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PRELIMINARY VISUALIZATION OF SURFACE WATER QUALITY FOR BANGKOK BY 5D WORLD MAP SYSTEM

Khoumkham Ladsavong [a], Petchporn Chawakitchareon [a*], Yasushi Kiyoki [b], and Shiori Sasaki [b]

[a] *Department of Environmental Engineering, Chulalongkorn University, Bangkok 10330, THAILAND*
[b] *Graduate School of Media and Governance, Faculty of Environment and Information Studies, Keio University, Shonan Fijisawa Campus, Kanagawa, JAPAN*

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ABSTRACT

This paper presents a preliminary visualization of surface water quality by 5D World Map (5DWM) system of three canals i.e. Bang Sue Canal, SamSen Canal, and Bang Krabue Canal in Bangkok Capital, Thailand. Seven sampling sites were selected and 13 parameters were analyzed i.e. temperature, pH, DO, BOD, COD, H_2S, SS, TKN, NH_3-N, NO_2-N, NO_3-N, TP, and Salinity. The previous data selected from 2007 to April 2017. Those parameters were analyzed and visualized by 5DWM system. The results indicated the 5DWM system visualized those parameters of each water sampling site in term of different colors and graphs that they indicated the water quality conditions change from past to present due to the system can show the water quality states in time series.

1. Introduction

The availability and quality of water either surface or ground, have been deteriorated due to some important factors, such as increasing population, urbanization, etc. (Effendi, 2016). Urban development without a proper plan often results in environmental issues or causes human pollution and activities to increase and surrounding environment to be polluted (Lee et al., 2017). For this reason, the natural resources requirement for the production or manufacturing in the industrial is increased too. Therefore, the environment issues have absolutely followed us, such as water quality pollution, air pollution, namely. For the river water quality can be contaminated by human activities in two way as point source and non-point source (Gyawali et al., 2013). Point source pollutants are involved pollution from a single concentrated source that can be identified, such as an

*Corresponding author (P.Chawakitchareon). Tel: +66-2-2186674 E-mail: petchporn.c@chula.ac.th.

outfall pipe from a factory or refinery (Ngwira and Lakudzala, 2018). Non-point source pollutants are washed from the earth's surface by storm runoff and enter water bodies of their own accord (Zampella et al., 2007). Thailand also faces those environment issues because in the big city has crowded area as Bangkok Capital. This city is a capital city of Thailand thus it is a crowded area and has the factories that restricts the concentration levels of chemicals and metal pollutants in wastewater being dumped into the environment. Form these few activities made the water quality pollution in Bangkok, such as the physical and chemical of water quality characteristic of canals is changed.

Therefore, the water quality characteristics of canals must usually measure and monitor. The Department of Drainage and Sewerage is responsible to observe, measure, monitor, and analyze the water quality of the canals in Bangkok Area. It is a department of Bangkok Metropolitan Administration (BMA), Thailand. The BMA is usually collected and analyzed the water quality in terms of physical, chemical, and biochemical characteristics of each sampling point monthly from the past up to present. Therefore, in this research, we would like to gather and visualize the data of water quality that BMA collected and analyzed. In this case, the researchers selected 7 sampling points in 3 canals i.e. Samsen, Bang Sue, and Bang Krabue Canal that they are very close to Chao Phraya River. The physical and chemical characteristic of surface water quality and 13 parameters (temperature, pH, DO, BOD, COD, H_2S, SS, TKN, NH_3-N, NO_2, NO_3, TP, and Salinity) are selected and visualized by 5DWM system.

2. Materials and Methodology

2.1 5D World Map System

5DWM system is a tool for visualizing the data information to the map which can display and encourage the similitude of multidimensional data. It has introduced the architecture of a multi-visualized and dynamic knowledge representation system (Kiyoki et al., 2016; Kiyoki et al., 2012; Sasaki et al., 2010). Besides that, 5DWM has SPA function that SPA is a fundamental concept for realizing environmental system with three basic functions "Sensing, Processing, and Analytical Actuation" to design a global environmental system with Physical-Cyber integration. Application of 5DWM system for visualization of water quality educated as a case study in Vientiane Capital, Lao PDR (Ladsavong et al., 2017) and Sichang Island, Chonburi Province, Thailand (Chawakitchareon et al., 2018). For the 5DWM system is indicated in figure 1.

