

CONSIDERATIONS ON SPATIAL AND TEMPORAL DYNAMICS OF FOREST ECOSYSTEMS IN SOUTHERN OLTENIA

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ABSTRACT. – **Considerations on Spatial and Temporal Dynamics of Forest Ecosystems in Southern Oltenia.** Because southern Oltenia is one of the Romanian regions most exposed to climate risk phenomena such as aridification, it is necessary to analyze spatially and temporally the forest areas considered to play an essential role in maintaining an optimal ecological balance in the region. This paper aims to analyze the dynamics of forest areas in the last three decades, attempting the same time to highlight the most important negative consequences on the environment and human communities. Following the diachronic analysis in the analyzed period (1981-2006) it comes out that there are large spatial differences at territorial level. The highest dynamics of forest ecosystems have been observed in the area of sand dunes. These dunes are found over large areas in the analyzed territory and their destabilization following deforestation is currently one of the major causes of intensification of aridification phenomenon, that has negative consequences at environmental, economic and social level.

Keywords: forest ecosystems, spatio-temporal dynamics, sand dunes, impact, environment.

1. INTRODUCTION

Globally, forest ecosystems are in constant change and the main cause is represented by anthropogenic influences (Vogelmann et al., 2012). Specialized research showed that, in the context of strong anthropogenic pressures over the past century, changes in land use (including the forest ecosystems) represents the main cause of global climate changes of the environment (MA, 2005; IPCC, 2007). Under these conditions, maintaining forest ecosystems in areas very affected by global climate changes, is essential. Otherwise, their loss can have major adverse consequences for ecological, climatic and hydrological fields (von Randow et al., 2012).

In Romania, there are now large regions affected by global climate changes. According to expert analysis on national climate (Păltineanu et al., 2007), among the most affected regions is the Romanian Plain (South-West, South and South-East) and most of the Dobruđa region. Also, the study area (southern Oltenia) is one of the most affected areas by the phenomenon of aridification in southwestern Romania.

Locally, in the last three decades, one may remark a clear trend of aridification (Dumitrașcu, 2006, Marinică & Văduva, 2010; Vlăduț, 2010; Dragotă et al., 2011), that is due to the synergistic context of global climatic changes (decrease of rainfall amounts, increase in global average temperatures) and local changes (deforestation).

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2. METHODOLOGY

This paper aims to analyze the spatio-temporal dynamics of forest ecosystems located in one of the most affected regions of Romania due the phenomenon of aridification, southern Oltenia. The analysis was possible using available cartographic and digital materials like: topographic maps, orthophotoplans and Corine Land Cover database. Thus, we used topographic maps of the area, 1981 edition, 1:25,000 scale, for extracting forest areas by vectorization / digitization, which is compared with the existing databases of the Corine Land Cover 2006 (European Environment Agency). For validation of the spatial information for forest areas delineated in the Corine Land Cover database, we consulted the 2008 edition orthophotoplans.

It was found that in the area of study the analyzed dynamics of forest ecosystems is not uniform in terms of space. Therefore the analysis was focused on three key areas of study, where forest dynamics proved to be the most intense. Also, the analysis of forest dynamics was pursued at the administrative level, namely at the level of the existing 113 administrative units in the region.

3. GENERAL ISSUES ABOUT THE STUDY AREA IN THE CONTEXT OF THE ARIDIFICATION PHENOMENON

Located in southwestern Romania (fig. 1), the study area overlaps for the most part with Oltenia Plain. The analyzed area, southern Oltenia, is bordered by the Danube to the West and South, Jiu in the East, and by Getic Plateau in the North and covers an area of 736723 ha, corresponding to 113 territorial-administrative units.

