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# LONG TERM CHANGES OF WETLANDS IN THE CONTEXT OF ANTHROPIC INFLUENCES: THE CASE OF ROSCI0222 (NORTH-EASTERN ROMANIA)

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**Abstract:** Since the mid-19th century, large surfaces of wetlands across Romania (over 1 000 000 hectares) were drained, resulting in productive lands. The aim of our study was to make a detailed analysis of the land use evolution of a Natura 2000 site of community importance from North-Eastern Romania over 100 years using both old maps and recent satellite images. In this approach we considered that although the old maps provide a primary historical source illustrating the character of the disappeared landscape structures and that the satellite images represents suitable sources for surveying the present state of land cover, they can not explain which are the drivers and mechanisms that led to the present land use configuration. Therefore, another aim of this research was the identifying of the factors that led to the landscape change taking into account another element beside the cartographic resources, when studying the land use evolution, the vegetation analysis. The historic cartographic maps and recent satellite images were digitised and analysed in relation with the historic vegetation data and recent vegetation study from the field to make a detailed analysis of the landscape evolution. Our results showed that in the last 60-70 years, the most important change has been the expansion of the agricultural surfaces and grasslands to the detriment of the wetlands, whose surface has been reduced by over 10 times during the mentioned period. The main drivers of these changes are related to agricultural development and pasture expansion, which are yet strongly related to natural factors (such as soil and climate characteristics). Our results showed that even though data from the old maps and the modern cartographic sources are very important tools for monitoring land use changes, they are not sufficient for a proper interpretation of the inner mechanism of landscape evolution. Combining historical and actual florist and phytocoenological studies with mapping tools provides better insights into the long-term evolution of landscape dynamics. This approach may be used to other Natura2000 sites and can provide the scientific basis for local and regional planning in order to preserve valuable elements of the landscape.

**Keywords**: historical cartographic resources; anthropic impact; land use change; GIS techniques; vegetation data; vegetation analysis.

## 1. INTRODUCTION

Land use, for its rapid change correlated to the increasing economic needs, has become an issue of global importance (Foley et al., 2005). The analysis of changes in land-cover is fundamental for understanding a whole range of social, economic, and environmental problems, land use being a key descriptor of human influence (Pelorosso et al., 2009). Over time, large areas suffered significant changes for the continuous development of the human communities and to the intensive land use (Ricca & Guagliardi, 2015). Land use activities, whether converting natural landscapes for human use or changing management practices on human-dominated lands, have transformed a large proportion of the planet's land surface (Foley et al., 2005). Intensive land use has caused a decline in biodiversity through the loss, change and fragmentation of habitats, and degradation of soil and water (Pimm & Raven, 2000; Foley et al., 2005; Damschen et al., 2006; Fischer & Lindenmayer, 2007.). All these have led to a great landscape change and loss of ecological capacities in a short time (Vitousek et al., 1997; Foley et al., 2005; Ricca & Guagliardi, 2015). In this regard, we can consider wetlands that suffered a great transformation from the past until present days worldwide. Wetlands are the Earth's most productive ecosystems. However, throughout time, they suffered conversions to intensive agricultural use and to other industrial and residential uses (Papastergiadou et al., 2008; Lieskovský et al., 2018; Dóka et al., 2019). Their loss and degradation continue in many European countries (Mitsch & Gosselink, 2015; Dóka et al., 2019). In Romania, for example, during the 1960-1989 period, over 1 000 000 hectares of wetlands from the floodplains of the majors' rivers were embanked to eliminate the flood risk, the wetland-related diseases (such as malaria), and to get new agricultural lands (Ciobotaru et al., 2016). This situation is well represented in ROSCI0222 - Sărăturile Jijia Inferioară-Prut, which makes the object of our study. In the last 100 years, the anthropogenic influence in the area has contributed to this state through the build-up of the roadbed of the railroad (finished in 1896), and embankments which acted as a barrier to water. To limit the effects of flooding, since the mid-19$^{th}$ century were created drainage channels and small ponds across the Jijia and its tributaries (Obreja, 1958). These have led to the degradation of the wetland, by converting it to agricultural use and fish farming (Vartolomei, 2004). The hydraulic engineering works have altered the natural habitats, and the exploitation of resources through intensive agricultural techniques, along with the lack of flooding led to soil salinization. Following the intensive anthropic activities in the area during the last decades, in 2008 the site receives protection status to preserve five habitats of community importance.