2.2 Data Collection

The data in this research collected from three canals i.e. Samsen, Bang Sue, and Bang Krabue Canal, Bangkok Capital, Thailand. The previous data of the water quality was selected from 2007 to 2017 or 11 years. Thirteen parameters are selected, including temperature, pH, DO, BOD, COD, H_2S, SS, TKN, NH_3-N, NO_2-N, NO_3-N, TP, and Salinity. From these parameters, 889 records were selected.

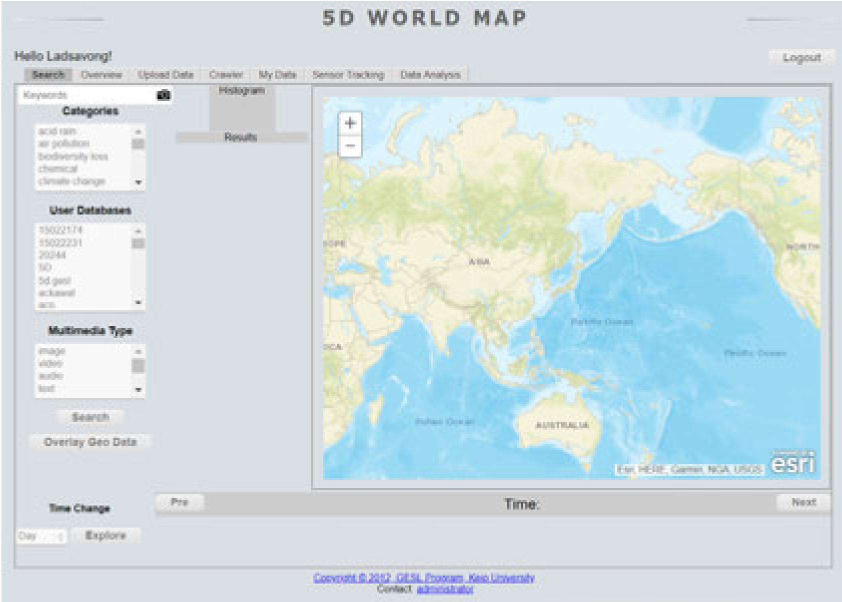
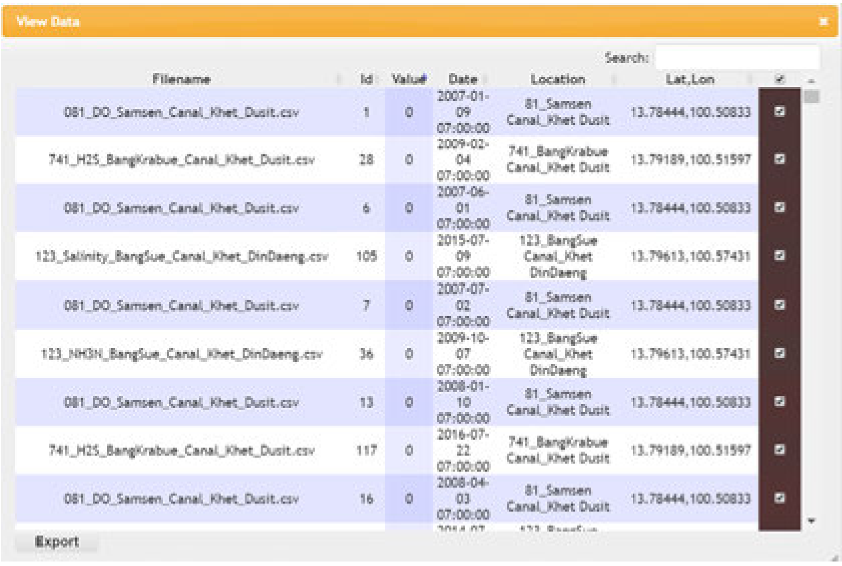


Figure 1: 5D World Map System

2.3 Data Preparation and Uploading

The collected data is prepared in CSV file by manual method. The prepared files must be in the 5DWM system required format. In this case, we prepared 98 files of 7 sampling sites for uploading to 5DWM system. If the files are correctly prepared, they can absolutely upload to the system. After the uploading completed, the data will display as shown in Figure 2, the system can visualize the surface water quality data, and can analyze the surface water quality of the canals from the past to present.



