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PROGRAMMABLE ECOSYSTEMS: EMPOWERING SOCIAL INTERACTION AND ECO-AWARENESS THROUGH URBAN COASTAL ENVIRONMENTAL ANALYSIS

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Abstract

Nowadays, over 60% of the world population live within a 40 miles wide area along the coastline. Additionally, coastal areas are among the best tourist attractions and economic activity hubs. According to the United Nations World Tourism Organization, the number of international tourist arrivals worldwide is expected to increase by an average of 3,3% a year over the period 2010 to 2030. In absolute numbers, international tourist arrivals worldwide are expected to reach 1,4 billion by 2020 and 1,8 billion by 2030. The combined effects of urbanization in coastal areas, global climate warming and the continuous increase of human flow can give rise on a decrease of the air and water quality as well as an increase in aesthetic and noise pollution and humidity levels [1]. While human presence has a significant impact on the urban environment, the urban conditions radically affect the intensity of tourism flow, as it is one of the main interests on the seaside. Traditionally, urban planning has been related to land-use, transportation, infrastructure and typology. The current study demonstrates that the urban morphology is largely influenced by environmental variables that radically alter the urban conditions and consequently, the human behaviour.

It is therefore clear that coastal urbanism and climate require a two-way focus. On the one hand, coastal activities, mainly tourist attractions, shape urbanizations that accelerate climate change effects. On the other hand, climate change is likely to have a significant influence on the tourism economies of island countries by way of degradation of environmental features important to tourists [2]. Weather and climate have an impact on tourist satisfaction, comfort and safety. Research has been conducted towards the investigation of emergent phenomena and complex systems in urban environments, where the city itself acts as an aggregator and disseminator of information. Sensor networks, statistics, smartphone data and social media form the basic urban elements that are stored, represented, analyzed and finally integrated in the urban design process.

Keywords: Climate change; tourism; coastal cities; social awareness.

1 Introduction

"When you can measure what you are speaking about, and express it I numbers, you know something about it"
Lord Kelvin

How does the transformation of urban climate factors impact the life and behaviour of the individuals that live in the city? Research has shown an association between climate change and city infrastructure systems such as water and energy supply. Urban studies demonstrate that urban effects spread far beyond the city's boundaries and trigger complex feedback/responses in the biosphere [3]. Adaptation to climate change depends centrally on what is done in urban centres – which now house more than half of the world's population and concentrate most of its assets and economic activities [4]. Notwithstanding the significant impact of cities on their local micro-climate, urban infrastructure is perceived as the static product of a number of equations that calculate a certain level of technical efficiency, neglecting the volatile aspect of urban environment that is driven by human activity. When it comes to examining the climate change effects, researchers tend to focus on the micro-scale of a building or the mega-scale of a region. The irony is that, despite these efforts, the innovation still remains at the social aspect of the urban environment. The city is transformed by the people that inhabit it. As a result, human behavior is an unacknowledged and unpredictable parameter that should be the primary indicator of urban transformation in terms of climate change.

This paper presents a study on the significant shift of urban design based on the notions of adaptability, sustainability and user engagement in the urban design process. What is challenging in this process is the method of bridging across planning rules, urban climatology data and common-user experience in a flexible platform that will enhance social awareness by providing sustainable patterns of activity and will serve as a valuable tool for urban designers, thinkers and decision-makers. The scope of this paper is to propose a methodology with a view to shaping the socio-environmental aspects of a totally new ICT culture, integrating the complex human behavior.

2 Programmable Open Source Environments

Intelligent cities represent closed systems and seek to mobilize technologies to eliminate the city's incompleteness. The intelligent cities model typically misses the opportunity to urbanize technologies, instead making them invisible and putting them in command rather than in dialogue with users [5]. Urban users are not urban experts, but have a very specific knowledge about their place. Saskia Sassen (2013) suggests the development of an urban Wikileaks-style platform that will enable a bottom-up urbanization, evolving from individual initiative [6]. In that sense, open sourcing knowledge would unveil additional layers of urban interaction and bridge across two different worlds: urban users would act like disseminators of urban knowledge and urban experts would leverage bits of knowledge towards the urban optimization.

How can code reshape the city's life? Through open source environments, users become the agents that alter the way cities are regulated. Smartphone data, sensors, votes, tags and comments are integrated into code space. As a result, software-sorted geographies produce individually tailored city maps that enable a customization of user's habits through urban climate simulation.

