B010

Fertility of Sediment from Forest Head Watershed of Kaeng Krachan down to Phetchaburi estuary

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Abstract

The Phetchaburi River has a total length of 227 kilometers, originating from upstream of Tanao Si Mountain Range in Kaeng Krachan National Park flows through Kaeng Krachan Reservoir, Agricultural area, Phetchaburi community, and flows out into the sea at Phetchaburi estuary. The river carries small sediments and minerals from upstream to the estuaries, which are important for estuary and coastal shellfish farming totaling 18,058 rai with the production of 6,884.06 tons per year of shellfish farming in 2019. Therefore, it is interesting to study the quality of sediment is pH, organic matter, calcium and magnesium content collecting sediment samples 13 points according to land use of 5 types are natural forest areas, Kaeng Krachan Reservoir, Agricultural area, Phetchaburi community and Phetchaburi estuary during the rainy season (September 2019) and summer season (February 2020). The results showed that sediment nutrients (Ca^{2+} and Mg^{2+}) in rainy season were higher than summer season for all land uses. When considering each area, nutrients from forest areas (2,300 and 2,700 mg/kg) were higher than Kaeng Krachan Reservoir (300-1,100 and 1,500-1,600 mg/kg).Forest area has accumulated a large amount of organic matter that good grip on nutrients, Kaeng Krachan Reservoir has a lot of sand sedimentation and weak acidity which hold fewer nutrients causing calcium and magnesium to be easily washed away. Calcium in sediment at Forest area, Kaeng Krachan Reservoir, Phetchaburi community, and Phetchaburi estuary is higher than in summer due to less and low water speed chance of organic matter and a lot of nutrients precipitation to stream bottom. In addition, Agricultural area has drainage from activities. But found that Phetchaburi community area in rainy season is higher because it's a high community area. When it rains it has greater leaching of nutrients from land into water sources. The estuary has the highest nutrient content in both seasons which are 3,100-6,400 and 11,000-18,400 mg/kg and summer 4,080-15,556 and 10,051-15,503 mg/kg. Small sediments adhere well to nutrients that are carried from upstream and settled at estuary which makes the nutrients have highest value at Phetchaburi estuary in both seasons. Magnesium was found that tend in same direction as calcium but with higher amounts. especially around Phetchaburi estuary due to the influence of seawater with higher magnesium content. Calcium and magnesium are adsorbed between the sediment particles. Areas with high levels of clay particles and organic matter are adsorbing nutrients better. including the transfer rate of dissolved calcium and magnesium from above sediment areas. The high levels of calcium and magnesium have a positive effect on the productivity of aquatic animals. The organic matter content and pH were in the range suitable for the growth of aquatic animals as well.

Keywords: Organic Matter, Calcium, Magnesium, Sediment

1. Introduction

Phetchaburi River is the main river located in Phetchaburi province. the river's total length of 227 kilometers originates from upstream at Tanaosri Mountain Range in the west of Thailand, head watershed Kaeng Krachan National Park flows through Kaeng Krachan district, Tha Yang District, Ban Lat District, Mueang Phetchaburi District, and flows into the estuary the Gulf of Thailand at Ban Laem District (Water Resources and Agriculture Institute, 2012). Phetchaburi watershed total area of 5,603 square kilometers, which is mostly forest area (57.24%), followed by agricultural area (28.86%), mixed area (6.19%), urban area (5.14%), and water source area (2.5 %) with 65,188 rai of aquaculture area (Land Development Department, 2020). Shellfish farm in the estuary and coasts 18,058 rai which production is cockles, mussels, and oysters in 2019 overall 6,884.06 tons (Fisheries Department, 2019) and value 303.79 million baht per year. Also, Shellfishes diversity in the Phetchaburi River has 12 types of scallops and 13 types of bivalves (Savika and Sitthi, 2013). Cockles (*Anadara granosa*) were first cultured at the Bang Tabun estuary at Ban Laem District Phetchaburi Province. Suitable areas for growth are muddy beaches and Mangroves that have clay or muddy clay. The cockles' food consists of decay organic matter and plankton which have been found the problem of dead mollusks caused by the flood season that is a large amount of sediment which inhibits filtration and respiration, as well as impurities, minerals, and toxins from land (Fisheries Department, 2019).

