SocioCoast: Design and Implementation of a Data-Driven Platform for Citizen Science in Coastal Areas

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Due to the rapid urbanization and globalization that has occurred in recent decades, cities have undergone significant changes and transformations. The smart city concept can lead to improvements in the life quality of citizens and contribute to the city’s sustainability by collecting humans’ real-time observations. More specifically in smart coastal areas, citizen’s science data can be utilized not only to increase the effectiveness of its services like smart tourism and smart transit but also to raise awareness about environmental issues. Emphasizing on coastal areas under the Blue Flag program and the Natura 2000 network, in this work, we introduce a system that aims to collect crowdsourcing data from citizens and tourists and combine or compare them with existing knowledge for these areas. We describe the design and implementation: the back-end, its data sources and also the front-end outputs, a web knowledge platform, and a crowdsourcing mobile application. Geospatial information as well as historical or real-time data collected will be provided to users for further exploitation and creation of their own applications. A demonstration of the system is also provided to showcase its usefulness in increasing attractiveness and raising awareness for coastal areas by offering users rich and updated information.

CCS Concepts: • Information systems → Crowdsourcing; Collaborative and social computing systems and tools; • Human-centered computing → Collaborative and social computing systems and tools;

Additional Key Words and Phrases: Citizen science, coastal areas, smart beaches, crowdsourcing, data collection, data visualization

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1 INTRODUCTION

The smart city concept has been in the spotlight for the last few decades, due to dramatic urbanization and globalization all over the world. We can find many articles in the existing literature regarding this concept, while some cities in Europe and beyond have already incorporated some characteristics that make them “smart”. Some examples are: (1) applications that measure traffic in real-time, (2) applications that reveal free parking lots, (3) real-time geolocation of public transport vehicles, and so on. Dubai is a developing tourist destination that has integrated smart city and smart tourism platforms to engaging many stakeholders [1]. Smart city concept is strongly connected to the Internet of Things (IoT) notion as it inherits essential building components such as data generation, data management and application handling from IoT [28]. A popular definition states that a smart city is “an urban environment which, supported by pervasive ICT systems, is able to offer advanced and innovative services to citizens in order to improve the overall quality of life (QoL)” [23].

According to Mohanty et al., the majority of smart city proposals consist of four main attributes, which are the following. (a) Sustainability, (b) QoL, (c) Urbanization, and (d) Smartness [16]. A sustainable city is a model of an urban center that makes rational use of the natural and technological resources that its population requires. The QoL in today’s contemporary cities is characterized by three dimensions: economic, social, and environmental. Each one defines the citizens’ level of satisfaction with their lives in this certain city. Urbanization focuses on economic, technological, and governing aspects when moving from a rural to an urban environment. Finally, the smartness of a city is defined as the willingness to improve social, environmental, and economic aspects of the city and its residents’ life [9, 27].

Regarding the second main feature of a smart city, themes or pillars, the most well-known pillar system is the four-pillar system which consists of institutional infrastructure, physical infrastructure, social infrastructure, and economic infrastructure [16]. Using this system as a mean, citizens can contribute towards the sustainability and flexibility of a city through ICT and thus improve its QoL.

The deployment of smart cities is an increasing trend during the last few years, therefore many real-world examples of smart cities can be found after a quick search of the existing literature. Cities in motion index (CIMI) was introduced by Berrone and Enric et al. [3] to examine indicators that cover 10 dominant categories in urban life i.e., the economy, technology, human capital, social cohesion, international outreach, environment, mobility and transportation, urban planning, public management, and governance [4].

Additionally, in recent years there has been an increase in attention to the needs for urban biodiversity in urban coastal areas discovery. Utilizing this knowledge to address and find solutions for environmental challenges and problems that the earth is facing in today’s world is an intriguing approach for smart areas [8, 20].

