

# **FINAL REPORT ON PROJECT “Mapping Types of Habitats at the Ribnica Quarry Using Contemporary Methods In Ecology ” SUBMITTED TO THE INTERNATIONAL JURY OF THE “QUARRY LIFE AWARD” CONTEST**

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## **Abstract**

During the realization of an entry project for the Quarry Life Award competition — created under the auspices of HeidelbergCement Kakanj, a company in Kakanj — a mapping of habitat types using contemporary methods in ecology was carried out. Field studies conducted involved the use of the DJI Phantom 2 drone for data collection. Photographs of five pilot areas were made. Field data and orthophotographic material — provided by the Faculty of Mathematics and Natural Sciences in Sarajevo (Prof. Samir Đug, PhD, and Prof. Nusret Drešković, PhD) — were analyzed, while mapping habitat types within the quarry area was executed in ArcView 3.2 software. The final product of the entire work is a thematic map of habitat types within the area of the Ribnica quarry.

## **1. Introduction**

In the past, researching and mapping vegetation was performed in the traditional way that involved going out into the field and mapping vegetation on the spot. This field work takes a lot of time and financial resources, and can be quite inaccurate (compared to mapping vegetation with the help of modern technology). Also, some areas are not suitable for study due to terrain inaccessibility. Today, in a time of great technological developments, we are seeing an increase in remote-controlled research. This does not mean that the human factor is entirely replaced by machines, but that the data collection is simpler, more efficient, and more accurate, while processing continues to be done by the same professionals in the field being investigated. Although faster and more efficient than traditional research, remote-controlled research still has some drawbacks. In the area of remote-controlled research, a special role is played by research done by means of satellites. However, the study of vegetation done with financially acceptable satellite images can be quite imprecise. Low resolution (more than 30 meters), as well as the appearance of clouds in certain areas, can render these recordings unusable for this type of research. With the advent of drones and unmanned aerial vehicles, analyzing vegetation becomes a lot easier and more accurate. This technological tool is essentially a robot that can be controlled using the remote control or can fly autonomously; the flight plan is software-programmed with the use of GPS, from point A to point B without direct human contact. Thanks to their small size and aerodynamics, drones can fly low above the ground and thus record more precise information than satellite images or manned aircraft. They can fly below the clouds, which gives them an advantage, especially in tropical areas where clouds often obstruct satellite images. According to expert estimates, drones flying at an altitude of 200 meters can make photos with a spatial resolution of up to 6 centimeters. The few drawbacks to using unmanned aircraft are: flight time limit, onboard camera weight limit, weather conditions (wind, rain), flight prohibition in controlled areas (airports). However, these shortcomings are negligible compared to all the advantages that drones possess.

### **1.1. Study Objectives**

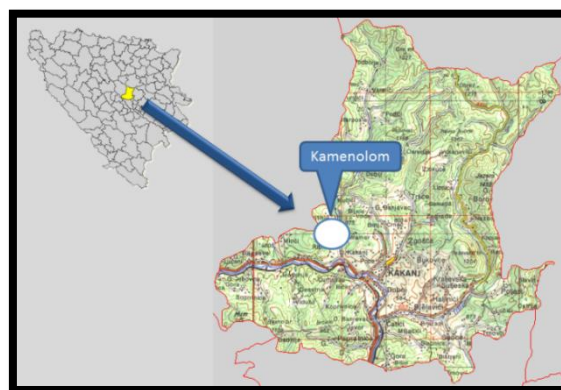
Mapping habitat types in the area of the Ribnica quarry aims to create insight into all participating habitats, as well as their distribution and conservation measures. These are the essential data for any other environmental research in this area. Based on maps of habitat types, non-degraded habitats can be preserved, while degraded habitats in areas which no longer see anthropogenic activities in the

quarry can be rehabilitated. Also, it is possible to plan further activities in the quarry by means of preserving as many habitat types as possible. The aim is also to show how the mapping of habitat types done by utilizing modern technology is much faster, more accurate, and cheaper than traditional means of mapping.

## **2. Methodology**

### **2.1. Decription of study area**

The region of central Bosnia and Herzegovina, whose biodiversity is very specific, was especially researched in the areas of high mountain ranges, until recently scientific research progressively developed in the direction of the study of ecosystems and landscapes of mountain areas, canyons and gorges. The study area, quarry Ribnica, is located in the area of internal Dinarides within the central Bosnia, in the Sarajevo-Zenica area. These terrains have hilly-mountain character, and are rugged with alluvial plains with very complex petrographic composition (Stefanovic et al., 1983). It is located 10 km northwest of Kakanj on the west bank of the river Ribnica. According to scientific research Barudanović and Mašić (2012), in the canyon of the Ribnica the great heterogeneity of habitats is represented. The diversity of flora, fauna, fungi and landscapes abounds with specifics that are result of orographic process, the process of pedogenesis and klimageneze. There is also a large variety of abiotic conditions: geological substrates, complex edaphic, hydrographic, microclimate and other factors. This area is heavily exposed to the effects of anthropogenic factors resulting in an imbalance in natural ecosystems. This activity is reflected in the activities of the quarry "Ribnica", based on rock exploitation.



