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TYPOLOGICAL CLASSIFICATION OF SETTLEMENTS IN THE RURAL HINTERLAND OF THE BAY OF BOKA KOTORSKA

SUMMARY

Rural settlements in the hinterland of the Bay of Boka Kotorska reflect the centuries-old blend of the outstanding natural values and different local traditions in the use of space. They were developed in different cultural, historical, social and economic conditions.

By applying the GIS tools and by overlaying different thematic maps with high resolution orthophotos, an analysis of spatial structures and causal processes in these areas is carried out. Topological classification of rural settlements is done based on morphological, geological and pedological characteristics of the settlement areas, on the presence of cultural and historical elements and forms of agricultural patterns. A key criterion in the classification was the presence of spatial elements that have contributed to the formation of an authentic and specific identity of these settlements. The three basic types and seven newly developed subtypes of rural settlements of Boka Kotorska are defined and shown. The identification of these settlements is done by further overlapping of extracted polygons with topographic maps.

Introducing spatial values and the historical development of rural settlements in the hinterland of the Bay of Boka Kotorska represent a solid basis that can be used to direct the course of their further development and highlight the importance of preserving the spatial identity. The analysis of traditional architecture and spatial planning and rational and careful study of the man's attitude towards the natural basis in the past enabled the use of former experiences to plan further development of these areas in order to restore the abandoned cultural context.

Keywords: rural settlements, typological classification, Mediterranean, Bay of Boka Kotorska, GIS.

INTRODUCTION

Boka Kotorska (Figure 1) is a cultural landscape of exceptional and universal values. It is surrounded by steep limestone mountains of the Dinaric karst, and its highest peaks are Mt. Orijen (1895 m) and Mt. Lovćen (1749 m).

The whole area with hinterland is Mediterranean, rugged area with specific morphological and hydrological features. Its distinctive, vertical jaggedness affected the climate diversity and the diversity of vegetation. Geographic location and specific natural morphological basis as well as climate conditions caused the

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formation of primordial human settlements. A village, in its long development history in these areas, has changed much less than a town and that is why the village has preserved the traditional homogeneous features.



Figure 1. Geographical position of the Bay of Boka Kotorska in Montenegro

The Mediterranean landscapes are characterized by a high degree of natural disturbance (Archibold, 1995; Allen, 2001) and by an early human influence that lasts up to nowadays (Allen 2003). The expansion of construction in recent decades and creating of modern, but with regards to urban planning, very unarticulated tourist resorts on the sites of the former villages influences the loss of identity and cultural heritage of the area. Traditional Mediterranean agricultural landscape with its features such as dry stonewalls and terraces are connected to the agricultural roots of most modern Mediterranean societies. However, traditional Mediterranean elements of agricultural landscapes (terraces, stone walls, trails, agricultural patterns) are not adequately preserved not only in this area but also in other parts of Mediterranean region - in Spain (Gomez-Limon and Frenandez 1999) and in Greece (Kizos and Kolouri 2006).

In the hinterland of the Montenegrin coast, the inadequate treatment of these settlements is also evident, along with the conversion of agricultural land into construction land, depopulation and decay (Šarović 2014), but also an inconsiderate integration into new settlement structures.

The research starts from the assumption that there are several different types of rural settlements in the hinterland of Boka that have developed under the influence of various natural and cultural-anthropogenic impacts. The purpose of this paper is to highlight the importance of responsible attitude towards village in future planning, through typological and spatial determinants perceived through certain methodological approaches.

MATERIAL AND METHODS

Spatial analysis covered the natural system (climate, geology, ground cover, etc.) and cultural characteristics (method of space use, cultural landmarks, constructions etc.). Starting from the aim of typological classification and the available data, criteria were selected and used to determine the types of rural settlements. The most relevant parameters which significantly influenced the classification structure were taken into account in the criteria selection process. (Đokić 2009)

The area of the Bay of Boka Kotorska is examined by using the software package ESRI ArcMap 10.1 and by analysing the data taken from geoportal of Real Estate Administration of Montenegro - REA: Digital orthophoto of entire Montenegro at resolution 0.2m TK 1: 25000 (RAE 2011), as well as various thematic maps (geology, soil, hydrology, hypsometric, etc.).

