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Environment impacts of undulated surf clam dredging operation off Prachaup Kirikharn province, Thailand

Isara Chanrachkij*, Shettapong Meksumpum[1], Jarumas Meksampan[2] and Sangtian Aujimangkul[3]

SEAFDEC/TD, PO Box 97 Phrasamut-Chedi, Samutprakarn, 10290 Thailand

[1] Department of Marine Science, Faculty of Fisheries, Kasetsart University, Bangkok 10900, Thailand

[2] Department of Fisheries Biology, Faculty of Fisheries, Kasetsart University, Bangkok 10900, Thailand

[3] Department of Fisheries Management, Faculty of Fisheries, Kasetsart University, Bangkok 10900, Thailand.

*Correspondence e-mail: isara@seafdec.org

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Original Article

Abstract

Environment impacts of experimental dredging operations for the undulated surf clam, *Paphia* sp. around Paknam-Pran and adjacent coastal areas (Amphur Pranburi and Amphur Sam-roi-yod, Prachaup Khirikhan Province, Thailand) were investigated in collaboration with Department of Fisheries, Thailand. Data were collected on physical parameters from water samples at surface layer (30 cm below sea surface), and nutrient parameters from surface as well as overlying water (50 cm above bottom sediment level).

Results show that water quality changed by dredging operation in the following ways: the most significant impact was increase in Total Suspended Solids (TSS), and consequently, decrease in water transparency. Dissolved oxygen concentration was marginally higher in several stations after dredging, possibly due to disturbance caused by dredge boat propellers. Concentrations of Ammonium-Nitrogen (NH4+-N), Silicate-Silicon (Si(OH)4-Si) and Orthophosphate-Phosphorus (PO43--P) marginally increased in almost all stations after dredging. There is a possibility that increase in nutrient concentration may lead to occurrence of red tide during and after the surf clam dredge fishing season.

Keywords: *Paphia sp, total suspended solids, turbidity, dissolved oxygen, nutrients.*

Introduction

Undulated surf clam, *Paphia* sp. (Born, 1778) has been one of the important marine resources of Thailand since the commencement of its fishery. The Department of Fisheries, Thailand (DOF-Thailand) initially reported harvesting of undulated surf clam in 1973. Historically, surf clams were not a favorite food for Thai consumers. However, after development of canned and frozen products in 1977 for export, the surf clam has emerged as a product of high demand. In 2009, the undulated surf clam harvest was estimated to be around 17,763 metric tonnes, valued at approximately 7 million US $ for the raw product and at approximately 20 million US $ for the processed export product (Department of Fisheries, 2011)

Fishing technology to harvest undulated surf clam was improved from hand dredge to iron dredges operated from motorized fishing vessel. Nowadays, fishing operations are prevalent in the entire Gulf of Thailand as well as in the Andaman Sea, which has resulted in depletion of this resource. In some fishing grounds, 3 to 5 years are required for recovery of the resource. Negative impacts of dredge fishing to aquatic, physical and chemical environmental conditions are less understood compared to the biological impacts. The objective of this paper is to understand the impact of dredging operation on the physical and chemical environment parameters in Paknam-Pran and adjacent areas of Thailand by conducting experimental dredging. The results are expected to provide input for sustainable clam resource management.

Material and methods

Sampling area

Paknam Pran estuary and adjacent areas, Amphur (District) Pranburi and Amphor (District) Samroi Yod, Prachaup Khiri Khan Province, Thailand, are important fishing hotspots in the central part of Gulf of Thailand. Large and small scale fishing activities using various types of fishing gear, namely; gillnet, collapsible trap, squid cast net, purse seine and trawl are operated in the estuary and adjacent coastal area. Undulated surf clam (*Paphia undulata*) dredging is one of the fishing activities prevalent in this area. Department of Fisheries (1992) and Isara Chanrachkij (2012) have demarcated the fishing grounds around Prachaub Khirikarn Province from Paknam Pranburi Estuary to south of Sattakut Island (Fig. 1). The total fishing area is approximately 61.5 sq.km. (DOF, 1992).

