Annals of Geographical Studies
Volume 2, Issue 1, 2019, PP 8-16

Diffusion of Geo-Environmental Datasets through Online Interactive and Real-Time Applications. Case Study: The Natura GR2440006 Protected Area

Antoniou Varvara[1], Vassilakis Emmanuel[2]

[1]*Dr Geosciences, Laboratory Teaching Staff of GIS and Natural Disasters, National and Kapodistrian University of Athens, Faculty of Geology and Geo environment, Panepistimioupoli, 15784 Ilisia, Greece,*

[2]*Assistant Professor of Remote Sensing and Tectonic Geomorphology, National and Kapodistrian University of Athens, Faculty of Geology and Geo environment, Panepistimioupoli, 15784 Ilisia, Greece, evasilak@geol.uoa.gr*

***Corresponding Author:** AntoniouVarvara, Dr Geosciences, Laboratory Teaching Staff of GIS and Natural Disasters, National and Kapodistrian University of Athens, Faculty of Geology and Geoenivronment, Panepistimioupoli, 15784 Ilisia, Greece, vantoniou@geol.uoa.gr*

ABSTRACT

A web - interactive application which spreads geo-environmental information over the internet and also accepts and manages real time rural data is described in this paper. Story Maps context has been chosen for this reason, since this is considered to be a new and innovative Web-based Geographic Information System application method for using it as a mean for organizing and presenting new digital geographic information by combining interactive maps with multimedia and other apps simultaneously in one platform. The protected area of Kallidromo Mt. (central Greece) was chosen as a case study, due to its environmental sensitivity since it is characterized as Natura protected area and also because of the availability of several kinds of geospatial data.

Keywords: *WebGIS, Story Map Journal, Kallidromo Mt, Greece, environment, Natura*

INTRODUCTION

The main aim of this work is to present a web - interactive application which depicts geo-environmental information and has the ability to be managed and used through internet for acquiring and represent several kinds of data in real time. For this purpose, ESRI's ArcMap v.10.6.1 Desktop (as a GIS platform) was used, in order to import, analyze, manage and organize different information layers, as well as ArcGIS Server v.10 for online publishing and Arc GIS Online for further processing. The protected area of Kallidromo Mountain (central Greece) was chosen as a case study, due to the existence of a large number, with high accuracy, data of different objects, which were collected within the EU funded research project LIFE - Conservation of priority forests and forest openings in "Ethnikos DrymosOitis" and "OrosKallidromo" of Sterea Ellada (LIFE11 NAT/GR/1014 "For Open Forests").The developed application can be accessed either in webgis-mfk.uoa.gr/LifeKallidromo, or through ESRI's online platform in https://goo.gl/7UAnQf.

MATERIALS AND METHODS

This paper aims to present a web-based application developed to disseminate information to geologists, earth scientists and non-expert users to explore the environmental protected area of Kallidromo Mountain (DiBiase et al., 1992; Antoniou et al., 2018). Therefore, a new web tool, Story Maps, deriving from the rapid evolution of the Geographic Information Systems (GIS) technologies, has been chosen."Story Maps" is a technique which has been developed the last few years for providing a powerful way of internet communication, where developers can promote spatial analytics with complex variable datasets, producing 2D or 3D thematic maps, accompanied by explanatory text (diagrams and tables can also be included) and/or multimedia context (photographs, figures or videos), aiming to emphasize and make more understandable their "story". A story map allows not only interaction with the map but also with the text. Graves (2015) notes that users are more likely to engage in a story that sustains their interest, so a variety of text, maps, graphs, and video or audio clips maximizes its overall content. Since, they are more or less a kind of Web Application and an open source dynamic and interactive tool, knowledge can be shared and exchanged at any topic (Kerski, 2016).

Moreover, Story Maps can be used from non-GIS users to distribute scientific results and make them easily understood (Janicki et al., 2016; Wright et al., 2014). The main advantages are the interactivity compared to the hard copy maps, the active intervention of any user and the ability to visualize a big variety of media at the same time. A story map is a "data-story-telling" or "data-driven-story-telling" instrument that has been used to reveal hidden information from data and present them to any user no matter how specialized or informed they are.

The methodology followed in order to develop the web application, can be distinguished in three steps (Figure 1):

- Collection and organization of vector and raster data as well as spatial and descriptive processing when required, in Desktop GIS environment (Arc Map v.10.6.1).
- Transformation of the data into an appropriate format (feature/image services) so that they can be used online and upload them in a Server environment using Arc GIS Server v.10, along with the upload of additional accessory material to the public repository of the Server (images, website links etc.).
- Creating web-based maps and applications in a network online environment (ArcGIS Online).

Among the different templates provided in the online Arc GIS platform, the "Story Map Journal" has been chosen to be the main application, since it has the ability to allow narration throughout a series of documents (Figure 2). This "app" is ideal for generating narratives that combine text, maps, images and videos, especially when adding large text or a variety of content. The application is also accompanied by an interactive builder, used for defining the necessary parameters and is automatically stored on the ESRI online platform. The Narrative Journal Map contains text entries in either a continuously-integrated format or in sections that are accessible to users by scrolling on the screen. In each section a picture, video, map or a website link is assigned and it is also possible to define actions within the text. For example, by clicking on a word, the displayed map could automatically be focused on a particular location. It is a simple and very flexible app, which can present a narrative text based on a single web map or it can lead users through multiple web maps and related images and videos and provide more detailed and in-depth information.

