DOI:
10.18742/pub01-148

Document Version
Publisher's PDF, also known as Version of record

KING'S WATER CENTRE

KING'S College LONDON

POLICY BRIEFS

Are microfibres a problem for aquatic ecosystems? What we don't know about textile pollution

AUTHORS: **Matteo Gallidabino,** King's Forensics, King's College London
Kelly Sheridan, Northumbria University and The Microfibre Consortium
Thomas Stanton, Loughborough University
Alana James, Northumbria University
Jessica Jemalem Ginting, Department of Geography, King's College London

KEY MESSAGE

The majority of garments are made from textile fibres. These fibres are lost from garments during their lifetime. Textile fibres in an environmental context are often referred to as microfibres. Microfibres are one of the most abundant anthropogenic particle types in the environment, and may represent a serious hazard to environmental and human health. Indeed, the presence of microfibres has been documented in many types of ecosystems, including terrestrial soils, indoor and outdoor air, ice and snow, as well as in marine and freshwater environments.[1] The materials of these fibres vary considerably, and the impacts of these different materials are not well understood. Whilst there is widespread concern about the impacts of plastic textile fibres, our work shows that natural textile fibres are more prevalent in the environment, and their environmental impacts have the potential to be greater than plastic fibres.

Credit: *Smirart, Canva.com, accessed July 2023)*

THE PROBLEM WITH MICROFIBRES

Textile fibres can be distinguished according to their origin into synthetic, semi-synthetic or natural. Most textile fibres typically contain chemical additives, such as dyes and finishing agents.[2,3] Synthetic fibres (e.g. polyester, nylon and polyamide) make up the majority of textiles[4,5] and account for up to 14% of global plastic production[6]. Natural fibres (e.g. cotton, wool) are the second most used type in textiles and account for a significant (and sometimes larger) proportion of fibres found in aquatic environments, which lead to problems of watershed degradation. Semi-synthetic or 'humanmade cellulosic' fibres (e.g. rayon, viscose) are the third most commonly found.

Microfibres are fibrous particles that are particularly small in size. These are shed into the environment from textiles from manufacturing (e.g. clothing, upholstery, carpeting)[7,8], to consumer use (i.e. laundering and wear)[9,10] and disposal[11]. Other sources of shedding come from the use of fishing gear, cigarettes[12] and personal care products[13]. However, we still know very little about the relative contributions of these different sources and about the actual ecotoxicology of them. This is a concern because microfibres can easily infiltrate environments and the organisms that inhabit them, thus posing a serious physical and chemical hazard.

Our recent study, "Prevalence and Characterisation of Microfibres Along the Kenyan and Tanzanian Coast", found that aquatic ecosystems are contaminated with microfibres of all kinds.[14] While 65% of all clothing produced globally is made from synthetic fibres, the prevalence of natural fibres in the environment highlights that the need for urgent analysis of all fibre types that are present in the environment.

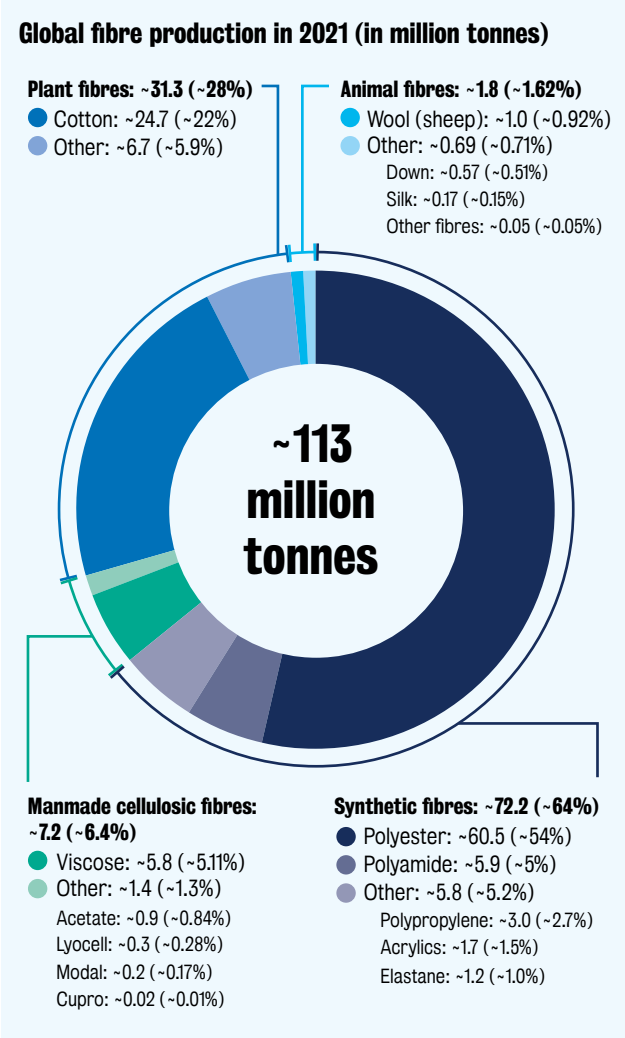
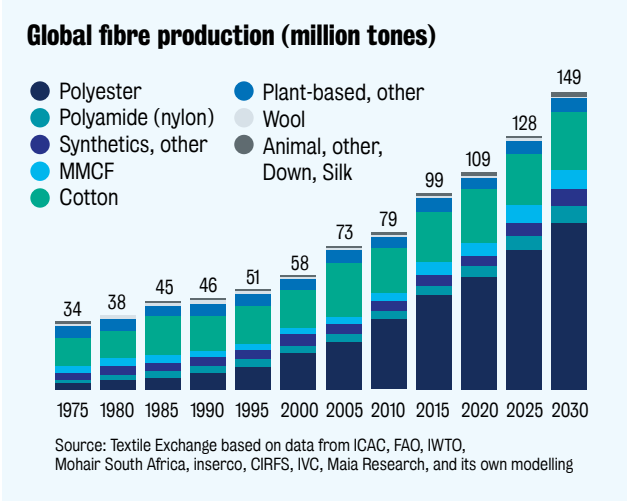