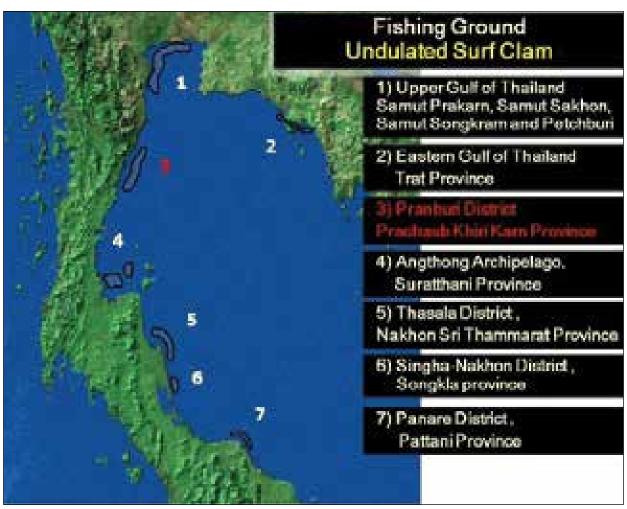

Fig. 1. Important fishing grounds of undulated surf clam (*Paphia* sp.) in Gulf of Thailand (source: Isara, 2012)

Fishing gear

The experimental dredge was made of a rectangular box shaped iron frame. The front portion was slightly higher than the rear side. The dredge was 220 cm in width (length of entrance), 100-110 cm in length (from entrance to rear side) and 12-16 cm in height (Fig. 2). The dredge slit had an interval of 1.2 cm. The weight of the dredge was approximately 80 kg. The frames were made of iron pipe with a diameter of 8-10 mm and 3 mm thickness. An iron plate, length equal to the width of dredge entrance, with a width of 8-10 mm and 3 mm thickness, was fixed at the mouth of the dredge, at an oblique

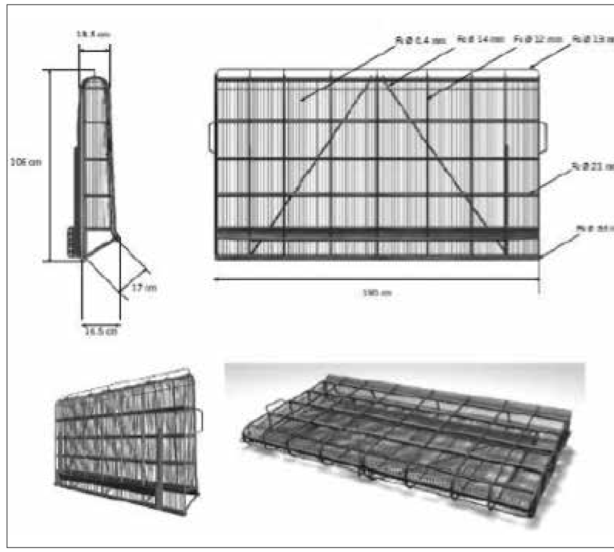

Fig. 2. Specification of iron dredge, entrance size 190 cm (source: modified from SEAFDEC, 2004)

angle at 30-40 degrees. Dredge pendants were made of iron chains. The dredge warp was a polypropylene (PP) rope, 4 strand Z twist and 24 mm diameter. The warp length was 2-3 times the sea depth.

Dredging operation

Six dredging tracks were fixed in four areas of Paknam Pranburi estuary and adjacent coastal areas, i.e. Pranburi Estuary, front of Kao Ka-lok and Ao Sam Roi Yod Bay Northern of Ko Sattakut Island. Two tracks (DG1-DG2 and DG3-DG4) were in the front of Paknam Pran estuary; one track (DG8- DG9, 2 times) was off Khao Karok; one track (DG13-DG14) was off Ao Sam Roi Yod Bay; and two tracks (DG15-DG16, 2 times, and DG15-DG17) were around Ban Bang Poo Bay (Fig. 3 and Table 1). In total, eight dredging operations were carried out. Before commencement of dredging, a speed boat was used for setting the position, sounding sea depth, and two flags were deployed to mark the starting and ending positions. Researchers onboard speed boat collected water samples before, during and after each operation. Dredging was conducted by the Department of Fisheries, Thailand research vessel, *R.V. Pramong 12*. Dredge was operated at stern deck with towing speed of 5-8 km/h. The duration of each dredging operation was 5-10 minutes, while an approximate distance of 1000 m was covered during the period. As the dredging ground between Ban Bang Poo bay and Ao Sam Roi Yod Bay was shallow (depth 3-5 m), the duration was reduced, thereby reducing the distance to 500 m. During dredging operations, researchers on speed boat conducted overlying water sampling on the dredging tracks. After completion of each operation, the dredge was heaved from sea bottom, and towed at sea surface for washing sediments out of the dredge.