The borders of rural settlements covered the built up part of the settlement, the accompanying agricultural land and other natural landscape elements (forest, waterways, etc.) which form a single spatial unit. After determining the boundaries of rural settlements by using orthophotographs as base, the overlaying of previously determined boundaries with other thematic maps was done and thus the given typological classification was made in accordance with previously established criteria. Overlay of satellite images with thematic maps (geologic maps, soil maps, exposure maps, slope and topographic maps and cadastral maps) enabled a detailed analysis of the spatial structure and the causal processes in them. A list of settlements in the study area was made according to the given typology classification.

Typological classification in this study was aimed at identifying different types of settlements starting from the elements that have contributed to the formation of distinctive looks of these rural areas. Starting from the assumption that the diversity of types of rural settlements emanated from the integral relationship of various natural and anthropogenic impacts, the following key criteria were selected for typological classification:

1. Geomorphological and pedological characteristics
2. Physiognomic structure of the settlement
3. Characteristics of settlements identity

Finally, after detailed analysis, typological classification of rural settlements of Boka Kotorska was prepared.

RESULTS AND DISCUSSION

Geological and pedological characteristics

The indirect effects of natural environmental factors are very important and undoubtedly determine man's material life in detail. The natural resources of the environment that man exploits are the richness of the soil, forests, grasslands, water reservoirs, springs, etc. These factors are evident in the types of settlements, the types of buildings, inhabitants' occupations, and lifestyle and so on. (Cvijić, 1966)

In relation to the geological substrate, it can be seen that the settlements were identified on sedimentary, coherent rocks (fossilized rocks as limestone and dolomites and non-petrified rocks as clays); on the complex of coherent and coherent/non-coherent rocks (flysch) and on alluvial and colluvial terrain (non-coherent clastic rocks) (Figure 2). In relation to its permeability, geological substrate considerably affects the quality of the surface pedological substrate.

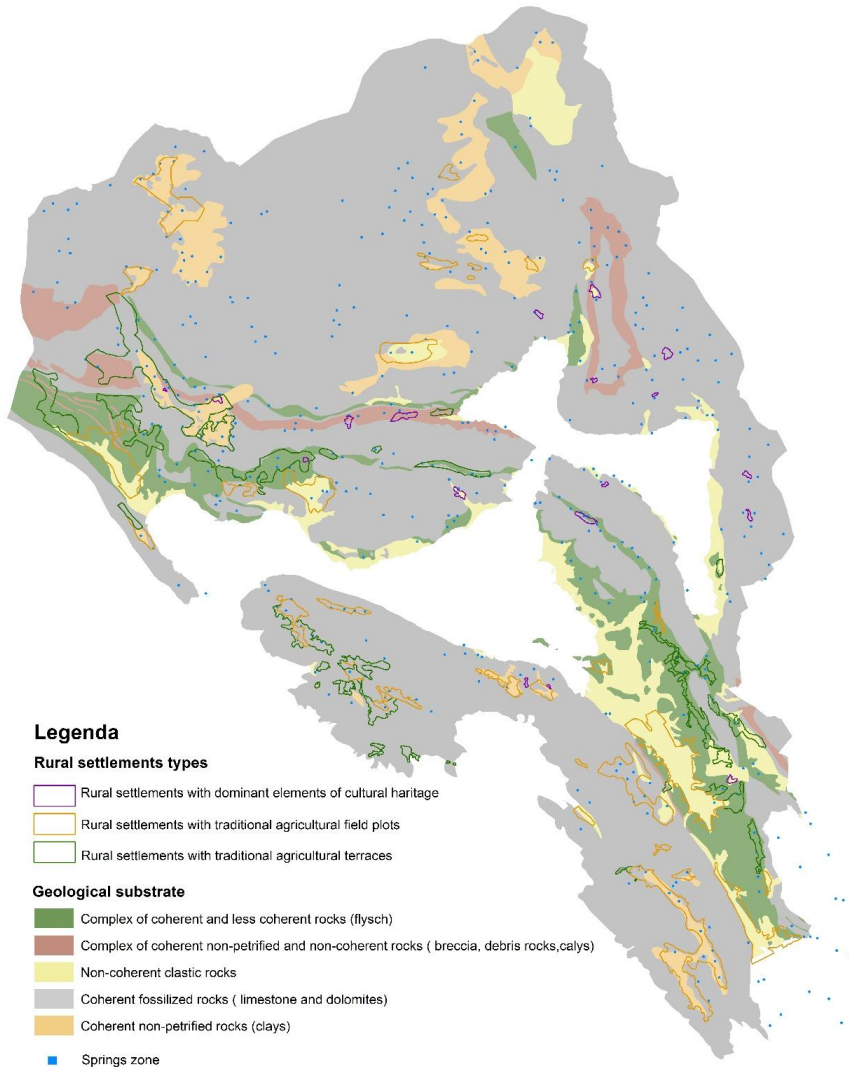


Figure 2. Map of the geological substrate overlapped with the types of settlements