Filename	Id	Value	Date	Location	Lat,Lon
081_DO_Samsen_Canal_Khet_Dusit.csv	1	0	2007-01-09 07:00:00	81_Samsen Canal_Khet Dusit	13.78444,100.50833
741_H2S_BangKrabue_Canal_Khet_Dusit.csv	28	0	2009-02-04 07:00:00	741_BangKrabue Canal_Khet Dusit	13.79189,100.51597
081_DO_Samsen_Canal_Khet_Dusit.csv	6	0	2007-06-01 07:00:00	81_Samsen Canal_Khet Dusit	13.78444,100.50833
123_Salinity_BangSue_Canal_Khet_DinDaeng.csv	105	0	2015-07-09 07:00:00	123_BangSue Canal_Khet DinDaeng	13.79613,100.57431
081_DO_Samsen_Canal_Khet_Dusit.csv	7	0	2007-07-02 07:00:00	81_Samsen Canal_Khet Dusit	13.78444,100.50833
123_NH3N_BangSue_Canal_Khet_DinDaeng.csv	36	0	2009-10-07 07:00:00	123_BangSue Canal_Khet DinDaeng	13.79613,100.57431
081_DO_Samsen_Canal_Khet_Dusit.csv	13	0	2008-01-10 07:00:00	81_Samsen Canal_Khet Dusit	13.78444,100.50833
741_H2S_BangKrabue_Canal_Khet_Dusit.csv	117	0	2016-07-22 07:00:00	741_BangKrabue Canal_Khet Dusit	13.79189,100.51597
081_DO_Samsen_Canal_Khet_Dusit.csv	16	0	2008-04-03 07:00:00	81_Samsen Canal_Khet Dusit	13.78444,100.50833

Figure 2: Data Completed uploading in 5DWM system

3. Proposed Method

In the water filed as environmental have many parameters in term of physical, chemical, and biochemical characteristic of monitoring and analysis. So, in this step, we aimed to visualization surface water quality at Bangkok Capital, Thailand with existing data and creating the

*Corresponding author (P.Chawakitchareon). Tel: +66-2-2186674 E-mail: petchporn.c@chula.ac.th.

multi-dimensional semantic space for multi-parameter of water quality. The sampling sites location is indicated in Figure 3 and Table 1.

Figure 3: Location of sampling sites

Table 1: Location of sampling points with latitude and longitude

Site	Canal	Latitude	Longitude
1	Samsen	13.78444	100.50830
2	Samsen	13.78300	100.51100
3	Samsen	13.75700	100.55000
4	Bangsue	13.79613	100.57430
5	Bangsue	13.79604	100.55040
6	Bangsue	13.80004	100.52120
7	Bangkrabue	13.79189	100.51600

In this research, water quality parameters i.e. temperature, pH, DO, BOD, COD, H_2S, SS, TKN, NH_3-N, NO_2-N, NO_3-N, TP, and Salinity were visualized and displayed by 5DWM system in term of single parameter and multi-parameter.

4. Results and Discussion

The parameters of water quality characteristic are in terms of physical and chemical were visualized and displayed by 5DWM system in different color as shown in figure 4. For overview of parameters that the system displayed in yellow and green color that they indicated the parameters values of each sampling site are different. The visualizing of each parameter is indicated in figure 5.

