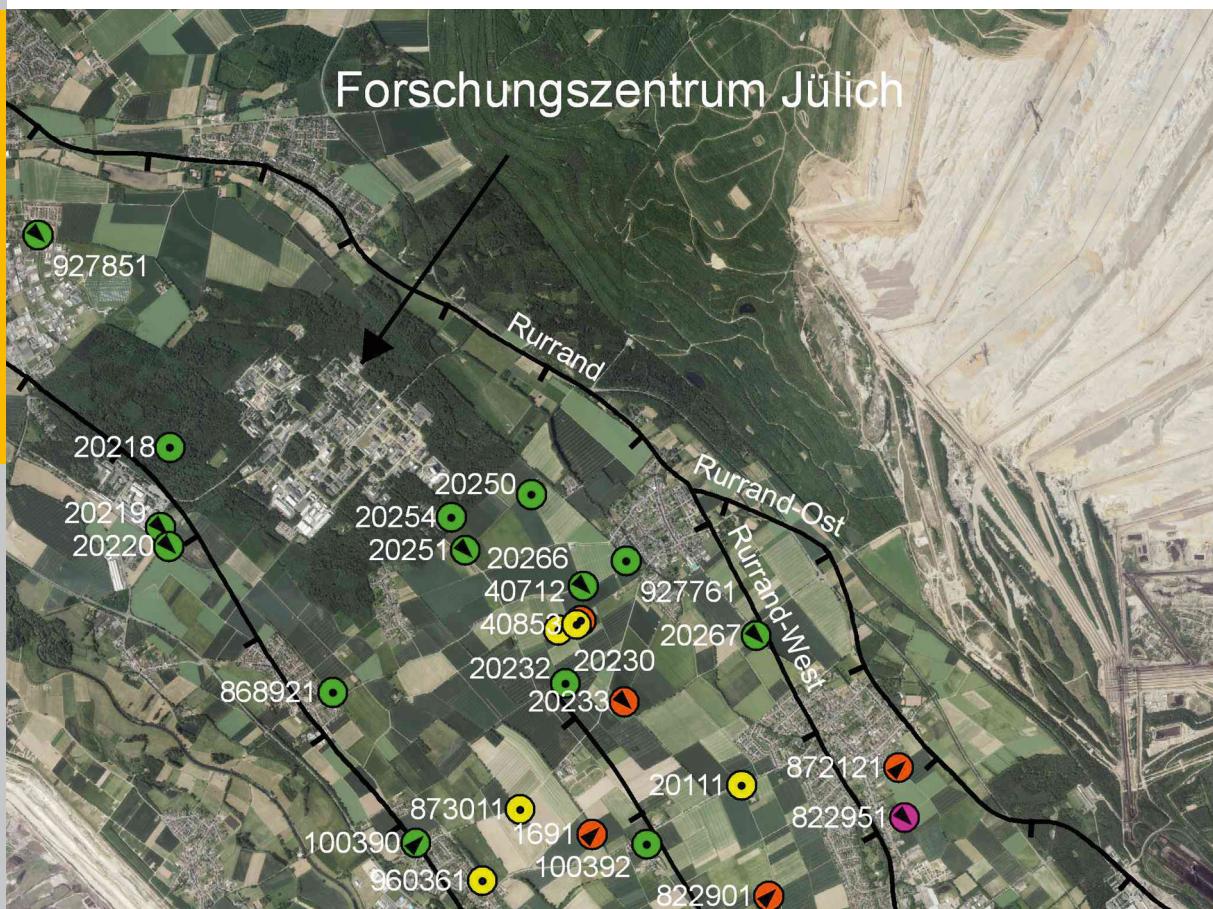


Atrazine in the environment 20 years after its ban: long-term monitoring of a shallow aquifer (in western Germany) and soil residue analysis

David Stefan Vonberg



Energie & Umwelt /
Energy & Environment
Band / Volume 293
ISBN 978-3-95806-099-9

 **JÜLICH**
FORSCHUNGSZENTRUM

Forschungszentrum Jülich GmbH
Institute of Bio- and Geosciences
Agrosphere (IBG-3)

Atrazine in the environment 20 years after its ban: long-term monitoring of a shallow aquifer (in western Germany) and soil residue analysis

David Stefan Vonberg

Schriften des Forschungszentrums Jülich
Reihe Energie & Umwelt / Energy & Environment

Band / Volume 293

ISSN 1866-1793

ISBN 978-3-95806-099-9

Table of Contents

Summary	3
Zusammenfassung	7
Danksagung	12
Preface	14
Abbreviations and Symbols.....	17
List of Figures	18
List of Tables	21
1. Introduction	23
1.1 Atrazine in the environment.....	23
1.1.1 Background information	23
1.1.2 Atrazine in groundwaters.....	24
1.1.3 Atrazine and its metabolites in soils	27
1.2 Study objectives	30
2. Study area	32
2.1 Regional and geologic setting	32
2.2 Hydrogeology	32
2.3 Soils and land use.....	35
3. Material & Methods.....	36
3.1 Groundwater monitoring.....	36
3.1.1 Monitoring principles.....	36
3.1.2 Pesticide Analytics - Sample treatment and analysis.....	37
3.1.3 Laboratory reporting limits & Data Censoring.....	38
3.1.4 Atrazine concentration trend analysis.....	40
3.1.5 Principal Component Analysis.....	40
3.2 Atrazine residue analysis of soil core samples.....	42
3.2.1 Soil samples and application history.....	42
3.2.2 Soil characteristics.....	44
3.2.3 Chemicals	46
3.2.4 Accelerated solvent extraction	46
3.2.5 Triazine extraction recovery	46
3.2.6 LC-MS/MS analysis.....	47
4. Results & Discussion	49

4.1	Groundwater monitoring.....	49
4.1.1	Groundwater chemistry.....	49
4.1.2	Data Censoring using “regression on order statistics” (ROS)	49
4.1.3	Summary statistics of monitoring data.....	52
4.1.4	Groundwater and triazine fluctuations in selected observation wells.....	67
4.1.5	Deethylatrazine to atrazine ratio (DAR).....	71
4.1.6	Principal Component Analysis (PCA).....	75
4.2	Soil residue analysis	78
4.2.1	Soil parameters.....	78
4.2.2	Accelerated Solvent Extraction (ASE) method validation	80
4.2.3	Triazine extraction recoveries.....	81
4.2.4	Triazine residues in soil cores	82
5.	Highlights and Conclusions	90
5.1	Atrazine groundwater monitoring.....	90
5.2	Atrazine soil residue analysis	91
5.3	Perspective on the long-term fate of atrazine in soils and model predictions.....	93
5.4	Final remarks.....	95
	References	97
	Appendix A: Groundwater monitoring	106
	Appendix B: Atrazine and 2-hydroxyatrazine soil residue analysis	140
	Accelerated Solvent Extraction (ASE) and LC-MS/MS method validation	142

**Energie & Umwelt /
Energy & Environment
Band / Volume 293
ISBN 978-3-95806-099-9**

