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WEB APPLICATION IN PROTECTION OF COASTAL VEGETATION AND PROMOTION OF LANDSCAPE VALUES OF SELECTED WATER RESERVOIRS NEAR KRAKÓW

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ABSTRACT

The subject of this paper is a possibility of using web applications to present the diversity of coastal vegetation as a phenomenon that has a spatial character as well as to promote landscape values and to protect the environment. Web applications supporting environmental protection and development are usually the result of previously carried out field tests – observations, measurements and others. Often they are created based on previously prepared spatial information system. In the paper a sample web application for two water reservoirs: Kopalnia and Wołowice (Przeginia Duchowna, Czernichów commune, Małopolska province) was presented. It was prepared based on a chosen programming tools and techniques, and field tests. Building of this application was determined by its educational, multimedia and interactive character, whereas coastal vegetation tests were the base for its creation. As a result of carried out phytosociological tests, diversity of coastal vegetation was stated. Despite the fact that it is difficult to determine the direct influence of the web applications on the environment protection and landscape values of a given region, they can be indicated as a tool that puts information pressure, i.e. influences the outlook and shapes environmental awareness of its users.

Key words: rural development, web applications, Internet map service, tools and programming techniques

INTRODUCTION

A man is at the same time the creature and the creator of the environment. The environment provides him with physical existence and moral, social and spiritual growth [Jacniacki 1989]. Technical progress, the development of all scientific disciplines, technology, computerization and motorization are inevitably connected with exploitation of the environmental resources and degradation [Król, Gola 2005].

M. Castells [2000] described a modern society as a 'network society'. The Internet as a medium of sharing information plays a crucial part nowadays [Szymielewicz, Mazgal 2011].

A huge potential of the Internet was quickly discovered [Duckett 2008]. Spatial data access through the Internet websites was initiated in the mid 90's of the 20th century. Nowadays many GIS systems function in a distributed network Internet/intranet. The Internet and web applications make using of the GIS technology possible. They allow to reduce costs, provide a fast data transfer and significantly make information search easier. The preparation of specialized map websites, which gather spatial data, allowed their users access not only to this data, but also to geo-information services [Bartelme 2005, Gotlib and others 2007].

Information that is accessible on the Internet is attainable everywhere: from simple, twenty-four-hour news, through portals which offer a specific knowledge, to highly specialized databases, available to specialists. Maps (spatial mapping), i.e. eliciting information about given spatial elements, is the most popular way of using access to the information [Dziubiński 2012].

Web applications are a special kind of software. Their tasks are processed on the server and then delivered to the end user through the net – Internet or intranet. In order to run the application the user uses the browser, which can generate data from the server and display them. Currently the way applications used by people work is even more important than in the past. Previously people working with computers were mostly familiar with technology, today computers users' circle is much wider [Darie and others 2006].

There are more and more web applications which support environmental protection and development. They differ in a degree of usability understood as an access to different functionalities, which usually is the result of methods and techniques used to prepare them. An exemplary applications supporting environmental protection and development are the ones which give the user information on: gradient and inclination of slopes, vegetation, woodiness [Temiz, Tecim 2009], firmness of soil, precipitation, they are also the ones based on maps and models of water erosion in soils [Drzewiecki, Mularz 2001], hydrodynamics models (flood danger and risk) [Banasiak 2012, Helis, Górecki 2013] or allowing to make a decision about management and agricultural works. A different application can be a map website based on the map of wind strength, which makes deciding about localization of wind power plant easier. Another application supporting environmental protection and development can be a website that presents a noise map for a chosen region (an acoustic map), which is made based on measurements of the road, railway and tram or industrial noise. A different example of a web application is an interactive address system based on a road map of a given commune, which can be used to inform people about changes in streets names and buildings numbering. A flagship web applications are spatial plans published in the form of an interactive map websites and Geoportal (geoportal.gov.pl) – a central access point to spatial data [Brylski 2011].

