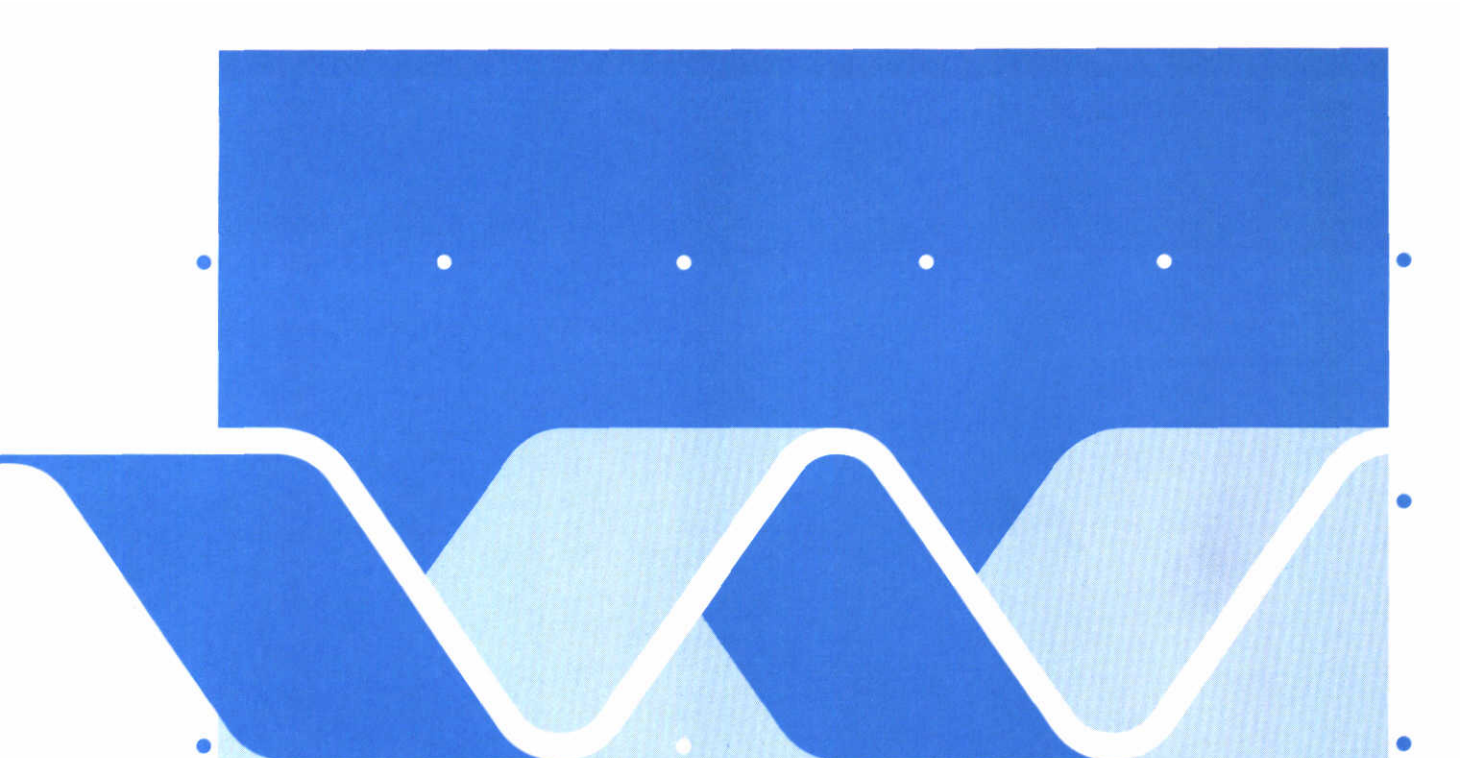




prepared for:

Rijkswaterstaat, RIZA Arnhem

Development of rainfall-runoff models for the Sieg and Lippe

Final Report, Volume II: Annexes, Tables and Figures

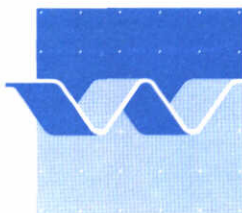
February, 1998

Development of rainfall-runoff models for the Sieg and Lippe

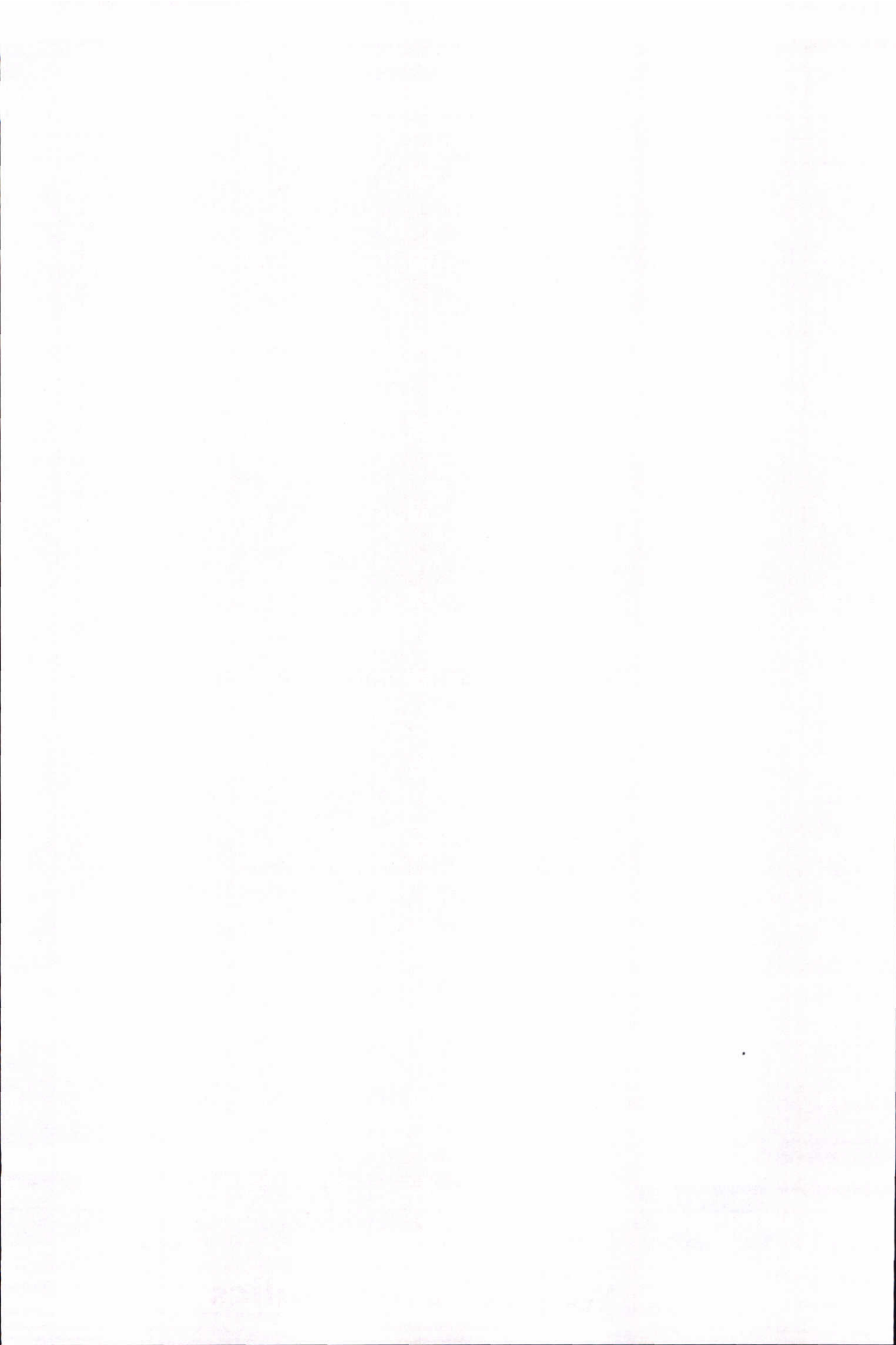
Final Report, Volume II: Annexes, Tables and Figures

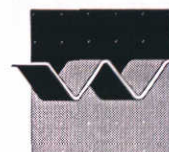
M.C.L.M. van Mierlo

R.H. Passchier



wl | delft hydraulics





delft hydraulics

CLIENT : Rijkswaterstaat RIZA (Arnhem)

TITLE : Final Report, Volume II: Annexes, Tables and Figures

ABSTRACT :

The FLORIJN project concerns the development of rainfall-runoff models for the rivers Sieg and Lippe in Germany. In this Volume of the Final Report (i.e. Volume II: Annexes, Tables and Figures) contains Annexes, Tables and Figures belonging to Volume I: Main Text

REFERENCES:

REV	ORIGINATOR	DATE	REMARKS	REVIEWED BY	APPROVED BY
	M. van Mierlo	19-2-1998		K.V. Heynert	E. van Beek
KEYWORD(S)			CONTENTS		STATUS
Rhine / Rijn			TEXT PAGES : TABLES : FIGURES : APPENDICES :		☐ PRELIMINARY ☐ DRAFT ☒ FINAL
			PROJECT IDENTIFICATION: R3049		

CONTENTS

Introduction

Annexes:

- Annex 1: Minutes of meeting with BFG
- Annex 2: Data Availability Sieg
- Annex 3: Data Availability Lippe
- Annex 4: Spatial relationships with KL-climatic stations in Sieg basin
- Annex 5: Spatial relationships with KL-climatic stations in Lippe basin

Tables of Chapter 10

Figures of Chapters 2, 3, 4, 5, 6, 7, 9, 10 and 11

I Introduction

The FLORIJN project concerns the development of a flood forecasting model for level gauge Lobith. The aim of the FLORIJN project is to be able to forecast high water levels at Lobith three day in advance with sufficient reliability. A part of the FLORIJN model comprises of rainfall-runoff models for the rivers Sieg and Lippe in Germany. RIZA commissioned the development of these two rainfall-runoff models to WL | Delft Hydraulics.

Three earlier reports, concerning the development of the two rainfall-runoff models, were produced, respectively: the First Progress Report in November 1996, the Second Progress Report in July 1997 and the Third Progress Report in November 1997. In accordance with the contract (RIZA-overeenkomst nr. RI-2040), the following subjects are to be reported upon in this Final Report, viz:

1. Data collection,
2. Validation of available hydro-meteorological data,
3. Preparation of data-sets with different spatial refinement,
4. Determination of spatial relationships between on-line and off-line stations,
5. System analysis (i.e. characteristics of the Sieg and Lippe catchments),
6. Advice on type of snow-melt module required,
7. Calibration & validation of the rainfall-runoff models, and
8. Sensitivity analysis of the rainfall-runoff models.

The Final Report consists of two Volumes, i.e. Volume I: Main Report and Volume II: Annexes, Tables and Figures. The current report concerns Volume II of the Final Report and contains all Annexes, Tables and Figures referred to in the Main Report.

ANNEXES

- Annex 1: Minutes of meeting with BFG**
- Annex 2: Data Availability Sieg**
- Annex 3: Data Availability Lippe**
- Annex 4: Spatial relationships with KL-climatic stations in Sieg basin**
- Annex 5: Spatial relationships with KL-climatic stions in Lippe basin**

Annex I Minutes of meeting with BfG

Project : Rainfall-runoff modelling of the river Sieg & Lippe.
Proj. No. : R3049.00
Concerns : Minutes of the meeting with BfG on January 29th, 1997 in their
office in Koblenz.
From : Thieu van Mierlo & Ron Passchier of DELFT HYDRAULICS.

Participants of the meeting were:

- Mr. Sprokkereef of Rijkswaterstaat, RIZA, Arnhem;
- Dr. Wilke (Regierungsdirektor), BfG
- Mr. Krahe, BfG
- Mr. Daamen, BfG
- Mr. R. Passchier DELFT HYDRAULICS
- Mr. T. van Mierlo DELFT HYDRAULICS

Context and scope of the meeting:

Dr. Wilke welcomed everybody and consequently opened the meeting. He requested Mr. Sprokkereef to elaborate on the purpose of the meeting. After this invitation Mr. Sprokkereef informed the meeting that RIZA, Rijkswaterstaat is developing the FLORIJN instrumentarium. The aim of FLORIJN is to predict high flood-levels on the river Rhine more than two days in advance. Apart from a hydro-dynamic model (based on SOBEK) for the stretch of the river Rhine from Andernach to Lobith, the FLORIJN instrumentarium will comprise of two rainfall-runoff models, respectively for the river Sieg and the river Lippe in Germany. Mr. Sprokkereef mentioned that he had requested Mr. Wilke for the present meeting in order to share the experience of the Bundesanstalt fuer Gewasserkunde (BfG) in modelling the rainfall-runoff process (with emphasis on snow modelling) of tributary rivers in the Rhine basin, and to be informed on relevant data available at BfG. After Mr. Sprokkereef's elaboration, Dr. Wilke suggested to start discussing on the experience of BfG in modelling hydrological processes and thereafter concentrate on availability of relevant data.

Experience of BfG in rainfall-runoff modelling:

The present status of the use of mathematical models by the BfG for predicting high-floods can be summarised as follows. Dr. Steinerbach developed a hydro-dynamic model, which is used to forecast low water levels (i.e. for navigation purposes) on the river Rhine. The input of the model comprises of on-real-time collected water levels (which are converted to discharges) on the river Rhine and on its main tributaries. Rainfall-runoff models are not linked with this hydro-dynamic model. There are plans to apply this hydro-dynamic model in future also for flood forecasting purposes.

At present there are no operational rainfall-runoff models available at BfG for predicting the outflow of tributaries of the river Rhine. Mr. Krahe developed a pilot rainfall-runoff model for a particular area in the northern part of the Moesel catchment. This model, based on the thesis work of Mr. Vehviläinen, includes a snow module. Calibration results of the pilot model were, however, not yet available. A copy of the thesis work of Mr. Vehviläinen was handed over in the meeting. Other experiences of models by BfG comprises of the application of the NASIM model, which is considered to be too complicated for real-time forecasting purposes. The NASIM model was applied by BfG for the Saar basin. Especially the derivation of the required parameters was cumbersome. Other models, which are considered by the BfG are the SRM, HSPF, Todini and HBV models. The HBV model will be tested soon for flood modelling. The HSPF model is applied for climate change studies, in co-operation with RIZA/Arnhem.

The Deutsche Wetter Dienst (DWD) has developed a physical and raster based (i.e. more complicated than a degree-day model) rainfall-runoff model, entitled SNOW-D, which is presently tested on the Neckar basin. It is anticipated that in future this model will be used for the whole of Germany. The model will be used for real-time forecasting purposes. The model input will be derived from the DWD weather forecast. Results of the SNOW-D model of its application on the Neckar basin were not available.

Relevant data available at BfG:

It was informed that the BfG does not collect hydro-meteorological data, and that streamflow data is collected by the various Staatliches Umweltambten, while meteorological data is collected by the Deutsche Wetter Dienst (DWD). The BfG retrieves meteorological data from the Deutschland Wetter Forecast (DWF) model. The DWF model is owned and operated by the DWD. The DWF model provides information on historical and forecasted (72 hours in advance) precipitation (both rainfall & snow). The information refers to rasters of 14 km by 14 km. At present the minimum time-step is 6 hours. It is anticipated that in future this time step can be reduced to 1 hour. An overview of additional data (e.g. temperatures, etc.) which can be retrieved from the DWF model was handed over in the meeting. Further on it to be mentioned that Mr. Krahe developed a software tool for comparing predictions by the Deutschland Wetter Forecast Model with the actual measured precipitation. The results of these comparisons will be very useful for the anticipated sensitivity analysis of the validated rainfall-runoff models of the river Sieg & Lippe. It was suggested that the best way for collecting the required meteorological data might be through DWD or the Rhine committee.

Actions:

1. It was agreed upon that Eric Sprokkereef will make an appointment with the Deutsche Wetter Dienst for a visit in February/ March 1997.

Annex 2 Data Availability Sieg

1. LUA-NRW meteorological stations (hourly data)

	Flood Period													
Name of station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Aue	-	-	-	-	-	-	X	X	X	X	X	X	-	-
Bonn Bockeroth	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Bonn-Heizkraftwerk	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brenzingen	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Eitorf	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Eschmar Muellekoven	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Frielingsdorf	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Haenscheid	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Helgersdorf	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Homburg-Broel	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Kuchenbach	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Lahnhof-Geiersgrund	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Lahnhof-1	-	-	-	-	-	-	-	-	-	-	X	X	-	-
Lehruch (Lehmbach)	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Marienfeld	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Neunkirchen Seelsch.	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Olpe	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Rehringhausen	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Siegen Ghs	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Suelze	X	X	X	X	X	X	X	X	X	X	X	X	-	-

2. DWD synoptic/KL-climatic stations (KL-climatic stations in bold)

	Flood Period													
Name of station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bad Marienberg	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bendorf	-	-	-	-	-	-	-	-	X	X	X	X	X	X
Bonn-Friesdorf	X	X	X	X	X	X	X	X	-	-	-	-	-	-
Bonn-Hardthoehe	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Koln-Wahn	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mendig	-	X	X	X	X	X	X	X	X	X	X	X	X	X
Noervenich	-	X	X	X	X	X	X	X	X	X	X	X	X	X

3. Rated river gauging stations (hourly discharge data)

Name of station	Flood Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Betzdorf	-	-	-	-	-	-	-	-	-	-	-	X	X	X
Broel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eitorf	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Heimborn	X	X	X	X	-	-	-	-	-	-	-	X	X	X
Helgersdorf	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lahnhof-1	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lohmar	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Menden	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Niederschelden	-	-	-	-	-	-	-	-	-	-	-	X	X	X
Overath	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Siegburg-Kaldauen	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Weidenau	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Annex 3 Data availability Lippe

1. LUA-NRW meteorological stations (hourly data)

	Flood Period													
Name of station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Baumberg	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Boenen	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Boke	X	X	X	X	X	X	X	X	X	X	-	-	-	-
Bottrop Eigen	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Brilon 1	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Buke	X	X	X	X	X	X	X	X	X	X	-	-	-	-
Castrop-Rauxel	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Detmold-Zentral KLG.	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Dorsten	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Dortmund Kurl	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Dortmund-Aplerbeck	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Dortmund-Marten	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Dortmund-Nettebach	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Effeln	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Herringen	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kleinenberg	X	X	X	X	X	X	X	-	-	-	-	-	-	-
Lippstad Lipperbr.	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Luedinghausen KLG	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madfeld	X	X	X	X	X	X	-	X	X	X	X	X	-	-
Niedermarsberg	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Oberhausen-osterfeld	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Olfen-Fuchtelner Muhle	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Ostbueren	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Paderborn PS1	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Rhyern	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unna	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Waltrop1	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Westerholt	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wippringsen	X	X	X	X	X	X	X	X	X	X	X	X	-	-

2. LUA-NRW synoptic/KL-climatic data (KL-climatic stations in bold)

	Flood Period													
Name of station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bad-Lippspringe	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bad-Salzuflen	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bocholt-Liedern	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Duesseldorf (Flugwewa)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Essen (WST)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Guetersloh	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hopsten	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kahler-Asten	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kalkar	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Koeterberg	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Laarbruch	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Luedenscheid	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Munster/Osnabr. (FWW)	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Rheine-Bentlage	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Warburg	-	X	X	-	X	-	X	X	X	X	X	X	-	-

3. Rated river gauging stations (hourly discharge data)

	Flood Period													
Name of station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bentfeld	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Haltern	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kessler 3	-	-	-	-	-	-	-	-	-	X	X	X	X	-
Leven	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lippstadt 2	-	-	X	X	X	X	X	X	X	X	X	X	X	-
Luenen	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menden	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Niederaden	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Niedertudorf	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nordborchen	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Olfen	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Schermbeck 1	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Westtunen	X	X	X	X	X	X	X	X	X	X	X	X	X	-

Annex 4 Spatial relationships of KL-climatic stations with Sieg areal rainfall

Sieg total basin

Variable No.	Name	Mean	Standard Deviation
1	SIEG TOTAL BASIN	.11150E+01	.22342E+01
2	Bad-Marienberg	.13257E+01	.27104E+01
3	Bonn-Friesdorf	.56473E+00	.14579E+01
4	Koln-Wahn	.86179E+00	.20411E+01

Correlation matrix

	1	2	3	4
1	1.000	0.836	0.639	0.735
2	0.836	1.000	0.672	0.668
3	0.639	0.672	1.000	0.658
4	0.735	0.668	0.658	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	Std. error of regr. coeff.
2	.51260	.01548
4	.35007	.02056
Intercept.....	.13379	

Variables **not** in regression

Variable Number	Tolerance level	Part. corr. coefficient
3	.46979	.03176

Dependent variable : SIEG TOTAL BASIN

Independent variable	Regression coefficient
Bad-Marienberg	.51260E+00
Koln-Wahn	.35007E+00

Intercept : .13379E+00

Agger basin

Variable No.	Name	Mean	Standard Deviation
1	AGGER	.12359E+01	.25915E+01
2	Bad-Marienberg	.13257E+01	.27104E+01
3	Bonn-Friesdorf	.56473E+00	.14579E+01
4	Koln-Wahn	.86179E+00	.20411E+01

Correlation matrix

	1	2	3	4
1	1.000	0.764	0.577	0.725
2	0.764	1.000	0.672	0.668
3	0.577	0.672	1.000	0.658
4	0.725	0.668	0.658	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	Std. error of regr. Coeff.
2	.48287	.02094
4	.49190	.02780
Intercept.....	.17187	

Variables ****not**** in regression

Variable Number	tolerance level	part. Corr. coefficient
3	.46979	-.04416

Dependent variable : AGGER

Independent variable	Regression coefficient
Bad-Marienberg	.48287E+00
Koln-Wahn	.49190E+00

Intercept : .17187E+00

Lower Sieg basin

Variable No.	Name	Mean	Standard Deviation
1	LOWER SIEG BASIN	.68562E+00	.16550E+01
2	Bad-Marienberg	.13257E+01	.27104E+01
3	Bonn-Friesdorf	.56473E+00	.14579E+01
4	Koln-Wahn	.86179E+00	.20411E+01

Correlation matrix

	1	2	3	4
1	1.000	0.720	0.763	0.719
2	0.720	1.000	0.672	0.668
3	0.763	0.672	1.000	0.658
4	0.719	0.668	0.658	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.16182	.01401
3	.45803	.02573
4	.22374	.01831
Intercept.....	.01962	

Dependent variable : LOWER SIEG BASIN

Independent variable	Regression coefficient
Bad-Marienberg	.16182E+00
Bonn-Friesdorf	.45803E+00
Koln-Wahn	.22374E+00

Intercept : .19619E-01

Middle Sieg basin

Variable No. Name	Mean	Standard Deviation
1 MIDDLE SIEG BASIN	.10956E+01	.23135E+01
2 Bad-Marienberg	.13257E+01	.27104E+01
3 Bonn-Friesdorf	.56473E+00	.14579E+01
4 Koln-Wahn	.86179E+00	.20411E+01

Correlation matrix

	1	2	3	4
1	1.000	0.831	0.644	0.734
2	0.831	1.000	0.672	0.668
3	0.644	0.672	1.000	0.658
4	0.734	0.668	0.658	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.52631	.01624
4	.36434	.02157

Intercept..... .08387

Variables ****not**** in regression

Variable Number	tolerance level	part. Corr. coefficient
3	.46979	.05247

Dependent variable : MIDDLE SIEG BASIN

Independent variable	Regression coefficient
Bad-Marienberg	.52631E+00
Koln-Wahn	.36434E+00

Intercept : .83867E-01

Upper Sieg basin

Variable No. Name	Mean	Standard Deviation
1 UPPER SIEG BASIN	.11485E+01	.22983E+01
2 Bad-Marienberg	.13257E+01	.27104E+01
3 Bonn-Friesdorf	.56473E+00	.14579E+01
4 Koln-Wahn	.86179E+00	.20411E+01

Correlation matrix

	1	2	3	4
1	1.000	0.806	0.569	0.646
2	0.806	1.000	0.672	0.668
3	0.569	0.672	1.000	0.658
4	0.646	0.668	0.658	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.57413	.01847
4	.21732	.02452
Intercept.....	.20014	

Variables ****not**** in regression

Variable Number	tolerance level	part. Corr. coefficient
3	.46979	-.03301

Dependent variable : UPPER SIEG BASIN

Independent variable	Regression coefficient
Bad-Marienberg	.57413E+00
Koln-Wahn	.21732E+00

Intercept : .20014E+00

Middle/Upper Sieg basin

Variable No.	Name	Mean	Standard Deviation
1	UPPER/MIDDLE SIEG	.11291E+01	.22741E+01
2	Bad-Marienberg	.13257E+01	.27104E+01
3	Bonn-Friesdorf	.56473E+00	.14579E+01
4	Koln-Wahn	.86179E+00	.20411E+01

Correlation matrix

	1	2	3	4
1	1.000	0.836	0.611	0.689
2	0.836	1.000	0.672	0.668
3	0.611	0.672	1.000	0.658
4	0.689	0.668	0.658	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.56900	.01656
4	.26280	.02199
Intercept.....	.14829	

Variables **not** in regression

Variable Number	tolerance level	part. Corr. coefficient
3	.46979	.00117

Dependent variable : UPPER/MIDDLE SIEG

Independent variable	Regression coefficient
Bad-Marienberg	.56900E+00
Koln-Wahn	.26280E+00
Intercept	: .14829E+00

Annex 5 Spatial relationships of KL-climatic stations with Lippe areal rainfall

Lippe total basin

Variable No.	Name	Mean	Standard Deviation
1	LIPPE (TOTAL BASIN)	.87130E+00	.19092E+01
2	Bad-Lippspringe	.10384E+01	.25237E+01
3	Bad-Salzuflen	.92170E+00	.22668E+01
4	Bocholt-L.	.78095E+00	.24527E+01
5	Dusseldorf (Fl)	.87090E+00	.21257E+01
6	Essen	.10002E+01	.23989E+01
7	Guetersloh	.85510E+00	.20624E+01
8	Kahler-Asten	.17821E+01	.37103E+01
9	Luedenscheid	.14205E+01	.30188E+01
10	Munster/Osn.	.79895E+00	.20937E+01

Period 1 - 12

Correlation matrix

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.782	0.748	0.629	0.706	0.767	0.841	0.765	0.766	0.816
2	0.782	1.000	0.797	0.431	0.534	0.620	0.858	0.754	0.681	0.644
3	0.748	0.797	1.000	0.411	0.534	0.591	0.825	0.641	0.624	0.676
4	0.629	0.431	0.411	1.000	0.613	0.635	0.499	0.502	0.589	0.599
5	0.706	0.534	0.534	0.613	1.000	0.902	0.609	0.600	0.744	0.670
6	0.767	0.620	0.591	0.635	0.902	1.000	0.686	0.677	0.792	0.730
7	0.841	0.858	0.825	0.499	0.609	0.686	1.000	0.716	0.694	0.782
8	0.765	0.754	0.641	0.502	0.600	0.677	0.716	1.000	0.835	0.641
9	0.766	0.681	0.624	0.589	0.744	0.792	0.694	0.835	1.000	0.677
10	0.816	0.644	0.676	0.599	0.670	0.730	0.782	0.641	0.677	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.09883	.01545
3	.06097	.01434
4	.09611	.00957
5	.06560	.01908
6	.05378	.01919
7	.19528	.02137
8	.08362	.00785
10	.22062	.01536
Intercept.....	.03424	

Variables ****not**** in regression

Variable	tolerance	part. Corr.
Number	level	coefficient
9	.19769	.03257

Dependent variable : LIPPE (TOTAL BASIN)

Independent variable	Regression coefficient
Bad-Lippspringe	.98834E-01
Bad-Salzuflen	.60974E-01
Bocholt-L.	.96106E-01
Dusseldorf (Fl)	.65602E-01
Essen	.53779E-01
Guetersloh	.19528E+00
Kahler-Asten	.83619E-01
Munster/Osn.	.22062E+00
Intercept	: .34237E-01

Lower Lippe basin

Variable		Mean	Standard
No.	Name		Deviation
1	LOWER LIPPE BASIN	.87505E+00	.21481E+01
2	Bad-Salzuflen	.91825E+00	.22624E+01
3	Bocholt-L.	.77740E+00	.24519E+01
4	Dusseldorf (Fl)	.86975E+00	.21257E+01
5	Essen	.99820E+00	.23988E+01
6	Guetersloh	.85200E+00	.20590E+01
7	Kahler-Asten	.17760E+01	.37095E+01
8	Luedenscheid	.14153E+01	.30164E+01
9	Munster/Osn.	.79275E+00	.20886E+01

Correlation matrix

	1	2	3	4	5	6	7	8	9
1	1.000	0.582	0.679	0.734	0.776	0.666	0.578	0.652	0.761
2	0.582	1.000	0.411	0.535	0.591	0.824	0.640	0.623	0.677
3	0.679	0.411	1.000	0.613	0.636	0.499	0.501	0.589	0.600
4	0.734	0.535	0.613	1.000	0.902	0.609	0.600	0.745	0.672
5	0.776	0.591	0.636	0.902	1.000	0.687	0.677	0.792	0.732
6	0.666	0.824	0.499	0.609	0.687	1.000	0.716	0.693	0.784
7	0.578	0.640	0.501	0.600	0.677	0.716	1.000	0.835	0.642
8	0.652	0.623	0.589	0.745	0.792	0.693	0.835	1.000	0.678
9	0.761	0.677	0.600	0.672	0.732	0.784	0.642	0.678	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.07069	.01617
3	.20786	.01420
4	.12664	.02812
5	.26698	.02845
8	-.05724	.01494
9	.32905	.02078
Intercept.....	.09207	

Variables **not** in regression

Variable Number	tolerance level	part. Corr. coefficient
6	.21229	.04166
7	.27161	-.01515

Dependent variable : LOWER LIPPE BASIN

Independent variable	Regression coefficient
Bad-Salzuflen	.70686E-01
Bocholt-L.	.20786E+00
Dusseldorf (Fl)	.12664E+00
Essen	.26698E+00
Luedenscheid	-.57245E-01
Munster/Osn.	.32905E+00
Intercept	: .92065E-01

Middle Lippe basin

Variable No.	Name	Mean	Standard Deviation
1	MIDDLE LIPPE BASIN	.83185E+00	.19455E+01
2	Bad-Lippspringe	.10384E+01	.25237E+01
3	Bad-Salzuflen	.92170E+00	.22668E+01
4	Bocholt-L.	.78095E+00	.24527E+01
5	Dusseldorf (Fl)	.87090E+00	.21257E+01
6	Essen	.10002E+01	.23989E+01
7	Guetersloh	.85510E+00	.20624E+01
8	Kahler-Asten	.17820E+01	.37104E+01
9	Luedenscheid	.14205E+01	.30188E+01
10	Munster/Osn.	.79895E+00	.20937E+01

Correlation matrix										
	1	2	3	4	5	6	7	8	9	10
1	1.000	0.761	0.734	0.590	0.682	0.745	0.824	0.747	0.762	0.787
2	0.761	1.000	0.797	0.431	0.534	0.620	0.858	0.754	0.681	0.644
3	0.734	0.797	1.000	0.411	0.534	0.591	0.825	0.641	0.624	0.676
4	0.590	0.431	0.411	1.000	0.613	0.635	0.499	0.502	0.589	0.599
5	0.682	0.534	0.534	0.613	1.000	0.902	0.609	0.600	0.744	0.670
6	0.745	0.620	0.591	0.635	0.902	1.000	0.686	0.677	0.792	0.730
7	0.824	0.858	0.825	0.499	0.609	0.686	1.000	0.716	0.694	0.782
8	0.747	0.754	0.641	0.502	0.600	0.677	0.716	1.000	0.835	0.641
9	0.762	0.681	0.624	0.589	0.744	0.792	0.694	0.835	1.000	0.677
10	0.787	0.644	0.676	0.599	0.670	0.730	0.782	0.641	0.677	1.000

Stepwise Regression

Variables in regression			
Variable	regression	std. Error of	
Number	coefficient	regr. Coeff.	
2	.06989	.01778	
3	.06997	.01655	
4	.06460	.01106	
6	.07989	.01563	
7	.23258	.02465	
8	.05619	.01105	
9	.07842	.01467	
10	.19385	.01772	
Intercept.....	-.00086		

Variables **not** in regression			
Variable	tolerance	part. Corr.	
Number	level	coefficient	
5	.17709	.03266	

Dependent variable : MIDDLE LIPPE BASIN	
Independent variable	Regression coefficient
Bad-Lippspringe	.69888E-01
Bad-Salzuflen	.69974E-01
Bocholt-L.	.64599E-01
Essen	.79887E-01
Guetersloh	.23258E+00
Kahler-Asten	.56194E-01
Luedenscheid	.78421E-01
Munster/Osn.	.19385E+00
Intercept	: -.85884E-03

Upper Lippe basin

Variable No.	Name	Mean	Standard Deviation
1	UPPER LIPPE BASIN	.95365E+00	.21556E+01
2	Bad-Lippspringe	.10372E+01	.25230E+01
3	Bad-Salzuflen	.91840E+00	.22624E+01
4	Bocholt-L.	.77780E+00	.24518E+01
5	Dusseldorf (Fl)	.86990E+00	.21257E+01
6	Essen	.99845E+00	.23988E+01
7	Guetersloh	.85255E+00	.20589E+01
8	Kahler-Asten	.17811E+01	.37140E+01
9	Luedenscheid	.14169E+01	.30165E+01
10	Munster/Osn.	.79290E+00	.20886E+01

Correlation matrix

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.858	0.747	0.472	0.580	0.643	0.819	0.776	0.704	0.669
2	0.858	1.000	0.798	0.430	0.534	0.619	0.858	0.753	0.681	0.646
3	0.747	0.798	1.000	0.411	0.534	0.591	0.824	0.639	0.623	0.677
4	0.472	0.430	0.411	1.000	0.613	0.635	0.499	0.501	0.589	0.600
5	0.580	0.534	0.534	0.613	1.000	0.902	0.609	0.599	0.744	0.672
6	0.643	0.619	0.591	0.635	0.902	1.000	0.686	0.676	0.792	0.732
7	0.819	0.858	0.824	0.499	0.609	0.686	1.000	0.715	0.693	0.784
8	0.776	0.753	0.639	0.501	0.599	0.676	0.715	1.000	0.834	0.641
9	0.704	0.681	0.623	0.589	0.744	0.792	0.693	0.834	1.000	0.678
10	0.669	0.646	0.677	0.600	0.672	0.732	0.784	0.641	0.678	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
2	.39157	.01853
5	.05949	.01372
7	.22964	.02230
8	.13866	.00967
Intercept.....	.05300	

Variables **not** in regression

Variable Number	tolerance level	part. Corr. coefficient
3	.28839	.06784
4	.58814	.02894
6	.14887	-.03170
9	.20881	-.01351
10	.31656	.03348

Dependent variable : UPPER LIPPE BASIN		
Independent variable	Regression coefficient	
Bad-Lippspringe	.39157E+00	
Dusseldorf (Fl)	.59493E-01	
Guetersloh	.22964E+00	
Kahler-Asten	.13866E+00	
Intercept	:	.52995E-01

Stever basin

Variable No.	Name	Mean	Standard Deviation
1	STEVE BASIN	.81680E+00	.20149E+01
2	Bad-Salzuflen	.91825E+00	.22624E+01
3	Bocholt-L.	.77740E+00	.24519E+01
4	Dusseldorf (Fl)	.86975E+00	.21257E+01
5	Essen	.99820E+00	.23988E+01
6	Guetersloh	.85200E+00	.20590E+01
7	Kahler-Asten	.17760E+01	.37095E+01
8	Luedenscheid	.14153E+01	.30164E+01
9	Munster/Osn.	.79275E+00	.20886E+01

Correlation matrix

	1	2	3	4	5	6	7	8	9
1	1.000	0.624	0.684	0.677	0.724	0.729	0.640	0.683	0.852
2	0.624	1.000	0.411	0.535	0.591	0.824	0.640	0.623	0.677
3	0.684	0.411	1.000	0.613	0.636	0.499	0.501	0.589	0.600
4	0.677	0.535	0.613	1.000	0.902	0.609	0.600	0.745	0.672
5	0.724	0.591	0.636	0.902	1.000	0.687	0.677	0.792	0.732
6	0.729	0.824	0.499	0.609	0.687	1.000	0.716	0.693	0.784
7	0.640	0.640	0.501	0.600	0.677	0.716	1.000	0.835	0.642
8	0.683	0.623	0.589	0.745	0.792	0.693	0.835	1.000	0.678
9	0.852	0.677	0.600	0.672	0.732	0.784	0.642	0.678	1.000

Stepwise Regression

Variables in regression

Variable Number	regression coefficient	std. Error of regr. Coeff.
3	.19070	.01147
4	.06623	.01471
6	.09047	.01834
7	.03185	.00853
9	.53647	.01819
Intercept.....	.05200	

Variables ****not**** in regression

Variable	tolerance	part. Corr.
Number	level	coefficient
2	.31245	.00506
5	.14180	.01949
8	.20449	.01735

Dependent variable : STEVER BASIN

Independent variable	Regression coefficient
Bocholt-L.	.19070E+00
Dusseldorf (F1)	.66233E-01
Guetersloh	.90475E-01
Kahler-Asten	.31855E-01
Munster/Osn.	.53647E+00
Intercept	: .52002E-01

Tables of Chapter 10

Table 10.1a.	Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.1b.	Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.2a.	Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.2b.	Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.3a.	Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.3b.	Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.4a.	Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.4b.	Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity $f_{\min}$.
Table 10.5.	Sieg Level 1, Results of rainfall sensitivity analysis for Period no. 5.
Table 10.6.	Sieg Level 1, Results of rainfall sensitivity analysis for Period no. 12.
Table 10.7.	Lippe Level 1, Results of rainfall sensitivity analysis for Period no. 7.
Table 10.8.	Lippe Level 1, Results of rainfall sensitivity analysis for Period no. 9.
Table 10.9.	Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{\min}=0.30$ was used.
Table 10.10.	Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.30$ for LUA-NRW & $f_{\min}=0.10$ for DWD
Table 10.11.	Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.30$ for LUA-NRW & $f_{\min}=0.50$ for DWD
Table 10.12.	Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{\min}=0.40$ was used.
Table 10.13.	Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.40$ for LUA-NRW & $f_{\min}=0.20$ for DWD
Table 10.14.	Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.40$ for LUA-NRW & $f_{\min}=0.60$ for DWD
Table 10.15.	Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{\min}=0.20$ was used.
Table 10.16.	Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.20$ for LUA-NRW & $f_{\min}=0.10$ for DWD
Table 10.17.	Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.20$ for LUA-NRW & $f_{\min}=0.30$ for DWD
Table 10.18.	Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{\min}=0.20$ was used.
Table 10.19.	Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.20$ for LUA-NRW & $f_{\min}=0.10$ for DWD
Table 10.20.	Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{\min}=0.20$ for LUA-NRW & $f_{\min}=0.30$ for DWD

Sieg Level 1, Period no. 5, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.1	6	8.6%	31.3%	-54.9%
	12	14.7%	29.1%	-54.8%
	18	16.0%	39.0%	-63.5%
	24	16.7%	55.6%	-79.5%
	30	22.0%	70.5%	-84.1%
	36	27.5%	83.0%	-88.6%
	42	29.7%	93.4%	-95.8%
	48	31.0%	102.1%	-105.9%
fmin = 0.2	6	8.1%	31.3%	-28.6%
	12	13.7%	29.1%	-38.2%
	18	14.7%	29.2%	-40.8%
	24	14.7%	41.0%	-50.4%
	30	19.6%	50.3%	-55.0%
	36	24.6%	57.1%	-59.5%
	42	26.4%	64.4%	-66.7%
	48	27.4%	69.7%	-76.9%
fmin = 0.3 (calibration value)	6	7.8%	31.3%	-28.6%
	12	13.1%	29.1%	-38.2%
	18	14.0%	26.6%	-40.8%
	24	13.7%	25.8%	-37.0%
	30	18.2%	31.4%	-45.1%
	36	22.9%	35.8%	-52.2%
	42	24.4%	38.8%	-58.4%
	48	25.0%	43.8%	-65.2%
fmin = 0.4	6	7.7%	31.3%	-28.6%
	12	12.8%	29.1%	-38.2%
	18	13.6%	26.6%	-40.8%
	24	13.3%	17.2%	-38.5%
	30	17.9%	26.2%	-45.3%
	36	22.6%	24.3%	-52.6%
	42	24.0%	26.0%	-59.0%
	48	24.6%	27.2%	-66.2%

Table 10.1a Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiriltration capacity f_{min} .

Sieg Level 1, Period no. 5, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.5	6	7.7%	31.3%	-28.6%
	12	13.1%	29.1%	-38.2%
	18	13.9%	26.6%	-40.8%
	24	13.7%	18.6%	-42.8%
	30	18.4%	26.2%	-45.5%
	36	23.3%	24.3%	-53.0%
	42	24.9%	21.9%	-59.6%
	48	25.9%	15.5%	-67.1%

Model parameters:				
fmin	0.10, 0.20, 0.30		alfa (1,1)	0.29
	0.40 or 0.50		alfa (1,2)	0.14
fmax	5.00		alfa (1,3)	0.10
kb	8.60		alfa (1,4)	0.00
psi	0.93		alfa (1,5)	0.00
kn	10.50		alfa (1,6)	0.00
nn	2.95		alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.1b Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity f_{min} .

Sieg Level 1, Period no. 12, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.1	6	8.8%	28.7%	-122.8%
	12	18.0%	64.7%	-221.1%
	18	24.8%	93.5%	-254.5%
	24	30.9%	111.0%	-254.5%
	30	36.2%	136.7%	-258.1%
	36	41.2%	156.0%	-261.3%
	42	45.5%	170.3%	-263.5%
	48	49.4%	184.7%	-260.9%
fmin = 0.2	6	6.1%	18.0%	-32.4%
	12	11.1%	39.2%	-69.1%
	18	14.6%	58.2%	-87.3%
	24	17.8%	78.3%	-93.4%
	30	21.3%	95.8%	-97.6%
	36	24.6%	109.8%	-100.3%
	42	27.7%	120.0%	-100.0%
	48	30.3%	128.8%	-96.4%
fmin = 0.3 (calibration value)	6	5.3%	18.0%	-28.9%
	12	10.2%	32.3%	-56.9%
	18	14.6%	42.0%	-69.8%
	24	18.9%	46.9%	-72.1%
	30	22.7%	56.5%	-73.8%
	36	26.5%	65.3%	-74.1%
	42	30.3%	77.6%	-73.1%
	48	33.5%	90.4%	-72.7%
fmin = 0.4	6	5.0%	23.0%	-27.5%
	12	8.6%	32.3%	-44.9%
	18	10.9%	42.0%	-49.8%
	24	13.2%	46.1%	-50.9%
	30	15.9%	53.7%	-48.4%
	36	18.6%	56.0%	-45.5%
	42	21.0%	56.0%	-54.0%
	48	23.0%	64.8%	-61.0%

Table 10.2a Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiriltration capacity f_{min} .

Sieg Level 1, Period no. 12, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.5	6	4.8%	29.5%	-27.5%
	12	8.2%	35.3%	-26.2%
	18	10.4%	42.0%	-33.6%
	24	12.5%	46.1%	-31.4%
	30	15.2%	53.7%	-38.9%
	36	18.0%	56.0%	-45.5%
	42	20.4%	56.0%	-54.0%
	48	22.3%	54.7%	-61.0%

Model parameters:				
fmin	0.10, 0.20, 0.30		alfa (1,1)	0.29
	0.40 or 0.50		alfa (1,2)	0.14
fmax	5.00		alfa (1,3)	0.10
kb	8.60		alfa (1,4)	0.00
psi	0.93		alfa (1,5)	0.00
kn	10.50		alfa (1,6)	0.00
nn	2.95		alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.2b Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiriltration capacity f_{min} .

Lippe Level 1, Period no. 7, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.01	6	3.5%	50.7%	-93.7%
	12	7.1%	42.0%	-98.0%
	18	10.5%	21.6%	-111.9%
	24	13.2%	26.0%	-120.0%
	30	15.3%	28.6%	-118.9%
	36	17.0%	30.6%	-115.7%
	42	18.7%	31.0%	-112.0%
	48	20.5%	35.1%	-109.5%
	54	22.4%	41.6%	-106.2%
	60	24.3%	47.1%	-111.6%
fmin = 0.1	6	2.8%	11.7%	-19.2%
	12	5.6%	18.0%	-27.3%
	18	8.0%	20.5%	-33.0%
	24	9.6%	24.2%	-35.5%
	30	10.6%	26.3%	-42.9%
	36	11.7%	28.0%	-43.5%
	42	12.9%	32.0%	-48.7%
	48	14.0%	35.5%	-55.8%
	54	15.2%	38.4%	-59.1%
	60	16.6%	41.0%	-68.4%
fmin = 0.2 (calibration value)	6	2.8%	11.7%	-19.2%
	12	5.7%	21.3%	-27.3%
	18	8.3%	32.3%	-33.9%
	24	10.1%	39.1%	-38.1%
	30	11.4%	44.2%	-47.3%
	36	12.7%	46.6%	-48.9%
	42	14.2%	47.4%	-54.7%
	48	15.7%	49.6%	-62.7%
	54	17.4%	51.8%	-66.7%
	60	19.4%	53.8%	-76.8%
fmin = 0.3	6	2.8%	11.7%	-19.2%
	12	5.9%	21.5%	-27.3%
	18	8.9%	32.9%	-33.9%
	24	10.9%	39.6%	-38.1%
	30	12.5%	44.9%	-47.3%
	36	14.0%	47.5%	-48.9%
	42	15.6%	48.7%	-54.7%
	48	17.2%	50.6%	-62.7%
	54	18.9%	52.5%	-66.7%
	60	20.9%	54.8%	-76.8%

Table 10.3a Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} .

Lippe Level 1, Period no. 7, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.4	6	2.9%	11.7%	-19.2%
	12	6.6%	21.5%	-27.3%
	18	10.2%	32.9%	-33.9%
	24	12.6%	39.6%	-38.1%
	30	14.5%	44.9%	-47.3%
	36	16.3%	47.5%	-48.9%
	42	18.1%	50.2%	-54.7%
	48	19.9%	51.2%	-62.7%
	54	21.8%	56.5%	-66.7%
	60	23.7%	60.5%	-76.8%

Model parameters:				
fmin	0.10, 0.20, 0.30		alfa (1,1)	0.52
	0.40 or 0.50		alfa (1,2)	0.41
fmax	5.00		alfa (1,3)	0.00
kb	3.37		alfa (1,4)	0.00
psi	0.80		alfa (1,5)	0.00
kn	32.60		alfa (1,6)	0.00
nn	2.41		alfa (1,7)	0.00
			alfa (1,8)	0.00
			alfa (1,9)	0.00
			alfa (1,10)	0.00

Table 10.3b Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiriltration capacity f_{min} .

Lippe Level 1, Period no. 9, Results of fmin sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
fmin = 0.01	6	4.2%	14.0%	-18.0%
	12	9.2%	26.7%	-48.0%
	18	13.6%	36.1%	-80.7%
	24	16.3%	41.6%	-98.3%
	30	18.9%	50.5%	-110.9%
	36	21.5%	60.1%	-124.6%
	42	23.8%	71.3%	-135.0%
	48	26.1%	80.6%	-134.7%
	54	28.5%	89.4%	-141.9%
	60	30.9%	97.7%	-141.6%
fmin = 0.1	6	3.9%	15.2%	-15.6%
	12	7.7%	33.9%	-30.3%
	18	10.3%	48.7%	-40.2%
	24	12.0%	52.9%	-46.8%
	30	13.6%	56.0%	-54.5%
	36	14.9%	54.3%	-61.5%
	42	15.8%	51.1%	-69.5%
	48	17.1%	55.7%	-74.7%
	54	18.5%	58.6%	-75.2%
	60	20.0%	60.7%	-68.6%
fmin = 0.2 (calibration value)	6	3.8%	15.2%	-14.1%
	12	7.3%	33.9%	-33.3%
	18	9.7%	48.7%	-37.7%
	24	11.2%	52.9%	-37.7%
	30	12.6%	56.0%	-32.3%
	36	13.8%	54.3%	-35.4%
	42	14.9%	51.1%	-38.8%
	48	16.1%	55.7%	-40.1%
	54	17.4%	58.6%	-43.8%
	60	18.5%	60.7%	-49.6%
fmin = 0.3	6	3.9%	15.2%	-14.1%
	12	7.9%	33.9%	-33.3%
	18	11.1%	48.7%	-37.7%
	24	13.1%	52.9%	-37.7%
	30	15.2%	57.3%	-32.3%
	36	17.0%	59.6%	-35.4%
	42	18.6%	60.1%	-38.8%
	48	20.3%	61.2%	-42.4%
	54	21.9%	62.2%	-49.8%
	60	23.4%	64.2%	-57.6%

Table 10.4a Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min} .

Lippe Level 1, Period no. 9, Results of f_{min} sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
$f_{min} = 0.4$	6	3.9%	15.9%	-14.1%
	12	8.2%	33.9%	-33.3%
	18	11.8%	48.7%	-37.7%
	24	14.1%	56.9%	-37.7%
	30	16.4%	62.5%	-33.0%
	36	18.5%	66.4%	-36.1%
	42	20.4%	68.1%	-40.1%
	48	22.3%	69.6%	-49.5%
	54	24.2%	70.8%	-58.4%
	60	26.0%	72.9%	-66.7%

Model parameters:				
f_{min}	0.10, 0.20, 0.30		alfa (1,1)	0.52
	0.40 or 0.50		alfa (1,2)	0.41
f_{max}	5.00		alfa (1,3)	0.00
kb	3.37		alfa (1,4)	0.00
ψ	0.80		alfa (1,5)	0.00
kn	32.60		alfa (1,6)	0.00
nn	2.41		alfa (1,7)	0.00
			alfa (1,8)	0.00
			alfa (1,9)	0.00
			alfa (1,10)	0.00

Table 10.4b Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min}

Sieg Level 1, Period no. 5, Rainfall sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Calibration:	6	7.8%	31.3%	-28.6%
	12	13.1%	29.1%	-38.2%
	18	14.0%	26.6%	-40.8%
	24	13.7%	25.8%	-37.0%
	30	18.2%	31.4%	-45.1%
	36	22.9%	35.8%	-52.2%
	42	24.4%	38.8%	-58.4%
	48	25.0%	43.8%	-65.2%
Overestimation of rainfall: + 20% for 0 < t < 24 hours + 40% for 24 < t < 48 hours	6	11.5%	31.3%	-37.1%
	12	16.0%	29.1%	-52.1%
	18	16.0%	26.6%	-59.5%
	24	15.8%	11.6%	-60.1%
	30	24.5%	26.2%	-89.5%
	36	29.3%	24.3%	-90.1%
	42	31.2%	21.9%	-90.3%
	48	32.3%	24.8%	-98.6%
Underestimation of rainfall: - 20% for 0 < t < 24 hours - 40% for 24 < t < 48 hours	6	10.4%	36.2%	-28.6%
	12	14.9%	35.5%	-38.2%
	18	14.9%	37.4%	-40.8%
	24	14.4%	40.4%	-37.0%
	30	21.5%	62.1%	-45.0%
	36	25.9%	62.2%	-52.2%
	42	26.9%	62.3%	-58.3%
	48	27.0%	61.5%	-65.1%

Model parameters:				
fmin	0.30	alfa (1,1)		0.29
fmax	5.00	alfa (1,2)		0.14
kb	8.60	alfa (1,3)		0.10
psi	0.93	alfa (1,4)		0.00
kn	10.50	alfa (1,5)		0.00
nn	2.95	alfa (1,6)		0.00
		alfa (1,7)		0.00
		alfa (1,8)		0.00

Table 10.5 Sieg Level 1: Results of rainfall sensitivity analysis for Period no. 5

Sieg Level 1, Period no. 12, Rainfall sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Validation:	6	5.0%	23.0%	-27.5%
	12	8.6%	32.3%	-44.9%
	18	10.9%	42.0%	-49.8%
	24	13.2%	46.1%	-50.9%
	30	15.9%	53.7%	-48.4%
	36	18.6%	56.0%	-45.5%
	42	21.0%	56.0%	-54.0%
	48	23.0%	64.8%	-61.0%
Overestimation of rainfall: + 20% for $0 < t < 24$ hours + 40% for $24 < t < 48$ hours	6	9.6%	18.0%	-80.1%
	12	12.1%	32.3%	-99.5%
	18	13.6%	42.0%	-104.3%
	24	15.1%	46.1%	-105.4%
	30	23.2%	50.2%	-150.1%
	36	25.3%	52.9%	-143.0%
	42	27.2%	52.9%	-142.0%
	48	28.6%	52.5%	-141.6%
Underestimation of rainfall: - 20% for $0 < t < 24$ hours - 40% for $24 < t < 48$ hours	6	9.9%	75.7%	-27.5%
	12	12.8%	73.2%	-26.2%
	18	14.7%	71.7%	-33.6%
	24	16.6%	71.1%	-31.4%
	30	23.2%	101.8%	-38.9%
	36	25.8%	101.7%	-45.5%
	42	28.2%	101.8%	-54.0%
	48	30.3%	102.0%	-61.0%

Model parameters:				
fmin	0.40	alfa (1,1)	0.29	
fmax	5.00	alfa (1,2)	0.14	
kb	8.60	alfa (1,3)	0.10	
psi	0.93	alfa (1,4)	0.00	
kn	10.50	alfa (1,5)	0.00	
nn	2.95	alfa (1,6)	0.00	
		alfa (1,7)	0.00	
		alfa (1,8)	0.00	

Table 10.6 Sieg Level 1: Results of rainfall sensitivity analysis for Period no. 12

Lippe, Level 1, Period no. 7, Rainfall sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Calibration:	6	2.8%	11.7%	-19.2%
	12	5.7%	21.3%	-27.3%
	18	8.3%	32.3%	-33.9%
	24	10.1%	39.1%	-38.1%
	30	11.4%	44.2%	-47.3%
	36	12.7%	46.6%	-48.9%
	42	14.2%	47.4%	-54.7%
	48	15.7%	49.6%	-62.7%
	54	17.4%	51.8%	-66.7%
	60	19.4%	53.8%	-76.8%
Overestimation of rainfall: + 20% for 0 < t < 24 hours + 40% for 24 < t < 48 hours + 60% for 48 < t < 60 hours	6	7.5%	11.7%	-29.7%
	12	9.9%	20.6%	-34.4%
	18	12.1%	29.3%	-38.7%
	24	13.5%	36.1%	-42.2%
	30	20.4%	36.8%	-70.9%
	36	21.3%	37.4%	-70.9%
	42	22.3%	40.0%	-70.4%
	48	23.5%	41.4%	-72.1%
	54	31.4%	34.3%	-103.2%
	60	32.7%	33.3%	-103.4%
Underestimation of rainfall: - 20% for 0 < t < 24 hours - 40% for 24 < t < 48 hours - 60% for 48 < t < 60 hours	6	7.3%	28.3%	-19.2%
	12	9.9%	30.8%	-27.3%
	18	12.2%	37.7%	-33.9%
	24	13.7%	40.8%	-38.1%
	30	20.0%	59.1%	-47.3%
	36	21.2%	60.8%	-48.9%
	42	22.5%	63.0%	-54.7%
	48	23.9%	65.0%	-62.7%
	54	29.4%	76.3%	-66.7%
	60	31.2%	76.9%	-76.8%
Model parameters:				
fmin	0.20	alfa (1,1)	0.52	
fmax	5.00	alfa (1,2)	0.41	
kb	3.37	alfa (1,3)	0.00	
psi	0.80	alfa (1,4)	0.00	
kn	32.60	alfa (1,5)	0.00	
nn	2.41	alfa (1,6)	0.00	
		alfa (1,7)	0.00	
		alfa (1,8)	0.00	
		alfa (1,9)	0.00	
		alfa (1,10)	0.00	

Table 10.7 Lippe Level 1: Results of rainfall sensitivity analysis for Period no. 7

Lippe, Level 1, Period no. 9, Rainfall sensitivity analysis:

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Calibration:	6	3.8%	15.2%	-14.1%
	12	7.3%	33.9%	-33.3%
	18	9.7%	48.7%	-37.7%
	24	11.2%	52.9%	-37.7%
	30	12.6%	56.0%	-32.3%
	36	13.8%	54.3%	-35.4%
	42	14.9%	51.1%	-38.8%
	48	16.1%	55.7%	-40.1%
	54	17.4%	58.6%	-43.8%
	60	18.5%	60.7%	-49.6%
Overestimation of rainfall: + 20% for $0 < t < 24$ hours + 40% for $24 < t < 48$ hours + 60% for $48 < t < 60$ hours	6	11.0%	15.2%	-33.5%
	12	12.8%	33.9%	-42.1%
	18	13.9%	48.7%	-51.7%
	24	14.9%	52.9%	-57.1%
	30	25.2%	56.0%	-105.0%
	36	25.4%	54.3%	-106.5%
	42	25.5%	51.1%	-105.7%
	48	25.9%	55.7%	-107.3%
	54	37.8%	58.6%	-143.3%
	60	38.1%	60.7%	-133.3%
Underestimation of rainfall: - 20% for $0 < t < 24$ hours - 40% for $24 < t < 48$ hours - 60% for $48 < t < 60$ hours	6	11.0%	33.7%	-14.1%
	12	12.8%	33.9%	-33.3%
	18	15.5%	48.7%	-37.7%
	24	16.7%	52.9%	-37.7%
	30	23.1%	62.1%	-32.3%
	36	24.0%	65.9%	-35.4%
	42	24.8%	67.4%	-38.8%
	48	25.8%	68.8%	-40.1%
	54	30.7%	72.9%	-43.8%
	60	31.6%	74.4%	-49.6%

Model parameters:				
fmin	0.20	alfa (1,1)	0.52	
fmax	5.00	alfa (1,2)	0.41	
kb	3.37	alfa (1,3)	0.00	
psi	0.80	alfa (1,4)	0.00	
kn	32.60	alfa (1,5)	0.00	
nn	2.41	alfa (1,6)	0.00	
		alfa (1,7)	0.00	
		alfa (1,8)	0.00	
		alfa (1,9)	0.00	
		alfa (1,10)	0.00	

Table 10.8 Lippe Level 1: Results of rainfall sensitivity analysis for Period no. 9

**Sieg Level 1, Period no. 5, Differences due to areal rainfall according to
 LUA-NRW (fmin=0.30) data and
 DWD (fmin=0.30) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.30).	6	7.8%	31.3%	-28.6%
	12	13.1%	29.1%	-38.2%
	18	14.0%	26.6%	-40.8%
	24	13.7%	25.8%	-37.0%
	30	18.2%	31.4%	-45.1%
	36	22.9%	35.8%	-52.2%
	42	24.4%	38.8%	-58.4%
	48	25.0%	43.8%	-65.2%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.30)	6	8.6%	31.3%	-28.6%
	12	15.1%	37.3%	-39.7%
	18	16.9%	57.0%	-63.2%
	24	18.0%	77.3%	-77.3%
	30	23.7%	94.5%	-86.2%
	36	29.4%	109.4%	-98.7%
	42	31.8%	121.9%	-122.9%
	48	33.8%	134.2%	-143.2%

Model parameters:				
fmin	0.30		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.9 Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall,
 in both computations **fmin=0.30** was used.

**Sieg Level 1, Period no. 5, Differences due to areal rainfall according to
 LUA-NRW (fmin=0.30) data and
 DWD (fmin=0.10) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.30).	6	7.8%	31.3%	-28.6%
	12	13.1%	29.1%	-38.2%
	18	14.0%	26.6%	-40.8%
	24	13.7%	25.8%	-37.0%
	30	18.2%	31.4%	-45.1%
	36	22.9%	35.8%	-52.2%
	42	24.4%	38.8%	-58.4%
	48	25.0%	43.8%	-65.2%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.10)	6	9.3%	31.3%	-47.0%
	12	16.7%	54.2%	-51.0%
	18	19.4%	82.8%	-61.3%
	24	21.7%	113.0%	-76.4%
	30	28.3%	141.1%	-82.8%
	36	34.9%	165.8%	-95.5%
	42	38.2%	187.2%	-120.3%
	48	41.2%	206.1%	-142.1%

Model parameters:				
fmin	0.10 or 0.30		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.10 Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall,
 fmin=0.30 for LUA-NRW & fmin = 0.10 for DWD.

**Sieg Level 1, Period no. 5, Differences due to areal rainfall according to
LUA-NRW (fmin=0.30) data and
DWD (fmin=0.50) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.30).	6	7.8%	31.3%	-28.6%
	12	13.1%	29.1%	-38.2%
	18	14.0%	26.6%	-40.8%
	24	13.7%	25.8%	-37.0%
	30	18.2%	31.4%	-45.1%
	36	22.9%	35.8%	-52.2%
	42	24.4%	38.8%	-58.4%
	48	25.0%	43.8%	-65.2%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.50)	6	8.1%	31.3%	-28.6%
	12	14.1%	29.1%	-44.8%
	18	15.2%	33.1%	-68.1%
	24	15.6%	38.3%	-79.3%
	30	21.0%	43.7%	-91.2%
	36	26.0%	49.6%	-103.2%
	42	27.6%	54.7%	-125.5%
	48	28.7%	58.0%	-141.8%

Model parameters:				
fmin	0.30 or 0.50		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.11 Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall,
fmin=0.30 for LUA-NRW & fmin = 0.50 for DWD.

**Sieg Level 1, Period no. 12, Differences due to areal rainfall according to
LUA-NRW (fmin=0.40) data and
DWD (fmin=0.40) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.40).	6	5.0%	23.0%	-27.5%
	12	8.6%	32.3%	-44.9%
	18	10.9%	42.0%	-49.8%
	24	13.2%	46.1%	-50.9%
	30	15.9%	53.7%	-48.4%
	36	18.6%	56.0%	-45.5%
	42	21.0%	56.0%	-54.0%
	48	23.0%	64.8%	-61.0%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.40)	6	5.2%	29.5%	-29.1%
	12	9.4%	45.1%	-26.2%
	18	12.2%	59.1%	-33.6%
	24	15.1%	64.0%	-43.3%
	30	18.4%	68.1%	-54.8%
	36	21.5%	70.9%	-68.5%
	42	24.2%	73.2%	-78.9%
	48	26.5%	75.7%	-87.9%

Model parameters:				
fmin	0.40	alfa (1,1)	0.29	
fmax	5.00	alfa (1,2)	0.14	
kb	8.60	alfa (1,3)	0.10	
psi	0.93	alfa (1,4)	0.00	
kn	10.50	alfa (1,5)	0.00	
nn	2.95	alfa (1,6)	0.00	
		alfa (1,7)	0.00	
		alfa (1,8)	0.00	

Table 10.12 Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall,
in both computations **fmin=0.40** was used.

Sieg Level 1, Period no. 12, Differences due to areal rainfall according to
 LUA-NRW (fmin=0.40) data and
 DWD (fmin=0.20) data

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.40).	6	5.0%	23.0%	-27.5%
	12	8.6%	32.3%	-44.9%
	18	10.9%	42.0%	-49.8%
	24	13.2%	46.1%	-50.9%
	30	15.9%	53.7%	-48.4%
	36	18.6%	56.0%	-45.5%
	42	21.0%	56.0%	-54.0%
	48	23.0%	64.8%	-61.0%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.20)	6	8.4%	29.5%	-77.7%
	12	17.3%	56.5%	-136.1%
	18	24.4%	78.8%	-154.9%
	24	30.7%	98.3%	-144.5%
	30	35.7%	114.6%	-144.5%
	36	39.7%	128.2%	-147.4%
	42	42.7%	141.3%	-150.0%
	48	45.4%	153.6%	-151.7%

Model parameters:				
fmin	0.20 or 0.40		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.13 Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall,
 fmin=0.40 for LUA-NRW & fmin = 0.20 for DWD.

**Sieg Level 1, Period no. 12, Differences due to areal rainfall according to
LUA-NRW (fmin=0.40) data and
DWD (fmin=0.60) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.40).	6	5.0%	23.0%	-27.5%
	12	8.6%	32.3%	-44.9%
	18	10.9%	42.0%	-49.8%
	24	13.2%	46.1%	-50.9%
	30	15.9%	53.7%	-48.4%
	36	18.6%	56.0%	-45.5%
	42	21.0%	56.0%	-54.0%
	48	23.0%	64.8%	-61.0%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.60)	6	5.2%	29.5%	-20.4%
	12	10.0%	45.1%	-18.7%
	18	14.0%	59.1%	-25.3%
	24	18.0%	64.0%	-31.4%
	30	21.4%	68.1%	-38.9%
	36	24.7%	70.9%	-45.5%
	42	28.0%	73.2%	-54.0%
	48	30.8%	75.7%	-61.0%

Model parameters:				
fmin	0.40 or 0.60		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00

Table 10.14 Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall,
fmin=0.40 for LUA-NRW & fmin = 0.60 for DWD.

Lippe Level 1, Period no. 7, Differences due to areal rainfall according to
 LUA-NRW (fmin=0.20) data and
 DWD (fmin=0.20) data

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.20).	6	2.8%	11.7%	-19.2%
	12	5.7%	21.3%	-27.3%
	18	8.3%	32.3%	-33.9%
	24	10.1%	39.1%	-38.1%
	30	11.4%	44.2%	-47.3%
	36	12.7%	46.6%	-48.9%
	42	14.2%	47.4%	-54.7%
	48	15.7%	49.6%	-62.7%
	54	17.4%	51.8%	-66.7%
	60	19.4%	53.8%	-76.8%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.20)	6	2.9%	12.8%	-19.6%
	12	5.9%	18.0%	-27.3%
	18	8.5%	23.6%	-37.8%
	24	10.2%	28.3%	-46.0%
	30	11.3%	31.3%	-44.6%
	36	12.4%	32.3%	-41.5%
	42	13.6%	34.7%	-43.6%
	48	14.6%	37.4%	-49.9%
	54	15.9%	39.5%	-52.6%
	60	17.2%	41.5%	-61.3%

Model parameters:				
fmin	0.20	alfa (1,1)	0.29	
fmax	5.00	alfa (1,2)	0.14	
kb	8.60	alfa (1,3)	0.10	
psi	0.93	alfa (1,4)	0.00	
kn	10.50	alfa (1,5)	0.00	
nn	2.95	alfa (1,6)	0.00	
		alfa (1,7)	0.00	
		alfa (1,8)	0.00	
		alfa (1,9)	0.00	
		alfa (1,10)	0.00	

Table 10.15 Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall,
 in both computations **fmin=0.20** was used.

**Lippe Level 1, Period no. 7, Differences due to areal rainfall according to
 LUA-NRW (fmin=0.20) data and
 DWD (fmin=0.10) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.20).	6	2.8%	11.7%	-19.2%
	12	5.7%	21.3%	-27.3%
	18	8.3%	32.3%	-33.9%
	24	10.1%	39.1%	-38.1%
	30	11.4%	44.2%	-47.3%
	36	12.7%	46.6%	-48.9%
	42	14.2%	47.4%	-54.7%
	48	15.7%	49.6%	-62.7%
	54	17.4%	51.8%	-66.7%
	60	19.4%	53.8%	-76.8%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.10)	6	3.5%	40.1%	-69.4%
	12	7.1%	35.7%	-73.7%
	18	10.3%	22.6%	-87.6%
	24	12.5%	28.6%	-95.7%
	30	14.3%	37.4%	-92.7%
	36	15.8%	43.4%	-89.6%
	42	17.5%	50.5%	-86.3%
	48	19.1%	56.9%	-83.3%
	54	20.8%	63.2%	-78.0%
	60	22.5%	69.9%	-82.6%

Model parameters:				
fmin	0.20 or 0.10		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00
			alfa (1,9)	0.00
			alfa (1,10)	0.00

Table 10.16 Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall,
 fmin=0.20 for LUA-NRW & fmin = 0.10 for DWD.

**Lippe Level 1, Period no. 7, Differences due to areal rainfall according to
LUA-NRW (fmin=0.20) data and
DWD (fmin=0.30) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.20).	6	2.8%	11.7%	-19.2%
	12	5.7%	21.3%	-27.3%
	18	8.3%	32.3%	-33.9%
	24	10.1%	39.1%	-38.1%
	30	11.4%	44.2%	-47.3%
	36	12.7%	46.6%	-48.9%
	42	14.2%	47.4%	-54.7%
	48	15.7%	49.6%	-62.7%
	54	17.4%	51.8%	-66.7%
	60	19.4%	53.8%	-76.8%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.30)	6	2.8%	11.7%	-19.2%
	12	5.6%	18.5%	-27.3%
	18	8.1%	24.7%	-33.9%
	24	9.7%	29.9%	-38.1%
	30	11.0%	33.6%	-47.3%
	36	12.2%	37.6%	-48.9%
	42	13.7%	41.7%	-54.7%
	48	15.2%	45.3%	-62.7%
	54	16.8%	48.4%	-66.7%
	60	18.6%	51.2%	-76.8%

Model parameters:				
fmin	0.20 or 0.30		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00
			alfa (1,9)	0.00
			alfa (1,10)	0.00

Table 10.17 Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall,
fmin=0.20 for LUA-NRW & fmin = 0.30 for DWD.

**Lippe Level 1, Period no. 9, Differences due to areal rainfall according to
LUA-NRW (fmin=0.20) data and
DWD (fmin=0.20) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.20).	6	3.8%	15.2%	-14.1%
	12	7.3%	33.9%	-33.3%
	18	9.7%	48.7%	-37.7%
	24	11.2%	52.9%	-37.7%
	30	12.6%	56.0%	-32.3%
	36	13.8%	54.3%	-35.4%
	42	14.9%	51.1%	-38.8%
	48	16.1%	55.7%	-40.1%
	54	17.4%	58.6%	-43.8%
	60	18.5%	60.7%	-49.6%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.20)	6	4.0%	15.2%	-22.4%
	12	8.4%	33.9%	-33.3%
	18	12.1%	48.7%	-41.7%
	24	14.5%	55.2%	-57.5%
	30	17.0%	66.4%	-68.4%
	36	19.2%	76.8%	-80.2%
	42	21.2%	86.3%	-96.5%
	48	23.1%	94.1%	-108.2%
	54	25.2%	99.4%	-111.7%
	60	26.8%	103.4%	-113.3%

Model parameters:				
fmin	0.20	alfa (1,1)	0.29	
fmax	5.00	alfa (1,2)	0.14	
kb	8.60	alfa (1,3)	0.10	
psi	0.93	alfa (1,4)	0.00	
kn	10.50	alfa (1,5)	0.00	
nn	2.95	alfa (1,6)	0.00	
		alfa (1,7)	0.00	
		alfa (1,8)	0.00	
		alfa (1,9)	0.00	
		alfa (1,10)	0.00	

Table 10.18 Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall,
in both computations **fmin=0.20** was used.

**Lippe Level 1, Period no. 9, Differences due to areal rainfall according to
 LUA-NRW (fmin=0.20) data and
 DWD (fmin=0.10) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.20).	6	3.8%	15.2%	-14.1%
	12	7.3%	33.9%	-33.3%
	18	9.7%	48.7%	-37.7%
	24	11.2%	52.9%	-37.7%
	30	12.6%	56.0%	-32.3%
	36	13.8%	54.3%	-35.4%
	42	14.9%	51.1%	-38.8%
	48	16.1%	55.7%	-40.1%
	54	17.4%	58.6%	-43.8%
	60	18.5%	60.7%	-49.6%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.10)	6	4.2%	15.2%	-26.8%
	12	9.5%	33.9%	-41.0%
	18	14.2%	48.9%	-54.5%
	24	17.2%	64.1%	-64.4%
	30	20.3%	77.6%	-79.3%
	36	23.2%	89.0%	-94.9%
	42	26.0%	97.9%	-114.3%
	48	28.5%	106.3%	-125.2%
	54	31.0%	113.7%	-132.5%
	60	33.3%	118.9%	-142.0%

Model parameters:				
fmin	0.10 or 0.20		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00
			alfa (1,9)	0.00
			alfa (1,10)	0.00

Table 10.19 Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall,
fmin=0.20 for LUA-NRW & **fmin = 0.10** for DWD.

**Lippe Level 1, Period no. 9, Differences due to areal rainfall according to
LUA-NRW (fmin=0.20) data and
DWD (fmin=0.30) data**

	Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
Areal rainfall according to rainfall observed at LUA-NRW stations (fmin=0.20).	6	3.8%	15.2%	-14.1%
	12	7.3%	33.9%	-33.3%
	18	9.7%	48.7%	-37.7%
	24	11.2%	52.9%	-37.7%
	30	12.6%	56.0%	-32.3%
	36	13.8%	54.3%	-35.4%
	42	14.9%	51.1%	-38.8%
	48	16.1%	55.7%	-40.1%
	54	17.4%	58.6%	-43.8%
	60	18.5%	60.7%	-49.6%
Areal rainfall according to rainfall observed at DWD stations & relations between rainfall at DWD stations and areal rainfall according to LUA-NRW stations (fmin=0.30)	6	3.9%	15.2%	-16.7%
	12	8.1%	33.9%	-33.3%
	18	11.2%	48.7%	-40.3%
	24	13.2%	52.9%	-53.1%
	30	15.0%	56.0%	-63.8%
	36	16.6%	60.8%	-69.8%
	42	18.3%	67.4%	-74.9%
	48	20.0%	73.9%	-83.8%
	54	21.9%	79.9%	-88.9%
	60	23.5%	82.4%	-87.8%

Model parameters:				
fmin	0.20 or 0.30		alfa (1,1)	0.29
fmax	5.00		alfa (1,2)	0.14
kb	8.60		alfa (1,3)	0.10
psi	0.93		alfa (1,4)	0.00
kn	10.50		alfa (1,5)	0.00
nn	2.95		alfa (1,6)	0.00
			alfa (1,7)	0.00
			alfa (1,8)	0.00
			alfa (1,9)	0.00
			alfa (1,10)	0.00

Table 10.20 Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall,
fmin=0.20 for LUA-NRW & **fmin = 0.30** for DWD.

Figures of Chapter 2

- Fig. 2.1. Length profile of the river Sieg.
- Fig. 2.2. Contributing area of the river Sieg.
- Fig. 2.3. Average slope of the river Sieg.
- Fig. 2.4. Upper Sieg, snow at Bad-Marienberg, Period 1980 - 1995.
- Fig. 2.5. Flood generation Upper Sieg basin, Period December 1986 - January 1987.
- Fig. 2.6. Precipitation - discharge relationship for the Agger basin, January 1980.
- Fig. 2.7. Precipitation - discharge relationship for the Agger basin, January 1981.
- Fig. 2.8. Length of the river Lippe
- Fig. 2.9. Contributing area of the river Lippe.
- Fig. 2.10. Average slope of the river Lippe.
- Fig. 2.11. Flood peaks in the river Lippe, Period: February 1984.
- Fig. 2.12. Flood peaks in the river Lippe, Period May-June 1984.
- Fig. 2.13. Flood peaks in the river Lippe, Period December 1993 - January 1994.
- Fig. 2.14.1. Hydrographs of river Sieg (i.e. Menden) and Lippe (i.e. Schermbeck), Period January-February 1980.
- Fig. 2.14.2. Hydrographs of river Sieg (i.e. Menden) and Lippe (i.e. Schermbeck), Period February 1984.
- Fig. 2.14.3. Hydrographs of river Sieg (i.e. Menden) and Lippe (i.e. Schermbeck), Period 4May - June 1984.
- Fig. 2.14.4. Hydrographs of river Sieg (i.e. Menden) and Lippe (i.e. Schermbeck), Period December 1986 - January 1987.
- Fig. 2.14.5. Hydrographs of river Sieg (i.e. Menden) and Lippe (i.e. Schermbeck), Period February - March 1987.
- Fig. 2.14.6. Hydrographs of river Sieg (i.e. Menden) and Lippe (i.e. Schermbeck), Period January 1995.
- Fig. 2.15. Location of the reservoirs in the Sieg and the Lippe basin.

Length profile Sieg river

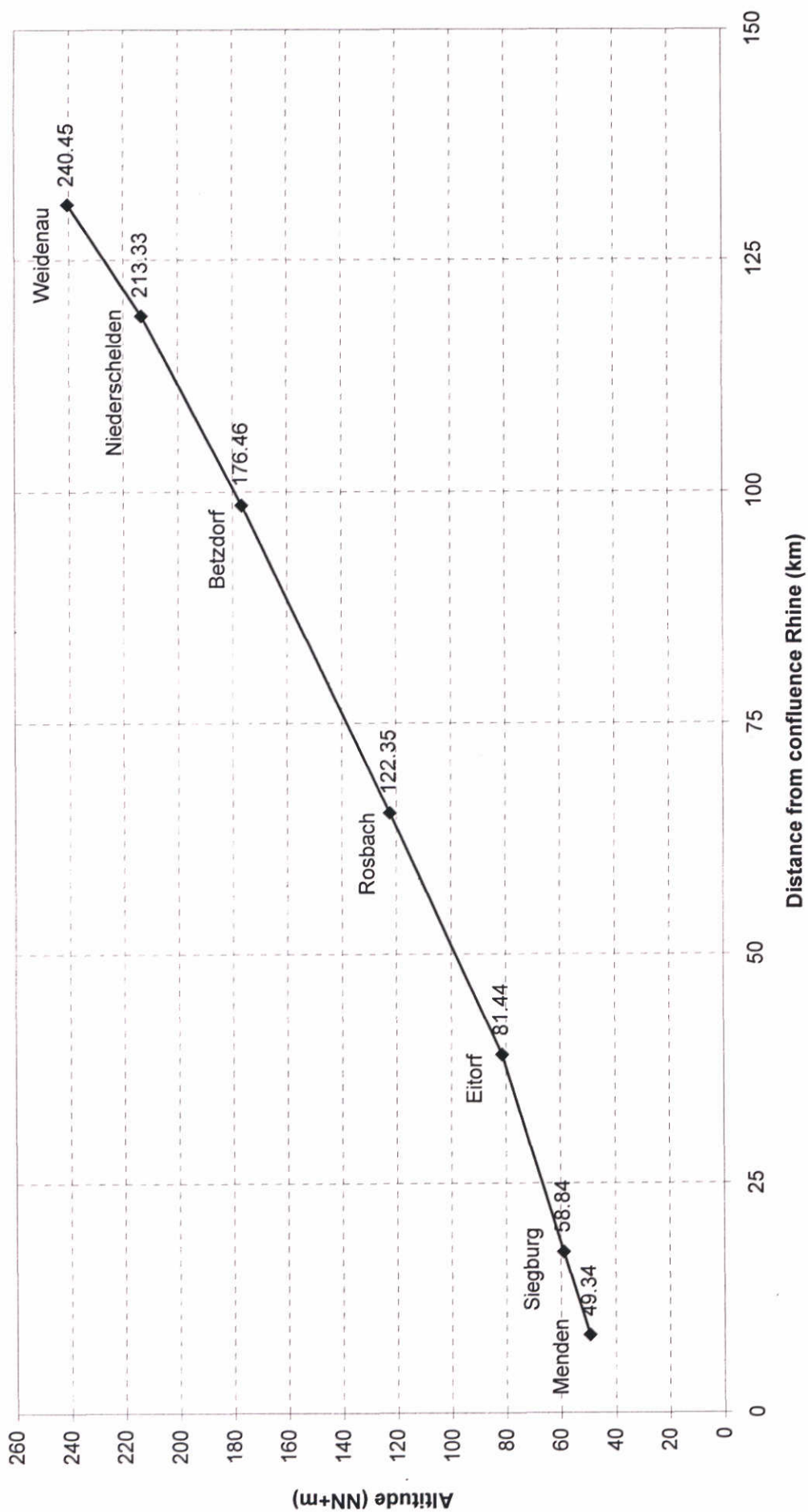


Fig. 2.1 Length profile of the Sieg river

Contributing area Sieg river

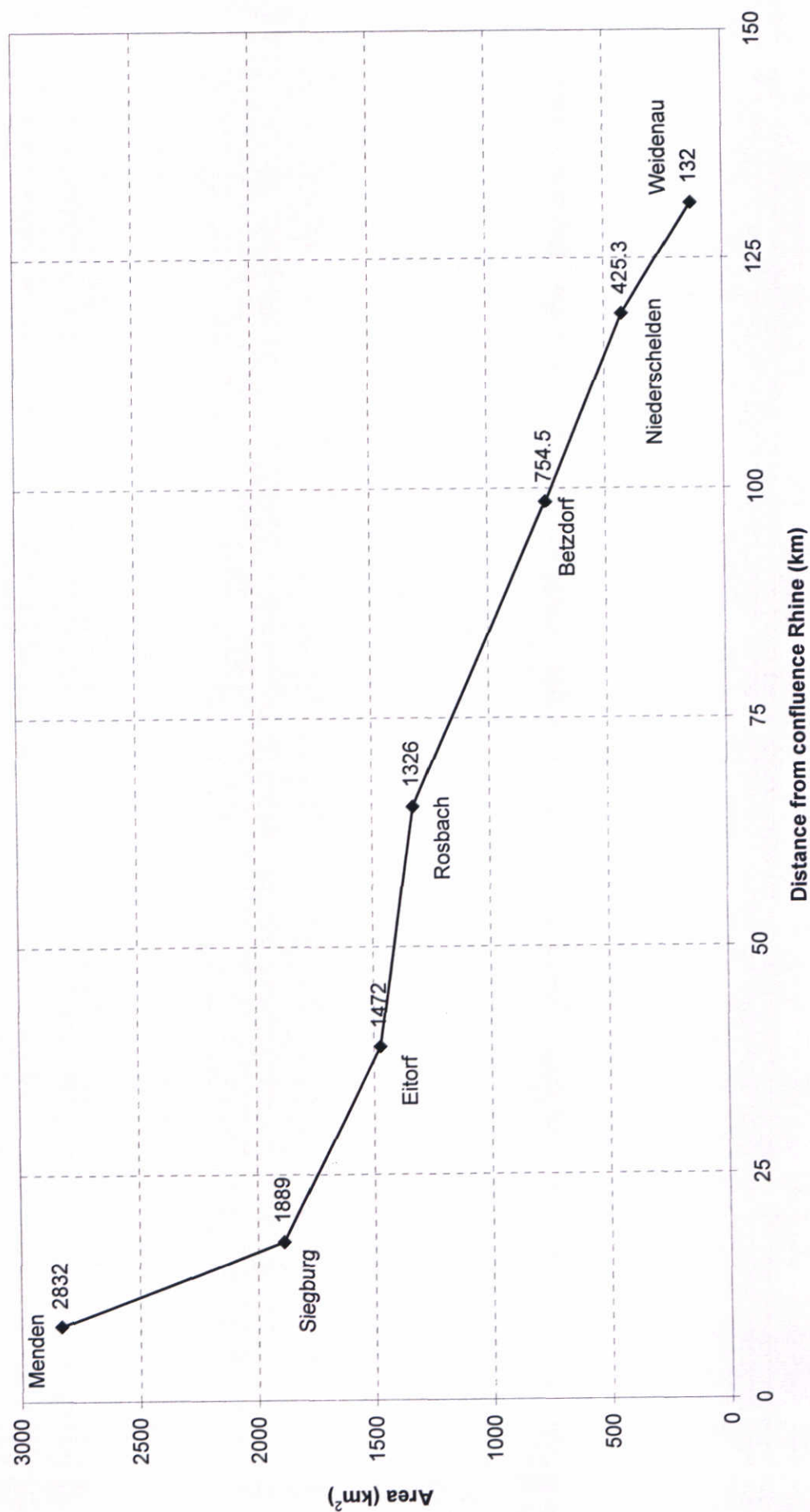


Fig. 2.2 Contributing area of the Sieg river

Average slope Sieg river

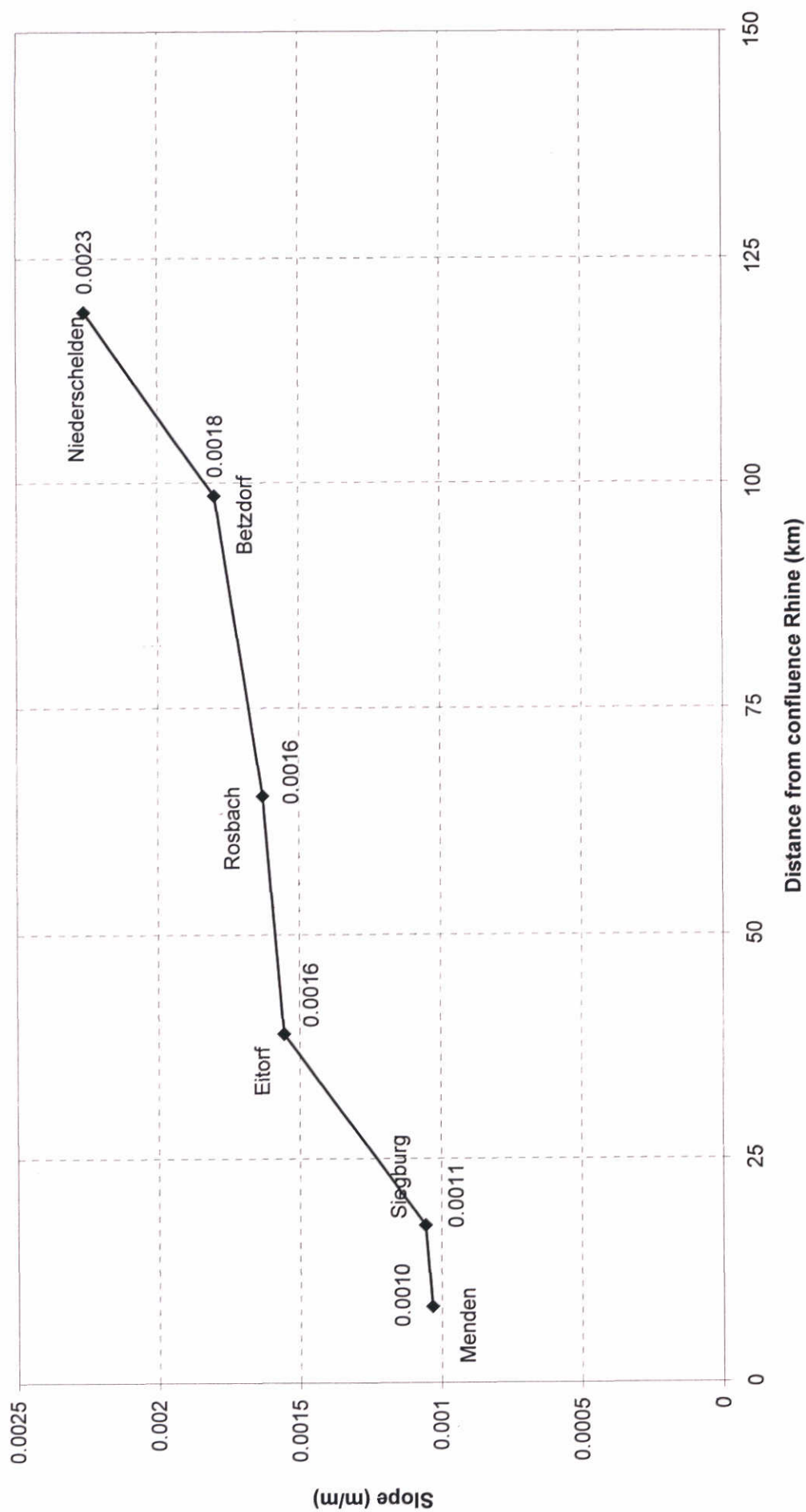
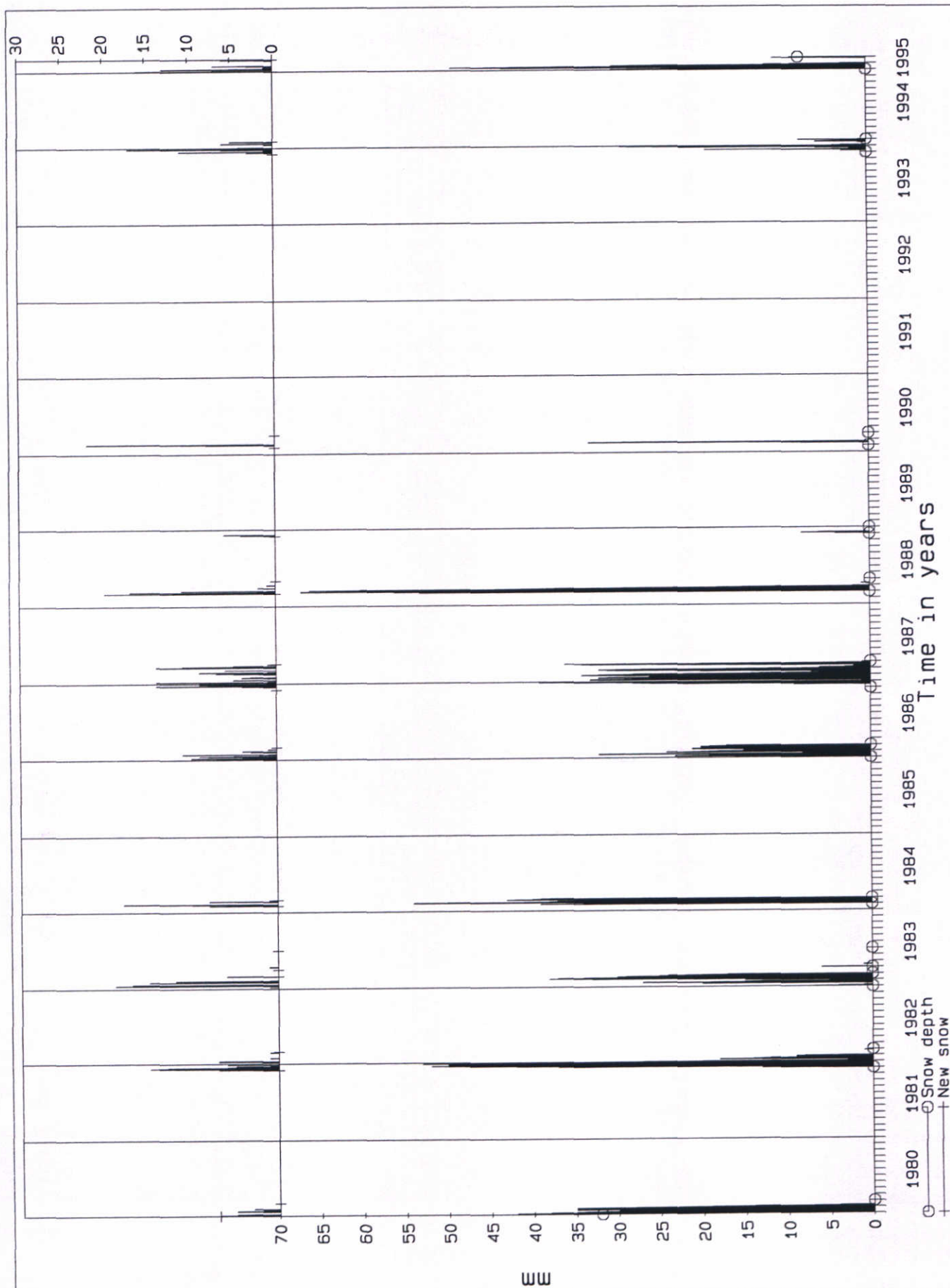
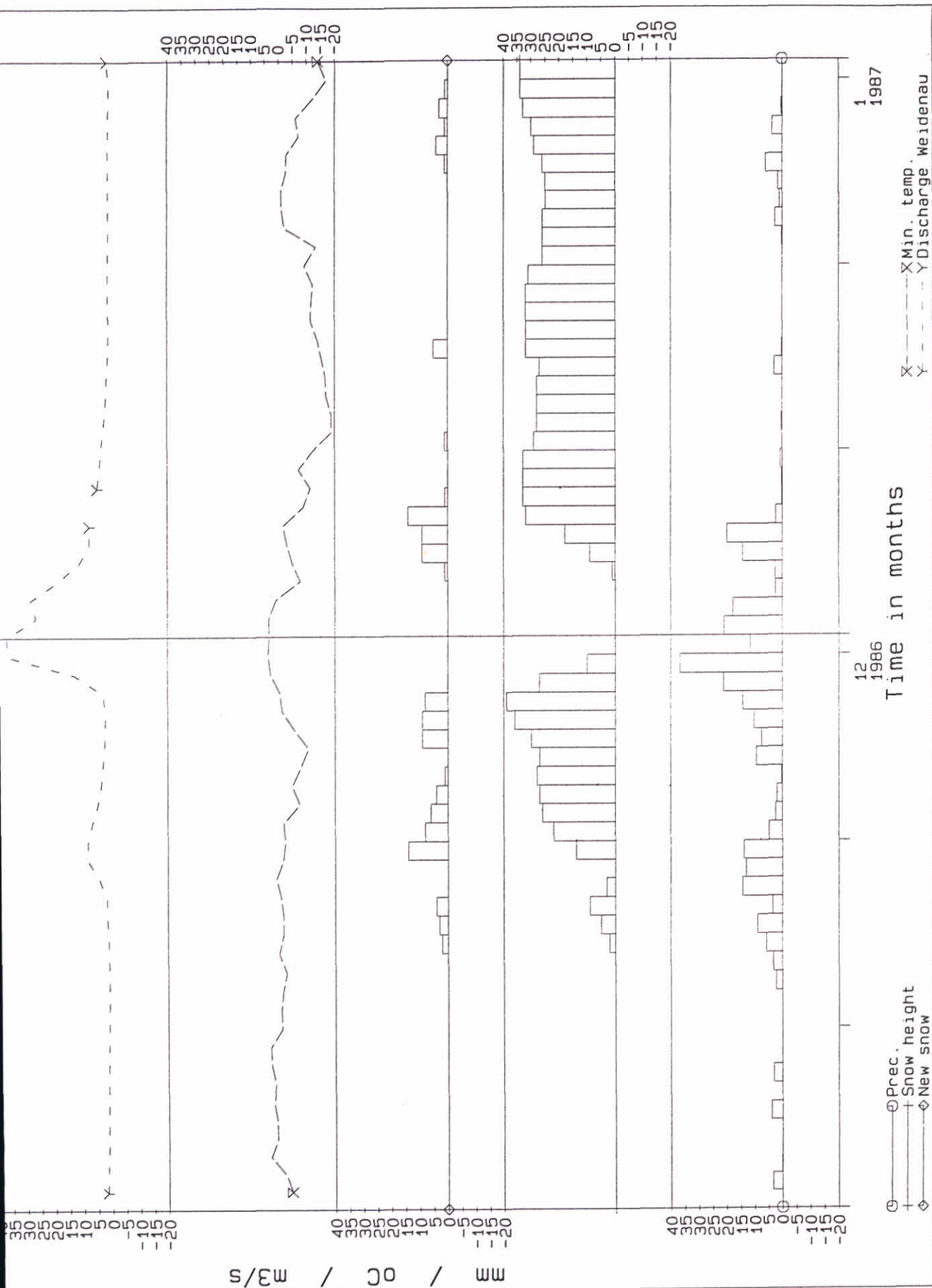