Pedologic substrate has an effect on the dividing structure of the area, and therefore the variety of landscapes (Aničić at all, 2007). On the other hand agricultural landscapes in the shallow soil and steep slope are usually uninhabited due to the inability to intensify the production (Naveh, 1993).

Considering the location and depending on the parent - basic rocks of rural settlements, the following soil types have been developed on the territory examined for this study (Figure 3): alluvial and alluvial-diluvial soils, brown soils on flysch, brown soil on limestone, red soil (terra rossa), limestone and dolomite black soil and karst terrain (Fuštić and Đuretić 2001).

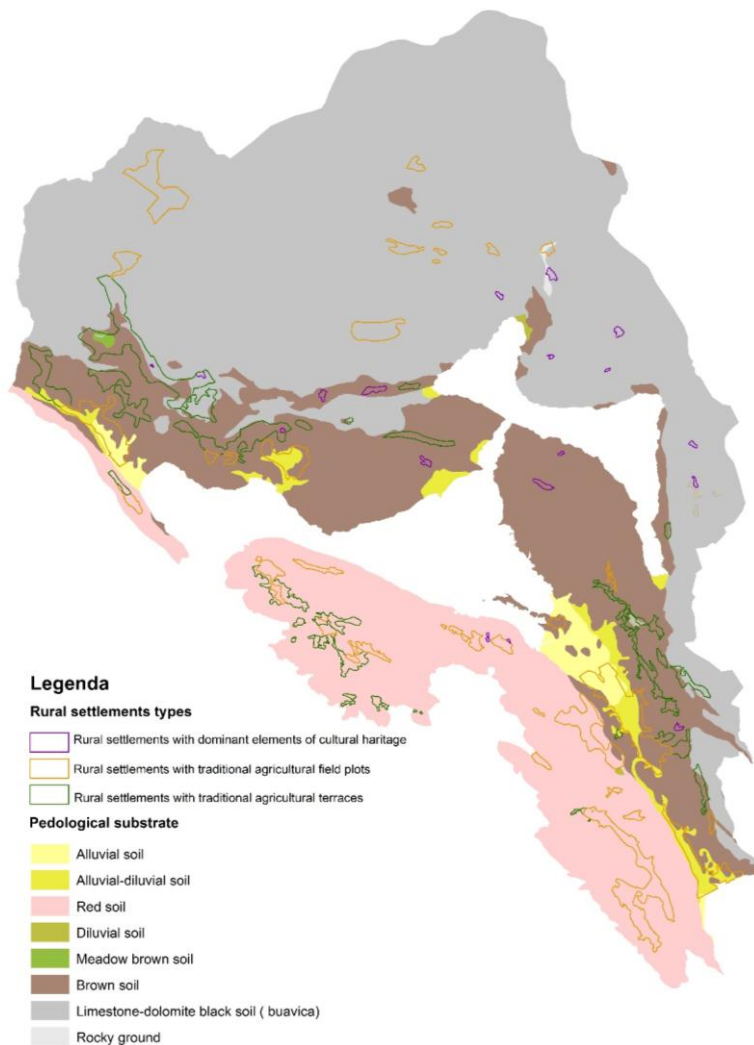


Figure 3. Pedological map overlapped with the types of settlements

The alluvial soil appears in Tivat field, and in smaller areas in Mrčevo field, and in the hinterland of Igalo. Alluvial and delluvial soil can be found as a continuation of alluvium in Sutorina, Tivat and Mrčevo field. Brown soil is present on the slightly and moderately steep parts of the coast. Steeper terrain of flysch hills is generally strongly eroded and covered with low vegetation, while

the milder slopes are terraced and turned into arable land. Terraced grounds with brown soil are particularly important for agriculture, as they are used mostly for olives, and then for other types of fruit, including figs, peaches and citrus. The quality of this soil depends on the width and length of the terrace, the content of the skeleton, terrain slope and terrace plateau, as well as other conditions.

