DRIVERS AND DYNAMICS OF AGRICULTURAL LAND FRAGMENTATION IN THE WESTERN PART OF THE ROMANIAN PLAIN

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Abstract. Excessive fragmentation of the agricultural land in Romania has been a governance challenge over the last decades, yielding multiple social and economic implications particularly for the development of the rural space. This study analyzes the causes of land fragmentation and the dynamics of land use during the last 30 years in the western part of the Romanian Plain (i.e. the Romanați Plain), an agricultural area where excessive land fragmentation is one of the most visible effects of land governance, which significantly connects with the way agricultural resources are used, the level of crop productions, as well as with land degradation. The agriculture in Romania has experienced strong changes since the fall of the totalitarian regime in 1989, passing through major transformations during the transition and post-transition periods toward market economy, especially in what regards land tenure, land structure and yield productivity. Based on field observations and semi-structured interviews with local authorities and managers of 15 farms of different sizes, we analyzed the main drivers of land fragmentation and their effects on yield production and on the evolution of the land use structure. It is shown that governmental measures regarding property ownership, irrigation system operation, demographic trends, EU Common Agricultural Policy and land and food markets are the main direct and indirect drivers of land fragmentation. Discussion about the implications of these findings for debates on adaptation and agricultural sustainability, and thematic research perspectives complete this article.

1. INTRODUCTION

Land fragmentation is one of the multiple consequences of the structural transformations that followed the fall of the centralized regime in Central and Eastern Europe, particularly of the many reforms during the transition and post-transition periods from a command economy toward market economy. The political and economic transitions have powerful impacts on what happens on land because past structures are reassessed for their utility, reorganized and new networks and patterns of land functionality emerge (IGBP Report No. 53/IHDP Report No. 19, 2005). At times of transition, the dynamics in all spheres (e.g. social, economic, and political) are quite sharp and likely to produce discontinuities of the processes that generate the functionality of different systems. Referring to the land system, it requires sound examination of the relationship between the socioeconomic dimension and land use, land cover and rural communities for understanding the land change patterns and for providing insights on appropriate coping strategies for development that might be taken at local and regional levels (Rindfuss *et al*., 2004; Verburg *et al*., 2015; Meyfroidt *et al*., 2018).

The countries of Central and Eastern Europe have been through a series of land reforms since 1989 with the purpose of privatizing state-owned agricultural land. Depending on each country conditions and historical background, this process took different implementation forms, being related

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to various degrees of land fragmentation (FAO, 2003; Hartvigsen, 2014; Banski, 2017). Hartvigsen (2014) synthesizes the ways land reforms occurred in Europe, highlighting the drawbacks and opportunities for rural development. For instance in Poland, where before the fall of the socialist regime land was private in as much as 75% of the agricultural land (i.e. private ownership as well as in private use by individual farms), less had to be returned to its former owners; the privatization here was mostly done by land sales in auctions and through direct sale to eligible groups, but with a preference for the former owners (Hartvigsen, 2014). In Hungary, it was established a compensation form, which was not limited only to agricultural land but to all assets nationalized from the citizens between 1949 and the beginning of transition in 1990; the compensation rights were given to former land owners; also, another form of ownership rights attribution consisted in the distribution of land to landless members of former collective farms and employees of state farms. Thus, in Hungary the 1.5 million new owners received in total 3 million ha through distribution of physical parcels (Hartvigsen, 2014). In Romania, as we will detail later, the privatization of the state-owned agricultural land was based on the restitution of land ownership rights in the form they were just before communism came into power in 1947. In general, land reforms generated in each country various degrees of land fragmentation. In the context of European Union, Romania is the country with the most numerous agricultural family farms of very small and small size (EUROSTAT, 2015, 2018), fact which is associated with a high degree of land fragmentation.

A distinction has been made in what regards the fragmentation of agricultural land, specifically the fragmentation of ownership and the fragmentation of land use (Hartvigsen, 2014; Ciaian *et al*., 2018; Looga *et al*., 2018). The relationship between the two aspects has implications particularly for the dynamics of the land market and the economic situation of farms, and for the development of agriculture, in general.

Land fragmentation is intrinsically connected to land tenure aspects. It particularly relates to land tenure form, i.e. referring to the particular packages of rights regulating who can benefit from land, but also to land tenure security, which is the overall assurance that those rights will be upheld (Robinson *et al*., 2014; Ciaian *et al*., 2018). In general, land tenure (i.e. all rules, norms, institutions that govern land use and access to land and land resources) is a key driver for land use structure and land use change, and an indication about the way agricultural land is managed in a localized context (Robinson *et al*., 2017; Sikor, 2009). Inadequate governance that undermine land tenure security is often associated with situations such as unsustainable farming practices that generate short-term gains at the cost of social and environmental imbalance or unjust investments (Behnassi and Yaya, 2011; Robinson *et al*., 2014).

Moreover, confused and insecure situations about land tenure, which in many cases overlap impoverished socioeconomic conditions of the rural life, could easily lead to such situations of land grabbing, financial speculations on the land and agro-food markets and investments where profits would be externalized (Popescu, 2018; Popovici *et al*., 2018). This is particularly true when market instruments are not strongly regulated in the interests of the local entrepreneurship and preservation of local land resources (Popescu, 2018).

At the same time, agricultural land fragmentation is in numerous cases associated to land degradation, being related to a complex array of socioeconomic, environmental and policy factors (e.g. land use change, land tenure security and property rights, agricultural subsidies and taxes, etc.) (Benedek, 2003; Robinson *et al*., 2014; Feranec *et al*., 2017). High fragmentation of land is associated with existence of numerous small farms and in many cases with subsistence agriculture. In such cases, unsustainable farming practices, difficult financial situations and lack of professional training cause land degradation over time.

Land fragmentation also contributes to yield variability, amplifying the climatic effects and the impact of the management practices. Identifying the main causes of yield variability and designing strategies to minimize them is essential for reducing the associated risks of low productions, land degradation, little technological uptake and inadequate adaptation measures for long-term sustainable management.

The links between land tenure and agricultural land use structure, and subsequent implications for crop production and farms' economic viability, could be well expressed in case-studies investigating site-specific socioeconomic and political factors, institutions and historical trajectories with implications for land use. Furthermore, in areas with the most dynamic land use changes, land tenure tends to be complicated, often subject to continuously emerging institutional (re)arrangements and, therefore, diverse land uses (Behnassi and Yaya, 2011).

