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Determination of recreational lake water quality status boundary: a case study of E.coli in Taiping Lake Garden, Perak, Malaysia

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ABSTRACT

This paper intend to discuss the development of water quality area especially E.Coli in order for a visitors would have to divert the dangerous area. The water status area delineation is vital for a recreational operator and visitor to plan their water activities. The study area chosen is Taiping Lake Garden which comprises of several lakes and attractive enough to lure the visitors everyday especially during public and school holidays. Two type of data been used namely primer and secondary data. Primer data are collected by taking samples from every single lake involved. The secondary data involved is mainly the border of the lake. Samples are being analysis in the lab to count for the existing of the E.Coli bacteria namely bacilliform. Then, the value was used in geographical information system with the spatial interpolation to create a border for high bacteria detected area and less risk area. Result showed that 14 stations have been detected with the bacilliform bacteria with 10 of that are high in bacilliform bacteria concentration. Approximately one quarter of the area not suitable for recreational activities this involves water direct contact.

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INTRODUCTION

Bacilliform bacteria in rod form live in warm blooded human and animal ingestion channel. The bacteria existence in water environment also involve in faeces pollution. There is maximum level of coliform number existence in the water body to conclude either the water is suitable to drink or direct contact with human such as bathing. The high existence of coliform bacteria in the water often leading to various diseases such as typhoid fever, cholera and diarrhoea. Chris (2004) also pointed out the effect of coliform bacteria mainly from the pig waste who gave various stomach problems. According to Malaysia Department of Environment (DOE) (1995), faeces coliform also can be used as a vital indicator to detect untreated pollution from human or animals waste. The standard level set by DOE and Ministry of Health (MOH) for the number of E.Coli existence in the water body is not more than 5000 most probable number (MPN)/100 ml water for recreational usage.

Study Area:

Taiping Lake Garden (TLG) is situated between 4°51'18.99" north and 100°44'52.09" east (Fig. 1) and among the earliest public garden in Malaysia from the year of 1880's. The building of lake main purpose is to enable community reach a recreational facility especially in urban area (Nor Azian, 2008). The existence of TLG also co-existed with the development of Taiping City which situated in Mukim Tupai, District of Larut Matang and Selama, Perak. The early history of TLG begin in 1884 and been inaugurated on November 17, 1893 by Sir Frank Swettenham as a Perak British Resident. The TLG been built from the mining remained by *kongsi (*group) leaded by Kapitan Chung Keng Kwee as a leader of Hai San Group. According to Low'c Mining Lease, 1887 the mining area will be leased for 21 years with the royalty paid for $2.00. The lessee will have to return the area to the State Government if the areas are not been cultivated for 12 consecutive months (Norasikin *et al*. 2013).

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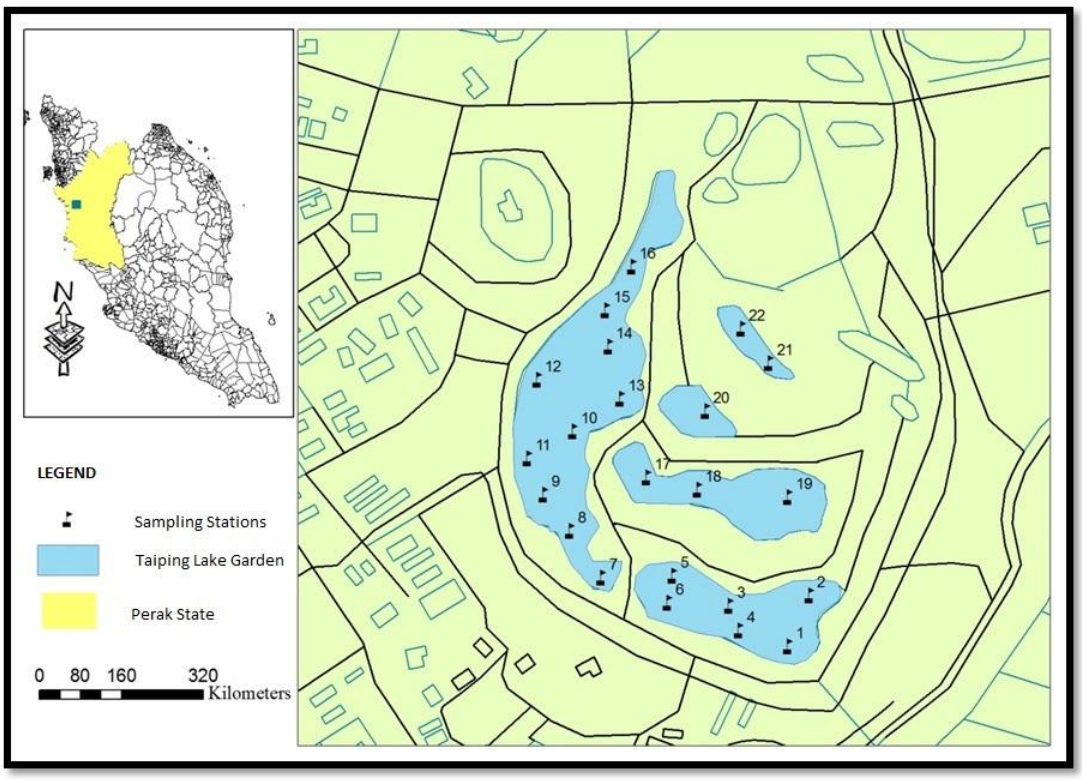