Monitoring land use changes and estimating their impacts is essential for a sustainable environmental management (Papastergiadou et al., 2008). Investigating land use change requires a historical perspective (Dale, 1993), which is considered to provide the context for framing modern ecological studies and designing conservation efforts (Boyle et al., 1997; Domotorfy et al., 2003).

Thus, research on land use and land cover change usually combine different data, such as historical cartographic resources (e.g. military maps/surveys) and maps derived from aerial photographs or satellite images, with the support of GIS (Pelorosso et al., 2009). The military surveys provide a primary historical source illustrating the character of the disappeared landscape structures, mainly in anthropogenically disturbed areas (Skaloš et al., 2011). Yet, since the data differs, the detection of long-term changes provides a series of problems. For example, the land cover information displayed on old topographic maps is difficult to integrate with land cover maps derived from remote sensing (Pelorosso et al., 2009) as the geometric and thematic characteristics of historical maps are not always known (Petit & Lambin, 2001; Pelorosso et al. 2009; Forejt et al., 2018). Nevertheless, comparative cartographic sources at a certain date are considered a suitable basis for evaluating landscape changes (Frajer & Geletič, 2011). From an ecological point of view, the old maps represent unique landscape management documents (Trpáková & Trpák, 2008), monitoring changes of land cover based on data from the old maps being a method used in many European countries (Breuste et al., 2009), such as the Czech Republic (Skaloš et al., 2011; Havlíček et al., 2014), Italy (Pelorosso et al., 2009), Greece (Mallinis et al., 2010) or Carpathian region (Lieskovský et al., 2018). The orthophotomaps are considered suitable sources for surveying the present state of land covers and for evaluating their changes. In Romania, the only studies concerning the long-term land cover change relate to changes of some residential and touristic areas (Pătru-Stupariu et al. 2011), conservation of the cultural heritage (Nicu & Stoleriu, 2019), traditional farming (Feurdean et al., 2016), or the biogeographical significance of some forests (Geacu et al., 2018), while specific studies on the temporal evolution of the protected areas (such as Natura2000 sites) under anthropogenic impact, are missing.

Although it is stated that the satellite images can provide information on the coarse changes regarding the wetland plant communities (Jensen et al., 1995), wetlands' extent, percentage of cover vegetation, or the evolution of plant communities (Tiner, 2004), remote sensing requires field verification, to validate the plant community types (Papastergiadou et al., 2008). Besides, it is mentioned that the fundamental problem in mapping land use is that it does not leave a particular identification that can be distinguished without site investigation (Pelorosso et al., 2009).

Since research on changes in surface area, structure, and functions of the wetlands are very important for determining the causes and consequences of their degradation (Papastergiadou et al., 2008), and also considering the limits provided by the cartographic resources in the land use change's analysis which requires field validation, (Forejt et al., 2018; Ciocănea et al., 2019), we aimed to answer the following questions: 1. What are the consequences of 100 years' anthropogenic influence on a Natura2000 site of community importance? 2. Which are the main drivers that influenced the land use changes? 3. Does the interpreting of historical and current maps only, captures all the landscape changes and explains the mechanisms (natural or anthropic) that generated them?

To achieve the aim of the study, first, we made a detailed analysis of the long-term changes in land cover of the site over the last 100 years, and second, we have introduced an additional element to the existing method of analysis of land use change based on old Military maps and satellite images, the historical and current vegetation data, with the support of GIS.

## 2. MATERIALS AND METHODS

The study area is located in the Lower Jijia Plain (a geomorphological subdivision of Moldavian Plain), framed on Iași County (Romania) (N: 47º24'3'', E: 27º19'17'') (Fig. 1).

