie agrară și dezvoltare rurală”, nr. 1, Editura Academiei Române, București, 2010.

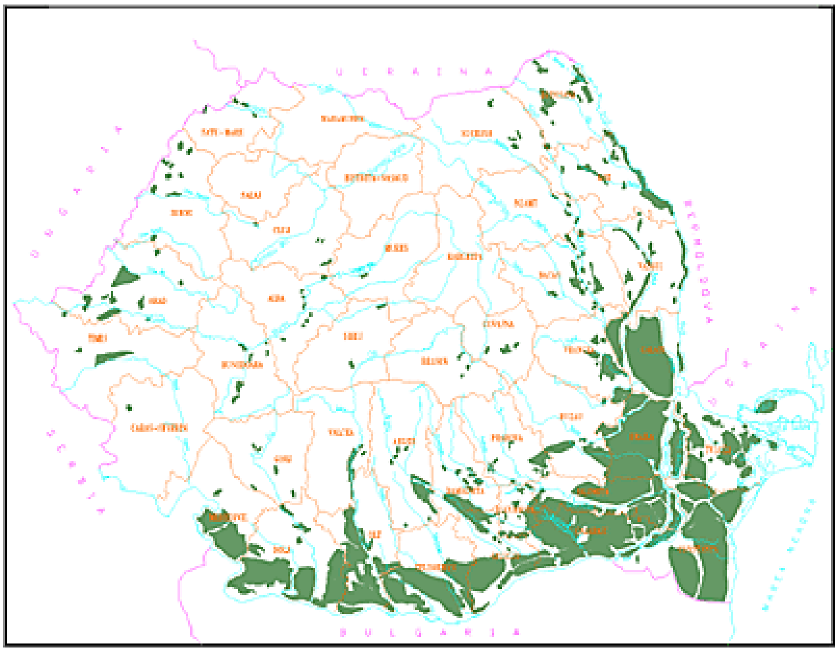

Figure 1. Land equipped with irrigation facilities in Romania.

In the period 1960–1965, the first land areas equipped with irrigation facilities under large-scale systems did not exceed 10 000 ha (Terasa Călăraşi, Roseți, Stoeneşti – Vişina etc.). In time, the large irrigation systems include areas of hundreds of thousands of hectares (Carasu, Ialomița-Călmățui, Terasa Brăilei de Nord, Terasa Corabia, Calafat-Băileşti, Izvoarele-Cujmir, Terasa Covurlui etc.) located along the Danube. These reached 140 thousand ha, summing up about 80%

of the entire equipped area. The water source for 75% of the hydro-melioration works is the Danube river (Lup, 2010).

After 1990, the reform process of the agricultural and forestry sector also included restructuring measures for the administration and use of the existing intermediary and final land reclamation infrastructure, through its transfer into the final beneficiaries (farmers') ownership and administration. These got organized according to Government's Emergency Ordinance no. 147/1999, approved with modifications by Law no. 573/2001, into associative structures named land reclamation organizations and federations of organizations.

By the year 2012, 492 land reclamation organizations (LRO) had been established, out of which: 457 irrigation water users' organizations (IWUO) with a gross area of 1,102,721.7 and net area of 1,071,523 ha (Table 2).

Table 2

Situation of land reclamation organizations (LRO) and of federations of land reclamation organizations (FLRO), on 6.02.2012

Organization form	**Number**	**Area ha**	
		Gross	**Net**
LRO (land reclamation organizations)	467	1,158,567.0	1,125,634.0
IWUO (irrigation water users' organizations)	457	1,102,721.7	1,071,523.1
with PT (infrastructure transfer protocol)	316	849,399.6	825,107.1
DDO (desiccation and drainage organizations)	9	55,846.0	54,111.0
New LROs	320	677,781.6	569,821.0
Reorg. LROs	146	480,786.1	465,813.1
Irrigation plots	1152	1,097,645.7	1,070,552.1
with PT (infrastructure transfer protocol)	710	804,302.6	785,182.1
FLRO (federations of land reclamation organizations)	10	98,696.0	95,586.0

Source: http://www.maap.ro

The irrigation water users' association is established by a protocol with certified statute under legal conditions. The statute includes provisions referring to: name, main location, patrimony, object of activity and purpose, management and control bodies, conditions for joining the association and getting out of the association, association members' rights and obligations. The association is for the purpose of carrying out one or several activities of public interest, such as: a) irrigation water delivery, operation, maintenance and repair of an irrigation, drainage and desiccation system serving several land owners; b) maintenance and repair of flood and soil erosion control facilities and carrying out other land reclamation activities that protect the soil on the land area of several landowners.

