IMPACT ASSESSMENT OF ELEPHANT CAMP ACTIVITIES ON WATER QUALITY OF MAE TAENG RIVER, CHIANG MAI PROVINCE

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ABSTRACT

The elephant camp is an elephant farming establishment and various activities related to tourism. Most of the elephant camps are located near the rivers to avoid water shortage problems. However, the elephant camps have carried out their activities without monitoring of environmental impacts. Potentially impacting the well-being of both water resources and elephants. This study aims to assess the water quality affected by elephant camp activities on the Mae Taeng rivers in Mae Taeng district, Chiang Mai province. The physical, chemical, and biological factors including aquatic insect samples were collected from 6 sampling sites along the river in the cold season (November 2020) hot season (April 2021), and wet season (September 2021). The water quality in the cold, hot, and wet seasons was classified as good to moderate, good, and poor to good, respectively, based on ASPT scores. The location and activities of the elephant camp impact the Mae Tang water quality, as classified by the ASPT Score, especially, during the cold and wet seasons at MT4 and MT5, sampling sites where the camps are located. The impact on water quality is not only the activities of the elephant camps but also various other human disruptions that affect the water quality. To clarify the impact of elephant camp activities on water quality, long-term monitoring and assessment are essential

Keywords: Activities, Elephant camp, Water quality

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INTRODUCTION

Surface water resources are the natural resources that humans have been using both direct and indirect from the past to the present such as consumption, food source, agricultural industry, transportation, water route tourism, recreation, as well as occupations. (Shiklomanov, 1991) An elephant camp is an establishment that raises or collects elephants for tourism, performances, or other benefit businesses from the elephants. The location of elephant camps is important to avoid the water resource shortage problem thus, most elephant camps in Thailand are located near the river. (National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperative, 2021) The high volume of water has been used for many activities in the elephant camps such as water drinking for many elephants in the camps, water supply for tourists' service, and daily routine water consumption of elephant camp's staff on the other hand, water resources is also used for other activities in the elephant camp such as elephant bathing activities for tourist bamboo rafting and elephant riding along the riverside. Mae Tang River is a popular place for tourism in Chiang Mai province from the beauty aesthetics river. Many establishments such as resorts, café restaurants, and water activity establishments are located along the river especially, elephant camps that had water consumption for raising and cleaning up waste from the elephants. Therefore, elephant camps are one of the sources of wastewater and drained to natural water sources that may affect water quality. Not only wastewater from the elephant camp but also human activity on all spatial scales along the river affects both water quality and quantity in aquatic ecosystems. (Peters and Meybeck, 2000) This study aims to assess the water quality affected by elephant camp activities on the Mae Taeng rivers in Mae Taeng district, Chiang Mai province. That will be beneficial to the elephant establishments, elephant health, and people who live around the elephant camp. Create scientific knowledge and understanding between elephant camp establishments and people who use the same water resource from upstream to downstream for water resource conservation and sustainability.

LITERATURE REVIEWS

The definition of an elephant camp refers to a location where activities such as elephant husbandry, elephant gathering for tourism, performances, or any other business related to elephants take place, with or without direct service fees. The selection of the location for an elephant camp takes into consideration the importance of physical, chemical, and biological hazards from the environment and enough water supply resources. (The National Bureau of Agricultural Commodity and Food Standards, 2008) The good practice guide of elephant camps followed by the National Bureau of Agricultural Commodity and Food Standards (2008) has the principle is to manage elephant waste, refuse, and wastewater from elephant camps in an environmentally and legally appropriate manner. Nowadays, concern about water quality and quantity issues is equally significant because of having abundant water from global warming (Sivakumar, 2011). The consideration of the types of pollutants in the water can indicate the occurrence of pollution. This is assessed based on the hazardous nature and concentration of pollutants in the water. Substances that are not inherently toxic but have high concentrations can still cause pollution and have an impact on water quality (Brooks et al., 2016). Pollution Control Department classified surface water quality standards into 5 types consisting of Type 1 is the natural water source that is not affected by human activities. Type 2 is the water resources used for aquatic organism conservation, water sports, and consumption. Type 3 is the water resources used for agriculture and water quality must improve before consumption. Type 4 is the water resources used for industry and water quality must especially improve before consumption. Type 5 is the Water resources used for transportation. Water quality must especially improve before consumption. Aquatic insects in freshwater ecosystems exhibit sensitivity to changes and disturbances. They have slow recovery rates, and some