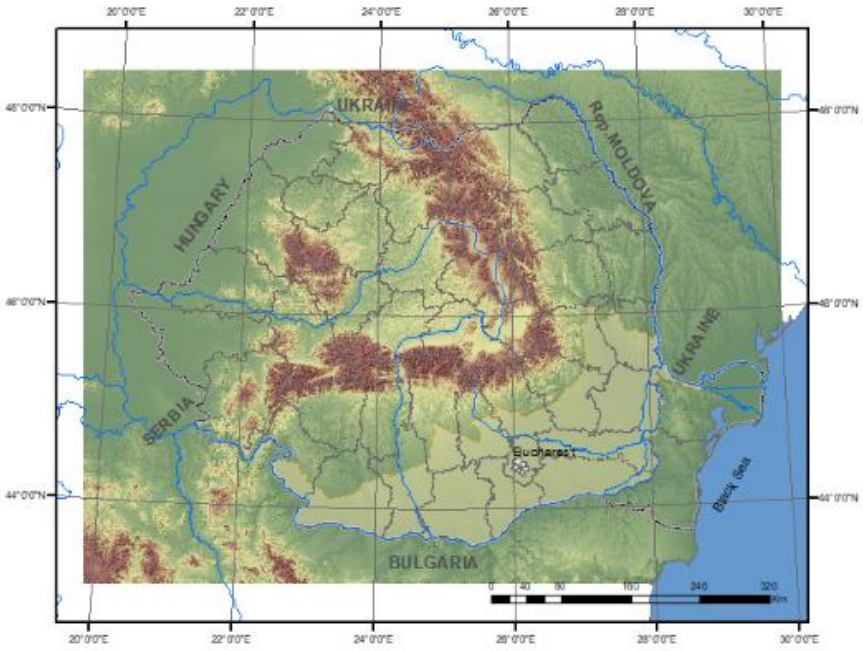
In this context, the aim of this paper is to comprehensively capture the relationships among the drivers of land fragmentation and land use structure and yield productivity in an exemplary area in the western part of the Romanian Plain (Fig. 1). Specifically, we investigated the dynamics and drivers of agricultural land fragmentation and the connections to the structure and yield productivity of farms in the Romanaţi Plain, an agriculturally dominant region in the western part of the Romanian Plain. The analysis was based on field observations along a North-to-South geographic profile and on a survey based on open-questions interviews with 15 farms and local authorities in representative localities of the study-area. The paper proceeds as follows: Section 2 discusses the main physical and socioeconomic characteristics of the study-area and their relevance for the agricultural land use (2.1). It also introduces the field analysis, namely the design of the semi-structured interviews conducted in the study-area with the local authorities and the farmers, and the related data, as well as the field observations (2.2). The following sections summarize the research results, i.e. the main phases of land use dynamics over the last 30 years with emphasis on the radical transformations of the transition periods towards market economy and their effects on land use (3.1), the field observations on land fragmentation (3.2) and the main drivers of land use fragmentation (4.1). The last section concludes the paper, referring to the implications of land measures and need for research for land consolidation (4.2).

2. DATA AND METHODS

2.1. Study-area

The region of the Romanaţi Plain, part of the Oltenia Plain, west of the Romanian Plain, was chosen as an exemplary case-study to show the characteristics of land fragmentation and the connections with land use structure and yield productivity. Located between two major tributaries of Danube, Jiu River in the west and Olt River in the east, the region is bordered in the north by the Getic piedmont hills and in the south by the Danube (Fig. 1).

The natural conditions in this geographical subunit of the Romanian Plain impose the particularities related to agricultural land use and farming practices. The main relief units are: i) the inter-fluvial piedmont plain in the north (i.e. genetically, it forms the southern part of the morfo-structural unit of the Getic Plateau), with altitudes between 180 m and 100 m, covered by loess deposits of 5–15 m thick and, partly, by sand dunes towards the contact with the rivers' formations, and ii) the terraces and adjacent floodplains of the Danube River and its two major tributaries, with altitudes from 75 m to 5 m (Bălteanu, 2006). The Danube floodplain, as well as the Olt floodplain, are largely extended, reaching 10–14 km (i.e. near Dăbuleni locality) and 6–7 km wide, respectively. Likewise, a non-uniform cover of sand dunes extends over floodplain areas, most of the rivers' terraces and partly over the piedmont plain areas in the north (e.g. on the Danube inferior terraces, between Bechet and Dabuleni localities, high (i.e. 15–20 m) and nonconsolidated eolian sand dunes are largely extended) (Geografia Romaniei V, 2005).



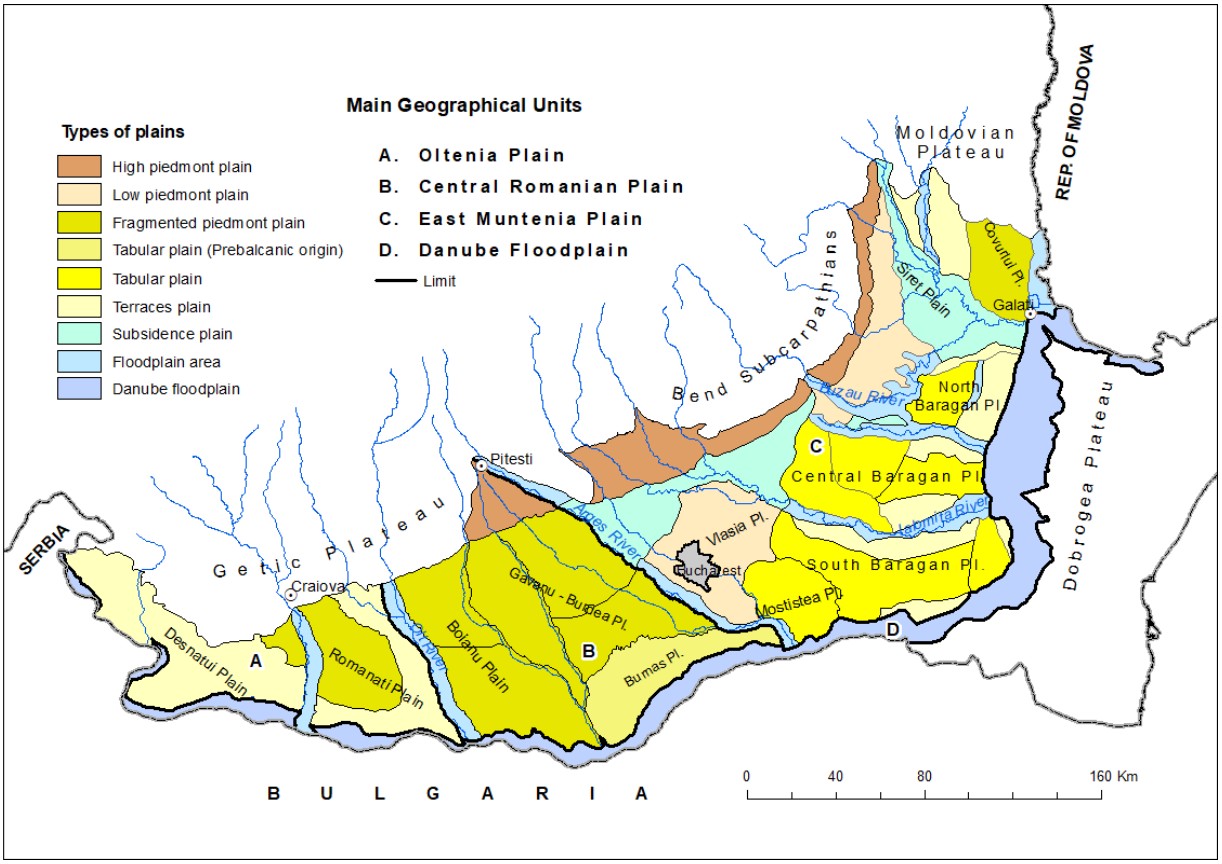


Fig. 1a – The main geographical units of the Romanian Plain.

