Development of Database on Beaches: Case Study

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Since both contemporary tourists and local communities are interested in the profile and the quality of beaches, the need for a transparent database of information on beaches arose, for both tourists and the local community. The purpose of this paper is to discuss elements for developing a database on beaches as a useful source of information for visitors, as well as local people. After a short review of literature on the subject, the case study method is used to present the best practice example from the management and spatial planning of Croatian beaches. The Croatian Ministry of Environmental Protection, Physical Planning, and Construction, in cooperation with the Institute of Oceanography and Fisheries of Split and with the Croatian Environment Agency, has developed a database on water quality for swimming, a web application for the entry, processing, and valorisation of data, along with reporting and public information on seawater bathing quality data for the Croatian Adriatic beaches. This paper analyses this database, and the authors suggest a design of the system of parameters appealing for tourists (i.e. capacity of the beach, parking possibilities, sports and other facilities on the beach) and their continuous monitoring and entry into the database. Thus, the necessary security measures, standards of tidiness, supply contents, and standard graphic representation could be formed in order to make beaches recognisable. The main conclusions of the paper relate to the need for the development of a database on beaches and suggest improvements for existing databases in terms of integration with GIS browsers as well as creating a new set of indicators and other data available, with the purpose of market valuation of space, environmental protection, and growth in the quality of tourism demand and supply.

Keywords: database development; innovation; tourism; spatial planning

Introduction

Coastal tourism, still one of the most popular means of tourism, uses beaches, bathing-water characteristics and quality as main resources of attraction. Therefore, beaches are among the most valuable ecosystems used for outdoor recreation worldwide.

'Wild' or urban, beaches play an significant role in tourism, and represent a focal point of significant tourist infrastructure that yields large economic inflows for both the private and public sectors. For example, it has been established that for each dollar invested in beach maintenance in the USA, $600 is returned as taxes paid by national tourism and $20 by foreign tourists (Cervantes & Espejel, 2008). However, due to mass tourism, beaches have become increasingly endangered by negative effects such as erosion, pollution, and landscape loss.

In order to brand high quality and sustainable stan-

dards, various awards gave been established for coastal destinations or beaches that have achieved the highest quality in water, facilities, safety, environmental education and management. Some of those international certifications include the Blue Flag, Blue Wave, National Healthy, Beach Campaign and Seaside Award.

Nevertheless, the issues regarding selecting indicators, collecting beach data and creating transparent and public available databases on beaches remain challenges for researchers, practitioners and decision makers worldwide. A contribution to this effort can be made by identifying and describing the examples of good practice, which has been done in this paper with the case study of Croatia.

Croatia is renowned for its coastal destinations based on beautiful beaches and well-preserved nature and landscapes, as well as the clean Adriatic sea.

The first part of the paper analyses the already existing database on bathing water quality of Croatian beaches, used to enter research result, result processing and evaluation, and to inform the public, which also contains some vital data appealing for tourists: sea-bathing water quality and bathing water profile.

In the second part of the paper, a system of parameters appealing for tourists is proposed (i.e. beach capacity, parking possibilities, detailed description of available catering, sports and other beach facilities and services) and their continuous monitoring and entry into the database. Thus, the necessary security measures, standards of tidiness, supply contents, and visual constants could be formed in order to make beaches recognisable both to local inhabitants and to tourists.

Case Study: Database for Croatian Adriatic Beaches

In cooperation with the Institute of Oceanography and Fisheries of Split, at the end of 2006 the Croatian Environment Agency started building a network application for the entry, publication, and management of indicators on the state of the marine environment. Both the database and the indicators on the state of the marine environment, mariculture, and fisheries were established in 2007 and have been continuously maintained through the input of new data from multiple network centres. The data sources are obtained from the Institute of Oceanography and Fisheries of Split, the Ruđer Bošković Institute – Centre for Marine Research of Rovinj, the Institute for Marine and Coastal Research of Dubrovnik, and the Hydrographic Institute of the Republic of Croatia of Split. In 2008, Croatian Waters and the Ministry of Environmental Protection, Physical Planning, and Construction, Department for Sea and Land Protection, also joined the project. (http://jadran.izor.hr/azo/).