species can only survive in moderately or low polluted water. Aquatic insects have some life stages or complete metamorphosis in the water and a crucial role in the ecosystem, primarily contributing to nutrient cycling by consuming plant and animal debris in water bodies. Due to their limited mobility and tendency to inhabit specific locations, coupled with relatively long life stages, they are well-suited to be efficient biological indicators for assessing water quality. (Yang et al., 2019) The use of aquatic insect groups for water quality assessment has been developed into various indices such as Biological Monitoring Working Party (BMWP) Score, Average Score Per Taxon (ASPT), and Similarity Index. The evaluation of the Biological Monitoring Working Party (BMWP) Score is another widely used method for water quality assessment. It was initiated by the National Water Council in the United Kingdom in 1981 and has been adapted to suit the specific geographical conditions of each country. In Thailand, the ASPT Score index has been adapted for use in the northern rivers, based on research by Mustow (2002). The classification involves categorizing aquatic insects at the family level, with each family receiving a score ranging from 1 to 10. The scoring is based on the adaptations of organisms to different oxygen levels. Organisms that are tolerant to low oxygen levels and can survive in highly polluted water receive lower scores. (Pinder & Farr, 1987)

RESEARCH METHODOLOGY

The study site area was at latitude 19°13'39" to 19°11'02"N, longitude 98°48'45" to 98°54'25"E in the Mae Tang River, Mae Tang district, Chiang Mai province. The 6 sampling sites are located along the river from upstream to downstream about 12 km. The first sampling site (MT1) was selected by the most natural area and the least human activity disruption. The 2nd sampling site (MT2) was the construction area near the river. The 3rd sampling site (MT3) was the site of the water path before flowing through Mae Tang elephant camp and the resort. The 4th sampling site (MT4) was Mae Tang elephant camp. The 5th sampling site (MT5) was the Mae Ta Man elephant camp. The last sampling site (MT6) is the bamboo rafting port area. Sampling periods were chosen to follow seasonal patterns in Thailand (hot, wet, and cold seasons). The sampling periods took place cold season in November 2020, the hot season in April 2021, wet season in September 2021. Biological factors and Physical Chemical factors were collected at 6 sampling sites from the third season. Macroinvertebrate samples were collected by D-frame net (weight 30 cm cross size, 500 μm mesh size). The sampling duration was around 15 minutes/site comprehensive around the sampling site by Kick-sampling method (Mustow, 2002). The macroinvertebrate samples were preserved with 90% alcohol. The macroinvertebrate samples were sorted and identified at the family level in the laboratory to analyze and interpret the water quality from biological factor data. The Physical-Chemical Factors consisting of water and air temperatures, pH, and dissolved oxygen were measured in the field, and biochemical oxygen demand (BOD), nitrate-nitrogen, ammonia nitrogen, and orthophosphate and biological data consisting of total coliform bacteria and fecal coliform bacteria were measured in the laboratory by collecting water samples from the field. The Water quality from 6 sampling sites was analyzed and interpreted to two criteria the first criterion was analyzed from Physical chemical factors by comparing and classifying to surface water quality standards followed by the Pollution Control Department of Thailand (1994). Another criteria water quality classification from biological factors of macroinvertebrate samples calculated from BMWP score and ASPT score (Mustow, 2002) following McCafferty (1981) and Mekong River Commission. (2006) Moreover, the soil substrate in Mae Tang River was collected from 6 sampling sites to study the ratio of particle size and type of substrate in each season that may be affected by human activity. The soil substrate samples were dried and weighed 1kg, and classified particle size by the Sieve analysis method (Anderson,2007).