Figure 1: *Global fibre production in 2021 (Source: Textile Exchange, Preferred Fibres and Materials Market Report 2022, p. 10)*



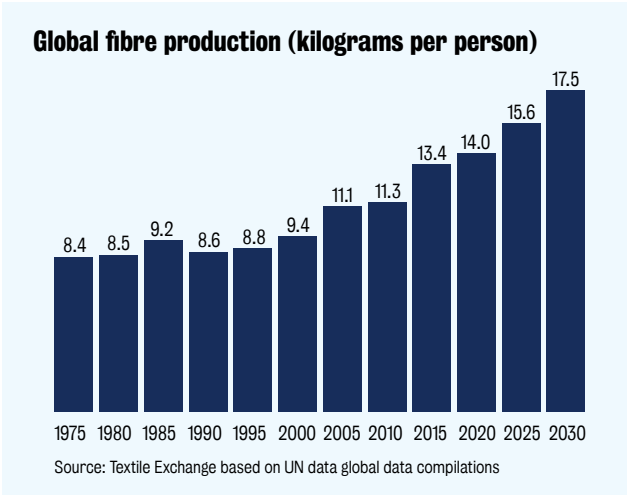


Figure 2: *Global fibre production from 1975 to 2030 (Source: Textile Exchange, Preferred Fibres and Materials Market Report 2022, page 9)*

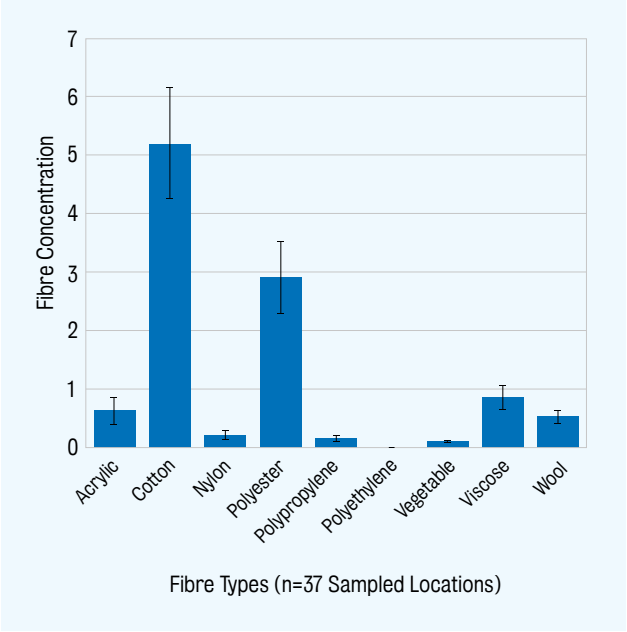


Figure 3: *Mean fibre concentration of fibre types recovered across sampled locations (Source: Reprinted with permission from KeChi-Okafor, C. et al. (2023) "Prevalence and characterisation of microfibres along the Kenyan and Tanzanian Coast', Frontiers in Ecology and Evolution")*

