Risk management of extreme flood events

Reconstruction and analysis of 19th century floods in SW Germany

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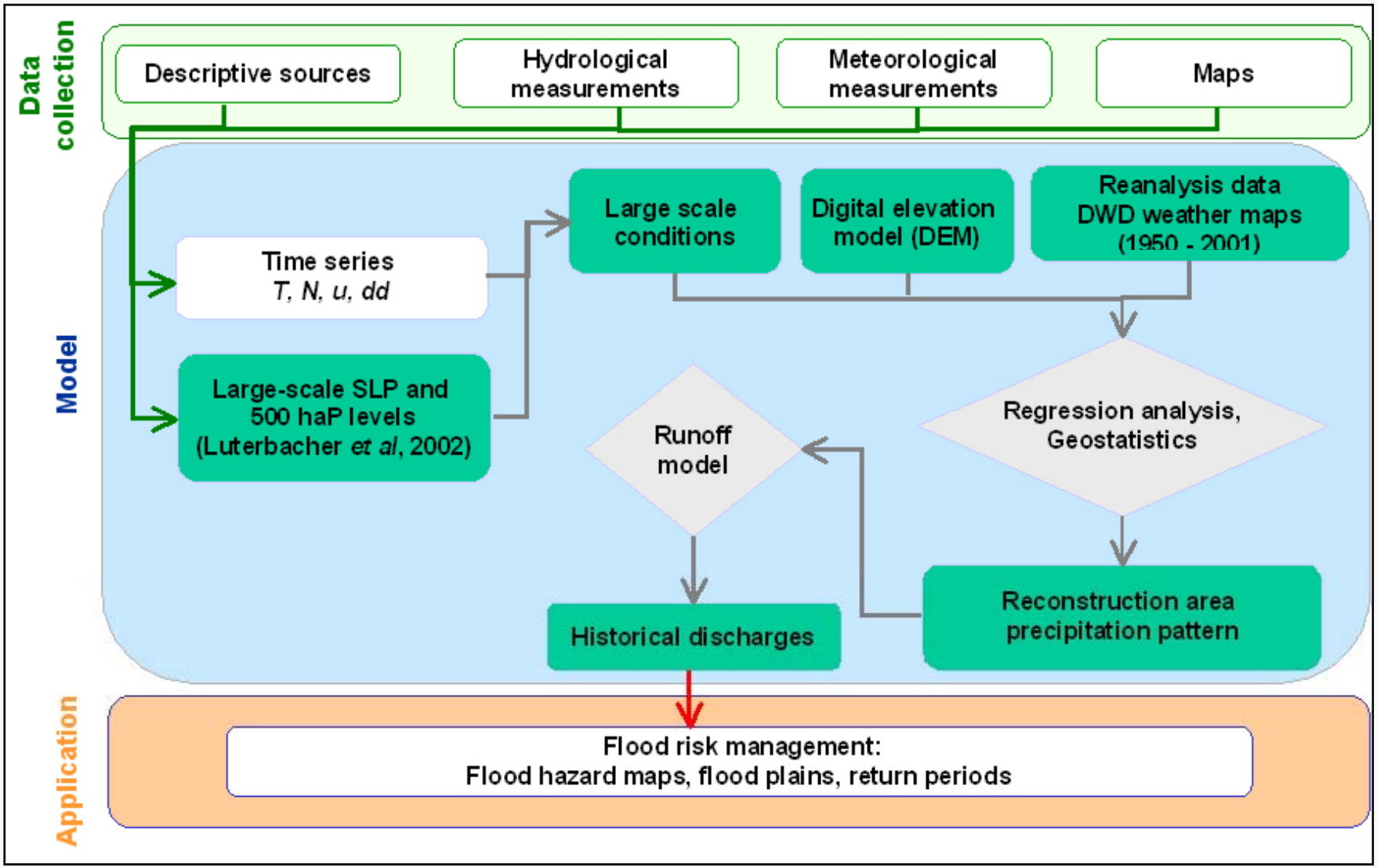
GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

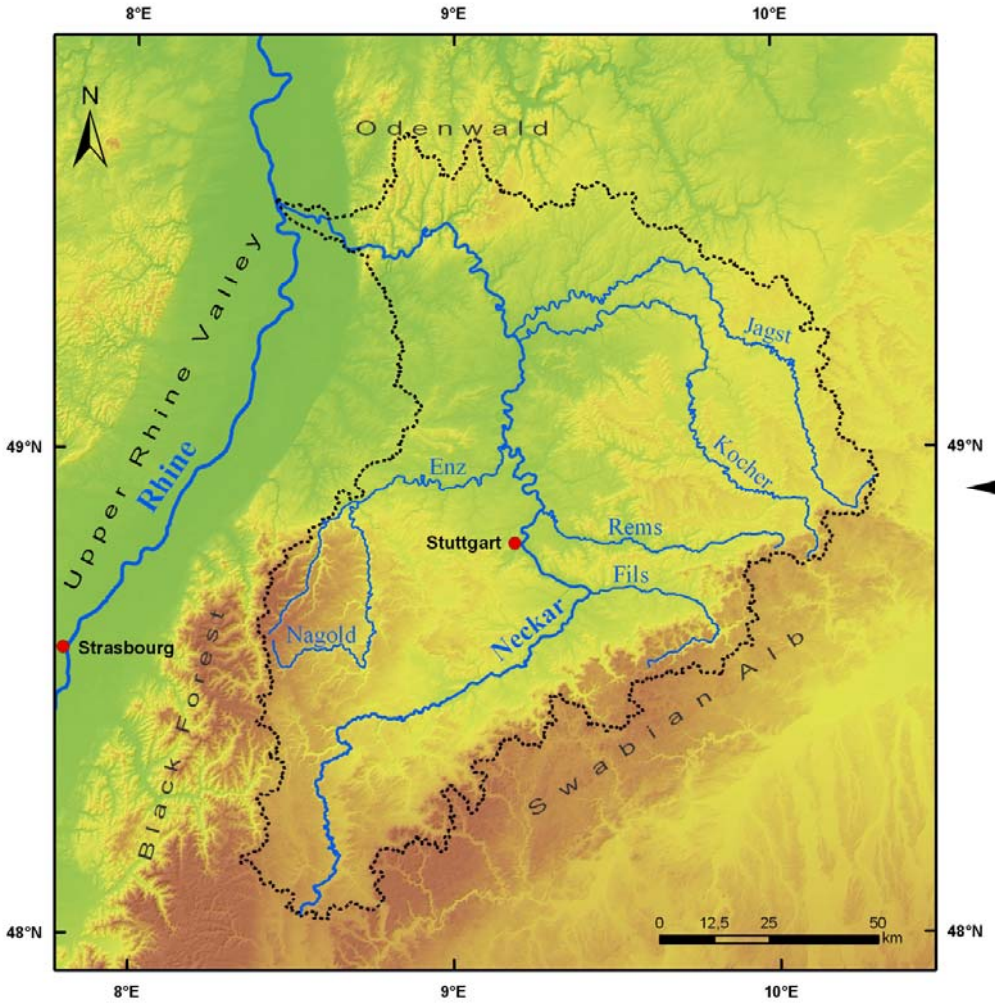
- How reliable are statements from extreme flood events which lay far in the past, i.e. before the official measurements of hydrometeorological parameter (prior to 1900)?
- Is it possible to reconstruct them seriously?
- Do such extreme events find their way into the recent flood risk management?

What caused the flood in the Neckar catchment in 1824?