MATERIALS AND METHODS

The aim of the paper was to prepare an exemplary web application, which – through fulfilling educational functions – would be used in coastal vegetation protection as well as in landscape promotion of chosen water reservoirs near Kraków. Additionally, the purpose of this work was to indicate that interactive web applications prepared on the basis of chosen programming

tools and techniques can be used to present the diversity of coastal vegetation as a spatial phenomenon.

The web application was prepared based on chosen programming tools and techniques for two water reservoirs: Kopalnia and Wołowice (Przeginia Duchowna, Czernichów commune, Małopolska province). Building of this application was determined by its educational, multimedia and interactive character, whereas coastal vegetation tests were the base for its creation.

Tested water reservoirs characteristic

Tests that were used as a base for web application were carried out on reservoirs chosen from a several pit reservoirs in the Czernichów commune. Reservoirs were selected because of their localization near Cracow, which suited the authors and was conducive to field tests. Reservoirs choice, carried out field tests and the web application that was created based on them are exemplary.

Kopalnia reservoir is located in the Rudno stream catchment area, near Przeginia Duchowna. Reservoir basin was created in a former place of exploitation of raw rock materials (sand). The reservoir surface is 1.1 ha, whereas the depth is diverse and estimated approximately at 1 – 4 m. Forests and wooded areas (47.8 %) and arable lands are the biggest part in land use around the reservoir.

Wołowice reservoir is located in the Vistula River valley, it is a meander of its old river bed (oxbow lake). The depression was created as a result of changes in a river bed route and gravel exploitation. The reservoir surface is 5.2 ha, the depth is diverse and estimated approximately at 1 – 5 m. Arable lands dominate in the land use (60.9 %).

Web application supporting environmental protection and development is usually the result of previously conducted tests – observations, measurements and others. It is created based on spatial information data prepared beforehand. The role of the application does not have to be limited only to data presentation. Chosen functionalities can also include their modelling in a real time [Silva, Eglese 2000].

The method of identifying areas where coastal vegetation occur

For the purpose of this paper coastal vegetation areas of occurrence were determined and characterized. They were defined based on characteristic species presence in a given plant society during field tests in June 2012. Tests were carried out in a several places of coastal area, where series of phytosociological photos were made. While determining the quantitative composition, cover estimating and number of specimens based on Braun-Blanquet scale were used.

Braun-Blanquet quantitative scale allows to estimate the cover and number of specimens of each plant species. Following markingsare used [Polakowski 1995]:

5 — the species covers more than 75% of the described area,

4 — the species covers 50-75%,

3 — the species covers 25-50%,

2 — the species covers 5-25%,

1 — the species is plentiful, covering a small area

+ — the species is sparse or very sparse,

+r — for indicating species rarity.

Determining the degree of coverage, the number of specimens and the percentage part of the area that is not covered with plants is done approximately. This method is based on characteristic species, popular and easy to use.

Based on the register of green plants the following vegetation units were distinguished: typically meadow, including "trampled beaches", units with ruderal species and areas with reed plants. On steep slopes ligneous species were identified (fig. 1).
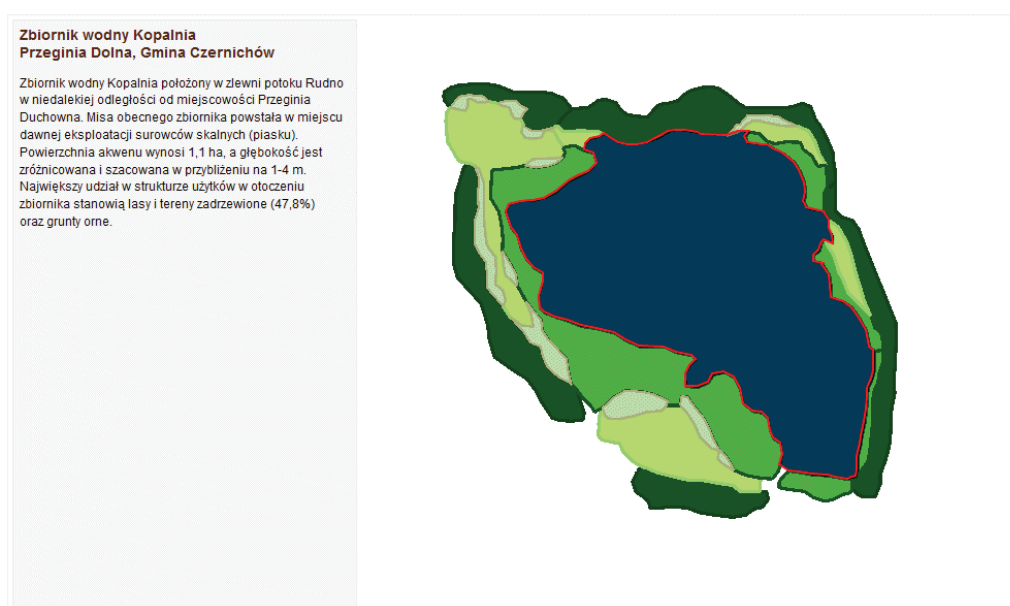
Source: own work

