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Poli4SDG: An Application for Environmental Crises Management and Gender Support

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Abstract—In recent years, the scale of the impact of climate change and its related side effects has become ever more massive and devastating. Sustainable Development Goals (SDGs), promoted by United Nations, aim to front issues related to climate change, among others. In particular, the project CROWD4SDG focuses on a bunch of SDGs, since it promotes environmental activities and climate-related issues. In this context, we developed a prototype of an application, under advanced development considering web design, that focuses on SDG 13 (SDG on climate action) by providing users with useful instruments to face environmental crises and climate-related disasters. Our prototype is thought and structured for both web and mobile development. The main goal of the application, *POLI4SDG*, is to help users to get through emergency services. To this extent, an organized overview and classification prove to be very effective and helpful to people in need. A careful analysis of data related to environmental crises prompted us to integrate the user contribution, i.e. exploiting a core principle of Citizen Science, into the realization of a public catalog, available for consulting and organized according to typology and specific features. In addition, gender equality and opportunity features are considered in the prototype, in order to allow women, often the most vulnerable category, to have direct support. The overall description of the application functionalities is detailed. Moreover, implementation features and properties of the prototype are discussed.

Keywords—Crowdsourcing, social media, SDG, climate change, natural disasters, gender equality.

I. Introduction

IN 2015, the 17 Sustainable Development Goals (SDG) outlined by the United Nations were adopted by all the member countries to promote welfare in accordance with the protection of the environment. Goal 13 (SDG 13) is focused about climate action. Hence, climate change represents one of the most important challenges today. The main purpose is to act effectively and promptly to protect climate change and its impacts. For a more immediate and efficient interaction, a component of fundamental importance concerns the use of Citizen Science. Social media represent today a powerful and essential tool to collect information that can provide significant knowledge, in terms of indicators and insights, after being properly analyzed and filtered. Citizen Science has been identified as a major source to gather information assessing SDG [1], [2]. Crowd4SDG is a three-year Horizon 2020 Research and Innovation programme supported by European Commission. Its objective in this scenario is to focus on the development of innovative Information Technology (IT) tools, instruments and strategic methodologies through a Citizen Science approach (see Fig. 1). Hence, Citizen Science offers

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Fig. 1 Crowd4SDG is a three-year Horizon 2020 Research and Innovation Action; it is supported by the European Commission's Science with and for Society (SwafS) programme [6]

the possibility of increasing the frequency and amount of collected data. At the same time, it also has the ability to manage logistical differences from country to country, keeping the information diversified and shortening the time required for data collection.

Despite being wide and often damaging, the impact of climate change is also highly targeted, since it does not affect people in the same manner [3], [4]. As a matter of fact, women are often more vulnerable than men to climate change and related collateral events [3]. Disasters resulting from massive events caused by climate change end up delineating pre-existing social differences in terms of gender inequality, vulnerability, social inferiority, discrimination and economic poverty (see Fig. 2). In [5], it is highlighted how climate change and the disasters deriving from it have a significant impact on society, in terms of gender discrimination and inequality. Crowd4SDG has the goal of either collecting information to evaluate SDG indicators or getting contribution of new proposals from citizens for active actions aimed at achieving SDG.

Another point worth noting is related to the awareness of the phenomenon of climate change and the opportunity to get new instruments to disseminate information. As a matter of fact, information connected with the management of emergency areas following damaging events to the environment is often vast and confusing [7]. Gender and climate issues are not considered in the right way. This represents a problem because data is often wild and not ordered on the web. To the best of our knowledge, there is not an organized classification of emergencies and the solutions adopted to solve them. Already existing work mainly focuses on environmental crises related to a single territory. Such a classification could be useful for people and associations to face new situations, to tackle in a deeper way emergencies and danger situations. Women's voice in this context should be taken into account substantially. The impact of emergencies on precarious women situation is very

Fig. 2 Some pictures collected from social media and international broadcaster: (a) Australia bushfires (2020), (b) Philippines flood (2015), (c) Indonesia tsunami (2004), (d) Florida hurricane Michael (2018), (e) Germany flood (2021), (f) Niger flood(2020), (g) Nepal earthquake (2015)

damaging and needs to be taken into proper consideration.

