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Coastal debris analysis in beaches of Chonburi Province, eastern of Thailand as implications for coastal conservation

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ABSTRACT

This study quantified coastal debris along 3 beaches (Angsila, Bangsaen, Samaesarn) in eastern coast of Thailand. Debris samples were collected from lower and upper strata of these beaches during wet and dry seasons. The results showed that Bangsaen had the highest average debris density (15.5 m^{-2}) followed by Samaesarn (8.10 m^{-2}), and Angsila (5.54 m^{-2}). Among the 12 debris categories, the most abundant debris type was plastics (>45% of the total debris) in all beach locations. Coastal debris distribution was related to economic activities in the vicinity. Fishery and shell-fish aquaculture activities were primary sources of debris in Angsila while tourism activities were main sources in Bangsaen and Samaesarn. Site-specific pollution control mechanisms (environmental awareness, reuse and recycling) are recommended to reduce public littering. Management actions in Angsila should focus on fishery and shell-fish culture practices, while Bangsaen and Samaesarn should be directed toward leisure activities promoting waste management.

1. Introduction

Coastal and marine debris are defined as any kind of manufactured or synthesized solid waste material that floats toward the marine or coastal area by any source (Coe and Rogers, 1997). The most common sources of marine and coastal debris include shoreline recreational activities, oceanic sources, smoking, and waste dumping into the sea or beach (Ocean Conservancy, 2010). Both coastal and marine debris have negative ecological and socio-economic effects on fishery, shipping and recreational activities by diminishing the aesthetic beauty of coastal amenities (Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF, 2012). Coastal debris negatively affects the coastal and marine biota in several ways such as accidental ingestion, entanglement, new habitat provision, and organism dispersal via the transport of invasive species (Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF, 2012). Consequently, the structure and functions of the ecosystem as well as services it provides are adversely altered.

Different methods have been employed for the quantitative assessment of coastal and marine debris in various parts of the world. The most well-known survey methods include ocean-based boat surveys (Thiel et al., 2003: Shiomoto and Kameda 2005), beach surveys (Scott, 1972; Corcoran et al., 2009) and aerial surveys (Pichel et al., 2007). The Asian continent, including Thailand is considered as hot spots of marine and coastal debris accumulation, which results from rapid economic development, increased coastal population, lifestyle alteration, weak management systems, and poor awareness about the proper disposal of products at the end-of-life (Jang et al., 2014, Ping, 2011).

Chonburi Province, which is located in eastern coast of Thailand, is the closest coastal area to the capital Bangkok. As such, this coastal region has become a major economic ecosystem for fishing, recreation, tourism and most notably, human settlement. The accumulation of marine and coastal debris in this region has gradually increased causing negative impacts on coastal ecosystems and the quality of life. In recognition of this growing problem, the Thai government and non-government organizations (NGOs) have implemented various management measures such as intermittent beach cleaning (Central database system and data standard for marine and coastal resources, 2013). However, such coastal debris management regimes would be inadequate to address the issues without reliable scientific information on quantity and its variability of coastal debris. Furthermore, currently published data are insufficient to identify site specific management priorities of regional coasts in Chonburi Province. Hence, this study explored quantitative and qualitative evaluation of the composition, seasonal, and spatial

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variability and sources of origin of coastal debris. Although the research findings of this study would contribute for development of site-specific management practices in the Chonburi coastal area, the analytical methods used in this study would be relevant and replicable to other coastal areas of Thailand as well as other countries.

2. Materials and methods

2.1. Study sites

Three sandy beaches in Chonburi Province, upper Gulf of Thailand were selected as the study areas (Fig. 1). These beaches include Angsila, Bangsaen, and Samaesarn which are known for different anthropogenic activities such as local tourism and fishery (having close proximity to the fishing pier, the fishing village and the sea food market). The three sites satisfied the following criteria recommended by the AMETEC protocol (Jang et al., 2014): being a sandy beach, having a sufficient coastal line with at least 100 m, and being uninfluenced by rivers. Bangsaen beach (13° 17′ 55.4″ N 100° 54′ 08.0″ E) is a local tourism based straight coastline, Angsila beach (13° 18′ 57.56″ N; 100° 55′ 4.44″ E) is a coastal fishery village with narrow coastal strip. Samaesarn beach (12° 33′ 58.72″ N; 100° 56′ 57.95″ E) in Sattahip District is known for commercial fishing, recreational fishing and tourism activities.