The website database and indicators on the state of sea environment, mariculture, and fisheries allows for various options of surveying and researching of a large number of available information; some of the most important highlighted in Table 1.

Some of the main indicators monitored and recorded regularly in the database are the following (http://jadran.izor.hr/azo):

- Quality assessment of the ecological status of transitional, coastal, and open sea waters
- Quality of cultured marine organisms and of seawater mariculture;
- Shellfish toxicity;
- Hot points;
- Impact of fishing on ecosystems;
- Impact of mariculture on ecosystems;
- Biological quality of transitional waters (e.g. macrophytes and macroalgae);
- Biomarkers;
- Entry and spread of invasive species;
- Concentration of chlorophyll in transitional and coastal waters and seawater;
- Statistics of fisheries;
- Main fishing areas;
- Index trend in marine organism biomass;
- Hazardous substances in marine sediment;
- Temperature, salinity, and density of water masses;
- Changes in seawater level;
- Safety of navigation in the Adriatic.

The stated indicators represent only a part of the overall number of indicators monitored and entered into the database and base of indicators on the state of the marine environment, mariculture, and fisheries.

Table 1 Main Website Options Available on the Database and Indicators on the State of the Marine Environment, Mariculture and Fisheries

Options available to the user	Description
List of indicators	List of active indicators (regularly updated).
Inactive indicators	Indicators with no systematic measurements and testing, or monitored over a longer period of time.
Research of indicators	Finding desired information on particular indicators is possible by setting simple requests.
EIONET tables	Contain tables with 'row' information on sea conditions, prepared for reporting purposes in EEA (European Environment Agency).
Croatian Environment Agency Geographical Information System (GIS) Browsers	GIS browser on the quality of transitional, coastal, and seawaters, fisheries and mariculture and GIS browser on the quality of sea-bathing water on beaches.
Statistics of database access	Statistics of database access (number of visits to web-page) according to accessing addresses and according to accessing indicators.
Remarks and suggestions	Enables entry of remarks and suggestions by database users and their review.

Notes Adapted from http://jadran.izor.hr/azo/

The inactive indicators, such impact of mariculture on eco-systems and main fishing areas, which are in preparation, should also be added.

Quality of Seawater on sea Beaches

Within the implementation of Regulations on Sea-Bathing Water Quality (Uredba o kakvoći mora za kupanje, 2008), the Ministry of Environmental Protection, Physical Planning, and Construction (MZOPUG) has in cooperation with the Oceanographic Institute (IOR) from Split and the Croatian Environment Agency (AZO) also developed a database on sea-bathing water quality, i.e. a network of applications for the entry, elaboration, valorisation of indicators, and reporting of information of public on sea-bathing water quality for Croatian Adriatic beaches. This database represents a part of the previously described database and base of indicators on the state of the marine environment, mariculture, and fisheries. It is used to enter research results, for data processing, for notifying the public, for national reporting on sea-bathing water and reporting to the European Union. Authorised persons use the database to enter monitoring results, for data processing, and for submitting periodical reports to counties and beach concessionaires, i.e. to units of local government. The MZOPUG uses the database to integrate data and notify the public through the specifically developed Croatian-English language browser on sea-bathing water quality. The integration of sea-bathing water profiles for all monitoring points of Croatian Adriatic beaches is envisaged via the database by entry of monitored results into specifically designated BWS forms and by assessments of pollution risks. The database should be integrated into GIS Browsers used in sea-bathing water profiling.

In May 2009, a workshop took place on assessment of microbiological indicators according to the Regulations on Sea-bathing Water Quality and use of program network application / database for the entry, elaboration, and valorisation of information on sea-bathing water quality. The workshop took place in the Institute of Oceanography and Fisheries in Split. It was attended by representatives of legal persons (authorised persons/County Department of Public Health) entrusted by counties with monitoring the sea-bathing water quality. The authorised persons from seven county institutes were introduced to the database, its possibilities, method of use, system of data entry, plotting of sampling points, preparing reports, etc. The standard methods provided by the Regulations, i.e. by the Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water (1976) to establish the presence of *Escherichie*