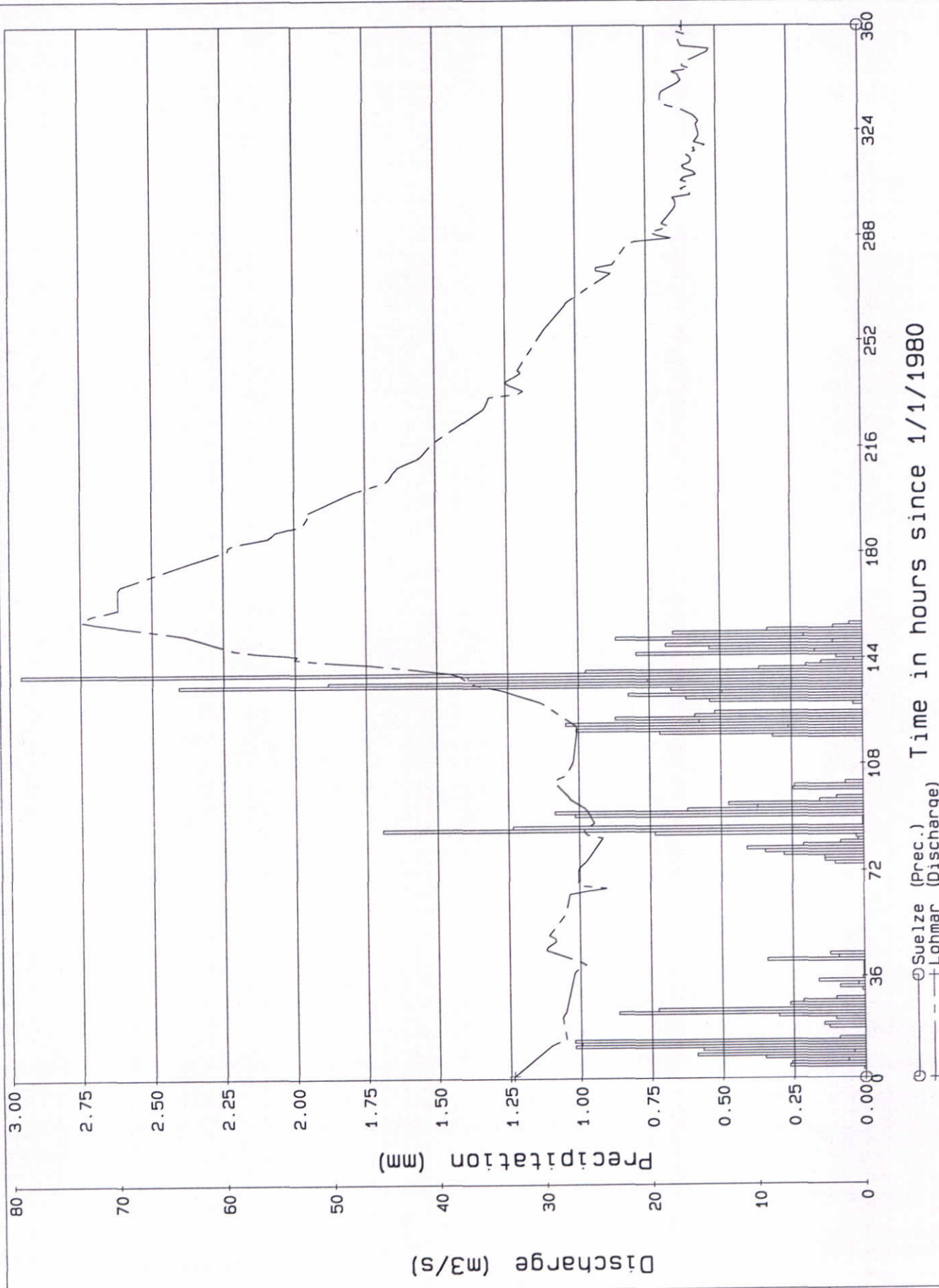
Fig. 2.3 Average slope of the Sieg river



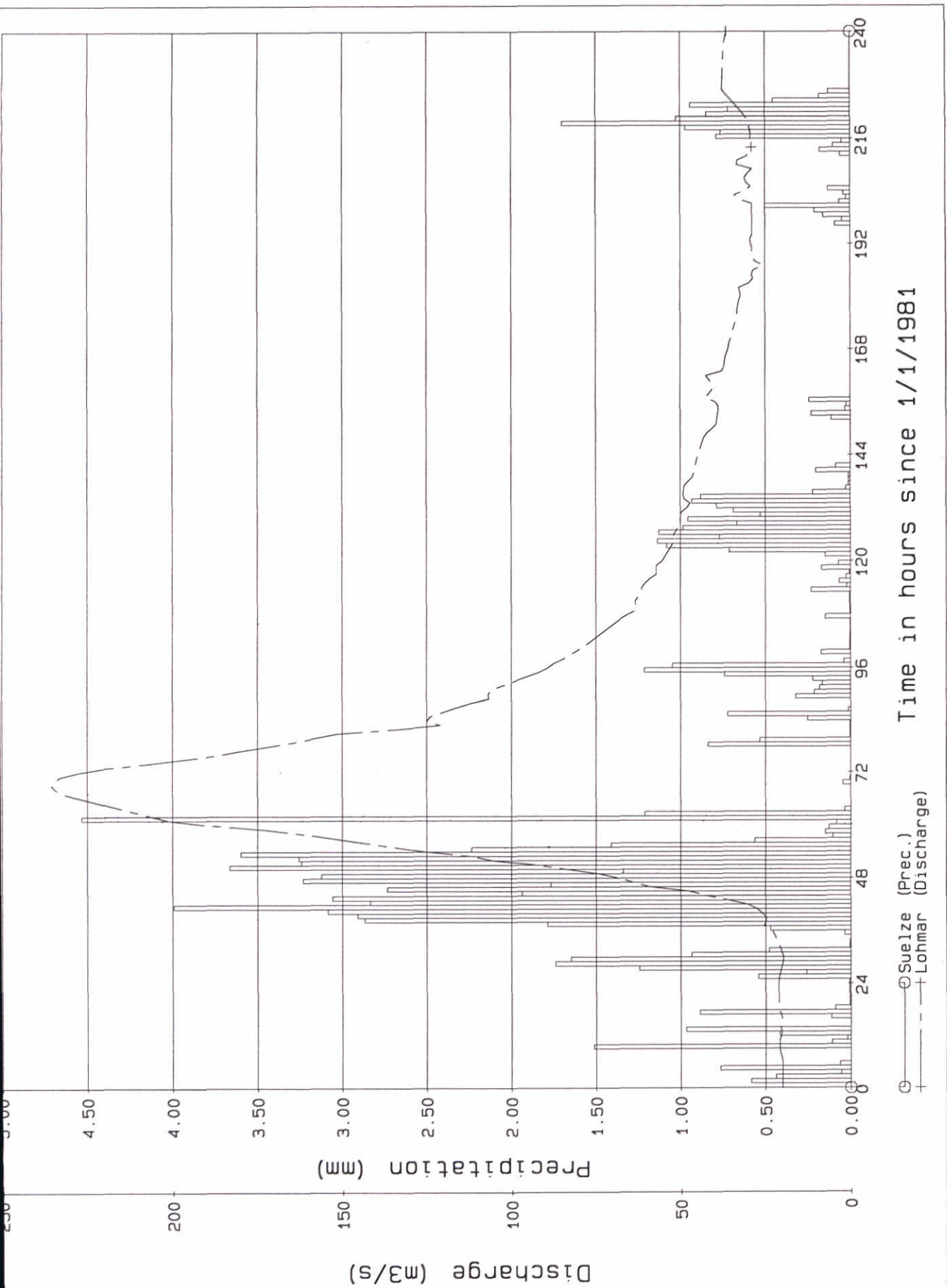
Snow at Bad-Marienberg (Upper Sieg)
 Period 1980 - 1995



Flood generation Upper basin Sieg
Period Dec. 1986 - Jan. 1987



Precipitation - discharge relationship
 Agger
 Flood January 1980



Precipitation - discharge relationship
Agger
Flood January 1981

Length profile Lippe river

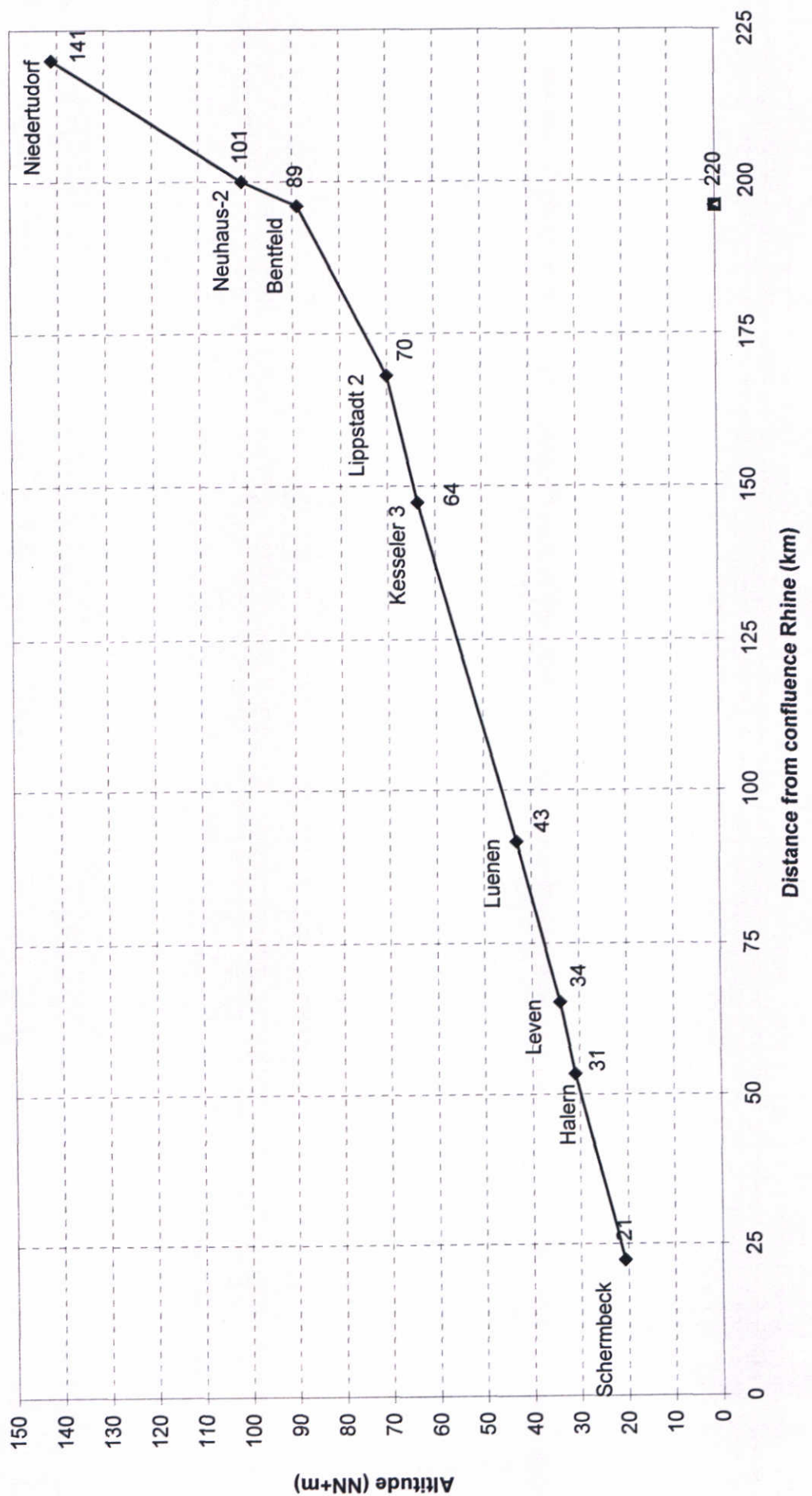


Fig. 2.8 Length profile of the Lippe river

Contributing area Lippe river

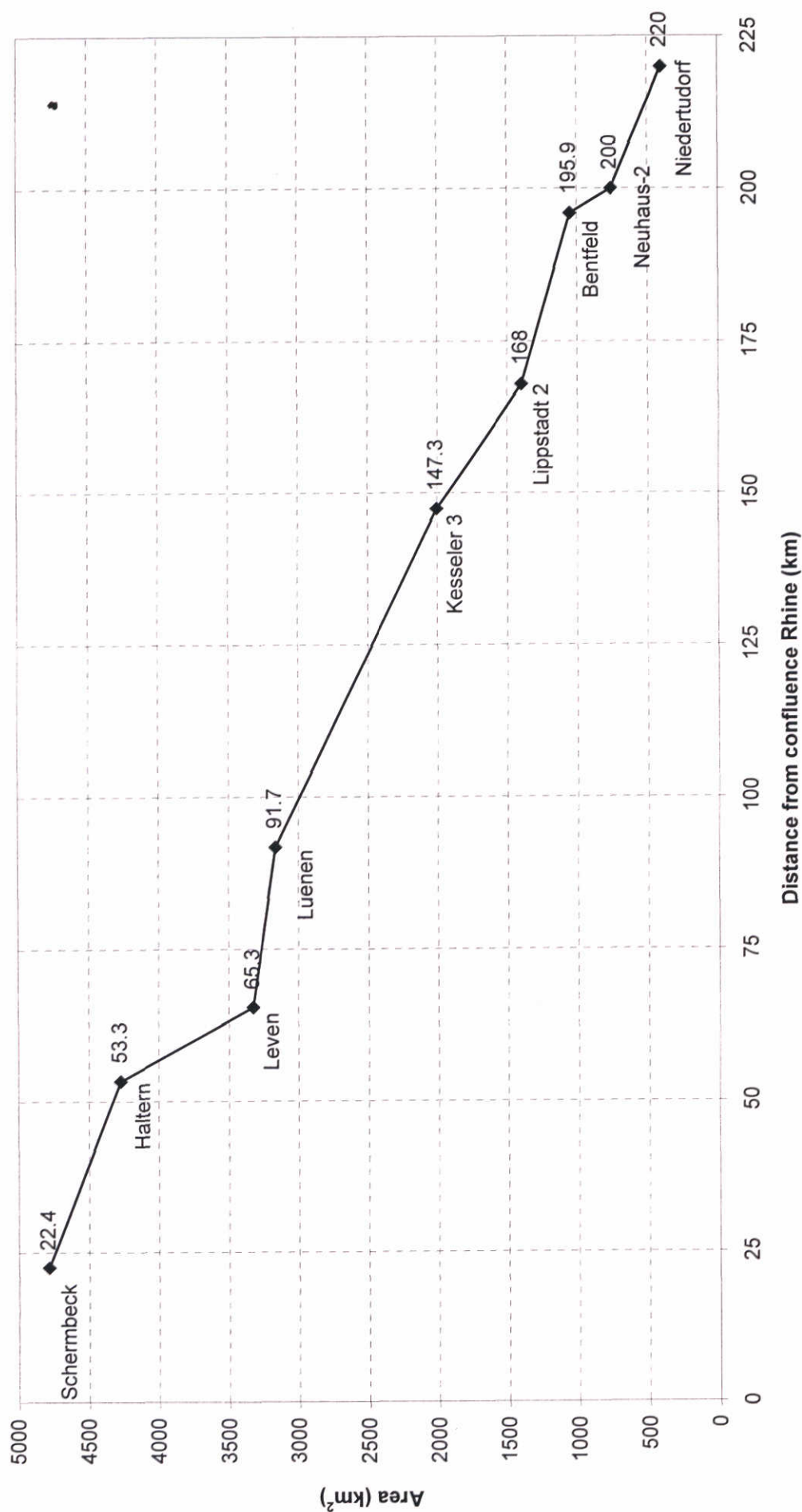


Fig. 2.9 Contributing area of the Lippe river

Average slope Lippe river

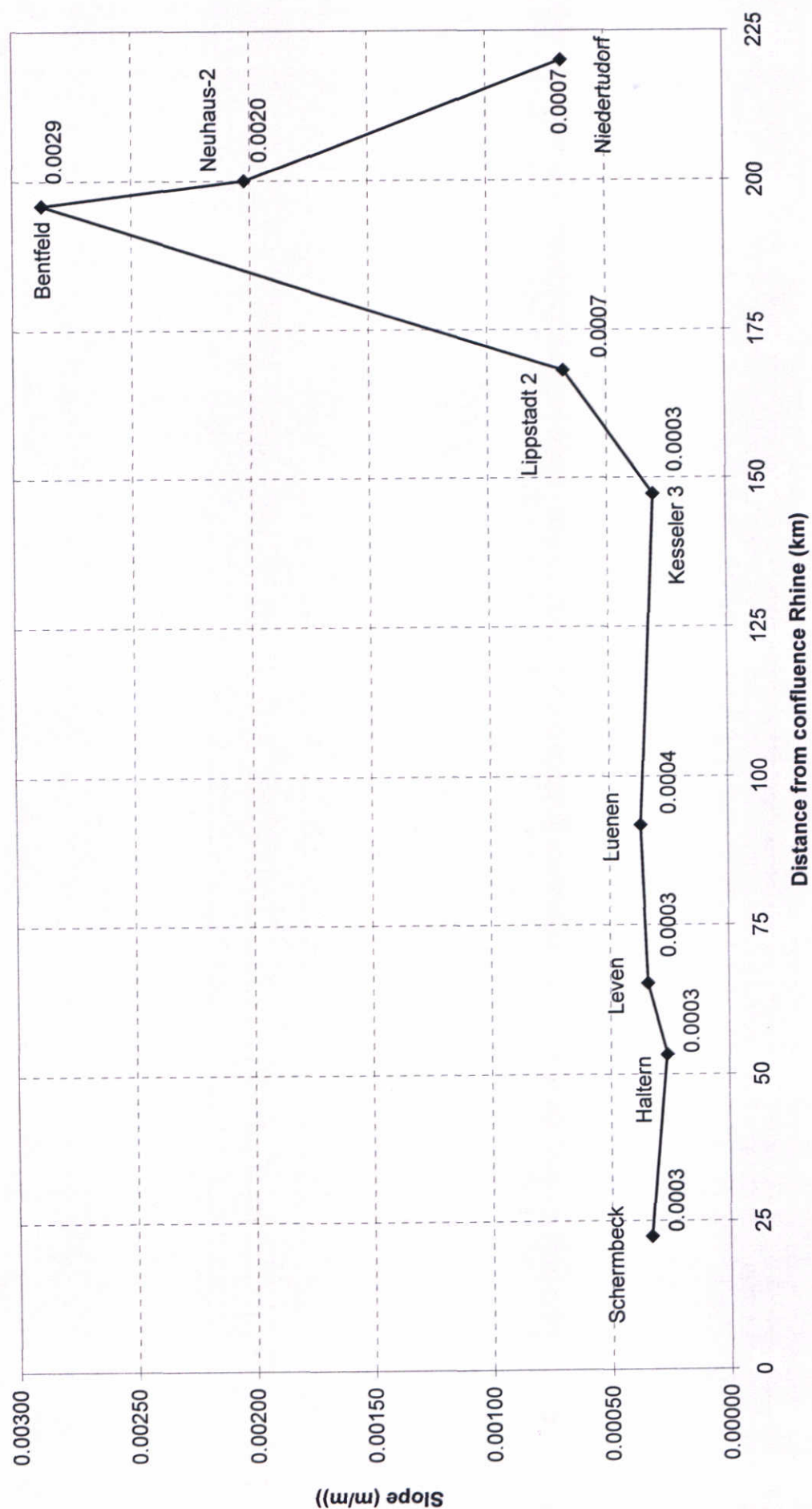
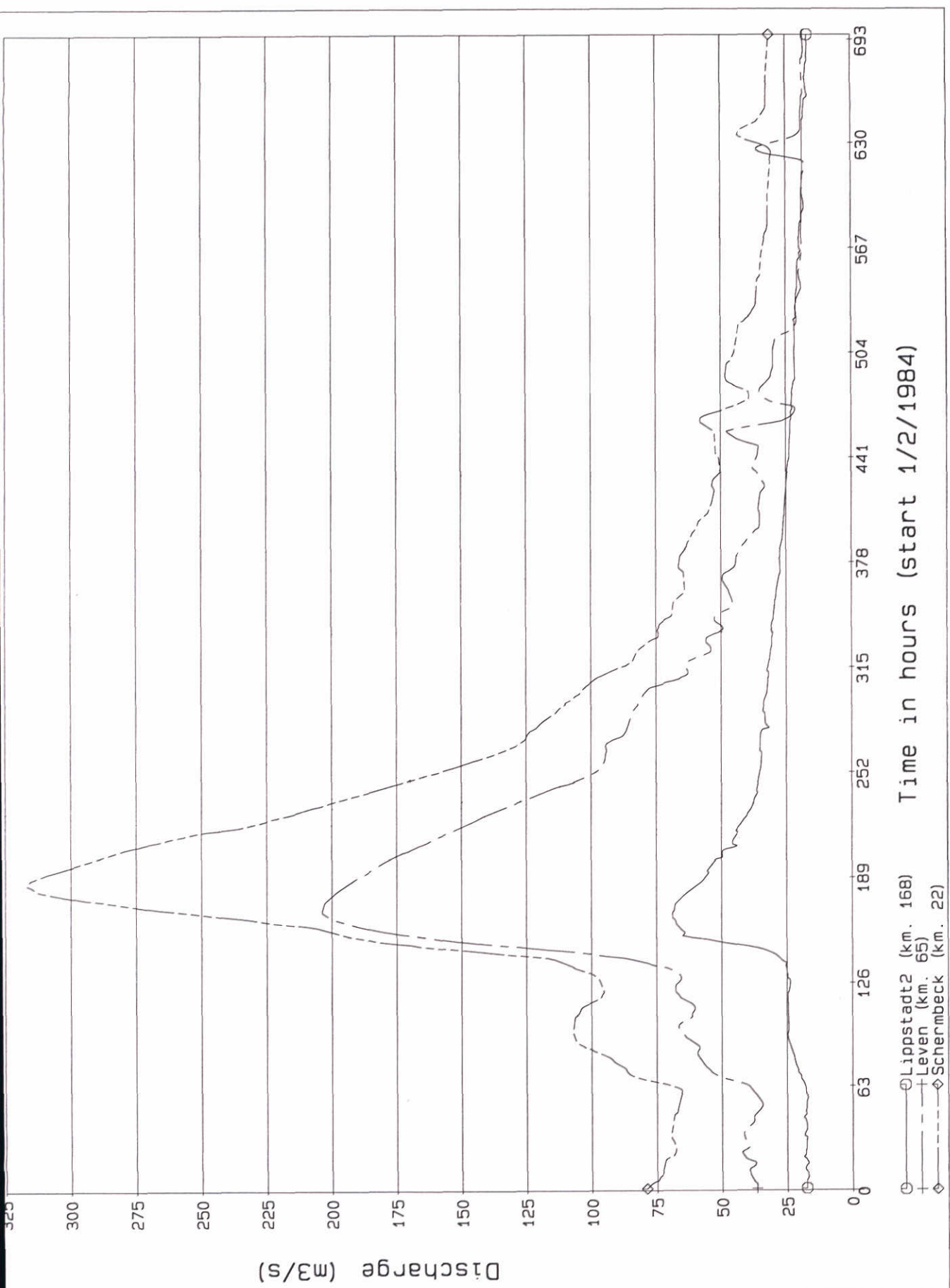
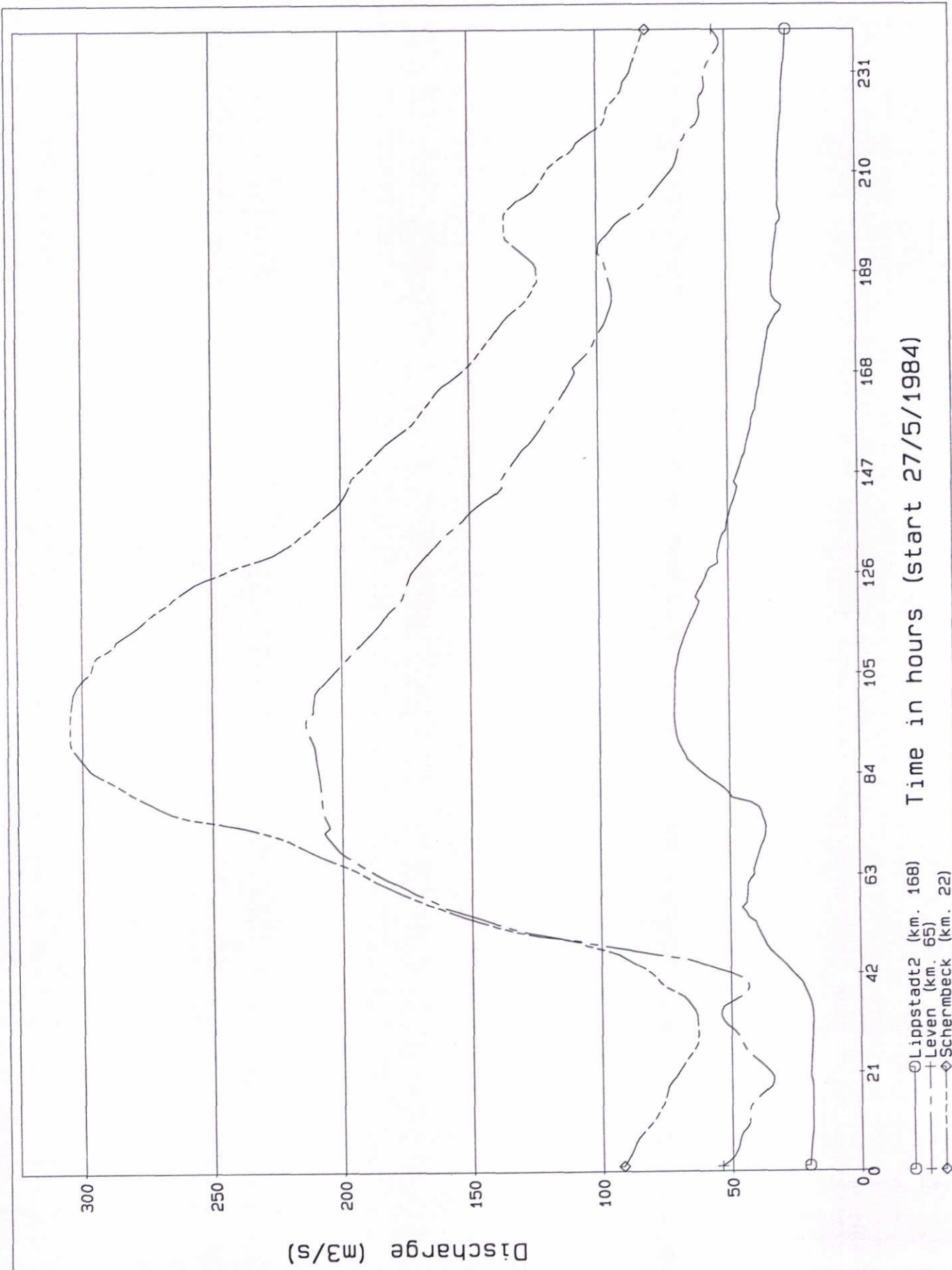


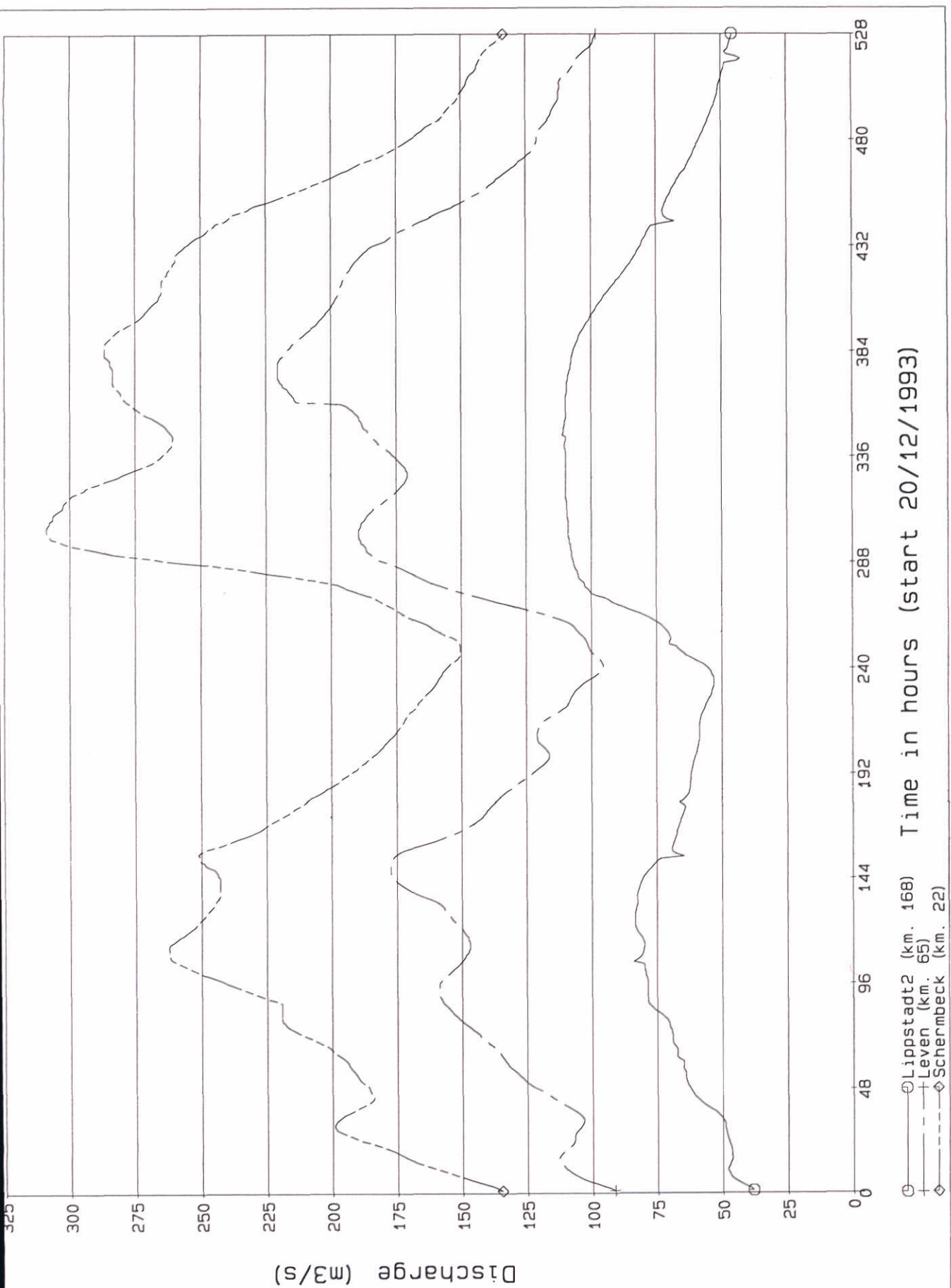
Fig. 2.10 Average slope of the Lippe river



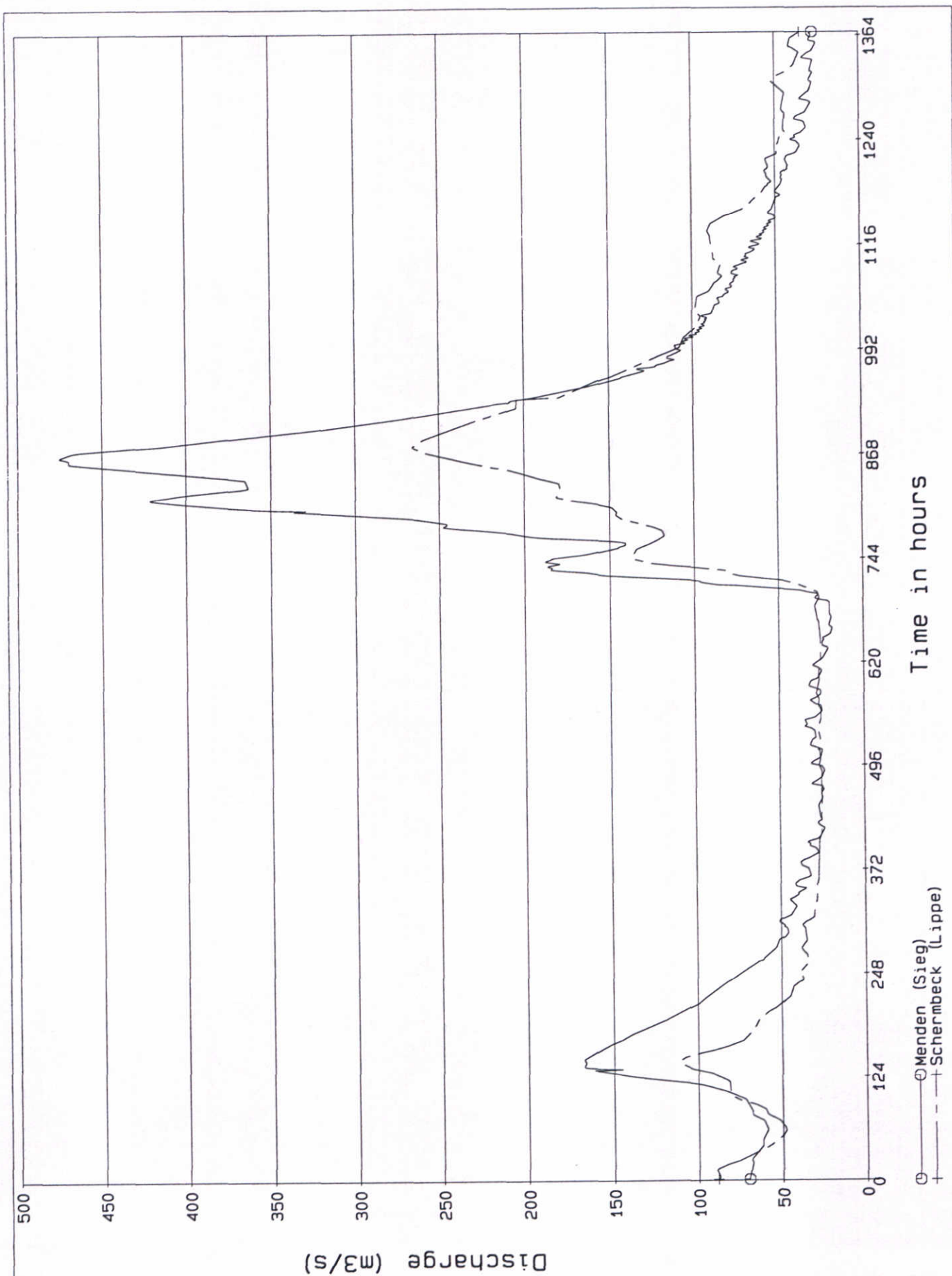
Flood peak Lippe
 Period February 1984
 Stations Lippstadt2, Leven, Schermbeck



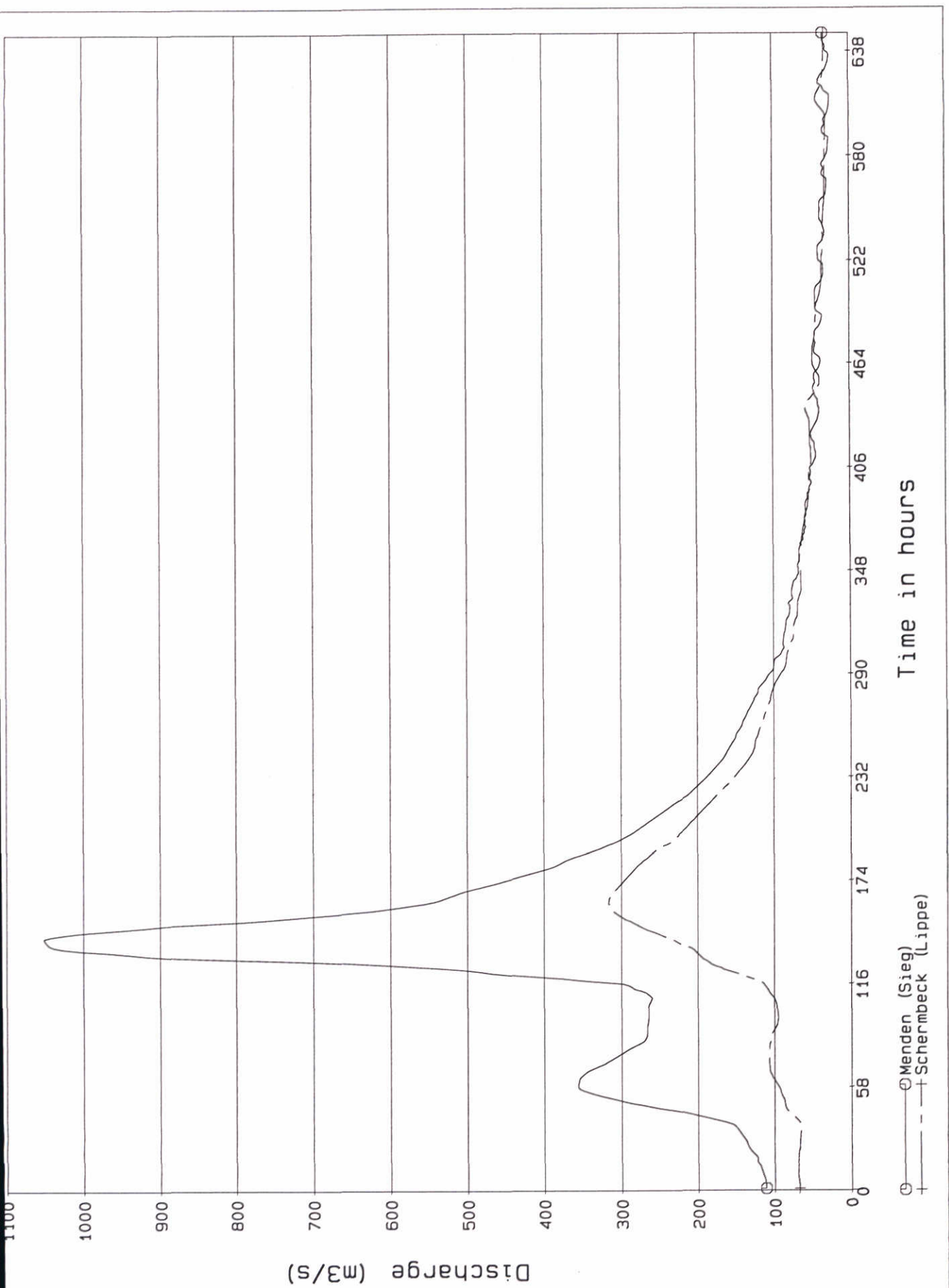
Flood peak Lippe
 Period May-June 1984
 Stations Lippstadt2, Leven, Schermbeck



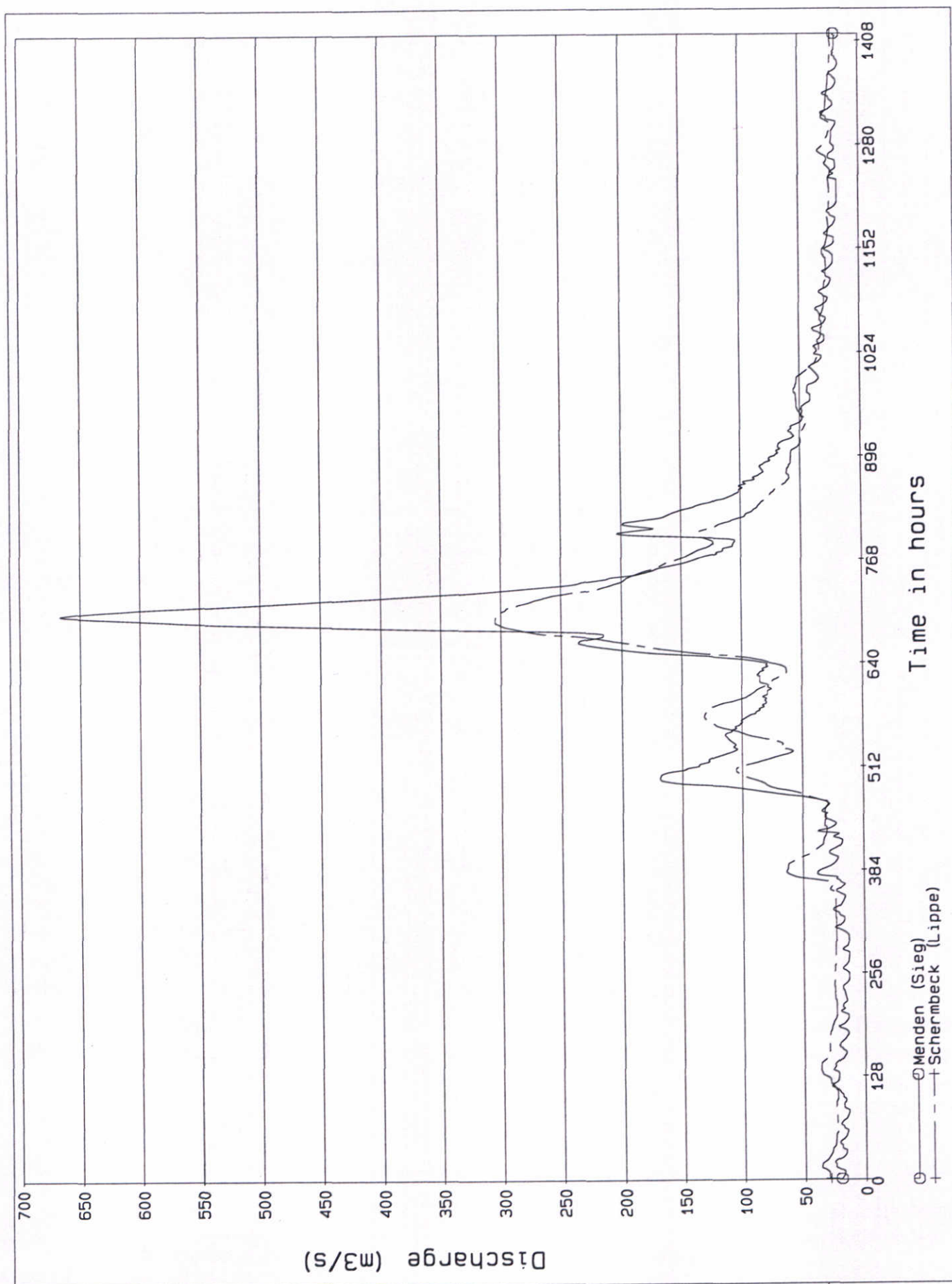
Flood peak Lippe
Period Dec. 1993 - Jan. 1994
Stations Lippstadt2, Leven, Schermbeck



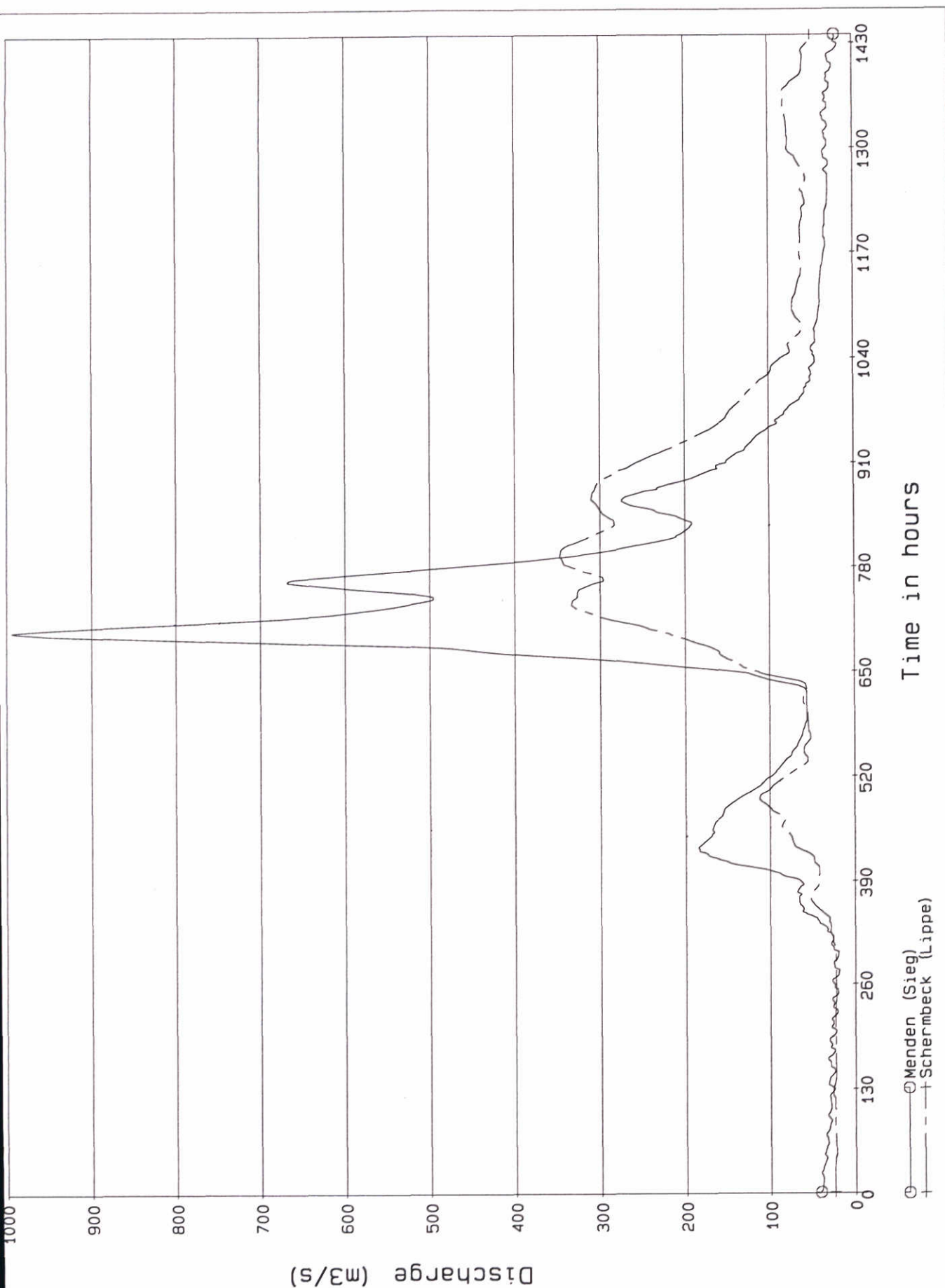
Hydrographs Sieg and Lippe
 Stations Menden and Schermbeck
 Period 1: 1/1/1980 - 29/2/1980



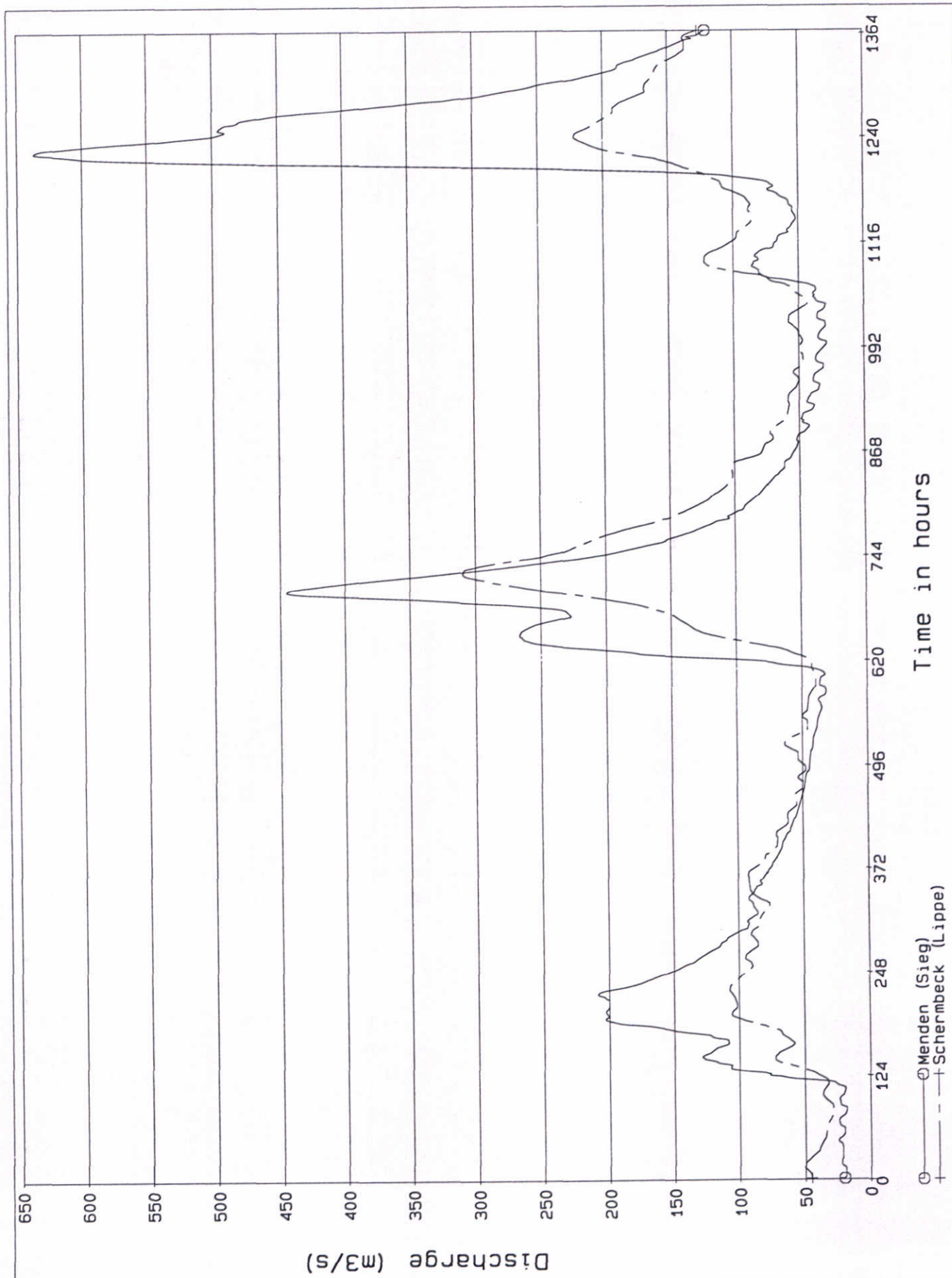
Hydrographs Sieg and Lippe
 Stations Menden and Schermbeck
 Period 5: 1/2/1984 - 29/2/1984



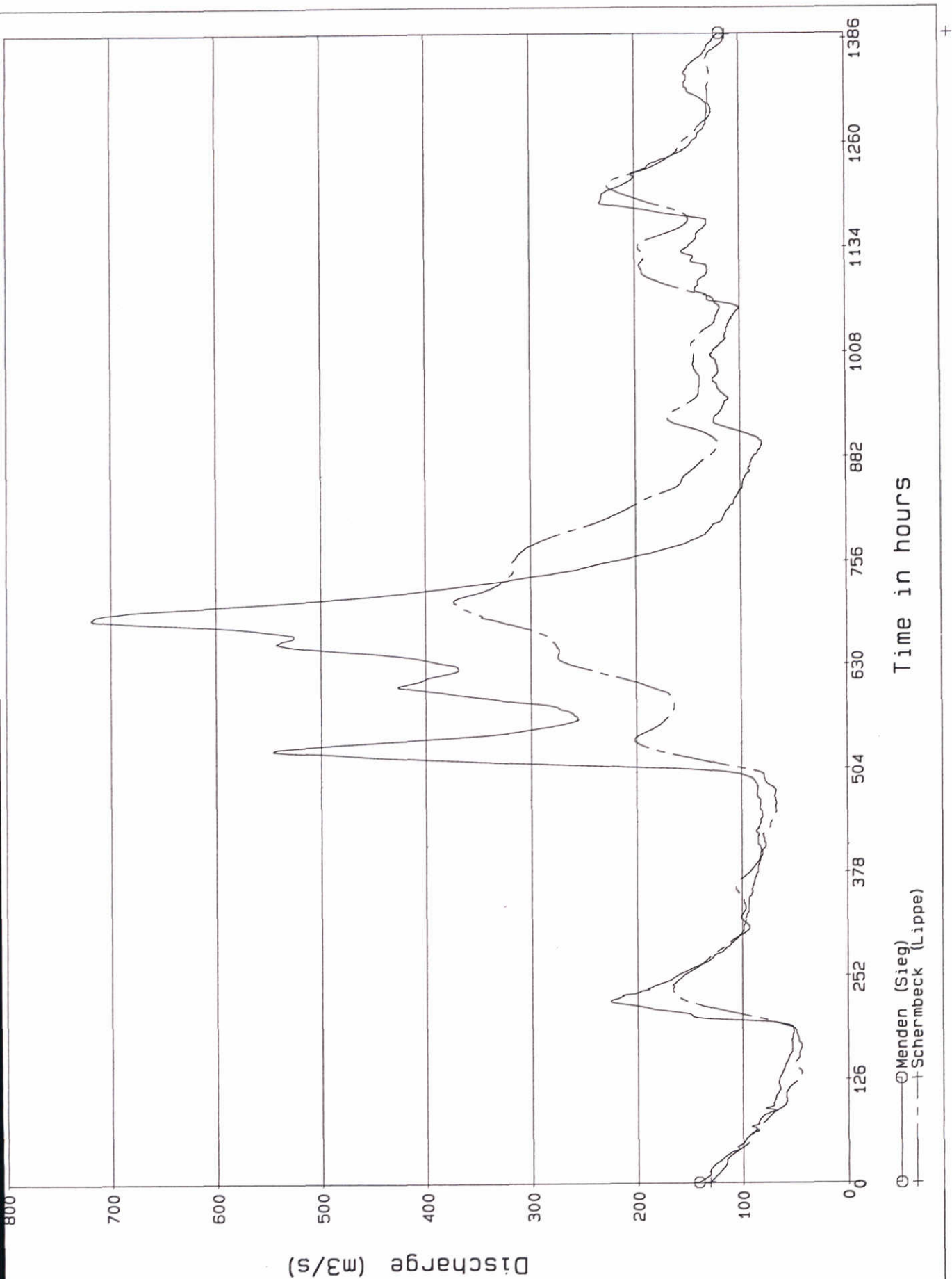
Hydrographs Sieg and Lippe
Stations Menden and Schermbeck
Period 6: 1/5/1984 - 30/6/1984



Hydrographs Sieg and Lippe
 Stations Menden and Schermbeck
 Period 8: 1/12/1986 - 31/1/1986



Hydrographs Sieg and Lippe
 Stations Menden and Schermbeck
 Period 9: 1/2/1987 - 31/3/1987



Hydrographs Sieg and Lippe
Stations Menden and Schermbeck
Period 14: 1/1/1995 - 31/1/1995

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FIG. 2.14.6

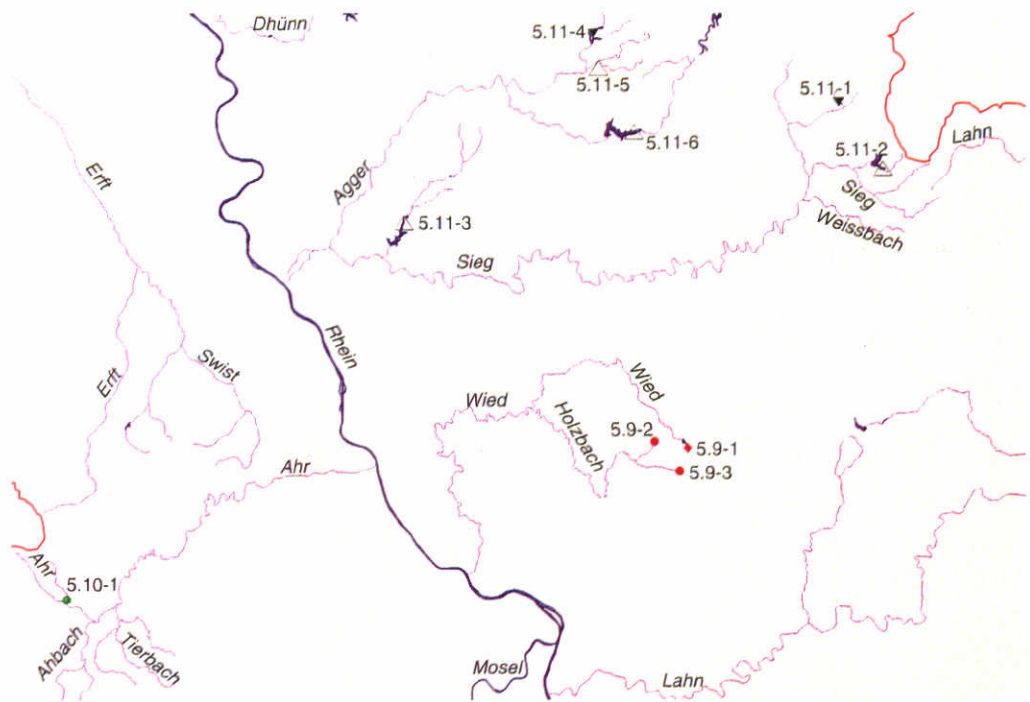


Fig. 2.15 Location of the reservoirs in the Sieg and Lippe basin

Figures of Chapter 3

- Fig. 3.1. Sieg basin, location of LUA-NRW and DWD meteorological stations.
- Fig. 3.2. Lippe basin, location of LUA-NRW and DWD meteorological stations.
- Fig. 3.3. Sieg basin, location of rated river gauging stations.
- Fig. 3.4. Lippe basin, location of rated river gauging stations.

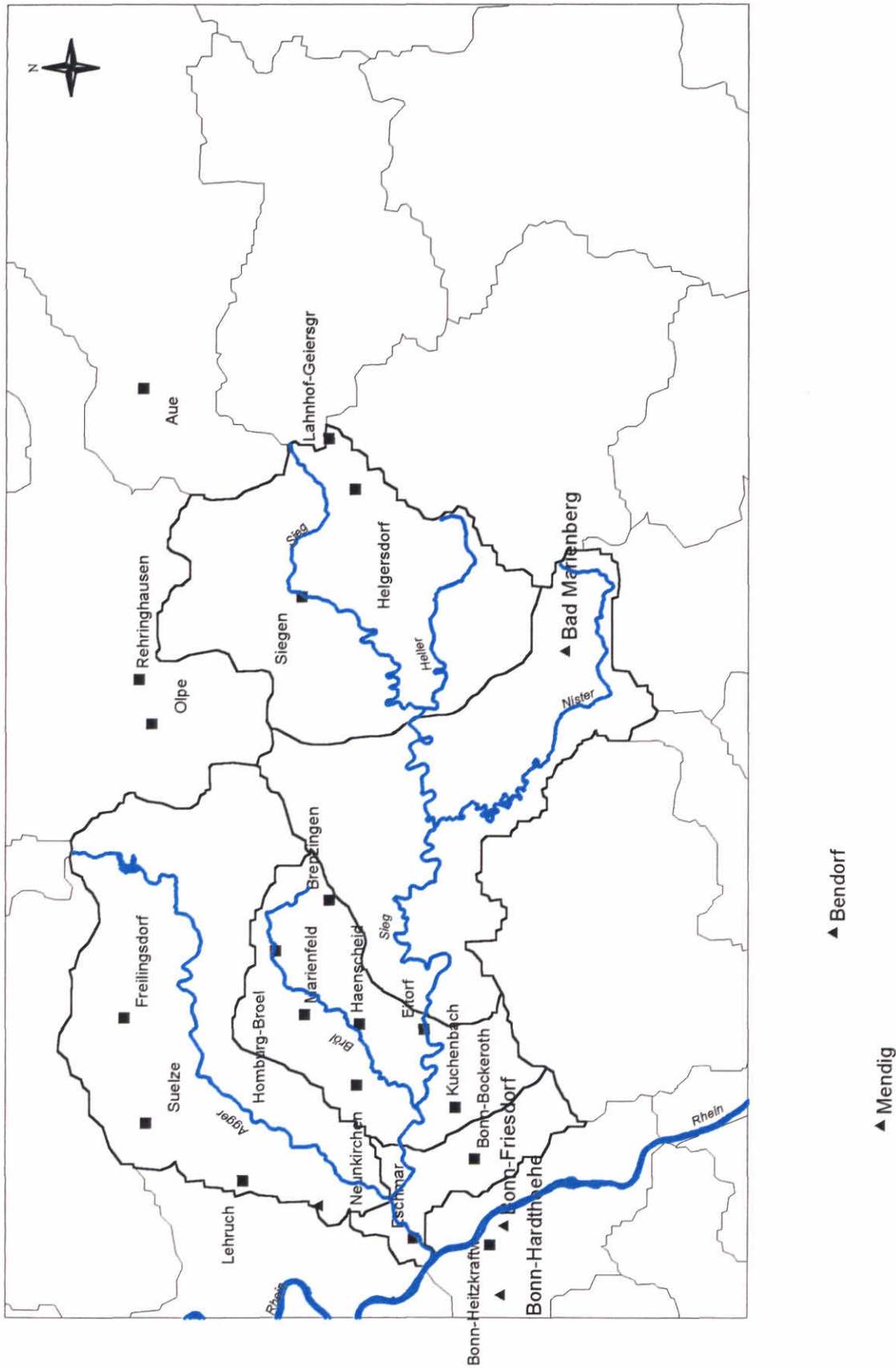


Fig 3.1 Sieg basin, location of LUA-NRW and DWD meteorological stations

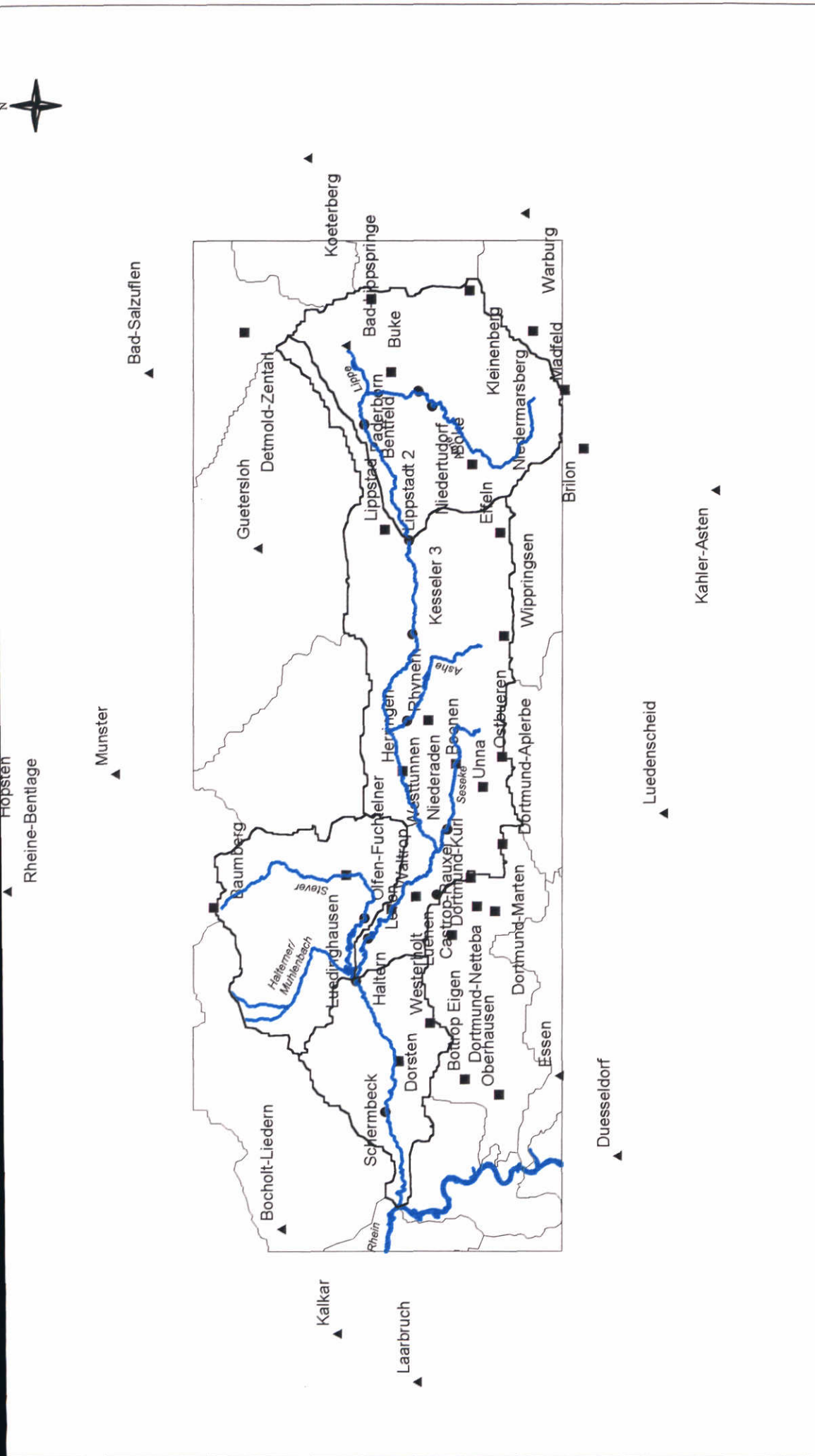


Fig 3.2 Lippe basin, locations of LUA-NRW and DWD meteorological stations

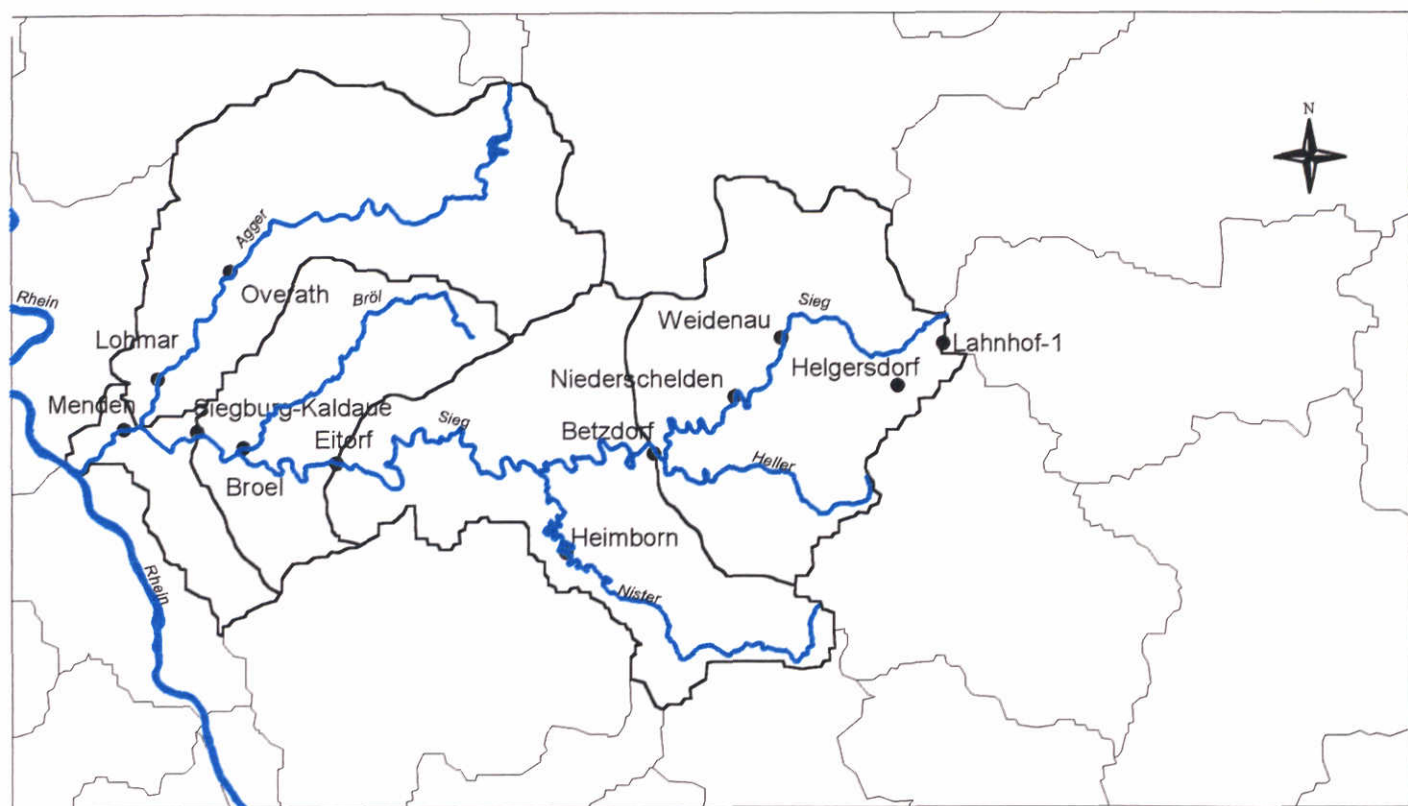


Fig 3.3 Sieg basin, location of rated river gauging stations

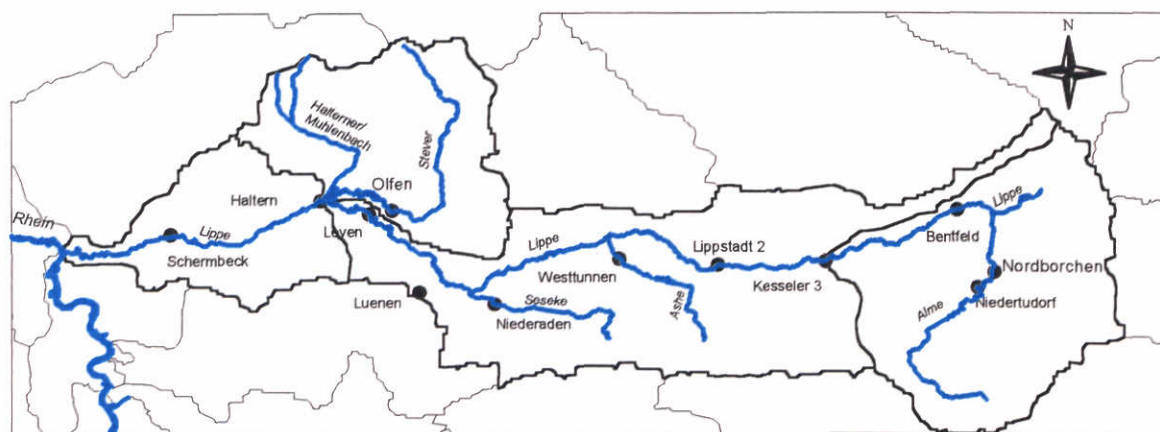


Fig 3.4 Lippe basin, locations of rated river gauging stations

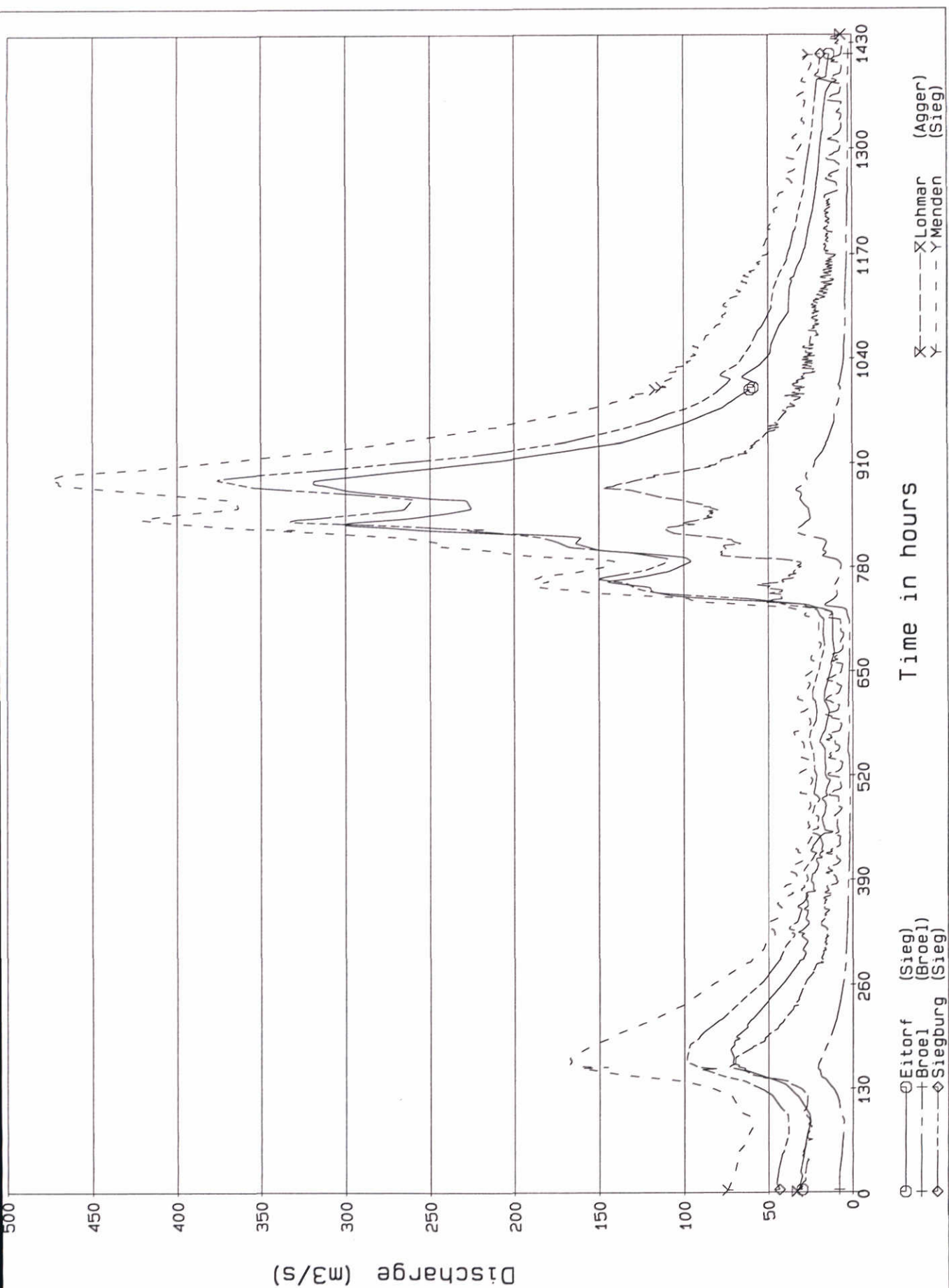
Legend:

Sieg: river Sieg

Eitorf: Discharge station Eitorf

Figures of Chapter 4

- Fig. 4.1.1. Hydrographs Sieg river and tributaries (uncorrected), Period no. 1.
- Fig. 4.1.2. Hydrographs Sieg river and tributaries (uncorrected), Period no. 2.
- Fig. 4.1.3. Hydrographs Sieg river and tributaries (uncorrected), Period no. 3.
- Fig. 4.1.4. Hydrographs Sieg river and tributaries (uncorrected), Period no. 4.
- Fig. 4.1.5. Hydrographs Sieg river and tributaries (uncorrected), Period no. 5.
- Fig. 4.1.6. Hydrographs Sieg river and tributaries (uncorrected), Period no. 6.
- Fig. 4.1.7. Hydrographs Sieg river and tributaries (uncorrected), Period no. 7.
- Fig. 4.1.8. Hydrographs Sieg river and tributaries (uncorrected), Period no. 8.
- Fig. 4.1.9. Hydrographs Sieg river and tributaries (uncorrected), Period no. 9.
- Fig. 4.1.10. Hydrographs Sieg river and tributaries (uncorrected), Period no. 10.
- Fig. 4.1.11. Hydrographs Sieg river and tributaries (uncorrected), Period no. 11.
- Fig. 4.1.12. Hydrographs Sieg river and tributaries (uncorrected), Period no. 12.
- Fig. 4.1.13. Hydrographs Sieg river and tributaries (uncorrected), Period no. 13.
- Fig. 4.1.14. Hydrographs Sieg river and tributaries (uncorrected), Period no. 14.
- Fig. 4.2.1. Hydrographs Lippe river and tributaries (uncorrected), Period no. 1.
- Fig. 4.2.2. Hydrographs Lippe river and tributaries (uncorrected), Period no. 2.
- Fig. 4.2.3. Hydrographs Lippe river and tributaries (uncorrected), Period no. 3.
- Fig. 4.2.4. Hydrographs Lippe river and tributaries (uncorrected), Period no. 4.
- Fig. 4.2.5. Hydrographs Lippe river and tributaries (uncorrected), Period no. 5.
- Fig. 4.2.6. Hydrographs Lippe river and tributaries (uncorrected), Period no. 6.
- Fig. 4.2.7. Hydrographs Lippe river and tributaries (uncorrected), Period no. 7.
- Fig. 4.2.8. Hydrographs Lippe river and tributaries (uncorrected), Period no. 8.
- Fig. 4.2.9. Hydrographs Lippe river and tributaries (uncorrected), Period no. 9.
- Fig. 4.2.10. Hydrographs Lippe river and tributaries (uncorrected), Period no. 10.
- Fig. 4.2.11. Hydrographs Lippe river and tributaries (uncorrected), Period no. 11.
- Fig. 4.2.12. Hydrographs Lippe river and tributaries (uncorrected), Period no. 12.
- Fig. 4.2.13. Hydrographs Lippe river and tributaries (uncorrected), Period no. 13.
- Fig. 4.2.14. Hydrographs Lippe river and tributaries (uncorrected), Period no. 14.
- Fig. 4.3. Relation curve Haltern-Schermbeck, Period no. 2
- Fig. 4.4. Relation curve Lippstadt2-Bentfeld, Period no. 2