Fig. 1: Study area

MATERIALS AND METHODS

Data:

There're two type of data's been used in this research namely primer and secondary. Primer data are being collected from the field work and preliminary survey. The primer data identified in this research is water quality data taken from the water sampling process. The attributes in the water quality data includes reference location done by using global positioning system device (GPS). Water sampling lab analysis taken from the lake for 22 observation location or stations situated in 4 different lakes namely Lake A, B, C and D (Table 1, Fig. 1). The water sampling also being used for other water quality analysis such as heavy metal substance. The secondary data identified been used are boundary such as lake boundary, mukim, districts and state. There are also information being taken from various sources such as National Archive, library, online, books and journals.

Data Analysis:

Sampling water in the bottles is taken to the lab for analysis. Colilert powder (Fig. 2) being used by mixing it in the 100 ml sample water before it being reside in the incubator for at least 24 hours in the temperature of 35^{o}C. Long wave ultra violet lamp (UV) (365 nm) being used to detect the existence of coliform. If water sample is yellow under the UV, it can be classified as positive. Next if the sample is positive the presence/absence (P/A) test should be conducted to get the reading of index quanti-tray/2000 MPN-Tabelle. After another 24 hours of incubator the value been recorded such as in Table 1.

Geographical Information System As An Analysis Tools:

According to Carter and Bonham (1994), geographical information system (GIS) is computer approached to manage a spatial data. According to Ruslan and Noresah (1998), GIS widely use in geography discipline to study the location and phenomenon occur in the location and its surrounding area. Normally the location defined in GIS is a coordinate location with a specific spatial reference. Even ESRI (2013) also states the GIS as one of the method for world data storage in different layering styles accordance to a geography perspective. Data been stored in different layers such as housing estates and road network by using the same coordinates system such as Rectified Skewed Orthographic (RSO) and Cassini. According to Nasir (2010), data can be present into different forms such as table, maps, figure etc. and be reusable either in other soft wares or printed.

Fig. 2: Tools for lab analysis

Interpolate:

Once the data being analysis and combined in the formal type of table (Table 1). It being merges into attribute in ArcGIS with sampling station as a referenced in longitude and latitude. Furthermore, spatial analyst in ArcGIS been used to interpolate the whole lakes. Interpolate is one of the tools do determine other location based on the regression technique widely use in GIS. Hence, the area been created from the output of the interpolation. Interpolate known as one of the spatial analysis in GIS and widely used as a terminology prompting the spatial kind of analysis. Normally it will involve the manipulation of vector and raster data and also other attributes spatial data's. Usually it will involve kriging and contouring analysis. Kriging interpolation is one of the methods widely used in GIS to predict a location value which situated in between two or more observation locations which had a value. Figure 3 showed the example of a location getting the value based on the real values from the other locations. Value of location Q is from the prediction of the actual values from P1…P7.

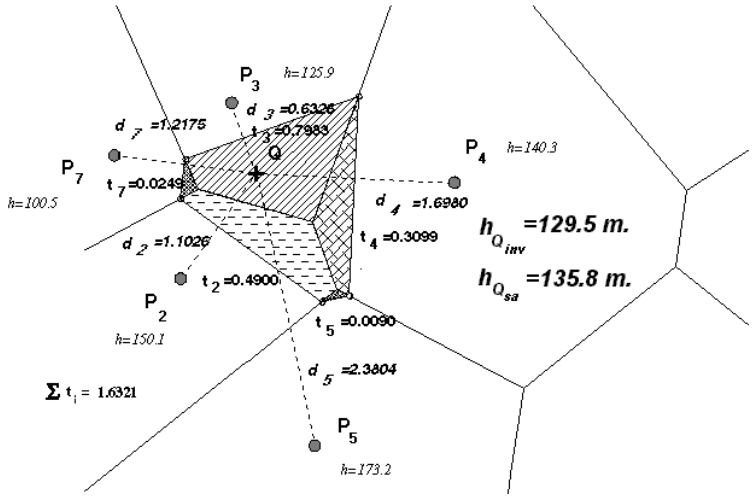

Fig. 3: Natural neighbour interpolation
Source: Sarkozy (2000)

