CHAPTER 5
DISCUSSIONS

5.1 Phytoplankton diversity

The largest number of phytoplankton species found from all study sites was Chlorophyta followed by Cyanophyta which related to the finding that Division Chlorophyta was the most species rich group (Peerapornpisal, 1996) and agreed with the study of phytoplankton diversity in the Banglang Reservoir, Yala Province in southern Thailand which found the greatest number of species were in Division Chlorophyta (50%) followed by Cyanophyta (21%) (Ariyadej, 2004). The most frequently abundant groups were also Cyanophyta and Chlorophyta which were found in all sampling sites. This related to the study of phytoplankton seasonality and limnology of reservoirs in the Huai Hong Khrai Royal Development Study Centre, Chaing Mai, Thailand which found some seasonal variation in species composition of phytoplankton in shallow reservoirs and found Cyanophyta was the dominant species (80%) followed by Chlorophyta (Peerapornpisal, 1996).

The lowest diversity of phytoplankton was found in very poor quality of water as the hyper-eutrophic level at the fish pond whilst the highest diversity of phytoplankton was found in clean-moderate quality of water as the oligo-mesotrophic level at the reservoir of Mae Kuang Udomtara Dam. The lowest diversity of phytoplankton was found at the fish pond which was always predominated by Cyanophyta, *Microcystis aeruginosa* as the green surface scum covering almost all of the surface water. There were only 2 Divisions with 2 species, *Microcystis aeruginosa* and *Monoraphidium arcuatum* that were found at the beginning of the cool dry season. The highest diversity of phytoplankton was found at the open water of Houy Yuak Reservoir, particularly in the summer, accounting for 27 species in 6 divisions and at the reservoir of Mae Kuang Udomtara Dam particularly in the summer accounting for 25 species in 5-6 Divisions and most of them were Division Chlorophyta and Divisioin Cyanophyta. The growth among different species in the multi-species algal community is likely to be limited by the resources, including different nutrients present (Wetzel, 2001).

This study found only one *Microcystis* species, *Microcystis aeruginasa* which was found in all sampling sites and regularly showed the high amount in the fish pond and Sakon Nakhon sewage oxidation pond in every season, but at the open water and the small pond of Houy Yuak Resevoir and the reservoir of Mae Kuang Udomtara dam, this species was found in high amounts in the rainy season. The first report of blooming *Microcystis aeruginosa* in Thailand was published in 1998 (Mahakhant, 1998). *Microcystis aeruginosa* also was found as the dominant species in a number of Thai water resources for water supply and fisheries having blooms in different seasons in particular Thai northern reservoirs (Peerapornpisal, 2002; Pekkoh, 2003; Prommana, 2003). Toxic potential of wastewater treatment plant water was likely presented in this study which found that cyanobacteria, *Spirulina pl*atensis and *Microcystis aeruginosa* were simultaneously blooming in a sewage oxidation pond. This was associated with the frequency of the dominance of cyanobacteria, such as *Planktothrix mougeotii*, *Microcystis aeruginosa* and *Pseudanabaena mucicola* with toxicity in a wastewater treatment plant in Portugal (Vasconcelos and Pereira, 2001). The abundance of some cyanobacterial species related to zooplankton groups affected by the unsuitability of the cyanobacteria as a food source, because of nutritional inadequacy, or through disruption of filter feeding or because of its toxicity (Hawkins and Griffiths, 1994).

