

Water Pollution by Plastics and Microplastics:

A Review of Technical Solutions from Source to Sea







© 2020 United Nations Environment Programme

ISBN No: 978-92-807-3820-9 Job No: DEP/2318/NA

This publication may be reproduced in whole or in part and in any form for educational or non-profit services without special permission from the copyright holder, provided acknowledgement of the source is made. The United Nations Environment Programme would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Communication Division, United Nations Environment Programme, P. O. Box 30552, Nairobi 00100, Kenya.

Disclaimers

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory or city or its authorities, or concerning the delimitation of its frontiers or boundaries. For general guidance on matters relating to the use of maps in publications please go to http://www.un.org/Depts/Cartographic/english/htmain.htm

Mention of a commercial company or product in this document does not imply endorsement by the United Nations Environment Programme or the authors. The use of information from this document for publicity or advertising is not permitted. Trademark names and symbols are used in an editorial fashion with no intention on infringement of trademark or copyright laws.

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the United Nations Environment Programme. We regret any errors or omissions that may have been unwittingly made.

UNEP promotes
environmentally sound
practices globally and
in its own activities. Our
distribution policy aims to reduce
UNEP's carbon footprint.



Water Pollution by Plastics and Microplastics:

A Review of Technical Solutions from Source to Sea

Josiane Nikiema, Javier Mateo-Sagasta, Zipporah Asiedu, Dalia Saad and Birguy Lamizana





Table of Contents

Ab	obreviations and Acronyms	vii
Ac	knowledgements	viii
Su	ımmary	ix
Se	ection I: Introduction	1
A.	A growing challenge	2
В.	Sources of microplastics and pathways to freshwater and the oceans	3
C.	Occurrence of microplastics in freshwater and the oceans	5
D.	Risks from microplastics	6
E.	Macroplastics: a major challenge on their own	8
F.	Objective and scope of the report	8
Se	ection II: Technologies to Prevent Wastewater Contamination at the Source	9
A.	Macroplastics management at source	10
	Enhancing plastic waste management to enable recycling	10
	2. Supporting informal plastic collection and the recycling value chain	13
	3. Implementing plastic recycling technologies4. Cost comparison	13 21
R	Microplastics management at source	22
٥.	Treatment units for treating pollution at source	24
	Design of new textiles to reduce microfibres generation during washing	26
	3. Policy tools to reduce use and misuse of microbeads	26
	4. Behavioural change campaigns to reduce the use of microbeads and generation of microfibres at source	27
Se	ection III: Technologies to Treat Wastewater and Run-off Before the Treatment Plant	28
A.	Macroplastics removal in run-off	29
	1. Booms	29
	2. Debris fins	31
	Deflectors Trash racks or meshes	31 32
R	Microplastics removal in run-off	32
υ.	Retention ponds	33
	Infiltration basins	34
	3. Gully pots	34
Se	ection IV: Wastewater Treatment Technologies	35
Α.	Description of processes and costs for municipal WWTPs	36
В.	Macroplastics removal at municipal wastewater treatment plants	39
C.	Microplastics removal at municipal wastewater treatment plants	39
	1. Key parameters impacting municipal WWTP performance	39
	2. Treatment performance per stage within a municipal WWTP	41
	3. Other potential solutions to improve WWTP performance in microplastics removal	48

D.	Microplastics removal at industrial wastewater treatment plants	49
	1. Textile dyeing WWTP - a typical case in China	49
	2. Landfill leachate	51
Se	ection V: Technologies to Treat Contaminated Sewage Sludge	52
	Macroplastics removal	53
В.	Microplastics removal	53
	Composition of sludge	53
	2. Impact of sludge treatment on microplastic concentrations within WWTPs	54
	3. Sludge post-treatment	54
Se	ection VI: Technologies to Treat Receiving Waters Downstream of Discharging Points	57
A.	Microplastics removal in wetlands	58
	Constructed wetlands	59
	2. Floating wetlands	59
В.	Microplastics removal in drinking water	60
	1. Bottled water	60
	2. Drinking water treatment	61
	3. Future trends	62
C.	Macroplastics removal in freshwater or the sea	63
	1. Boats	63
	2. Debris sweepers	64
	3. Sea bins	64
Se	ection VII: Selecting and Combining Solutions	66
Se	ection VIII: Annexes	68
A.	Types of plastics and their use	69
В.	Plastic breakdown pathways in the environment.	70
C.	Plastic breakdown pathways in landfills	71
D.	Characteristics of microplastics found in wastewater	71
E.	Removal of microplastics by wastewater treatment plants - compilation of data	72
F.	Wetlands	79
Re	eferences and Further Information	81

