LITTORALIZATION AND BEHIND: ENVIRONMENTAL CHANGE IN MEDITERRANEAN CROATIA

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ABSTRACT

Mediterranean Croatia is a typical karst environment, with considerable human impact on landscape change. Coping with scarcity of water, soil and regular summer droughts, as main constraints related to Dalmatian karst, population has adopted pastoralism as the most adaptable economic activity and lifestyle throughout the centuries. Excessive pastoralism in the conditions of Mediterranean climate, thin soil cover and especially steep slopes eventually led to the deforestation.

However, abandoning of land due to the process of littoralization in the second half of 20th century, initiated the inverse process of natural succession and re-afforestation. For interior Mediterranean Croatia, the littoralization process means primarily the loss of population. Depopulation, at the other hand, reduces the environmental pressure. Thus, depopulation, abandoning of land, and dissolution of traditional lifestyle based primarily on pastoralism and localized tillage zones, start the natural process of succession and re-afforestation.

GIS modelling of environmental change based on different databases from 19th -21st century pointed to the main trends of landscape change as autochtonous deciduous forest *degradation* and *extensification*. The extensification is represented mainly by change of arable to degraded forest, to pasture or to deciduous forest, or change of pasture to degraded forest.

KEYWORDS: Mediterranean Croatia, littoralization, karst, environmental change, GIS modelling

RESUMÉ

La littoralisation et ses conséquences: les changements environnementaux en Croatie Méditerranéenne

La Croatie méditerranéenne est un environnement karstique typique, dans lequel existe une considérable influence anthropique sur le changement du paysage. Face à la pénurie d'eau, à la pauvreté du sol, et à la sécheresse estivale régulière, contraintes caractéristiques du karst dalmate, la population a adopté le pastoralisme/l'élevage comme mode de vie, comme activité économique la mieux adaptée à travers les siècles. Dans les conditions climatiques méditerranéennes, une mince couche de sol et des pentes raides, l'élevage excessif a finalement conduit à la déforestation.

Toutefois, l'abandon de terres agricoles, en raison de ce processus de littoralisation de la seconde moitié du 20e siècle, a lancé un processus inverse de succession naturelle et de reforestation.

En Croatie méditerranéenne intérieure, le processus de littoralisation implique d'abord une perte de population. Cette dépopulation, quant à elle, réduit la pression environnementale. Ainsi, le dépeuplement, l'abandon des terres, et la dissolution du mode de vie traditionnel basé essentiellement sur l'élevage et sur les zones d'agriculture localisées engagent le processus naturel de succession et de reforestation.

La modélisation SIG du changement environnemental, fondée sur différentes bases de données du 19e au 21e siècle, a mis en évidence les grandes tendances de l'évolution du paysage: la *dégradation* de la forêt de feuillus autochtone et *l'extensification*. L'extensification est principalement représentée par la transformation des zones agricoles en forêt dégradée, en pâturages ou en forêt de feuillus, ou par la transformation des pâturages en forêt dégradée.

MOTS-CLÉS : Méditerranée, Croatie, littoralisation, karst, changements environnementaux, modélisation SIG.

SPACE AND PROCESS

The research area is Mediterranean - Adriatic Croatia that is recently, in the last 50 years, affected by two processes, actually operating together, one behind the other. The process of littoralization took place in the seventies and brought economic and demographic progress and growth to the littoral zone. At the same time there is a demographic and economic decline in the rural hinterland, behind the process and space of littoralization.

There are, therefore, two synchronous, mutually induced and interlinked, but opposite processes, that are spatially and processually one behind the other. The process of littoralization is actually enabled by the population outflow from the rural hinterland.

It is obvious that such a massive population outflow, related, of course, with the abandoning of land and traditional livelihood and subsistence economy, highly affected the man-environment relation and thus initiated considerable environmental change.

Karst environment of Mediterranean Croatia is marked by rock permeability and scarcity of water and soil and restricted, highly localized arable, with regular summer droughts. Coping with these constraints throughout the centuries, population has adopted pastoralism as the most adaptable economic activity and lifestyle. Excessive pastoralism in the conditions of Mediterranean climate, thin soil cover and especially steep slopes eventually led to the deforestation. Narrative (travel accounts) and graphic (cadastral and cartographic) sources dating as early as 18th century, have documented the image of the Dalmatian karst hinterland as rocky, dry and desert land.

Abandoning of land due to the process of littoralization in the second half of 20th century, however initiated the inverse process of natural succession and re-afforestation. For interior Mediterranean Croatia, the littoralization process means primarily the loss of population. Population mostly permanently abandoned land and emigrated to the growing cities – working centers in the littoral zone. Thus, dissolution of traditional lifestyle based primarily on pastoralism and localized tillage zones in the karst hinterland, started the natural process of succession and re-afforestation.