OpenStreet Map and Geofabrik Tools constitute significant efforts towards web-based collection of user data related to the city. What's more interesting is that developers have already redesigned OpenStreet Map with an integrated a feedback mechanism that enables users to vote already proposed ideas or submit a new one. The new 'engaging audience' OpenStreet Map allows users not only to collect and map data on a city map, but also to suggest ways to improve technical and aesthetic elements of the interface. Geofabrik tools are based on OpenStreet Map and Google maps while introducing the idea of comparing two maps 'in a side-by-side full screen display and even has a slaved crosshair pointer for exact comparisons' [7]. Open sourcing the city connects both experts and non-experts and allows for the extraction of useful data, by incorporating people to add their impressions and interpretations of the urban fabric.

2.1 Achieving user engagement

The objective of this study is to set some parameters for the development of a tool that will promote educational awareness on climate change phenomena and engage users through interactive reward mechanisms that will alter the perceived role of the user. The goal of engaging users is to develop a dataset of environmental parameters and create innovative ways of demonstrating the significance of user participation in the complex process of climate adaptation. The key for innovation is to radically change the role of the user from static to dynamic. In other words, users are not just receivers of information, but cooperate to restructure the data transmitted through the internet.

To achieve maximum understanding of the environmental mapping of the city, it is necessary to determine distinct ways to approach each group of users according to their relation to the urban context and their level of technology knowledge. Hence, the platform is designed with layers of information, ranging from simple visual information to the environmental indexing of the city. Users can load an interactive map of the city and navigate through different types of information: their personal sensing data, fixed sensor data, user comments and votes, tagged on specific points of the interactive map. The platform enables interaction between user and ICT system as well as interaction between users through the ICT system. Hence, user opinion is shaped through both objective and subjective data. Although no specific skills are required for user participation, advanced users can opt for increased data relevance by increasing the sampling scale of the amount of data loaded to a specific point of the city. Data points can be extended by other data points [8]. Low required effort, conversation immediacy and efficient feedback encourage initial and continuing user participation. Internet of Things has contributed to the evolution of data related to things. By associating measurements with Social Tagging, the platform intends to promote the Internet of People, by sharing data transmitted towards user behavioral change. Users explore environmental models, give their opinions and input data. Models are subsequently reshaped and users re-evaluate, creating a continuous improvement loop.

2.2 Focusing on Urban Coastal Areas

A significant percentage of cities are located on coastlines. Urban waterfronts constitute a buffer zone between the land and sea, and therefore require a singular urban approach in terms of human intervention and user behavior. ‘Coasts are among the most complex, vulnerable and sensitive of all natural ecosystems, and their management presents various problems and difficulties especially in our era of climate change, in which coastal cities and populations face a range of serious threats’ [9].
Coastal areas deal with common urbanization problems, mainly caused by tourist activities and lack of planning in building construction. Marine and coastal tourism affects the level of air and water pollution; tourist attractions cause noise pollution while uncontrolled construction and excavation affect beach erosion levels. The main common issues of coastal cities nowadays are closely related to tourism. European coastal areas are subject to the Integrated Coastal Zone Management guidelines, a framework that ‘aims for the coordinated application of the different policies affecting the coastal zone and related to activities such as nature protection, aquaculture, fisheries, agriculture, industry, off shore wind energy, shipping, tourism, development of infrastructure and mitigation and adaptation to climate change.' [10]. By focusing our research on coastal cities, the acquired knowledge can be easily transmitted to larger communities and then integrated in policy - shaping procedures. The process of capturing data and gathering information in a user-friendly way can be easily associated with activities supporting local and hyperlocal connections, such as tourism activities. In our study, tourism is the medium to create an ICT fabric that will drive climate adaptation through behavioral change.

3 User Interface

The user interface is based on a simple and clear layout. The user can switch between two layouts, the single map and the map compare layout (Figure 1). Each map can be loaded as a simple map or as an earth view (Figure 2). Once the map is loaded, the user can select one or more of the five parameters: CO2 concentration, humidity, temperature, noise and water pollution levels. Each parameter is color-coded, so that each parameter is easily identified on the map (Figure 3). By selecting one point, a checkbox appears giving the latest measurement of the specific parameter at the point selected. The user can also select the ‘data’ button in the checkbox and visualize in a graph the captured data of that point over time.

Figure 1: User Interface: Map Compare Mode

The layout design facilitates the map customization by the user. At the top of the screen, a semi-transparent strip integrates the toolbar containing the login/register as well as search and switch between single and map compare modes buttons. At the bottom, the user can choose the city and the environmental data to be shown on the map. By clicking the circular parameter buttons, a drop-down menu appears on the left, where the user can select the fixed sensor measurements, the mobile sensors, he can upload his own data or tag a specific point on the map and write down his own experience.
The decision to provide the map compare mode in addition to the single map was based on the very concept of comparison being the driving force of the user behavior. Subjective data is compared to objective data, sensor data of two cities are visualized side-by-side and mobile sensors are validated through the comparison to fixed detectors.

