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GIS solution for coastal area protection in Republic of Croatia

1. Introduction

The Adriatic Sea, its islands and coast are one of the biggest ecological and economical riches of Croatian Republic (RoC). Inshore ground and islands are situated over the area of seven State-Countys with altogether 1.427.000 inhabitants, and centers of five Towns (Rijeka, Zadar, Šibenik, Split and Dubrovnik) are situated on the coast. On the 5790 km long seacoast are situated 24 Settlements with more then 5000 inhabitants, and six cities with more then 30.000 inhabitants. RoC has about 1200 islands, cliffs and rocks, and out of that number 66 are inhabited islands. Besides coastal industry and shipbuilding, of superior economic importance for the entire state are tourist activities in coastal area and islands. We should not forget traffic importance and potential of the Adriatic Sea. In the coastal area are also situated three National Parks and some Nature Parks.

Unfortunately, because of general carelessness, bad regulations, contempt of regulations as well as absence of continuous supervision and protection of coast and islands, we are witnessing daily devastation of the coastal area by illegal and unplanned building of catering establishment and apartment colonies.

To prevent further devastation of the most valuable coastal area, in Law of amendments for Physical Planning (Republic of Croatia, 2004.) July 2004. y. Croatian parliament defines **protected coastal area (PCA)** of speciall interest for RoC, as an area, which contains all the islands, area that spreads 1000 m from the coastline inland and 300 m in to the sea. Two months later the Government of the Republic of Croatia brings in the Act about land restructuring and coastal area protection (Republic of Croatia, 2004.), which states that physical planning inside PCA will be based so as to preserve natural, cultural, historical and traditional values, environmental protection, and resources of drinking water, map administration and protection, public interest in exploitation, recovery of endangered areas, preserving uninhabited islands, natural beaches and forests, restrict building and expanding buildable areas. This Act has defined protected coastal area and has describee in detail conditions and criterions for construction and implementation of spatial maps. SGA has been obliged

by this Act to define borders of the protected coastal area on Croatian base maps in scale 1: 5000 supplements with Digital Ortho photo maps **within 30 days**.

Because of task complexity and shortage of time, and according to the abilities of modern computer technology and the existing fund of digital spatial data, SGA, in cooperation with Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC) initiates the project to design and construct an appropriate computer application that will be enable an up to date and relevant way to meet the undertaken task.

2. Project law background

Protected caostal area (PCA) was for the Legal Background of the Project first time mentioned inside Law of amendments for Physical Planning (Republic of Croatia, 2004.) in accordance with which it is decided in paragraph 45a that PCA includes all the islands, and the area that spreads 1000 m from the coastline inland and 300 m in to the sea. PCA has been defined with the intent to protect the coastal area, and its finaly, workable and economically effective exploitation and it is of major interest for RoC. Consequently, it has also been decided that inside PCA it is not possible to build without urban planning, apart from infrastructure objects out of the construction area margin according to the relevant Act of urban planning. All Physical plans within the protected coastal area as well as plans whose are partially within that area, must obtain an approval from MEPPPC.

Pursuant to Article number 45. Item number 1. Law for Physical Planning, the Government of the Republic of Croatia at the meeting held on 9'Th of September 2004 made a decision about land restructuring and coastal area protection (Republic of Croatia, 2004). The passed Act must be applied on the procedure of manufacturing and deciding on Physical Plans, as well as in procedures of their execution. As it has been said before, PCA includs all the islands, and the area that spreads 1000 m from the coastline inland (in terms of this decision is the line of bore on the coast) and 300 m in to the sea from the coastline, and is inscribed on Croatian base maps in scale 1:5000 supported with Digital Ortho photo maps. That Physical planning inside PCA will help conservation and prevention of environmental, cultural and traditional values of coastal landscapes as well as planning of complete organization of coast and islands. The Government's Act also regulates terms and criteria for production and implementation of Physical plans, in terms of restriction of allowing new building areas and upgrading the existentones, whether for individual buildings or different types of buildings, port planning and coastal earthwork.

In Article number 16. the Government decision about land restructuring and coastal area protection, SGA is obligeded in a period of 30 days from the day of this Act coming into effect to inscribe the border of PCA on Croatian base maps supplement with Digital Ortho photo maps. This project was conducted in cooperation with State Geodetic Administration (SGA), Ministry of

Environmental Protection, Physical Planning and Construction (MEPPPC) and company Zavod za fotogrametriju Inc Zagreb, Croatia which has realized this whole idea.