Similar processes with regional differences around European Mediterranean have been addressed by a number of authors in comprehensive volumes of Armiero, M. (ed.) 2006, in Grove and Rackham's Ecological History of the Nature of Mediterranean Europe, 2001. The relation between vegetation and landscape change is particularly addressed in Mazzoleni, di Pasquale, Mulligan, di Martino and Rego (eds) 2005, while the land use change and desertification problem as a major environmental, economic and political problem in Mediterranean countries is discussed in Brandt and Thornes (eds) 1996. Antrop (1993) discusses the recent experience of observation the transformation of the Mediterranean landscapes. Hughes (2005) and Simmons (1998, 2008) have put these issues in the context of the overall environmental change in the Mediterranean. There are also a number of regional and local case studies from different regions of the Mediterranean that cannot be all listed. The Croatian context of environmental and landscape change related to the processes of deforestation/re-afforestation of the Mediterranean – Adriatic region is addressed primarily by Fuerst-Bjeliš and associates (2003, Fuerst-Bjeliš et al., 2003;Fuerst-Bjeliš, Lozić, 2006;

Fuerst-Bjeliš, Zupanc, 2007; Fuerst-Bjeliš et al., 2011) , and recently Čuka (2010) and Durbešić (2012).

SOURCES AND METHOD

Tracing the environmental change of Mediterranean Croatia is based on the GIS analysis of a number of sources, different in character and different in relation to their origin. They include narrative sources (travel accounts), cadastral documents, topographical maps and satellite images. The availability of sources has determined both – the temporal, as well as spatial frame of the research. The initial period of research, based on the old cadastral survey data and travel accounts, goes back to 18^{th} – 19^{th} centuries. Following comparative periods in monitoring the environmental change are transitional period from 1975 to 1979 and recent period from 2004 to 2010, based primarily on recent databases such as topographical maps, satellite images and forestry databases. The transitional period of seventies is very important due to the strong population shifts in Mediterranean Croatia those years, as a consequence of the process of littoralization.

The original documents are available in the State Archives of Split and Zadar, Map Archives of Istria and Dalmatia, in the Institute for Adriatic Crops and Karst Reclamation and Hrvatske šume (*Croatian Forests*) databases, in CORINE Land Cover Croatia database. Bringing together so many different sources and databases required highly demanding process of unifying and leveling the categories of land use throughout the centuries and corresponding survey methodologies.

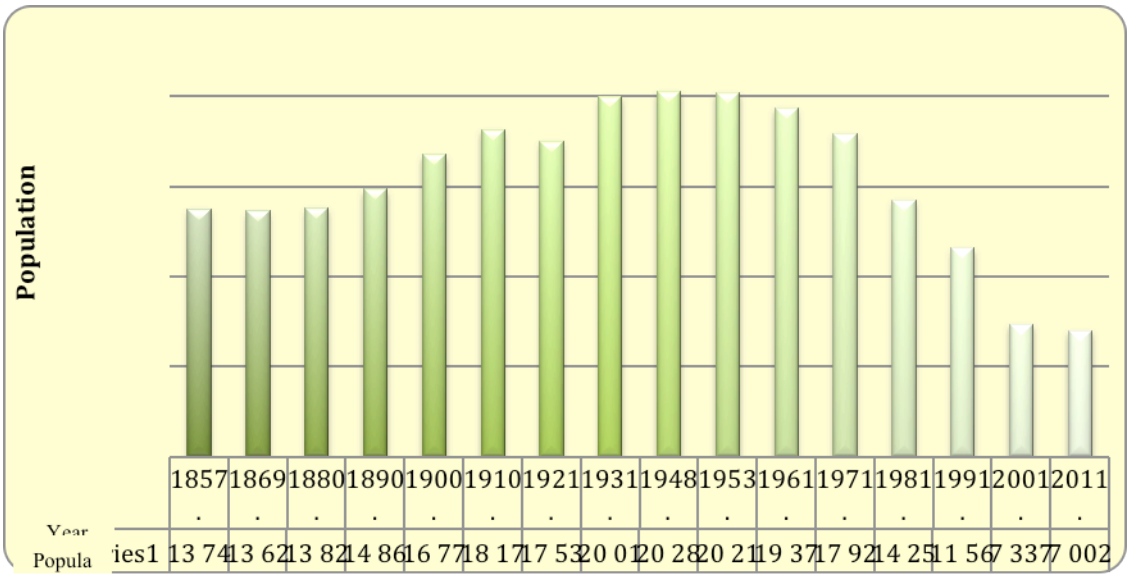
The GIS model of landscape change is organized around three levels: 1. Definition of landscape types, 2. Definition of landscape change types and 3. Definition of landscape change trends. Land cover has been the main criterion used in classification of the landscape types.