This work proposes a prototype application *POLI4SDG*, that aims at providing a complete outline on emergencies' type, grouping over their category. It attempts at supporting people worldwide, taking into account the specific area and territory, providing support to people in analogous situations. The proposed prototype has the core innovative idea of building a structured catalog, available for consultation, not related to a single territory, but to wider areas. An organized information of this type proves to be essential and very useful when people face new emergencies, since they can use the data made available by the application as a comparison and inspiration for help and support. Likewise, our aim is to increase information about environmental emergencies and their management through the direct intervention of the population. Another fundamental aspect is to have a section of the application intended exclusively for the female gender. In this way, we are able to generate statistics and indicators regarding the condition of women through direct feedback from the affected population. We developed a prototype for such application, for both web and mobile release (with a main focus on web development), that is able to face the specific issue of SDG 13. We presented *POLI4SDG* in the #Open17ClimateGenderChallenge, a call for projects launched by Crowd4SDG to tackle climate and gender issues. Our project was selected for a training course with partners European Organization for Nuclear Research(CERN), United Nations Institute for Training and Research (UNITAR), Université de Genève, Politecnico di Milano, Consejo Superior de Investigaciones Científicas (CSIC) and Université de Paris Cité. Our project was also selected for participation in the challenge-based innovation workshop, co-organized by CERN IdeaSquare.

As a matter of fact, there are many situations in the last years in which we have seen uncontrolled and dangerous events that have cause serious problems to people (see Fig. 2). An example is the episode of the Australian bushfires of season 2019-2020 [8]–[10]. Besides fires, also floods are becoming more and more frequent, both in less developed countries, e.g. Niger and Philippines, and in European metropolitan cities, e.g. in Belgium, Germany and Netherlands [11]–[14]. The impact of these events can be disastrous in different types of territories. Even if industrialized and metropolitan cities have more infrastructure and more resilient buildings, there can be massive damage and lethal consequences. The presence of cars and technological infrastructures can lead to damage that would not occur in a rural reality, free from this type of artifact. On the other hand, in areas characterized by precarious buildings, the effects triggered by a flood become significant both for physical damage to people and for the loss of precious livelihoods, e.g. houses destroyed, access to resources prevented. For this reason, our prototype does not want to focus on a single territory, but we also aim to characterize the environmental event in relation to the location, context and damage, from a global perspective. The application builds on existing crowdsourcing elements, among which some open source tools, VisualCit [15] and Citizen Science Project Builder [16], [17].

The remainder of the paper is organized as follows. Section II further describes the purpose of this work and details the related work. Section III describes the proposed application and its structural implementation. Finally, Section IV draws the conclusions, outlining the possibilities of future work.

II. Background and Related Work

Several topical issues that today are of pivotal importance in society have been identified as reasons for the fact that female gender proves to be more vulnerable and more negatively damaged than male gender, when it comes to climate change [7]. This trend is valid in general, but proves to be markedly systematic in the case of floods [3], [4]. The first key element of the analysis is poverty. Since women represent the segment of the population that generally has the least economic resources, in case of climate crises they are exposed to greater risk [3]. Other key elements are inequality and violence. Inequality is particularly evident in labor division. In developing countries in particular, women play a fundamental role in the procurement and management of livelihoods related to agriculture and herding. In such scenario, floods, for example, increase significantly female workload, considering activities like the water supply. Hence, a flood event at the same time increases the overall daily labor of a woman and the corollary role activities, e.g. housework, childcare and assistance for the elderly. In addition to this aspect, it must also be considered that an emergency situation makes a woman more exposed to being victim of violence. The main cause of the greater vulnerability of women is not linked to an intrinsic factor of gender, but to the social and cultural structures that limit women's access to rights such as fundamental resources, information, decision-making and education [7].