An important feature of the landscape in this region plays an essential role in emphasizing the impacts of the aridification phenomenon. The presence of sand dunes in large areas causes negative consequences for local water resources (Irena Mocanu et al., 2011), and thus for the socio-economic development. These dunes, fixed or mobile, have a maximum thickness of sand layer of 15-20 m and can be found near the Danube and Jiu terraces. The terraces represent the source of sand dunes of the region with elongated shape caused by the continuous action of deflation due to the winds with prevailing North-West and South-East directions (*Geografia României, volumul V*) (fig. 1). Some of these dunes are fixed mainly by forest vegetation and crops with key role in maintaining their position (vineyards). A primary cause of these mobile dunes is the forest ecosystems dynamics in the context of intense deforestation after the second half of the twentieth century.

In Romania, from the total area occupied by soils with sandy texture (330000 ha), 35% (approx. 116300 ha) are found in the study area, comprising the existing sand dunes (fig. 1). These sand dunes represent a very important disruptive element in the regional socio-economic development and a contributing factor to aridification in the area by reducing the water resources due to their high permeability.

Climate plays an essential role in increasing aridification by changing the parameters of local temperature and precipitation (rainfall tends to decrease and the average annual temperatures increase) (Dumitrașcu, 2006), due mostly to global climate changes. Another major cause of local changes with an increased role in the aridification phenomenon is the altered land use, especially after 1990 (Prăvălie & Sîrodoev, 2013).

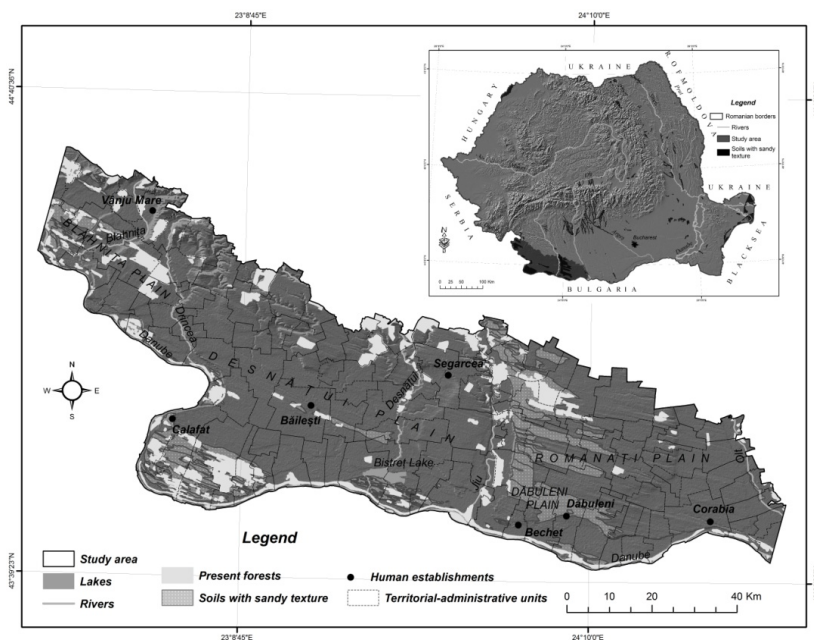


Fig. 1. Location of the southern Oltenia area in Romania (data processing geo-spatial.org)

The existing forest vegetation in the study area is a basic component in stabilizing sand dunes, in fighting the wind deflation, maintaining an optimal ecological balance and thus in reducing the negative effects of the phenomenon of aridification. In this sense, one notices the forest steppe area with the main species of *Quercus pubescens*, *Q. cerris*, *Q. frainetto* and *Q. pedunculiflora* (Pătroescu, 2005), and the broad-leaved forests area, on small spaces, in the North of the study area. Also, non-zonal forest vegetation represented by forests of acacia (*Robinia pseudoacacia*) is very important.

In the last century, massive acacia plantations were conducted in southern Oltenia, as they play an essential role in stabilizing sand dunes (Nuţă, 2005). Their emphasized dynamics after the second half of the twentieth century (especially after 1990), in areas heavily affected by wind deflation phenomena led to important local ecological, climatic, hydrological and social imbalances.