These organizations and federations are legal public utility entities, without patrimonial purpose, which take over in the land users' interest both the ownership right and the right of use of the water users' association on the irrigation infrastructure into state or administrative-territorial units ownership, consisting of pumping stations, hydro-technical constructions, together with the related equipment and land, underground pipes, as well as other similar assets located on the organization territory.

Depending on the hydro-melioration facilities that have been taken over, the associative structures received the following names: irrigation water users' organizations (IWUO); drainage and desiccation organizations (DDO); soil erosion control organizations (SECO); flood control organizations (FCO).

4.2. The irrigated agro-eco-system in the county Brăila

In Brăila county, which is located in the south-eastern part of Romania, the plain is the prevailing relief unit, with quite a dull landscape, without natural barriers (Fig. 2). The flora and fauna of Brăila county are specific to the plain region. The steppe was turned into agricultural land, Brăila county being one of the most developed counties in Romania from the agriculture point of view. Although the land areas are extremely fertile, the frequency of drought leads to the diminution of yields, much under the profitability limit.

Brăila county is one of the ***large agricultural counties of the country.*** With an agricultural area of 388,435 hectares and 345,911 hectares arable land, Brăila county is one of the areas that has one of the greatest possibilities to contribute to Romania's food supply and to export availabilities. This potential is doubled by a *good soil quality*, as about 48.5% of its land area consists of chernozem soils – very fertile soils, and almost 30% of alluvia and alluvial soils, which provide good crop development conditions by hydro-melioration and irrigation measures.

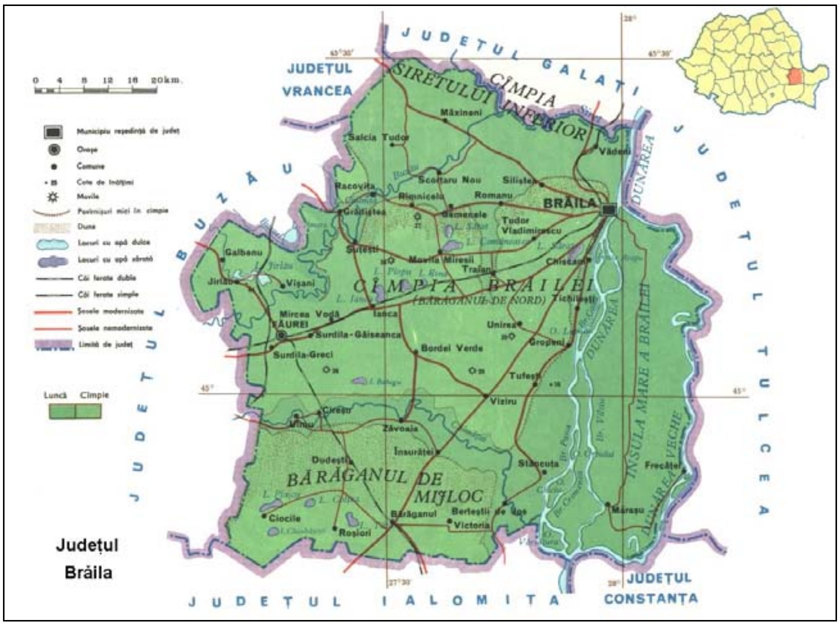

Figure 2. The relief units in Brăila county.

The climate is of temperate-continental type, with average temperatures of 11.1°C, with dry summers and cold winters. From the thermal point of view, Brăila county, being located in the south-eastern part of the country and crossed by the parallel 45° (near the locality Viziru), features favourable conditions for the growth and development of a wide range of cereals, industrial crops, vegetables, fruit-trees and vine, and here even varieties and hybrids with a long vegetation period can be cultivated. The obtained crop production, mainly in the case of cereals and fodder crops, creates good conditions for raising animals (bovines, sheep, pigs and poultry).

Brăila county has 13 hydro-melioration developments, with a total gross area under hydro-melioration works of 351,482 ha and a total net area of 334,047 ha (Table 3).

