Marine weather monitoring through a WebGIS application

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Abstract. Meteorological parameters are considered as significant physical parameters that are essential for the study of a variety of phenomena in the atmosphere, the climate, the weather and the general physical environment at the Earth surface. Extreme values of these parameters which in turn characterize extreme weather events are expected to increase regarding frequency and intensity because of the rapidly changing climate but they can be identified by monitoring meteorological parameters. Furthermore, extreme weather events seriously affect sea-transportation and relative processes with great economic importance. A modern and integrated method to monitor these parameters and phenomena is the Geographic Information Systems (GIS). This study describes the main procedures for the development and the operational use of a WebGIS application regarding marine weather monitoring and forecasting in port areas and the sea-corridors.

Keywords: Marine weather, Port Community Systems, extreme weather, WebGIS

1 Introduction

Recently, there is an increasing tendency for the development and the usage of GIS applications regarding environment. These applications are focusing not only in spatial analysis, decision making and future planning using the wide range of GIS capabilities, but they also provide integrated web based services to end–users and general public, through modern visualization of scientific results and information using interactive maps and graphs (e.g [1]; [2]). More specifically, GIS applications are essential for a modern, visual representation of environmental issues through monitoring the spatial and temporal changes, supporting planners and stakeholders to design and envision in medium and long-term scale the environmentally sustainable future.

It is well known that many port related activities and the huge increase of maritime commerce through intermodal and unimodal transportation have a great impact in marine and air environment (e.g [3]; [4]; [5]; [6]; [7]; [8]).

On the other hand, marine transportation and all relative port daily activities that could be affected from extreme weather events, have crucial economic importance for sea commerce. International organizations like IMO (International Maritime Organization) and WMO (World Meteorological Organization) define legislations & strategies to ensure maritime safety and they require accuracy of weather reports & forecasts so that to decrease accidents and minimize economic and human losses. Conclusively, it is essential the need for robust prognosis of extreme weather events in port areas, early warning systems, automatic real-time information and high weather forecast quality (especially about storms, heavy precipitation, wind, waves and extreme temperatures) for the sustainable development of sea commerce.

This study presents a WebGIS application (www.portweather.eu), which provides marine weather monitoring and forecasting to support the mercantile and passenger traffic. The application provides also information for past weather conditions and the climatic profile of four port areas of interest [Bari (Italy), Corfu (Greece), Igoumenitsa (Greece), Patras (Greece)]. The WebGIS application has developed with the general objective to enhance the reorganization of the transport services, reducing potential accidents by monitoring weather conditions and improve services to passengers and port stakeholders.

Section 2 presents the available data and applied methods and section 3 describes the WebGIS system the main menus and functionalities of the application.

2 Data and methods

The WebGIS application for the marine weather monitoring/forecasting (www.portweather.eu) in ports and their surroundings use real-time measurements from ground stations nearby the ports of interest. It provides forecasts from three-hourly to three days ahead. The measurements and the forecasts concern basic meteorological parameters, referred in the Table 1.

Table 1. The meteorological parameters provided in the WebGIS for port weather monitoring/forecasting.

Parameter	Unit
Temperature	Celsius (°C)
Precipitation	mm
Wind speed	Bft
Wind direction	Degrees
Cloudiness	%
Humidity	%

The real-time and forecasted values for the parameters of the Table 1 come from the "http://openweathermap.org/" service. This service provides data of ground

weather stations as well as forecasts based on their models. An Application Program Interface (APIs) has developed to retrieve information from the servive in suitable time-steps and text format. Then, all the retrieved data are analyzed and visualized automatically in the WebGIS application.

This WebGIS application consists of a software framework that integrates modules providing various functionality along with specific user–written code to achieve the required system functionalities. The WebGIS platform utilizes open–source frameworks and libraries to achieve a professional level of development and maintenance. More specifically, the Codeigniter – PHP MVC Framework, the Twitter Bootstrap – CSS Framework, the jQuery – JavaScript Library, the jQuery UI – JavaScript GUI Library and the Google Maps API (version 3) – web mapping service, are used. Such tools have been used in many applications (e.g [9];[10]).