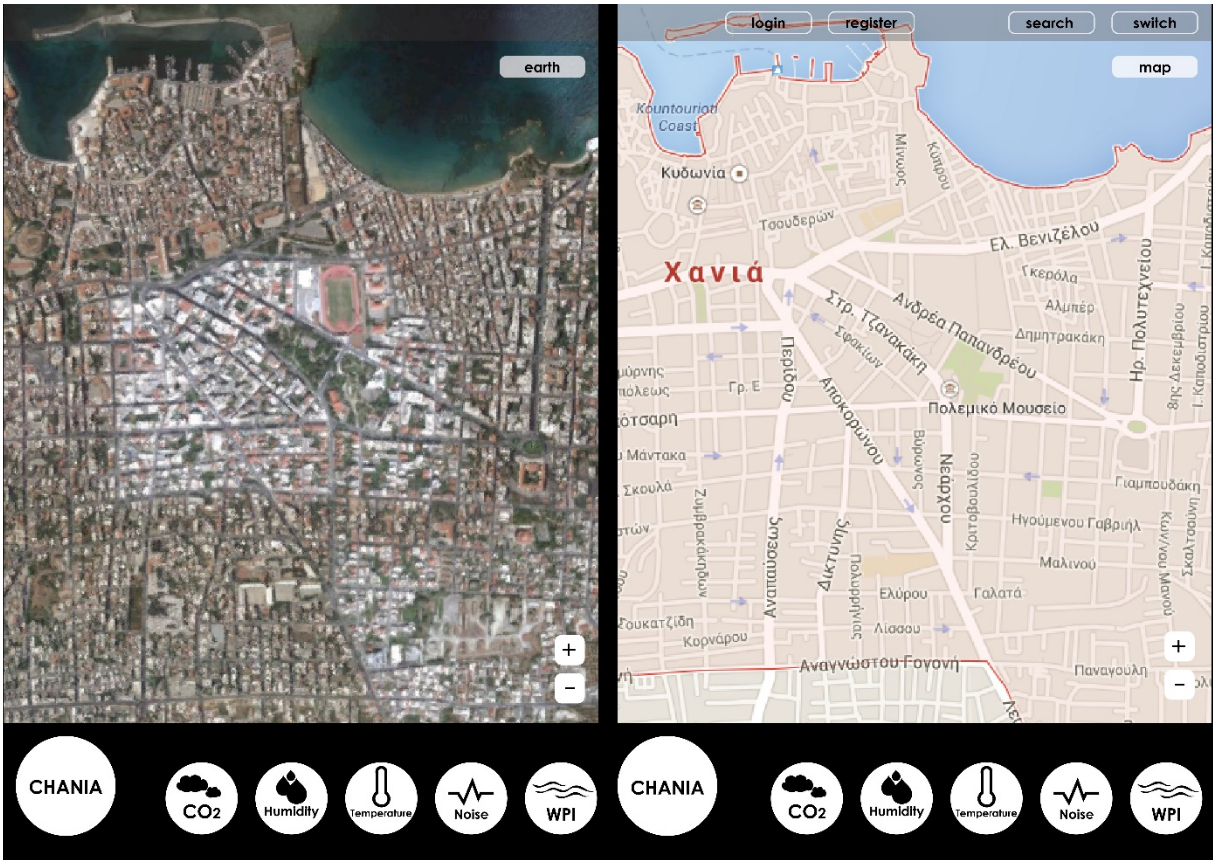

Figure 2: Map and earth view

4 Gathering Data

Data Gathering consists of two layers of information: data captured through sensors, or objective data; tags, comments and votes known as social tagging, which constitutes the subjective portion of the data. Captured data are entered in the sensor hub, then processed and validated. The relevance of sensor data is ensured through fixed sensor measurements that transmit air and water pollution data, temperature and humidity levels as well as noise pollution. CO2 and noise detectors, thermometers and humidity meters transmit data from fixed points of the city, while the Arduino micro-sensors generate data that is automatically uploaded traced and entered in the database. The code translates the validated datasets into visual information. User sensing data is presented in the form of feeds; sensing feeds include objective data, while subjective data represent the opinion feeds. Feeds are associated with data points which constitute the basic entities of the platform.