4 RESULTS AND DISCUSSIONS

Following the analysis of forest dynamics between 1981 and 2006, it was noticed a decrease in forests in the entire area by about 7%, from 62058 ha in 1981 to 57573 ha in 2006 respectively. Spatially, an unequal distribution of forest dynamics was noticed, as most of the missing 4485 ha are in areas with sand dunes. In this way, we have identified three main areas where the dynamics of forest areas was most evident (fig. 2): Jiana - Izvoarele, Ciuperceii Noi – Piscu Vechi and Dăbuleni – Apele Vii, which were analyzed as case studies.

In the first case study, the Jiana – Izvoarele area (fig. 3), we noticed a high negative dynamics of forest areas during nearly three decades. Between 1981 and 2006 large areas of forests have disappeared in Izvoarele village, to the South, North and North-West of it.

From the approximately 4500 ha of existing forest in the year 1981, one remarks a decline by 36% (1640 ha) in 2006. In terms of spatial dynamics, massive decreases of forest areas were observed to the North of Pătulele village, South-West of Jiana village (areas with extensive sand dunes) and North-West of Izvoarele village.

Regarding the main extinct species, generally one could notice acacia (*Robinia pseudoacacia*) and sometimes poplar (*Populus canescens*) hybrid species artificially introduced for the replacement of native species with low productivity, such as white poplar (*Populus alba*) and black poplar (*Populus nigra*) (Jiana Forest Arrangement, 1997). One noticed a slight decrease in the forests of *Quercus pedunculiflora* and *Quercus pubescens*, located South of Gogoșu village.

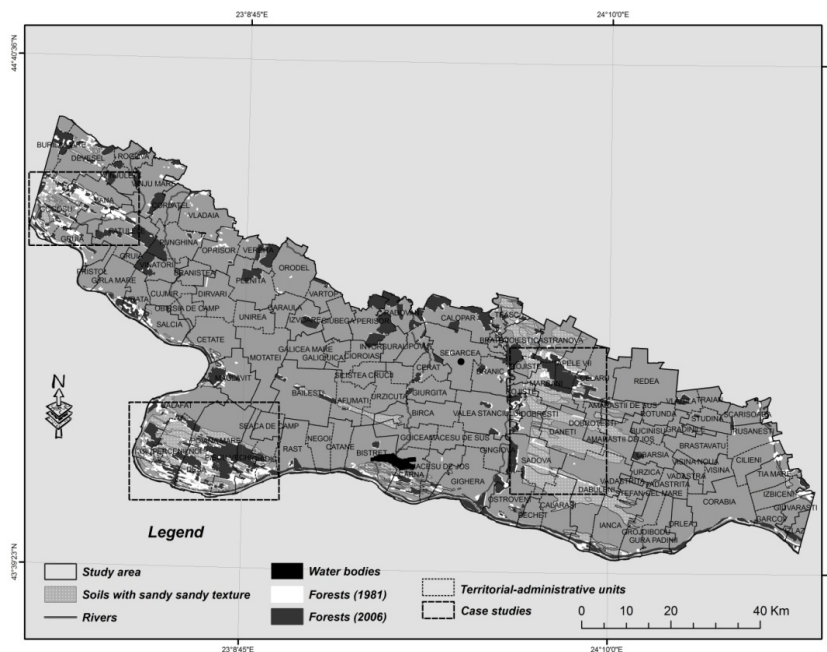


Fig. 2. Spatial delineation of areas with the most intense dynamics of forest areas between 1981 and 2006

The causes of area loss of forest ecosystems (acacia and poplar) are both anthropogenic and climatic. Deforestation carried out by authorized owners after restitution of lands covered by forests, based on the land fund law 18/1990, and their transformation either in agricultural lands or in abandoned fields, is one of the main causes of the disappearance of forest ecosystems in the region. Another major cause is represented by unfavorable climatic conditions, in this case the prolonged droughts during the last two decades (Dumitrașcu, 2006) with direct consequences on cutting works well over provisions in the local forest districts (Jiana Forest Arrangement, 1997).