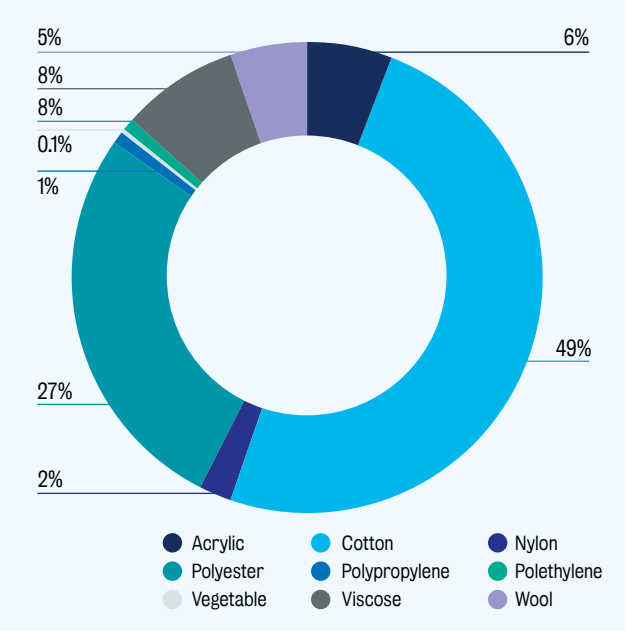


Figure 4: *Percentage composition of fibres recovered across* **the 37 sampled locations (Source:** *Reprinted with permission from KeChi-Okafor, C. et al. (2023))*

CAUSES OF MICROFIBRE POLLUTION AND IMPACTS ON ORGANISMS AND THE ENVIRONMENT

Microfibre loss from textiles used in fashion is the highest contributor to microfibre pollution. The rise of ultra-fast fashion and direct-to-consumer retailers has made the need to address this issue all the more urgent. In 2021, global fibre production reached 113 million tonnes (Figure 1). Between 1975 to 2020, total global fibre production quadrupled and is expected to increase to 149 million tonnes by 2030 (Figure 2).[15] As the abundance of microfibres in the environment will continue to rise, there is increased risk of negative impact on the growth and behaviour of aquatic life, from foraging and feeding practices to organism fitness levels.[16,17] High concentrations and toxicity will influence key biological functions, chronic effects over prolonged exposure periods, as well as the interactive effects with other environmental factors.

MYTHS AND GAPS IN OUR UNDERSTANDING OF MICROFIBRES

A common misconception is that textiles made from natural fibres will biodegrade in the environment and so natural microfibres are not a significant pollution problem. In fact, the dominance of natural microfibres across all environments suggests that microfibre biodegradability may be much less significant than rates of microfibre accumulation.

Natural microfibres, such as cotton and wool, are understudied in comparison to plastic microfibres, and are often excluded or misidentified as plastic in academic literature. When all microfibre types are taken into consideration, our research (Figure 3) showed that the presence of natural microfibres (cotton, vegetable and wool) outweighed synthetic microfibres (acrylic, nylon, polyester, polypropylene, polyethylene). When examining the coast between Lamu and Zanzibar in Kenya and Tanzania respectively, natural microfibres were in higher abundance in 33 of the 37 sampled sites (Figure 4). Congruent with recent studies[18,19,20,21], these findings support the need for more research into the environmental impacts of natural microfibres.

To advance our understanding on natural microfibres and more broadly on microfibres pollution, there are knowledge gaps in the following areas: how and why concentrations vary between environments and locations; at what concentrations fibres are toxic to different organisms – if they are at all — and how factors such as fibre type, chemical treatment or shape, influence toxicity.

RECOMMENDATIONS AND WAYS FORWARD

To reduce microfibre pollution and mitigate its impacts, we must address the problem of garments shedding throughout the life cycle from manufacturing, to use, and to end of life. Minimising garment shedding can be achieved through research and innovation, but it is a complex issue with no quick fix. A textile's shedding capability is influenced by multiple factors, and solutions such as washing machine filters cannot prevent shedding entirely, nor does it address the other ways in which microfibres shed (such as during use). Different regions may also need different approaches to innovation. For example, a majority of households in the Global South do not use electric washing machines, so strategies to reduce garment shedding through washing machine filters would be inappropriate.

To address this complex issue, a multifaceted approach to research must be taken. First, we must quantify the relative contribution of each pollution pathway to overall microfibre prevalence and identify relative concentrations and organisms at risk. Second, we must conduct studies to better understand the ecotoxicological impact of microfibres across aquatic, terrestrial, and atmospheric environments. Above all, more sustainable consumption practices are desperately needed to minimise the impacts of all social and environmental harms associated with the fashion and textile industry. Better industry practices, supported by an improved scientific understanding of microfibres, can support pollution mitigation strategies to prevent future environmental degradation.

1 Athey SN, Erdle LM. Are we underestimating anthropogenic microfiber pollution? A critical review of occurrence, methods, and reporting. Environ. Toxicol. Chem.. 2021, 41(4):822–37. doi:10.1002/etc.5173

2 Ladewig, S.M.; Bao, S.; Chow, A.T. Natural Fibers: A Missing Link to Chemical Pollution Dispersion in Aquatic Environments. Environ. Sci. Technol. 2015, 49, 12609–12610.

