Research Project	**A Dynamic Dengue Fever Risk Area Model for Real-Time Control in Local-Global Spreading : Case Study Surabaya, Indonesia**
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1. Research Outline

To combat the transmission of dengue, a mosquito-borne virus that threatens some 4 billion people worldwide, it is important to pay attention on people movement, not just on the traditional mosquito control-and-prevention methods. In this research, we study about relation between moving pattern of people with spreading of disease in Surabaya, Indonesia. The feature of research is real-time analysis of global-local spreading in network. The objective of the research is to build risk model of area due to disease transmission among people during their regular daily movement (from 09.00 to 18.00). There are 2 variable for transmission disease that will be attribute of human movement: (a) Dengue Location-Contraction Risk represents risk of site, and dynamic weather symbolizes number of adult mosquito that possible to transmit disease. The proposed research is builds upon my previous achievement about general situation in spreading dengue fever in Surabaya and that a transmission rate is different when people is exposure at different site. This model consist of (a) state-space model of routine movement cycle (b) algorithm of local-global scenario of spreading (c) prediction of next infection area by relation in graph of human moving, and (d) determine vulnerability value of suspected area. Since it is based on data-driven model, this model is flexible in changing of pattern. Therefore, the control action can be performed quickly and effectively according to the situation.

2. Research Result

2.1 System Design

Basic concept of this system is figures out physical phenomena of disease transmission in network and transform to Linier Time Invariant state. This state is transfer function system that represents behavior of system. Spreading disease in this study involved 3 components: human moving, weather and disease contracting location. Attribute of human moving are origin location, destination location and number of people. Weather is variable that reflect mosquito existence. System design is illustrated in figure 1.

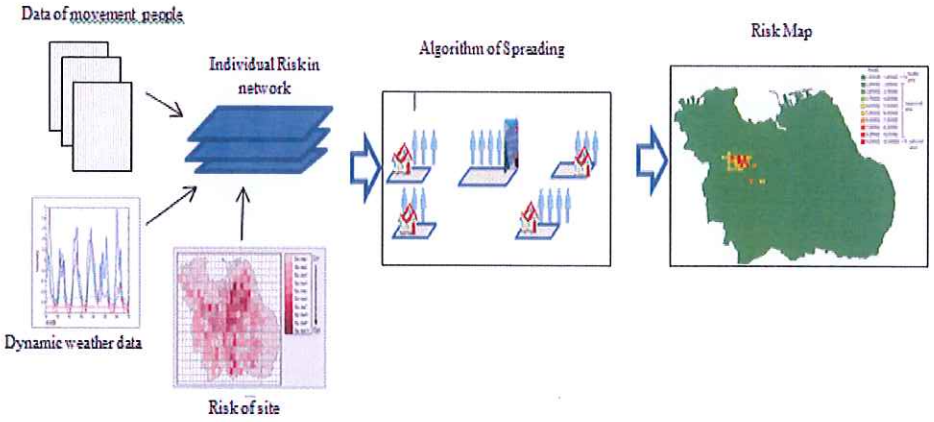


Figure 1. Design system of Global-Local area spreading

To perform algorithm, I define Healthiness of Area as an accumulation of individual risk, T , when they stay in the area. That value reflecting resistance of area in dengue transmission The movement in this study is assumed over from origin (home) to destination (school, office, etc) in the morning and from destination to origin in the evening return to home. Every individual who is entering the destination area brings Individual risk (T). The next step is calculating dynamic of Healthiness area in state-space by combining relation in graph of movement with total risk. From this algorithm we can predict next spreading. The result will be visualized in term of map

2.2 EKSPERIMENTAL STUDY AND FIELD WORK

For implementation, I choose one sub district in Surabaya namely Manukan area. The area will be grid by 40m x 40m. For this purpose, I went to Surabaya from August 26,2015 to October 3,2015. I went to Ministry of Health Indonesia in Jakarta to get the permission for taking a data. After get permission, I went to Surabaya, the research site, to conduct an interview. Numbers of respondent are around 857 people (161 families). Since the number of interviewer is quite big, I empowered local woman, especially house wives to support my research. First, I held small workshop and discussed about the basic knowledge in dengue spreading, as shown in figure 2

Figure 2. The Workshop

Then, they will be a volunteer to interview the people around their home: family or neighbor. They collected data about daily movement, awareness and daily activity. Then, they will report when infected people will found in their areas as an input of algorithm to determine dynamic risk.

The result became input for my algorithm. Through the data, I run my model. The result is shown in figure 3.

