Microplastics in the source and drinking water of South Africa's largest bulk drinking water supplier

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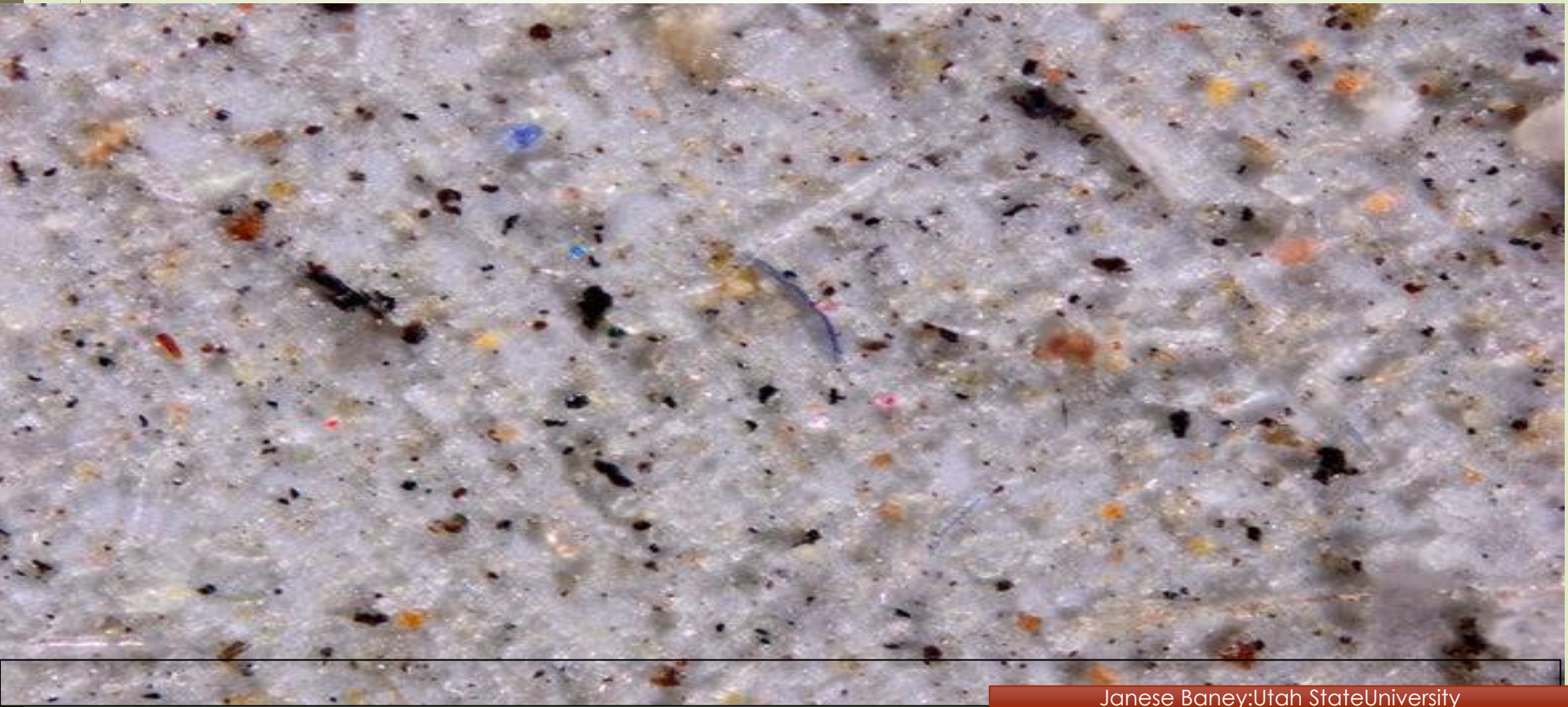


Problem Statement

The absence of information on the prevalence of plastic particles in the source water (surface water), used for potable water production, in South Africa and the resultant potential impact on tap water destined for human consumption

Priority issues that require investigation include:

To determine the extent of the prevalence of Microplastics

To determine their common associated monomers/additives In the two largest DWTW

Overview of the presentation:

- Global Perspective
- South African Perspective

South Africa's largest bulk drinking water supplier :

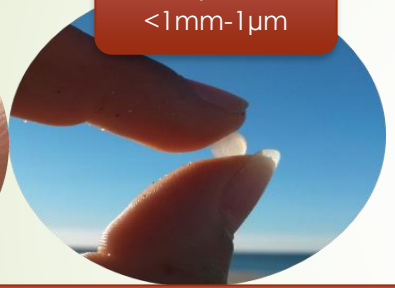
- Methodology
- Results
- Conclusions

Sources of Microplastics

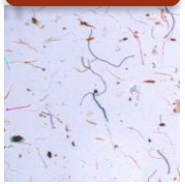
Primary microplastics are items of plastic that are a smaller than 5mm, e.g. nurdles (plastic beads used in plastic manufacturing), microbeads from cosmetics, and fibers from clothing. Mostly used for external use

Meso (1mmm<x2.5cm)

Mini/micro <1mm-1µm



Fibres



Secondary microplastics are formed when larger plastic items, such as bottles, are made brittle by UV light and broken down by wave action.

Mega >1m

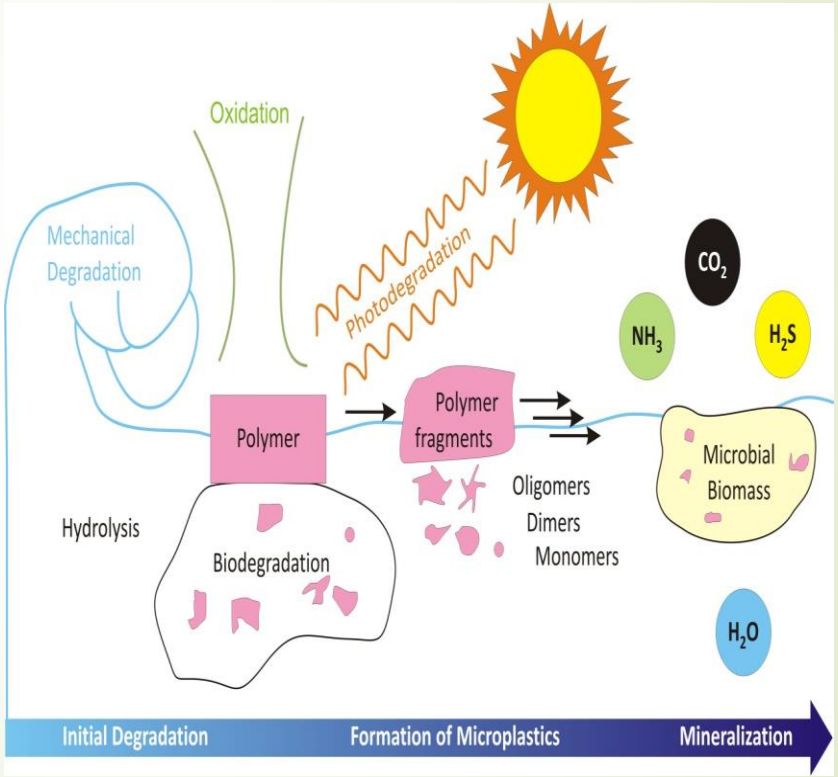
macro <2.5cm<<1m

Types of Microplastics

Degradation pathways:
Physical degradation (abrasive forces; heating / cooling; freezing / thawing; wetting / drying etc.)
Photodegradation (usually by UV light)
Chemical degredation (oxidation or hydrolysis)
Biodegradation by organisms (bacteria, fungi, algae etc.)