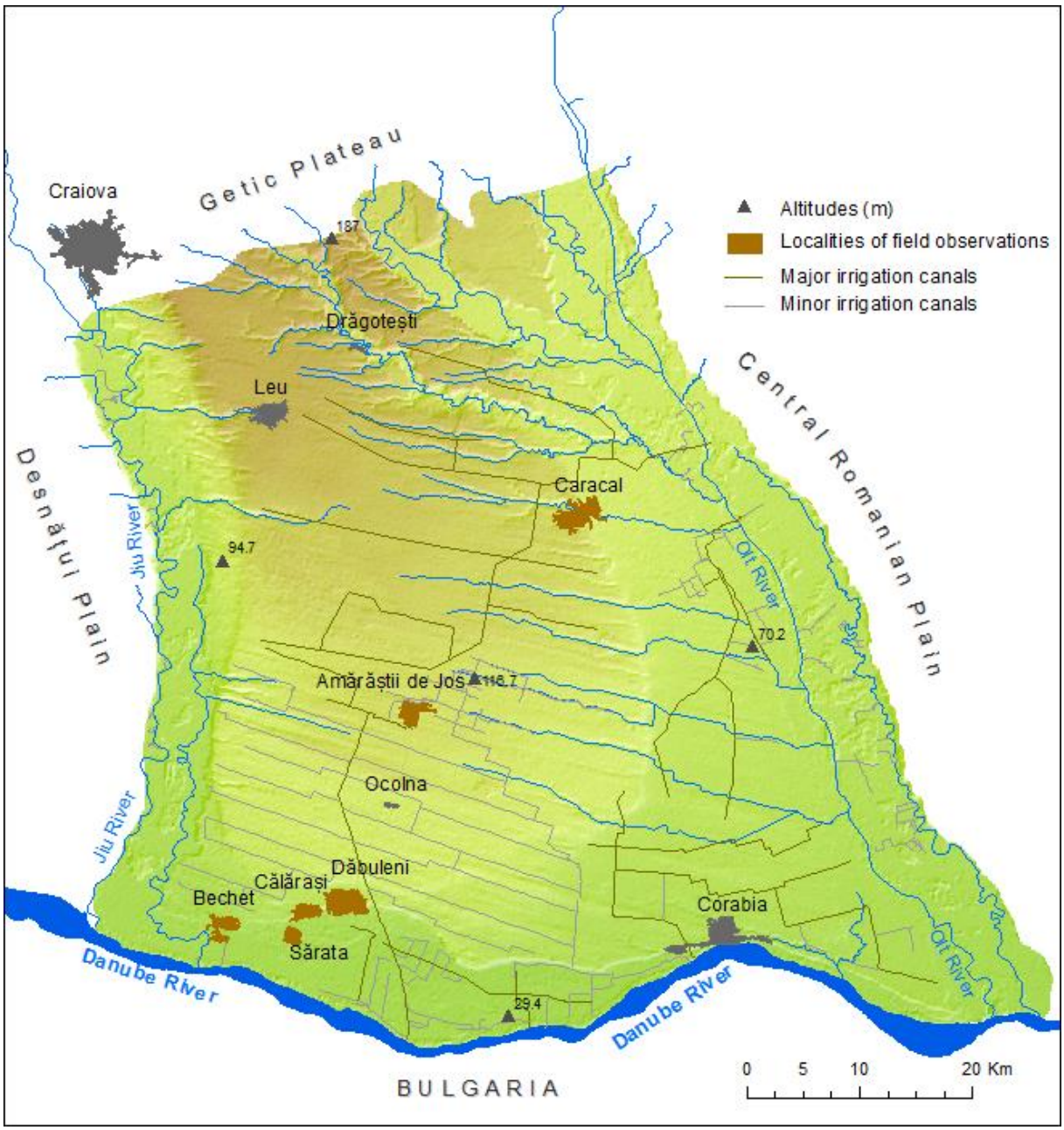


Fig. 1b – Study-area: Romanați Plain, West of the Romanian Plain.

Nutrient rich soils, specifically the Chernozem types with a good water retention capacity are met in the northern part of the region (Canarache, 2006), down to Amaraştii de Jos – Ocolna alignment of localities, being suitable for high crop productions. Conversely, towards the south, sand soils are dominant, while alluvial soils, under different evolutionary development phases, are specific for floodplains areas. These types of soils require substantial supplementary land amendments (e.g. fertilization, irrigation / water drainage) in order to support economically profitable cropping systems.

The region has a temperate-continental climate with Sub-Mediterranean influences, where the mean annual temperatures rise as high as 11^0C, while the precipitations amount to 525–600 mm per year

(Geografia României V, 2005). Likewise, frequent and even more intensive droughts are an evidence of the area, as they are for the entire Romanian Plain, constraining farmers' activities and needing significant actions of both mitigation and adaptation to these conditions (Lupu *et al*., 2018). Fig. 2 suggests that lower yields correspond to drought, although detailed analyses are needed for explaining the climate-driven variability of crop yields and the associated socioeconomic drivers behind yield productions.

Fig. 2 – Crop yields during 1990 – 2017 in the Romanian Plain at county level.

Therefore, the particularities of the relief, given primarily by the thick loess deposits, river terraces and floodplains and the presence of sand dunes, along with the soil and climatic characteristics impose the local conditions for agricultural activities. Moreover, the climatic scenarios show that the seasonality of precipitation will increase and the summer precipitation in south-eastern part of the Danube basin will decrease, while the weather and hydrological extremes (droughts, heat, and floods)

will increase with higher certainty (Mauser and Stolz, 2018). As well, the climatic scenarios project increases in drought intensity and frequency for Central and South-Eastern Europe, thus affecting the agricultural productions as well as the hydrological regime with consequences on the region's water availability (CLAVIER, 2009; IMPACT2C, 2015).

In this case, the adaptation implies both agro-technical measures (e.g. drought resistant cultivars, farming practices based on preserving/increasing soil water retention capacity, efficient application of irrigation in order to optimize crop water productivity, etc.) (Sandu and Mateescu, 2014), and sustainable land use and water resources management at regional scale (e.g. equitable allocation of water among sectors, upstream-downstream beneficial integration of water resources, application of efficient irrigation supply systems according to the environmental conditions and availability of water resources) (Mauser and Stolz, 2018).

2.2. Open-question interviews and field observations

Local information was collected by conducting semi-structured interviews with farmers and local authorities in 4 localities of the study-area during a field trip activity organized dewing September 9 – 12 2018 (Fig. 1). The scope was, on the one hand, to compile site-specific data on crop productions and structure, farming practices and agricultural resources management at farm level, and, on the other, to understand the main processes and characteristics of farms' development and land use dynamics, as well as the socioeconomic factors that influence or directly impact the land use system in the study-area. Table 1 presents the questions which formed the base of the discussions, including topics on farms' land use structure and yields obtained over the last years as well as on the farming practices during the growing season. Aspects concerning the physical and economic constrains that are hindering the activity of the farms were also considered. Further, issues on the effects of different land policies, such as the role of the incentives per hectare of cultivated land or the distribution of irrigation water at no costs (Law no. 133 / 2017) were discussed with the interviewee. Different-sized farms were subject to our analysis, specifically small, medium small, medium and large size farms (Table 1). Additionally, discussions with mayors, representatives of agricultural units in the town halls in Bechet and Dăbuleni towns, Călăraşi, Amărăştii de Jos and Amărăştii de Sus communes were held for capturing as much as possible details on the land use situation in the area.