Table 3

Area and organization forms of the hydro-melioration developments in Brăila county, in 2012

No.	**Hydro-melioration development**	**Total gross area**	**Land Reclamation Organizations**					
			IWUO		DDO		FLRO	
		ha	no.	ha	no.	ha	no.	ha
1	Terasa Brăilei	34,332	26	34,332				
2	Terasa Ialomiței	18,905	19	18,905				
3	Terasa Viziru	19,482	16	19,482				
4	Nămoloasa – Maxineni	13,224	12	13,224				
5	Ianca Surdila Greci	13,600	5	13,600				
6	Incinta BH Călmățui	9,608	4	9,608				
7	Insula Marea a Brăilei	211,200	1	68,934	1	69,241	2	73,025
8	Terasa Latinu Vădeni	4,075	6	4,075				
9	Grădiștea – Făurei – Jirlău	8,877	3	8,877				
10	Călmățui – Gropeni	11,533	4	11,533				
11	Incinta Lunca Râu Buzău	2,070	2	2,070				
12	Incinta Brăila – Dunăre	3,784	3	3,784				
13	Incinta Noianu Chișcani	787	1	787				
	TOTAL	351,482	104	355,266	1	69,241	2	73,025

Source: National Registry of Land Reclamation Organizations, Land Reclamation Directorate, MAFRD, September 4, 2012.

The existence of the ***large irrigation systems,*** on areas over 10,000 ha, such as those from Insula Mare a Brăilei, Terasa Brăilei, Terasa Viziru, Terasa Ialomiței, Ianca Surdila Greci, Nămoloasa-Maxineni and Călmățui-Gropeni, greatly compensates the water deficit in the hot period of the year, specific to the steppe zone. It is worth mentioning that only in the hydro-melioration from Insula Mare a Brăilei, 68,934 ha are equipped with irrigation facilities and 69,241 are equipped with drainage and desiccation facilities.

In Brăila county, the pumping heights are lower, only 13% of the areas equipped with irrigation facilities having over 75 m pumping heights. In spite of these advantages, it is estimated that after 1990, the total production and labour productivity are low in the crop and animal production sectors, and they do not reflect the natural potential of the area, the local tradition and experience.

The human resources from the coverage area of the irrigation system Terasa Brăilei are available as regards both as number and training. The large shares of the population employed in agriculture describe a mainly mono-occupational profile, and the low demographic pressure on the financial resources reveals the land use potential in agriculture development.

4.3. The agricultural eco-system in the hydro-melioration system fromTerasa Brăilei

The irrigation system "Terasa Brăilei" is located in the North Bărăgan Plain, in the eastern part of Romania, and it is under ANIF administration, branch: Argeş – Ialomiţa – Siret, administration unit Brăila Nord**.**

The total area of the system, designed and executed in the period 1969–1972, is 67,500 ha out of which the net agricultural area (recognized as being of public utility) is 40,993 ha. At present, the total gross area equipped with hydro-melioration facilities is 351,482 ha, accounting for more than 90% of the county agricultural land area, while the total gross area equipped with irrigation facilities accounts for more than 72% of the county agricultural area, *i.e.* almost 82% of the county arable area (Table 4).

The micro-relief and soil and hydro-geological conditions under the system "Terasa Brăilei" imposed the execution on 17% of the county agricultural area of a network of *water removal-desiccation* works and *closed drainage* in the salty depressions in order to increase natural drainage and remove the water collected in depressions, in order to prevent the enrichment and rise of the phreatic layer.

The system "Terasa Brăilei" is supplied with water from the Danube river, with a water flow of *53.24* m^3/s, the catchment of water flows taking place at the points with the most favourable conditions in the area, by two water inlets and floating pumping stations *SPA km. 166* and *SPA GROPENI km. 196* and through the repumping station *SRPD4* from the thermal power station.

The water removal-desiccation network consists of four systems with gravity unloading in the Buzău river (the removed water flow is 3.30 m^3/s) and in the Danube (the removed water flow is 8.1 m^3/s). The closed drainage fields have a total area of 1844 ha.

The canals and the main water removal-desiccation stations are functional but in certain areas they need clearing of vegetation and unclogging. The small water removal stations from the small depressions need rehabilitation works as they are not operational being devastated and/or worn out and obsolete.

The irrigation methods are *sprinkler irrigation* (96.80%) and *bed irrigation* (3.2%) with the following facilities:

− sprinkling with pipes under pressure served by electrical pumping stations on 22,880 ha (32%);

− sprinkle irrigation with conduits under pressure served by thermal aggregates on 24,740 ha (34.6%);

− sprinkling with impermeabilized open channels and sewers from which the thermal aggregates are fed on 21,580 ha (30.2%);

− “bivalent” type (bed and sprinkler on 2,300 ha – 3.2%).

