CHAPTER 1

INTRODUCTION AND OBJECTIVES

1.1 BACKGROUND AND PROBLEM STATEMENT

Problems of poor water quality in the Pong River were recorded as far back as 1987 (KKU, 1987), and the first major fish-kill event that was reported was in 1993 (CMS, 1995). Fish kills could have been caused by either low DO, high ammonia, high nitrite, toxic metals, pesticides and diseases. Due to lack of understanding of mechanism in this river, the cause of fish kills have yet to be identified.

In 1995, the river water in the area between the Chot lagoon and Pong River turned brownish in color and strong odor could be smelled. DO in this area was reported to be 0.1 mg/L. The diversity of aquatic fauna had reduced from 16 to 8 species. Approximately 3,800 grams of aquatic fauna, particularly fish less than one kilogram, had been estimated to die in this fish-kill incident (CMS, 1995). The mill reportedly spilled untreated wastewater into the Chot Creek, which connected to the Chot lagoon.

Net-pen freshwater aquaculture of Nile tilapia, *Oreochromis niloticus*, as shown in Appendix A, started in the Pong River in 1997, and it immediately experienced the fish kill. Over 500,000 fish in aquaculture died in 1997 (Inmuong, 1998). The pulp and paper mill near the river had long been suspected for causing the water pollution since it released its effluent to the creek which ended up in the Chot lagoon. In the highly publicized case of the 1997 fish-kill incident, the mill was held responsible, and paid a compensation of 2.95 million baths to aquaculturalists (Inmuong, 1998).

In 1998, the mill completely stopped releasing its effluent to the Chot lagoon, and diverted the effluent to irrigate its Eucalyptus plantation. The fish kill, however, did not stop. In 1999, a major fish kill occurred again with less severity than in 1997, perhaps because aquaculturalists transferred their fish from the net pens to the nursery ponds in time. This time the mill was not held liable for the fish deaths because it did not release any effluent to the Chot lagoon.

After 1999, the fish kill had continued in the river, but to a lesser degree. Appendix A show pictures of fish deaths at the KP/BN aquaculture on July 7th, 2002. Basketfuls of dead fish (50-70 kg) had been collected at this site for four to five days. Upon visual examination, rashes around the mouth and tail, with popped-out or cloudy eyes were seen in dead fish (Appendix A).

The discharge of untreated effluent in the Chot lagoon was suspected to be the cause of the fish kills. Therefore, the original Chot lagoon was modified by paving a road in the middle to separate the lake into two parts. The inner part of the Chot lagoon was initially isolated, dredged and converted into a fish-raising pond. Creek Chot which used to be connected to the inner part of the Chot lagoon was redirected to the outer part of the Chot lagoon. The fish in the fish pond still died in the summer, even though the pond was completely isolated and dredged. Fish farmers had to re-connect the inner and outer parts of the Chot lagoon together by laying underground pipes to allow the fish to swim to the outer part of the Chot lagoon. Dead fish in the inner pond were reported to show the same characteristics as those described earlier. Fish with no scales such as eels, reportedly, showed skin lesions (Yostintia, 2002).

Many researchers and government agencies including the Environmental Center Region 6, Department of Industries, Pollution Control Department, and Khon Kaen University

have been vigorously studying this river, but the cause of the fish kill could not be identified. All studies agreed that there was one common water-quality deficiency in all fish kill events. It was low DO. But no one could tell what caused low DO, as there was no water-quality monitoring data a few days before the fish kill.

Without knowing the cause, the remediation steps to prevent fish kills could not be planned. Meanwhile, as the last resort, aquaculturalists reduced the severity of fish kills, by adding potassium permanganate to the water or mixing antibiotics to the fish feed (Yostintia, 2002). Chemotherapeutics have added unnecessary costs to the aquaculture business. Moreover, the continual use of chemotherapeutics has prevented Thailand from creating value-added fish products for consumers in the premium-priced market, who were willing to pay premium prices for the least contaminated fish product.

In recent years, the application of mathematical modeling techniques has played an important role in water quality management and planning (Beck, 1985; Dillaha, 1998; Henderson-Sellers, 1991; Jamal, 1986; Orlob, 1992; Tim and Jolly, 1994). This study thus employed computer modeling, in addition to direct chemical analysis, to study the cause-effect relationship of fish kills.

1.2 RESEARCH OBJECTIVES

The main purpose of this study was to determine the cause of fish kills in the Pong River. Toxic and conventional water quality parameters would be studied by direct measurement and computer modeling, when applicable, to determine the cause-effect relationship for the fish kills. For the direct measurement, various methods of chemical

analysis, GC/MS, and algal enumeration were employed. For the modeling, the following tasks were performed:

1) collect hydrological and hydraulic information for the study area;
2) collect and do chemical analysis of the water quality parameters in the runoff;
3) develop a reliable method to estimate the unavailable runoff data for each segment of the river;
4) Calibrate the temporal and spatial accuracy of the transport model using lignin/tannin;
5) use WASP to construct a dynamic model, not a typical steady-state model, in order to study the fish kill; and finally
6) do simulation to re-create the past conditions which led to the fish kill in 1999. Technique of sensitivity and scenario analysis were employed for this purpose.