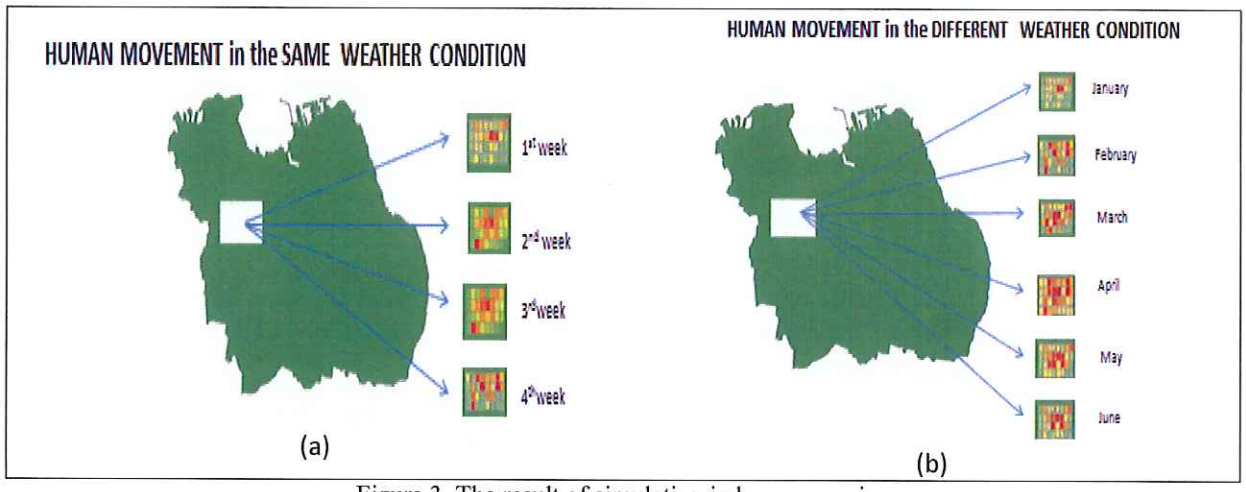


Figure 3. The result of simulation in human moving
(a) Human movement in the same weather condition
(b) Human movement in the different weather condition

To validate my model, I simulated by the real data and compared the result with data of infected area from Surabaya Municipal. The research results are planned to present at the international journal (**Wahjoe T Sesulihatien, Yasushi Kiyoki, 2014, A Dynamic Dengue Fever Risk Area Model for Real-Time Control in Local-Global Spreading, INFORMATION MODELLING AND KNOWLEGDE BASES XXVII (final review)**)

Moreover, I also analyzed relation between monthly dynamic of weather with number of dengue occurrences. The data is gathered monthly from 2007 to 2012. From the data I got the relation between weather and ecological stage of mosquito. This relation is important in determined strategy for combatting the dengue spreading. The result is shown in figure 4

stage	Strategy of control
Gonothropic development	insecticide for larvae
Methamorphose	interrupting aquatic stage
Sporogonic development	reppelent
Activity level	individual protection
Oviposition choice	vegetation control
Gonothropic cycle	chemical spray
Resting	eliminating habitat
Development rate	outdoor control (electric)
Flight path	mechanical barrier

(a)

Season	Tested data	Similarity	error (%)
Wet	"February 2006"	"January 2007"	17
		"January"2008"	
		"January 2009"	
Transition	"June 1989"	" March 2009"	36
		"May 2008"	
		"June 2011"	
Dry	"Sept 1990"	" October 2011"	23
		"november 2007"	
		" December 2012"	

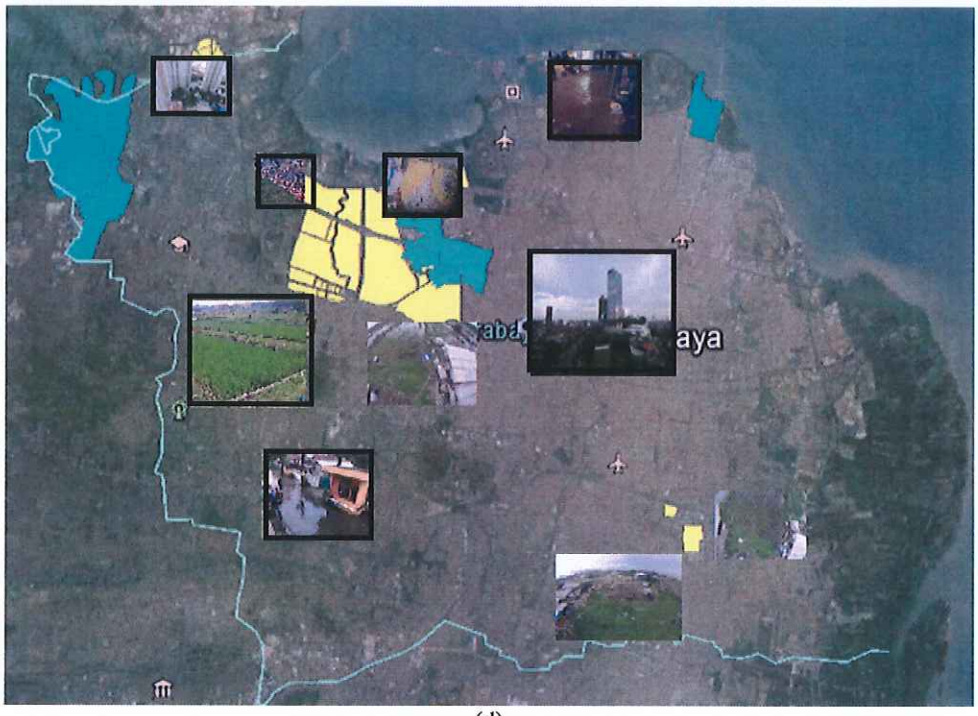
(b)