Table 1

Semi-structured interview topics and questions

Topic	Issues discussed in the interview
Farm characteristics	– Short description of the evolution of the farm – Size, land structure and crop production in 2017 and 2018 – Main farming practices – Types of hybrids used – Physical constraints (e.g. soil, access to water and climate) – Agricultural infrastructure (i.e. (non)operational irrigation systems, investments in agricultural technology)
Challenges for crop production	– Natural hazards (i.e. droughts, floods, hail spells) – Socioeconomic constraints (e.g. land ownership issues, high input production costs, crop prices, labour force in agriculture, social risks in rural areas)
Governance issues	– EU structural measures; national sectoral incentives; National Programme for Irrigation Rehabilitation 2020; existence and function of the Organization for Irrigation Water Users in study-area; – agricultural services (e.g. support for the agro-food products on the market, development of the food markets; land markets; cooperation among profiled/related institutions)

The most common crops in the area are winter wheat, maize, barley and sunflower, while a particular feature in this part of the Romanian Plain is the cultivation of water melon, being a well-known product on both local and external food markets. Farms have a rather heterogeneous structure, especially in the case of small farms, while the most visible feature in the agricultural landscape is the excessive land fragmentation (Table 2).

Table 2

Characteristics of the analyzed farms

Category	Size	Crop structure	Examples of crop productions (2018)*
Small	> 5 ha and < 20 ha	heterogeneous	3.5 t/ha (corn); 2.5 t/ha (wheat); 2.0 t/ha (barley)
Medium small	> 20 ha and <100 ha	heterogeneous	2.0 t/ha (sunflower)
Medium	> 100 ha and <300 ha	4–5 main crops	5.75 t/ha (corn); 5 t/ha (wheat); 2.0 t/ha (sunflower)
Very large	> 1000 ha	3-4 main crops	3 t/ha (sunflower)

* higher yields were obtained in 2017 as compared to 2018 which was considered an agricultural year affected by drought; ** very small (< 5 ha), medium large (>300 ha and <500 ha) and large (>500 ha and < 1000 ha) size farms will make the subject of further investigations concerning land fragmentation in the Romanian Plain area

In addition to the information derived from our field interviews on the land use system in the study-area, we have scoped out a series of publications in the domain of rural and agricultural development strategies, land and water resource quality and use, land use management, etc. in order to document on the study objective and provide consistency to our results regarding the drivers and dynamics of land fragmentation in the Romanați Plain, west of the Romanian Plain.

3. RESULTS

We distinguished the dominant phases in the evolution of land use based on both interviews derived-information and literature documentation, we synthesized the data collected about land fragmentation and, subsequently, summarized the drivers of land use change and fragmentation.

3.1. Phases of land use changes during the last 30 years

In Romania, the current land use structure is a result of the disruptive dynamics of land use processes that have occurred particularly over the last 30 years during the transition and post-transition periods toward market economy. These processes relate to a series of interconnected drivers of land use change, such as the socioeconomic factors, land governance, agricultural infrastructure, land markets, etc. Their effects consist in highly spatially diverse situations, e.g. fragmented lands alternating with large parcels belonging to commercial-oriented agricultural holdings, various farming practices, considerable destruction of the irrigation systems which are crucial for drought combat, little social returns for the local community from the locally well performing agricultural activities, etc. Three distinct intervals could be distinguished in the evolution of land tenure, land structures and type of farms in Romania since early 90s. They are described synthetically in Fig. 3.

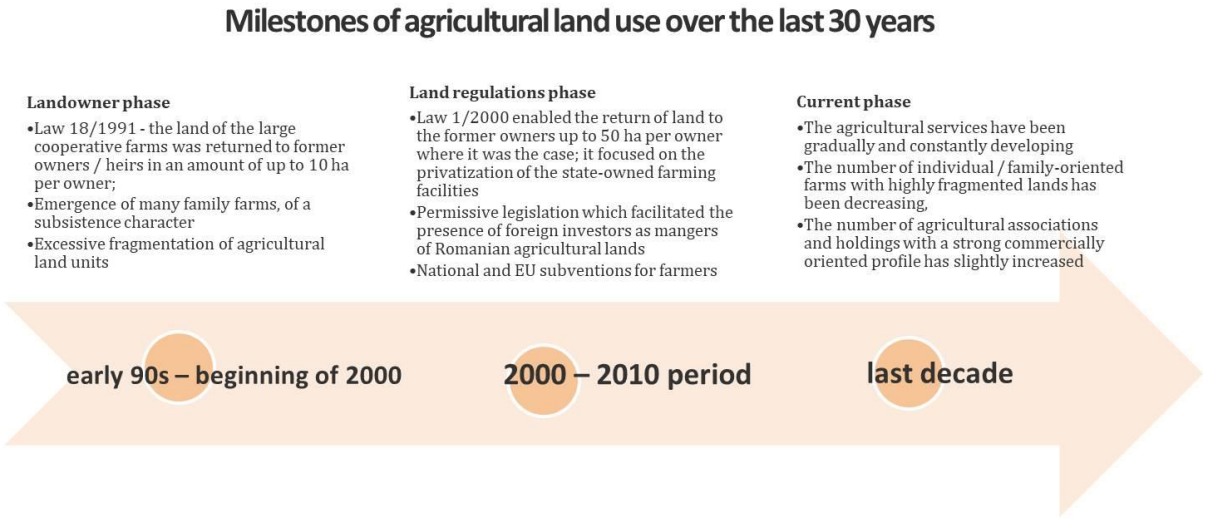


Fig. 3 – Land use dynamics during the last three decades in the Romanian Plain.

Specifically, ***in the first 10 years*** (1990 – 1999 period) since the fall of the totalitarian regime, the excessive fragmentation of cropland, emergence of numerous individual (family) farms of subsistence agriculture, poor agricultural infrastructure and services (degraded irrigation systems, inappropriate farming practices, lack of investments in the agricultural infrastructure etc.) contributed to obvious changes in the agricultural landscape, as well as to significant impact on agricultural productivity and reduction of crop production. The land law (i.e. Law 18/1991) had a major effect on the land structures at that time. It stipulated that the land which formed the large cooperative farms during the centralized regime to be returned to the former owners and/or their heirs in an amount of up to 10 hectares. The effect was an excessive fragmentation of the agricultural land. At the same time, the socioeconomic consequences of land restitution in this phase manifested intensely. The rural space experienced a demographic increase through the return of the new land owners to their homelands simultaneously with the emerging of numerous family farms, many of which of subsistence character. Moreover, the recipients of the agricultural land were new, of a rather advanced age and unexperienced to aspects related to modern farming practices, to the functioning of land and food markets in a free market economy, and, thus, the management of their land was challenging (Benedek, 2003). The agricultural infrastructure had become technically worn-out, obsolete and degraded, the most common example being the substantial destruction of the irrigation system (Bălteanu and Popovici, 2010). Also, the low incomes, the poor capital of land exploitation of the new owners, the absence of the financial instruments to encourage and help the local entrepreneurs in agriculture (e.g. credits), etc. led to a weak position of local investors on the land market making it vulnerable in front of foreign investors (Popescu, 2018). The way the land rights were restituted during this phase contributed a great deal to a design of land tenure system which was not sustainable (e.g. in many cases it was difficult to return the parcels on the same location because during the communism the borders among the individual land properties were erased or because of the changes in the structure of the agricultural landscape or of the rural localities; ambiguous reconstruction of the owners' land rights; lack of economic and natural evaluation of land before restitution, this being only based on physical measurements, etc.) (Popescu, 2018).