Hydrographs Sieg river and tributaries

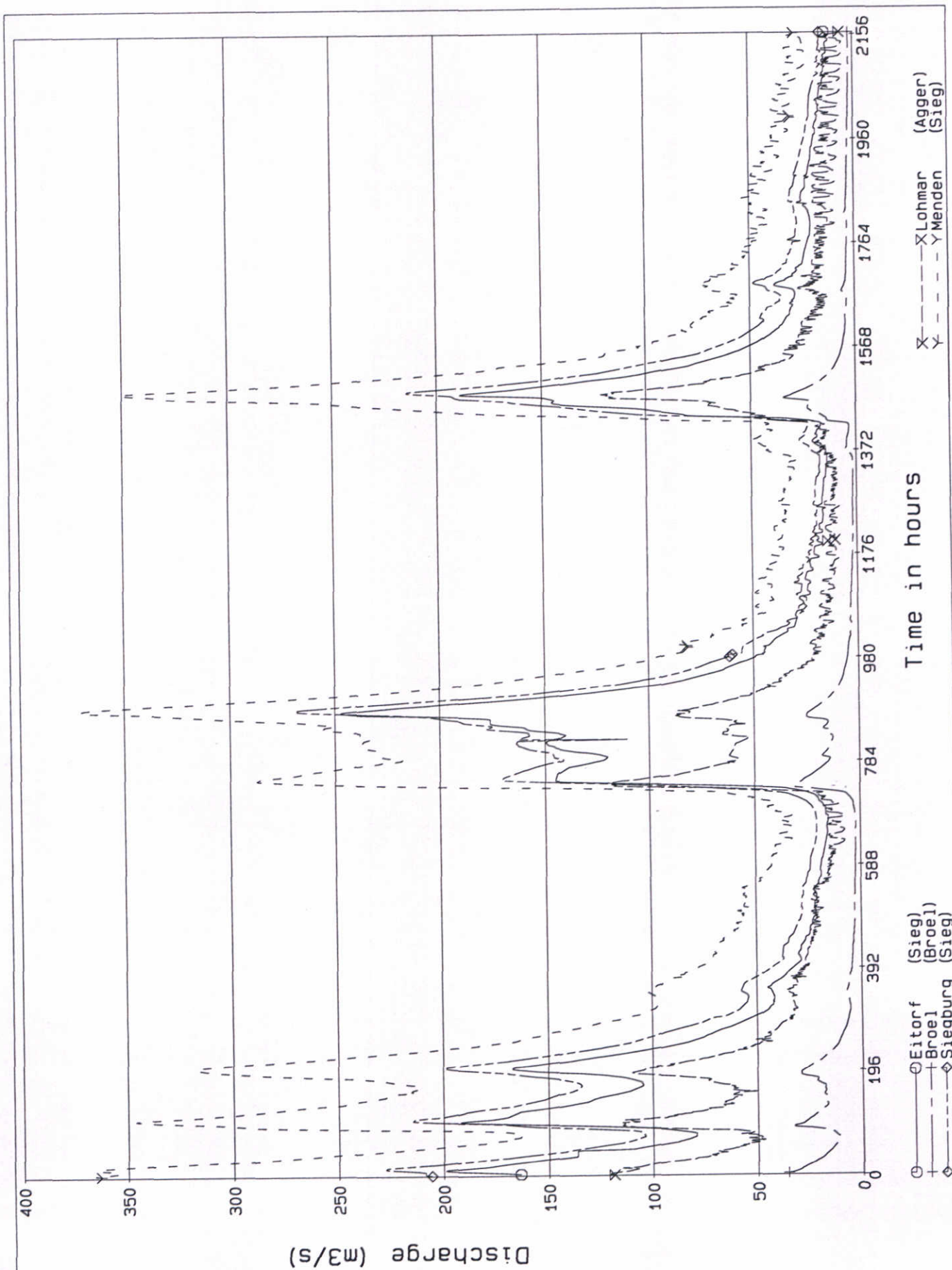
Period 1: 1/1/1980 - 29/2/1980

DELFT HYDRAULICS

Uncorrected

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FIG. 4.1.1



Hydrographs Sieg river and tributaries

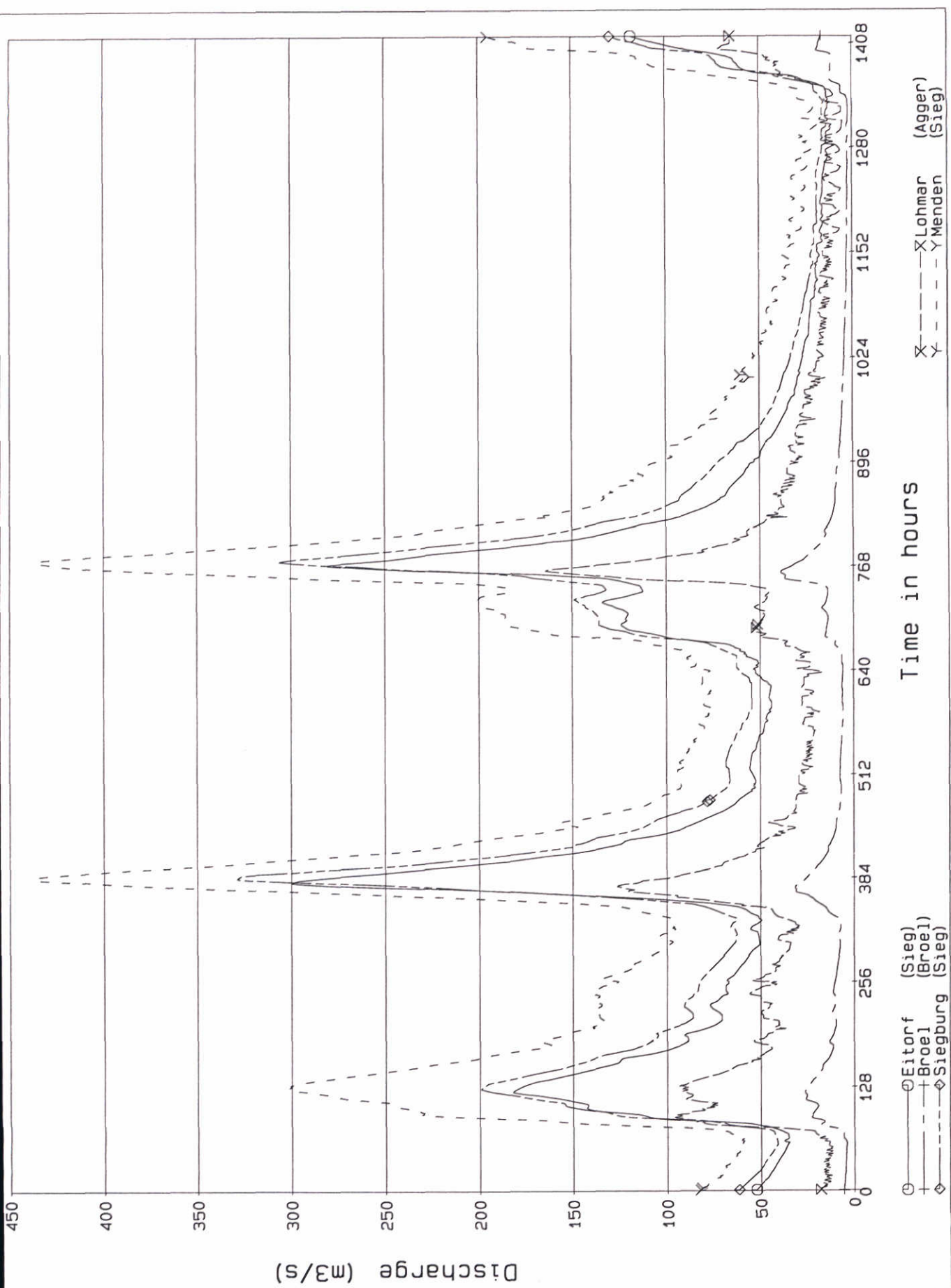
Period 2: 1/12/1981 - 28/2/1982

DELFT HYDRAULICS

Uncorrected

R3049

FIG. 4.1.2



Hydrographs Sieg river and tributaries

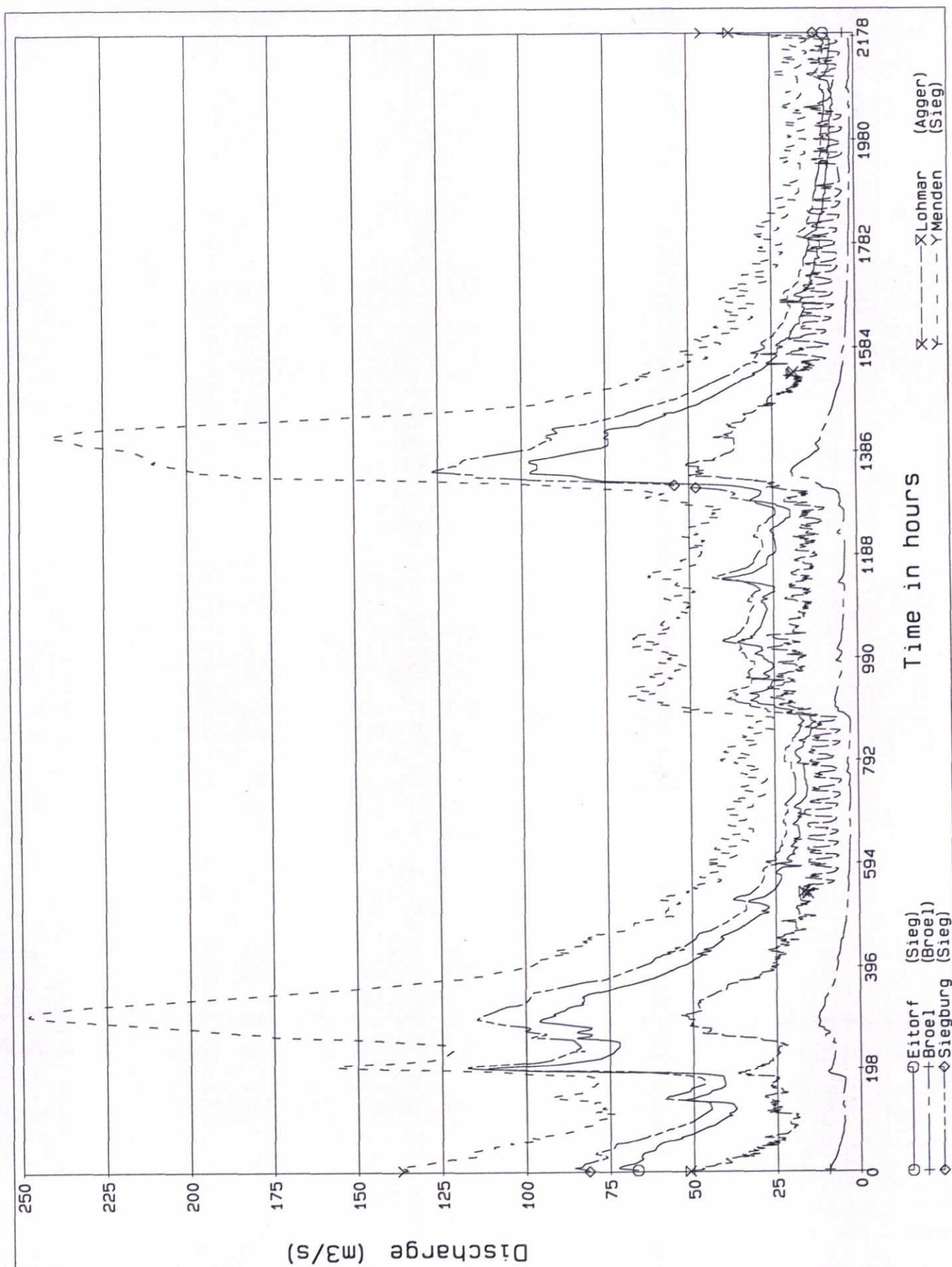
Period 3: 1/1/1983 - 31/2/1983

DELFT HYDRAULICS

Uncorrected

R3049

FIG. 4.1.3



Hydrographs Sieg river and tributaries

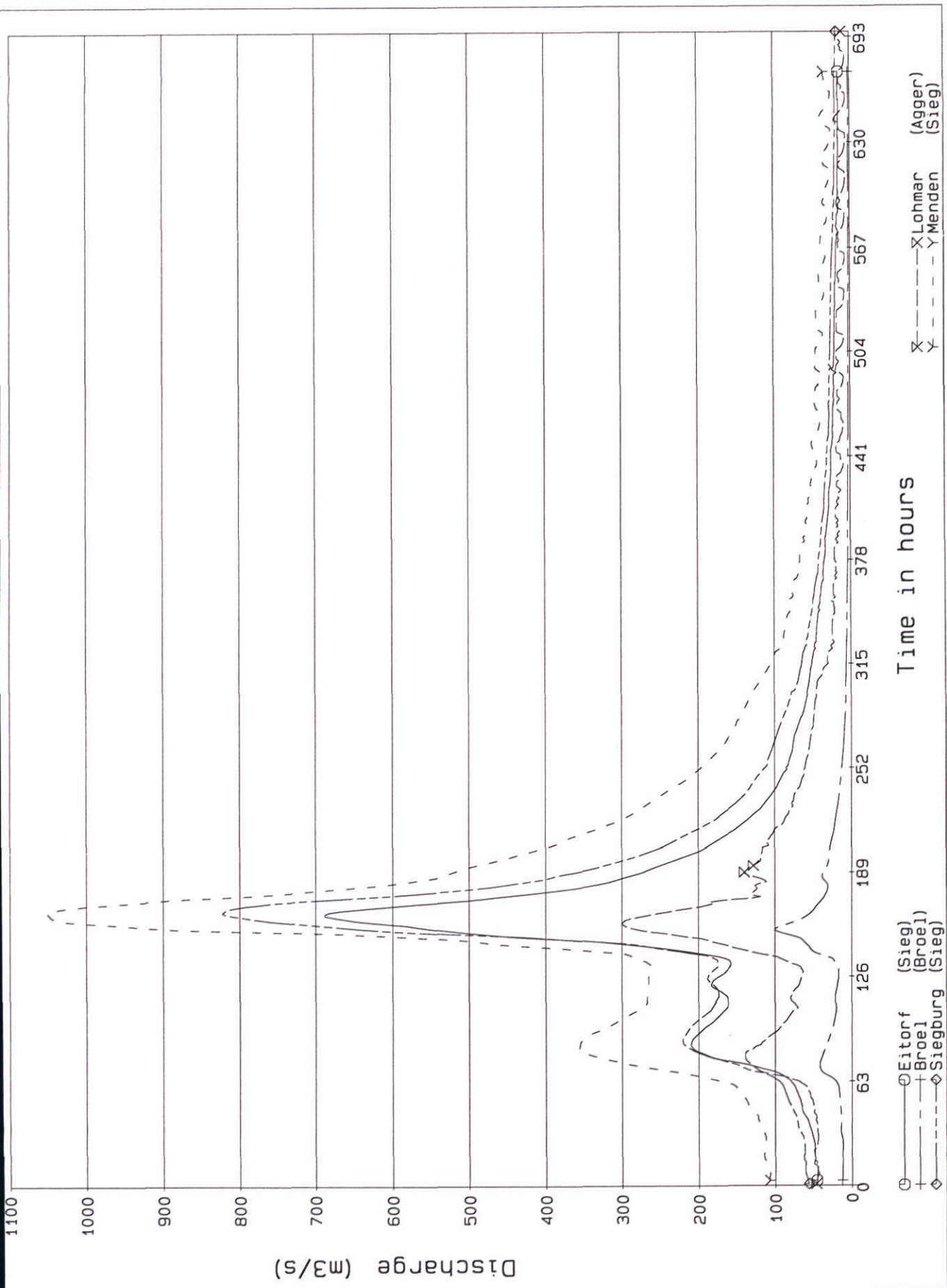
Period 4: 1/4/1983 - 30/6/1983

DELFT HYDRAULICS

Uncorrected

R3049

FIG. 4.1.4



Hydrographs Sieg river and tributaries

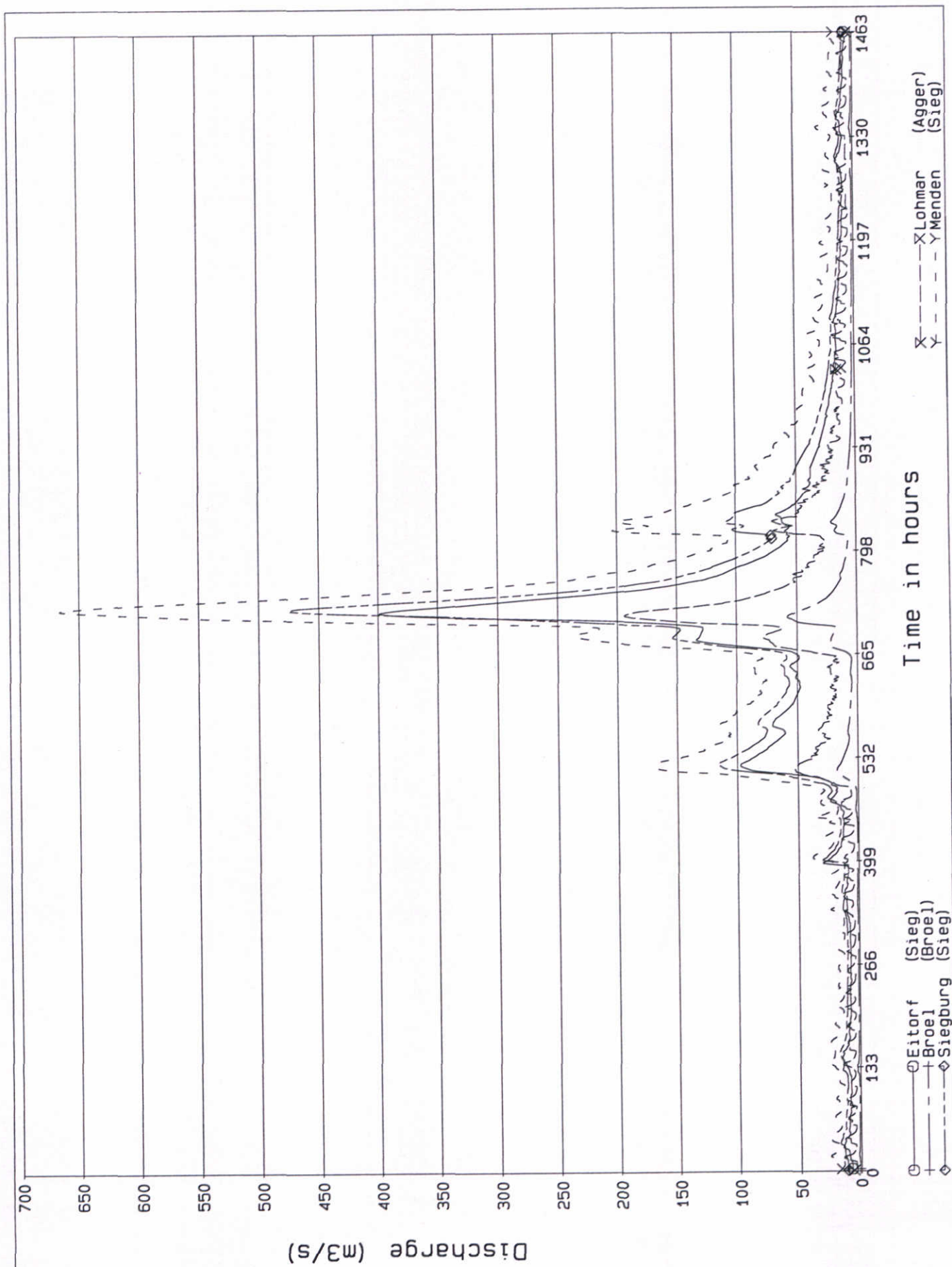
Period 5: 1/2/1984 - 29/2/1984

DELFT HYDRAULICS

Uncorrected

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FIG. 4.1.5



Hydrographs Sieg river and tributaries

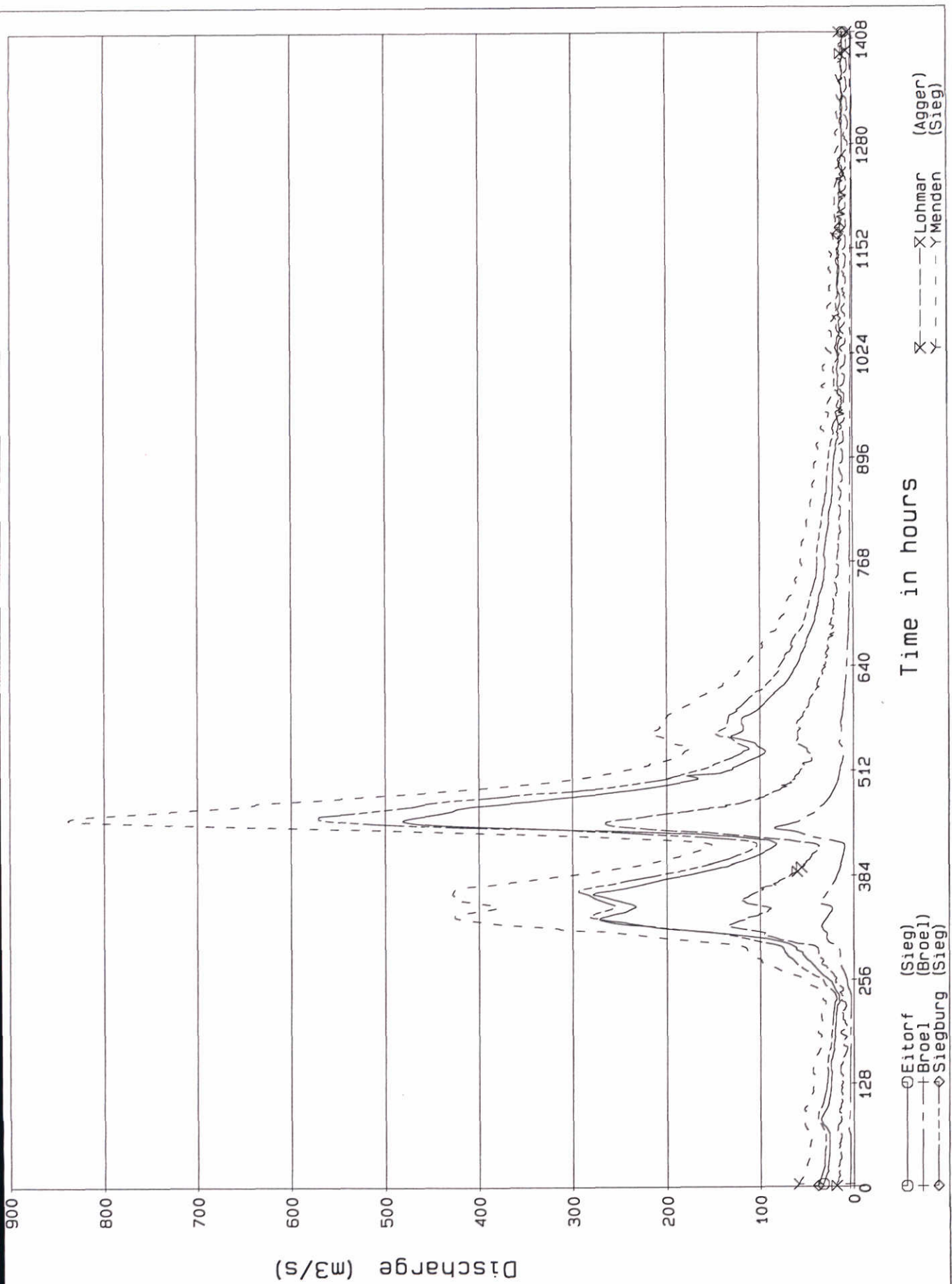
Period 6: 1/5/1984 - 30/6/1984

DELFT HYDRAULICS

Uncorrected

R3049

FIG. 4.1.6



Hydrographs Sieg river and tributaries

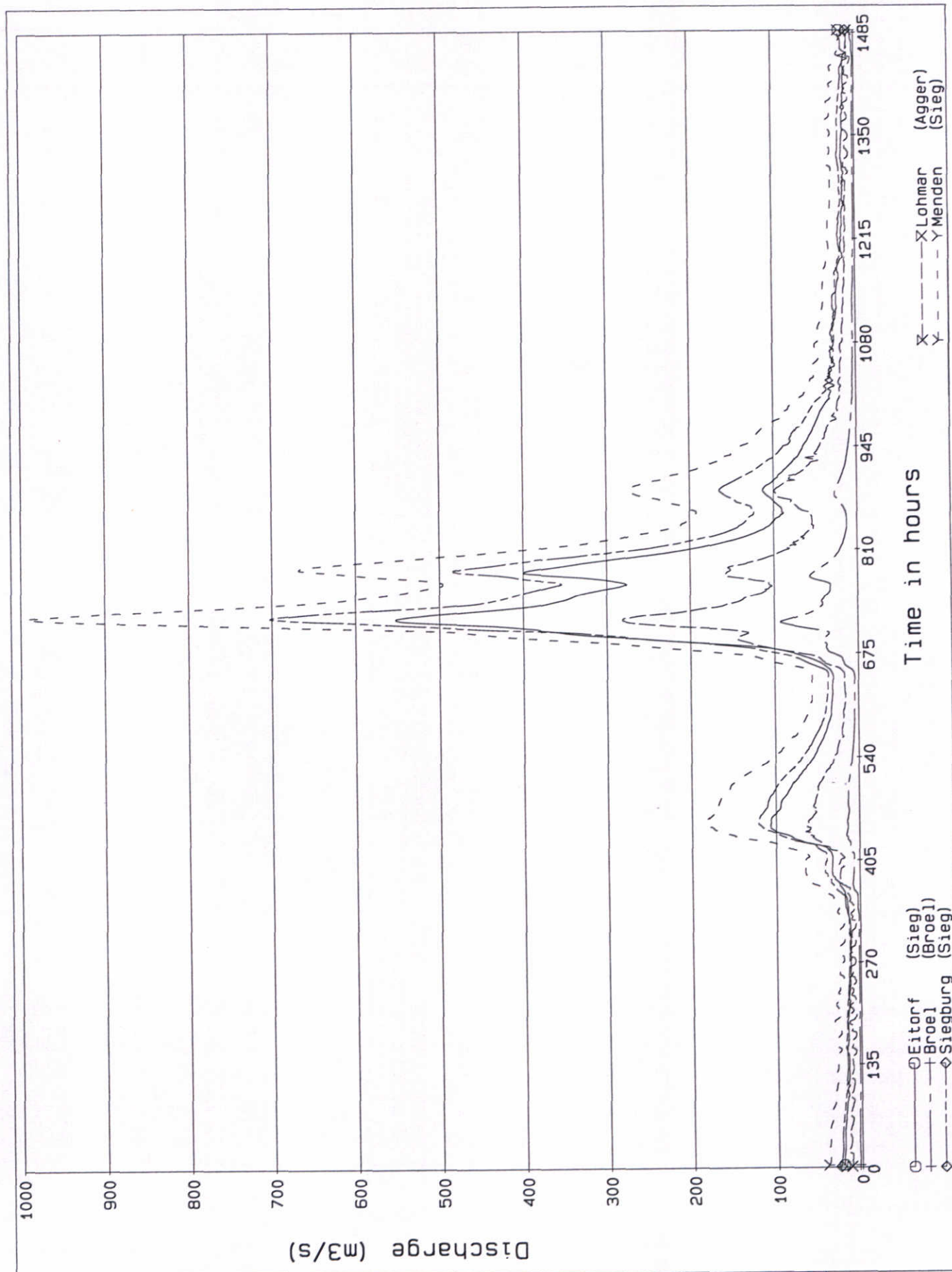
Period 7: 1/1/1986 - 28/2/1986

DELFT HYDRAULICS

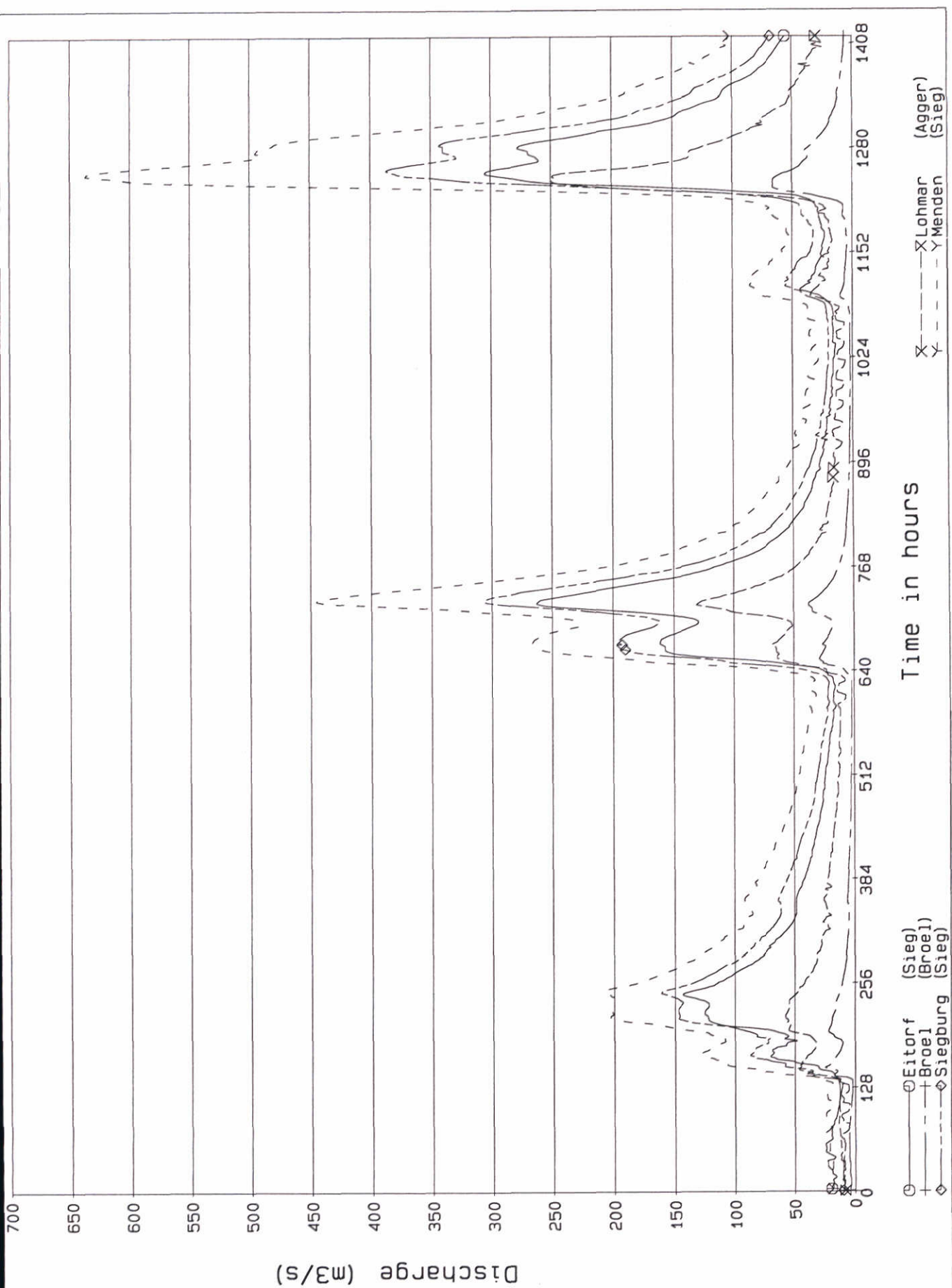
Uncorrected

R3049

FIG. 4.1.7



Hydrographs Sieg river and tributaries Period 8: 1/12/1986 - 31/1/1987 DELFT HYDRAULICS	Uncorrected	
	R3049	FIG. 4.1.8