RESEARCH RESULTS

The percentage of the substrate in Mae Tang River from 6 sampling sites in cold, hot, and wet seasons were shown in Figure 1. The sampling site MT1 was found to have the highest percentage of pebbles followed by sand and granule, respectively in all seasons. The sampling site MT2 found the highest percentage of pebbles in the cold season on the other hand, the percentage of sand was the highest in the wet season. The ratio of pebbles is almost the same as sand in the hot season. The sampling site MT3 found the highest percentage flowing by sand and granule, respectively in cold and wet season but in hot season was found the highest percentage of granules followed by pebble and sand. The sampling site MT4 in the cold season found an equal ratio of pebbles, granules, and sand that contrasted with the highest percentage of pebbles followed by sand and granules in the hot season. The sampling site MT5 was found to have the highest percentage of pebbles followed by sand and granule, respectively in all seasons. The sampling site MT6 was found to have the highest percentage of sand followed by pebble and granule, respectively in the cold season. In the hot season, the highest percentage of pebbles and almost equal percentage of granules and sand. In the wet season, the highest percentage of pebbles flows by sand and granule, respectively. The results of the percentage of substrate from 6 sampling sites showed that the ratio of substrate particle size in each sampling site was related to the seasonal changing. The water quality of Mae Taeng classification by Surface water quality standard of the pollution control department (1994) in the cold, hot, and wet Season were shown in the table 1. In the cold season were found type 2 of water quality at MT1, MT3, and MT6 sampling site while at MT2, M43 and MT5 sampling site showed the type 5 water quality. In the hot season were found the type 2 of water quality at all sampling sites. In the wet season were found the type 4 at MT1, MT2, MT5 and MT6 sampling sites. While at MT3 and MT4 sampling site showed the type 5 water quality.

The water quality of Mae Taeng classification by a biological factor calculated from ASPT score in the cold, hot, and wet seasons were shown in Table 2. The ASPT score of the cold season showed the highest score at the MT1 and MT2 which interpreted good water quality while the MT3, MT4, MT5 and MT6 were moderate water quality. The ASPT Score of the hot season was in the range of 6.2 to 6.9 which showed good water quality. However, The ASPT score of the wet season showed various scores from 4.8 to 7.9 depending on the sampling site location. The highest ASPT score was MT1 site which showed good water quality while the MT3, MT4 and MT5 s showed moderate water quality with ASPT scores of 5.5, 5.3 and 6.3, respectively. On the other hand. The sampling sites MT2 and MT6 showed poor water quality with ASPT scores of 4.8 and 4.9 respectively. The water quality of Mae Taeng from the 6 sampling sites showed good water quality, good to moderate water quality and poor to water quality in the hot, cold and wet seasons, respectively.