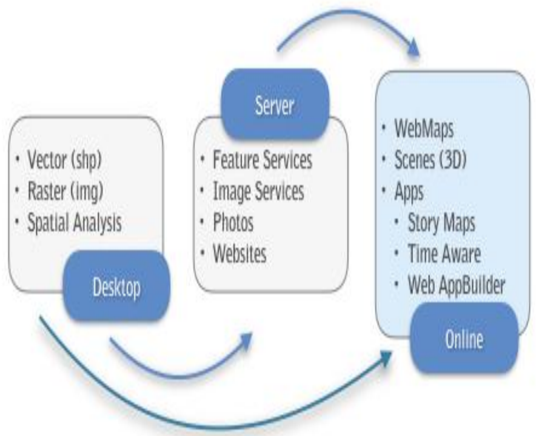

Figure 1. *Workflow showing the necessary steps for creating a Story Map (Antoniou et al., 2017).*

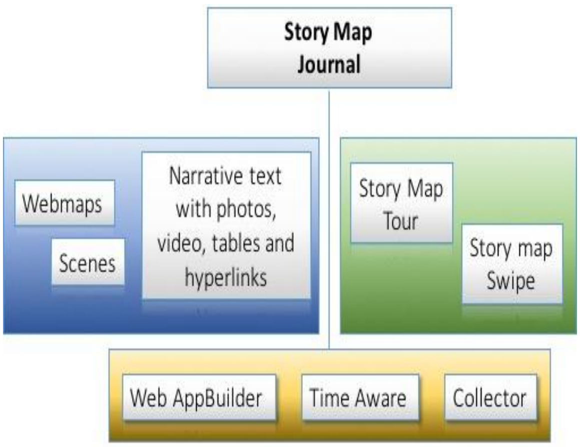

Figure 2. *Components combined to develop the main web application based on the "Story Map Journal" template.*

In the described application, in addition to narrative text, images, tables, hyperlinks, and two- or three-dimensional web maps were added (Neumann A., 2008; Newman et al., 2010). Also, depending on the type of information that each time had to be depicted two other story maps templates, Story Map Tour and Story Map Swipe were embedded, as well as Time Aware, Collector and Web App Builder applications. Using this template and in order to be presented in a unified and homogenized way as part of a single web-based tool, the data collected within the framework of the research project, and especially at the areas where four seasonal ponds are formed, at Kallidromo’s meadows, the application was divided into four sections, one for each pond studied and one for the meadows, while initially, general information of the area is given as well. The online web maps are accompanied by texts, pictures, diagrams and tables coming from the corresponding progress reports that have been submitted during the research project. More data from Open Street, as well as, land use information from Corine 2012 were also used as additional material together with real-time data collection and forest fire risk assessment (Antoniou, 2016). A description of the way in which the various thematic items are examined and represented at the homepage of the application, concerning the protected area of Kallidromo Mt. (Natura 2000-GR2440006), are given below:

- Narrative text framed by three-dimensional representations of the area, where the exact positions of the ponds and the location for all the different types of data are shown. A web map using satellite imagery as base map, shows the boundary of the protected area and the pond coastlines (Figure 3).
- A collection of the available high-resolution remote sensing data (WorldView-2 satellite images and historical aerial photographs) representing the environmental regime at four-time snapshots (1970, 1986, 1996 and 2013) and yielding the changes in a 43 years’ period between 1970-2013. Four web maps were created and using a combination of two datasets, each time, Story Map Swipe applications were set (Figure 4) and embed into the main application, used for multi temporal change detection purposes throughout the several periods of image acquisition. It must be noted that after the comparison of 1996 and 2013 ortho-rectified images, the boundaries of a forest fire were identified, and its extent was digitized in order to be used for the forest fire assessment.
- Real time meteorological data transmitted by a meteorological station installed within the region. A webpage was embedded into the main application containing a list of values for the measured parameters in graphical form.
- Information about the detailed topographic analysis which was carried out using high precision Real Time Kinematics (RTK) equipment. The locations of the three GPS bases along with all the necessary metadata, one for each pond area, are displayed, while pop-ups give any further information for each base.
- General information about the measurements acquired by near surface geophysical methods (Schlumberger and Electrical Resistance Tomography) which were used to identify the subsurface strata and accurately delinate the impermeable underlying layers contributing to the water concentration Alexopoulos et al., 2014.
- Water chemistry and soil geochemistry analysis results from samples collected from the boundaries and inside the ponds. By using hyperlinks in the narrative text, users can explore the variance of each element tested. Also, two interactive Time Aware applications were created, one showing the analyses of the anions and one of the cations based on the time of measurements (Figure 5).
- General information about plant communities and invertebrates found both in the pond area and in the area of the meadows studied, accompanied by representative photographs can be accessed through hyperlinks within the narrative text.

