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ASPECTS REGARDING SPATIAL AND TEMPORAL DYNAMIC OF IRRIGATED AGRICULTURAL AREAS FROM SOUTHERN OLTENIA IN THE LAST TWO DECADES

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Abstract. Destruction of irrigation systems in southern Oltenia with the change of political regime after 1990 represented a real impact both on the environment elements and on human communities in the region. Synergistically context of severe climatic factors with aridity trends, the misuse of the land and the disappearance of irrigation systems in the last two decades has led today to a real environmental degradation in southern Oltenia region. This paper aims to analyze the evolution and the spatial current situation of irrigation systems, highlighting the synergistic causes of catastrophic restraint of irrigated areas in the last two decades as well as important aspects about the impact of the collapse of irrigation sector on agriculture and implicitly on regional and local socio-economic development.

Introduction

Historically, Romania has a long tradition in the use of irrigation systems, which are used ever since the Daco-Romanian period for pastures, hayfields and fruit-trees. Irrigation systems used at that time were not concentrated in regions affected by drought, so the first concerns about their use in rainfall deficient areas such as the Romanian Plain emerged in the 19th and 20th centuries (Gheorghiu, 1964). Thus, among the first major researches on irrigation development in Romania were realised by engineer A. Davidescu, the early twentieth century, resulting in important studies on irrigation possibilities for geographical space Siret – Argeş from Romanian Plain (Grumeza & Klepş, 2005).

After 1945 were conducted the first thorough researches on irrigation regime and water requirements of irrigated crops. These researches were conducted as fields of experimentation, experimental center Studina in southeastern Oltenia being among the first of its kind nationwide. The greatest achievements in the field

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of irrigation in Romania have been made after 1970, when it's the beginning for large irrigated agricultural areas. Also, during this period began the construction of a series of modern and large scale irrigation arrangements, among the most remarkable of this kind being Sadova-Corabia irrigation system in the southern region of Oltenia (Grumeza & Klepş, 2005).

Changes in the political and social fields after the transition year 1990 have led to the onset of decline of irrigation systems in the context of lack of technical maintenance and refurbishment and numerous infractions that led to the disappearance of the technical infrastructure. Also, shortage in the last twenty years of adequate staff to work in the field of irrigation sector (professional engineers) and weak national strategies for rehabilitation and reform are other major causes of increased degradation of this sector of great national importance (Giurgiu , 2011).

Methodology

This paper analyzes spatio-temporal dynamics of the irrigated area in the analyzed region in the last two decades. In this direction, were used spatial data from 1990, from specialized sources, these data being checked subsequently by consulting some information from the National Research and Development Institute for Land Improvements - INCDIF -, "ISPIF" Bucharest. For an up to date spatial situation of the irrigated areas were used 1:5000 orthophotomaps, trying to delineate as much as possible irrigated agricultural areas according to their texture. The mapping was realized in ArcGis 9.3 software.

To validate the information about present irrigated areas were consulted current reports of the National Agency for Land Improvements Mehedinţi (N.A.L.I. Mehedinţi) and Dolj (N.A.L.I. Dolj). The present study utilizes also data sets on the evolution of the irrigated areas in the past 20 years, which is processed using spreadsheet software.

Study area in context of the need for land improvements

The study area, southern Oltenia, is delineated by administrative criteria (corresponding to a total of 113 territorial-administrative units) and overlaps in most part with Oltenia Plain (fig. 1). It is bordered by the Danube, Olt and Getic Plateau (overlapping in its southwest on a small area). From pedoclimatic point of view the analyzed area is characterized by severe conditions and fits in one of the regions of the country with the most arid conditions (Păltineanu et al., 2009).

Thus, under a climate with semiaridity trends, now can be distinguished a number of changes in the climatic parameters of temperature and precipitations (increasing average temperatures and lowering yearly average rainfall, especially after 1980) (Dumitraşcu, 2006). Changes in average annual temperatures have direct consequences on evapotranspiration regime, regime that is temperature

dependent factor especially in a directly proportional relationship (Berbecel et al., 1970). In essence, increasing average annual temperatures caused an increase in evapotranspiration regime with negative consequences on local water resources diminishing and consequently on human society (most affected being the agricultural sector).