5.2 Environmental factors

The driving force and mechanisms of seasonal changes are related to variations in the physical, chemical and biotic environment, e.g. changes in solar irradiance and nutrient levels (Harris,1986). This research found that many physico-chemical parameters did not directly vary with a seasonal change so the physico-chemical quality of water among different seasons year round was not much different at each study site. The depth of water resource and the water volume did directly vary by the seasonal change. The highest water volume was found in the rainy season and the lowest water volume was found in the summer in all study sites apart from Sakon Nakhon sewage oxidation pond which was not effected by the seasonal change but may directly depend on the rate of draining wastewater from the community running into the oxidation pond. It was found that the large reservoir, the reservoir of Mae Kuang Udomtara Dam, presented a poor quality of water and a poor trophic level occurring at the same period with the highest water volume in the reservoir. In the temperate countries, the large proportion of lakes are rather deep thus the vertical temperature varies distinctly. Furthermore, the climatic factors in each season especially the light intensity and temperature clearly differ, therefore the stratification of the physico-chemical characteristics occured. Sometimes there is thermocline in the summer and the water surface became frozen in the winter. These phenomena affect the vertical distribution of the physico-chemical parameters which influence the growth of phytoplankton in general of the temperate zone (Goldman and Horne, 1983).

Water temperature was affected by a seasonal change in that it was high in the rainy season and it decreased in the cool dry season and increased again in the summer. Conductivity tended to increase from the rainy season to the cool dry season and was continuously higher in the summer. The fish pond and Sakon Nakhon sewage oxidation pond always presented very high conductivity (>200 μScm^{-1}) during three seasons covering a year that indirectly indicated the eutrophic and hyper-eutrophic levels. The alkalinity level was also found to be very high in the fish pond and Sakon Nakhon sewage oxidation pond. The alkalinity and the pH level were not dependant on the seasonal change. The dissolved oxygen (DO) was not dependant on the seasonal change apart from at the open water location of Houy Yuak reservoir presenting the high DO in the rainy season but it increased in the cool dry season and the summer, respectively. The biochemical oxygen demand (BOD_5) was found with large variation. The fish pond and the small pond of Houy Yuak reservoir presented the increasing level of BOD_5 from the rainy season to the cool dry season and to the summer but at other sites, they not dependant on the seasonal change. The BOD_5 level was found to be very high in the fish pond and the sewage oxidation pond indicating very high contamination levels in water by organic matter and was classified as the hyper-eutrophic status. Inorganic nutrients in water and sediment which were nitrate-nitrogen and ammonium-nitrogen, and soluble reactive phosphorus were not dependant on the seasonal change apart from at the open water of Houy Yuak reservoir when it was found that the amount of water ammounium was high in the rainy season but it decreased continuously in the cool dry season and the summer, respectively. Whilst, ammonium-nitrogen both in water and sediment in the fish pond and Sakon Nakhon sewage oxidation pond was found in very high amounts. The high concentration of soluble reactive phosphorus in water in the reservoir of Mae Kuang Udomtara Dam may be the effect of releasing soluble reactive phosphorus from the sediment at the lake bottom under the anaerobic condition of the deep water. Moreover, Cations in water can interact with soluble reactive phosphorus which is an anion then it precipitates to the lake bottom. The high transparency of water in the reservoir of Mae Kuang Udomtara Dam indirectly indicated low amount of cations in the water, which related to remaining high amount of soluble reactive phosphorus in the water. The highest concentration of soluble reactive phosphorus in the reservoir of Mae Kuang Udomtara Dam was found at the beginning of the summer which was the same period with the highest number of total bacterial plate count in the water. It was possibly that the increase of both soluble reactive phosphorus and the number of total bacterial plate count may be caused by the human activities during that time. However, the soluble reactive phosphorus in the water at the small pond of Houy Yuak Reservoir was not related to very high concentrations of soluble reactive phosphorus in the sediment.

The compounds found in the sediment are the important factors affecting the phytoplanktons. The growth of green algae *Scenedesmus acutus*, was influenced by nitrogen released from the sediment, though nitrogen was not actually supplied from the sediment. The growth of filamentous cyanobacterium *Oscillatoria agardhii* was mainly influenced by phosphorus released from the sediment. On the other hand, the growth of *Microcystis aeruginosa* was influenced by some materials, which were not nitrogen and phosphorus (Tada *et al*., 2001). The relationship between manganese and complexing-agents released from sediment is thus important for controlling the growth of *M.*

aeruginosa in eutrophic lakes (Tada *et al*., 2002). Whilst, the importance of shallow sediments in the recruitment of *Anabaena* and *Aphanizomenon* was studied and it was found that it was related with the conditions present on the sediment, for example high temperatures early in the season and more light than at the deeper sites, should be favorable for germination earlier after ice-out than in deeper parts of the lake (Karlsson-Elfgren and Kristina Brunberg, 2004).