Forest Fire Risk Assessment Application

Apart from the data collected and processed within the framework of the research project, an effort was made to assess the forest fire risk throughout the protected area. In order to illustrate forest fire assessment we used the Web App Builder tool, which was also embedded into the main application. This tool, in addition to displaying different levels of information, widgets etc., increases the user interactivity by giving extra web editing capabilities. Thus, other than the basic focusing tools, positioning and location of the area in map extent, more tools-widgets were added (Figure 6) and are described below:

- *Legend*, which depicts the information layers that are active each time.
- *Layer List*, which displays the information layers, which ones are active and additionally, gives the possibility to be partially parameterized based on the user's options. The information layers added to this application are related to ponds, settlements, fire hydrants, observer towers, road network,

electricity network and 1997's burned area. Corine 2012 land use, slope aspect, slope inclination and the final risk map were also added in vector and raster format. Conversion from one form to another resulted in the multiplicity of entities for each of these information layers, so Visibility Range was defined. The dual format (vector and raster) was introduced in case the available data need to be imported in different kinds of tools added to the application.

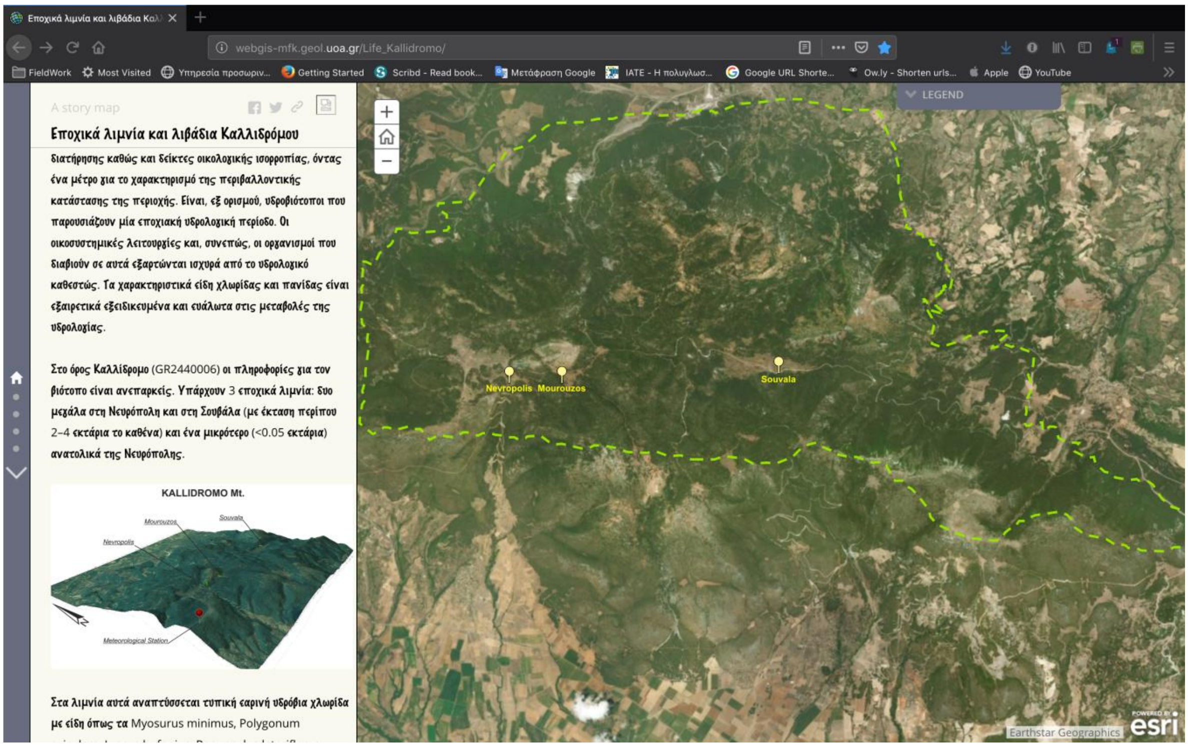

Figure 3. *Application screenshot showing part of Story Map's home screen. A 3D representation of the area enriched by narrative text, while a web map using imagery as basement, shows the spatial distribution of Kallidromo Mt. protected area and the location of the ponds.*