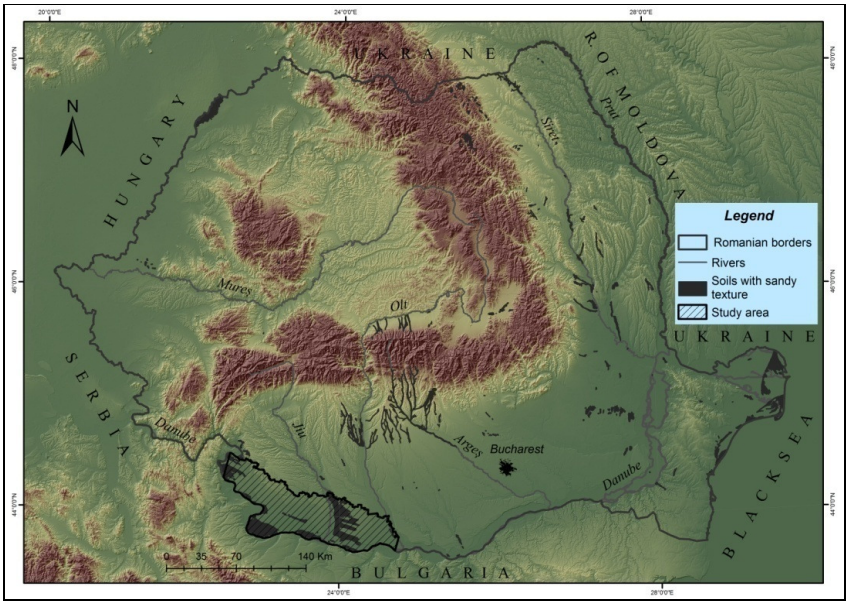


Fig. 1 Location of the study area in the southwest part of Romania
(elaboration of data from geo-spatial.org)

Another major cause of scarcity of water resources is the presence of sandy deposits over large areas, which are characterized by low water holding capacity (Parichi & Oancea, 1984). These deposits are sandy textured soils, from the total area of 330 000 ha in Romania, 35% (approximately 116 300 ha) being found in the area of the study (fig. 1).

The existence of sandy textured soils over sandy surfaces and with very low organic elements (approximately 1.5% humus) (Maxim, 1972) is a major contemporary issue both in terms of retention of water resources and in terms of preservation of an optimal ecological balance at regional level. An example is the areas with sandy deposits at the left side of Jiu, which in the synergistic context of cutting protective forest belts (Nuţă, 2005), intensifying the phenomenon of deflation and destruction of irrigation system Sadova - Corabia after 1990

(Grumeza & Klepş, 2005), currently produced a real degradation of agricultural lands and, taken together, at the level of the socio-economic component.

Considering the existing environmental conditions, irrigation systems play an essential role in maintaining optimal hydrological balance, so their absence is an amplification factor of aridity phenomenon becoming more pronounced in recent decades.

Results and discussions

Romania currently has 15 million hectares of agricultural lands, of which approximately 9.5 million are cultivated (P.R.R.I., 2008). These cultivated agricultural areas require largely irrigations, especially during periods of drought, but after 1990 this possibility was notably reduced. Evolution landscaped areas for irrigation in the second half of the twentieth century (fig. 2) reveals a maximum level in 1990 when a total of approximately 3.2 million ha of agricultural land were irrigated, mainly with large irrigation pumping systems.