**Figure 1:** Location of the quarry Ribnica

### **2.2. Materials**

For data collecting we used DJI Phantom 2 drone with GoPro HERO 3+ black edition camera (figure 2), Zenmuse H3-3D Gimbal, and Boscarn RX LCD 5802 display, wich enabled real-time observation of the study area by drone (figure 3).



**Figure 2:** GoPro Hero 3+ black edition



**Figure 3:** DJI phantom 2, Boscarn RX LCD 5802 display

Zenmuse gimbal H3-3D (Figure 4) allows the stability of the camera so the photos can be taken while the drone is in motion. While flying, drone is leaning in different directions, along with a camera. Gimbal operates on gyroscope principle, and thus stabilize the camera, keeping it in the same position regardless of the movement of the drone. Gimbal also reduces the 'blur' effect, which appears in photographs taken in the motion. Without gimbal, drone would have to hover in place while taking pictures, which would slow down the whole process of data collecting. Rubber parts at the top gimbal prevent the transmission of vibrations (that drone engines produce) to the camera and thus enables stable image (which is important when shooting videos). Thanks to Boscam RX LCD display 5802 (Figure 5) it is possible to 'see' the aerial photo at the moment when it is taken. This way, movement of the drone is proceeded in the exact way to make photos that overlaps by 25% at least, which is essential for second phase that include image editing



**Figure 4 :** Zenmuse H3-3D Gimbal with GoPro camera



**Figure 5:** Boscam RX LCD 5802 Channel Diversity Receiver Monitor

## 2.3. Methods

Working methods involve two steps: Fieldwork and data processing.

### 2.3.1.

#### Fieldwork

The first step was to take aerial photos of the study area. Five representative pilot areas have been chosen (Figure 6). Two pilot areas are located above the quarry floors, one includes vegetation around quarry facilities, and another one includes vegetation just above the highest floor of the quarry. Other three areas are under the quarry floors: one is directly below the lowest floor, second one is around roads in the quarry and third one is around the river Ribnica. The choice of pilot areas was based on aerial photos with resolution 0.5m and videos made with drone. During research we made around 420 aerial photos and 5 videos. We have used videos to observe the terrain and to pick pilot areas, and then we systematically photographed selected areas. Due to some issues with software that connects a smartphone with a camera (losing the wifi connection), the camera was programmed to shoot photo every 10 seconds. Our drone was flying about 50 m above the base and was moving along a flight path (Figure 7) at a speed of about 5 m / s. Zenmuse gimbal enabled taking photos while the drone was in motion so we did not have to stop the machine before each photo is taken. It is very important that the images overlap by at least 25%.



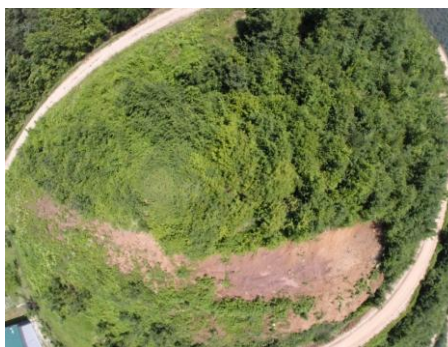
**Figure 6:** Pilot areas



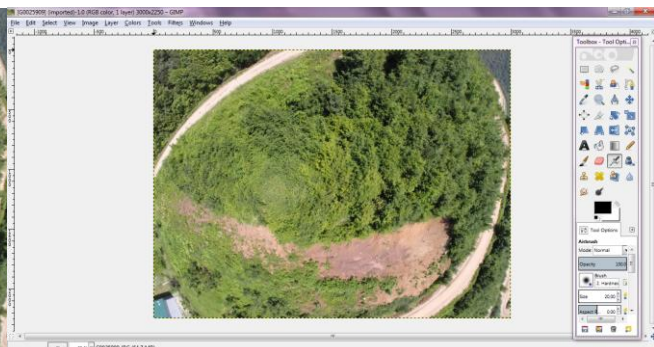
**Figure 7:** Scheme of drone's flight path

### 2.3.2. Data processing

The first step of data processing was removing the 'fish-eye' effect. Fisheye effect creates a strong visual image distortion. Photos have convex shape and linear objects on the photo are distorted (Figure 8). This effect occurs at the lens with ultra wide-angle shooting. It is often intentionally used in photography as „art effect“, however, for the purposes of mapping, it is necessary to be removed. Fisheye effect was removed by using GIMP2 software. First, it is necessary to import images into the software (Figure 9).