The physico-chemical parameters of sediment had the obvious differentiation in each site. The conditions of sediment at the water resource bottom was not the same as the condition of the water. The sediment texture in each site was not much affected by the seasonal change and regularly contained the same components. Nitrate-nitrogen was found in some study sites over some seasons whilst, ammonium-nitrogen and soluble reactive phosphorus were always found in very high amounts in the sediment and they were present in high amounts in the water. Most sediment samples were acidic, especially sediment samples collected from the deepest water resource, the reservoir of Mae Kuang Udomtara Dam, that may relate to the anaerobic activities by bacteria processing in anaerobic conditions in lake bottom sediment, such as denitrification, sulfate reduction and anaerobic digestion causing a variation of these compounds in the sediment and thus releasing them into the water (Day, 1989).

5.3 Microcystin analysis

Overall, amounts of microcystins in scum, water and sediment samples indicated that all study water resources were toxic to humans and animals involving the water at all sites, in particular at the green surface bloom of *Microcystis* water resources. Intaking high amounts of microcystins can result in serious injury of liver in humans and animals. Short exposure to toxins may also result in a long-term injury and chornic low-level exposure may cause liver injury from continuous oral exposure to microcystins. In particular the possibility of carcinogenesis and tumour growth promotion need careful evaluation, because both have beenn shown in animal experimentation (Chorus and Batram, 1999). Various microcystins were found in the scum collected from study sites presenting different content and different quotas in predominant cyanobacterial scum samples. Microcystin-RR and microcystin-LR were found as the principal toxins in the scums and total concentration of both of them were more than 50% of total microcystins in the scum at the fish pond and the reservoir of Mae Kuang Udomtara Dam, and more than 90% of total microcystins at Houy Yuak Reservoir, Sakon Nakhon sewage oxidation pond and the prawn pond. Although, the highest concentration of total microcystins was found in the scum collected from the fish pond, the highest toxicity perhaps was not related to the highest total microcystin concentration according to toxicity studies, microcystin-LR is one of the most toxic microcystins with an LD_{50} of 50 μg kg^{-1} which is approximately 10 times more toxic than microcystin-RR (Chorus and Batram, 1999). So that, the scum samples from the reservoir of Mae Kuang Udomtara Dam and the prawn cultivation pond may be more toxic than the scum sample from the fish pond because the scum samples from the reservoir of Mae Kuang Udomtara Dam and the prawn pond contained approximately 2 times higher microcystin-LR concentration than that in the fish pond scum sample. Predominant cyanobacterial scum from the reservoir of Mae Kuang Udomtara was found to contain microcystin-LR, microcystin-RR and two unknown microcystin variants at total concentration of 0.46 g kg^{-1} dry weight. The most abundant variant was microcystin-LR at concentration of 0.22 g kg^{-1} dry weight. It corresponded with the reporting that the Mae Kuang Udomtara scum sample contained total microcystin 0.81g kg^{-1} dry weight, and six microcystin variants (Mahakhant, 1998). As many scientific records have stated, microcystin-RR and microcystin-LR were the most frequent variants found in cyanobacterial scum materials and water samples throughout the world (Chorus and Batram, 1999). Overall, microcystin-LR and microcystin-RR concentrations were very rare in the water whilst, the total concentration of unknown microcystins were principal toxins in the water samples from every water resource. However, microcystin-LR was the main toxin in water at the beginning of the summer at the fish pond. This study found that the *Microcystis* amount and microcystins in water at every site were not related to the seasonal change but seem to be related to water quality suitable for their massive growth. Several species of cyanobacteria were found and these included potential microcystin producing genera such as *Anabaena* spp. and *Oscillatoria* spp. However, they sometimes were found in small amounts and were not candidates for significant microcystin production in the pond. The principal source was clearly genus *Microcystis* since it occurred as the dominant genus in the massive scum at the water surface, especially in the fish pond and Sakon Nakhon sewage oxidation pond. However, not all species within a genus or strains within a species produce a particular toxin (Huisman *et al*., 2005). It is also possible that other genera of cyanobacteria in ponds could be sources of cyanotoxins in addition to microcystins. Our demonstration of microcystins in predominant *Microcystis* scum substantiated their principle source in the water and verified that the *Microcystis* species included toxic strains. The lack of a direct connection between microcystins in scum and the amount of dissolved microcystins in water can be affected by various factors, including mixing due to wind action or currents (Jone and Orr, 1994). Furthermore, microcystins may be removed by many factors under natural environmental conditions for example, biodegradation by bacteria in water and sediments (Lam *et al*., 1995), photochemical breakdown and isomerisation (Tsuji *et al*., 1993), and sorption onto sediment particles (Rapala *et al*., 1993). This study did not analyse microcystins extracted from *Microcystis* scum in a manner parallel to the microcystins in water and *Microcystis* amount because of many variances in the natural environmental conditions mentioned previously. Studies over prolonged periods usually show that toxin concentration per gram dry weight of scum may vary substantially over a time scale of weeks to months, but rarely from day to day as is sometimes reported. In any case, the maximum time of toxin concentration and maximum biomass did not necessarily coincide (Chorus and Bartram, 1999) and there can be significant variations in the amount of toxins per mass of cyanobacteria over time. The determination of microcystin accumulation in the scum remains an interesting subject for further study. This may help establish the relationship between microcystins in the scum and in the water.

