MORIĆ-ŠPANIĆ, Antonio; FUERST-BJELIŠ , Borna (2017). *The GIS Model for the revitalization of traditional island cultures: the Island…*
The Overarching Issues of the European Space: Society, Economy and Heritage in a Scenario … Porto: FLUP, pp. 374-392

THE GIS MODEL FOR THE REVITALISATION OF TRADITIONAL ISLAND CULTURES: THE ISLAND OF HVAR, CROATIA

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Abstract

During the last hundred years, the planting of grape vines and olive trees on the Croatian Mediterranean islands have been many times reduced due to the population outflow and deagrarisation. (re)activation of overgrown agricultural land with traditional island cultivates would prevent the further spread of maquis, contribute to the increased branding of indigenous products and also help in the general development of rural zones on the island, severely affected by depopulation. Using the GIS tools to integrate various relevant databases and spatial parameters for each cultivate (vine, olive, lavender), a spatial model has been created for the (re)activation of the potentially most suitable land areas. In regard to the total area of the abandoned and overgrown agricultural land, spatial modelling has indicated the possibility of potential (re)activation of its 66%.The case study was carried out on the Central Dalmatian island of Hvar, in the Mediterranean Croatia.

Keywords: GIS, island of Hvar, Croatia, lavender, Mediterranean landscape, traditional Meditarranean crops, deagrarisation.

Résumé

Les plantations de cultures traditionnelles, de vignobles et d'olives sur les îles du bassin méditerranéen ont fortement diminué ces cent dernières années à cause de l'exode massif de leur population et suite à la désagrarisation. La (ré)activation de terres agricoles envahies par la végétation grâce à des cultures insulaires traditionnelles permettrait de stopper la progression du maquis, contribuerait au renforcement de la labellisation des produits autochtones de ces îles et, plus généralement, au développement des zones rurales insulaires fortement touchées par la dépopulation. Par l'utilisation d'outils SIG dans l'intégration de diverses bases de données appropriées et par l'application de paramètres de configuration spatiale pour chacune des cultures (vigne, olives, lavande), un modèle d'agencement de l'espace a pu être établi pour la (ré)activation des terrains potentiellement les plus favorables pour chaque culture. Une telle modélisation de l'espace agricole a montré une (ré)activation potentielle possible pour 66 % des terrains en friche et/ou envahis par une végétation sauvage. Cette recherche a été conduite en Croatie méditerranéenne, sur l'île de Hvar en Dalmatie centrale.

Mots-Clés: SIG, île de Hvar, Croatie, lavande, paysage méditerranéen, cultures méditerranéennes traditionnelles, désagrarisation

1. Introduction

The rural Mediterranean landscape from the mid-20th century has experienced a very high degree of vulnerability. Direct spatial consequences are most apparent when studying the changes that occurred in the ways of using the landscapes. During the last decades, the main driver of economic development in the Mediterranean area has been tourism, and the results of this shift are obvious when one examines the neglect, as well as the careless attitude towards the agricultural areas. The maintenance of traditional Mediterranean agricultures marks in a particular way an island life style that is closely linked to nature, and which is an important creative element of the island's unique identity. Deagrarisation and orientation towards tertiary and quaternary economic activities had a very high influence on the alteration of spatial perspectives in regard to Mediterranean rural and primarily island zones. During the last hundred years, the planting of grape vines and olive trees on the Mediterranean islands have been many times reduced.

During the last 30 years, many studies on changes in the Mediterranean environment were carried out, based on the methodological concept of land use (Antrop, 1993; Aretano et al., 2013; Serra et al., 2008). Aničić et al. (2007) and Hrdalo et al. (2008) dealt with the revitalisation and the typology of agricultural landscapes in Croatia. A. Čuka (2010) analysed changes in the landscape of the island Pag, and linked them to significant socio-demographic shifts and processes. A. Durbešić (2012) analysed changes, typologies and transformation trends in the landscape along the southern slopes of the Svilaja mountain range, by recording and applying analytical GIS models relating to the modification of spatial data. Based on an analysis of cadastral, cartographic and narrative sources, dating from the last 250 years, Fuerst-Bjeliš and co-authors described various changes in the Mediterranean environment and rural landscape in the Dalmatian hinterland (Fuerst, Bjeliš et al., 2011; Fuerst-Bjeliš and Durbešić, 2013; Durbešić and Fuerst-Bjeliš, 2016). These studies have confirmed a major connection between littoralization on the one hand and population reduction in rural areas within the hinterland, which is also true for islands, on the other hand. Population outflow generates a chain development, involving the abandonment of traditional subsistence activities, farming and animal husbandry, and the initiation of a process of vegetation succession, bringing about changes in the traditional landscape, including even the loss of certain types, e.g. vineyards (Fuerst-Bjeliš and Durbešić, 2013; Durbešić and Fuerst-Bjeliš, 2016). Studies that examined environmental shifts and the impact on traditional island crops on Greek islands are of importance (Bevan and Conolly, 2011; Kizos et al., 2010; Kizos and Koulouri, 2006; Kizos and Spilanis, 2004; Van der Sluis et al., 2014). As was shown, cultivation and the production of traditional agricultural crops on Greek, Italian and Spanish islands in the Mediterranean mainly followed vital market trends in accord with local tourist offers, whereas agricultural production in the

Mediterranean island area of Croatia is to a great degree behind the results of neighbouring countries. One of the representative examples of these noted spatial processes is the island of Hvar, located in the Croatian Mediterranean region of Central Dalmatia.