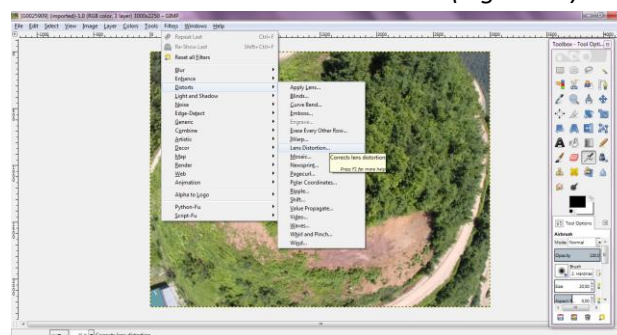
**Figure 8:** Fisheye effect



**Figure 9:** Importing images into GIMP 2 software

Then in the toolbar choose:

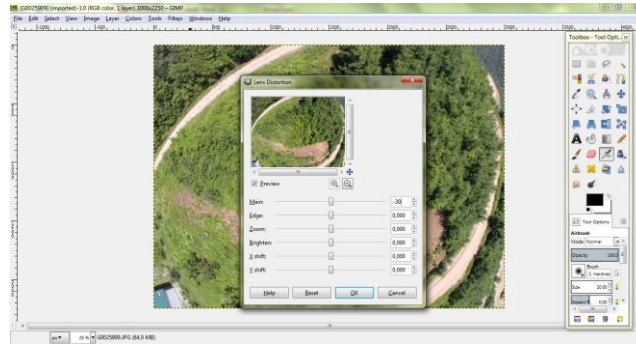
*Filters> Distorts> Lens Distortion (Figure 10)*



**Figure 10 :** Choosing option *Lens Distortion*

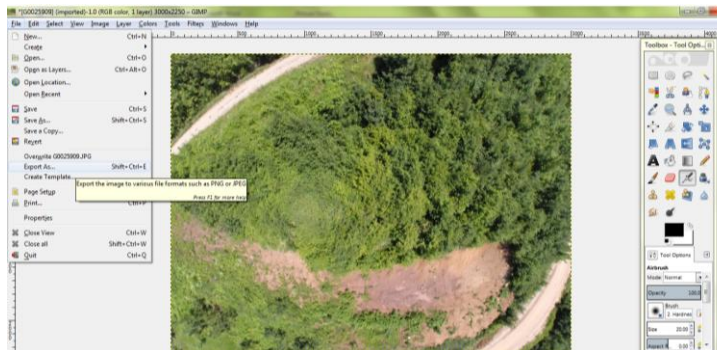


By changing the parameters the fish-eye effect has been removed (Figure 11)



**Figure 11:** Changing parameters

After changing parameters the photo was exported by choosing option *File > Export As* (Figure 12). The final result is photo without fisheye effect (Figure 13).



**Figure 12:** Exporting



**Figure 13:** Final result

When working with a large number of pictures (over 400 in this case), it is useful to learn shortcuts to speed up the job. Just adjust the settings in the Filters for the first picture. Each additional image can be edited only by pressing *Ctrl + F*, thereby carrying out the same changes as in the previous. Also, exporting goes much faster shortcut *Shift + Ctrl + E* is used.

### 2.3.3. Data processing in ArcView software

GIS methodology includes the steps of:

1. Data collection and processing of existing data, which includes the preparation of ortho-photo images and adequate topographical maps, as well as the preparation of the project in ArcView software. Then, field research with collecting GPS data, to locate species and plant communities and their distribution to the study sites, has been performed.
2. Analysing and creating the following geodatabases based on collected data, by using ArcView GIS software. Basic map-unit correspond with an area that has homogenous cover (grass, forest, water, rocks, etc.) or a combination of elementary zones (homogeneous) which is a characteristic structure of land cover (cover larger areas that make a type of land cover). In terms of size, this unit represents a significant area of land, which is clearly different from the surrounding units. Also, the structure of land cover is stable enough to serve as a unit for collecting precise information. When defining the basic units, it must be clear that in the nature, the soil cover always appears as a combination of surfaces that are more or less homogeneous / heterogeneous, regardless of the scale that is used. Creation of thematic maps was done in ArcView 3.2 software. Habitats are mapped as a separate vector layer (polygon) which included the following habitat types: primary, secondary, tertiary and aquatic habitat. Each type of habitat is associated with attribute data that included a description of the type of habitat,