Figure 4: Overview of visualization of multi-parameter

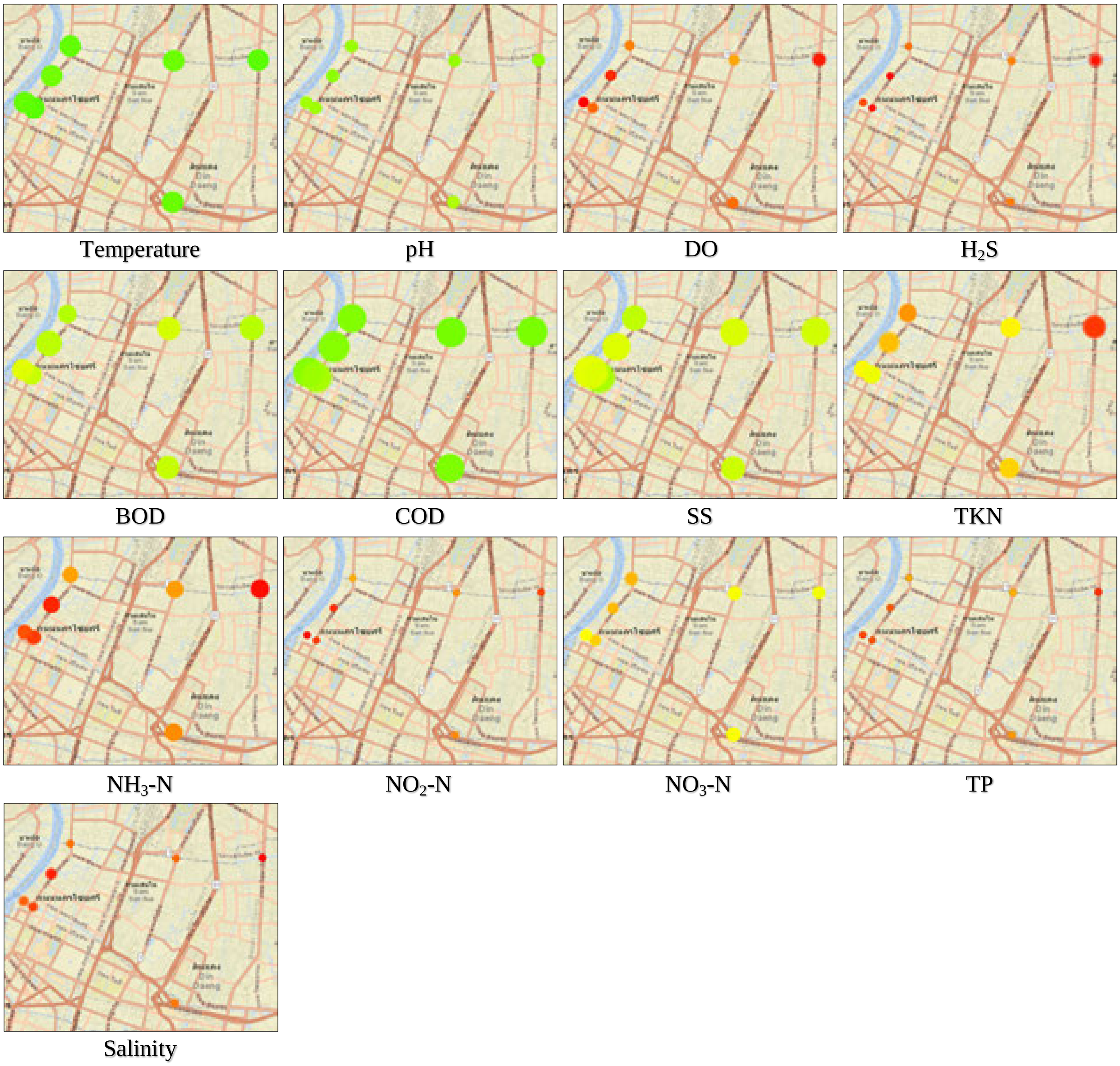


Figure 5: Single parameter visualization with 5D World Map system

From Figure 5, the temperature indicated that seven sampling points displayed in green color. Thus, 7 spots have the similar temperature values. For pH values of 7 spots were similar because the 5DWM system visualized in the same color (Green).

The DO values of 7 sampling points were different because the system displayed in orange and red. In this case, the red color means the DO values were nearly zero or zero and the orange spots mean the DO had the values of 5 to 6 mg/L. On the other hand, a big red spot means the DO was higher than another spot.

The 5DWM system visualized the H_2S in term of red and orange color. The small red spots mean the H_2S values were nearly zero or zero, the orange spots shown that the H_2S values were low, and the big red spot indicated the H_2S value was higher than another spot.