3 Main menus of the WebGIS application

The central introductory interface of the WebGIS application gathers a list with all the available ports on the platform. By clicking on the port of choice, it is appeared the main meteorological parameters and all the relative weather information.

More specifically, there is a checkbox regarding climate; by selecting it, graphs about climatic behavior of main meteorological parameters in the area surrounding the port of interest are provided (Figure 1).

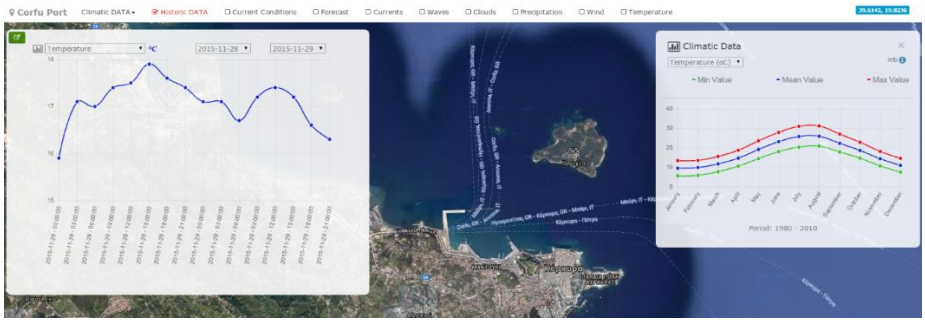

Fig. 1. The weather information about the port of Corfu (Greece). The same list of content is available for all ports. On the left, a past period of time is selected and illustrate the temporal evolution of a parameter. On the right, the climatic variation of a parameter in monthly basis is seen.

The current meteorological conditions in a port area can be seen when the check-box “Current conditions” is selected. By clicking this, a legend that contains the current values of various meteorological parameters (temperature, pressure, humidity, clouds, wind) is provided (Figure 2).

Then, the user may select “forecast” check-box and so the temporal weather estimations for a time that extents from three hours to three days three interval is illustrated (Figure 2).

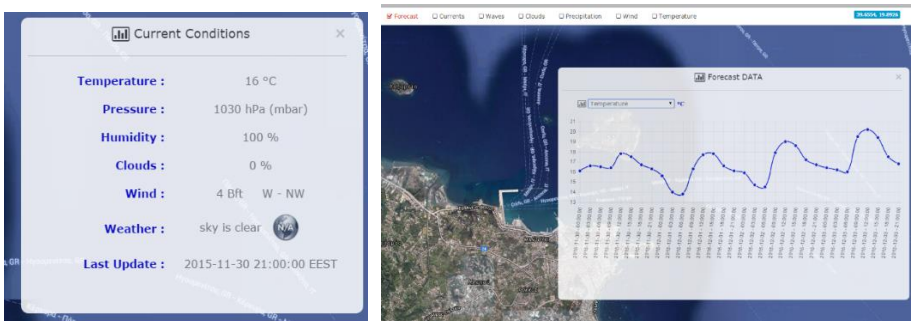

Fig. 2. Screen with the current conditions (on the left) and the forecast (on the right).

The WebGIS application includes an alert system about extreme weather events. Extreme weather events are considered of particular interest because such phenomena and situations can cause great economic loses, damages to infrastructures and private properties and even human losses. Thus, alerts about potential extreme weather events are of crucial importance for the sea transport and all port activities.

More analytically, when a value of the meteorological parameters (monitored or forecasted) exceeds a threshold value, an alert sign (like the on presented at Figure 3), is appeared in the graphical interface of the web-based application. The threshold values for all the meteorological parameters have defined through a climatic statistical analysis of the historical data for the last decade.