A new value is based on the calculation from the below formula.

$$\gamma(h) = \frac{1}{2n(h)} \sum_{i=1}^{n(h)} [F(\mathbf{x}_i) - F(\mathbf{x}_i + \mathbf{h})]^2 \quad (1)$$

Source: Sarkozy (2000)

RESULTS AND DISCUSSION

There are three (3) type of recreational found directly intact with water pond in TGC namely twin paddle boating (Fig. 4), boating (Fig. 5), swan boat paddle (Fig. 6) and globe trolling (Fig. 7). Normally these activities will have minor interaction between people and water with only feet will directly intact with water. But in some circumstances there are some incident where people accidently fall into the pond or many cases where some people washing hands and face from the pond. The delineation of water quality reside in the pond will help the business owner to determine the high risk area and block the visitor from going to the high prone areas. This result also will enable visitor to plan the trip. Lastly, Taiping Municipal City (TMC) also will have the information on the water status quality and planning the necessary action to curb from untoward accident happens.

Fig. 4: Twin Paddle Boat

Fig. 5: Boat

Fig. 6: Swan Paddle Boat For 4

Fig. 7: Globe trolling

Table 1 has showed the value of E.Coli from the lab analysis by stations for every pond in TLG. Bacilliform bacteria in the rod form lived in the warm blooded intestine channel either in human or animals. The existing in the water will directly indicate the faeces pollution. There is limitation on the bacilliform bacteria existing to determine the suitability of the water for consumption or bathing. The high bacteria existing normally leading to various diseases sources such as high fever, cholera, diarrhoea and many others. According to Department of Environment (DOE) (1995), faeces coliform is vital indicator to detect pollution from human and

animal waste especially untreated waste. One of the main sources of stomach diseases especially in tropical country is from E.Coli bacteria. According to WHO (1996), E.Coli bacteria normally are found in one of the group bacteria from human and animal waste especially pig farming. Normally this group of bacteria inhabitant in the warm blooded intestine. Furthermore, water bacteriology inspection will need to conduct to ascertain the water quality safe for human uses (Ishii & Sadowsky, 2008). In Malaysia, DOE and Ministry of Health (MOH) has a guideline for water consumption in the case of E.Coli is 5000 MPN/100 ml water.

Based on table 1 there are eight stations with 1, 4, 5, 8, 11, 12, 13 and 16 that have been identified have no coliform. The other stations have been detected with the existing of the bacteria and even higher from the standard in Malaysia which is 2,419.2 Idexx Quanti-Tray/2000 MPN. Among the highest stations with bacilliform bacteria are station 2, 3, 6, 7, 14, 15, 18, 21 and 21 (Table 1). While for station 10 detected with only 66.7 Idexx Quanti-Tray/2000 MPN. Overall output has showed that TLG has been infected by a very serious bacteria coliform pollution and it need to be monitor due to seriousness of the illness to the visitor. Therefore, the TMC must control the septic system sewage and animal excreta that are not channelled into the lake, especially the Pond B as cola mini offers recreational water sports activities. If the TMC failed to do so this will make things worse in the Taiping lake gardens, water sports activities because of the increasing number of E.Coli in the water can be harmful to human health.

Next, the interpolation method is used to plot the product of the water quality parameters based on data E.Coli dissolved in water for the whole station. Interpolation mapping is used to predict the value of the cells in the raster of a limited number of sample points. It can also be used to predict the values of the unknown to any geographical point data such as elevation, rainfall, chemical concentrations, noise levels, etc. (Nicholas, 1997). Based on the findings of Figure 8 shows the concentration of E.Coli obtained only two prognostic classifications only. Interpolation analysis showed that only 16 stations alone is predicted to experience low E.Coli content and the assumption by using interpolation is a perfect choice because it is easy to know the tendencies of other sample points to be included in this class group. A prediction made can be stated with a high degree of confidence that at Station 16 this certainly has the E.Coli concentration is low because most stations receive from external environmental influences such as the entry of water drainage in the catchment pond nearby and close to -use changes around the lake.

