

# WIENER MITTEILUNGEN

WASSER • ABWASSER • GEWÄSSER

Band 198

10 WIE 198

Gregor Laaha

## Process based regionalisation of low flows

**INSTITUT WAR — Bibliothek —**

Wasserversorgung, Abwassertechnik  
Abfalltechnik und Raumplanung  
Technische Universität Darmstadt  
Petersenstraße 13, 64287 Darmstadt  
TEL. 0 61 51/16 36 59 + 16 27 48  
FAX 0 61 51/16 37 58

Herausgeber:

o.Univ.-Prof. Dipl.-Ing. Dr. Dr.h.c. Dieter Gutknecht  
Institut für Wasserbau und Ingenieurhydrologie  
Technische Universität Wien

Wien, 2006

**WAR TU Darmstadt**



57516135

# Table of contents

<b>1. Introduction</b>	<b>1</b>
<b>2. Seasonality indices for regionalising low flows</b>	<b>3</b>
2.1 Introduction	3
2.2 Data	5
2.2.1 Study area	5
2.2.2 Discharge data	6
2.2.3 Disaggregation of nested catchments	6
2.2.4 Low flow characteristics	7
2.2.5 Catchment characteristics	8
2.3 Seasonality analysis	8
2.3.1 Seasonality measures	8
2.3.2 Delineation of homogeneous regions	12
2.4 Method of regionalisation and cross-validation	16
2.4.1 Multiple regression	16
2.4.2 Regionalisation methods examined	17
2.4.3 Cross-validation	18
2.5 Results	19
2.5.1 Examining model assumptions	19
2.5.2 Relative importance of predictor variables	22
2.5.3 Overall performance of models	23
2.5.4 Estimation performance of individual catchments	25
2.5.5 Regional performance of models	26
2.6 Discussion	28
2.6.1 Performance of regionalisation methods as compared to the literature	28
2.6.2 Relative performance of regionalisation methods	28
2.6.3 Relative performance of approaches to seasonality analysis	30
2.6.4 Most important controls in comparison with controls in the literature	31
2.7 Conclusion	34
<b>3. A comparison of low flow regionalisation methods – catchment grouping</b>	<b>36</b>
3.1 Introduction	36

3.2	Method	39
3.2.1	Classification of catchments	39
3.2.2	Regional regression approach	42
3.2.3	Analysis of predictive performance	43
3.3	Results	45
3.3.1	Residual pattern approach	45
3.3.2	Weighted cluster analysis	46
3.3.3	Regression tree	50
3.3.4	Regions of similar low flow seasonality	52
3.4	Discussion	54
3.4.1	Variance explained by grouping alone (ANOVA)	54
3.4.2	Goodness-of-fit of regression models	55
3.4.3	Predictive performance of various grouping methods	56
3.4.4	Heteroscedasticity, outliers and bias	58
3.5	Conclusion	60
<b>4.</b>	<b>Low flow estimates from short stream flow records – a comparison of methods</b>	<b>63</b>
4.1	Introduction	63
4.2	Data	66
4.2.1	Discharge data and selection of gauges	66
4.2.2	Low flow characteristics	66
4.2.3	Catchment characteristics	67
4.3	Climate adjustment techniques	67
4.3.1	General concept	67
4.3.2	Donor selection	67
4.3.3	Record augmentation	70
4.3.4	Combining adjusted values from multiple donors	71
4.4	Evaluation method	71
4.4.1	Variation of record length	71
4.4.2	Statistical performance measures	72
4.5	Results	74
4.5.1	Errors of unadjusted low flow characteristics	74

4.5.2	Relative performance of donor selection techniques	75
4.5.3	Relative performance of record augmentation techniques	78
4.5.4	Heteroscedasticity and outliers	80
4.5.5	Spot gaugings	84
4.5.6	Effect of discharges	86
4.6	Discussion	87
4.6.1	Assessment of climate adjustment methods	87
4.6.2	<i>Effect of record lengths</i>	88
4.6.3	<i>Value of short time series compared to regionalisation</i>	89
4.7	Conclusions	91
<b>5.</b>	<b>A national low flow estimation procedure for Austria</b>	<b>93</b>
5.1	Introduction	93
5.2	Data	95
5.2.1	Discharge data, disaggregation and catchment selection	95
5.2.2	Low flow characteristic and catchment characteristics	95
5.3	Estimation strategy	95
5.4	Gauged sites	97
5.4.1	Reference period	97
5.4.2	Temporal adjustment	98
5.5	Ungauged sites	98
5.5.1	Catchment grouping	98
5.5.2	Regression model	99
5.5.3	Spatial adjustment	101
5.6	Uncertainty assessment	103
5.6.1	Confidence limits	103
5.6.2	Error of spatially unadjusted prediction	103
5.6.3	Error of spatially adjusted prediction	104
5.7	Summary of Austrian procedure	105
<b>6.</b>	<b>Summary of results and conclusions</b>	<b>111</b>
<b>7.</b>	<b>References</b>	<b>117</b>