2.2. Survey design and sample collection method

Repeated-measures approach was used to evaluate the temporal and spatial variability of the composition and abundance of coastal debris (Zuur et al., 2009). Debris samples were collected during both dry (mid-February to mid-May) and wet season (mid-May to mid-October) in 2015. Debris sampling was conducted three times per season during low tide (minimum — 0.99 m in July 2015, maximum — 2.00 m in May 2015), as it provided the maximum beach surface area for sample collection during low tide (Thailand Tide Chart – Mobile Geographics, 2015). Wide belt transects (10 m × 2.5 m) were positioned parallel to the shoreline as shown in Fig. 2. Three transects were placed on the upper stratum of the beach (i.e. the back of the beach, which is characterized by coastal vegetation or roads and high-tide wrack marks). Also another three transects on the lower stratum were placed in the intertidal zone. Each belt transect was located using GPS coordinates to ensure that they were placed in the same position during replications of the survey. Two trained people collected all surface debris in each transect by walking in a perpendicular direction to the water edge. The surface sand of each belt transects was dug (approximately 5 cm) using fingertips and then sieved using 1 mm sieves. Debris samples were transferred into sealed bags, labeled and stored for further analysis. Relatively larger debris that was difficult to collect were measured and recorded on site.

2.3. Composition analysis and quantification of debris

At the initial stage of composition assessment, the collected debris were classified under 11 broad categories: general plastic, food waste, styrofoam, glass, medical/personal hygiene related items, metal, paper, smoking/firework items, rubber, wood and cloth (Nualphan, 2013; Rosevelt et al., 2013). A hand lens/magnifier was used to identify sieved minute debris particles and differentiate natural or biological matter from synthetic debris. The debris were subsequently subdivided into 47 specific subcategories/litter items based various factors, such as origin, type of materials, utility/importance. The data were recorded separately in the data sheets in accordance with the recommendations of the International Coastal Cleanup (ICC) protocols (Ocean Conservancy, 2007). For each category, the debris were counted, and weighed by using a hand-held digital balance (to 0.1 g; TANITA, KD1927301RD) under the existing state (wet or dry). Debris density was defined as the numbers of debris found per transect (25 m^2). The volumes (mL/transect) of each debris type was measured using garbage bags with a known volume. The length of each debris fragment was identified using a measuring tape and categorized into three class sizes, namely micro debris (<2 mm), meso (2 mm–2 cm), and macro (>2 cm) to assess the abundance of the different sizes of debris. The litter items were then discarded into garbage bins, ensuring that no environmental

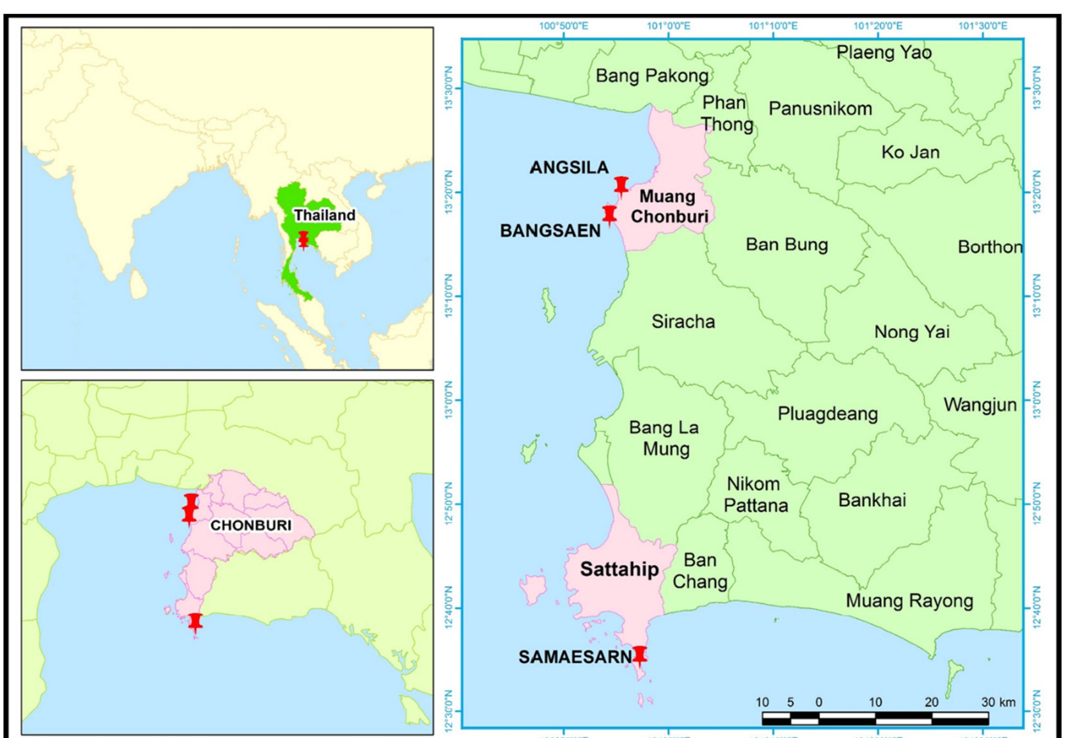

Fig. 1. Sampling sites in eastern coast of Thailand.

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