Sediment is organic or inorganic particles from soil erosion and weathering of rocks (terrigenous) near the stream and also biogenous sediments that were transported or spontaneously occurring in water sources after that sink to the water bottom. (Waraporn and Jintana, 2007). Sediment is transported through water and wind processes cause soil particles to disperse (Detaching) into the river. Large sediments will precipitate upstream while small sediments are blown away (Transportation) to deposit at estuary (Niphon, 1984). Sediment is a habitat, food source, reproduction, and nutrient accumulation for benthos (Charumat, 2003). The organic matter in sediment is a food source and aquatic organisms' energy up to 10-20% (Mayer, 1990) because sediment particles can absorb nutrients into the water well which find the organic matter that varies according to human activities which factors related to the accumulation of organic matter in sediment are pH and clay particles (Niwuth, 1991). sediment pH affects the distribution of shellfish if its low pH tends to slow shell formation (Diaber, 1982).

It is evident that sediment plays an important role and relation with sediment organisms. Therefore, this research aims to study the fertility of sediment from forest head watershed of Kaeng Krachan down to Phetchaburi estuary in each season for the benefit of raising shellfish in the Phetchaburi estuary in the future.

2. Material and Methods

2.1 Determination of sediment sampling points

Set up soil sediment sampling in Phetchaburi River according to land use for 5 types from upstream forest area of Kaeng Krachan National Park to the Phetchaburi estuary total of 13 points consisting of natural forest area (mixed deciduous forest) 1 point (S1), Kaeng Krachan reservoir 2 points (S2-S3), agricultural areas 2 points (S4-S5), Phetchaburi community area 6 points (S6-S11), and Phetchaburi estuary 2 points (S12-S13). (Figure 1)