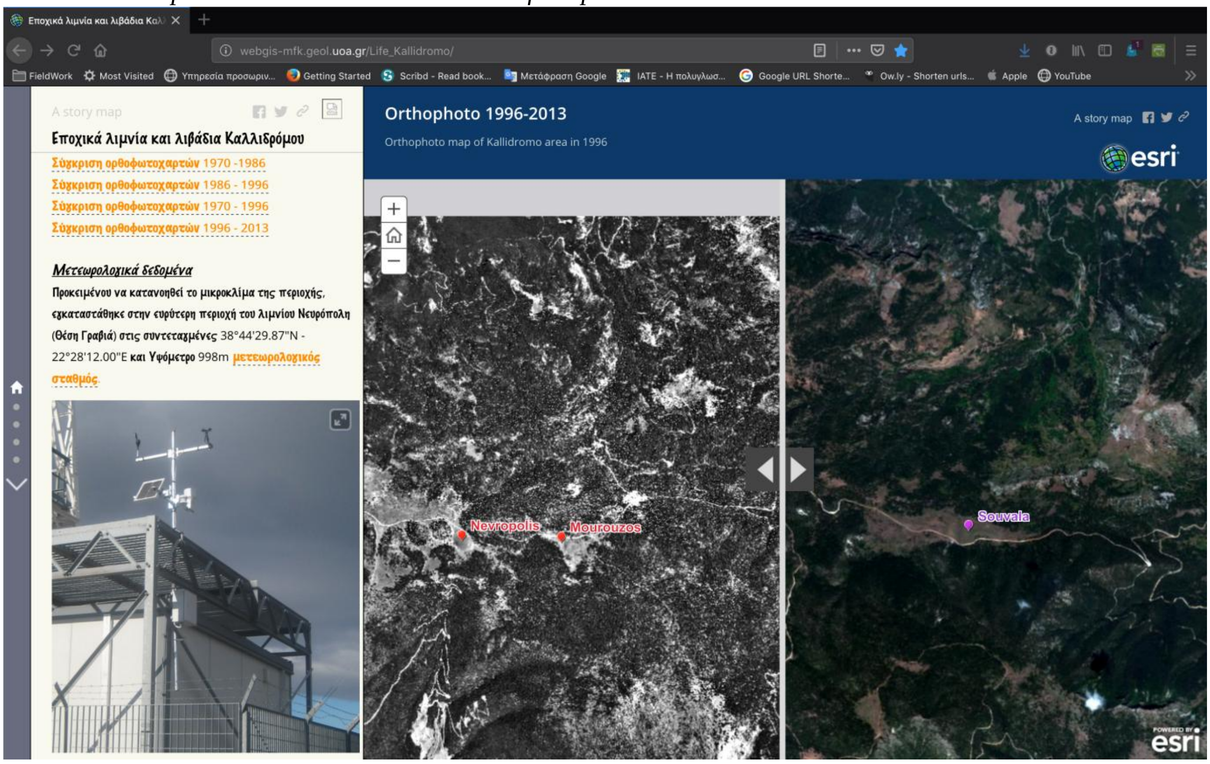

Figure 4. *Screenshot showing narrative text on the left, where hyperlinks (orange letters) lead to ortho-photo-mosaic comparisons that appear in the main panel on the right. The Story Map Swipe of two web maps*

represents the same area with1996 (left) and 2013 (right) ortho-photo-mosaics. Additionally, information and multimedia content about the meteorological station is provided.

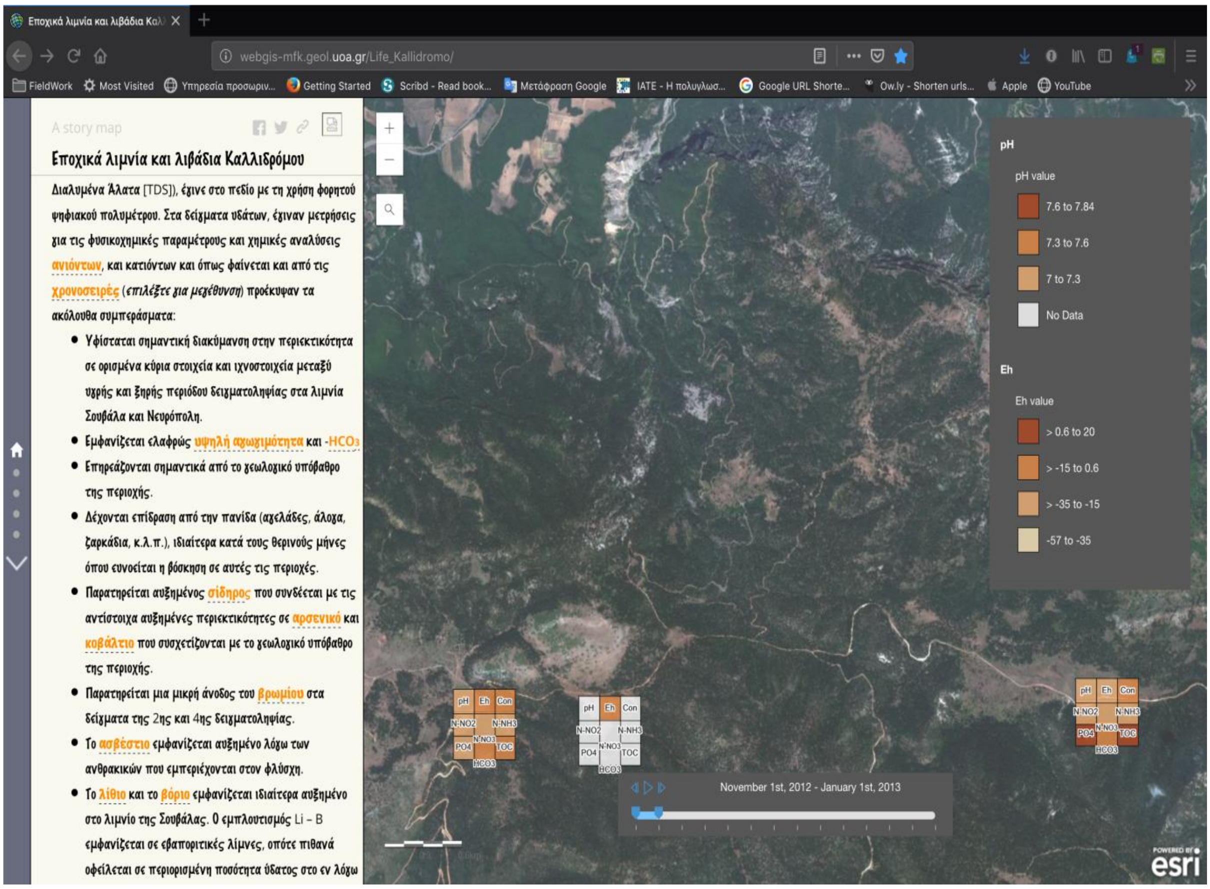

Figure 5. *Screenshot showing narrative text on the left, where hyperlinks (orange letters) lead to multimedia context on the right. Using anion hyperlink a Time Aware application is showing the analyses results based on sampling collection period.*