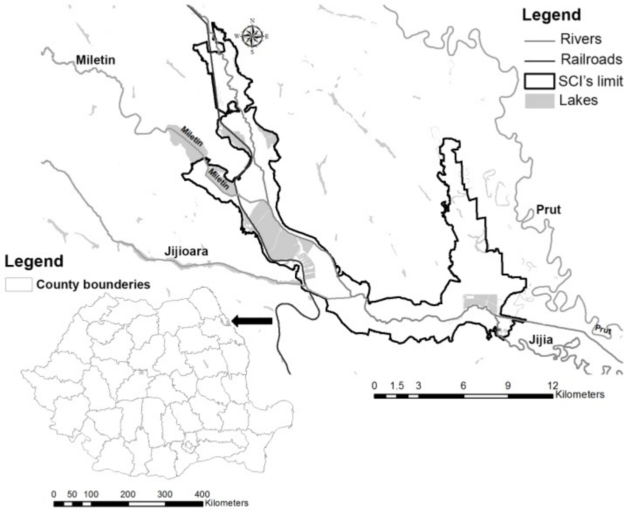


Figure 1. Location of the ROSCI0222 – Sărăturile Jijia Inferioară-Prut

In December 2008, the area has received protection status, being registered under the principles of Annex I of Habitats Directive as ROSCI0222 (Standard Data Form). The most representative of the protected habitats is the priority one, 1530 - Pannonic salt steppes and salt marshes. The area covers a surface of 10900 hectares (Standard Data Form), with elevation ranging from 32 m to 148 m. Low plateaus or hills are the most common landforms of the area characterised by well-developed plains with small slopes (<0.35%) (Tufescu, 1935; Obreja, 1958) that influenced the generation and maintenance of stagnant water surfaces. The representative soil categories are aluviosol, cernisol, and salsodisol – solonetz (Munteanu & Florea, 2001). The properties of the rocks composing the lithological deposit of the Moldavian Plain (clay, marl, sand, and gravel) show high erodibility, permeability, and resistance to decay and disintegration (Ion et al., 2011). All these features contributed to the wetlands formation in the study area (Ion et al., 2011). Between 1974 and 1981, a series of dikes were built in the area, before that, the site being known as the Jijia Pond, because of the large areas covered by water and swampy vegetation edified by reed (*Phragmites australis*) (Obreja, 1958). The rainfall regime, with two annual periods of maximum precipitation, along with the geological substratum of the riverbed, explains the frequent flooding of the area. Over 17 years (1908-1925), the lower course of the Jijia River flooded 16 times (Obreja, 1958). To this situation also contributed the anthropogenic influences, through the construction of the roadbed of the railroad (finished in 1896), which acted as a barrier for water. To limit the effects of flooding, since the mid-19$^{th}$ century, drainage channels and small ponds were made across the Jijia and its tributaries (Obreja, 1958) which have led to drainage or otherwise degradation of marshes, by converting them to agricultural use and fish farming (Vartolomei, 2004).

To analyse the changes occurred in the study area over the 100 years period, we used data illustrating past land cover features from the closest dates of the main events that may have influenced the land cover changes (Fig. 2). To highlight the current land use pattern under the pressure of the specified events, we used the satellite imagery provided by Google Earth (2009). All the old maps used in our study were downloaded from the Geo-Spatial website (http://geo-spatial.org/harti). In the period 2013-2015, we did fieldwork research to investigate the current land use of the analysed site. Therefore, we recorded phytocoenological relevés in different areas of the site such as to cover as much as possible of the actual vegetation diversity. The identification of the actual plant communities was carried out using the Braun Blanquet method (Braun Blanquet, 1932; Gafta & Mountford, 2008). In order to observe the vegetation transition since 100 years ago until the present time, we analysed the historical data from the literature on flora and vegetation studies from the area.

We performed the land use mapping with the TNTMips v.6.9 (Microimage) and ArcGIS v.9.3 by geo-referencing the Military and topographic maps in the Stereo 70 (Dealul Piscului) Romania Projection system and vectoring the thematic layers. We digitised each land use category we could differentiate, based on the available tools; thus, the number of land use categories depends on the cartographic base. For the historical maps, we established the land use categories according to both the Conventional Sign Atlas (Toma & Manaila, 1975) and the maps' legend, while for the satellite images, we settled the land use categories based on the vegetation data registered in the field.

Since some land use categories were difficult to differentiate on the maps, we included sub-categories in overall categories (Fig. 3). With the help of the vegetation analyses, we could digitise on the current map different subclasses that are not differentiated on the historical maps, such as alluvial,