*Corresponding author (P.Chawakitchareon). Tel: +66-2-2186674 E-mail: petchporn.c@chula.ac.th.

The BOD was displayed in term of light green and yellow. In this case, the big green circles had the highest values than another circle, the yellow circles had the higher values than the small green circle, but they were less than the big green circles. For this reason, the BOD values of each sampling site were different. The COD values of each sampling point were similar because the system visualized in term of same color (Green) and the size of circles are also nearly the same.

The SS values of those sampling points were so different because the 5DWM system displayed the SS values in term of different color and size of the circles. The big yellow circle had the highest value than another circle. The small circles had the less values than another spot. For green circles were between the big and small circle.

The TKN values of the sampling points were different because the system visualized the sampling points in different color. In this case, the big red circle had the highest value than another circle and the small yellow circle had the less value than another spot. For orange circle was between the big red and small yellow circle.

The NH_3-N values of each sampling point were very different because the system displayed them in term of difference color. In this case, the big red circle had the highest value and the small red circles had the less values than another circle. For orange circles were between the big and small red circle.

The NO_2-N values of each sampling point were different because they had different color. In this case, 7 sampling sites had very less values because the circles size are very small. The red color circles had the NO_2-N values between 0 to 0.49 (mg/L as N) and the orange circles had the NO_2-N values between 0.5 to 1 (mg/L as N). The NO_3-N values of each sampling site were different because they were different color. The yellow color circles had the highest values than the orange circles. The TP values of each sampling point were very low because the circles sizes were very small. The orange circles had the highest values than the red circles.

Finally, the Salinity values of each sampling point were different because they had different circles colors and sizes. In this case, the big red circle had the highest value and the small red circle had the less value than another circle. In case of single parameter visualization, the NH_3-N is selected to display from 2007 to 2017 for finding the water quality conditions changing. The results indicated in Figure 6.

From Figure 6, the b NH_3-N changed from 2007 to 2017 that indicated in the sampling sites colors and sizes of circles because the big circles had high values and small circles have less value. The NH_3-N in 2008 was different from another year and it had less values due to the sizes of circles were small. The red circles had higher values than orange circles. From displaying of 5DWM system, the ammonia concentration is found in the canals.