The largest areas of red soil of uninterrupted continuity are found on the peninsula Luštica and Donji Grbalj. It is mainly of the shallow layer both on steeper slopes and on the milder slopes with usually high percentage of shadiness. Milder slopes are partially terraced and therefore somewhat deeper layer was created, while the flat terrain of the villages of Donji Grbalj and Donje Luštice, with a deep layer of settled or coluvial red soil.

Limestone-dolomite black soil is also known as *buavica*, is the soil that is formed on pure limestone, however in the colder climate. This soil appears on the steep terrain from Morinj to Risan, above Perast and Dobrota. *Buavica* is very shallow soil, except in karst sinkholes and inlets, which appear sporadically.

For the purposes of obtaining clear criteria that influenced the morphology and typology of settlements, a combination of geological and soil characteristics was examined. In relation to the geological substrate and soil type, the following types are defined: rural settlements on the red soil on limestone terrain, rural settlements on the brown soil on *flysch* terrains, rural villages on the alluvial and alluvial-diluvial soils and rural settlements on the limestone-dolomite black soil.

Physiognomic structure-settlements morphology

According to the typology related to the genesis i.e. development of villages (Popović 2011), hinterland villages mostly belong to the type of spontaneously developed villages. These villages usually consist of housing with agriculture, but there are those which contain parcels for lots of other uses (churches, schools, cafes, etc.).

According to the typology related to the settlement size (Monstat 2011), villages in the hinterland of the Bay of Boka Kotorska mostly belong to small villages (0-100 and 100-500 inhabitants). Only a small number of settlements belong to the medium-sized villages (500-1000 inhabitants).

According to their basic functions, there are two types of villages: primary rural settlements and villages with the village center. According to the physiognomic structure, the villages in the hinterland of the Bay of Boka Kotorska belong to so-called compact villages (densely concentrated residential buildings) and dispersed villages (scattered residential buildings).

Dispersed villages are divided into regions that are distant from one another, and the houses in the region may be concentrated or dispersed. Compact villages are the villages where houses are densely packed. The houses in these villages can be arranged without order or grouped in ordered rows. There are one or two main streets that intersect in the form of a cross. Both types of villages may have their hamlets (Cvijić 1987).

The basic characteristics of rural settlements of compact type are groups of houses built on a small distance or physically connected into residential assemblies. With regards to the relief, differences can be noted between the settlement types formed on the flat terrains and those that are located on the steep slopes of the Mediterranean hills. The conditions of the terrain at an incline influenced developing of certain types of housing constructions, thus establishing new subtypes within the basic type of rural settlements: rows of houses parallel to the contour lines and the rows of houses perpendicular to the contour lines.

In houses that are parallel to the contour lines, the approach road and the house front door were oriented down slope: to agricultural land and to the sea, which influenced forming of assemblies in the form of a series of the contour line by adding new units in the same direction.

In the house position perpendicular to the contour lines, gable-end wall is on the hillside, and a row is formed by building the new units, but due to the terrain inclination, the segments of the row could be gradually staggered in height. In these settlements there are stairs instead of the street.

Special and atypical residential assembly shapes are cluster settlements in the village of Krtole. The settlements are formed by grouping the houses and gardens, oriented towards the inner courtyard. This concept is derived from the need to create conditions for the successful defense, which was achieved by highly compacted cluster-groups (Vuksanović and Popović, 2009).

In architectural terms, three types of buildings may be distinguished in these settlements: residential buildings of traditional rural architecture, traditional buildings changed by contemporary architectural interventions and modern buildings.

Characteristics of the rural settlement identity

Referring to the presence of cultural landscape elements which contribute to the uniqueness of the villages in this area, two subcategories can be distinguished:

Typology in relation to the form of a landscape/agricultural pattern (fields, traditional terraces) recognizes:

- The rural settlements with traditional terraces
- The rural settlements with traditional agricultural fields

Typology based on the presence of cultural and historical elements and the presence of environmental units identifies:

- old isolated rural settlements that are important environmental complexes or built heritage of the area.

