

From Micro Environmental Sensors to Citizen as Sensors: The Smart Environmental Sensing Web of EPA

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Abstract—This article describes how the Environmental Protection Administration (EPA) under the Executive Yuan of Taiwan (R.O.C.) leverages its Smart Environmental Sensing Web comprising crowdsourcing and crowd-sharing [1] built on its existing internet of things (IoT) based environmental monitoring system to make the public care more about the quality of their living environment, and create positive feedback loops of information flows. .

Keywords- Micro Environmental Sensors; Social Network ; Citizen as Sensor; Crowd-sourcing; Internet of Things; Location-Based Service; PM_{2.5}.

I. INTRODUCTION

The Smart Environmental Sensing Web includes continually expanding Micro Environmental Sensors, an environmental quality sensor networking platform, an Environmental Info Push application for smart phones, and an i-Environment website. In Section 2, we also encourage the deployment of sensors, Open Data and crowd-sharing to maximize the benefits of the Smart Environmental Sensing Web. Users may use community links to stimulate other people’s concern about the quality of living environment to create positive feedback cycle of data flows (in Figure 1).

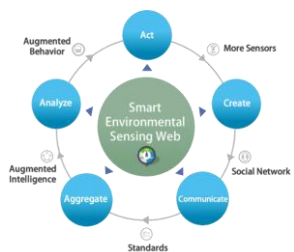


Figure 1. Figure 1. The Conceptual Cycle of Smart Environmental Sensing Web

II. METHODS

A. Data enrichment—Crowdsourcing

In addition to collecting and disseminating the various types of environmental monitoring information generated by Taiwan EPA, the Smart Environmental Sensing Network will also incorporate data from Micro Environmental Sensors operated by local governments, educational institutions, enterprises, and individuals.

In order to increase the density of the environmental sensing network, Taiwan EPA encourages citizens to join the network by installing personal air sensors in their living environment, such as AirBox and Location Aware Sensing System (LASS), which monitors air quality that people actually breathe. Since 2016, Taiwan EPA has also continued to develop new sensors that can transmit real-time data to the Smart Environmental Sensing Web via other modes of transmission, such as Bluetooth, Wifi, or Long range (LoRa) [3]. Since LoRa technology has advantages of low power consumption and long range capability, Taiwan EPA has begun deploying these sensors in a certain industrial park.

B. Technique of implementation

Smart Environmental Sensing Web comprises crowdsourcing and crowd-sharing built on its existing IoT-based environmental monitoring system, including the continually expanding Micro Environmental Sensors, an environmental quality sensor networking platform with data visualization technology and location-based services to design graphical dashboards and interactive maps enabling users to access real-time local environmental information at any time, while also adding a convenient notification function that sends alerts when needed(in Figure 2).

The Environmental Info Push App provides the public with environmental information that is updated every minute. Internet access is all it takes for people to know the air quality near their home or the place they plan to visit, so they may take appropriate measures to protect their health.

III. CURRENT PRACTICES—CROWD-SHARING

To raise the public’s environmental awareness and call attention for sources of air pollution in people’s immediate living environment, in the spirit of crowdsourcing, EPA launched Air-Photo, a function of Environmental Info Push app through which people can share a photo stamping real-time air quality data on it, and share the photo on the map as well as on one’s own Facebook Wall. Thus, through crowdsourcing and crowd-sharing, the public is engaged as “citizen sensors” and made more aware of environmental issues (see Figure 3).



Figure 2. Environmental Info Push App Air-Photo for crowdsourcing (2018)

The Air-Photo emoji from March to June in 2017 was analyzed and compared with the Air Quality Index (AQI) at the time of posting. It was found that emoji of “Normal” took the most part correspond to the first three AQI levels. On the other hand, when the AQI turned to unhealthy or very unhealthy, the posts of “Hate” or “Can’t Stand” emoji had increased significantly. (see Figure 4)

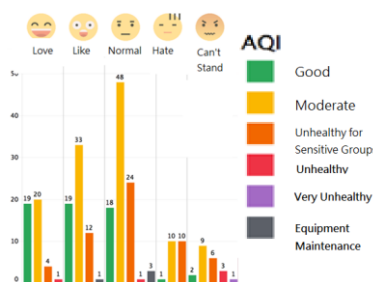


Figure 3. The Relationship between Environmental Info Push App Air-Photo emoji and Air Quality Index (2017/03-2017/06)

Through the analysis of spatial and temporal changes of the Air-Photo emoji and the correspond AQI, it is found the Air-photo were mainly post within the metropolitan areas. Besides, the users of the posters spread from the north to the south and east of Taiwan. During summer, users were less likely to share the emoji with Air-Photo while the AQI were also better. However, when the AQI turned worse, there was a higher probability of Air-Photo sharing with negative emoji among users in central and south regions, while the correspond AQI tended to be the unhealthy to sensitive group or unhealthy.

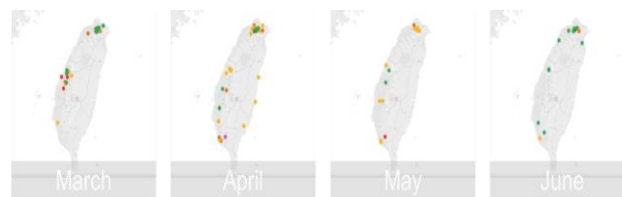


Figure 5. The analysis of spatial and temporal changes of the Air-Photo emoji and the correspond AQI (2017/03-2017/06)

Meanwhile, the northern metropolitan area of Taiwan mixed different emoji levels. Thus, there was no obvious correlation between those emoji sharing and the change of the AQI in northern metropolitan. (see Figure 5.)

IV. USING THE TEMPLATE

In light of the worldwide positive acclaim of Open Data and Micro Environmental Sensors, Taiwan EPA will continue to maintain the concept of open, transparent and innovative applications [6] to serve society with public, diversified, and convenient information services to facilitate people’s decision-making that involves environmental aspects. Taiwan EPA furthermore hopes that the Smart Environmental Sensing Web along with the relative apps will motivate the citizen more concerning about the quality of their living environment and transfer the Micro Environmental Sensors to Citizen as Sensors, and create positive feedback loops of information flows

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