Title	BUILDING PUBLIC E-HEALTH WITH 5D WORLD MAP SYSTEM(EH5D) : AWARENESS SCENARIO OF DENGUE SPREADING IN SURABAYA
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BUILDING PUBLIC E-HEALTH WITH 5D WORLD MAP SYSTEM(EH5D): AWARENESS SCENARIO OF DENGUE SPREADING IN SURABAYA

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Abstract

Dengue is a mosquito-borne infection found in tropical and sub-tropical regions around the world. The incidence of dengue has grown dramatically around the world in recent decades, which has been caused by uncertain climate change and human movement. To suppress disease outbreak, comprehensive awareness should be constructed through the new knowledge on dengue mechanism. Problem instill awareness is how to formulate perception through comprehensive information, because actually people get piece of information in dengue but this information could not perform perception. This paper presents the scenario of building awareness through different types of information in 5D world map system. This scenario including weather and human movement is drawn in several types of data based on an awareness-architecture with physical layer, abstract layer and output layer. The different aspects are represented by different types of data such as sensing data of climate, socio-cultural statistical data of contagious place and multimedia data of social phenomena. The main contribution of this research is to construct a new analytical environment for building comprehensive awareness about communicable diseases by integrating various types of information, data, and the analyzed results. As a case study, Surabaya is chosen as target area for analysis.

Keyword: Awareness, Dengue, Infection disease, Knowledge base, Multimedia, Spatiotemporal Database, Sensor, Environmental Analysis

1. INTRODUCTION

Prevention of epidemic disease now becomes one of the most important and difficult issues in the world regarding global climate change and high mobility of people all over the world. The uncertain climate changes take part in the emergence or resurgence of vector-borne disease while travelers amplify the epidemic area all around. One of the fastest epidemic diseases in the history declared by WHO is dengue fever [1]. In line with increasing people traveling around the world, spreading of dengue increases dramatically [2].

The potential incidence of dengue is a complex phenomenon [3] including unpredictable nature of disease dynamics [4], pattern of human moving [5] and environment treatment for multiplying number of vector [6]. Combating dengue needs an integration of sensing nature behavior, investigating pattern of traveling and improving hygiene human behavior [7]

As same as other communicable diseases, management of dengue disaster should involve community participation, particularly in awareness part. One difficulty of awareness is non uniform understanding [8] and people perception [9] about dengue. Some studies about community participation show that knowledge about dengue is increasing recently [10][11],[12], but people's perception about dengue is not accomplished in term of awareness in fact [13], because their knowledge is based on piece of information, for example due to sanitation, symptom, mosquito, etc.. Awareness needs the integration of several types of information and data to perform comprehensive perception

Regarding the problems of dengue spreading, EEPIS and Keio have been conducted a research collaboration for building dengue e-health assessment and awareness with 5D World Map System [14][15][16][17]. Basically, this public e-health with 5D World Map (EH5D) is constructed by physical modeling and social modeling. EEPIS has been preparing the physical models and Keio provides5D World Map System.

This paper addresses to build a new approach in awareness by integrating several types of information and data. Physical modeling result is integrated with various multimedia information resources with temporal, spatial and semantic correlation computing functions in 5D World Map System. Final result is temporal-spatial and semantic multiple views for various multimedia dengue information resources