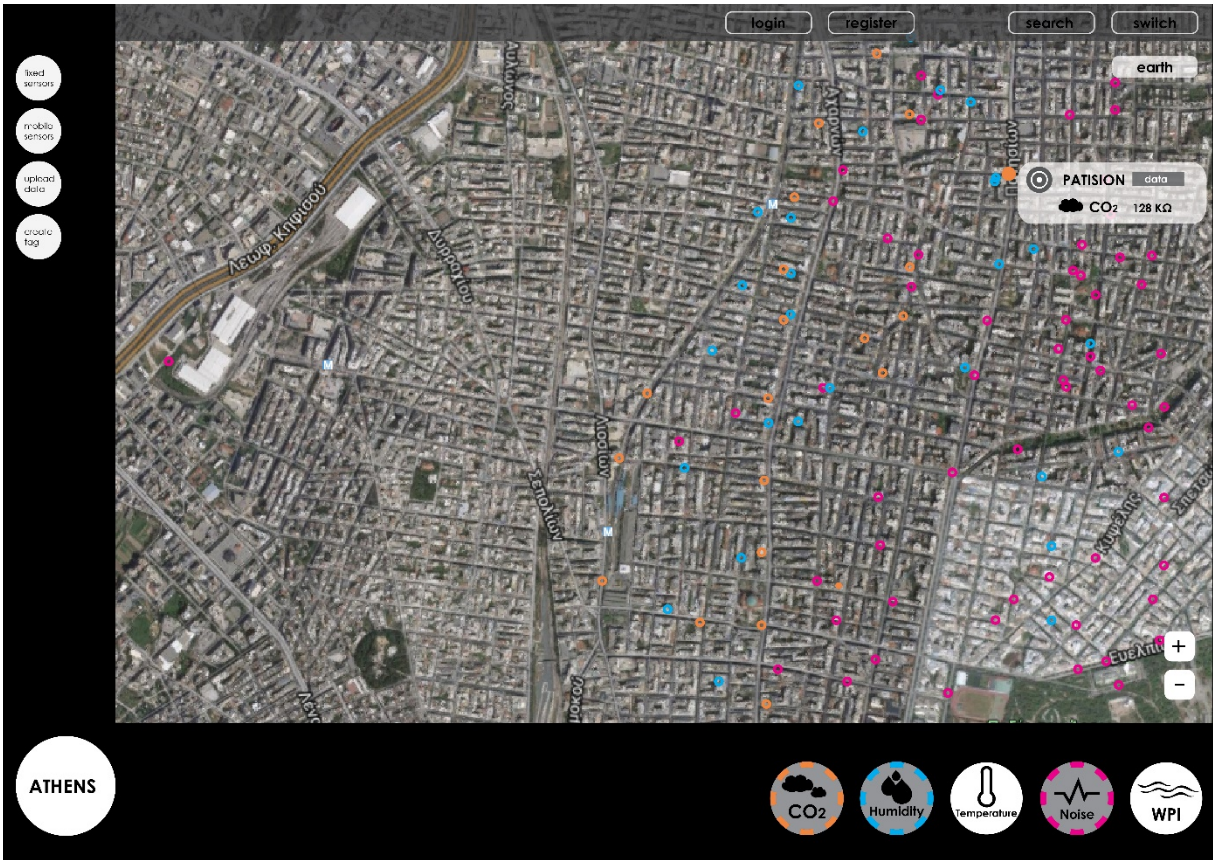

Figure 3: Point Selection

5 Processing Data

The platform endeavors to combine sensing technologies and user opinions into a functional data processing engine. Data Processing is achieved through the Processing GUI, while the DPE will be used to post-process entries to discover synergies between social and absolute data. Although it is important to collect and explore different types of data, the first priority of the system is absolute data accuracy. After mining and parsing, data are stored in the input table, ensuring the availability of data and flexibility of the system. Research has also been conducted towards the overall optimization of the code [8]. Given that data are accumulated on certain points, a system should be developed, so that the data processing engine loads a percentage of data, to ensure accessibility through lighter applications (smartphone apps etc.).

The opportunity to handle both sensor and subjective data acquisition in real-time is the key innovation of the platform. Users will be able to upload their sensor data and tag them with subjective data. In that respect, the process of opinion formation will be visible to experts and at the same time, the objective-subjective data comparison will reshape the user opinion (Figure 3). Non-experts are not able to decipher data linked to environmental parameters. By linking the 'feels like' environmental data with the absolute measurements, a profound quantitative understanding of the environmental mapping will be triggered.