As the results show, there is an effect of sterilisation on microcystin-LR sorption onto the sediment. Decreasing microcystins in supernatants during magnetic stirring of sediment may be associated with the biodegradation by bacteria and microcystin sorption onto sediment. These related to degradation of microcystins in sediment in both oxic and anoxic denitrifying conditions, which found that nitrate respiration may be an important process in the removal and detoxification of microcystins at the reservoir bottom under the environmental conditions (Holst *et al*, 2003). Furthermore, aquatic bacterial species of *Sphingomonas* can initiate ring-opening of microcystin-LR to produce linear (acyclo-) microcystin-LR as a transient intermediate. This compound was nearly 200 times less toxic than the parent toxin (Chorus and Bartram, 1999). Large variations of the result of microcystins in non-sterilised sediment may be caused from the lysis of *Microcysitis* cells in the sediment during magnetic stirring of the sediment. So double sterilisation can stop the biodegradation of microcystins from bacteria in sediment, whilst microcystins can remain in the sterilised sediement with almost the same concentration or no significant effect to the toxin amount and toxicity because microcystins are cyclic peptides, and are extreamely stable and resistant to chemical hydrolysis or oxidation at near neutral pH levels remaining potent even after boiling (Harada *et al*, 1996). Double sterilisation also showed the small variation of microcystins remaining in the supernatant after being separated from the sediment because it could break all *Microcystis* cells in the sediment giving stable microcystin concentration in the sediment. So that the sediment should be properly double sterilised before the experiment with microcystins to obtain the proper result. The effect of microcystin-LR concentration on microcystin sorption onto the sediment was determined presenting that percent sorption of microcystin onto the sediment was negatively related to the concentration of microcystin-LR. The binding site on the sediment particle surface would be sufficient area for binding with the low concentration of microcystin-LR but may not be enough for higher microcystin concentration which means the percent sorption of microcystin-LR would be limited by the area of the binding site at the sediment particle if they exceed microcysistin-LR concentrations, the percent sorption would then not increase. It was associated with the finding that the degree of sorption was influenced by pH with 40% of sorbed toxin liberated by altering the pH of the overlying water from pH 7 to 11 (Morrison and Codd, 2004). The effect of sediment concentration on microcystin-LR sorption onto the sediment was found to be the directly positive relationship. Increasing sediment concentration increased the binding site at the sediment particle surface leading to higher capacity for sorption of microcystin-LR. Microcystins contain a chemically unique C20 β-amino acid, Adda (3-amino-9-methoxy-2,6,8-trimethyl-10-phenyldeca-4,6-dienoic acid) based on deca-4,6-dienoic fatty acid. The structure of this part of microcystins may make them susceptible to scavenging by fine-grained particles. Microcystin-LR is one of the more hydrophilic of this family of microcystin/nodularin toxins and, with its evident affinity for clay surfaces, it is possible that other members of this family of compounds will show a similar behavior (Morris *et al*., 2000). Not only microcystins, but the other toxins such as neurotoxins, brevetoxins produced by dinoflagellate, *Karenia brevis* were also removed from water by clay flocculation (Pierce *et al*., 2004). Cylindrospermopsin was also removed from water using commercial clay, montmorillonite. However, in batch experiments commercial montmorillonite suspensions of 0.1 to 5.0 $g\ l^{-1}$ were found to remove 11 to >96% of a 2.5 $\mu g\ ml^{-1}$ microcystin-LR solution, whilst no removal was found using commercial kaolinite suspensions of the same concentration (Morrison and Codd, 2004). Thoughtfully, microcysin-LR sorption onto sediment depends on physico-chemical nature of binding sites on sediment particles which are affected by the following, the capacity of the binding area on sediment surface, the concentration of microcystins in suspension, the concentration of sediment in suspension and the exposure time between binding site onto sediment particle and microcystins.