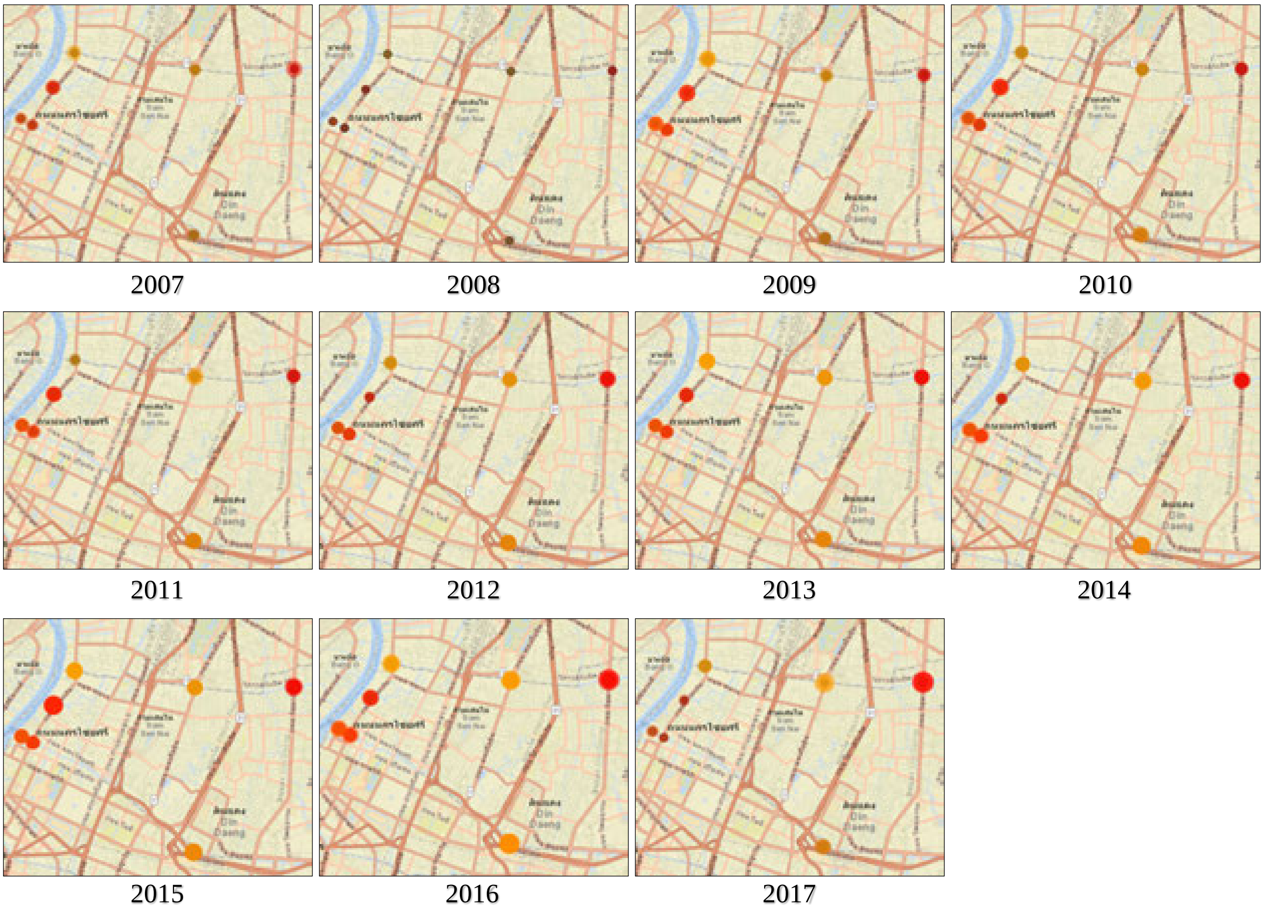
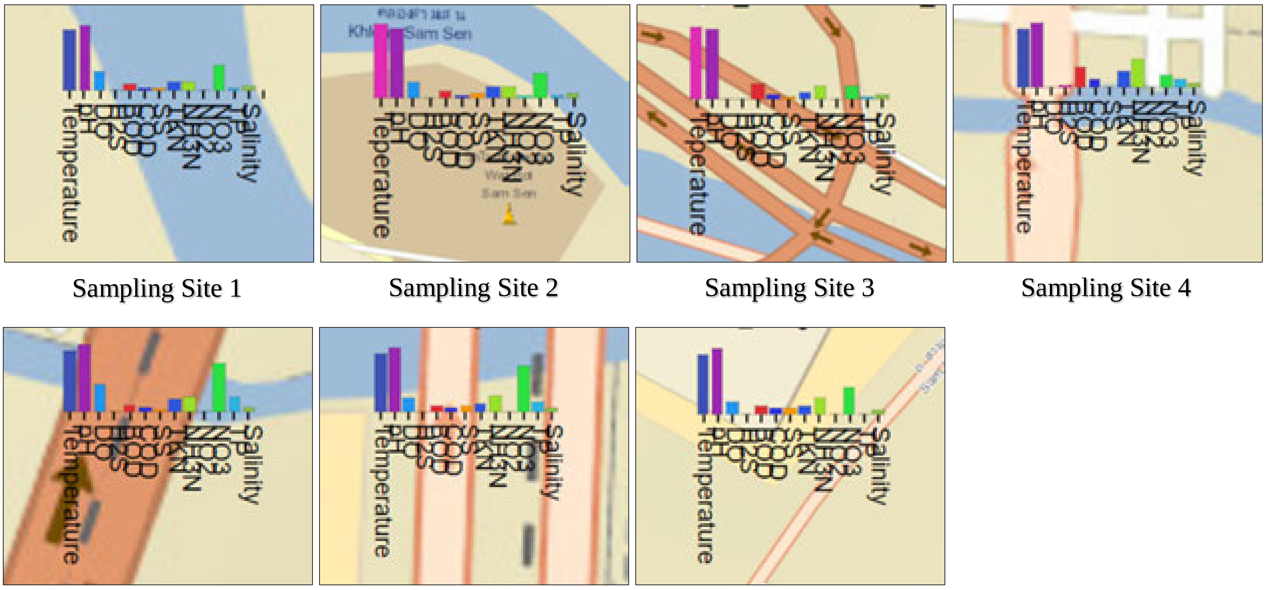


Figure 6: Visualization of NH_3-N from 2007 to 2017.