The design and implementation of collective awareness prototypes is essential and directly related to the need to aggregate and summarize current information about smart areas, with new data from residents or tourists based on their live observations. Having as motivation the above current landscape of smart cities and biodiversity and with a focus on coastal areas, this work attempts to integrate components of citizen science, crowdsourcing, and scientific observations in a smart city concept. It introduces SocioCoast system consisting of a web knowledge platform and a crowdsourced mobile application. SocioCoast aims to strengthen the Blue Flag programme, improving the beach experience for visitors, contributing to a more direct communication with operators.

An initial version of this work, covering the architecture of the platform, is available in an existing publication [22]. This work presents the extended implemented version of this framework. The proposed platform aims to develop smart coasts and smart coastal areas and is inspired by the concept of smart cities. With the help of SocioCoast’s applications, visitors can learn important details about the coastal region they are visiting. That information is provided not only from the project’s initial data sources, but also from crowdsourcing through the use of the SocioCoast’s mobile application. In essence, everyone who uses the prototype, either scientists or

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ordinary people, will be able to immediately benefit from their own crowdsourcing observations in the proposed prototype. In fact, the prototype of SocioCoast is unique because although there are many other applications related to Blue Flag beaches, none of them combines its rich information about beaches with UGC and visualize them in the same platform.

The rest of the article is structured as follows. Section 2 reviews the current background related to smart coastal areas and how citizen science and especially data from crowdsourcing are connected with this concept. A user study concerning requirements gathering is described in Section 3, whereas an overview of SocioCoast’s architecture and its components are presented in Section 4. Sections 5 and 6 present demonstrations of the web Knowledge Platform and the mobile application, respectively. Finally, Section 7 concludes the work and discusses some future prospects.

2 BACKGROUND AND RELATED WORK

2.1 User Generated Content for Smart Cities

User-generated content (UGC) is an important component of a city’s overall knowledge for a better understanding of cities’ dynamics [29]. An increasing range of services and programs are now accessible for environmental condition monitoring and real-time analytics. By utilizing social and crowd sensing, residents contribute to the “smartness” of a city’s infrastructure [2]. Smart cities typically have sensors installed to monitor traffic, pollution, parking issues, and estimate attendance at engagements, among other things [26]. In a smart city, residents and visitors play the role of human sensors, broadcasting real-time data about the city’s pulse [30] and as a result, mitigate or prevent crises and disasters (e.g., extreme weather conditions). A significant amount of geolocation content is produced by both transient (i.e., visitors) and permanent residents, modeling urban settings into dynamic ones [10]. Such content is considered vital not only for enhancing a smart area’s existing knowledge but also for citizens’ science in general as a destination concept [17]. As a result, applications and services for smart areas and especially smart cities, including crowdsourcing data or User Generated Content, are proliferating year by year. Previous works have focused on the above. The CITY-SENSE framework is a prime example of a citizen observatory implementation [13]. The principles and architectural components required to build a CITY-SENSE observatory are described in detail in this study. Its aim is to increase people’s awareness of their surroundings and give users the power to produce information by sharing their own firsthand experience with crucial indicators that systematically determine a city’s QoL. Tourism analysis as an extra benefit of UGC in smart places has also been analyzed [14]. Every person can contribute generated content to a city’s already existed knowledge, if he/she happens to be a resident there or just a passerby, by reporting his/her observations related to the city’s “smart” aspects. Actions like this can help to promote and develop the notion of smart tourism [11, 18].

2.2 Biodiversity Data as Source of Information for Urban Coastal Areas Discovery

Numerous datasets and methods are currently available to improve and develop biodiversity analytics for various purposes. iNaturalist is one of the most well-known open citizen science data sources. It is an organism-tracing tool and a comprehensive system for recognizing biodiversity species. It can be used to access observational data gathered by other users, record public observations, assist in the identification of species in an area, or develop synergies to collect such information. The observations of iNaturalist include a date and a location but do not contain any information about the sampling process [5]. The dataset can be used for analyses of terrestrial [24] or marine [6] biodiversity.