Creating of rural settlements types

Although mapping uses the layers of digital data within a GIS environment, the boundaries between units have to be determined visually (Vogiatzakis et al 2006). When selecting criteria for types creating, the main goal is to classify rural settlements typologically according to the key characteristics

that influenced the formation of an authentic and specific identity of the area. Thus, in the hierarchical sequence, the criterion related to the identity and characteristics of the settlement that make it different from other types will be in the first place. It will be followed by geomorphic characteristics and structural-morphological characteristics of the village.

Based on previous studies, the graphic substrates with the anticipated data are formed. By overlapping them in ArcGIS software, by comparing and combining all the above mentioned criteria, three basic types and seven subtypes of rural settlements can be distinguished in the area (Figure 4).

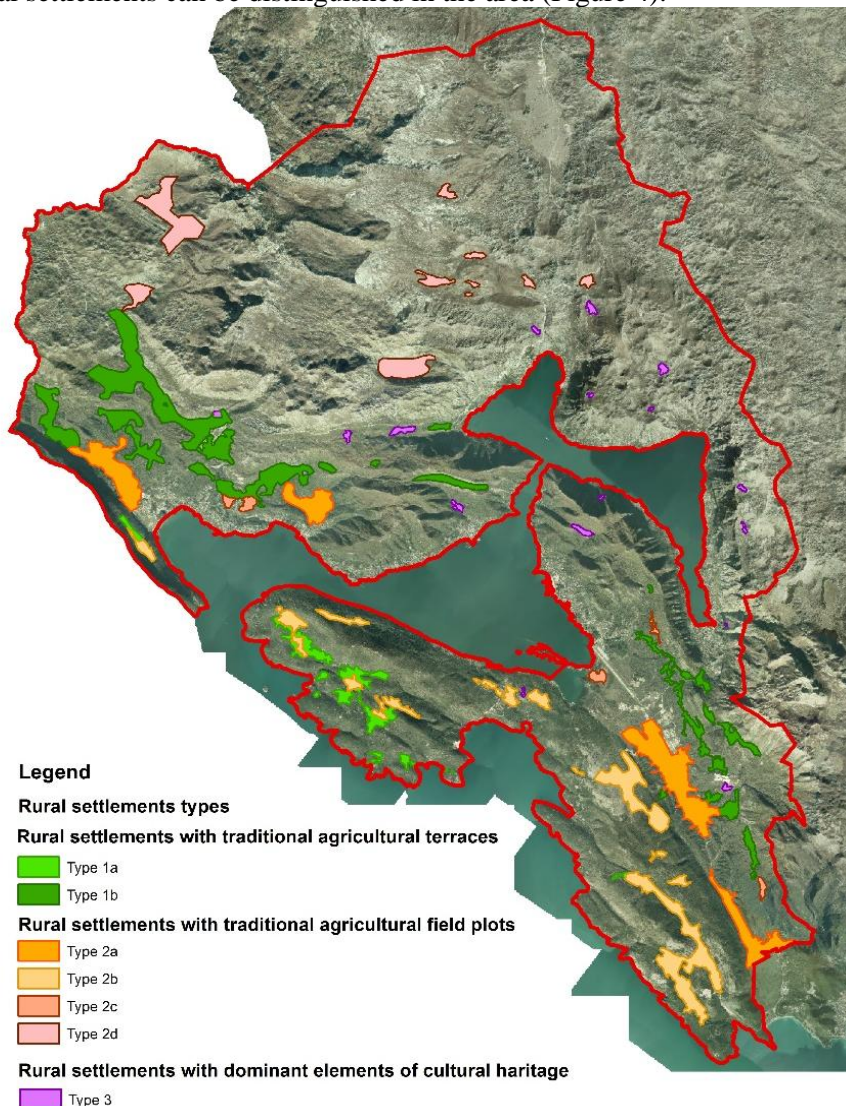


Figure 4 Graphical representation of rural settlements subtypes in the Bay of Boka Kotorska overlaid with an orthophoto

TYPE 1 The rural settlements with traditional terraces

1a. the limestone terrain with red soil (terra rossa)

1b. the flysch terrains with brown soil

The villages belonging to dispersed settlements type are imbued with agricultural terraces. Settlements belonging to the type 1a are located on the poor skeletal fields on shallow soil, so the dominant spatial characteristic of this settlement type are terraces with olive trees. Olive groves are bounded by dry stonewalls and dry stonewalls are also dominant as support to terraced terrains in which olives trees were planted and olive growing used to be very extensive. Today, most of these olive groves are abandoned and overgrown by shrubby vegetation.