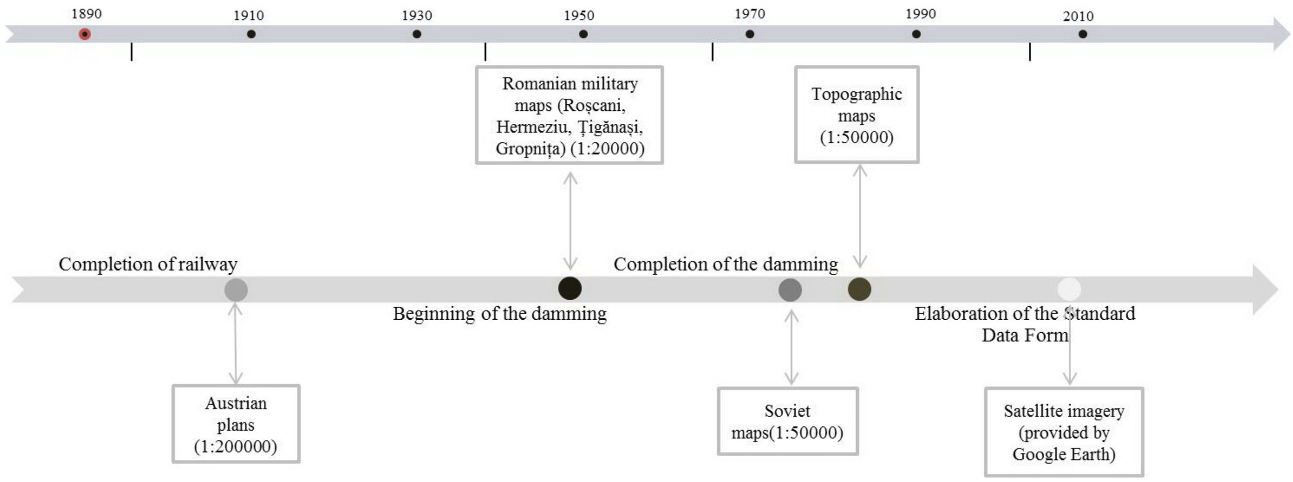


Figure 2. The historic cartographic resources used

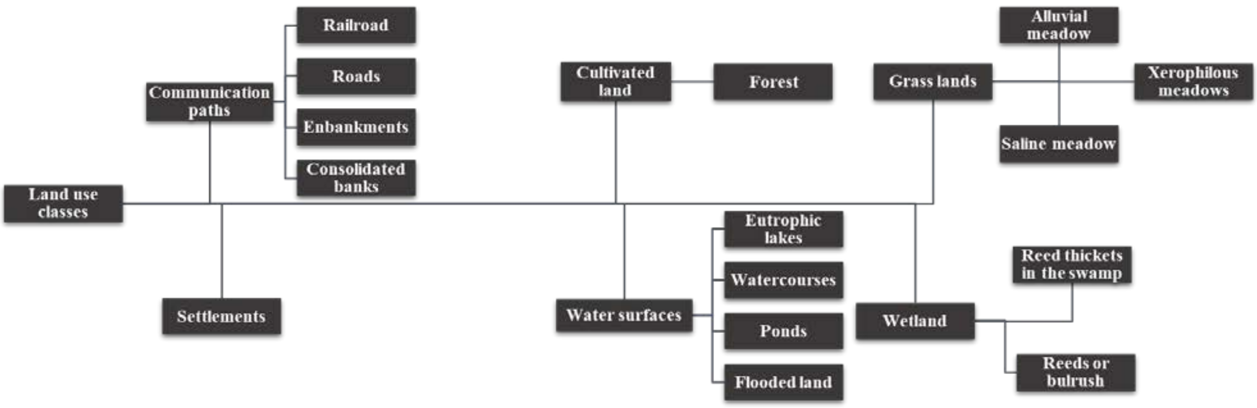


Figure 3. Land use classification system

Table 1. Analysis of land use categories' cover over 1910 – 2009 period

| Land use categories | | 1910 | | 1944-1954 | | 1975 | | 1981 | | 2009 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ha | % | ha | % | ha | % | ha | % | ha | % |
| Communication paths | | 645.52 | 5.87 | 326.48 | 2.97 | 546.6 | 4.98 | 526.34 | 4.79 | 428.96 | 3.9 |
| Cultivated land | | 27.76 | 0.25 | 44.81 | 0.4 | 29.16 | 0.26 | 25.26 | 0.23 | 2648.67 | 24.12 |
| Forest | | - | - | 35.98 | 0.32 | 44.71 | 0.4 | - | - | 133.41 | 1.21 |
| Grass land | | 303.95 | 2.76 | 594.54 | 5.41 | 6673.55 | 60.79 | 6989.71 | 64.69 | 5610.84 | 51.74 |
| | Alluvial meadow | - | - | - | - | - | - | - | - | 1448.31 | 13.19 |
| | Saline meadow | - | - | - | - | - | - | - | - | 4231.82 | 37.92 |
| | Xerophylous meadow | - | - | - | - | - | - | - | - | 69.16 | 0.63 |
| Settlements | | 64.78 | 0.58 | 74.57 | 0.67 | 53.48 | 0.48 | - | - | 71.55 | 0.65 |
| Water surface | | 1008.58 | 9.18 | 231.72 | 2.11 | 687.1 | 6.26 | 1392.36 | 12.68 | 1233.94 | 11.24 |
| Wetland | | 8932.56 | 81.32 | 9667.5 | 88.07 | 2940.77 | 26.79 | 1931.22 | 17.58 | - | - |
| | Reeds or bulrush | - | - | - | - | - | - | - | - | 778.7 | 7.09 |