- *Attribute Table*, which depicts the descriptive information of features defined in the tool settings.
- *Query*, which gives the user the opportunity to perform searches on land-use and forest fire risk map based on database fields and apply spatial filtering specified in the tool settings. The Result would automatically be saved as an extra layer of information and could be displayed in the Layer List tool, if necessary.
- *Swipe*, which allows an information layer to be compared to another one already defined, which in this case is the forest fire risk map.
- *Chart*, provides the ability to create graphs based on data collected from the slope aspect (vector version), Corine 2012, slope inclination (vector version) and forest fire risk map (vector version) database, each time after setting a spatial filter. Both type of graphs and the information layers with the corresponding database fields should be specified in the tool settings.
- *Geo LookUp*, provides the ability to import a Comma Separated Values (csv) file and be placed on the map, e.g. containing points of interest and then enrich them based on the available information levels and fields activated in the tool settings. The information layers of the forest fire risk map and Corine 2012 are activated. Points are added to the map and the pop-up menu is enriched with the new fields. The result file, if not removed, is added to the list of information levels displayed in the Layer List and Attribute Table tool. The structure of the csv file must include the following fields: the coordinates of the points (in WGS 84 or on the projection of the map), the name of the point of interest and the position of the point depending whether the point is placed inside

or outside the map extent.

- *Measurement*, enables users to measure distances along a bold line or the area of a closed surface and obtain the coordinates of any point on the base map.
- *Draw*, allows users to add patterns of any shape or color for which they can also take measurement data (length, perimeter, area, etc.).
- *Bookmarks*, stores pre-defined displays for any of the three ponds. For the convenience of the user, in each bookmark the pond name and a representative photo is being added, while addition of new bookmarks is possible.
- *Basemaps*, which allow the user to change the application's base map by selecting one from the platform's basic map gallery, and
- *Print*, where users can print thematic maps in predefined or even own choice, dimensions.
- Collection, processing and analysis of data introducing forest fire assessment was conducted in Arc Map environment (Singh et al., 2014).