RESULTS AND DISCUSSION

Overall results show the importance of human impact in landscape change, both in the processes of degradation, deforestation, as well as re-afforestation, due to the depopulation and rural exodus, and in the process of deliberate reclamation and protection of previously degraded and eroded slopes.

The area of research refers to the interior part of the Mediterranean Croatia - Dalmatia, represented by two different types of karst environments: dry rocky lowland and mountain Svilaja slopes, as more humid type of the environment.

The population of the mountain area (fig.1) have drop down to the half of the number recorded by the first official population census in 1857. Still, the population decrease was not a constant process. Very well inhabited area of Dalmatian hinterland in the early modern period, with numerous patronymic settlements, high average family size of 9 -10 members (Friganović, 1961; Fuerst-Bjeliš, 2003; Matas, 1993) and strong agricultural base enabled the subsequent rise of the population till the second half of the 20th century. Industrialization and consequently the complex process of littoralization in the littoral cities taking place from 1961 to 1981 are considered as main causes of demographic decline in the hinterland (Faričić, 2011; Friganović,1990; Fuerst-Bjeliš *et al*, 2011). In the period from the census years of 1953 to 2011, the population of mountain Svilaja slope in central Dalmatian hinterland has drop down to one third. The research has shown that such a massive population decrease coincides with the deep environmental and landscape change.



Source: Durbešić, A., 2012.

Fig.1. General population trend 1857-2011, Mountain Svilaja slope, central Dalmatian hinterland

DRY LOWLAND KARST

The case study of dry lowland karst area of the Dalmatian hinterland was based on the comparative analysis of the Grimani cadastral records from the 18th century and recent databases dating from the turn of the 20th and 21st centuries, such as topographical survey (1:25 000), satellite images and forestry data for the locality of *Mirillovich Zagora* (table 1). Results have shown the absolute prevalence of pasture ("*pascolo*") in the share of 86% of

total research area in the 18th century. The rest of the area, apart from the arable, was rocky karst (12%).

Table 1 - Environmental structure of dry lowland karst of *Mirillovich Zagora*, central Dalmatian hinterland, 18.th century

Environmental feature	**Share in %**
Pasture	86
Mountain	1
Rocky karst	12
Other	1

Source: Fuerst-Bjeliš, 2003; Fuerst-Bjeliš, Zupanc, 2007

The comparative data for the turn of the 20th and 21st centuries enabled an insight into the process of massive re-afforestation. The main environmental feature at the beginning of 21st century (table 2) are various types of degraded forest, such as *macchia* and *guarrigue*, in the same share as pastures were 250 years ago (86%). Degraded forest have spread all over the area and covered almost equally both, the arable and pastures, that clearly points to the depopulation, abandoning of land and the dissolution of traditional lifestyle (Fuerst-Bjeliš, 2003; Fuerst-Bjeliš and Zupanc, 2007; Fuerst-Bjeliš *et al*., 2011).

Table 2 - Vegetation structure of dry lowland karst of *Mirillovich Zagora*, central Dalmatian hinterland, 21.st century

Vegetation type	**Surface (ha)**	**Surface share (%)**
Forest	85,21	1,62
Macchia	3456,84	65,77
Guarrigue	1103,06	20,99
Pasture	610,70	11,62
Total	5255,81	100,00

Source: Forestry database 2010, Hrvatske šume, d.o.o.

SVILAJA MOUNTAIN SLOPE

More detailed case study of Svilaja mountain slopes shows similar trend of environmental change. Study is based on a number of different sources, the oldest being the cadastral documentation from the 19th century, including recent data, such as topographical survey maps (1:25 000), Institute for Adriatic Crops and Karst Reclamation, CORINE Land Cover Croatia and Croatian Forestry databases, as well as satellite images (Durbešić, 2012).

Main environmental feature of the 19th century Svilaja mountain (table 3), in the circumstances of prevailing pastoralism, are pastures (67%). Taking into consideration that mountain is kind of a „humid island" in generally very dry area of Dalmatian hinterland, the fact that there is a considerable share of autochthonous deciduous forest (17,3%) in the environmental structure is not surprising. By the turn of the 20th – 21st century, the majority of the area covered by pastures and mountain deciduous forest has been reduced and replaced primarily by various forms of degraded forest (*macchia, garrigue*).

Table 3 - Overall landscape change by main landscape types, Svilaja mountain, central Dalmatian hinterland: 1830 – 2010

Landscape type	**1830 - 1848**	**1975**	**2004-2010**
Pasture	67,04	39,45	36,01
Deciduous forest	17,32	15,34	11,40
Arable	14,18	14,30	8,80
Vineyard	0,33	0	0
Macchia/guarrigue	0	28,41	35,08
Coniferous forest	0	2,46	7,16

Source: Durbešić, A., 2012.

