Environmental Technology & Innovation 5 (2016) 106–116

Contents lists available at ScienceDirect

Environmental Technology & Innovation

journal homepage: www.elsevier.com/locate/eti

Technology-based management of environmental organizations using an Environmental Management Information System (EMIS): Design and development

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HIGHLIGHTS

- The proposed system can bridge the chasm between technology and public participation in environmental decision making in a more formal manner.
- The system promotes a holistic strategy for exploiting explicit and tacit knowledge to improve environmental management processes.
- The developed system facilitates environmental management to deal with more complex factors associated with issues of various natures.

ARTICLE INFO

Article history:
Received 19 August 2014
Received in revised form 27 December 2015
Accepted 17 January 2016
Available online 21 January 2016

Keywords:
Environmental information system
Environmental management
Protected areas
Relational database
Mapping
Web-GIS

ABSTRACT

The adoption of Information and Communication Technologies (ICT) in environmental management has become a significant demand nowadays with the rapid growth of environmental information. This paper presents a prototype Environmental Management Information System (EMIS) that was developed to provide a systematic way of managing environmental data and human resources of an environmental organization. The system was designed using programming languages, a Database Management System (DBMS) and other technologies and programming tools and combines information from the relational database in order to achieve the principal goals of the environmental organization. The developed application can be used to store and elaborate information regarding: human resources data, environmental projects, observations, reports, data about the protected species, environmental measurements of pollutant factors or other kinds of analytical measurements and also the financial data of the organization. Furthermore, the system supports the visualization of spatial data structures by using geographic information systems (GIS) and web mapping technologies. This paper describes this prototype software application, its structure, its functions and how this system can be utilized to facilitate technology-based environmental management and decision-making process.

1. Introduction

The effective management of the natural environment greatly affects human societies and plays a significant role in conserving the world's natural resources contributing to a higher quality of human's life. The prospect of using information systems in environmental management has been upgraded lately with the development of new monitoring

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http://dx.doi.org/10.1016/j.eti.2016.01.006
2352-1864/

and management systems (Melville and Ross, 2010; Campos, 2012; Jiang and Pan, 2012). Furthermore, Environmental Informatics is an interdisciplinary branch of science that is rapidly gaining ground (Hilty et al., 2006; Huang and Chang, 2003). In this science, methods, techniques and disciplines of computer science are combined in order to analyze and elaborate information that contribute to an effective management and protection of the environment (Page and Rautenstrauch, 2001).

Environmental Management Information Systems (EMIS) are defined as organizational–technical systems for systematically obtaining, processing, and making relevant environmental information available in companies (El-Gayar and Fritz, 2006; Page and Rautenstrauch, 2001). Environmental Management Information Systems (EMIS) are defined as socio-technological systems with the aim to gather, process, and provide environmental information inside companies (Isenmann, 2008). In recent years, various Information Systems have been developed for the management and processing of the environmental information (Buhren and Decker, 2008; Mugerezi, 2006). Buhren and Decker (2008) describe the procedure of building an Environmental Management System, explaining its role and purpose in urban management, focusing on how the system can be used in the partner cities of the Sustainable Cities Programme (SCP). Mugerezi (2006) designed and implemented an Environmental Management Information System that covers the gathering of all relevant information for the Environmental Planning and Management (EPM) Process and includes the collection of information about various environmental issues. The Habitats Directive on the conservation of natural habitats and of wild fauna and flora, was adopted in 1992 (Council Directive 92/43/EEC, 1992). In accordance with this directive, Member States took measures to maintain or restore natural habitats and wild species and established environmental organizations with laws (Italy: Presidential Decree No 357 (1997), Greece: Law No. 2742 (1999), Spain: Royal Decree No 1997 (1995)) for managing protected areas and natural parks (Evans, 2006; Evans et al., 2013; Guignier and Prieur, 2010; Ostermann, 1998; Morris, 2011; Pinton, 2001; Rauschmayer et al., 2009). In Greece, according to the Law No. 2742/99 the principal goal of the environmental organization is the management of the nature and the landscape, as well as areas designated as Special Areas of Conservation (Papageorgiou and Vogiatzakis, 2006; Papageorgiou and Kassioumis, 2005). Also, according to the same law, environmental organizations are responsible for collecting and elaborating environmental data and for creating and managing relational databases.

Considering the development of information technology and the growing amount of information about the environment, it becomes necessary for an environmental management organization to utilize an information system that will manage all relevant environmental information and also will be used as a tool for a better and more efficient management of the protected area and the natural resources (Graham et al., 2003; Worboys et al., 2001). This paper describes an environmental management information system of this kind, which was developed using several technologies and programming tools. The system combines characteristics of Environmental Management Information Systems (EMIS) and Human Resource Management Information Systems (HRMIS). HRMIS are Information Systems that provide information used by human resource management in decision making (Sims, 2007; Ngai and Wat, 2006). In the following sections, the functions of the prototype application and the development methodology will be discussed in more detail. Furthermore, an example study is then used to show how this software system can be applied.

2. Materials and methods

2.1. Requirement analysis

The first stage in designing the system is to define the kinds of data that is going to be stored in the database, and to specify the information that EMIS system is going to manage. This step is of primary importance so as to define the modules of the software and its structure (Elmasri and Navathe, 2011; Maciaszek, 2007; Ramakrishnan and Gehrke, 2003).

According to the article 7 of the Directive of the European Parliament on public access to environmental information (Directive 2003/4/EC, 2003), which amended the previous directive on the freedom of access to information on the environment (Council Directive 90/313/EEC, 1990) Member States shall ensure that environmental information progressively become available in electronic databases which should be easily accessible to the public through public telecommunication networks. Also, according to the article 2f of the same directive the system must provide information about the environmental data of the organization, regarding measurements of air pollution (e.g. CO, NO), water pollution (heavy metals, Biochemical Oxygen Demand etc.) or other type of environmental data.

Except for fulfilling the legal obligations of the environmental organization, this information can also be utilized in making decisions and taking measures about environmental issues and also sending documents and reports to the local and the governmental authorities (Ministry of the Environment, Judicial Authorities). These data are valuable for performing environmental risk assessment and developing risk management strategies (Lener et al., 2013; Smith, 2013). The system, also manages information about the protected species of the organization's jurisdiction area, regarding methods of monitoring and registering the biodiversity in the protected area (Danielsen et al., 2000).

Also, it is necessary the system to provide information about the staff of the organization, helping in human resources management and in project management, such as: education, curriculum vitae, residence, contact information, hiring data (hire date, salary, position, etc.) and information regarding user's registration to the system (Gerber et al., 1995). The system manages geographic information that can be displayed on geographic web maps accompanied by descriptive data. The visualized spatial data are helpful for environmental project management and planning (Bishop and Lange, 2005).