

## Effect of drought on water resource: a case study of Chao Phraya river

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### **Abstract:**

*This research aims to assess the changing of physical and chemical water quality of the Chao Phraya river in drought condition from the climate change impact. The chemical and physical parameters were evaluated by using the data from fifteen water sampling sites along the river from different land uses. The highest BOD of 6.78 mg/L was found at Prapadaeng district. During the low flow period and drought, high chloride and total dissolved solids (TDS) concentrations of 2487 and 9080 mg/L, respectively were found. The relationship between chemical and physical parameters revealed that electrical conductivity (EC) can be used to evaluate TDS and chloride concentration through linear regression.*

**Keywords:** Chao Phraya river; water drought; surface water; water quality

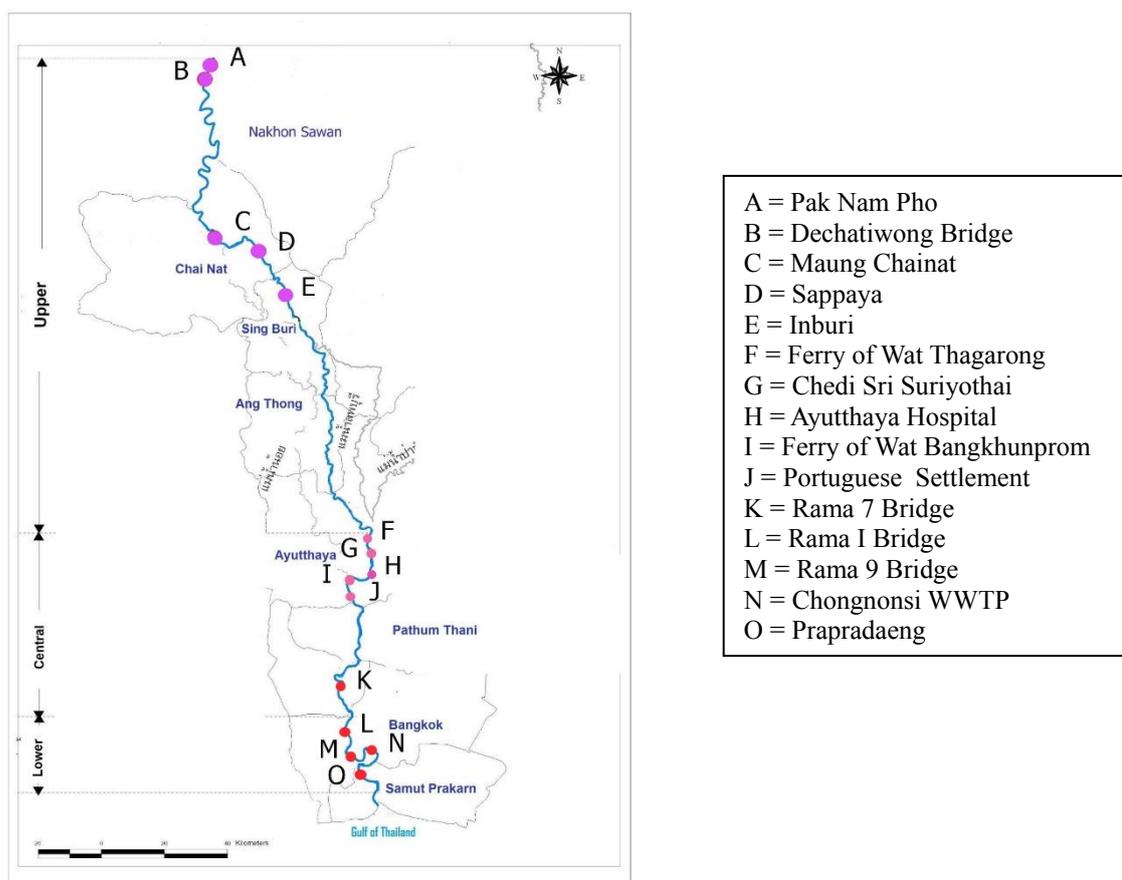
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### **1. Introduction**

The gradual climate change is occurred in many places on Earth. There is a significant increasing in frequency and extremity of meteorological and hydrological events that lead to distinct excess or lack of water in landscape. These phenomena affects both quantity and quality of water as well as impacts on aquatic organisms. Thailand has experienced an impressive growth in population, industry and agriculture (Molle, 2002), which improper management concerns the impacts of pollution on the environment. Water pollution is one of the most serious environmental problems in Thailand. The wastewater discharges emit various kinds of pollutants. These substances include household chemicals, which are surfactants, pharmaceuticals and insect repellents, agricultural chemicals, which are pesticides, and industrial chemicals, inorganics and heavy metals (Knepper et al., 1999). Due to their environmental persistence, these pollutants can cause contamination of surface water. Thailand's water pollution crisis is the disposal of domestic waste, agriculture runoff, and industrial wastewater effluents into rivers. A monitoring of biochemical oxygen demand (BOD), dissolved oxygen (DO) and total coliform bacteria (TCB) in main rivers revealed that water quality has been deteriorated (Pollution Control Department, 2012). The Chao Phraya river is an important river in Thailand. It has an area of 160,400 km<sup>2</sup> and 372 km length that passes through various different land use patterns. Water chemical and physical quality could be changed by human activities at each land use and climate conditions. These changes affect its quality and consequently its suitability for water supply production, irrigation and other beneficial uses as well. Thus, the purpose of this study is to analyze the chemical and physical parameters of water quality during drought and their correlation.

