Beilage 2C

Beilage C

Bericht über das Treffen der Unterarbeitsgruppe Hydrologie am 17. März 2017

Report

of the Hydrology Working Sub-group for the

Drava River

2017

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE

LAND KÄRNTEN
Abt. 8 - Kompetenzzentrum
Umwelt, Wasser und Naturschutz

HYDRO grafie
Kärnten
... am Puls des Wassers.

INDEX OF CONTENTS

1 MINUTES

of the 3rd meeting of the Working subgroup for Hydrology for the Drava River,

Working group "Water Management"

Ljubljana, Slovenia, March 17, 2017

1.1 Attendance

In accordance with paragraph 2.8 of the minutes of the 23rd session of the Permanent Slovenian-Austrian Commission for the Drava (15 to 16 May 2014) to establish a subgroup for the hydrology within the Working group for Water Management, 3rd meeting was held at the Slovenian Environment Agency (ARSO). A list of attendance is enclosed.

The meeting was chaired by Dr Mira Kobold, head of the working subgroup on the Slovenian side. Both sides agreed that the working language of the meeting is English.

The Slovenian side thanked the Austrian side for implementation of joint hydrometric measurements on the border profile of the Drava River with demonstration of the profile measurements of suspended load, which were realized on November 4, 2016.

1.2 Adoption of the agenda

The following agenda was adopted:

1. Hydrological data for 2016
2. Suspended load of the Drava
3. Water balance 2016 (report of Carinthia)
4. Data exchange, operation of the forecasting services and communication during the high waters and floods
5. Flood forecasting model of the Drava River
6. Exchange of experience and good practices
7. Miscellaneous

1.2.1 Hydrological data for 2016

Hydrography of Carinthia:

- gauging station Lavamünd / KW Lavamünd MQ=253 m^3/s
- Lavant / Pegel Krottendorf: MQ=12 m^3/s
- mean discharge of the Drava River at Lavamünd Grenze: MQ=265 m^3/s
- highest flood discharge of the Drava River at Lavamüd Grenze: HQ=970 m^3/s (HQ_1=990 m^3/s)

Verbund:

- Drava at the powerplant Lavamünd (without Lavant): MQ= 253 m^3/s

ARSO:

- gauging station Črneče: MQ= 291 m^3/s (determination of mean annual discharge is unsatisfied)
- highest flood discharge of the Drava River at Črneče: HQ = 970 m^3/s (17.06.2016)

DEM:

- Drava at hydropower plant Dravograd MQ=265 m^3/s

1.2.2 Suspended load of the Drava

Both sides presented the results of analyses of suspended load for the year 2016. ARSO doesn't have the monitoring of suspended load on the Drava River in the frame of national monitoring. The monitoring on the Drava River is performed by the DEM company on four measuring sites of hydropower plants. For the year 2016, ARSO analyzed the DEM data of suspended load for the locations of hydropower plants Dravograd, Vuzenica, Mariborski otok and Markovci. The data for HP Dravograd are not reliable because of measurement problems.

HD Kärnten calculates the yearly balance of suspended load for four stations on the Drava river and tributaries.

Suspended load for 2016 of Drava Lavamünd Ort: 0,13 million tons. It fits with results of Verbund.

Suspended load for 2016 of Drava Lavamünd Grenze: 0,26 million tons.

1.2.3 Waterbalance 2016

Carinthia:

	2016 (mm)	1981-2010 (mm)	Deviation of annual values from the period (%)
Precipiation	1326	1198	+10,7
Flow rates	658	593	+11,3
Evapotranspiration	642	582	+10,3

1.2.4 Data exchange, operation of the forecasting services and communication during the high waters and floods

The established operational data exchange was extended as determined at the 2nd meeting of the sub-group for hydrology for the Drava River and the document "Data exchange with partner institutions ARSO – KTN AT" was revised and updated in September 2016. In the data exchange, ARSO added 8 new automatic meteorological stations and one new hydrological station Zavrč on the Drava River.

The communication during the high waters between forecasting services is good. The automated dissemination procedure is operational and is not experiencing any problems. In July 2016 Hydrological forecasting service at ARSO asked for extending the list of recipients of the high water warnings issued by HD Kärnten. ARSO provided the list of mobile phone numbers and an email address, which were then added. At the following high water event (August 2016), all previous and additional recipients received the warning via SMS and email.

ARSO also contacted Verbund and asked for adding an additional mobile phone number to the recipient list in case of issued warning. It was agreed to add the recipient. Up to date, there were no flooding events and consequently no warnings issued.

1.2.5 Flood forecasting model of the Drava River

In the Slovenian hydrological forecasting system (HFS) that is operational at ARSO, only the Drava River is not covered by the model. Based on good experience with the Mur model that was developed in joint cooperation with the Hydrographic department of Styria, ARSO is also interested in cooperation on the Drava model.

HD Kärnten is not very interested to set up the new model for the Drava river basin because they use its own model. But they are ready to provide all necessary data and information if

ARSO wants to establish the model for the Drava river catchment in AUT and SLO with MIKE technology. The potential model results will be distributed to HD Kärnten. In the case of some project they will be an end user.

Slovenia (ARSO) started the inception phase of the model in autumn 2016 in which the required data (geographical data, historical meteo and hydro data, list of automatic stations for operational phase) were identified. The request for support with necessary data was sent to Hydrography of Carinthia, however the organisations have not yet discussed the details or the next steps. ARSO is proposing a meeting in second half of May 2017 in Klagenfurt, dedicated to the Drava model development, beginning with an overview of available historical data and expanding the current real-time data transfer from meteo and hydro stations.

1.2.6 Exchange of experience and good practices

At the last meeting Mr. Moser informed Slovenian side about the method of determining of GF100 factors. ARSO sent the Q100 for Slovenian side of the Drava River basin to make the comparison with Austrian catchments.

Comparison of HQ100 of rivers near the border of Carinthia and Slovenia

Country	River / Station	EZG (km2)	HQ100 (m3/s)	GF100 = HQ100/EZG^0,6	method
Car	Drau / Rosegg	6927	2300	11,41	stat + reg
Car	Drau / Pegel Lavamünd Ort	10915	2700	10,20	stat + reg
Car	Drau / Pegel Lavamünd Grenze	11884	2800	10,05	stat + reg
Car	Rosenbach / Mündung	41,2	110	11,82	reg
Car	Feistritzbach / Mündung	35,9	95	11,08	reg
Car	Loiblbach / Pegel Tscheppaschlucht	44	95	9,81	stat + reg
Car	Vellach / Pegel Miklauzhof	194,3	270	11,44	stat + reg
Car	Feistritzbach / Pegel Feistritz	8,7	30	8,19	stat + reg
Car	Loibach / Pegel Loibach	19,9	44	7,31	stat + reg
Slo	Drava / HE Dravograd	12071,3	2612	9,29	stat
Slo	Meza / Otiski Vrh I	550,89	372	8,43	stat
Slo	Meza / Podklanc	309,5	215	6,89	stat
Slo	Meza / Crna	94,77	130	8,47	Studie IzvRS
Slo	Suhadolnica / Stari Trg I	59,2	93,3	8,06	stat
Slo	Sava Dolinka / Kranjska Gora	44,98	86,4	8,80	stat
Slo	Sava Dolinka / Jesenice	257,5	259	9,26	stat
Slo	Radovna / Podhorn	166,8	165	7,66	stat
Slo	Mosenik / Trzic	38,5	88,4	9,89	stat
Slo	Trziska Bistrica / Preska	121	153	8,61	stat
Slo	Kokra / Kokra I	112,3	182	10,71	stat
Slo	Kokra /Kranj II	220,2	241	9,47	stat
Slo	Poljanska Sora / Ziri III	54,4	182	16,55	stat
Slo	Selska Sora / Zelezniki	104,1	403	24,82	stat
Slo	Lucnica / Luce	57,5	161	14,16	stat
Slo	Dreta / Krase	100,8	267	16,77	stat
Slo	Savinja / Nazarje	457	609	15,44	stat
Slo	Savinja / Solcava I	63,7	129	10,67	stat

stat + reg.... Statistical and regional analysis methods
stat... statistical method
reg.... Regional analysis methods (no gauging station)

1.2.7 Miscellaneous

Experts agree that measurements of hydrological parameters in the middle of accumulation are not suitable. The Austrian experts have good experience with measurements at stations located below the hydropower plants. ARSO should think about the moving of existing hydrological station at Črneče below the HP Dravograd, where the location is convenient for discharge, turbidity and suspended load measurements.

