Geoderma xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

The distribution and morphology of microplastics in coastal soils adjacent to the Bohai Sea and the Yellow Sea

Qian Zhou[a,b], Haibo Zhang[a,c], Chuancheng Fu[a,b], Yang Zhou[a], Zhenfei Dai[a,b], Yuan Li[a,b], Chen Tu[a], Yongming Luo[a,b,*]

[a] Key Laboratory of Coastal Zone Environmental Processes and Ecological Remediation, Yantai Institute of Coastal Zone Research, Chinese Academy of Sciences, Yantai 264003, China
[b] College of Resources and Environment, University of the Chinese Academy of Sciences, Beijing 100049, China
[c] Key Laboratory of Soil Contamination Bioremediation of Zhejiang Province, School of Environmental & Resource Sciences, Zhejiang Agriculture and Forestry University, Hangzhou 311300, China

ARTICLE INFO

Keywords:
Microplastics
Coastal soils
Shape types
Abundance
Spatial distribution
Surface morphology

ABSTRACT

Microplastics (< 5 mm) are considered to be emerging pollutants of global concern. Investigations on microplastics pollution in coastal and marine environments have increased recently but knowledge gaps still exist regarding microplastics in coastal beach soils with high-intensity human activities. In the present study a total of 120 soil samples were taken from 53 sites along > 3000 km of coastline in Shandong province, east China, adjacent to both the Bohai Sea and the Yellow Sea coastlines under different land use management. Microplastics were separated from the soil samples using a continuous flow and floating separation apparatus. The shape type, size, abundance, spatial distribution, polymer composition and surface morphology of the microplastics were identified by a range of advanced microscopic and micro-analytical methods. The analytical results show that seven shape types, namely foams, pellets, fragments, flakes, fibers, films and sponges, were present in the beach soils. The polymer composition of the microplastics included polyethylene, polypropylene, polystyrene, polyether urethane and a polymer blend of both polyethylene and polypropylene. Approximately 60% of the observed microplastics had a size range < 1 mm. Microplastic abundance varied greatly among the soils, ranging from 1.3 to 14,712.5 N kg^{-1} (dry weight) as influenced by high-intensity human activities such as mariculture, tourism, and port construction. The seven shape types of microplastics from the coastal environment had different weathering surface morphologies, showing scratches, creases, micropores, cracks, either concave or convex, and of various shapes and sizes, possibly due to physical friction, photochemical oxidation and/or animal attack. Algae or crude oil was observed on the surface of some microplastics. The weathered surfaces of microplastics might act as a high-capacity carrier with adhering microorganisms and chemicals. Further studies are required on the weathering processes, sorption capacity and transport of microplastics especially in smaller size (< 1 mm) under coastal conditions.

1. Introduction

The occurrence of microplastics (< 5 mm) in coastal and oceanic environments has gained global recognition due to their threats to the marine environment and ecology (Law and Thompson, 2014). An estimated 4.8 to 12.7 million metric tonnes of plastic debris enter the oceans annually (Jambeck et al., 2015) and may be a secondary source of microplastics through fragmentation. Microplastics are ubiquitous in the offshore and coastal zones, especially in coastal areas with high-intensity human activities.

The widespread occurrence of microplastics in sea water and sediments has been surveyed worldwide, covering beaches, estuarine and sub-tidal habitats, surface waters and bottom sediments of seas and inland lakes (Browne et al., 2011; Browne et al., 2010; Woodall et al., 2014; Desforges et al., 2014; Zhou et al., 2015; Su et al., 2016). However, the status of the shape types, abundance, distribution and morphologies of microplastics in coastal beaches, especially in coastal soils with high-intensity human activities, adjacent to the Bohai Sea and the Yellow Sea, east China, are poorly understood. Limited investigations on the microplastics in the beaches close to Bohai Sea were

* Corresponding author at: Key Laboratory of Coastal Zone Environmental Processes and Ecological Remediation, Yantai Institute of Coastal Zone Research, Chinese Academy of Sciences, Yantai 264003, China.
E-mail address: ymluo@yic.ac.cn (Y. Luo).

https://doi.org/10.1016/j.geoderma.2018.02.015
Received 13 December 2017; Received in revised form 4 February 2018; Accepted 8 February 2018
0016-7061/ © 2018 Elsevier B.V. All rights reserved.

reported recently by Yu et al. (2016) and Zhou et al. (2016).

The coast of Shandong province in east China is > 3000 km long corresponds with parts of the Yellow Sea and the Bohai Sea. There are seven cities along the coast with a population of > 34 million (Shandong Statistical Yearbook, 2016). Mariculture, tourism, transportation, oil production, mining, salt harvesting, sea fishing and port construction and reclamation have developed intensively in recent years. The economy is booming and population growth has led to the introduction of large quantities of plastic debris into the coastal beaches and the seas (Bulletin of Marine Environmental Quality of China, 2016). However, the occurrence and sources of the microplastics remain to be systematically investigated. Coastal beaches of Shandong province were therefore selected to study contamination with microplastics. The objectives were to investigate the shape type, size, composition, abundance, distribution and surface morphology of microplastics in the coastal beach soils and to examine the relationship between the occurrence of microplastics and intensive human activities in the coastal zone.