Hypothetical computer application has been developed in two phases. In the first phase, the coastline i.e. PCA, was designated without considering the importance of joining of land waters, i.e. deltas and canals with the sea. Unlike the firstone, in the second phase considered Agreement on establishing the line between maritime delimitations and land waters, consolidated between State Directorate for Water Management and Ministry of Maritime Affairs, Transport and Communications (Republic of Croatia, 2001). The above mentioned Act establishes the line between maritime delimitations and land waters in relation to deltas that mount in sea and canals joint with sea, altogether on 26 locations.

3. Development of computer application for PCA

After adopting Act of amendments for Physical Planing, SGA is predicting its own responisilities inside this Law and considering how to deal with expected tasks. Two different ways of solving the task of inscribing of area boundary on corresponding cartographic backgrounds have been considered. One way is digital cartographic process with the final product – a map with inscribed boundary line – in analog form, i.e. "on the paper". The other way suggests that the result of digital cartographic process be digital review PCA. If you look at advantages and disadvantages of both ways and considering the expected short time for delivery, SGA has decided to use the second way, i.e. to make digital review with GIS solution, which will allow reviewing PCA boundary line with corresponding cartographic backgrounds and the possibility to simply explore through geographical or administrative names.

By being made public the Government decision about land restructuring and coastal area protection, SGA becomes formally obliged to draw PCA boundary on cartographic background. The Act specifies that PCA boundary must be drawn on Croatian base map in scale 1:5000 update with Digital Ortho photo map, which was earlier unknown and thus the main reason why we couldn not start preparing the project.

Right after the publication of the Act, the cooperation of SGA and MEPPPC, as well as the representatives of Zavod za fotogrametriju Inc, which was chosen as technical support, was stepped up. The conception of application was determined at numerous meetings.

3.1 Sources

3.1.1 Cartographic backgroung

As it is regulated in the Act, cartographic background for laying PCA border is Croatian Base Map in scale 1: 5000. Sheets of that map cover the whole coastal area and almost the entire island area except a few islands (Silba, Olib, Premuda, Lastovo, Mljet and a part of Vis), data contents mostly corresponding to the state in 1970s and 1980s.

In the context of its activities SGA has over several past years conducted scans and georeferences of sheets of CBM (Croatian Base Map). Only the sheets that cover the subject area have already been scanned and georeferenced, but as works were done repeatedly and by different performers, the final results were not equal and consistent. Adjustment and data processing of large number of raster files requested increased the engagement of human and computer resources. The results of that processing were 1624 sheets of CBM in digital raster (TIF) format, in color, with georeferencing data (TFW).

3.1.2 Coastal line

Protected coastal area is defined by the distance from the coast line. As this line has never been determined from terrestrial sensing, which would request long term measurements, the same is taken in the shape of the coastal line mapped from photogrammetric shooting in scale 1: 20 000 in the process of producing a new topographic map in scale 1: 25 000 (TM 25). SGA has been producing sheets of TM 25 since 1996, and till now 2/3 of state area has been covered or is in the process of making. About 70% of near coast area has been covered with sheets of TM25 in different stages of production. Coast line data in digital vector form have been detached from digital data of TM25. According to TM25 specifications, positional accuracy of this data is 1 m for well defined and built objects (in this case: concrete or stone coast, pier, breakwater, pier etc.) and 3 m for less defined, natural objects (natural coasts and beaches).

As new TM25 still does not exist for the whole coast and island area, for about 30% of the area, the coast line which was vectorized from scanned TM25 published in 1970s in earlier projects was taken.

3.1.3 Administrative boundaries

For the needs of spatial browsing and positioning, state and administrative boundaries data in Croatia taken from Official register of spatial entities of SGA in digital vector form were included in the application (see Picture number 1).
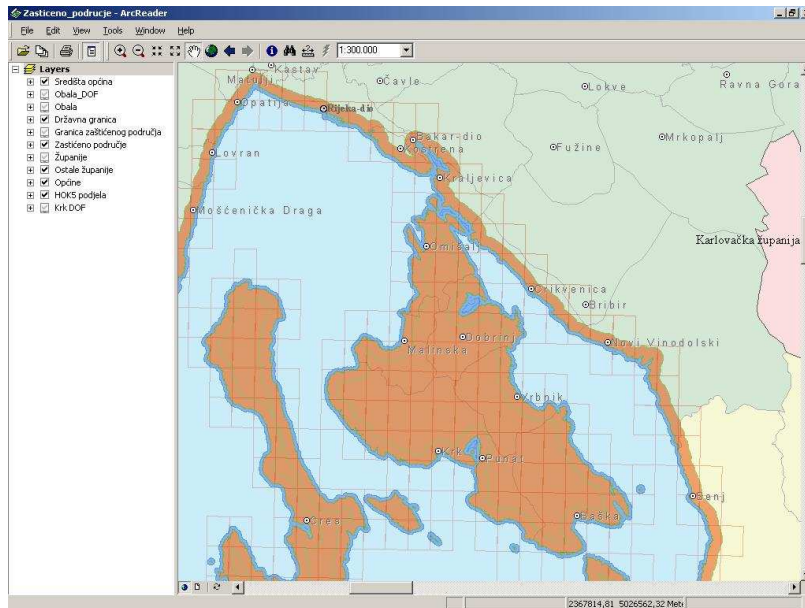
Picture number 1: Data View window with administrative boundaries and PCA boundary line