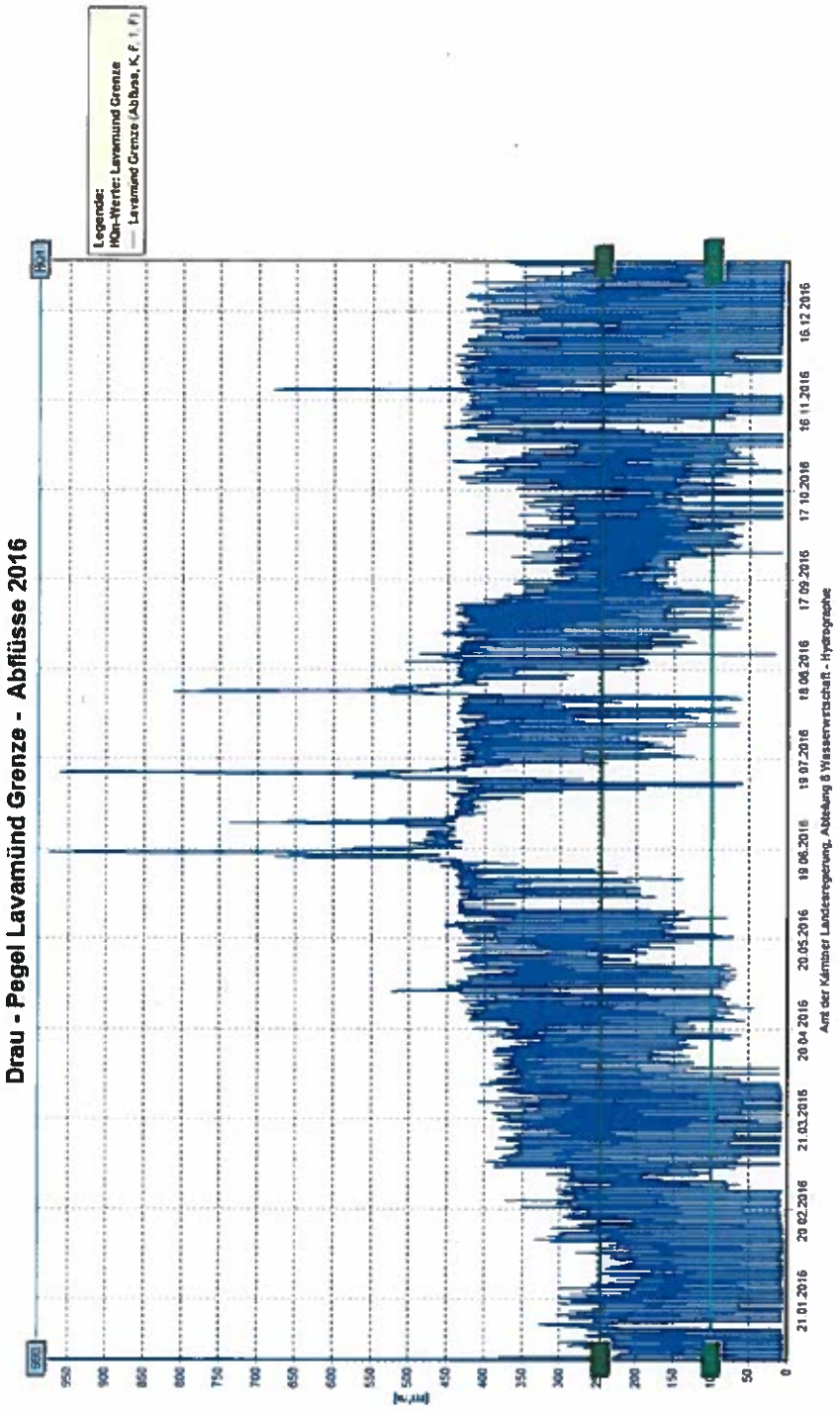
Prepared by:

Dr Mira Kobold

2 DATA - HD KÄRNTEN

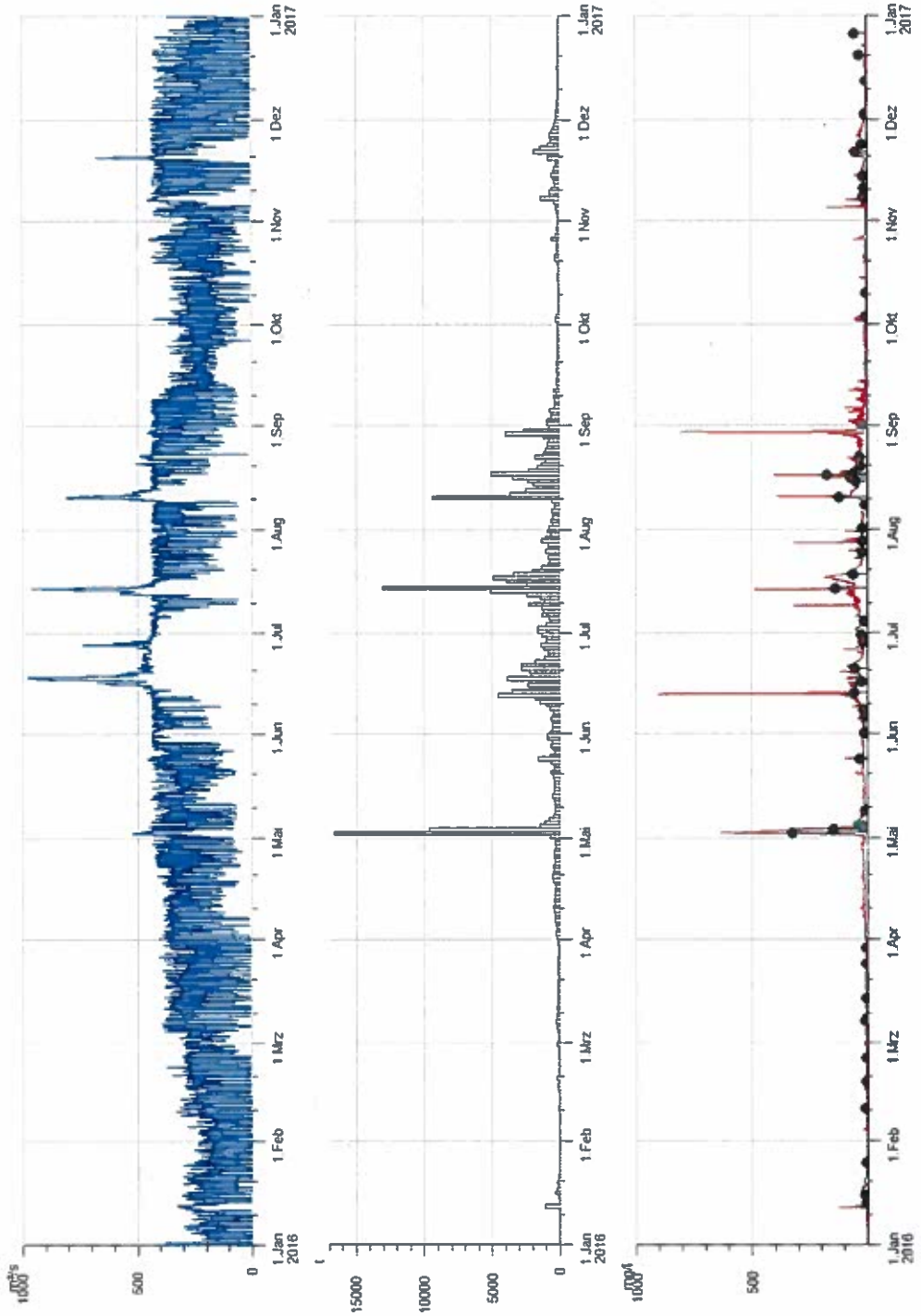
- Discharges 2016: Drava: Lavamünd with Lavant
- Suspended load 2016
- Suspended load 2009 – 2016
- Water balance of Carinthia
- Results of comparison of HQ100

