year month day
2014 1 16

Department	Environment and Life Engineering	ID	119403
Name	Tomoya Kataoka		

Supervisor	Shigeru Kato Takanobu Inoue

Abstract

Title	Measurement and application of residence time of plastic litter on beaches

(800 words)

Understanding of residence time of plastic litter on beaches is crucial to take measures in plastic pollution. In this study, the residence time is measured on a beach, and the application of the residence time to beach clean-ups is discussed.

Firstly, we measured the residence time of certain fishery floats through two-year mark-recapture (MR) experiments on Wadahama Beach, Niijima Island, Japan. The remnants of floats have decreased during two year according to exponential function. This enables us to consider that the floats are backwashed offshore at a constant rate regardless of the magnitude of the storm events in the experiment period. The residence time was calculated from the exponential decay of remnants, which was 224 days. In addition, to clarify the physical mechanism determining the residence time on the beach, we investigate the movements of floats. The floats were accumulated in two areas of Wadahama Beach with moving northward and southward. And the extent of floats was significantly correlated with the decreasing rate and the frequency of event that wind-waves run up until backshore. In addition, the highest concentration area of floats corresponds to the accretion area of alongshore sediment transport. Therefore we assume that the floats are accumulated by being transported by longshore currents, and are backwashed offshore in the transport process.

To demonstrate the assumption for the backwash process, we investigated the physical mechanism of backwash of floats found on Wadahama Beach through the two-year MR experiments in situ and numerical experiments to identify where the floats are backwashed offshore. We calculated the residence time in each 100-m transect divided 900 m long into nine transects based on the beached position investigated by the MR experiments. The residence time in the 100-m transect corresponding to the highest concentration area was the closest to the true residence time (224 days). This suggest that the floats were frequently backwashed offshore near this 100-m transect. The suggestion was supported by the numerical experiments. These findings demonstrated our assumption of the backwash process of floats on Wadahama Beach.

Meaning of measurement of the residence time was confirmed by investigating the dependence of effects of the beach clean-ups on the residence time based on a linear system analysis. We have focused on three beach clean-up effects (BCEs): improvement of landscape on a beach, decrease of total mass of toxic metals and prevention of generation of plastic fragment. The BCEs depend strongly on a dimensionless residence time divided the residence time by the period of litter input flux (litter input period), and the BCEs become high as the dimensionless residence time is longer. And also the BCEs depend on the time when the beach clean-ups are conducted, and the beach clean-ups when the remnants of floats become the peak (cleaning time) are more effective. Therefore it is crucial to understand the three factors for effective clean-ups: the residence time, the predominant litter input period and the effective cleaning time.

To understand the predominant litter input period and the effective cleaning time (i.e. when the remnants become peaks), we attempt to develop a new technique on Sodenohama Beach in Tobishima Island, Japan for sequential monitoring of remnants of plastic litter on sites where plastic litter with various colors have been stranded. The new technique is described as following three steps: (1) Color references (ellipsoid bodies in CIELUV color space) to detect plastic pixels from images are generated by converting RGB values obtained from the original photographs into CIELUV values. (2) The plastic pixels are detected using the color reference and a composite image method. (3) The area covered by plastic litter (covered area) is calculated by applying a projective transformation to webcam images. We successfully monitored the temporal variability of the covered areas on Sodenohama Beach during 14 months. The advantage of this technique is to detect plastic pixels with various colors except black and transparent. The new technique enables us to sequentially monitor the temporal variability of remnants of plastic litter on various beaches.