The LifeWatchGreece (LGW) platform is another tool that relies on crowd-sourced knowledge for biodiversity monitoring [15]. LWG is a central platform that facilitates data exchange and integrated analytics. It has a variety of virtual labs and e-Services that are currently being developed to support users and data rates. Life
Natura Themis\(^3\) mobile application is a different type of tool related to areas of the Natura 2000 Network. It is part of a five-year program concerning the criminal prosecution of wildlife crimes and the restoration of environmental damage in these areas. Through this application, users can report violations they observe in a Natura 2000 area, while the application guarantees the anonymity of the complaint submitted. Complaints are then assessed and coded to the appropriate category of environmental crime to be forwarded to the relevant authorities. At the same time, users are informed about the progress of their complaints.

2.3 Weather Conditions as a Type of User Generated Content for Smart Areas

Traditionally, a network of meteorological measuring stations is needed for accurate weather estimations. However, previous works are focusing on using crowdsourcing and available ICT tools available. Muller et al. analyze a variety of existing and proposed approaches to crowdsourcing atmospheric and weather data, they look into the reliability of such data, and consider possible uses concerning the weather, climate, and society \([19]\). “Atmos” is a relevant crowdsourcing weather software toward this scope \([21]\). This application was created not only to periodically take weather readings from smartphone sensors, but also to allow people to input their forecasts for the present and the future \([21]\).

In the framework of SocioCoast, for a smart area and especially for a smart coast area weather conditions can be a crucial deciding factor for tourists and locals to visit a beach. For instance, if someone is interested in doing wind-surfing he/she could check the weather temperature and the wind speed and direction to identify if the conditions suitable for surfing on a specific day. Apart from existing meteorological models which provide daily forecasts, crowdsourced data from visitors will enhance this knowledge and give more accurate information on the weather conditions, given the fact that these observations are real-time.

2.4 Smart Coastal Areas: Concepts, Platforms, and Applications

Smart coastal areas and beaches can be considered a subcategory of smart cities. A few smart cities that are already developed like Barcelona \([14]\) and Dubai \([1]\) are in fact smart coastal areas as well, where monitoring mechanisms for environmental issues can be applied, especially regarding beach monitoring \([7]\). IoT sensors are utilized in smart beaches in particular to monitor the beach or to increase beach safety by deploying smart cameras \([1]\). However, the advancement of urbanization in these areas has also led to problems related to the city’s ability to maintain its environmental sustainability. To examine pollution load in Surabaya coastal area Rahmat et al. modeled the water area dynamics, as a source of information and data to increase public awareness of the water pollution caused by their activities in the inland region \([25]\). A related platform that is created to facilitate this smart concept and more specifically the smart city concept is named Smart City Platform (SCP). An SCP offers urban operation and services supporting the operation of municipal services, as well as efficiency, performance, security, and scalability, by directly integrating city’s systems or through open interfaces between the SCP and external providers \([12]\).

3 REQUIREMENTS GATHERING FROM USERS

Smart coastal areas are ideal targets for specified UGC content i.e., marine or terrestrial biodiversity (Section 2.2), oceanographic and weather data (Section 2.3), reports for environmental hazards and infrastructure issues in these areas, and so on. By contributing their observations, citizens and tourists will contribute to the preservation and protection of these areas and the existent flora and fauna near them. Taking all of the aforementioned factors into account and as a continuation of the prior work for SocioCoast’s framework \([22]\), in this article, we introduce the SocioCoast platform prototype that is based on the idea of crowdsourced collected data for selected beaches and coastal areas under the Blue Flag program. Visitors and tourists can submit their observations to the platform,

\(^3\)http://www.lifethemis.eu/.
and then appropriate governmental or non-governmental organizations, such as municipalities or environmental organizations, can review the collected material. By using these data, the appropriate authorities will be notified when user observations necessitate their intervention for legal or environmental reasons. The overall prototype’s goal is to improve the already available information on beaches that are offered under the framework of the Blue Flag program.

As part of requirements gathering for the SocioCoast’s tools and having the above as basis, a questionnaire-based requirements study was conducted aiming at identifying and verifying the needs and priorities that the platform should cover, as well as at drawing useful conclusions about the structure, operation, and design of the knowledge platform. The designed questionnaire was addressed to simple users of the web platform application including 21 questions. In the beginning of the questionnaire, some general information about the SocioCoast prototype and specifically about the knowledge platform was provided for the participants to keep in mind before completing the questionnaire. Next, a few of the survey’s questions will be presented alongside provided responses.