In this context, Citizen Science plays a fundamental role. Its main utility relates to the possibility of allowing the collection of relevant information for evaluating the SDGs. The possible sources of extraction considered in this area are social media and crowdsourcing. Such Citizen Science approaches are discussed along with the related challenges and possible solutions to solve them in [2]. Hence, the variety of background of contributors and the mere nature of the contributions (which may turn out to be unclear or anonymous) represent a challenging problem for Citizen Science. In [18], some of the possible solution and improvement strategies to increase the quality of information are discussed. Human factors are basic elements to be considered for information quality when selecting contributors. In addition, in presence of a considerable amount of knowledge, also the background and training of the person must be considered as a discriminating factor for the selection of the individual contributor. Machine Learning (ML) is very useful to automate data analysis procedures, given the large amount of collected data. Through ML methods, also the selection of information based on relevance is discussed in [19]. The focus is on the role of social media in emergency situations, i.e. floods and earthquakes. Crowdsourcing tools are considered and analyzed as well as technologies to improve the quality of results through models trained via ML, to allow automatic post annotations. In the area of social media usage, the state-of-the-art has been growing rapidly in recent years. In [20], the task of retrieving relevant posts for the target analysis is discussed. The search keyword during an emergency event is automatically refined and improved. In [21], the social media post is filtered on the basis of the characteristics of the image. This filtering allows you to select good quality posts and images for crowdsourcing, since it reduces the amount of information to be processed by the crowd and allows the system to process large datasets.

Considering Twitter, among the available social media to extract information, in [22] information from tweets to assess the social impact in the event of hydro-meteorological events is discussed. The result was that most tweets are of an informative or descriptive nature. The analysis of this work focuses on the textual analysis of the tweet, to identify the source and intention of the information. Other aspects that are evaluated concern the difficulty of analyzing the dataset. In this context, the main difficulty lies in the need for manual annotation to identify the relevant tweets. In [15], VisualCit tool, that we adopted for our application, is exploited. In this work, the analysis of images from tweets is carried out automatically by discriminating the relevance of the post on the basis of ML classifiers. Images are filtered at different levels to exclude images that are not photos. The images in public places are then selected, and the geolocation is done automatically. By considering only the selected tweets, crowdsourcing is performed to collect additional information relevant to the analysis of the tweets. This procedure significantly reduces the number of tweets that require analysis. Moreover, the possibility of deriving statistical indicators on the basis of the information collected, considering a case study, is discussed.

III. Methodology and Implementation

As anticipated in Section I, the purpose of this work is to face the lack of structure in the information connected to emergencies worldwide. To this aim, we propose *POLI4SDG* (see Fig. 3), a JavaScript application of the methodology proposed in this section that provides a complete summary on emergencies' categories. Through the application, the user can write a report regarding an emergency, visualize statistics, consult collected information and, specifically for women, ask for further support. The report of the user is used to grow the collection of information about emergency management. These data are further increased through crowdsourcing tools, VisualCit and Project Builder. Pictures are first crawled from the available social media (VisualCit), then labeled through crowdsourcing (Citizen Science Project Builder). It aims at helping people worldwide, considering its specific territory, assisting people in comparable situations. The core idea leading *POLI4SDG* is to keep a diary of resolution measures applied after climate-related disastrous events. Both individuals, companies and climate organizations can register and report the occurred event in the application. They also have the feature to suggest decisive interventions aimed at facing the emergency. To summarize, the main features are the following.