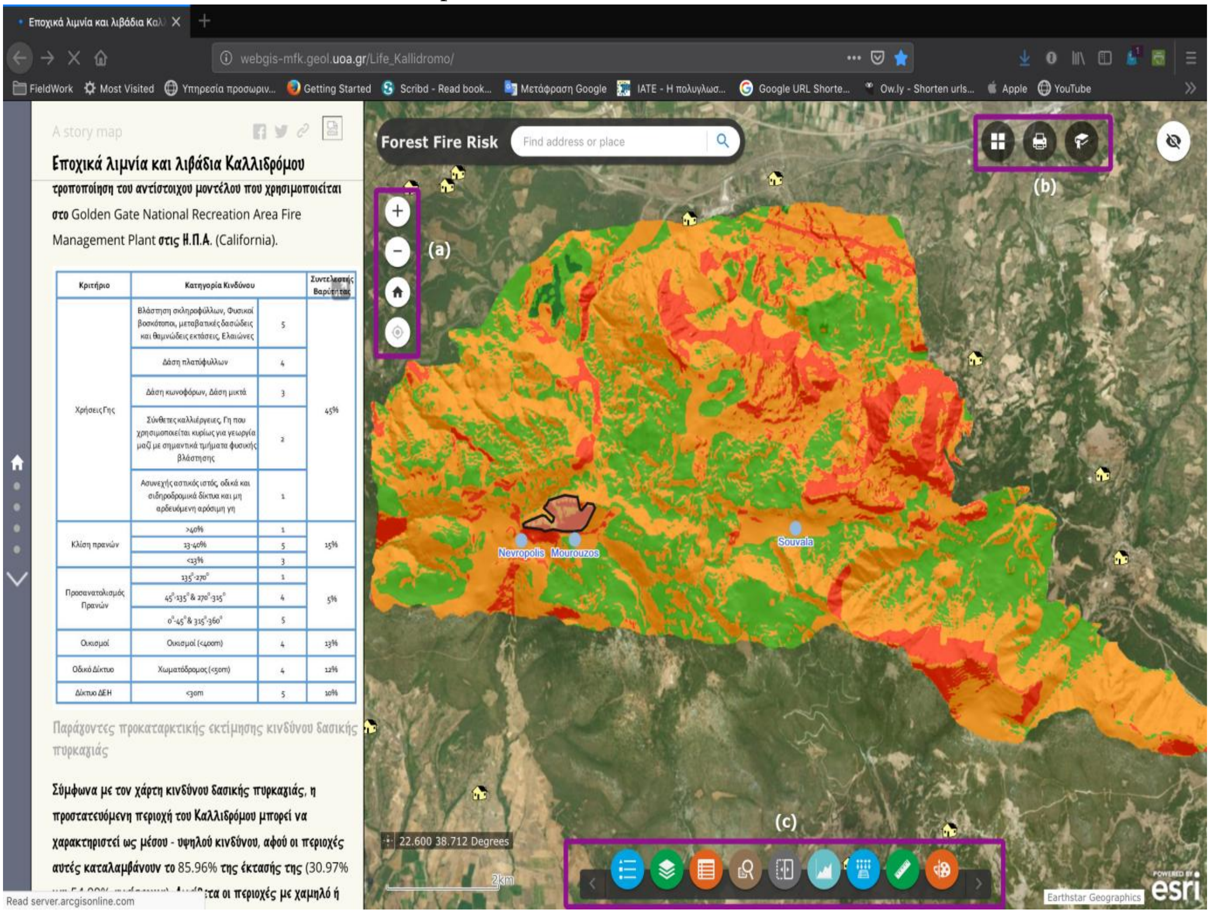

Figure 6. *Screenshot showing the Web App Builder application home screen that was created to represent the forest fire risk assessment. The following three tool groups are marked: (a) Zoom In, Zoom Out, Default Extent and My Location (top to bottom), (b) Bookmarks, Base maps, Print and Show Map Overview (left to right) (c) Legend, Layer List, Attribute Table, Query, Swipe, Chart, Geo LookUp, Measurement, Draw.*

In order for the scientists to collect real-time data, an editing application, Collector for Arc GIS, was set and embedded into the main one (Figure 7). The appropriate layers of information were created in Desktop-Arc Map environment. The web map created in Arc GIS Online platform, contains large scale topographic maps of the ponds' areas as base map, information layers related to the field data collection for (i) biotic environment data entry, including information about the spatial sampling location, the vegetation group, unit, sample type and date of collection in addition to representative photos or video and (ii) online mapping of areas with increased risk (e.g. landslide, flooded area, surface ruptures etc.), their spatial position, descriptive information, along with in situ measurements and media uploading.

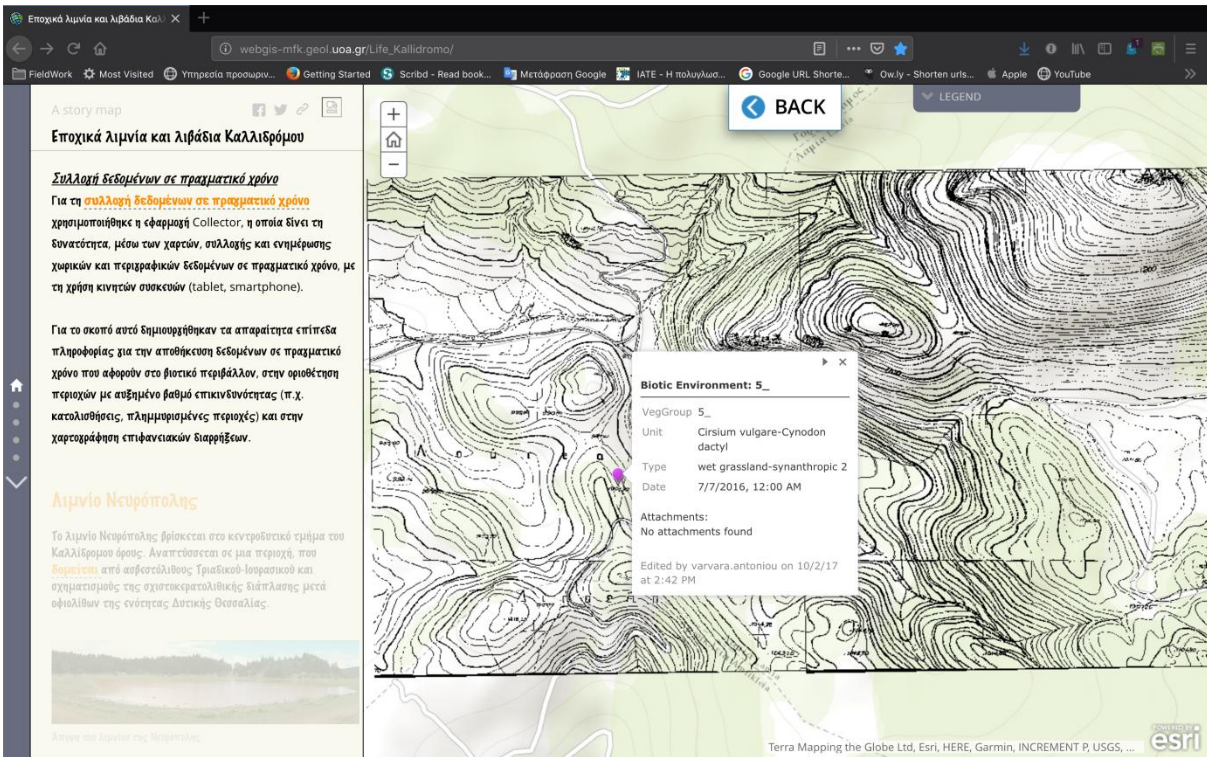

Figure 7. *Screenshot showing the web map created for real time field data collection, while the pop-up provides information for a collected point of interest.*