List of Figures

Fig 1	Taskwisel askutiana fan waste mannanant	.,
Figure 1.	Technical solutions for waste management	Х
Figure 2.	Different examples of microplastics	3
Figure 3.	Main sources and pathways of macroplastics and microplastics to water	4
Figure 4.	Median and variation in microplastic number concentrations in individual samples taken from different water types	6
Figure 5.	Typical waste management service chain in developing countries	11
Figure 6.	Percentage of inadequately disposed plastic waste in the world in 2010	12
Figure 7.	Routes for recycling of solid plastic waste	14
Figure 8.	Process leading to mechanical recycling of plastic waste	15
Figure 9.	PET bottle recycling in South Africa	16
Figure 10.	Cost distribution of PETCO operations	16
Figure 11.	The Carbios technology	17
Figure 12.	Minimum and maximum value of carbon dioxide (CO ₂) in euros	21
Figure 13.	Examples of plastic clean-up efforts; left: combination bin and boom system that captures floating trash; right: a boom	30
Figure 14.	Concrete debris fins extending upstream from a bridge pier	31
Figure 15.	Upstream view of a steel debris deflector	31
Figure 16.	Debris racks	32
Figure 17.	Stormwater management processes (e.g. retention and detention ponds, infiltration)	33
Figure 18.	Concrete gully pot design	34
Figure 19.	Typical screen	39
Figure 20.	Correlation between MFs and suspended solids (SS) in industrial wastewater	41
Figure 21.	(A) Profile of microplastic concentrations and (B) cumulative microplastics removal efficiency during treatment in a typical WWTP in China	42
Figure 22.	Average microplastics flow in liquid and sludge within a WWTP with primary, secondary and t ertiary treatment processes	46
Figure 23.	Fate of microplastics (in numbers) as they pass through a typical WWTP	47
Figure 24.	Fate of microplastics (in numbers) as they pass through two WWTPs	48
Figure 25.	Wastewater treatment process within a facility	50
Figure 26.	Concentration of microplastics in soil following one to five consecutive applications	55
Figure 27.	Garbage collection boat on the Pearl River in Guangzhou, China	64
Figure 28.	Debris sweepers	64
Figure 29.	Seabin placed in a river	65
Figure 30.	Examples of combinations of solutions to water pollution by microplastics from source to tap	67

List of Tables

Table 1.	Description of removal of macroplastics and microplastics (MPs) during wastewater treatment processes	xiv
Table 2.	Key actions needed by different stakeholders	12
Table 3.	Comparison of technologies for chemical or tertiary recycling of plastics	17
Table 4.	Recycling and incineration in the Netherlands: benefits, limitations and drivers	20
Table 5.	Net costs of recycling and incineration (euros per metric ton of plastic) and CO ₂ emissions from recycling and incineration (metric tons of CO ₂ per metric ton of plastic)	21
Table 6.	Costs of technologies used to prevent municipal wastewater contamination	22
Table 7.	Sources, measurements and strategies for mitigation of microplastics upstream of water bodies	23
Table 8.	Costs of technologies used to prevent municipal wastewater contamination	24
Table 9.	Composition of laundromat wastewater effluent	25
Table 10.	Concentrations and releases of microplastics and microfibres 100-1,000 μm in size in laundry effluents in Sweden	25
Table 11.	Particle size distribution and concentration of microbeads from selected PCCPs	26
Table 12.	Costs of technologies used to prevent run-off contamination	30
Table 13.	Conventional treatment of wastewater: objectives, fate of microplastics and costs	36
Table 14.	Operating parameters which could affect WWTP performance in removing microplastics	40
Table 15.	Selected cases of preliminary and primary treatment performance with respect to microplastics removal	43
Table 16.	Selected cases of secondary treatment concerning microplastics removal	44
	Selected cases of tertiary and disinfection treatment performance, concerning MP removal	45
Table 18.	Influent quality and treatment performance of various elemental processes in removal of microfibres	50
Table 19.	Composition of landfill leachate in China	51
Table 20.	Composition of sludge based on its origin	53
Table 21.	Main characteristics of the sludge dewatering process	54
Table 22.	Examples of uses of WWTP sludge in different parts of the world	55
Table 23.	Costs of technologies used to remove plastics in water contamination	58
Table 24.	Microplastics removal efficiencies of two constructed wetlands (CWs) in Sweden	59
Table 25.	Abundance per water volume (L-1) and size distribution of microplastics in bottled water	60
Table 26.	Microplastics removal during drinking water treatment processes	62
Table 27.	Costs of wastewater treatment in developing countries	72
Table 28.	Costs in USD of water treatment in the United States for different WWTP capacities (in m³ per day)	73
Table 29.	Construction and operating and maintenance costs for secondary treatment upgrades or new	70

预览已结束,完整报告链接和二维码如下:

https://www.yunbaogao.cn/report/index/report?reportId=5_13732