Table 2 Monitoring Results, Sea-Bathing Water Quality

County	Period	Total	Excellent	Good	Sufficient	Poor
Dubrovnik-Neretva County	09.07.2012–19.07.2012	106	101 (95.3%)	2 (1.9%)	3 (2.8%)	0 (0.0%)
Split-Dalmatia County	09.07.2012–16.07.2012	144	136 (94.4%)	3 (2.1%)	5 (3.5%)	0 (0.0%)
Šibenik-Knin County	09.07.2012–17.07.2012	92	89 (96.7%)	2 (2.2%)	1 (1.1%)	0 (0.0%)
Zadar County	10.07.2012–20.07.2012	85	81 (95.3%)	2 (2.4%)	2 (2.4%)	0 (0.0%)
Lika-Senj County	09.07.2012–11.07.2012	46	46 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Primorje-Gorski Kotar County	09.07.2012–19.07.2012	237	234 (98.7%)	1 (0.4%)	2 (0.8%)	0 (0.0%)
Istra County	09.07.2012–18.07.2012	202	196 (97.0%)	0 (0.0%)	6 (3.0%)	0 (0.0%)
Total	09.07.2012–20.07.2012	912	883 (96.8%)	10 (1.1%)	19 (2.1%)	0 (0.0%)

Notes Source: http://www.izor.hr/kakvoca/kakvoca.html

Coli and intestinal enterococci were also presented.

The goals of the sea-bathing water quality monitoring program on beaches are the following:

- Protection of bathers' health and health education of the public;
- Management of beaches in order to preserve their natural resources and sustainable use;
- Identifying pollution sources, prioritisation, monitoring the construction of sewage systems;
- Monitoring of the operation of existing systems, in cooperation with the competent institutions from different sectors;
- Reporting on sea-bathing water quality regarding the national needs and the EU requirements;
- Notifying the public on sea-bathing water quality;
- Tourism promotion.

Table 2 shows that most counties have positive trend of 'excellent' sea-bathing quality graded (1), or even looking in the total, which shows that 96.8% of Croatian beaches shows excellent quality of sea-bathing water, while the small remaining number of beaches are classified as having 'good' or 'sufficient' sea-bathing water quality. Most importantly, no Croatian beaches (none shown in the database) are classified as 'poor' and graded (4).

For tourism purposes, i.e. for the purpose of informing the public, a bilingual Internet application was developed, available on website http://www.izor.hr/kakvoca/ and http://www.izor.hr/bathing/, which is part of the database on sea-bathing water quality and began with operations in May 2009. Through the application, the public can preview all the sampling points, sea-bathing quality grading during the monitoring season after each consequent entry into the database, and information on sudden and short-term pollution.

The application is easy to use, and besides the information on sea bathing quality it also gives a criteria review, i.e. information on other hydro-meteorological conditions on the day of sampling. Because of the substantial public interest, it is planned to translate the application into several additional foreign languages, which would be significant for tourism.

The database on sea-bathing water quality on sea beaches has been developed by ESRI software and allows the usage of common GIS tools: minimising/maximising the map scale, moving over the map, identification of active topic features, finding desired information by user's questions, etc., and contains annual sea-bathing water assessments for sea beaches from 2009 to 2012.

By accessing the GIS browser, reviewing sea-bathing water quality via monitoring stations along the entire Croatian coast is enabled. Access is possible via selected assessing points or via an interactive map with indicated measurement locations. Each measurement location contains information on the names of beaches, the counties, and on the latest sea-bathing water monitoring and assessment results. For some beaches, pictures are also available, while others offer an overview of particular facilities and services on

Table 3 Accessing Database for the Period 2003–2011

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of accesses	280	1396	4822	4667	9911	3487	5461	5977	3382

Notes Source: http://jadran.izor.hr/azo/

the beach, such as restaurants, cafe bars, rescue service, sanitary facility, shower, changing rooms, playground, slides, etc. In addition to the stated features, the proximity of hotels, camps, or moorings and ports is also displayed, which is particularly useful for nautical tourists.

Besides the monitoring results for every surveyed beach, the website also shows the available and unified research results, as well as the web page access statistics. The access statistics shows the number of visits to the web application.