- Generally a cold and wet summer and autumn in SW-Germany
- Thunderstorms with strong precipitation in wide areas of the Neckar catchment on Oct. 26
- Heavy rainfall (36h) from Oct. 28 evening until the early morning of Oct. 30 in SW-Germany

Combination of saturated soils (-> no more water retention capability) and the following extreme rainfall caused highest Neckar flood for the last 300 years

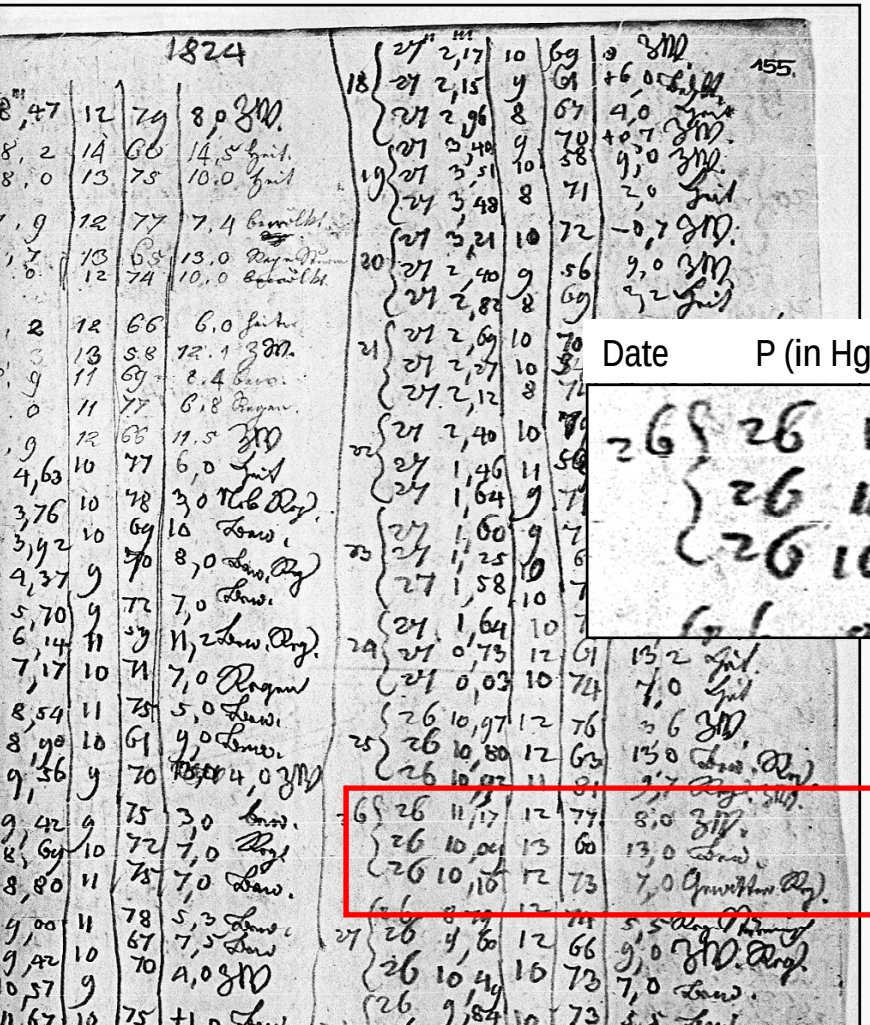

Data collection
Descriptive sources
Hydrological measurements
Meteorological measurements
Maps
Model
Time series
T, N, u, dd
Large-scale SLP and
500 haP levels
(Luterbacher et al, 2002)
Large scale conditions
Digital elevation model (DEM)
Reanalysis data
DWD weather maps
(1950 - 2001)
Runoff model
Regression analysis,
Geostatistics
Historical discharges
Reconstruction area
precipitation pattern
Application
Flood risk management:
Flood hazard maps, flood plains, return periods



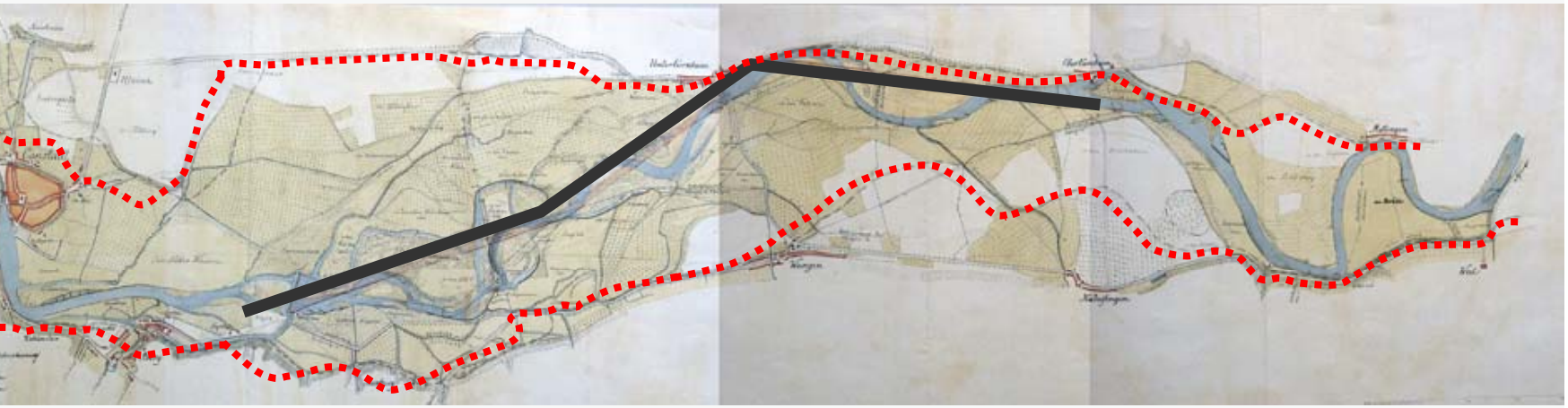
Catchment area: ~ 14000 km²
(40 % of Baden-Württemberg)
Length of River Neckar: 367 km

<u>Important tributaries:</u>
Enz (2223 km²)
Kocher (1989 km²)
Jagst (1837 km²)

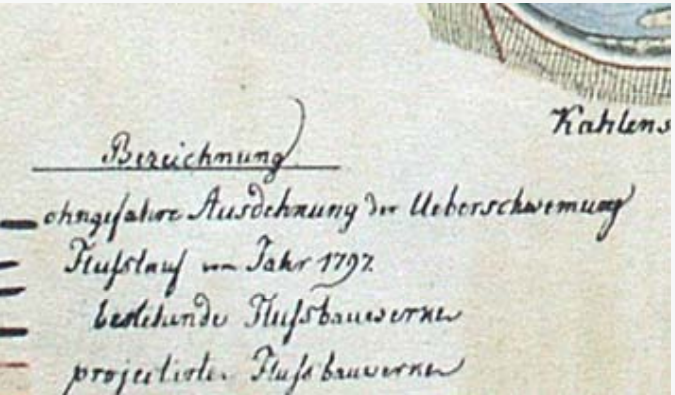
Meteorological observations of J.G.F. Bohnenberger in Tübingen (1815-1828)