3 Chan, C.K.M.; Park, C.; Chan, K.M.; Mak, D.C.W.; et al. Microplastic Fibre Releases from Industrial Wastewater Effluent: A Textile Wet-Processing Mill in China. Environ. Chem. 2021, 18, 93–100.

4 Carr Sources and Dispersive Modes of Micro-Fibers in the Environment. Available online: https://setac.onlinelibrary.wiley.com/doi/10.1002/ieam.1916 (accessed on 13 June 2023).

5 Textile Exchange. Preferred Fiber and Materials Market Report 2021; Textile Exchange: Lamesa, TX, USA, 2021. https://textileexchange.org/knowledge-center/reports/preferred-fiber-materials-market-report-2021/

6 Gavigan J, Kefela T, Macadam-Somer I, et al.. Synthetic microfiber emissions to land rival those to waterbodies and are growing. PLOS ONE. 2020, 15(9). doi:10.1371/journal.pone.0237839

7 Chan et al.

8 Zhou H, Zhou L, Ma K. Microfiber from textile dyeing and printing wastewater of a typical industrial park in China: Occurrence, removal and release Sci. Total Environ. 2020, 739

9 De Falco F, Cocca M, Avella M, et al. Microfiber Release to Water, Via Laundering, and to Air, via Everyday Use: A Comparison between Polyester Clothing with Differing Textile Parameters. Environ. Sci. Technol. 2020, 4, 6, 3288–3296

10 Napper IE, Thompson RC. Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions Mar. Pollut. Bull. 2016, 112, 39-45

11 Sun J, Zhu Z-R, Li W-H, et al. Revisiting microplastics in landfill leachate: Unnoticed tiny microplastics and their fate in treatment works. Water Res. 2021, 116784

12 Belzagui F, Buscio V, Gutiérrez-Bouzán C, et al. Cigarette Butts as a microfiber source with a microplastic level of concern. Sci. Total Environ. 2021, 762, 144165

13 Ó Briain O, Marques Mendes AR, McCarron S, et al. The role of wet wipes and sanitary towels as a source of white microplastic fibres in the Marine Environment. Water Res.2020, 116021

14 KeChi-Okafor C, Khan FR, Al-Naimi U, Béguerie V, Bowen L, Gallidabino MD, et al. Prevalence and characterisation of microfibres along the Kenyan and Tanzanian Coast. Frontiers in Ecology and Evolution. 2023;11. doi:10.3389/fevo.2023.1020919

15 Textile Exchange. Preferred Fiber and Materials Market Report 2022; Textile Exchange: Lamesa, TX, USA, 2022. https://textileexchange.org/knowledge-center/reports/preferred-fiber-and-materials/

16 Rebelein A, Int-Veen I, Kammann U, et al.. Microplastic fibers — underestimated threat to aquatic organisms? Sci. Total Environ. 2021, 777:146045. doi:10.1016/j.scitotenv.2021.146045

17 Siddiqui S, Hutton SJ, Dickens JM, et al. Natural and synthetic microfibers alter growth and behavior in early life stages of estuarine organisms. Front. Mar. Sci.. 2023, 9. doi:10.3389/fmars.2022.991650

18 Stanton T, Johnson M, Nathanail P, et al. Freshwater and airborne textile fibre populations are dominated by 'natural', not microplastic, Fibres. Sci. Total Environ. 2019, 666:377–89. doi:10.1016/j.scitotenv.2019.02.278

19 Nel HA, Hean JW, Noundou XS, et al.. Do microplastic loads reflect the population demographics along the Southern African coastline? Mar. Pollut. Bull.. 2017, 115(1–2):115–9. doi:10.1016/j.marpolbul.2016.11.056

20 Suaria G, Achtypi A, Perold V, et al. Microfibers in Oceanic Surface Waters: A global characterization. Sci. Adv.. 2020, 6(23). doi:10.1126/sciadv.aay8493

21 Jeevanandam M, Talelign W, Biru A, et al. Evidences of microplastics in Hawassa Lake, Ethiopia: A first-hand report. Chemosphere. 2022, 296:133979. doi:10.1016/j.chemosphere.2022.133979

CONTACT

Dr. Matteo Gallidabino (matteo.gallidabino@kcl.ac.uk), King's College London

ABOUT KING'S WATER CENTRE

King's Water Centre works to incubate, elevate, and empower the best science and innovation to tackle the world's water problems. We are curiosity-driven, interdisciplinary, and solutions-focused. Based in the heart of London, King's Water Centre brings together scholars and practitioners for a just and sustainable water future.

HOW TO CITE THIS WORK

Gallidabino, M. et al. (2023) Are textile fibres a problem for aquatic ecosystems? What we don't know about textile pollution. London: King's College London. DOI: 10.18742/pub01-148 doi.org/10.18742/pub01-148