Hydrographs Sieg river and tributaries

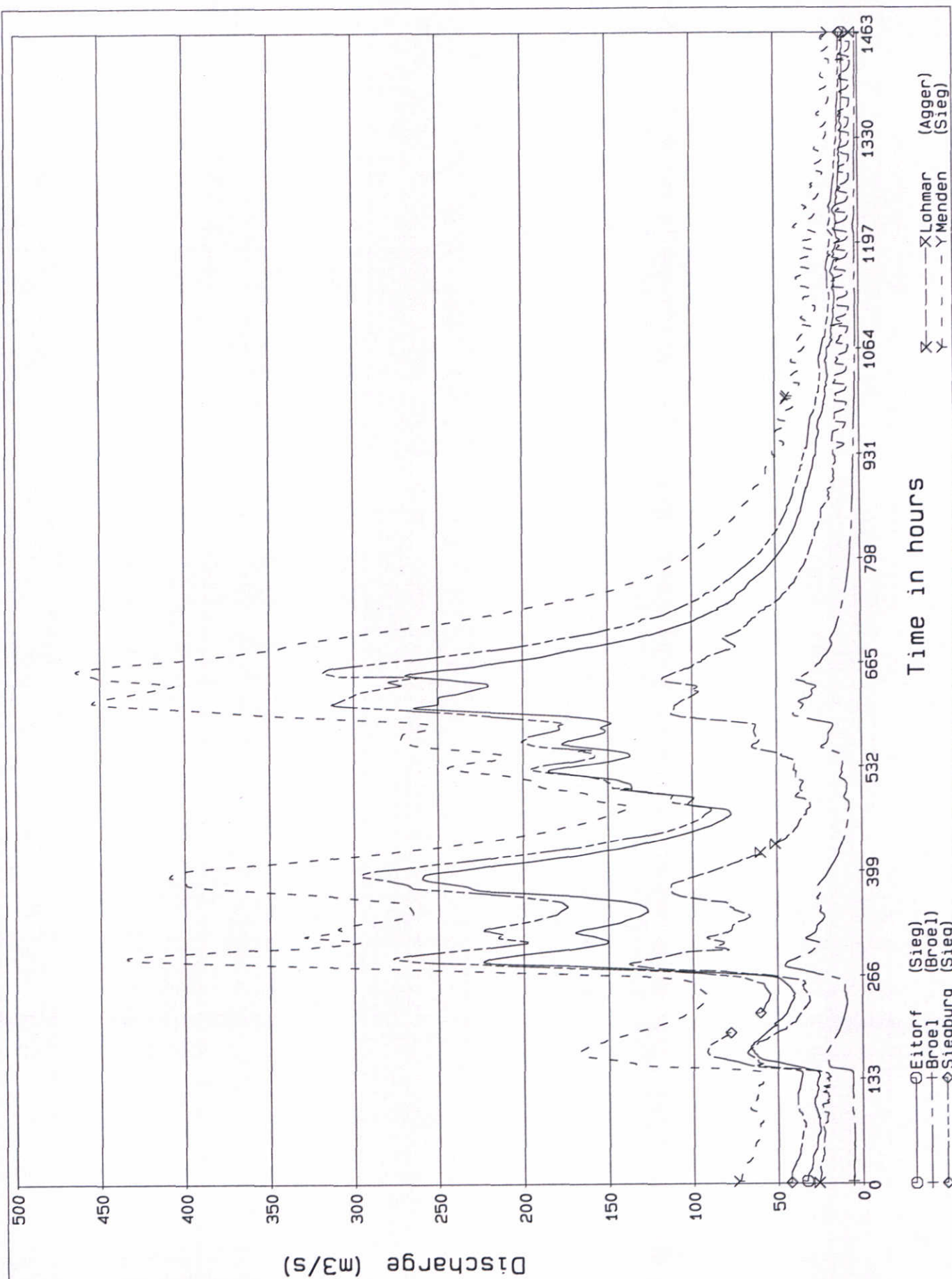
Period 9: 1/2/1987 - 31/3/1987

DELFT HYDRAULICS

Uncorrected

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FIG. 4.1.9



Hydrographs Sieg river and tributaries

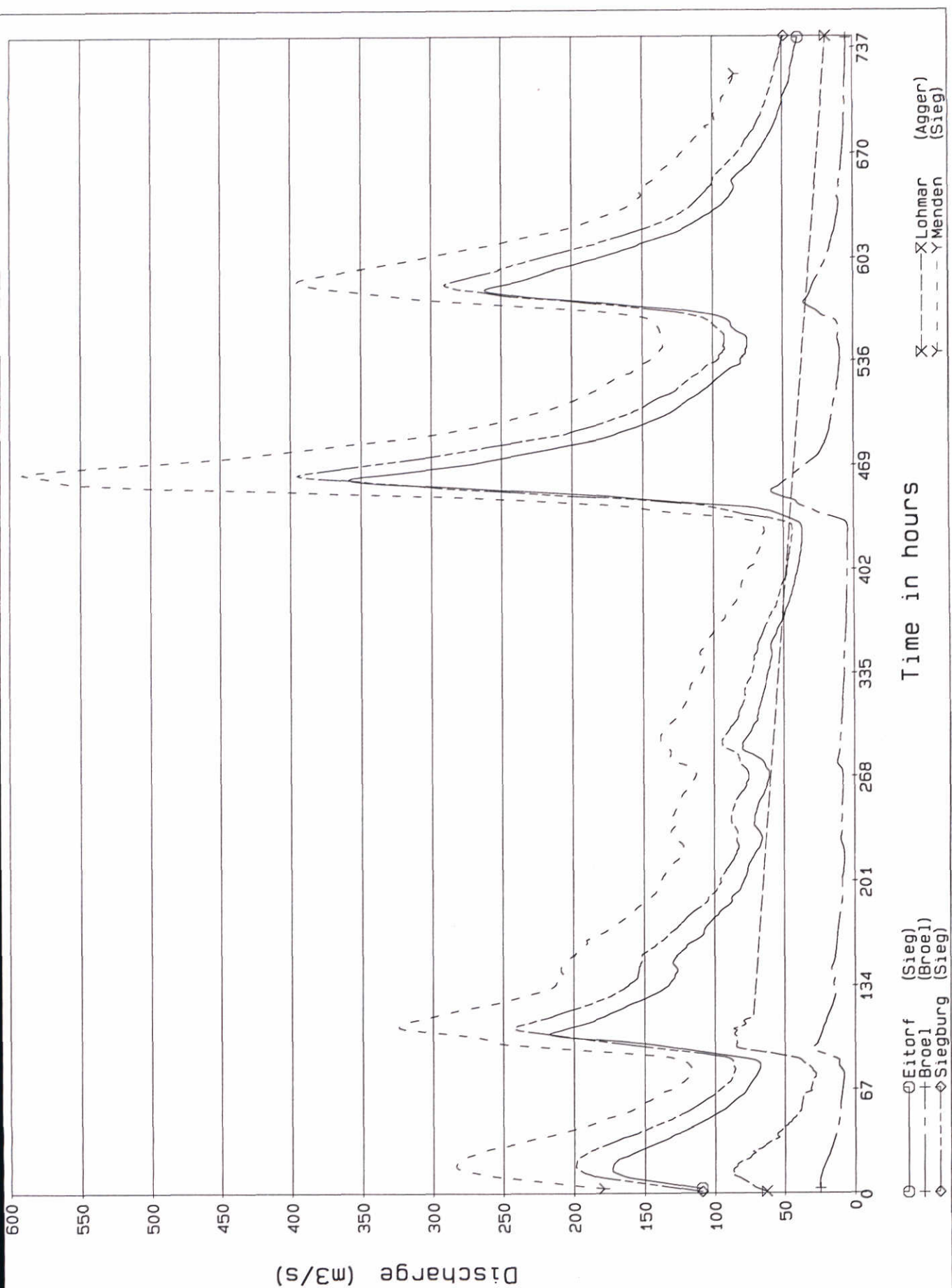
Period 10: 1/3/1988 - 30/4/1988

DELFT HYDRAULICS

Uncorrected

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FIG. 4.1.10



Hydrographs Sieg river and tributaries

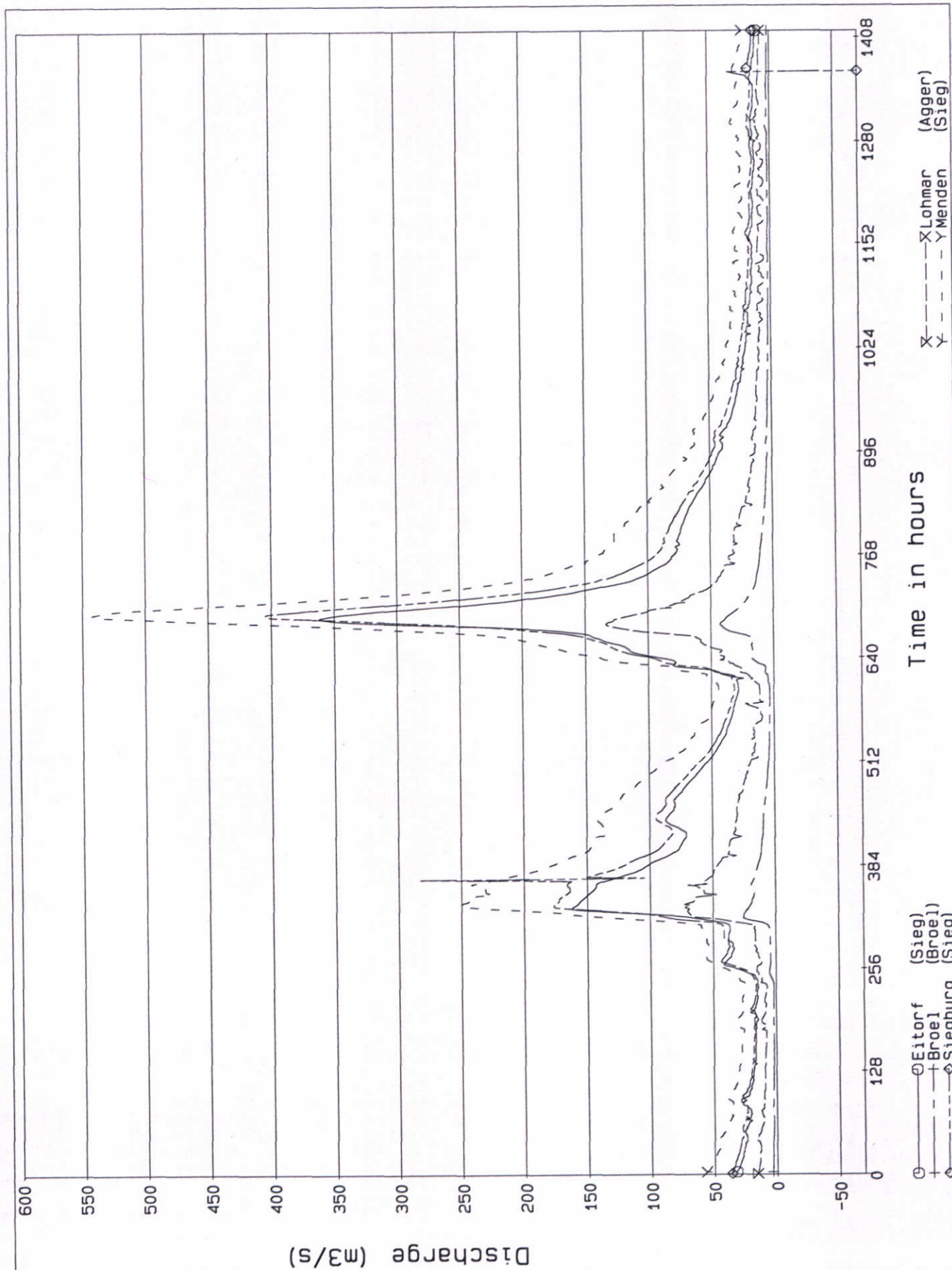
Period 11: 1/12/1988 - 31/12/1988

DELFT HYDRAULICS

Uncorrected

R3049

FIG. 4.1.11



Hydrographs Sieg river and tributaries

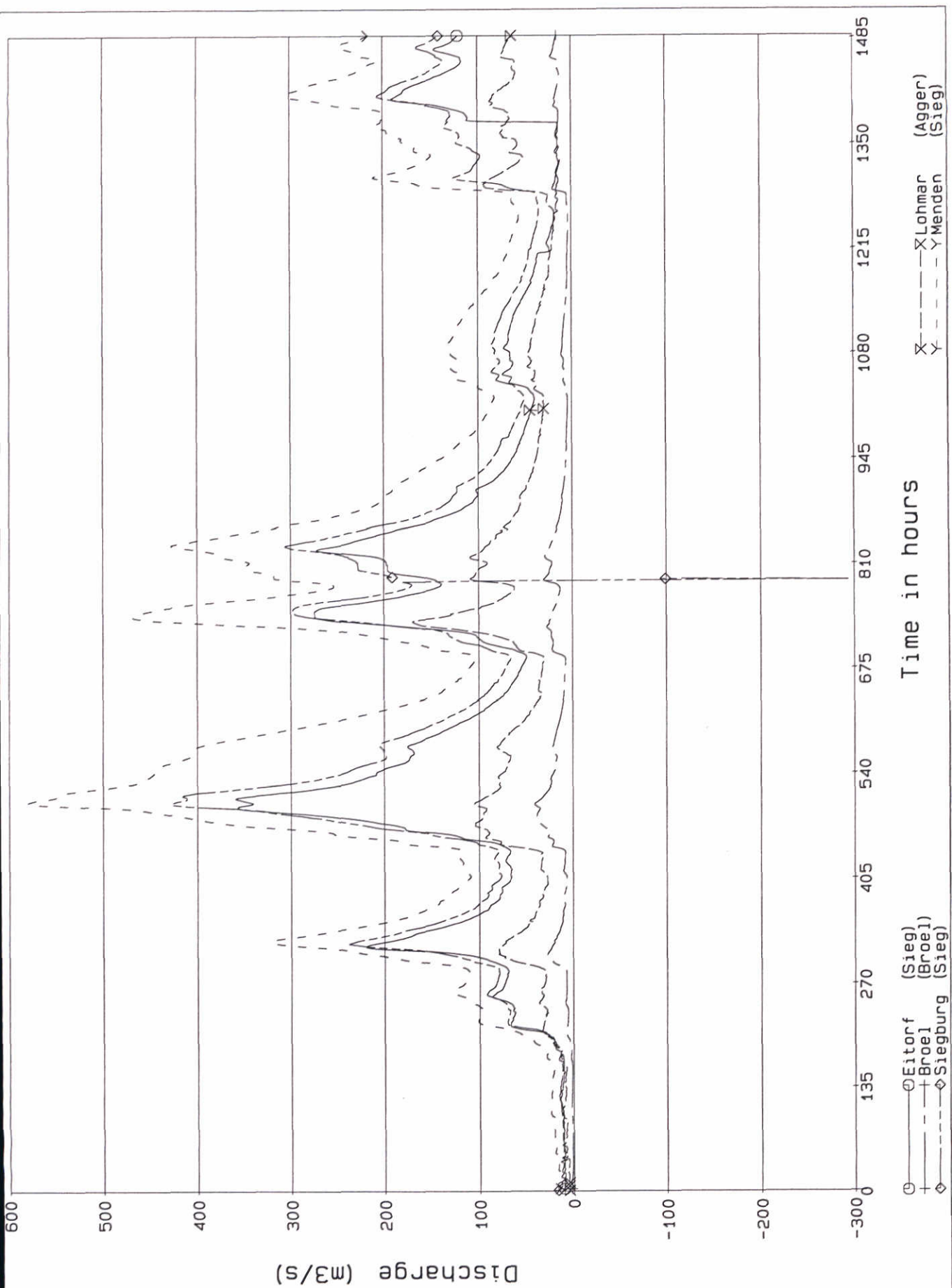
Period 12: 1/2/1990 - 31/3/1990

DELFT HYDRAULICS

Uncorrected

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FIG. 4.1.12



Hydrographs Sieg river and tributaries

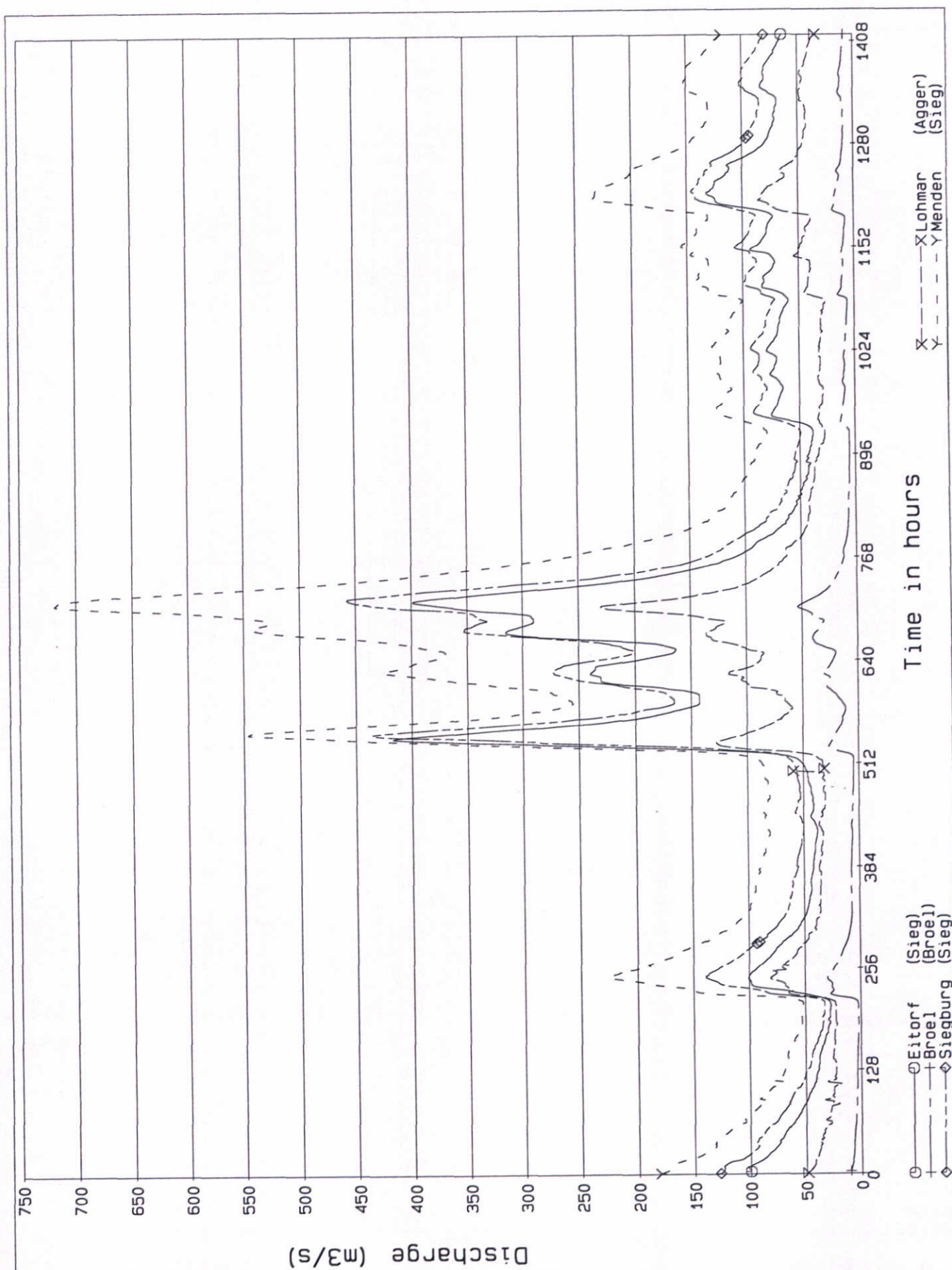
Period 13: 1/12/1993 - 31/1/1994

DELFT HYDRAULICS

Uncorrected

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FIG. 4.1.13



Hydrographs Sieg river and tributaries

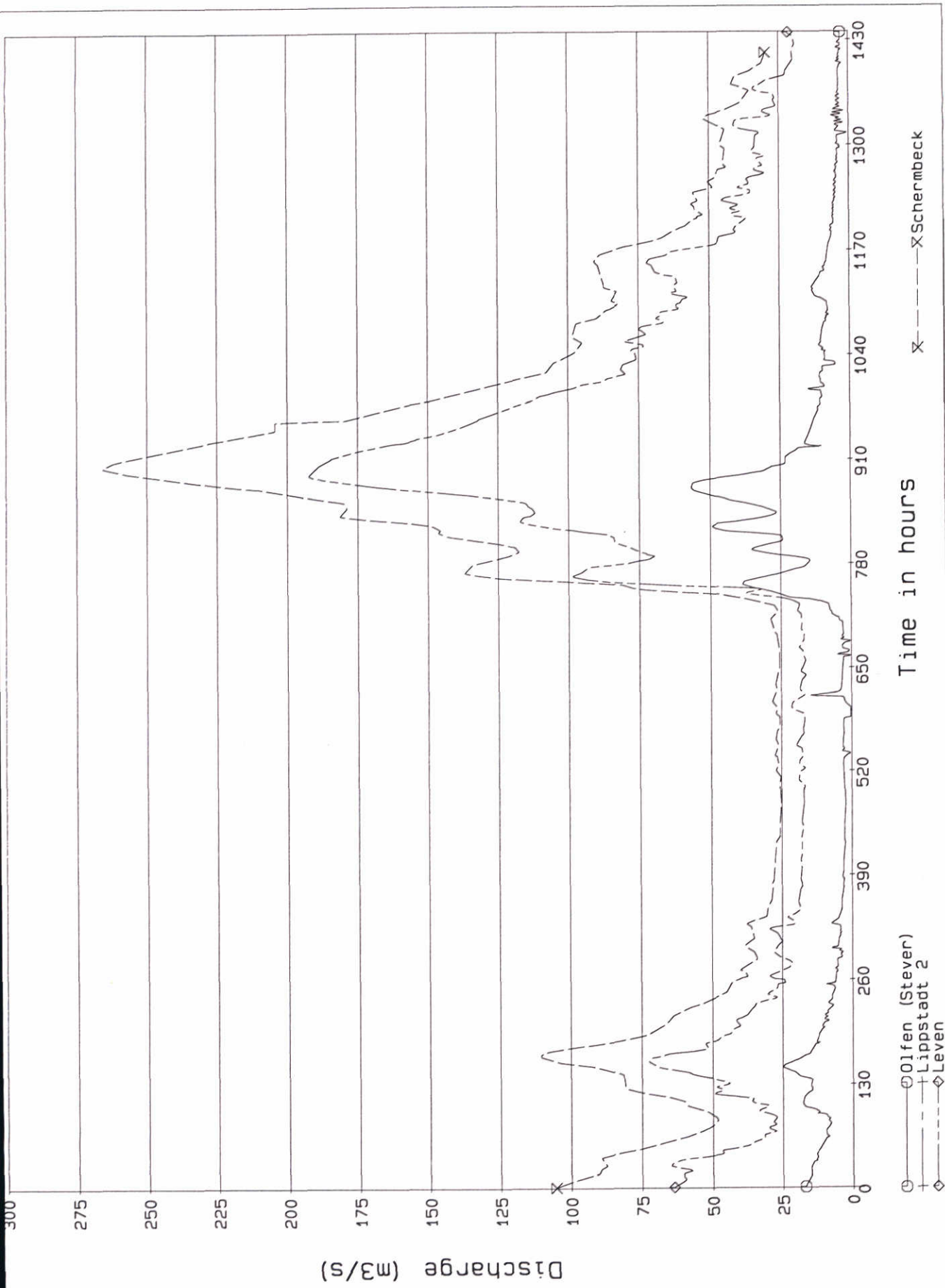
Period 14: 1/1/1995 - 28/2/1995

DELFT HYDRAULICS

Uncorrected

R3049

FIG. 4.1.14



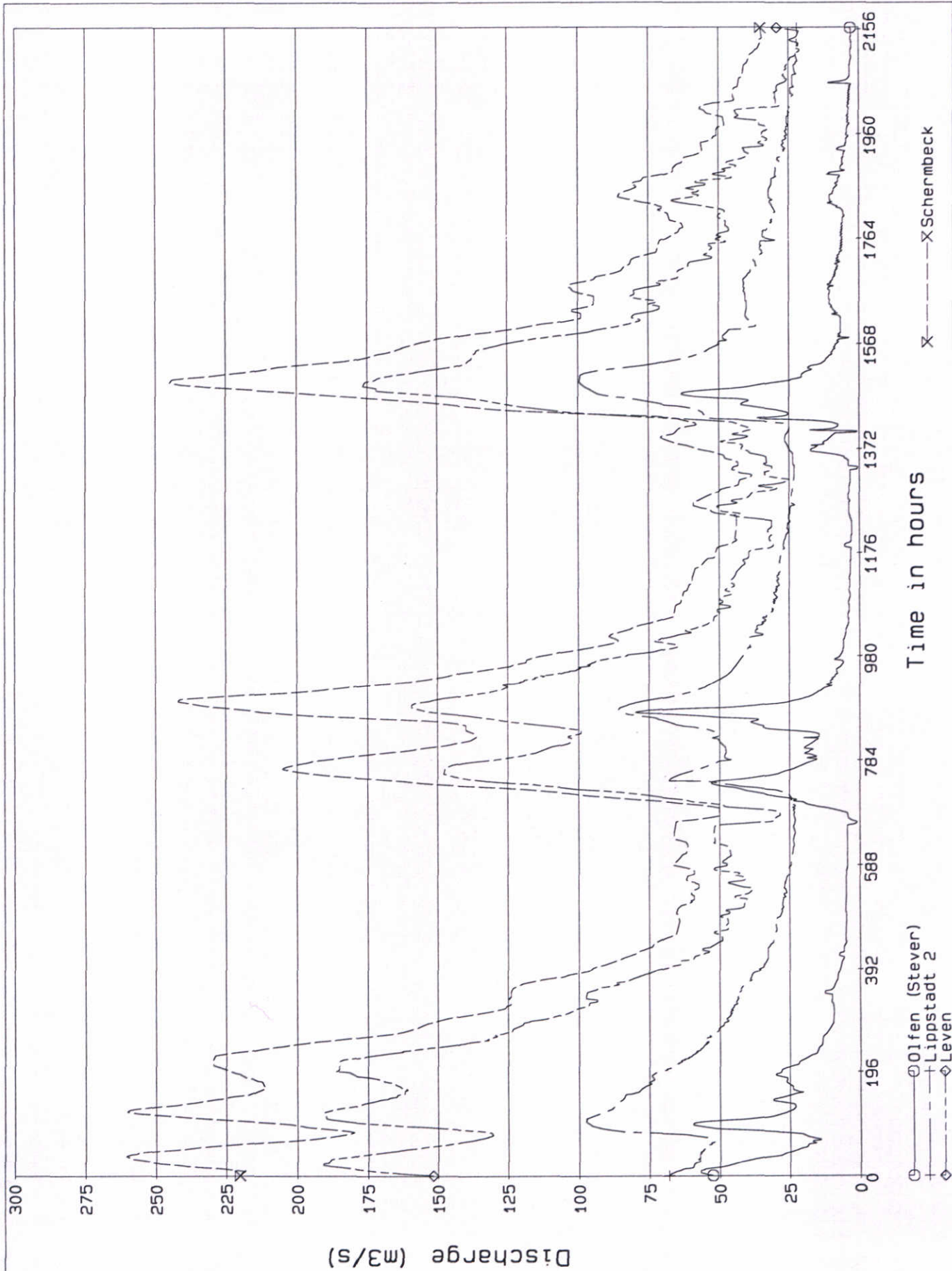
Hydrographs Lippe river and tributary

Period 1: 1/1/1980 - 29/2/1980

DELFT HYDRAULICS

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FIG. 4.2.1



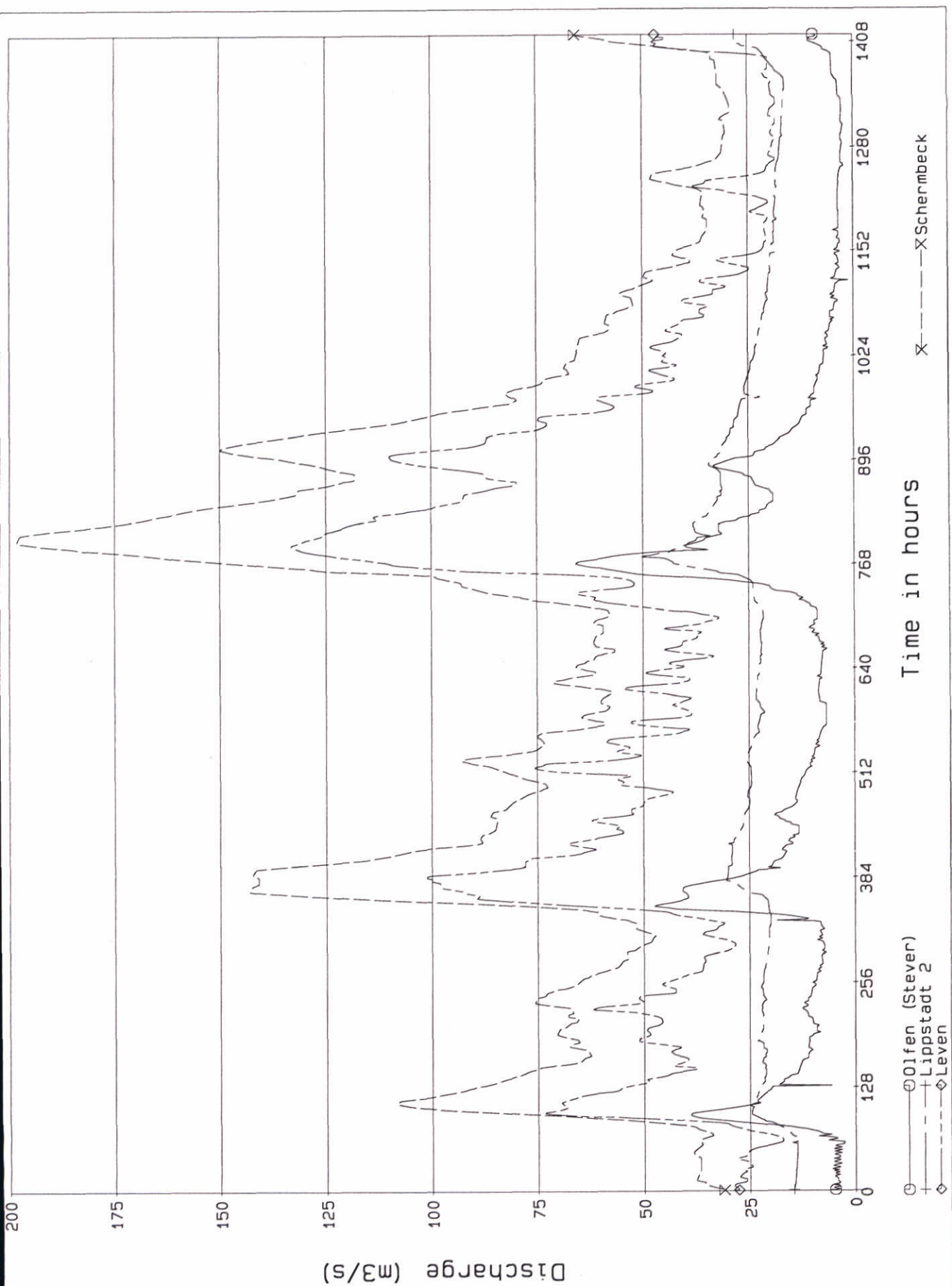
Hydrographs Lippe river and tributary

Period 2: 1/12/1981 - 28/2/1982

DELFT HYDRAULICS

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FIG. 4.2.2



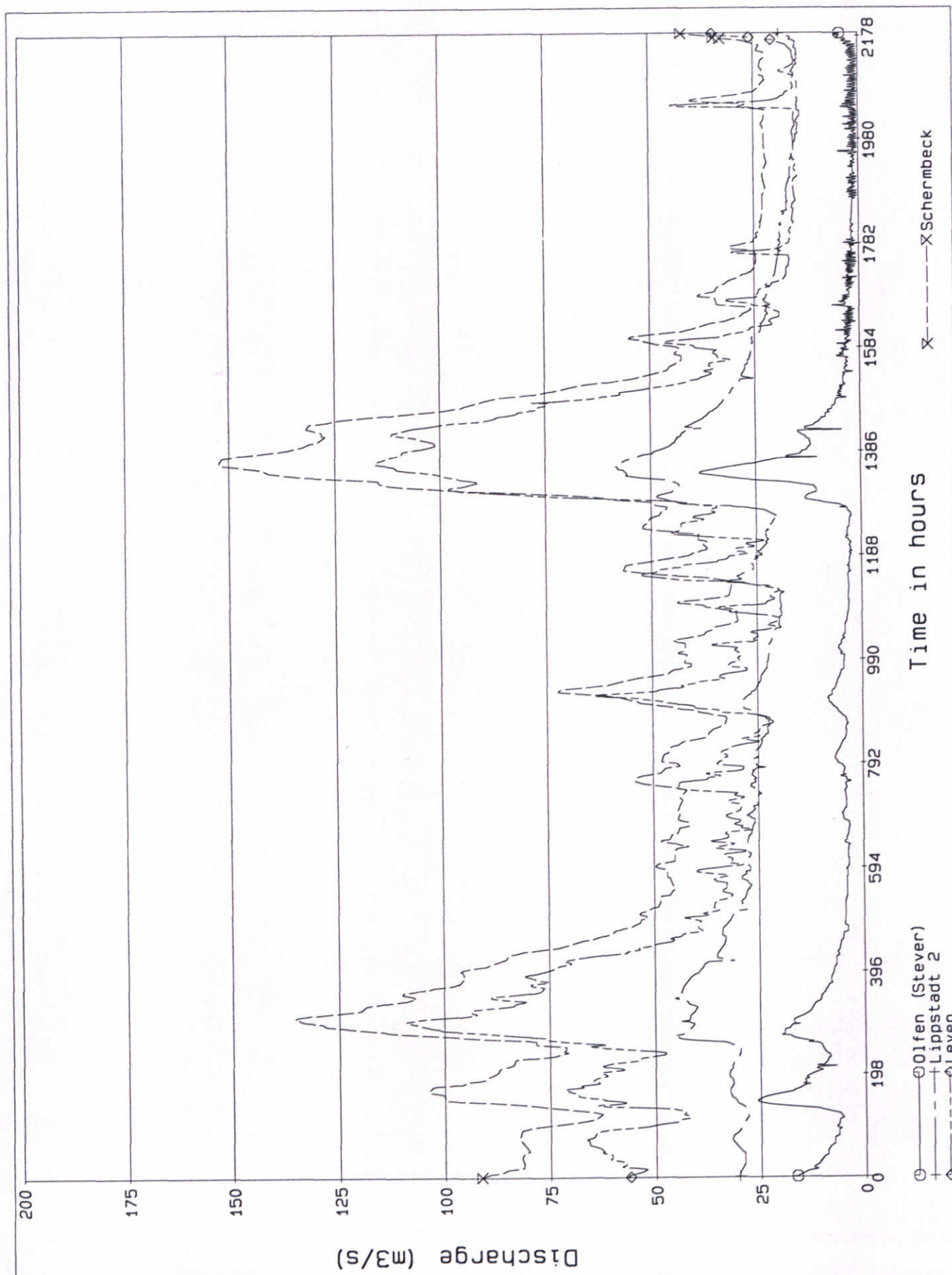
Hydrographs Lippe river and tributary

Period 3: 1/1/1983 - 28/2/1983

DELFT HYDRAULICS

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FIG. 4.2.3



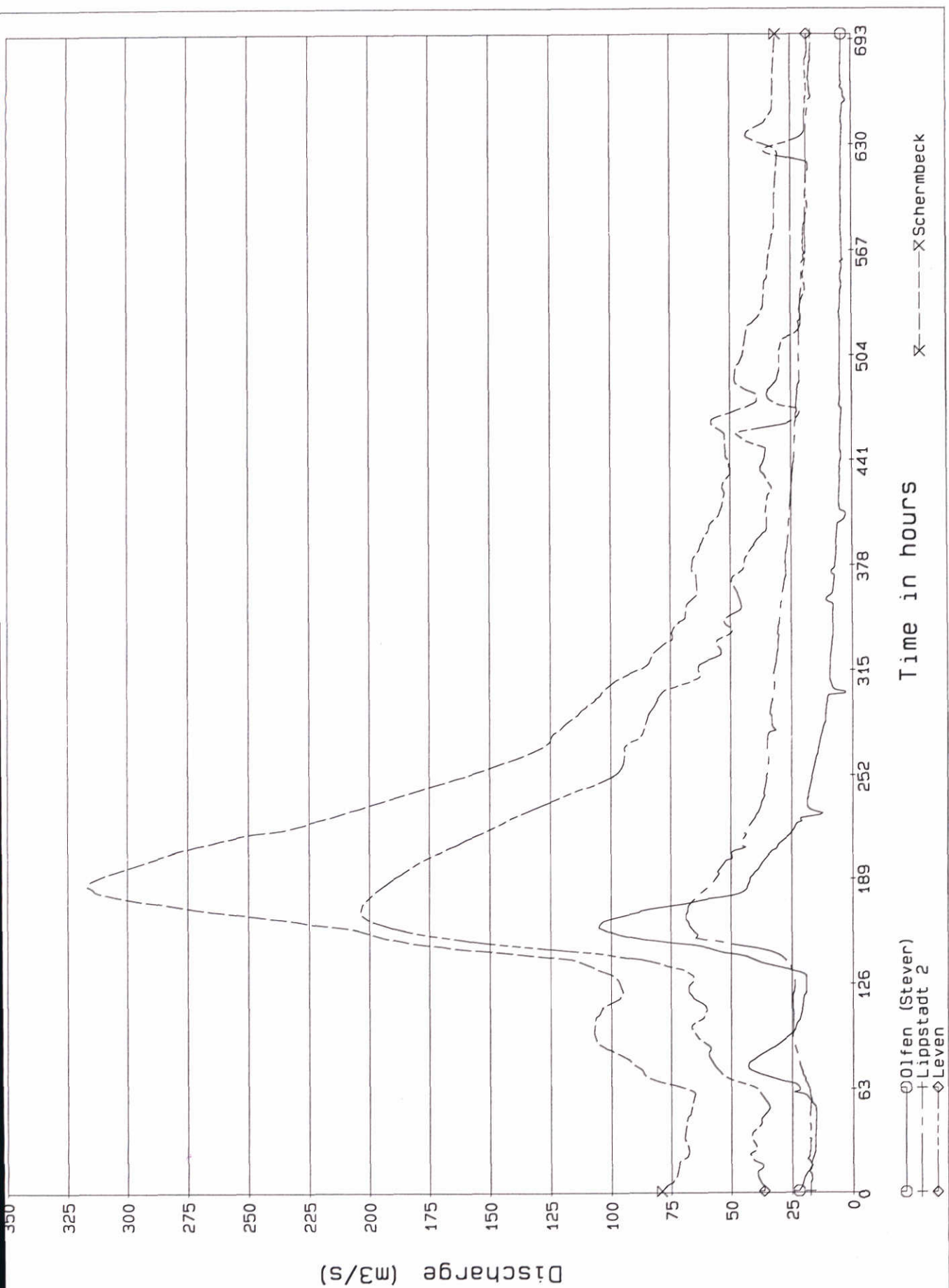
Hydrographs Lippe river and tributary

Period 4: 1/4/1983 - 30/6/1983

DELFT HYDRAULICS

R3049

FIG. 4.2.4



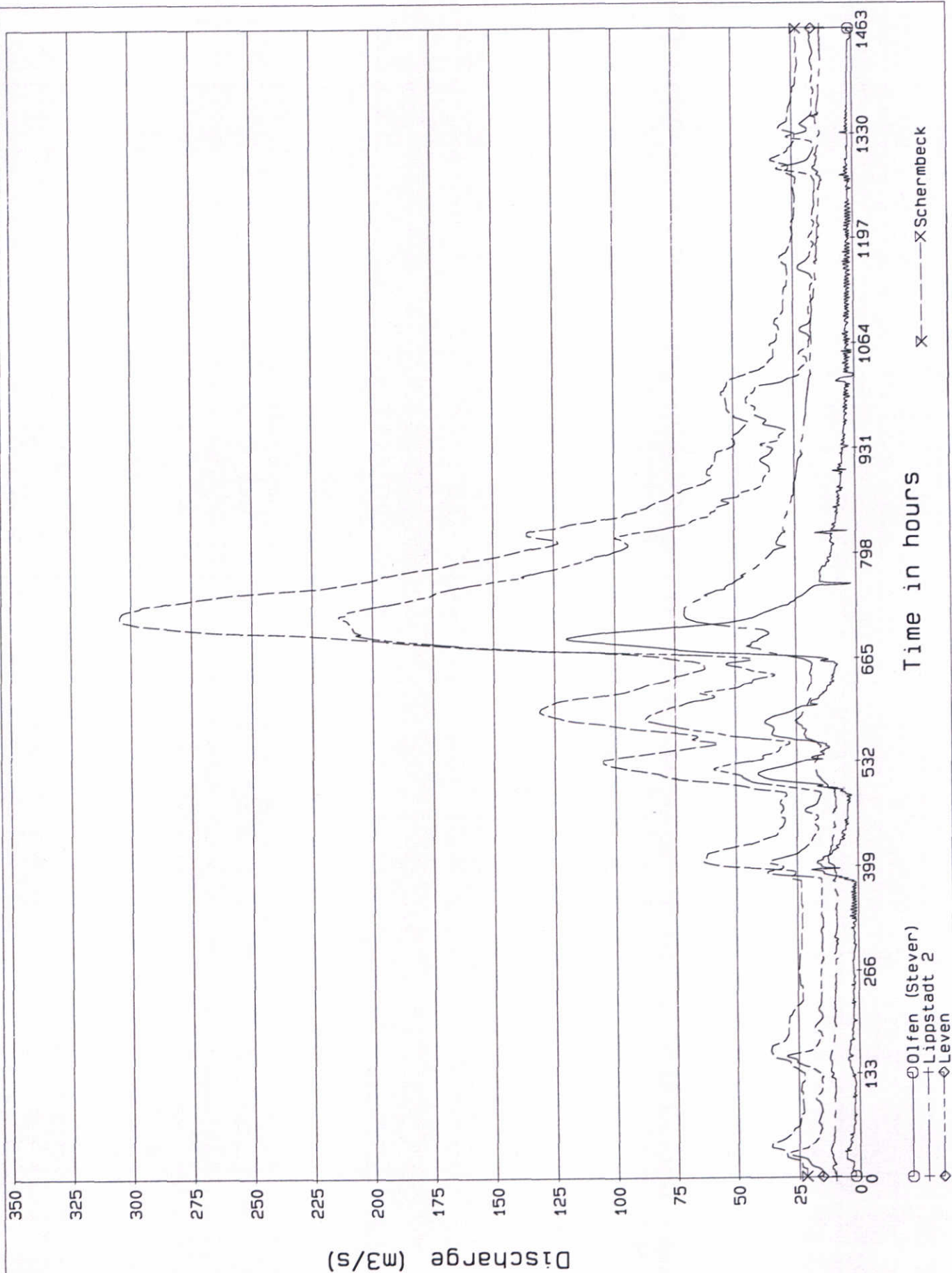
Hydrographs Lippe river and tributary

Period 5: 1/2/1984 - 29/2/1984

DELFT HYDRAULICS

R3049

FIG. 4.2.5



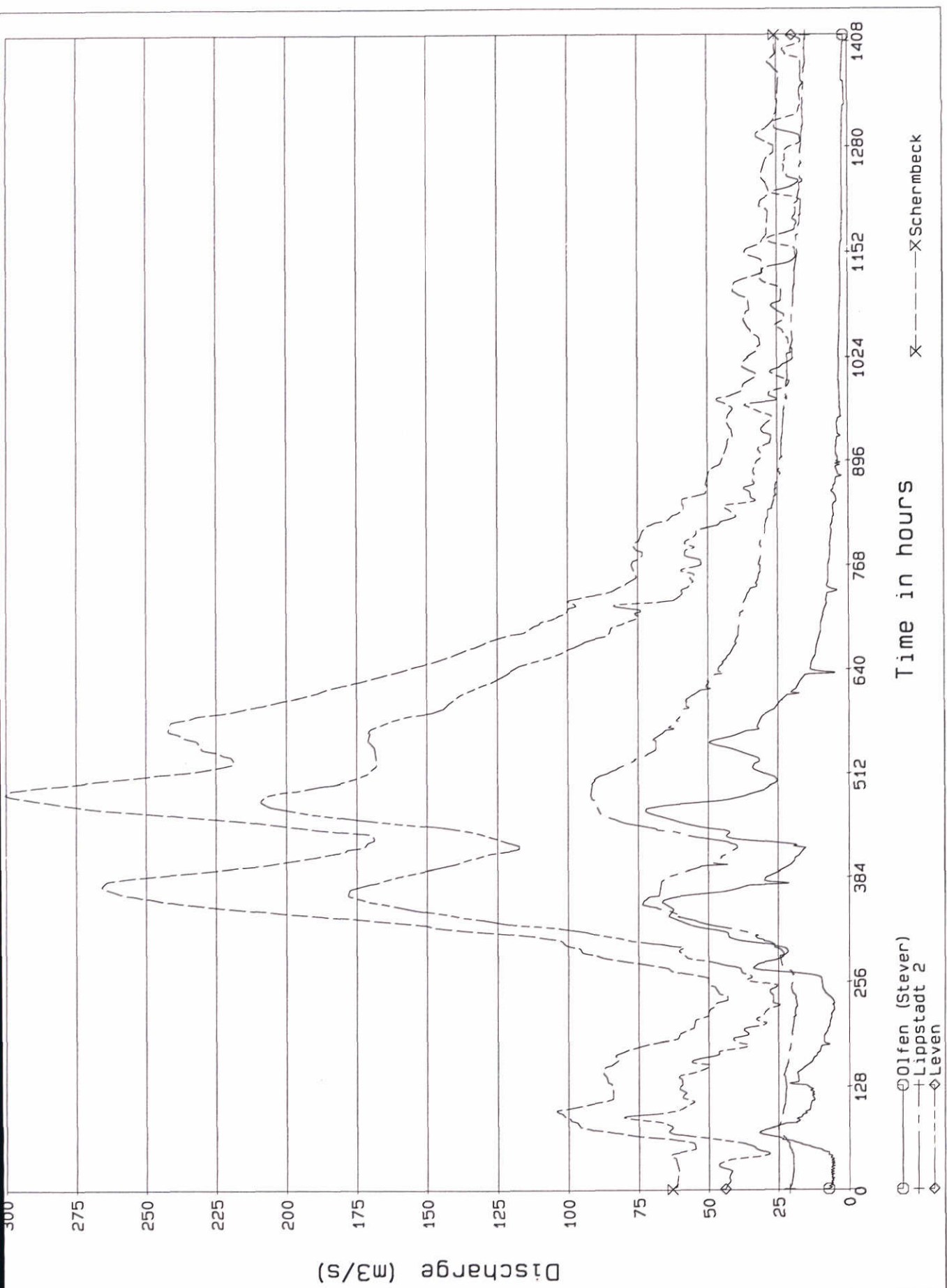
Hydrographs Lippe river and tributary

Period 6: 1/5/1984 - 30/6/1984

DELFT HYDRAULICS

R3049

FIG. 4.2.6



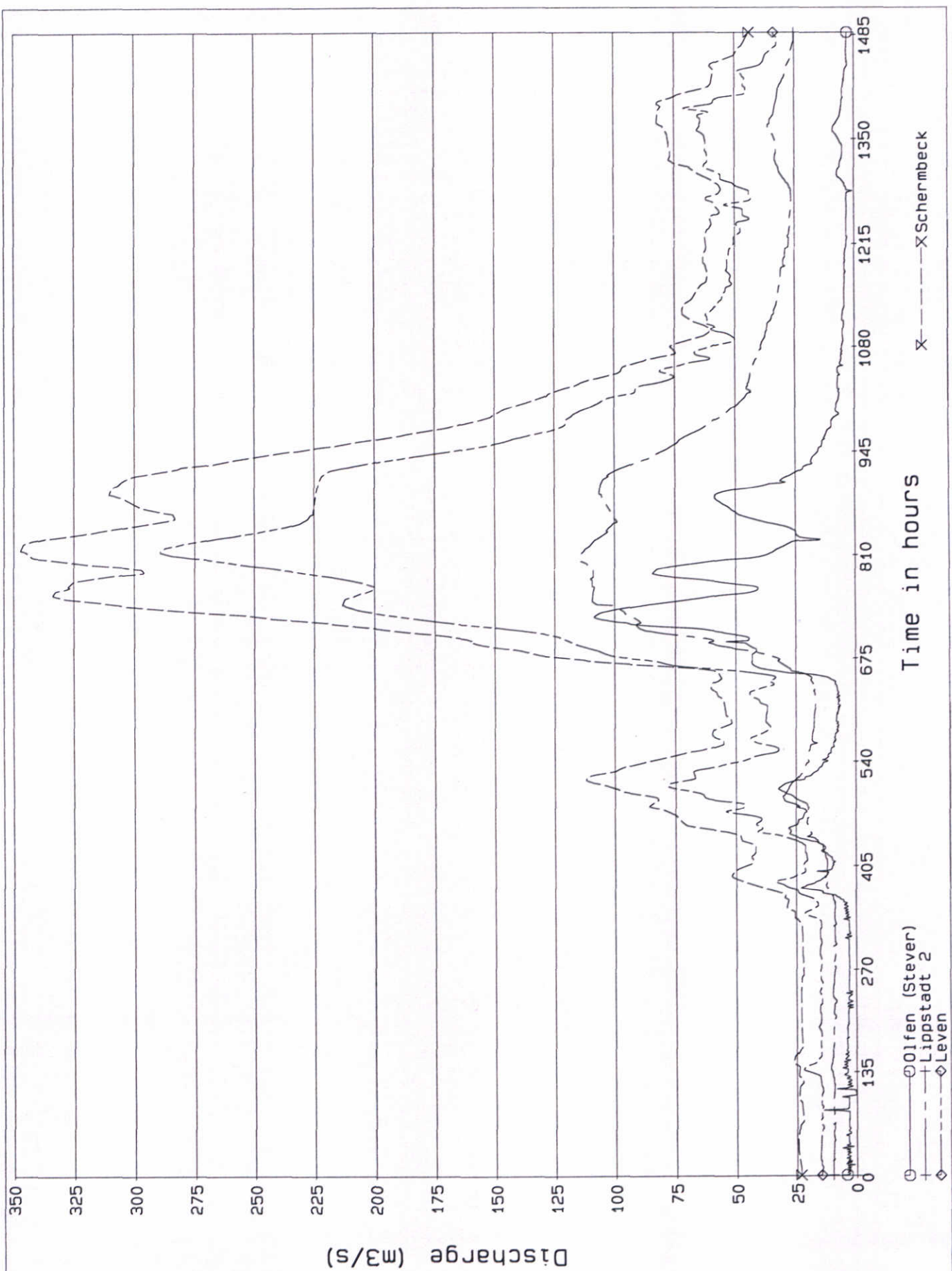
Hydrographs Lippe river and tributary

Period 7: 1/1/1986 - 28/2/1986

DELFT HYDRAULICS

R3049

FIG.4.2.7



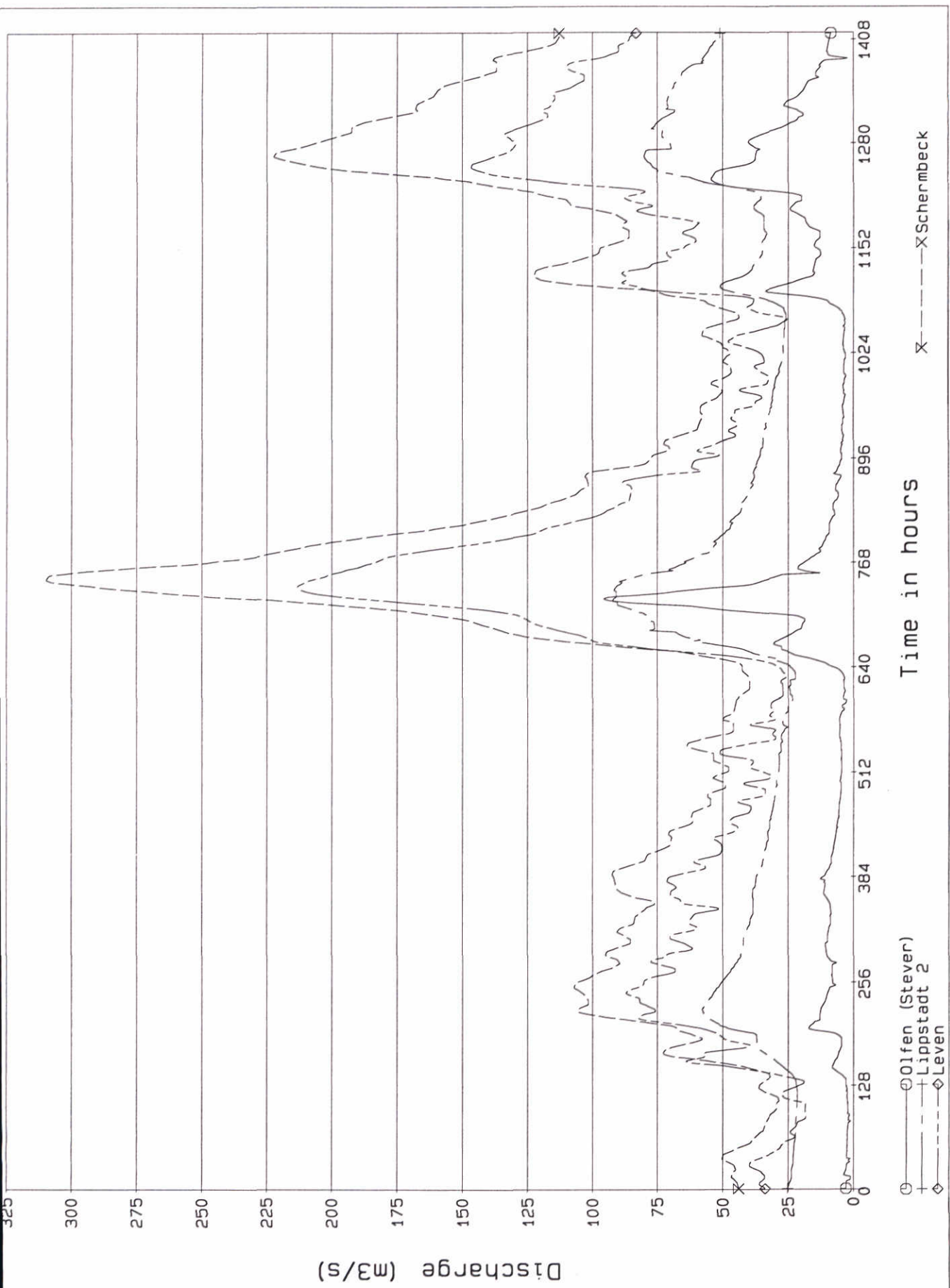
Hydrographs Lippe river and tributary

Period 8: 1/12/1986 - 31/1/1987

DELFT HYDRAULICS

R3049

FIG. 4.2.8



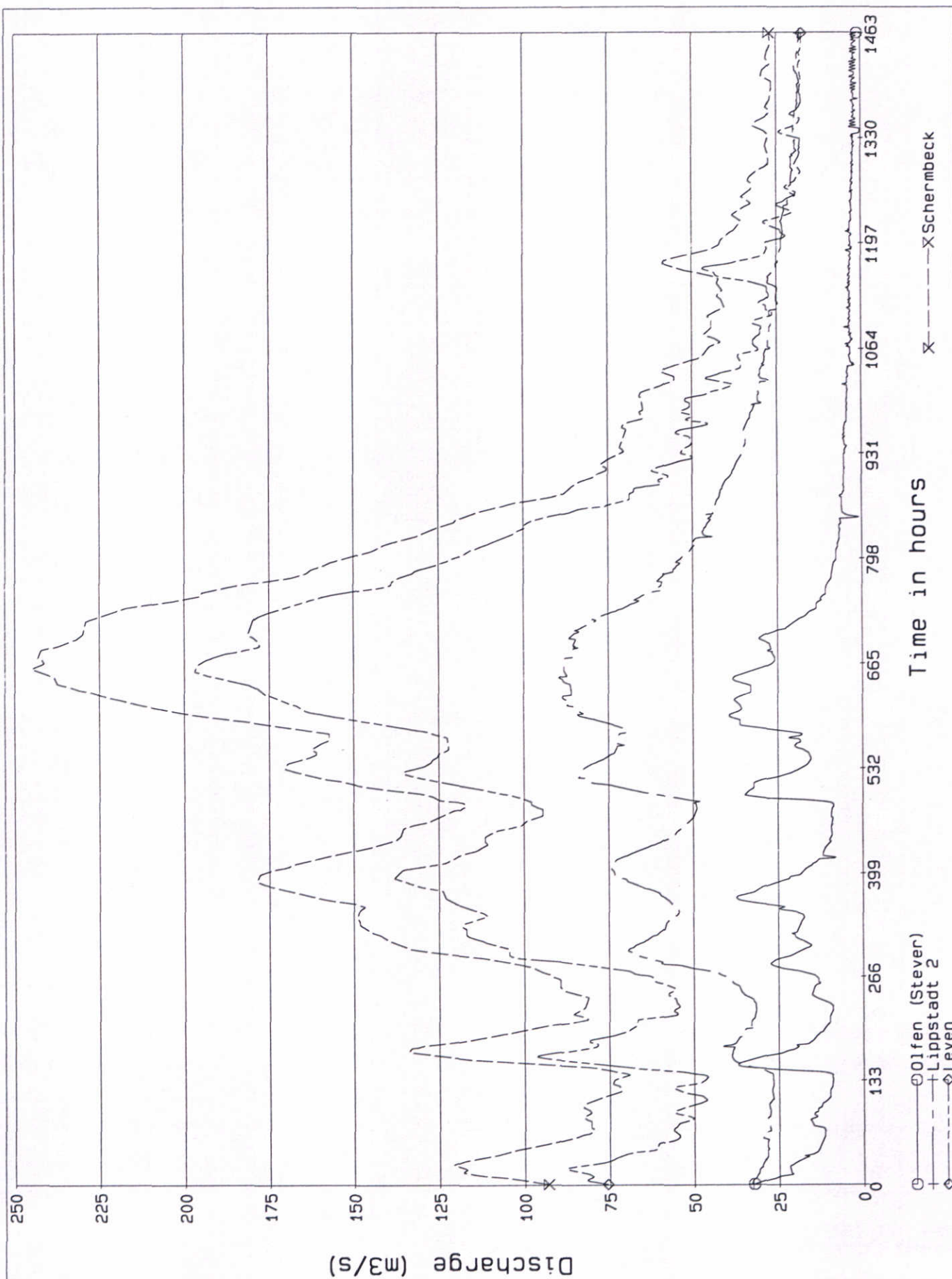
Hydrographs Lippe river and tributary

Period 9: 1/2/1987 - 31/3/1987

DELFT HYDRAULICS

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FIG. 4.2.9



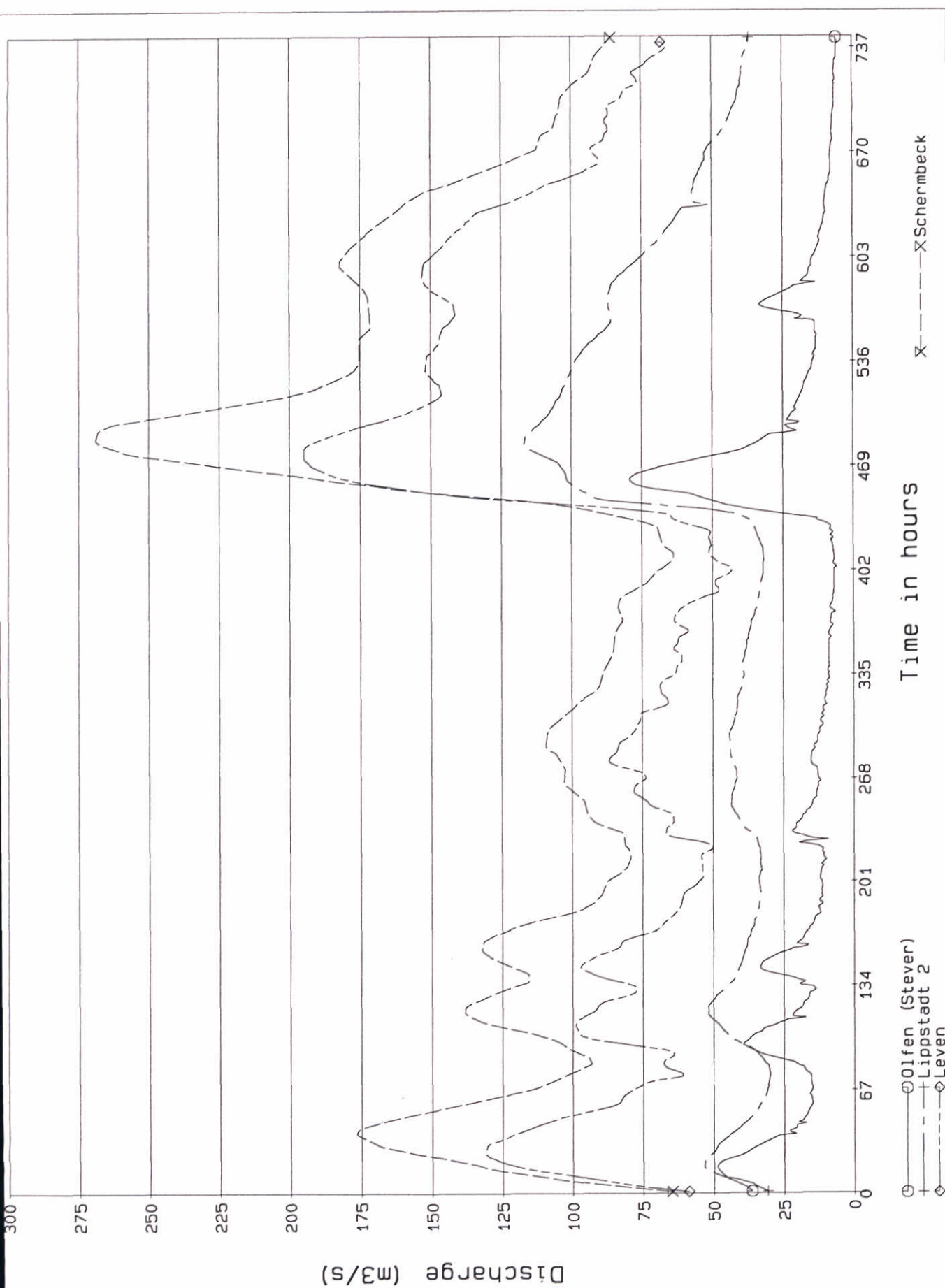
Hydrographs Lippe river and tributary

Period 10: 1/3/1988 - 30/4/1988

DELFT HYDRAULICS

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FIG. 4.2.10



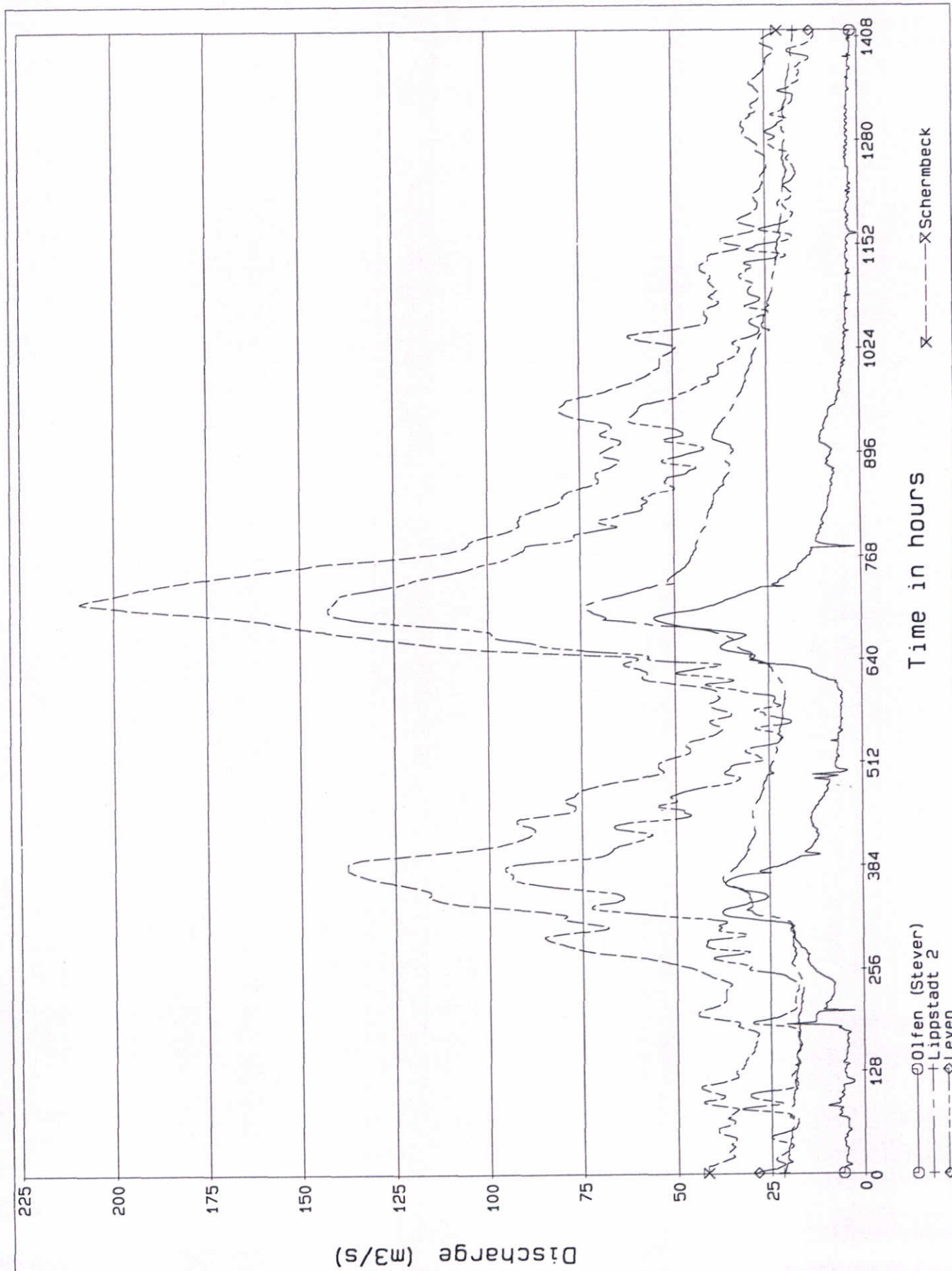
Hydrographs Lippe river and tributary

Period 11: 1/12/1988 - 31/12/1988

DELFT HYDRAULICS

R3049

FIG. 4.2.11



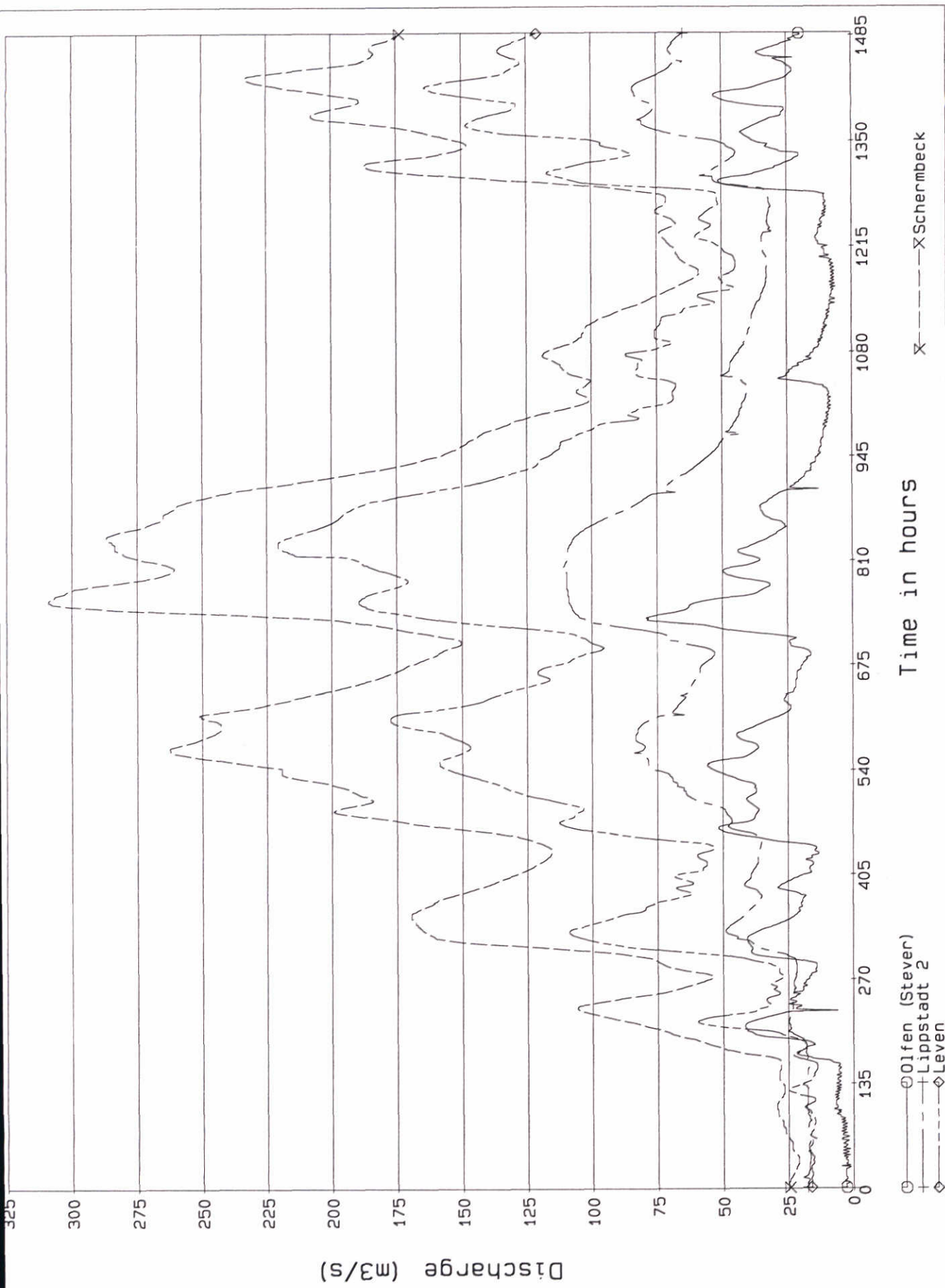
Hydrographs Lippe river and tributary

Period 12: 1/2/1990 - 31/3/1990

DELFT HYDRAULICS

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FIG. 4.2.12



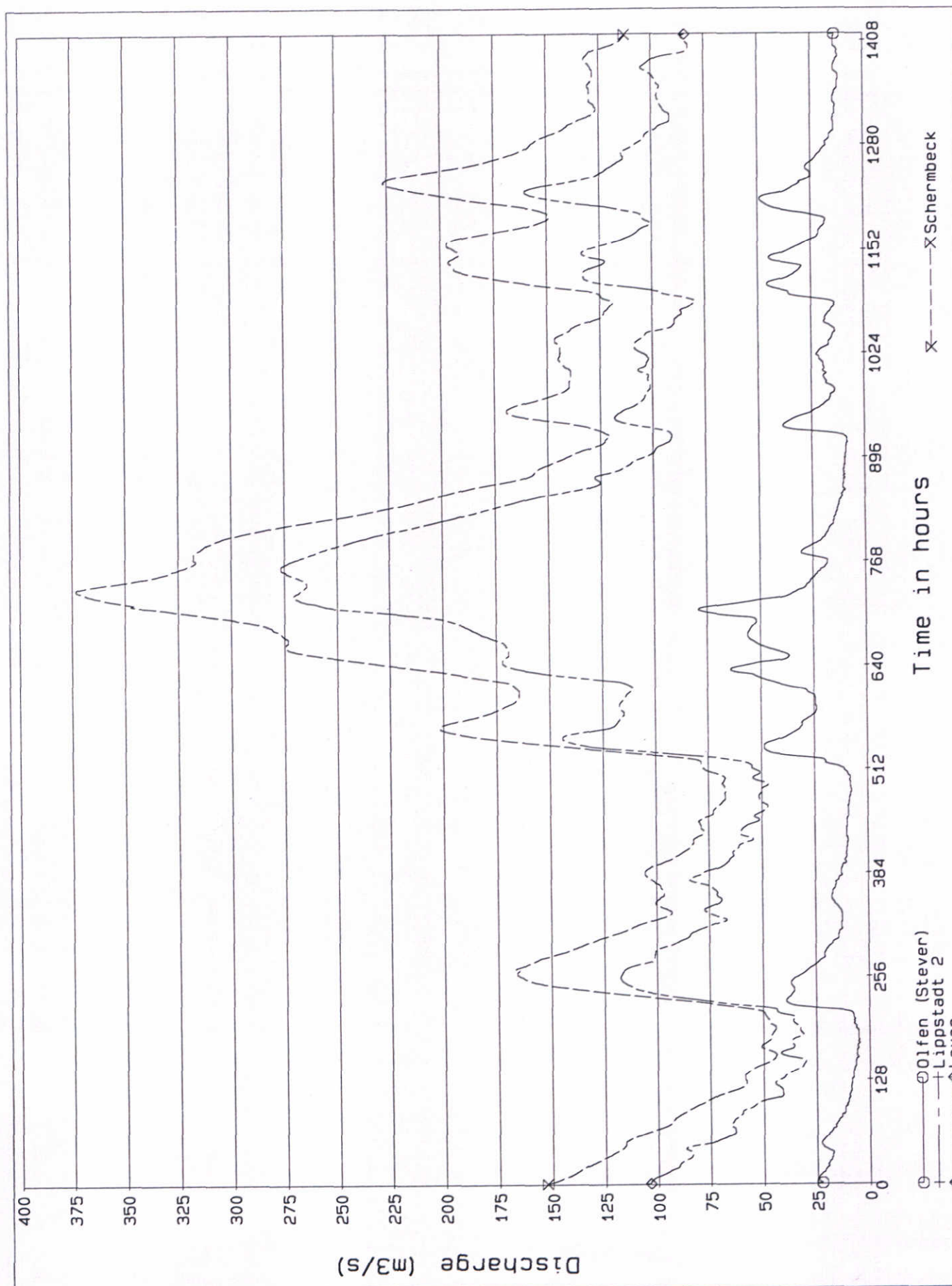
Hydrographs Lippe river and tributary

Period 13: 1/12/1993 - 31/1/1994

DELFT HYDRAULICS

R3049

FIG. 4.2.13



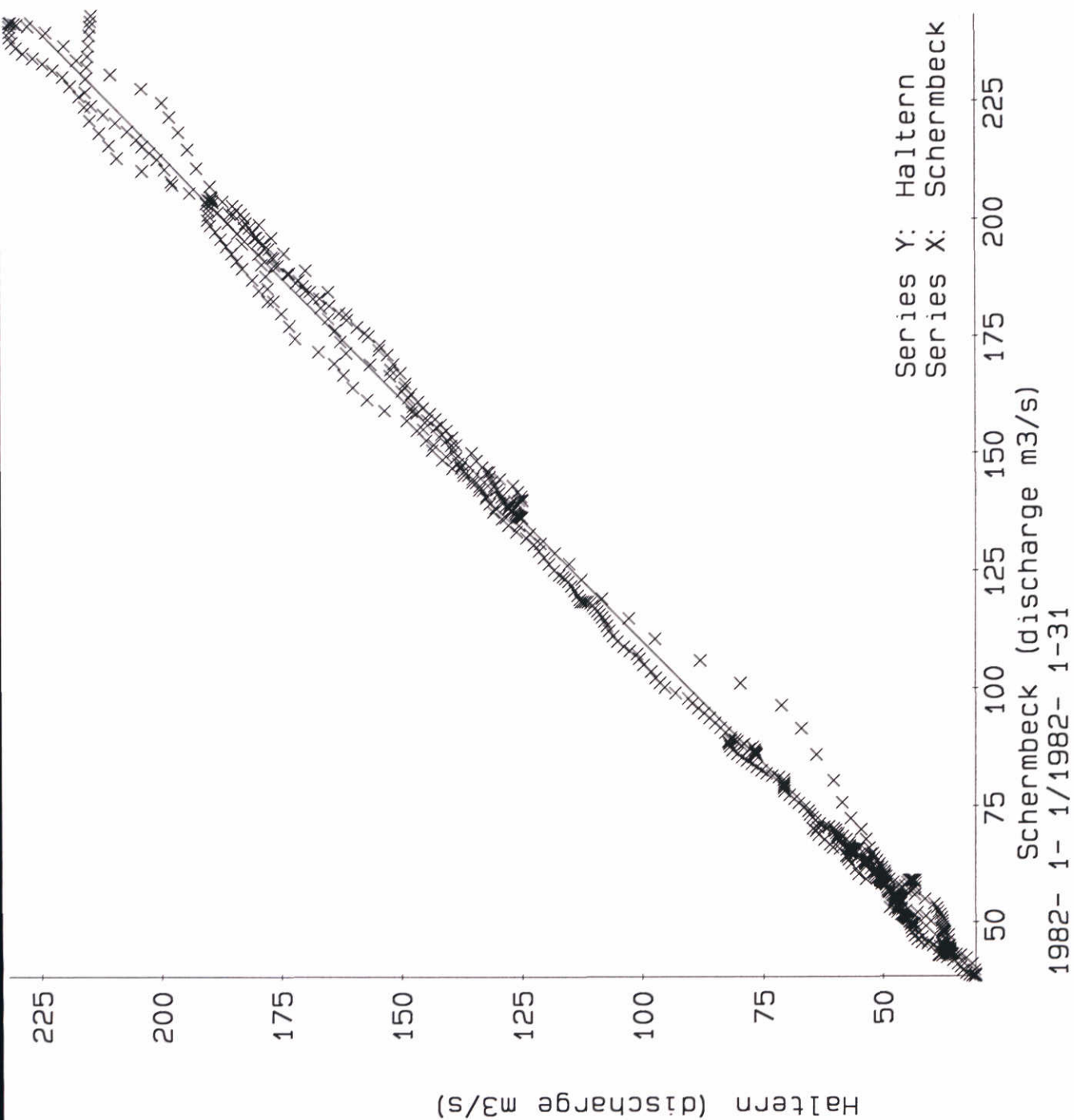
Hydrographs Lippe river and tributary

Period 14: 1/1/1995 - 28/2/1995

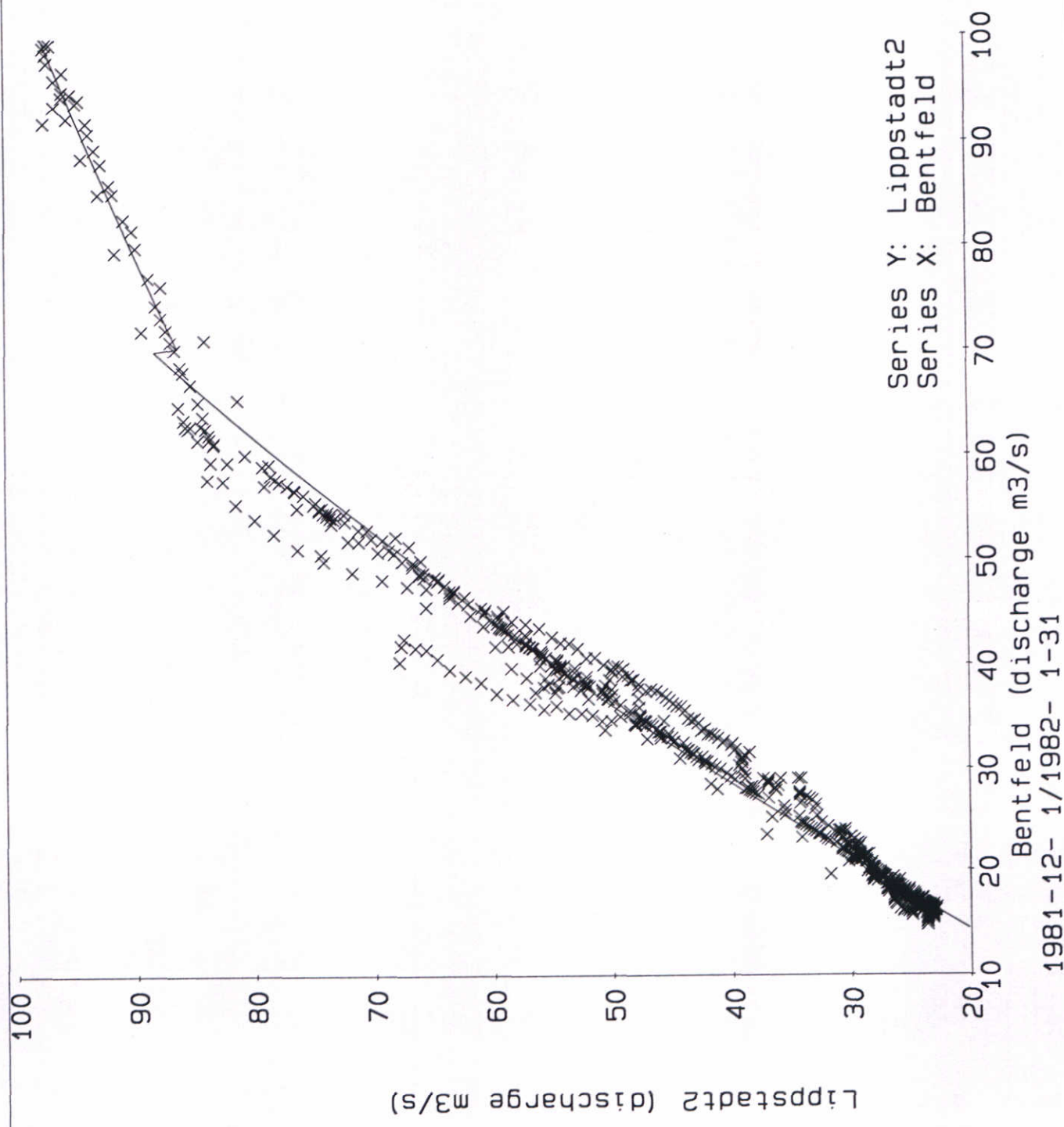
DELFT HYDRAULICS

R3049

FIG. 4.2.14



Relation curve Haltern - Schermbeck
Period 2: 1/1/1982 - 31/1/1982



Relation curve Lippstadt2 - Bentfeld
Period 2: 1/12/1981 - 31/1/1982

Figures of Chapter 5

- Fig. 5.1. Sieg, division into subbasins.
- Fig. 5.2. Lippe, division into subbasins.

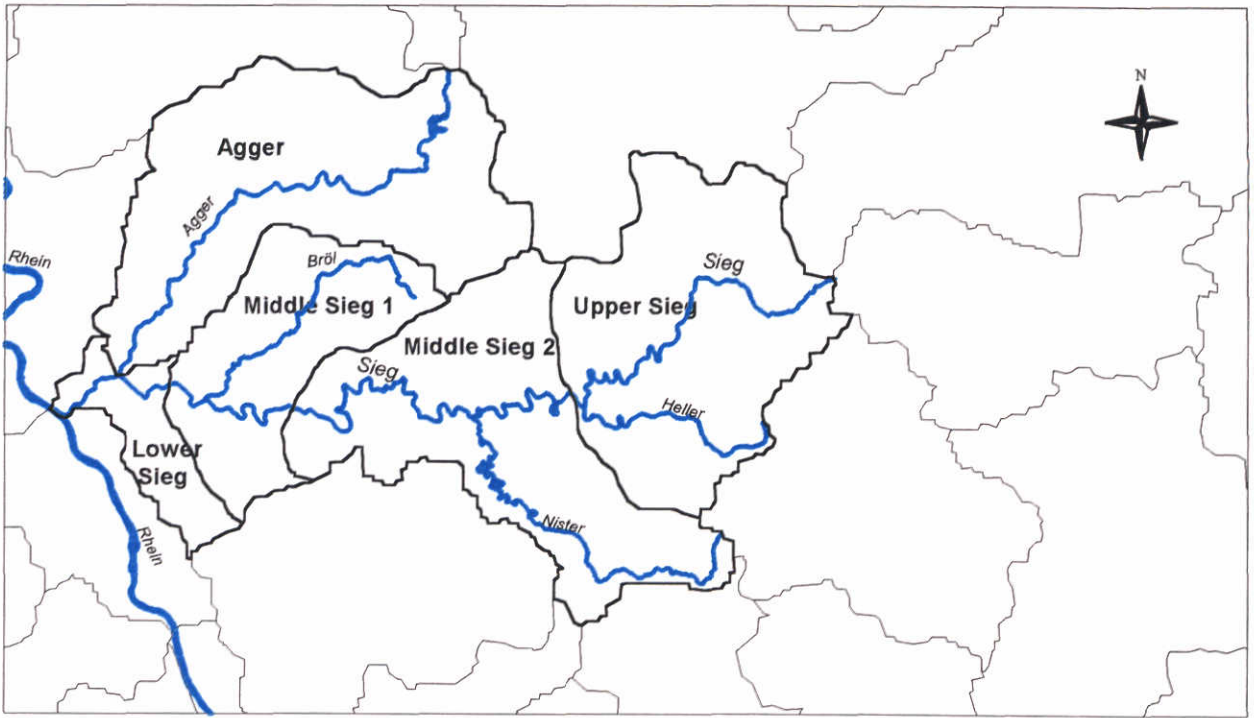


Fig 5.1 Sieg basin, division into subbasins

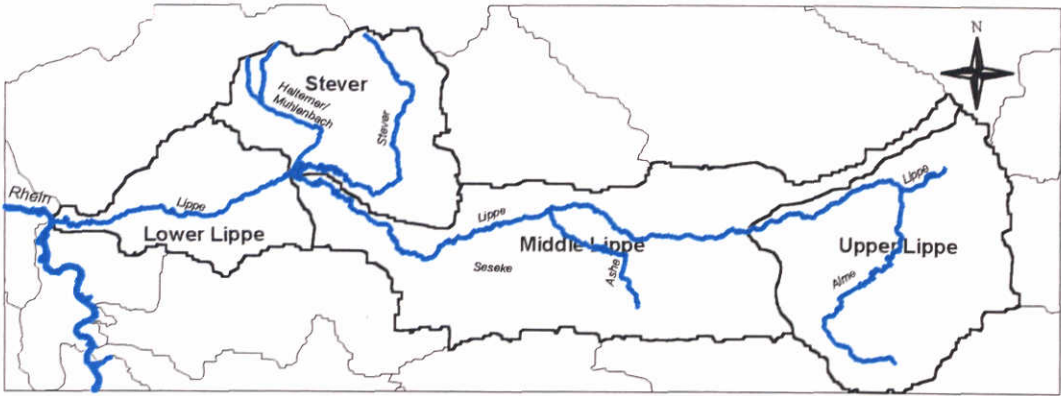


Fig 5.2 Lippe basin, division into subbasins

Legend:
Sieg: river Sieg
 Lower Sieg: Lower Sieg basin

Figures of Chapter 6

- Fig. 6.1a. Thiessen polygons for the areal rainfall in the Total Sieg Basin (Period no. 7 -11).
- Fig. 6.1b. Thiessen polygons for the areal rainfall in the Total Sieg Basin (Period no. 13).
- Fig. 6.2. Residual series of daily-averaged temperatures in Lower and Upper Sieg subbasins for the period 1980 -1995.
- Fig. 6.3. Residual series of daily-averaged temperatures in Lower and Upper Lippe subbasins for the period 1980 -1995.

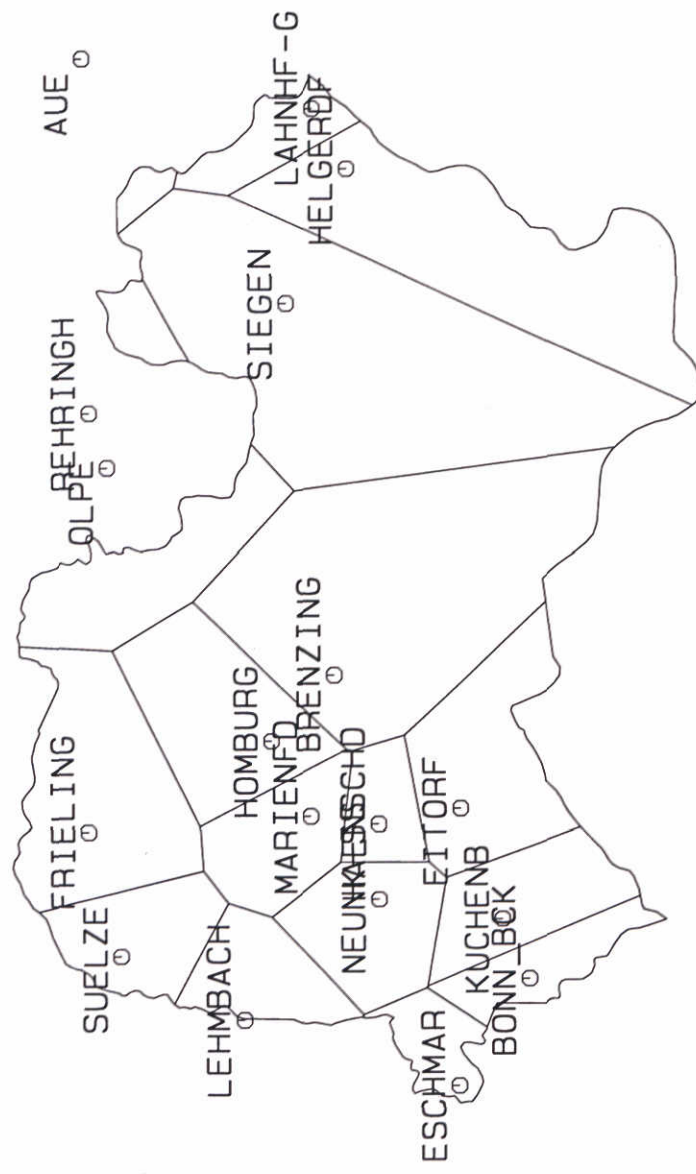
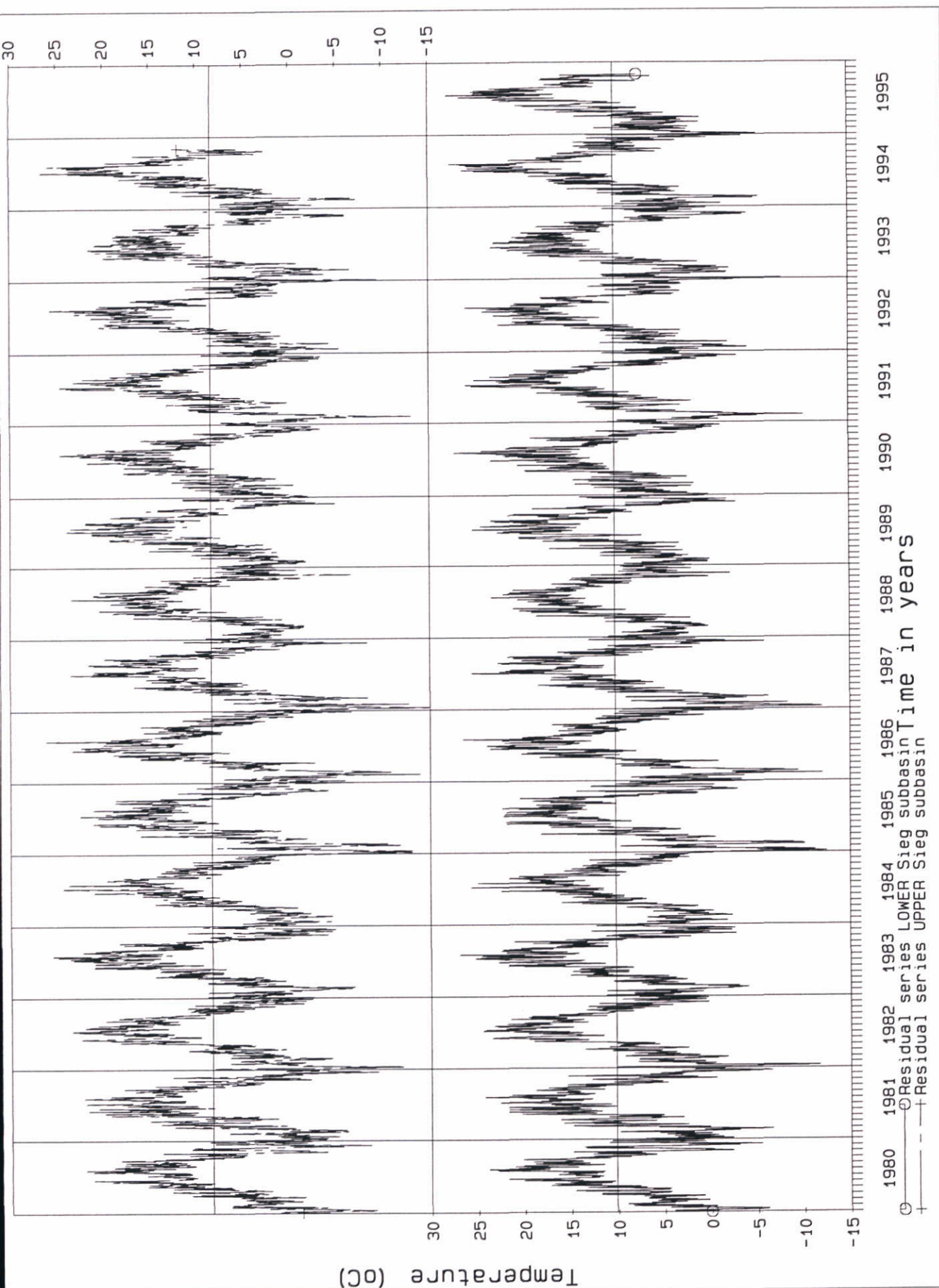


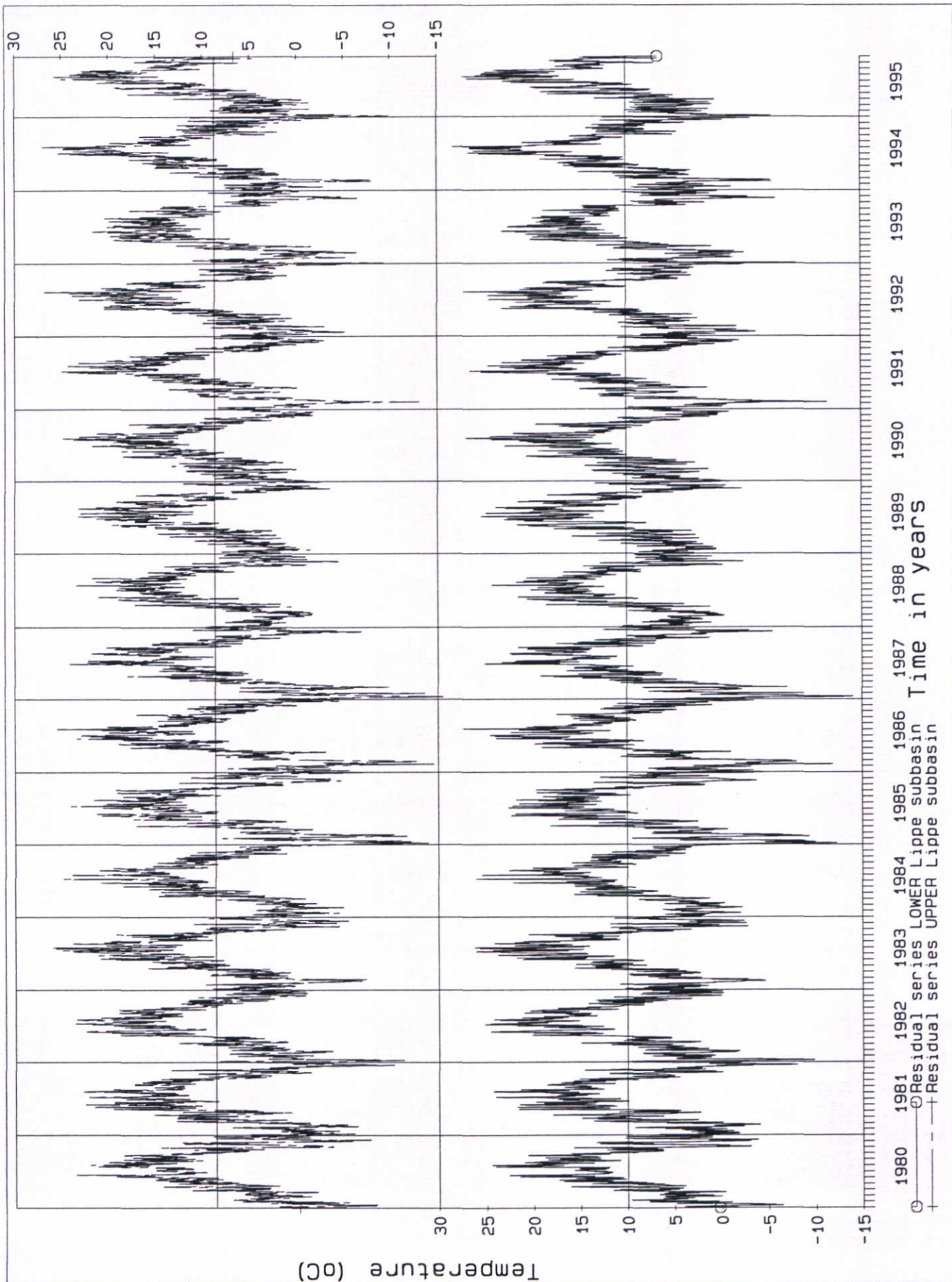
fig. 6.1a Thiessen polygons for the areal rainfall in the total Sieg basin (Period 7 - 11)



Fig. 6.1b Thiessen polygons for the areal rainfall in the total Sieg basin (Period 13)



Residual series average daily temp.
Lower and Upper Sieg subbasins
Period 1980 - 1995



Residual series average daily temp.
Lower and Upper Lippe basins
Period 1980 - 1995

Figures of Chapter 7

- Fig. 7.1.1. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Total Sieg basin.
- Fig. 7.1.2. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Agger basin.
- Fig. 7.1.3. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Lower Sieg basin.
- Fig. 7.1.4. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Middle Sieg basin.
- Fig. 7.1.5. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Upper Sieg basin.
- Fig. 7.1.6. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Middle/Upper Sieg basin.
- Fig. 7.2.1. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Total Lippe basin.
- Fig. 7.2.2. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Lower Lippe basin.
- Fig. 7.2.3. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Stever basin.
- Fig. 7.2.4. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Middle Lippe basin.
- Fig. 7.2.5. Multiple regression between DWD KL-climatic rainfall series and LUA-NRW areal rainfall series for the Upper basin.

———— Multiple regression

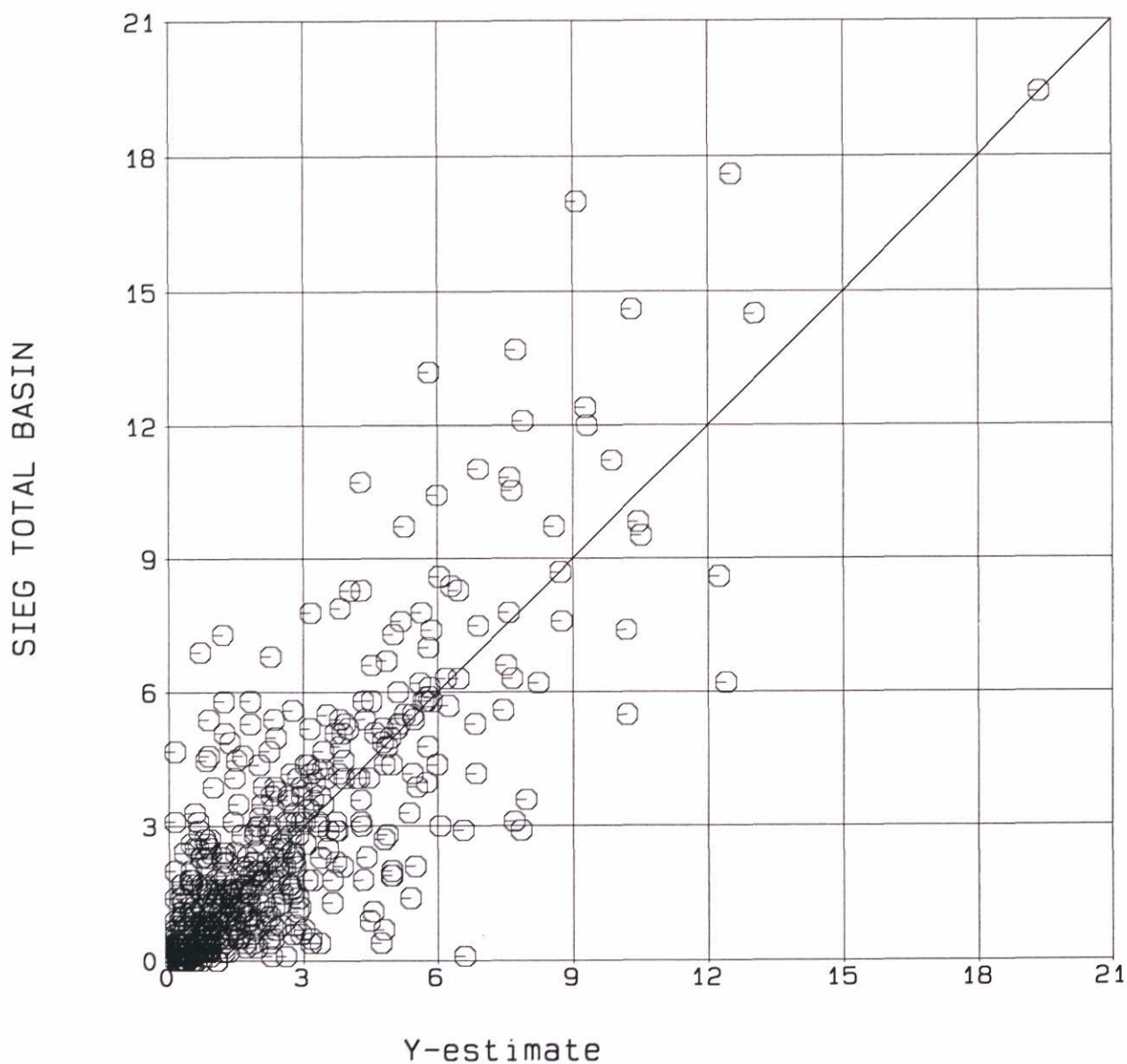
Regression coefficients :

Bad-Marienberg .51260E+00

Koln-Wahn .35007E+00

Intercept = .13379E+00

See = .11072E+01



Multiple regression climatic stations
and Sieg total basin areal rainfall

Multiple regression

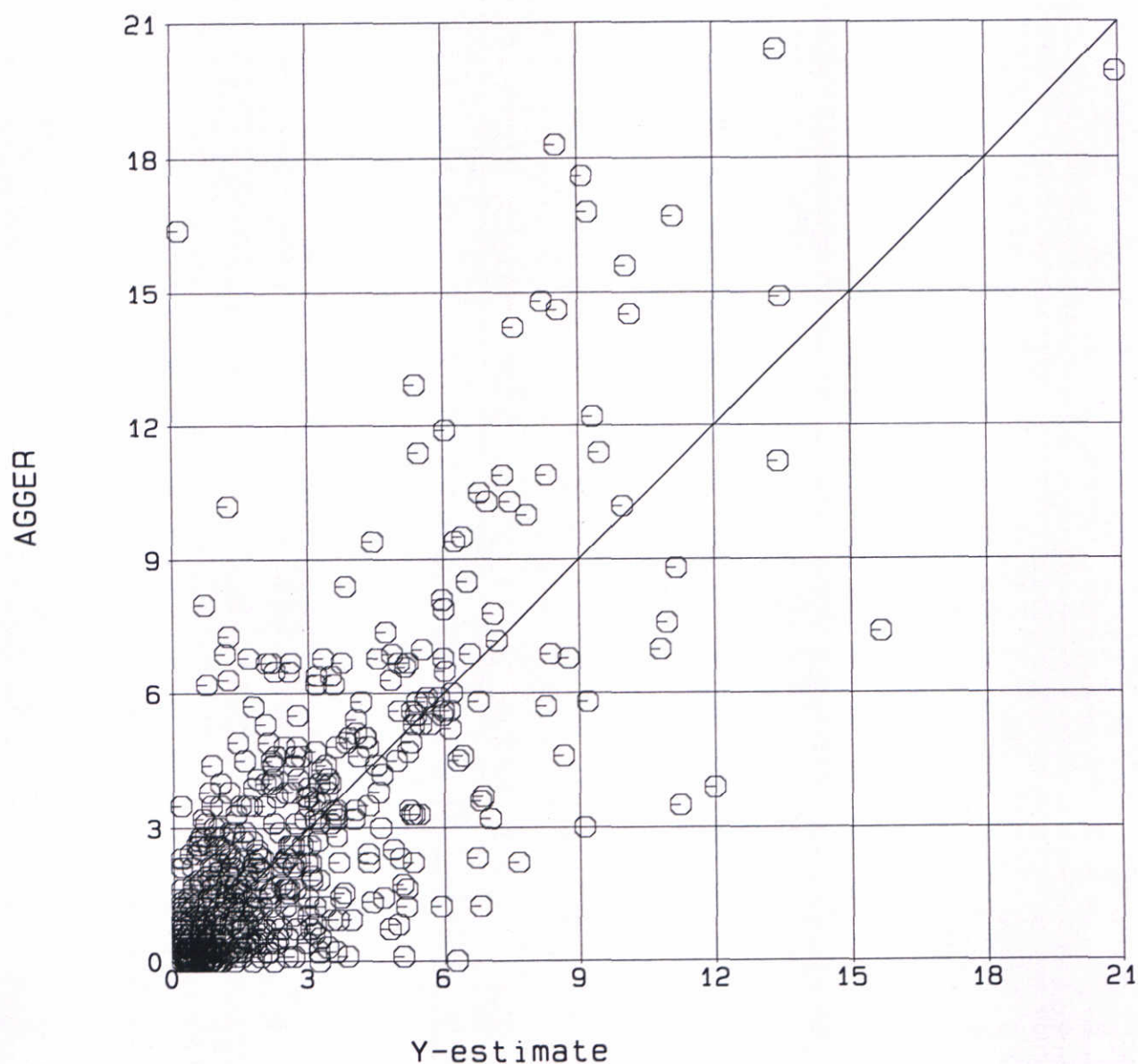
Regression coefficients :

Bad-Marienberg .48287E+00

Koln-Wahn .49190E+00

Intercept = .17187E+00

See = .14974E+01



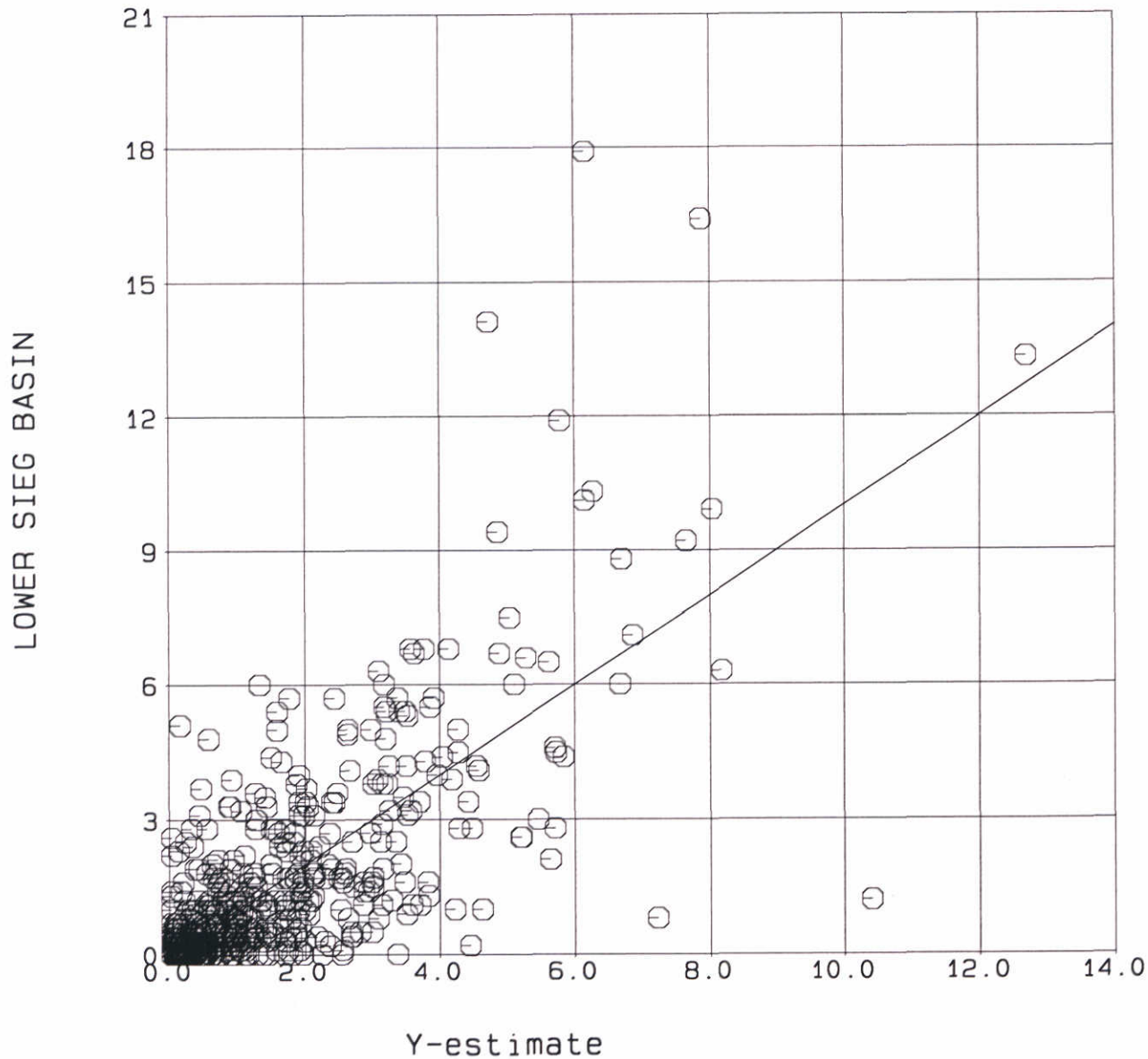
Multiple regression climatic stations
and Agger basin areal rainfall

Multiple regression

Regression coefficients :

Bad-Marienberg .26491E+00
Koln-Wahn .34761E+00
Intercept = .34871E-01

See = .10202E+01



Multiple regression

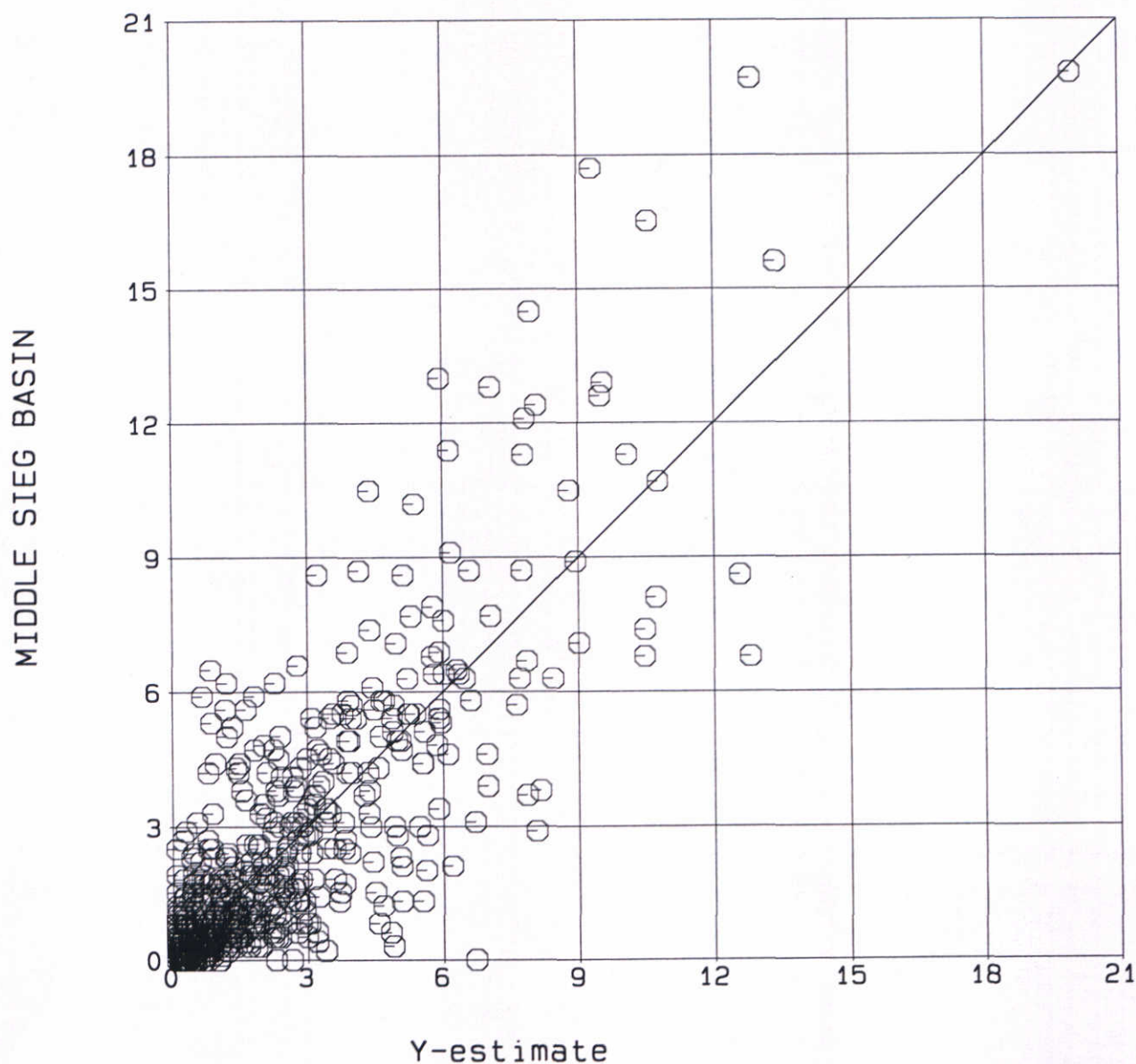
Regression coefficients :

Bad-Marienberg .52631E+00

Koln-Wahn .36434E+00

Intercept = .83867E-01

See = .11614E+01



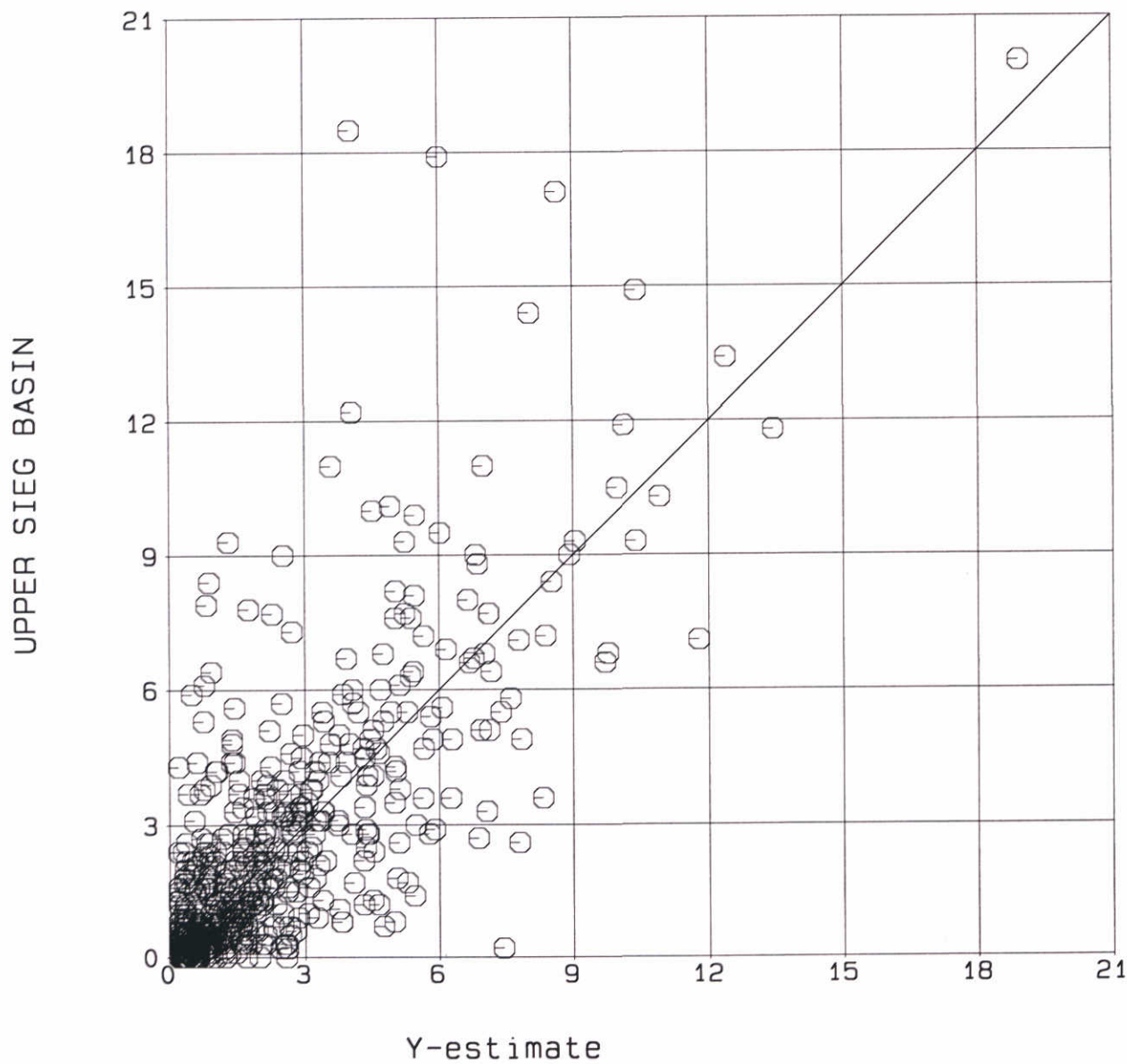
Multiple regression climatic stations
and Middle Sieg basin areal rainfall

———— Multiple regression

Regression coefficients :

Bad-Marienberg .57413E+00
Koln-Wahn .21732E+00
Intercept = .20014E+00

See = .13206E+01



———— Multiple regression

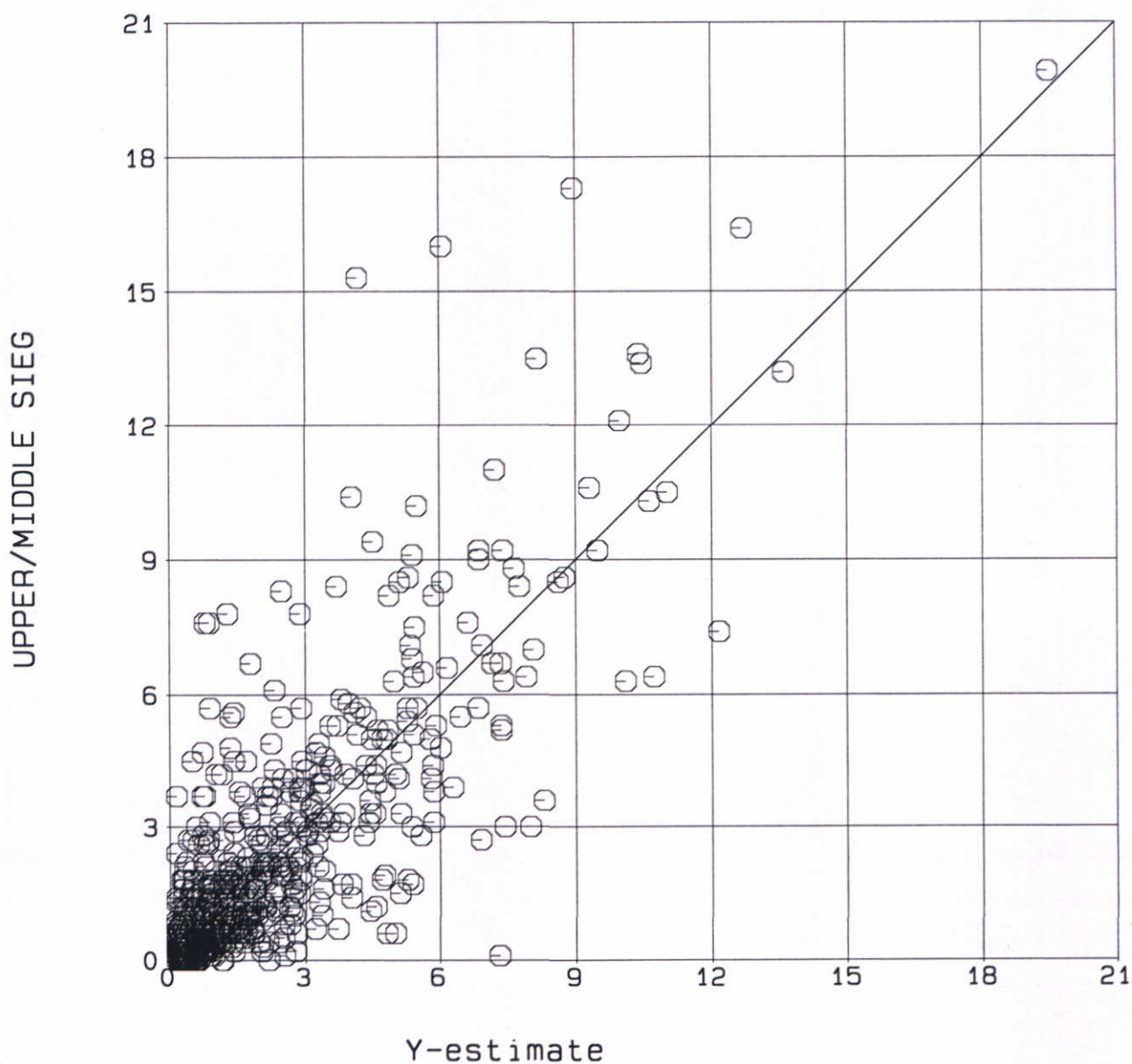
Regression coefficients :

Bad-Marienberg .56900E+00

Koln-Wahn .26280E+00

Intercept = .14829E+00

See = .11840E+01



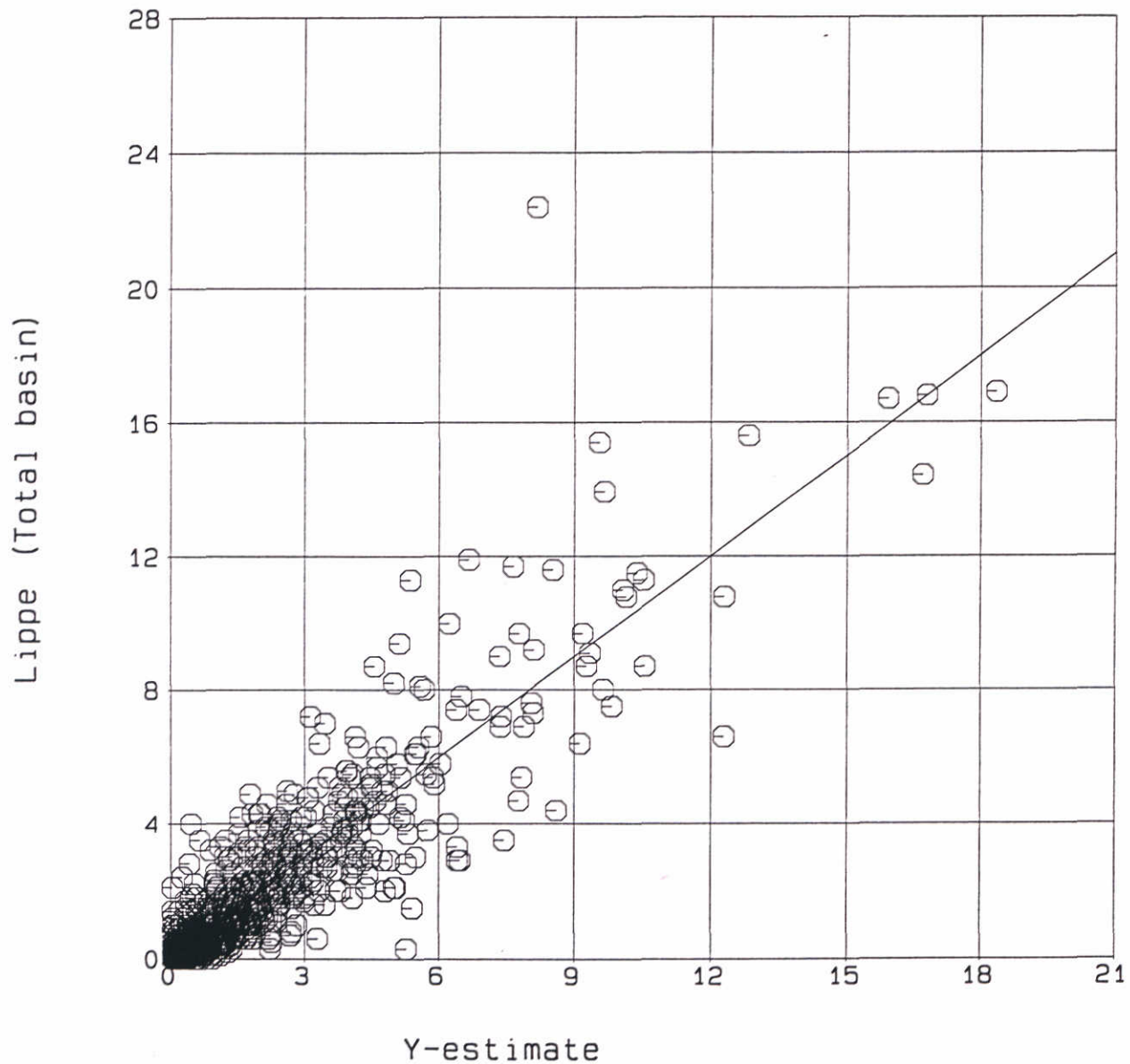
Multiple regression climatic stations
and Middle/Upper Sieg areal rainfall

Stepwise Regression

Regression coefficients :

Bad-Lippspring	.98834 E-01	Guetersloh	.19528 E+00
Bad-Salzuflen	.60974 E-01	Kahler-Ast	.83619 E -01
Bochalt-L	.96106 E-01	Munster	.22062 E+00
Dusseldorf	.65602 E-01		
Essen	.53779 E-01	Intercept	.34237 E-01

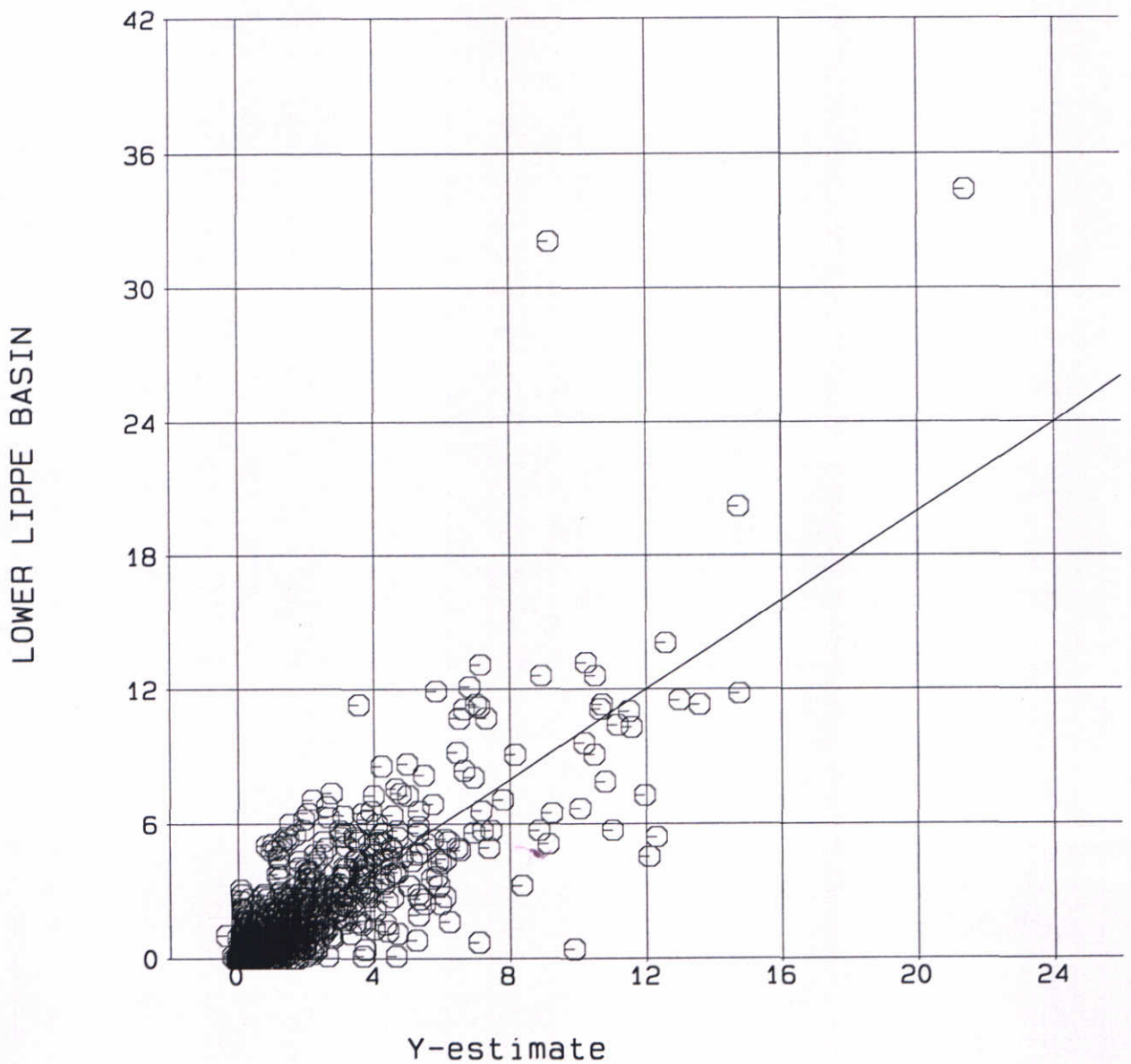
See = .77368E+00



Stepwise Regression

Regression coefficients :

Bad-Salzuflen	.70686 E-01	Munster	.32905 E+00
Bocholt-L	.20786 E+00		
Dusseldorf	.12664 E+00	Intercept	.92065 E+01
Essen	.26698 E-00		
Luedenschd	-.57245 E-01		



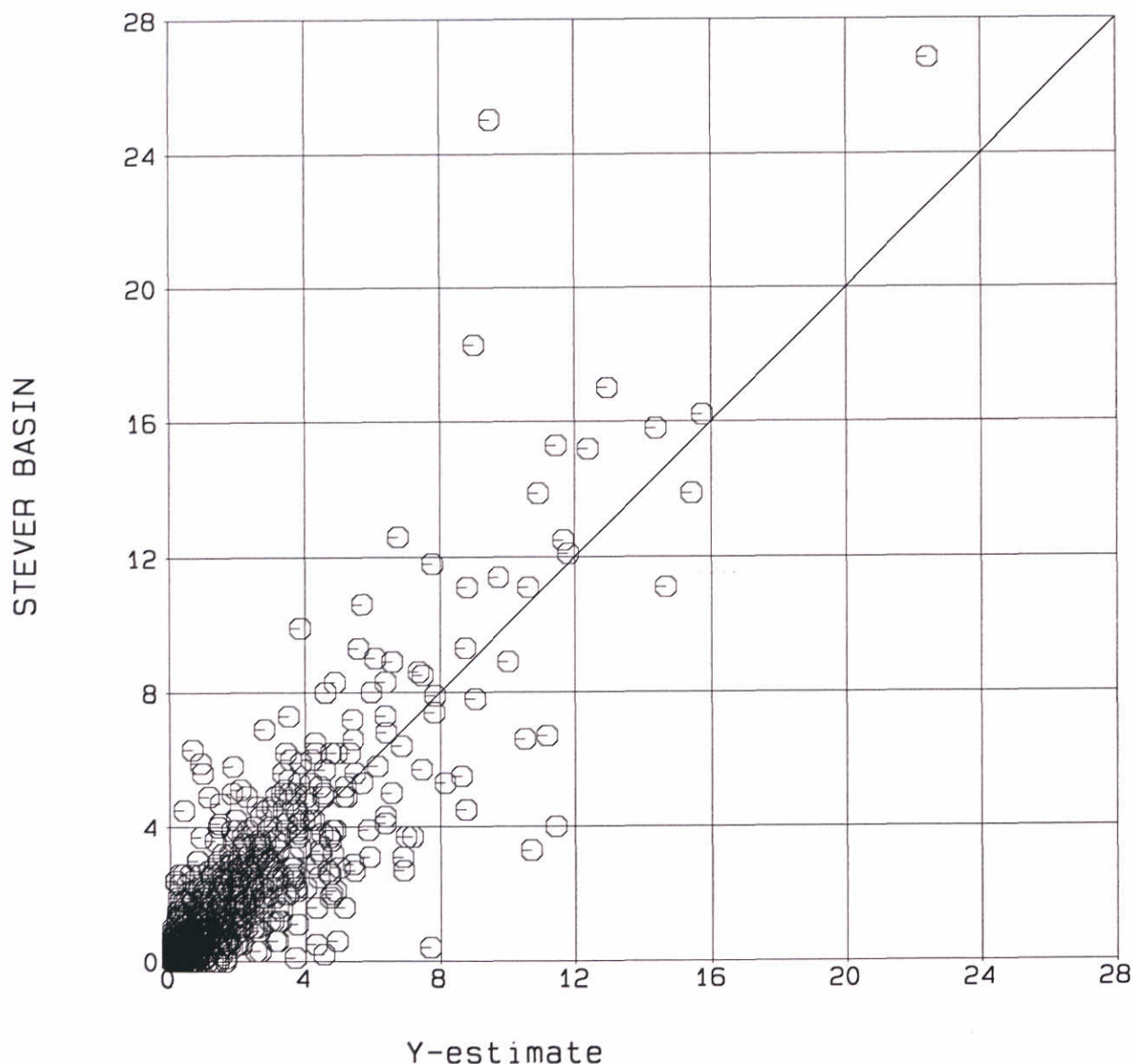
Multiple (step-wise) regression
Climatic stations and Lower Lippe
areal rainfall

— Stepwise Regression

Regression coefficients :

Bocholt-L	.19070 E+00	Intercept	.52002 E-01
Dusseldorf	.66233 E-01		
Guetersloh	.90475 E-01		
Kahler-Ast	.31855 E-01		
Munster	.53647 E+00		

See = .93539E+00

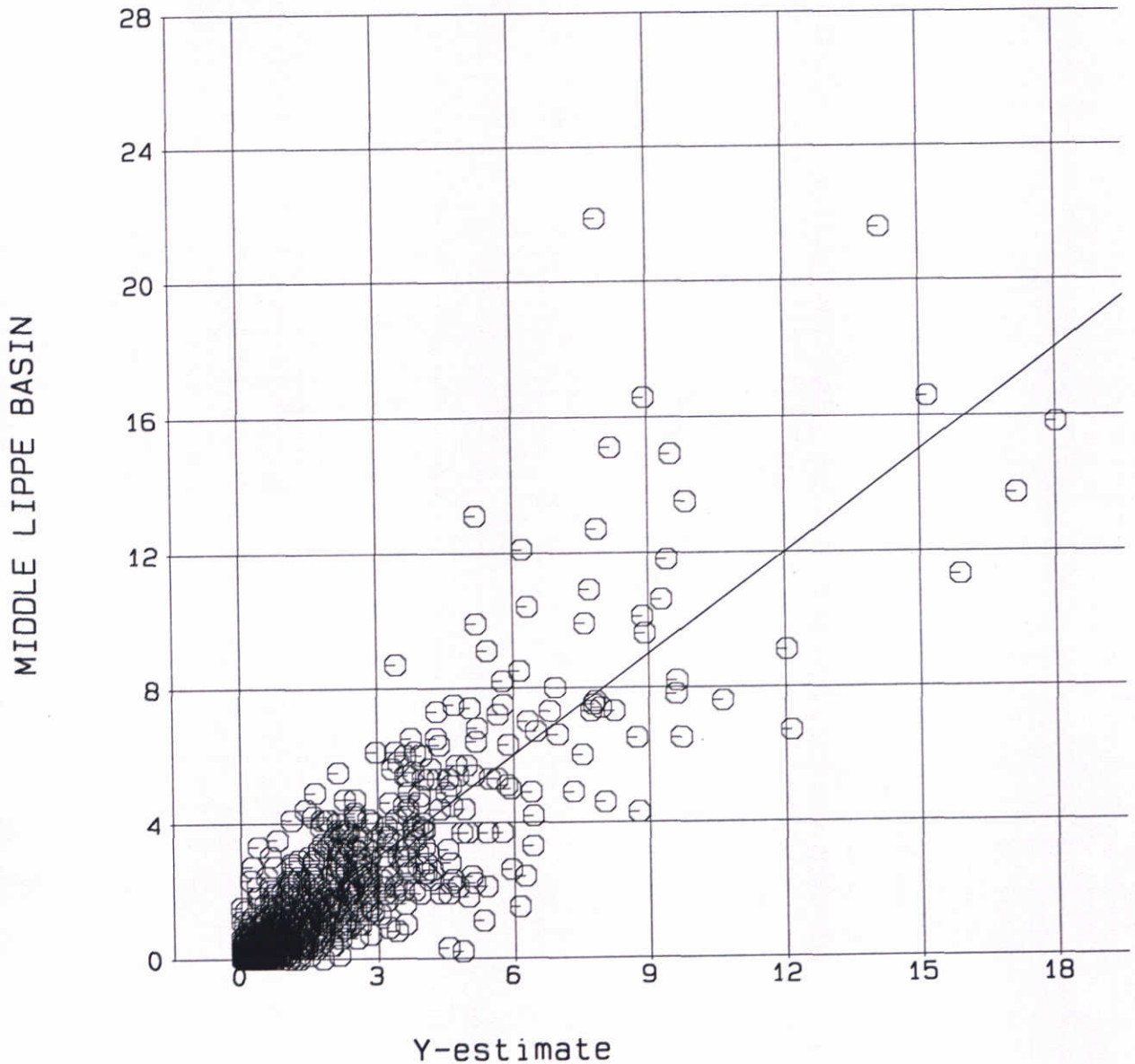


Multiple (step-wise) regression
Climatic stations and Stever basin
areal rainfall

Stepwise Regression

Regression coefficients :

Bad-Lippsp	.69888 E-01	Kahler-Ast	.56194 E-01
Bad-Salzuf	.69974 E-01	Luedenschd	.78421 E-01
Bocholt-L	.64599 E-01	Munster	.19385 E+00
Essen	.79887 E-01		
Guetersloh	.23258 E+00	Intercept	-.85884 E-03
See	=	.89248E+00	



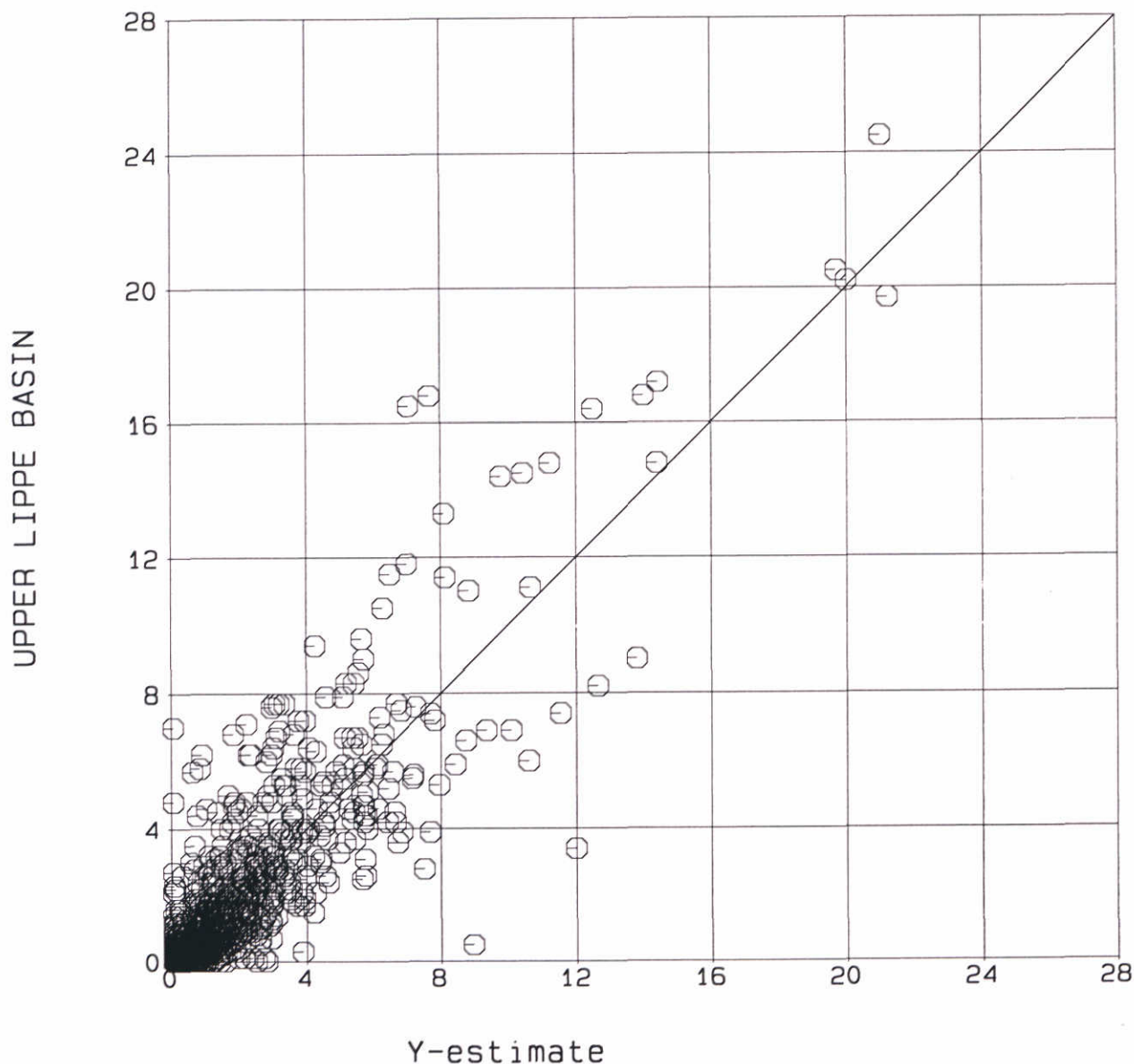
Multiple (step-wise) regression
Climatic stations and Middle Lippe
areal rainfall

———— Stepwise Regression

Regression coefficients :

Bad-Lippspring .39157E+00
Dusseldorf (F1) .59493E-01
Guetersloh .22964E+00
Kahler-Asten .13866E+00
Intercept = .52995E-01

See = .98363E+00



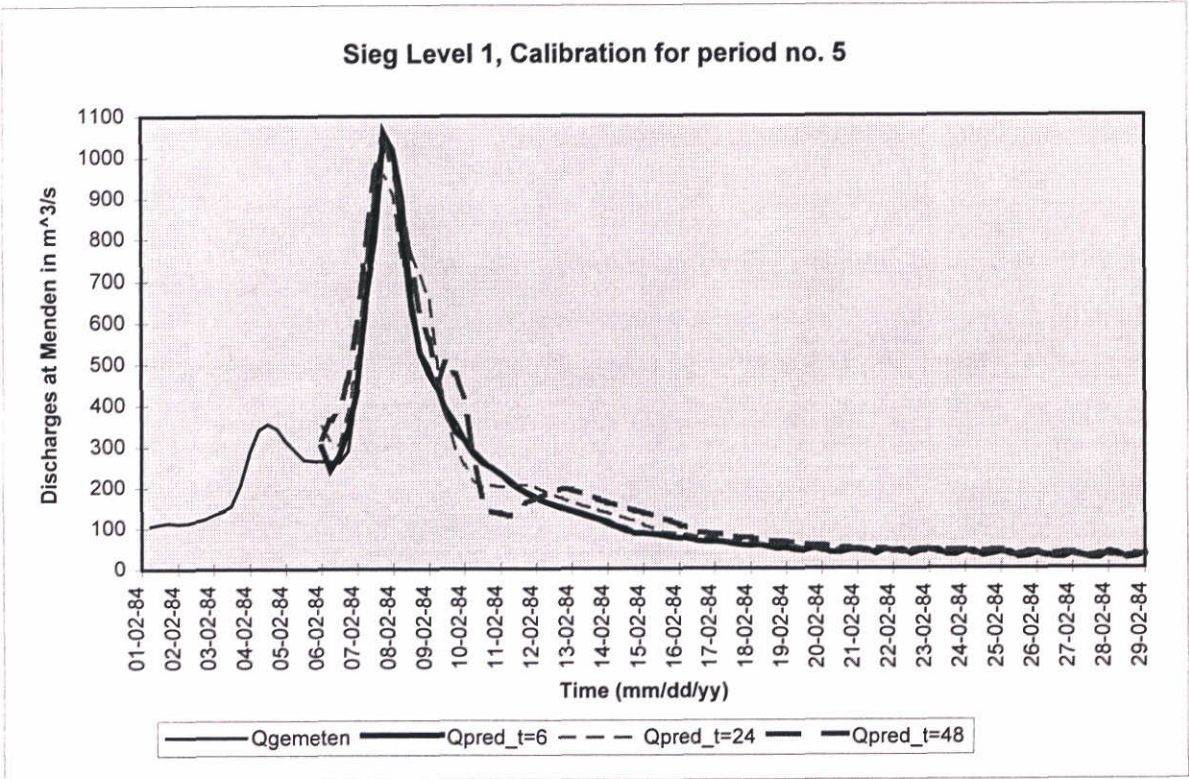
Multiple (step-wise) regression
Climatic stations and Upper Lippe
areal rainfall

Figures of Chapter 9

- Fig. 9.1. Sieg, Calibration for Period no.5.
- Fig. 9.2. Sieg, Validation for Period no.7.
- Fig. 9.3. Sieg, Validation for Period no.8.
- Fig. 9.4. Sieg, Validation for Period no.12 ($f_{\min}=0.30$).
- Fig. 9.5. Sieg, Validation for Period no.12 ($f_{\min}=0.40$).
- Fig. 9.6. Total Sieg at Menden, Sieg Level 2, Calibration for Period no. 5.
- Fig. 9.7. Total Sieg at Menden, Sieg Level 2, Validation for Period no. 7.
- Fig. 9.8. Total Sieg at Menden, Sieg Level 2, Validation for Period no. 8.
- Fig. 9.9. Total Sieg at Menden, Sieg Level 2, Validation for Period no. 12 ($f_{\min}=0.40$ for Middle/Upper Sieg).
- Fig. 9.10. Total Sieg at Menden, Sieg Level 2, Validation for Period no. 12 ($f_{\min}=0.70$ for Middle/Upper Sieg).
- Fig. 9.11. Agger at Lohmar, Sieg Level 2, Calibration for Period no. 5.
- Fig. 9.12. Agger at Lohmar, Sieg Level 2, Validation for Period no. 7.
- Fig. 9.13. Agger at Lohmar, Sieg Level 2, Validation for Period no. 8.
- Fig. 9.14. Agger at Lohmar, Sieg Level 2, Validation for Period no. 12.
- Fig. 9.15. Sieg at Siegburg, Sieg Level 2, Calibration for Period no. 5.
- Fig. 9.16. Sieg at Siegburg, Sieg Level 2, Validation for Period no. 7.
- Fig. 9.17. Sieg at Siegburg, Sieg Level 2, Validation for Period no. 8.
- Fig. 9.18. Sieg at Siegburg, Sieg Level 2, Validation for Period no. 12 ($f_{\min}=0.40$ for Middle/Upper Sieg).
- Fig. 9.19. Sieg at Siegburg, Sieg Level 2, Validation for Period no. 12 ($f_{\min}=0.70$ for Middle/Upper Sieg).
- Fig. 9.20. Lippe at Schermbeck, Lippe Level 1, Validation for Period no. 7.
- Fig. 9.21. Lippe at Schermbeck, Lippe Level 1, Validation for Period no. 8 ($f_{\min}=0.20$).
- Fig. 9.22. Lippe at Schermbeck, Lippe Level 1, Validation for Period no. 8 ($f_{\min}=0.40$).
- Fig. 9.23. Lippe at Schermbeck, Lippe Level 1, Calibration for Period no. 9.
- Fig. 9.24. Lippe at Schermbeck, Lippe Level 1, Validation for Period no. 10.
- Fig. 9.25. Lippe at Schermbeck, Lippe Level 3, Validation for Period no. 7.
- Fig. 9.26. Lippe at Schermbeck, Lippe Level 3, Validation for Period no. 7 ($f_{\min}=0.14$ for Stever basin and $f_{\min}=0.25$ for Middle Lippe basin).
- Fig. 9.27. Lippe at Schermbeck, Lippe Level 3, Validation for Period no. 8.
- Fig. 9.28. Lippe at Schermbeck, Lippe Level 3, Calibration for Period no. 9.
- Fig. 9.29. Lippe at Schermbeck, Lippe Level 3, Validation for Period no. 10.
- Fig. 9.30. Lippe at Haltern, Lippe Level 3, Validation for Period no. 7.
- Fig. 9.31. Lippe at Haltern, Lippe Level 3, Validation for Period no. 7 ($f_{\min}=0.14$ for Stever basin and $f_{\min}=0.25$ for Middle Lippe basin).
- Fig. 9.32. Lippe at Haltern, Lippe Level 3, Validation for Period no. 8.
- Fig. 9.33. Lippe at Haltern, Lippe Level 3, Calibration for Period no. 9.
- Fig. 9.34. Lippe at Haltern, Lippe Level 3, Validation for Period no. 10.
- Fig. 9.35. Lippe at Leven, Lippe Level 3, Validation for Period no. 7.
- Fig. 9.36. Lippe at Leven, Lippe Level 3, Validation for Period no. 7 ($f_{\min}=0.25$ for Middle Lippe basin) .
- Fig. 9.37. Lippe at Leven, Lippe Level 3, Validation for Period no. 8.
- Fig. 9.38. Lippe at Leven, Lippe Level 3, Calibration for Period no. 9.
- Fig. 9.39. Lippe at Leven, Lippe Level 3, Validation for Period no. 10.
- Fig. 9.40. Lippe at Lippstadt2, Lippe Level 3, Validation for Period no. 7.
- Fig. 9.41. Lippe at Lippstadt2, Lippe Level 3, Validation for Period no. 8.
- Fig. 9.42. Lippe at Lippstadt2, Lippe Level 3, Calibration for Period no. 9.
- Fig. 9.43. Lippe at Lippstadt2, Lippe Level 3, Validation for Period no. 10.
- Fig. 9.44. Observed snowheights in the Sieg basin (i.e. Stations Bad-Marienberg, Bonn-Friesdorf and Koln-Wahn).
- Fig. 9.45. Observed snowheights in the Lippe basin (i.e. Station Bad-Lippspringe).