saline, and xerophilous meadows, on the historical maps they only being referred to as grasslands. During the field observations, we identified the Natura 2000 habitat 1310 - *Salicornia* and other annuals colonising mud and sand, only on restrained and scattered surfaces, which is why we didn't map it but included it in the saline meadow land use category. For each land use category, we calculated the total area (expressed in hectares) and its coverage percentage over the analysed period (Table 1).

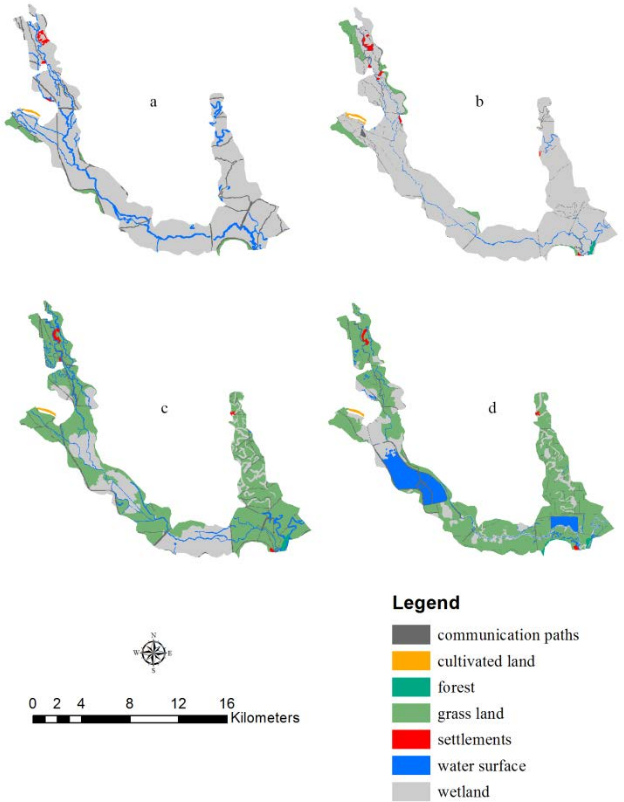


Figure 4. Land use patterns based on the interpretation of historic maps: (a) 1910; (b) 1944-1954; (c) 1975; (d) 1981

## 3. RESULTS AND DISCUSSION

As in other communist countries, such as the Czech Republic (Lipsky, 1995), in Romania in the last 40-50 years of the 20$^{th}$ century, the landscape suffered important changes. The flooding risk in the Jijia River basin and the policy of "returning the land to the agriculture use", led to the initiations of hydraulic engineering works, resulting in a severe degradation of wetlands.

For the GIS technologies, the comparison of the historical cartographic data with the current satellite images, and adding to the analysis of land use change the historic and actual vegetation data, we produced an accurate, up to date, and detailed evolution of the land use categories from the study area, over the 100 years period by using GIS and vegetation data (Fig. 4, Fig. 5).

The most significant change in land use during the analysed time period is the decrease of wetland. In 1910 and during the period 1944-1954, the wetland was the ascendant land use category (Table 1) and until 1981 it decreased by almost 64%. In 2009, the remnants of wetland are the hygrophilous vegetation edified by reeds or bulrush (Table 1, Fig. 5). The wetlands' decline from 1910 seems to be related to the increasing of grassland, which occupied 51.74% of the total area in 2009, with an increase of 48.98% during the last 100 years, and to the arable land which in 2009 occupied a proportion of 24.12% of the site's area. Following the vegetation analysis in the period 2013-2015, we differentiated the grassland categories into saline, alluvial, and xerophilous meadows. After calculating the area occupied by each of the three grassland categories, it was highlighted that the most significant proportion was being occupied by the saline meadows (37.92%), followed by the alluvial meadows (13.19%) and only 0.63% of the site's surface as being occupied by the xerophilous meadows. These results are supported by the vegetation analysis, the main phytocoenological unit identified in the area nowadays being specific to the Pannonic salt steppes and salt marshes habitat type, with plant communities such as *Puccinelietum limosae*, *Iridetum halophylae*, *Limonio gmelini-Artemisietum monogynae*. Other meadows dominated by plant communities such as *Trifolio-Lolietum perennis*, *Rorripo austriacae-Agropyretum repentis*, *Medicagini lupulinae-Agropyretum repentis* were identified in the area and were included in the alluvial meadow category. The *Taraxaco serotinae-Festucetum valesiacae*, *Stipetum tirsae*, *Elytrigietum hispidi* plant Associations compose the Ponto-sarmatic steppes (62C0 habitat) and are represented on the map from 2009 as xerophilous meadow (Fig. 5).