Figure 1 Areas where coastal vegetation occur and species connected with them, vector map prepared in Quantum GIS program, Kopalnia reservoir

Used computer methods

Raster maps of Kopalnia and Wołowice reservoirs, which include the range of occurrence of each coastal vegetation zones, were recreated using the method of manual vectorization using Quantum GIS application.

Quantum GIS (QGIS) is a user friendly, free and open source GIS software, that works on GNU/Linux, Unix, Mac OSX and MS Windows platforms. QGIS was created in 2002 as a GIS browser for Linux platform. The first intention of its creators was the visualization of PostGIS data [Nowotarska 2009].

QGIS programme is created by the community from all over the world. That includes not only programmers, but also people who translate, create documents and test the programme. Ordinary users are also members of this community. A vast majority of work on the project is carried out as a voluntary service, although there are also assignments for which financial support is obtained. Commercial companies, people working with research and science, but first of all – enthusiasts, participate in the development of the programme [Jurgiel, Mostowska 2010].

Preparing maps in a vector form allowed to export them to a raster base. Maps export was done using HTML Image Map Plugin. The main point of the export is a hypertext document coupled to the raster, it contains coordinates of traverses previously plotted on a vector map. Layer of polygons and linear or punctual objects is converted into area of active references that can be associated with random tabular data – textual or numerical. The plugin allows to define map dimensions and to programme map interactivity.

Application interactive software was prepared based on chosen jQuery plugins: CraftMap and Map Hilight, set in HTML document structure and formatted using CascadingStyle Sheet (CSS). JQuery is a lightweight JavaScript library and JavaScript is an object-oriented programming language [Ullman 2013]. The main reason for the usage of scripting languages which are processed by the server is a possibility to deliver websites with dynamic content (DHTML) to users. It is an important feature, because a content that adjusts to user's needs or goes through constant changes, permanently rivets his attention [Welling, Thomson 2005].

CraftMap Plugin using exact x, y coordinates locates a dynamic point, which can be a carrier of text information, graphic information or both at the same time, on a defined raster base. A script construction does not limit the number of points that are possible to locate on the layer just before the raster, although the layer is able to fit as many points as it is allowed by its size. The information connected with points is presented at user's request in the form of a dynamic "pop-up" window. Pop-up is a window that suddenly appears (pops up), it presents a specific content in the Internet browser. Pop-up can be displayed in a new window, box or on a new tab. It can also be dynamically displayed through Java scripts or Flash animations. Pop-up is mainly associated with Internet advertisements, although it is also applicable for supporting navigation on websites, usually through short help texts, explanations or information in a graphic form.

CrafMap Plugin in a basic version (programming base) was prepared and made public by M. Dziewulski [2013] based on *free for non-commercial use* license, which allows free usage of the plugin in non-commercial projects.

JQuery Map Hilight is an independent and universal module, which allows to present phenomena that have spatial character, along with their data. JQuery Maplight is based on coordinates of polygons which were previously created in Quantum GIS programme and exported to *.html files using HTML Image Map Plugin. Script works in XHTML language based on the usemap attribute, which defines map address for a given element, informing browser that a given graphic (raster) is being mapped. Everything is based on mapping the references, which is a peculiar creation of references from a chosen graphic area. The effect of framing and shading of elements of any shapes is triggered under the influence of user's activity on the layer that is being created directly above raster in a real time.