A few initial hypotheses have served to motivate this research on the possibilities and the potential localities for the revitalisation of traditional island cultures (especially vines, olive trees and lavender). The agricultural capacities of islands, together with their ideal pedoclimatic conditions, are an important economic resource for the development of ecological agriculture. Their (re)activation would reduce the extension of degraded forest areas and the consequential disappearance of various types of traditional landscapes. The reactivation of agricultural capacity as well as the revitalisation of traditional Mediterranean island crops would, at the same time, also have potentially strong socio-demographic implications, in terms of stopping the outflow of the island populations, strengthening the subsistence basis of such populations, and complementing the existing island economies orientated towards tourism.

The main goal of this study is to construct a model of the potentially most suitable localities for the revitalisation of traditional island cultures. Since the use of GIS application tools in geo-ecological spatial analysis has a very excessive level of application, the capabilities of GIS technology were precisely the basis for this modelling. The main tasks, prior to the modelling, were the reconstruction and the interpretation of the intensity of environmental changes during the last forty years, as well as the definition of the typology and the dominant trends that changed the island's landscape. Based on the identified changes in the landscape and in land use, and likewise on a complex analysis of specific requirements of the given traditional island cultivates *vis-à-vis* the soil, slopes and expositions, the potentially most suitable zones for the revitalisation of each observed vanishing traditional island crop were modelled.

2. The Research Area

The area of research is the Hvar island group, with a total area of 313.82 km^2 (31,382.09 hectares), which in addition to the central key island of Hvar (298.04 km^2) includes a group of smaller surrounding islands, islets and rock formations. It is located in the central part of the eastern Adriatic maritime zone, or in other words in the Croatian Mediterranean. Hvar, with a length of 68 km from east to west, is the longest island in the Adriatic (Figure 1).

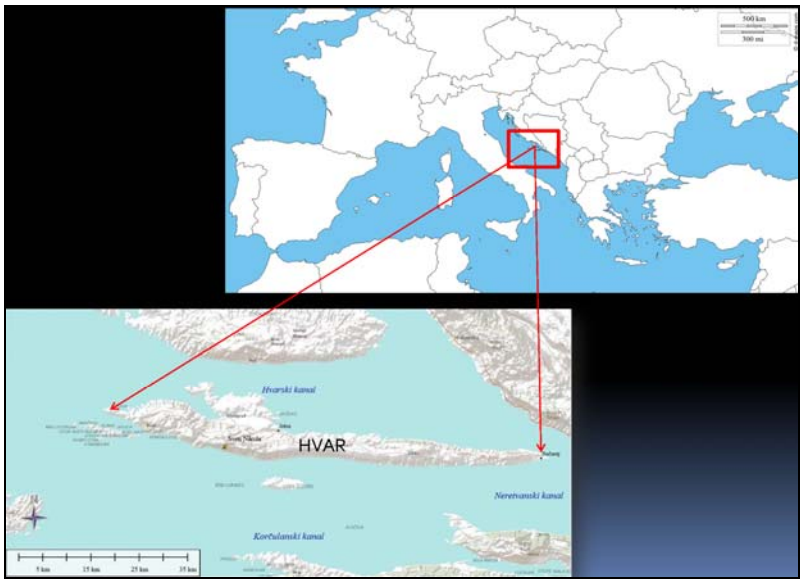

Figure 1 - Research area.

2.1. Environmental setting

The island of Hvar is, in line with its climatic-ecological characteristics, part of the Mediterranean region. According to Köppen's classification of climate, the largest overall area of the island has a Mediterranean type of climate with dry and hot summers (*Csa*), and only the highest parts of the island, the biotopes of the black pine (*Pinus nigra var. dalmatica*), have a Mediterranean type of climate with dry and warm summers (*Csb*). The average air temperature in January is 8.6°C, and in July 23.4°C. Hvar has a yearly average of 2,722 sunshine hours. Its average overall yearly level of rainfall is 788.7 mm, with a maximum in November and December, which is typical for maritime types of annual precipitation (Maradin, 2008). The amount of rainfall on the island varies: 750 mm in the west, increasing to up to 1300 mm in the east.

Climatic conditions caused the development of typical island vegetation. Yet the original vegetation cover of the island of Hvar[1] was altered by human influences dating back to antiquity. Biogeographical research indicated that anthropogenic modification and degradation of the original forms of vegetation began along the Adriatic coast about 2,800 years ago (Trinajstić, 1977). In addition to wildfire, the most destructive form of deforestation, the island's forests were most often destroyed by daily cutting needs for firewood, for the construction of dwellings and for agricultural

[1]Among the central Dalmatian islands, Hvar stands out due to the largest number of plant species – with an overall number of 1,163, which is more than the total number of plant species in countries such as Ireland or Denmark.

tools. Many of the forests on the island were cleared when the price of Dalmatian wine increased, as a result of the *Phylloxera* grapevine epidemic in France.

The island's surface area is, for the most part, included in the Stenomediterranean and Eumediterranean vegetation zone, with evergreen oak (*Quercus ilex*), Dalmatian black pine (*Pinus nigra var. dalmatica*) and Aleppo pine (*Pinus halepensis Mill*.) forests. Due to the degradation of these forest types a climatogenic lower level vegetation group developed: maquis shrubland. Further degradation of the maquis brought about the shrubland type known as garrigue.

Climatic characteristics, apart from influencing the composition of vegetation, created conditions for the growth and cultivation of traditional Mediterranean island crops: grapes, olives and medicinal and aromatic plants.