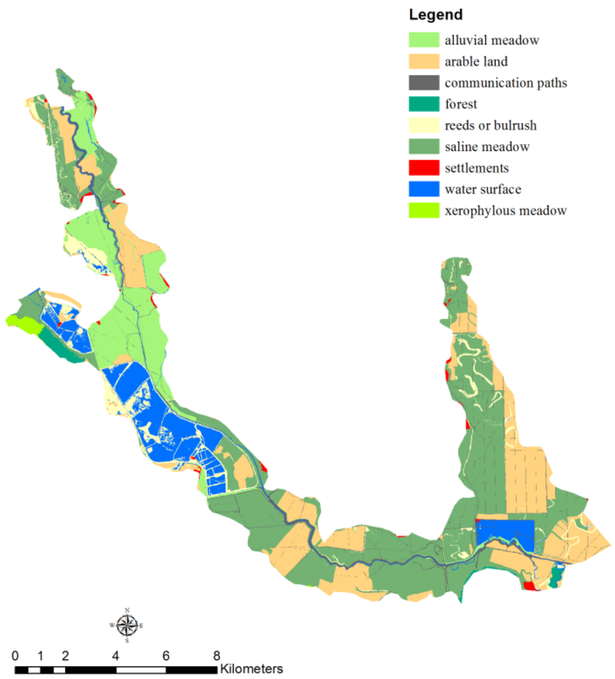


Figure 5. Land use pattern based on the interpretation of the satellite image: 2009

The phytocoenological units that show the wetland character of the area nowadays are the plant communities such as *Scirpo-Phragmitetum*, *Typhetum angustifoliae* and *Typhetum latifoliae*, which forms Reed stretches along the rivers and ponds. The phytocoenosis of the Phragmiti-Magnocaricetea (reed beds) and Bolboschoenetalia maritimi form a part of the salt steppes habitat, species such as *Bolboschoenus maritimus* and *Eleocharis palustris* occurring on salty marsh surfaces.

Analysing the comparative distribution of the areas occupied by grasslands before 2009 and by the alluvial meadows and saline meadows in the present time, we believe in the maps before 1990, all the surfaces with herbaceous vegetation were represented as wetlands or grasslands. This approach, therefore, explains the total absence of saline meadows from all the maps before 1990. Although they are not mapped before 1990, saline grasslands have been reported from the area through vegetation data from the first half of the 20th century. The historic flora and vegetation data mentioned in 1941 the presence of species such as *Puccinellia limosa* (that forms communities on large areas) and *Iris halophila* (occupying large surfaces), but without data on the occupied areas (Răvăruț, 1941). This, however, shows the existence of saline areas in the site, even before the main hydro techniques occurred, when (according to the map's interpretation) the largest area was dominated by wetlands. The topography of the area, through the impermeable layers of the substrate and solid alluvial deposits accumulated over time, alongside the existence of salsodisoil (solonetz) and correlated to extended periods of drought which created both flooding and dryness in the period before diking, led to soil salinisation. In droughty summers, sandy-argillaceous alluviums from the Jijia riverbed are covered with white salty efflorescence (Obreja, 1958). This statement is confirmed by research on vegetation by the mid-20th century when species such as *Halimione verrucifera*, *Camphorosma annua*, *Bassia prostrata*, *Salicornia europaea*, *Suaeda maritima*, *Salsola kali*, *Puccinelia limosa*, *Iris halophylla*, and plant communities such as *Salicornietum herbaceae*, *Salsoletum sodae*, *Puccinellietum distantis*, *Iridetum halophilae* were identified in the area by Răvăruț (1941) and Răvăruț et al. (1968), before the major hydro technical works occurred. Marshland salinisation is furthermore sustained by the presence of *Salicornietum herbaceae* (widespread at Larga Jijia), *Salsoletum sodae*, *Camphorosmetum ovatae*, and *Puccinellietum distantis* (abundant on wet ground) plant communities in the study area (Răvăruț et al., 1968). The *Agrosti-Beckmannietum* Association identified in the area by Răvăruț et al. (1968) shows another stage of transition to *Juncetum gerardi* or *Puccinellietum distantis*, following the increase of soil salinity.