Map Hilight Plugin in a basic version (programming base) was prepared and made public by D. Lynch [2013] based on a MIT License.

Finished application files were placed on the server and published on the Internet. Information on Czernichów commune, concept dictionary connected with environmental protection and a gallery of phytosociological photos with species description were added to the application (fig. 2).

Figure 2 Interface of the web application describing water reservoirs near Kraków

Application is available at: http://www.bonar.homeproject.pl
Source: own work

RESULTS

Issues presented in the paper should be discussed from two points of view: filed tests i.e. tests on coastal vegetation of chosen reservoirs and characteristics of used tools and computer techniques.

Coastal vegetation of Kopalnia and Wołowice reservoirs

Directly around Kopalia reservoir there is a relatively diverse vegetation. On the flat coast carpet plants have developed, with such characteristic plants like: perennial ryegrass (*Lolium perenne*), white clover (*Trifolium repens*) and broadleaf plantain (*Plantago major).* Whereas on a more moist parts of slopes there are plant communities where following species dominate: sweet vernal grass (*Anthoxantum odoratum*), Yorkshire fog (*Holcus lanatus*), flatweed (*Hypochoeris radicata*) and suckling clover (*Trifolium dubium)* (table 1).

Table 1 List of plant species found within the coastal zone of the Kopalnia water reservoir

Kopalnia water reservoir					
Species	Coastal slope	Carpet plants	Species	Reed-bed on the coast	Carpet plants
Agrostis capilaris		+	*Phragmites australis*		
Agrostis gigantea	+		*Plantago lanceolata*		+
Alectropholus glaber	+		*Plantago major*		1
Anthoxantu odoratum	3		*Poa trivialis*		2
Centaurea jacea	+		*Solidago gigantea*	1	
Equisetum arvense	1		*Tanacetum vulgare*	+	
Hieracium pilosella	+		*Trifolium dubium*	2	
Holcus lanatus	1	1	*Trifolium repens*	+	3
Hypochoeris radicata	2		*Rumex acetosella*	+	
Juncus tenuis		+	*Vicia angustifolia*	1	
Leucanthemum vulgare	+		*Hieracium sp.*	+	
Lolium perenne	+	4	*Leontodon hispidus*	1	
Lotus corniculatus	1				
Phleum pratense		+			

Source: ownwork

Within the coastal zone of Wołowice reservoir vegetation from *Molinio-Arrhenatheretea* class is a dominating plant community, however it shows a certain diversity that depends on a habitat, including mainly moisture. Anthropogenic activities had a strong influence on the composition of coastal slope vegetation, it is indicated by a significant share of species from *Artemisietea vulgaris* class in that zone, including: giant goldenrod *(Solidago gigantea)* common tansy *(Tanacetum vulgare),* creeping thistle *(Cirsium arvense)* and others. Reed-bed vegetation from *Phragmitetea* class is poor in relation to species. A dominant species in slope vegetation is reed canary grass *(Phalaris arundinacea).* A large area in this zone is occupied by bramble (*Rubus sp.).* Table 2 contains detailed analysis of coastal vegetation.

Table 2 List of plant species found within the coastal zone of the Wołowice water reservoir

Wołowice water reservoir					
Species	Coastal slope	Slope	Species	Coastal slope	Slope

Achillea millefolium	1		*Juncus effusus*		+
Agrostis capilaris	+		*Lathyrus pratensis*		+
Agrostis gigantea	+	+	*Leucanthemum vulgare*	+	
Arrhenatherum elatius	1		*Lolium perenne*	+	
Artemisia vulgaris	2		*Lotus corniculatus*	+	
Aster annuus	+		*Lychnis floss-cucculi*		+
Calystega sepium		+	*Lysimachia vulgaris*		+
Carex leporina	+		*Phalaris arundinacea*		5
Centaurea jacea	2	+	*Plantago lanceolata*	+	
Cirsium arvense	+		*Poa pratensis*	1	+
Crepis biennis		+	*Poa trivialis*	+	
Equisetum arvense	+		*Rubus sp.*		2
Festuca pratensis	2		*Rumex*		+
Festuca rubra	+		*Sanguisorba officinalis*		+
Galium mollugo	1		*Scrophularia*		+
Galium ulliginosum		+	*Solidago gigantea*	1	+
Holcus lanatus	+		*Tanacetum vulgare*	2	