The questionnaire was available online (in the Greek language\textsuperscript{4}) and was distributed to the contacts of consortium members (in Greece and in Cyprus) in order to reach as many individuals as possible. The first part of the questionnaire focused on general information of participants. From the total number of 75 participants, 40 of them were men whereas the rest 35 were women so we can say that we approximately had a gender balance in the participant’s answers. In terms of age group, Figure 1 illustrates the five different age groups of the participants with the corresponding percentages. The largest participation was from people aged 35–49 years old, while the smallest was from people over 65 years old.

The next section of the questionnaire focused on users’ interaction with similar platforms or applications. Nine out of ten participants had never used a similar application before, while the rest mentioned the following as similar applications: (1) Costa Nostrum, (2) Meteo, (3) i-Naturalist and (4) Cretan beaches. In the next question regarding what information or features users who used a similar platform liked, all the answers indicated below received users’ votes:

- Beach weather conditions for a specific day;
- Suitability for swimming at a beach on a specific day;
- Presentation of all kinds of flora and fauna present on a beach;
- Services offered on a beach;
- Information comparison between two beaches;
- Other (e.g., terrain morphology)

\textsuperscript{4}https://tdy.io/hbSo0Z.
The last and most important section was about the SocioCoast platform. A crucial question was about the kind of information users will be most interested in viewing on the online platform. Specifically, users were asked to determine an ascending order of priority in the following five categories of information/data: (1) General Information about beaches, (2) Biodiversity data, (3) Oceanographic and Meteorological Data, (4) Infrastructure and Accessibility for disabled people, and (5) Cultural Heritage. Figure 2 illustrates the degree of importance of each information/data category according to the participants’ answers. A strong preference for general information e.g., the location of the beach, if it belongs to the Natura 2000 network and so on, was observed, whereas the majority of the participants seemed to be less interested in the cultural heritage that may exist near these coastal areas. At the end, we asked participants for their own recommendations for additional data and received several answers. The most important ones indicated were: (1) the water quality at each beach, (2) the existence of lifeguards, (3) transport and parking near the beaches, and (4) evaluation of beaches from users.

4 SOCIOCOAST: A WEB PLATFORM AND A MOBILE APPLICATION FOCUSING ON CROWDSOURCING IN COASTAL AREAS

This section aims to present the overall framework of SocioCoast’s prototype through an in-depth analysis of the functionality and structure of its basic components. The detailed design was conceived taking into consideration user needs, especially for the kind of data to be included in the system. Figure 3 illustrates the proposed framework in three main dimensions. The first one is the main Data Sources where data are coming from, the second is the Back-end system, and the third refers to the Front-end of SocioCoast’s applications. In terms of implementation and programming tools used, the web knowledge platform of SocioCoast is currently built using Django, a free and open-source, high-level Python web framework that encourages rapid development and clean, pragmatic design.5

5https://www.djangoproject.com/.
4.1 Data Sources

SocioCoast platform prototype uses various types of data coming from different data sources. These data sources are broken down into the following categories: (a) institutional observations, (b) scientific literature, (c) open-source datasets and applications for oceanographic and biodiversity data, and finally (d) crowdsourcing data—UGC. Institutional observations refer to observations on beaches and coastal areas that are made by experts using proper measurement equipment, i.e., in target beaches of Greece from Hellenic Centre for Marine Research (HCMR) experts. Existing scientific literature and multiple open-source applications are currently being used to gather oceanographic and biodiversity data and store it in the SocioCoast’s database (3.2.4). Two main sources that are currently being used concerning oceanographic and meteorological data are: (1) Copernicus Marine Environment Monitoring Service (CMEMS) for the area of the Mediterranean sea and (2) POSEIDON system for the Greek marine area.