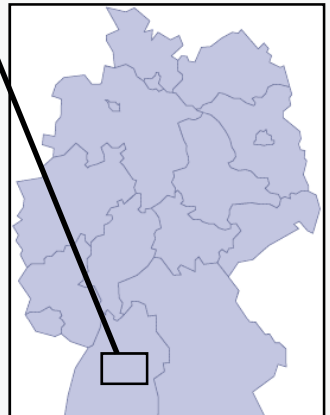


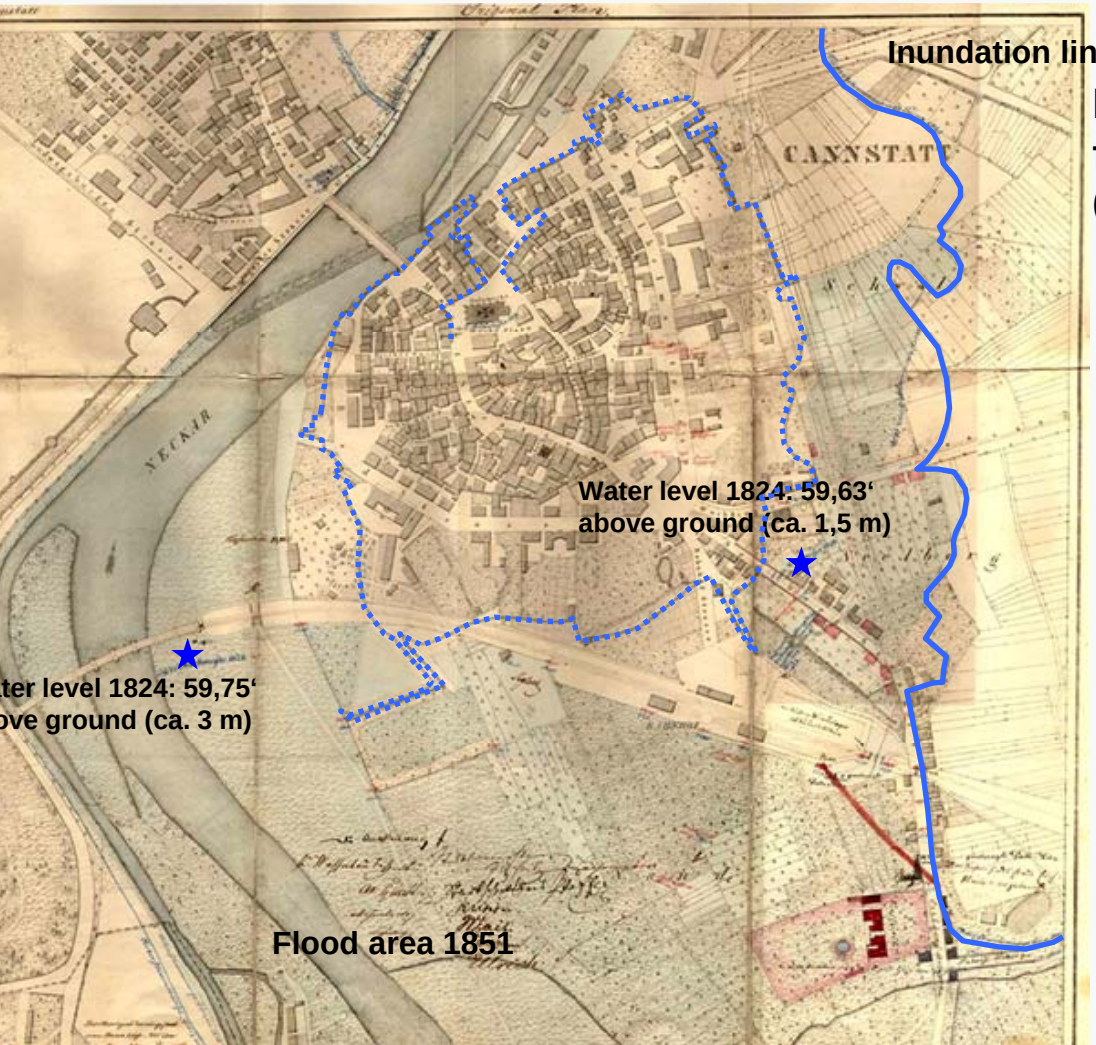
Date	P (in Hg)	T_1 (°R)	RH(%)	T_2 (°R)	Weather Description
26	11,17	12	77	8,0	
26	10,04	13	60	13,0	
26	10,10	12	73	7,0	



of the Neckars with planned river corrections and inundation line from the 1817 flood (Quelle: Seeger, 1822)







Inundation line 1845

Map of inundation areas for Bad Cannstatt, 19. Ct.

(City archive Stuttgart)

ecipitation from October 10/28 to 10/29 1824 (36 h) at different sites Baden-Württemberg (Schübler 1825)

	auf 1 Pariſer Qu. Schuh.	oder die Höhe des Regens betrug	
n Freudenſtadt auf dem Schwarz-wald	1044 Cubikz.	7,2 Zoll.	194 mm
n Wangen im Neckarthal	804 —	5,5 —	149 mm
n Hohenheim auf den Fildern	684 —	4,7 —	127 mm
n Stuttgart	663 —	4,6 —	124 mm
n Genkingen auf der Alp	500 —	3,4 —	92 mm
n Tübingen im Neckarthal	480 —	3,3 —	89 mm
n Giengen am ſüdöſtlichen Abhang der Alp	477 —	3,3 —	89 mm
Mittel	664 —	4,6 —	124 mm

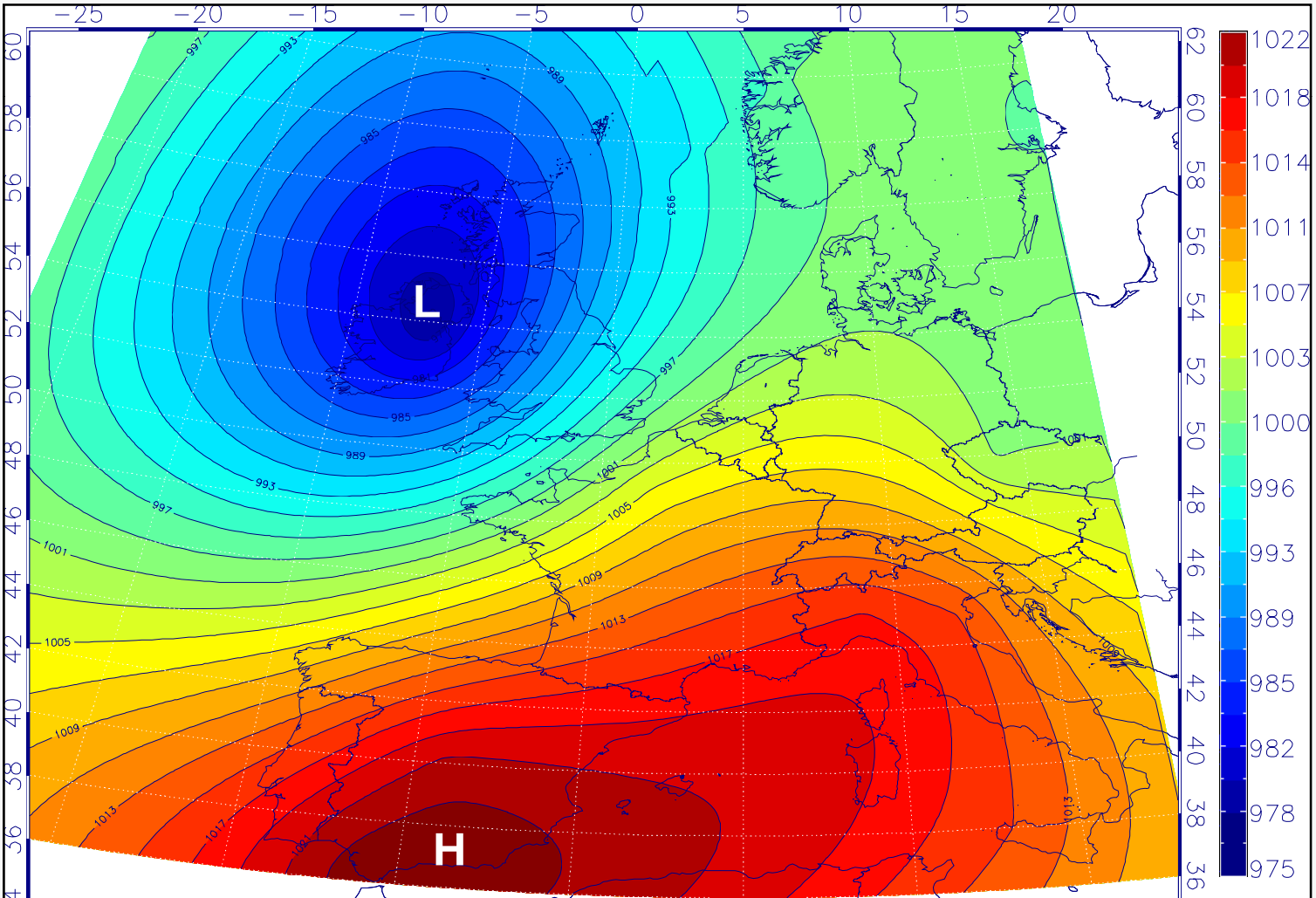
Reconstruction of the weather situation at the end of October 1824

arge scale data (Europe)