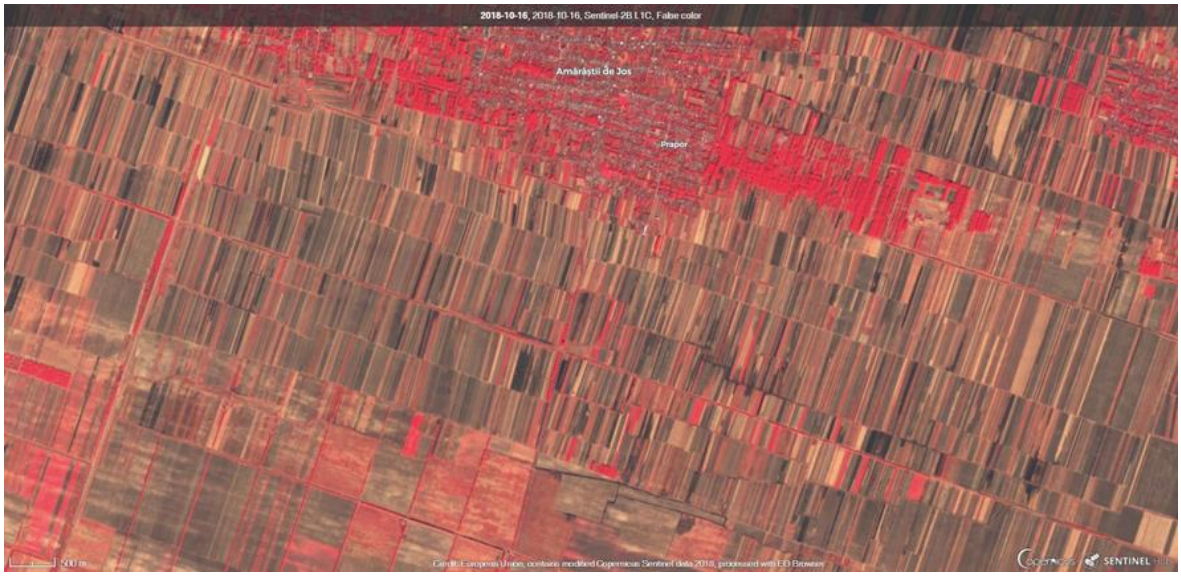
The second interval corresponds with the ***2000–2010 period*** which was marked by important regulations regarding land property and land market. First, it was the revision of the previous land law which increased the return of the land to the former owners up to 50 ha, where it was the case, and the privatization of the agricultural land and farming facilities belonging to the state-owned agricultural

enterprises (i.e. Law 1 /2000). Also, the land market was quite flexible and thus attractive for investors and many agricultural lands could be sold and leased on long terms. It was the period when foreign investors acquired large amounts of lands, particularly in the Danube floodplain areas, starting their agricultural businesses here, to the disadvantage of local (potential) investors who had weaker capacities for investments. This aspect relates to the first two laws issued in 2005 regarding the reform of the property and justice systems, i.e. Law no. 247/2005, and Law no. 312/2005 that gave foreign citizens the possibility to acquire land. This was the beginning for foreign investors to hold under lease agricultural land in Romania and develop businesses here. However, the largest surfaces of agricultural land were acquired by foreign investors after Romania`s integration in EU. The second important milestone of this interval was Romania's integration in European Union in 2007 when the legislative norms and access to EU structural funds created opportunities for modernization and development of the agricultural sector, aspect that marked a period of improvement of the quality of the farming practices as a consequence of the farmers' possibility to loan a credit from the banks to start / improve their agricultural businesses. At the same time, the legislation was designed to facilitate and improve farmers' association structures with the purpose of increasing the potentials for sustainable and profitable agricultural productions. It could be said that during this period the dynamics concerning the use of the agricultural land in our study-area, as it was also the case of the Romanian agricultural in general, were very much influenced by the incentive-based policy instruments (national and European Union through Common Agricultural Policy) which farmers could access. These instruments have aimed to primarily help farmers to increase their work productivity (i.e. primarily through modernization of farms' infrastructure and farming practices) and contribute to rural development (e.g. investments in rural infrastructure, incentives for new farms of young local entrepreneurs, etc.), including the safeguard of the agroecosystems' goods and services, particularly in terms of productivity increase and land resources' protection (Bold, 2018).

Over ***the last decade***, the development of the agricultural services has been gradually and constantly on an upward trend (e.g. ship of the agricultural products, mainly by terrestrial routs, but, recently also by water through fluvial or Black Sea ports, the acquisition of containers and the possibility to store larger amounts of agricultural products, the emergence of consultant companies to support farmers to develop investment projects, etc.). The number of individual / family-oriented farms with highly fragmented lands has been starting to decrease, while the agricultural associations and holdings which are commercially oriented increased. During our interviews, the farmers' opinions concerning the process of land or farm association and/or land leasing, exchange and transaction have been mixed. They confided that although it is commonly agreed on the advantages of managing large, spatially continuous fields instead of very small or small farms composed of fragmented parcels, this process is not always straightforward due to financial benefits and opportunities people (i.e. owners) expect in doing so. In many cases it is the quality of land or the offers made that they invoke as major constraints for land association process. However, the situation is spatially different, as, still, in many parts land fragmentation remains high, impeding the performance of profitable agricultural productions, and the agricultural resources are unexploited and/or impacted by drought and desertification / land degradation, water stress, confusion about property rights. It is in this context that the many national or EU funds have been supporting, to a large extend, the 'big cropping system' where the investments favored the modernization and investments in irrigation system and the acquisition of, for instance, GPS guided machineries that could serve large cultivated areas. In certain cases, such investments outclass the potential of medium-sized farms to use the new infrastructure to its full capacity due to insufficient land capital. Therefore, investments, particularly in the modernization of farm through infrastructure, need to be designed according to the physical particularities and capital and well as to the future farms' potential to extend.

3.2. Field observation on land fragmentation in the study-area

One of the striking and at the same time visible feature in the analyzed area was the high fragmentation of the cropland (Fig. 4). For example, there are numerous cases where one very small farm, under 5 ha, has its cropland spread discontinuously in ~ 8 to 10 plots, or a small farm of 14 ha was divided into 14 parcels. Fig. 5 synthesizes the information collected in this respect from the individual farms as well as from the agricultural units of the local administrations. It represents the ratio of land fragmentation per farm, considering the number of plots and the size of the farm. It reflects the highest degree of fragmentation in the case of small farms.



a)

b)

Fig. 4 – COPERNICUS Sentinel-2B L 1C, Oct. 2018, false color (843); Land fragmentation in the Romanaţi Plain (Amărăștii de Jos (a) and Dăbuleni (b)) (*Source: COPERNICUS Sentinel Hub*).