3.1.4 Digital Ortho photo

The Act regulates PCA charting on CBM completed with ortho photo display. Since the formulation is not totally clear, and digital ortho photo (DOP) in the scale of 1: 5000 is not made for the most part of subject area, same refers to DOP in the scale 1: 2000, which SGA produces only for special needs of cadastre survey executions. Introducing DOP in the application is solved on the level of several patterns, i.e. area covered with two sheets of CBM i.e. DOP 1:5000 in color of the area of island of Krk (see Picture number 2).
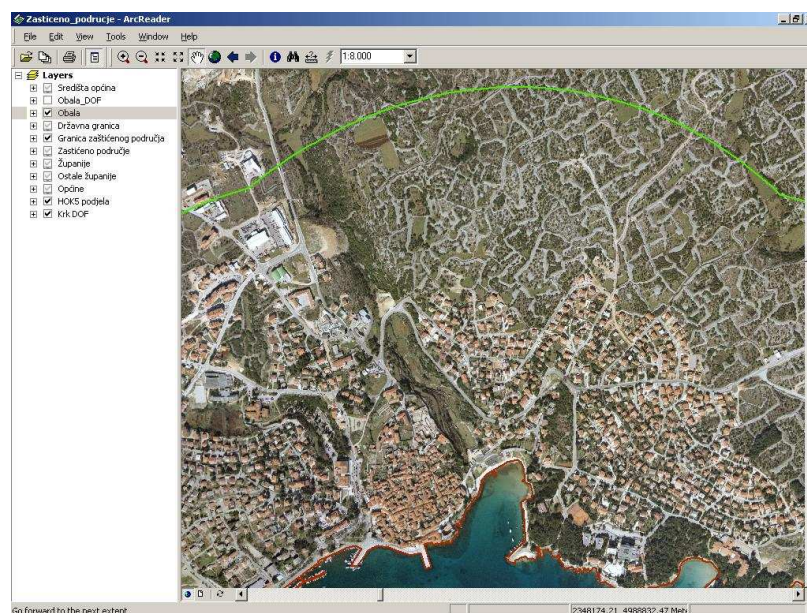
Picture number 2: Data View window with Digital Ortho photo map in background

3.2 Making the application

Application conception, which was accepted in coordination of SGA, MEPPPC representatives and technical part of work performers, was complex and demanding, especially if the very short term for performance is taken into consideration. It was obvious that application would be made in GIS surround and with usage of existing GIS program platforms. The production of a new application that would not lean on existing commercial programs would demand much more time. Also, the chosen platform had to have the ability of viewing and searching data by using simple and free software.

After reviewing the abilities of different program packages, it was decided that products of American company ESRI will be used. GIS and data cartographic processing were done using program packages ArcGIS and ArcPublisher, and free software ArcReader of the same house was used as data reviewer. Performed operations included:

- coast line data processing and PCA production,
- processing and loading cartographic background,
- processing data of administrative division and settlements,
- making application introduction part,
- making data reviewer,
- making short instructions for using data and application,
- Preparation for data delivery.

3.3 Description of application for PCA

For using PCA application a computer with Windows operating system and USB 2.0 port is required. Application and data are on a disk size 200 GB for whole Croatia or 40 GB for each county. The disk is built in a portable case with its own power supply, which is connected to computer trough USB 2.0 port. Application is automatically started after connecting the disk or choosing adequate command.

As mentioned earlier, the application consists of introduction part and data reviewer. By opening the application, you open the first page (slide) of introduction part on which is the name of application, state institute that had ordered and made application, legal fundament and the name of the company that had made technical preparations. Clicking a mouse opens the following page with annotation about basic information of the content and the way to use the application. The next page gives a warning with the purpose of protecting the data from illegal usage or distribution, and the following page gives information about basic software and hardware configuration for using the application. The last page of the introduction part enables the user to install and/or start free reviewer (ArcReader) and data review. In the application version with data for the whole Croatia at this point can be selected the state-county to be viewed.