2.2. Socio-environmental context

Population, as the most important factor influencing environmental changes, is a fundamental natural resource and constitutes the basis for all regional, economic, social and other planning (Šterc and Komušanac, 2012). Almost all small Mediterranean islands, except those in the Balearic Archipelago, are characterized by lower levels of development in relation to the national territories of the countries to which they belong (Conti and Segre, 1998), and these economic results directly affect the demographic picture. Small Mediterranean islands, including the Dalmatian ones, in the previous century underwent persistent population decline, and some suffered total demographic extinction.

The Dalmatian islands recorded their demographic maximum at the beginning of the 20th century. The main cause for this was a culmination in the development of viticulture and in the production and export of wine in Austria-Hungary, at that time. The onset of the *Phylloxera* grapevine epidemic in 1894 brought about mass emigration of the island populations, and a rapid decline in the number of inhabitants on the Dalmatian islands. In the 1920's and 1930's, the islanders emigrated mostly overseas[2].Afterwards, immediately after World War II, they migrated to larger cities along the coast and in the interior of the Croatian Republic (Split, Rijeka, Zagreb), and later to more developed European countries.

Social and economic development on the Croatian islands after World War II significantly differed from developments on other Mediterranean islands. The Croatian islands were the only ones that remained within the socialism system[3]; they were the only ones that also experienced rapid industrialization, the concentration of their rural populations in several cities, insensitive broad

[2]Although not in a large number to the United States, due to a new US immigration regulation which restricted immigration from Mediterranean and Eastern European countries.
[3]Excluding, of course, the very small and mostly unpopulated Adriatic islands in Albania.

economic policy actions and socialist corporations as practically the only forms of economic organization[4].

During the 1960's enhanced population reduction was not just caused by long-term and intensive emigration, but by the fact that the islands, for the first time, experienced natural decrease rates (more deaths than births), which is a current trend today on almost all the Dalmatian islands. After World War II the islands closer to the coast were losing population at an annual rate of -0.6%, and more distant, outlying islands at a rate of -2.4%, and therefore the population of the outer islands split in half (Conti and Segre, 1998). According to the 2011 census of the Republic of Croatian, approximately 88,000 inhabitants lived on the country's 41 inhabited islands in the Adriatic (Morić-Španić, 2015).

Population pressure on the environment of the island of Hvar varied considerably during the past 150 years, from the time of the first official census in 1857. Hvar, with its 11,077 inhabitants, according to the 2011 census, is today one of the most inhabited Croatian islands[5].

Growth of the number of inhabitants on the island of Hvar in all of the island's settlements, except in the town of Hvar, has been cohesive, with a similar population trend (Figure. 2). From the first census in 1857 to the year 1900 the island's population continuously increased, which resulted in the highest number of island inhabitants (18,091 people). Due to the occurrence of grapevine disease, the population of the island's settlements rapidly declined in the period between 1900 and 1910, with an average annual rate of -0.70. Because of further continuous decline, in 1961 the island's population was already 30% lessened in comparison to its peak in 1900. Grapevine disease and the deterioration of agricultural activities, as well as the additional effects of war misfortune (suffering due to war), became a kind of "catalyst" for emigration abroad, mainly to South America (Antić, 1991).

Due to increased littoralization of economic and social activities, mainly the development of mass beach tourism, from 1961 inner (non-coastal) island villages with a rural character, experienced a more intense population drop than the island as a whole. During the last 50 years, two island settlements (out of a total of 27), namely Malo Grablje and Humac located in the interior of the island, completely lost their inhabitants.

In 2011, the population density of the island amounted to 35.3 inhabitants / km^2, and the ratio of old to young inhabitants was extremely negative (21.5% vis-à-vis 13.0%). These negative indicators have an explicit effect on the employment (and reproduction) potential of the island, and this is also indirectly manifested by the present state of the island's land use.

[4]National Programme for Island Development, 1997 (*Nacionalni program razvitka otoka*)
[5]The most densily inhabited Croatian island is the Island of Krk (19,383 inhabitants).

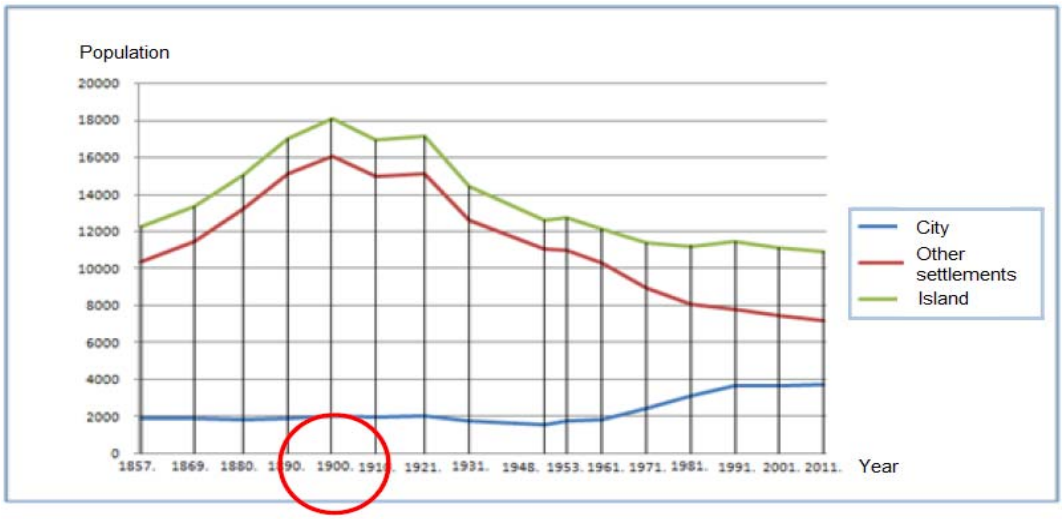

Figure 2 - General population trend 1857–2011; island of Hvar, city of Hvar and other rural settlements
Source: Population Census. *Naselja i stanovništvo RH 1857–2001.Državni zavod za statistiku, Zagreb, 2005.*