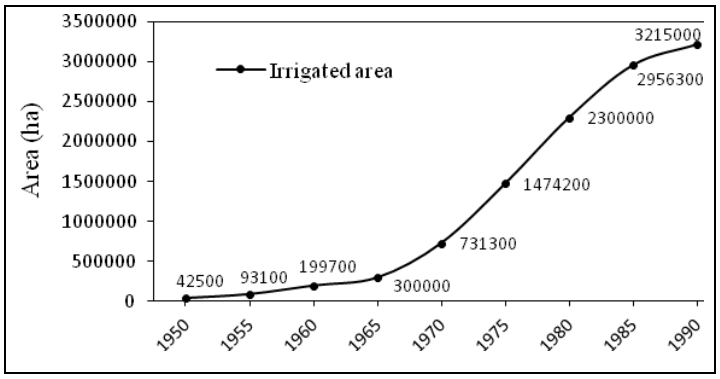


Fig. 2 Temporal dynamics of irrigated areas in Romania in the period 1950-1990 (data processing Grumeza & Klepş, 2005)

The events that followed after 1990 (change of political regime, weak progress, lack of funds, the transfer of management of irrigation systems to Water User Associations in 1999 and later to other organizational structures without the possibility of a viable management from their part) led to a catastrophic decline of irrigation systems, so that now total irrigated area is well below 1 million hectares (P.R.R.I., 2008).

At the level of 1990, the Oltenia Plain irrigation system represented 16% (approximately 510 000 ha) from the total irrigated area at the national level at that time (fig. 3). The complex system of irrigation in the analyzed area, obtained by georeferencing the cartographic base from specialized sources (Dumitraşcu, 2006,

121 p), was made up of 12 irrigation subsystems, each subsystem covering an irrigated area between 6500 ha (Calafat – Ciuperceni subsystem) and 88 000 ha (Caracal Plain subsystem spread in north outside of the study area on a surface of another 40%) (fig. 3). It should be noted that in the study region, the total amount of irrigated area suffers a slight modification as Caracal irrigation system fits into the space defined in this paper only on an area of 53 127 ha, the remaining 40% (34 873 ha) extending to the northern part of Oltenia Plain.

Although in terms of irrigated area, Caracal irrigation system had the highest coverage (with an area of nearly 90 000 ha) of Oltenia Plain, in terms of technical infrastructure Sadova-Corabia system was among the most modern in Romania, beside other irrigation systems similar to the Carasu one from southern Dobrogea (Grumeza & Klepş, 2005). From a technical standpoint, the system was fully automated (triggering watering depending on the needs of the land), water losses through seepage were minimal in the context of special padding at the transport infrastructure level (Klepş, 1994). The importance of developing such an irrigation system was vital, especially in the context of the existence of large areas situated east of Jiu, areas covered with sandy dunes (fig. 3), with low water holding capacity from precipitations.

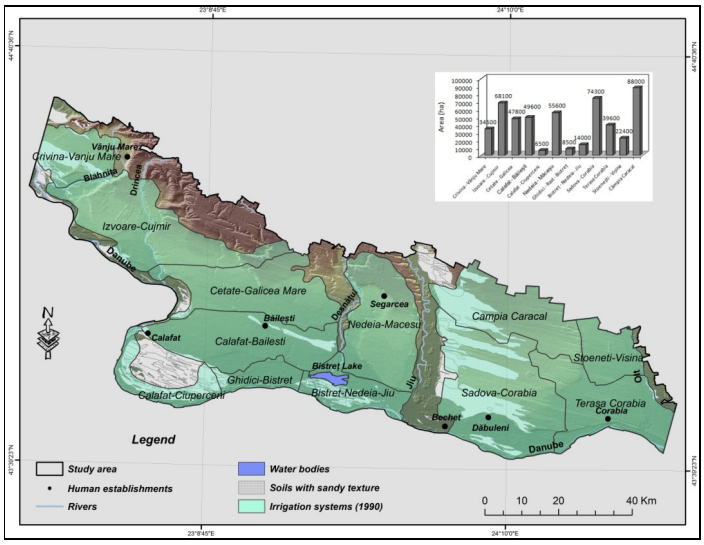


Fig. 3 Spatial delimitation of irrigated areas in southern Oltenia in 1990 (processing after Dumitraşcu, 2006)

The entire irrigation system in southern Oltenia was developed after 1970, and it covers extensive agricultural areas (crops of corn, wheat, sunflower, rice fields and other crops) from Mehedinti and Dolj counties, which are generally irrigated by sprinkler method (N.A.L.I. Mehedinți; N.A.L.I. Dolj). It was designed with the help of primary and secondary pumping stations that transport water through pipelines, in most part from the Danube.