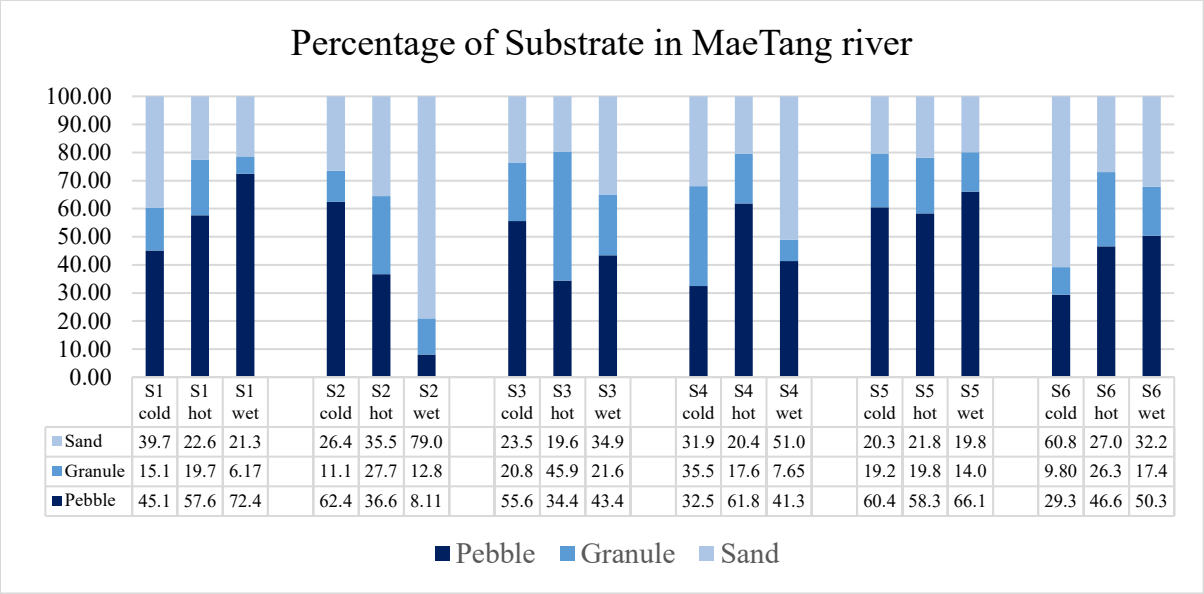

Figure 1 The percentage of substrate particle size in Mae Tang River

Table 1 The water quality of Mae Taeng River classification by Surface water quality standard in cold, hot, and wet Season (PCD, 1994)

Sampling site	Water quality		
	Cold	Hot	Wet
MT 1	Type 2	Type 2	Type 4
MT 2	Type 5	Type 2	Type 4
MT 3	Type 2	Type 2	Type 3
MT 4	Type 5	Type 2	Type 3
MT 5	Type 5	Type 2	Type 4
MT 6	Type 2	Type 2	Type 4

Table 2 The water quality of Mae Taeng River classification by ASPT score in cold, hot, and wet Season (Mustow, 2002)

Sampling site	Water Quality clarification by ASPT score					
	Cold		Hot		Wet	
	ASPT Score	Water Quality	ASPT Score	Water Quality	ASPT Score	Water Quality
MT1	6.7	Good	6.9	Good	7.9	Good
MT2	6.3	Good	6.2	Good	4.8	Poor
MT3	5.4	Moderate	6.8	Good	5.5	Moderate
MT4	5.4	Moderate	6.4	Good	5.3	Moderate
MT5	5.6	Moderate	6.4	Good	6.3	Moderate
MT6	5.7	Moderate	6.7	Good	4.9	Poor

DISCUSSION & CONCLUSION

The MT1 site showed the highest percentage ratio of pebbles followed by sand and granules in every season in addition, the percentage of pebbles in the wet season was higher than in the cold and hot seasons from the increase of velocity and volume same with the MT5 and MT6 sampling site. On the other hand, the MT2, MT3 and MT4 sampling sites showed the highest percentage ratio of sand in the wet season especially, MT2 which was the highest percentage compared with the other sampling sites in all seasons cause of rainy leaching soil particles from the construction area at MT2. The ratio of the substrate between MT4 and MT5 which was the location of the Mae Tang and Mae Ta man elephant camps showed MT4 was a higher percentage of sand than MT5 in the cold and wet seasons. The higher sand ratio of MT4 was affected by higher numbers of tourism activities consisting of elephant riding along the riverside and bamboo rafting than MT5.In conclusion, the substrate particle samples of all sampling sites showed different percentages of pebble granules and sand in each season. Not only the high velocity and volume but also human activity disruption may affect the substrate and change the aquatic ecosystem. (Nittrouer et al., 2012)