This study found clearly that the extraction of microcystin-LR from the sediment was very difficult which follows the suggestion that the more hydrophilic microcystins such as microcystin-RR, are strongly adsorbed on sediment. The extraction is dependent on the physico-chemical properties of the microcystins and sediment, of which the hydrophilic interaction was particularly critical because microcystin-RR was more tightly adsorbed on the sediment than microcystin-LR. When microcystins are adsorbed on sediment, the hydrophilic part such as the arginine and glutamic acid moieties would tightly interact with the sediment (Tsuji *et al*, 2001). This study found low and very low percent recovery of extraction by various solvents. The highest percent recovery was 18% given by sterilised Milli-Q water as the solvent for extraction which was higher than 12% recovery given by 0.1% TFA in methanol, whereas 5% acetic acid in 0.1% TFA in methanol gave very poor percent recovery. These figures differed from the results of extraction of microcystin-LR and RR spiked in sediment using different extraction solvents and ultrasonication, solvents containing trifluoroacetic acid (TFA) gave better results and the acetic acid containing solvent system gave a relatively high recovery, it was at most 60% (Morrison and Codd, 2004; Tsuji *et al*, 2001). However, the amplitude of ultrasonication did not improve the recovery and that of microcystin-RR was quite low (Tsuji *et al*, 2001) which related to these study's findings that the ultrasonication plus microwave did not improve the recovery of the extraction of microcystin-LR from the sediment. Application of microwave and ultrasonication to extract microcystins in sediment did not show the better percent recovery of extraction because the sediment particles were broken to be very smaller particles by very high levels of the heat by the microwave and very high vibration levels by ultrasonication, leading to the increase of the particle surface into very small broken sediment particles which were the binding areas between microcystins and sediment particles. These resulted in lower microcystin amount in the supernatant as shown by very low percent recovery of extraction. According to the results of total microcystins levels in Thai environmental sediment samples, it was found that the highest concentrations of total microcystins in water and sediment were found in the same water resource, which was at the fish pond and also the low concentration of total microcystins in water and sediment were found in the same water resource which was at the reservoir of Mae Kuang Udomtara Dam. However, both total microcystins in water and sediment were not directly correlated to each other during the three seasons. It was found that while the water contained total microcystins in a low concentration, the sediment contained a high concentration. Also, while the total microcystin level in water decreased, the total microcystins in the sediment did not decrease during the three seasons.