Settlements belonging to type 1b (Figure 6) are located on moderately sloping terrain, mostly on the border with alluvial-diluvial fields. The soil is of better quality compared to type 1a (Figure 5), and except for olives, other types of fruits are grown, including figs, peaches and citrus. These settlements are located in the zone of luxuriant vegetation and they are therefore gentler and have more favourable microclimate conditions than the type 1a settlements. For the reasons mentioned above and due to their spatial characteristics and recognizability, these settlements are considered to be of special types.

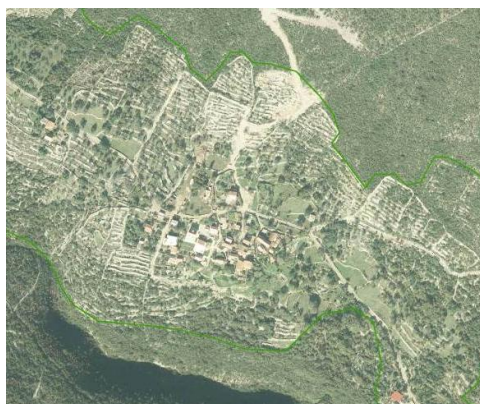


Figure 5. TYPE 1a - Mrkovi on Luštica



Figure 6. TYPE 1b - Mojdež near H. Novi

The analyses of the similar types of landscapes in Mediterranean areas (Ogrin 2005) indicated that the most important criteria for positioning the vineyards are exposition, slope and narrow terraces, wide terraces are more appropriate for olives and when selecting the locations, not only exposition and slope, but also the appropriate altitude have to be considered. The key criterion for positioning the orchards is the soil quality, in addition to exposure and slope.

TYPE 2. Rural settlements with traditional agricultural fields

2a. the alluvial and alluvial-diluvial terrain

2b. the limestone terrains with red soil

2c. the flysch terrains with brown soil

2d. the limestone and dolomite black soil

The villages belong to a dispersed settlement type, with buildings scattered in no particular order. The arrangement of buildings varies from totally chaotic, through linear and radial arrangement along the roads to the settlements with facilities concentrated mainly along the field borders.

Within the basic type, four subtypes have been distinguished, depending on the location of rural settlements and geological and pedological base which influenced the morphology of the settlements themselves. The example of these settlements can serve to establish a causal relationship and the influence of parent material or composition of the substrate on which the settlements are developed. Although a field matrix is the common pattern that appears repeatedly for all subtypes, they differ in their size, shape and form.

Type 2a (Figure 7) is characterized by fields asymmetrically divided up in square and rectangular parcels of land. The alluvial fields are characterized by high level of groundwater, so these terrains require certain ameliorative measures such as drainage and dewatering of water surplus. Vegetation is hydrophilic, meaning that deciduous tree species are characteristic of such terrains. The settlements are imbued with groves, but to a lesser extent and mainly in linear lines. All these influenced the establishment of distinct spatial design characteristics of this type of settlement.

Type 2b (Figure 8) is completely different, as they are settlements in lowland limestone terrains in red soil. The settlements are elongated. These terrains are permeable and therefore agricultural activity is focused on crops that do not have special requirements for more intensive irrigation. The terrain is favourable for the cultivation of olive trees, and in the visual sense, this type of settlement is recognizable by grey-green colour of the olive groves. The fields are divided up in symmetrical and asymmetrical elongated allotments with dry stone walls and hedges.

Spatial and landscape recognisability is also a feature of the similar terrains in neighbouring Croatia, in the area of Dubrovnik coast, where fields as landscape element create space complexity with their appearance and distribution of parcels and where different land use influences the diversity in dividing up the land into parcels. Growing cultures are vegetable gardens, orchards, vineyards, fields, and occasionally meadows. (Hrdalo et al., 2008)

Type 2c (Figure 9) is the least frequent settlement type. With regards to the form, these settlements are similar to settlements on the alluvial and diluvial terrains, but they are much smaller in area. They are on the brown soils on flysch. The fields are asymmetrically divided up into mostly rectangular parcels, interspersed with groves.