Social and political reform after the transition year 1990 has led to a major collapse of irrigation systems both in the study area as well as at national level. An important part of irrigation systems have been dismantled or abandoned, and some agricultural areas that still today could benefit from irrigations have decreased in the context of excessive cost of transported water.

Analysis of temporal dynamics of irrigated areas in the last two decades in Dolj county (county that overlaps most of its part with the analyzed area), reveals a drastic decrease of the irrigated agricultural areas (fig. 4).

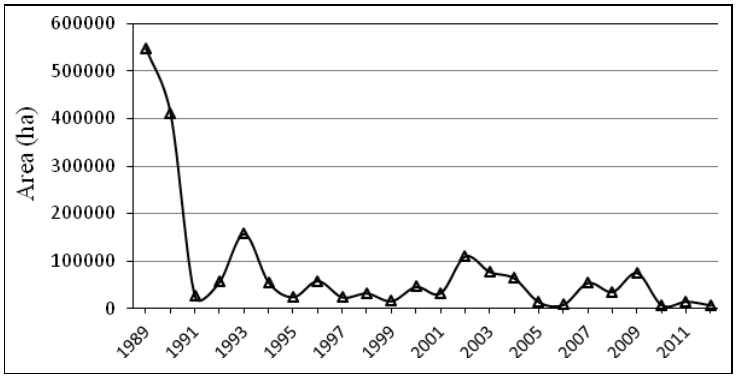


Fig. 4 Temporal dynamics of irrigated agricultural areas in Dolj County in the period 1989 - 2012 (data processing N.A.L.I. Dolj)

Although there are oscillations in the increasing process concerning the dynamics of irrigated areas after 2000, these are determined by prolonged droughts in recent years, which required the partial putting in operation of irrigation systems. Recent years reveals a drastic decrease of the irrigated areas, the historical low in last decades occurring in the year 2012 with an irrigated area of approximately 7200 ha (N.A.L.I. Dolj).

In terms of spatial analysis of current irrigated areas, was attempted the delimitation of the current irrigated agricultural areas. In this direction were used 1:5000 orthophotomaps, 2008 edition, agricultural areas (generally arable lands) being defined by their specific texture after irrigations (in order of highest rigor has

been taken into account and the presence of water in the channels near agricultural areas). It should be noted that this separation is relative, because, based on available cartographic materials (orthophotomaps), it is very difficult to recognize irrigated agricultural areas.

The GIS analysis of irrigated agricultural areas in 2008 (fig. 5) reveals a dramatic decrease of the irrigated areas compared to those from 1990. Thus, if in 1990 in the analyzed area irrigated agricultural areas occupied an area of 474 027 ha, in 2008 has been observed that these areas have been reduced with 95%, irrigated surfaces occupying only 21 173 ha. The difference of 40% between obtained data from the orthophotomaps and those recorded by N.A.L.I. Dolj in 2008 (35 604 ha) (fig. 4) can be explained because the data recorded by this institution covers the whole territory of the county, so there are irrigated areas and outside the study area (especially in Caracal Plain).