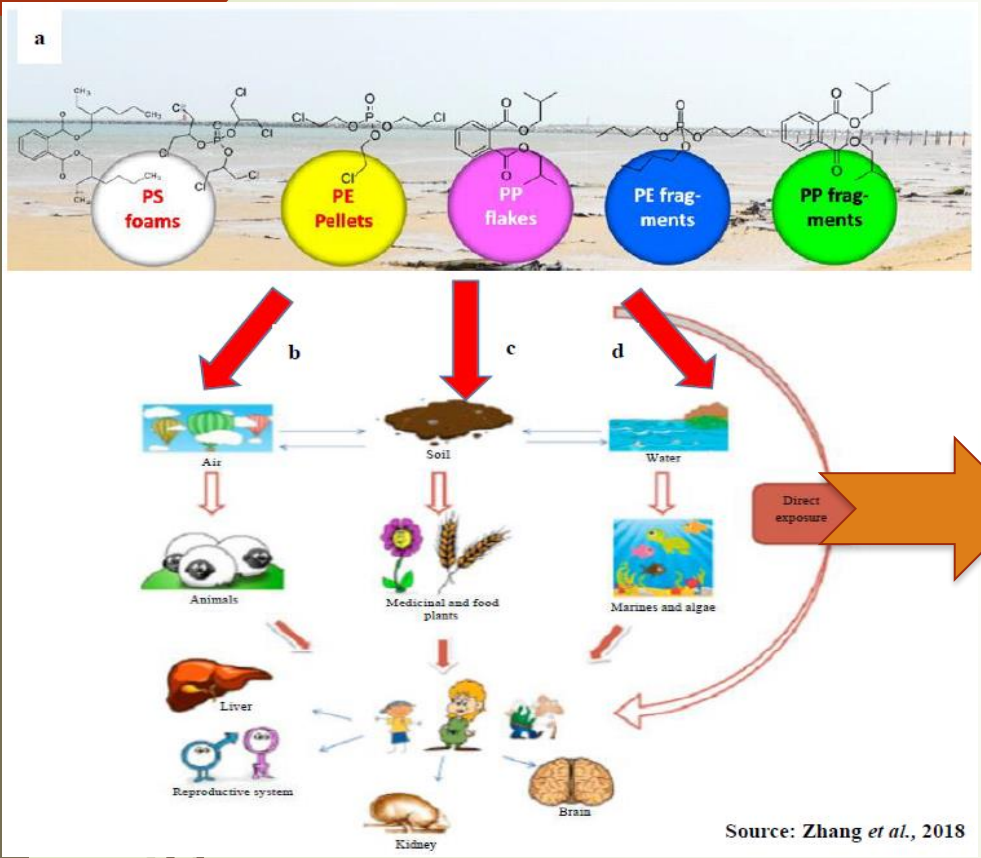
Microbeads
Polymer (ingredients used):
Polyethylene
Polypropylene
Polyethylene terephthalate
Polymethyl methacrylate

Monomers and Additives
Di-n-butyl phthalate,
Benzyl butyl phthalate,
Bis (ethylhexyl) phthalate,
Styrene, Bisphenol A (BPA),
Ethylene glycol,
Vinyl Chloride



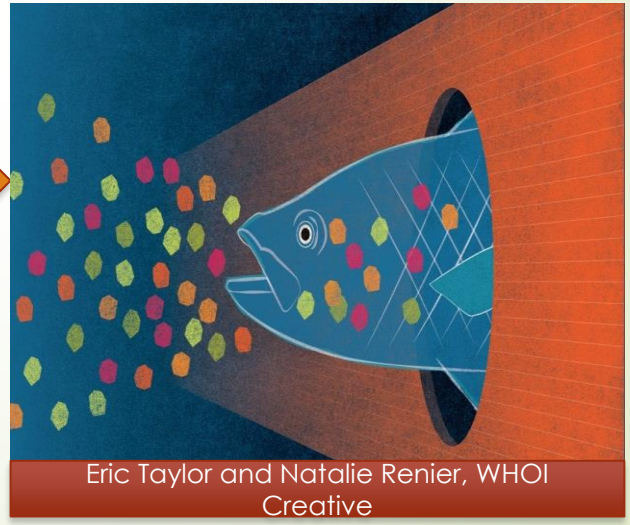
(adapted from Wagner and Lambert, 2018)

Microplastic ingestion



Micro plastics in surface water

- Global Studies focus on marine enviroment



Eric Taylor and Natalie Renier, WHOI Creative

Microplastics in drinking water

Impacts on Human health (WHO)

- WHO published a report
- impact of microplastics in drinking water on human health
- They concluded that currently, the effects are unknown

Potential hazards

Three possible routes by which microplastics could impact human health:

1.Physical: Microplastics could enter the body and damage internal structures

2.Chemical: For instance, plastic additives such as plasticizers could enter drinking water

3.Biofilm: Microorganisms might attach to microplastics and form colonies, which could cause harm

- Evidence of all three routes is incredibly limited
- Concluded that the latter two are of least concern
- Microplastics larger than 150 micrometers probably do not enter the human body;
- smaller particles may get in, but uptake is limited.
- Absorption of nanosized particles might be more common, but again, data are limited.