The anthropic impact, through the hydraulic engineering works, has altered the habitats and the exploitation of the resources by intensive agricultural techniques is also responsible for the soil salinisation. Therefore, the landscape features combined with the anthropic disturbance favoured the installation of the saline vegetation. Chifu et al., (1998) mentioned the most frequent plant communities from the Lower Jijia Plain as being those developing on substrates salinisation conditions such as *Juncetum gerardii*, *Salicornietum europaeae*, *Salsoletum sodae*, *Puccinellietum limosae*, *Iridetum halophilae*, and *Agropyro-Leuzeetum salinae*. Nowadays, saline meadows are used for grazing (with sheep and cattle) and less for other agricultural purposes. But salinisation, erosion, desertification, compaction, and pollution, represent detrimental effects of agricultural practices on soil quality (Zalidis et al., 2002; Shrivastava & Kumar, 2015). Salt marshes occur on soils with a high concentration of salt, covered by water during most of the vegetation period. The direct contact between managed fields and lower soil salinity (caused by drainage) supported the colonisation of the soil by *Phragmites australis*, *Bolboschoenus maritimus*, *Typha angustifolia*, and *T. latifolia*, which can create vegetation cover within a few months. On the edges of water courses and in the permanent ponds developed the *Scirpo-Phragmitetum* Association (Răvăruț et al., 1968). This is the reason *Phragmites australis* is considered sometimes an invasive species in salt habitats (Šefferová et al., 2008). Other studies evidenced the ability of reeds to respond rapidly to environmental changes such as changes in hydroperiod and soil disturbance (Galatowitsch et al., 1999), nutrient enrichment and hydrology alteration (Urban et al., 1993). In 1968 the *Caricetum acutiformis-ripariae* plant community was mentioned as being the most frequent hygrophilous association around permanent ponds, at a lower depth. In the same period, it was mentioned from the area the *Agrosti-Caricetum distantis* Association, which makes transitions from hygrophilous vegetation to halophilic Associations on temporarily wet and slightly salinised land, being replaced by *Agropyretum repentis* in case of soil salinity decrease, or by *Puccinellietum distantis* if the salinisation increases, in both cases when the water level decreases (Răvăruț et al., 1968). Other studies on the land use/land cover changes of wetlands also showed a conversion of large areas of the wetland into salinised land during the four decades analysis, the increase in the spatial extent of the salinised land being attributed to human activities such as agriculture and water use, and also to the changes in air temperature and annual precipitation (Zhang et al., 2017). Another research on spatio-temporal changes in a wetland from Greece, emphasized the major causes of wetland degradation as being the altered natural hydrologic regimes and changes in habitats structure with serious impacts on the composition of plant communities (Ehrenfeld, 1983; 2000; Papastergiadou et al., 2008). Because of the hydrologic change there has been a decrease in species richness followed by an increase in the dominance of one plant species (such as *Typha angustifolia* and *Phragmites australis*), as well as the absence of species sensitive to human disturbance along with the presence of dense stands of reed bed vegetation (Ehrenfeld, 2000).

The area occupied by the water surface category also suffered fluctuations (increased) over the 100 years period (Table 1) because of the regularisation of the Jijia River and to the construction of ponds designated for pisciculture. The water surface land use category is represented on the old maps only by the Jijia and its tributaries courses, to the map of 2009, adding the surfaces of the build-up ponds. Most of the lakes and ponds from the study area are of anthropic origin. Their eutrophic character is because of the pisciculture, through the fish food supply. The vegetation installed on the water surface depends both on the natural fluctuations of the water, and on the anthropic ones, the ponds being periodically depleted and filled. On the water surface (ponds, lakes), vegetation comprising phytocoenosis of habitat 3150 - Natural eutrophic lakes with Magnopotamion or Hydrocharition have installed. Therefore, on the water surface of the lakes and ponds were identified communities of *Lemno-Hydrocharitetum morsus-ranae*.