The direct consequences of population loss in rural and agricultural areas are abandoned land, the disappearance of traditional subsistence activities – farming and animal husbandry, the departure of traditional crops, the start of a process of vegetation succession and change, and even the loss of traditional cultural landscapes (Fuerst-Bjeliš and Durbešić, 2013). The causes of this process are multiple and complex. Island regions are socio-environmental systems particularly sensitive to all changes within or outside the systems themselves. The primary trigger, on Hvar, that started this chain process was the grapevine epidemic, which during the specified period of economic growth demolished the entire structure of the island system. This collapsed and weakened system later received outside effects from the littoralization procedure along on the coast, but also from the inside island structure, where particularly fragile internal settlements, without population strength, remained detached from the new trends oriented towards tourism.

Looking through the prism of marginalisation studies, islands are potentially marginal zones, since they are subject to multiple factors within the marginalisation process. The most important factor is geometric (or spatial) marginalization (Leimgruber 2004; Déry, et al., 2012), due to greater or lesser distances and weaker connections to the coast, as well as between the islands themselves. Based on various results, research clearly confirmed that external, distant islands, experienced a much higher rate of population decline. Similarly, this is obvious also on the level of each island itself; internal settlements are much more empty, because they are not within the main development trends, which are located in the coastal areas of the islands. Yet these tendencies likewise point to another type of marginalization – and this is processual marginalization. It occurs in circumstances when the local framework, in this case the island, is integrated into a new and

different system, while it still lacks the means to suitably adapt to the new functioning conditions (Leimgruber 2004; Déry, et al., 2012). This is often associated with new market conditions. Hence, in our case, what happened would have been that the local island milieu, as a sensitive socio-environmental system, failed to adapt adequately to the new market circumstances that were imposed after the grapevine epidemic destroyed viticulture as a positive economic activity. Instead of adaptation to new conditions, emigration occured.

3. Data and Methods

During the entire research procedure, GIS tools were used to interpret, classify and visualise spatial contents, to depict the status and trends of environmental changes and their typology, as well as to analyse the island's agricultural capacity. In addition, by integrating multiple databases into GIS, the potentially most suitable surface areas for the revitalisation of traditional island cultivates were modelled. For this purpose, different databases were used, which were necessary in order to analyse changes in the environment and in landscape types, to determine trends towards changes and to model zones for the revitalisation of traditional island crop cultures.

The time-frame of this comparative analysis of landscape structures extends from the year 1975 to the year 2011. Basic data on the land use in 1975 were obtained by vectoring the *Forest-vegetation map of the island of Hvar* (scale 1: 50,000)[6]. Land use and land cover data pertaining to the island at the beginning of the 21st century was derived as the result of a multifactorial overlapping effort involving three databases. Data from the public company *Croatian Forests*[7] (2002) and also from the landscape databases of *CORINE Land Cover* (2000) was corrected and modified using digital orthophoto images of the island in 2011[8]. Unifying the designations and the categorisation of land use types in 1975 and in 2011 enabled further spatial analysis through the definition of landscape typology and of trends leading to changes.

For the purposes of modelling, lithological and pedological data was, first of all, vectored (Marinčić, 1995, Bogunović, 1995). By using the raster layer *Digital Elevation Model* (ASTER GDEM) a hypsometric map of the island was made, a map displaying relief profiles as well as maps showing inclinations and exposures of slopes. Through the integration of these databases into GIS, information was obtained on the potentially most suitable areas for each traditional cultivate: for grapevines, olives and lavender.

[6]Institute for Adriatic Crops and Karst Reclamation (*Institut za jadranske kulture imelioraciju krša*) in Split.
[7]*Hrvatske šume*.
[8]State Geodetic Directorate (*Državna geodetska uprava*).

4. Results and Discussion

4.1. Land use and landscape change

In order to determine the typology of the landscape, and to make a comparative analysis of the different periods so that the trend leading to changes could be deduced, it was necessary to categorize, systematize and unify the land use categories from different periods of time (1975 and 2011). Five basic types and four subtypes of landscape were allocated on the island territory of Hvar (Figures 3 and 4).

The **coniferous forest** landscape type includes the region of the Aleppo pine (*Pinus halepensis Mill*.) forest and the forest of Dalmatian black pine (*Pinus nigra var. dalmatica*), present during the two studied time periods. In the initial period (1975) the coniferous forest covered more than 26% of the examined area of the island, but today this percentage amounts to only 16.48% of the studied area (Table 1).