Table 4

Share of areas under hydro-melioration developments in the area Terasa Brăilei

No.	**Item**	**Area (ha)**	**Share in total agricultural area**	**Share in total arable area**
1	Total gross area under hydro-melioration developments	351,482	90.49	–
2	Total net area under hydro-melioration developments	334,047	86.00	96.57
3	Total gross area equipped with irrigation facilities	282,241	72.66	81.59
4	Total net area equipped with irrigation facilities	268,476	79.33	77.61
5	Total gross area under drainage and desiccation developments	69,241	17.83	20.02
6	Total net area under drainage and desiccation developments	65,571	16.88	18.96
7	Total arable area of county	345,911	89.05	100.00
8	Total agricultural area of county	388,435	100.00	–

Source: Calculations based on data from the National Registry of Land Reclamation Organizations, Land Reclamation Directorate, MAFRD, September 4, 2012.

The irrigation system Terasa Brăilei is located in an area with continental climate, with higher temperatures and lower rainfall values than the annual averages in recent years. The prevailing winds blow from the direction N and NE in the conditions of climate aridization, when the moisture deficit in soil reaches 350 mm/season in the vegetation period, and crop irrigation is imperiously necessary.

The soils under the irrigation system Terasa Brăilei are mainly of chernozem type, with suitability classes for agriculture I and II. These are soils with a high natural fertility, and the humus content is 3.0–4.5%.

In the period of maximum operation of the irrigation system, due to the rising of the phreatic layer, the phreatic-humid soils and medium salty soils appeared, mainly in the deeper depressions. The percentage of areas under these soils increased from 4–5% to about 10%.

The level of fertilizer application is low, which ensures a low impact on the environment factors, but with the risk of exhausting the nutrients in soils.

The application of pesticides presents the risk of soil pollution, of surface waters and of phreatic layers. In the area of Terasa Brăilei irrigation system, a low amount of pesticides was applied, about 50% of the necessary, and the utilized substances were less toxic, as they were from the 3rd and 4th toxicity group.

The soils are not in danger of erosion, as the sprinkler irrigation brings a smaller amount of water in soil than the infiltration rate. Wind erosion is also low in the vegetation period as sprinkling also increases soil particles cohesion. Due to water quality from the Danube, which belongs to the C2/C3 salinity class, the soils can be subject to a slow salinization process.

The soils under the irrigation system from Terasa Brăilei are suitable for the application of irrigation accompanied by the related desiccation system and need the application of certain agricultural technologies adapted to the planned crops, which should ensure a sustainable use of soils and the protection of subsoil.

The Danube water corresponds to STAS 9450/88 standards for the water quality used in the irrigation of crops. The higher water mineralization in the desiccation system reveals the impact of agro-chemical substances upon the water collected in the irrigation system area.

At present, the wild fauna and flora specific to the steppe zone, which used to prevail in Bărăganului Plain, are much modified, their place being taken by agricultural crops and domestic animals. The irrigation system has a non-significant impact upon the terrestrial habitats, but it is estimated that the removal of water from the desiccation system impacts the aquatic habitats. There are no protected areas and no endangered species in the irrigation system area.

At present, the spontaneous vegetation is found only on an insular basis, on the natural grassland, as well as by the road side, along the irrigation dykes and canals. It is also found on the fallow land and remains of primary steppe meadows, groups with Festuca Vallsiaca, Stipa lessingiana, Stipa capillata and other xerophilous grasses. The trees are found in isolated groups consisting of poplars, willows and acacias, oak trees and different other species. The flora is completed by halophilous vegetation as well as by aquatic vegetation. Most plants develop their evolution cycle before the dry periods at the end of summer.

4.4. Management and conservation of the irrigated agro-eco-system

The agricultural environment protection is obviously an organic component of sustainable development of agriculture according to ecological criteria, contributing to the intact preservation of the biological resources, to the health of plants and soil, to the increase of its production capacity. The protection of agricultural eco-systems has in view the balance between biocenosis and biotope, between the vegetable and animal world on the agricultural land areas.

In the anthropized cultivated biosystem, the ecological equilibrium must be maintained between biocenosis and biotope, within the biocenosis and inside the biotope, as well as between the natural processes and the farmer’s activity.

Briefly, *the agricultural environment protection strategy targets the rational use of natural and material resources, in agreement with the design of less polluting technologies.* The scientific research improvement and the continuous eco-system surveillance are of great importance, mainly on the irrigated areas. The great ecological complexity of the agricultural land, diversified through anthropic intervention, makes it necessary to approach solutions on a correct basis, as the land areas have distinct particularities, hence their differentiated treatment.