There are *several causes that lead to a high degree of land fragmentation* in the study area:

- First, the land that during communism time belonged to the cooperative structure was restituted to the former owners, leading to the division of large agricultural land into in small parcels.
- Second, a large share of the people that obtained their land back at that time were already elderly, and the land was handed on to their heirs, this being a subject to further division.
- The third issue that contributed to land fragmentation was that, in many cases, the owners had not received their lands on the same location as it had been before restitution. The initial agriculture or forest function of the land was converted into another function, e.g. construction, and therefore the plots were discontinuously spread.
- Fourth, the confusion about property rights and the conflicts that prolonged the clarification of the size and location of the plots (in many cases they were solved in law courts) induced changes in the structure of the land, further increasing the land fragmentation.
- Fifth, the degradation of the irrigation system was, undoubtedly, one of the biggest cause of the transformations in land use structure. Usually, the farmers chose to split the land into multiple (small) plots allocated to different crops in order to be able to cultivate it in the absence of the necessary infrastructure suitable for larger cropping fields.
- Sixth, the EU subventions per hectare that farmers can access ensure the economic maintenance of their farms and offer possibilities for development. Apart from the opportunity for investments, the EU support gives farmers a sense of stability which restrain them from exchanging the plots with neighbor farmers, particularly in the case of small-sized farms, in order to merge the plots and reduce land fragmentation.
- Last, but not least, the natural conditions impose a series of constrains with regard to the compactness of the land structure. For instance, the dunes with sand soils cover extensive areas on the Danube terraces (e.g. the large area around Dăbuleni, see Fig. 5), constraining land management to particular uses and farming practices. During the operation of the irrigation systems such lands were large vineyards, while nowadays these areas are fallow lands, the owners preferring not to cultivate them due to increased input costs and low yields. As well, increasing drought periods are a serious limitation for a performing agriculture in the Romanian Plain, requiring different farming options and land uses to limit its effects.

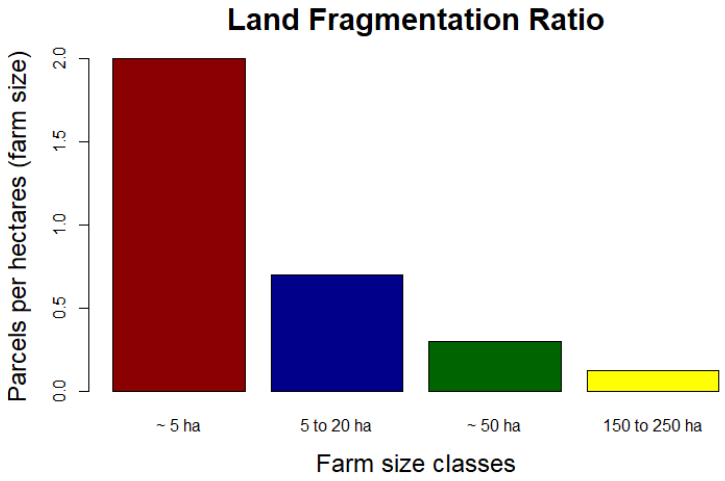


Fig. 5 – Land fragmentation ratio for the farms in the Romanați Plain area, west of the Romanian Plain.

Photo 1. Crop plots in the South of the Oltenia Plain (Sarata),
September 9th 2018. Photo: Lupu, L.

Photo 2. Amarastii de Jos, September 11th 2018; a narrow barley strip (8.7m × 1140m)
of a plot on a small size farm. Photo: Lupu, L.

Photo 3. Two farming practices (treated and not treated land for weeds) applied on a winter wheat plot; Amarastii de Jos, September 11th 2018, Photo: Lupu, L.

4. DISCUSSION AND CONCLUSIONS

4.1. Drivers of land use dynamics in the Romanian Plain, with implication for land fragmentation

The changes in land use in the study-area, and, in general, in the entire Romanian Plain are a clear expression of the planning measures concerning the management of agricultural land over time, on the one hand, and of the human use of the region's natural capital, particularly the agroecosystems goods and services, on the other.

As mentioned before, the agriculture in the Romanian Plain was profoundly affected by the disruptive changes of the transition and post-transition periods, particularly in terms land use, land property structure, sectoral economic development and workforce, institutional (re)arrangements, resources management, land and agri-food markets and socioeconomic profile of the rural areas. Correlated with the projected impacts of climate change scenarios, these aspects are of high relevance for the agricultural production which depends on the environmental conditions as well as on the farming practices and resource management strategies. In this context, the drivers of change, which are briefly described below, represent the key factors that interdependently generated the current functionality and structure of the agricultural land in the Romanian Plain, including our study-area.

1. Land ownership

One of the key drivers shaping the present agricultural land use has obviously been the change of land ownership. The collapse of the centralised ruling political system in 1989 and the transition toward capitalism led to transformations of agricultural land use structure through land restitution and privatization so the ratio between land users and land owners has drastically changed. For instance, before 1989 the state had over 90% of agricultural land in use and only a small share of it belonged to owners, particularly the in the mountain and hilly areas; in 2007 the number of individual agricultural exploitations was 3.9 million, covering 65% of the agricultural area, while the rest of the 35% of the area was cultivated by agricultural enterprises with juridical status (INS, 2010). In 2016 the number of individual exploitations decreased to 3.4 million, being with 5.7% smaller than in 2013, while the number of agricultural enterprises with juridical status also decreased with 6.4% as compared to 2013 (INS, 2017). However, the INS 2017 communication note states that the average size of cropland per agricultural exploitation is slowly increasing in both categories, individual exploitation (from 2.02 ha in 2013 to 2.04 ha in 2016) and agricultural enterprise with juridical status (214 ha as compared to 207 ha). Ownership changes associated with other governance settings (e.g. legal and institutional arrangements with regard to farm associations and agricultural services, land market, etc.) has largely impacted land use, particularly through fragmentation and cropping patterns.

2. Irrigation infrastructure

Romania benefits from a large experience in irrigation. During 70s–80s, an extensive irrigation system was installed to serve approximately 3 million hectares. It was built especially in the south of Romania, the Danube being the main source of water abstraction for irrigation). These large infrastructures turned inoperative and/or were destroyed following the period of land restitution and privatization when the owners lacked the necessary capacity, financial and/or managerial, to maintain, secure and use the irrigation systems, while the interested state companies had also had difficult times concerning restructure, reorganization or closure. Despite the acute need of irrigation application in the Romanian Plain, the coverage of the irrigated areas is below 10% of the total area equipped with supply systems (Fig. 6), the reasons being multiple, mainly due to the advanced degree of deterioration

of the old infrastructures, drop of the irrigation water demand particularly in highly fragmented farmlands, water and pumping energy costs, and frequent reorganizations of the administration of the water users. Regionally, the situation is slightly different as in the south-eastern part of the Romanian Plain the irrigated area is about 20% of the total area equipped for irrigation, while in its south-western part, it drops to an insignificant value. This situation reflects the territorial disparities of the cropland management. Some of the large agricultural holdings of strong commercial profile are found in the eastern part of the Romanian Plain where they have good conditions for intensive agriculture using modern infrastructures, including irrigation at large scale and farming practices for higher yields and profits. Contrary, the agriculture in the western part is still related to the existence of small farm properties and land fragmentation which constrain the growth of agriculture and development of rural areas (Dumitraşcu, 2006).