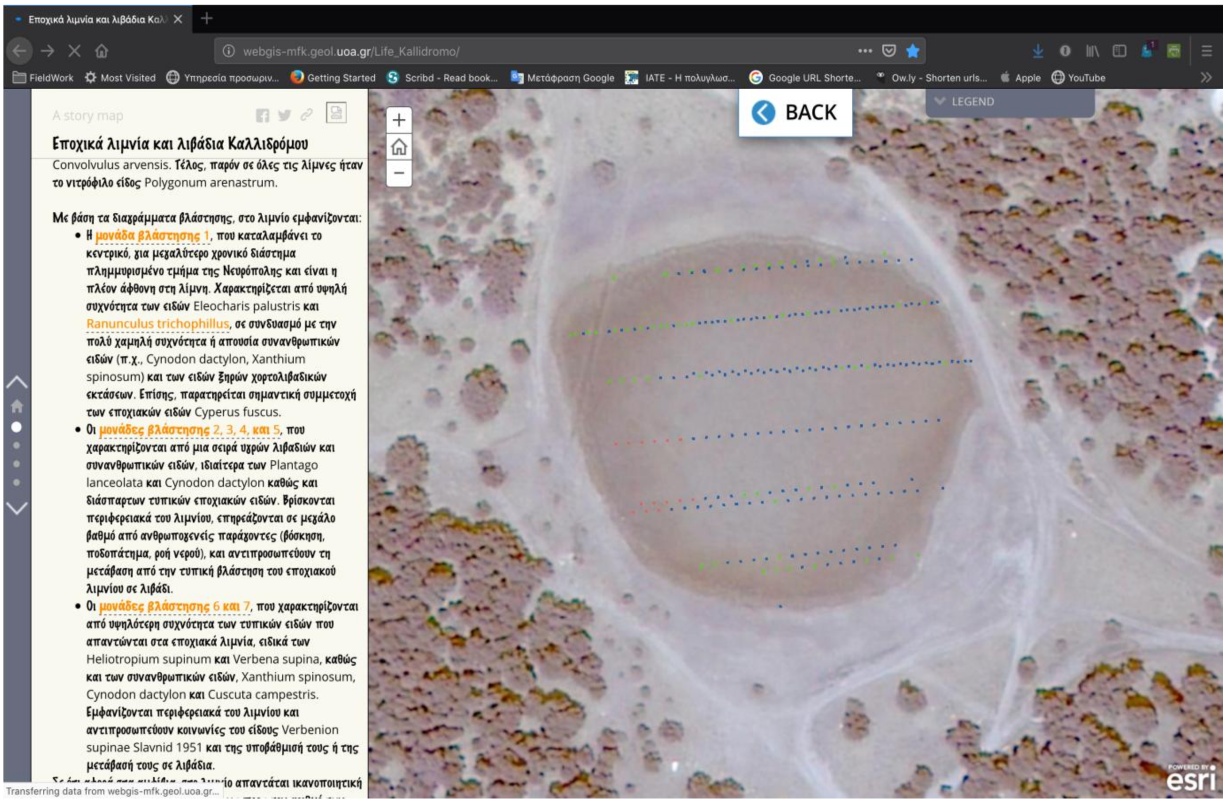

Figure 8. *Indicative web map showing sampling locations categorized per unit of vegetation in the area of the Nevropolis pond.*

As far as the Mediterranean Seasonal Ponds, which on one hand, according to international conventions, are small protected habitats that host a significant number of flora and fauna species with rare and endemic species and on the other ecological balance indicators as a measure for characterizing the environmental status of the area, a separate session was created for each one of them that includes:

- Description of the geological structure of the wider area accompanied by the spatial distribution of the litho logical outcrops.
- Description of the tectonic structure of the wider area accompanied by a Story Map Tour application where points of observation in vector format, and geo coded field photographs were included.
- Micro topographic high precision measurements of the pond's bottom and surrounding areas
- Results of the Geophysical campaigns conducted, accompanied by a web map showing the measurement locations.
- Plant communities and invertebrates found in the pond, where a web map shows the sampling positions categorized per unit of vegetation (Figure 8).

The last section of the application is dedicated to Kallidromo meadows, where habitat 6210, semi-natural dry meadows on limestone substrates (Festuco-Brometalia) was investigated, which is considered a priority because it is an important area for orchids. The distinguished vegetation groups are presented in table format, within the narrative text and with representative photographs. The spatial distribution of the meadows as well as of the Black Peak, the sampling positions and the corresponding results are illustrated within the web maps according to the group of vegetation to which they belong.

Results and Discussion

This paper aims to present a web-based application which was created by gathering and using all available geo-information, even in real-time, with the purpose of spreading them widely.

Story Maps context has been chosen, since this is considered to be the new and innovative Web GIS application method for using geographic positioning as a mean for organizing and presenting information by combining interactive maps with text, photos, videos and audiovisual media simultaneously in one application. In addition, Story Maps can be designed for the broad, non-specialized audience, they may also be useful to individual categories of users who can make use of the results of spatial analysis, without requiring any special knowledge or skills.

The choice for this type of application fully covered the initial queries. It is, therefore, possible to integrate all the data for an area and be accessible by users at different points. It is possible to collect, update and view spatial data within a GIS environment in real time. It is user friendly and provides the ability to manage different kind of information via a computer screen, tablet or smart phone.

Apart from monitoring an area with the use of specialized equipment, the general need to collect data in real time is gradually increased. The tests carried out to check the application stability, usability and ease gave very satisfactory results and proved to be useful for both scientists to pursue their research activities and the general public to be informed about the environmental regime of a given area.