Type 2d (Figure 10) is very distinctive, especially if we take into account that the settlements located in the valleys in the zone of so-called severe rocks, on the slopes of the mountains Lovćen and Orijen, belong to this settlement type. These settlements are located at high altitudes in the zone of colder climate. Fields are symmetrical and elongated. Most of the buildings are located along the plain borders. This points the way of dealing with space in terms of its optimal use for agricultural production.



Figure 7. TYPE 2a Kutsko polje



Figure 8. TYPE 2b - Zvinje

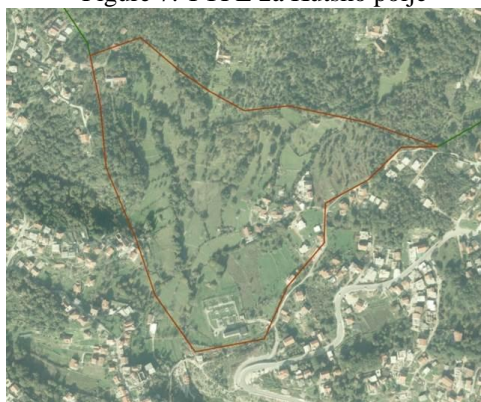


Figure 9. TYPE 2c- Podi above Topla



Figure 10. TYPE 2d - Kruševice

TYPE 3 Rural settlements with the dominant cultural and historical elements

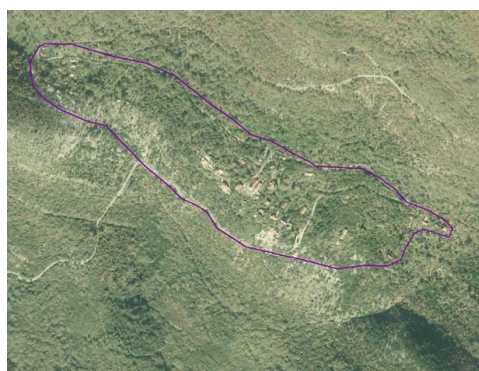


Figure 11. Gornja Lastva



Figure 12. Mali Zalazi

These settlements are of compact type, mostly abandoned with the remains of former buildings and other traditional elements. These settlements are important because of their history and architectural heritage that bear the

characteristics of the culture of the people from this area. The old demolished and semi-torn buildings of stone, collapsed roofs, abandoned mills for the production of olive oil, threshing floors, cisterns and wells, gardens, staircases, churches and tombs make these villages special and valuable (Figure 11 and 12).

List of rural settlements according to their type

The boundaries of rural settlements that were previously typologically defined are overlaid with topographic maps in GIS, which allowed the identification of the village names. The names of the villages enabled further inquiry through literature (about their historical development, the time they appeared, location and conditions under which they were developed).

TYPE 1

1a. Rural settlements with traditional terraces on limestone terrains with red soil: Mrkovi, Gošići, Bratevina, dio Radovanića, Marovići, Babičevine, Begovići, Kraljevići, Merdari.

1b. Rural settlements with traditional terraces on flysch terrains with brown soil: Rastovo, Šćepovići, Mojdež, Porobići, Ratiševina, Kameno, Mokrine, Trebesinj, Sašovići, Sušćepan, Podi, Kavač, Dub, Trojica, Naježići, Mirac, Pelinovo, Vuksanovići.

TYPE 2

2a. Rural settlements with traditional agricultural fields on alluvial and alluvial-deluvial terrains: Sutorinsko polje, Kutsko polje, Mrčevo polje.

2b. Rural settlements with traditional agricultural fields on limestone terrains with red soil: Žvinje, Klinci, Zabrdje (Stojkovići, Trojanovići), Radovanići, Begovići, Brguli, Babunci, Kostići, Radovići, Loke, Đuraševići, Lješevići, Pobrđe, Ukopci, Trešnjica, Glavatičići, Kubasi, Kovači, Zagora, Krimovice, Bijelske Kruševice.

2c. Rural settlements with traditional agricultural fields on the flysch terrains with brown soil: Sušići (a part of the village of Podi), Kvekići, Kralj, Uvala Bradišta, Donji Bogdašići.

2d. Rural settlements with traditional agricultural fields on limestone and dolomite black soil: Kruševice, Vrbanje, Ubli, Krivošijska sela: Malov do, Unijerina, Knežlaz, Dragoševo selo, Polje.