Nevertheless, the use of irrigation throughout the Romanian Plain is a prerequisite for drought mitigation and productive agriculture. In the recent past (2009 – 2016) about 600 000 hectares total the land that could be irrigated (National Agency for Land Reclamation in Romania – AFIR, 2017), while the situation is improving with the support of increased subsidies and investments in this sector. In this respect, the National Programme for the Rehabilitation of the Primary Irrigation Infrastructure of the Ministry of Agriculture and Rural Development (MADR, 2016) stipulates that 2 006 941 hectares are going to be ready for irrigation by 2020.

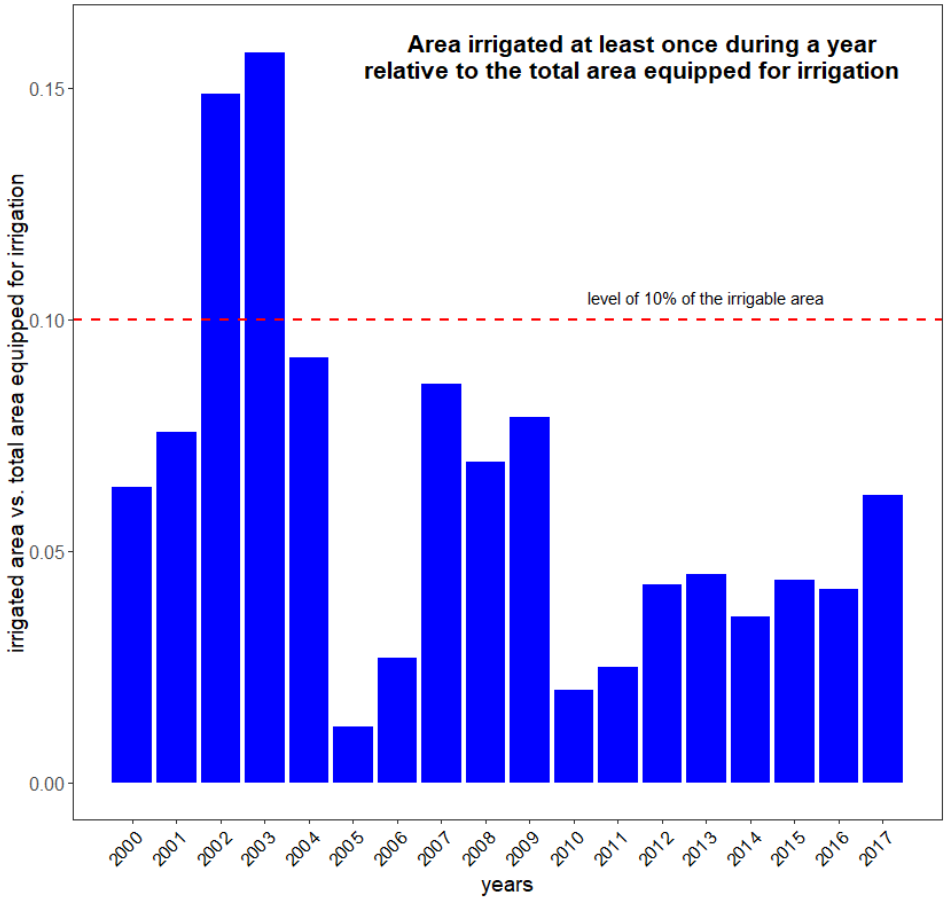


Fig. 6 – Irrigated areas in the Romanian Plain over 2000–2017 period.

Photo 4. Non-operational secondary irrigation canal in the Romanaţi Plain;
Photo taken by Lupu, L., September 9th, 2018.

Photo 5. Operational primary irrigation canal (Magistral) in the Romanaţi Plain;
the farmers with nearby croplands are most likely to use the water from it during the irrigation periods;
Photo taken by Lupu, L., September 9th, 2018.

3. Demographic trends

Rural areas are subject to increasing depopulation and ageing processes. These demographic trends are also coupled with relatively poor social and physical infrastructure and a relatively low connectivity to the urban centers which is the case for numerous rural localities. One of the most noticeable phenomena which has a strong impact on rural demography and its activities is the migration outside Romania. This process has changed the structure of the rural population. For instance, in the Oltenia Plain, the population aged 65 and above accounts for more than 110 000 persons (i.e. 22% of total population, higher than the national average which is 16 %) (INS, 2019).

Also, the population occupied in agriculture holds a large share (i.e. 73% of the employed population works in agriculture in the rural area in the Oltenia Plain) denoting not only a high concentration of a single economic sector, but also a lack of connecting services to it.

Such demographic trends and labor force aspects are important divers in agricultural land use management / land use change. Many agricultural farms in the flat areas of Romania represent a family or extended family business, which are run usually by farmers who are over 55 years old, being

generally small-sized farms. The possibility to leave the home place and the diverse and attractive opportunities for off-farm jobs create issues of farms' succession. This means that many of these farms lack successors who can take over the business once the farmer is no longer able to work it. It takes hard work and time to be able to make profit of these small plots of land and many young people feel that they can achieve better quality of lives by moving to urban areas or abroad. Therefore, depopulation, ageing and declining interest of the youth in agricultural activities are one of the challenges faced particularly by small sized farms.

4. Land markets

The newly enforced regulations on land privatisation, ownership titles and rights opened opportunities to transact the land. As well, real estate and construction companies created a strong competition for the agricultural land found in the vicinity of cities. The regulations on land markets were more flexible on the onset of the privatisation process and have become gradually more restricted. The average price of 1 ha of land is nowadays around 6000 euros, varying considerably across regions and depending on the land quality (www.agrointel.ro), raising from less than 2000 euros in 2010 (EC, 2016). Apart from the easy lease or sell of (good quality) land during the 2000s which favoured numerous foreign investors to make profits, the land market led to changes in the use of agricultural land. However, this aspect is very much related to the local quality of the land and the price, as well as to the economic interests of the owner or farm manager.

5. European Union Common Agricultural Policy

Generally the EU CAP, through subventions for farms and rural development, has been oriented so far toward the support and stimulation of production. However, in Romania the activities should had been prioritized according to the necessities of the farms. The recent reform of EU policy on agriculture articulates the necessity of adopting agricultural practices oriented toward green economy by supporting the economic growth while preventing environmental risks (EC, 2010). It is acknowledged that sustainable agricultural measures can support water management through sustainable farming practices. More efficient water saving irrigation techniques will have to be developed and applied along with sustainable regulatory actions envisioning water use, with special attention to water demand to prevent or effectively respond to water scarcity challenges (EC, 2010).

Nevertheless, the EU subsidies in agriculture along with the possibility of bank loans have greatly helped farmers to improve their farming practices and make them more efficient through modern and highly performant machineries, use of new cultivars and fertilizers as well as through services such as consultancy. The financial support in agriculture through EU and national funding have helped farmers maintain their agricultural business constant, and in many cases expand them, fact that clearly influenced land use in agricultural areas.