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	7.8%	31.3%	-28.6%
12	13.1%	29.1%	-38.2%
18	14.0%	26.6%	-40.8%
24	13.7%	25.8%	-37.0%
30	18.2%	31.4%	-45.1%
36	22.9%	35.8%	-52.2%
42	24.4%	38.8%	-58.4%
48	25.0%	43.8%	-65.2%



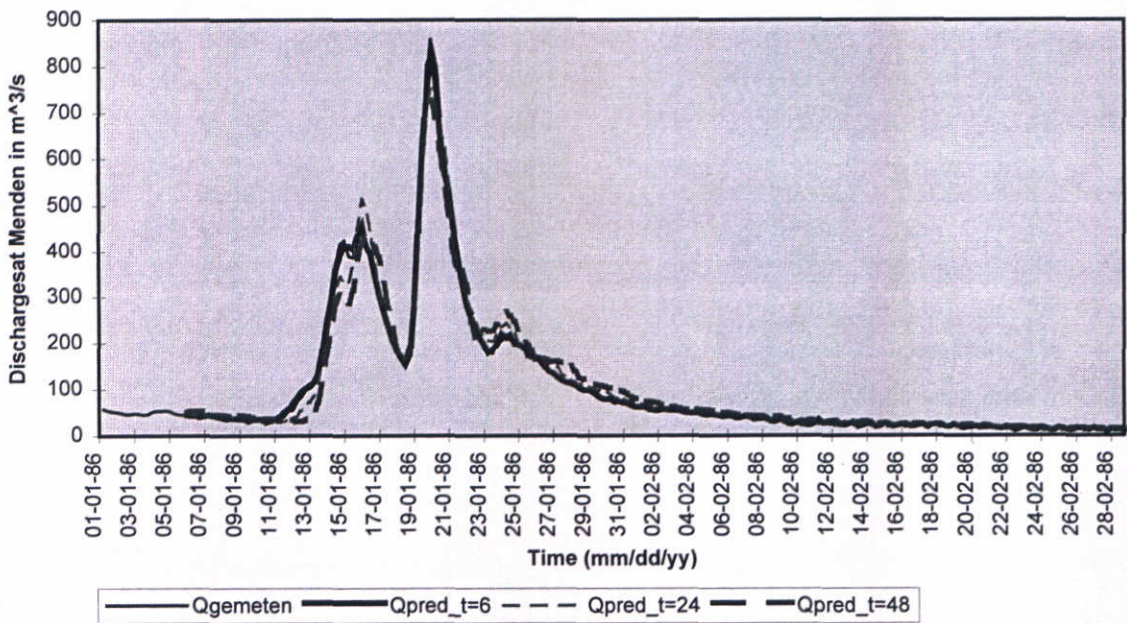
Model parameters			
fmin	0.30	alfa (1,1)	0.29
fmax	5.00	alfa (1,2)	0.14
kb	8.60	alfa (1,3)	0.10
psi	0.93	alfa (1,4)	0.00
kn	10.50	alfa (1,5)	0.00
nn	2.95	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.1. Sieg at Menden, Sieg Level 1, Total Sieg basin, Calibration for Period no. 5

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	6.9%	36.1%	-40.9%
12	10.7%	31.3%	-43.5%
18	11.2%	41.1%	-60.7%
24	10.8%	49.1%	-33.3%
30	14.6%	56.4%	-55.6%
36	17.7%	60.1%	-58.3%
42	18.5%	65.4%	-54.5%
48	18.4%	67.7%	-45.1%

Sieg Level 1, Validation for period no. 7



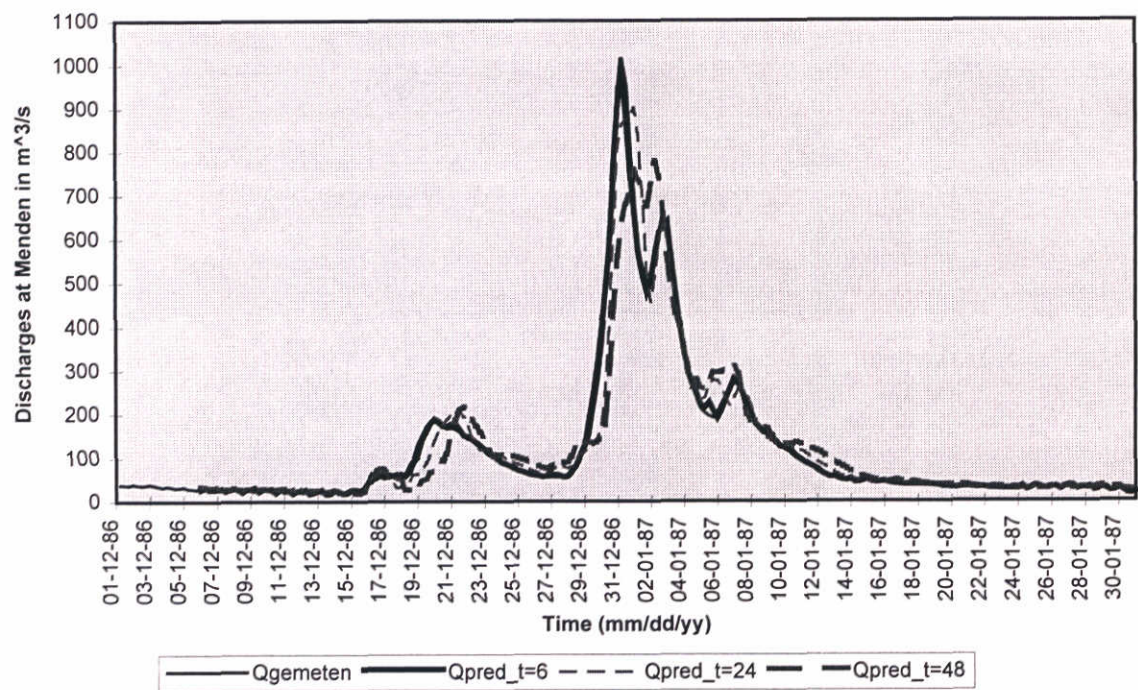
Model parameters			
fmin	0.30	alfa (1,1)	0.29
fmax	5.00	alfa (1,2)	0.14
kb	8.60	alfa (1,3)	0.10
psi	0.93	alfa (1,4)	0.00
kn	10.50	alfa (1,5)	0.00
nn	2.95	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.2. Sieg at Menden, Sieg Level 1, Total Sieg basin, Validation for Period no. 7

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	7.0%	24.5%	-40.3%
12	11.6%	39.4%	-61.9%
18	13.8%	51.6%	-69.1%
24	14.9%	59.7%	-46.5%
30	18.5%	63.2%	-50.8%
36	21.2%	65.3%	-73.3%
42	22.6%	68.8%	-75.4%
48	23.4%	71.8%	-79.4%

Sieg Level 1, Validation for period no. 8

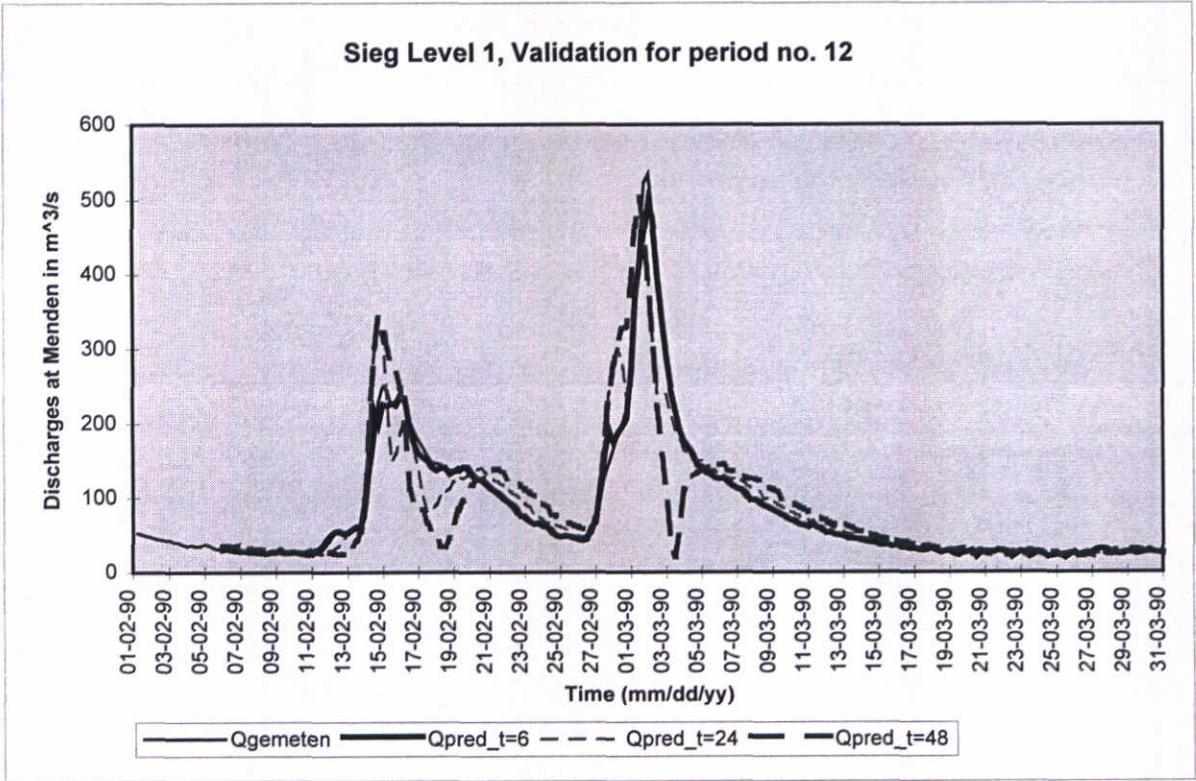


Model parameters			
fmin	0.30	alfa (1,1)	0.29
fmax	5.00	alfa (1,2)	0.14
kb	8.60	alfa (1,3)	0.10
psi	0.93	alfa (1,4)	0.00
kn	10.50	alfa (1,5)	0.00
nn	2.95	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.3. Sieg at Menden, Sieg Level 1, Total Sieg basin, Validation for Period no. 8

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	5.4%	18.0%	-28.9%
12	9.5%	32.3%	-56.9%
18	12.3%	42.0%	-69.8%
24	15.1%	46.9%	-72.1%
30	18.3%	56.5%	-73.8%
36	21.5%	65.3%	-74.1%
42	24.3%	77.6%	-73.1%
48	26.7%	90.4%	-72.7%

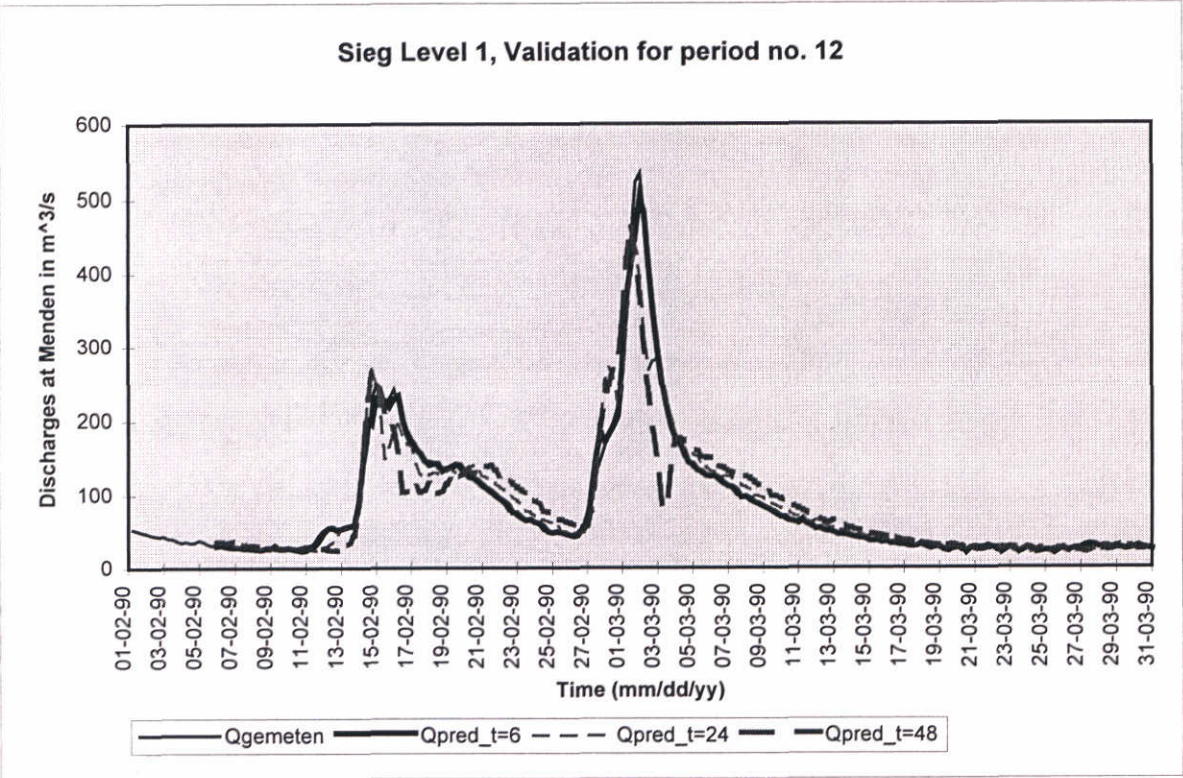


Model parameters			
fmin	0.30	alfa (1,1)	0.29
fmax	5.00	alfa (1,2)	0.14
kb	8.60	alfa (1,3)	0.10
psi	0.93	alfa (1,4)	0.00
kn	10.50	alfa (1,5)	0.00
nn	2.95	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.4 Sieg at Menden, Sieg Level 1, Total Sieg basin, Validation for Period no. 12 (fmin=0.30).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	5.0%	23.0%	-27.5%
12	8.6%	32.3%	-44.9%
18	10.9%	42.0%	-49.8%
24	13.2%	46.1%	-50.9%
30	15.9%	53.7%	-48.4%
36	18.6%	56.0%	-45.5%
42	21.0%	56.0%	-54.0%
48	23.0%	64.8%	-61.0%



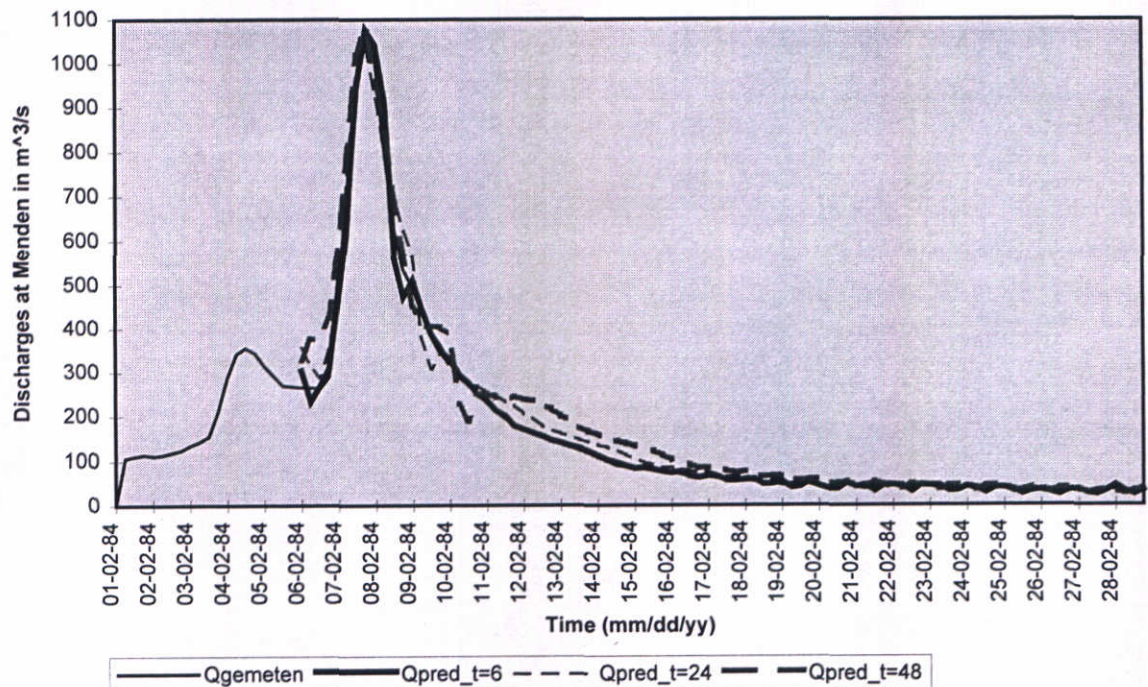
Model parameters			
fmin	0.40	alfa (1,1)	0.29
fmax	5.00	alfa (1,2)	0.14
kb	8.60	alfa (1,3)	0.10
psi	0.93	alfa (1,4)	0.00
kn	10.50	alfa (1,5)	0.00
nn	2.95	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.5 Sieg at Menden, Sieg Level 1, Total Sieg basin, Validation for Period no. 12 (fmin=0.40).

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	7.2%	25.6%	-29.2%
24	13.4%	21.5%	-37.7%
48	25.0%	29.8%	-60.5%

Sieg Level 2, Total Sieg, Calibration for Period no. 5



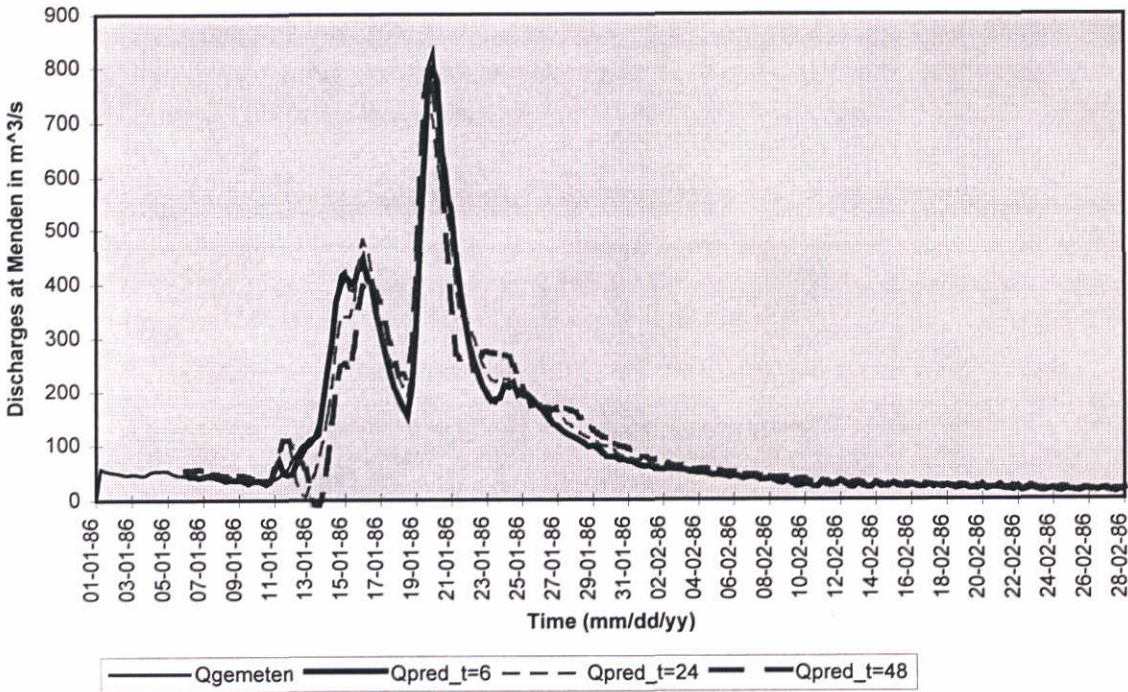
Model Parameters	Lower Sieg	Agger	Middle/Upper Sieg
fmin	0.01	0.54	0.40
fmax	5.00	5.00	5.00
kb	0.10	0.10	0.10
psi	1.00	0.89	0.94
kn	25.00	9.51	8.20
nn	2.60	2.10	3.50
alfa (1,1)	0.20	0.20	0.52
alfa (1,2)	0.00	0.00	0.41
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00

Fig. 9.6. Sieg at Menden, Sieg Level 2, Total Sieg basin, Calibration for Period no. 5

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	8.9%	35.9%	-66.5%
24	18.0%	93.8%	-110.5%
48	26.4%	108.3%	-111.7%

Sieg Level 2, Total Sieg, Validation for Period no. 7



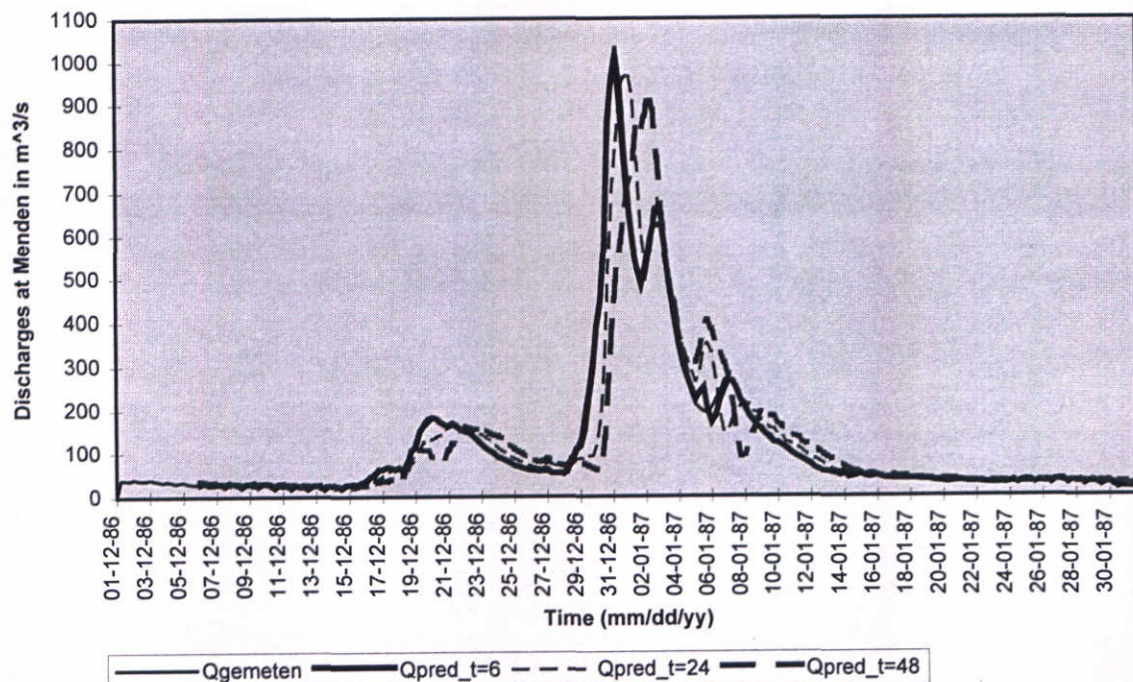
Model parameter	Lower Sieg	Agger	Middle/Upper Sieg
fmin	0.01	0.54	0.40
fmax	5.00	5.00	5.00
kb	0.10	0.10	0.10
psi	1.00	0.89	0.94
kn	25.00	9.51	8.20
nn	2.60	2.10	3.50
alfa (1,1)	0.20	0.20	0.52
alfa (1,2)	0.00	0.00	0.41
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00

Fig. 9.7. Sieg at Menden, Sieg Level 2, Total Sieg basin, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	6.0%	23.4%	-37.0%
24	16.9%	71.1%	-82.6%
48	28.6%	87.2%	-110.0%

Sieg Level 2, Total Sieg, Validation for Period no. 8



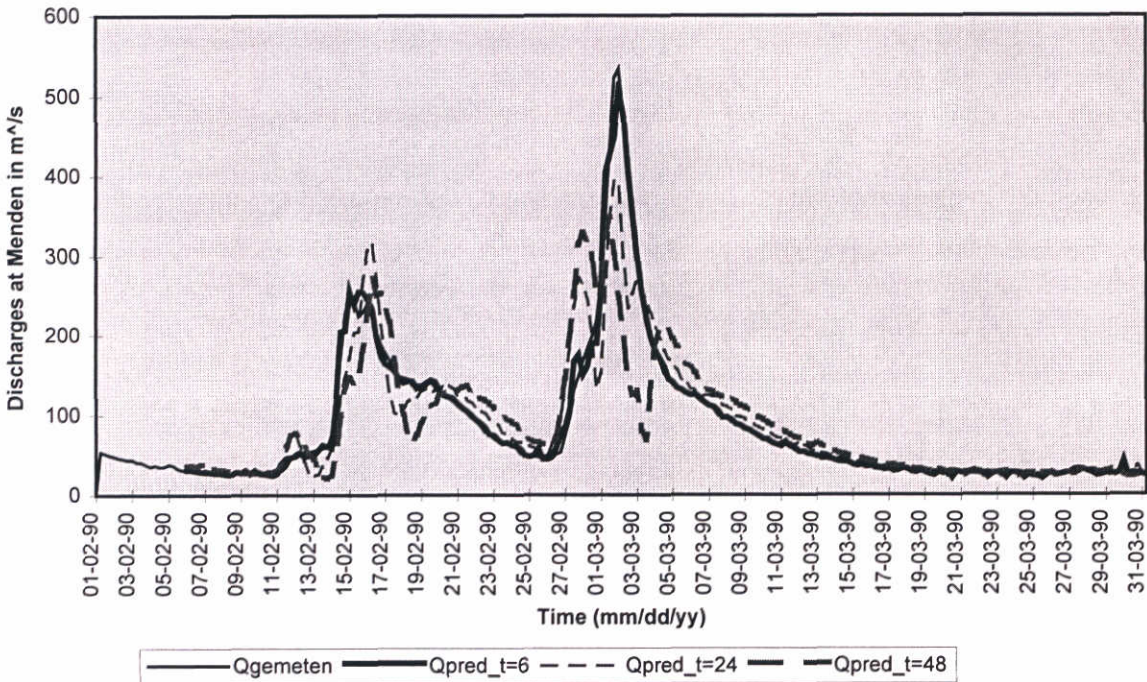
Model Parameters	Lower Sieg	Agger	Middle/Upper Sieg
fmin	0.01	0.54	0.40
fmax	5.00	5.00	5.00
kb	0.10	0.10	0.10
psi	1.00	0.89	0.94
kn	25.00	9.51	8.20
nn	2.60	2.10	3.50
alfa (1,1)	0.20	0.20	0.52
alfa (1,2)	0.00	0.00	0.41
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00

Fig. 9.8 Sieg at Menden, Sieg Level 2, Total Sieg basin, Validation for Period no. 8

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	5.7%	21.9%	-43.8%
24	17.7%	56.7%	-87.3%
48	27.9%	68.1%	-112.6%

Sieg Level 2, Total Sieg, Validation for Period no. 12



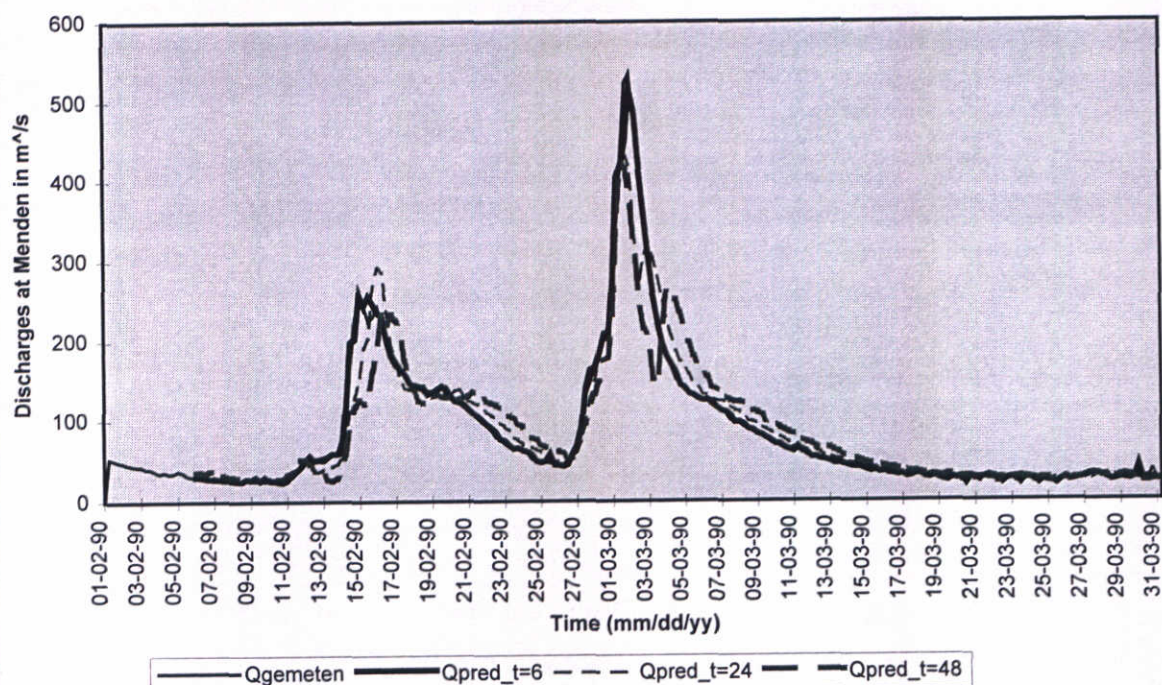
Model Parameters	Lower Sieg	Agger	Middle/Upper Sieg
fmin	0.01	0.54	0.40
fmax	5.00	5.00	5.00
kb	0.10	0.10	0.10
psi	1.00	0.89	0.94
kn	25.00	9.51	8.20
nn	2.60	2.10	3.50
alfa (1,1)	0.20	0.20	0.52
alfa (1,2)	0.00	0.00	0.41
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00

Fig. 9.9. Sieg at Menden, Sieg Level 2, Total Sieg basin, Validation for Period no. 12 (fmin=0.40 for the Middle/Upper Sieg).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	4.8%	20.5%	-43.3%
24	13.6%	42.6%	-39.3%
48	22.9%	55.8%	-66.5%

Sieg Level 2, Total Sieg, Validation for Period no. 12



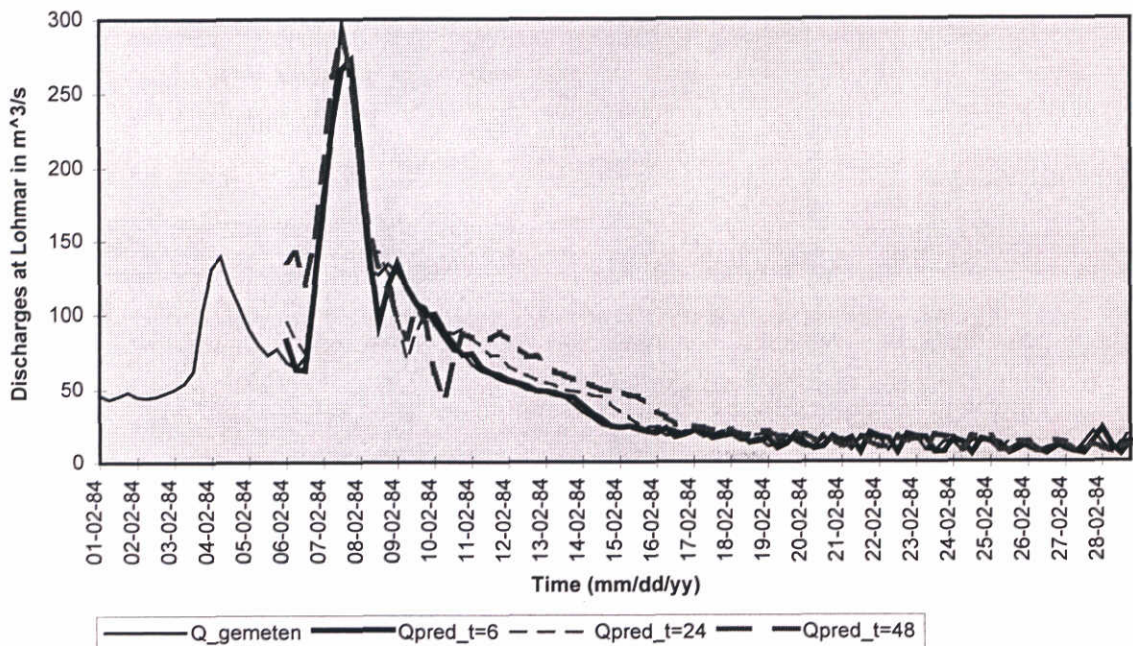
Model Parameters	Lower Sieg	Agger	Middle/Upper Sieg
fmin	0.01	0.54	0.70
fmax	5.00	5.00	5.00
kb	0.10	0.10	0.10
psi	1.00	0.89	0.94
kn	25.00	9.51	8.20
nn	2.60	2.10	3.50
alfa (1,1)	0.20	0.20	0.52
alfa (1,2)	0.00	0.00	0.41
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00

Fig. 9.10. Sieg at Menden, Sieg Level 2, Total Sieg basin, Validation for Period no. 12 (fmin=0.70 for the Middle/Upper Sieg).

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	21.6%	62.0%	-102.4%
12	28.7%	71.7%	-222.4%
18	26.9%	62.3%	-134.6%
24	20.4%	48.1%	-135.4%
30	30.8%	54.6%	-136.2%
36	38.9%	70.7%	-141.1%
42	39.8%	57.6%	-142.0%
48	37.0%	50.4%	-149.6%

Sieg Level 2, Agger, Calibration for Period no. 5



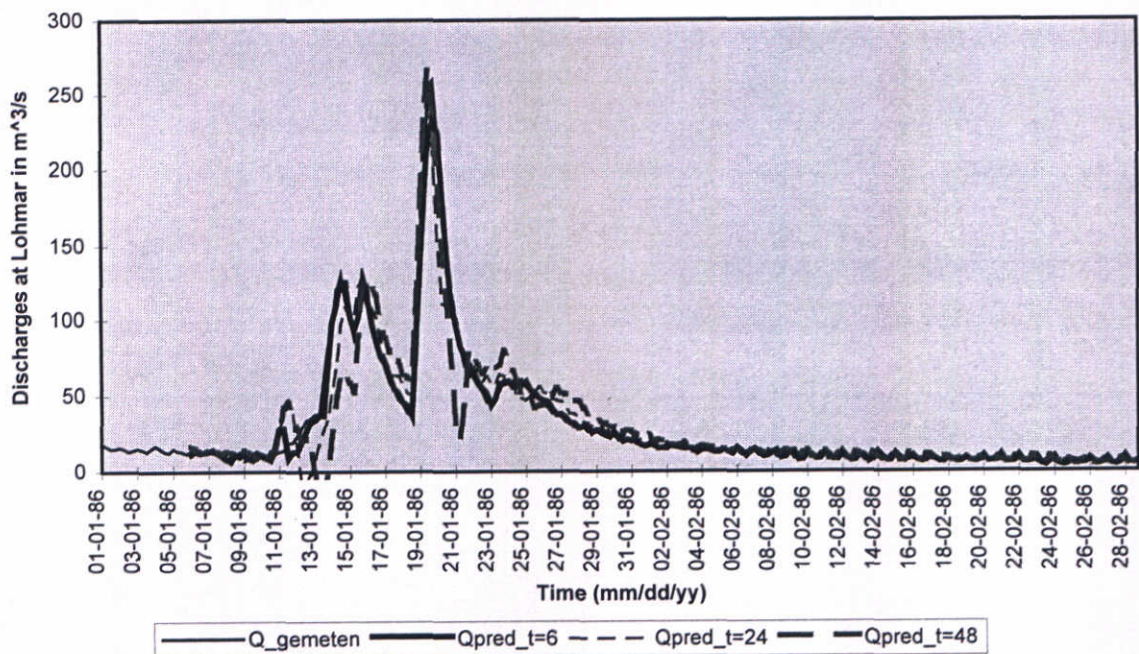
Model parameters			
fmin	0.54	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.00
kb	0.10	alfa (1,3)	0.00
psi	0.89	alfa (1,4)	0.00
kn	9.51	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.11. Agger at Lohmar, Sieg Level 2, Agger basin, Calibration for Period no. 5.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	15.6%	50.5%	-110.6%
12	22.4%	81.8%	-235.9%
18	21.5%	107.6%	-248.4%
24	17.9%	127.9%	-208.1%
30	25.0%	136.3%	-221.9%
36	30.0%	143.4%	-230.5%
42	28.3%	145.8%	-233.6%
48	25.6%	149.0%	-207.2%

Sieg Level 2, Agger, Validation for Period no. 7



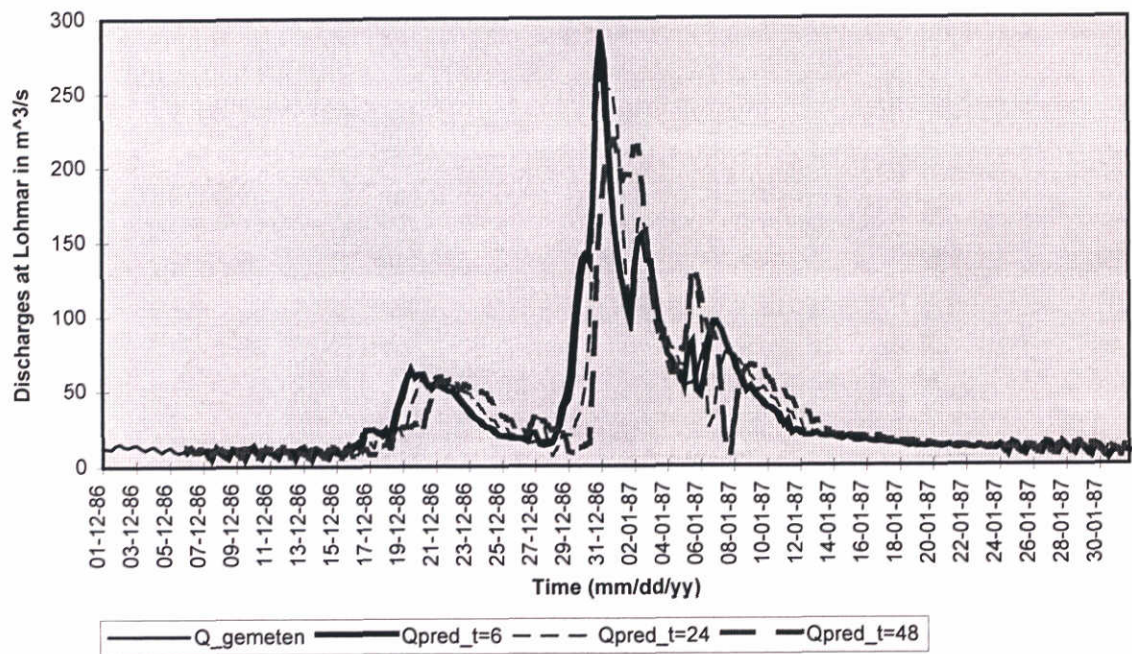
Model parameters			
fmin	0.54	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.00
kb	0.10	alfa (1,3)	0.00
psi	0.89	alfa (1,4)	0.00
kn	9.51	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.12. Agger at Lohmar, Sieg Level 2, Agger basin, Validation for Period no. 7

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	14.4%	54.4%	-78.7%
12	21.8%	59.2%	-130.8%
18	22.9%	68.5%	-138.9%
24	21.0%	78.2%	-119.6%
30	29.4%	84.9%	-121.5%
36	34.0%	88.0%	-137.8%
42	34.5%	89.5%	-151.2%
48	33.3%	92.0%	-139.2%

Sieg Level 2, Agger, Validation for Period no. 8



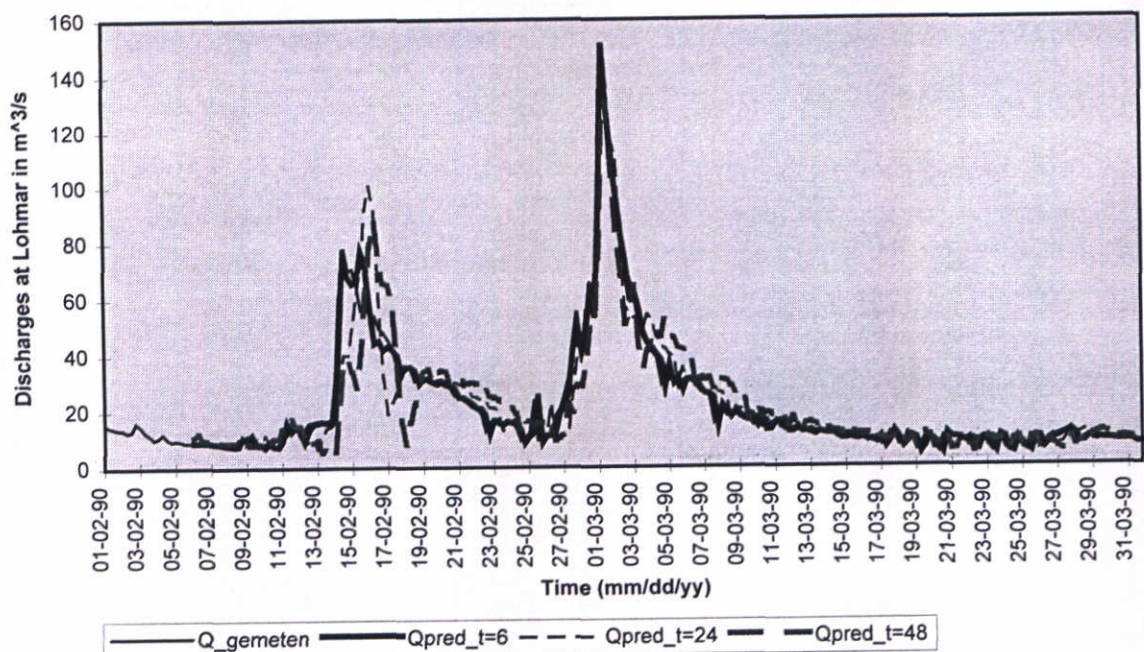
Model parametres			
fmin	0.54	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.00
kb	0.10	alfa (1,3)	0.00
psi	0.89	alfa (1,4)	0.00
kn	9.51	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.13. Agger at Lohmar, Sieg Level 2, Agger basin, Validation for Period no. 8.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	12.4%	54.7%	-119.8%
12	17.6%	53.4%	-100.9%
18	18.5%	57.5%	-100.9%
24	18.6%	60.9%	-84.2%
30	22.5%	66.1%	-86.3%
36	26.3%	68.3%	-104.9%
42	26.6%	73.6%	-97.9%
48	26.4%	81.1%	-115.5%

Sieg Level 2, Agger, Period no. 12



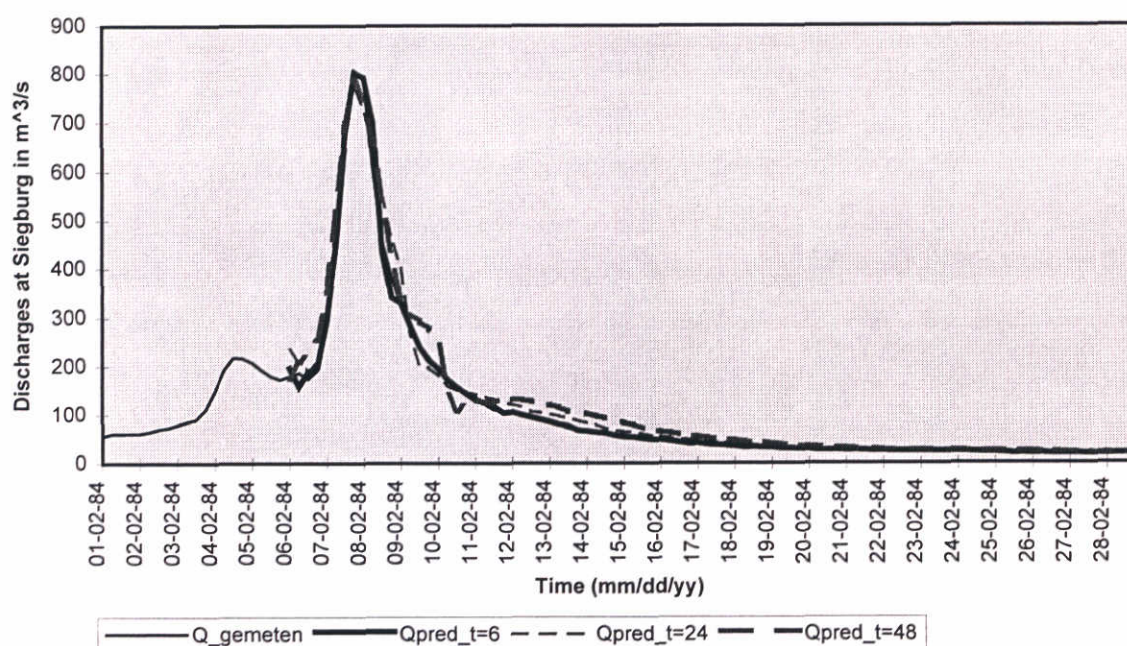
Model parameters			
fmin	0.54	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.00
kb	0.10	alfa (1,3)	0.00
psi	0.89	alfa (1,4)	0.00
kn	9.51	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.14. Agger at Lohmar, Sieg Level 2, Agger basin, Validation for Period no. 12.

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	2.6%	14.8%	-16.3%
12	5.1%	15.1%	-26.6%
18	8.4%	13.9%	-23.7%
24	11.2%	17.3%	-30.6%
30	14.1%	22.8%	-36.9%
36	17.0%	26.2%	-43.2%
42	19.7%	29.1%	-49.7%
48	22.2%	30.7%	-57.3%

Sieg Level 2, Middle/Upper Sieg, Calibration for Period no. 5



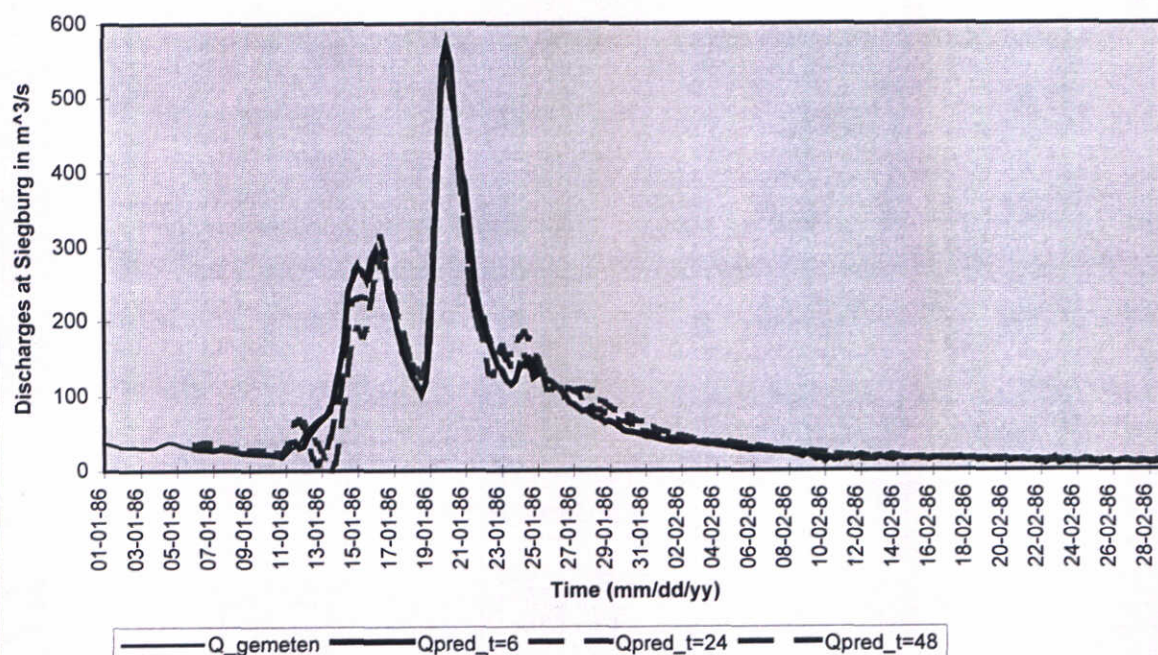
Model parameters			
fmin	0.40	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	0.10	alfa (1,3)	0.00
psi	0.94	alfa (1,4)	0.00
kn	8.20	alfa (1,5)	0.00
nn	3.50	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.15. Sieg at Siegburg, Sieg Level 2, Middle/Upper Sieg basin, Calibration for Period no. 5.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	5.8%	29.9%	-47.3%
12	8.6%	55.3%	-73.7%
18	11.5%	74.7%	-90.6%
24	13.7%	88.5%	-91.0%
30	16.3%	97.6%	-95.4%
36	18.4%	103.3%	-97.0%
42	20.0%	103.0%	-99.1%
48	21.1%	100.9%	-100.3%

Sieg Level 2, Middle/Upper Sieg, Validation for Period no. 7



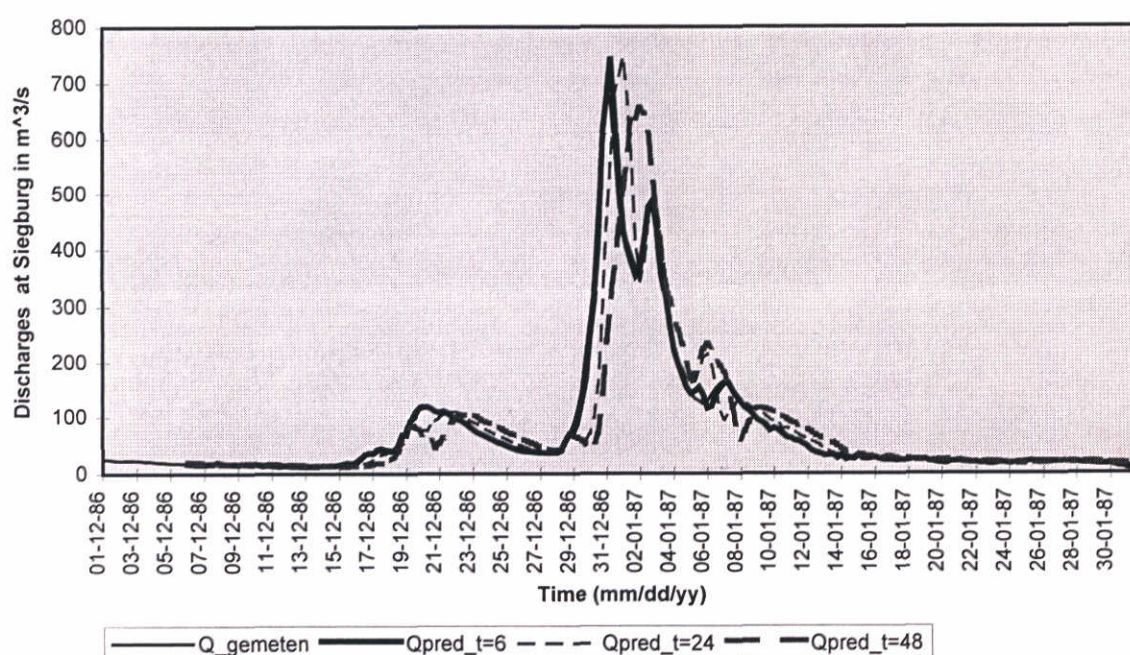
Model parameters			
fmin	0.40	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	0.10	alfa (1,3)	0.00
psi	0.94	alfa (1,4)	0.00
kn	8.20	alfa (1,5)	0.00
nn	3.50	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.16. Sieg at Siegburg, Sieg Level 2, Middle/Upper Sieg basin, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	4.1%	22.7%	-19.9%
12	8.4%	45.2%	-48.7%
18	13.5%	65.9%	-65.5%
24	17.0%	75.1%	-72.0%
30	20.5%	80.9%	-79.5%
36	23.5%	85.3%	-84.3%
42	26.4%	85.6%	-87.0%
48	29.1%	86.5%	-91.6%

Sieg Level 2, Middle/Upper Sieg, Validation for Period no. 8



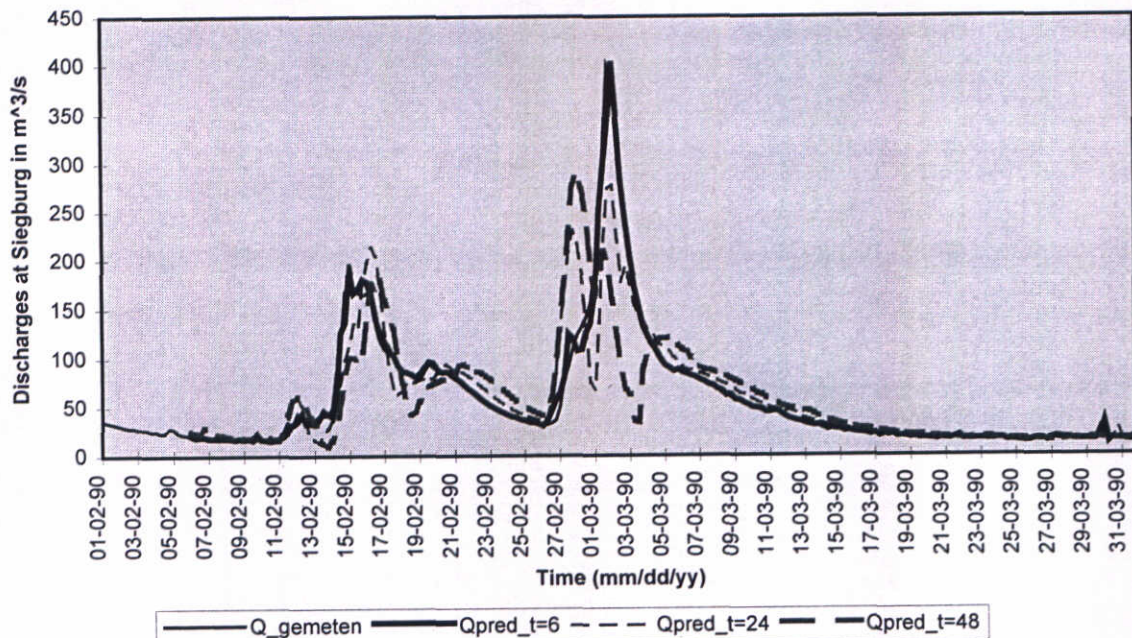
Model parameters			
fmin	0.40	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	0.10	alfa (1,3)	0.00
psi	0.94	alfa (1,4)	0.00
kn	8.20	alfa (1,5)	0.00
nn	3.50	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.17. Sieg at Siegburg, Sieg Level 2, Middle/Upper Sieg basin, Validation for Period no. 8

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	5.6%	33.7%	-86.4%
12	10.4%	44.7%	-111.1%
18	15.6%	54.6%	-142.7%
24	19.4%	67.9%	-149.9%
30	22.9%	71.3%	-151.0%
36	25.7%	83.1%	-154.4%
42	28.2%	81.0%	-156.7%
48	30.5%	79.2%	-158.2%

Sieg, Level 2, Middle/Upper Sieg, Validation for Period no. 12



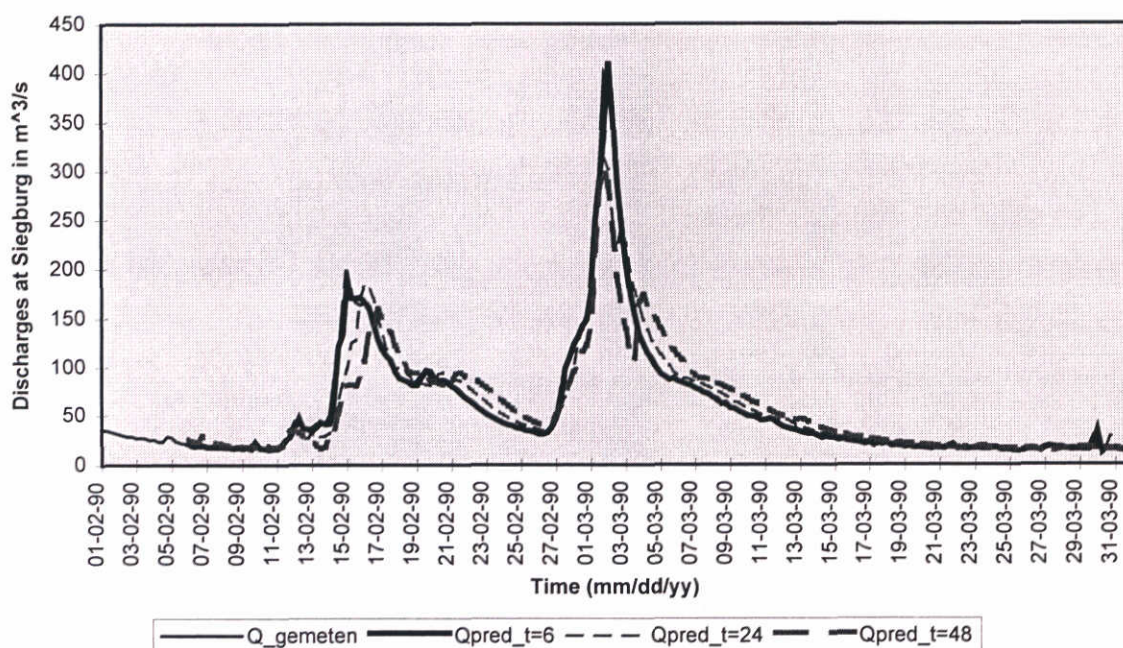
Model parameters			
fmin	0.40	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	0.10	alfa (1,3)	0.00
psi	0.94	alfa (1,4)	0.00
kn	8.20	alfa (1,5)	0.00
nn	3.50	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.18. Sieg at Siegburg, Sieg Level 2, Middle/Upper Sieg basin, Validation for Period no.12 (fmin=0.40 for Middle/Upper Sieg).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	4.3%	33.7%	-86.4%
12	7.2%	44.9%	-87.9%
18	10.8%	46.9%	-69.9%
24	13.7%	50.0%	-75.5%
30	16.7%	55.7%	-85.6%
36	19.4%	60.4%	-92.3%
42	21.8%	61.8%	-94.8%
48	24.1%	63.4%	-97.3%

Sieg, Level 2, Middle/Upper Sieg, Validation for Period no. 12



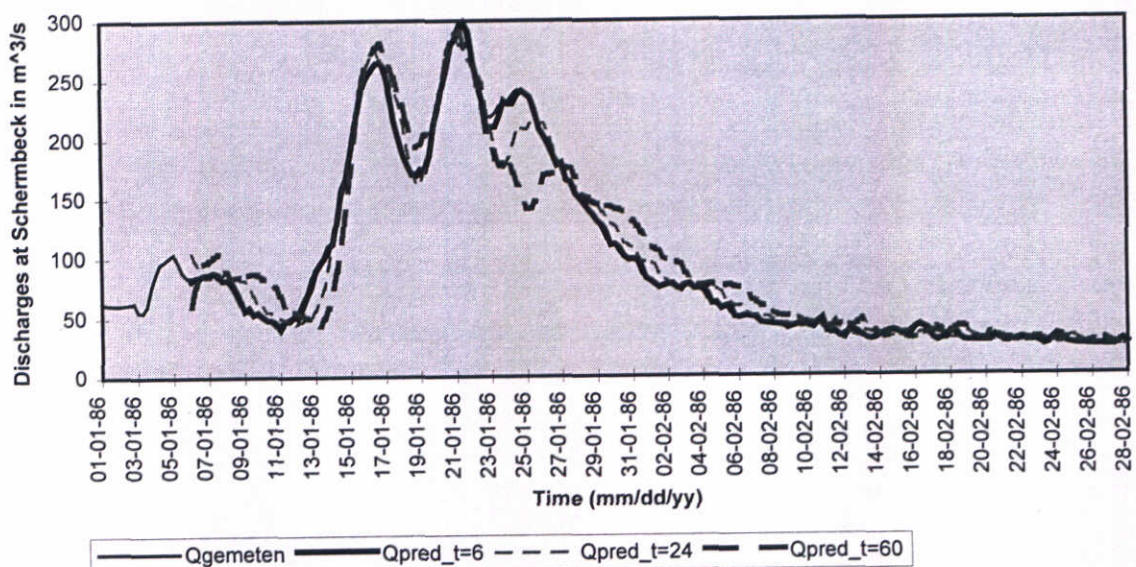
Model parameters			
fmin	0.70	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	0.10	alfa (1,3)	0.00
psi	0.94	alfa (1,4)	0.00
kn	8.20	alfa (1,5)	0.00
nn	3.50	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00

Fig. 9.19. Sieg at Siegburg, Sieg Level 2, Middle/Upper Sieg basin, Validation for Period no.12 (fmin=0.70 for Middle/Upper Sieg).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	2.8%	11.7%	-19.2%
12	5.7%	21.3%	-27.3%
18	8.3%	32.3%	-33.9%
24	10.1%	39.1%	-38.1%
30	11.4%	44.2%	-47.3%
36	12.7%	46.6%	-48.9%
42	14.2%	47.4%	-54.7%
48	15.7%	49.6%	-62.7%
54	17.4%	51.8%	-66.7%
60	19.4%	53.8%	-76.8%

Lippe Level 1, Validation for period no. 7



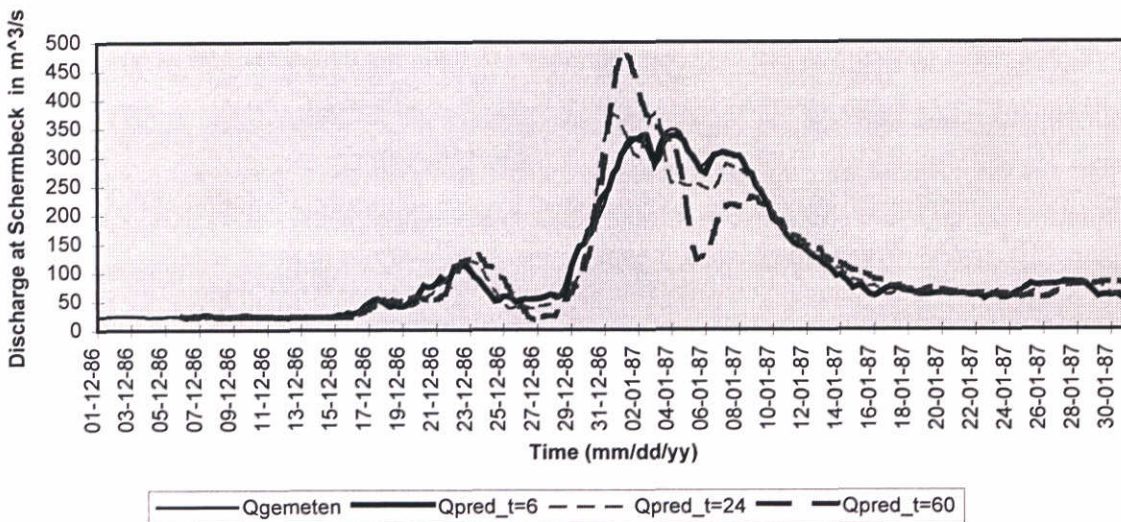
Model parameters			
fmin	0.20	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	3.37	alfa (1,3)	0.00
psi	0.80	alfa (1,4)	0.00
kn	32.60	alfa (1,5)	0.00
nn	2.41	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.20. Lippe at Schermbeck, Lippe Level 1, Total Lippe basin, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	3.0%	23.7%	-12.1%
12	6.2%	32.7%	-29.1%
18	9.6%	35.6%	-44.1%
24	11.7%	35.5%	-51.3%
30	13.7%	36.8%	-55.9%
36	2.5%	6.5%	-1.6%
42	17.0%	52.8%	-75.9%
48	18.4%	59.0%	-77.9%
54	19.9%	64.7%	-81.9%
60	21.1%	70.4%	-87.9%

Lippe Level 1, Validation for period no. 8



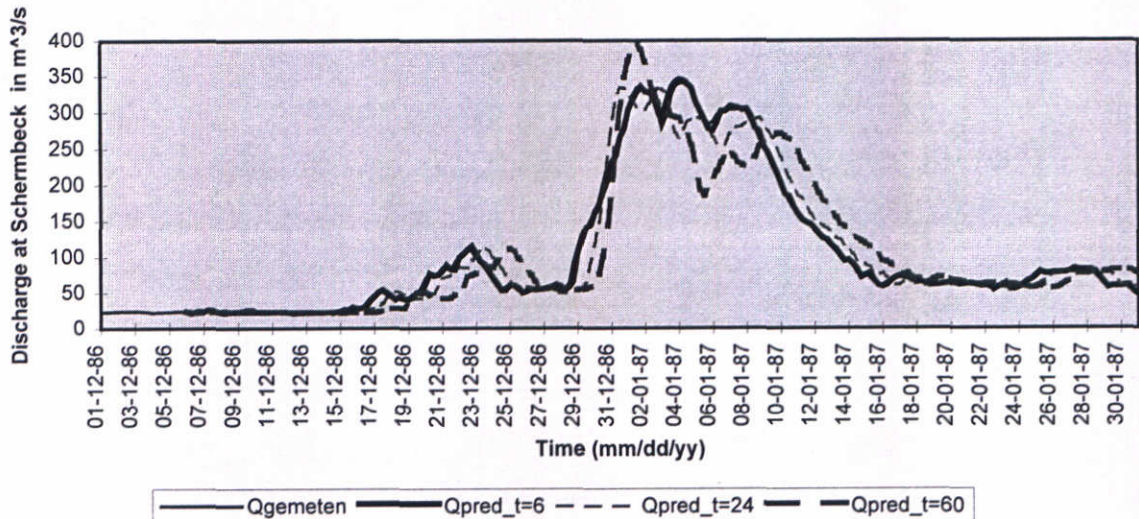
Model parameters			
fmin	0.20	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	3.37	alfa (1,3)	0.00
psi	0.80	alfa (1,4)	0.00
kn	32.60	alfa (1,5)	0.00
nn	2.41	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.21. Lippe at Schermbeck, Lippe Level 1, Total Lippe basin, Validation for Period no. 8 (fmin=0.20).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	3.0%	27.3%	-10.9%
12	6.6%	41.9%	-24.4%
18	10.2%	52.0%	-45.2%
24	12.5%	56.7%	-59.1%
30	14.8%	59.3%	-69.8%
36	2.5%	6.5%	-1.6%
42	19.0%	62.8%	-95.4%
48	20.7%	62.1%	-103.9%
54	22.5%	60.0%	-95.4%
60	24.3%	61.6%	-87.9%

Lippe Level 1, Validation for period no. 8



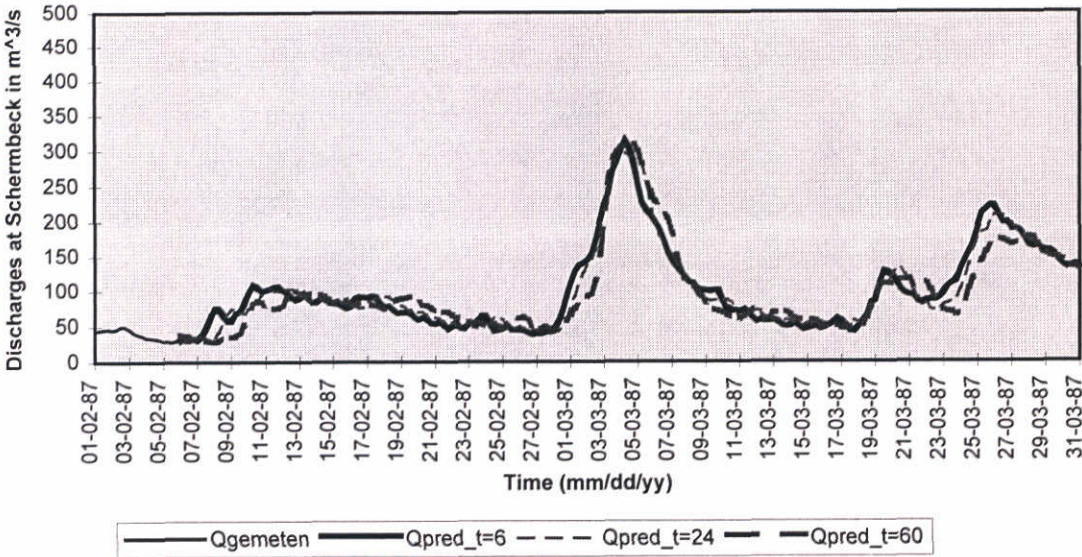
Model parameters			
fmin	0.40	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	3.37	alfa (1,3)	0.00
psi	0.80	alfa (1,4)	0.00
kn	32.60	alfa (1,5)	0.00
nn	2.41	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.22. Lippe at Schermbeck, Lippe Level 1, Total Lippe basin, Validation for Period no. 8 (fmin=0.40).

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	3.8%	15.2%	-14.1%
12	7.3%	33.9%	-33.3%
18	9.7%	48.7%	-37.7%
24	11.2%	52.9%	-37.7%
30	12.6%	56.0%	-32.3%
36	13.8%	54.3%	-35.4%
42	14.9%	51.1%	-38.8%
48	16.1%	55.7%	-40.1%
54	17.4%	58.6%	-43.8%
60	18.5%	60.7%	-49.6%

Lippe Level 1, Calibration for period no. 9



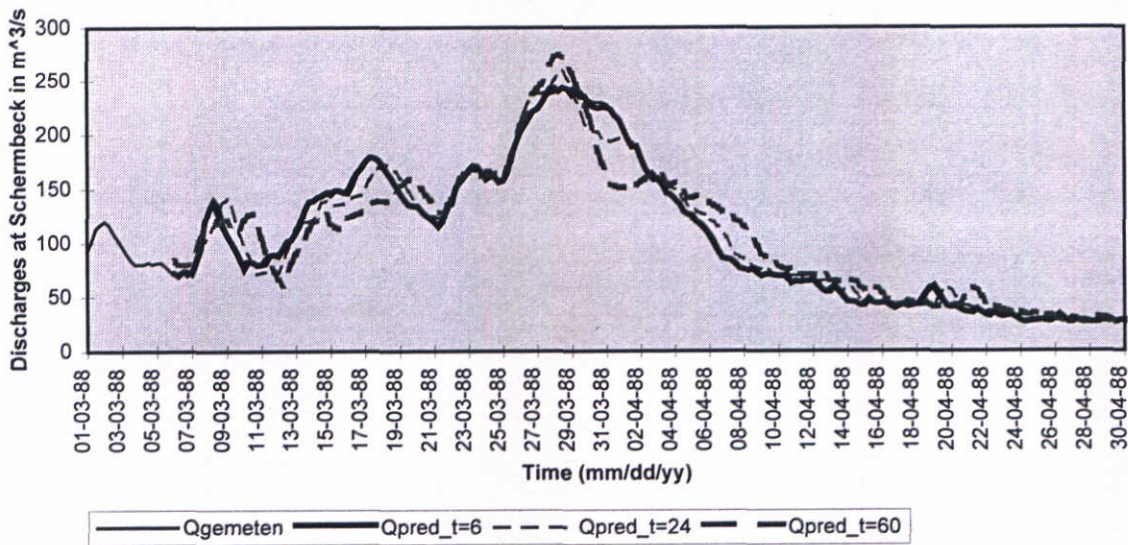
Model parameters			
fmin	0.20	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	3.37	alfa (1,3)	0.00
psi	0.80	alfa (1,4)	0.00
kn	32.60	alfa (1,5)	0.00
nn	2.41	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.23. Lippe at Schermbeck, Lippe Level 1, Total Lippe basin, Calibration for Period no. 9

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	2.4%	11.6%	-9.1%
12	4.9%	21.3%	-23.3%
18	7.1%	26.7%	-33.4%
24	8.8%	27.4%	-39.4%
30	10.5%	28.5%	-46.5%
36	12.1%	29.0%	-59.9%
42	13.6%	28.6%	-64.6%
48	14.9%	31.1%	-60.6%
54	16.1%	34.9%	-64.4%
60	17.2%	35.4%	-55.6%

Lippe Level 1, Validation for period no. 10



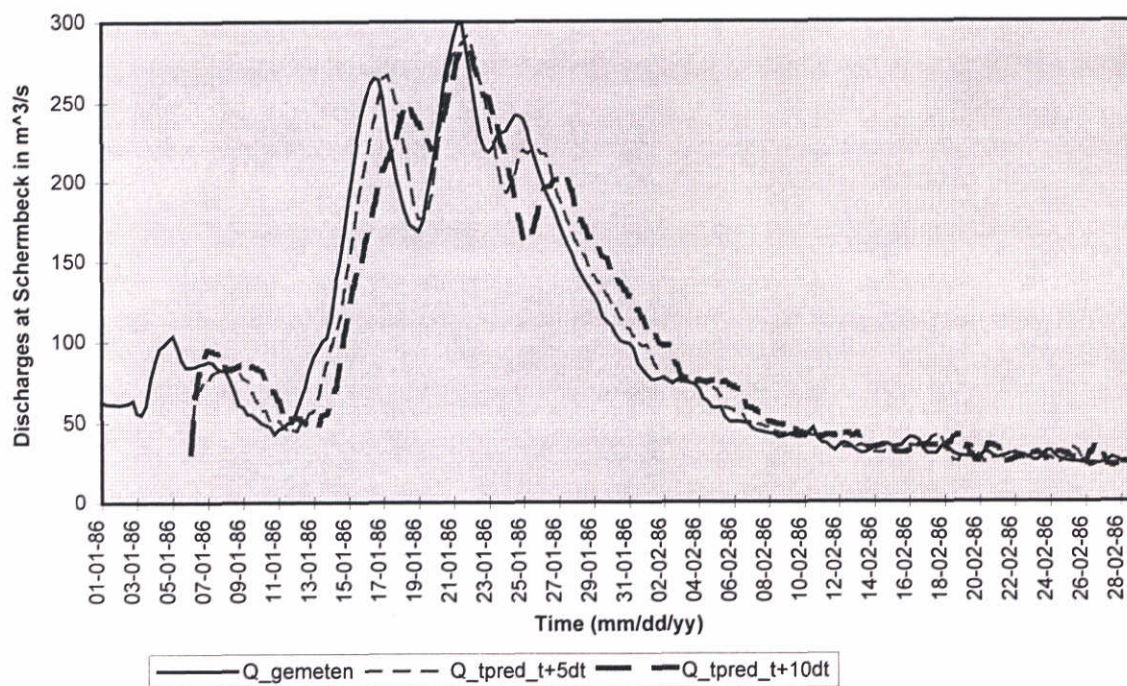
Model parameters			
fmin	0.20	alfa (1,1)	0.52
fmax	5.00	alfa (1,2)	0.41
kb	3.37	alfa (1,3)	0.00
psi	0.80	alfa (1,4)	0.00
kn	32.60	alfa (1,5)	0.00
nn	2.41	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.24. Lippe at Schermbeck, Lippe Level 1, Total Lippe basin, Validation for Period no.10.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	11.8%	60.2%	-37.8%
54	20.6%	62.3%	-62.6%

Lippe Level 3, Total Lippe, Validation for Period no. 7

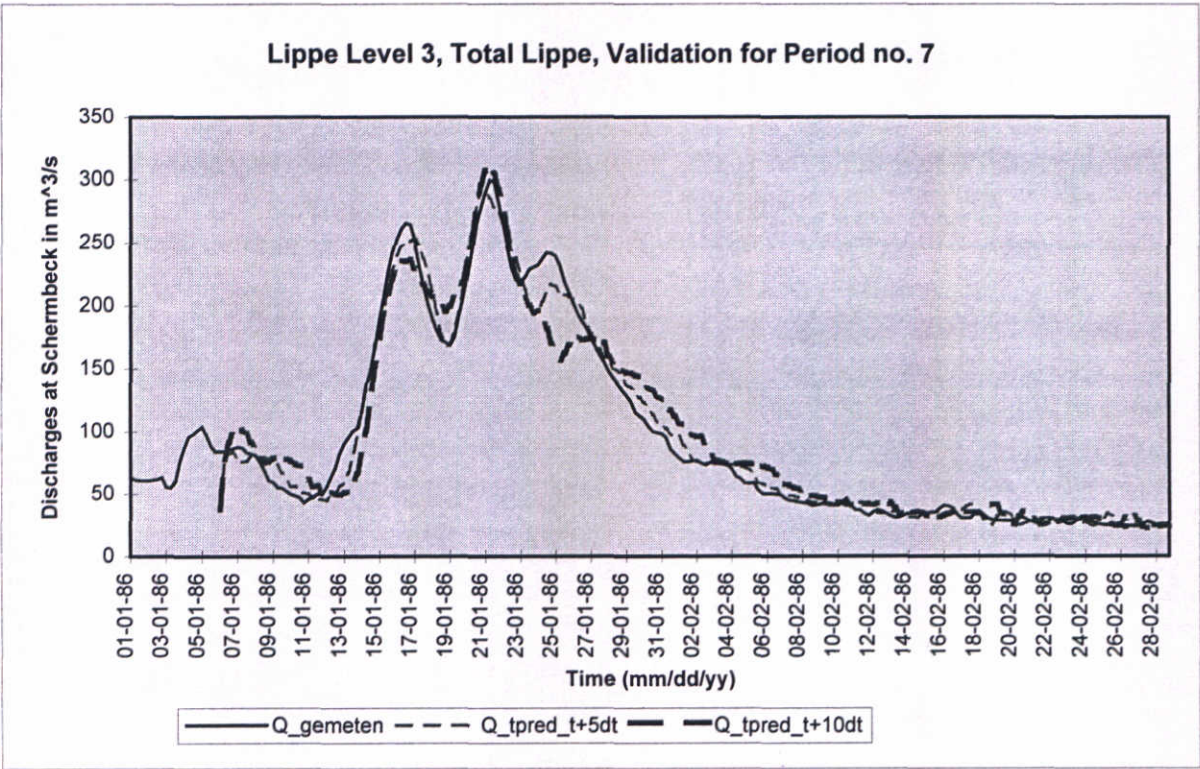


Model parameters	Lower Lippe	Stever	Middle Lippe	Upper Lippe
fmin	0.50	0.55	0.35	0.35
fmax	5.00	5.00	5.00	5.00
kb	0.10	0.30	0.10	0.10
psi	1.00	0.90	1.00	0.98
kn	35.00	23.00	35.00	35.00
nn	2.05	2.10	2.20	2.10
alfa (1,1)	0.30	0.20	0.20	0.20
alfa (1,2)	0.10	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00	0.00
alfa (1,10)	0.00	0.00	0.00	0.00

Fig. 9.25. Lippe at Schermbeck, Lippe Level 3, Total Lippe basin, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	9.7%	52.9%	-37.8%
54	17.1%	55.1%	-54.2%



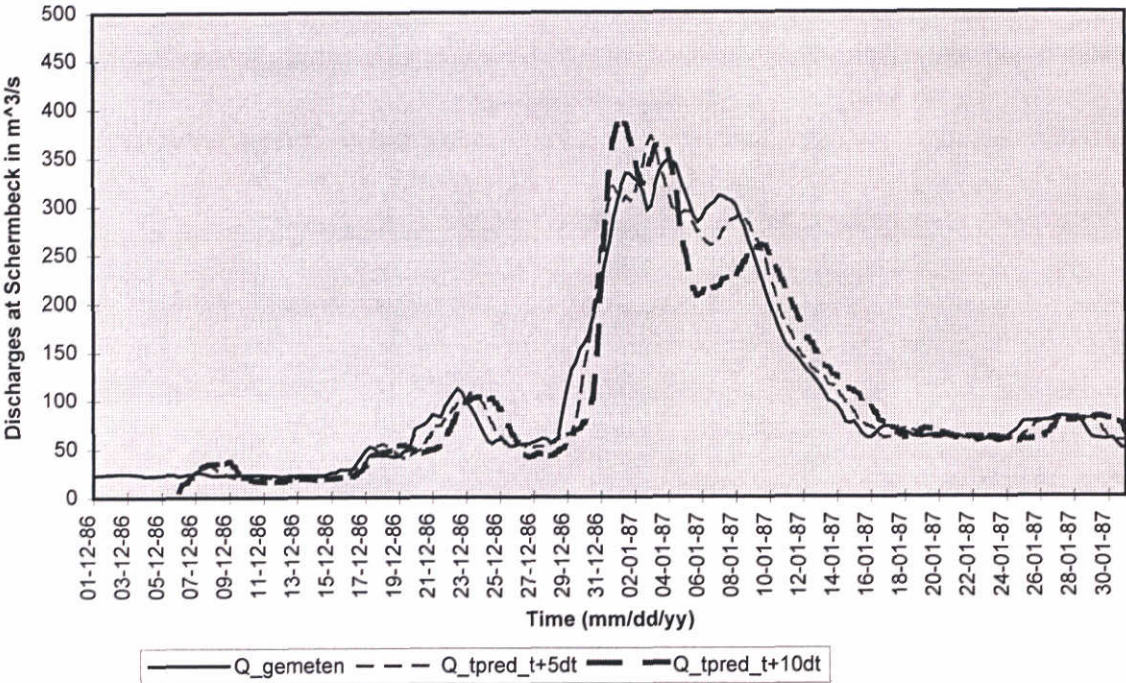
Model parameters	Lower Lippe	Stever	Middle Lippe	Upper Lippe
fmin	0.50	0.14	0.25	0.35
fmax	5.00	5.00	5.00	5.00
kb	0.10	0.30	0.10	0.10
psi	1.00	0.90	1.00	0.98
kn	35.00	23.00	35.00	35.00
nn	2.05	2.10	2.20	2.10
alfa (1,1)	0.30	0.20	0.20	0.20
alfa (1,2)	0.10	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00	0.00
alfa (1.10)	0.00	0.00	0.00	0.00

Fig. 9.26. Lippe at Schermbeck, Lippe Level 3, Total Lippe basin, Validation for Period no. 7 (fmin=0.14 for Stever basin and fmin=0.25 for Middle Lippe basin).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	12.3%	65.9%	-51.6%
54	23.4%	67.6%	-83.9%

Lippe Level 3, Total Lippe, Validation for Period no. 8



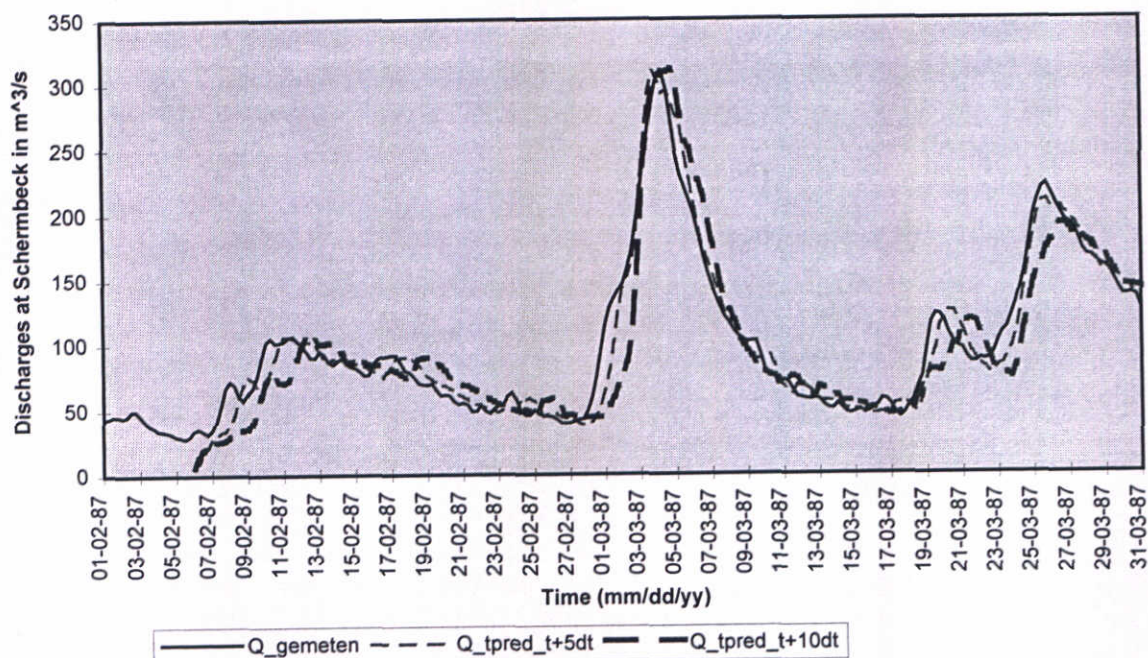
Model Parameters	Lower Lippe	Stever	Middle Lippe	Upper Lippe
fmin	0.50	0.55	0.35	0.35
fmax	5.00	5.00	5.00	5.00
kb	0.10	0.30	0.10	0.10
psi	1.00	0.90	1.00	0.98
kn	35.00	23.00	35.00	35.00
nn	2.05	2.10	2.20	2.10
alfa (1,1)	0.30	0.20	0.20	0.20
alfa (1,2)	0.10	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00	0.00
alfa (1,10)	0.00	0.00	0.00	0.00

Fig. 9.27 Lippe at Schermbeck, Lippe Level 3, Total Lippe basin, Validation for Period no. 8.

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	11.5%	84.2%	-29.4%
54	18.8%	80.4%	-37.9%

Lippe Level 3, Total Lippe, Calibration for Period no. 9



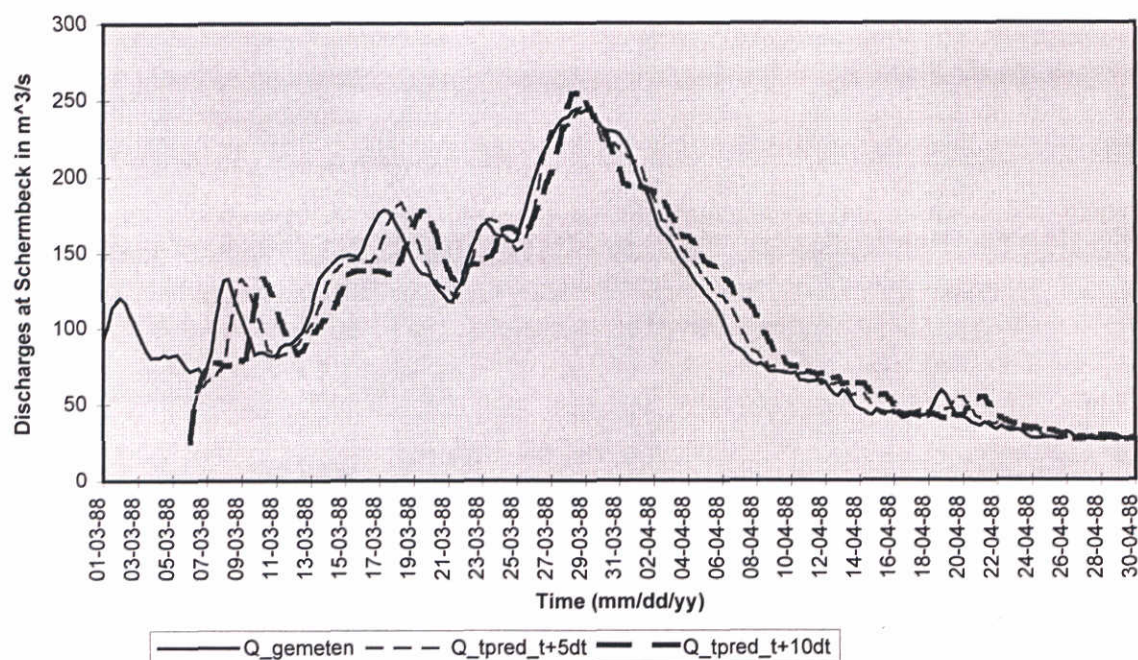
Model Parameters	Lower Lippe	Stever	Middle Lippe	Upper Lippe
fmin	0.50	0.55	0.35	0.35
fmax	5.00	5.00	5.00	5.00
kb	0.10	0.30	0.10	0.10
psi	1.00	0.90	1.00	0.98
kn	35.00	23.00	35.00	35.00
nn	2.05	2.10	2.20	2.10
alfa (1,1)	0.30	0.20	0.20	0.20
alfa (1,2)	0.10	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00	0.00
alfa (1,10)	0.00	0.00	0.00	0.00

Fig. 9.28. Lippe at Schermbeck, Lippe Level 3, Total Lippe basin, Calibration for Period no. 9

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	8.6%	59.2%	-38.3%
54	16.5%	63.6%	-58.4%

Lippe Level 3, Total Lippe, Validation for Period no.10



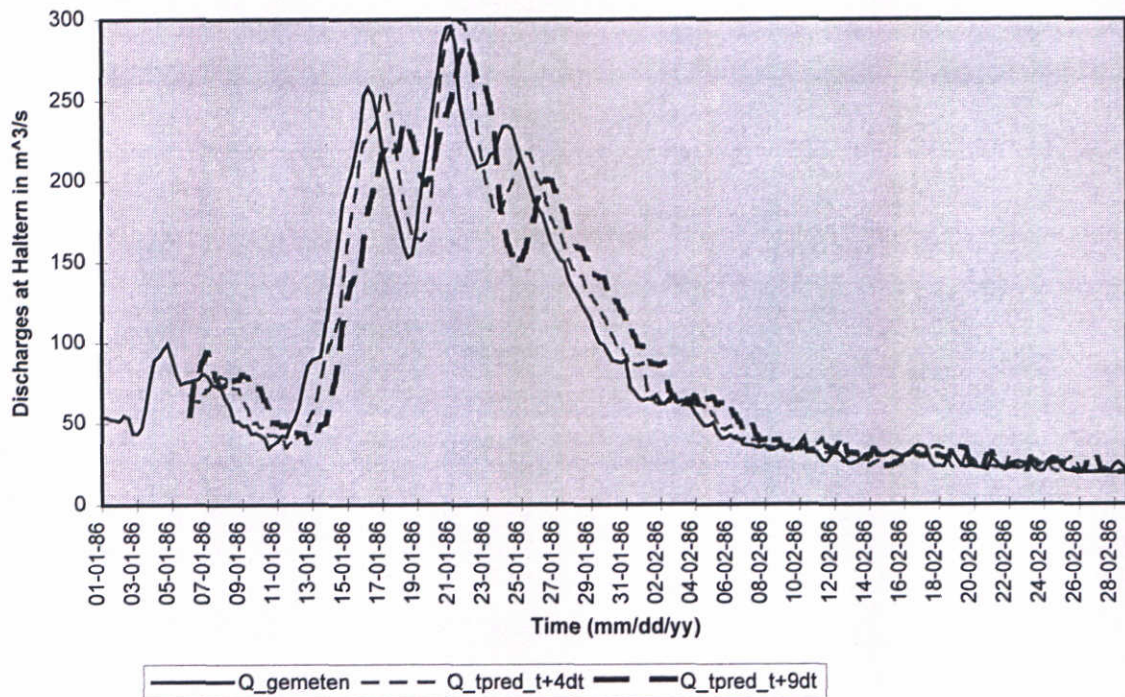
Model Parameters	Lower Lippe	Stever	Middle Lippe	Upper Lippe
fmin	0.50	0.55	0.35	0.35
fmax	5.00	5.00	5.00	5.00
kb	0.10	0.30	0.10	0.10
psi	1.00	0.90	1.00	0.98
kn	35.00	23.00	35.00	35.00
nn	2.05	2.10	2.20	2.10
alfa (1,1)	0.30	0.20	0.20	0.20
alfa (1,2)	0.10	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00	0.00
alfa (1,10)	0.00	0.00	0.00	0.00

Fig. 9.29. Lippe at Schermbeck, Lippe Level 3, Total Lippe basin, Validation for Period no. 10.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	14.2%	42.2%	-52.9%
54	23.2%	55.0%	-74.1%

Lippe Level 3, Upper Lippe & Middle Lippe & Stever, Validation for Period no. 7



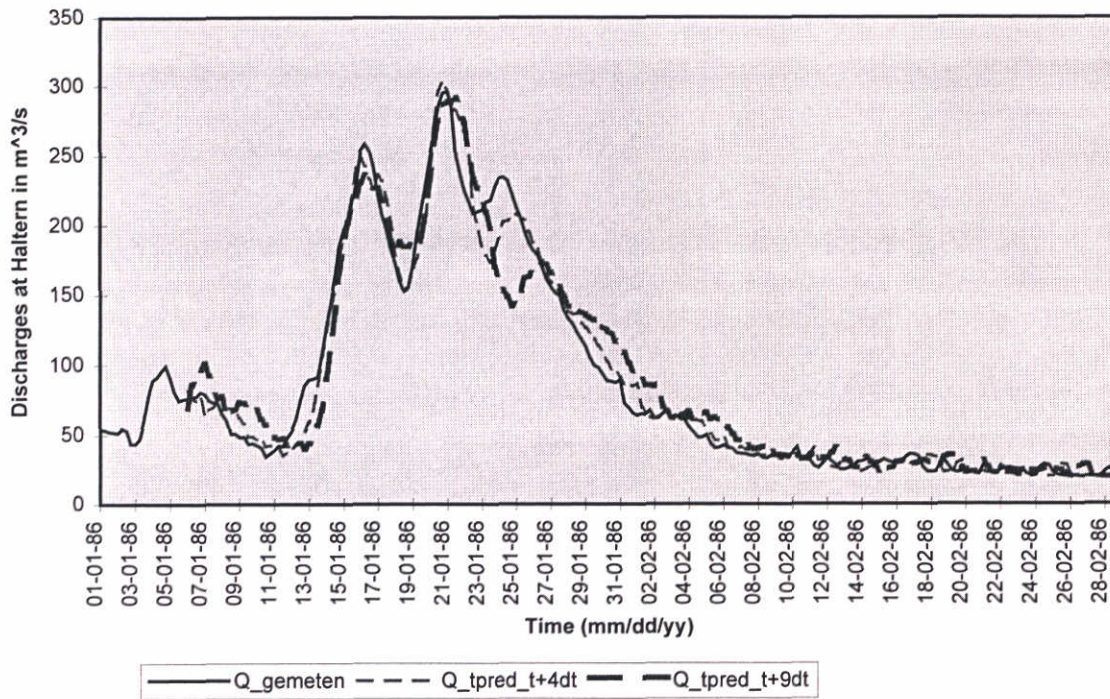
Model Parameters	Stever	Middle Lippe	Upper Lippe
fmin	0.55	0.35	0.35
fmax	5.00	5.00	5.00
kb	0.30	0.10	0.10
psi	0.90	1.00	0.98
kn	23.00	35.00	35.00
nn	2.10	2.20	2.10
alfa (1,1)	0.20	0.20	0.20
alfa (1,2)	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00

Fig. 9.30. Lippe at Haltern, Lippe Level 3, Upper Lippe & Middle Lippe and Stever basins, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	11.8%	40.8%	-52.9%
54	19.0%	52.9%	-66.8%

Lippe Level 3, Upper Lippe & Middle Lippe & Stever, Validation for Period no. 7



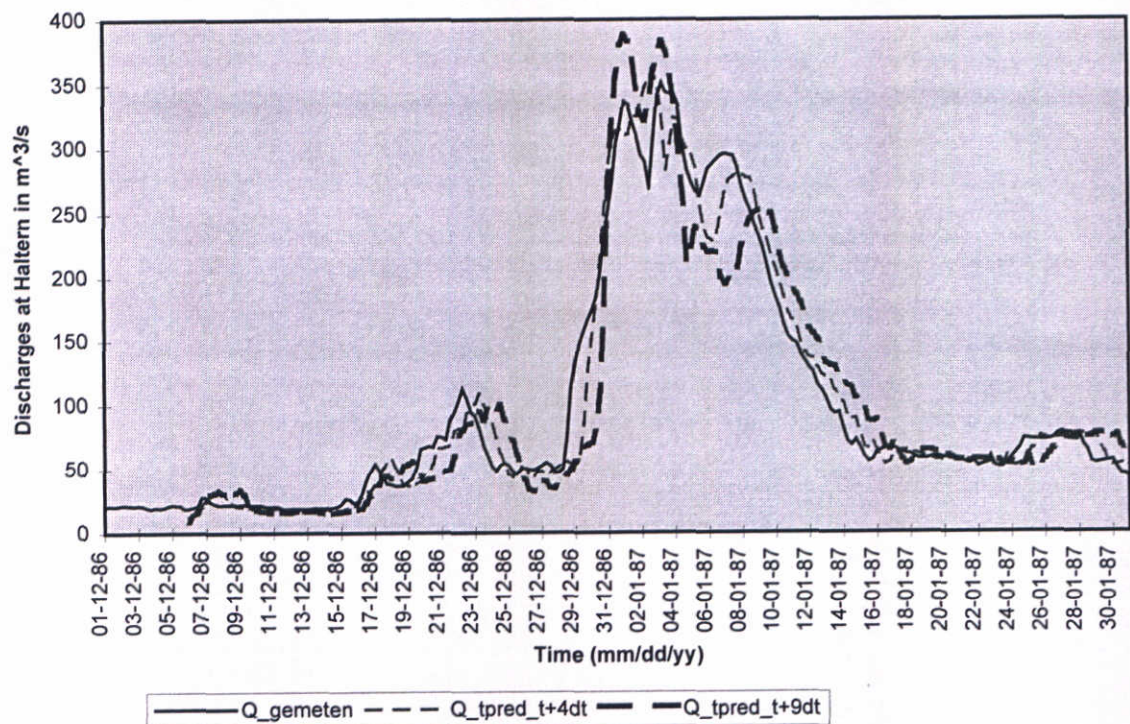
Model Parameters	Stever	Middle Lippe	Upper Lippe
fmin	0.14	0.25	0.35
fmax	5.00	5.00	5.00
kb	0.30	0.10	0.10
psi	0.90	1.00	0.98
kn	23.00	35.00	35.00
nn	2.10	2.20	2.10
alfa (1,1)	0.20	0.20	0.20
alfa (1,2)	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00

Fig. 9.31. Lippe at Haltern, Lippe Level 3, Upper Lippe & Middle Lippe and Stever basins, Validation for Period no. 7 (fmin=0.14 for Stever basin and fmin=0.25 for Middle Lippe basin)

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	13.6%	59.2%	-65.4%
54	24.4%	59.1%	-97.3%

Lippe Level 3, Upper Lippe & Middle Lippe & Stever, Validation for Period no. 8



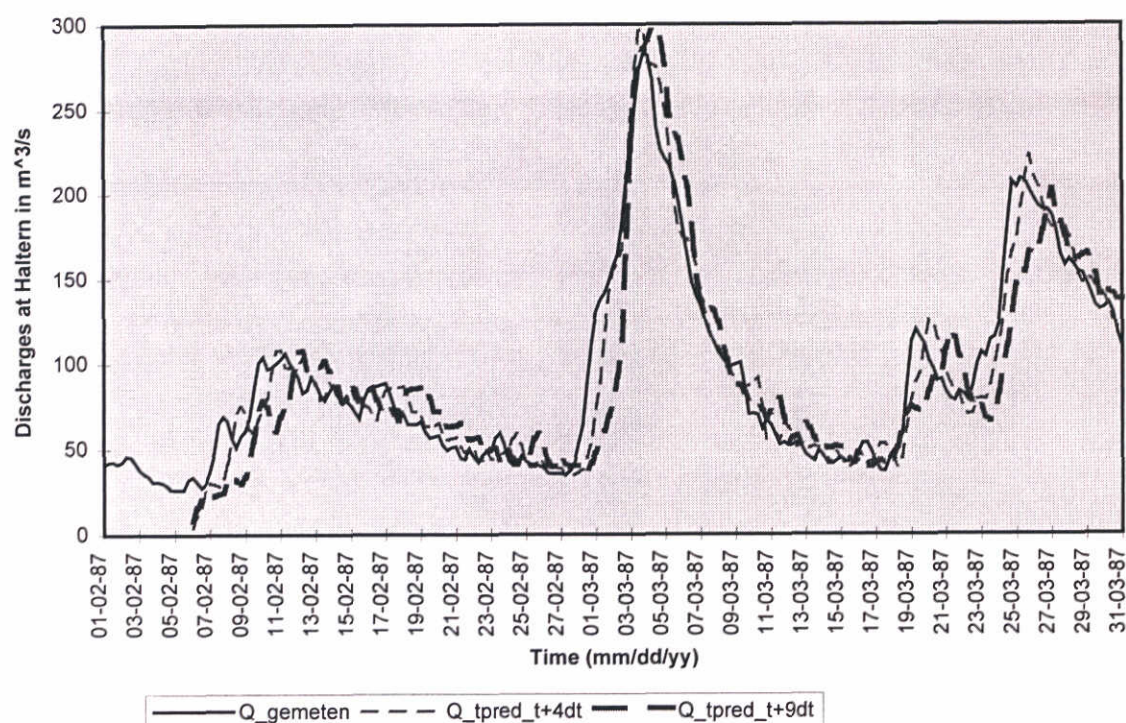
Model Parameters	Stever	Middle Lippe	Upper Lippe
fmin	0.55	0.35	0.35
fmax	5.00	5.00	5.00
kb	0.30	0.10	0.10
psi	0.90	1.00	0.98
kn	23.00	35.00	35.00
nn	2.10	2.20	2.10
alfa (1,1)	0.20	0.20	0.20
alfa (1,2)	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00

Fig. 9.32. Lippe at Haltern, Lippe Level 3, Upper Lippe & Middle Lippe & Stever basins, Validation for Period no. 8.

