Longitudinal sampling design and instrument development for investigation of microplastics in costal sediments

R.A. Hansen[1], A. Gross[1]

[1]Department of Business and Technology, University of Aarhus, Herning, 7400, Denmark
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Presenting author e-mail: rah@btech.au.dk

Background

More than five trillion pieces of plastic already exists in the oceans (Eriksen, Lebreton et al. 2014), and it is estimated that between 4.8 and 12.1 million tonnes of plastics enter the marine environment from land sources annually (Jambeck and Geyer (2015). Additional research shows that weathering makes plastics degrade into small piece (Andrady 2011) of which the majority is estimated to be less than 5mm in size (Brandon, Goldstein et al. 2016). These small particles are referred to as MicroPlastic (MP) (Thompson, Olsen et al. 2004). The big questions are: Which impact does MPs have on our environment? Where/How is MPs transported in our food chains? Before these major questions can be answered, it is necessary to identify the sources of MPs into the nature. The majority of the research which has focus on source determination of MPs has focused on MP sampling on oceans and larger seas – only limited attention has been on MP in the costal sand sediment. Furthermore, despite the increasing interest in MP there are still no Standard Operation Procedure (SOP) in respect to sampling of MPs from costal sediments. National Oceanic and Atmospheric Administration has proposed a SOP (Masura, Baker et al. 2015), including using small shovels for sample excavation. This study proposes a new SOP with rigorous focus on a set of easy repetitive steps using newly developed sampling device in order to insure a uniform sampling methodology. The amount of available data continuous grow rapidly, thus establishing such SOP is very important since it provide ability to benchmark across studies. Based on this the purpose of this study is twofold: (1) Building of a multi-seasonal sampling data set and (2) development and testing of appropriate instrumentation and SOP.

Method and Materials

Nine sampling sites from Denmark and Sweden were selected to provide a sampling pattern covering the coastal areas surrounding the inner Danish water of Kattegat (Fig.1). Even though, Kattegat extends to include waters south from Funen and Zealand sampling site the Funen and Zealand location will also represent the MP imprint south from these sampling sites. The eastern sampling area of around 190 km is a coastal area with only little coastal sand sediments are covered by three locations. The total sampling area is of ca. 553 kilometres; see red line in figure 1.In order to estimate variation at different spatial levels, a nested sampling methodology was adopted (Morrisey et al., 1992). On the individual sampling stations, sampling procedure follows one adapted from Fauziah and Liyana et al. (2015) where two transects is measured (45 meters in total, three stations with 15 meters apart) (1) one at the lowest tidal line on the beach section (2) one parallel with 15 meters measured perpendicular to the first line. A considerable part of research still utilise simple tools, e.g. table spoons (Cooper, Corcoran 2010) or handpicked (Turner, Holmes 2011) for excavation purposes when sampling. Therefore, instrument development is important to ensure reliable results which can be compared across studies. Figure 2 shows a newly developed excavation device capable of delivering fast and similar excavations across individual stations on a site. Internal dimensions measuring 30 by 30 cm, and height of inner chamber is 13 cm. Two flanges are positioned opposite to each other to ensure a uniform depth in each excavation and levers to push the device firmly into the sediment prior to sampling. All components are constructed from stainless steel to prevent rust and corrosion from the saline marine environment.

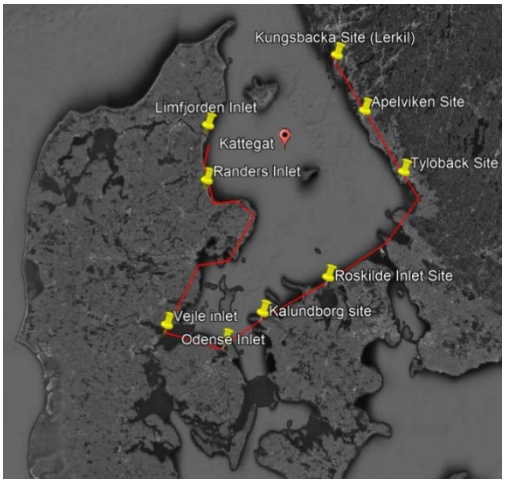

Figure 1: Sampling locations in Denmark and Sweden and covered coastal area

Results

Initial studies of the new sampling methodology has been conducted covering five Danish locations. In Fig. 1 is the geographic position of the sites presented, and in Fig. 3 is the amount of the MPs, found at the different sites split in spheres, fragments, fibres and unknown presented. We observe that only $\approx 22 m^{-3}$ fragments and $\approx 11 m^{-3}$ fibre were identified at Limfjorden Inlet, while 11 to 18 times more MPs particles ware identified at the other four sites. This large difference between the amounts of identified MPs can be explained from how the five sites are

located in relation to the water in-/outflow to Kattegat – the Limfjorden inlet is located parallel to the water in/outflow, while the other four sites are located perpendicular to the inlet.
Furthermore, two samples (an X- and Y-sample) from Odense inlet are presented in Fig. 3. X-sample is taken at the water's edge while the Y-sample is displaced 15 meters in parallel up the shore. A few lesser MPs particles were identified for the Y-samples compared with the X-sample but the difference is not significant. However, the four X-sites located perpendicular to Kattegat inlet loo-alike, almost the same number of MPs was identified the four fractions this indicate that the MP affect the costal marine environment originates from the sea. The dominant particles were black fragments and blue fibrous particles. Spherical particles indicating microbeads are present but only in limited quantities as identified in Fig. 3 Finally, the different MPs types and quantities found in the Danish marine environment is supported by other studies e.g. Strand, Lassen et al. (2014).

Figure 2: Newly developed excavation device for microplastic sediment sampling

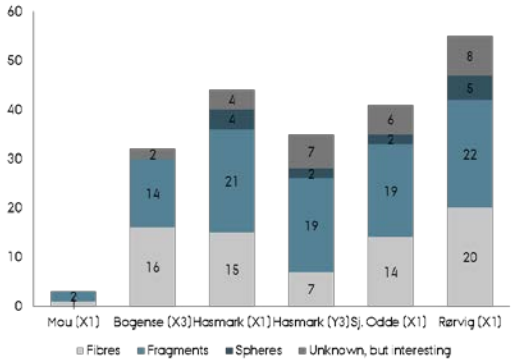

Figure 3: Results coverings some Danish locations

Discussion and Conclusion

We have presented a new SOP involving a new developed sampling device to insure a uniformly sampling methodology. Such an approach is needed if research studies from different research groups should be able be compared, and this will give the scientific community a better understanding of the impact MPs have on our environment. **Future research** is needed, this short abstract only provide initial and consequently limited result on the approach. Continues data will be provided in the years to come.

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