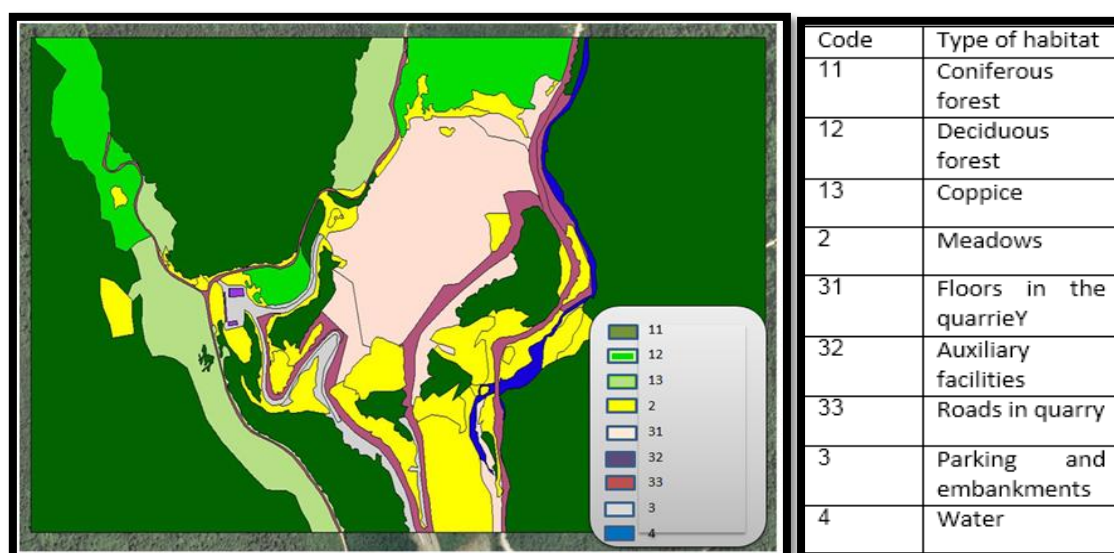
where each separate type is shown with different color. For defining the type of habitat, data obtained by field surveys, data from aerial images and data from map of forest vegetation from 1979. were combined. According to a map of forest vegetation (Figure 14), (Stefanovic and Beus, 1979), the area around the quarry Ribnica were represented with the following communities: *Fagetum montanum* (11), *Seslerio - Fagetum*, *Ostryo - Fagetum*, *Acer obtusati - Fagetum* (17), *Pinetum sylvestris* (31), *Quercetum petrae - montanum* (51), *Querco - Carpinetum* (531)



**Figure 14:** Map of forest vegetation of the area around the quarry from 1979, scale 1: 200,000  
(Stefanović Vitomir, Beus Vladimir)

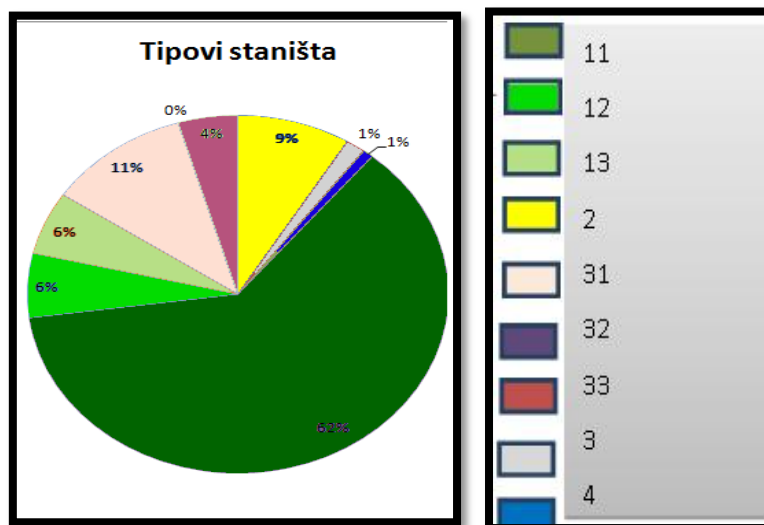
### 3. Results and discussion

The results of the field and GIS data processing showed that, in the study area of the size of 96.401 ha, are nine habitat types (Figure 15).



**Figure 15:** Map of habitat types

Dominant are coniferous forests (59,619 ha), which occupy 62% of the entire area (Chart 1). On secondary habitat types, dominant are meadows that cover an area of 8,424 ha (9% of the total study area). Tertiary habitat types occupy an area of 16,511 ha, mainly floors of the quarry - 10,639 ha.