The water quality classification by surface water quality followed by the Pollution Control Department, Thailand (1994) standard into 5 types according to utilization. The Mae Taeng River in the cold, hot and wet season were classified as Type 2 and 5, Type 2 and type 2 & 4 respectively. The suggestion of PCD (1994) type 2 standard was improving water quality and sterilizing before consumption the conservation of aquatic organisms, fishing, swimming and water sports. However, the suggestion of PCD (1994) type 4 and 5 standards were especially improving quality and sterilizing before consumption and usage for agriculture and industries in type 4 and draining wastewater and transportation in type 5. The comparison of surface water quality between sites during the same season revealed that the BOD factor values for MT2 and MT4 were higher than the PCD (1994) type 4 standard (BOD less than 4 mg/L). Additionally, during the cold season, the fecal coliform bacteria value for MT5 exceeded the PCD (1994) type 4 threshold (fecal coliform bacteria less than 4,000 MPN/100 mg) In addition, the value of total coliform bacteria and fecal coliform bacteria of MT1, MT2 and MT4 was higher than PCD (1994) type 3 (Total & fecal coliform bacteria less than 20,000 and 4,000 MPN/100 mg.) The high value of BOD, total coliform bacteria and fecal coliform may be attributed to wastewater drainage from the elephant camp situated on MT4 and MT5.Therefore, total coliform bacteria and fecal coliform Bacteria are commonly used to indicate cleanliness and contamination of waste from human and animal' digestion (Anna et al, 2005)

The comparison of water quality between cold, hot and wet seasons with the same sampling found that MT1 had the highest ASPT score and good water quality in all seasons may be attributed to the least human activity disruption compared to other sites. During all seasons, MT1 was found to have a higher ratio of pebble substrate compared to sand and granules, creating a habitat suitable for caddis flies. (Dudgeon, 1996) Especially, The highest percentage of granules in the wet season affects to the finding of caddis flies. The group of case-making caddis flies tends to inhabit areas with high water velocity and pebble substrate or large rocks that have a high BMWP score, resulting in a correspondingly high ASPT score. In the wet season, the MT2 sampling site had poor water quality, whereas it showed good water quality during the cold and hot seasons. MT2 had the lowest ASPT score, correlating with the highest percentage of sand when compared to the other 6 sampling sites across all seasons. The substrate ratio affects the discovery of macroinvertebrates, as the various characteristics of the substrate influence the habitat selection of aquatic insects based on their morphological and feeding traits. (Dudgeon, 1996) Thus, the lowest ASPT score at the MT2 site is a consequence of a low count of aquatic insects and a high percentage of sand, attributed to soil particle leaching influenced by construction activities in the vicinity. The MT3 MT4 and MT5 sampling sites had moderate, good and moderate water quality during the cold, hot and wet seasons

respectively. The water quality of the third site was influenced by the presence of the resort, Mae Tang elephant camp, and Mae Ta man elephant camp, which contributed to numerous disruptions from human activities and wastewater. Meanwhile, the MT6 sampling site had moderate, good, and poor water quality during the cold, hot, and wet seasons, respectively. The poor water quality was attributed to the high velocity and volume of the river as the aquatic insects are swept away by the strong currents during the rainy season, resulting in a significant decrease in density and species diversity. (Chartchumni et al., 2017)

For accurate water quality assessment, it is essential to monitor physical, chemical, and biological factors, following the surface water standards established by the Pollution Control Department (PCD, 1994), to ensure the appropriate use of water resources. Seasons impact the physical, chemical, and biological factors in aquatic ecosystems, especially the particle size of the substrate, affecting the habitat of aquatic insects and the abundance of their presence. Study sites with a higher number of aquatic insects contribute to a higher ASPT score, indicating good water quality. During the rainy season, changes in physical factors lead to a stronger water flow, impacting substrate ratio and the dispersion of aquatic insects.

In conclusion, the location and activities of the elephant camp have an impact on the water quality of the Mae Tang River, by the ASPT Score classification. Especially, during the cold and wet seasons at MT4 and MT5, where the camps Mae Tang and Mae Ta Man are situated. It is not only the activities of the elephant camps but also various other human disruptions that affect the water quality of the Mae Taeng River.

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