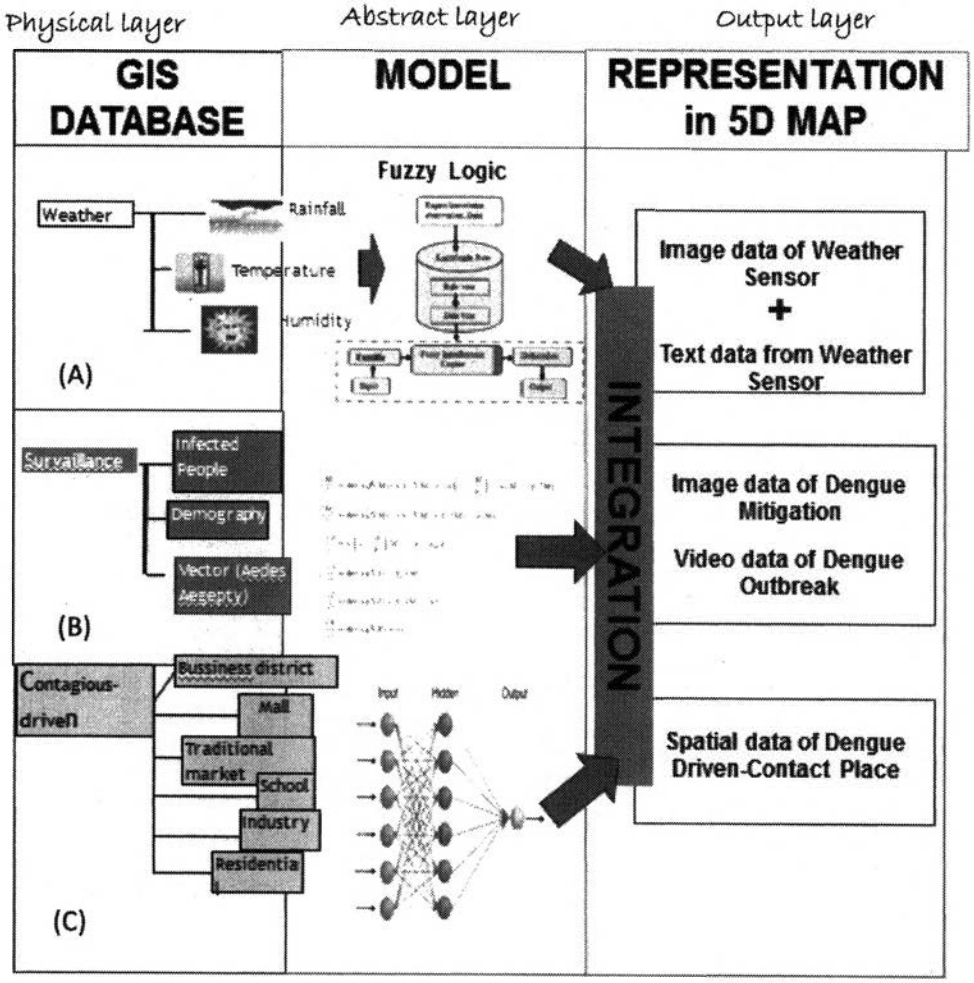


Figure 1. Architecture design of public e-health with 5D World Map (EH5D)

2. SYSTEM ARCHITECTURE

As discussed earlier, in awareness of communicable disease such as dengue fever context, the critical issue is how to build a system with dynamic parameters to create awareness, especially for different kinds of community. In this paper, several aspects is represented by different types of data such as sensing data of climate, socio-cultural statistical data of residence, and multimedia data of social phenomena due to dengue are rolled into comprehensive scenario as shown in Figure 1.

This scenario of awareness involves the integration of several aspects. Left side of Figure 1 shows several kinds of data that take a part in perform awareness (physical layer). Different types of data need different methods in handling. The methods for analyzing data are illustrated in middle part of Figure 1 (abstract layer).

First, the weather aspect that contributes to increasing number of mosquito is analyzed (Figure 1 (A)). The aspect is represented as the sensor data of temperature, rainfall and humidity. By using Fuzzy Logic, these data will be extracted to get meaning, which is associated with mosquito breeding: from Low to High. It is symbolized in 5D Map by two types of data: image of weather sensor and text data as an output of this sensor.

Second, human-movement aspect is analyzed, which plays an important role in spreading (Figure 1 (B)). This aspect is denoted by GIS data about contagious place in where contact among people happened and dengue transmission may occur. It is processed in Neural Network to get ranking of risk.

Third, the geographical information of distribution of building and districts such as business district, industrial district, residential district, mall, traditional market, school, hospital etc. is collected and analyzed for calculating the level of risks of each area (Figure1 (C)).

All the aspects will be variables in Suspected Infected Recovery model (SIR) [18] for analyzing dengue spreading phenomena. Because this model is not easy to understand, to simplify, another data exploring outbreak and mitigating will be implemented to explain what will be happened when dengue outbreak and what should to do for restraining from outbreak.

2.1 Physical Layer (Sensor data)

To monitor the temperature, humidity, pressure, wind speed, wind direction and rainfall, many sensors are integrated. While weather meters utilize for monitoring wind speed, wind direction and rainfall. The sensor consists of a wind vane for the direction of the wind, anemometer cup to determine the wind speed and tipping bucket to measure rainfall as illustrated in figure 2

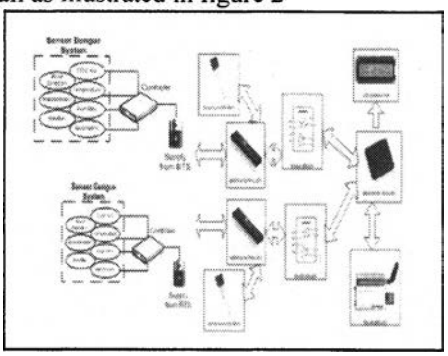


Figure 2 Weather sensor

For processing data from all the sensors in node Arduino board is embedded Data transmission from the sensor to the center using IEEE 802.11n wireless technology, which this device can transmit data at up to 300Mbps capacity with a range of more than 15km. The device used was a long-range rocket wifi AirMax M5.