4.2 Back-End

The Back-end of the proposed platform prototype consists of the following three elements: (a) the Data Loader which uploads all different data to the prototype’s database, (b) the Data Handling which is responsible for gathering and processing the data and (c) the Data Sharing component which makes only selected data available for download and further exploitation of them from the users.

4.2.1 Database. We are using a non-relational database (DB), more specifically a Mongo-DB, because the majority of the data from the various data sources are in the form of JSON files and some of the data within the same collection do not have the same structure. Using a non-relational DB, such as Mongo-DB, allow us to store collections of data that do not necessarily have any logical connection to each other, for instance, common

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6https://marine.copernicus.eu/
7https://poseidon.hcmr.gr/
fields or common types of data. This database consists of various collections which correspond to every type of information present in the applications including users’ personal information, UGC, and so on.

4.2.2 Data Loader. In general, a data loader facilitates the process of accessing and transferring data from multiple sources into a central location, such as a cloud data warehouse or a simplified Application Programming Interface (API). To be more precise, this framework includes a Representational State Transfer (REST) API, that was developed as a component of the web knowledge platform. This API was created using the Django REST framework, and its documentation was created using Django REST Swagger and Python programming language. Appropriate calls have been created for all of the data that are used in the web platform and the mobile application. The main reason for that is that the mobile application is deriving these data from the REST API to make them visible in its Graphical User Interface (GUI).

4.2.3 Data Handling. As indicated, the data used in the SocioCoast’s prototype are derived from a variety of sources and must be treated properly in order to be effective and simple to use. To decrease the response time of API calls made to obtain historical data each time needed, these data were then filtered to keep the interested variables and information for our prototype and then locally stored in files of various formats (“csv”, “netCdf”), before finally transmitted to the database component. Similarly, static data from institutional observations and the scientific literature (mainly for biodiversity) were stored in SocioCoast’s database using this way as well. However, for the real-time data, a constrained time window was established and by executing particular scripts we are perform daily updates on the data.

4.2.4 Data Sharing. Selected amount of the SocioCoast’s data are accessible through the REST API described before (3.2.1) and can be downloaded by each user who owns a valid account on the SocioCoast’s tools. This type of information may be useful for a researcher or a data analyst to develop new applications or draw conclusions coming from real observations. Another aspect of data sharing that is important to note, is the framework’s scalability, which allows it to function in the opposite direction as well. Meaning that, new data obtained from SocioCoast users (primarily biodiversity data) can be shared to the same data sources from which similar data are collected and used by the SocioCoast’s applications. In this way, the proposed prototype enhances the knowledge not only of its applications but also of other open-source applications and wide datasets.

4.3 Front-End

4.3.1 Web Knowledge Platform. In this section, we focus on a description of the front end of the SocioCoast’s web knowledge platform and more precisely on the functions and the information offered to users by the platform. It is important to note that both users with active accounts (i.e., registered users) and anonymous guests can access the platform but guest users have access to only a limited range of the functionalities. The main functions the web knowledge platform offers (excluding typical functions: registration, login, etc.) to its users can be categorized to the following dimensions:

- (1) Blue Flag Beaches of SocioCoast
- (2) Problem Reporting
- (3) Biodiversity Data
- (4) Oceanographic and Meteorological Data
- (5) Weather Forecast

The first category offers different functions to the users such as: (a) View a map with all the targeted coastal areas, (b) View general information about each beach, (c) Add/Edit of coastal areas (d) View a map of each targeted beach including its Blue Flag points of interest, (e) Add/Edit of points of interest for a specific area. The
reporting of a problem for the target beaches is done through the mobile application, while the interaction with
the knowledge platform is done through the platform’s Internal API. After a report is submitted, it then becomes
available on the knowledge platform. Each simple user who uploads data via observations is able to view only
his/her own reports, not the ones coming from other users of the system. Regarding Biodiversity Data, users are
able to: (a) View a list with all biodiversity data for a selected coastal area, (b) View a detail page for selected
species, and (c) View related charts for biodiversity species. Apart from these functions, users with appropriate
permissions in the system (i.e., biodiversity experts, administrators) can add new biodiversity data lists. For both
Oceanographic and Meteorological Data and Weather Forecast, all the data are being visualized through different
graphs offering to users the ability to make combinations and comparisons of their choice. Users are also able to
view general information about the targeted fixed stations that oceanographic data are derived from. The stations
are visible on the same map with the map of beaches indicated previously. Further explanations regarding each
function alongside with relevant screenshots from the web platform are given in Section 4.1, which focused on
a demonstration of the platform.

