**ABSTRACT**

**SPATIAL AND TEMPORAL SEA SURFACE TEMPERATURE VARIATIONS NEAR COAL-FIRED THERMAL POWE PLANTS: REQUIREMENT FOR MEETING WATER QUALITY REGULATIONS FOR THERMAL DISCHARGES**



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Thermal discharges from coal-fired thermal power plants located in coastal areas are known to cause thermal pollution to the adjacent marine environments. Monitoring of the SST at the vicinities of coal-fired thermal power plants to see to it that the temperatures are still within the environmental regulatory limit for thermal discharges is one of the strategies being adopted to mitigate its adverse effect to the marine environment. Spatial and temporal SST variabilities at the vicinities of Masinloc Coal- Fired Thermal Power Plant (MCFTPP) in Masinloc, Zambales and that of the Quezon Power Limited, Co. (QPL) in Mauban, Quezon have been determined using time domain empirical orthogonal functions (EOF). EOF analyses of two MCFTPP SST data sets and one QPL SST data set yield three dominant EOF modes each. MCFTPP data set 1 yield 66%, 18% and 7% of the total variance for Mode 1, Mode 2 and Mode 3, respectively while MCFTPP data set 2 yield 70%, 22% and 8% of the total variance for Mode 1, Mode 2 and Mode 3, respectively. The lone QPL data set yield 85%, 10% and 5% of the total variance for Mode 1, Mode 2 and Mode 3, respectively. Modes 1, 2 and 3 are explained largely by the tidal height variations, power plant load variations and air temperature variations, respectively. The SSTs near MCFTPP and QPL are uniformly affected by the tidal changes whether or not the locations of the SSTs are near the outfall/discharge outlet. For MCFTPP, the SSTs near the outfall/discharge are more affected by the power plant loads compared with the SSTs located far from the outfall. The SSTs at the stations near the outfall/discharge outlet are not affected by air temperature changes anymore due to the stronger influence of the power plant load changes over the air temperature changes, the stations far from the outfall/discharge outlet are still affected by the diurnal changes. The results of Delft3D-FLOW (a commercially available hydrodynamic model) temperature and surface current velocity runs were compared with the results of actual horizontal and vertical temperature and surface current velocity measurements for MCFTPP and QPL in 2004 and 2005 using CTD, ADCP and drogue. The comparisons gave good results. The closeness of the actual horizontal and vertical temperature and surface current velocity values from the Delft3D-FLOW values are evident in the horizontal and vertical temperature and surface current velocity comparison graphs and figures. Scatter plots of the actual temperature and surface current velocities and the Delft3D-FLOW results gave corresponding high correlation coefficient values. RMSE between observed and modeled temperature and surface current velocity values are minimal. The FLOW module of Delft3D accurately predicted the general patterns of the thermal dispersion process but did not fully reproduce all detailed temporal and spatial patterns. This level of predictive capability of Delft3D-FLOW is already enough for this mathematical model to be utilized in the design of thermal discharge outfall/outlet in the feasibility study stage of thermal power projects, to determine the mixing zone and to develop SST sampling program for SST monitoring in the EIA stage of the power plant projects. To determine the optimal number of sampling stations and frequency in monitoring thermal discharges from coal-fired thermal power plants, the optimum interpolation with spatial correlation function method of spatial analysis and its error analysis and the first order autoregressive process model AR(1) were applied to MCFTPP and QPL. The areas affected by the

3°C, 2°C and 1°C rise in temperature were delineated in the results of the June 2005 MCFTPP CTD thermal mapping during low, high and slack tides. Two, three, four and five-station sets were positioned along the 3°C, 2°C and 1°C isotherms either at the low, high or slack tides cases. The resulting RMSE along the area affected by the temperature rise between 3°C to 2°C rise should be <= 1 during all tide conditions. Five stations positioned primarily along the 3°C, 2°C and 1°C isotherms during flood tide gave an RMSE of <=1 to area affected by the 3°C and 2°C temperature rise which is still the same (RMSE <=1) if superimposed to the low and slack tide situations. Based on this result, a general methodology in determining the minimum number of sampling stations and frequencies for SST monitoring near coalfired thermal power plants to ensure compliance with the environmental regulatory requirement on the allowable rise in temperature from the ambient was recommended. The first order autoregressive process model AR(1) was applied to the primary 1-year, 10-minute interval SST data at MCFTPP and the secondary 1-year, 30-minute interval SST data at QPL which were both aggregated to 1,2 and 3-day averages. The 3-day aggregated MCFTPP data from March 3, 2005 to March 3, 2006 gave a correlation of 0.81. Instead of sampling every end of 3 day or 121 samples a year for a 3-day aggregated data, one only needs about 47.47 samples per year, that is sampling every end of 7.69th day (47.47 x 7.69 = 365) for a 3-day aggregate. Temperature shall be measured starting the 5.69th day up to the 7.69th day to have a 3-day aggregated temperature data. The 3-day aggregated QPL data from September 4, 2004 to September 4, 2005 gave a correlation of 0.98. Instead of sampling every end of 3 day or 121 samples a year for a 3-day aggregated data, one only needs about 54.57 samples per year, that is sampling every end of 6.69th day (54.57 x 6.69 = 365) for a 3-day aggregate. Temperature shall be measured starting the 4.69th day up to the 6.69th day to have 3-day aggregated temperature data.