TYPE 3

Rural settlements with the dominant cultural and historical elements - isolated abandoned or partially abandoned the old rural settlements: Gornji Stoliv, Gornja Lastva, Mandići, Špiljari, Mali Zalazi, Velji Zalazi, Poljice, Donje Ledence, Velje selo, Veljinići, Stepen, Vala iznad Bijeje, Nogulovići, Bunovići, Bogišići, zaseok Meštovići, dio Pelinova.

Representation of the defined types

Rural settlements with traditional terraces on flysch terrains with brown soil (type 1b) represent the most common type in the study area when we take into account the total area of all settlements of this type (Table 1). Immediately

after the type 1b, by representation, there are rural villages with traditional agricultural fields on alluvial and alluvial talus fields (type 2a) and the limestone terrain with red soil (type 2b). These data show that the land and soil suitability for agricultural development is highly important for development and size of rural settlements in the Bay of Boka Kotorska

Table 1. Representation of the defined types of rural settlements in the Bay of Boka Kotorska

Rural settlement type	Area (ha)	Percentage of types
Type 1b	1721,50	34,40%
Type 2a	1130,79	22,59%
Type 2b	999,63	19,97%
Type 2d	606,35	12,12%
Type 1a	324,86	6,49%
Type 3	125,10	2,50%
Type 2c	96,68	1,93%

CONCLUSIONS

GIS technologies made typological classification much easier especially when it comes to the analyses of the the dependence of structural and morphological characteristics of different types of settlements in relation to geological and pedological substrate, as well as in relation to the cultural and historical context in which they were developed.

As result of typological classification in the study area, three basic types and seven subtypes of rural settlements were identified. The diversity of rural areas in the hinterland of the Bay of Boka Kotorska was created by combining the exceptional natural values and various traditional forms of space utilization.

Rural settlements in coastal area were developed mostly on limestone, flysch and alluvial surface, and even in some sites in the municipality of Herceg Novi there are rural settlements on the fluvio-glacial sediments and moraines. The mere geological substrate conditioned the quality and thickness of soil substrates and therefore the activity of the population and morphology of these settlements.

Settlements that were developed on slopes are of terraced settlement type. On limestone, they are mostly traditional terraces with olive groves, while in the settlements on the flysch and clay terrains with brown land, the quality of soil stimulated agricultural activities and they are much more present. Rural settlements of terraced type are very attractive because of a number of traditional cultural elements which are, not only the specifics of buildings, but also the elements such as the retaining walls and borders, traditional plant species (olives, figs, vines and mulberry) and the like. On the other hand, the settlements that developed in the plains have completely different characteristics. Here again we have agriculture, but in this case it is a matrix consisting of fields bordered by

hedges and borders. Particularly interesting are old and mostly abandoned rural settlements in hilly areas where space is becoming practically empty.

In this climate typical agricultural activities are linked to the cultivation of olive trees, citrus, grapes and some mixed crops in the fields. Agriculture with mainly Mediterranean crops has created unique field patterns, thus enriching a landscape picture of this area.

As a result of the above, it can be concluded that the most common type of rural settlements in the Bay of Boka Kotorska is of type 1b - rural settlements with traditional terraces on flysch terrains with brown soil.

Starting from the primary objective of this typological classification and it is the establishing of the guidelines for the development and preservation of the rural settlements authenticity in the Bay of Boka Kotorska, the identification of these types of settlements has firstly acknowledged their identity characteristics that will be drivers of their further development and that should be preserved and valorized. Knowledge of architectural elements and traditional agricultural patterns, origins and identity can facilitate and define principles of urban development planning and revitalization of these models of rural settlements.

Factors that may adversely affect the preservation of spatial identity in rural areas are depopulation, abandonment of traditional ways of farming, illegal and uncontrolled construction and disrespect of natural characteristics and traditional forms of construction. Due to the lack of knowledge about spatial values, there is a risk of conversion of this areas into the urban zone with tourist facilities and complete abandonment of villages in the hinterland as well as the loss of agricultural land. Such a development would completely destroy the complexity of the area and reduce the existing spatial values.

In order to provide clearer guidelines for the revitalization of the area, after a typological classification was carried out, it is necessary to further research and identify individual landscape elements within rural areas (built-up environment, various agricultural patterns, systems of roads, social infrastructure elements, etc.). It is also important to examine the effects of (non) adapting the modern construction to the traditional structure/morphology of the rural settlements.

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