4.3.2 Crowdsourcing Mobile Application. The mobile application is the second component of SocioCoast’s
front-end. It was developed in Flutter, a cross-platform development environment provided by Google™.
The latter enabled the development and maintenance of a common codebase for the target operating systems
of the end-user smart devices, i.e., iOS and Android. A further description of functionalities and indicative
screenshots are provided in Section 5.2. Broadly, the sections that the application component is divided are as
follows:

(1) Login screen and Main screen
(2) Beach list and biodiversity
(3) Profile details
(4) Weather – Play – Groups

5 WEB PLATFORM DEMONSTRATION

The web Knowledge Platform is available to different types of user roles for users with valid accounts: (1) simple
users, (2) advanced users, (3) public bodies, (4) beach managers, and (5) administrators of the system are the
major stakeholders involved. In this section, a series of related scenarios are described, each one using different
user type, showing the interaction of the users with the prototype’s components and using relevant screenshots
from the implemented web platform.

5.1 Beach Mapping and Problem Reporting

Consider a simple user of the platform, Tom, who is planning to go for swimming on a Saturday morning at
one of the targeted beaches of SocioCoast, Vai beach in Crete. Before going, Tom selects this beach from the
home page of the web Knowledge Platform (Figure 4) and checks the Blue Flag points of interest to ensure that
there is parking space and toilets (Figure 5). Tom arrives at the beach, but he observes evidence of oil spills in
the water before diving into the sea. He decides to report this issue using the mobile application of SocioCoast,
providing details such as the time and location of the issue, along with a brief description and a clear photo. The
moment that the report is submitted, Vai’s beach administrator gets a notification e-mail and the report is now
visible on the web platform but only for him/her and the person who submitted the report (Tom). Supposing
that Tom has submitted other reports in the past, he can view all of his reports from his profile page shown in
Figure 6.

Later the same afternoon, the beach manager of Vai beach login to his account in the SocioCoast’s platform
to check for new problem reports for his beach. Figure 7 illustrates a list with problems statements as reported

9https://flutter.dev/.
by users alongside with their status (i.e., solved or unsolved). The beach manager can reply to the user who created the report and also to change its status (Figure 8). If absolutely needed, the manager will forward this report to the relevant public body/local authority, e.g., Municipality of Sitia for relevant subsequent actions (i.e., addressing it and updating its status).
5.2 Editing and Addition of Beaches by Authorized Users

A crucial aspect of the web Knowledge Platform is the sustainability and expansion of its information through appropriate functions offered to the users. Toward this direction, the platform offers certain categories of users the chance not only to edit the information of existing coastal areas, but also to add new areas as well. Georgia, an administrator of the prototype, is about to update the general information of two beaches in Cyprus. After entering her admin account, she selected the Cyprus area and views a list with the selected beaches of Cyprus, as Figure 9 illustrates. From this list, by clicking the “Edit” link for the beach she wants to change, she is transferred to a new page that allows her to make changes. Similarly, if she wanted to add a new beach, she would have clicked the green “New” button and would have to fill appearing in Figure 10. If the information that will be entered is valid, the new beach will be successfully added to the Cypriot or Cretan beaches lists, respectively.
5.3 Biodiversity Viewing

Maria, a Cretan researcher in marine biodiversity field, is an advanced user in SocioCoast’s applications. She is about to visit a selected beach of the platform, Adelianos Kampos beach, as part of her investigation. However, before going to the beach, Maria had a look on the existing biodiversity of this beach from the SocioCoast’s platform, viewing a relevant list illustrated in Figure 11. She also had the chance to view related charts about...
Fig. 11. Marine species list for “Adelianos Kampos” beach.