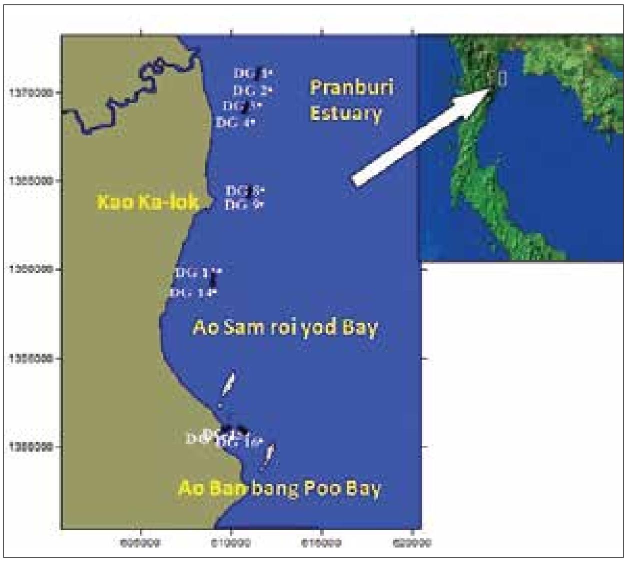

Fig. 3. Survey stations in the coastal waters of Amphur Pranburi District and adjacent area, Prachuap Khirikarn Province

Table 1 Position and coordinate of stations of dredging experiment

Station No.	Position (UTM*)	
	East	North
DG 1	612166	1371163
DG 2	612122	1370177
DG 3	611539	1369325
DG 4	611180	1368384
DG 8	611718	1364530
DG 9	611673	1363724
DG 13	609342	1359915
DG 14	609073	1358794
DG 15	610866	1350728
DG 16	611628	1350325
DG 17	609992	1350504

*UTM = Universal Transverse Mercator

Water sample collection and analysis

The geographical position of survey stations was recorded using GPS. Depth at survey stations was recorded by an echo sounder. Data on sea surface temperature (SST), salinity, dissolved oxygen (DO) and pH at surface layer (30 cm below sea surface) were collected using a multi-parameter environment monitor (YSI Model 600 QS). Transparency data was obtained by Secchi disc measurement. Data on water quality parameters, particularly concentration of nutrient parameters, i.e. NH4+-N, NO2-+NO3 -N, Si(OH)4-Si and PO43--P were collected using a vertical type water sampler from 30 cm below sea surface and overlying water (50 cm above bottom sediment). Water samples for nutrient analysis were pre-filtered through a 0.7 μm glass fiber filter (GF/F). Pre-filtering was done immediately at the sampling site in order to avoid degradation of samples. Nutrient concentration was analyzed in the laboratory using an auto-analyzer SKALAR segment flow. TSS was determined by freeze dryer method in the laboratory of Department of Marine Science, Faculty of Fisheries Kasetsart University, Bangkok.

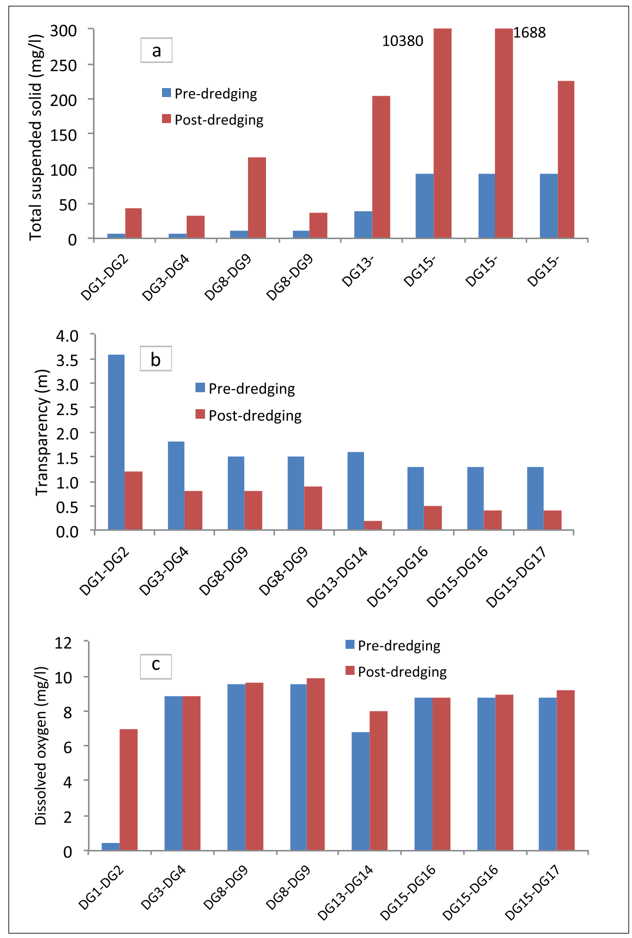

Fig. 4. Water quality in pre and post dredging operations; (a) Total Suspended Solid; (b) Transparency; (c) Dissolved Oxygen

Results

Sea surface temperature, salinity and pH did not show any significant difference in the tracks before and after dredging operation.