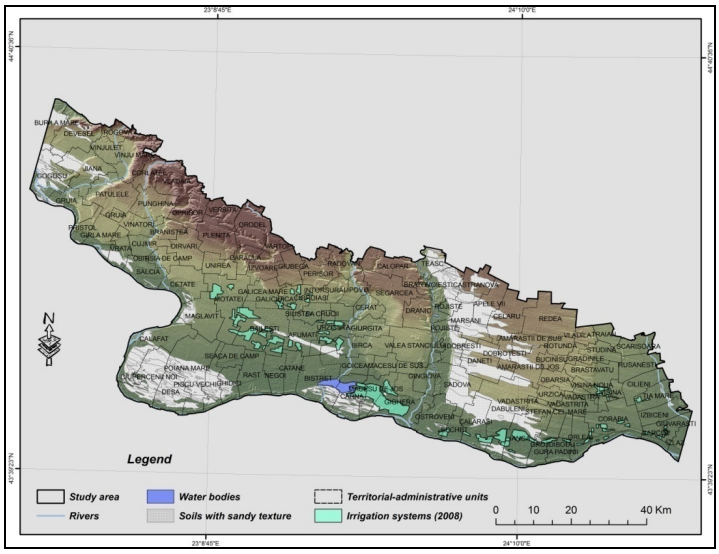
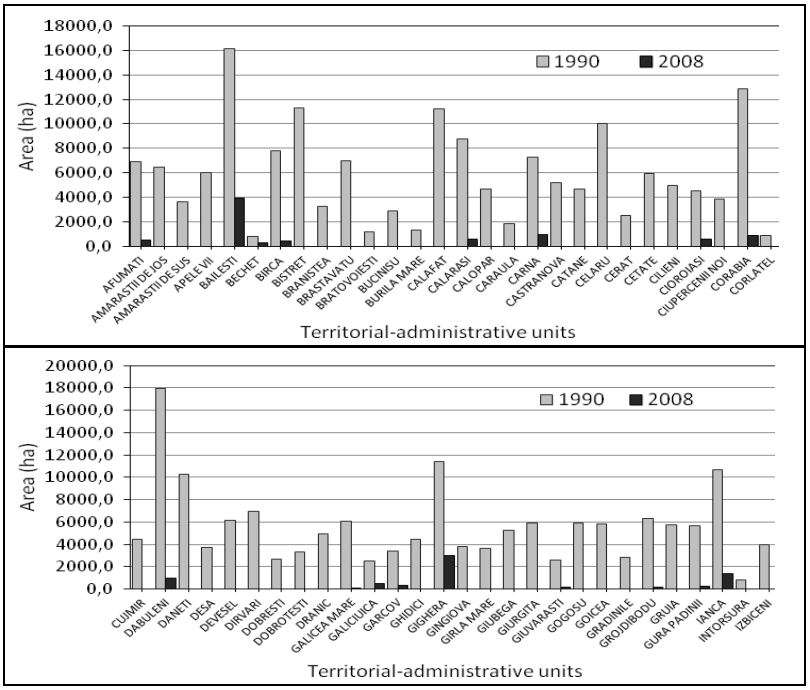


Fig. 5 Spatial delimitation of irrigated areas in southern Oltenia in 2008
(data processing orthophotomaps, 2008)

There are still irrigated areas around some major localities such as Băileşti and Dăbuleni, in these cases there are associations of water users who still afford to pay the high costs of irrigations (N.A.L.I. Dolj). In some cases, for irrigated areas have not been used irrigation systems, an example in this case being the Dăbuleni area, where the owners built their own wells for irrigation of melons (N.A.L.I. Dolj).

Also through such systems are irrigated significant areas of rice fields east of Bistreţ Lake, but in the last two decades they were significantly reduced both in the area between Jiu and Bistreţ Lake and in other areas from the region (Băileşti Plain, Jiu Meadow, etc.) (Prăvălie & Sîrodoev, 2013). Also it should be noted that at the Mehedinţi county level irrigations haven't been made since 2007, the irrigation systems of Crivina-Vânju Mare and Izvoare-Cujmir being totally abandoned (N.A.L.I. Mehedinţi).

From an administrative point of view (fig. 5), the temporal dynamics of the irrigated areas reveals a sharp decline in all territorial-administrative units. From the 113 administrative units, 97% (109) benefited in 1990 from irrigation systems, irrigated areas ranging from tens of hectares to over 10 000 hectares in some cases (Dăbuleni, Băileşti, Corabia, etc) (fig. 6). In 2008 have been noticed irrigated areas in only 23% of cases (26 administrative units), which are much reduced compared to 1990 (fig. 6).