### **2. Methods**

Fifteen sampling sites on the Chao Phraya river were selected as shown in Fig. 1 and Table 1. Water samples from each sites were integrated from the grab samples of the river using a vertically water sampling. Then, it was analyzed for Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total dissolved solids (TDS), Electric Conductivity (EC), and chloride using the standard method for water and wastewater examination (APHA, 2005).



**Fig. 1** Sampling locations in the Chao Phraya river.

**Table 1** Sampling location in different land uses along the Chao Phraya river

<b>Residential &amp; commercial area (RA)</b>	<b>Agricultural area (AA)</b>
A: Nakhon sawan @ Pak Nam Pho	C: Chainat @ Maung
B: Nakhon sawan @ Dechatiwong Bridge	D: Chainat @ Sappaya
F: Ayutthaya @Ferry of Wat Thagarong	E: Singburi @ Inburi
G: Ayutthaya @ Chedi Sri Suriyothai	
H: Ayutthaya @ Hospital	
I: Ayutthaya @ Ferry of Wat Bangkhunprom	
J: Ayutthaya @Portuguese Settlement	
<b>Urban area (UA)</b>	<b>Industrial area (IA)</b>
K: Bangkok/Nonthaburi @ Rama 7 Bridge	O: Samut Prakarn @ Prapradaeng
L: Bangkok @ Rama I Bridge	
M: Bangkok @ Rama 9 Bridge	
N: Bangkok @ Chongnonsi WWTP	

### 3. Results and discussion

In 2014, the summer season of Thailand appears on February through May. However, in some areas, high pressure from China has extended to collision with hot air mass over Thailand. This causes thunderstorms that changes the climate and influences the water drought. The dryness of river led to the high EC, dissolved solids, and chloride ion in urban area, which refers to saltwater intrusion

from the gulf of Thailand (see Fig. 2). High TDS and EC affect the water supply production and water irrigation in the lower part of the river. The highest chloride and TDS concentrations of 2487 and 9080 mg/L were found near the gulf of Thailand because low flow of river and drought condition. Chloride concentrations in excess of about 250 mg/L can give rise to detectable taste in water. Biochemical Oxygen Demand (BOD) is one of the most important and useful parameter which indices the organic strength of a wastewater. BOD measurement permits an estimation of the waste strength in terms of the amount of dissolved oxygen required to break down the wastewater. It was used to measure the ability of self-purification of water resource, to check the quality of water and to design of wastewater treatment. From this study, COD and BOD tend to increase from upper to lower part of the river. The BOD/COD ratio is low in the agricultural and industrial areas. The low BOD/COD ratio implies that river was contaminated with chemical substances. The ratio less than 0.10 reveals the presence of large portion of hard-biodegradable COD (Samudro and Mangkoedihardjo, 2010).

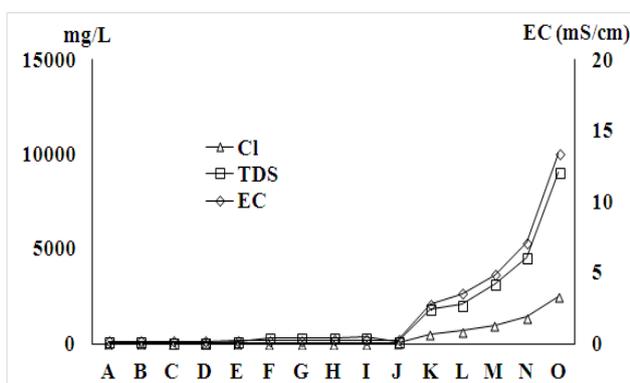


Fig. 2 Concentrations of TDS, Cl and EC ratio.

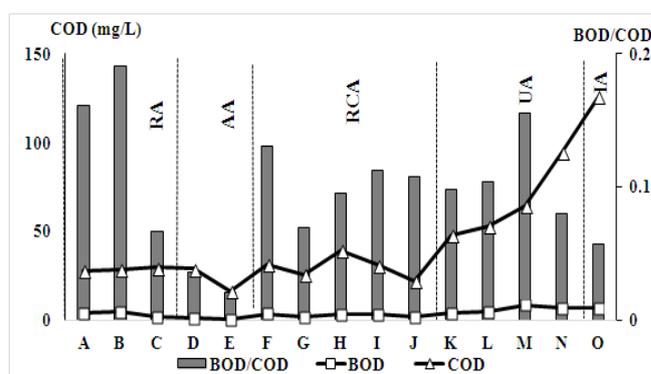


Fig. 3 Concentrations of COD, BOD and BOD/COD.