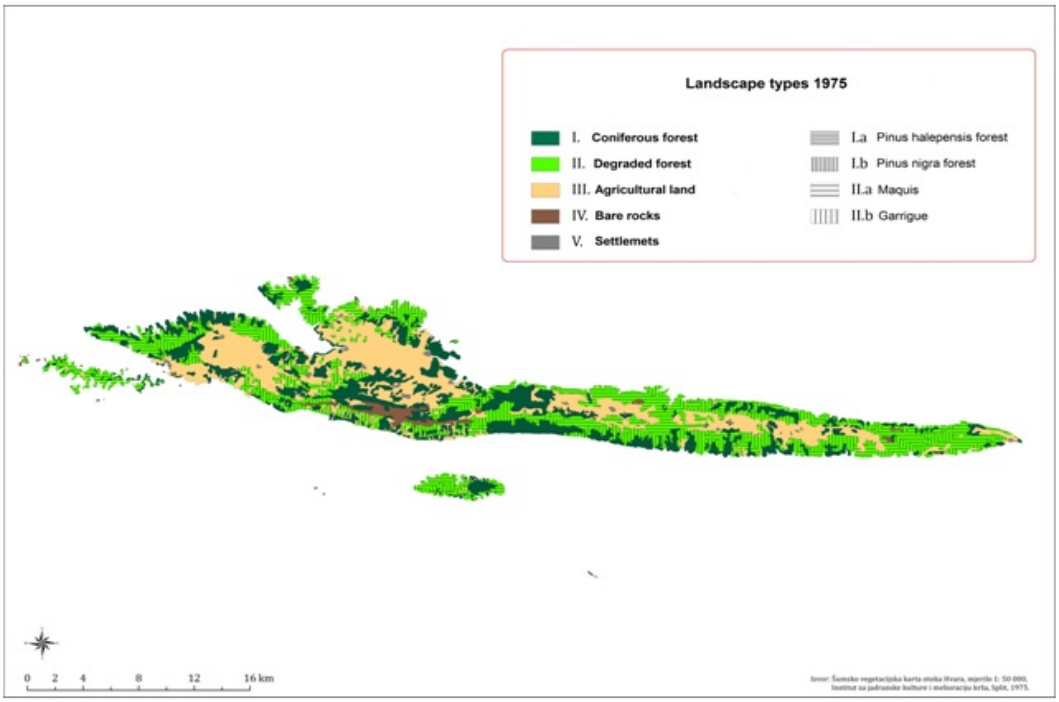

Figure 3 - Landscape types 1975. (Source: *Institute for Adriatic Crops and Karst Reclamation*, modified by the authors)

Because of the various vegetation features of pine forests, the extreme landscape values of the Dalmatian black pine forest – and also because of the later's more pronounced degradation,

two subtypes of coniferous forests were differentiated: the Aleppo pine and the Dalmatian black pine forest. The surface area of the Aleppo pine forest decreased from the initial period by 30%, whereas Dalmatian black pine forest showed a much more pronounced degradation – even up to 70%.

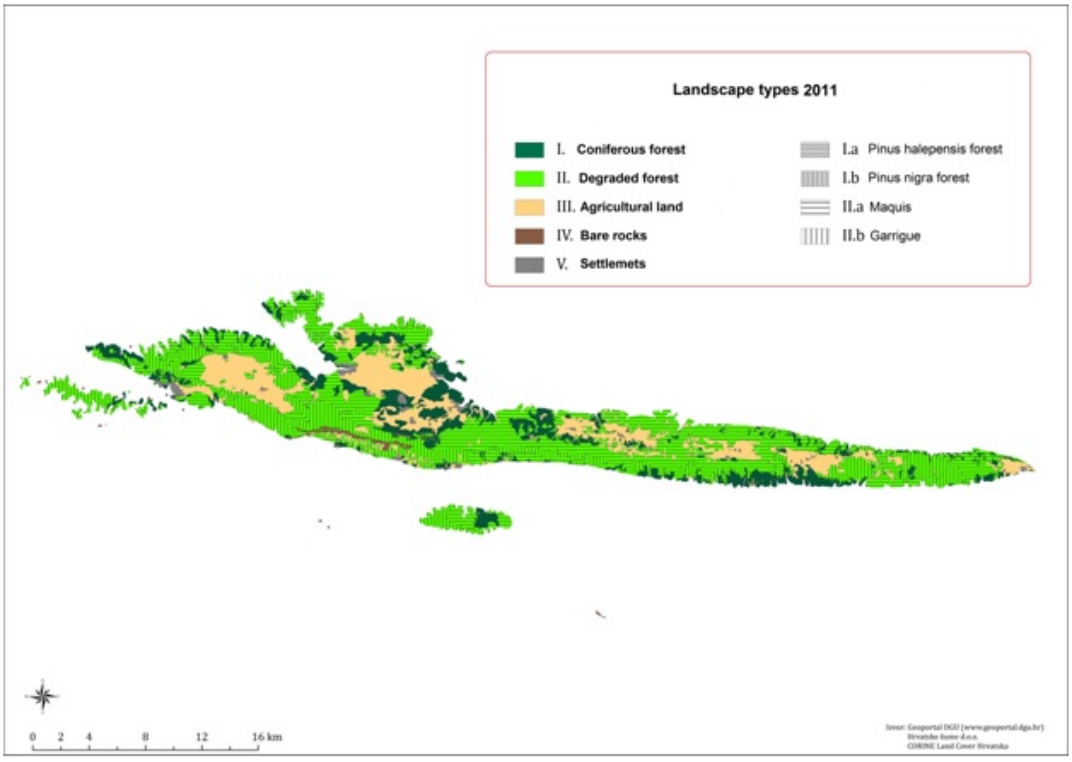

Figure 4 - Landscape types 2002–2011 (Source: *CORINE Land Cover* database, *State Geodetic Directorate* and *Croatian Forests company* database; fieldwork research. Map created by the authors)

Hence, in this relative ratio, the percentage of the Aleppo pine forest increased in the total area of the coniferous forests on the island from 96.26% to 98.06%.