In addition, the 5DWM system can visualize the multi-parameter together and displayed in term of graphical (Sasaki and Kiyoki, 2018). The results indicated in figure 7, this figure indicated that 13 parameters were different when we looked at the graphs, but the temperature and pH values were quite similar in 7 sampling sites. The 5DWM system visualized and displayed 13 parameters in term of graphs that easier for data analysis or water quality analysis from the past to present because this system can display in the time series which made the users can analyze and compare the surface water quality of each sampling point directly. Therefore, this system is good for the visualization and interpretation of surface water quality in this research.

For clearly visualization to know the water quality changing from 2007 to 2017, the sampling site 6 is selected to display in the time series, the results indicated in Figure 8.

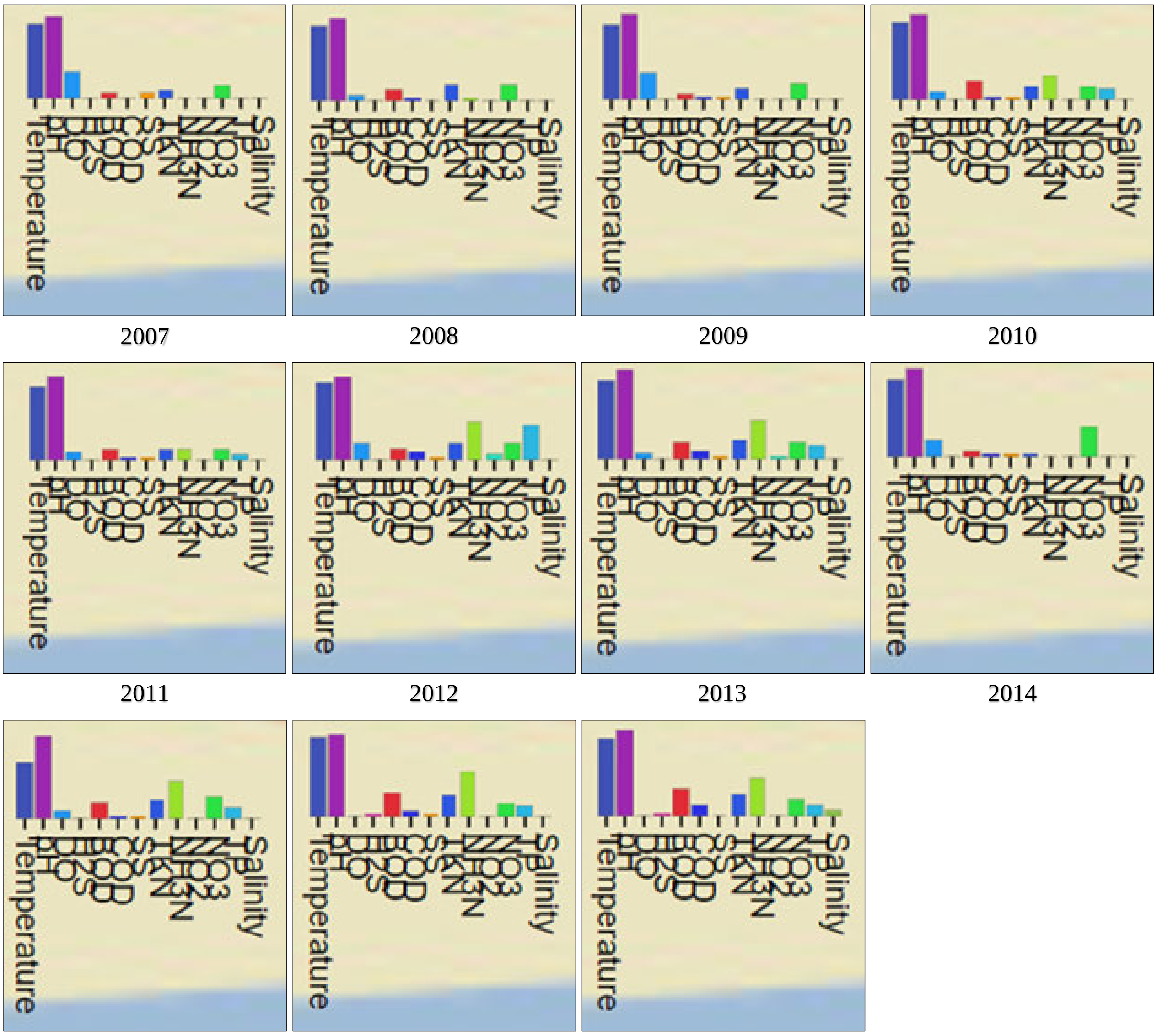
*Corresponding author (P.Chawakitchareon). Tel: +66-2-2186674 E-mail: petchporn.c@chula.ac.th.