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	13.6%	87.4%	-44.5%
54	21.0%	75.2%	-50.8%

Lippe Level 3, Upper Lippe & Middle Lippe & Stever, Calibration for Period no. 9



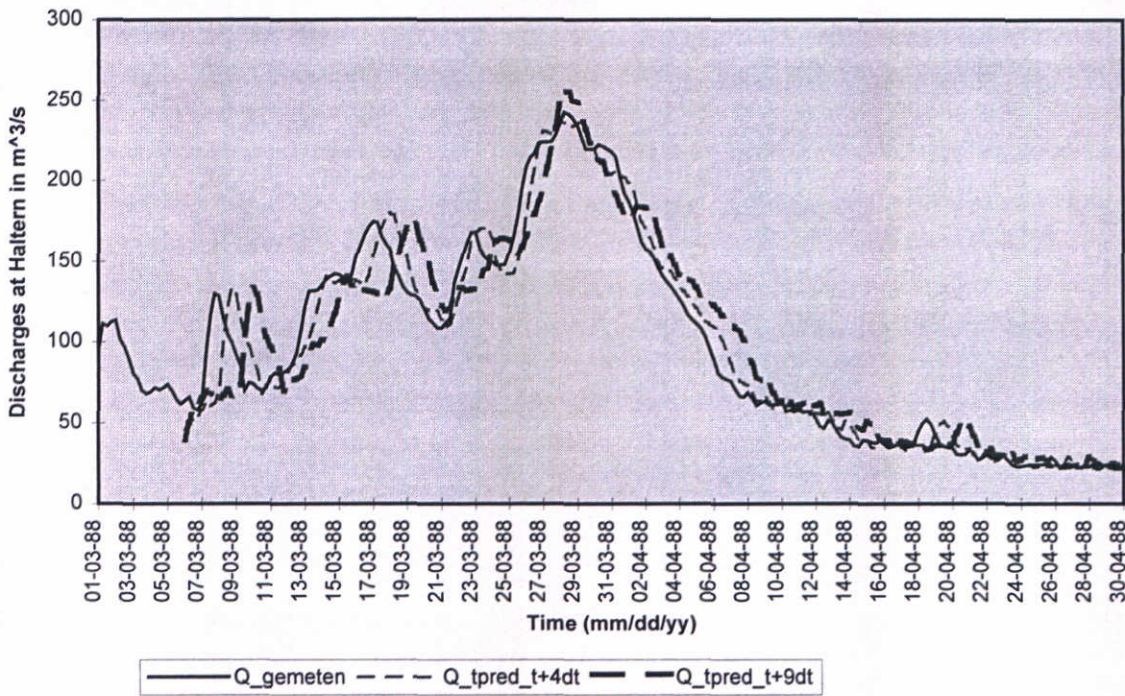
Model Parameters	Stever	Middle Lippe	Upper Lippe
fmin	0.55	0.35	0.35
fmax	5.00	5.00	5.00
kb	0.30	0.10	0.10
psi	0.90	1.00	0.98
kn	23.00	35.00	35.00
nn	2.10	2.20	2.10
alfa (1,1)	0.20	0.20	0.20
alfa (1,2)	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00

Fig. 9.33. Lippe at Haltern, Lippe Level 3, Upper Lippe & Middle Lippe & Stever basins, Calibration for Period no. 9.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	10.2%	51.5%	-46.6%
54	18.7%	50.5%	-80.7%

Lippe Level 3, Upper Lippe & Middle Lippe & Stever, Validation for Period no. 10



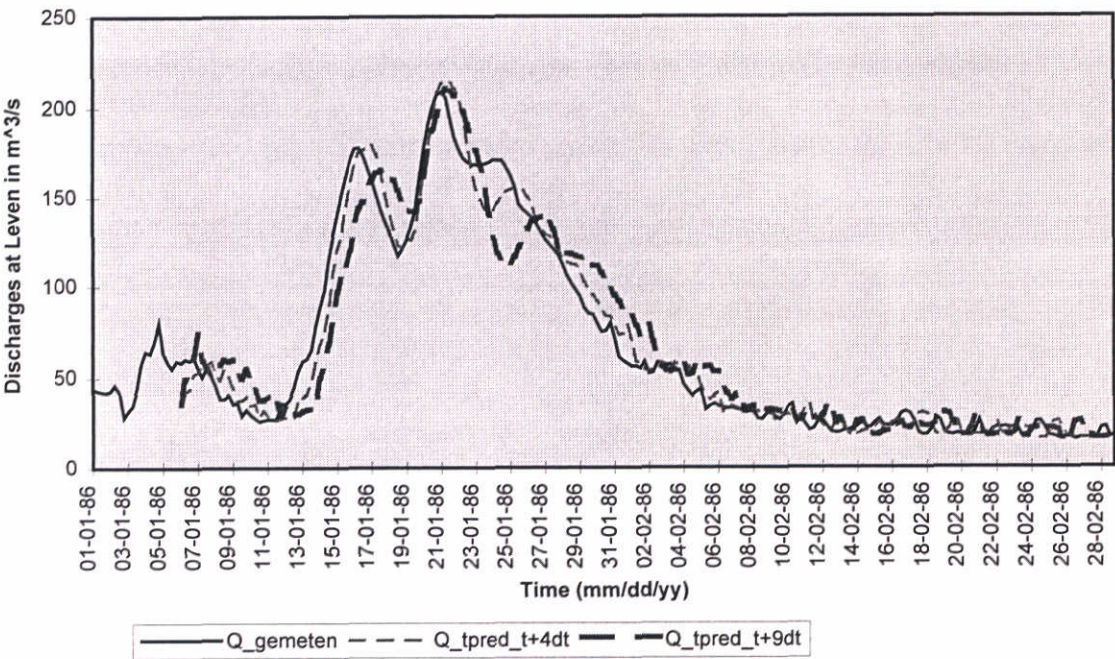
Model Parameters	Stever	Middle Lippe	Upper Lippe
fmin	0.55	0.35	0.35
fmax	5.00	5.00	5.00
kb	0.30	0.10	0.10
psi	0.90	1.00	0.98
kn	23.00	35.00	35.00
nn	2.10	2.20	2.10
alfa (1,1)	0.20	0.20	0.20
alfa (1,2)	0.00	0.05	0.10
alfa (1,3)	0.00	0.00	0.00
alfa (1,4)	0.00	0.00	0.00
alfa (1,5)	0.00	0.00	0.00
alfa (1,6)	0.00	0.00	0.00
alfa (1,7)	0.00	0.00	0.00
alfa (1,8)	0.00	0.00	0.00
alfa (1,9)	0.00	0.00	0.00

Fig. 9.34. Lippe at Haltern, Lippe Level 3, Upper Lippe & Middle Lippe & Stever basins, Validation for Period no. 10.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	14.1%	69.3%	-36.9%
54	22.5%	75.0%	-54.4%

Lippe Level 3, Middle Lippe & Upper Lippe, Validation for Period no. 7



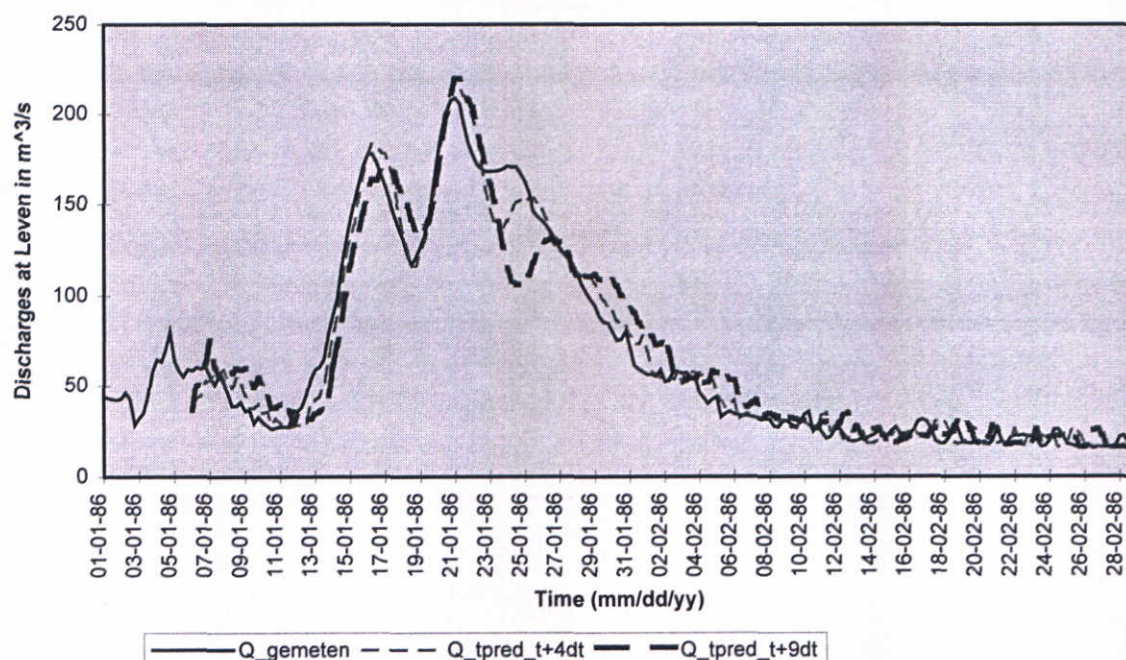
Model parameters	Middle Lippe	Upper Lippe
fmin	0.35	0.35
fmax	5.00	5.00
kb	0.10	0.10
psi	1.00	0.98
kn	35.00	35.00
nn	2.20	2.10
alfa (1,1)	0.20	0.20
alfa (1,2)	0.05	0.10
alfa (1,3)	0.00	0.00
alfa (1,4)	0.00	0.00
alfa (1,5)	0.00	0.00
alfa (1,6)	0.00	0.00
alfa (1,7)	0.00	0.00
alfa (1,8)	0.00	0.00
alfa (1,9)	0.00	0.00
alfa (1,10)	0.00	0.00

Fig. 9.35. Lippe at Leven, Lippe Level 3, Middle Lippe & Upper Lippe basins, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	13.3%	69.3%	-36.9%
54	21.2%	75.0%	-44.6%

Lippe Level 3, Middle Lippe & Upper Lippe, Validation for Period no. 7



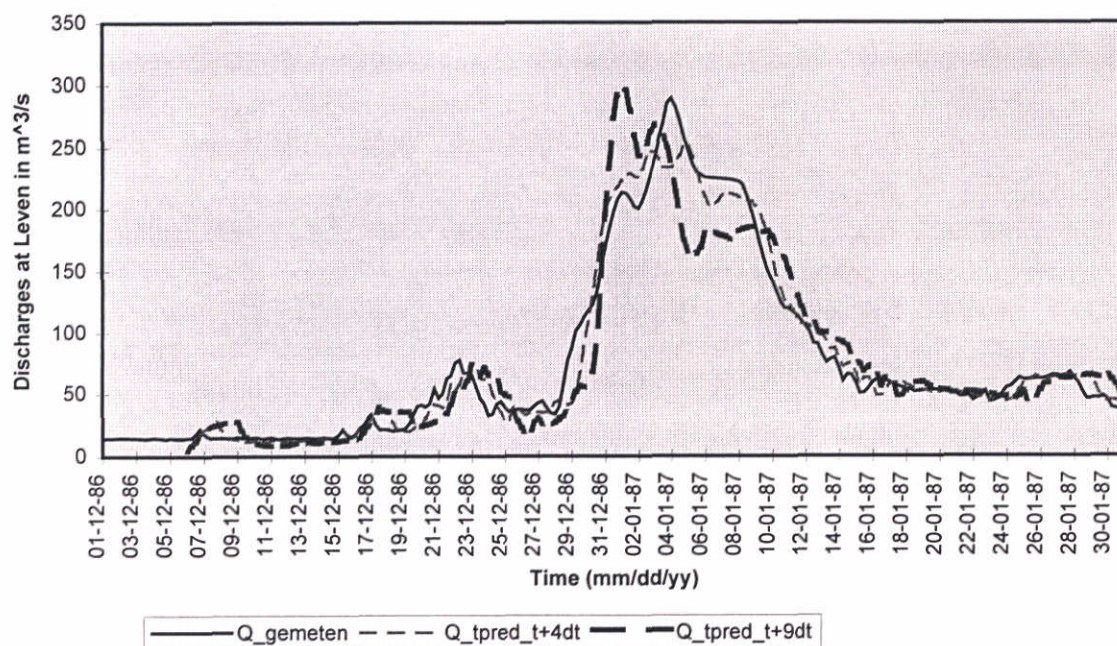
Model parameters	Middle Lippe	Upper Lippe
fmin	0.25	0.35
fmax	5.00	5.00
kb	0.10	0.10
psi	1.00	0.98
kn	35.00	35.00
nn	2.20	2.10
alfa (1,1)	0.20	0.20
alfa (1,2)	0.05	0.10
alfa (1,3)	0.00	0.00
alfa (1,4)	0.00	0.00
alfa (1,5)	0.00	0.00
alfa (1,6)	0.00	0.00
alfa (1,7)	0.00	0.00
alfa (1,8)	0.00	0.00
alfa (1,9)	0.00	0.00
alfa (1,10)	0.00	0.00

Fig. 9.36. Lippe at Leven, Lippe Level 3, Middle Lippe & Upper Lippe basins, Validation for Period no. 7 (fmin=0.25 for Middle Lippe basin).

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	15.1%	91.0%	-65.4%
54	28.3%	103.7%	-65.4%

Lippe Level 3, Middle Lippe & Upper Lippe, Validation for Period no. 8

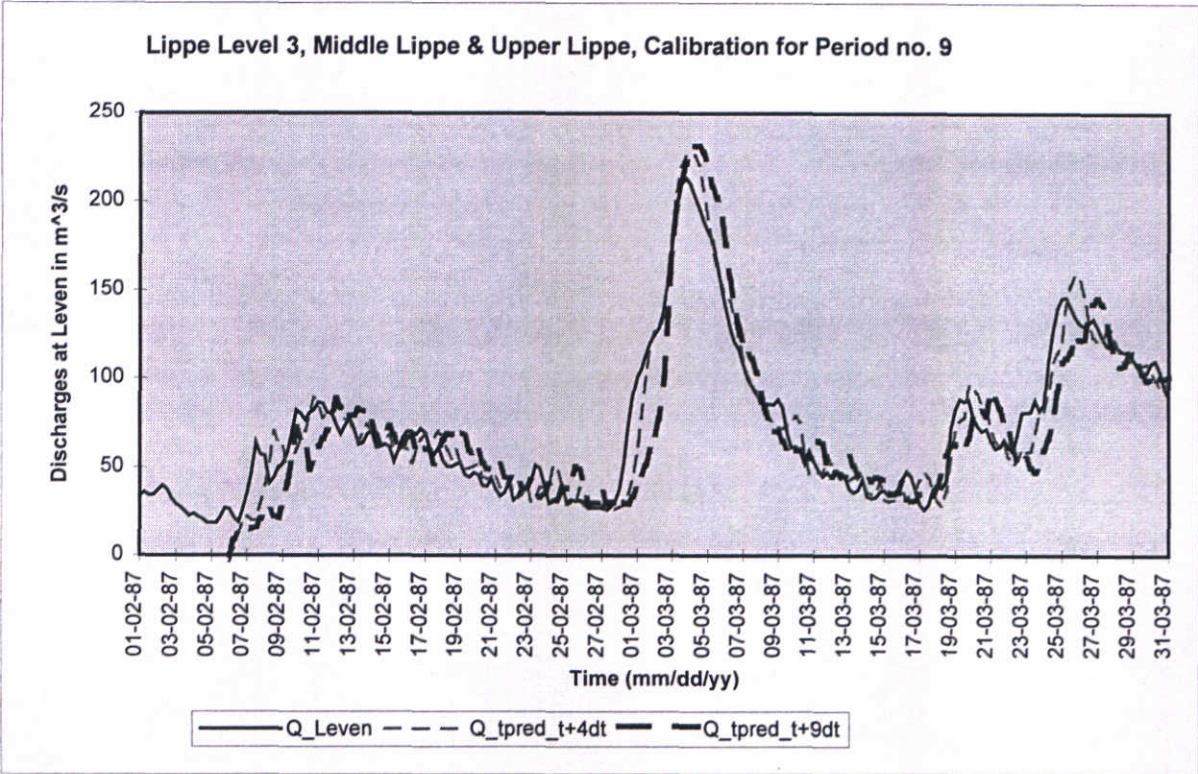


Model parameters	Middle Lippe	Upper Lippe
fmin	0.35	0.35
fmax	5.00	5.00
kb	0.10	0.10
psi	1.00	0.98
kn	35.00	35.00
nn	2.20	2.10
alfa (1,1)	0.20	0.20
alfa (1,2)	0.05	0.10
alfa (1,3)	0.00	0.00
alfa (1,4)	0.00	0.00
alfa (1,5)	0.00	0.00
alfa (1,6)	0.00	0.00
alfa (1,7)	0.00	0.00
alfa (1,8)	0.00	0.00
alfa (1,9)	0.00	0.00
alfa (1,10)	0.00	0.00

Fig. 9.37 Lippe at Leven, Lippe Level 3, Middle Lippe & Upper Lippe basins, Validation for Period no. 8.

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	14.6%	80.4%	-113.1%
54	21.8%	63.3%	-100.6%



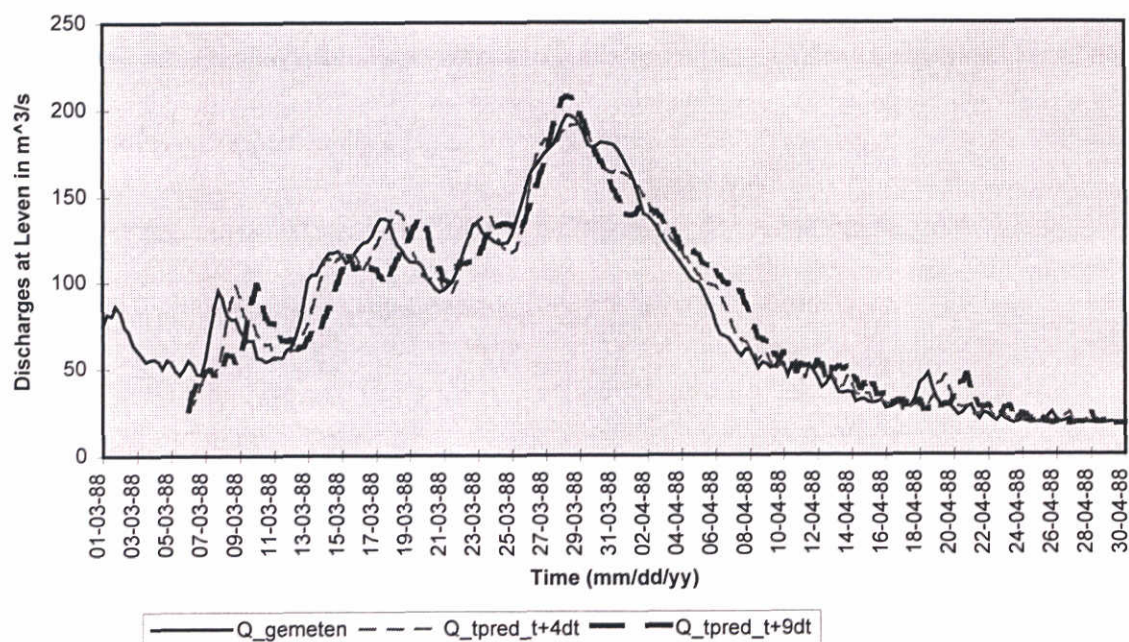
Model parameters	Middle Lippe	Upper Lippe
fmin	0.35	0.35
fmax	5.00	5.00
kb	0.10	0.10
psi	1.00	0.98
kn	35.00	35.00
nn	2.20	2.10
alfa (1,1)	0.20	0.20
alfa (1,2)	0.05	0.10
alfa (1,3)	0.00	0.00
alfa (1,4)	0.00	0.00
alfa (1,5)	0.00	0.00
alfa (1,6)	0.00	0.00
alfa (1,7)	0.00	0.00
alfa (1,8)	0.00	0.00
alfa (1,9)	0.00	0.00
alfa (1,10)	0.00	0.00

Fig. 9.38 Lippe at Leven, Lippe Level 3, Middle Lippe & Upper Lippe basins, Calibration for Period no. 9.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum local Efficiency
24	9.8%	63.2%	-52.9%
54	18.4%	78.5%	-51.5%

Lippe Level 3, Middle Lippe & Upper Lippe, Validation for Period no. 10

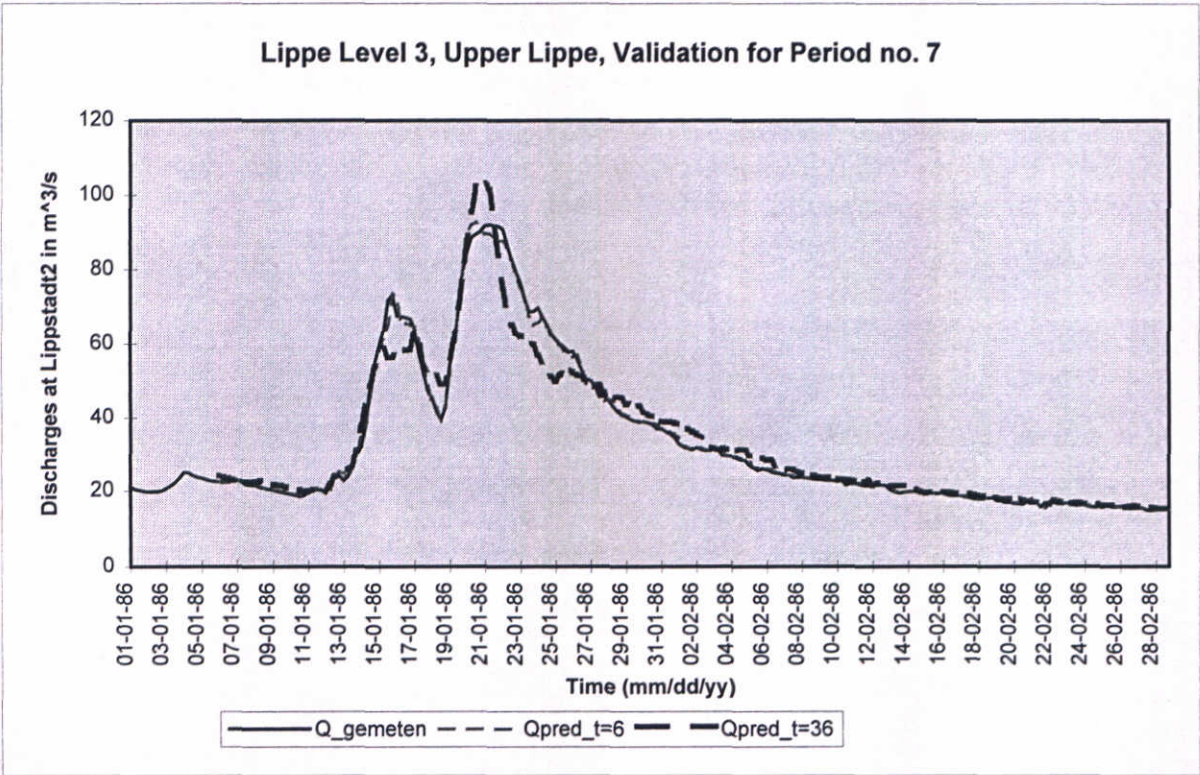


Model parameters	Middle Lippe	Upper Lippe
fmin	0.35	0.35
fmax	5.00	5.00
kb	0.10	0.10
psi	1.00	0.98
kn	35.00	35.00
nn	2.20	2.10
alfa (1,1)	0.20	0.20
alfa (1,2)	0.05	0.10
alfa (1,3)	0.00	0.00
alfa (1,4)	0.00	0.00
alfa (1,5)	0.00	0.00
alfa (1,6)	0.00	0.00
alfa (1,7)	0.00	0.00
alfa (1,8)	0.00	0.00
alfa (1,9)	0.00	0.00
alfa (1,10)	0.00	0.00

Fig. 9.39. Lippe at Leven, Lippe Level 3, Middle Lippe & Upper Lippe basins, Validation for Period no. 10.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	1.8%	9.2%	-10.4%
12	3.1%	13.3%	-13.1%
18	4.1%	15.7%	-18.6%
24	4.9%	17.9%	-19.0%
30	5.9%	21.7%	-22.6%
36	6.9%	22.7%	-24.5%

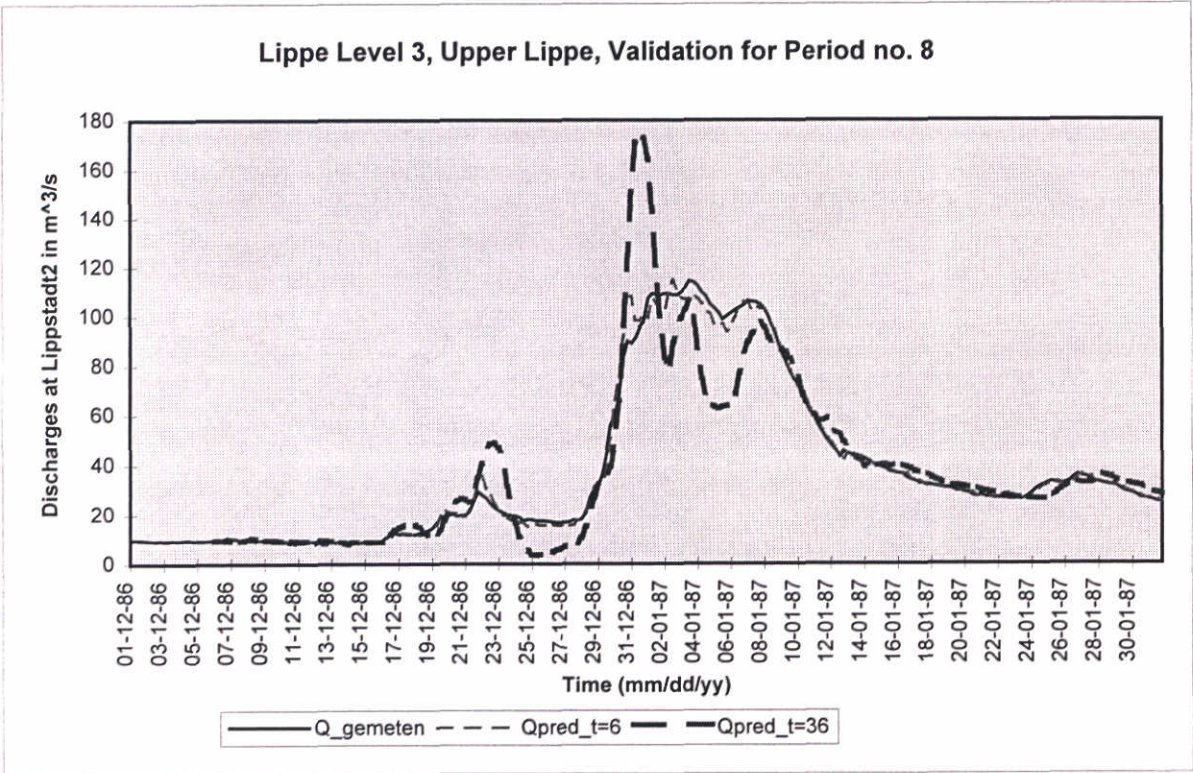


Model parameters			
fmin	0.35	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.10
kb	0.10	alfa (1,3)	0.00
psi	0.98	alfa (1,4)	0.00
kn	35.00	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.40. Lippe at Lippstad2, Lippe Level 3, Upper Lippe basin, Validation for Period no. 7.

SUMMARY OF VALIDATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	3.8%	16.3%	-27.4%
12	7.6%	30.3%	-49.6%
18	10.8%	43.1%	-74.4%
24	13.6%	55.9%	-89.9%
30	16.2%	67.9%	-104.9%
36	18.7%	79.5%	-114.6%

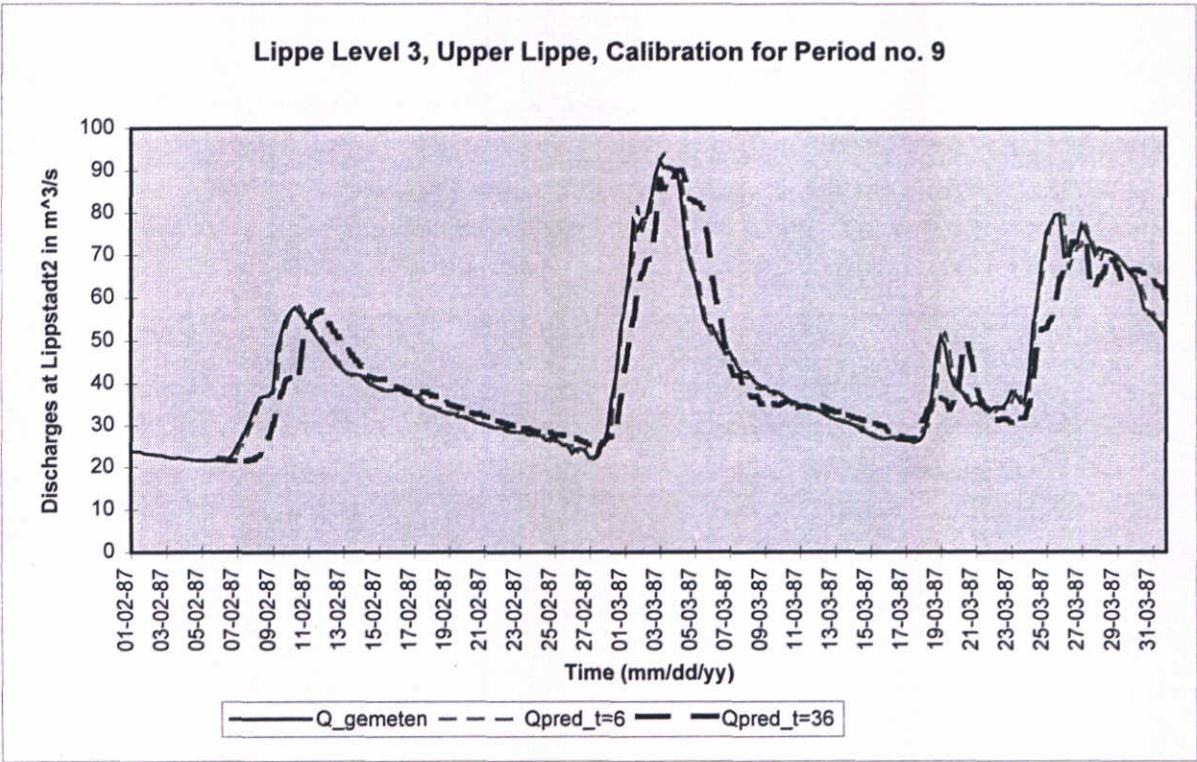


Model parameters			
fmin	0.35	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.10
kb	0.10	alfa (1,3)	0.00
psi	0.98	alfa (1,4)	0.00
kn	35.00	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.41. Lippe at Lippstadt2, Lippe Level 3, Upper Lippe basin, Validation for Period no. 8.

SUMMARY OF CALIBRATION RESULTS:

Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	2.5%	17.0%	-14.0%
12	4.8%	25.9%	-21.2%
18	6.7%	30.7%	-28.3%
24	8.3%	33.9%	-30.9%
30	9.8%	33.4%	-38.3%
36	11.2%	37.1%	-46.8%



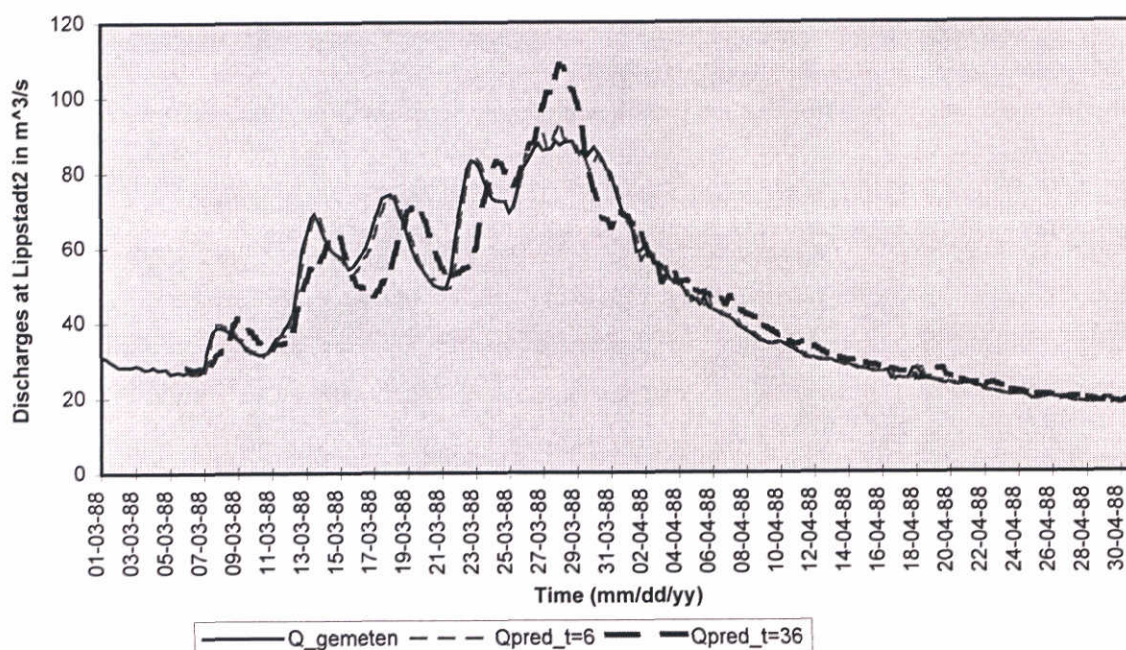
Model parameters			
fmin	0.35	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.10
kb	0.10	alfa (1,3)	0.00
psi	0.98	alfa (1,4)	0.00
kn	35.00	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.42. Lippe at Lippstadt2, Lippe Level 3, Upper Lippe basin, Calibration for Period no. 9.

SUMMARY OF VALIDATION RESULTS:

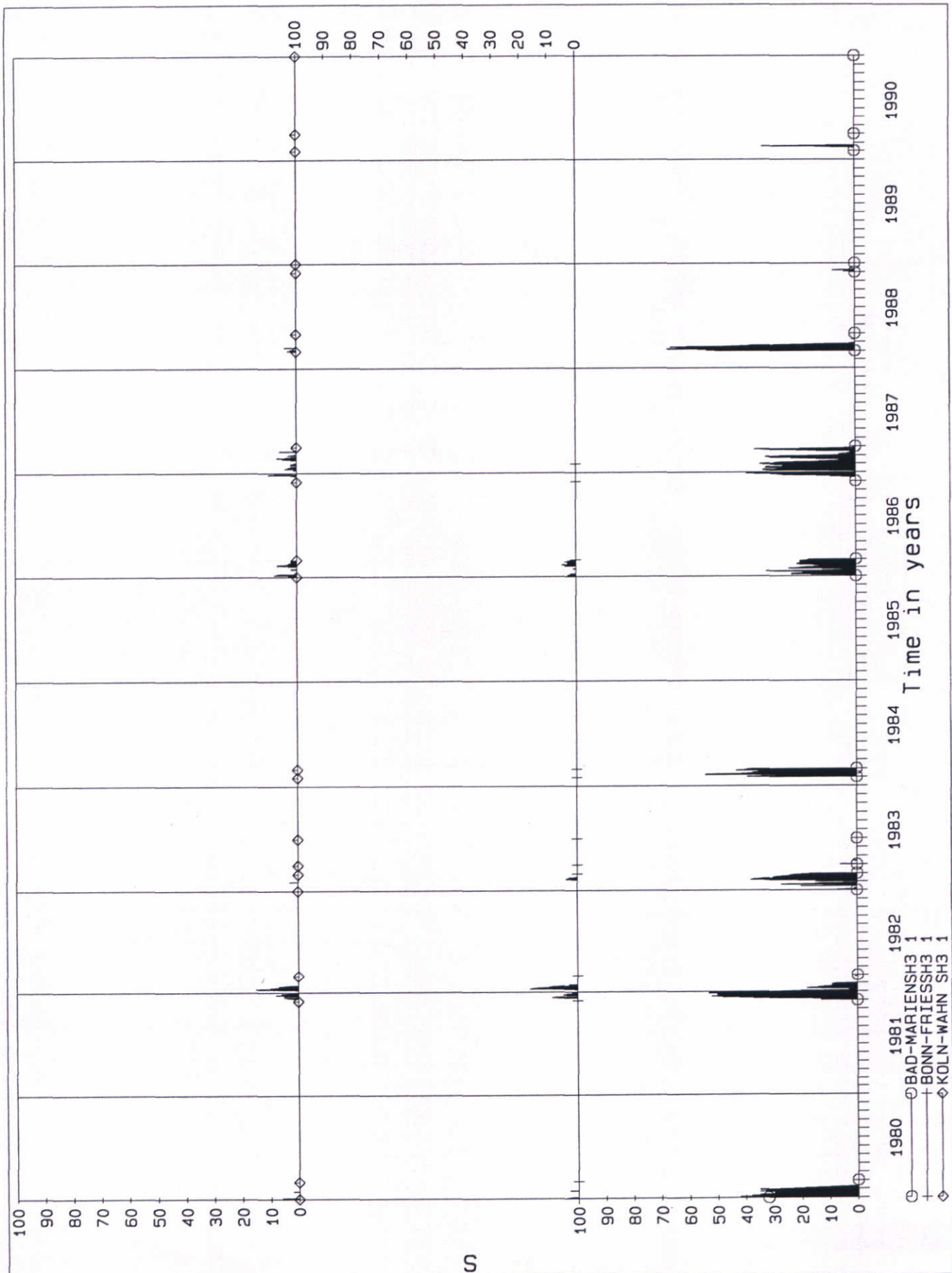
Prediction in hours in advance	Mean Absolute Efficiency	Maximum Local Efficiency	Minimum Local Efficiency
6	2.0%	11.0%	-9.1%
12	3.8%	17.9%	-10.5%
18	5.4%	23.5%	-16.2%
24	6.9%	27.7%	-20.6%
30	8.2%	31.7%	-25.4%
36	9.4%	32.8%	-28.3%

Lippe Level 3, Upper Lippe, Validation for Period no. 10

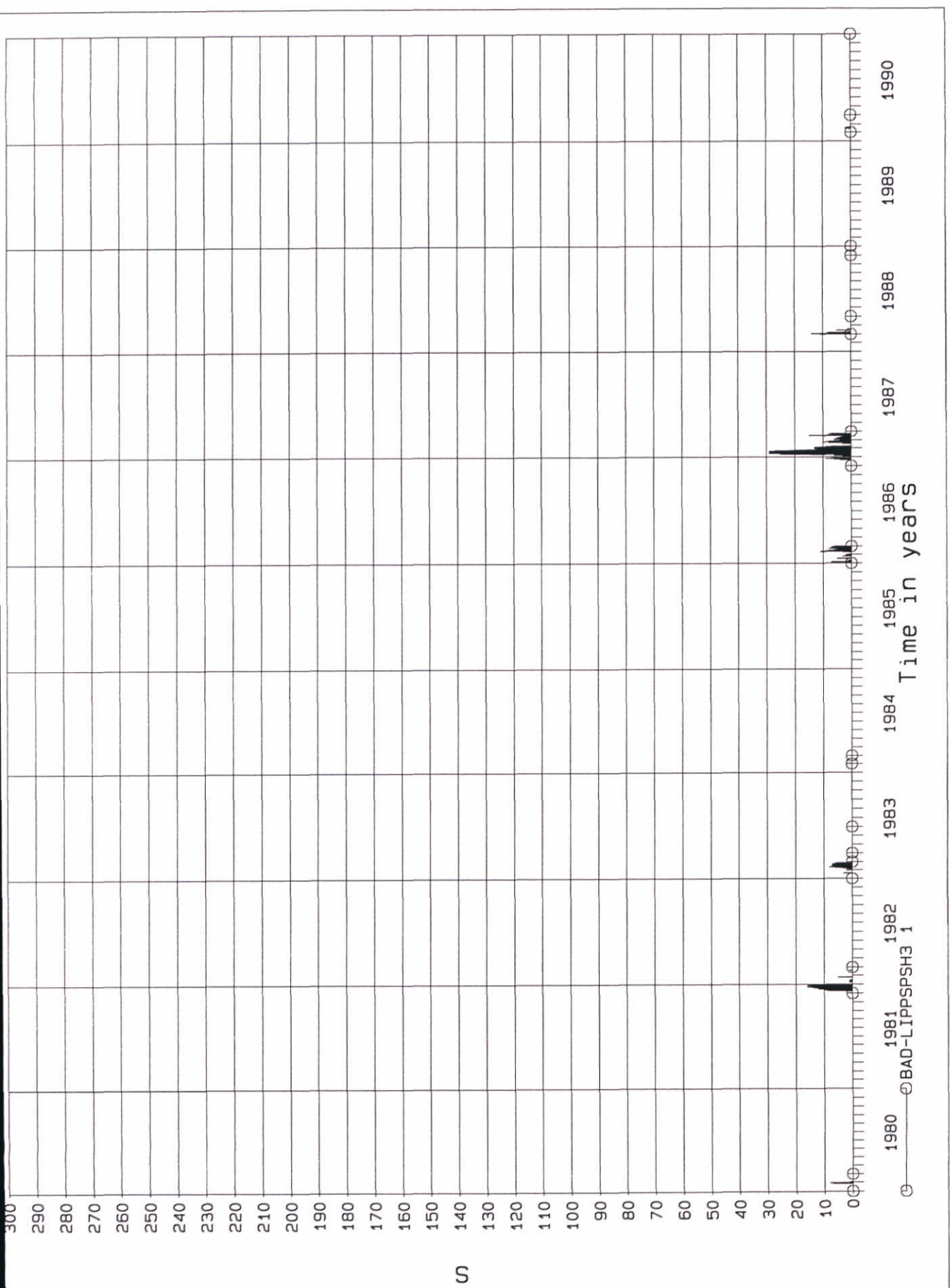


Model parameters			
fmin	0.35	alfa (1,1)	0.20
fmax	5.00	alfa (1,2)	0.10
kb	0.10	alfa (1,3)	0.00
psi	0.98	alfa (1,4)	0.00
kn	35.00	alfa (1,5)	0.00
nn	2.10	alfa (1,6)	0.00
		alfa (1,7)	0.00
		alfa (1,8)	0.00
		alfa (1,9)	0.00
		alfa (1,10)	0.00

Fig. 9.43. Lippe at Lippstadt2, Lippe Level 3, Upper Lippe basin, Validation for Period no. 10.



Observed snowheights in the Sieg basin



Observed snowheights in Lippe basin

Figures of Chapter 10

- Fig. 10.1A Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead.
- Fig. 10.1b. Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead.
- Fig. 10.2a. Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead.
- Fig. 10.2b Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead.
- Fig. 10.3a. Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead.
- Fig. 10.3b. Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead.
- Fig. 10.3c. Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} for 60 hours ahead.
- Fig. 10.4a. Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead
- Fig. 10.4b. Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead
- Fig. 10.4c. Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min} for 60 hours ahead
- Fig. 10.5. Sieg Level 1, Results of rainfall sensitivity analysis for Period no. 5.
- Fig. 10.6. Sieg Level 1, Results of rainfall sensitivity analysis for Period no. 12.
- Fig. 10.7a. Lippe Level 1, Results of rainfall sensitivity analysis for Period no. 7.
- Fig. 10.7b. Lippe Level 1, Results of rainfall sensitivity analysis for Period no. 7.
- Fig. 10.8a. Lippe Level 1, Results of rainfall sensitivity analysis for Period no. 9.
- Fig. 10.8b. Lippe Level 1, Results of rainfall sensitivity analysis for Period no. 9.
- Fig. 10.9. Sieg, Period no. 5, LUA-NRW areal rainfall and DWD areal rainfall.
- Fig. 10.10. Sieg, Period no. 12, LUA-NRW areal rainfall and DWD areal rainfall.
- Fig. 10.11. Sieg, Period no. 5 & 12, Correlation between LUA-NRW and DWD areal rainfall.
- Fig. 10.12. Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.30$ was used.
- Fig. 10.13. Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.30$ for LUA-NRW & $f_{min}=0.10$ for DWD.
- Fig. 10.14. Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.30$ for LUA-NRW & $f_{min}=0.50$ for DWD.
- Fig. 10.15. Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.40$ was used.
- Fig. 10.16. Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.40$ for LUA-NRW & $f_{min}=0.20$ for DWD.
- Fig. 10.17. Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.40$ for LUA-NRW & $f_{min}=0.60$ for DWD.
- Fig. 10.18. Lippe, Period no. 7, LUA-NRW areal rainfall and DWD areal rainfall.
- Fig. 10.19. Lippe, Period no. 9, LUA-NRW areal rainfall and DWD areal rainfall.
- Fig. 10.20. Lippe, Period no. 7 & 9, Correlation between LUA-NRW and DWD areal rainfall.
- Fig. 10.21a. Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.
- Fig. 10.21b. Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.
- Fig. 10.22a. Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.10$ for DWD.
- Fig. 10.22b. Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.10$ for DWD.

Figures of Chapter 10 (continued)

- Fig. 10.23a. Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.30$ for DWD.
- Fig. 10.23b. Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.30$ for DWD.
- Fig. 10.24a. Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.
- Fig. 10.24b. Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.
- Fig. 10.25a. Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.10$ for DWD.
- Fig. 10.25b. Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.10$ for DWD.
- Fig. 10.26a. Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.30$ for DWD.
- Fig. 10.26b. Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min}=0.30$ for DWD.

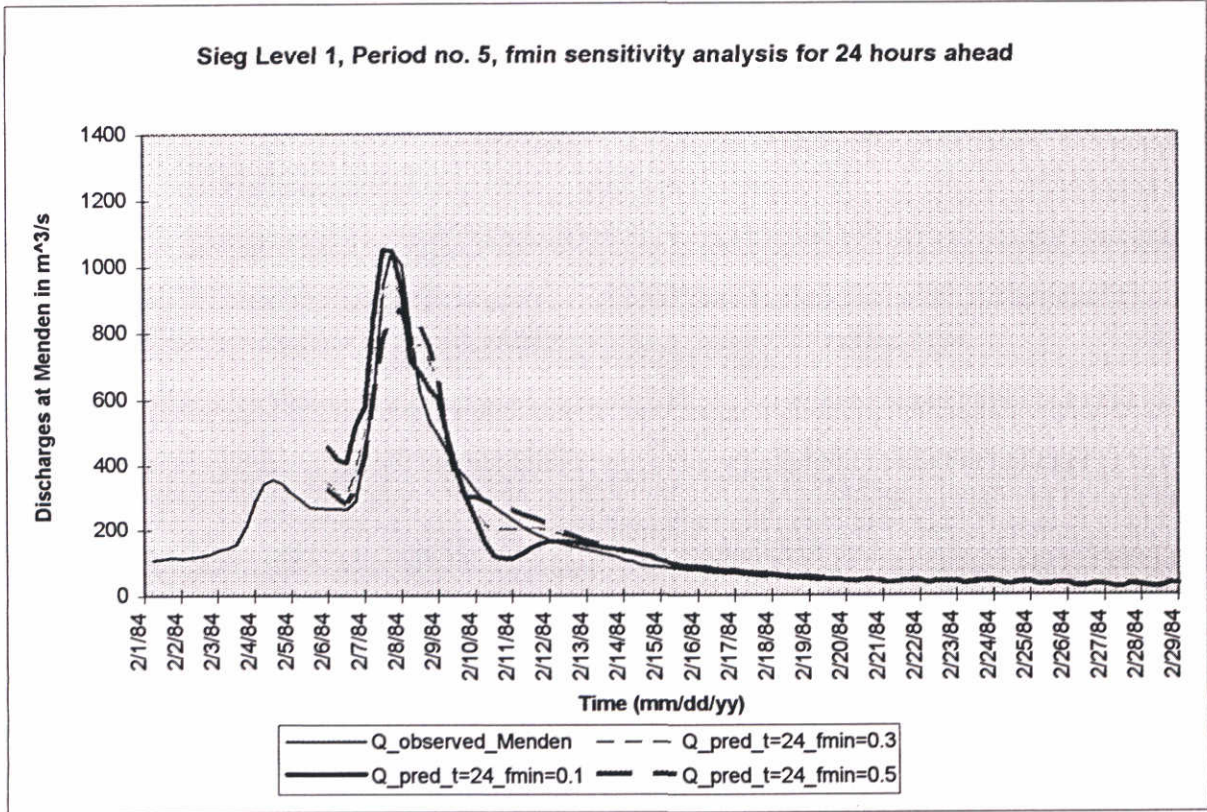
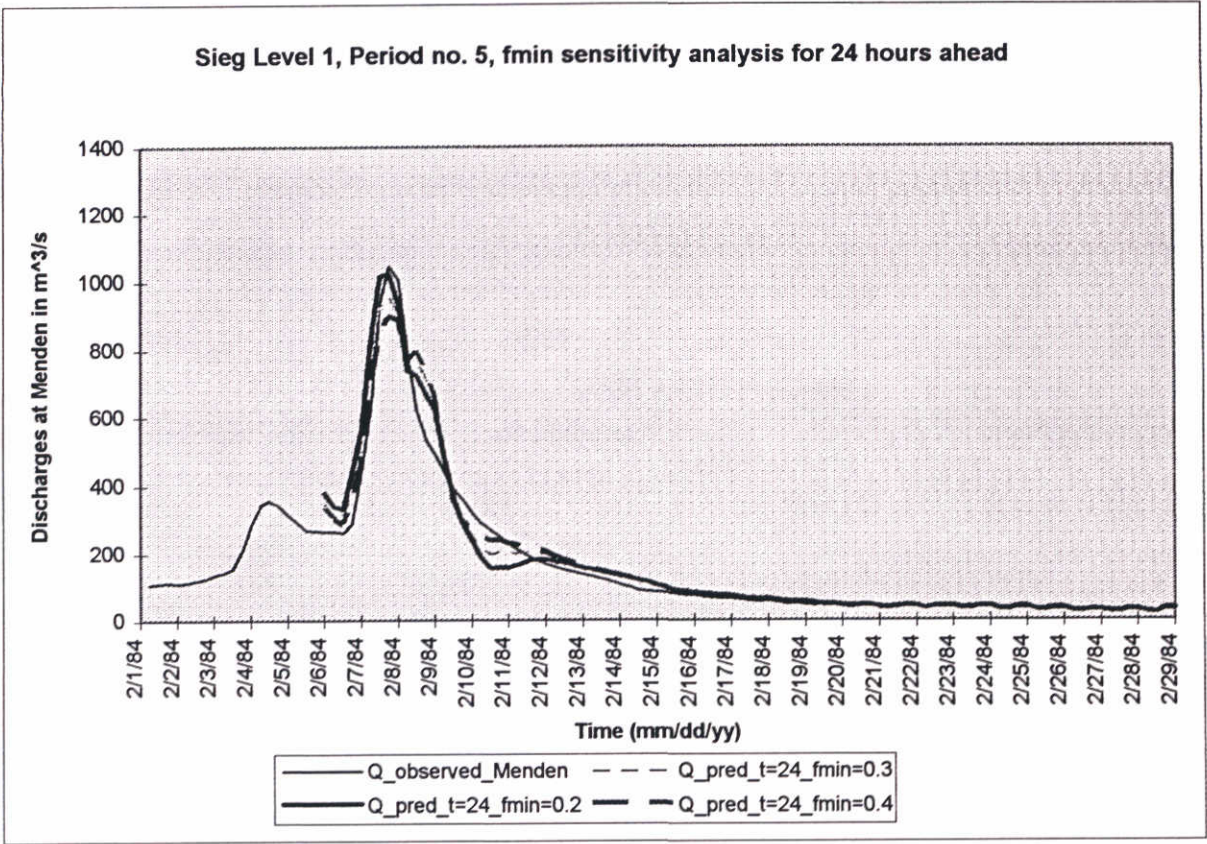


Fig. 10.1a Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead.

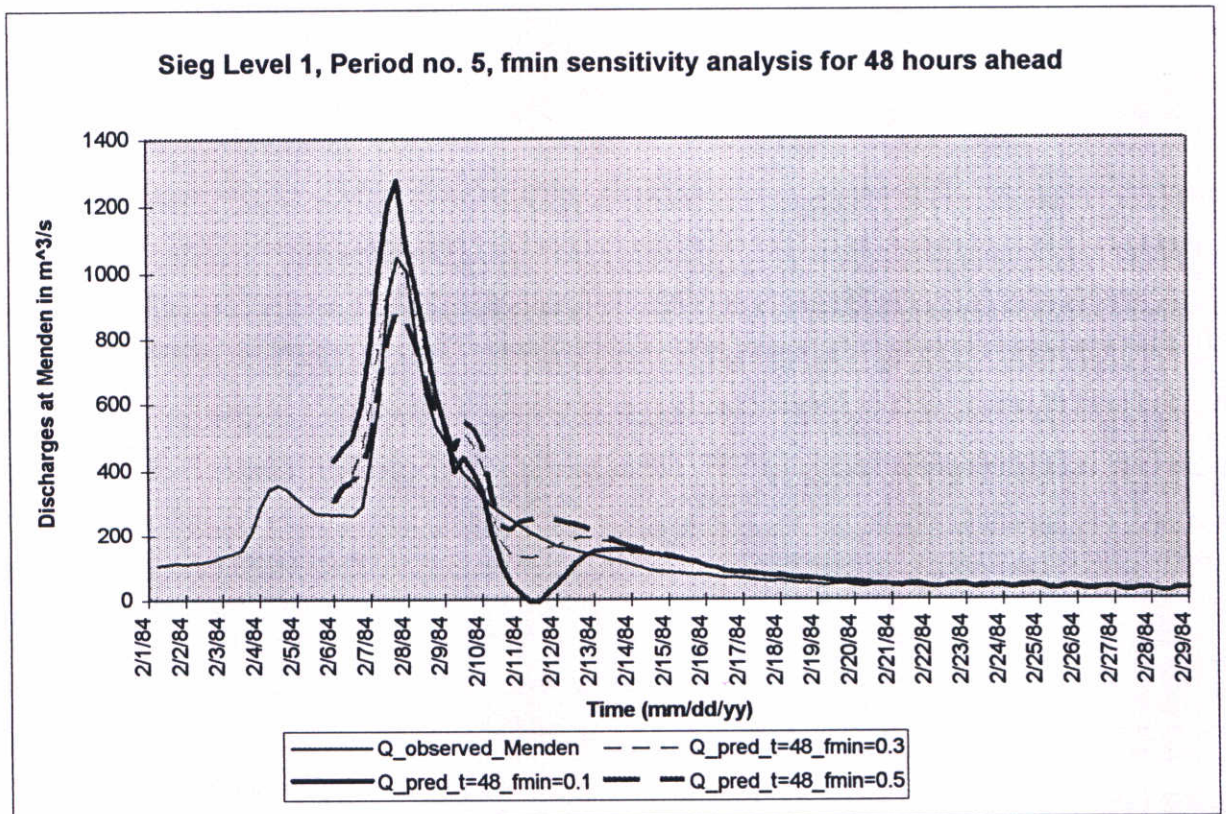
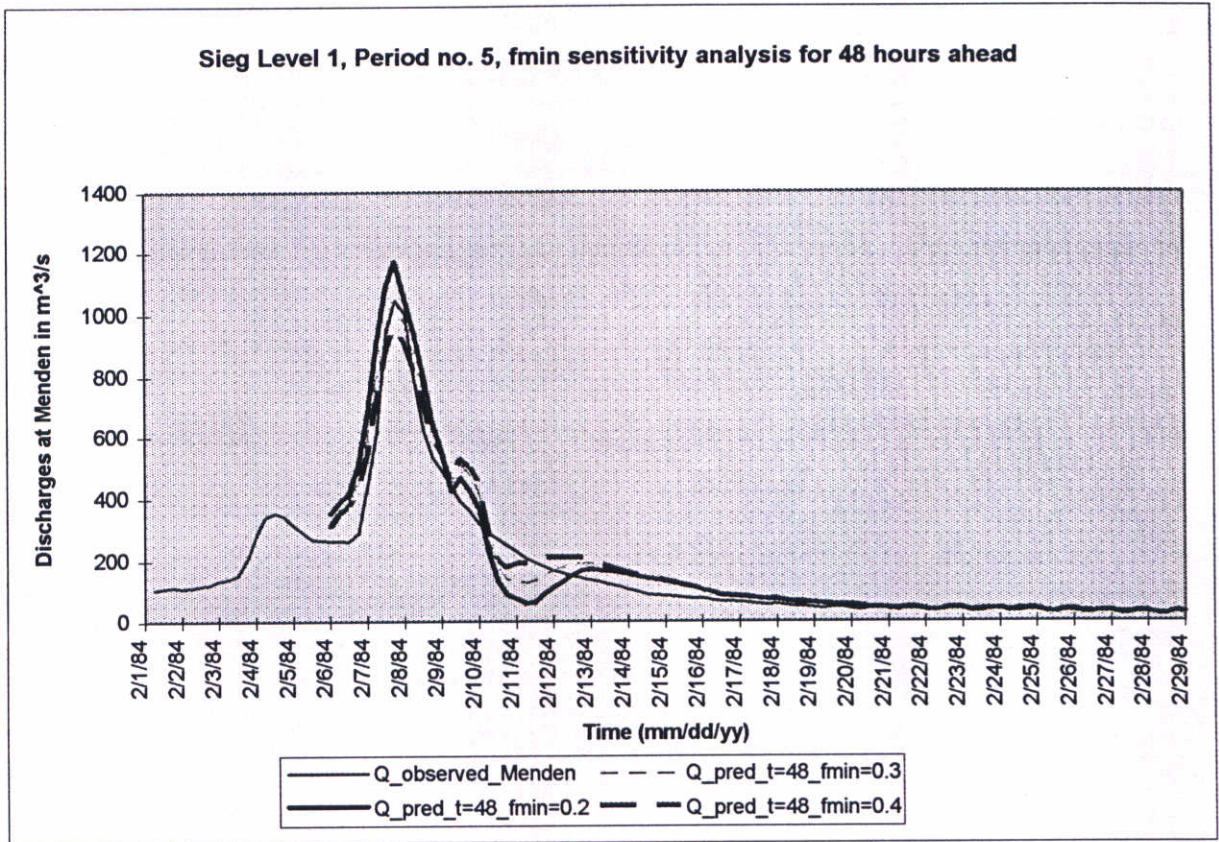


Fig. 10.1b Sieg Level 1, Period no. 5, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead.

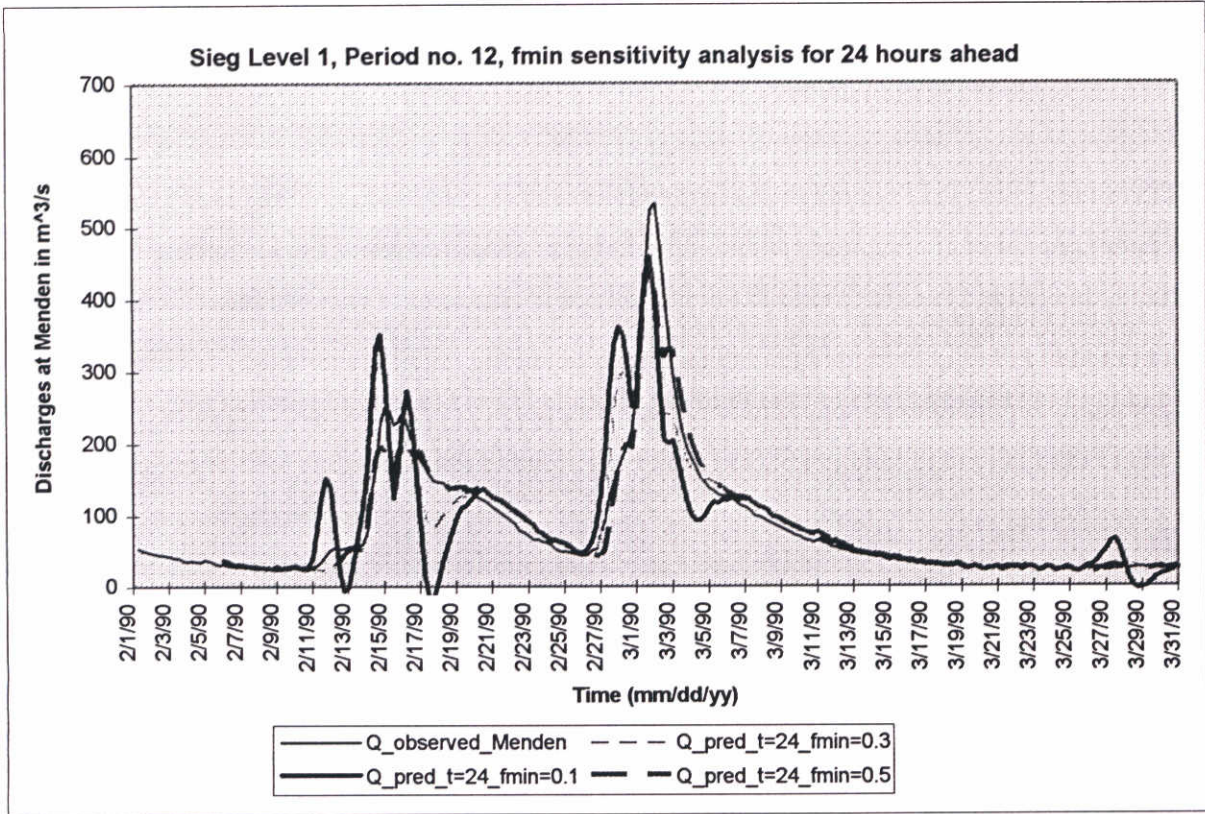
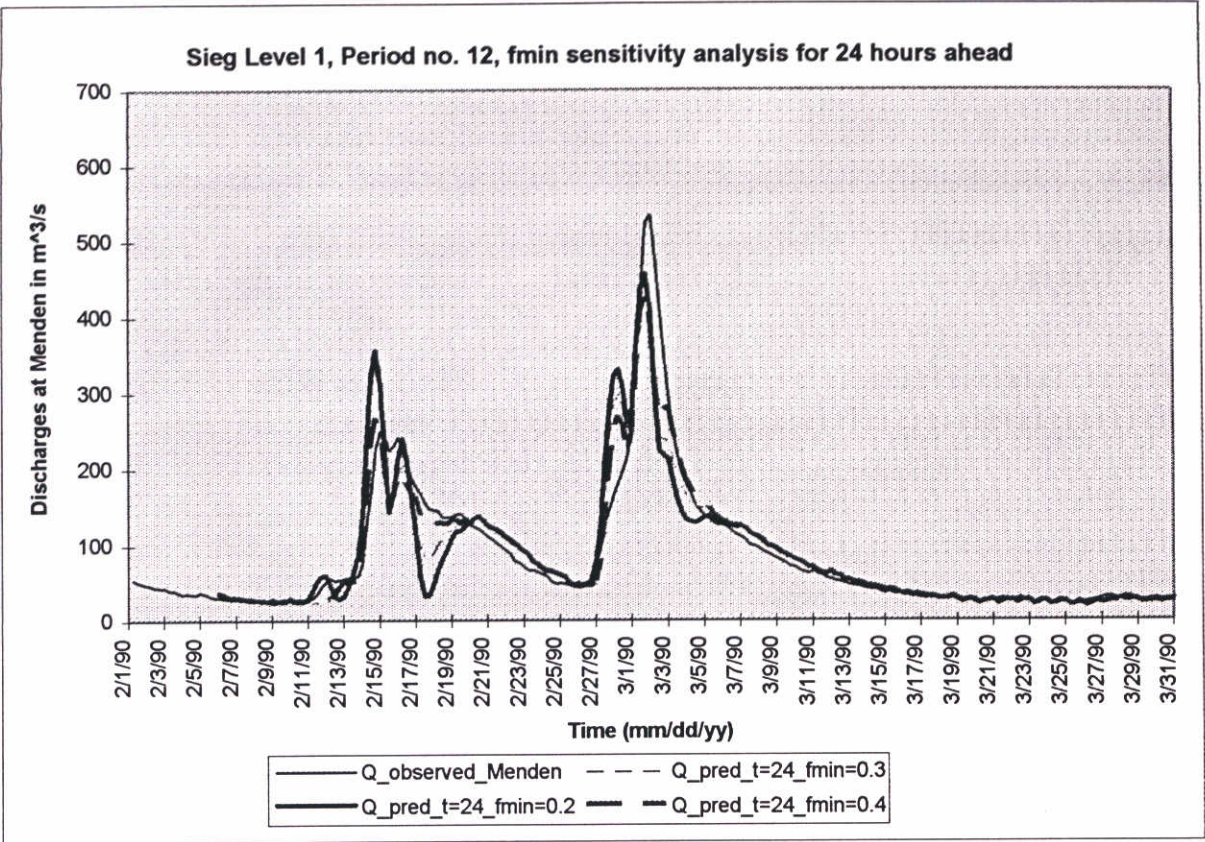


Fig. 10.2a Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead.

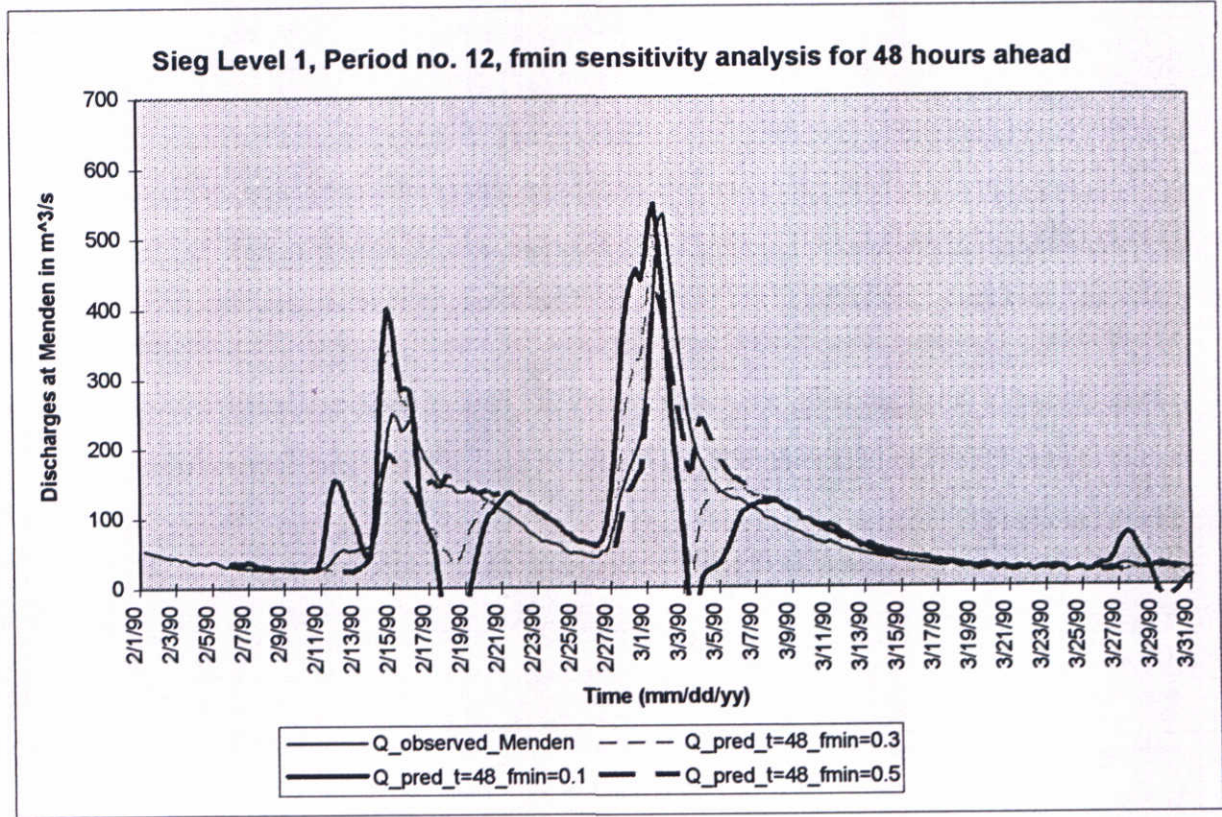
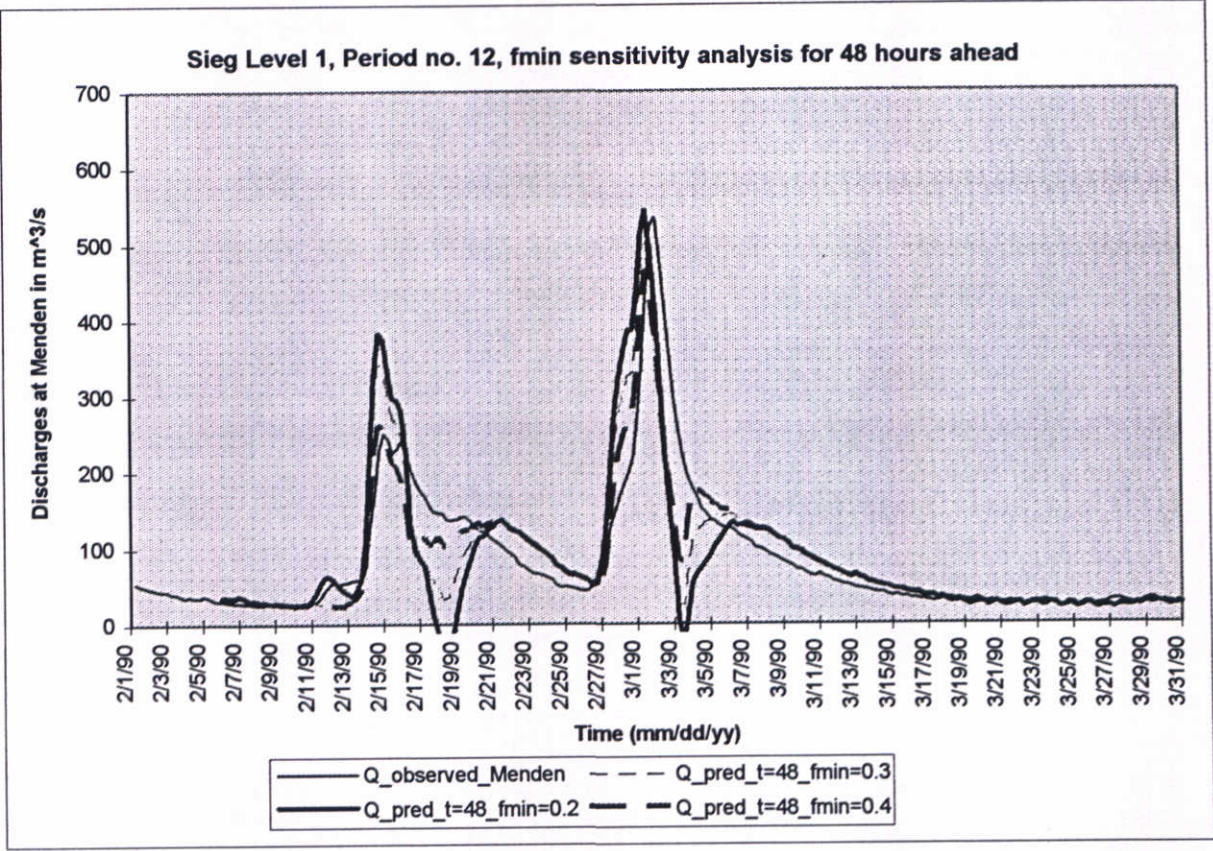


Fig. 10.2b Sieg Level 1, Period no. 12, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead.

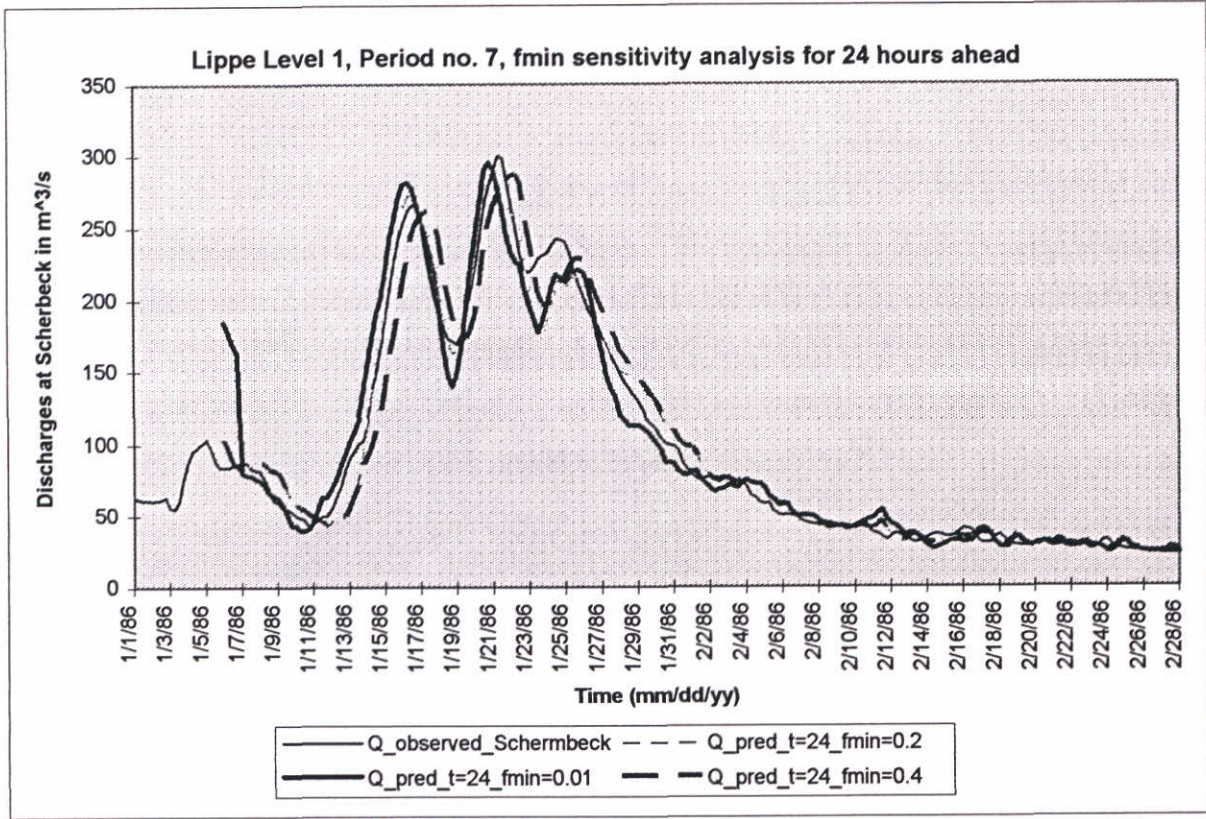
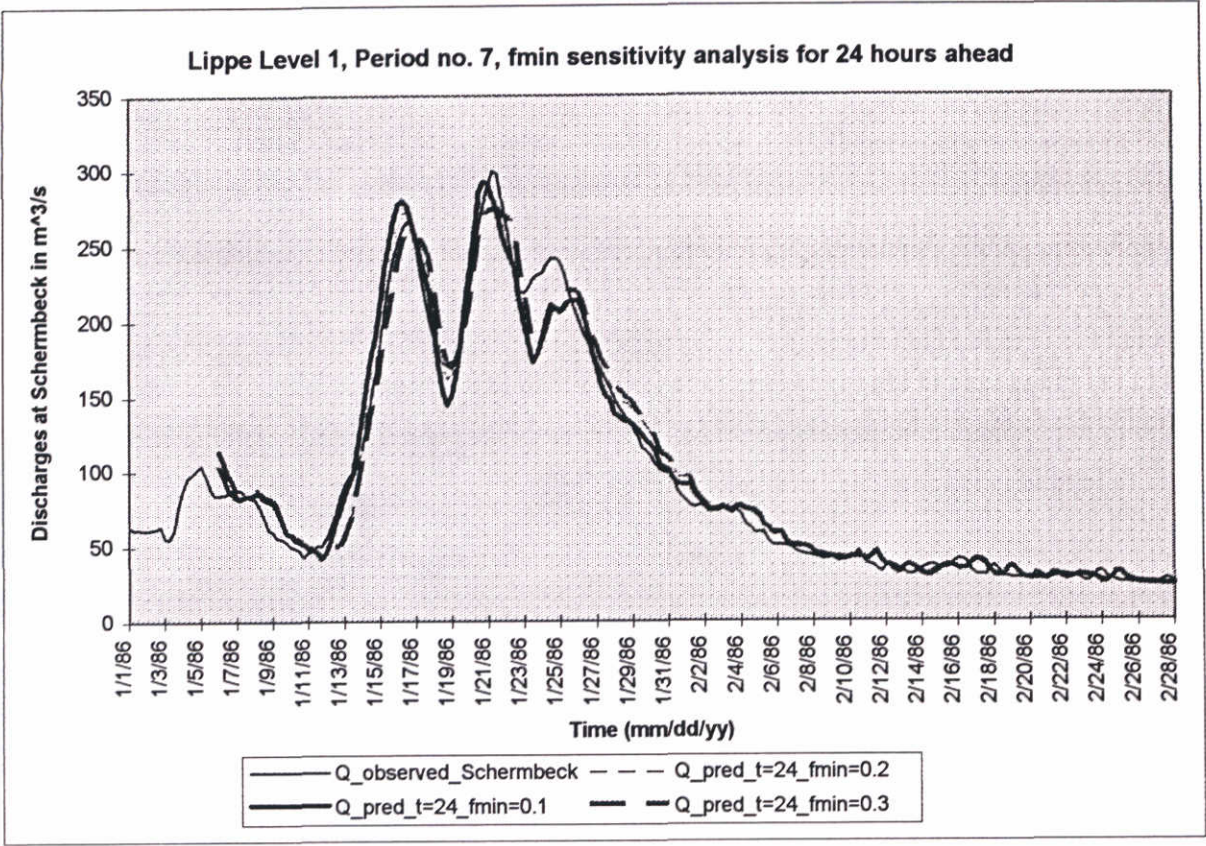


Fig. 10.3a Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead.

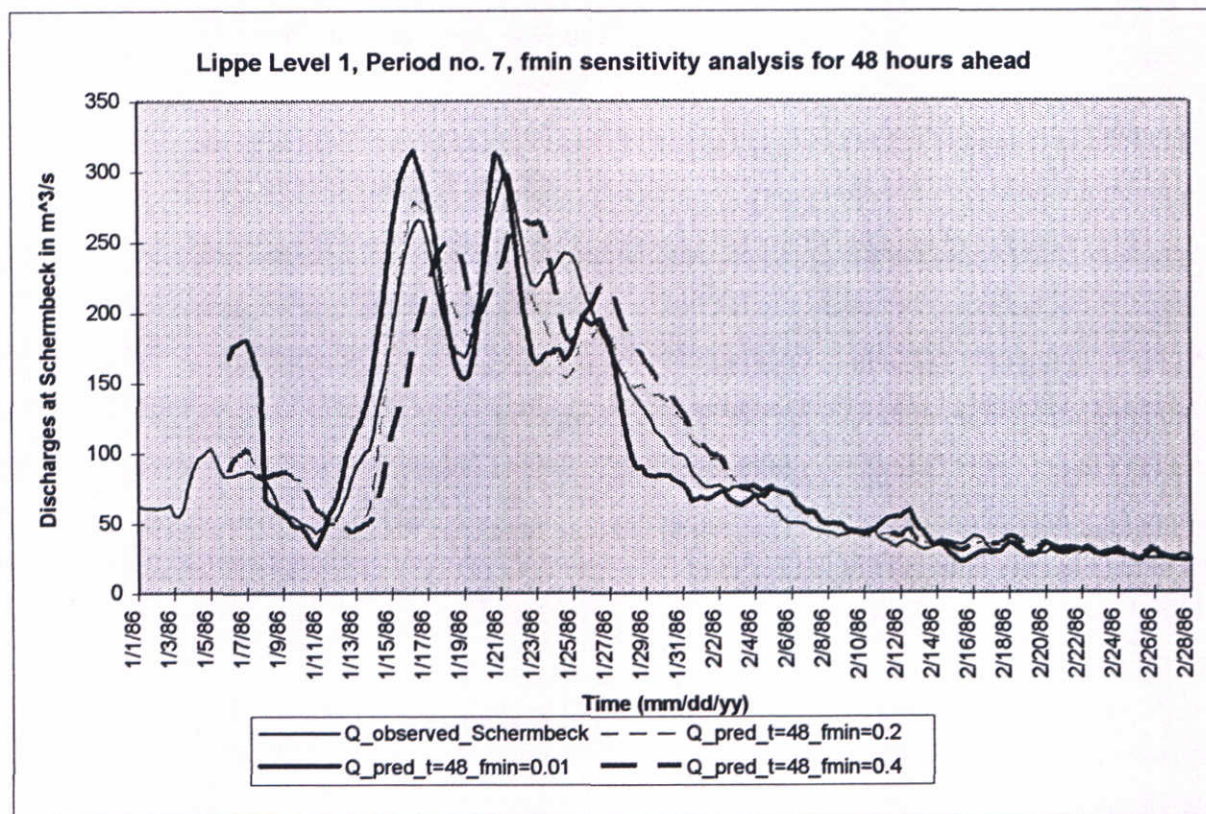
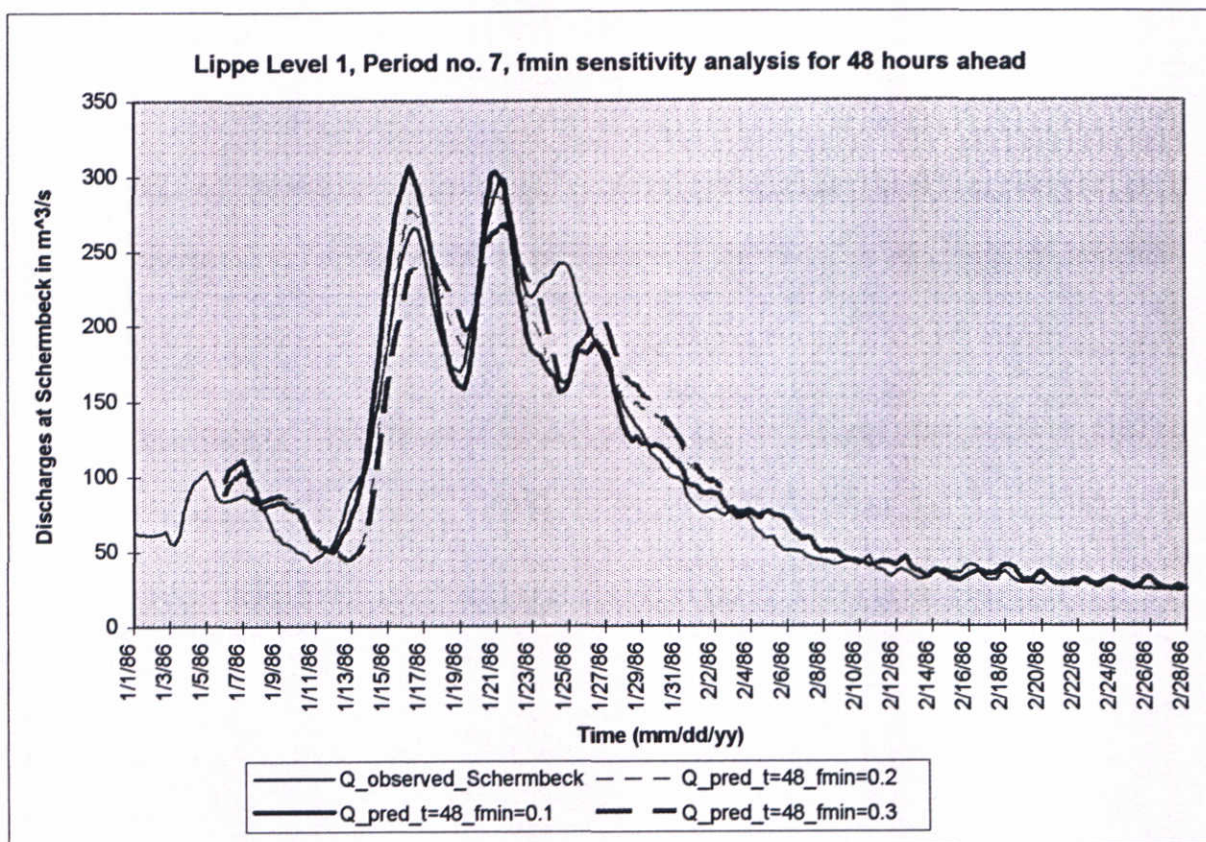


Fig. 10.3b Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} for 48 hours ahead.