5.4 Multiple-correlations

This study found that the trophic levels of water resources evaluated using dominant phytoplanktons and physico-chemical parameters following Wetzel (1983), Lorraine and Vollenweider (1981), AARL-CMU, PP-Score and PC-Score (Peeraporpisal, 2006; Peerapornpisal *et al*., 2004) were related to the result of grouping the water environmental factors by PCA case score. On the graph of PCA case score for water environmental factors, the high value on axis 2 can represent the very polluted water trophic level while the low value on axis 2 also can represent the very clean water trophic level that means the dominant phytoplanktons following Wetzel (1983) were related to the water environmental factors in this study. Although the result of grouping environmental factors in water did not look different from the environmental factors in the sediment, the plots on a graph of sediment were closer than the plots on a graph of water indicating that physico-chemical and biological parameters in the sediment were more difficult to be effected than these in the water which affected by seasonal change. These indicated that water environmental factors of five water resources were more sensitive for seasonal change than the sediment environmental factors. As a result of PCA, the water and sediment environment factors of water resources were not much affected by seasonal change but the result of DCA could explain that the dominant phytoplanktons could be different or changed by seasonal changes in some water resources. The dominant phytoplankton compositions were changed by the seasonal changes in the reservoir of Mae Kuang Udomtara Dam and in the small pond of Houy Yuak Reservoir. However, successing dominant species during seasonal changes in the reservoir of Mae Kuang Udomtara Dam were still classified into the same group of desmids. Although, chlorophyte, desmids had the high number in terms of species, they were found only at the water supply reservoir of Mae Kuang Udomtara Dam which was classified into oligo-mesotrophic status. It agreed with Yuwadee (2005; 2006) which reported that desmids were found as the bioindicator for the low nutrient water in some northern Thai water resources. In agreement with many contributing reports, desmids seemed to be associated with nutrient poor waters in tropical lakes (Green *et al*., 1995).

Also, in temperate regions, it has been long recognized that desmids are associated with oligotrophic waters (Wetzel, 1983). Likely, it was related to the proposal that the mucilaginous capsules at desmid cell surface could be importantly useful as nutrient-trapping in low nutrient concentration conditions or oligo-trophic environments which may limit the growth of other phytoplankton groups (Yeh and Gibor, 1970; Lange, 1976). Whereas, there was no appearance of desmids in two locations of Houy Youk Reservoir and in Sakon Nakhon sewage oxidation pond. However, there was only one species of the desmid which was found in a fish pond at only one sampling time in a very small amount. This associated with many reports on the occurrence of few desmid species in eutrophic or hypereutrophic status of water (Palmer and Square, 1977). However, these few results on phytoplankton species as biological factors for indicating trophic conditions in tropical reservoirs have to be used with a precaution. This study contributed a strongly positive correlation between *Microcystis aeruginasa* and the very polluted water as hyper-eutrophic with a number of microcystins in water and sediment. *Microcystis* biovolume had a highly positive correlation with ammonium-nitrogen, it clearly supported the association between the nutrient rich status and proliferation of *Microcystis* spp. in many natural environments throughout the world. In agreement with this result, phosphorus and ammonium-nitrogen were the environmental factors which showed positive corrrelations with dominant *Microcystis aeruginosa* in oligo-mesotrophic reservoir in northern Thailand (Peerapornpisal *et al*., 1999), whilst factors affecting the phytoplankton species were alkalinity, water temperature, water transparency, nutrients and conductivity in oligo-mesotrophic reservoir in southern Thailand (Ariyadej, 2004). These results agreed with the findings that cyanophyte was the most abundant group in a shallow eutrophic tropical pond contributing more than 60% of the total phytoplankton (Yusoff and Anton, 1997). The common occurrance of cyanophyte could be the usual indicator for nutrient enrichment (Varis, 1990). Cyanophytes are further characterised by a favourable energy balance. Their maintenance constant is low which means that they require little energy to maintain cell function and structure (Gons, 1977; Van and Herdman, 1979). As a result of this, the cyanobacteria can maintain a relatively higher growth rate than other phytoplanktons when light intensities are low. The cyanophyte will therefore have a competitive advantage in waters which are turbid due to dense growths of other phytoplanktons. Therefore, in waters with high turbidity they have better chances of out–competing other species. The growth rate of cyanophyte is usually much lower than that of many algal species (Hoogenhout and Amez, 1965; Reynolds, 1984). So, at the light saturation and low turbidity level, desmids can grow faster than cyanophyte. This explaination supports the highest frequency and distribution of desmids in very low turbid water like the reservoir of Mae Kuang Udomtara Dam. However, *Microcystis aeruginosa* had been found in high amounts at the water surface in 1999 to 2000 when the water was classified as oligo-mesotrophic status (Pekkoh *et al*., 2003). Whereas *Cylindrospermopsis raciborskii* could proliferate when the nutrients were decreased and seemed related to pH and temperature (Bronco and Senna, 1994) which agreed with this research result that it can grow in the limited nitrogen and phosphorus environment (Lee, 1999). Nitrate-nitrogen and ammonium-nitrogen in water had the influence to many planytoplanktons, which were *Microcystis aeruginosa*, *Oscillatoria* spp. *Spirulina platensis* and *Diatomella* sp. but nitrate-nitrogen and ammonium-nitrogen in sediment had the influence to *Planktolyngbya limnetica*, *Oscillatoria* sp. 1 and *Cylindrospermopsis raciborskii*. Soluble reactive phosphorus both in water and sediment had not any influence directly to any phytoplankton in this study. Nutrient supply ratios did not directly increase algal abundance and biomass, but were responsible for controlling the species composition of the phytoplankton. High total N:P ratios were found to result in an increase in cryptophytes and chrysophyte populations (Anton *et al*., 1995).