Figure 3. The result of dynamic weather changing
(a) The relation between stage and the strategy
(b) The example of evaluation in semantic searching

The result is presented in **IEEE 18th International Electronics Symposium 2015** with a title Ecological Context-Dependent Analysis and Prediction using MMM : A Case of Dengue Fever Disease.

In my observation, rainfall play an important role in dynamic weather changing. However, the impact of rainfall in every area is different. Therefore, I explored more deeply about it. For this purpose I went to Indonesia once more in rainy season (January 29,2016 to February 5,2016) to take a picture of several places in Surabaya by drone. Again, I went to jakarta to get the permission, and after that I went to Surabaya. For this purpose, I use Android HTC Desire Eye as a camera in the drone. The result is shown in figure 4

(a) (b) (c)



(d)

Figure 4. The drone experiment
(a) Camera-handled in a drone
(b) Experiment to fly the drone
(c) The result of picture taking by a drone
(d) The example of picture in several area in Surabaya

The result shows briefly that in the area where dengue fever case is severe, number of water in land use area (outside the home) is usually bigger. However the result should be investigated more.

3. The Future Work

From several result in internship, I gathered several information that is important to build the system for combatting dengue. In the future, I plan to perform the Cyber Physical System with new sensor, for example drone to replace water -observation by human, wearable device to sense transmission of disease by human movement.

Publication

1. Wahjoe Tjatur SESULIHATIEN, Tri HARSONO, Shiori SASAKI, Yasushi KIYOKI, 2014, Building Public E-Health With 5D World Map System(EH5D): Awareness Scenario Of Dengue Spreading In Surabaya, The Third Indonesian Japanese Conference on Knowledge Creation and Intelligent Computing (KCIC) 2014
2. Wahjoe T Sesulihatien, Shiori Sasaki,Yasushi Kiyoki, Ecological Context-Dependent Analysis and Prediction using MMM: A Case of Dengue Fever Disease, International Electronic Symposium, 2015, Surabaya, Indonesia.
3. Wahjoe Tjatur SESULIHATIEN, Shiori SASAKI, Yasushi KIYOKI, Tri Harsono, Ahmad Basuki, Azis Safie , Local-Regional-Global Analysis on Infectious Disease with Analytical Visualization Functions of 5D World Map System: A Case of Comparative Analysis on Dengue Fever Spreading in Indonesia and Malaysia, The Third Indonesian-Japanese Conference on Knowledge Creation and Intelligent Computing (KCIC) 2015
4. Wahjoe T Sesulihatien, Yasushi Kiyoki, 2014, Drawing Human-involved in Dengue Spreading: from Population Density to Contagious Place, INFORMATION MODELLING AND KNOWLEGDE BASES XXVI, pagel 396-40
5. Dadet Pramadihanto, Wahyu T Sesulihatien, Soffi Patrisia, Shiori Sasaki, Yasushi Kiyoki, 2014, Challenge in Urban Flood Mitigating System: Decision Support based on Cyber-Physical-Human Infrastructure, INFORMATION MODELLING AND KNOWLEGDE BASES XXVI, pagel 361-375
6. Wahjoe T Sesulihatien, Yasushi Kiyoki, 2014, A Dynamic Dengue Fever Risk Area Model for Real-Time Control in Local-Global Spreading, INFORMATION MODELLING AND KNOWLEGDE BASES XXVII (final review)
7. Wahyu Tjatur SA, Ira Prasetyaningrum,Tri harsono, Shiori Sasaki,Yasushi Kiyoki,2013, Demam Berdarah dalam Perspektif Urban : Analisa Statistik untuk *Awareness Strategy, in* "The National Conference on Smart-Green Technology in Electrical and Information System(CGTEIS)"2013, Proceeding CGTEIS 2013 page 23-31.