Conclusions

The initial concern was about choosing the kind of application that should be usable and easily accessible. Information can actually be organized in few ways. Whether in alphabetical order, but this is not very handy, either in chronological order, but this order has limitations, or be organized by category or hierarchy in some sort of ranking. The use of spatial organization, the system that organizes the information based on its location in space and taking into account that most people wish to be informed through audiovisual media, while they better understand the surrounding space when they navigate to, through mapping, offers a unique imaging capability, while at the same time serving as a useful and dynamic way of gathering information.

Additionally, the ability provided by technological development, to upload all the available information to the internet, and in particular to usable end-user applications, leads to an increasing number of users who besides being informed, they can also interact with them.

However, these are possibilities that are directly dependent on the technological infrastructure that both the application manufacturer and the individual users have at their disposal. The technology infrastructure concerns internet infrastructures (internet access and network signal performance), capabilities of the hosting server, the capabilities of each device that will be used (computer, tablet, smart phone) as well as the capability and the licensing degree of such software (access to online geographic information platforms).These are also possibilities that are not stable, but they evolve and change every day. Major upgrades occur every 3 months to online platform (by ESRI), which has both positive and negative consequences. Positive because of further possibilities and negative because the upgrades were done simultaneously for all users, regardless of their activities at the given time. This may delay the creation of applications due to possible technical problems, as well as harmonization with the new desktop interface, which usually accompanies them. Here, should be added, any problems that can be created in the future for existing applications due to browser's upgrades.

Acknowledgements

Field data were collected within the research project Conservation of priority forests and forest openings in "Ethnikos Drymos Oitis" and "Oros Kallidromo" of Sterea Ellada, LIFE11 NAT/GR/1014, "For Open Forests".

References

[1] Antoniou, V., 2016. Development of modern, online-interactive applications using WebGIS for processing and mapping geoenvironmental information and real time field data, to prevent and manage natural disasters. Master Thesis, National and Kapodistrian University of Athens, 138p.

[2] Antoniou, V., Mavroulis, S., Spyrou, N-I., Bardouli, P., Andreadakis, E., Skourtsos, E., Kaviris, G., Sakkas, V., Carydis, P., Lekkas, E., 2018. Storytelling Technologies for Dissemination of Scientific Information of Natural Disasters: The June 12, 2017, Mw 6.3 Lesvos (Northeastern Aegean, Greece) earthquake story map. Proceedings of the 9th International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology (PATA), 25–27 June 2018, Possidi, Greece; 2018 p.10-13.

[3] Antoniou, V., Nomikou, P. et al., Bardouli, P., Lampridou, D., Ioannou, Th., Kalisperakis, I., Stentoumis, Ch., Whitworth, M., Krokos, M. &Ragia, L. An Interactive Story Map for the Methana Volcanic Peninsula. Proceedings of the 4th International Conference on Geographical Information Systems Theory, Applications and Management (GISTAM 2018), 17-19 March, Funchal, Madeira, Portugal; 2018 p.68-78, ISBN: 978-989-758-294-3.

[4] DiBiase, D., MacEachren, A., Krygier, J. and Reeves, C. Animation and the Role of Map Design in Scientific Visualization. Cartography and Geographic Information Systems. 1992;19(4): 201-214.

[5] Graves, M.E. Spatial Narratives of Struggle and Activism in the Del Amo and Montrose Superfund Cleanups: A Community-Engaged Web GIS Story Map. Master's Thesis, University of Southern California, Los Angeles, CA, USA, 2015.

[6] Janicki, J., Narula, N., Ziegler, M., Guénard, B., &Economo, E. P.. Visualizing and interacting with large-volume biodiversity data using client–server web-mapping applications: The design and implementation of antmaps.org. Ecological Informatics. 2016; 32: 185–193.

[7] Kerski J. Communicating with Story Maps. Available on line: http://www.josephkerski.com/wp-content/uploads/2016/07/Story_Maps_full_current.pdf (accessed on 10 July 2018).

[8] Neumann A. Web Mapping and Web Cartography. In Encyclopedia of GIS (Shekar S., Xiong H., eds.), New York: Springer Science; 2008. P. 1261-1269.

[9] Newman G., Zimmerman D., Crall A. Laituri M., Graham J. &Stapel L. (2010). User-friendly web mapping: lessons from a citizen science website. International Journal of Geographical Information Science. 2010; 24(12): 1851- 1869.

[10] Singh, Y., Sharma M.P., Sharma S.D., Prawasi, R., Yadav, K. &Hooda, R.S. (2014). Application of GIS Technique to select suitable sites for erecting watch towers in forest areas of mountainous tract. Int. J. Computer Technology & Applications. 2014; 5(2): 462-468.

[11] Wright, D.J., Verrill, A., Artz, M. & Deming, R. Story maps as an effective social medium for data synthesis, communication, and dissemination, Eos, Trans. AGU, 95, Fall Meet. Suppl., Abstract. 2014, IN33B-3773.

Citation: *Antoniou Varvara, Vassilakis Emmanue," Diffusion of Geo-Environmental Datasets through Online Interactive and Real-Time Applications. Case Study: The Natura GR2440006 Protected Area", Annals of Geographical Studies, Engineering and Technology, vol. 2, no. 1, pp. 8-16, 2019.*