Total microcystins in sediment was not clearly correlated to *Microcystis aeruginosa* biovolume in water. Total microcystins in sediment originated from principal sources which were first, dissolved microcystins in water mixing with sediment particle, second, released microcystins from cyanobacterial cell or filament in sediment and third, released microcystins from the condition of sorption onto sediment. Microcystins are preserved with benthic *Microcystis* during autumn and winter because they possibly play an important role during the reinvasion phase, either by improving growth of the initial pelagic population or by activating resting colonies (Ihle *et al*., 2004). However, microcystin amounts in sediment may not be stable if originated from cell lysis resulting in dissolved microcystins in water which can be affected by various factors including agitation due to wind action or water currents (Jone and Orr, 1994) and are continuously associated with microcysin persistence and accumulation in sediment. Furthermore, microcystins in sediment may have been decreased by biodegradation of bacteria (Lam *et al*., 1995). These were related to the degradation of microcystins in sediment at both oxic and anoxic denitrifying conditions which found that nitrate respiration may be an important process in the removal and detoxification of microcystins at the reservoir bottom in the environmental conditions (Holst *et al*, 2003). This study found the effect of pH on microcystins in sediment and total microcystins in sediment positively correlated to sediment pH, there has been very little scientific research done on this. However, the effect of pH was examined in a study using mouse bioassay to detect effects of pH on toxin production, cells were found to be more toxic when grown at high and low pH values (Van and Eloff, 1983). This study found the strong correlation among percent microcystin sorption onto sediment, percent clay and percent organic matter in sediment samples which strongly agreed with the results of the adsorption of microcystin-LR by natural clay particles and found that microcystin-LR was susceptible to be adsorbed by fine-grained particles, particularly certain clays. Because of their small size, clay minerals remain in suspension for long periods and hence can act as a major vector for adsorbed compounds, transporting them over considerable distances. Clays can also have a protective role for otherwise quite labile adsorbed organic compounds (Morris *et al*., 2000). In addition, this is particularly the case for the smectite group of clay minerals, because their structures can be expanded along the *c* axis by the adsorption of organic compounds as well as water molecules in interlayer positions (Grim, 1953). Also, fuller's earth sedimentary clay that contain a high proportion of clay minerals of the smectite group is very important for application as a bonding agent for foundry sands, in civil engineering and oil well drilling fluids, for pet litter, water stable carriers for pesticide and herbicides, or for refining edible oils and fats (British Geological Survey, Natural Environment Research Coucil, 2006). These indicated that the significant potential use of clay for many aspects of organic substance removal is very high and needed to be developed to find the best of use of them.