these data, for example, a bar chart showing the number of species per category (Figure 12). However, while visiting Adelianos Kampos after a while, she comes upon some plant and fish species that she had not noticed in the biodiversity list of the platform. Believing that it would be a great idea to inform others about them, she submits her observations attaching relevant photos by using the proposed mobile application. After sending her
viewings, they will be visible to the web Knowledge Platform in the “Species Observations” tab either in a list (“Search” option) or in a graph format (“Visualization”, “Charts” options) in Figure 13. The administrators will be able to verify an observation (species report) based on their knowledge and experience with similar data. Reporting of biodiversity species already existing in the applications is also available. When selecting a species from a beach’s biodiversity list, recent observations from users are presented as well.

5.4 Weather Forecast Viewing
Weather forecast is also a very useful part of the platform especially for athletes or ordinary people who practice water sports. More specifically, a famous windsurfer could login to the web platform and be informed about the weather forecast for the next days for a specific beach he/she is about to visit to decide on whether to visit the beach or not depending on the weather conditions and the sport he/she of preference. Comparison of weather conditions between two different beaches is also available through interactive charts offered by the web platform. Figure 14 demonstrates a relevant example comparing the expected rainfall in Konnos (blue line) and Landa (red line) beaches. In case the surfer wants to report his/her view about the weather, weather contribution function is also available through the mobile application and these observations will be visible in “Weather Observations” tab in the web platform.

6 MOBILE APPLICATION DEMONSTRATION
6.1 Login Screen and Home Screen
The mobile application initiates with a login screen as shown in Figure 15(a). Peter, a registered visitor of Socio-Coast uses the login functionality when exploring a new beach in Crete. Apart from verified users like Peter, the login operation also supports an anonymous login scheme. Anonymous users can take advantage of all functionality provided by the application except profile-related information. The login screen also provides the user with links for new user creation and for password reset. The Home screen of the SocioCoast’s application is shown in Figure 15(b). From this screen, Peter can view: (a) a map, which contains markers for the Blue Flag beaches currently supported at the top, (b) four large button choices in the middle representing four main functionalities, and (c) a navigation bar, which provides a quick way to navigate to other sections.

6.2 Beach List and Biodiversity
Peter wants to have an overview of all beaches available in the system. When he clicks the “Beaches” button in the bottom navigation bar, a list of beaches organized by distance from his current location appear (Figure 16(a)).
The list also contains easy-to-read information about the coastal areas such as its country, whether it is a Blue Flag beach, whether it is a Natura 2000 area and if there is accessibility for disabled people. By selecting an area, Peter can observe a zoomed-in map of the beach with markers highlighting the facilities, amenities and services within the vicinity of the beach and also three tabs: “Facilities”, “Weather”, and “Biodiversity”. The “Facilities” tab presents a menu with checkboxes where Peter can browse a range of categories for facilities and selectively show only the ones of his interest (Figure 16(b)). In addition to this, Peter can report an issue about a certain facility, e.g., “showers not working” along with a photo and a small description. The “Weather” choice tab, that is of particular interest to Peter as windsurfing is his hobby, reveals a horizontal list of weather predictions for the particular coastal area. Using the drop-down menu in the top of the section, Peter can select among four types of weather predictions, namely: (1) cloud coverage, (2) wind, (3) rainfall, and (4) temperature (Figure 16(c)). This is an opportunity to report on the weather conditions and assist his fellow windsurfers. Similarly, using the “Biodiversity” tab, Peter is able to view a horizontal list of marine and terrestrial species for that coastal area (Figure 16(d)). Although he did not observe anything particular during this visit on the beach, Peter goes through the available options: from that list the user can report an observation of a particular species he/she observed by pressing the small eye-like graphic at the bottom of a species as shown in Figure 16(d). By doing this he/she will be redirected to a relevant form to complete.

Peter thinks this is a nice change to see what other users have reported concerning biodiversity, as his friend Helga would find this very interesting. A list containing all the existing species for the targeted coastal areas is presented by selecting the “Biodiversity” option from the home screen (Figure 17(a)). Peter can also filter results based on a simple search functionality provided. A species details screen contains relevant information about the selected species including a gallery of photos, as illustrated in Figure 17(b).

