



PROTECTING SURFACE WATER FOR HEALTH

**IDENTIFYING, ASSESSING
AND MANAGING
DRINKING-WATER QUALITY
RISKS IN SURFACE-WATER
CATCHMENTS**

PROTECTING SURFACE WATER FOR HEALTH

IDENTIFYING, ASSESSING AND MANAGING DRINKING- WATER QUALITY RISKS IN SURFACE-WATER CATCHMENTS

Editors: Bettina Rickert, Ingrid Chorus, Oliver Schmoll

WHO Library Cataloguing-in-Publication Data

Protecting surface water for health. Identifying, assessing and managing drinking-water quality risks in surface-water catchments

I. World Health Organization.

ISBN 978 92 4 151612 9

This publication was originally published under ISBN 978 92 4 151055 4

Subject headings are available from WHO institutional repository

© **World Health Organization 2016**

All rights reserved. Publications of the World Health Organization are available on the WHO website (<http://www.who.int>) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; email: bookorders@who.int).

Requests for permission to reproduce or translate WHO publications –whether for sale or for non-commercial distribution– should be addressed to WHO Press through the WHO website (http://www.who.int/about/licensing/copyright_form/index.html).

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 World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by the World Health Organization to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use.

Design and layout by L'IV Com Sàrl, Villars-sous-Yens, Switzerland.

Printed by the WHO Document Production Services, Geneva, Switzerland.

CONTENTS

Foreword	v
Acknowledgements	vii
Introduction	x
Chapter 1 – Catchment risk assessment and management approaches	1
1.1 Health and environmental risk assessment and management frameworks	3
1.1.1 Health risk assessment and management frameworks	3
1.1.2 Environmental risk assessment and management frameworks	5
1.1.3 Comparison of health and environmental risk assessment and management	5
1.1.4 Integrating drinking-water quality and environmental risk assessment and management approaches	5
1.2 Catchment risk assessment and management considerations in small water supplies	9
Chapter 2 – Hazards, their transport and attenuation	11
2.1 What are the main hazards?	13
2.1.1 Microbial hazards	13
2.1.2 Chemical hazards	20
2.1.3 Hazards from eutrophication	33
2.1.4 Physical hazards and acceptability issues	36
2.1.5 Radiological hazards	37
2.2 Which features and processes determine pollution pathways?	38
2.2.1 Catchment conditions and transport processes influencing pollution pathways	39
2.2.2 Waterbody conditions influencing hazard transport and attenuation	42
2.2.3 Transport and attenuation processes influencing pollution	49
2.2.4 Drinking-water abstraction from surface waterbodies	55
Chapter 3 – Hazardous activities in the catchment and their control	57
3.1 Main sources of hazards and main pathways by which hazards are introduced into waterbodies	58
3.2 Inspecting the catchment and establishing an inventory of activities	60
3.2.1 Phase 1: Preparing a catchment inspection	60
3.2.2 Phase 2: Conducting a catchment inspection	67
3.3 Agriculture	71
3.3.1 Agricultural practices that may affect surface-water quality	71
3.3.2 Checklist for assessing pollution risk from agricultural activities	75
3.3.3 Examples of hazardous events and control measures for agricultural activities	77
3.4 Aquaculture and fisheries	80
3.4.1 Aquaculture and fisheries activities that may affect surface-water quality	81
3.4.2 Checklist for assessing pollution risk from aquaculture and fisheries	84
3.4.3 Examples of hazardous events and control measures for aquaculture and fisheries activities	85
3.5 Wastewater and stormwater effluents	86
3.5.1 Wastewater and greywater disposal practices that may affect surface-water quality	90
3.5.2 Checklist for assessing pollution risk from wastewater and stormwater effluents	91
3.5.3 Examples of hazardous events and control measures for wastewater and stormwater effluents	94