3 Stations with historical air pressure measurements

→ Synoptic weather maps of the mean sea level pressure (MSLP)

→ Determination of the large scale atomspheric circulation pattern


−25
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1022
1018
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1007
1003
1000
996
993
989
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982
978
975
L
H
997
993
989
985
981
977
973
969
965
1001
1005
1009
1013
1017

Spatial modeling of heavy rainfall in October 1824

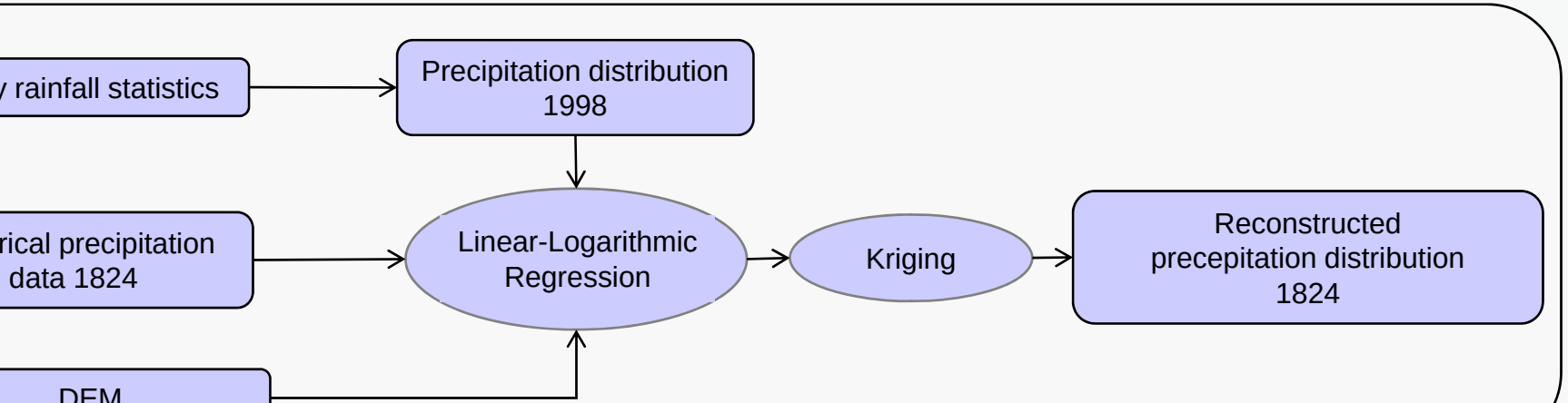
Comparison of regional rain pattern & large-scale atmospheric conditions with recent data (DWD, 1934 - 2004)

→ Best correspondence: **Oct. 27 and 28 1998 (circulation type CW)**

Adjustment of the 1998 event

- Historical rainfall data
- Digital elevation model (DEM)

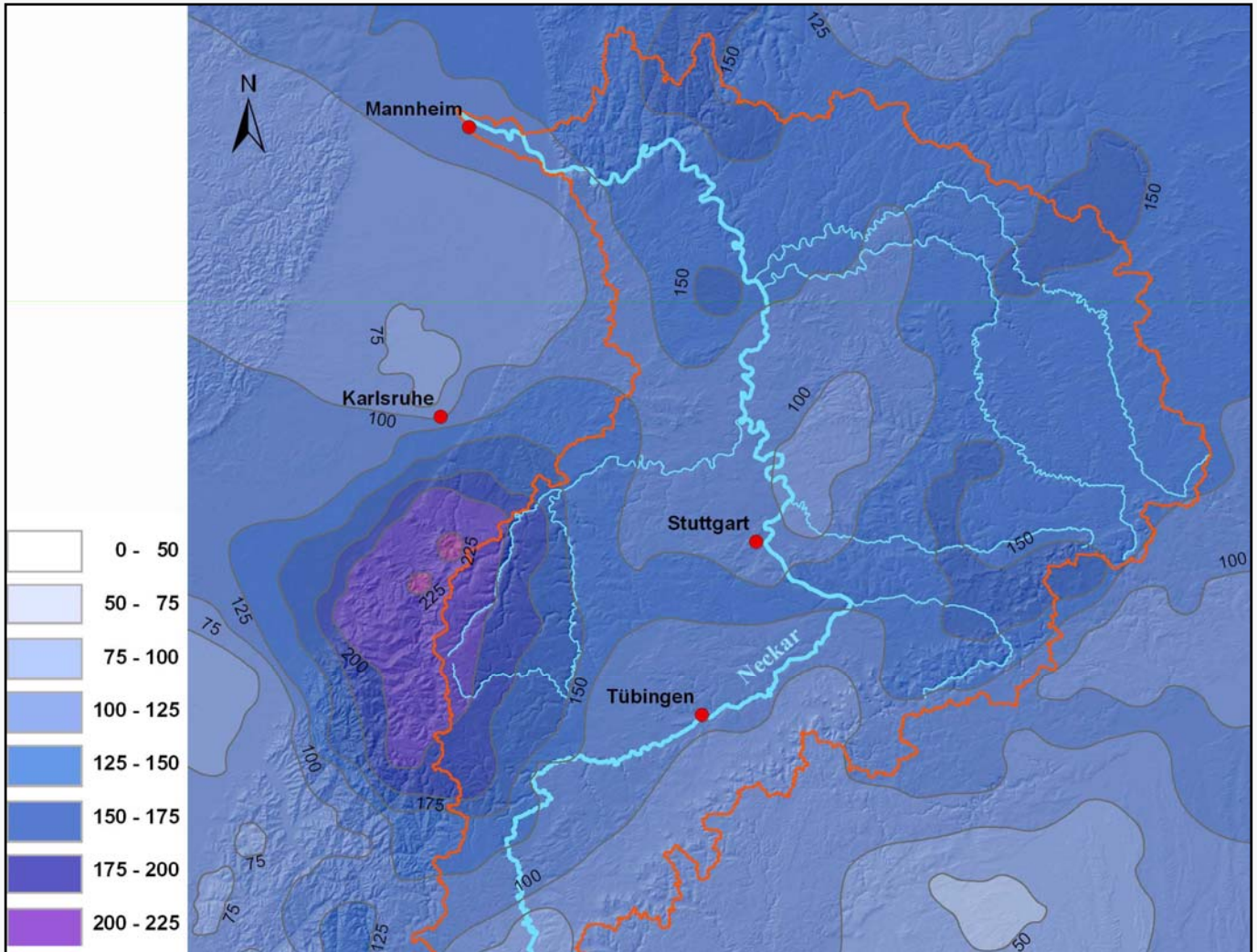
Spatial interpolation of the modeled rainfall data (220 stations in SW - Germany) on a 1 km grid (Kriging)



Risk management
of extreme
flood events

Xfloods

led precipitation
nt for the Neckar
ment Oct. 28./29.
(36h)