The protection of irrigated agricultural eco-systems comprises objectives and actions adopted in most countries, and it has the following management objectives:

– active cooperation between the agricultural biosphere and the industrial biosphere, while applying less polluting technologies, at accepted limits, for each polluting agent;

– maintaining and improving the surface and ground water quality devoted to agricultural land irrigation, in order to avoid certain negative effects upon soil and crops;

– air resource management, with the diminution of polluting emissions to the lowest levels, which should not exceed the atmosphere regeneration capacity;

– ecological protection of crops by integrated control measures, mainly in the control of pests and diseases, providing for a good phyto-sanitary condition and the diminution of applied pesticides;

– improvement of the national monitoring and information system for the control, surveillance and research of irrigated eco-systems, by land, air and remote sensing.

In Romania, the agricultural environment pollution and degradation increased as a result of anthropic activities and natural phenomena such as flooding, prolonged drought and landslides. A significant contribution to agro-eco-system degradation is brought by the clearing of tree and vine plantations, as well as by the demolition of certain industrial units.

The polluted waters used in irrigation contaminate the soil, which leads to low yields on the polluted and degraded land. That is why the reconstruction and rehabilitation of the degraded agricultural areas is a priority, before some other components of the agro-eco-system, so that the respective areas can be introduced in the economic circuit.

The *restoration ecology* concept has been increasingly used recently, which was coined by the West-European researchers, who gave up the ecological reconstruction concept and replaced it by rehabilitation, re-establishment (restoration), with concrete objectives and actions, such as: *natural and artificial regenerations, crop rotation, bio-remedies, and ecological constructions.*

At the same time, the reconstruction of land areas degraded by the industrial activities represent an extremely important issue, as large areas were taken out of the agricultural circuit in the coal basins, in the area of electrical power and thermal stations, in the non-ferrous mine areas and in the area of certain chemical plants, of oil pipes and oil wells.

In the area of the *irrigation system Terasa Brăilei*, the anthropic activities led to environmental disequilibria over time. These were manifested by air pollution, surface and ground water and soil pollution.

Among the activities that exercise an anthropic pressure upon biodiversity, we can mention certain inadequate agricultural methods and techniques (use of polluted waters, pesticide use, intensive grazing, unorganized grazing, burning the stubble fields, etc.) as well as the exploitation of certain species by hunting and fishing activities.

At the same time, at present, the effects of certain interventions that were made several decades ago are still manifested, which targeted land reclamation or pisciculture objectives (removing the moisture excess for obtaining new agricultural land, modification of the water circulation regime in certain ponds in order to facilitate fish harvesting).

Many aquatic eco-systems drained out as an effect of deepening the communication canals with the Danube with piscicultural purpose some years ago, which produced modification in the water circulation regime. Naturally, the Danube used to flood the land and feed the ponds, and after the flooding the waters stagnated for a longer period of time, and they were affected only by the excessive evapo-transpiration in the drought period. The digging of canals for piscicultural purposes determine the premature draining of water into the Danube; this phenol-menon was also favoured by the fact that, in time, the bottom of ponds rose by the accumulation of alluvia brought about by the river.

Biodiversity conservation can be affected by the over-exploitation of natural resources as a result of population's pauperization. In the present operation conditions of the irrigation system Terasa Brăilei, it is estimated that the impact upon the terrestrial habitats is low, and the removal of waters from the desiccation system can have an impact on only on the aquatic habitats. In spite of the modifications produced in the structure of agricultural systems through irrigation, these preserve important ecological values, being 50% natural.

Considering the complex situations and conditions of irrigated agriculture in the world, the more recent studies of the *International Commission on Irrigation and Drainage* propose the following actions for rational water management:

1. Conventional actions:

a) *technical*: lining the water transport and distribution network; transport of water through low pressure conduits; increase of the scale of sprinkler and drip irrigation, instead of bed irrigation, by furrows, strips or flooding; levelling the land by using laser technology; storage of water from rainfall and leakage (losses), from the water transport and distribution network, in small accumulations under the irrigation development; artificial recharge of aquifer layers;

b) *agronomical*: irrigation water application in critical stages of plant development; irrigation scheme correlated with the soil-plant-weather relation; organic and plastic mulches; cultivation of crop varieties resistant to drought and with high productivity per unit of water applied; improvement of soil moisture management; increased cultivation of crops in greenhouses and plastic tunnels; utilization of used waters for crop irrigation; low norm irrigation;

c) *management*: improvement of maintenance and exploitation of land equipped with irrigation and drainage facilities; promoting the participatory management; management transfer to water users' organizations; management of ground water sources;

d) *institutional*: training managers in irrigations, field workers and farmers; adequate fees for water from public utility units and for water pumping power; dissemination of water management technologies; promoting public awareness in water conservation and saving measures through mass-media.