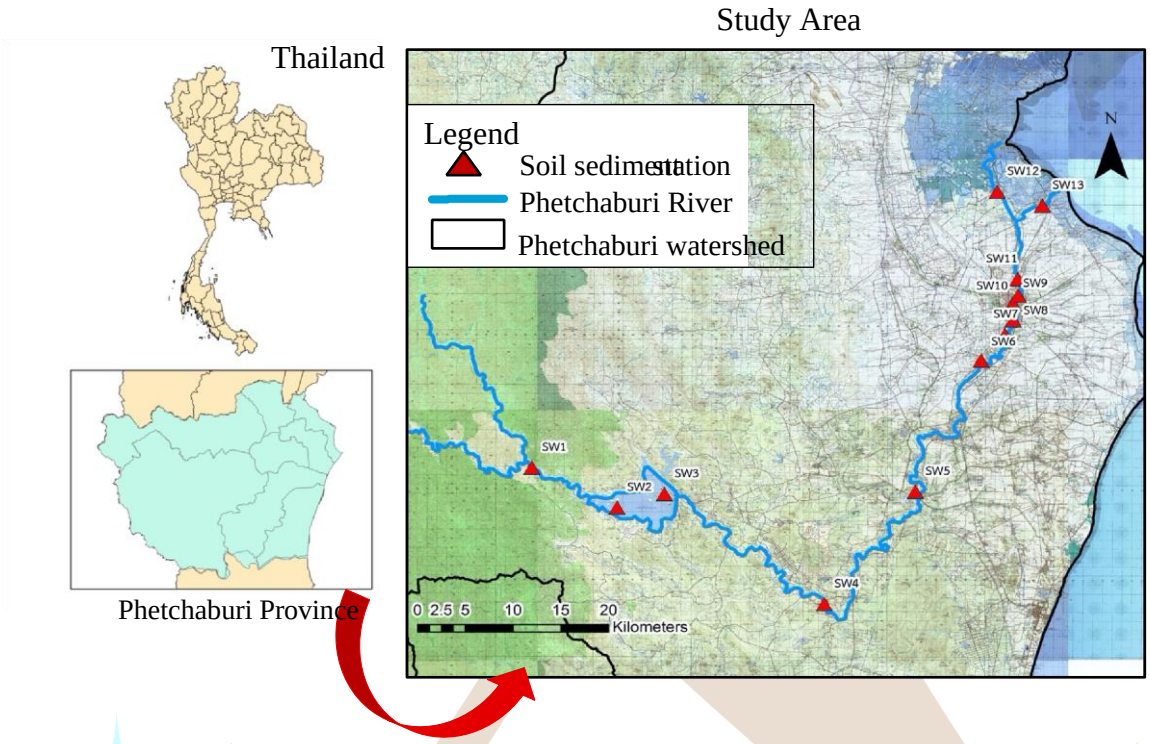

Figure 1 Sediment sampling station in Phetchaburi watershed

2.1 Sediment sampling

The sediment sample was collected in 2 seasons is rainy season in September 2019 and the summer in February 2020 according to the designated sampling point using Ekman's grab soil sampling tool in 8-9 centimeters of sediment are collected from surface sediments.

Prepare sediment sample before analysis is carried out drying the sediment samples for 1 week then grind it thoroughly and sift with 2 and 0.5 mm sieve.

3. Data Analysis

Analyze soil sediment texture (Hydrometer method), pH (soil to water ratio, 1:1), and organic matter (Walkley and Black titration method) according to standard operating for the Digestion of Solid Samples Using Method (U.S. EPA, 1999)

a) Analyze soil sediment calcium and magnesium (Atomic absorption spectrophotometer method) at Faculty of Agriculture, Kasetsart University.

4. Results and discussion

4.1 Sediment quality in each season and land use is described as follows

Calcium and magnesium in each season were not significantly different ($p>0.05$). Nutrients (Ca^{2+} and Mg^{2+}) In the rainy season, sediment was higher than in the dry season in all land uses. The calcium content in the sediment was higher only in the Forest area, Kaeng Krachan Reservoir, Phetchaburi community, and the Phetchaburi estuary is higher than in summer. When considering each area, it was found that nutrients from forest areas are higher than the sediment in the reservoir and have the highest value Phetchaburi estuary in both seasons. Factors affecting nutrients are soil texture, organic matter, and pH each season were not significantly different ($p>0.05$). The highest amount of organic matter at Phetchaburi estuary in the rainy season The summer is highest in the forest area. The pH is highest in summer. As for the sediment, it was found that in the rainy season there was more leaching of clay particles and the highest value was at the Phetchaburi estuary.

Table 1 Soil sediment nutrients from Phetchaburi River in each land use and season.

Season	Land use	Soil Particle			Soil Texture	OM (%)	pH	Nutrients (mg/kg)	
		%Sand	%Silt	%Clay				Total Ca	Total Mg
Rainy (September 2019)	Natural forest area	73.76	11.36	14.88	loamy sand sandy loam sandy loam	1.82	6.48	2,300	2,700
	Kaeng Krachan reservoir	62.94	18.18	18.18		1.30-1.45	5.48-6.77	300-1,100	1,500-1,600
	Agriculture area	65.4	22.72	11.88		1.90-3.55	6.62-7.15	1,200-1,400	1,600-2,000
	Phetchaburi community area	52.12	23.54	24.43	sandy clay loam	1.38-1.80	5.97-8.36	2,300-13,700	2,100-10,600
	Phetchaburi estuary	18.3	27.0	54.47	clay	5.35-6.46	7.60-8.41	3,100-6,400	11,000-18,400
Summer (February 2020)	Natural forest area	33.54	43.58	22.88	medium loam loamy sand medium loam sandy loam	4.20	6.26	2,892	2,240
	Kaeng Krachan reservoir	85.76	10.36	3.88		0.86-0.88	7.03-7.39	725-903	509-961
	Agriculture area	33.54	43.58	22.88		0.85-1.07	6.66-6.81	845-2,645	950-2,098
	Phetchaburi community area	62.27	15.77	17.01		0.60-1.08	6.99-8.55	626-4,481	974-2,598
	Phetchaburi estuary	26.94	32.18	40.88	clay	2.89-3.48	8.63-8.88	4,080-15,556	10,051-15,503