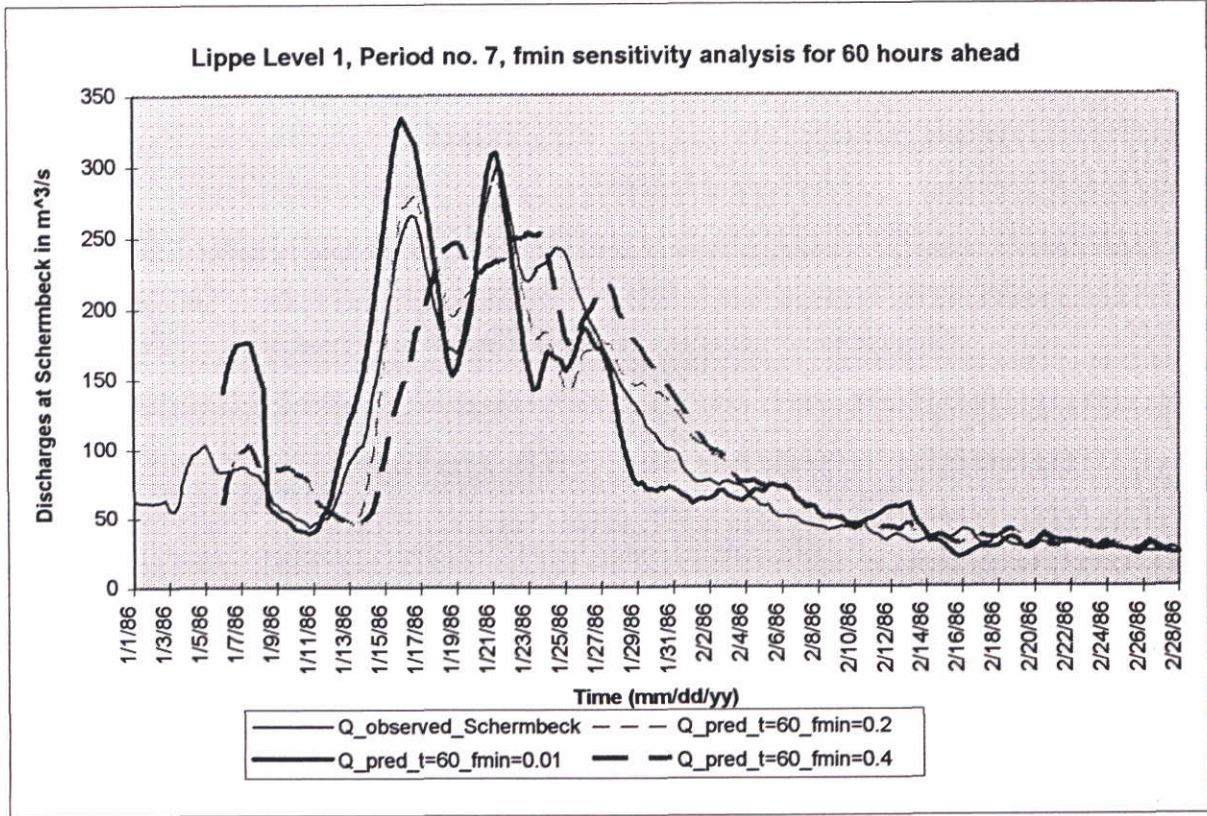
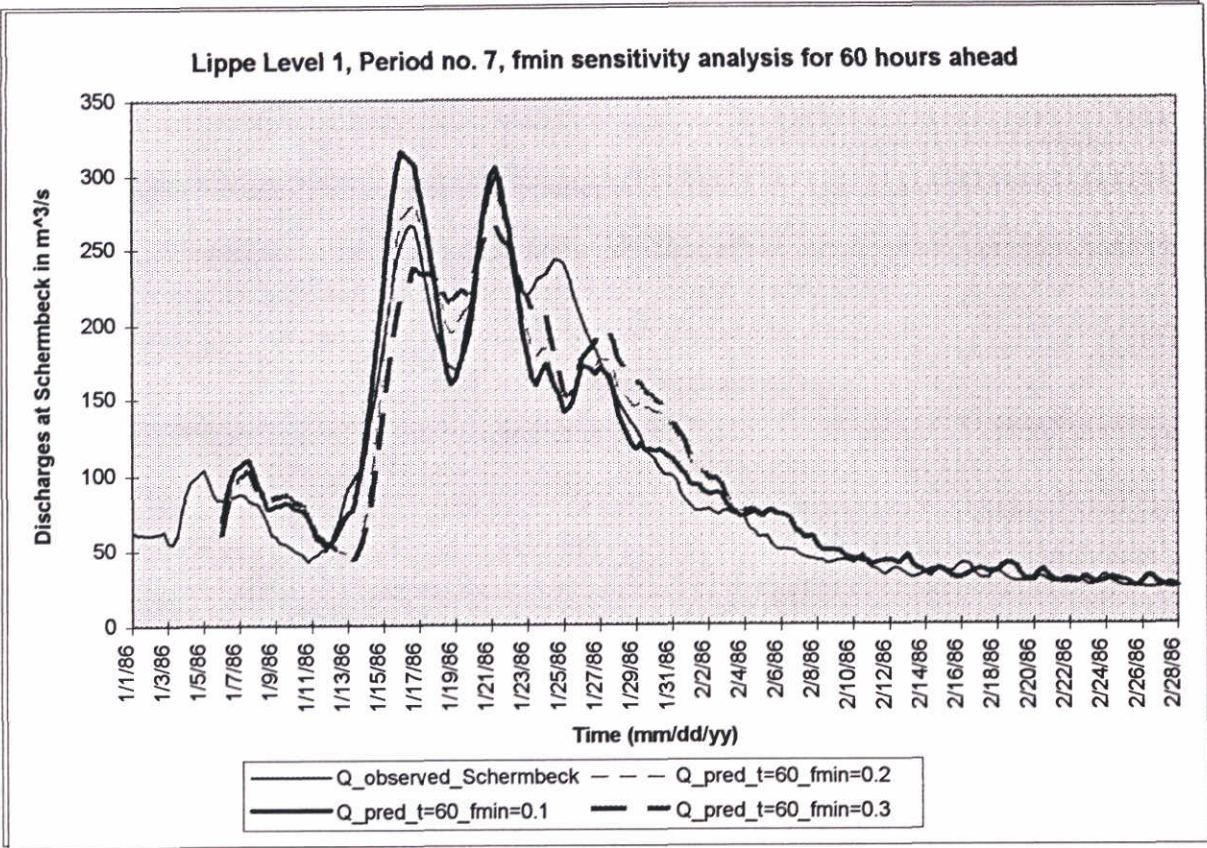


Fig. 10.3c Lippe Level 1, Period no. 7, Results of sensitivity for the minimum infiltration capacity f_{min} for 60 hours ahead.

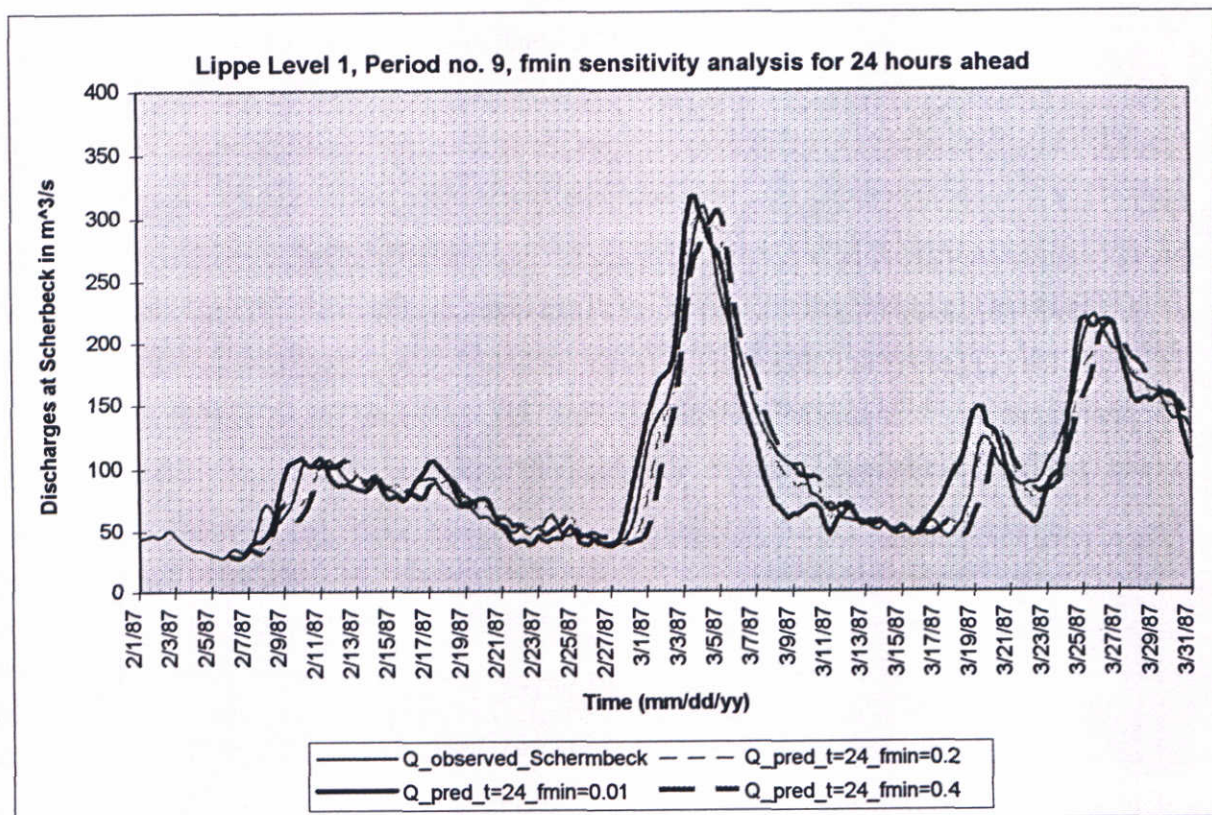
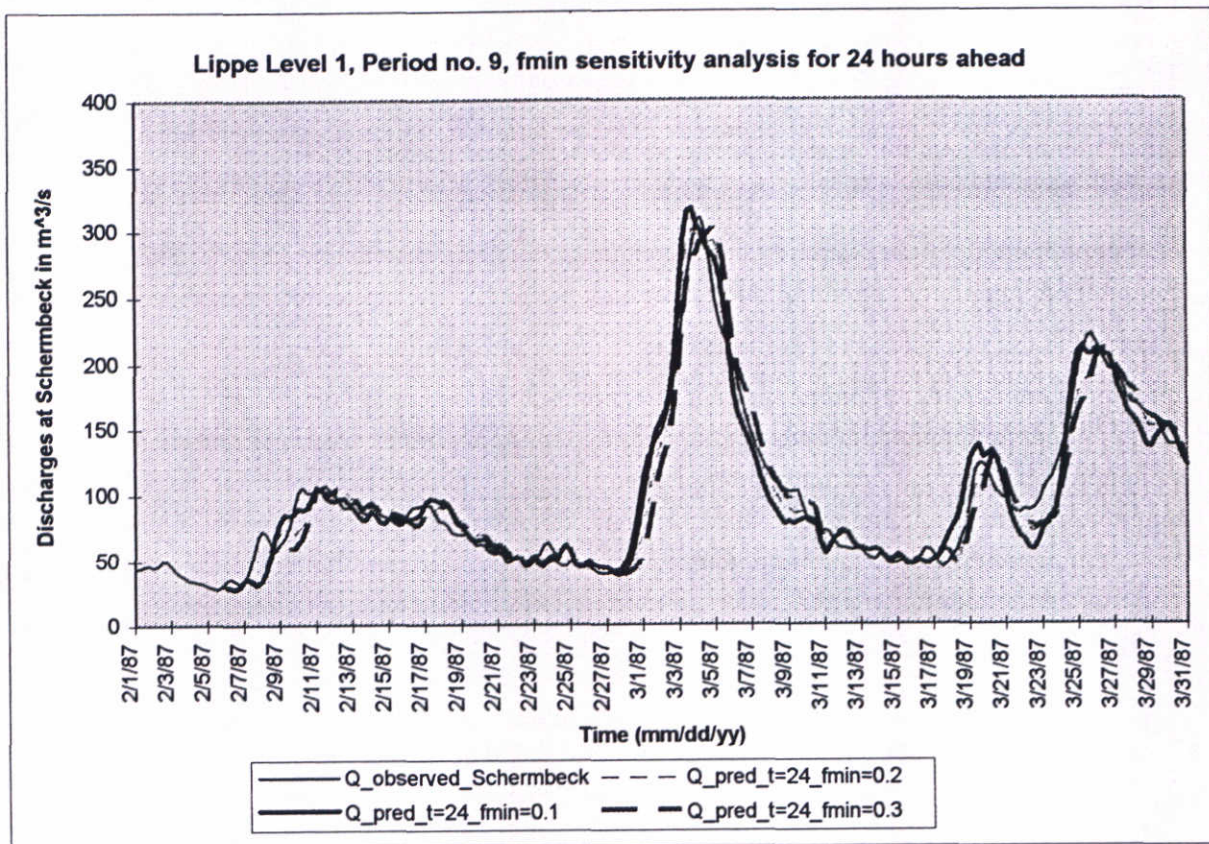


Fig. 10.4a Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min} for 24 hours ahead

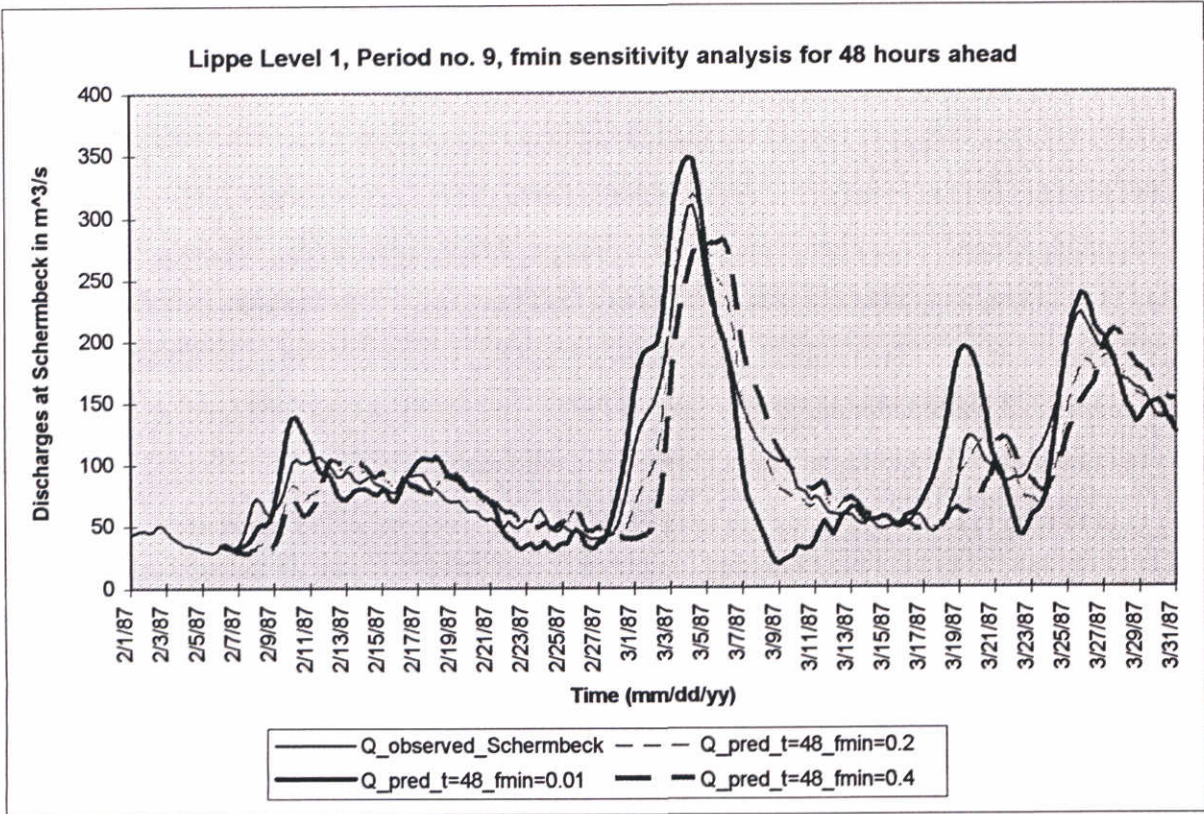
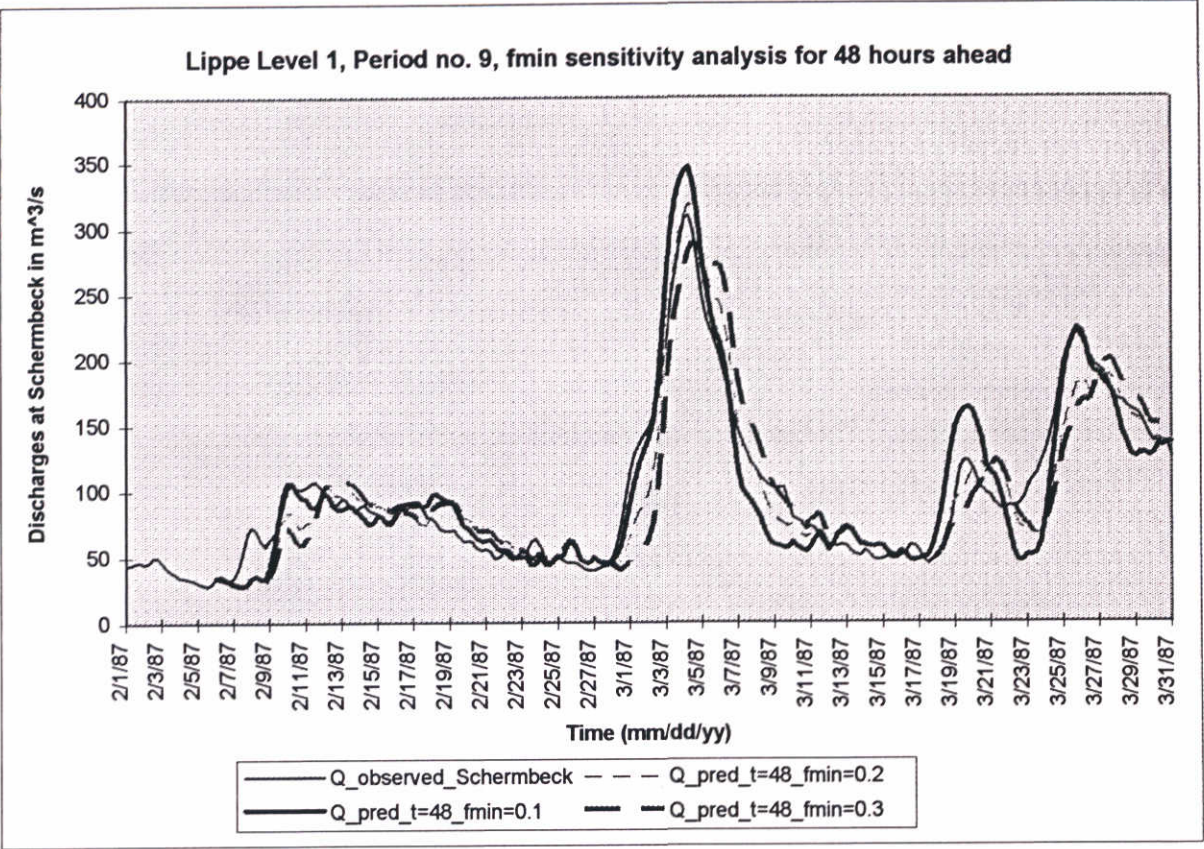


Fig. 10.4b Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity $f_{\min}$ for 48 hours ahead

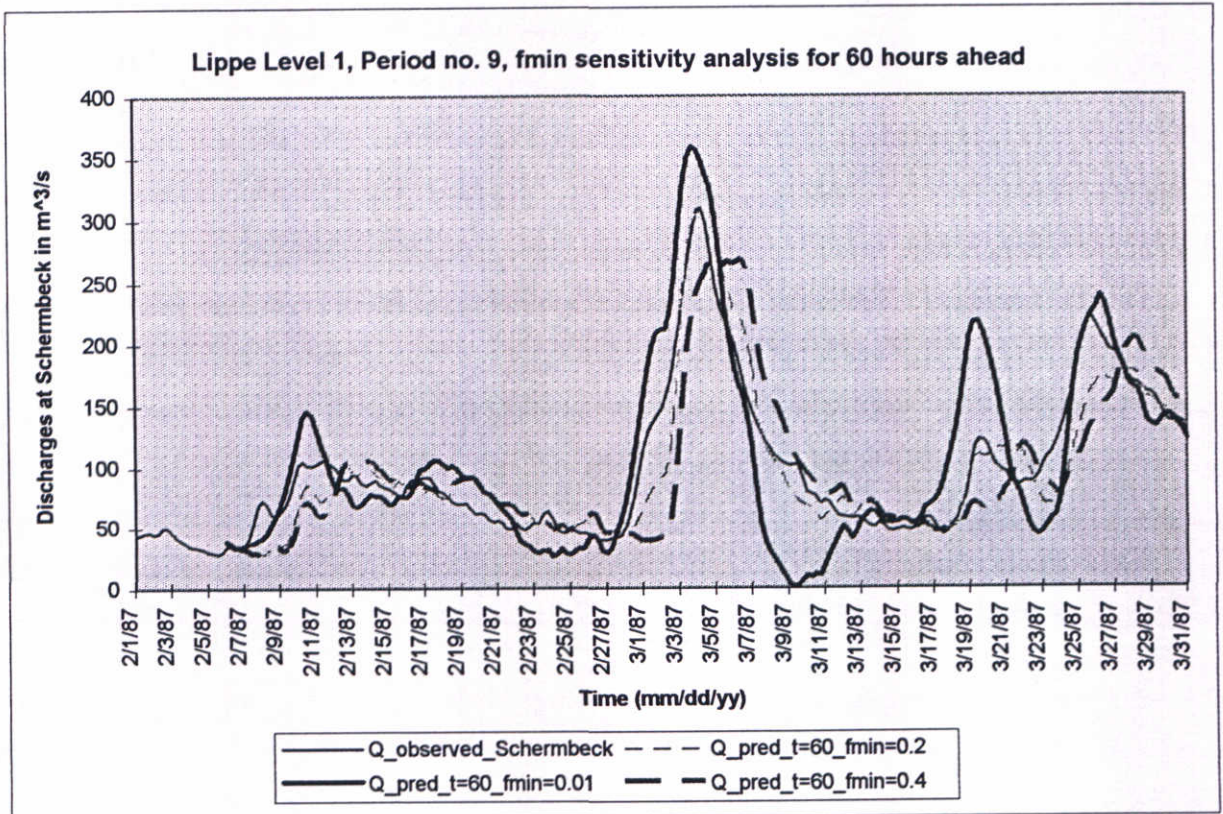
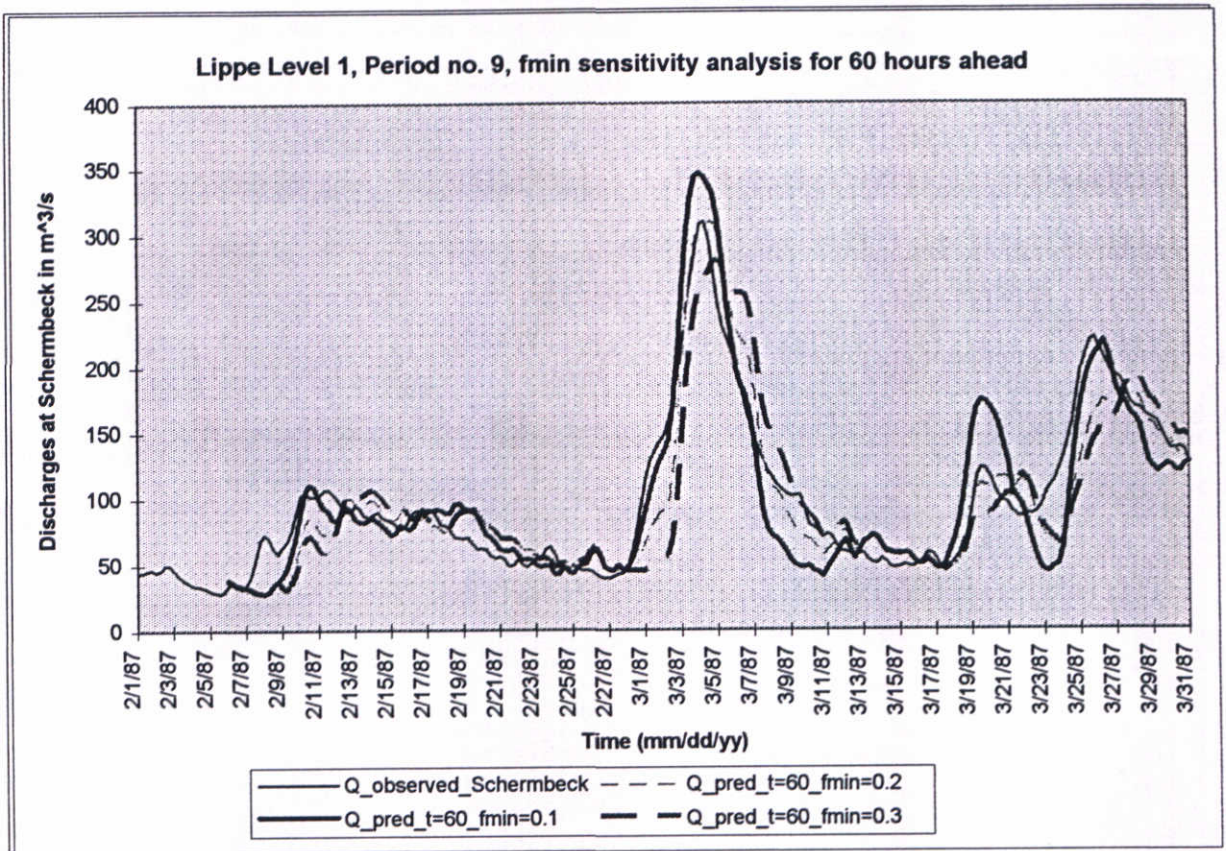
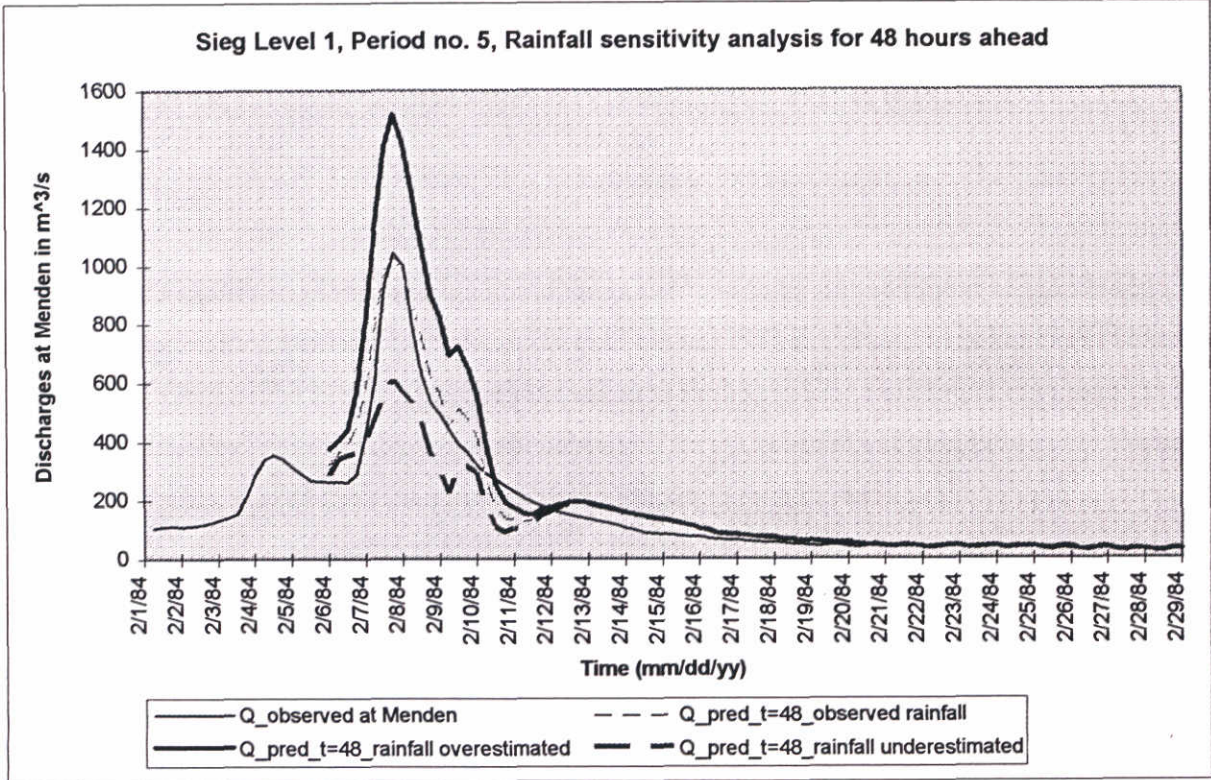
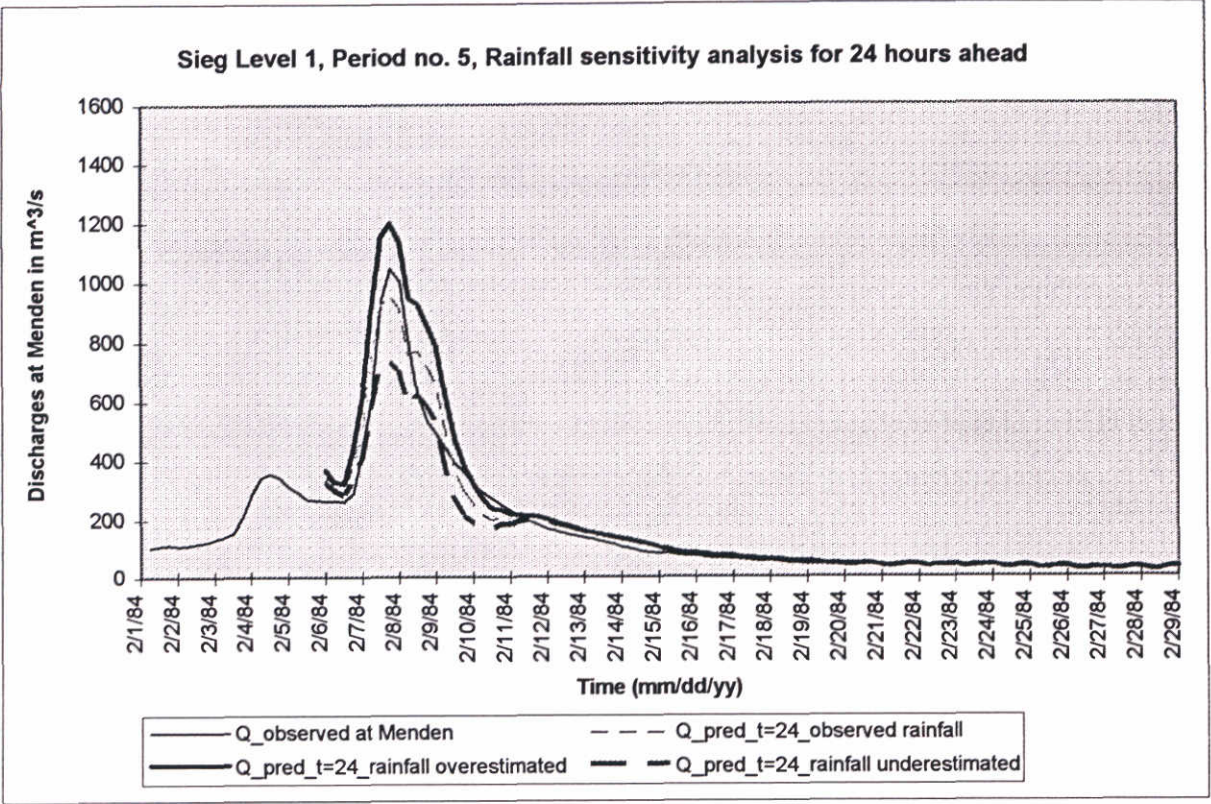


Fig. 10.4c Lippe Level 1, Period no. 9, Results of sensitivity for the minimum infiltration capacity f_{min} for 60 hours ahead

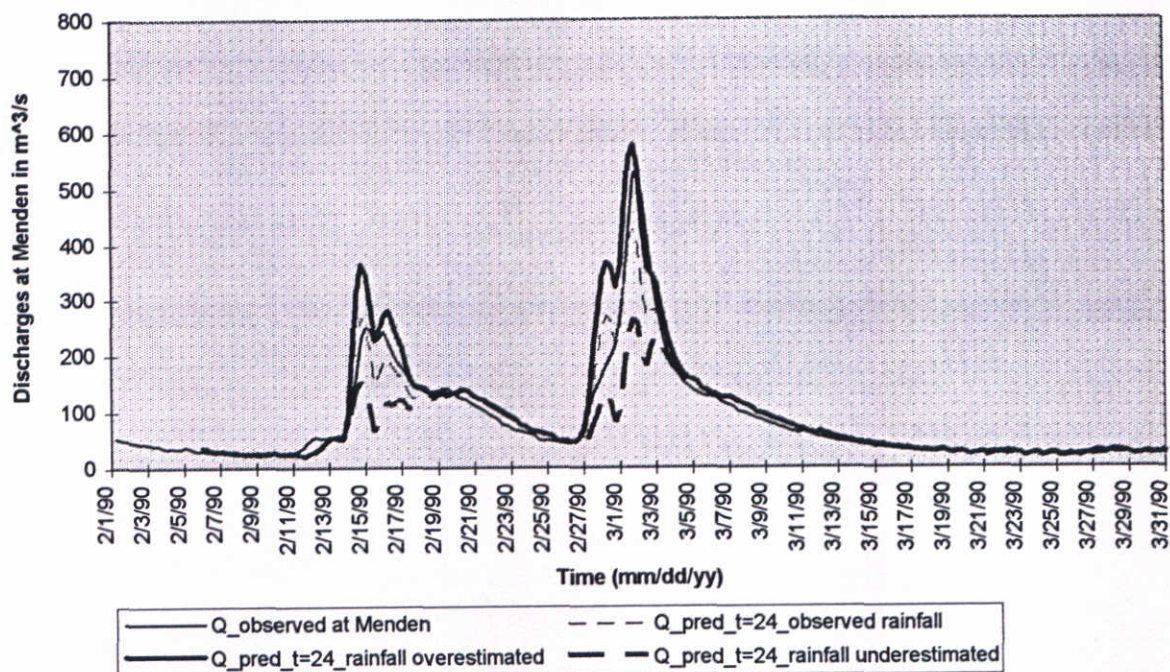


Notes:

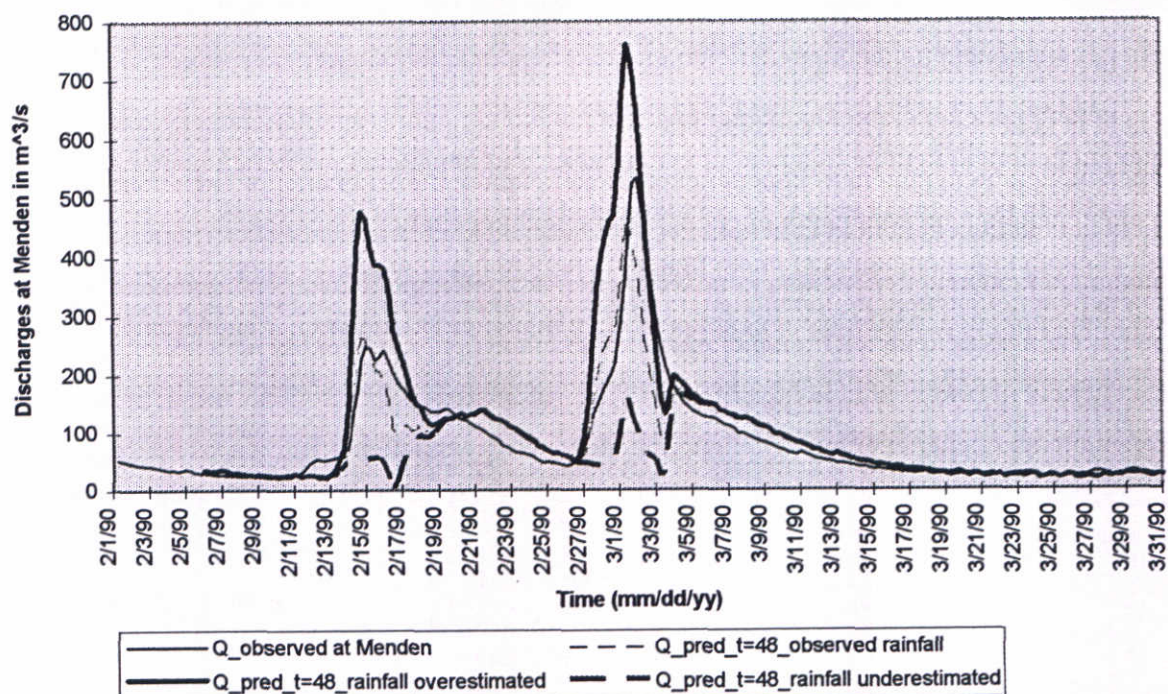
1. Overestimation of forecasted rainfall refers to: +20% for $0 < t < 24$ and +40% for $24 < t < 48$ hours;
2. Underestimation of forecasted rainfall refers to: -20% for $0 < t < 24$ and -40% for $24 < t < 48$ hours;

Fig. 10.5 **Sieg Level 1: Results of rainfall sensitivity analysis for Period no. 5.**

Sieg Level 1, Period no. 12, Rainfall sensitivity analysis for 24 hours ahead



Sieg Level 1, Period no. 12, Rainfall sensitivity analysis for 48 hours ahead



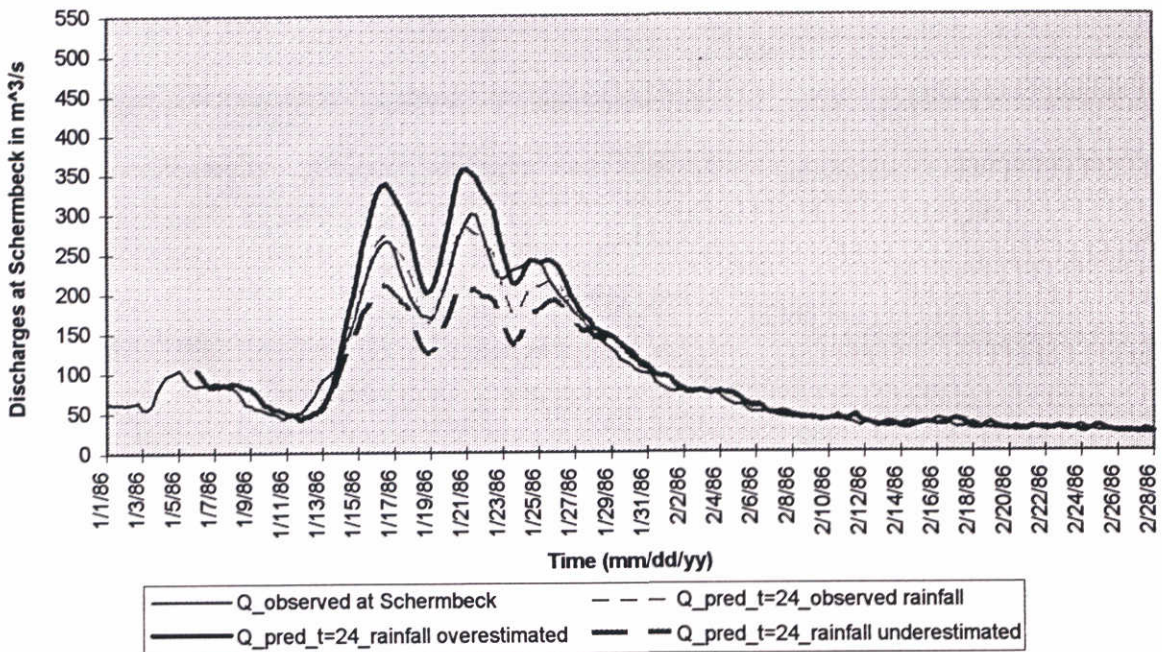
Notes:

1. Overestimation of forecasted rainfall refers to: +20% for $0 < t < 24$ and +40% for $24 < t < 48$ hours;
2. Underestimation of forecasted rainfall refers to: -20% for $0 < t < 24$ and -40% for $24 < t < 48$ hours;

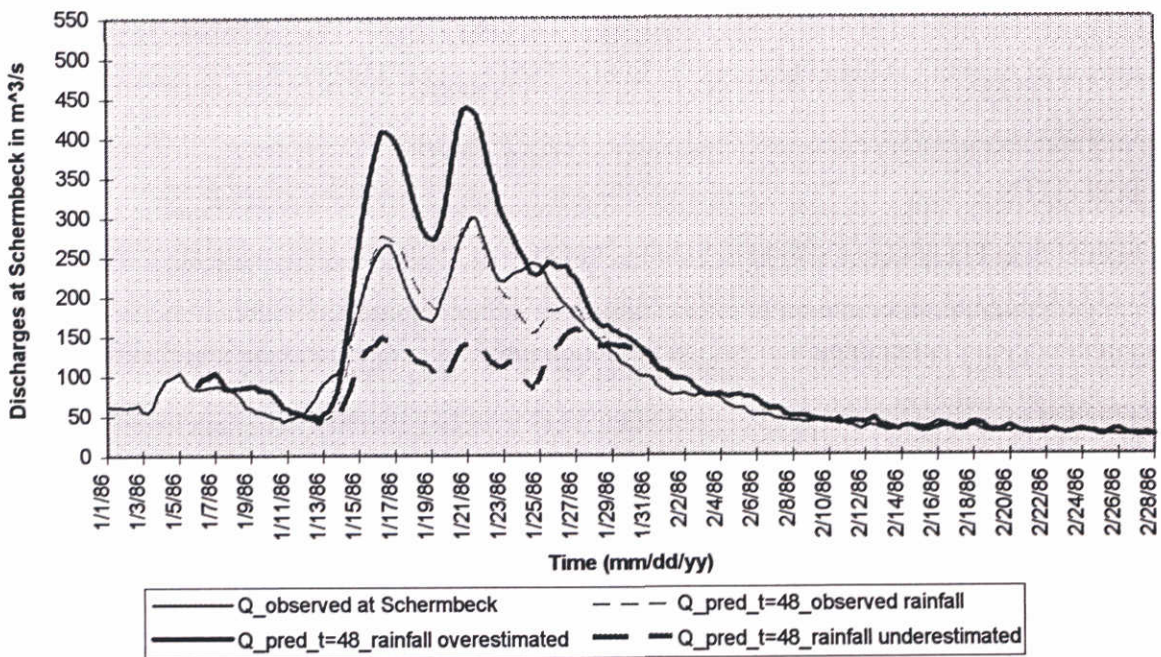
Fig. 10.6

Sieg Level 1: Results of rainfall sensitivity analysis for Period no. 12.

Lippe Level 1, Period no. 7, Rainfall sensitivity analysis for 24 hours ahead



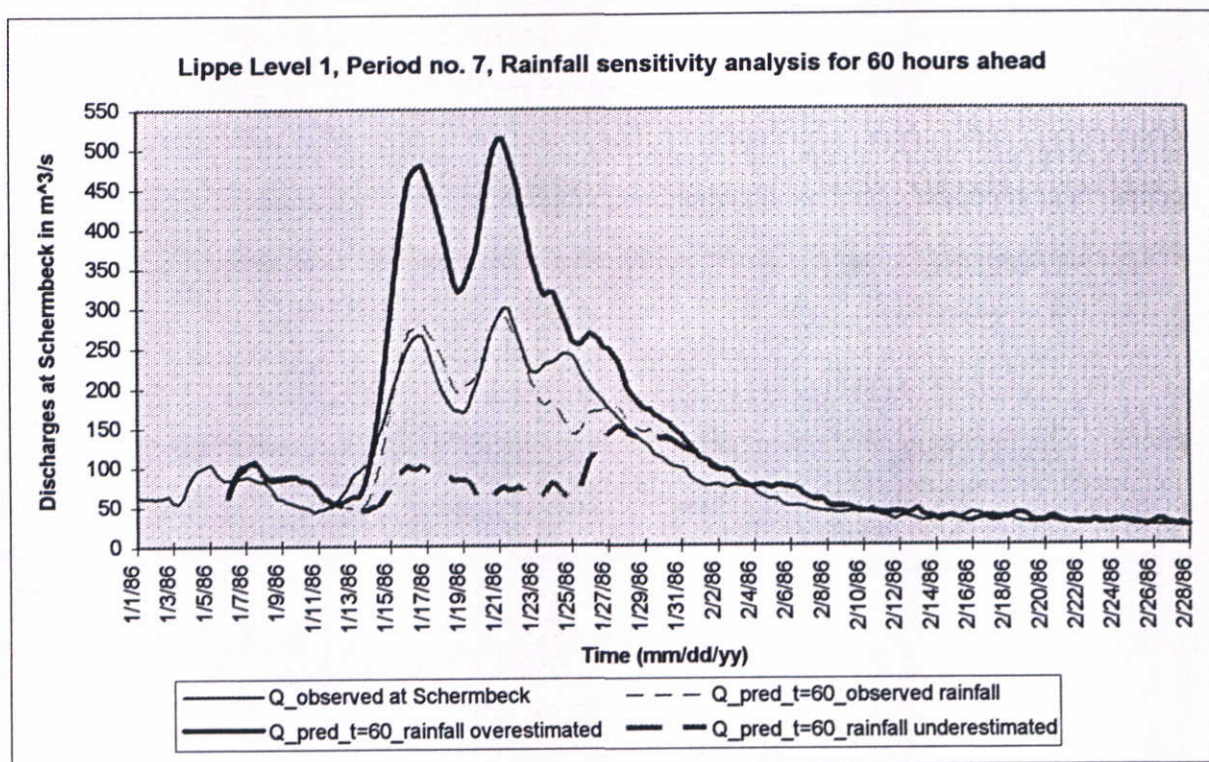
Lippe Level 1, Period no. 7, Rainfall sensitivity analysis for 48 hours ahead



Notes:

1. Overestimation of forecasted rainfall refers to: +20% for $0 < t < 24$, +40% for $24 < t < 48$ hours, and +60% for $48 < t < 60$ hours.
2. Underestimation of forecasted rainfall refers to: -20% for $0 < t < 24$ and -40% for $24 < t < 48$ hours; and -60% for $48 < t < 60$ hours.

Fig. 10.7a Lippe Level 1: Results of rainfall sensitivity analysis for Period no. 7.

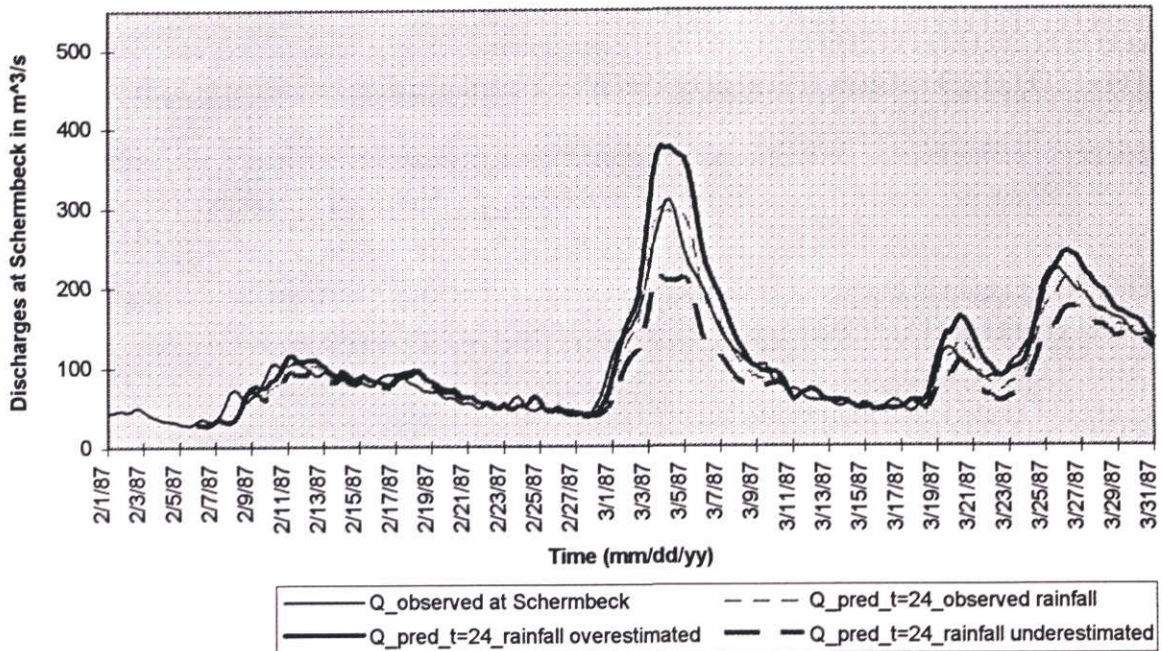


Notes:

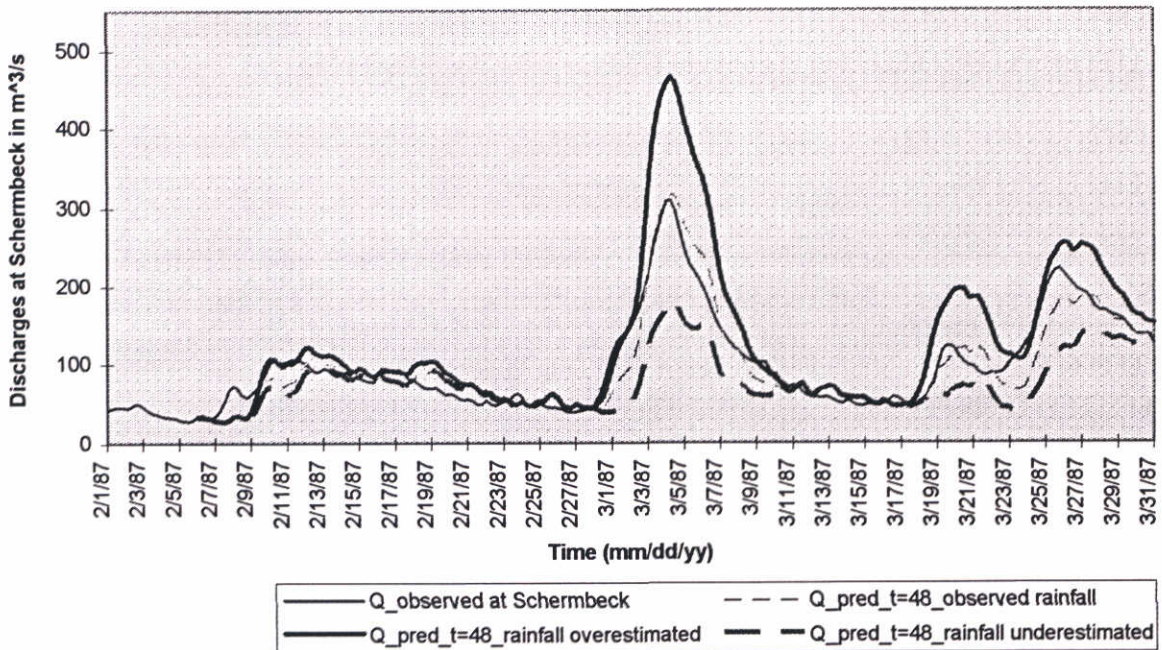
1. Overestimation of forecasted rainfall refers to: +20% for $0 < t < 24$, +40% for $24 < t < 48$ hours, and +60% for $48 < t < 60$ hours.
2. Underestimation of forecasted rainfall refers to: -20% for $0 < t < 24$ and -40% for $24 < t < 48$ hours; and -60% for $48 < t < 60$ hours.

Fig. 10.7b Lippe Level 1: Results of rainfall sensitivity analysis for Period no. 7.

Lippe Level 1, Period no. 9, Rainfall sensitivity analysis for 24 hours ahead



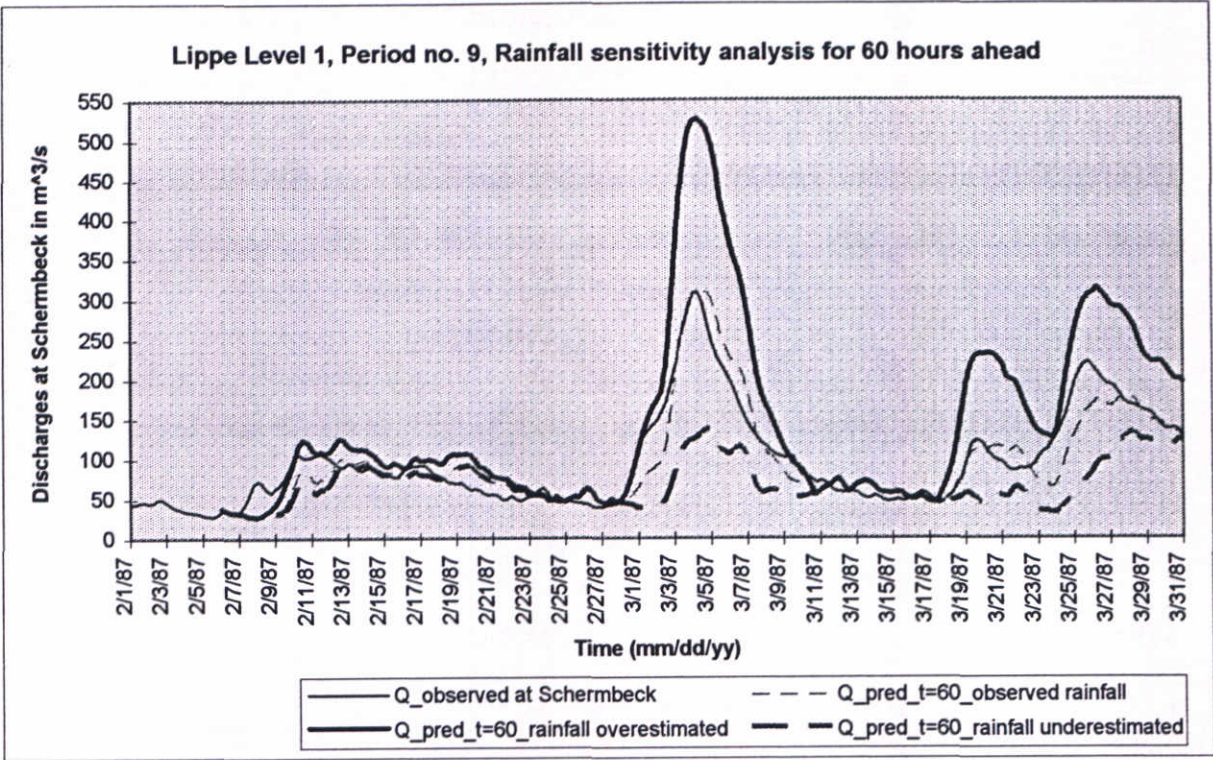
Lippe Level 1, Period no. 9, Rainfall sensitivity analysis for 48 hours ahead



Notes:

1. Overestimation of forecasted rainfall refers to: +20% for $0 < t < 24$, +40% for $24 < t < 48$ hours, and +60% for $48 < t < 60$ hours.
2. Underestimation of forecasted rainfall refers to: -20% for $0 < t < 24$ and -40% for $24 < t < 48$ hours; and -60% for $48 < t < 60$ hours.

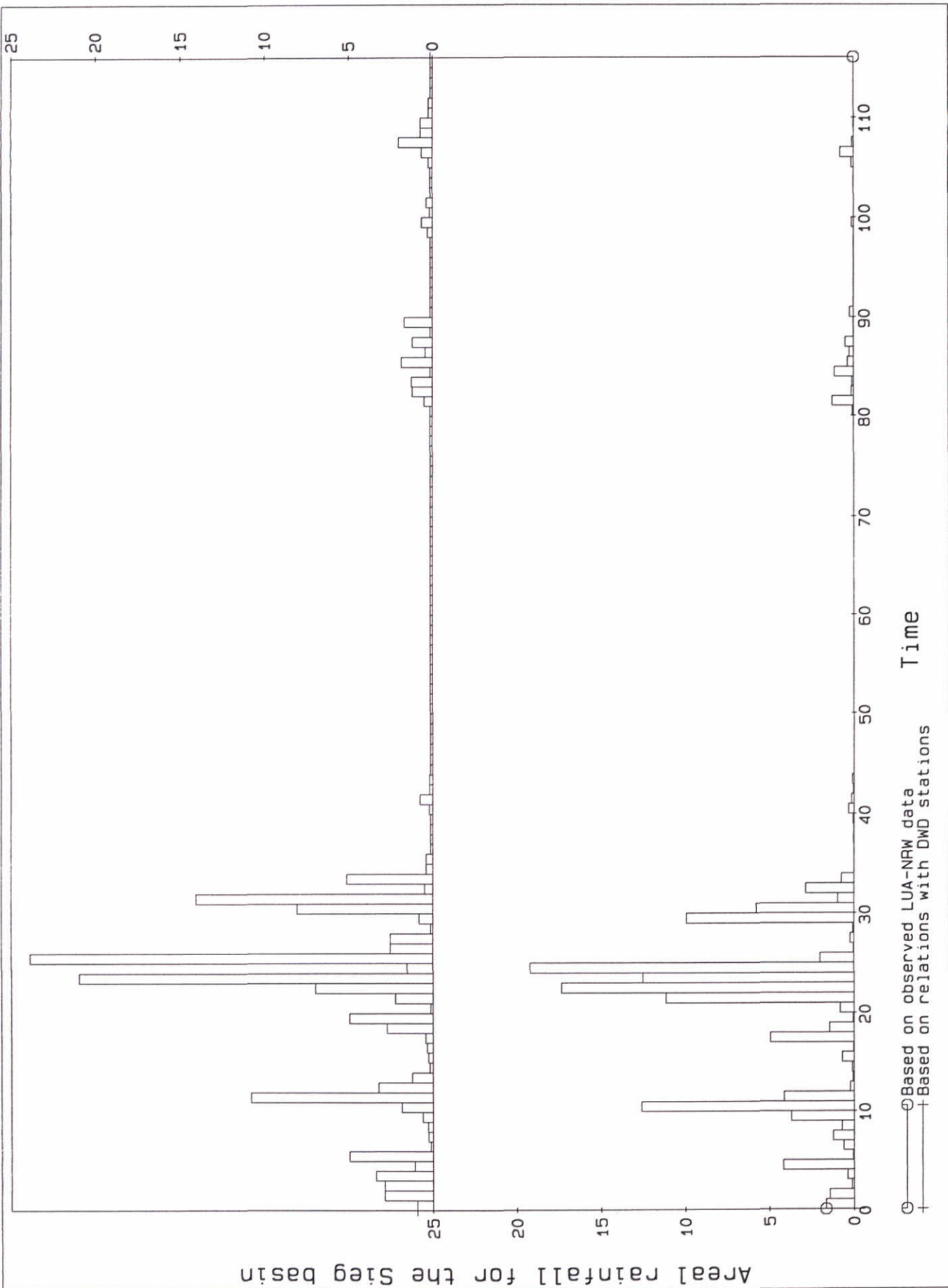
Fig. 10.8a Lippe Level 1: Results of rainfall sensitivity analysis for Period no. 9.



Notes:

1. Overestimation of forecasted rainfall refers to: +20% for $0 < t < 24$, +40% for $24 < t < 48$ hours, and +60% for $48 < t < 60$ hours.
2. Underestimation of forecasted rainfall refers to: -20% for $0 < t < 24$ and -40% for $24 < t < 48$ hours; and -60% for $48 < t < 60$ hours.

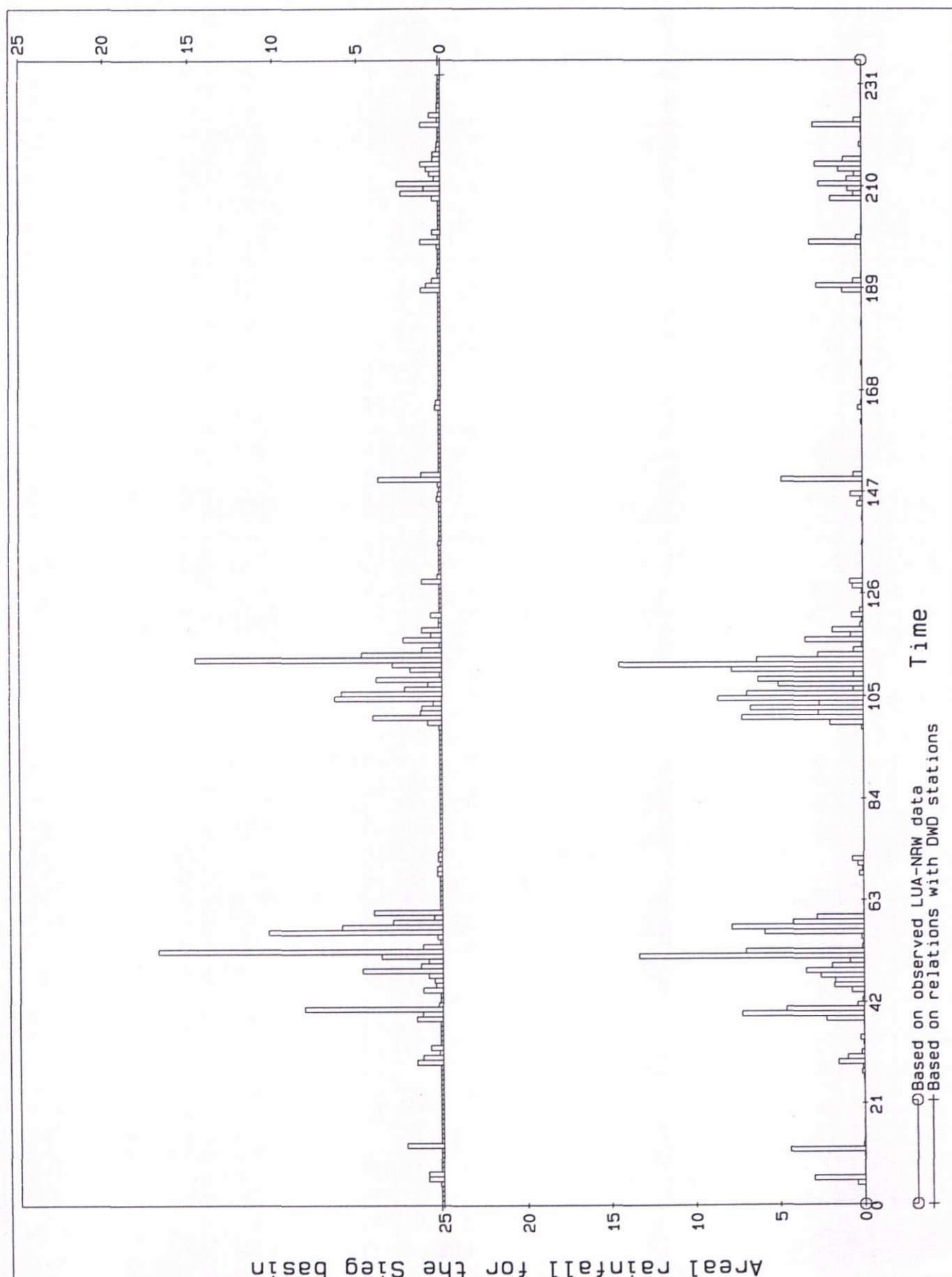
Fig. 10.8b Lippe Level 1: Results of rainfall sensitivity analysis for Period no. 9.



Areal rainfall for the Sieg basin

Sieg basin, Areal rainfall comparison.
Observed & computed (with established
DWD relationships) areal rainfall.

Period no. 5



Sieg basin, Areal rainfall comparison.
Observed & computed (with established
DWD relationships) areal rainfall.

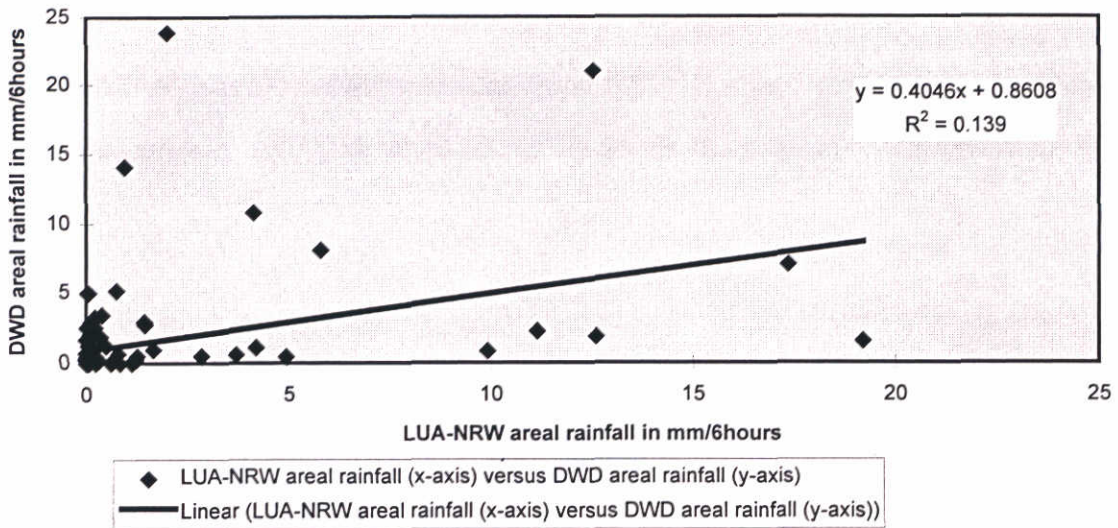
DELFT HYDRAULICS

Period no. 12

R3049

Fig. 10.10

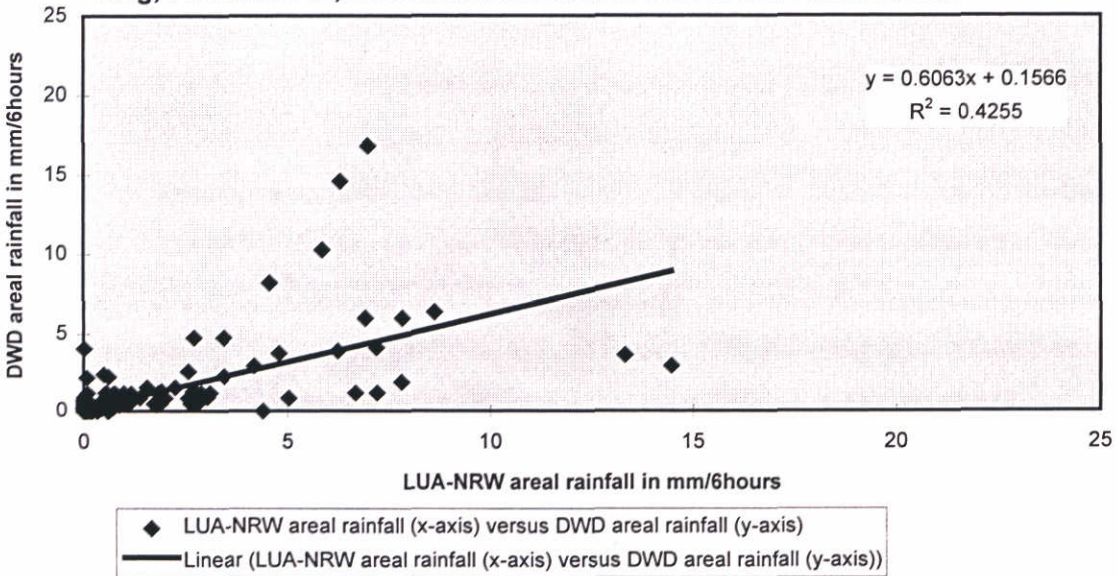
Sieg, Period no. 5, LUA-NRW areal rainfall versus DWD areal rainfall



Period no. 5:

Correlation coefficient between LUA-NRW & DWD areal rainfall	0.37	
Total volume of LUA-NRW areal rainfall	127.9	mm
Total volume of DWD areal rainfall	149.0	mm

Sieg, Period no. 12, LUA-NRW areal rainfall versus DWD areal rainfall

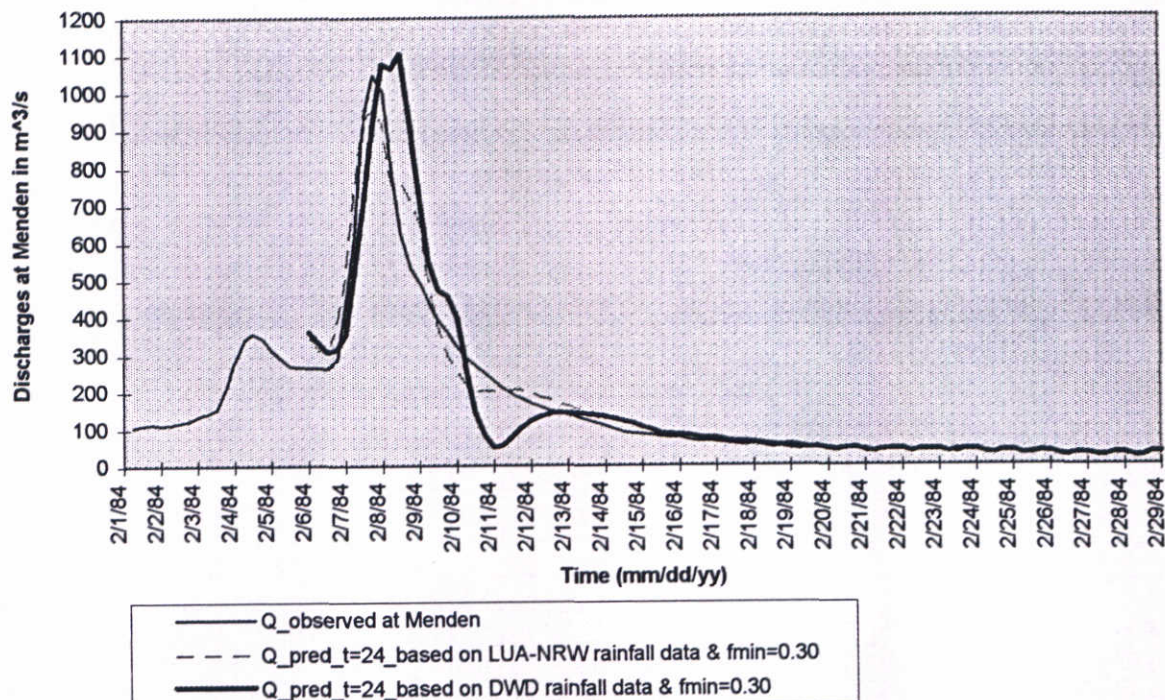


Period no. 12:

Correlation coefficient between LUA-NRW & DWD areal rainfall	0.65	
Total volume of LUA-NRW areal rainfall	201.8	mm
Total volume of DWD areal rainfall	158.8	mm

Fig. 10.11 Sieg, Period 5 & 12, Correlation between LUA-NRW and DWD areal rainfall.

Sieg Level 1, Period no. 5, Difference due to areal rainfall according to LUA-NRW (fmin=0.30) data and DWD (fmin=0.30) data for 24 hours ahead.



Sieg Level 1, Period no. 5, Difference due to areal rainfall according to LUA-NRW (fmin=0.30) data and DWD (fmin=0.30) data for 48 hours ahead

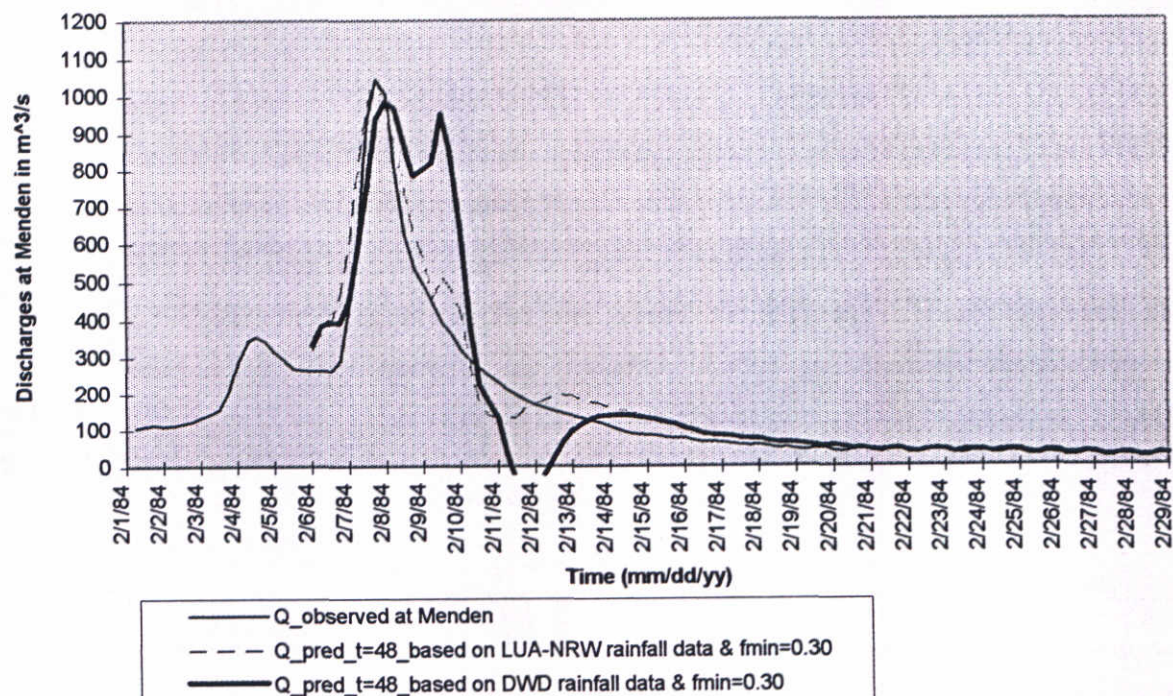
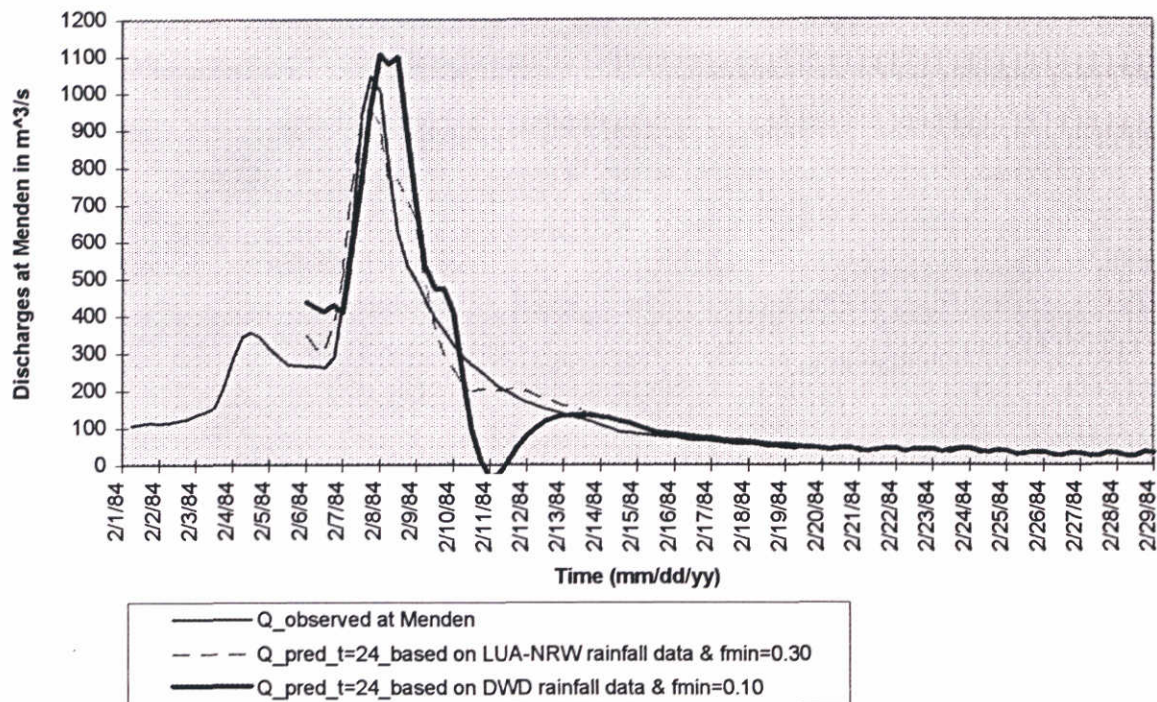


Fig. 10.12 Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $fmin=0.30$ was used.

Sieg Level 1, Period no. 5, Difference due to areal rainfall according to LUA-NRW
($f_{min}=0.30$) data and DWD ($f_{min}=0.10$) data for 24 hours ahead.



Sieg Level 1, Period no. 5, Difference due to areal rainfall according to LUA-NRW
($f_{min}=0.30$) data and DWD ($f_{min}=0.10$) data for 48 hours ahead

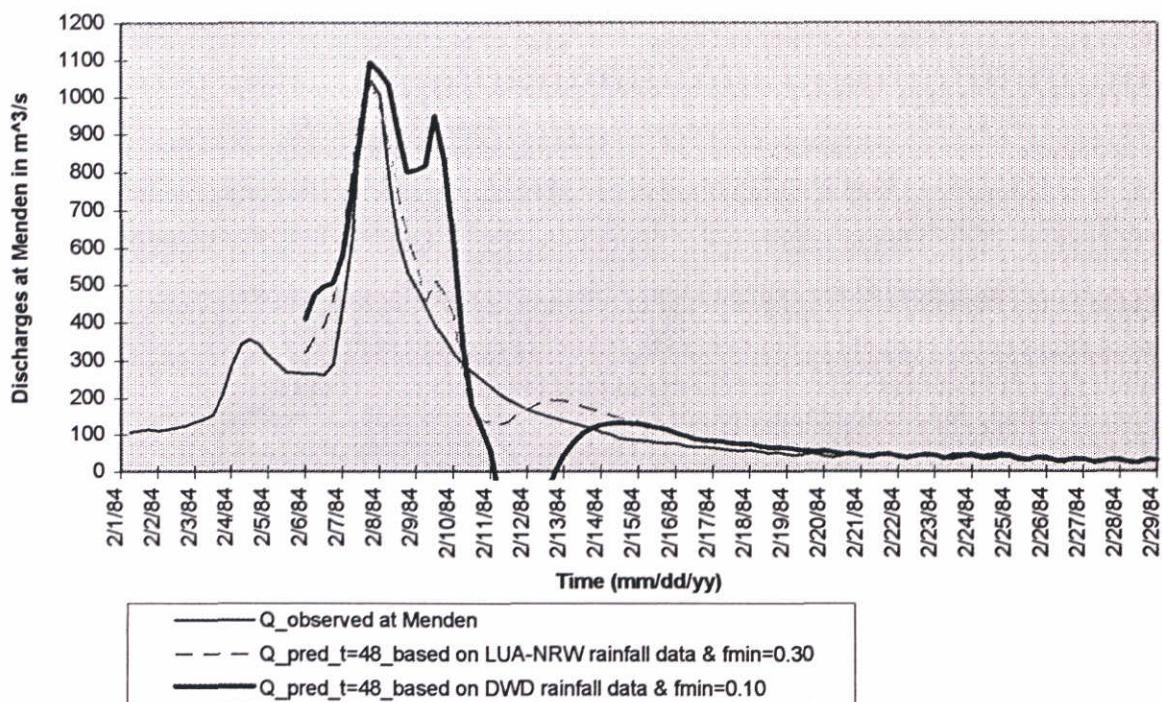
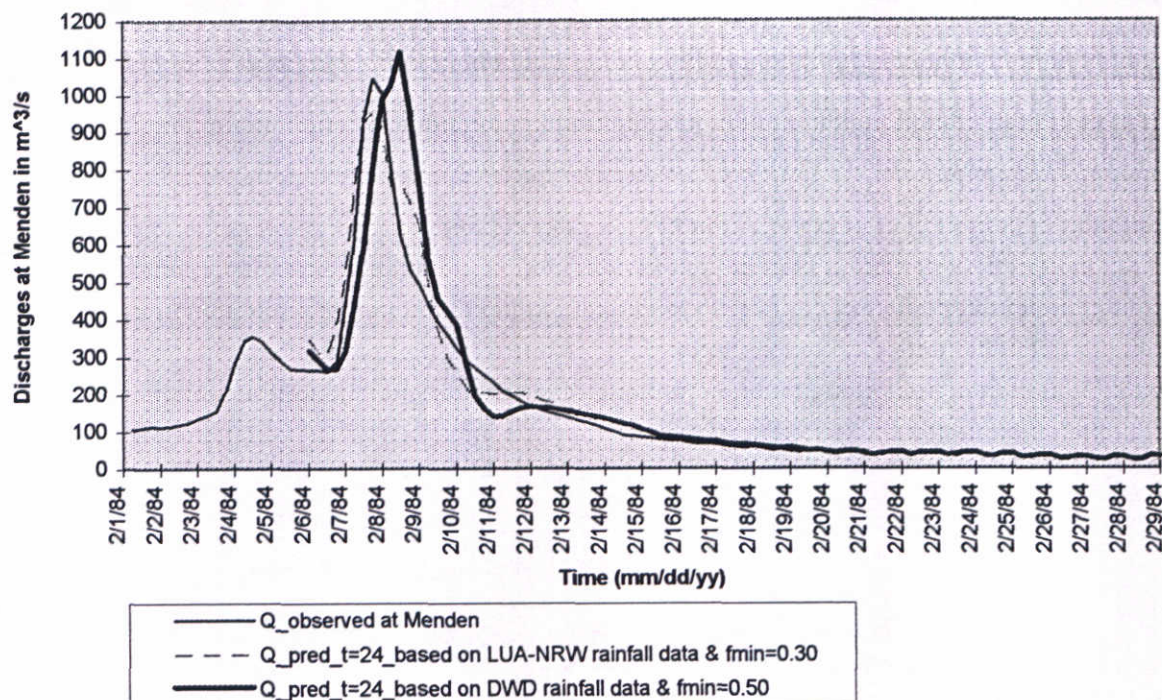


Fig. 10.13 Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall,
 $f_{min}=0.30$ for LUA-NRW & $f_{min} = 0.10$ for DWD.

Sieg Level 1, Period no. 5, Difference due to areal rainfall according to LUA-NRW ($f_{min}=0.30$) data and DWD ($f_{min}=0.50$) data for 24 hours ahead.



Sieg Level 1, Period no. 5, Difference due to areal rainfall according to LUA-NRW ($f_{min}=0.30$) data and DWD ($f_{min}=0.50$) data for 48 hours ahead

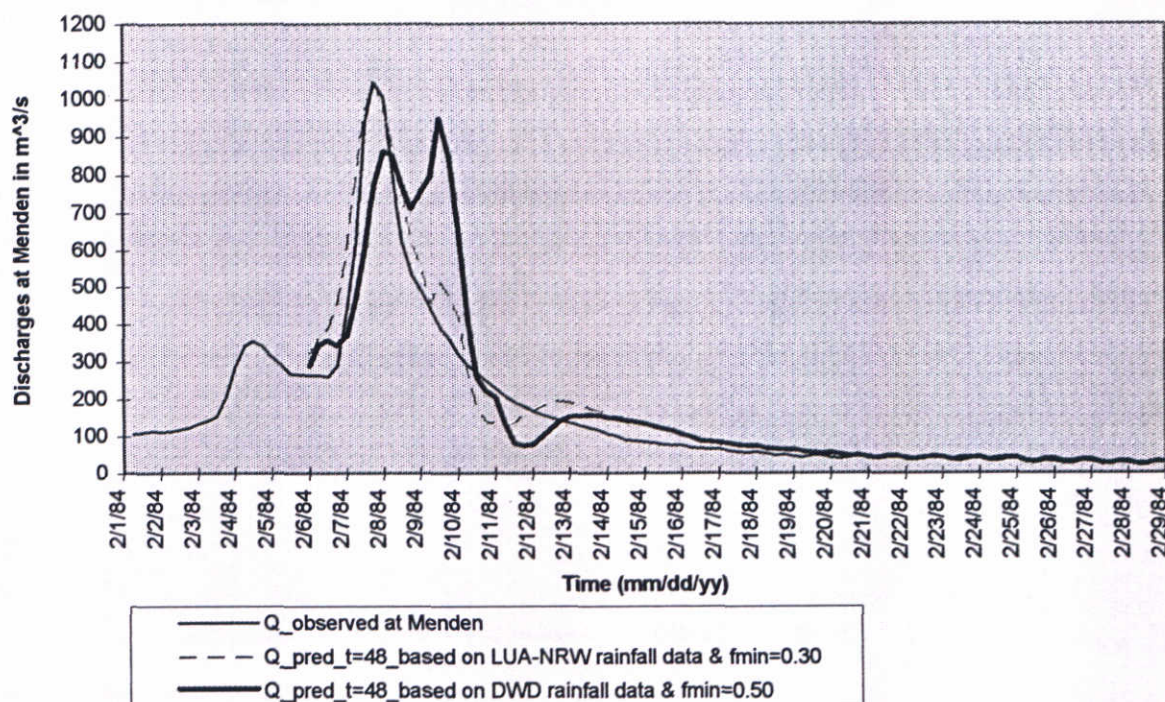


Fig. 10.14 Sieg Level 1, Period no. 5, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.30$ for LUA-NRW & $f_{min} = 0.50$ for DWD.

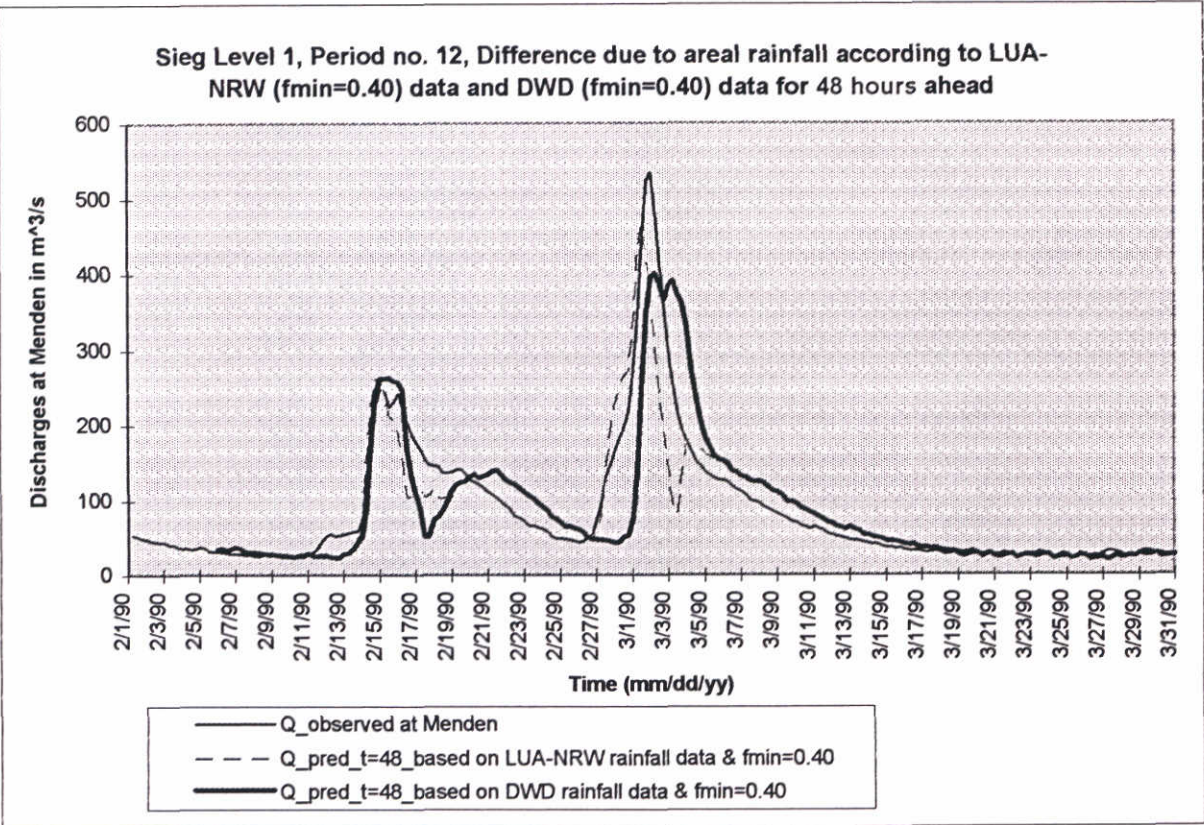
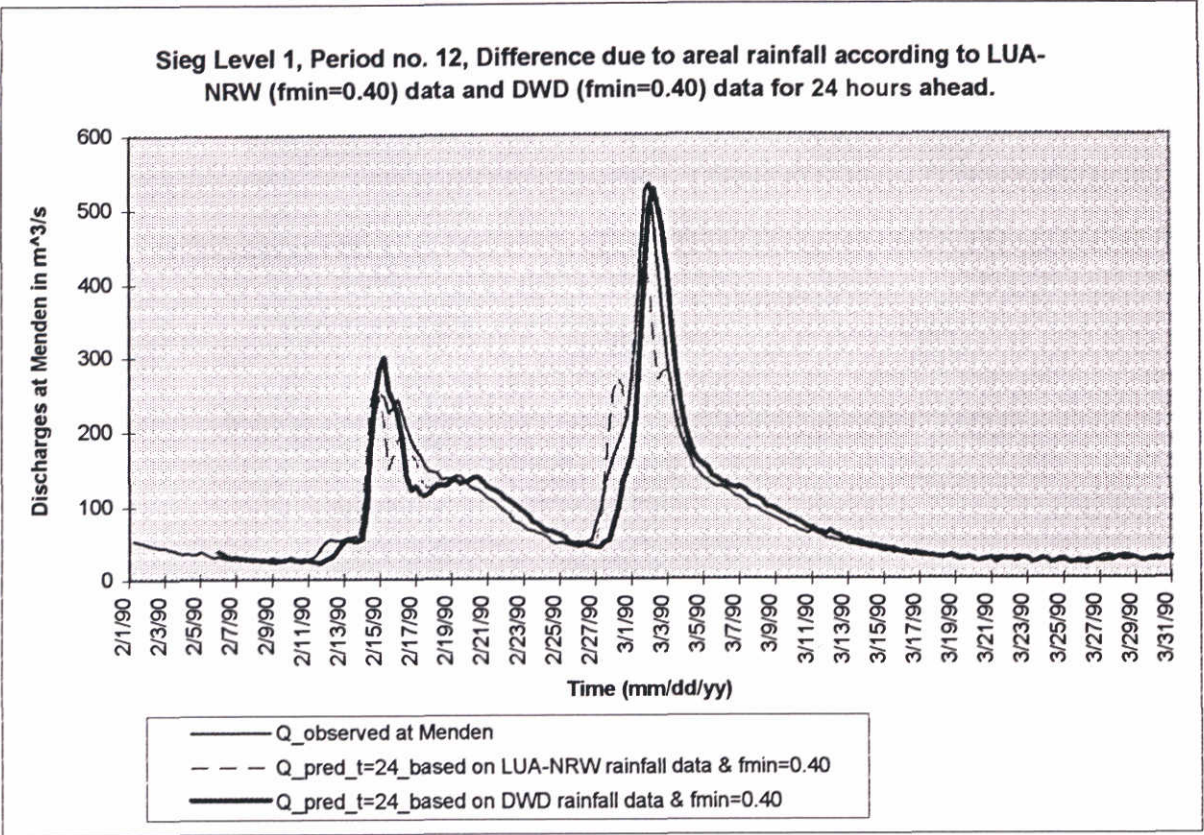


Fig. 10.15 Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.40$ was used.