Source: ownwork

Usability of applied computer tools and techniques

Application presented in the paper fulfils W3C technical requirements for XHTML 1.0 Strict and CSS 3.0 specifications. W3C is an international organization associating about four hundred entities from around the world, including commercial companies, organizations, government agencies and universities. Guidelines prepared by W3C are not legally binding and their following is not obligatory, although they are acknowledged and respected in the community of websites and applications creators from around the world.

The application was verified using cross-validation. The W3C Markup Validation Service showed syntax errors – „there is no attribute data-coords". This error is a result of using a marker that is not listed in a document specification. It is not an error that influences application usability, but it should be deleted by replacing "data-coords" attribute with a different one which is consistent with W3C specification. The result of validation and usability characteristics of "Water reservoirs near Cracow" web application are presented in table 3.

| he diversity of coastal ones as a spatial n. | HTML Image Map Plugin. Vector model, raster model. | XHTML 1.0 Strict, CSS 3.0, jQuery Maplight, jQuery CraftMap | Validator. The validation result: 1 error / 0 warnin The W3C Markup Validation Service showed syn — there is no attribute „data-coords". This error is a result of using a marker that is not document specification. |

tion. Functionality, interactivity

tion interactivity software was prepared based on jQuery CraftMap and Map Hilight Plugins. JQuery Map Hilight Plugin is an inde odule, which allows to present spatial phenomena, along with data connected with them. The plugin is based on polygons coor cs of the usemap attribute, which defines map address for a given element, informing browser that a given graphic (raster) is being r ming and shading of elements of any shapes is triggered under the influence of user's activity on the layer that is being created directly e. JQuery CraftMap Plugin is functioning based on markers whose localization on the map is based on coordinates defined in pixels.

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SUMMARY

The analysis of phytosociological constitution of coastal vegetation of Kopalnia and Wołowice reservoirs showed its great diversity on a small area. What is characteristic is that there were places where coastal vegetation zone was narrow, sometimes narrower than 0.5 m. It was also stated that typical plant formations, characteristic of lakes coastal zone (i.e. emerged, narrow and wide-leaved plants that are rooted on the coast with shoots creeping in the water) have not developed. Constitution of costal slope vegetation, especially in Wołowice reservoir, is greatly modified by anthropogenic activity, it is indicated by a significant share of ruderal species in that area.

Computer techniques and tools presented in the paper can be successfully used to build interactive applications, which then can be put on the Internet. Using specialised software desktop GIS type allowed to present coastal vegetation zones in the form of vector studies and made it possible to export them to raster files. Programming techniques and tools presented in the paper in cooperation with raster base complemented with vertices coordinates allow to present any phenomenon that has a spatial character. The advantage of applications prepared that way is their versatility – they can be used not only as a web application (published on the Internet), but also from any digital data carrier like e.g. flash drive or CD-ROM.

Concept of creating the application and its architecture are reflected in the fact that the application is easy to use and relatively easy to modify or upgrade. Furthermore, application created that way looks the same and functions smoothly in all browsers. Using techniques and tools accessible within Open Source license does not require from the creator or user any license fees or specialised software.

Computer techniques and tools used in the paper have also their limitations. It is impossible to prepare the interactive change of map scale, i.e. the change of number of details presented on the map, and the dynamic change of thematic layers that can be turned on or off at user's request, without the necessity to reload the application in the browser window.

Thematic, interactive applications that present information on landscape or tourist values of a given region, with a dictionary, descriptions and photo gallery, published on the Internet and made public to a wide group of users can contribute to popularization of environmental protection ideas. It is difficult to determine the direct influence of web applications on the environment and landscape protection. However, they can be used as a tool exerting information pressure i.e. influencing users' outlook and forming their environmental awareness.

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