4.1 Compare soil sediment quality by land use

Rainy season: organic matter in soil sediment maximum at Phetchaburi estuary (2.12-2.76%) due to the community being all-around when rainy the surrounding nutrient, organic matter, and sewage are leached from land to the water (Kawita, 2003) including this area is precipitated clay (24.43%clay) it makes higher organic matter than other areas. Agriculture area has a secondary value where is received effluent from agriculture, farming, livestock farming. Phetchaburi communities have high human settlements that receive organic substances from the sewage communities (garbage, excrement, washing) containing organic matter (protein, carbohydrate, and fat) along with the rainy season substances from land are washed into the water and community sewage discharge. while the lowest is at Kaeng Krachan reservoir (S2-3) because when the rains have a large amount of water in the stream and fast current cause amount of organic matter in soil sediment are decrease. pH value was highest in the Phetchaburi estuary (7.60-8.41) because of the influence of seawater with alkaline and the lowest in Kaeng Krachan reservoir (5.48-6.77) due to the reservoir has high water depth in the rainy season when organic degradation occurs by bacteria it reduces oxygen when oxygen rundown will happen sulfur-based bacteria which cause hydrogen sulfide compounds that are acidic makes soil sediment at reservoir area more acid than in other areas.

Considering that calcium in each area found the highest at Phetchaburi communities (2,300-13,700 mg/kg) during the rainy season due to this area soil sediment is loamy sand that is transferred a lot of clay particles which good grip nutrients and maybe leached lime from land to water. The lowest value at Kaeng Krachan reservoir area as the soil sediment is high particles of sandy soil (62.94 %sand) it also has a mild acidity (6.12) which soil sediment is very grainy and acid, so it has low of calcium ions because calcium is easily washed away. (Millar et all, 1964), the magnesium section was found more likely in the same direction as calcium but was more difficult to wash away than calcium, so it was found in highly soil sediment.

Summer the maximum organic matter in soil sediment at natural forest areas (4.20%) since trees are deciduous and fall leaves into the water this cause more leave to accumulate and deposits into soil sediment this area has an increased amount of organic matter in soil sediments (Wilasinee, 1990) along with the low speed of stream that a large chance of organic matter precipitate to the stream if the speed and water quantity low cause the chances of organic matter precipitation are high (Suthipong, 1992) and it is also found all seasons which organic matter quantity the lowest at Kaeng Krachan reservoir where the sediment is blown from upstream and precipitated which is sandy (85.76%sand) there was little organic matter. Factors were directly related to organic content are soil acidity and clay particles. pH value was found the highest at the Phetchaburi estuary (8.63-8.88) influences seawater that has the most abundant ions alkalinity (Cl^-, Na^+, SO_2^{4-}, Mg^{2+}, Ca^{2+}, K^+, and HCO_3^-) and the lowest at forest areas (6.26) where is the highest organic content (4.20%) causes the pH value to be high, while Kaeng Krachan reservoir and Phetchaburi communities have similar values.

The Phetchaburi estuary (S12-13) has the highest calcium content (4,080-15,556 mg/kg) this area was found that soil sediment has a shells composition that contains the main calcium component (Libes, 1992) corresponding Monthon (2010) was found the sediments at the estuary consisted of silica and calcium which are biogenous sediments when these mollusks die will fall into the water bottom. Magnesium is found more likely to go in line with calcium, but in larger quantities, especially at Phetchaburi estuary because it is influenced by seawater with a higher content of magnesium than calcium also very variable and is easier to wash away. Calcium and magnesium dissolving occurs both during drowning and accumulation in sediments, as well as the

transfer rate of dissolved calcium and magnesium from the water above the sedimentary soil (Libes, 1992). therefore, the estuary area is larger magnesium. It is found that areas with high pH or alkaline find a large amount of calcium. For all parameters, it was found that there was a decrease in value during the Kaeng Krachan reservoir. This causes a significant decrease in the accumulation of organic and mineral content. The reservoir is found extensive, the sediment has little accumulation, possibly sediment of plankton organisms. Humus (Patrawut, 2005)

