Micro litter in the urban environment: sampling and analysis of undisturbed snow

Microdéchets en milieu urbain : échantillonnage et analyse dans de la neige vierge

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RÉSUMÉ

Des microdéchets issus d'échantillons de neige vierge provenant de six sites de la ville de Luleå, dans le nord de la Suède, et d'un site témoin/référence dans les zones rurales à l'extérieur de la ville, ont été analysés. Tous les échantillons ont été prélevés par carottage sur toute l'épaisseur de neige, 72 à 106 cm d'épaisseur et datent de 107/8 jours. Les carottes de neige ont été fondues, puis filtrées à l'aide de filtres de 300 et 50 µm, laissant des particules de microdéchets qui ont ensuite été comptées et classées au microscope. On y a trouvé des fibres naturelles et synthétiques, des fragments de plastique, du caoutchouc noir et d'autres particules noires anthropiques. Les résultats ont montré que les fibres présentes dans la neige étaient du même ordre de grandeur que celles dans les eaux usées non traitées et les retombées atmosphériques. Les particules de caoutchouc n'ont été détectées que dans la neige prélevée aux abords des routes très fréquentées, ce qui indique que cette granulométrie de caoutchouc ne se déplace pas très loin. Des particules de combustion ont été détectées en très grande quantité dans tous les échantillons. Elles proviendraient du trafic (sites centraux) et du chauffage au bois (sites résidentiels). Les fragments de plastique représentent la catégorie la moins détectée dans cette étude et on n'en dénombre que quelques-uns par litre de neige fondue.

ABSTRACT

Micro litter was analysed in undisturbed urban snow samples from six sites in the Town of Luleå, Northern Sweden and one control/reference site in the rural areas outside the city. All samples were taken through the whole snow depth, 72-106 cm deep and 107/8 days old, using a snow core sampler. The snow samples were melted, filtered consecutively on 300 and 50 µm filters, and finally analysis of micro litter particles on the filters were counted and categorised under a microscope. The categories were natural and synthetic fibres, plastic fragments, black rubber and other anthropogenic black particles. The results showed that fibres were in the same order of magnitude in the snow as in untreated wastewater and atmospheric fallout. Rubber particles were only detected in snow from the sites near trafficked roads indicating that this size range of rubber does not transport very far. Combustion particles were detected in the highest concentration in all samples. These are proposed to originate from traffic (central sites) and wood burning (residential sites). Plastic fragments were the least detected category in this study corresponding to only a few items per litre of melted snow.

KEYWORDS

Atmospheric deposition, microplastics, micro litter, urban environment

1 INTRODUCTION

Microplastics are today ubiquitous in the marine environment, in the sediments as well as in the water column (Eriksen et al. 2014), and studies in freshwater bodies indicate a similar situation (Wagner et al. 2014). Once within a receiving waterbody, microplastics may be ingested by aquatic fauna and either incorporated in their tissue or excreted in faeces. In addition, due to their hydrophobic properties, microplastics have a propensity to adsorb a wide range of organic substances such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls and pesticides (Frias et al. 2010) and thereby they may further increase the transport and, subsequently level of organism exposure, to these pollutants. Activities and materials in the urban environment are believed to be a major source of microplastics and other type of micro litter in the aquatic environment. The micro litter is transported from the urban to the marine environment for example via wastewater, runoff and atmosphere (Dris et al., 2016; Magnusson et al. 2016). The particles can for example be tire wear (rubber), textile fibres (natural, synthetic or mixtures) asphalt wear and plastic fragments.

The aim of this study was to investigate the presence and quantities of different categories of micro litter, including microplastics, in the urban environment and variations depending on land use. This was done by taking snow samples from undisturbed snowpacks.

2 METHODS

Snow samples were taken at six locations in the Town of Luleå, Northern Sweden: Two locations in the city centre of which one was close to a trafficked road (24000 average daily traffic, denoted B1) and one was situated in a park (B2). Two other locations were selected in a residential area, one in the back yard of a detached private house (C1) and one in the courtyard of apartment buildings (C2). The remaining two sites were located in a light industry/commercial area (D1 and D2). In addition, one reference/control site was selected in the rural areas outside Luleå (A).