Fluss	HQ_{1824} (m^3/s)	HQ_{100} (m^3/s)	HQ_{extrem} (m^3/s)
Neckar	**137**	**260**	**390**
Neckar	**223**	**348**	**522**
Neckar	**416**	**549**	**800**
Neckar	**1400**	**1145**	**1600**
Nagold	192	181	273
Enz	580	504	757
Enz	563	513	766
Enz	612	586	821
Neckar	**2398**	**1877**	**2550**
Kocher	411	350	490
Kocher	1002	709	993
Jagst	461	387	582
Jagst	984	525	771
Neckar	**4185**	**2665**	**3600**
Neckar	**4335**	**2806**	**3700**
Neckar	**4264**	**2833**	**3750**

ee main reasons for the winter flood 1882

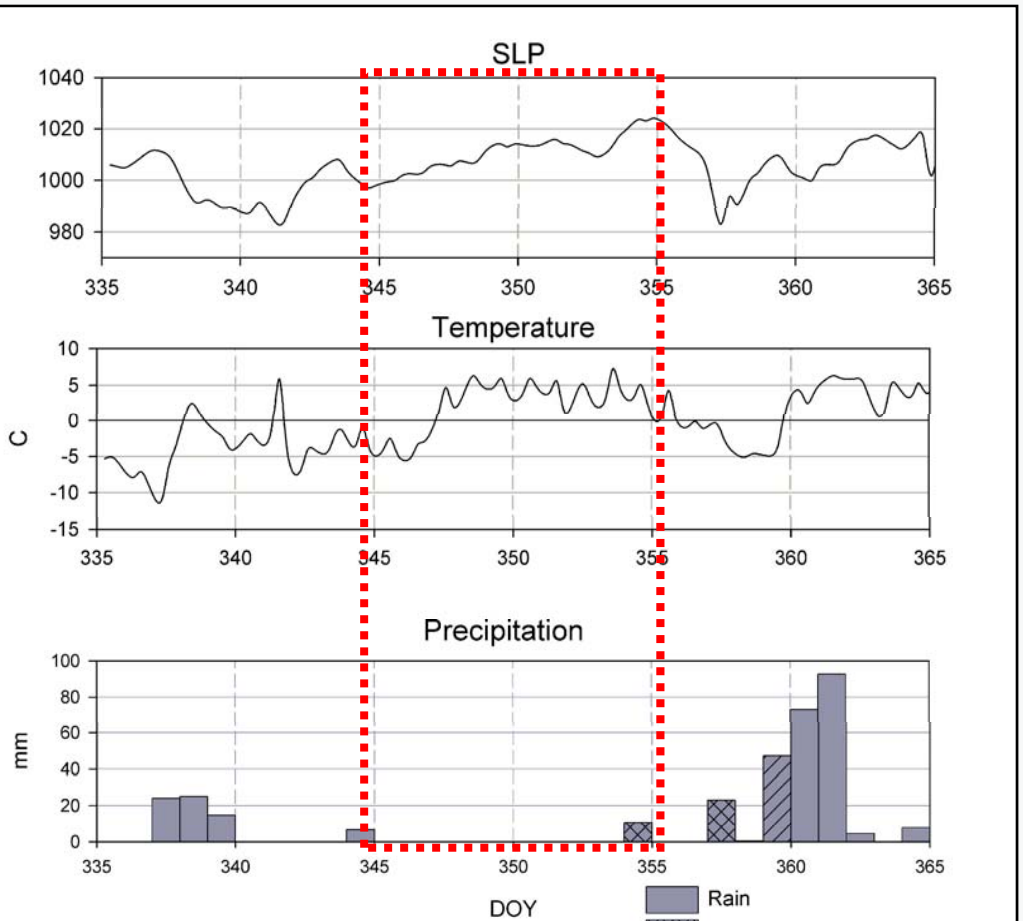
High soil saturation in the Neckar-catchment, caused by high precipitation sums in November 1882

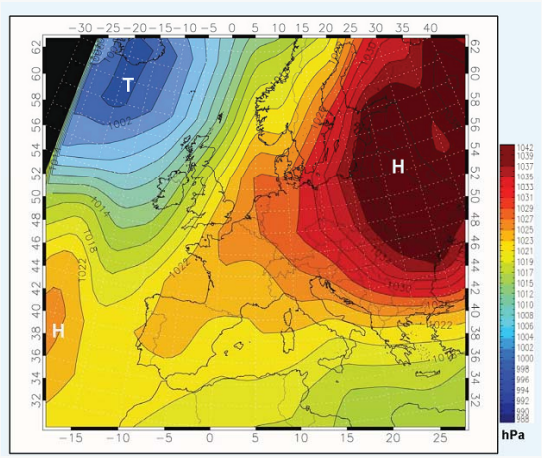
Strong snow fall in SW-Germany during Christmas until 25.12.1882

2-day precipitation event (rain) from 26.-27.12.1882

Rapid increase of air temperature at 26.12. causing a fast snow melt which was the main reason for this flood

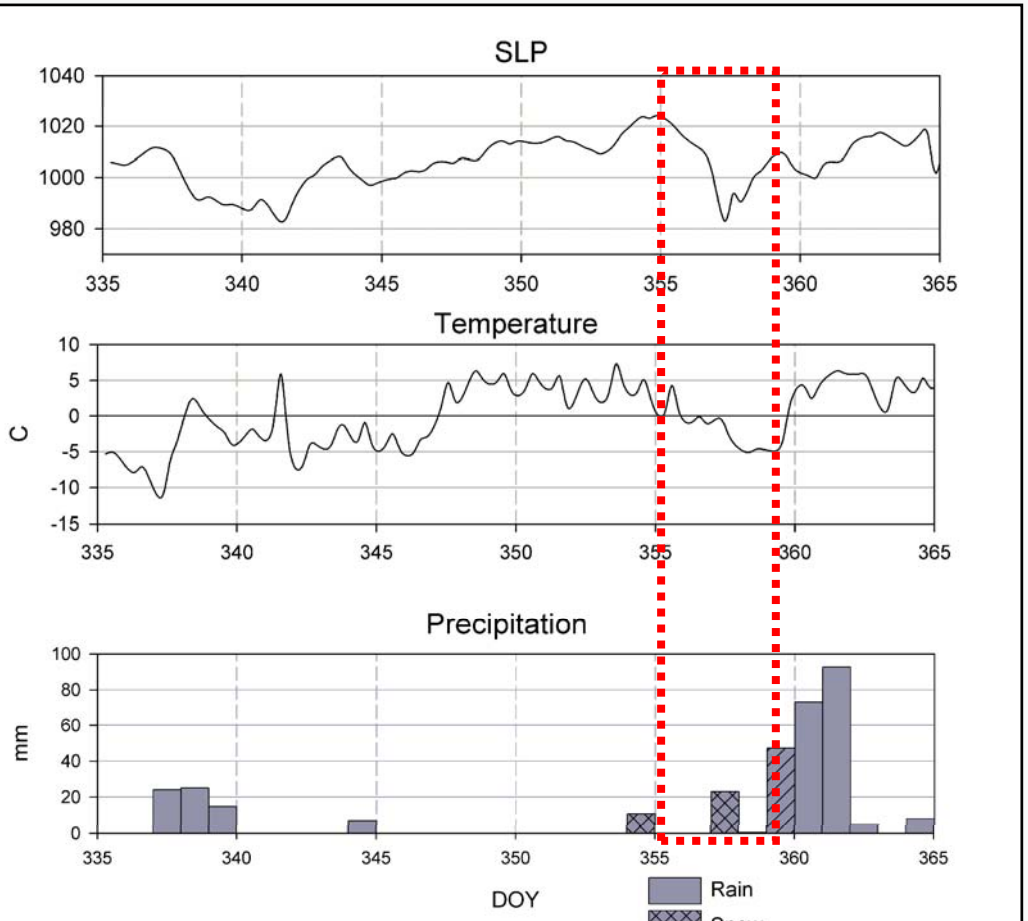
eteogramm December 1882 for Höchenschwand (1012 m NN)