**Chart 1:** Percentage of habitat types

Analysis of the data collected in the field showed that in the area of the quarry rayon are four categories of habitat types: 1. Primary habitats, 2. Secondary habitats, 3. Tertiary habitat types and 4. Water habitat.

#### 1.1. The primary habitats

These habitat types include primary ecosystems (Figure 16) which are represented in the form of: coniferous forest (A), scrub (B) and deciduous forests (C).



**Figure 16:** Types of primary habitats; A) conifer forests; B) Coppice; C) Deciduous forests

The most common are coniferous forests with 62% of the surface, while deciduous trees take 6% and shrubs take also 6% of the study area.

#### 1.2. The Secondary habitats

These habitats include secondary ecosystems where primary production decreased for 33% compared to the primary ecosystems, and in this area is represented as meadows (Figure 17) and take 9% of the study area.





**Figure 17:** Secondary type of habitat - meadow

### 1.3. The Tertiary habitat types

Tertiary ecosystems are degraded habitats (Figure 19), which is characterized by very large anthropogenic influence (over 66.66%). In the area of the quarry Ribnica are represented as: floors of the quarry (A), auxiliary facilities (prefabricated offices and parking) (B), roads through the quarry (C).



**Figure 18:** Tertiary habitat types

Floors of quarry occupy 10,639 ha (11% of the area), roads 4,438 ha (4%), parking and road embankments around 1,413 ha (1%), while the auxiliary objects are negligible size.

### 1.4. Aquatic habitats

Aquatic type of habitat is a river that flows through Ribnica quarry and occupies 1% of the entire area (Figure 19).



**Figure 19:** Aquatic habitat – river Ribnica

After analysis of habitat types, the degree of threatness and conservation status of each of these habitat types was determined, in aim of suggesting conservation measures and management according to a sustainable basis. Based on the results of these analyzes, it is possible to conclude that



the best preserved habitats are primary ecosystems that are far away from the floors of the quarry where exploitation is done, and where there are no anthropogenic influence, while at least preserved are those habitat types which are under direct anthropogenic influence (floors of the quarry, roads, dams, etc.). Based on the available literature data, especially data from the final report of Quarry Life Award project entitled "Biodiversity and REMEDIATION OF THE QUARRY RIBNICA" (Đug, S. 2012) and our own observations in the field, it can be said that vegetation was presented by plant communities (level of class and association) that are listed below. Broadleaved trees and shrubs belong to the class *Querceto-Fagetum* Br.-Bl. Et Vlieger 1937. Forest plant communities (associations) which are dominant in the area of the quarry Ribnica are *Querceto-Carpinetum betuli* (H 38) em. Bleč. 58 (community of oak and hornbeam), *Acer obtusati Fagetum moesiaca* Fuk. Et col (63) Fuk. 67 (endemic community of thermophilic forests of Bosnian maple *Acer obtusatum* and Moesian beech *Fagus moesiaca*) and *Quercetum montanum petraeae illyricum* Stef. (61) 64 (community of sessile oak), while conifer forests are described by association *Pinetum sylvestris dinaricum* Stef. 58 (community with white pine). Meadow habitat type are described by classes *Plantaginetea maioris*, with representative species *Taraxacum officinale*, *Trifolium repens*, *Trifolium*, *Bellis perennis*, *Poa annua* and others., and class *Chenopodietea* with representative species: *Ballota nigra*, *Tussilago farfara* and others. The final result of the project is the map of habitat types printed on a waterproof material and delivered to the quarry office, with the aim of informing and educating employees and visitors, and for planning future activities in this area (Figure 20).



**Slika 20:** Izgled mape tipova staništa za informisanje i edukaciju u kamenolomu

#### 4. Conclusion

A detailed analysis of data showed 9 types of habitats in the quarry. According to the level of preservation, they are classified into different categories. The first category are the primary types of habitats: coniferous forests, deciduous trees and shrubs. Secondary type of habitat are meadows. Tertiary habitat types are anthropogenic features: floors of the quarry, the quarry roads, embankments around roads and auxiliary facilities. River Ribnica that flows through the area of the quarry represents aquatic habitat. Despite extremely strong anthropogenic pressures on this area, diversity of habitats and vegetation cover indicates that the exploitation of resources in the quarry can not stop existence of wildlife. The employees should keep acting towards for preserving it and promoting its diversity. It can be concluded that the use of modern methods in ecological research significantly brings to more precisely information with less time needed for research, and all that for the main aim: conservation of biodiversity and conservation of habitat types in the study area.

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