Apart from the dominant process of deciduous forest degradation i.e. transition to macchia, guarrigue and pasture, the analysis has shown locally different process of forest spreading. The mountain top area, as it has been mined during the Croatian Independence War in nineties, has not undergone any other human impact, which eventually resulted in spreading the deciduous forests on the expense of pastures. Moreover, the analysis recorded the local introduction and spread of non-autochthonous coniferous forest due to the reclamation process of highly eroded slopes in order to recover the soil cover.

Arable as a landscape type remained mainly on the better quality red soils in the areas of karst poljes (Petrovo and Mućko polje), while almost half of the arable area of the

mountain slopes has gone through the extensification and transition to macchia, guarrigue and pasture.

Grape growing and managing vineyards as landscape type require intensive human work. Considering the massive depopulation taking place in the second half of the 20th century, the complete disappearance of vineyards as landscape type, recorded and defined in earlier research periods is not at all a surprising consequence, though it is a serious damage to the cultural landscape.

LANDSCAPE CHANGE TRENDS

GIS modeling of environmental change based on different databases from 19th -21st century pointed to the main trends of landscape change (Durbešić, 2012). The main trend in landscape change is defined as extensification and transition to macchia, guarrigue and pasture (table 4).

Table 4 - General landscape change trends, Svilaja mountain, central Dalmatian hinterland.

General landscape change trends	Area (ha)	Share in the total area (%)
NO CHANGE	10.592,82	39,38
RECLAMATION	1.560,03	7,16
EXTENSIFICATION	10.067,71	37,43
DEGRADATION	3.540,44	13,16
INTENSIFICATION	698,13	2,60
DISSAPEARANCE	68,87	0,26
Water courses, settlements, excavations...	371,82	1,39
TOTAL	26.899,81	100,00

Source: Durbešić, A., 2012.

Half of the whole area of research can be defined by *extensification* (37%) and autochthonous deciduous forest *degradation* (13%) in environmental and landscape change. Dominant trend in more than 65% of deciduous forests is transition to degraded types of forests, i.e. macchia, guarrigue and pasture.

The examples of extensification trends are change of arable to degraded forest, to pasture or to deciduous forest, or change of pasture to degraded forest. These trends cannot be classified as positive or as negative *per se*, however they are the reflection of negative demographic trends developing behind the process of littoralization. The research has also revealed the trend of *disappearance* of the vineyards as landscape type, recorded and defined in earlier research periods.

One of the trends of environmental change is defined as *reclamation* of previously highly degraded and eroded areas. The primary autochthonous deciduous forest has been replaced by coniferous forest. Further development will eventually lead to soil recovery and spontaneous introduction of autochthonous deciduous vegetation, and stop the erosional processes and flooding.

The change of pastures to arable is defined as *intensification* trend. In accordance to the aforesaid depopulation process, the share of intensification trend (2.6%) is highly localized and rather negligible.

Around 39% of the total area has not undergone any landscape change. The environmental stability mainly refers to the peak area that is additionally under no human impact since it is mined area from the last war in nineties (table 5).

Table 5 - Prevailing general landscape structure in central Dalmatian hinterland, 21st century

AREA	**PREVAILING LANDSCAPE**	**TYPE**	**(%)**
	Degraded forest: macchia/ guarrigue	Pasture	Total
Dry lowland area (M. Zagora)	86,8	11,6	98,4
Mountain Svilaja	35,1	36,0	71,1

Source: Fuerst-Bjeliš, 2003; Fuerst-Bjeliš *et a*l., 2011, Durbešić, 2012.

As both dominant trends, degradation, as well as extensification lead to the increase of the areas of degraded forest, the abundance of dry burning material also inevitably leads to the increase of fire risk potential. While in the 19th century moderate fire risk prevailed at more than 80% of the whole territory, more than 50% of the territory was under the great risk in the seventies. At the beginning of 21st century, areas under the extreme fire risk are introduced and rising up.

CONCLUSIONS

The main turning point in recent environmental change of Mediterranean Croatia is related to the strong population shift around seventies as a direct consequence of the process of littoralization. Behind the economic and demographic growth of the littoral, there is population and economic decline in the hinterland, leading to considerable environmental change, mostly defined by the processes of extensification and re-afforestation. Environmental change is just a loop in a chain reaction. Littoralization induced depopulation,

depopulation caused the abandoning of land a disappearance of traditional lifestyle based primarily on pastoralism, and change in traditional lifestyle reduced the environmental pressure and initiated the natural succession. Although there are negative socio-demographic processes behind the process of re-afforestation, the re-afforestation *per se* is not negative, especially in the previously highly degraded and eroded areas. However, the analysis pointed out to the serious problem of disappearance of traditional landscape types, such as vineyards, that are a severe damage to the cultural landscape and traditional cultural values of the space.

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