2.1 Discharges 2016 Drava River: Lavamünd with Lavant (Lavamünd Grenze)

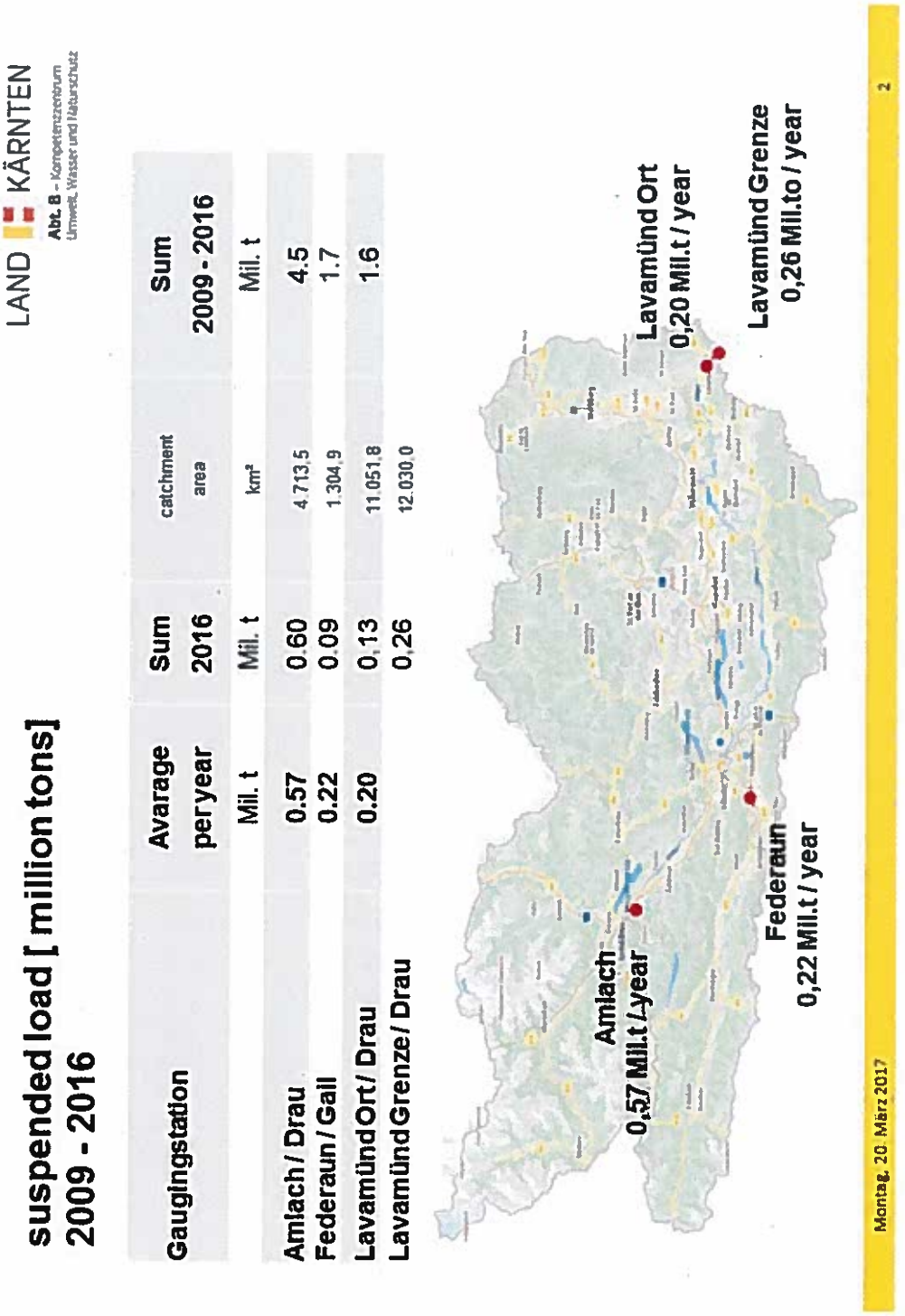


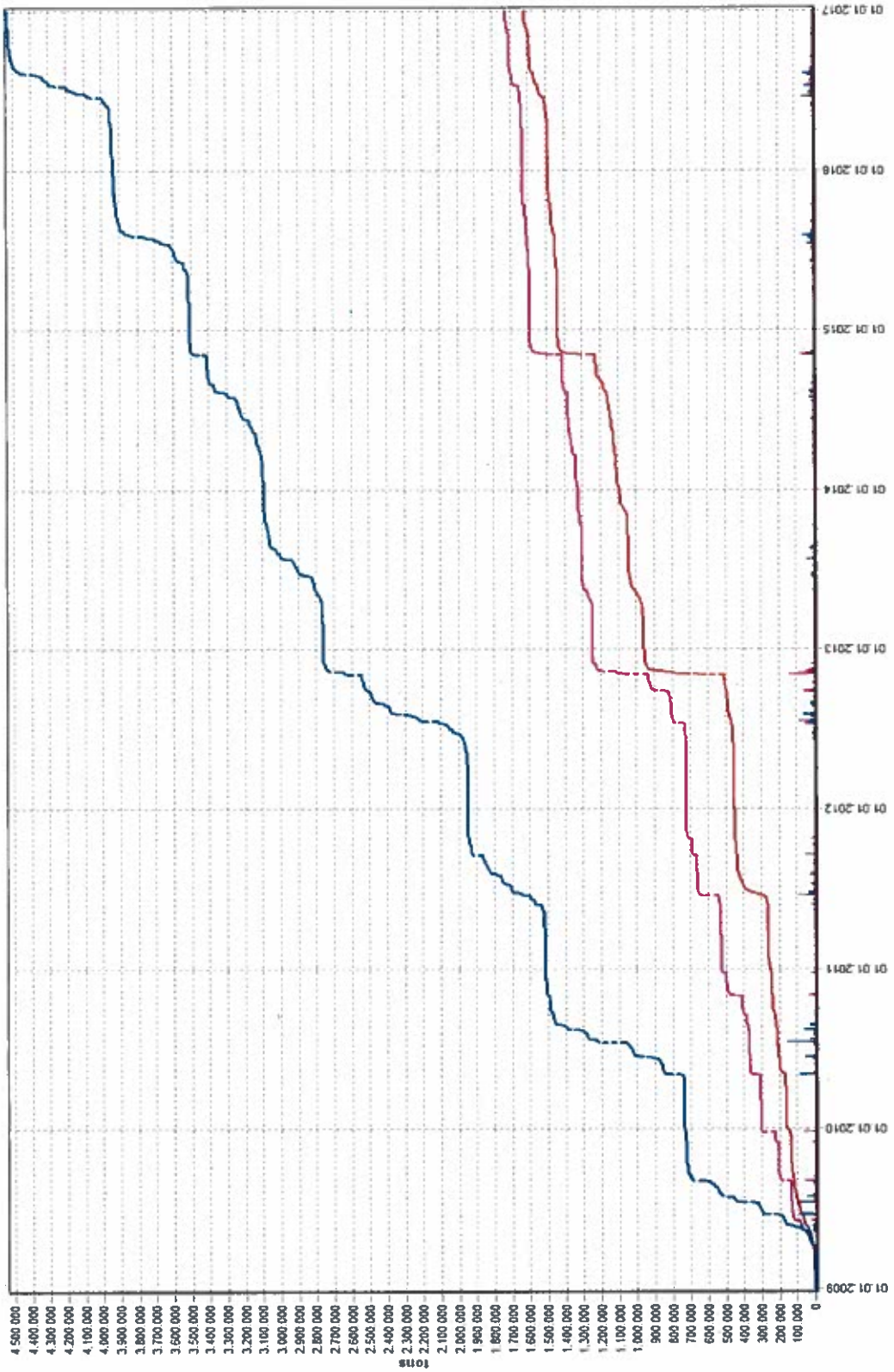
2.2 Suspended load 2016

Lavamünd Grenze:

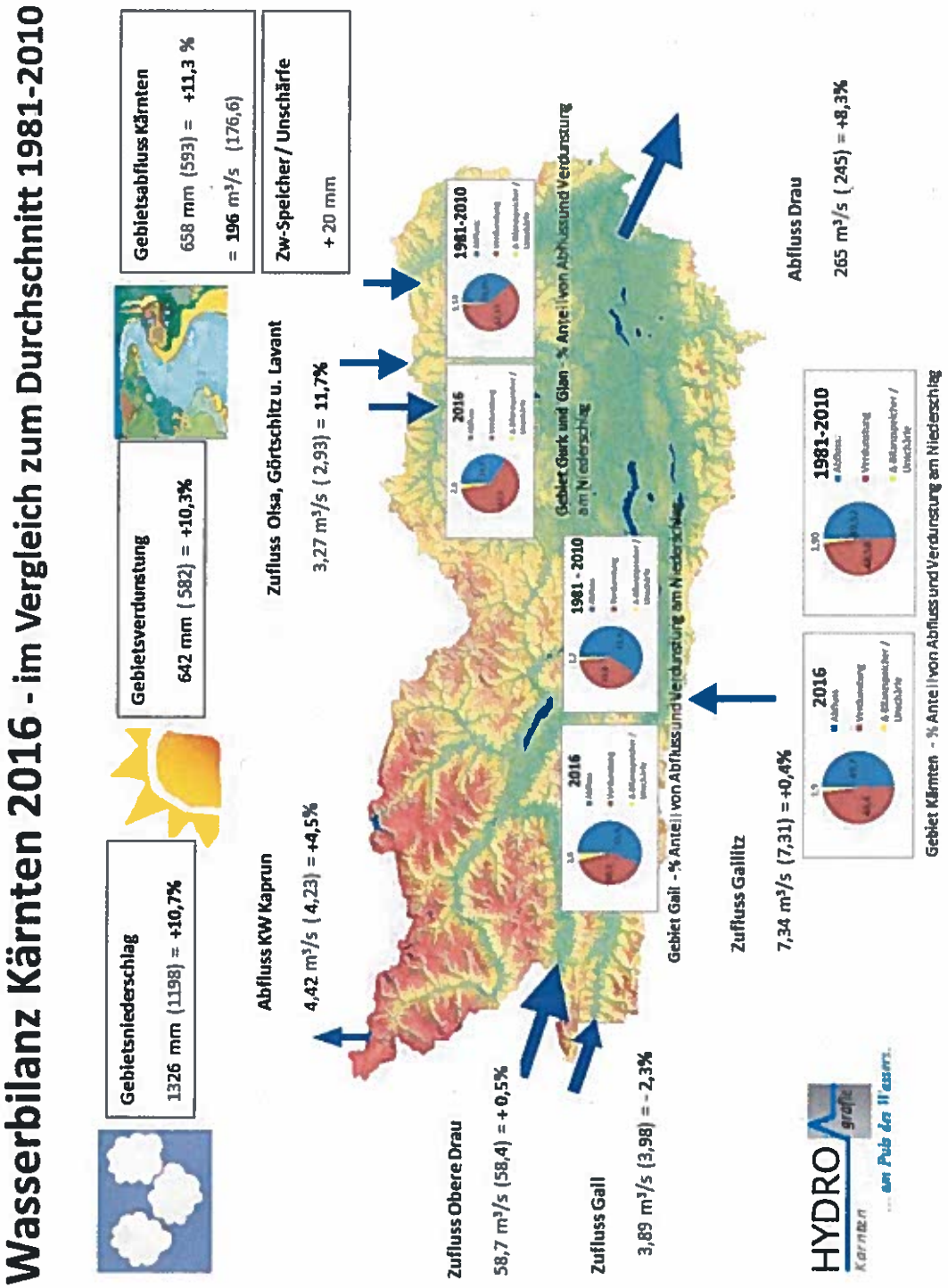


2.3 Suspended load 2009-2016



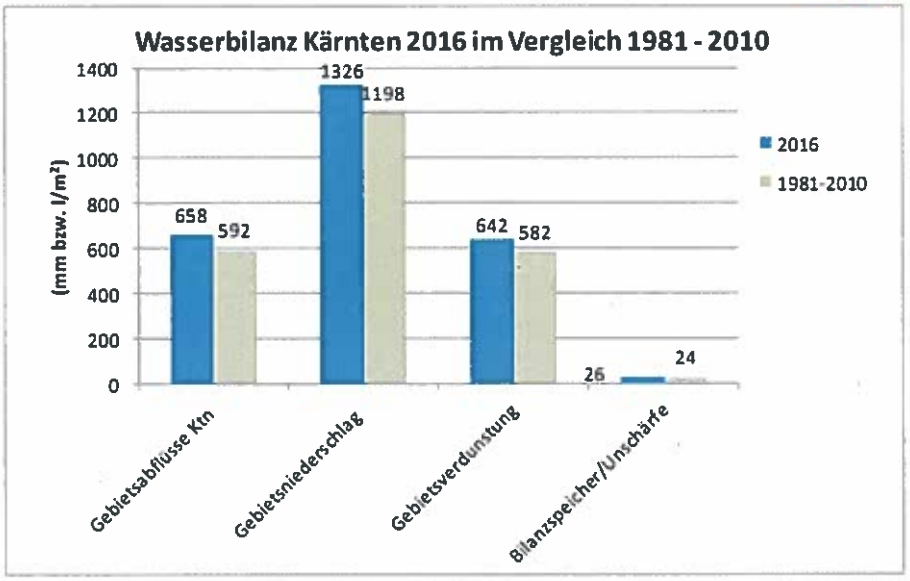

01.01.2017
01.01.2016
01.01.2015
01.01.2014
01.01.2013
01.01.2012
01.01.2011
01.01.2010
01.01.2009
4.500.000
4.400.000
4.300.000
4.200.000
4.100.000
4.000.000
3.900.000
3.800.000
3.700.000
3.600.000
3.500.000
3.400.000
3.300.000
3.200.000
3.100.000
3.000.000
2.900.000
2.800.000
2.700.000
2.600.000
2.500.000
2.400.000
2.300.000
2.200.000
2.100.000
2.000.000
1.900.000
1.800.000
1.700.000
1.600.000
1.500.000
1.400.000
1.300.000
1.200.000
1.100.000
1.000.000
900.000
800.000
700.000
600.000
500.000
400.000
300.000
200.000
100.000
0
tons