In the case of poplar species, one noticed other secondary causes of their fading (and after cutting more than necessary by local forest districts) in the semi-endorheic interdune areas. With the upstream construction of Porțile de Fier II (Iron Gate II) hydropower works and the water balance changes (reductions in groundwater levels downstream) one observed poplar species drying out over large areas in sandy interdunes space (Șimian Forest Arrangement, 2010).

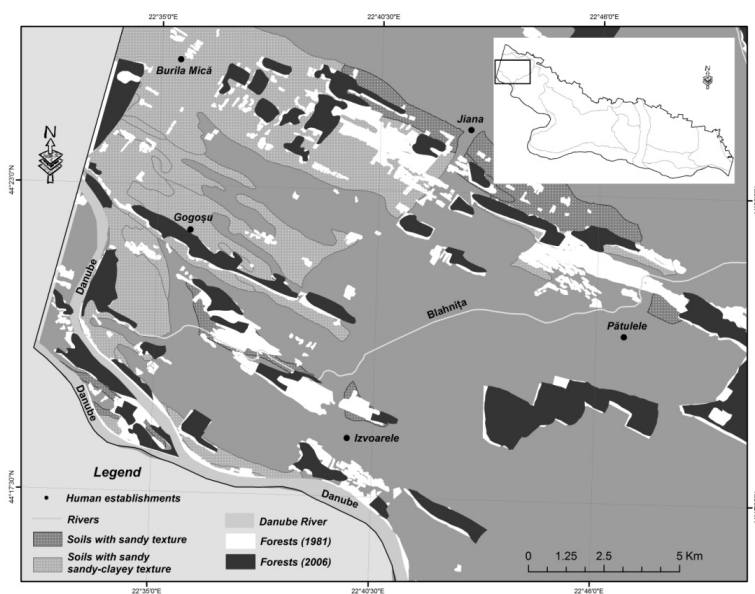


Fig. 3. Spatial and temporal dynamics of forest ecosystems in Jiana - Izvoarele area (1981-2006)

The second case study, Ciupercenii Noi – Piscu Vechi area (fig. 4) shows an accelerated dynamics of forest areas, especially South of Desa village, in the Danube floodplain sector. Generally, acacia prevails in this area, but also floodplain vegetation represented by species of willow (*Salix alba*) and poplar. In the analyzed period, one noticed a decline of about 1500 ha, from 12400 ha existing at the level of 1981 to 10880 ha in 2006. During the late nineteenth century, among the first acacia plantations in southern Oltenia were made in Ciuperceni – Desa area, because sand dunes in this area were a disaster for localities due to frequent sandstorms (Nuță, 2005). Since the second half of the twentieth century, in the context of political decisions to expand agricultural areas, much of acacia plantations have been deforested, later being partly replanted in order to restabilize the sand dunes (Dumitrașcu, 2006).

The analysis of the dynamics in 1981-2006 period highlighted the massive losses of forest areas, especially acacia and even poplar, due to anthropogenic (deforestation), climatic and hydrological causes. Prolonged droughts in the last three decades represented an important cause for the fading away of acacia species in large areas and after cuts well above the necessary in the local forest districts (Poiana Mare Forest Arrangement, 2004). Also, the lowering of the groundwater level when water

from the Danube withdrew from abandoned channels in Rast head area is another important cause of poplar species drying when located in sand interdunes space (Calafat Forest Arrangement, 2004).