4.2 Soil sediment quality each season

The organic matter of soil sediment in both seasons was not significantly different ($p>0.05$) In the rainy season, there is a higher amount of organic matter in soil sediment than in summer, when it rains, washing things on the ground, a suspension blow, minerals from the ground into the water more than summer (Kavita, 2003) In addition, precipitation rates in the rainy season are more precipitous, due to the high rainfall in area and flood from upstream will fallen sediment which large particles, giving this period a lot of sediment accumulation. (Patrawut, 2005) thus accumulating a high organic matter in soil sediment. The lower value in summer, considering the soil texture there is less clay particle composition than rainy season as the particles of sand raise, the amount of organic matter in soil decreases. The adhesion of organic matter was therefore reduced in value (Somjette et al., 1987) along with summer temperatures are rising, resulting in better biological catalysis, with factors affecting the amount of organic matter in soil sediment including soil texture, where soils high in clay particles were better at adhesion to organic matter (Robinson, 1971; Oschwald, 1972). Soil sediment pH is higher in summer than in the rainy season (5.48-8.88) in both seasons was not significantly different ($p>0.05$) inline with Pichit et al., (1996) found that pH values in Bangprakong estuary and Chonburi Bay in 1995 was between 6.0-8.5. pH values affect the spread of aquatic animals and the formation of shells. If there is a low pH value (acidity) gets the formation of a slow shell. The pH value depends on the terrain and environment of various environments, such as ground and rock characteristics and activity of soil microorganisms (Maitree and Jaruwan, 1985)

Calcium and magnesium each season were not statistically significant differences. ($p>0.05$) In rainy season is higher than in summer, because in the rainy season the particles of the soil are washed. Calcium and magnesium are absorbed in particles of soil sediment that make the rainy season more valuable. Calcium and magnesium also come from the composition of shelled, plankton, protozoa and shelled animals that are dead and crushed in the water bottom. It was also found that nutrients spread, the source of important nutrients comes from the water flowing through the ground. The nutrients are attached to the sedimentary soil, as well as the cells and tissues of the organism fall into the water bottom and accumulate in the soil sediment (Sanit, 1999).

5. Conclusion

From the study of soil sediment quality in the Phetchaburi River during the rainy season and summer, it found that organic matter content, pH, calcium, and magnesium in each season was not significantly different ($p>0.05$). The amount of organic matter in the rainy season was higher than in summer, due to the rainy season washing things on the ground, suspended solids are carried minerals and organic matter from the ground into the water a lot. Total organic matter in the rainy season was highest at the Phetchaburi estuary. Summer peak in natural forest area, the amount of organic matter in soil sediment is attached well in soils with small particles or very clay. The pH value of each season was not significantly different ($p>0.05$). The highest value at the Phetchaburi estuary in both seasons is due to the influence of seawater. The lowest in the rainy season was at Kaeng Krachan Reservoir and the lowest in summer was in the natural forest area. The pH depends

on the terrain. and many environmental conditions such as ground, rock formations, and soil microbial activity. Calcium and magnesium in each season were not significantly different ($p>0.05$). The highest values were at the estuary and the lowest at Kaeng Krachan Reservoir in both seasons where calcium and magnesium are absorbed between the sediment particles, Areas with high levels of clay particles and organic matter absorb nutrients better, including the transfer rate of dissolved calcium and magnesium from above sediment areas.

It was concluded that the sources of these nutrients came from water runoff and from seawater entering the estuary. Nutrients are attached to the sediment that convection of small sediments and clay particles from upstream, Including agricultural and community areas to sediment at estuary r has a beneficial effect on shellfish farming. Because the small particles absorb water well. The cockles like to live in muddy soil. In sediment containing sand, the cockle growth rate was slower than normal, and sediment with a high clay particle composition will have good grip on organic matter. It is a good source of food for cockles that feed and put themselves in the mud. pH and the amount of organic matter in the right range. The suitable pH value for the growth of aquatic animals is in the range of 6.5-9.0. If less than 4 and greater than 11, the aquatic animal will die. Organic matter content suitable for aquaculture is approximately 2-6% (Boyd et al., 2002), and high calcium content has also been found to have a positive effect on fish production (Hartman P. et.al. 2016).

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