Table 3 indicates the number of database visitors, which varies depending on the month. Surprisingly, the database access also grows in winter months, i.e. the off-season period. A possible proposal suggests that the database should be also translated into other foreign languages in addition to English in order to enable foreign tourists as potential database users to become acquainted and informed of available information.

The sea-bathing water profile assessment must be carried out by the county, while the monitoring activities should be performed by a legally authorised person or entity. According to the regulations, the bathing water profile must contain the locations of sampling points, descriptions of the physical, geographical and hydrological characteristics of the bathing water, assessments of bathing water quality, identification and assessment of causes of pollution that might affect bathing waters and impair bathers' health, establishment of the pollution risk level, etc.

Experts participating in meetings on health monitoring within the application of WHO and UNEP/MAP guidelines suggest that a standardised form should be applied by different counties for information on individual assessments of sea-bathing water. The system of profiles in the standardised form should be provided in order for the data from different areas to be measurable and comparable. Maps should be established with tagged points showing identified and possible pollution sources, classifying sea-bathing water and all assessment results. Use of photographs is also recommended in profile assessment. A sea-bathing water assessment profile is based on primary data (BWP files), data from cartographic representation of the beach, data based on site visits, basic physical and hydrological properties of seawater quality. Site visits include control of waste water outfalls, fresh water inflow by torrents, rivers and submarine springs, determination of a number of bathers, and seawater circulation, along with additional information. If the presence of waste water outfalls is assessed, the type of treatment (i.e. the outfall efficiency) must be determined. Based on this, the potential waste water risk is assessed. In the assessment of coastal springs, submarine springs, fresh water inflow and torrents inflow, the type of discharged waste water facility must be determined, the size of the settlement from which the waste water originates, and water flow in the sea-bathing season. Based on the above, the assessment of risk caused by the deposition of river waste water is determined. Potential risk caused by a large number of bathers is also determined. Based on all stated risk assessments, the overall risk of sea-bathing water pollution is determined and classified.

As another obligation for counties, the Act on Environmental Protection (Zakon o zaštiti okoliša, 2007) and the Regulation on Seawater Bathing Quality (Uredba o kakvoći mora za kupanje, 2008), the following measures must also be emphasised:

- Implementation of management measures;
- Establishment of sea beaches on which bathing water quality monitoring shall be performed;
- Preparation of a cartographic representation of the county sea beaches;
- Development of the bathing water profile;
- Information and notification,

- Reporting,
- Securing funds for the implementation of the Bathing Seawater Quality Monitoring Program.

Database Financing, Development Potential, and Good Practice Examples

Funds for bathing-water quality monitoring on beaches, the development of cartographic representations of beaches and development and updating of bathing-water profiles should be secured by the counties. Tourism companies, concessionaries, and local government also participate in the financing of the Bathing Seawater Quality Monitoring Program. In order to increase the number of sampling points and beaches in particular counties (Ministry of Environmental Protection, Physical Planning, and Construction, 2009, p. 7), new, interested legal entities should also be involved into the monitoring program.

Bathing-water quality monitoring activities are performed by a legal entity authorised for monitoring activities in the field of environmental protection pursuant to the Environmental Protection Act and to the Act on Waters and according to the county selection. Monitoring activities performed by authorised persons are: sampling, monitoring other sea quality characteristics, laboratory analysis of samples, assessment of results obtained through sampling, preparation of reports and development of the bathing-water profile. Monitoring activities are carried out by county Departments of Public Health in seven coastal counties of the Republic of Croatia.

The bathing season on sea beaches lasts from June 1st until September 15th, unless due to weather conditions and local customs, the representative body of the county issues a decision on the bathing season lasting for a longer period of time. Monitoring of water quality is carried out from May 15th until September 30th. Before the beginning of each bathing season, the county must define the sampling. Prior to the beginning of bathing season, the authorised person must prepare the bathing-water monitoring calendar, subject to the approval of the competent administrative body in the county. Monitoring bathing-water quality must begin at the latest within four days from the day set out in the monitoring schedule (calendar).