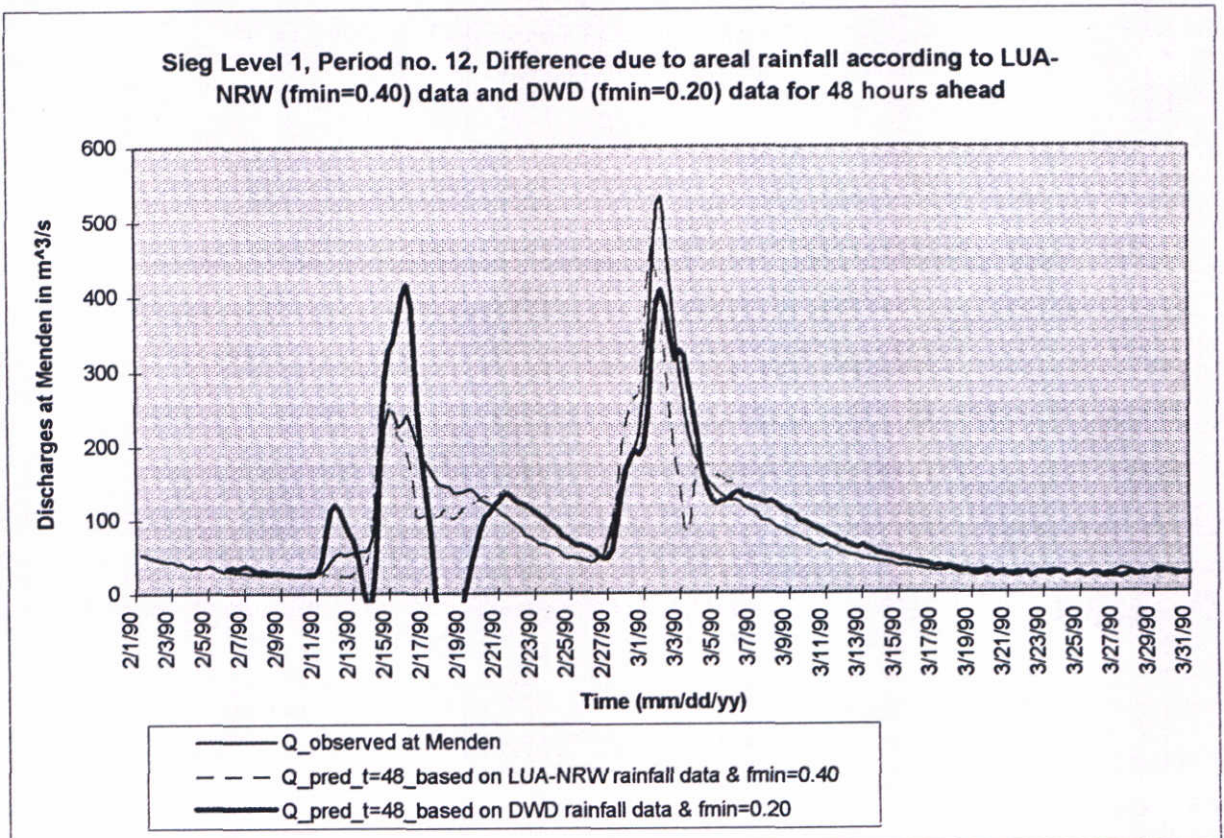
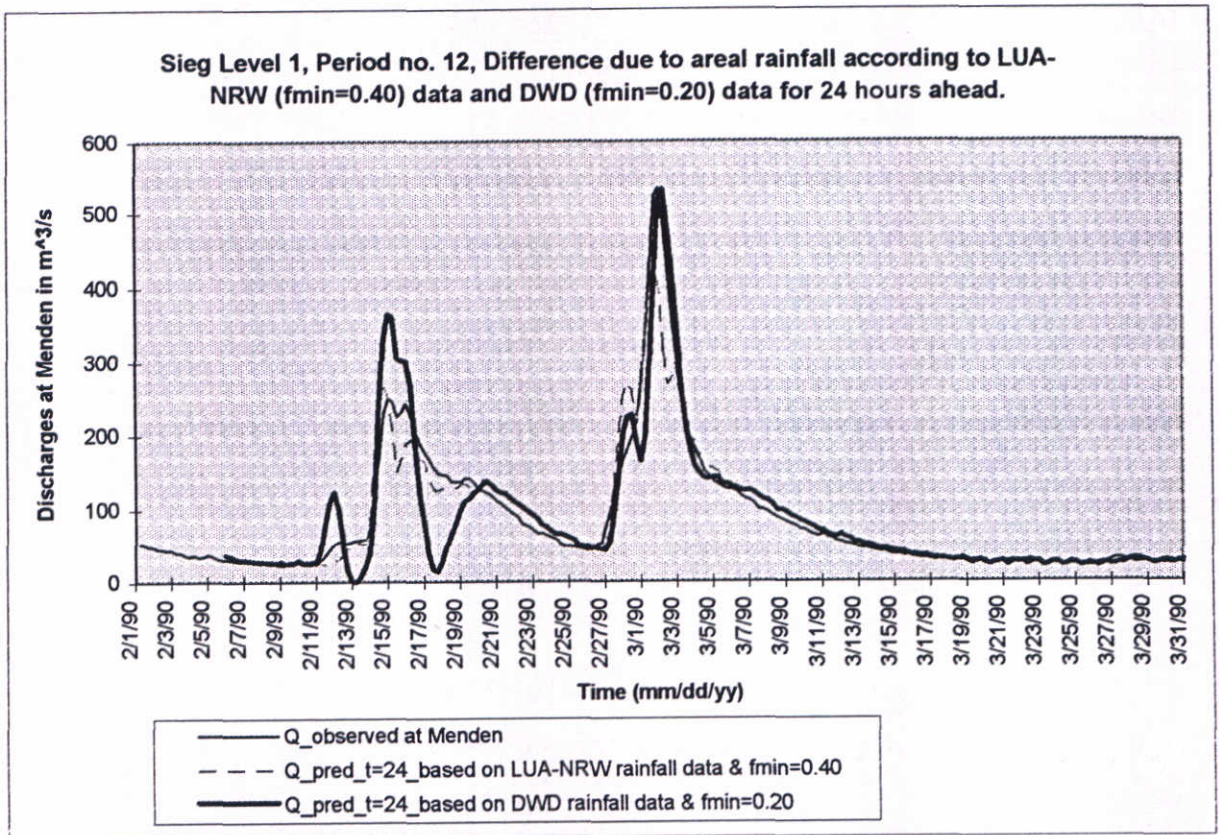


Fig. 10.16 Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.40$ for LUA-NRW & $f_{min} = 0.20$ for DWD.

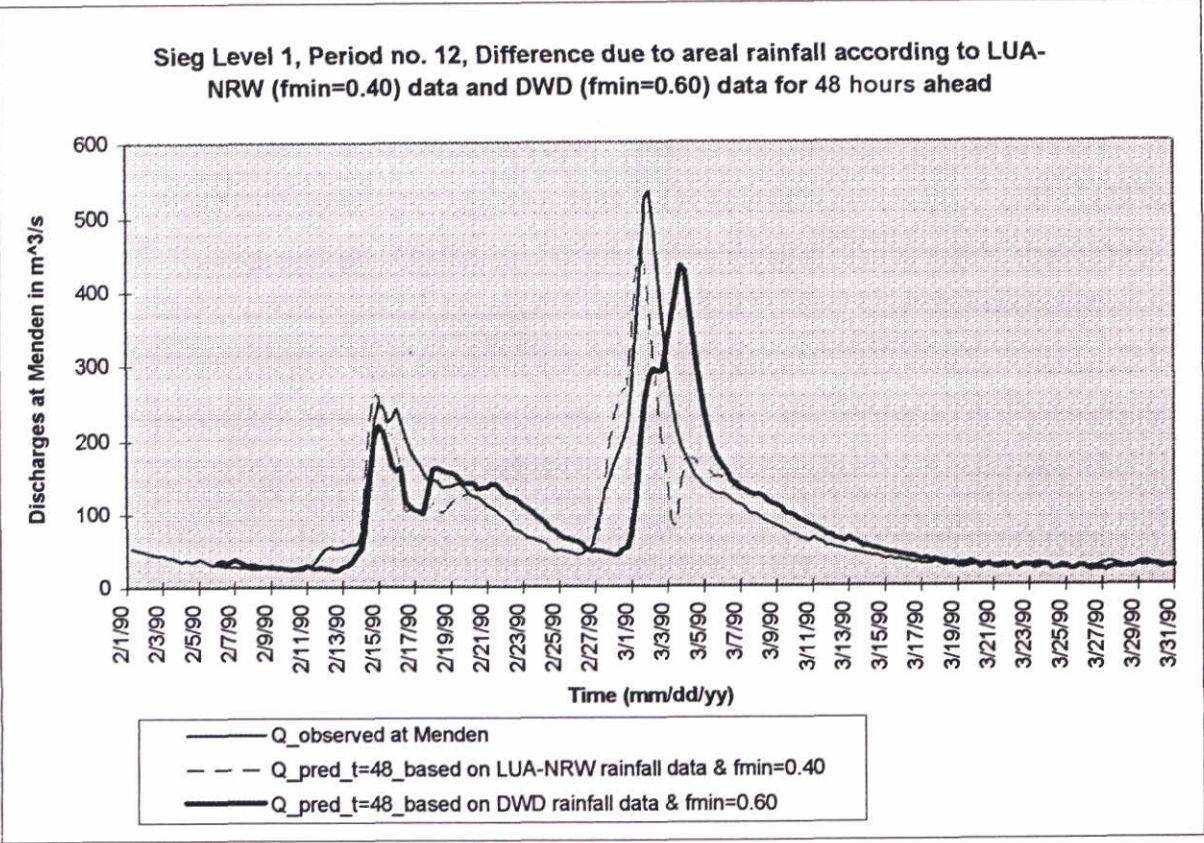
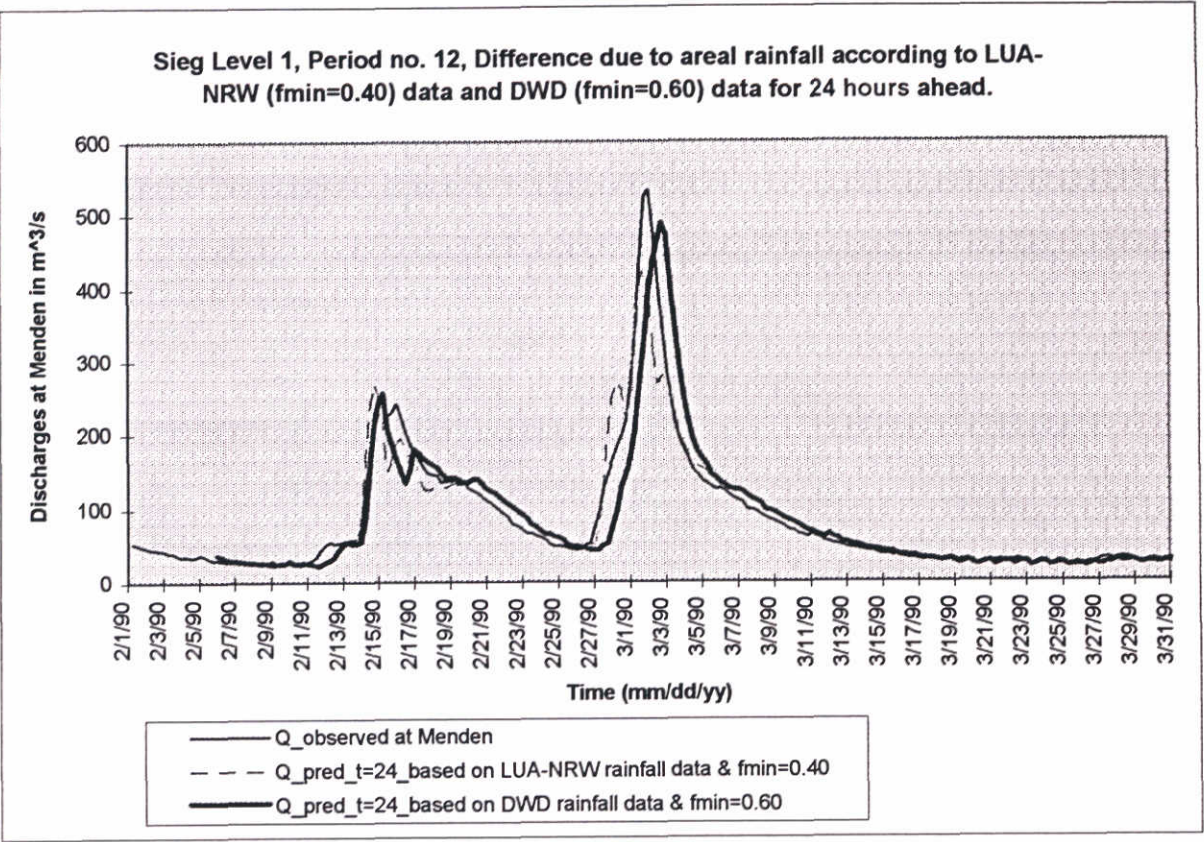
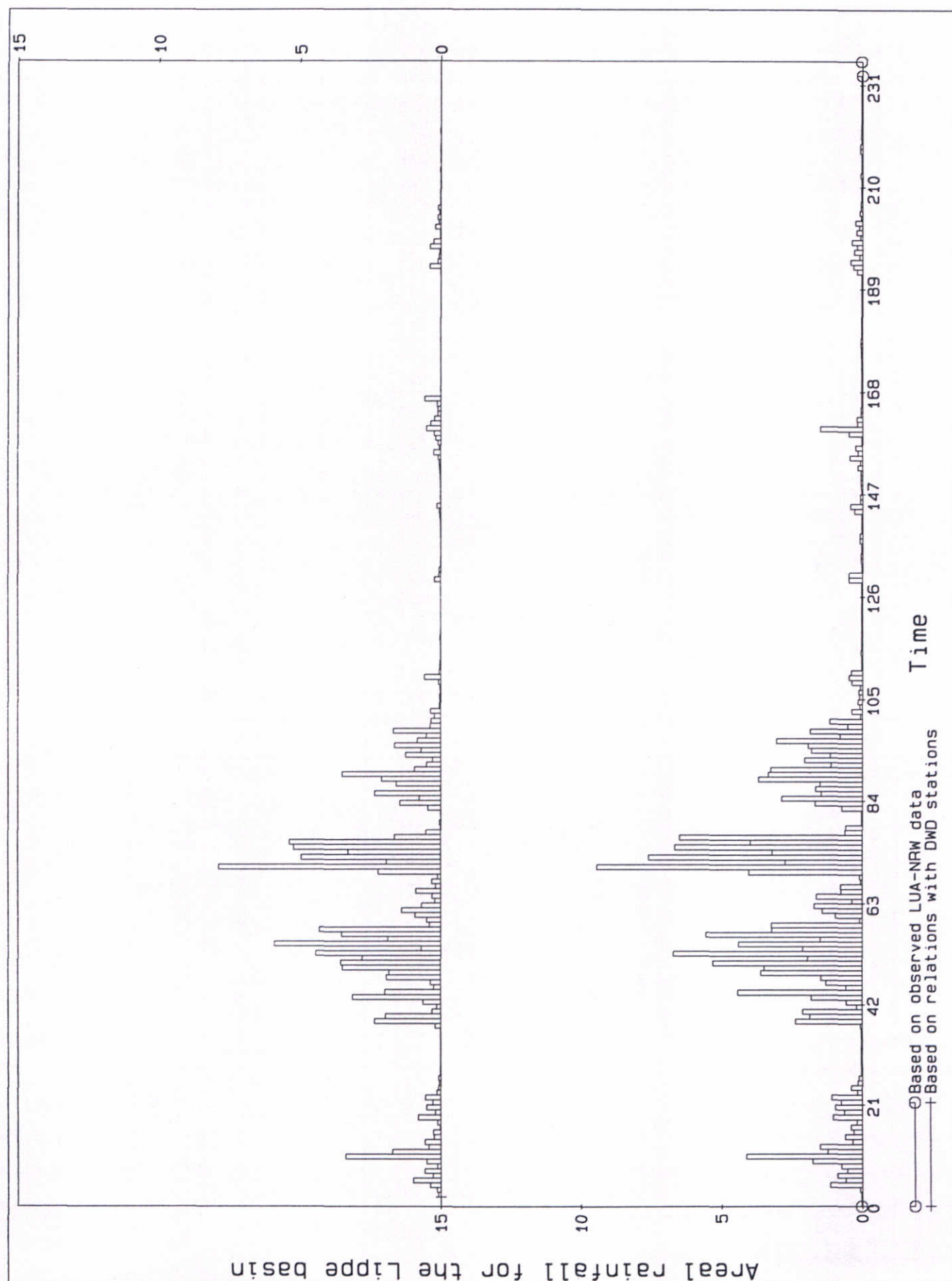


Fig. 10.17 Sieg Level 1, Period no. 12, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.40$ for LUA-NRW & $f_{min} = 0.60$ for DWD.



Areal rainfall for the Lippe basin

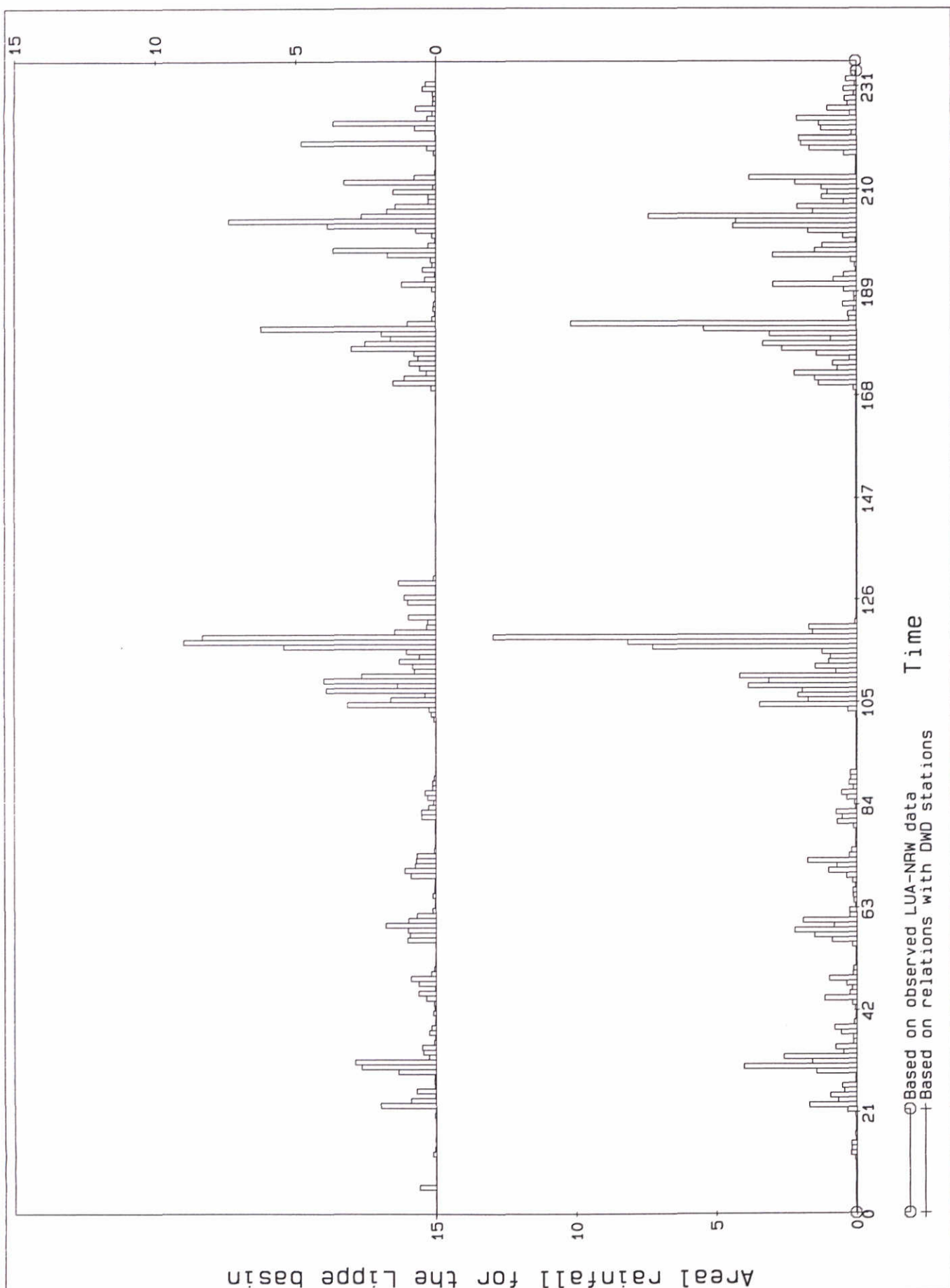
Lippe basin, Areal rainfall comparison
Observed & computed (with established
DWD relationships) areal rainfall

DELFT HYDRAULICS

Period no. 7

R3049

Fig. 10.18



Lippe basin, Areal rainfall comparison
Observed & computed (with established
DWD relationships) areal rainfall

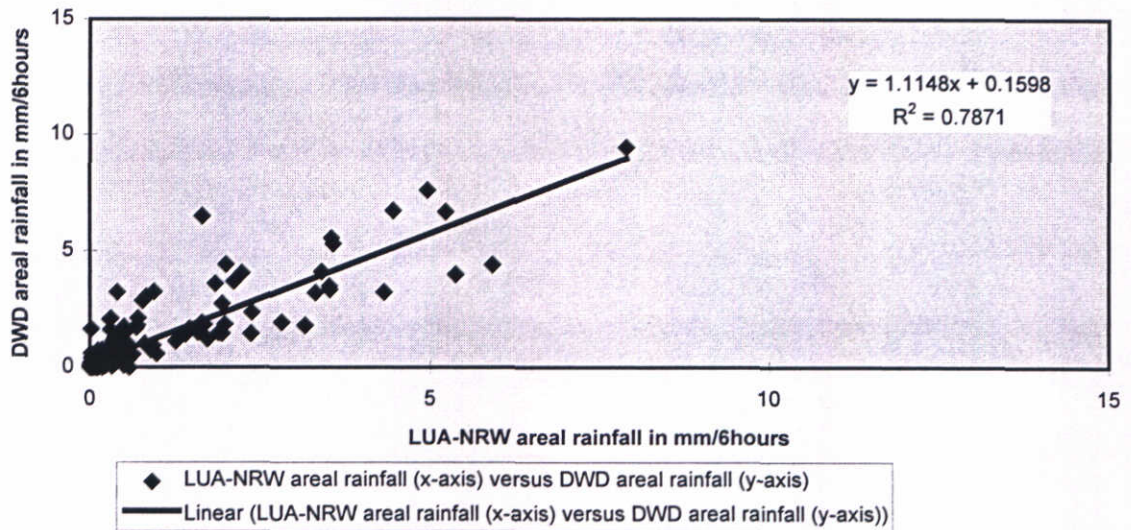
DELFT HYDRAULICS

Period no. 9

R3049

Fig. 10.19

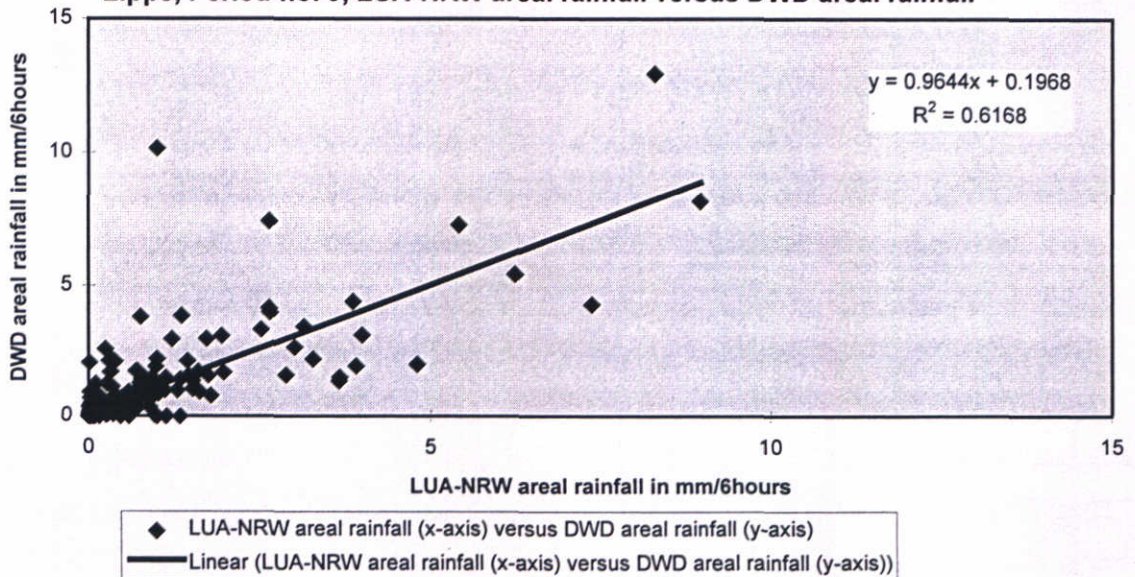
Lippe, Period no. 7, LUA-NRW areal rainfall versus DWD areal rainfall



Period no. 7:

Correlation coefficient between LUA-NRW & DWD areal rainfall	0.89	
Total volume of LUA-NRW areal rainfall	126.0	mm
Total volume of DWD areal rainfall	177.7	mm

Lippe, Period no. 9, LUA-NRW areal rainfall versus DWD areal rainfall

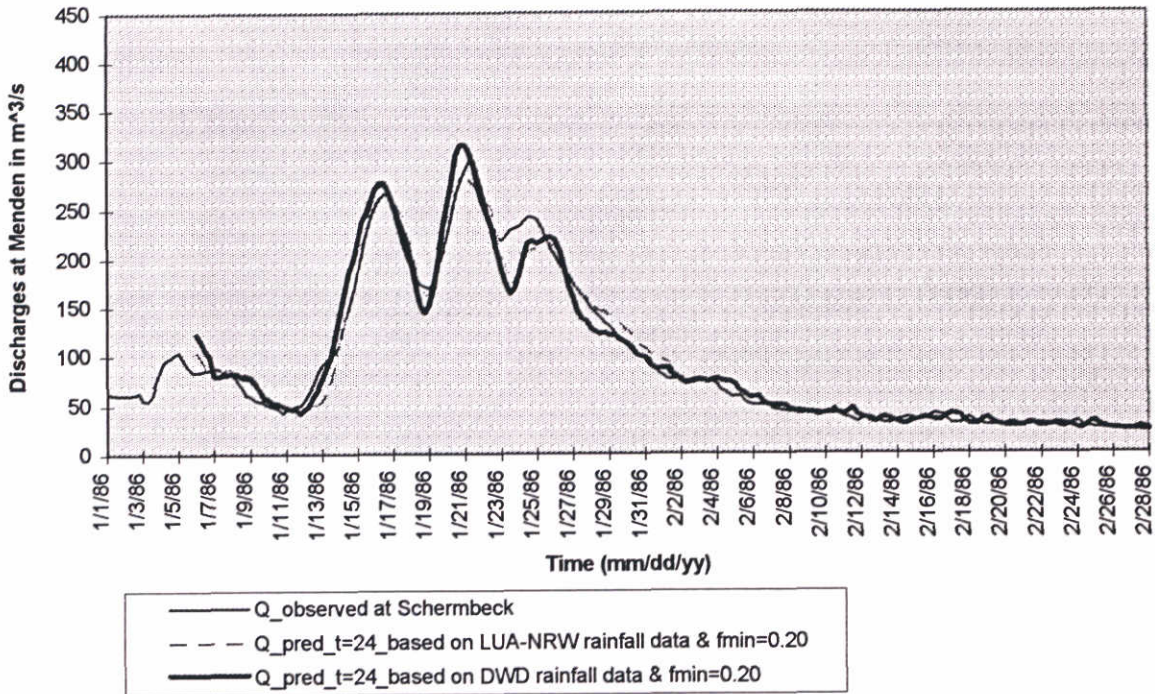


Period no. 9:

Correlation coefficient between LUA-NRW & DWD areal rainfall	0.79	
Total volume of LUA-NRW areal rainfall	148.0	mm
Total volume of DWD areal rainfall	188.6	mm

Fig. 10.20 Lippe, Period 7 & 9, Correlation between LUA-NRW and DWD areal rainfall.

Lippe Level 1, Period no. 7, Difference due to areal rainfall according to LUA-NRW ($f_{min}=0.20$) data and DWD ($f_{min}=0.20$) data for 24 hours ahead.



Lippe Level 1, Period no. 7, Difference due to areal rainfall according to LUA-NRW ($f_{min}=0.20$) data and DWD ($f_{min}=0.20$) data for 48 hours ahead

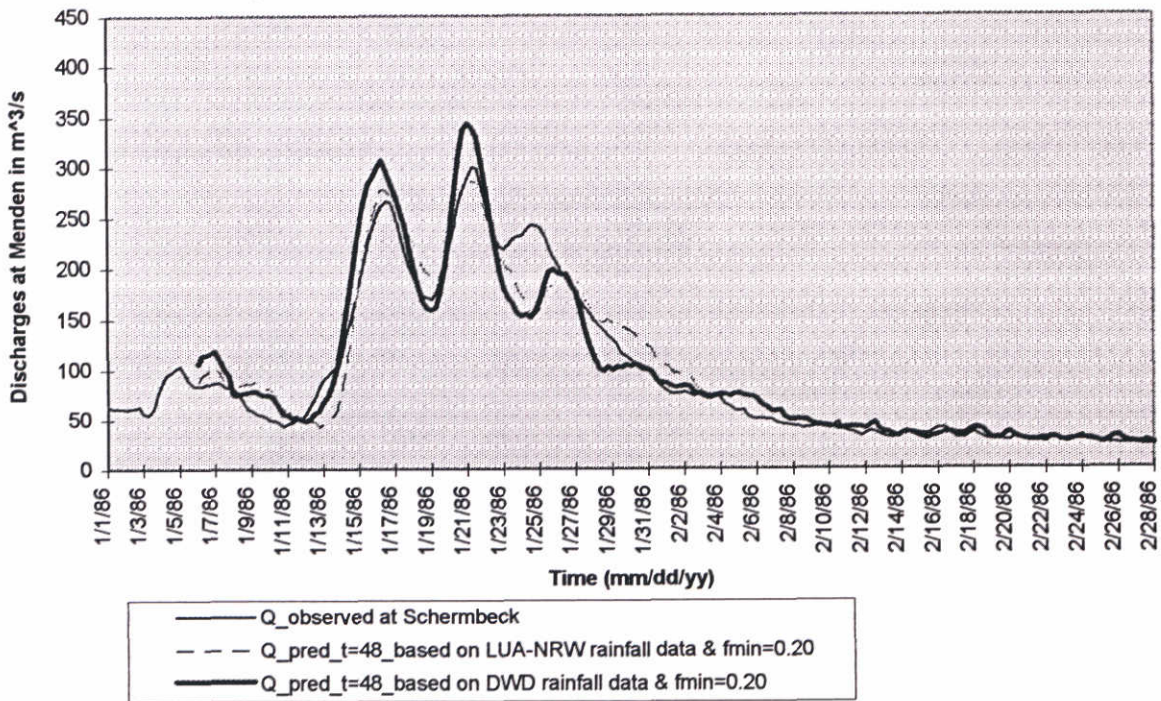


Fig. 10.21a Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.

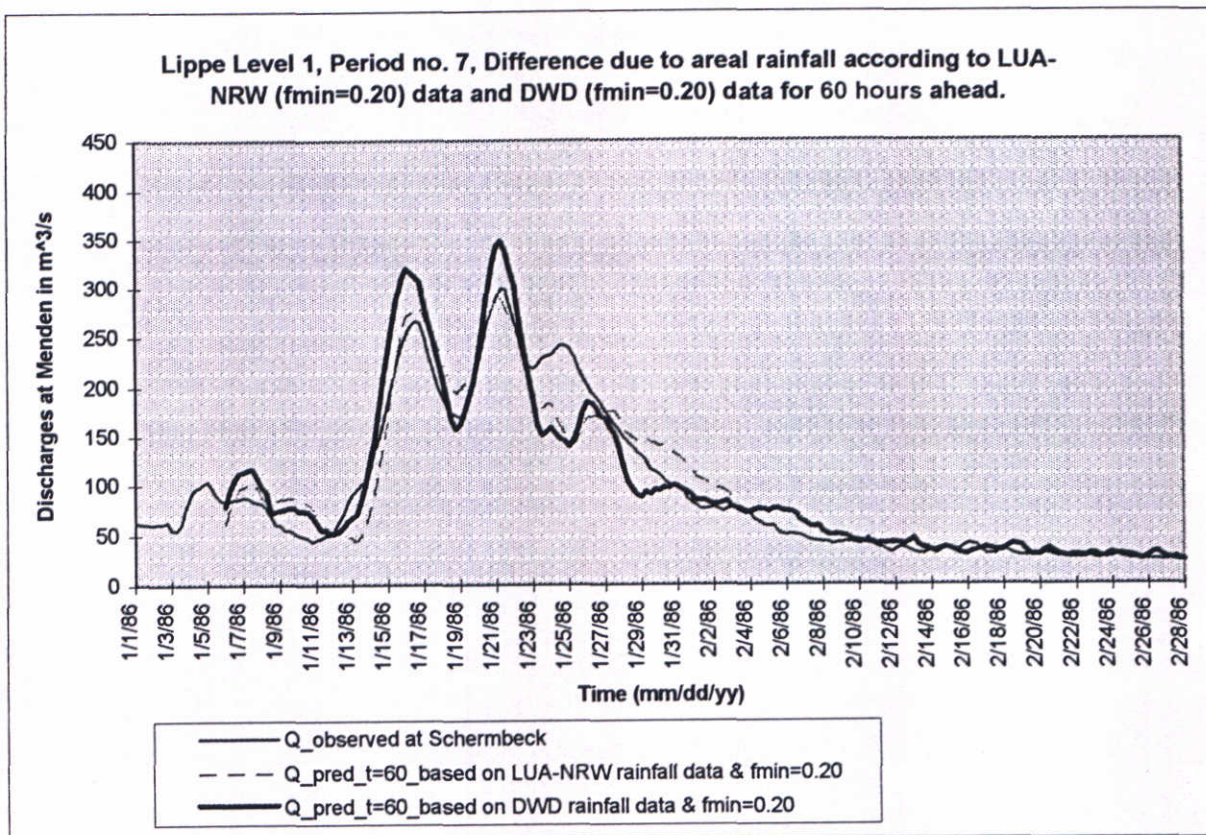


Fig. 10.21b Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.

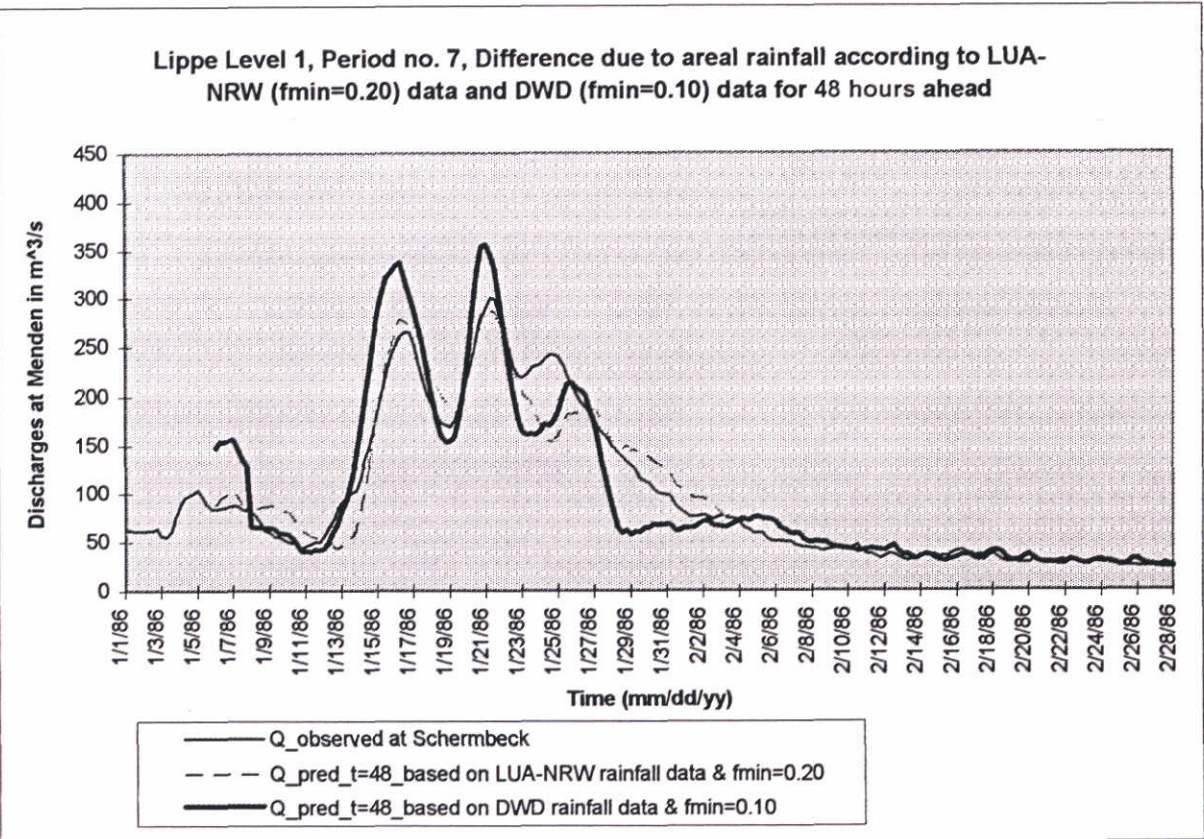
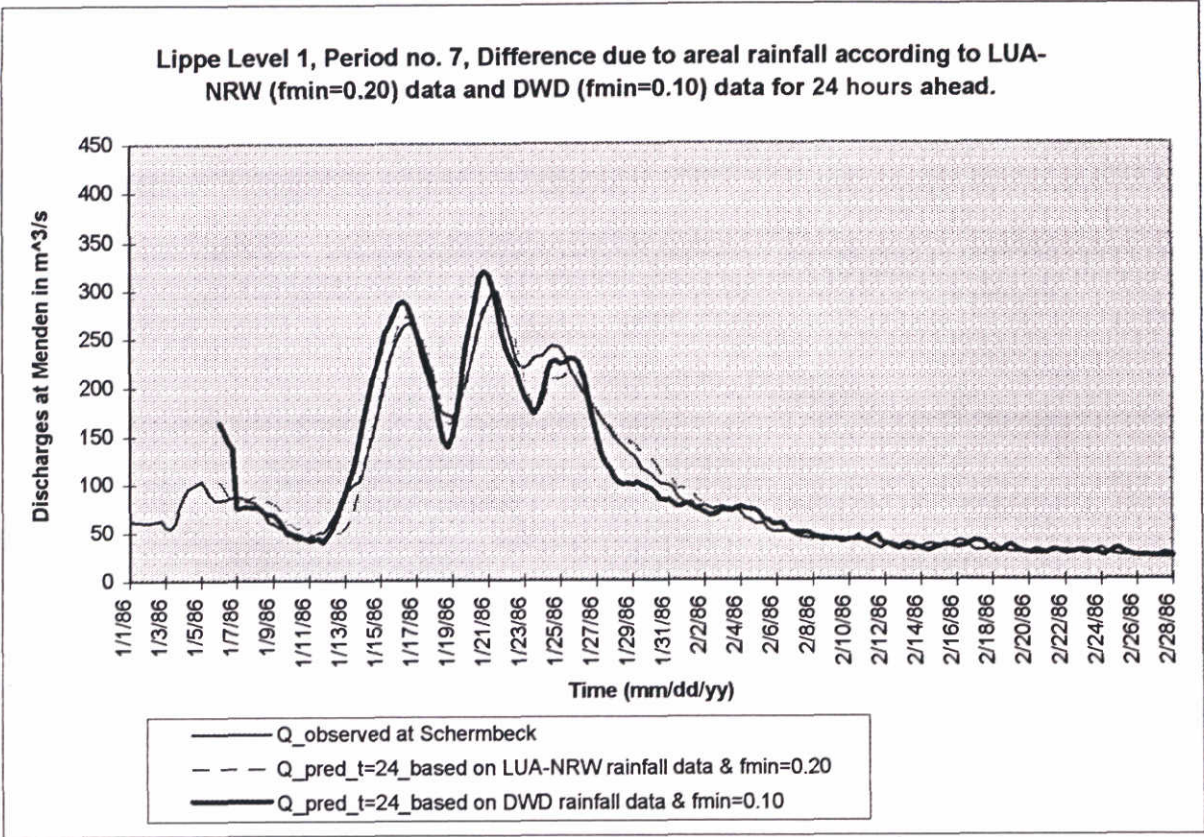


Fig. 10.22a **Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.10$ for DWD.**

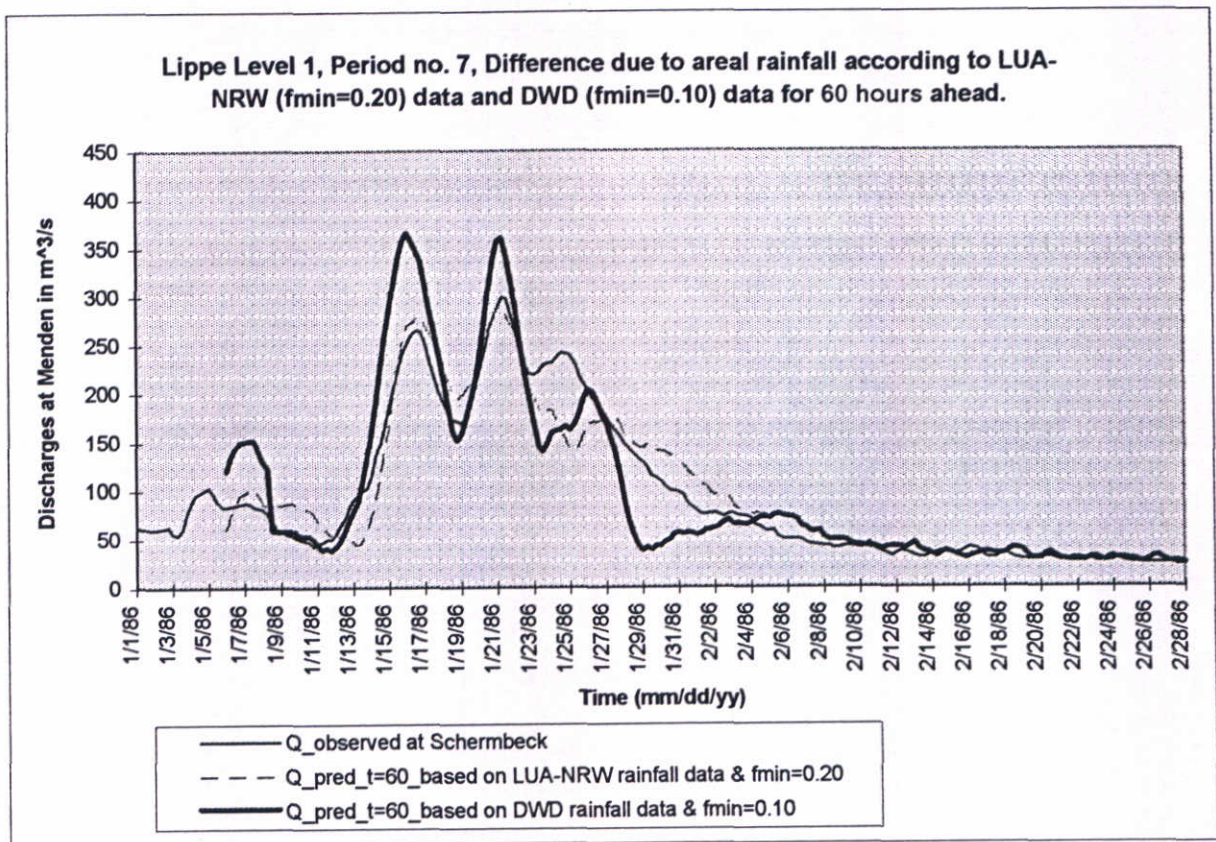


Fig. 10.22b

Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.10$ for DWD.

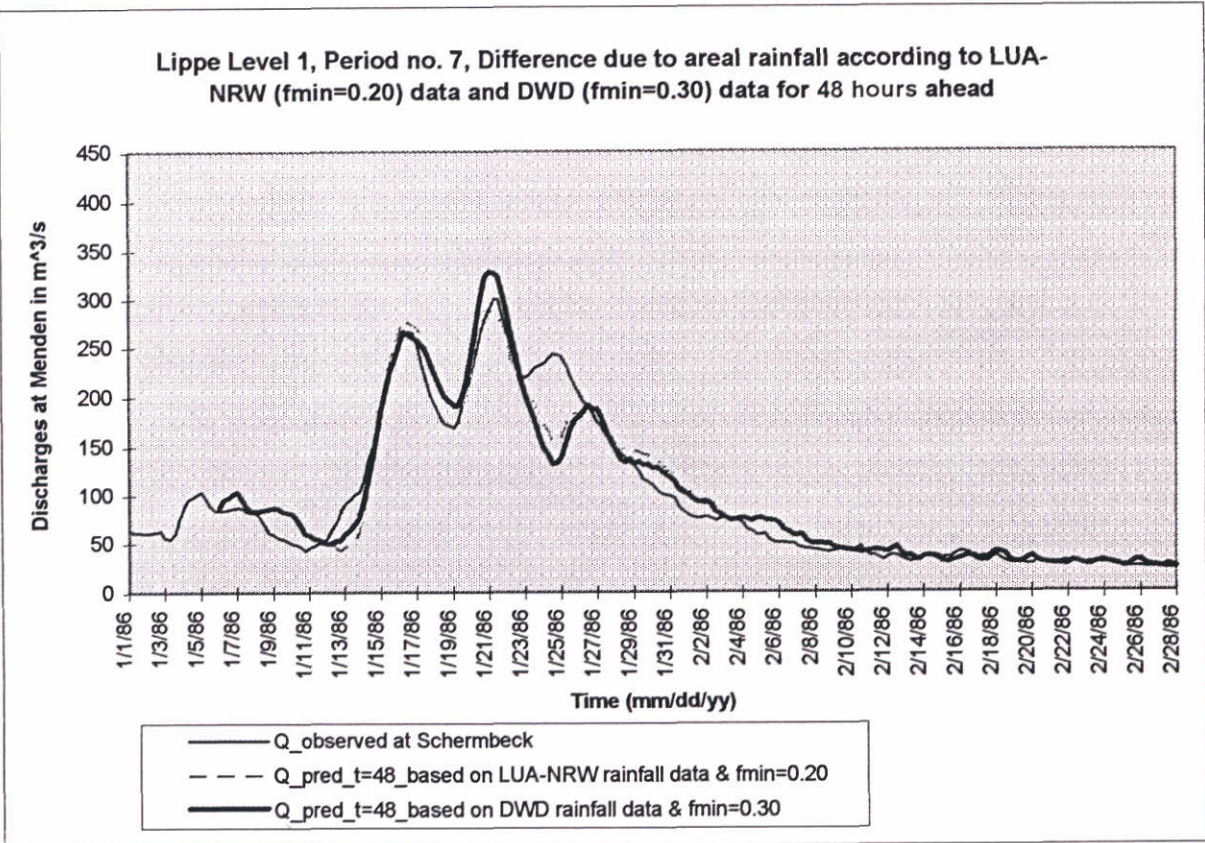
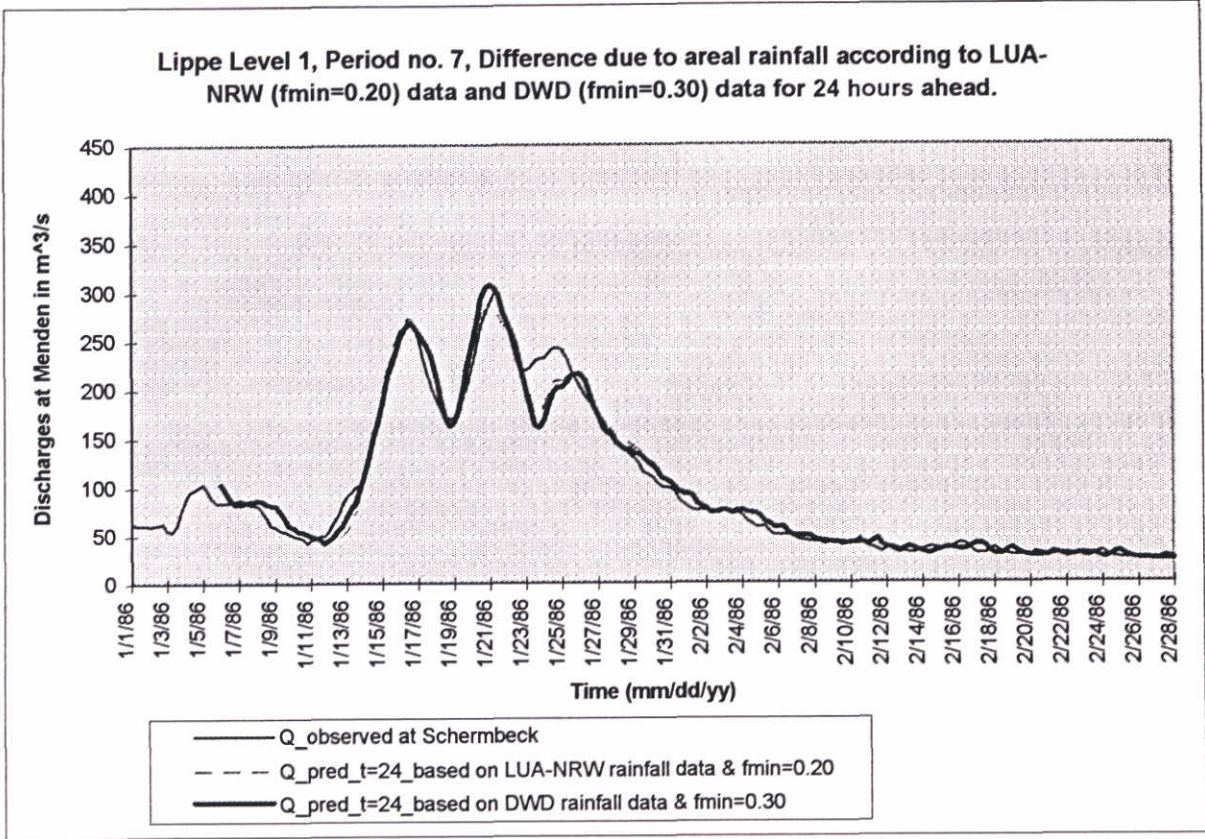


Fig. 10.23a Lippe Level 1, Period no. 7, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.30$ for DWD.

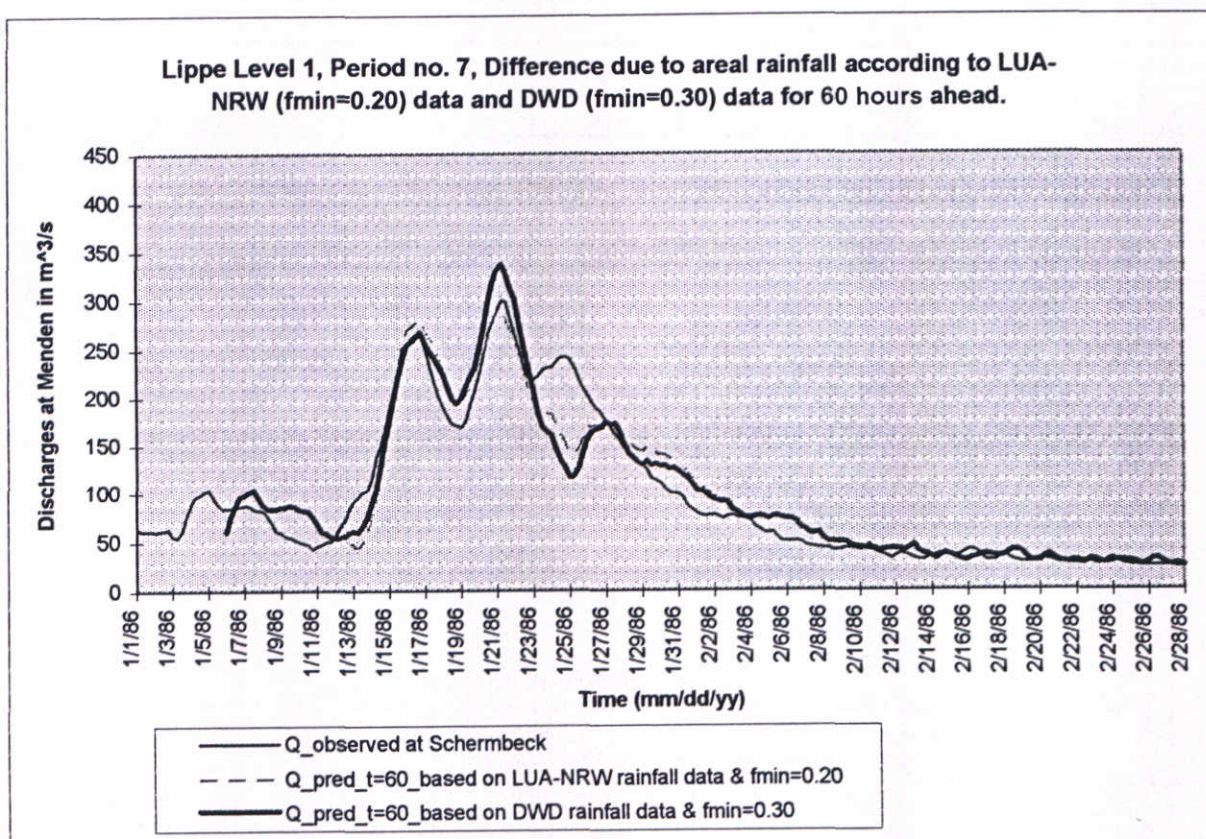


Fig. 10.23b Lippe Level 1. Period no. 7. Sensitivity to LUA-NRW and DWD areal rainfall.
 $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.30$ for DWD.

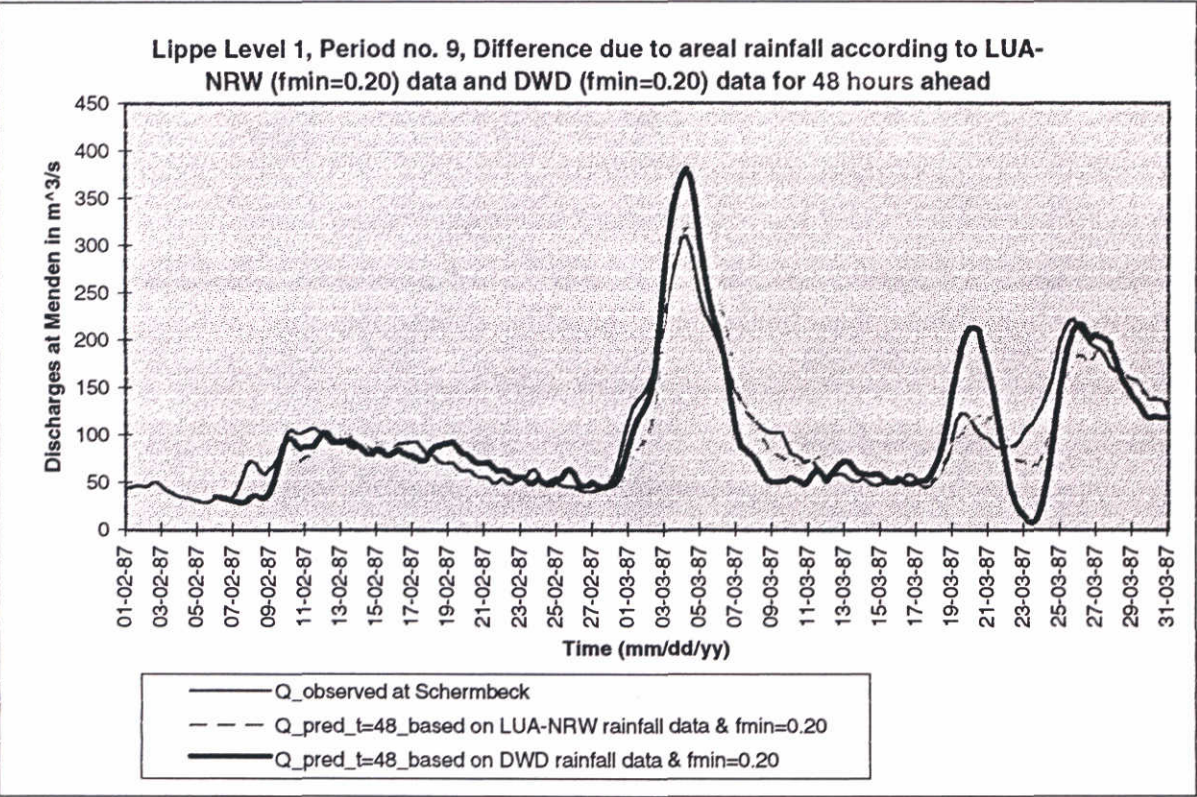
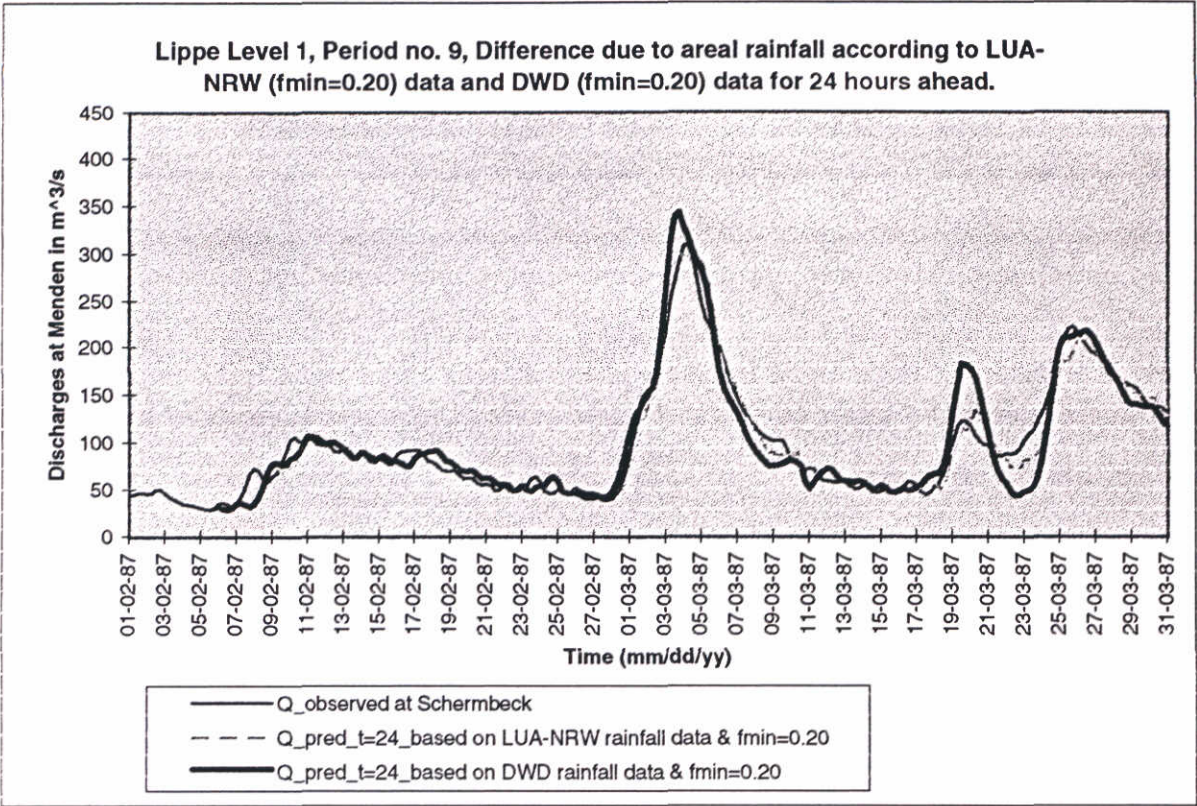


Fig. 10.24a Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.

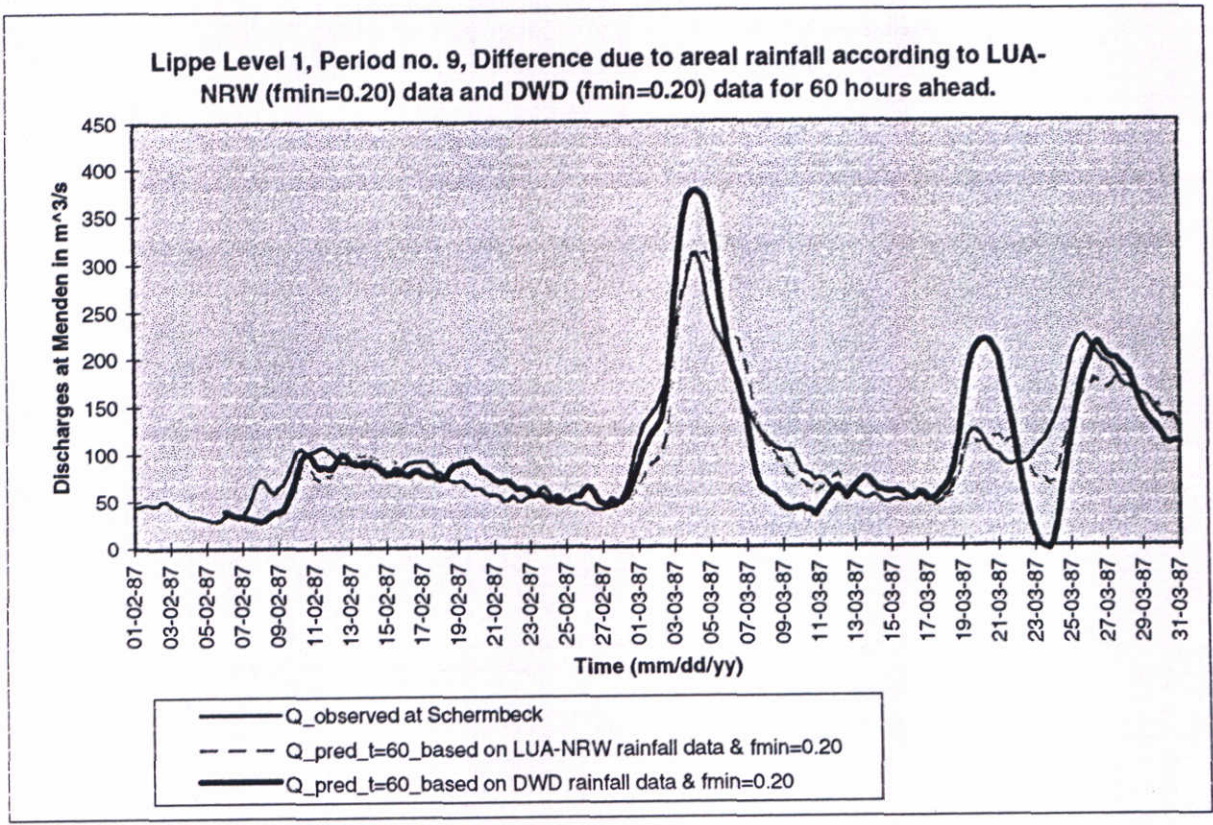


Fig. 10.24b Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, in both computations $f_{min}=0.20$ was used.

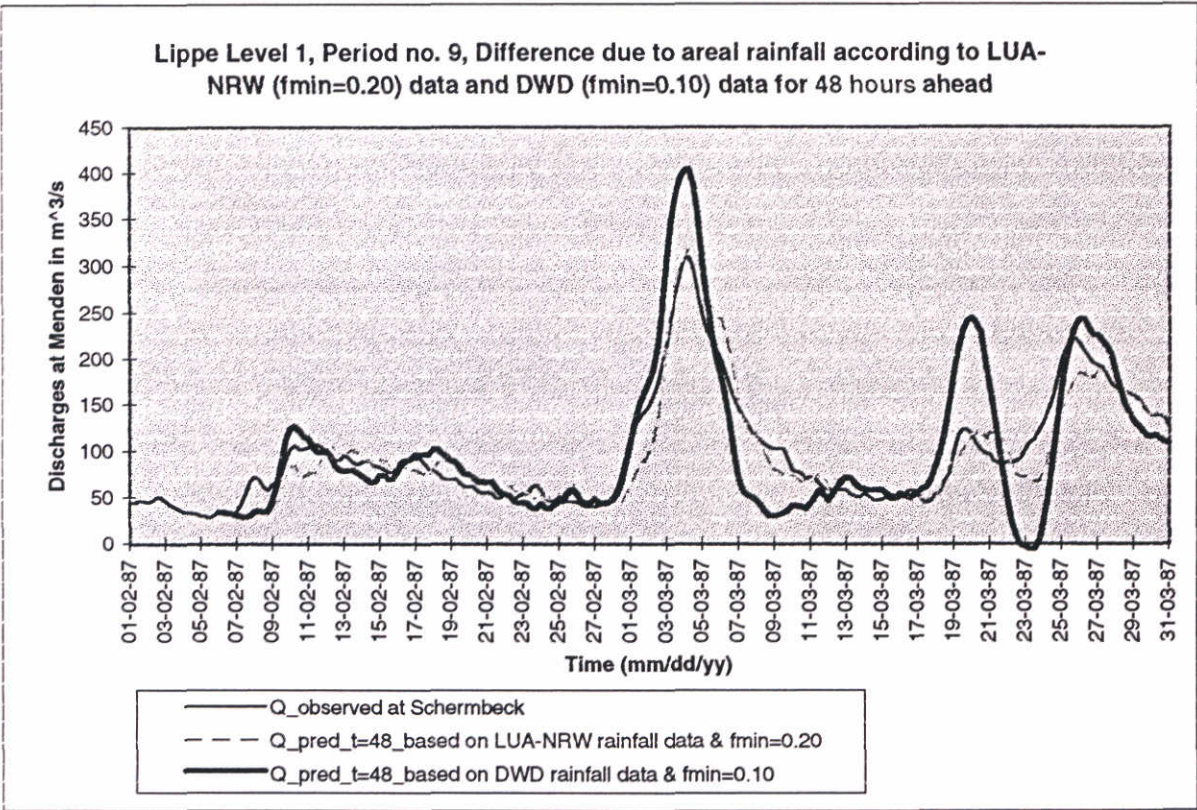
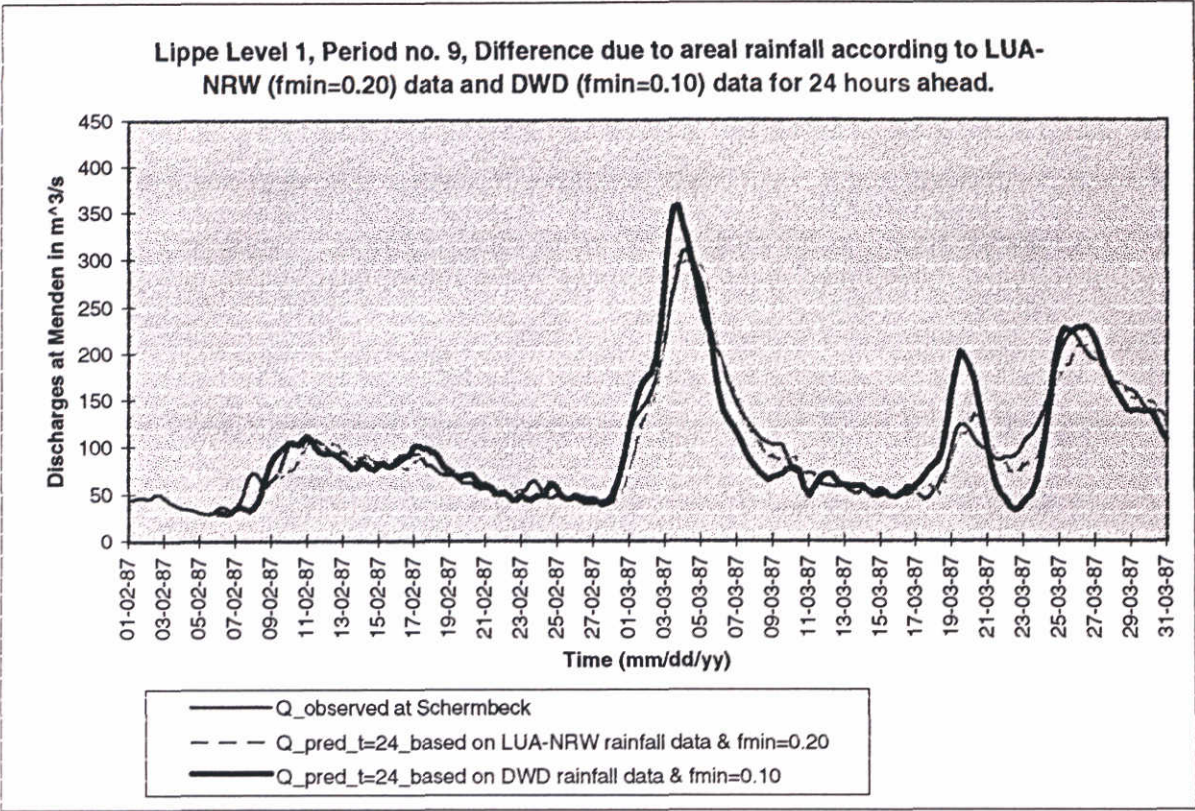


Fig. 10.25a Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.10$ for DWD.

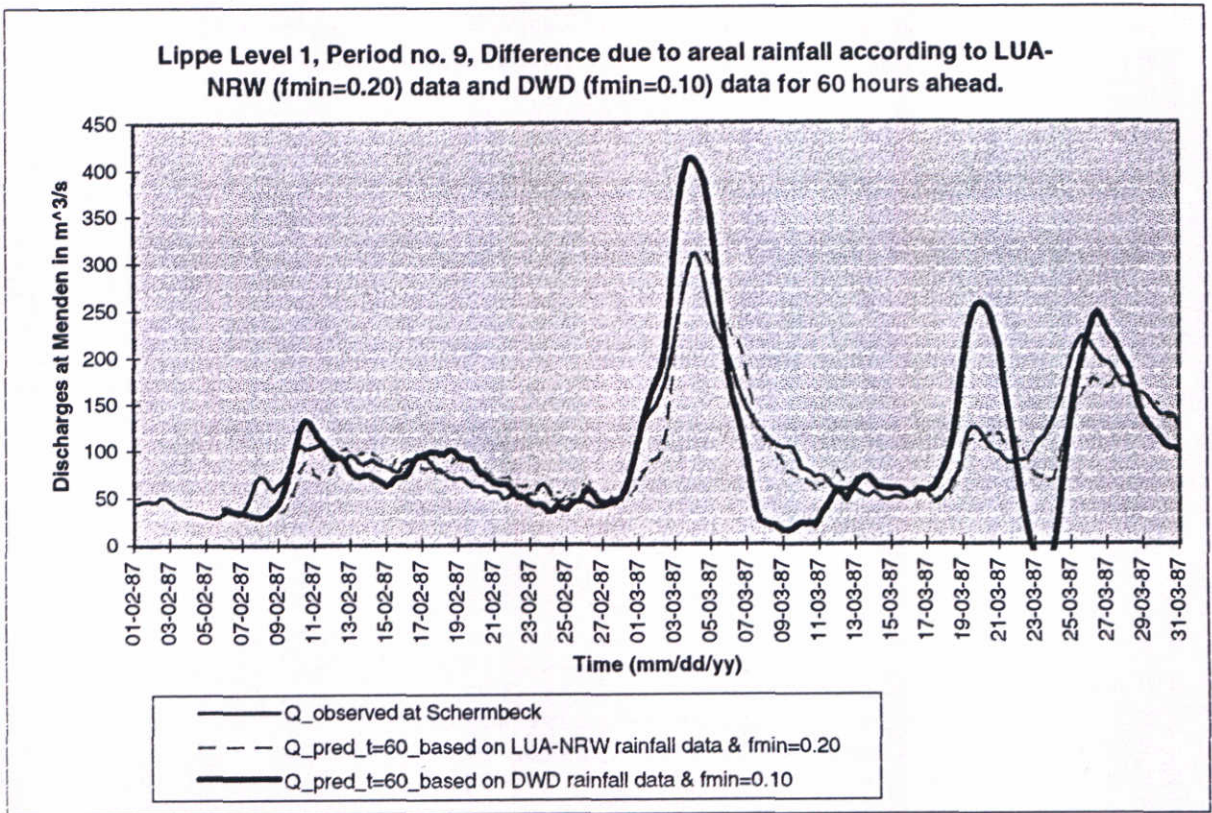
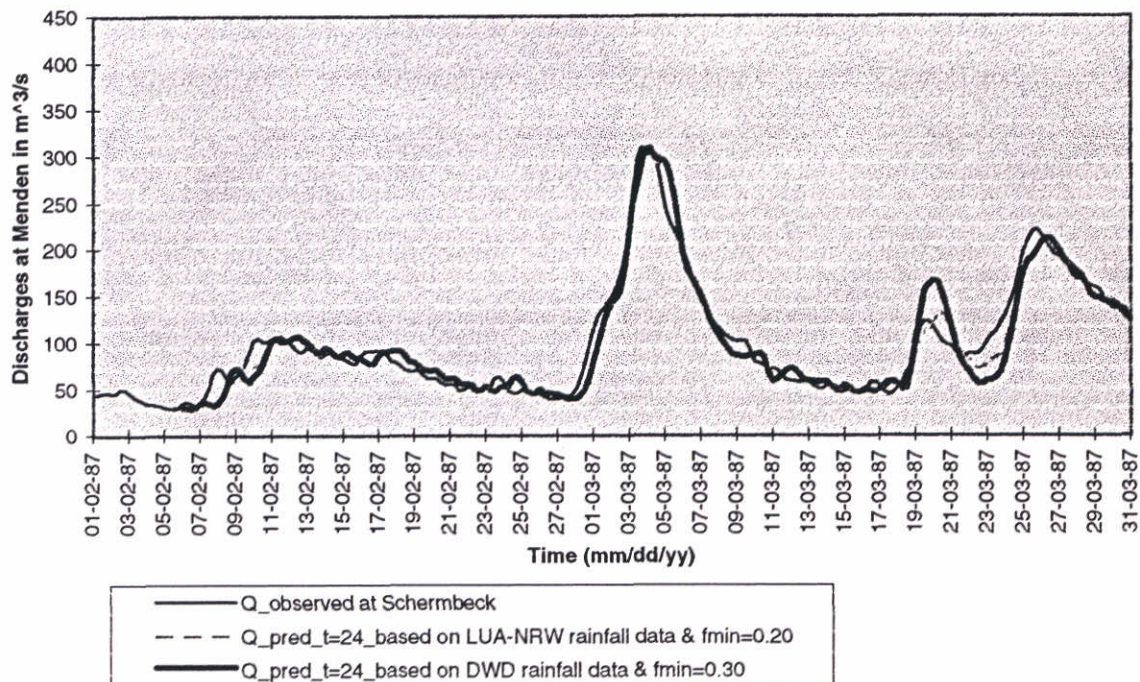


Fig. 10.25b Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall.
 $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.10$ for DWD.

Lippe Level 1, Period no. 9, Difference due to areal rainfall according to LUA-NRW ($f_{min}=0.20$) data and DWD ($f_{min}=0.30$) data for 24 hours ahead.



Lippe Level 1, Period no. 9, Difference due to areal rainfall according to LUA-NRW ($f_{min}=0.20$) data and DWD ($f_{min}=0.30$) data for 48 hours ahead

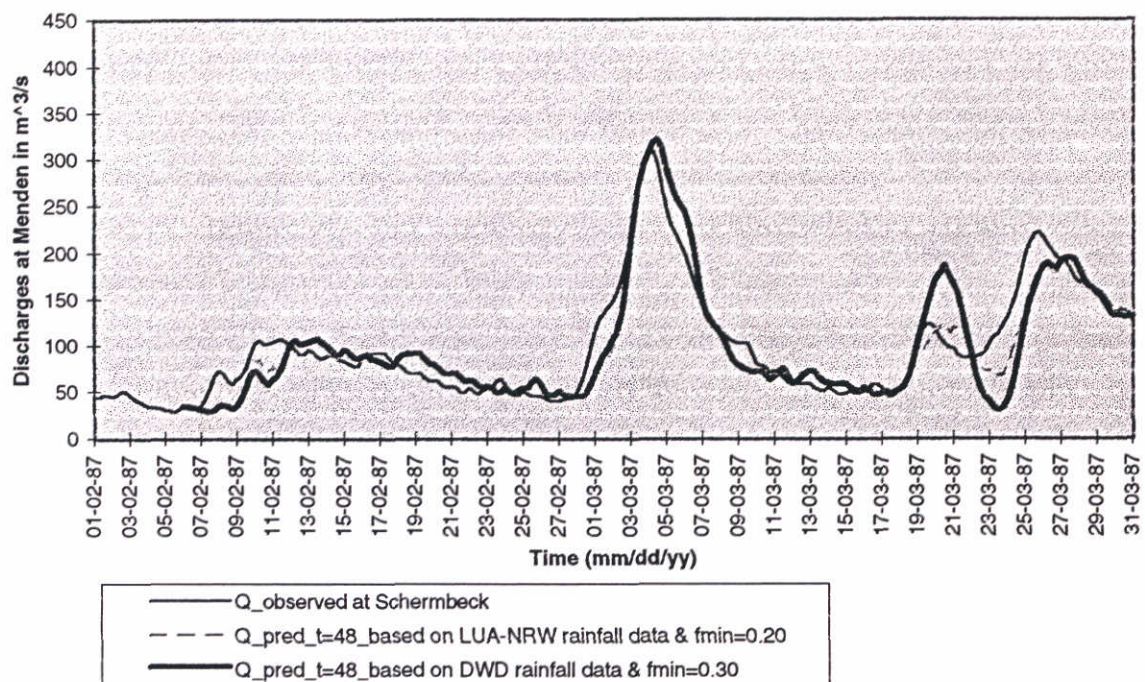


Fig. 10.26a Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.30$ for DWD.

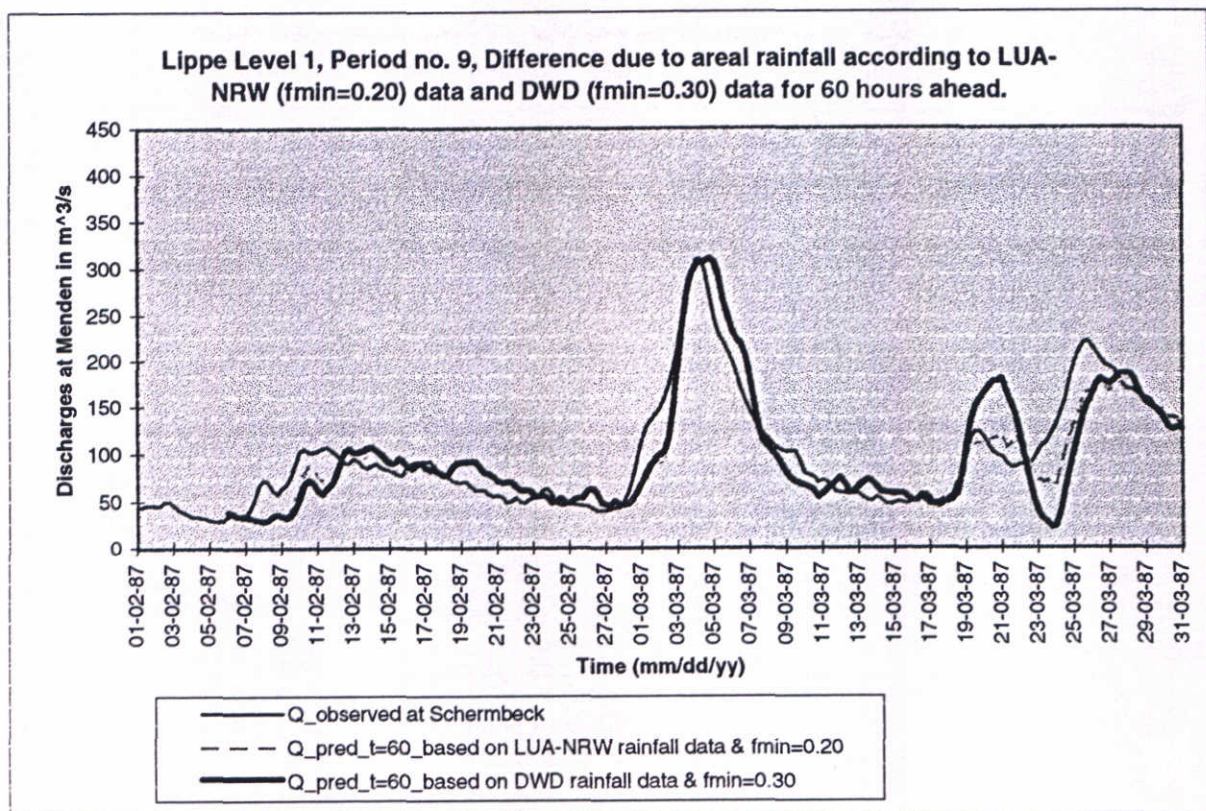


Fig. 10.26b Lippe Level 1, Period no. 9, Sensitivity to LUA-NRW and DWD areal rainfall, $f_{min}=0.20$ for LUA-NRW & $f_{min} = 0.30$ for DWD.

Figures of Chapter 11

- Fig. 11.1 Domain of the Deutschland-Modell (DM) and the Europa-Modell (EM). Fine raster representent the DM.
- Fig. 11.2 Deutschland Modell (DM) raster with the basin of the Rhine River

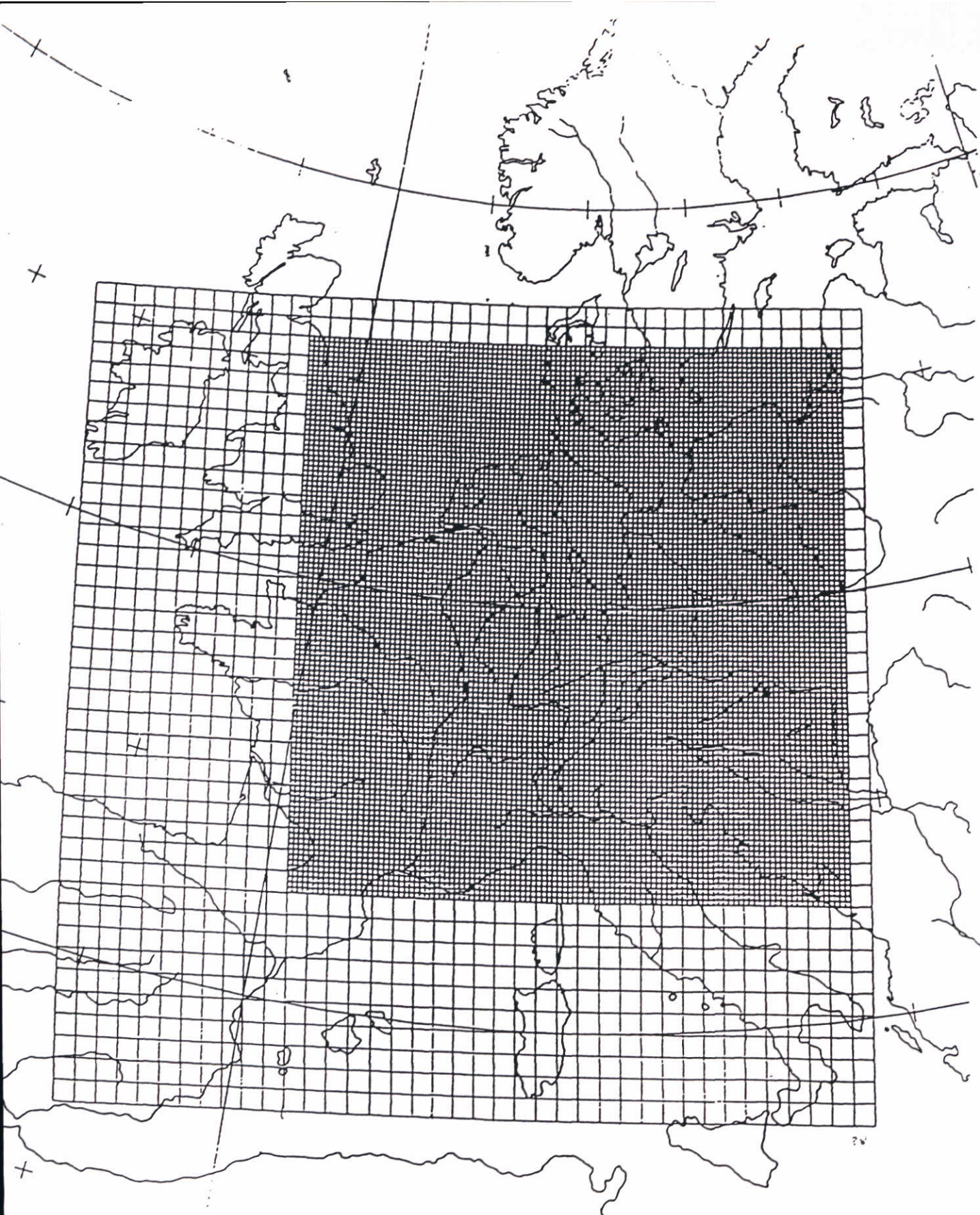


Fig. 11.1 Domain of the Deutschland-Modell (DM) and the Europa-Modell (EM)
Fine raster represents the DM

Rheingebiet **DM-Raster**

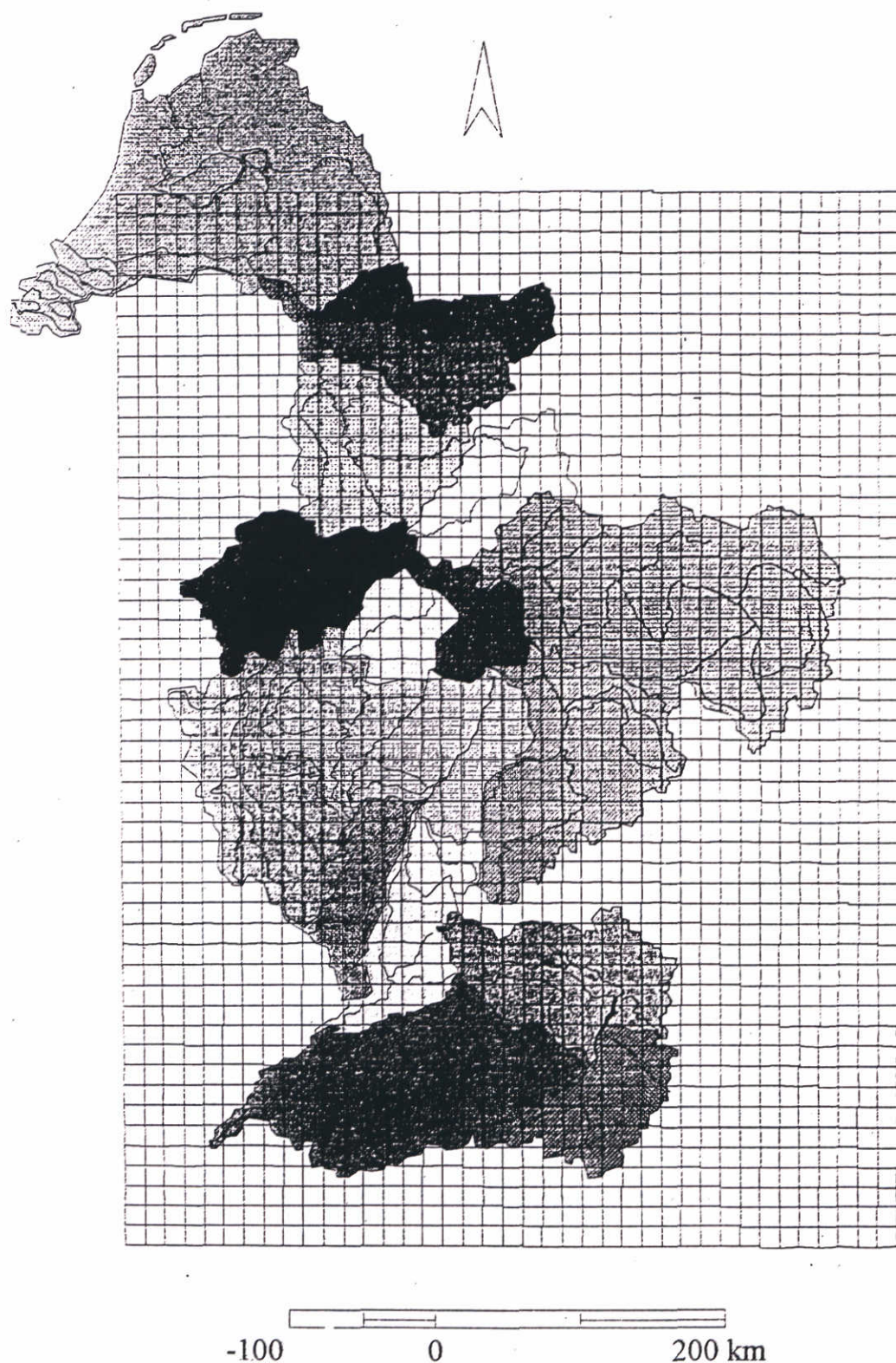
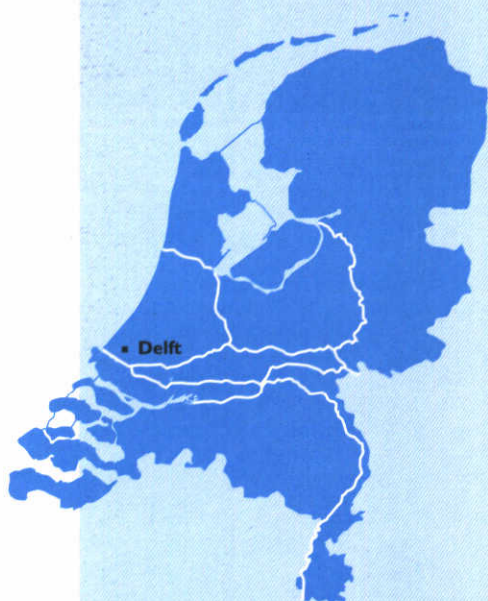


Fig. 11.2 Deutschland-Modell (DM) raster with the basin of the Rhine river



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