- The application generates a global mapping, characterizing areas with related events and the interventions implemented for resolution, prevention and maintenance.
- The mapping is useful to characterize the area at a certain degree of risk and management of emergencies. We defined numerical levels that express the risk connected to a given territory, as well as the effectiveness and timeliness of interventions.
- The list of adopted measures to face a specific emergency can be publicly consulted in our application (listed for category) to help people in future disastrous events.
- Data related to women are of a particular interest for *POLI4SDG*. Since female decision-making power is limited in organizations, we focus on determining the percentage, level of influence and effects of women that participate in the organizations that adopt our application.
- Statistics considering women's point of view are developed. A survey directed to female users is devoted at determining the most suitable definitive measures to employ. In particular, we ask for the best interventions to improve women condition, as well as the status of their family and social context.
- Crowdsourcing through VisualCit and Project Builder tools is exploited in the moment in which the application recognizes a new emergency issue. In detail, the application filters and selects images related to emergencies on social media. Then, the crowd of application users (i.e. people registered to the application) is requested for classification and identification of the crawled images from social media.

The complete series of *POLI4SDG* mobile application mockups is shown to have a more immediate visual impact

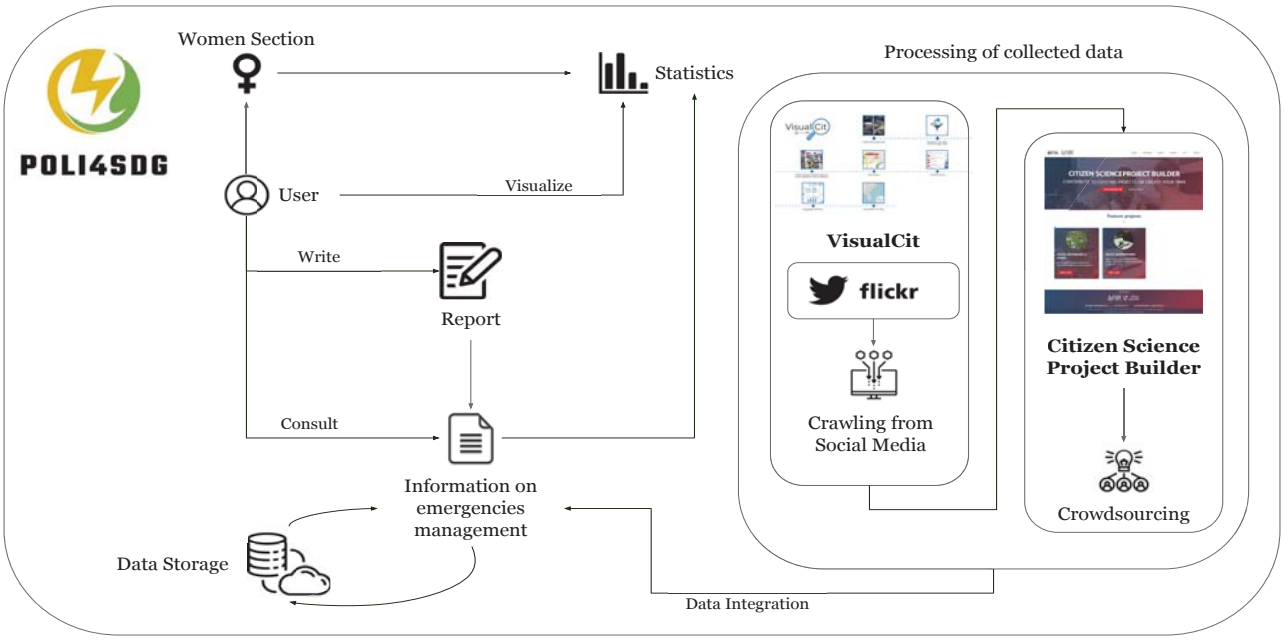

Fig. 3 Overview of the *POLI4SDG* application

Fig. 4 Web Application Mockup of global mapping page of *POLI4SDG*

(see Fig. 5). For the web application (see Fig. 4), the same layout style for the mobile Front End has been adopted. The user can select search for a specific location, select images of interest and read the detail of the corresponding event. A word cloud component is also provided to suggest keywords search on social media. From the *POLI4SDG* application mockups, the main functionalities can be derived. First, a new user can register as an individual but also as a group. Hence, both companies and climate activist associations can register to the application. Furthermore, it is expected that other social media account will be connected. The association with other social network accounts is foreseen. This allows to exploit already existing networks and to eventually spread *POLI4SDG* across other social media platforms. The other functions are:

- *Menu*: the menu that presents the Homepage as a background and contains the global mapping.
- *Reports*: the list of reports that contains the categories of emergencies the user can click on.
- *Contribute*: the data entry functionality in which the user can submit a new report.
- *She Voice*: the field dedicated to women's voice to express their opinion about both prevention measures and required intervention for solving issues caused by emergencies.
- *Statistics*: display of relevant canvas and statistics.

Reports section contains the categories of emergencies we consider in the application. By clicking on it, the user will be able to see data related to the specific type of emergency. An *Advanced Search* option is also available. *Homepage* shows a map that can be restricted to a specific area or enlarged to greater territories in which the emergencies are underlined and listed below. *Contribute* section is the section in which the user can make a report, inserting new data in the application. In this section, the user has the opportunity to fill fields, providing the features of the emergency he/she is reporting. In addition, the user registers the exact position of the report using the GPS location. Moreover, the section *She Voice* is devoted to women and has the goal of collecting data regarding women's opinion after emergencies. These data are fundamental to support our stats, and to make a deeper analysis of the figures of women, considering their role and their impact on decision-making.

Considering the adopted tools, VisualCit has been adopted for the purpose of crawling images from social media. The tool actually supports crawling from both Twitter and Flickr as social media sources. Once the pictures have been crawled, the procedure continues by filtering them through VisualCit tool as well. Such measure allows to remove duplicate images,

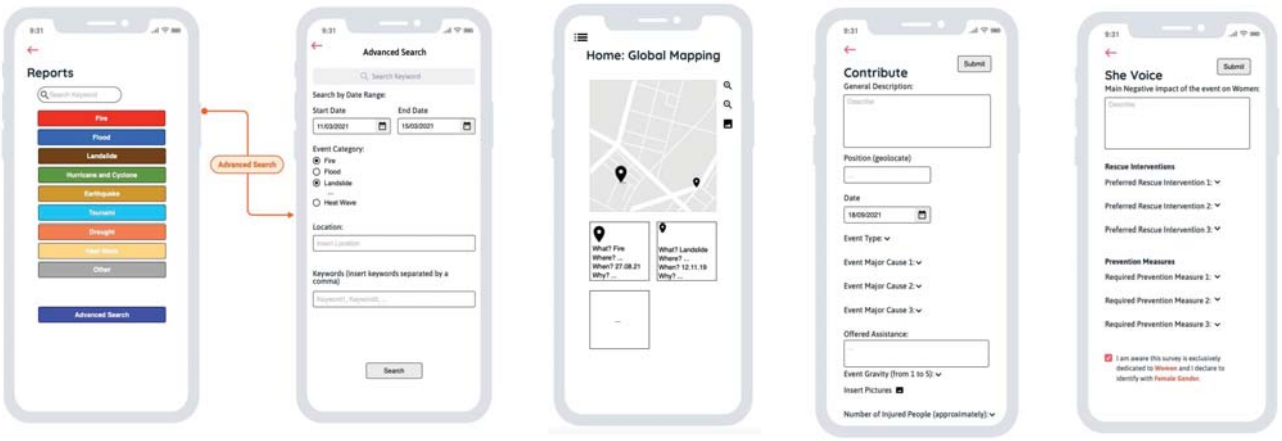

Fig. 5 *POLI4SDG* mobile application mockups: From the left, Reports, Advanced Search option, Homepage, Contribute and She Voice. These figures are for illustrative purposes, to show how the mobile version will look like and its properties

pictures that are not photos and to select a specific category of images, e.g. photos taken outdoors. The search on VisualCit is realized through the keywords that are automatically generated from the new reports that were inserted and registered. When a new report is uploaded by a user, the application classifies it and performs research of related images on social media to increase the dataset of information available to other users. The result of the crawling phase is then processed by Citizen Science Project Builder tool. This process allows to label the new collected pictures from social media and to increase the information describing them. The adopted crowd for labelling are the application users themselves. This iterative procedure allows to rapidly increase the amount of information related to a new event the first time it is created. With the exception of the notification that asks the user to label new images, the use of crowdsourcing tools remains transparent to the interface.