Fig. 4 shows the relation among physical and chemical parameters of the Chao Phraya river. It is found that chloride concentration and TDS have a linear relation to EC. Thus, measuring EC can predict the chloride and TDS concentrations by  $TDS = 663.37EC + 18.054$  ( $R^2 = 0.9970$ ) and  $Cl = 191.61EC - 6.7588$  ( $R^2 = 0.9977$ ), respectively. BOD and COD has weak linear relation which the correlation coefficient ( $R^2$ ) of 0.5451, whereas it shows better  $R^2$  of 0.7193 for polynomial function (see Fig.5). Table 2 shows the investigation of each function for different land uses. It was found that COD gave better correlation with BOD in agricultural area than RA and UA.

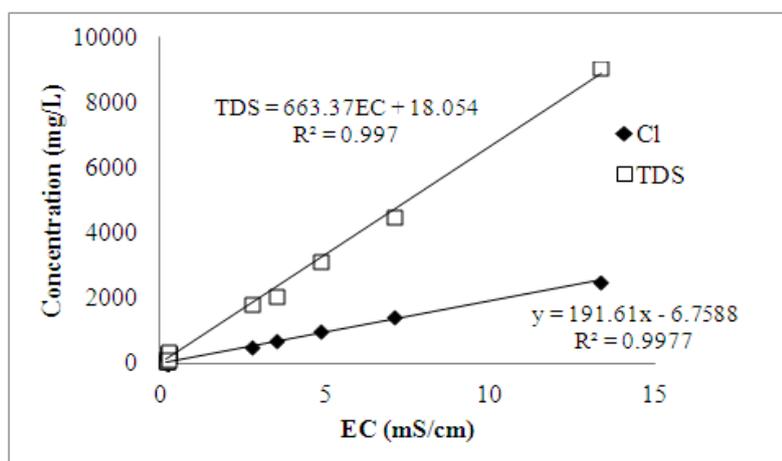
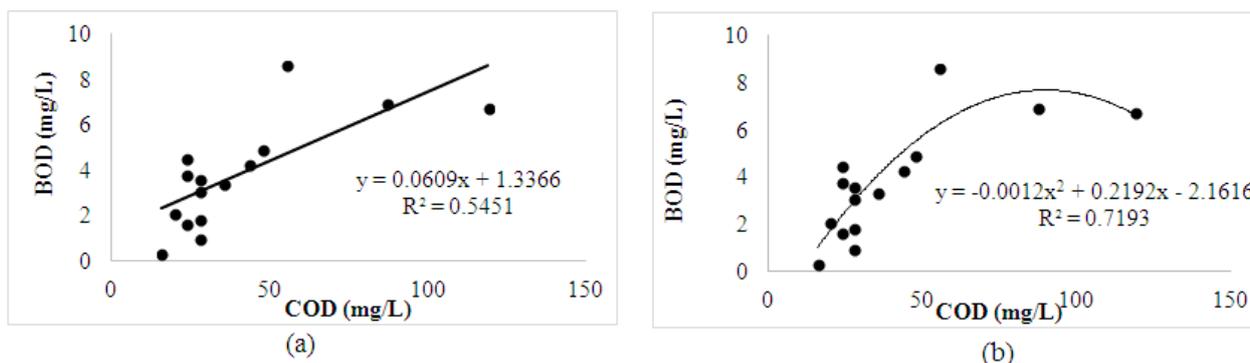


Fig. 4 Linear relation between EC-TDS and EC-chloride.



**Fig. 5** Relation between EC-TDS and EC-chloride (a) Linear (b) Polynomial.

**Table 2** The concentration of BOD/COD ratio by land use.

Land use	Linear		Polynomial	
	Equation	R <sup>2</sup>	Equation	R <sup>2</sup>
RA	BOD = 1.3963COD + 2.628	0.0757	BOD = -3.0331COD <sup>2</sup> + 19.686COD - 3.289	0.3493
AA	BOD = 7.5193COD + 15.886	0.6852	BOD = -11.948COD <sup>2</sup> + 33.801COD + 6.017	1.0000
UA	BOD = 4.7978COD + 28.767	0.2278	BOD = -7.2109COD <sup>2</sup> + 97.801COD - 249.69	0.8484

#### 4. Conclusion

The physical and chemical quality of Chao Phraya river in drought period is implicate with human activities and seasonal change. EC has a very good correlation of TDS and Chloride by using linear function. The BOD shows good correlation with COD when polynomial function was used. High correlation between BOD and COD was found in agricultural area.

#### 5. Acknowledgement

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