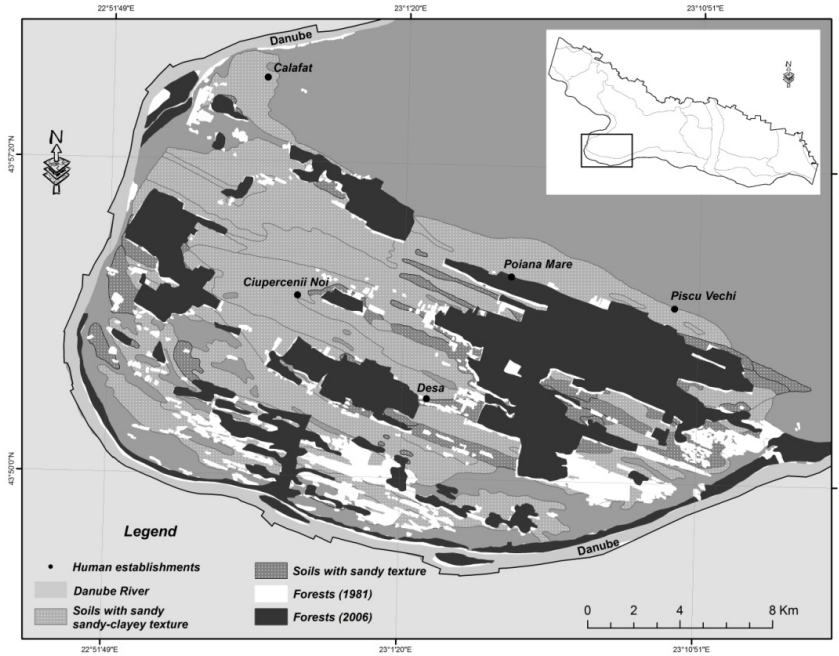


Fig. 4. Spatial and temporal dynamics of forest ecosystems in Ciuperceii Noi – Piscu Vechi area (1981-2006)

The last case study analyzed, the Dăbuleni - Marșani area (fig. 5), raises another problem of a different category in terms of the dynamics of forest areas. Although significant decreases in forest areas were not observed in this case except for some places in the Jiu floodplain (floodplain vegetation) and in Apele Vii village area (acacia plantations), however, an important issue is the fact that existing protective forest belts of this region largely disappeared, and the ones still existing today are in an advanced state of decay.

According to the diachronic analysis using the 1981 topographical map and the 2006 Corine Land Cover, one may observe the disappearance of protective forest belts, North and South of Sadova village and West of Amărăștii de Sus village (fig. 5). These forest belts were planted after 1974, after the deforestation of 5000 ha of acacia forest following the completion of Sadova - Corabia irrigation system between 1972 and 1974 (Sadova Forest Arrangement, 2003). Reactivation of sand dunes after the wide-ranging mentioned deforestation required the creation of extensive networks of forest belts, perpendicular to wind direction, with a total length of approximately 1600 km (Nuță, 2005). Although the layout direction of forest belts is generally North-South to fight against the West-East phenomenon of deflation, the spatial and temporal analysis of the

dynamics of the study area captures only a part of forest belts (those with large widths and North-West - South-East direction) (fig. 5) due to their reduced width (8-10 m) and the limited spatial resolution of the cartographic and digital materials used.