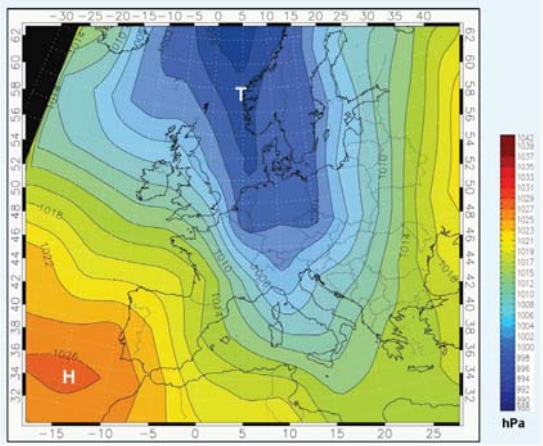




SLP 20.12.1882

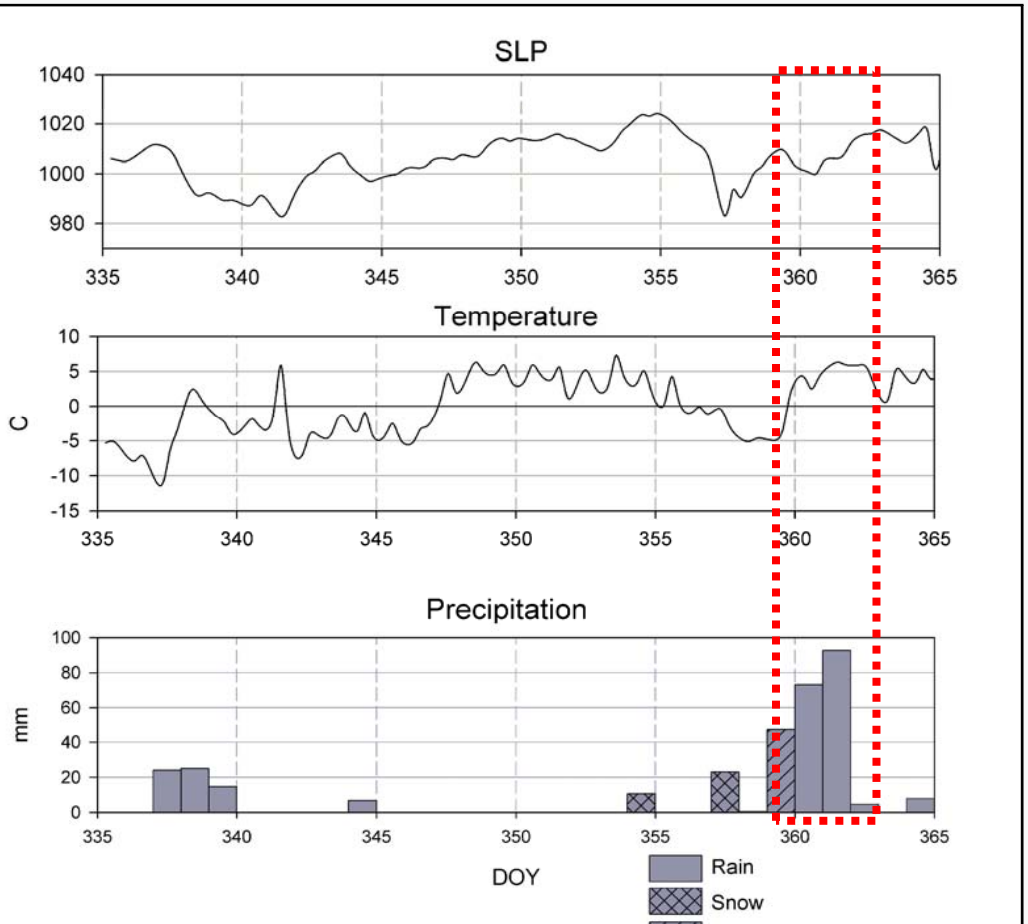
eteogramm December 1882 for Höchenschwand (1012 m NN)

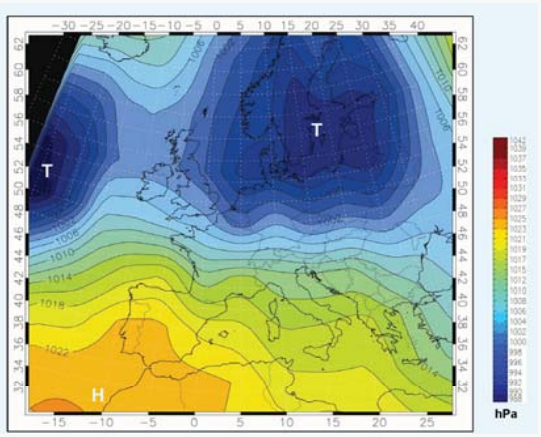




SLP 23.12.1882

eteogramm December 1882 for Höchenschwand (1012 m NN)





SLP 26.12.1882

ipitation data for LARSIM

Historical data
1882
43 Stations

Interpolation

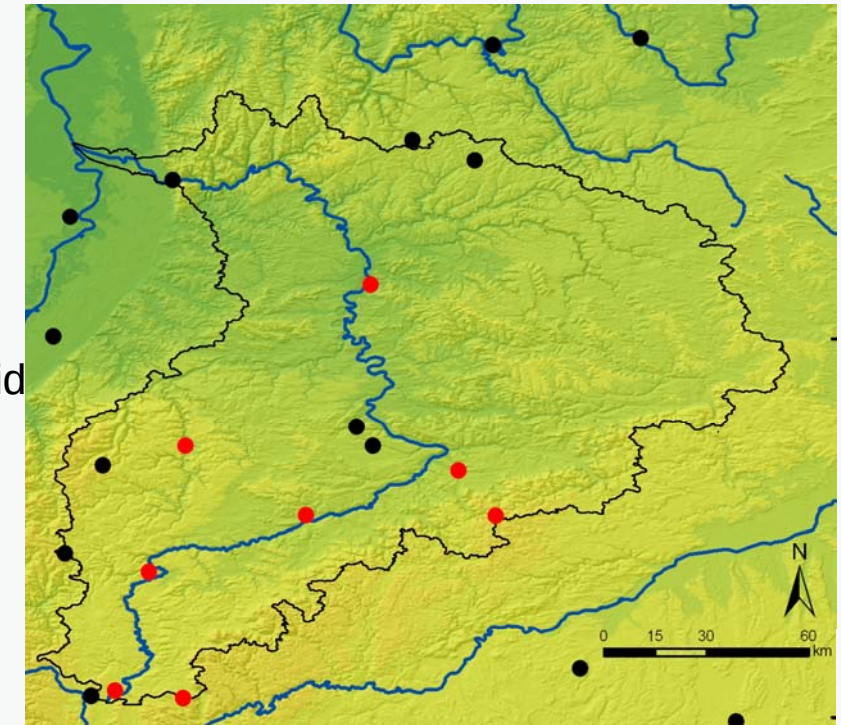
patial data of rain
grid on a daily basis

Interrogation from the grid

Daily rain 1882
each LARSIM station

Tape 13

To low number of historical stations in the Neckar Catchment to calculate a plausible precipitation disipitation for the 1882 flood



ermination of the compared precipitation pattern

	Freudenstadt	Villingen	Stuttgart	Buchen	Ansbach
.12.	35,0	18,3	7,1	30,3	0,2
.12.	55,9	32,5	10,5	33,7	21,4
.12.	74,8	20,3	5,3	33,2	16,1

Historical data
25.12.-27.12.1882
(Precipitation im mm)

	Freudenstadt	Villingen	Stuttgart	Buchen	Ansbach
5.12.	1	0.52	0.2	0.87	0.01
6.12.	1.6	0.93	0.3	0.96	0.61
7.12.	2.14	0.58	0.15	0.95	0.46