2. Non-conventional actions:

a) *innovative technologies*: use of irrigation systems with low energy consumption; automated canal network; integrated control system for water courses; water administration systems; detectors for the surveillance of soil moisture on the land areas equipped with irrigation facilities; irrigation warnings; mobile and fast internet communication, remote sensing, mobile telephony; soil drainage control; use of biotechnology/crop varieties;

b) *innovative management*: integrated management of water resources; basin organizations for water administration; manuals on the irrigation schemes and water consumption audit; innovative methods for water and energy fees and for cost coverage; agricultural technologies for soil conservation (non-tillage); consulting the beneficiaries; support decision systems and methods; farmers' involvement; public-private partnership.

5. CONCLUSIONS

The agricultural ecosystems or agro-eco-systems appeared as a result of humans' intervention on the natural ecosystems that they fully or partially transformed. By correlating the ecology with the agricultural science, a great part of the biotic and abiotic components of the agro-eco-system directly participate to the growth and development of crops, as well as to the ecological stability of the landscape.

As an economic production unit, the irrigated agro-eco-system is characterized by the inseparable symbiosis with the human activity. In the absence of humans, the crops and in general the entire agricultural ecosystem cannot compete against wild plants and natural ecosystems.

In Romania, due to the weather conditions, the irrigation of crops represents an important technological link. The infrastructure serving the irrigation systems, largely designed in the command economy period, is adjusted to the new operation structures resulting from the land restitution process in our country, which led to an excessive agricultural and forest land fragmentation.

The county Brăila is one of the large agricultural counties of the country. The economic development is medium compared to the national level, and agriculture is the most important sector, favoured by fertile soils, by the rich water sources, by the irrigation infrastructure, by the weather conditions and local tradition. The water deficit in the hot season (specific to the steppe zone) is compensated by the existence of large irrigation systems, organized into 13 hydro-melioration developments, with a total gross area of 351,482 ha and a total net area of 334,047 ha.

The irrigation system "Terasa Brăilei", under ANIF administration, branch: Argeş – Ialomița – Siret, administration unit Brăila Nord, has a total area of 67,500 ha, designed and executed in the period 1969–1972, out of which only 33,208 ha net agricultural area benefit from subsidies at present (if the water demand implies the irrigation of at least 20% of a consolidated served area).

The irrigation system has a non-significant impact upon the terrestrial habitats, while the desiccation system impacts the aquatic habitats. There are no protected areas and no endangered species have been detected in the irrigation system area.

The irrigated agriculture influence upon the environment is mainly determined by:

– the utilization modality of agricultural areas;

– hydro-melioration systems (for irrigations, drainage and desiccation and soil erosion control);

– application of chemical and organic fertilizers, of pesticides.

The protection of agricultural eco-systems comprises objectives and actions that are taken in almost all countries and refers to:

– application of less polluting technologies;

– maintaining and improvement of surface and ground water quality used for the irrigation of agricultural land;

– measures and actions targeting the integrated control of pests and diseases;

– surveillance and monitoring of eco-systems by land, air and remote sensing.

At present, there is an increased focus on the rehabilitation, protection, rationalization, transformation and control of the natural environment, using the eco-system engineering and the experimental ecology, by reaching a balance between the vegetable and animal world on the irrigated agricultural land and outside it.

Known and practiced since ancient times, irrigation became a basic component of the cropping technology in the last decades, not only in the dry areas, where no crops could be cultivated in the absence of irrigation, but also in the semi-arid and sub-humid areas.

Depending on the phyto-technical measures, different types of irrigation are applied in the different periods of crop development (supply irrigation, sprouting irrigation and vegetation irrigation). The irrigation water management is conform with the European Union requirements, which regulate the framework of action, cooperation, coordination and implementation of the common norms on sustainable water and soil use.

The investments in the irrigation infrastructure have a favourable impact upon the environment by diminishing the drought risk, aridization control, reducing the water losses through infiltrations, with negative consequences upon the phreatic water and soil, etc.

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