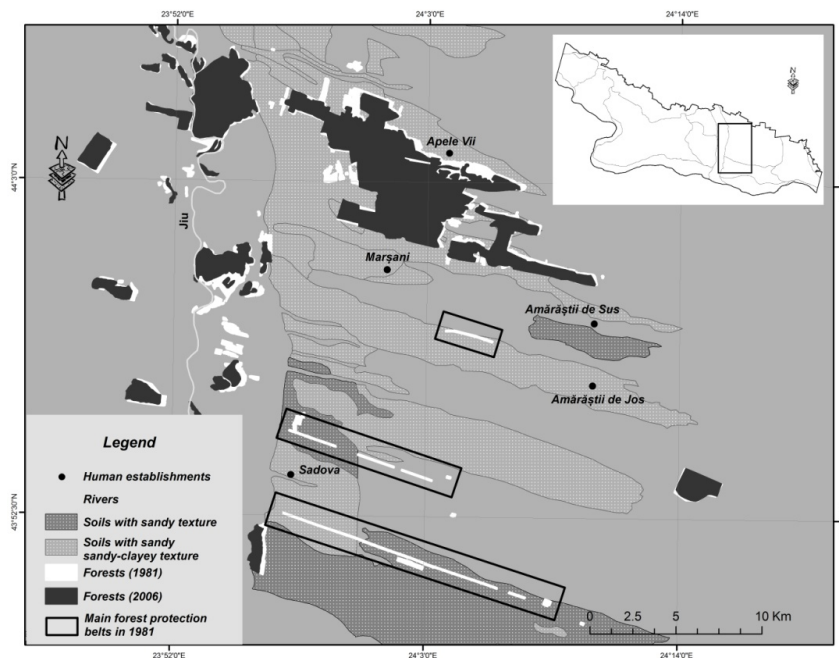


Fig. 5. Spatial and temporal dynamics of forest ecosystems in Dăbuleni – Apele Vii area (1981-2006)

According to some specialized studies, it has been found that during the last three decades (1979-2005) an area of 87% of forest belts was destroyed only in Dăbuleni village, respectively from 1125 ha in 1979 to 137 ha in 2005 (Achim *et al.*, 2012). Their disappearance is in part due to climatic stress conditions, but mostly due to illegal cutting which has led today to a real reactivation of sand dunes with adverse consequences on land degradation in the region (Ignat *et al.*, 2009).

The analysis of the dynamics of forest ecosystems at the level of the territorial-administrative units in the region reflects large regional differences (fig. 6). Of the total of 113 administrative units overlapping the analyzed area (fig. 2), 48% (54 municipalities) have recorded a decline in forest areas, while a rate of 21% (24 municipalities) did not record any dynamics because there were no forest areas in the two years of reference (as noticed, due the spatial resolution of the two sources, the topographical map and Corine Land Cover database).

The strongest negative change is noticed in the municipalities of Jiana (663 ha forest areas lost), Pătulele (540 ha), Vrața (463 ha), Desa (462 ha), Gogoșu (361 ha) and Piscu Vechi (350 ha) and irrational deforestation is the main cause. The situation is even more complicated considering that most mentioned municipalities correspond to areas with the largest sand deposits in southern Oltenia.