2.2 Abstract Layer (Socio-cultural data)

In case of awareness, risk is main objective. Risk assessment is the process of obtaining quantitative or qualitative measures of risk levels. The risk assessment progresses through [18] the sequential phases of (1) problem formulation, (2) risk analysis, and (3) risk characterization. In this case, problem formulation is finding connection between places of contagious with number of victim. It is expected drawing the disease contagious pattern. This methodology was developed to sift among a large number of potentially impacted places to identify ranking, as shown in figure 3.

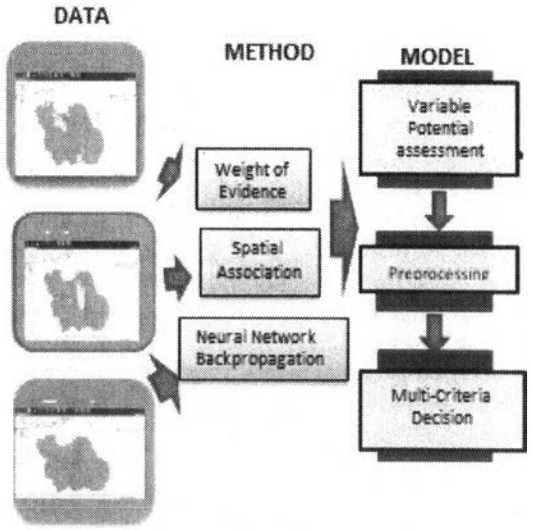


Figure 3. Spatial risk framework

This method combines Weight of Evidence for selecting potential variable [19] spatial association for preprocessing among different feature class [20] and neural network for multi-criteria decision [21] .As a result, some variable that close-related to risk assessment is overlaid as contagious placed in spatial data and visualized in KML type data.The expected result is people's understanding about dengue transmission risk of several places where they may visit frequently

2.3 Output Layer (multimedia data)

The usages of this system can be described by several significant study scenarios: (1) Cross-topic environmental studies using multimedia retrieval, (2) Time-series based environmental-change observation, and (3) Cross-space environmental-issue overview. For this purpose, three-tie architecture of Client/Server/Database is conducted as a pillar of Web application in 5D Map .To enhance analysis, the 5D World Map System will layered with dynamic modeling and spatial risk model.

This map contains what is happening in physical world about dengue (represented by spreading model) and the changes by timeline. The data taken from this process will be used to review and analyze to assess environmental impacts.

3. OVERVIEW OF 5D WORLD MAP SYSTEM

5D World Map System is a knowledge creation and sharing system which enables semantic, temporal and spatial analysis of multimedia, integrates and visualizes the analyzed results as a 5-dimentional dynamic historical atlas (5D World Map Set)[14][15][16][17]..The main feature of this system is to create various context-dependent

patterns of environmental/historical/cultural stories according to a user's viewpoints dynamically. This system generates multiple views of semantic and temporal-spatial relationships among multimedia of the multidisciplinary fields such as global environmental issues. A semantic associative search method is applied to this system for realizing the concept that "semantics" of words, features of multimedia, and events according to the "context". Semantically-evaluated and analyzed multimedia data are also mapped dynamically onto a time-series multi-geographical space. This system provides high visibility of semantic correlations between multimedia in time series variation with geographic information

By applying to the analysis of environmental issues, 5D World Map System can be a knowledge sharing system to analyze the commonality and difference among regional environments in a global view, and a collaborative knowledge creation system for remote users such as researchers and students of the same environmental issues around the world.

The latest 5D World Map System consists of five main functions: (1) Cross-topic multimedia search by semantic similarity calculation, (2) Multimedia database overview by spatiotemporal information, (3) Media data uploader for multi users, (4) Differential computing for spatiotemporal data, and (5) Historical-geographical information visualization.

(1) Multimedia Search by Semantic Similarity Calculation [23]
Metadata of multimedia data such as word frequency of documents or color frequency of images are vectorized and mapped onto the semantic or color space for calculating the similarity between a query and the multimedia. By this function, the correlations between (a) multimedia and/or keywords input by a user as a query and (b) multimedia data mapped onto the search spaces are calculated.