Standardized historical data
25.12.-27.12.1882

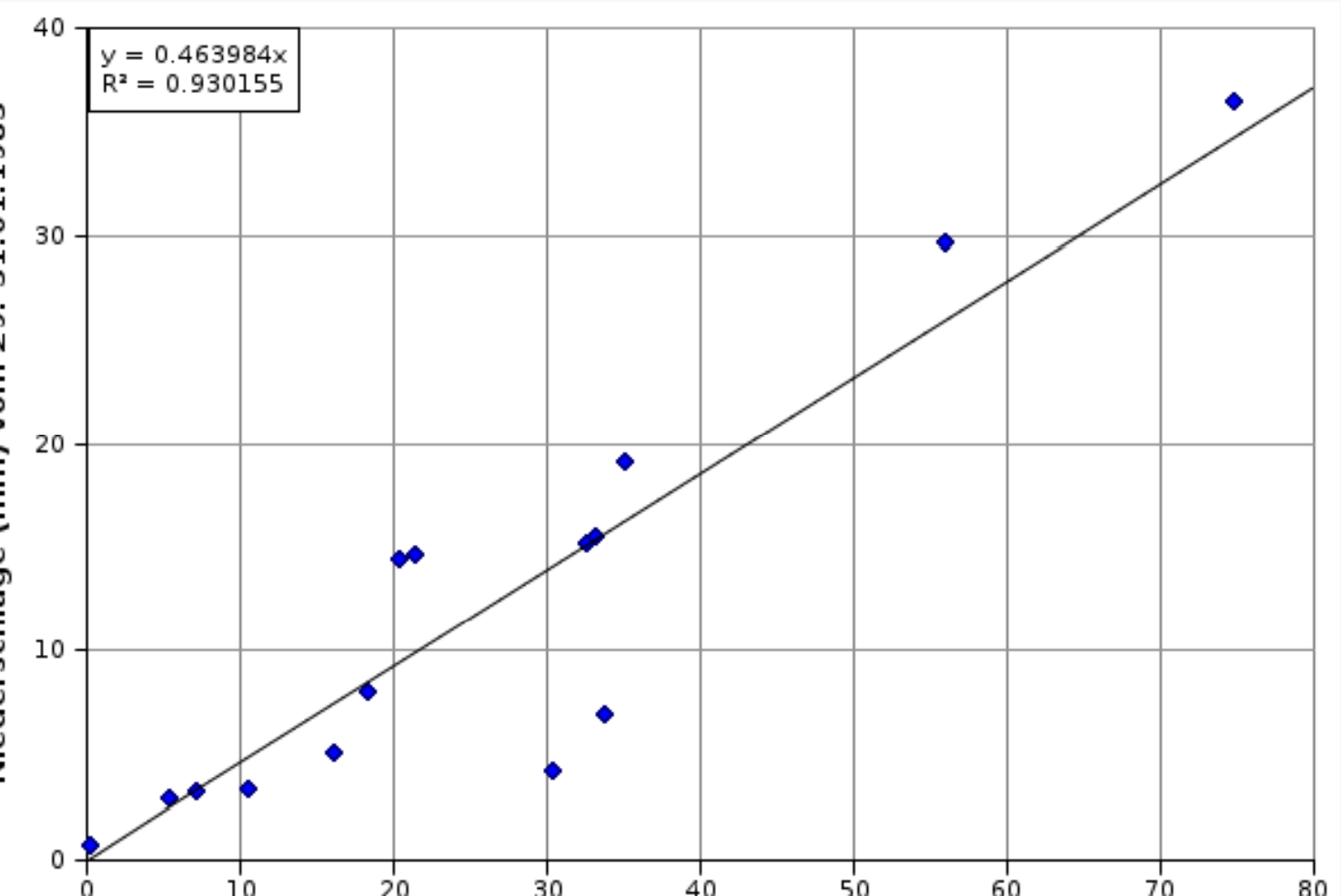
DWD Data 1958-2005

Comparison with
recent data

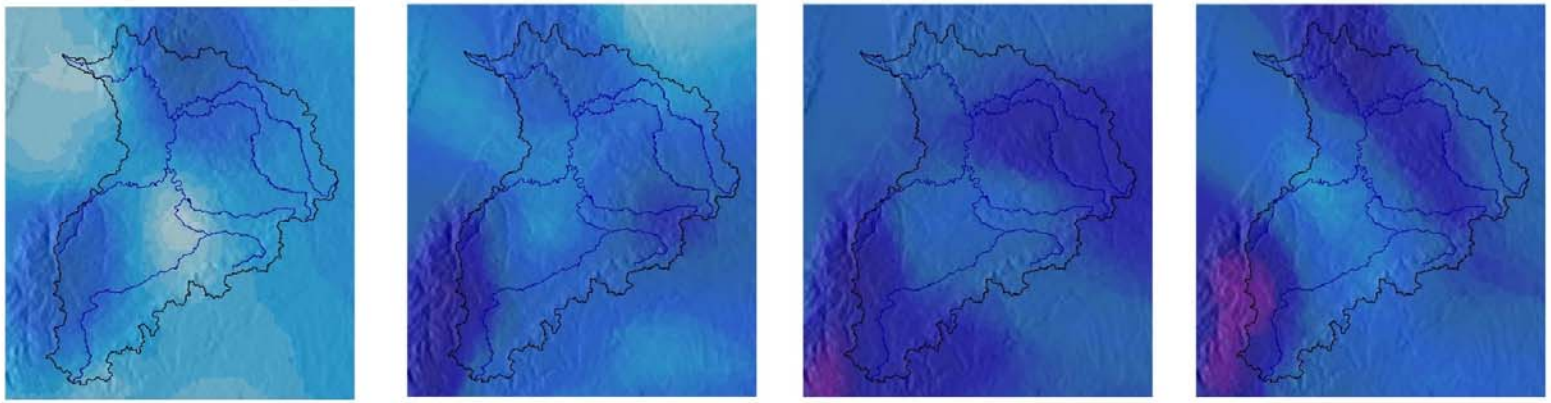
	Freudenstadt	Villingen	Stuttgart	Buchen	Ansbach
9.01.	1	0,42	0,17	0,22	0,04
0.01.	1,55	0,8	0,17	0,36	0,77

Best match
29.01.-31.01.1983

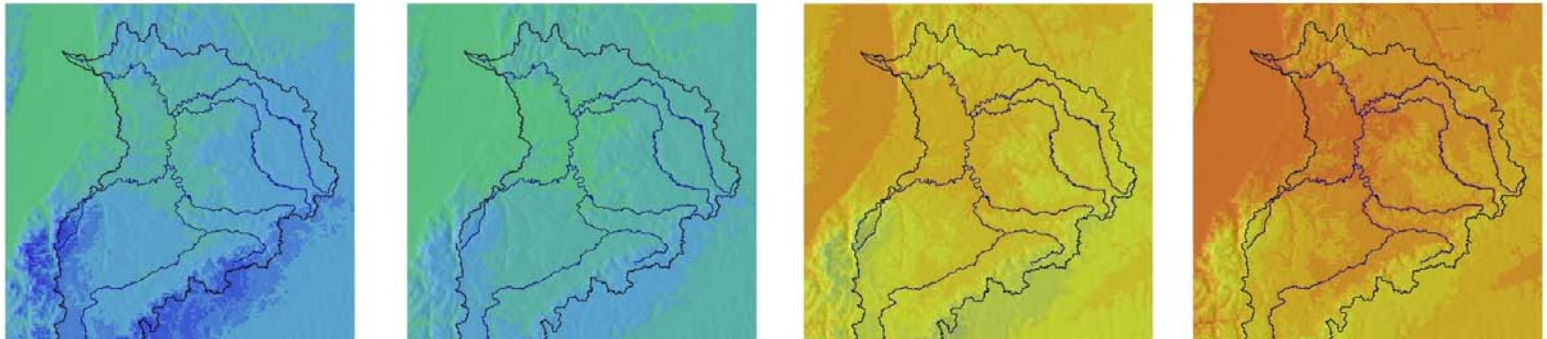
ermination of the compared precipitation pattern