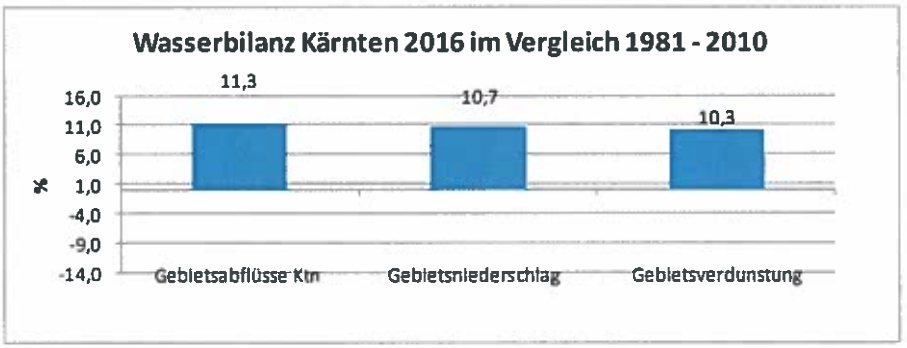
2.4 Water balance of Carinthia 2016



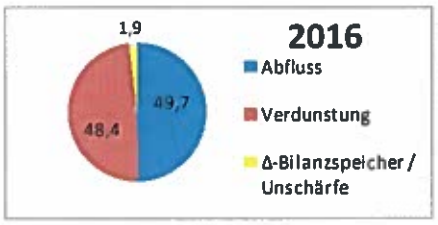
Wasserhaushalt Kärnten

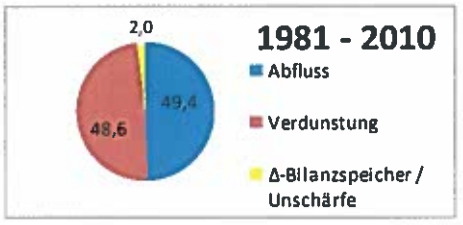
Bilanz 2016 im Vergleich zur Periode 1981 - 2010





% -Anteile des Abflusses und der Verdunstung am Niederschlag 2016 und der Periode 1981-2010



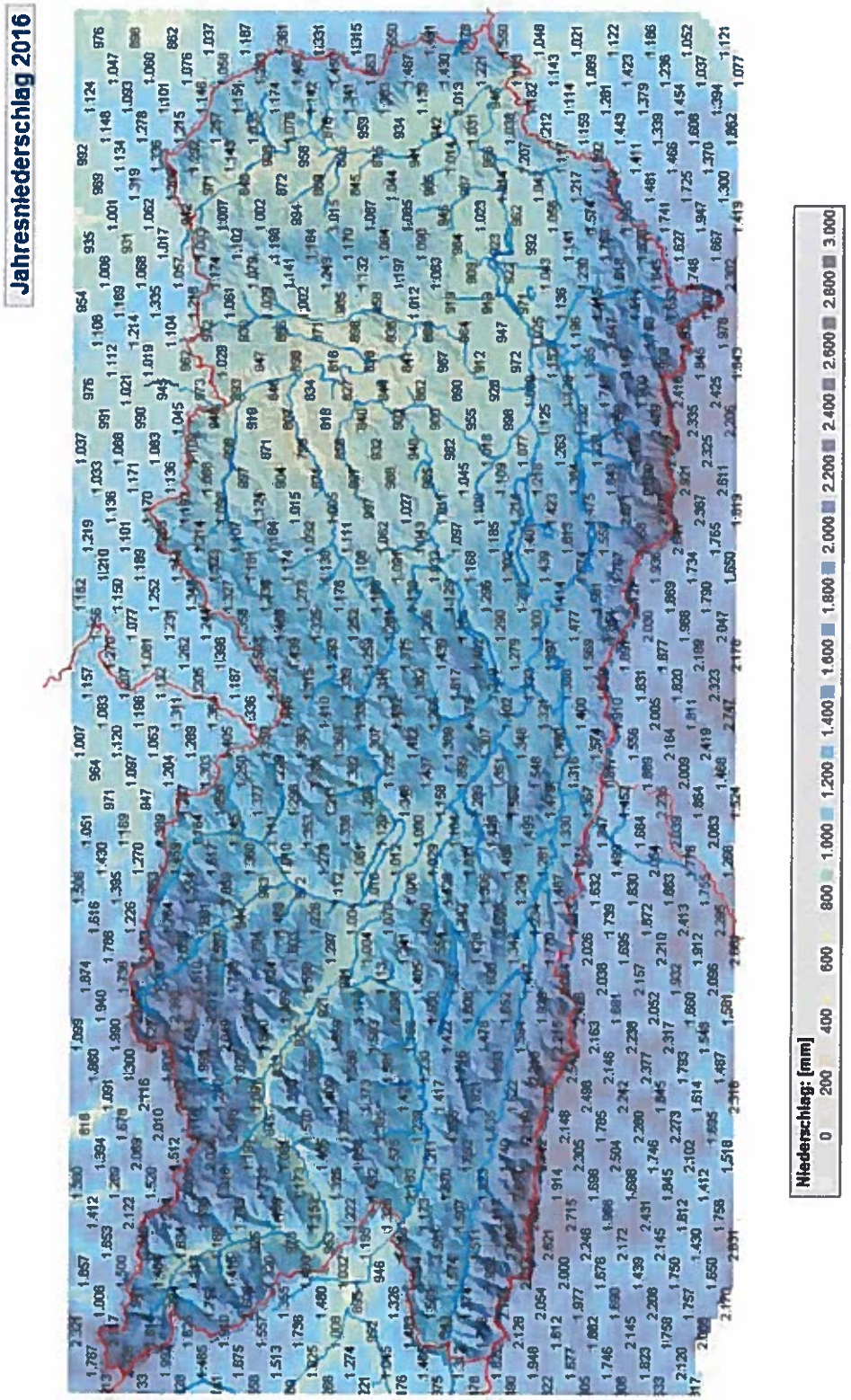


Zu- und Abflüsse (m^3/s):	2016	1981-2010
Ktn Zuflüsse MQ:	73,20	72,62
Ktn Abflüsse MQ:	269,2	248,8
Ktn Gebietsabfluss MQ:	196,0	176,2

Grenze Slo/Drau:	2016	1981-2010
NQt (m^3/s):		51
HQ (m^3/s):	970	1672
HQ_{100} = 2800 m^3/s		

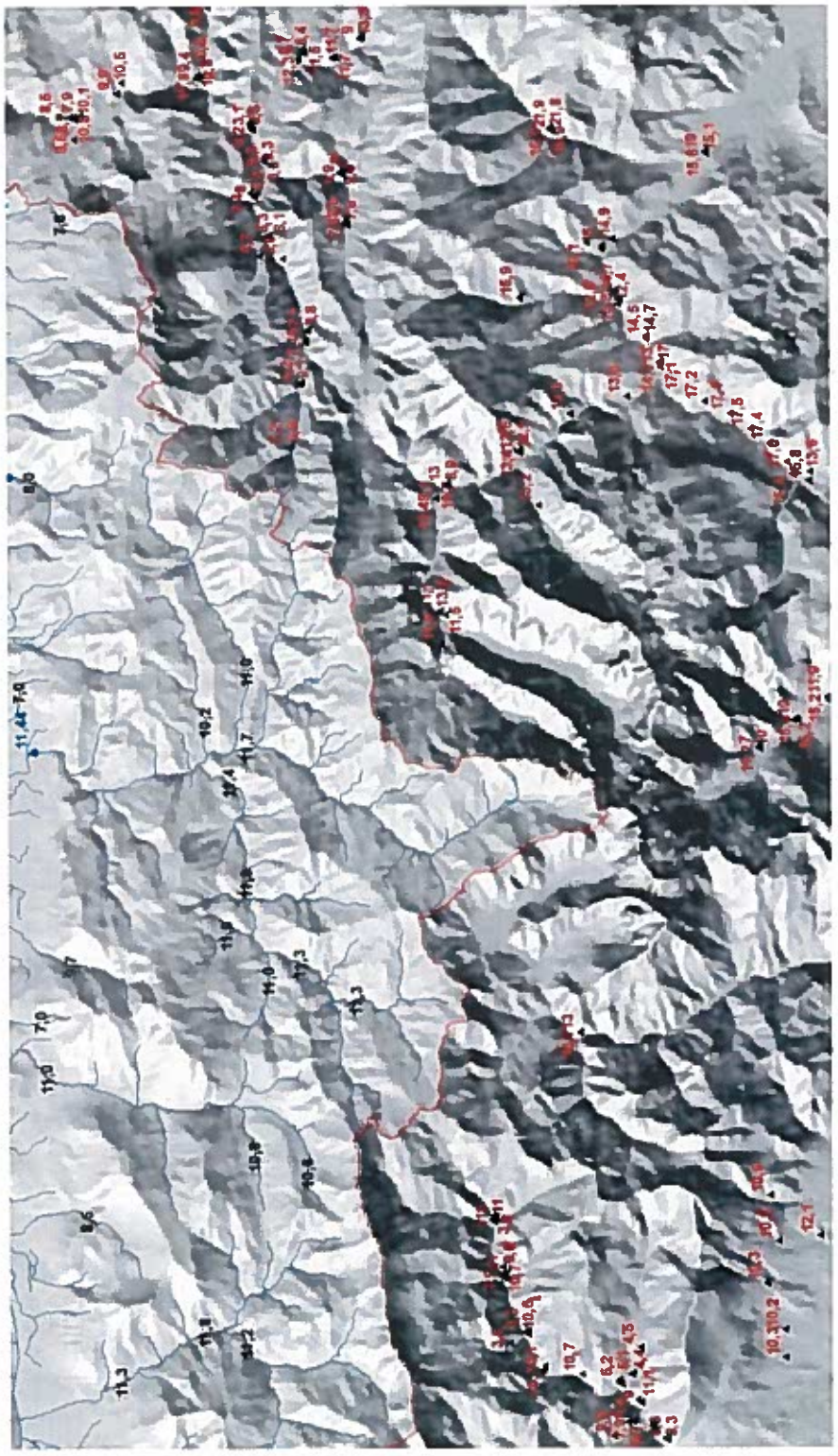
Ktn-Zuflüsse: Drau (Osttirol), Gail, Gailitz, Olsa, Görtschitz, Lavant **Ktn-Abflüsse:** Drau, Möll KW Kaprun