In 2009, the anthropic land use category reached a percentage of 29.88% (divided into 24.12% arable land and 5.76% communication paths, settlements, or other land use classes of anthropic origin) towards 6.7% occupied in 1910 (Table 1). We relate the observed differences in growth of this land use class both to the expansion of arable land during 100 years as a result of river regulation and to the possibility to differentiate the arable land from the grassland on the satellite image. Even considering that a decrease in grassland and wetland cover and an increase in the arable land area were signs of the intensification of agricultural production (Skaloš et al., 2011), that this category of land use is represented on the old maps only by vine crops is interesting. Given that animal breeding and agriculture are traditional occupations since the earliest periods for the local community, how can we explain the low percentage occupied by the anthropic class on the historic maps? An explanation may be given if we analyse the surfaces occupied by the settlements during the different time periods. Therefore, the settlements' area in 1910 (65 ha) and between 1940 and1954 (74 ha), are comparable to those in 2009 (71 ha). On the actual map, only the built-up areas were considered as settlements. Thus, with surfaces almost identical, we consider that settlements represented on old maps contained both inhabited and cultivated areas. Moreover, other authors noted the same problem when combining some categories of landscape on old maps, especially with regard to human settlements (Pătru-Stupariu et al., 2011). Another explanation may be the temporary character of some cultivated surfaces, exposed to the periodic flooding and assimilated to wetlands on old military maps.

The plant communities such as *Convolvulo-Agropyretum repentis*, *Xanthietum riparii*, identified in the area nowadays, are an index for the anthropic disturbance, showing that agriculture, animal grazing, and soil erosion are the most common anthropic activities disturbing the area.

All these considered we believe that although the anthropic influence contributed to the land use changes of the site, it is not the only responsible factor that led to the wetland regress during 100 years. If we refer only to the expansion of grasslands (both alluvial meadows and salt steppes) in the detriment of wetlands, we can consider this evolution as a natural response of the landscape to the anthropic mediated changes of the environment. The anthropic factor only generated the natural response of the vegetation based on the physical-geographic and ecological features of the area, modifying the proportion of different plant communities. We therefore consider that the landscape is constantly changing (Antrop, 2005), as a result of the complex interactions of natural (climatic event, increased temperature, decreased precipitation) and anthropic (infrastructure construction, agricultural development, pasture expansion etc.) factors (Asselen et al., 2011). Most often, landscape changes are perceived as a threat or as a negative evolution, especially if they are associated with biodiversity loss (Papastergiadou et al., 2003; 2008; Antrop, 2005). Sometimes, however, the effects of these changes are surprising. Thus, with ROSCI0222, reducing wetlands' surface, the dominant element of the landscape in the past, allowed the diversification of habitat types, which led to the designation of the area as a site of community interest.

The main contribution of this work is highlighting the need of including another element to the study of land use change besides the cartographic resources, rather the vegetation analysis (both historical data and actual surveys). This resource offers better insights into the study of land use evolution and identifies the factors that changed the landscape. Even if the cartographic resources are useful in the analyses regarding landscape evolution, without vegetation data, we may misinterpret them. For example, in our case study, only on the basis on the historic and current maps, we could conclude that salinized grasslands are a recent occurrence of the last 30 years. But even if we consider these grasslands as a result of the anthropic intervention, the information provided by the maps cannot explain how they became from a non-existent category in the 1980s, the main category of grasslands in the 2000s. This methodological gap can be filled by integrating historical florist and phytocenological information in the map analysis. While this information may explain some processes of landscape change, surveying actual vegetation allowed us to differentiate the grassland types on the satellite image (such as alluvial grasslands and salt steppes), information that is not emphasised solely by the analysis of the cartographic resources with the support of GIS.

## 4. CONCLUSIONS

During the last 100 years, the land use suffered important changes, large areas of wetland turning into salinised land. The actual saline meadows are not the exclusive result of the anthropic intervention in the last decades, but the interaction between the anthropic disturbance and the physical-geographic characteristics of the area, a statement sustained by the historic vegetation data.

Even though monitoring changes in land cover based on data from old maps is a used method in many European countries, and although GIS and historical documents are very important tools for monitoring landscape changes, they are not sufficient for a proper interpretation of the landscape evolution, monitoring the changes in vegetation being required. Combining historical and actual floris and phytocoenological studies with mapping tools provides better insights into the long-term evolution of landscape dynamics. This approach may be used to other Natura2000 sites and can be applied in landscape planning procedures in order to provide relevant landscape management.

We consider this study to contribute to a deeper understanding of land-use and land cover change and to more appropriate policy intervention. We agreed that landscape from the past can not be brought back (Antrop, 2005), but analysis of spatial and temporal changes in landscape pattern-driven factors could provide the scientific basis for local and regional planning, to maintain the valuable elements of the landscape.

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