By opening data reviewer the picture with vector boundaries of state-counties is presented. Further enlarging of the picture or changing scale of presented picture we can see how the content of review is changing; in other words, a larger scale is giving a more detailed review. By a huger scale (1:10 000 and more) is presented cartographic background - Croatian Base Map with PCA boundary line. Data reviewer enables easier searching and positioning through local autonomy entities (city/municipality) or through populated cities bigger than 1000 inhabitants, as well as the distance measuring, printing and other easier actions.

3.4 The presentation of application for PCA

The developed application for protected coastal area has been presented to Minister Mrs. Matulović-Dropulić and her cabinet and other associates Ministry of Environmental Protection, Physical Planning and Construction on time according to Government regulation. The Product was very well appraised, and it was arranged that State Geodetic Administration would undertake the distribution of those data for all potential users.

Immediately afterwards, the application was presented to the chairmen of state-county departments for Physical Planning. On this occasion every chairman was given a portable disc with data for each single county together with the instructions for usage, and a CD with data of protected coastal area in different forms (DWG, DXF, and E00).

4. Using application for pca and future development

4.1 Working with application

After starting the application, we can see the preliminary pages (a fore described introduction part of application) of all kind of information about how the data was produced, as well as the Government act and other regulations, which were used in creating these pages. With one click on the mouse we can open the application in ArcReader where the display is divided into two windows, with the table of contents lists data views (layer legends) on the left and display area (where the map features draw) on the right side (see Picture number 3).

In our case in data view window we can see vector data (boundaries) and raster data (cropped and georeferenced Croatian Base Maps), also in table of contents lists organized data frame as container for the same vector datasets (feature layers) and raster datasets (raster layers) on the map. Data separated in layers are displayed in data view window in different scale ranges (for example from M 1: 10 000 000 to M 1:300 000). The ranges are determined in accordance with the size of displayed territory and are presented per importance. A check box next to a layer indicates whether it is currently

visible on the map. The active layer appears in bold font in the table of contents (Bockenhauer Mark; Clark Kristin, 2002.).
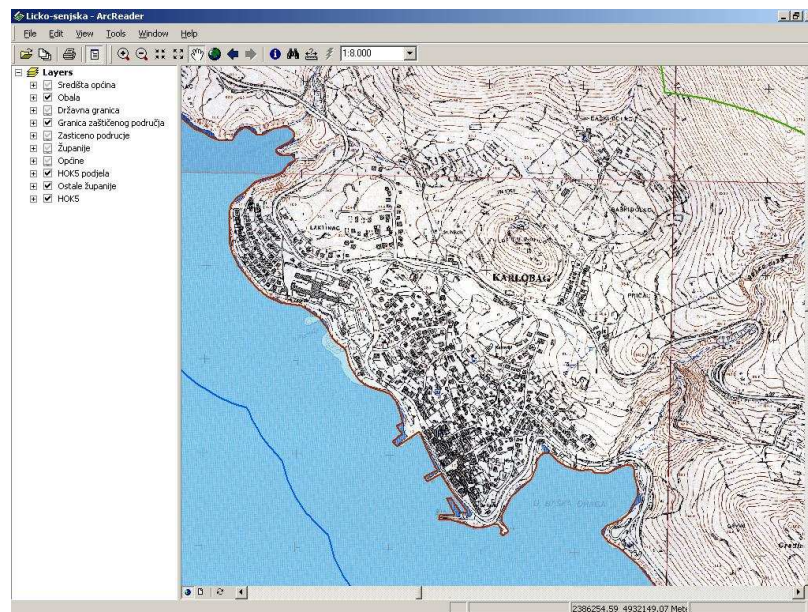
Picture number 3: Final look of application for protected coastal area

Identify features tool allows you to display the attributes for any feature you click on with your pointer. If you want to search for attributes you can search in all layers in your map or just in a specific layer. You can also choose to search all the fields (coast, state-county, city/municipality and CBM etc.), specific fields, or each layer's primary field for the appearance of the string you typed earlier. After the search is over, the window expands to reveal the findings. You will work in Data View, if you want to display, explore and analyse the data. When you choose to create a hard copy map, you need to move to the Layout View for printing the area of interest in the wanted scale.