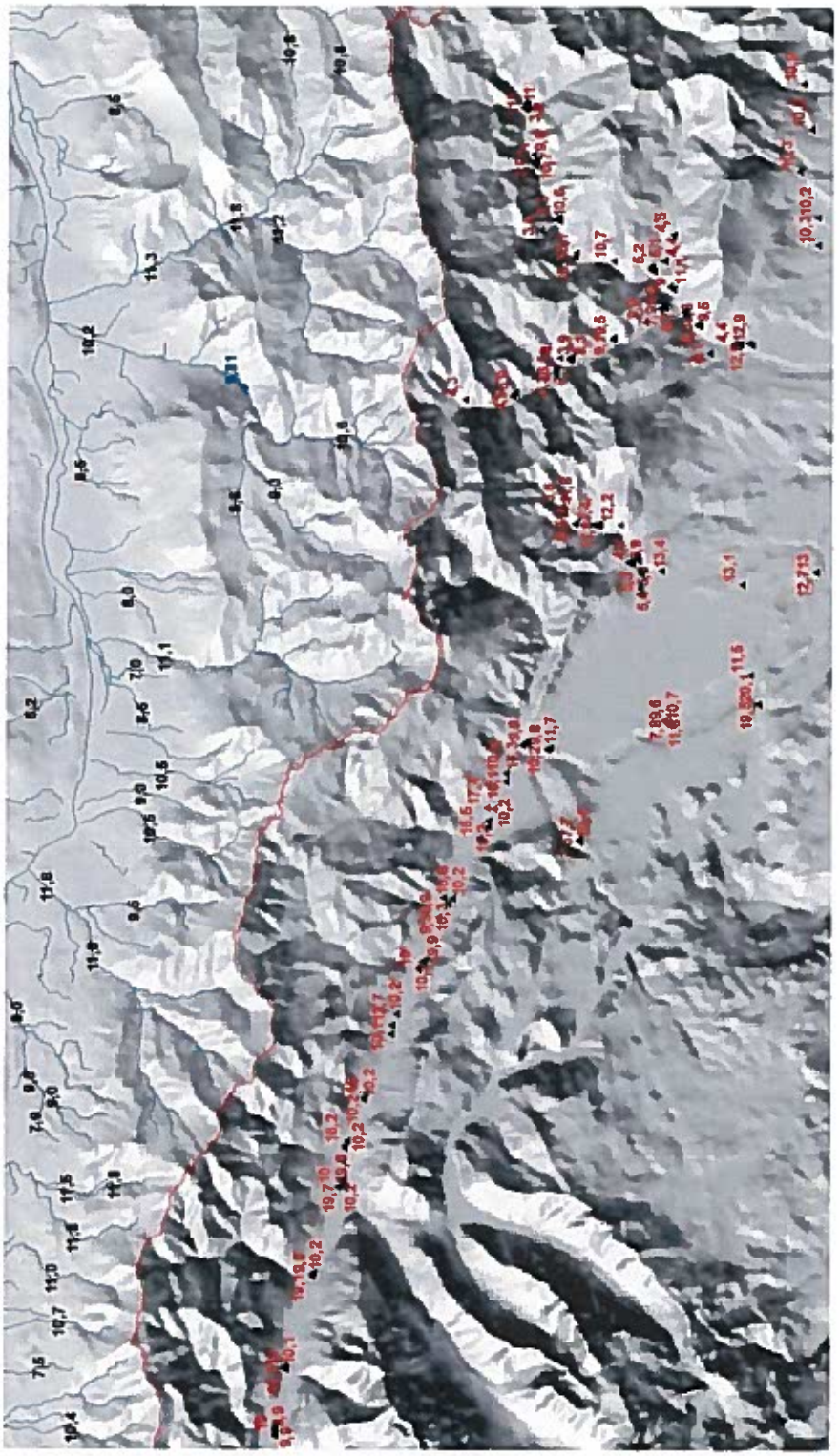
Δ - Bilanz Modell- u. Datenunschärfe bzw. Wasserzwischenspeicherung (- aus Vorjahr; + fürs nächste Jahr)

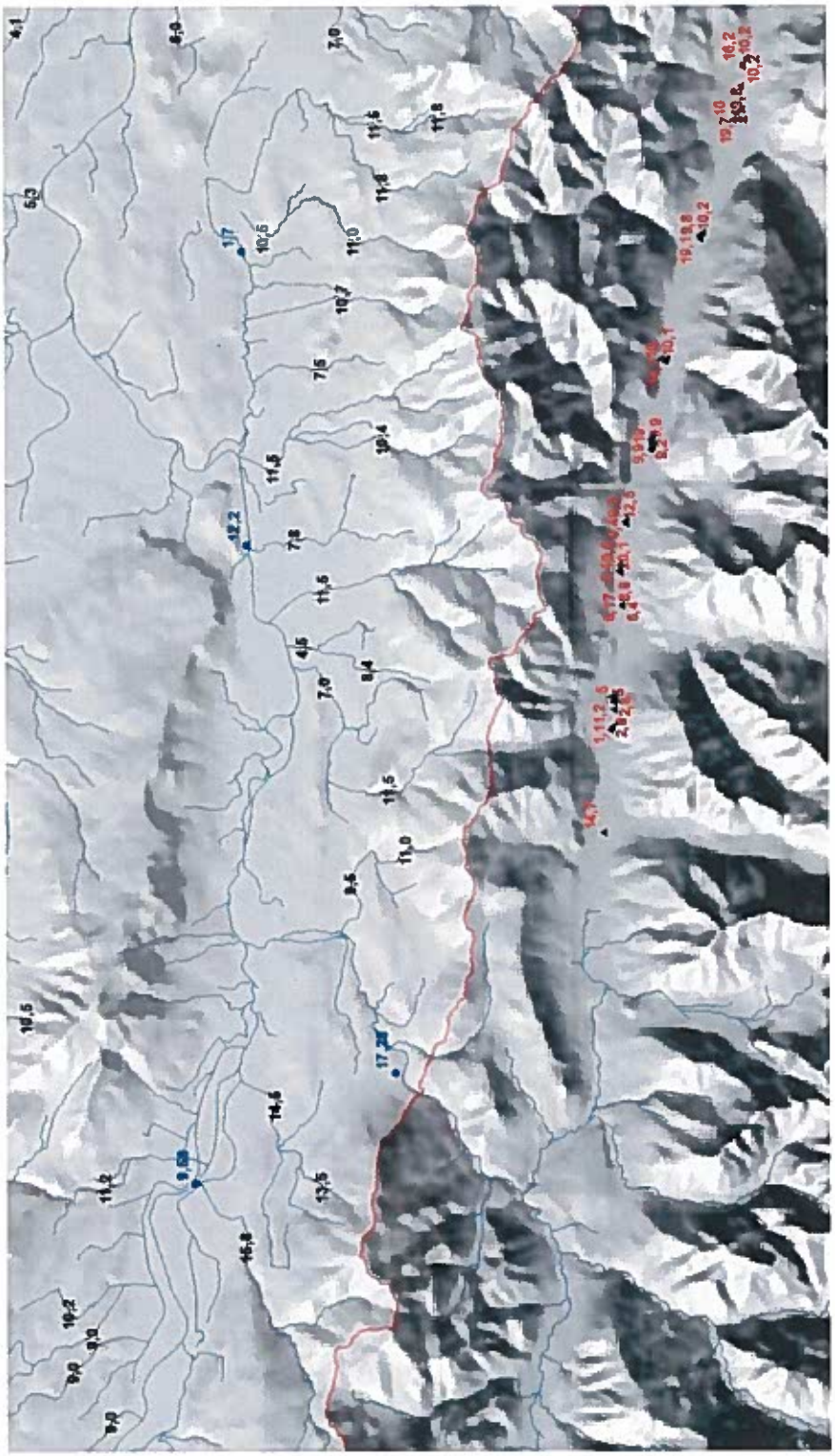

Jahresniederschlag 2016
Niederschlag: [mm]
0 200 400 600 800 1.000 1.200 1.400 1.600 1.800 2.000 2.200 2.400 2.600 2.800 3.000
Amt der Kärntner Landesregierung, Abteilung 8 / Wasserwirtschaft / Hydrographie