6.3 Profile Details

Let’s see what else Peter can find in his profile. A drawer that directs to actions related to the particular logged in user is revealed from the list-like button in the top-left of the screen (Figure 18(a)). “My contributions” selection
enables a list with all of the user’s crowdsourcing contributions either regarding weather or biodiversity (Figure 18(b)). Respectively, “My reports” selection reveals a list of the reports that the user has submitted. If a user’s report is still open, it is signified by a yellow circle, whereas if it is closed it is signified by a green circle as shown in Figure 18(c).

6.4 Weather—Play—Groups

These functionalities are not yet fully implemented but scenarios and screens have been determined as part of the initial design of the application (Figure 15(b)). The “Weather” button on the home screen will reveal a collective listing of all weather conditions for all coastal areas supported. The “Play” button will reveal a sliding puzzle game to the users with a random picture of a specie to solve. Lastly, the “Groups” option will support the creation of groups from users and then the creation of activities or events inside the group.

7 DISCUSSION

The requirement analysis (Section 3) showed that people are willing to use applications providing information about coastal areas and beaches. Despite this, only a fraction of the participants has previously used such applications. The analysis also suggested that people who have used similar applications liked different types of information provided by these applications. Overall, the existing applications focus on targeted services, failing to fulfill users’ needs for a complete set of information.
Fig. 16. Beach list and details with crowdsourcing.
Fig. 17. Biodiversity list and details on the mobile application.

(a) Species

(b) Details for "Chromis chromis"

Fig. 18. Profile actions and details in the mobile application.

(a) User Profile

(b) My Contributions

(c) My Reports

SocioCoast aims to solve this gap by developing a toolkit, combing different sources of information, and providing users with an overview of the conditions of coastal areas and beaches. The web knowledge platform allows users to pre-plan their visit to a beach, considering weather conditions, their interests, and the biodiversity information presented. While real-time data in the mobile app allows greater flexibility, users can change their plan based on real-time conditions (e.g., weather). Combining these two, SocioCoast can maximize the user’s experience during their visit.

In addition, SocioCoast does not target a specific group of people. People with different backgrounds and expertise can use it and benefit from it. Scientists, biodiversity experts, and environmental organizations can utilize the data collected from crowdsourcing in several ways: (a) research and development, (b) citizen science, and (c) data validation. Moreover, ordinary visitors can educate themselves through the rich information related to biodiversity and contribute to the preservation and protection of the environment through crowdsourcing.

8 CONCLUSIONS

In this work, we introduced the SocioCoast framework consisting of a web Knowledge Platform and a mobile application focusing on citizens’ science and crowdsourcing in coastal areas. A demonstration of the two applications with specific scenarios was provided, including the main user roles of the prototype. The applications are both extendable and sustainable to ensure their proper functionality over time, and also provide ways of expansion to other geographical areas in the future. The ultimate goal of this work is to preserve and protect the environment via users’ involvement and observations, more specifically the coastal areas through more complete information about these areas and by giving visitors the ability to contribute their observations through crowdsourcing.

Future work primarily focuses on the uptake of the system by visitors and citizens via an extended evaluation with user participation and targets, also the following directions. (a) Completion of “Weather”, “Play”, and “Groups” functionalities of the mobile application. (b) Completion of weather observation by users using a scale from 1 to 5 for wind, cloud coverage, rain, temperature, and wave height. (c) Expand the prototype’s applications further from Greece and Cyprus to European areas initially and later even to areas outside Europe. The existing knowledge about the beaches of the SocioCoast project will be used to structure the collected information and data about the new beaches. (d) Enrich open data sources such as the iNaturalist, a biodiversity species recognition system, using crowdsourcing data coming from users’ observations through the mobile application. (e) Implement “Big Data Analysis” as an autonomous component of the web knowledge platform. This component will function as a large-scale data analytics engine and manage big data algorithms and approaches that are gathered and stored on the web knowledge platform.

REFERENCES


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