Apart from forests, reduction in area coverage in the examined period was also recorded in cases of **rocky** landscape types and in **agricultural areas** (Table 1). Rock surfaces decreased by almost 130%, which can certainly be linked directly to the abandonment of traditional activities on the island – primarily animal husbandry in this case, and simultaneously to the significant spread of degraded forests. At the same time, the landscape type marked by **agricultural areas** showed a decrease in size by 30% in relation to the initial period, as a result of the intensive development of tertiary activities and the ever more pronounced deruralization of the island.

In contrast, the degraded forest, **maquis** and **garrigue**, at present the most widespread landscape type, in the examined period showed a significant spatial expansion from the former

41.41% to the present 59.92% of the total surface area of Hvar's island group (Table 1). Today, in the degraded forest landscape the percentage of maquis compared to garrique is practically twice greater (maquis 37.93%: garrigue 21.99%), which is in line with the advancing process of vegetation succession.

Table 1 - Landscape types. Island of Hvar, 1975-2011

Landscape types	1975		2011	
	Area surface (ha)	% of the island area	Area surface (ha)	% of the island area
Coniferous forest	8,220.75	26.20	5,172.06	16.48
Degraded forest	12,997.25	41.41	18,802.13	59.92
Bare rocky karst	688.80	2.20	259.70	0.83
Agricultural land	9,256.71	29.49	6,641.85	21.16
Built areas	218.57	0.70	506.35	1.61
Total	31,382.09	100.00	31,382.09	100.00

Source: *Forest-vegetation map of the island of Hvar (1975),* databases of *CORINE Land Cover, Croatian Forests* company database and *State Geodetic Directorate* (2002-2011).

Furthermore, the landscape type comprising **built areas** and **settlements** has shown the largest relative increase in its spatial area in relation to the initial period, almost 140% (Table 1). More than a doubling of its surface coverage was the result of extensive apartment building (i.e. apartmentisation) on the island, construction of camps and other infrastructural facilities.

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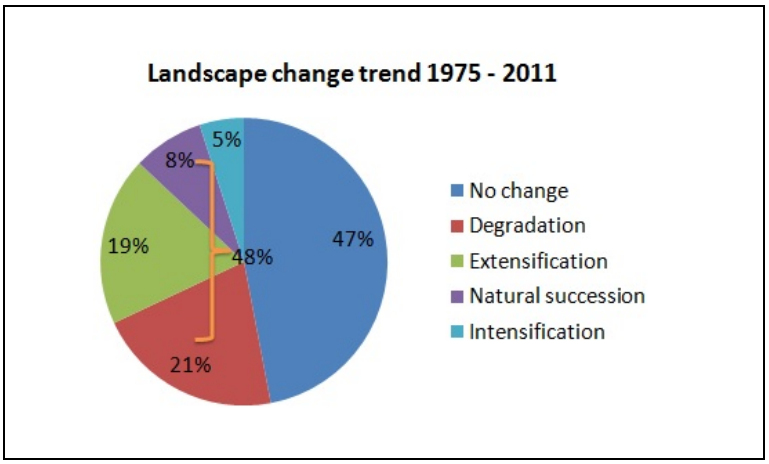

Figure 5 - Landscape change trends 1975–2011. (Source: Institute for Adriatic Crops and Karst Reclamation, *CORINE Land Cover* database, *State Geodetic Directorate* and *Croatian Forests company* database; fieldwork research. Calculated by the authors)

By unifying the labels of land use categories, and by defining the basic types and subtypes of landscapes, the methodological basis was obtained for the spatial comparison of landscape changes that occurred during the observed time period of thirty years. Overlapping the standardised typological categories using GIS software tools resulted in the modelling of new parameters in the existing database of spatial information, on the basis of which trends leading to changes in the landscapes were generated (Figure 5).

The research results showed that in the examined period on about half of the island's overall surface (47%), no changes occurred in the types of landscape. As was confirmed by the evidence, the largest contiguous zone, **without any trend leading to a change**, was the area in which agricultural lands were still in use.

On the rest of the island (48%), three trends dominated: **degradation**, **extensification** and **natural succession** (Figure 5). The altering trend leading to **degradation** was evidenced on about 21% of the area. Since human impact is the most important factor in the transformation of the environment (Palang et al., 2000), its destructive overtones, confirmed by frequent fires and soil erosion, certainly stand behind this negative spatial trend.

Just as significant is the shift trend towards **extensification**, present on about 19% of the island's surface. Extensification is caused by the expansion of degraded forest types (maquis and garrigue) into so-called "non-forest" forms of landscapes. The most striking progression of vegetation occurred when it expanded into previously arable agricultural areas of the island

4.2. Implications for traditional crops

Although a part of the Mediterranean rural area during the 20th century showed a population increase, as well as an intensification of olive growing and viticulture, some areas experienced an economic and demographic decline, which directly affected the traditional cultural landscape (Antrop, 1993). Dry-stone walls, a symbol of the hard subsistence labour of island farmers, are increasingly disappearing due to the succession of natural vegetation, and deagrarisation is now present even in the most fertile island areas (Čuka, 2010).