(2)Multimedia Database Overview by Spatiotemporal Information
Various multimedia data (Text, Image, Sound, Movie), within a selected category or across the categories, are visualized onto a set of time-series world maps. By this function, the comparative analysis among various countries, regions, cities from the aspect of differences and similarities is realized, and the time-series changes can be observed.

(3) Multimedia Data Uploader
Users can upload the multimedia data in various format .txt, .pdf, .csv, .jpg, .png, .gif, .mpeg, .kml) on various topics (e.g. "wild fire", "history of the agreements on global environment", etc.) and share them from remote client. By this function, a collaborative database creation and a real-time analysis on the global environment are realized. Users can upload, share, download, edit any contents and re-upload their edited multimedia.

(4) Differential computing for spatiotemporal data
This new function visualizes numerical and statistical [24] data with spatiotemporal information such as population, energy consumption/production, GDP, CO2 emission, ratio of forest coverage, oil dependency rate, etc.. By this function, users can visualize the collected numerical values onto the time-series multi-geographical spaces as a set of colored polygon data or variable-sized markers. In addition, this function can visualize the differences extracted from a set of time-series geographical images such as satellite images, aerial photos, and meteorological information images as colors. The differences are calculated from the correspondence relationship between the positions on a set of time-series images and geographical coordinates (latitude and longitude).

(5)Historical-geographical information visualization
This new function maps and visualizes by overlaying the geographical information data in the format of KML such as polygon data of landform, ocean area, forest area, iced area, desert area etc., location data of city, road, river, canyon etc., statistical data of population, GDP, house index etc.. The function creates the geographical information database automatically based on a KML file uploaded from a user with the attributes of date, user name, category etc. Multiple geographical data in KML format can be visualized on the same map at once.

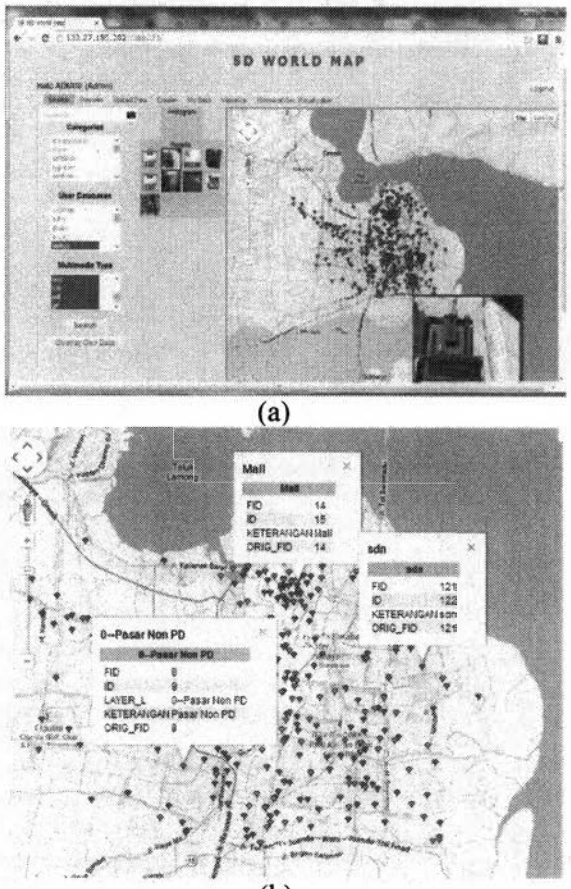
5D World Map System enables users to perform a multifactorial analysis on multiply-layered multimedia, statistical data, and geographical data with spatiotemporal information at once.

5D World Map System realizes a comparative analysis on the difference, commonality and time-series change of each country, region, city and village in the global society by calculating the similarity and difference between various multimedia and statistical data with spatiotemporal information. In addition, this system contributes to set academic and research environments to create knowledge database collaboratively and share the global-view analysis with remote users. Especially in the field of global environmental analysis, which needs the vast amount of data and integrated analyses, 5D World Map System can be a collaborative research platform for the international multidisciplinary research projects.

4. PROTOTYPE IMPLEMENTATION

Based on the system architecture described in section 2 and the output system by 5D World Map System described in section 3, we implemented a prototype of EH5D with the dengue spreading data in Surabaya, Indonesia. The current study of analyzing dengue spreading by EEPIS utilizes data of Surabaya, second big city in Indonesia. Surabaya has 5 districts consisting of 31 sub-districts, namely kecamatan, and 160 villages [22].A village is considered as the smallest unit under Indonesia public health system.