Animal studies have produced evidence to suggest that our bodies might absorb very small microplastics. However, the WHO report explains that

Materials and method

Sampling Points
- Source Water Samples supplying DWTW
- Samples at the Plant following the treatment works
- Samples from the distribution network
- Sampling points

Sample preparation and FTIR (Fourier transform infrared spectroscopy) analysis of microplastics,

Unfiltered water sample

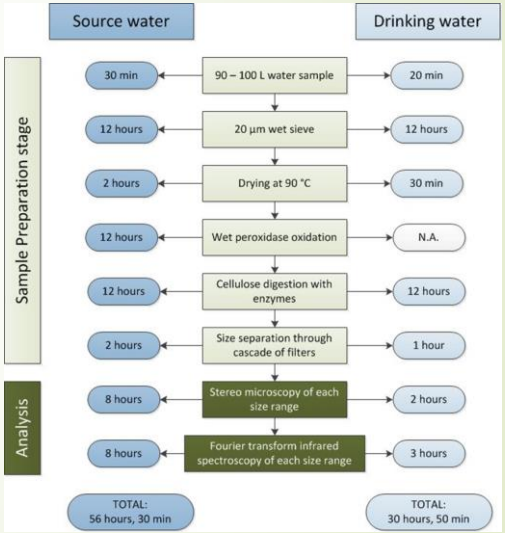
Monomers/additives analyses
Di-n-butyl phthalate, Benzyl butyl phthalate, Bis (ethylhexyl) phthalate, Styrene, Bisphenol A (BPA), Ethylene glycol, Vinyl Chloride