2.5 Results of comparison of HQ100

Graphical presentation of GF100 factors

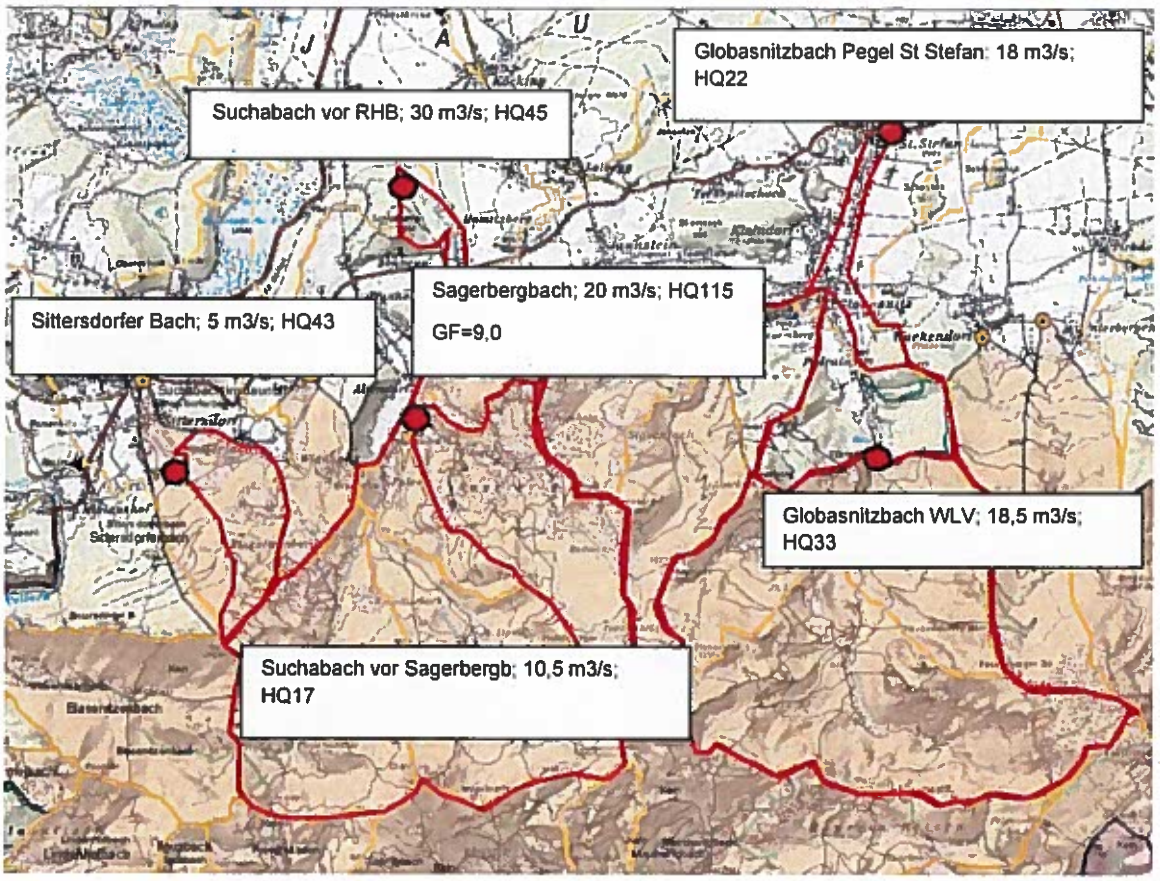


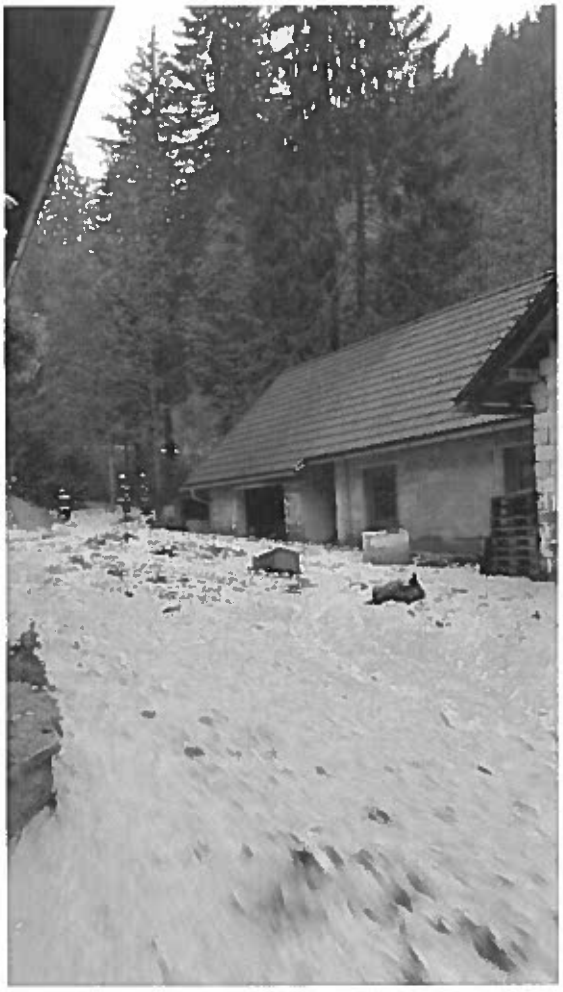




FLOOD EVENT / HOCHWASSER AM 15.08.2016

Area / Schwerpunkt: Gebiet Sittersdorf, Gösselsdorf und Globasnitz

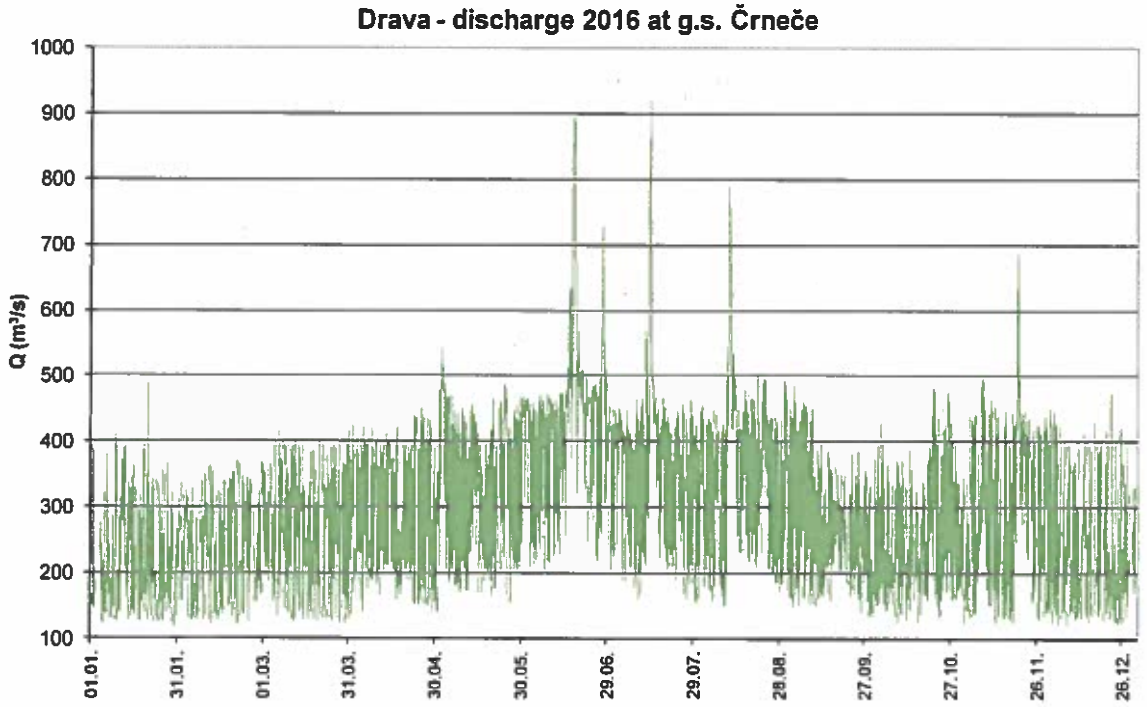




An examble: Flood-event 2016; Sagerbergbach HQ=20 m^3/s; E = 3,8 km^2; GF = 9,0 (Anuality: 115) GF100=8,5

3 DATA - SLOVENIAN ENVIRONMENT AGENCY (ARSO)

3.1 Discharges 2016 for the Drava River: gauging station Črneče



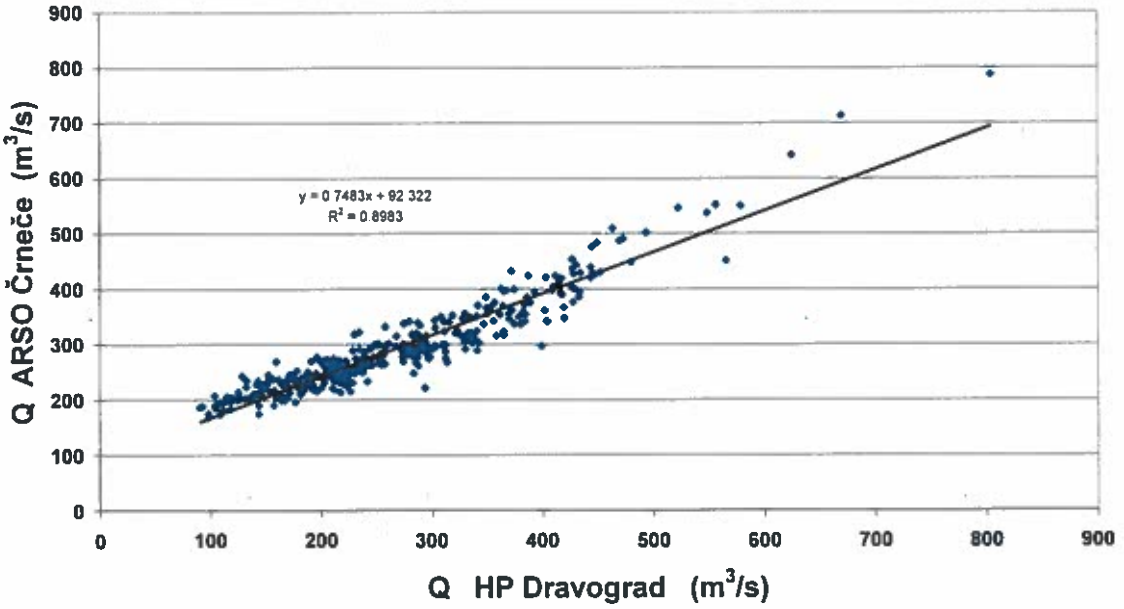
Gauging station Črneče on the Drava River:

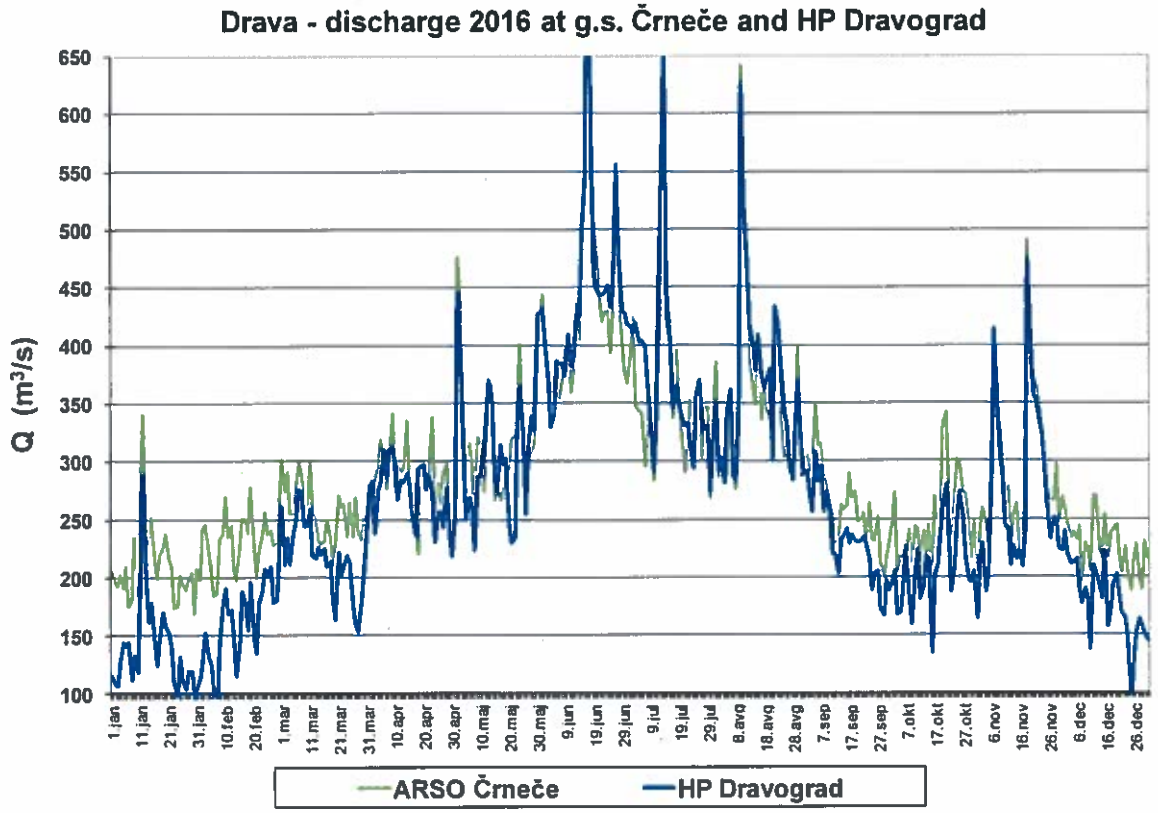
Mean value discharge 2016 : MQ = 291 m^3/s

Highest discharge 17.06.2016: HQ = 970 m^3/s

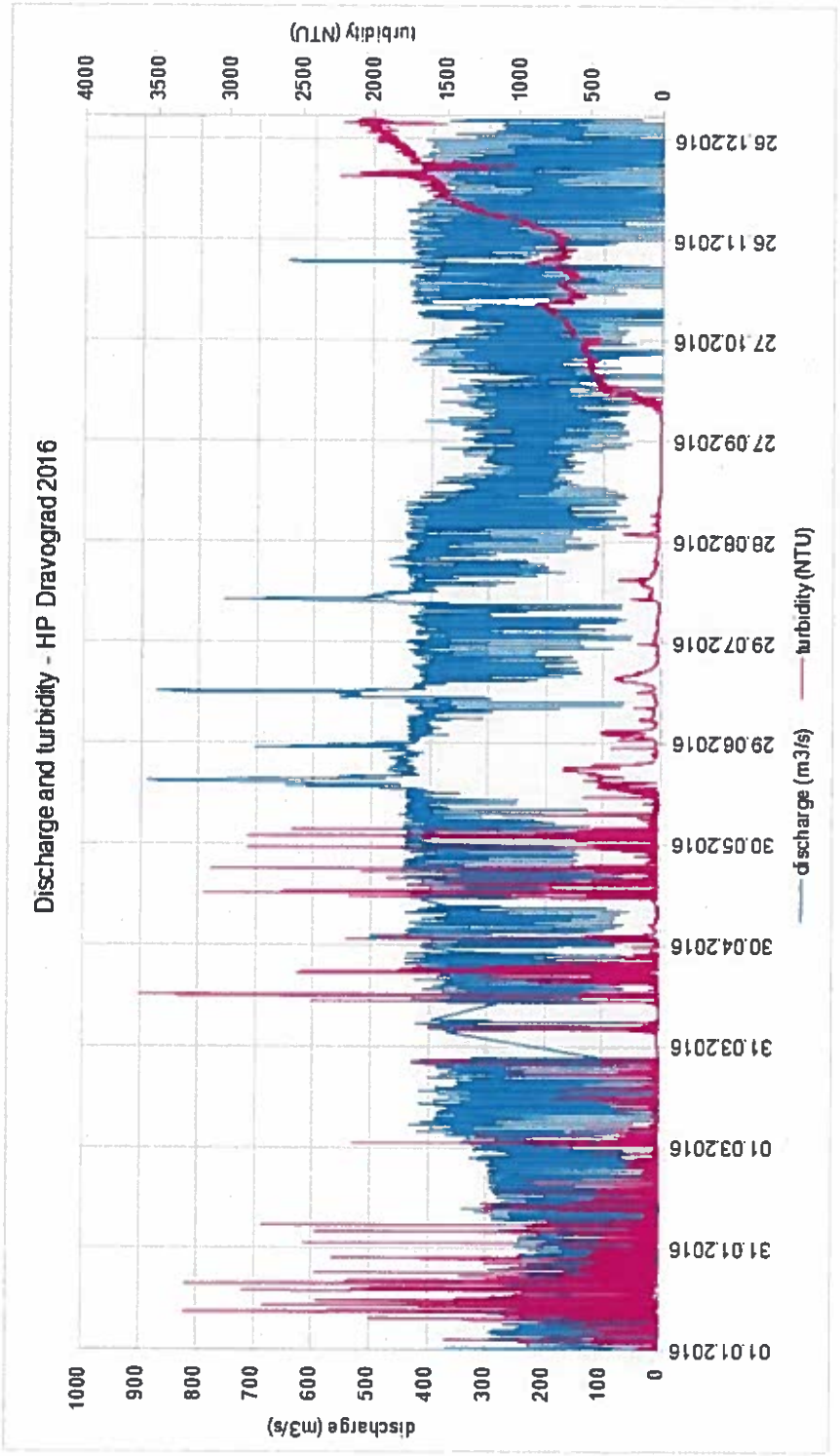
Correlation between mean velocity measured with fixed ADCP and mean velocity measured with ADCP on boat (hydrometric measurement) at gauging station Črneče is not very good.

Due to the poor correlation between measured velocities, the correlation between discharges on hydropower plant (HP) Dravograd and gauging station Črneče is not optimal:


y = 0.7483x + 92.322
R² = 0.8983
Q ARSO Črneče (m³/s)
Q HP Dravograd (m³/s)
0
100
200
300
400
500
600
700
800
900