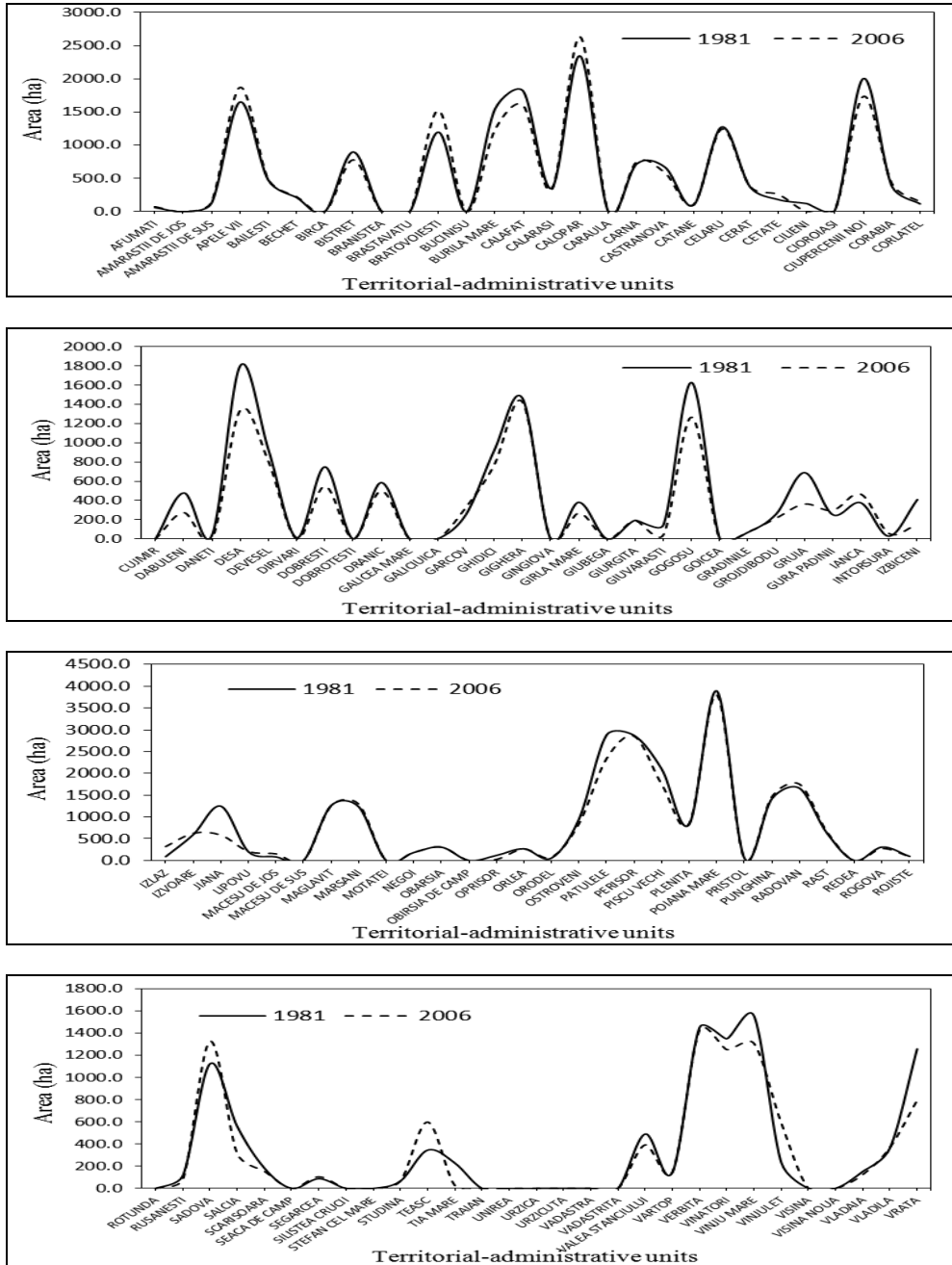


Fig. 6. Dynamics of forest areas (ha) in South Oltenia, at the level of the territorial-administrative units (1981 - 2006)

However, in 31% of the cases (35 municipalities), forest areas recorded a positive dynamics due to both the action of afforestation and the natural regeneration and expansion of some forest ecosystems, especially in the floodplain sectors of rivers. The greatest increase in forest areas (over 200 ha) was recorded in the municipalities of Apele Vii, Bratovoiești, Calopăr, Izlaz, Sadova, Teasc and Vinjuleț (fig. 6). In some of them a positive dynamics of forest ecosystems was recorded, especially in Jiu floodplain sector.

5 CONCLUSIONS

Maintaining forest ecosystems in southern Oltenia region is of vital importance as the study area is the most exposed to environmental imbalances at the national level. These imbalances are caused by the phenomenon of aridification which has become more pronounced in last decades. The analysis of spatio-temporal dynamics of forest ecosystems during the last three decades highlights important regional differences. We distinguished intense dynamics especially at the level of the most important key areas. These areas are represented by the case studies analyzed in this paper and require continuous forest cover on larger surfaces, in the context in which there are areas of sand dunes.

From the investigation, one has generally noticed a clear trend of decrease in forest ecosystems, even if growth in the forest areas was recorded in individual cases at the level of some territorial-administrative units. Most of the territorial-administrative units have recorded a decline in forest ecosystems. In some cases one noticed a drastic situation like in some municipalities located in sand dunes areas: Jiana, Gogoșu, Pătulele, Desa and Piscu Vechi, where total losses of forests in the analyzed period exceeded 2000 hectares (between 300 and 700 ha lost forest areas / administrative unit). An important issue is the situation of a large number of territorial-administrative units where forest ecosystems are completely lacking.

An emergency intervention of policy decisional factors is therefore necessary at both the level of national and local authorities. One of the most viable strategies to fight against environmental imbalances in the region is the afforestation of degraded lands with modern technologies, regardless of the ecological rehabilitation costs.

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