There are several data types processed and visualized onto a new visual and analytical system, 5D World Map System to provide a broad knowledge of dengue fever. Figure 4(a) shows the mapping and overlaid results of various types of data: socio-cultural data, multimedia (image, text and movie) and sensor data, and the combination of image data about weather sensor and sociocultural information related to drive contagious among people.



(a)

(b)

Figure 4. An example of mapping results: (a) socio-cultural data, multimedia and sensor data related to dengue fever, and (b) information about human contact

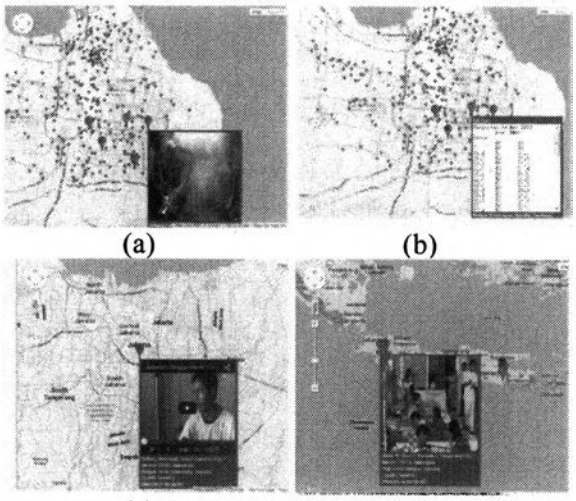
An image of weather sensor illustrates dependency of mosquito population to weather [26]. From figure 4, people can pay more attention if the weather is change, especially in the sense of sanitation because nice weather is good environment for mosquito breeding as shown in Figure 4(b) The results of this figures is expected bearing in mind improvement of knowledge in relation with dengue fever prevention, mainly about the place where they visit and when the certain circumstance in weather is adequate.

This combination is projected form consideration about important factors in dengue transmission: human contact and weather. Human contact is described by contagious place [25] as shown in Figure 4(b). It has different feature classes: point (school, market, mall, and victim) and polygon (industrial, resident). It is overlaid in shape file and converted to KML for 5D map. This figure associate with possibility of dengue transmission through contact among people. This contact usually happened from 09.00 to 16.00. It is revealed with interview with the victim. Table 1 shows the examples of sampling data of respondents due to place of activity during the time mention above.

Table 1. Sampling data of interview with victim

Name	Gender	Age	Activity from 09.00-16.00
Ananda	Male	3	at home
betri	Female	13	Secondary School
Reskia A.	Female	12	Secondary School
Umayah	Female	35	at home, market, neighbour's house
OppyPrayogi	Male	22	Office

In Figure 5, (a) the image shows example of mitigating system in dengue disaster. This picture is took in Surabaya Chemical spray is alternative to prevent spreading of dengue but it is controversial method because the side effect is harmful for environment and causing another sickness such as eyes infection or throttle.



(a) (b)

(c) (d)

Figure 5. Mapped multimedia and sensor data related to dengue fever in Surabaya and Indonesia:
(a) an image of disinfection in Surabaya,
(b) statistical data of sensors in Surabaya,
(c) a video of news of dengue in Jakarta,
(d) an image of hospital with infected children in Jakarta

Figure 5 (b) shows data of the weather sensor in text file. From this data, the information gathered is about nice weather for mosquito breeding. To get the information, all data about temperature: humidity, wind speed and rainfall should be processed with statistical method Figure 5(c) and (d) show different type of data about dengue news. In Figure 5(c), the video data is utilized to describe dengue spreading in Jakarta while in Figure 5(d) the image data of infected children in one of hospital in Jakarta. Both are illustrating dengue outbreak event in Indonesia, and expected to impress people then lead them to start a campaign against dengue by themselves.

5. CONCLUSION

In this paper, we have presented the scenario of building awareness through different types of information in 5D world map system. This scenario including weather and human movement is drawn in several types of data based on an awareness-architecture with physical layer, abstract layer and output layer. This research collaboration for building dengue e-health assessment and awareness with 5D World Map System (EH5D) is constructed by physical modeling and social modeling.

Dengue fever, the serious disease in Indonesia has been illustrated as a mosaic of different types of data in 5D World Map. To get the new knowledge about this disease, several methods should be implemented in this mosaic. The future work is to determine risk map, draw the pattern of human moving and social aspect in 5D World Map as a road to build policy in e-Health regarding with dengue fever.

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