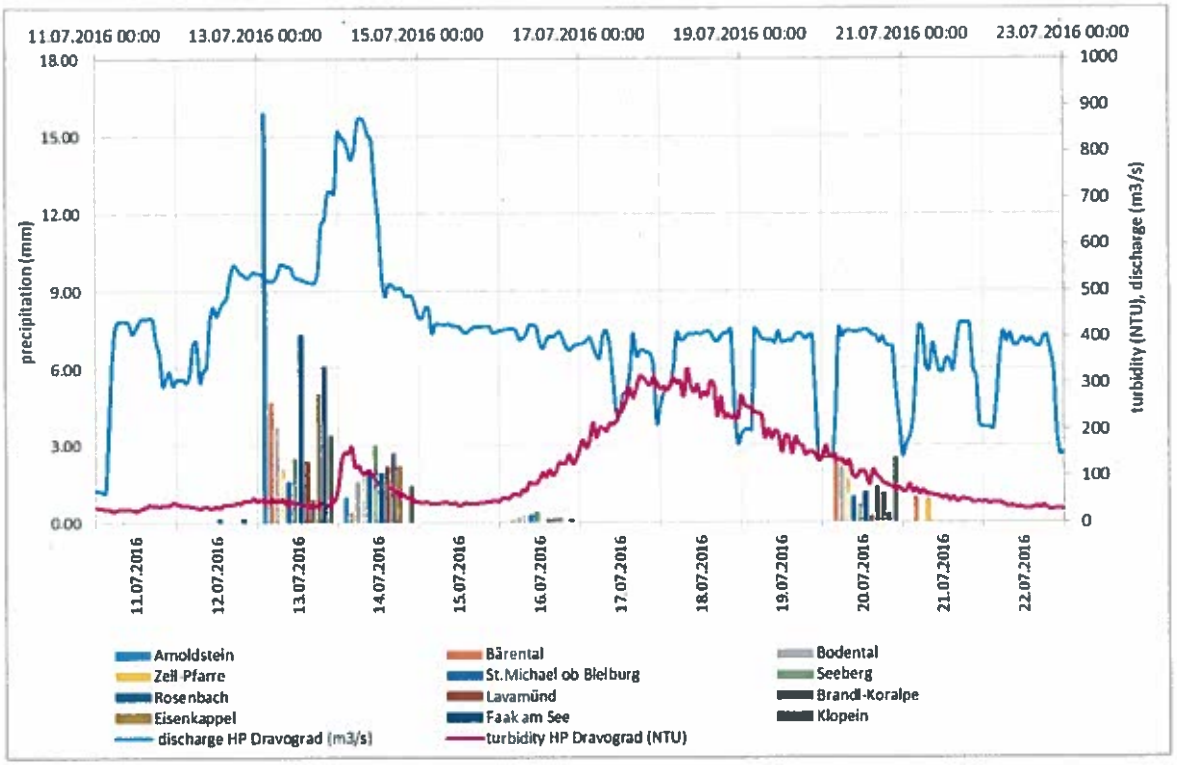

Drava - discharge 2016 at g.s. Črneče and HP Dravograd
Q (m³/s)
650
600
550
500
450
400
350
300
250
200
150
100
1.jan
11.jan
21.jan
31.jan
10.feb
20.feb
1.mar
11.mar
21.mar
31.mar
10.apr
20.apr
30.apr
10.maj
20.maj
30.maj
9.jun
19.jun
29.jun
9.jul
19.jul
29.jul
8.avg
18.avg
28.avg
7.sep
17.sep
27.sep
7.okt
17.okt
27.okt
6.nov
16.nov
26.nov
6.dec
16.dec
26.dec
ARSO Črneče
HP Dravograd

3.2 Suspended load 2016 for the Drava River: DEM data for HP Dravograd

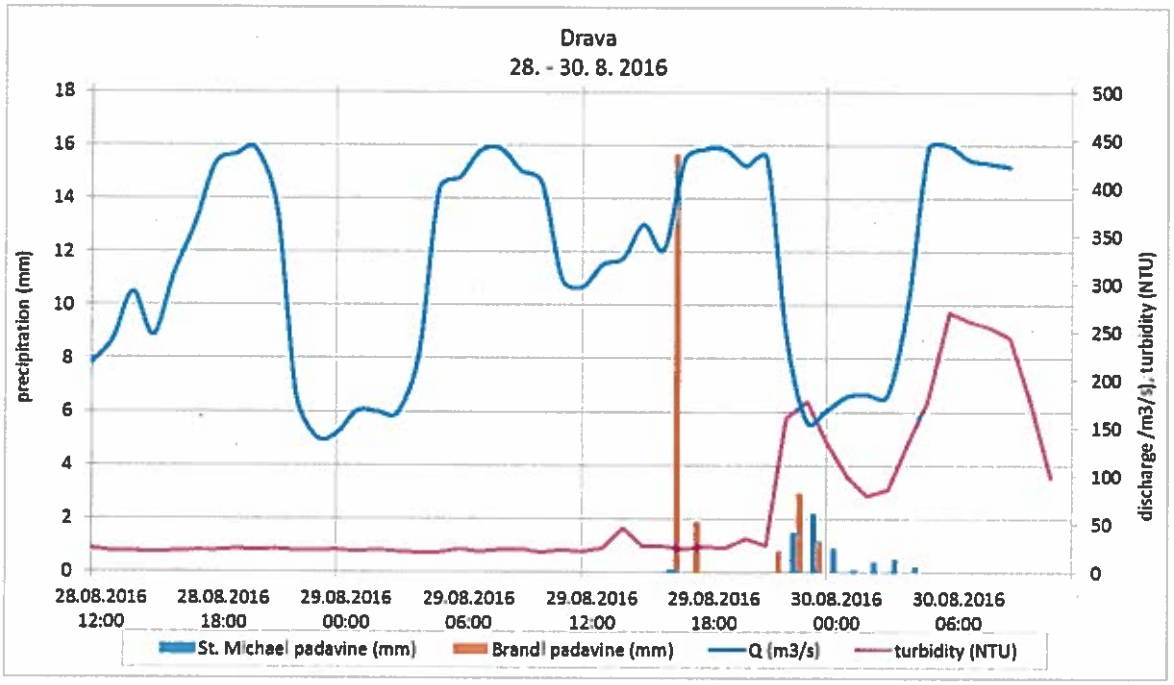


Correlation between discharge and turbidity on HP Dravograd is not very good. In January 2016 turbidity sensor measured high turbidity, but discharge on measuring point was not increased. Last three months of the year the turbidity was increasing permanently while discharge remains mean between 250 and 350 m^3/s.

For some events with increased turbidity on HP Dravograd in 2016 the analyses between discharge, turbidity and precipitation in the catchment have been performed.

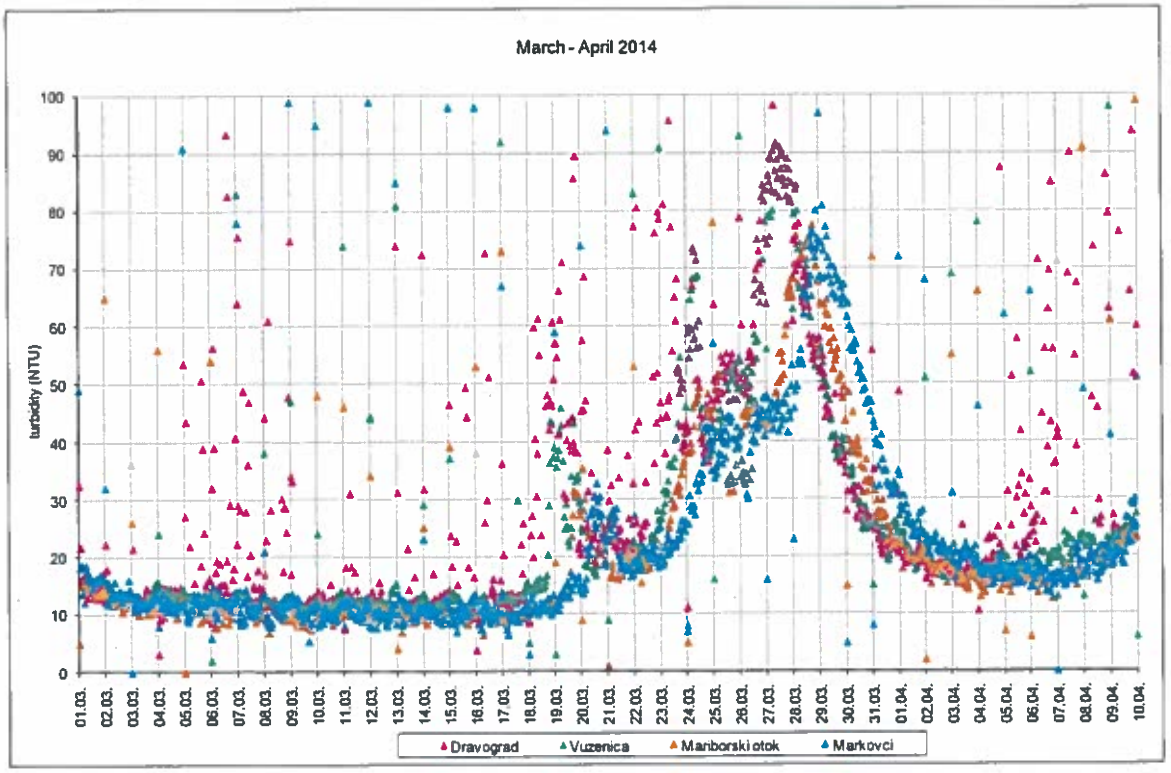


Discharge and turbidity on HP Dravograd and precipitation at twelve stations in Austria. Despite the fact that the amount of precipitation is small, the turbidity on 18 July 2016 significantly increased.



Increased turbidity does not always coincide with an increased discharge at the monitoring site, but can be a reflection of rainfall in the catchment area.

Turbidity sensors on HP Dravograd, Vuzenica, Mariborski otok, and Markovci on the Drava River in Slovenia show good consistency. For example in March 2014, travel of high turbidity is well seen in the figure below. Maximum turbidity on HP Dravograd was measured 27.3.2014 at 07:00 , on HP Vuzenica 27.3.2014 at 11:00, on HP Mariborski otok 28.3.2014 at 17:00 and on HP Markovci 29.3.2014 at 00:00.



Turbidity sensors on four measuring sites on the Drava River show good consistency

4 ATTENDANCE LIST

3rd meeting of the Working subgroup for Hydrology for the Drava River, Working group "Water Management", Permanent Slovenian-Austrian Commission for the Drava

Ljubljana, 17 March 2017

ATTENDANCE LIST

Name	Organization	Signature
Bogdan LALIĆ	ARSO	
MIRA KOBOLD	ARSO	
Sašo Kreslin	DEM	
Karlheins Ogertschnig	KLEK BUND	
Floriana Ulaga	ARSO	
ANDREJ GOLOB	ARSO	
Elisabeth GUTSCHI	HD Kärnten	
CHRISTIAN KOPEINIG	—u—	
Johannes Moser	—u—	

Attachment to the report of the Working Sub-group for Hydrology for the Drava River, 2017

Adapted Values for suspended load at the Carinthian gauging stations:

Gaugingstation	avarage suspended load	Sum of suspended load 2016	catchment area	River	Sum of suspended load 2009 - 2016
	Mil. to	Mil. to	km²		Mil. to
Amlach	0,55	0,42	4.713,50	Drava	4,4
Federaun	0,22	0,12	1.304,90	Gail	1,7
Lavamünd Ort	0,19	0,11	11.051,80	Drava	1,5
Lavamünd Grenze		0,21		Drava	

18.05.2017; Moser