Total Suspended Solids (TSS)

The TSS substantially increased in all the tracks after dredging operation. Range of TSS pre-dredging was from 6.00 mg/l to 92.35 mg/l (Fig. 4a) with an average of 24.87 mg/l. The range of post-dredging was from 36.10 mg/l to 10,380.00 mg/l with

Fig. 5. Re-suspended sediment spreading at the sea surface while the dredge is being hauled

an average of 163.00 mg/l. Thus the average TSS increased by 6.5 times. While the dredge is hauled, dense re-suspension of sediment spread occurred in the sea surface (Fig. 5). Massive TSS increase from 92.35 mg/l to 10380 mg/l was found in the dredging track DG15-DG16. The lowest difference was in tracks DG8-DG9 where the TSS increased from 10.60 mg/l to 36.10 mg/l.

Sea water transparency

Sea water transparency substantially decreased in all the tracks after the dredging operations. The range of transparency in pre-dredging was recorded as 1.3 m to 3.6 m with an average of 1.5 m, while in post-dredging it was 0.2 m. to 1.2 m with an average of 0.65 m. Thus, the average transparency reduced by half after dredging. The transparency loss was maximum in tracks DG13-DG14, where it reduced from 1.6 m to 0.2 m (Fig. 4b).

Dissolved Oxygen (DO)

DO concentration marginally increased in almost all the tracks after dredging. Range of DO concentration during pre dredging was recorded as 6.42-9.52 mg/l with an average of 8.78 mg/l. Post-dredging DO concentration was in the range from 6.94 to 9.90 mg/l, with an average of 8.90 mg/l. While the highest difference in DO concentration was in tracks DG13-14 (6.83 mg/l to 8.03 mg/l), the DO remained constant in tracks DG3-DG4 (Fig.4c).

Ammonium-Nitrogen (NH4+-N)

Concentration of NH4+-N increased in all the tracks after the dredging operations, being substantial in a few tracks. The range of NH4+-N concentrations during pre-dredging was 7.52-10.80 μM with an average of 10.03 μM. The concentration ranged from 9.19 to 12.53 μM post-dredging with an average of 11.07 μM. The highest difference was found in tracks DG15-DG17, where it increased from 7.52 μM to 12.53 μM. Dredge track DG3-DG4 recorded the lowest difference in NH4+-N concentration between pre and post dredging, increasing from 10.03 μM to 10.44 μM (Fig. 6a).

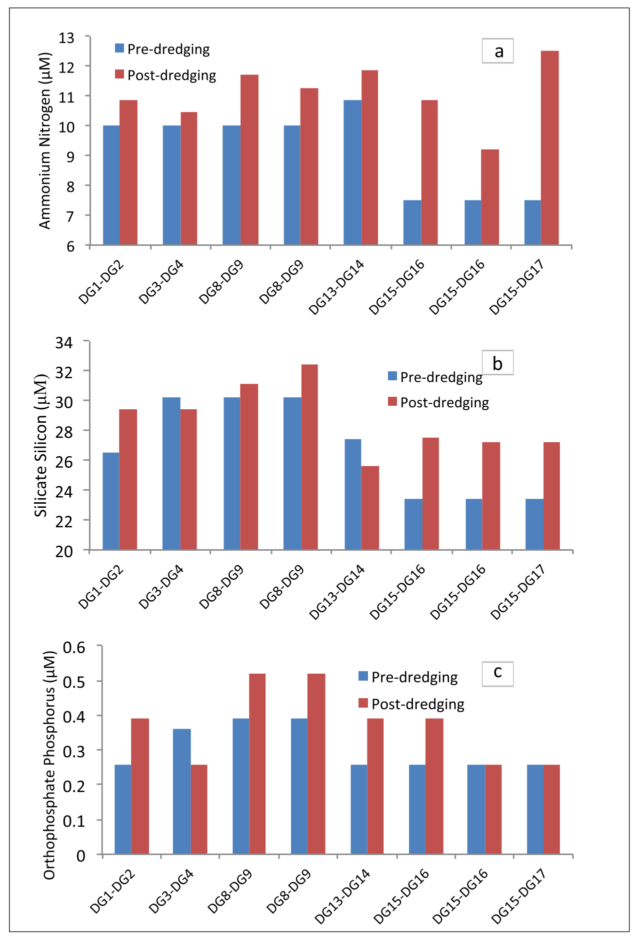

Fig. 6. Nutrient concentration in pre and post dredging operations; (a) Ammonium-Nitrogen (NH4+-N); (b) Silicate-Silicon (Si(OH)4 –Si); (c) Orthophosphate-Phosphorus (PO43--P)