2. Materials and methods

2.1. Sampling

A total of 120 soil samples from 53 coastal beach sites were collected during April and May 2015 from northern Dongying city to southern Rizhao city, along > 3000 km of coastline in Shandong province, east China, covering parts of both the Bohai Sea and Yellow Sea coastlines under different land use patterns. The sampling sites were selected according to high-intensity human activities and different land use patterns, covering tourist beaches (TBs), beaches adjacent to mariculture areas (MBs), beaches near fishing ports (PBs) and undeveloped beaches (UDBs) as shown in Fig. 1.

The soils were sampled from roughly the top 2 cm of the profiles in the intertidal zone between the waterline and high tide line using a clean stainless-steel shovel. Two or three replicate samples from each site were taken randomly using a multipoint mixed method and the mass of each sample was about 4 kg. Wet sediment samples were homogenized and analyzed immediately after transfer to the laboratory. The water content of the soil samples was determined by mass loss after drying in an oven at 105 °C for > 12 h. The abundance of microplastics was therefore determined based on the dry weight of the soil samples.

2.2. Separation of microplastics

The separation method and apparatus for microplastics from the soil samples was established and improved based on Nuelle et al. (2014). Briefly, a continuous flow and floating separation apparatus was set up, composed of air-induced overflow and wet sieve, that can separate the microplastics from soils or sediments efficiently based on air flotation and density separation using saturated sodium chloride solution ($\rho = 1.2\ g\ cm^{-3}$). Then residue in the sieve (300 mesh) was collected in glass dishes cleaned using ultrapure water before use. The residues were further floated using a saturated solution of sodium iodide ($\rho = 1.6\ g\ cm^{-3}$) and filtered if they contained a large number of solid particles. The separated samples were then covered with aluminum foil and air dried until further analysis in the laboratory.

2.3. Classification and enumeration of microplastics

Samples were observed under the magnifying glass or stereomicroscope (SMZ25, Nikon Corporation, Tokyo, Japan). Particles which were visually identified or suspected to be “plastics” (see Nor and Obbard, 2014) were transferred from the residues to clean, black and smooth cardboard, and classified according to shape. All particles transferred to the cardboard were photographed using a digital camera (Coolpix P510, Nikon) for particle counting and size measurement.

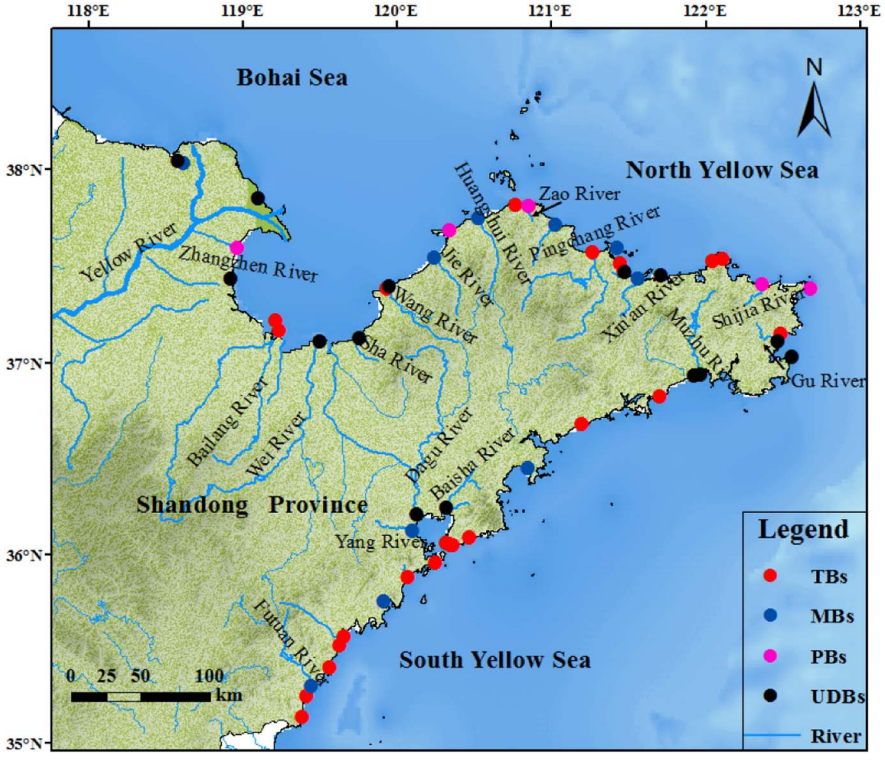

Fig. 1. Sketch map showing the sampling sites on the coastline of Shandong province, east China. (Note: TBs refers the tourist beaches, MBs refers the beaches adjacent to mariculture areas, PBs refers the beaches near fishing ports, UDBs refers the undeveloped beaches.)

Download English Version:

https://daneshyari.com/en/article/8894083

Download Persian Version:

https://daneshyari.com/article/8894083

Daneshyari.com