The Citizen Science Project Builder [23] is a web-based tool that allows any user and volunteer to take part in complex data classification tasks. The platform is maintained by the Citizen Science Center Zurich. The tool allows for the development of Citizen Science projects that involve data classification, by using a project-building interface. The web-interface is based on PyBossa, a technology developed by Scifabric [24] in 2015 [16], that integrates with other products for data collection, e.g. Google Spreadsheets, Twitter, Amazon S3, Youtube. VisualCit is a social media data analysis tool pipeline developed at Politecnico di Milano, that provides features of image selection and filtering from Twitter and Flickr [15]. Besides filtering based on Artificial Intelligence methods applied to pictures, VisualCit also allows to associate a location to a post, even if the tweet was not naively geolocated.

POLI4SDG exploits a set of web pages. It is thought for release as a mobile application and as a web application in the near future. Considering the web Front End, pages have been created through the use of HTML, CSS and JavaScript on the models provided by BootStrap. Considering the Back End, JavaScript programming language has been exploited. BootStrap is a collection of graphical, stylistic and layout tools that provide a huge amount of customizable functionalities and styles, according to the specific requirement. Its use proves to be very versatile, since it is compatible with the latest versions of the main available browsers. Its main function is defined as responsive web design. Hence, it is able to dynamically adapt according to the size and characteristics of the adopted device. Hence, this collection of graphic-type tools is a multi-device and multi-platform library.

Considering data storage, we plan to adopt cloud-based techniques. This implementation choice is mainly due to scalability features, extremely high flexibility and low fixed costs of cloud solutions, with respect to traditional database approaches [25].

To summarize, we have developed a methodology and implementation of a new technique to improve the structure of information about environmental emergencies. Direct contribution of the population is shared across the application. Such innovation allows to have broader and more structured information, since the prototype is based on the categorization of events, solutions adopted and all useful feedback in emergency situations from people in environmental crises. Classification of incidents allows users to consult more quickly and efficiently environmental crises information. Moreover, crowdsourcing allows to speed up data collection and labeling.

IV. Conclusions and Future Work

This work responds to a deep need in social sciences. It exploits crowdsourcing to have people feedback and data. Furthermore, it provides a systemic and precise classification of emergencies, solutions and measures that can be of great advantage for individuals, companies and associations. Moreover, it pays a great attention to women's point of view, providing a dedicated interface in which women can collect their specific needs when facing an emergency and their voice can be heard. *POLI4SDG* faces several problems. From a data analysis perspective, mapping climate-related disasters is hard, considering localization and temporal features of the event. Still today, in many areas of the world it is difficult to determine the exact time a disaster happened, since there is a gap in terms of days in the information flow. From a user perspective, it can be difficult to understand how to behave in the moment of an unusual and rare event such as an

environmental disaster. For example, he may not know who to contact or how to behave or where to go. *POLI4SDG* is innovative in this sense because it combines the two aspects by supporting the user. Hence, the application also collects data to establish the evolution of events and evaluate forecasts and future trends, on the basis of statistical probabilities.

As next steps, to increase the support given to the user, we plan to introduce economic-related features. We would like to provide concrete economical support to the user, through voluntary donation mechanisms. The core idea for this extension will be based on a BlockChain system, enabling and exploiting cryptocurrency transactions. Other possible extensions may relate to the increase of number the supported functionalities or to improve the already-existing features. Such improvements may include the betterment of the localization of the emergency when the user draws up the report or the increase in the number of supported emergencies. We also plan to openly release our implementation to the public in the near future.

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