Silicate-Silicon (Si(OH)4-Si)

Concentration of Si(OH)4-Si increased in some tracks after the dredging operations, i.e., DG1-DG2, DG8-DG9, DG15-16 and DG15-17. In two tracks, namely DG3-DG4 and DG13-14, the concentration marginally decreased. The range of Si(OH)4-Si concentration in pre dredging was 23.40-30.20 μM with an average of 26.85 μM. Post-dredging, the concentration ranged from 25.67 to 32.46 μM with an average of 28.75 μM. Track DG15-16 registered the highest difference between pre and post dredging, where it increased from 23.40 μM to 27.55 μM. In the track DG3-DG4, the Si(OH)4-Si concentration marginally decreased from 27.40 μM to 25.67 μM (Fig. 6b).

Orthophosphate-Phosphorus (PO43--P)

Concentration of PO_4^{3}--P increased in five of the eight tracks after the dredging operation (Fig. 6c). The range of PO_4^{3}--P concentration in pre dredging was 0.26-0.39 μM with an average of 0.29 μM. Post-dredging, the range was 0.26-0.52 μM with an average of 0.39 μM.

Discussion

The following changes were observed due to clam dredging operation: (i) Total Suspended Solid (TSS) increased by 6.5 times; (ii) consequently, water transparency reduced by half; (iii) dissolved oxygen concentration was marginally higher, which may be the result of propeller of the dredge vessel mixing air and seawater; and (iv) the nutrient sources of phytoplankton , i.e. Ammonium-Nitrogen, Silicate-Silicon and Orthophosphate-Phosphorus marginally increased. Si(OH)4-Si, an essential nutrient for diatoms was found in higher concentration in Ao Sam Roi Yod Bay; and NH4+-N was found in higher concentration around Paknam Pran estuary after dredging operation. Nutrient enhancement by dredging operation would directly influence the concentration of chlorophyll *a*. By the combinations of all these factors, the growth of phytoplankton would be enhanced, potentially causing red tide phenomenon after the dredging season.

High turbidity directly impacts the respiration of marine organisms, particularly the slow swimming demersal fishes (Siri and Permsak, 1985). The sediments block gas exchange in the gills and cause mortality of marine animals by hypoxia. Sediment cover and low turbidity also affect hatching of fish eggs. Pelagic fish and fast swimming fish may escape from turbid areas. Hall and Spencer (1999) recorded the picture of beam trawl track on sandy bottom in Adriatic Sea and reported that suspended sediments from trawling reduced light penetration and underwater visibility from 20 m to 0 m at a height of 1 m above sea bottom. They also reported that it takes 15 hours for the area to return to natural visibility. Chayarat (2007) reported that suspended solids and reduced transparency resulted in a shallower eupohotic zone. The primary productivity, in particular Chlorophyll *a*, reduces in areas of high turbidity.

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References

Chayarat, T. 2007. Relationships between Environmental Factors and Production Potential of Razor Clam (*Solen* spp.) at Don Hoi Lord, Samut Songkhram Province. Thesis Master of Science, Department of Marine Science, faculty of Fisheries, Kasetsart University, Thailand. 219 pp. (In Thai)

Department of Fisheries Thailand. 1992. Undulated Surf Clam in Thailand. Marine Fisheries Division, Department of Fisheries, Bangkok, Thailand. 62 pp. (In Thai)

Department of Fisheries Thailand. 2011. Fisheries Statistics of Thailand. Information Technology Center, Department of Fisheries, Bangkok, Thailand. 91 pp. (In Thai)

Hall-Spencer J.M. 1999. Effect of Towed Demersal Fishing Gear on Biogenic Sediments: A 5- Year-Study. Institute of Biomedical and Life Sciences, Graham Kerr Building, University of Glasgow, Scotland. 15 pp.

Isara Chanrachkij. 2012. Environmental Impacts of Undulated Surf Clam (*Paphia* spp.) Dredge Fishing: Case Study in Paknam Pranburi Estuary and Adjacent Areas, Pranburi District and Sam Roi Yot District, Prachaub Khiri Khan Province, Thesis Master of Science, Department of Marine Science, Faculty of Fisheries, Kasetsart University, Thailand. 354 pp. (In Thai).

SEAFDEC/TD. 2004. Fishing Gear and Method in Southeast Asia I: Thailand. Revised edition. Training Department, Southeast Asian Fisheries Development Center. Samutprakarn. 416 pp.

Shettapong Meksumpum. 1998. Red Tide. Department of Marine Science, Faculty of Fisheries, Kasetsart University, Thailand. 81 pp. (In Thai)