In order to evaluate the eco-awareness evolution, it is really important to find out more about the environmental knowledge of the average user. Although the main assumption here is that non–experts are not familiar with environmental measurements, it is crucial to identify how users perceive data and how they process the combination of amounts thereof. Which of the environmental characteristics has the stronger impact on the user's perception? How much do social biases affect his/her perception of the quality of the environment and individual behavior [11]? Amazon's Mechanical Turks is a crowdsourcing Internet marketplace that enables individuals and businesses (known as Requesters) to coordinate the use of human intelligence to perform tasks that computers are currently unable to do [12]. MT will be a useful system to check the baseline of user behavior and test the platform efficiency concerning user engagement and behavioral change.

Moreover, the synergies between sensor data and user opinion will contribute to new mechanisms of environmental communication and impact assessment of environmental policies. The multi-disciplinary collection of data will allow for multiple - scale mapping of the city, ranging from the interstices of open areas between buildings, neighbourhoods or the city itself. The objective – subjective combination outcome is also a new way to conceive and evaluate urban design. If people can evaluate and update the existing urban environment, they can evaluate design ideas, proposals and policies. In that respect, the platform would become a powerful optimization tool for architects, urban designers and decision-makers. If Mechanical Turks are the crowdsourcing web service that outsources computation to humans, we are close to the creation of crowdsourcing design services that will affect the way people perceive design strategies as well as the way they use scientific data to accept, reject or ameliorate a proposed design idea.

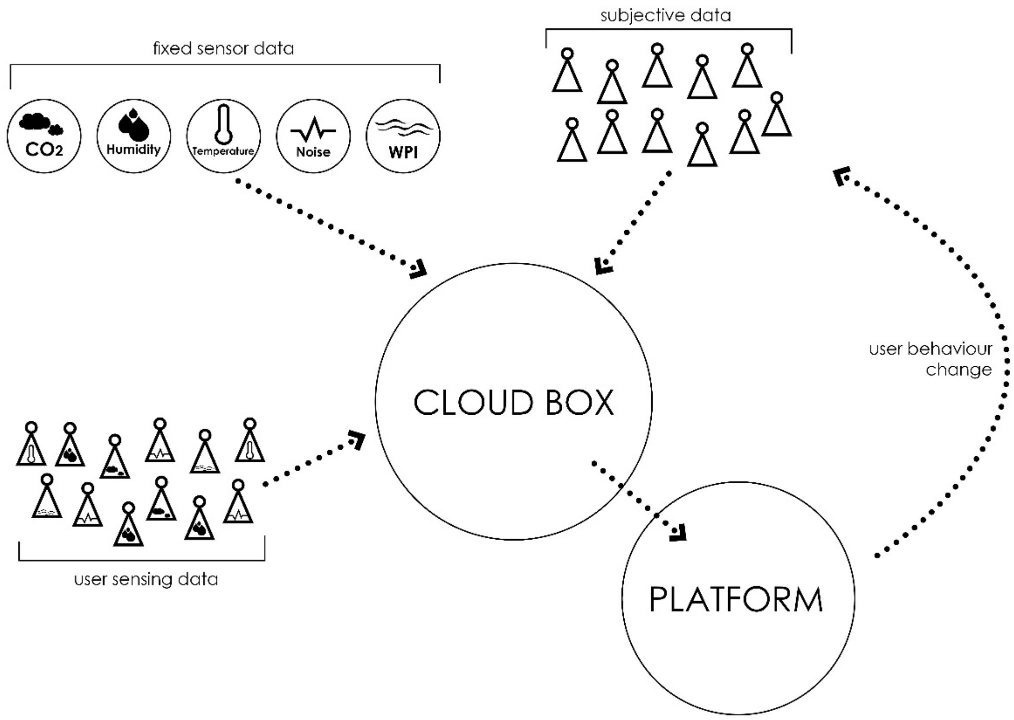

Figure 4: Data synergies

6 Discussion and Future Work

The platform suggests a new kind of interaction of humans with ICT. The goal is to enhance initial user participation through a smart reward system and produce a self-sustained feedback mechanism that will be able to ensure change in daily routines. In the future, the platform may incorporate more detailed user profile information. Although the layering of the platform, in basic and advanced user mode alike takes into account that not all users will respond in the same way, it still excludes factors such as educational level, social norms, age and culture. By taking into account these factors, users could be offered a customizable interface and special reward bonuses according to their profile. Furthermore, the application could be established as a key tool for architects, by offering design prototypes and case studies of how other communities have dealt with similar problems. Environmental simulation in our case has a twofold importance: on the one hand, it stimulates the environmental concern by involving the public; on the other hand, it bridges the gap between urban design and scientific data through user interaction.

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