Table 4 Overall Number of Sea-Bathing Water Samples for the 2009 Season

County	(1)	(2)
Dubrovnik-Neretva County	95	1
Split-Dalmatia County	142	5
Šibenik-Knin County	90	1
Zadar County	93	0
Lika-Senj County	46	0
Primorje-Gorski Kotar County	236	0
Istra County	203	1
Total	905	8

Notes Column headings are as follows: (1) overall number of samples, (2) number of samples classified as poor sea-bathing water quality. Adapted from Ministarstvo zaštite okoliša, prostornog uređenja i graditeljstva (2009, p. 10).

Based on the results of monitoring the bathing-water quality, the individual, annual, and final sea-bathing water quality is assessed.

The individual assessment is determined after each analysis carried out during the bathing season, according to the limit values for the microbiological parameters.

The annual assessment is determined after the end of the bathing season, based on a set of data on bathing-water quality for that particular bathing season, according to the limit values of this regulation.

The final assessment is determined after the end of the last bathing season and the three preceding bathing seasons, according to the limit values of the regulation.

Based on the individual assessment, sea-bathing water is classified as excellent, good and sufficient. Based on the annual and final assessments, sea-bathing water is classified as excellent, good, sufficient and poor. Classified bathing water is labelled on the cartographic representation and on the information board placed on the beach by a circular symbol: excellent: blue, good: green, sufficient: yellow, poor: red.

In case of sudden pollution of bathing water at beaches, the authorised entity (the County Department of Public Health) shall, upon receiving the notification on pollution, immediately carry out sampling of the sea water and submit the obtained results to

the competent administrative body in the county and to the environmental inspection. The obtained results are not taken into account (they are not included into the data set for sea-water quality evaluation) when assessing the bathing water quality.

The authorised entity should submit the results on individual assessment to the county within seven days of assessing the bathing water quality. The annual assessment must be submitted to the county by the authorised entity within thirty days after the end of bathing-water quality monitoring. Individual assessments must be submitted immediately to the ministry, and final assessment by November 5th of the current year. The ministry develops a report on the annual assessment of the Croatian Adriatic beaches, at the latest by December 15th of the current year. The first report on the final assessment must be submitted by the county to the ministry at the latest by November 5th, 2012. The ministry develops the first national report on the final assessment at the latest by December 15th, 2012. The Croatian Environment Agency should deliver the report on individual, annual, and final assessments on sea-bathing water quality on Croatian Adriatic beaches to the European Commission in accordance with the implementation of the Directive 2006/7/EC (2006).

As an example of good practice, the Institute for Physical Planning of the Primorsko-Goranska County can be mentioned; their study on seawater beaches of the county area was developed in 1999. It displays 385 beaches, together with data on beach borders and other relevant information, shown in 1:5000 scale. The borders of the sea beaches were determined considering the data from the Study on Seawater Beaches from 1999, data on maritime domain, data from regional municipality and city plans, and data obtained by field visit to beaches. A legal framework was followed, prescribing the cartographic presentation of sea water beaches that must contain the following data (Uredba o kakvoći mora za kupanje, 2008, Art. 8):

- The borders of the sea beach;
- Place of outfall and quantities of waste water (Q daily);
- Submarine outfall with identification of outfall profile and length, and the sea depth at the place of discharge;
- Type of waste water treatment facility;
- Coastal springs, submarine springs, fresh water inflow and torrents inflow;
- Coordinates (geographical longitude and latitude) of sampling points;
- Assessing classification of bathing sea water quality.

The GIS database was established, showing the measurement results and available on the Internet. Also useful for tourism purposes, it shows pictures of beaches, information on particular beach buildings, and enables visitors to comment.

Each cartographic presentation also includes the legend explaining the symbols for borders of sea beaches, areas under concession, beach equipment (availability of facilities and services on the beaches), measuring points, etc. The aforementioned GIS database represents a good practice in promoting beaches and information on beaches to tourists, but it still lacks additional elements that would make it more attractive to visitors. Static character information, which should surely be added to the database, include the capacity and the position of available parking places, detailed descriptions of catering, sports, amusement, and other services and facilities on the beach, etc. Regarding dynamic character information and (given the considerable growth of online available web cameras in tourist destinations) web-camera pictures of the nearest selected beach access to the GIS database should be considered.