Small entirely agricultural surfaces and a large number of land plots are the basic hallmarks of agriculture on the central Dalmatian islands, and likewise on the island of Hvar. In the year 2011, on the island of Hvar 6,641.85 hectares of agricultural land were recorded. Agrarian zones were classified into three categories: vineyards, olive groves and other areas of agricultural land. Today, on about 60% of the island's total agricultural surface, we can find traditional island cultivates: vines, olives and lavender.

The peak in the development of viticulture on Hvar was recorded in the year 1900, when around 5,800 hectares of vineyards were situated on the island, and the total quantity of wine

produced amounted to about 15,000 hectolitres[9]. Vineyards in 2011 covered only 1,670.42 hectares of the island, accounting for about 25% of the total agricultural land.

Olive (*Olea europea L.)* growing on the island of Hvar always developed in the shadow of viticulture. Research has shown that today olive trees are present on about 28% of Hvar's agricultural land surface (1,896.57 hectares), which is also the highest recorded percentage of landscapes under olive groves in the last 150 years. Most of the olive groves are located in the eastern part of the island, where the most unfavourable natural conditions also exist (in relation to the soil, relief and climate).

After the collapse of the vineyards, a large portion of the agricultural areas on the island remained abandoned. With the introduction of a completely new crop – lavender (at first *Lavandula angustifolia* and *Lavandula latifolia,* later *Lavandula hybrida Reverchon*), there was an attempt to recover – at least somewhat – the economic value of these areas, and to provide the impoverished agricultural population with an opportunity for new revenue. Lavender began to be officially cultivated on the island of Hvar from the year 1928, when the first seedlings were planted near the village of Velo Grablje. The actual development of lavender production began after World War II (Poduje, 1975). The main cause for the rapid increase in the cultivation of lavender after World War II were the high prices and the high demand for this plant, due to the lack of aromatic raw materials (Vernazza, 1957). It could be said that the golden era of lavender was between the 1952 and 1963. World production of lavender in 1966 amounted to 800 tons, and on Hvar in the same year about 70 tons of lavender flowers were produced, 90% of the total production of this plant in the Socialist Federal Republic of Yugoslavia, and about 8% of the total world production (Petrić, 2006).

Figure 6 - Lavender fields, island of Hvar (Author: Antonio Morić-Španić, August 2013)

[9]The most valuable island vine varieties are *Plavac Mali* and *Drnekuša* (red grapes), as well as *Bogdanuša* and *Prč* (white grapes).

Since the lavender plantations are not classified as a separate category in system of the national *Agency for registering land parcels* (ARKOD), field mapping of the plantations was conduced. Three major fires in the last twenty years almost completely destroyed Hvar's lavender plantations, and therefore it is possible to estimate that today the island has only about 340 hectares of planted lavenders, which is just slightly more than 5% of the agricultural land area (Figure 6).

4.3. GIS locality modelling

Managing spatial data with the help of GIS technology enables analysis and spatial modelling, on an advanced level. Combining spatial data sets with optimal growing conditions for indigenous island crops, creates a basis for strategic planning in order to implement the sustainable development of the island's area.

The proposal for the revitalisation of agricultural zones on the island of Hvar is based on a comparative spatial analysis of arable agricultural lands in 1975 and of today's agricultural zones on the island. On 58.59% of the agricultural land dating from 1975, no changes have occurred.

On the remaining surface of the former farmlands, the **transformation trend leading to extensification** is under way (2,694.90 hectares), as well as the process of natural vegetation succession and the expansion of degraded forest types (maquis and garrigue). Precisely these once arable zones, because of the still existing parcelization, marked by dry-stone wall boundaries and positions on terraced localities, represent the "frozen" agricultural capital of the island, which could be reactivated in a relatively short time period (Figure 7).

Figure 7 - Extensification and natural succession (Author: Antonio Morić-Španić, August 2013)

Through the GIS correlational analysis of soil types, slopes, terrain exposures and the farming requirements of selected traditional indigenous crops and varieties, a spatial model was obtained, which indicated the most favourable localities for cultivation, if the previous arable areas of the island would be activated (Figure 8). The analysis is focused on indigenous grapevine types: the varieties *Faros*, *Drnekuša*, *Bogdanuša*, and *Prč*, and also lavender fields and olive groves.

Orientation towards the quality and cultivation of indigenous varieties of the island would be the only way to revitalise the island's viticulture, since only in this way would winemakers on Hvar be able to become competitive on the wine market.[10] The agricultural EU policy promotes high-quality varieties of wine sorts and also geographical authenticity and originality, as the primary indicators on the market.