Sampling Site 1 Sampling Site 2 Sampling Site 3 Sampling Site 4

Sampling Site 5 Sampling Site 6 Sampling Site 7

Figure 7: Multi-parameter Visualization with 5D World Map system along 7 sampling sites



2007 2008 2009 2010

2011 2012 2013 2014

2015 2016 2017

Figure 8: Multi-parameter visualization with 5D World Map system in sampling site 6.

Figure 8 indicated that temperature and pH were quite similar from 2007 to 2017. The NH_3-N concentration had higher values in 2012, 2013, 2015, 2016, and 2017. For other parameters were also changed from 2007 to 2017. Therefore, the water quality of the canals was absolutely changed from the past to present.

5. Conclusion

The 5DWM system is a good system for surface water quality analysis and monitoring because it gathered the data in the past up to present for visualizing and displaying that facilitate the users for direct analysis and explain about the water quality conditions due to this system can visualize multi-parameter of the water quality characteristic together. Moreover, this system can monitor the water quality in the real time because it has sensing. Therefore, the 5DWM system can apply to environmental analysis and monitoring. For the next step, we will educate the temporal-data mining of surface water quality for applying the world-wide rivers or canals.

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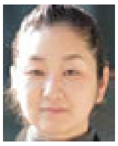
Khoumkham Ladsavong is a graduate student in Department of Environmental Engineering, Chulalongkorn University, Thailand. He earned her bachelor degree in Environmental Engineering from Laos University, Laos. His research encompassed surface water quality monitoring and visualization.

Dr.Petchporn Chawakitchareon is an Associate Professor in Department of Environmental Engineering at Chulalongkorn University. She received her B.Sc. (Med.Tech) and M.Sc.(Biochemistry) from Mahidol University. She obtained her PhD in Environmental Engineering from ENTPE-LyonI, France. Dr.Petchporn current interests involve utilization of industrial waste for environmental engineering applications and environmental data mining applications.

Professor Dr. Yasushi Kiyoki has been with Department of Environment and Information Studies at Keio University and from 1998 and he is currently a professor. Since 2011, he is a chair and coordinator of "Global Environmental System Leader Program (GESL)" in KEIO University. His research addresses semantic computing, environmental engineering, data mining, multimedia database systems, and knowledge base systems. He serves as the editor-in-chief on Information Modelling and Knowledge Bases (IOS Press). He was a keynote speaker in 7th IEEE International Conference on Semantic Computing, Sept. 2013, as the title of "A "*Kansei:* Multimedia Computing System for Environmental Analysis and Cross-Cultural Communication."



Dr. Shiori Sasaki received her M.A. degree in Law & Politics and Ph. D. degree in Media and Governance from Keio University. She is a Project Assistant Professor of Graduate School of Media and Governance, Keio University from 2004. Her research interests are in the field of Information Modelling, Knowledge Database, Multimedia Retrieval and Analysis and Information Visualization. With research experiences in the field of International Relations and Information Technology, she has engaged in several interdisciplinary research projects which propose multimedia data analysis methods for the field of humanities and social science. She is a Program Co-Chair of an annual joint-conference between Indonesian and Japanese young researchers on Knowledge Creation and Intelligent Computing (KCIC) from 2012.