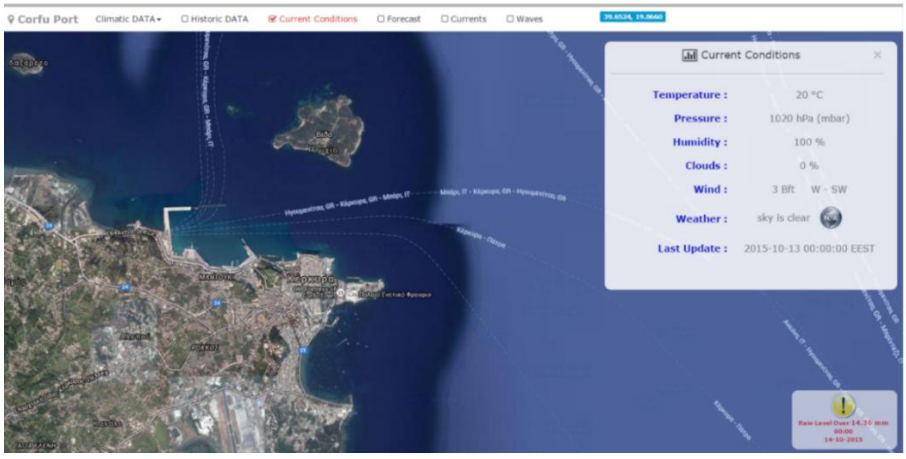

Fig. 3. An example of the alert signal (down right of the figure) is shown when a value of meteorological parameter (monitored or forecasted) exceeds a pre-defined threshold value.

There are three different alert labels (signs) according to the intensity of the extreme weather event (Figure 4). The first alerts refer to a potentially extreme event,

the second level is the appearance of an extreme event and the third level is referred to a very extreme event.

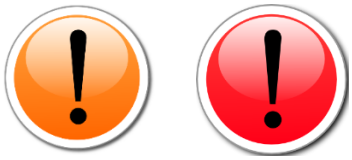

Fig. 4. Alert symbols referring to extreme and very extreme events correspondingly.

The WebGIS application also provides interactive maps (Figure 5), which provide spatial distributions of main meteorological parameters such as cloudiness, precipitation, wind, temperature and pressure. This module is particularly interest as it describes the weather conditions of the sea-corridors among ports of Adriatic and Ionian Sea.

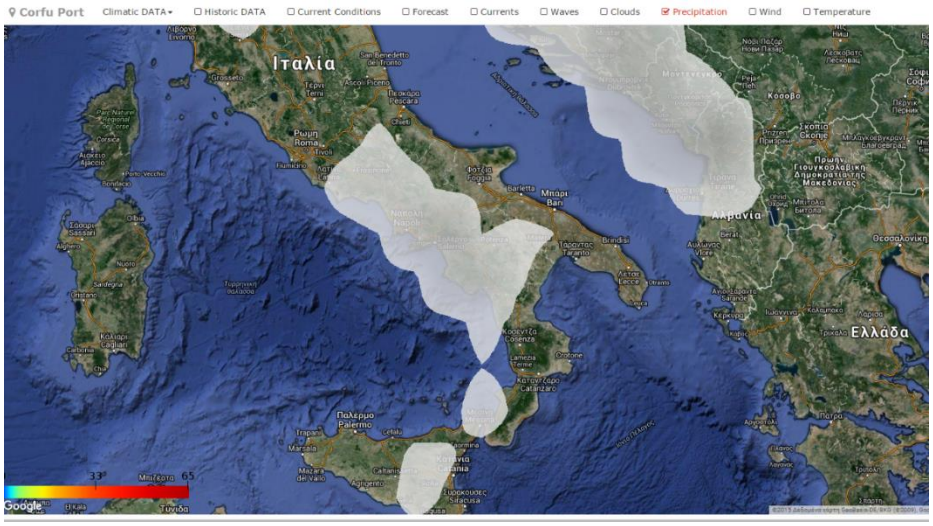

Fig. 5. The spatial distribution of precipitation is provided from the "http://openweathermap.org/" service and visualized through the WebGIS application.

4 Conclusions

The presented WebGIS application provides essential information about weather conditions at ports of Ionian and Adriatic Sea as well as in their greater areas. The application has developed with modern techniques and creates an integrated web-based interface easy to use and portable with every mobile device.

This application not only provides information about current meteorological situation and forecasts, but also alerts in case of extreme weather events referring to temperature, precipitation and wind. The WebGIS is very useful for port stakeholders because it helps them to improve the safety of many operations and especially activi-

ties that are affected from meteorological conditions and extreme weather phenomena.

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