Filtered wate samples

Fibres &fragments identification and enumeration

(filtered through 20 um mes stainless steel sieve

- Samples stored in cooler boxes 4-5®C
- Analyses by NW university
  - FTIR

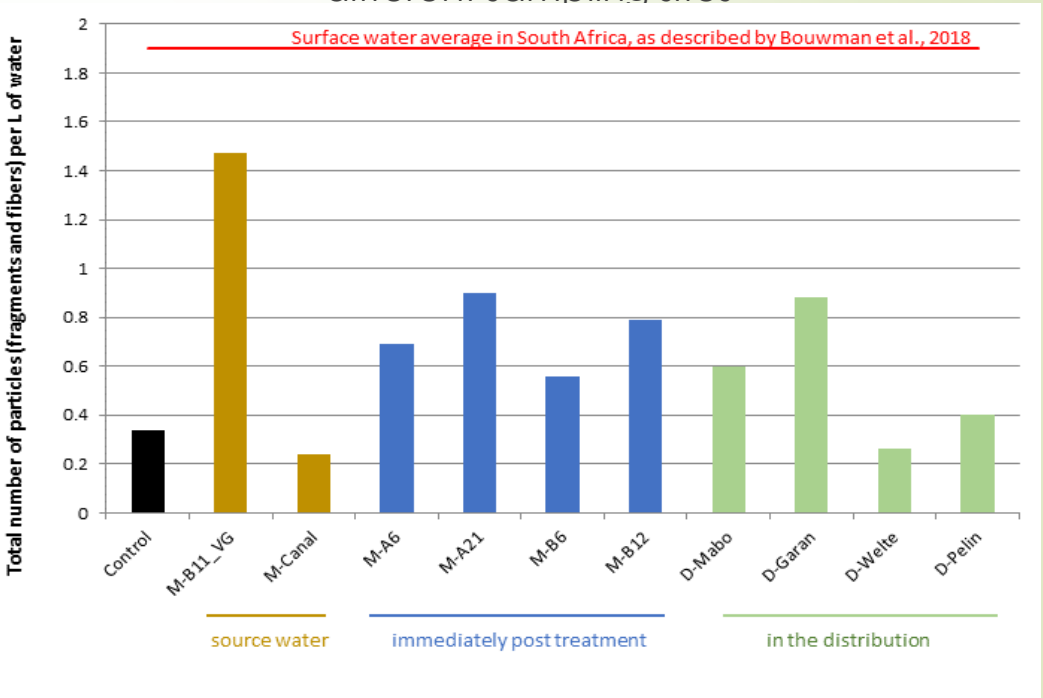


Results and discussions

Total microplastics counts (per 1L of water) at the different sampling sites

		Size ranges (in µm)							
		25-300	301-600	601-900	901-1200	1201-1500	>1500	Sub-Total	TOTAL
Control	Fragments	0.06	0.03					0.09	0.34
	Fibers	0.03	0.07	0.05	0.02		0.08	0.25	
M-B11_VG	Fragments	1.22				0.01	0.01	1.24	1.47
	Fibers	0.05	0.02	0.01	0.04	0.01	0.1	0.23	
M-Canal	Fragments	0.02						0.02	0.24
	Fibers	0.13	0.02		0.02	0.01	0.04	0.22	
M-A6	Fragments	0.25	0.11	0.01				0.37	0.69
	Fibers	0.07	0.12	0.03	0.02	0.01	0.07	0.32	
M-A21	Fragments	0.42	0.05					0.47	0.9
	Fibers	0.07	0.12	0.08	0.02	0.05	0.09	0.43	
M-B6	Fragments	0.11	0.14	0.04		0.01	0.01	0.31	0.56
	Fibers	0.03	0.06	0.03	0.01	0.04	0.08	0.25	
M-B12	Fragments	0.39	0.01	0.01				0.41	0.79
	Fibers	0.05	0.06	0.04	0.05	0.07	0.11	0.38	
D-Mabo	Fragments	0.16	0.02					0.18	0.6
	Fibers	0.06	0.14	0.1	0.05	0.03	0.04	0.42	
D-Garan	Fragments	0.19	0.01					0.2	0.88
	Fibers	0.13	0.12	0.06	0.03	0.05	0.29	0.68	
D-Welte	Fragments	0.12	0.01					0.13	0.26
	Fibers	0.03	0.06		0.01		0.03	0.13	
D-Pelin	Fragments	0.09	0.01	0.01				0.11	0.4
	Fibers	0.08	0.07	0.02	0.02	0.01	0.09	0.29	

Total microplastics counts (fragments and fibers) at different sampling sites



Results and discussions

Monomer / Additives analysis

Sample point	Di-n-butyl phthalate	Benzyl butyl phthalate	Bis (ethylhexyl) phthalate	Styrene	Bisphenol A (BPA)	Vinyl Chloride
M-B11_VG	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
M-Canal	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
M-A6	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
M-A21	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
M-B6	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
M-B12	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
D-Mabo	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
D-Garan	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
D-Welte	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L
D-Pelin	<50 µg/L	<50 µg/L	<50 µg/L	<1 µg/L	<500 µg/L	<1 µg/L

Conclusions

- Scoping study showed the control to have 0.34 microplastics particles per Liter
- Three of the samples showed negligible concentrations of microplastics
- The other samples all show very low microplastics concentrations when compared to other studies (<1 particles per Liter) in all of drinking water samples taken
- The microplastics concentration in the source water ranged from 0.24 to 1.47 particles (either fragments or fibers) per Liter

- In the drinking water immediately post treatment from 0.56 to 0.9 particles per Liter

-In the distribution from 0.26 to 0.88 particles per Liter

- No evidence could be found that the drinking water treatment processes at DWTW reduce the number of microplastics from source water to final treated water
- The known monomers / additives associated with microplastics could not be detected in any of Rand Water's samples, neither the drinking water nor the source water. Di-n-butyl phthalate, Benzyl butyl phthalate, Bis (ethylhexyl) phthalate, Styrene, Bisphenol A and Vinyl Chloride, were all below the detection limit of the method.