Discussion

Our findings demonstrate that the highest POM content is unexpectedly found on beaches where kelp has been cleared. Moreover, it was observed that POM content does not generally differ monthly. This may mean that POM content is not influenced by seasonality. Although, this might not be a plausible inference since the study took place only over three months. It has been observed that on beaches with heavy wrack loadings, an anoxic layer forms beneath the seaweed having a hostile effect on meiofauna (McGwynne et al. 1988). This could explain why there is less POM on uncleared beaches. However, on those beaches with smaller amounts of seaweed, the nutrients from the algal leachates and seaweed inhabitants’ faeces percolate to the interstitial microorganisms and meiofauna (White et al. 2005). Of the microbial regeneration of nutrients from kelp wrack, 95% of nitrogen may be returned to the sea (Koop et al. 1982); concentrations of nitrate and phosphate are higher in coastal waters where beaches are adjacent with accumulations of wrack (Robertson and Hansen 1982). Therefore, a disadvantage could be that removing seaweed regularly from an area could interfere with nutrient recycling from faecal matter and may deprive interstitial organisms of the dissolved organic material that is leached from the kelp (Anderson et al. 1989).

The non-removal of kelp from the focused beaches of this study may be beneficial. Indeed, the higher POM content in the soil on some cleared beaches may contribute to the succession of dune vegetation (McKenna et al. 2000), given that dune formation is influenced by kelp wrack deposition higher up on the shore (Zemke-White et al. 2005). Although, additional input of POM across a certain threshold may not be detrimental, but rather poses no additional advantages on vegetation (Haslam and Hopkins 1996). However, little research has looked at the effect of POM in beach soils on the dune vegetation.

The increase of wrack generally brings an increase of decomposers, subsequently increasing POM and dissolved nutrients, respectively (e.g. Dugan et al. 2011). However, since kelp is absent in cleared areas, one would expect that the amount of POM should decrease. Furthermore, since the Cape Town Municipality facilitates kelp removal, regularly at the cleared areas, (Yoshikawa 2013) there is little time for decomposers to break down the kelp to the high POM content we observe. An explanation for the high POM content on cleared beaches may be related to wind (e.g. Moore 1972). Urbanization along the coast may promote blowback of sediment and, therefore, significantly increase the POM content when it should be expectedly low. We can then assume that with an increase in turbulence comes an increase in blowback of POM, although the wind may sometimes be strong enough to blow the particulate into the sea, a significant amount might still be lost on the sandy shore on the way to the sea. If urbanization was not present, or rather less prevalent, we might expect significant losses of particulate as it would be carried off by the wind and deposited elsewhere. Even markedly further from the site.

The high POM contents at Hout Bay West, Fish Hoek and Muizenberg may be related to the high number of dogs that are walked on these beaches, more specifically when kelp has not yet been removed from the beaches. These dogs are likely to deposit their faeces on the beach where, not only limited to Cape Town beaches, dog owners rarely remove the faeces from the beach (Wright et al. 2009). Dogs may excrete their faeces among the kelp, increasing the rate of decomposition and, therefore, increase the POM content resulting in a high content once the kelp has been removed (Martin and Gruber 2005). The way this may occur is in the high number of microbes that are present in dog faeces (Martin and Gruber 2005). Additionally, trampling of POM into the beach soil by both dogs and humans may serve to increase the rate at which particulates are incorporated into the beach soils and, consequently, the point at which they are most accessible for processing by microbes. Indeed, the amount of trampling events may increase with the amount of people and animals present. One would also expect that this would increase with seasonality since people would choose to walk on the beach and walk their dogs in favourable. However, given the relatively short period of this study, this may not be significant to the obtained results. Nevertheless, these combined effects, along with wind blowback may therefore increase the POM content. Additionally, the storm drain present at Hout Bay West may leach nutrients into the beach soils promoting microbial diversity and abundance, therefore increasing the rate of decomposition of kelp. A similar inference may be true for Muizenberg where the Zandvlei estuary may also bring additional nutrients to the beach, via the estuary itself and from shore waves. However, this too occurs seasonally (Thornton et al. 1995) and, therefore, may not be of much significance.

Conclusion

We can conclude that there are different factors influencing the higher POM content in uncleared beach soils. A higher POM content brings about a higher diversity and abundance of microbial organisms. Whether this is of concern to the smaller beach ecosystem remains unclear and is to be considered in future studies. Indeed, more studies similar to this need to be conducted to further shed light on the relation of kelp removal to POM content in the soil on beaches and over a longer period of time.

This study focused on a single city's beaches, it would be interesting to compare the results of other beaches in other parts of the world and what action the authorities managing these areas may take. Moreover, since the method of kelp management by the Cape Town Municipality is to dispose of the kelp in landfills and not for commercial uses (Yoshikawa 2013), one must consider that the former method may result in a waste disposal problem on land. To use the beach-cast kelp as fertiliser may be a highly plausible method that would be of environmental and economic interest, which may also serve to partly replace the use of commercial fertilisers in urbanized coastal areas (Jöborn et al. 2001). Besides the supply of nutrients (which may be caused by growth hormones occurring in the macroalgae), the use of composted macroalgae improves the structure of the soil by increasing the content of humus (Haslam and Hopkins 1996). Additionally, if burial of kelp on site was accepted as a common method, the POM in the soil may increase prompting more activity in the soil on apparently cleared beaches. Griffiths et al. (1983) observed that particulate or dissolved kelp detritus becomes part of the sand column is taken up by those organisms found below the driftline, namely bacteria, nematodes and oligochaetes. The results from this study could act as a tool in further management of kelp wrack on Cape Town beaches to ensure the best management practices.

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