3.6	Commerce, industry, mining and military sites	98
3.6.1	Sources of contamination and pathways to surface waterbodies	98
3.6.2	Checklist for assessing pollution risk from commerce, industry, mining and military sites	103
3.6.3	Examples of hazardous events and control measures for commerce, industry, mining and military sites	105
3.7	Traffic	109
3.7.1	Traffic activities that may affect surface-water quality	109
3.7.2	Checklist for assessing potential pollution from traffic activities	111
3.7.3	Examples of hazardous events and control measures for traffic activities	113
3.8	Recreational activities	115
3.8.1	Recreational activities that may affect surface-water quality	116
3.8.2	Checklist for assessing pollution risk from recreational activities	117
3.8.3	Examples of hazardous events and control measures for recreational activities	119
Chapter 4	Assessing and managing surface-water risks through the WSP process	121
4.1	Assemble the WSP team for the catchment and waterbody and engage with stakeholders	122
4.2	Describe the catchment and waterbody	125
4.3	Hazard analysis, control measures and risk assessment	129
4.3.1	Compile an inventory of hazards and potentially hazardous events	129
4.3.2	Conceptual model for risk assessment in the catchment	129
4.3.3	Assess the degree of inherent protection of the raw water	131
4.3.4	Identify and validate existing control measures	137
4.3.5	Assess the risks	139
4.3.6	Prioritize the risks of raw-water contamination at the offtake point	147
4.3.7	Risk assessment data gaps and uncertainties	148
4.3.8	Document the risk assessment	149
4.4	Develop, implement and maintain an improvement and upgrade plan	149
4.5	Define monitoring of the control measures	152
4.6	Verify the effectiveness of the WSP	154
4.7	Prepare management procedures	154
4.7.1	Standard operating procedures	155
4.7.2	Incident and emergency procedures	155
4.8	Develop supporting programmes	155
4.9	Plan and carry out periodic review of the WSP	156
4.10	Revise the WSP following an incident	156
Annexes		157
Annex A:	Case studies	157
Case study A1:	Risk assessment for a drinking-water reservoir in Germany	157
Case study A2:	WSP implementation for surface-water protection in Nepal	161
Annex B:	Lists of boxes, checklists, figures and tables	164
Acronyms and abbreviations		167
References		170

FOREWORD

Access to safe drinking-water is fundamental to human development and a basic human right. A lack of access to safe drinking-water sources, coupled with inadequate sanitation and hygiene, remains one of the most critical public health challenges globally.

Despite the significant achievements by the end of the Millennium Development Goal (MDG) era, an estimated 663 million people still lack access to an “improved” source of drinking-water. Many more still lack access to “safe” drinking-water, with at least 1.9 billion people relying on an unimproved source or an improved source that is faecally contaminated. Through the Sustainable Development Goals (SDGs), countries around the world have expressed strong political will to ensure not only that a drinking-water service is extended to unserved populations, but also that this drinking-water is universally safe. This is expressed in Goal 6 of the SDGs, with Target 6.1 stating “By 2030, achieve universal and equitable access to safe and affordable drinking-water for all”.

However, as land-use pressures and competition for limited water resources intensify through population growth, it is clear that the entire water cycle needs to be managed as a whole to ensure that limited freshwater resources within are protected. Unless managed effectively, these pressures may affect surface-water quality both directly and indirectly, with adverse effects on public health. Emerging health concerns in this regard, including through climate change, are increasing prevalence of toxic cyanobacterial blooms in addition to on-going threats from pathogens causing cholera, typhoid and other enteric diseases.

Protecting surface water for health

embraces the concept put forward by Goal 6 of the SDGs, recognizing that the protection of water quality and water-related ecosystems contributes to public health protection.



In recognition of this need for a holistic approach to water cycle management, Goal 6 of the SDGs extends beyond human-related targets to capture those concerned with the environment: improving ambient water quality (Target 6.3), integrating water resources management (Target 6.5) and protecting and restoring water-related ecosystems (Target 6.6). *Protecting surface water for health* embraces the

concept put forward by Goal 6 of the SDGs, recognizing that the protection of water quality and water-related ecosystems contributes to public health protection.

This book provides a structured approach to understanding surface waters and their catchments to support the identification, assessment and prioritization of the risks, and the development of management strategies for their control, as a basis for providing safe drinking-water. Where source-water quality is maintained, less treatment effort is needed and the provision of safe drinking-water may be achieved with greater reliability. Thus, source-water protection is a key element in a multi-barrier approach to the provision of safe drinking-water. This is particularly true in resource limited settings where there is a lack of effective and reliable water treatment.

This publication is one of a series of supporting documents that provides guidance on implementing the World Health Organization's (WHO) *Guidelines for drinking-water quality* (WHO, In preparation-a) and, in particular, water safety plans (WSPs). WSPs are considered best practice for water supply management with over 90 countries having WSP implementation experience. WHO has produced a number of publications to support water safety planning throughout the drinking-water supply chain, including the complementary publication *Protecting groundwater for health: managing the quality of drinking-water sources* (Schmoll et al., 2006). *Protecting surface water for health* provides guidance and supporting information on the development and application of WSPs in drinking-water catchments to address the assessment and control of surface-water hazards in an effective way. Thus, it is anticipated that this publication, along with the other WHO publications on WSPs, will support the continued uptake and improvement in water safety planning and thereby contribute to the achievement of related SDG water targets.



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_26988