Table 1: Total Coliform bacteria by station (Idexx Quanti-Tray/2000 MPN)

Station	Pond	Longitude	Latitude		Small	Big	Total (Codecalculation)
1	A	4.848780	100.750385		-	-	-
2	A	4.849261	100.750400		48	49	> 2419.2
3	A	4.849304	100.749671		48	49	> 2419.2
4	A	4.848994	100.749446		-	-	-
5	A	4.849545	100.748861		-	-	-
6	A	4.849272	100.748599		48	49	> 2419.2
7	B	4.849705	100.747713		48	49	> 2419.2
8	B	4.850261	100.747369		-	-	-
9	B	4.850844	100.746913		46	49	1986.28
10	B	4.851565	100.747188		47	10	66.7
11	B	4.851875	100.746630		-	-	-
12	B	4.852768	100.746866		-	-	-
13	B	4.852714	100.747719		-	-	-
14	B	4.853228	100.747949		48	49	> 2419.2
15	B	4.853698	100.747815		48	48	> 2419.2
16	B	4.854366	100.748169		-	-	-
17	C	4.851204	100.748241		38	49	980.4
18	C	4.851020	100.748995		48	49	> 2419.2
19	C	4.850921	100.750344		24	38	125
20	D	4.852201	100.749108		43	49	1413.6
21	D	4.852998	100.750186		48	49	> 2419.2
22	D	4.853420	100.749822		48	49	> 2419.2

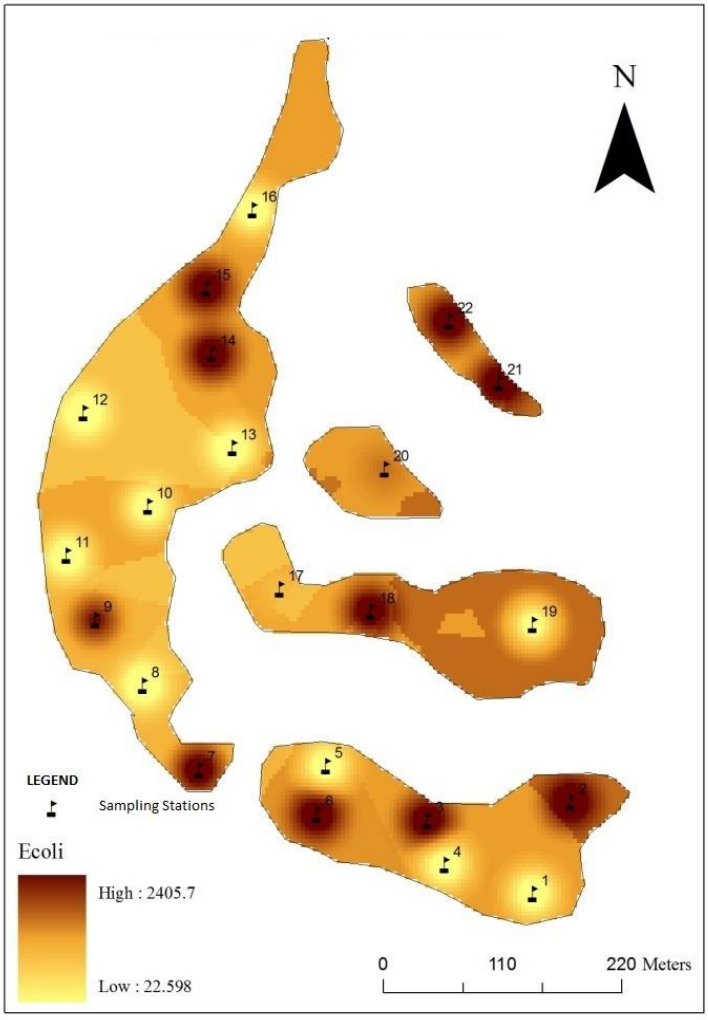

Fig. 8: E.coli concentration

Conclusion:

TLG is one of the major attraction in the Perak State where people can be seeing flooded the area during weekends or public holidays. Young people and families are the main visitors found in TLG. Besides visiting Taiping Zoo's, most of the visitor will try the water lake recreational activities. By knowing the E.Coli concentration level in TLG ponds, it will help several parties to avoid any untoward incidents such fatality or diseases due to E.Coli contaminated. The authority might do something in term of planning by doing some preventive measurement. The sport operators also will have the knowledge of dangerous area and the might need to prevent a visitor from going there by placing some or cordoned the area. Lastly, this also will maintain the confident and help the visitors to do recreational activities even better.

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