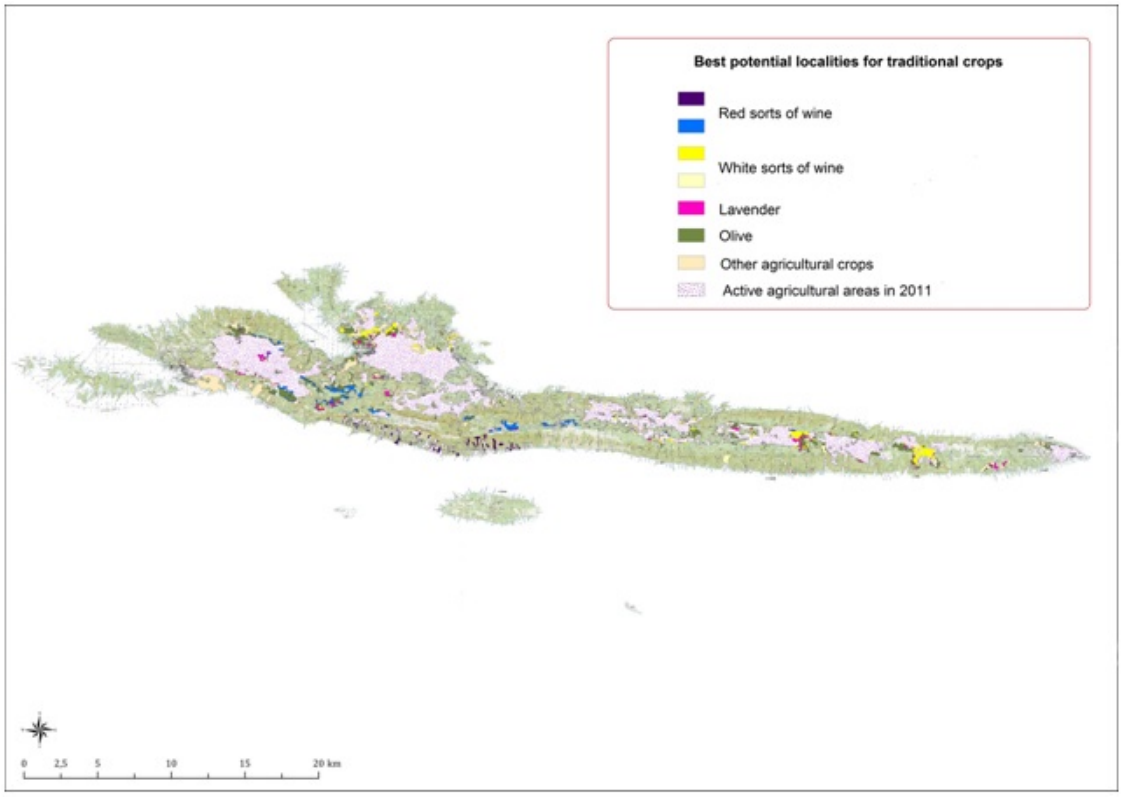

Figure 8 - GIS modelled – best potential localities for traditional crops, island of Hvar. (Source: Morić-Špenić, 2014)

Cultivation of indigenous red wine sorts from the *Faros* variety is possible in all the abandoned agricultural lands in the colluvium. Specified sites include 123.79 hectares of potential

[10]Of course, cooperation between winemakers is also important, in order to produce the economic results.

land for the cultivation of first-rate varieties of red wine, and all of them are located on the southern slopes, within the slope gradient above the 5° ratio.

In determining the possible potential land area for growing indigenous red grapevine of the *Drnekuša* variety, the height above the sea level was designated as the fundamental spatial component. The exceptionally high-quality wine *Drnekuša* is produced in zones 300 metres above the sea level (Tomić, 1995). By means of the analysis, a potential range of 243.46 hectares was allocated, for the most part in the central zone of the island's ridge.

Several parameters were taken into account when the attempt was made to determine the most suitable natural habitats for growing indigenous white grapevine of the *Bogdanuša* variety. High quality *Bogdanuša* wine is produced on slopes with an angle of 0–5 °, in red soil and sandy-loam regosol soils (Tomić, 1995). A total of 409.26 hectares from former agricultural areas meets all three of these conditions.

An almost forgotten variety of white wines, *Prč*, once had its natural habitat along the shores of the southern bays in the eastern part of the island. Activation of 99.09 hectares of abandoned agricultural land, dating from the initial period of production, could again revive this growth.

The largest number of factors was taken into consideration in the analysis aimed at determining the potential zones for the cultivation of lavender. These zones included terrain slopes which have an angle over 5°, with southern exposure and the following soil categories: sandy-loam regosol soil terraces, skeletal calcareous regosol soils and red and brown regosol soil floor. Via correlation of the GIS analysis, 173.51 hectares of the most valuable island locations for the cultivation of this aromatic herb were allocated.

Even though olive trees can grow in locations where no other cultivates can develop, nevertheless higher crop yields result on terrains with a slope of 2–5° and with red and brown regosol soils and skeletal calcareous regosol soils. Localities with the above characteristics include 736.60 hectares in the land area of Hvar's earlier agricultural zone.

5. Conclusion

By means of the spatial analysis of the environmental status of the island of Hvar in the period from 1975 to 2011, significant changes in the land use of the island were confirmed. The reduction in the size of areas with traditional cultivates, and the pronounced extensification process (expansion of maquis) were the two most important factors in the last 40 years leading to changes. As a result of these processes, in 2011 traditional island crops were planted on only about 10% of the total area of Hvar island (3,907 hectares).

(Re)activation of overgrown agricultural surfaces with traditional island cultivates would prevent the further spread of maquis, would contribute to the increased branding of indigenous

products and would also help in the general development of rural zones on the island, intensely affected by depopulation. Through the use of GIS tools to integrate various relevant databases and spatial parameters for each cultivate, a spatial model has been created for the (re)activation of the potentially most suitable land areas.

In regard to the total area of the abandoned and overgrown agricultural surface of 2,695 hectares, spatial modelling has indicated the possibility of potential (re)activation of 1,787 hectares, which would be 66% of that land area. This would also mean an increase of 46% in the total agricultural area of the island, under traditional crops.

GIS analysis and modelling may clear up and point to the spatial potential and availability of spatial resources and opportunities, but what is equally important is the local community, its demographic potential as well as socio-cultural inheritance, worldviews and mentality.

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