4.2 Distribution application and vector data of PCA

Distribution vector data for PCA or produced application for local autonomy entities (city/municipality) and for all potential users for the purpose of making physical plans has been undertaken by State Geodetic Administration. Through Regulations for setting the costs for using the data of State geodetic measurements and real estate Cadastre (Republic of Croatia, 2003.) the price for publishing this product has been determined. Application for PCA for areas of a city or municipality in protected coastal area is identical to the developed application for area of state-county described before, with the diference that for preparing data for PCA, CD or DVD ROM is used depending on the number of raster location maps of the requested area.

4.3 Enlargement and improvement of application

Short term of delivery did not allow the possibility of making tests and optimizing all the data and application. Hence the first version of application needs large memory capacities (disks), because of large number of raster data, which results in decelerating work with application. Optimizing data can decrease the large quantity of data so that the data for one state-county are reduced and thus can be saved on DVD ROM, and work with application is speeded up. This is visible by the distribution of application for PCA for areas of city or municipality, where the data are separated along specific smaller entireties and they are distributed on CD ROM, which has sped up work with application.

With this digital vector border protected coastal area shown on Croatian Base Map, SGA has made possible the further work scheduled by the Government decision, which is to make physical plans for areas of city or municipality. Because of relatively out-dated CBM raster data, the next step will be to load Digital Ortho photo maps in scale 1:5000 with latest information on buildings and other objects, into application. Further work may start by loading Cadastre plans into application, so that the position of every single parcel in respect to the PCA border can be determined. Besides further work on cartographic background data inside of PCA application, we are considering distribution of those data through Intranet or Internet.

5. Conclusion

The final product is an independent application appropriate for installation from hard disk, DVD ROM or CD ROM, dependent on the size of requested area, which will allow reviewing PCA boundary line with corresponding cartographic background and the possibility exploring geographical or administrative names (coast, state-county, city/municipality and CBM etc.) in a simple way.

The described application possesses good layout qualities of articulate and functional view, easier searching and positioning, distance measuring, printing the area of interest in the wanted scale, and it is also independent from commercial (sales) software.

We predict this application will be expanded with loading Digital Ortho photo maps in scale 1:5000 (test area of island of Krk) into application, and larger scale maps - Cadastre plans in scale 1:2000 and Digital Ortho photo maps in scale 1:2000, also new coastal line mapped from photogrammetric shooting of all the protected coastal area in the Republic of Croatia

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GIS solution for coastal area protection in Republic of Croatia

Abstract

Croatian Government has decided to protect its coastal area from illegal building, which has resulted in protected coast including all the islands and area that spreads 1000 m from the coastline inland and 300 m in to the sea. This project was conducted through cooperation of State Geodetic Administration (SGA), Ministry of Environmental Protection, Physical Planning and Construction, and finally a company, which has realized this whole idea. Hence, the GIS application using ArcGis software was created, as well as vector coastline with Croatian base maps at scale 1:5000 in background. This application guarantees user articulate and functional view using specified data also explore location of interest inside the protected coastal area. Distribution of those data for area planning purposes on the Adriatic coastline is undertaken by State Geodetic Administration. The high number of requirements endorses the value of the product. The next step will be replacement of Croatian base maps with Digital Ortho photo maps for background.

Keywords: protected coastal area, Government act, software application, Croatian Base Map, Digital Ortho photo map.

Sažetak

U rujnu 2004. godine Vlada Republike Hrvatske donijela je Uredbu o uređenju i zaštiti zaštićenog obalnog područja mora (ZOP-a), gdje je Državna geodetska uprava (DGU) obavezana ucrtati granicu ZOP-a na Hrvatsku osnovnu kartu (HOK) dopunjenu ortofoto (aerofoto) prikazom. U suradnji s Ministarstvom zaštite okoliša, prostornog uređenja i graditeljstva (MZOPUG), Državna geodetska uprava (DGU) oblikovala je i izradila odgovarajuću računalnu aplikaciju, koja na pregledan i funkcionalan način, omogućuje korisnicima pretraživanje podataka, pozicioniranje na lokaciju po izboru i uvid u zaštićeno obalno područje. Tehničku podršku izvedbi aplikacije dala je tvrtka Zavod za fotogrametriju d.d. iz Zagreba. Distribuciju podataka ZOP-a za potrebe izrade prostornih planova preuzela je DGU, a količina zahtjeva potvrđuje vrijednost izrađenog proizvoda. Budući razvoj aplikacije odrazio bi se postupnom promjenom Hrvatske osnovne karte (HOK-a) u pozadini s Digitalnom ortofoto kartom (DOF).

Ključne riječi: zaštićeno obalno područje, Uredba Vlade, računalna aplikacija, HOK, DOF.