Snow cores were taken through the whole snow depth using a SnowHydro SWE Coring Tube, 160 cm long and 62 mm inner diameter. The snow depth was between 72 and 106 cm and was 107 to 108 days old since the first day of snow fall until the day of sampling. The samples were directly transferred to clean glass beakers and covered with aluminium foil to protect from contamination. The core sampler was cleaned upon arrival to every new site by taking three snow cores that were discarded before sampling began. All samples were taken and processed in duplicates and at site B1 a blank sample was prepared by leaving a glass beaker open while taking a snow sample. The blank sample was further processed along with the other samples. All samples were stored in a freezer until the day before filtration (described below) when they were placed in room temperature to melt over night.

The melted snow samples were consecutively filtered over 300 and 50 µm plankton nets in a stainless steel apparatus. All sample handling was restricted to a laminar flow hood. After filtration, the filters were transferred to petri dishes awaiting analysis. Analysis was carried out under a microscope (Nikon SMZ-U ZOOM 1:10) on 75 times magnification. Micro litter particles on each filter were counted and categorised following a procedure and protocol similar to those described by e.g. Dris et al (2015) and Norén (2007) in order to separate biological from synthetic material. This ended up in five categories: Natural fibres, synthetic fibres, plastic fragments, black rubber and other black anthropogenic particles (e.g. road wear and combustion particles).

3 RESULTS AND DISCUSSION

Table 1 presents the concentrations of micro litter in the melted snow and calculated daily surface loads measured at the seven sites. The two size fractions (50-300 µm and >300 µm) are summarised for this study. However, in general a higher number of particles was detected in the smaller size fraction.

On average, the distribution between synthetic and natural fibres was equal. The calculated surface loads of synthetic fibres was coherent with the results from a study of atmospheric outfall of synthetic fibres conducted in Paris when the surface load of synthetic fibres was estimated to be in the range 2-355 fibres/m^2/day. However, in that study the sampling was conducted on roof tops and not ground level. The concentration of fibres in the size fraction >300 µm (data not shown) was compared to those measured in incoming wastewater (in the same size fraction) to two Swedish wastewater treatment plants (Setälä et al. 2016). In that study the number of synthetic and natural fibres were 7-12 items/L and 65-90 items/L, respectively, to be compared with 8-16 items/L and 8-36 items/L, respectively, in this study.

Table 1 Micro litter in undisturbed urban snow calculated as concentrations in melted snow and daily surface loads. The two size fractions 50-300 µm and >300 µm are summarised.

Site	Natural fibres		Synthetic fibres		Plastic fragments		Black rubber		Other black	
	L^{-1}	$m^{-2}d^{-1}$	L^{-1}	$m^{-2}d^{-1}$	L^{-1}	$m^{-2}d^{-1}$	L^{-1}	$m^{-2}d^{-1}$	L^{-1}	$m^{-2}d^{-1}$
A	20	43	22	38	n/d	n/d	n/d	n/d	155	305
B1	90	134	95	142	3	5	34	51	1600	2380
B2	97	179	101	186	n/d	n/d	39	72	834	1520
C1	46	106	70	163	n/d	n/d	n/d	n/d	695	1620
C2	93	180	55	106	n/d	n/d	n/d	n/d	357	685
D1	107	161	94	140	3	5	39	58	587	882
D2	36	103	69	115	5	11	n/d	n/d	600	991

While fibres were detected in same concentration range in all urban snow samples, black rubber particles were only detected at the sites located near trafficked roads, i.e. one of the central sampling sites and both sites in the light industry/commercial area. It seems like these type of particles are not transported very far. If smaller size fractions, <50 µm, were to be analysed it is though possible that rubber particles would be detected since smaller and lighter particles are more easily transported in air (Thorpe & Harrison, 2008).

The most common category in this study was “other black” particles. These include combustion particles. The highest concentrations were measured in the city centre and the reason for this is proposed to be traffic. Concentrations in the same levels were also measured in snow from the residential site, this is proposed to be due to wood-burning in the households indoor and outdoor fireplaces, an activity which is known to increase during the winter season.

4 CONCLUSIONS

In this study micro litter >50 µm was successfully measured in undisturbed urban snow samples from six urban sites and one rural control site. The most common category of micro litter was anthropogenic black particles originating from road wear and combustion. The second common category was fibres (natural and anthropogenic). Rubber particles were detected in samples from sites located near trafficked roads and only a few number of plastic fragments were detected in this study. The largest number of micro litter particles was measured in the city centre and light industry/commercial sites and smallest in the rural site.

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