6. Agri-food markets

The agri-food markets are usually dominated by big companies which dictate crops' selling price. However, the agriculture in Romania is still dominated by individual agricultural exploitations or relatively small exploitations. These types of exploitations are known to be less productive than the exploitations in the EU countries. In this respect, the relations between the local producers and the agri-food consumption markets need to be reinforced in the sense of increasing, through efficient new regulations, the implication of the local producers on the market fluxes (Popescu, 2013). Therefore, farms would better respond to the domestic demand for agricultural products, being able to use their land accordingly.

7. Physical / natural drivers: climate, soil types and forest belts

Increased frequency and intensity of droughts; diversity of soils, including extended areas of sand dunes as in the Romanaţi Plain (e.g. Dabuleni – Ocolna area); forest (belts) degradation / destruction represent important drivers that decisively influence land use and crop production. As well, land fragmentation dynamics over the last 30 years has generated different structures of land uses according to the degree of fragmentation. Such aspects require integrative solutions for the management of farms, including both climate change adaptation measures and economic viability and grow of farms. In this respect, there have already been initiated studies concerning Danube basin on water use efficiency, crop potential and sustainability in agriculture (Probst *et al*., 2018).

4.2. Conclusions and further research

Agricultural land fragmentation is an important issue in terms of both, land governance and land use system research. The paper explained how the excessive land fragmentation in the western part of the Romanian Plain connects with the existence of numerous individual, family-based farms (i.e. an effect of the return of landownership rights to former owners and/or their heirs), along with other factors such as socioeconomic background and tendencies, agricultural infrastructure maintenance and agrarian policies. In this context, the prevailing issues reside in finding optimal solutions to concurrently use the agricultural potential of the area while maintaining the agroecosystem functions, respond to the farmers' needs, and increase wellbeing of the rural communities.

In Romania, land tenure issues are associated to the return of land property rights to former landowners which took place in relatively successive episodes over the last three decades, being rather distinct and little coherent from a strategic point of view and/or insufficiently grounded in studies meant to enable sustainable land use structures and evolutions (Popescu, 2018). From this point of view, the consequences of land regulations in the first decade of the transition period led to an excessive fragmentation of the agricultural land and emergence of numerous small, family-oriented farms (the average farm size reached 1.9 hectares). Also, the process of land restitution triggered a reinvigoration of the rural space through the return of a large share of the newly landowners to their home places.

The next decade was marked by legislatives norms that ensured the privatization of the state-owned farming facilities. At the same time the socioeconomic conditions in the rural space were marked by advanced ageing of people working the lands, stronger depopulation, and insufficient and/or poor agricultural infrastructure of farms.

Further, the national and EU supporting funds for agriculture were established when Romania joined the EU community in 2007, with the purpose of growing agricultural productivity, modernization / development of agricultural infrastructure and rural development. The support schemes were set out within the framework of National Development Programmes for Agriculture 2007–2013 and 2014–2020, respectively (MADR, 2014, 2016). They included, for example, support for the development of new farms managed by young farmers, rehabilitation of the principal irrigation system infrastructure, subventions per cultivated hectare, modernization of farms, training programs and development of agricultural services, etc. In this context, aspects related to land fragmentation evolved contextually, with a general tendency to convert from strong fragmentation associated to individual, small and very small family-oriented farms to larger fields attributed to agricultural associations and holdings having a commercially-oriented profile. However, this situation is spatially diverse throughout the Romanian Plain since in many areas, as it is the case of our study-area, the fragmentation still high and the lands are prone to drought and desertification, water stress or are insufficiently exploited compared to their productive potential.

Setting out and extending the agricultural associations instead of managing small farms seems beneficial and a promising development prospect considering the socioeconomic tendencies in the rural areas. However, this process is not always straightforward due to the expectations, financial and/or societal, that farmers/land owners assume. In many cases it is the price of land offers and the quality of the agricultural land that farmers invoke as major constraints in the association process.

As investigated in our study, the very high degree of land fragmentation is the case of the very small (< 5 ha) and small farms (> 5 ha and < 20 ha) in the Romanaţi Plain, being subject to lower yields, heterogeneous land use structure and less profitable agricultural activities. Land fragmentation appears to be a significant determinant of farm productivity in such cases due to farming management difficulties, in particular because of the problems induced by resource efficiency use and labor efficiency, even if other variables, such as fertile soils, use of quality seeds and fertilization are controlled for. At a larger governance level, land fragmentation is important and needs to be taken into account when designing land management strategies as the scale of agricultural producers is, in many cases, different, e.g. in the western part of the Romanian Plain (e.g. Romanaţi Plain) small farms are perceived differently compared with the eastern part of the region (e.g. Bărăgan Plain).

Worth mentioning that drought increasing frequencies, inoperative and/or not affordable irrigations systems, various ecological constraints, e.g. the presence of sand soils over large areas, amplify the difficulties of farming management in agricultural areas characterized by high land fragmentation. They further contribute to low performing agriculture, requiring governance alternatives oriented toward stronger measures of adaptation and integrated resource use efficiency policies.

Agricultural land fragmentation connects with different research issues found at the interference of social sciences, landscape and resource management. Detailed investigations could offer scientifically grounded evidence on the agroecosystems' potentials in particular areas and could improve the current policies, especially in the domains relating to global environmental change. In this respect, *the Earth Observation datasets*, such as COPERNICUS satellite data, are truthful monitoring instruments that could be used to develop and quantify spatial metrics, necessary for timely and pragmatic agricultural land decisions. The new generation of COPERNICUS products cover multiple domains, including land use / cover systems, have higher resolutions and can serve *integrative modelling and simulation techniques* to evaluate hot spots and agroecosystems' vulnerability to various stresses, e.g. water stresses, improper farming practices, inefficient land use structures, spatial discontinuities based on clearly defined land cover classes, etc. The present analysis on land fragmentation will be further extended by using COPERNICUS remote sensing data series and other ancillary data in order to capture the full spectrum of aspects related to the dynamics and structure of land uses and crop systems in representative areas of the Romanian Plain.

As well, *case study comparisons offer substantial information in what regards better management solutions*. Land fragmentation is reflected differently in different parts of the Romanian Plain. The variety of ecological conditions and environmental alterations / changes along with different dynamics of the socioeconomic factors (different market forces, particularly in what regards land acquisition and crop prices, the legacy of the local people considering the land and their perspectives toward sustainable land use, demographic trends in the rural space and the local workforce capital, the access to technological innovations, etc.) define particular land structures and different measures for land use. Each case-study highlights the ways in which land tenure form, knowledge and value systems (traditional and local knowledge), lifestyles and socioeconomic settings relate to land use options, while comparative analyses reveal the spatial and temporal impacts of decision making processes (IGBP Report 53 / IHDP Report 19, 2005). Therefore, cross-regional studies, based on systematic approaches concerning land fragmentation, determine under what conditions land governance provides better options for agricultural and societal development, the outcomes of such analyses contributing to eventual corrections of the negative feedbacks of land use policies. At the same time, the complex

relationships between land use structure and human activities, including the decision making processes, are not amenable to simplistic replication which means that their predictability will never emerge from individual case studies (IGBP Report 53 / IHDP Report 19, 2005). In this sense, it is the regional comparisons, chosen on the basis of documented conceptual models that form the necessary tools for reaching integrated outcomes.

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