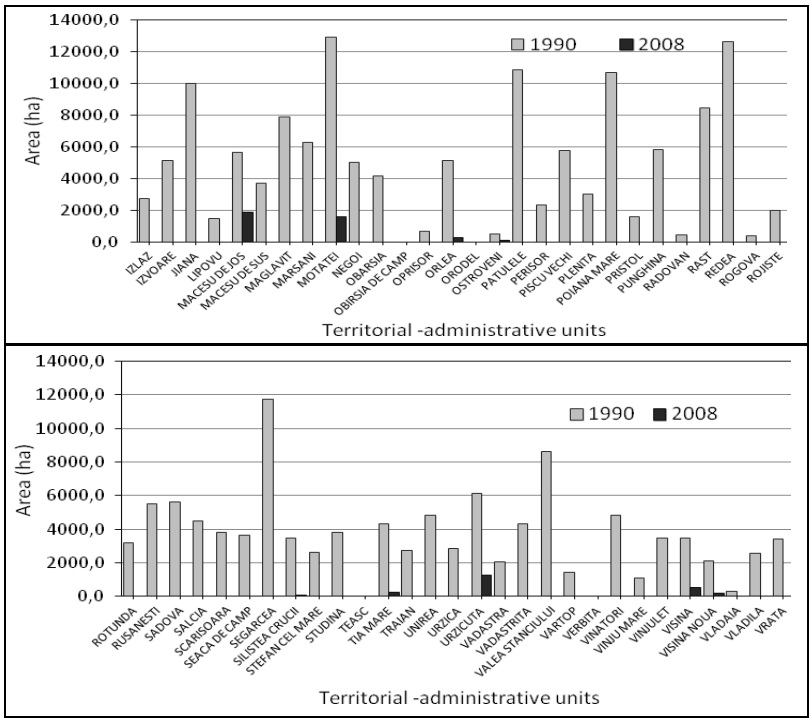


Fig. 6 Temporal dynamic of irrigated areas (ha) at the level of territorial-administrative units in southern Oltenia (1990-2008)

The complex causes of decline in irrigation sector are mostly represented by the last two decades mismanagement of national authorities unable to implement effective policy reform. The transfer of irrigation systems to Irrigation Water Users Associations through the GEO147/1999, later reorganized as Irrigation Water Users Organizations under the Law 138/2004 (P.R.R.I., 2008) proved to be a long-term unviable strategy because of the limited possibilities of maintenance by the owners. Maintenance and energy high costs combined with the impossibility of upgrading irrigation equipments by Irrigation Water Users Organizations led to a gradual degradation and abandonment of irrigation systems. Moreover, lack of financial support from the state (the absence in recent years of subsidies from state received by the owners) is another major cause of their abandonment (N.A.L.I. Dolj).

Other causes of decline in irrigations sector in analyzed area are related to various offenses in the last two decades that led to destruction through theft of the

technical infrastructure. Also, the waste of water resources (in most cases in southern Oltenia) caused by the lack of warnings on the water requirement of land is another current dysfunction of irrigations sector both in the analyzed area, but also in general, national context (Giurgiu, 2011).

It should be noted that besides socio-economic benefits, irrigations systems in southern Oltenia have determined a number of dysfunctions in the environment. Among the most important are the disappearance of forest ecosystems (protective forest belts) with construction of irrigations infrastructure and expansion of agricultural areas. This is the case of the Sadova-Corabia irrigation system that after its implementation around 1969 has determined massive acacia deforestations on surfaces of thousands of hectares (Nuţă, 2005). Another major problem is the fact that after the loss of water through seepage, in the malfunctioning context of transport infrastructure (pipelines, canals), there was an increase in local groundwater levels which led to the phenomenon of secondary salinisation (the case of Calafat – Băileşti irrigation system) (Dumitraşcu, 2006).

Conclusions

The decline of irrigation systems was one of the worst consequences of Romanian agriculture in the last two decades, and this is valid also for the study area. Synergistic context of scarce national strategy for rehabilitation and reform of irrigations sector, of the lack of legislation and the sustainable measures with the role to stop the theft of the technical infrastructure, of severe lack of funds and the deficit becoming more pronounced of specialized personnel are the main causes of the collapse of the irrigation systems in southern Oltenia.

In this stage, amid the amplification of aridity phenomenon in recent decades, the analyzed area requires an extensive rehabilitation of irrigations systems. The presence of sandy textured soils on very large areas (one third of total national surface) is another reason why the rehabilitation of irrigation systems should be a priority both in the agricultural policies of the study area, and national policies.

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