Besides the already stated additions, the database should be promoted with appropriate marketing tools to tourists and potential visitors in order for them to obtain additional insight into the services and facilities of the tourist destination they are visiting.

The sea-bathing water quality assessment results for the Republic of Croatia sea beaches in 2011 indicate extremely high sea water quality. Specifically, from the total of 906 sampling points, 95.92% were graded excellent, 2.54% were graded good, 1.10% of sampling points were graded sufficient, and only 0.44% of sampling points were graded poor. Therefore, authors sug-

gest such positive results should be applied in better promotion of the Croatian coast. As other Mediterranean countries cannot boast such positive results in water quality, the quality of the Croatian Sea should be emphasised more.

Conclusions

Regarding the possibilities for further development of the database on Adriatic beaches, the fact that sea represents one of the most valuable resources of the tourism services both for the Croatian maritime area and for the maritime areas of other Adriatic countries (Slovenia, Italy, Montenegro, Albania) has to be taken into account. Therefore, the possibility of a joint on-line project on Adriatic beaches should be considered and nominated for EU grant programs available through Transnational Cooperation Programs

As the annual assessment of sea-bathing water quality includes probability factors for normal distribution of results, it also represents an assessment of predictability and stability of sea quality for a particular beach. This creates an objective assessment of sea bathing beach water quality, also confirmed by previous assessments based on 20 years of monitoring of sea bathing beach water quality. A part of annual evaluations for beach waters, which proved to be 'statistically poorer than expected' will find their verification in the final assessment, which will include the results of the four previous bathing seasons and, therefore, represent the real state of sea-bathing water quality on beaches.

The database on sea-bathing water quality was created, tested, and upgraded during the 2009 research season, and the professional workshops were recommended for authorised persons regarding use of database. The database offers multiple possibilities: data entry and processing, notification of public (both local inhabitants and tourists), information on local, regional, national, and international levels.

In collaboration with the Croatian Environment Agency, the Ministry of Environmental Protection, Physical Planning, and Construction should use the GIS system as a part of database on sea water quality in order to enable input and integration of the sea-bathing water profile in all seven Adriatic Croatian counties. Therefore, the beach area definition is recommended, together with the list of all buildings existing in particular beaches, as well as the arrangement of multilingual browsers to inform the public about sea-bathing water quality.

In any case, an increased number of sea-bathing water quality sampling points on beaches along the entire Adriatic coast is recommended, and the system of sea quality assessment should be immediately transparent to tourists and local inhabitants. Thus, the required security measures would be obtained, together with the standards of tidiness, content of tourism services offered, and visual constant that would make the beaches identifiable.

The design of the Internet register/database on beaches intended to promote tourism is also significant, and designing visually attractive interactive applications with information on Croatian beaches is recommended. The cooperation between MZOPUG and AZO should be utilised in overtaking part of data and technology applied in the preparation of the database on sea-bathing water quality (GIS browser, information on sea cleanliness, objects available on beaches, possibility to comment and give suggestions, etc.).

Afterwards, a system of indicators appealing to tourists could be designed (i.e. carrying capacity of beaches, parking possibilities, detailed description of available catering, sports, and other forms of beach services, etc.) together with their continuous monitoring and entry into the database. Provided indicators could contribute to the knowledge development as well as practical ideas on how to promote the area's tourist services in terms of beach resources.

New beaches, not included water quality monitoring system, but visited during summer months, could also be included in the new database. In order for tourists to be informed about seawater quality, promotion of the future database is recommended on tourist fairs and similar events. Thus, the database will be also presented to employees from the tourism sector in order to induce them to integrate the database into their regular work (particularly in boards of tourism and tourist agencies).

Apart from future development and specialisation, the database should be integrated with GIS browsers

applied in the preparation of sea-bathing water quality profiles for the purpose of the market valorisation of the area, environmental protection, and growth in tourist services and demand quality. In that matter, IT technologies and spatial planning could be linked together in order to improve tourist attractiveness of coastal destinations and create grounds for the future sustainable planning and development of beaches.

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