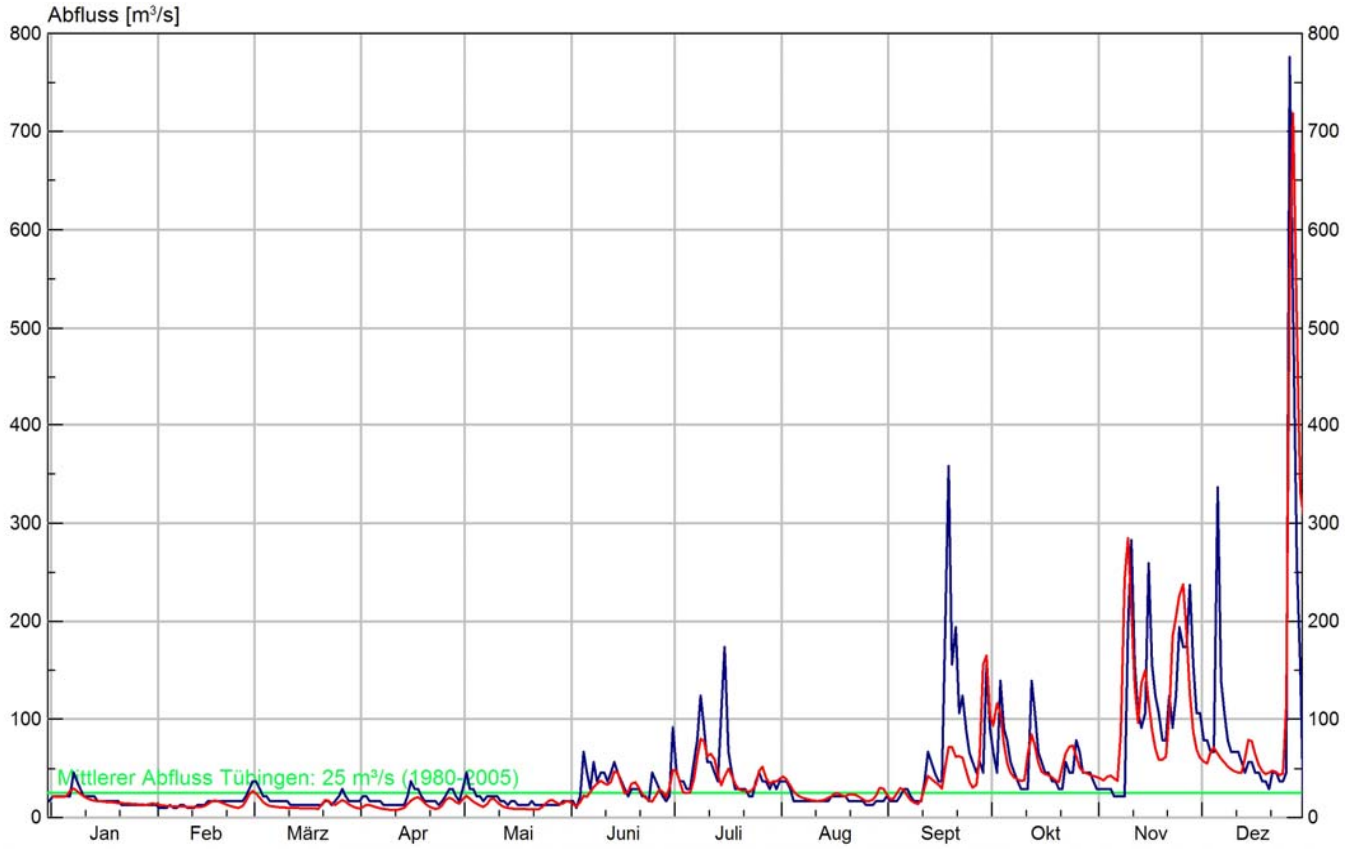
24.12.1882 25.12.1882 26.12.1882 27.12.1882

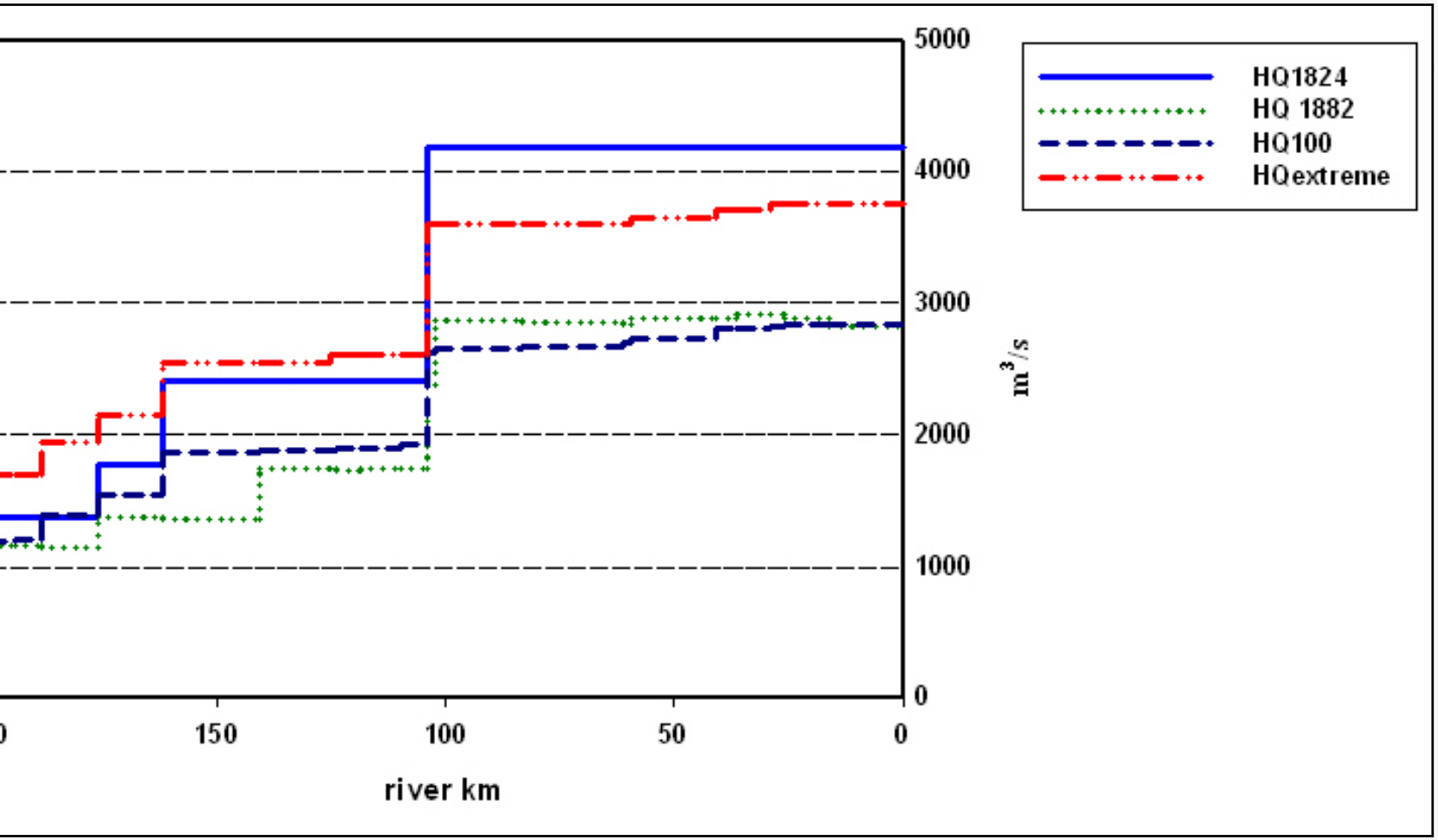


Precipitation



parison of the historical discharges with the LARSIM simulation at the gauge ngen 1882




5000
4000
3000
2000
1000
0
m³/s
HQ1824
HQ 1882
HQ100
HQextreme
150
100
50
0
river km

clusion

is possible to reconstruction historical flood events and their spatial modelling
f extreme precipitation in a high areal and time resolution prior to official
neasurements

Modelling of discharges for historical flood events is generally possible

Prolongation of data series will precise the calculation of return periods

The reconstruktion of historical flood events contributes to the recent flood risk management

Thank You for Your Attention!

Research groupe „Reconstruktion historical floods at the University Freiburg (x_{floods})

→ Subproject of the BMBF-Research initiative *RIMAX* *(*Risik management of extreme flood events)

→ Homepage: www.xfloods.de bzw. www.rimax-hochwasser.de

Schriftfeld