

# Report

of the Hydrology Working Sub-group for the

# Drava River

2018



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

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

HYDRO   
Kärnten  
*... am Puls des Wassers.*



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# 1 MINUTES

of the 4<sup>th</sup> meeting of the Working subgroup for Hydrology for the Drava River,  
Working group "Water Management"

Klagenfurt, Carinthia, March 20, 2018

## 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 hydrology within the working group for Water Management, 4<sup>th</sup> meeting was held at the Carinthian department Abt. 8.

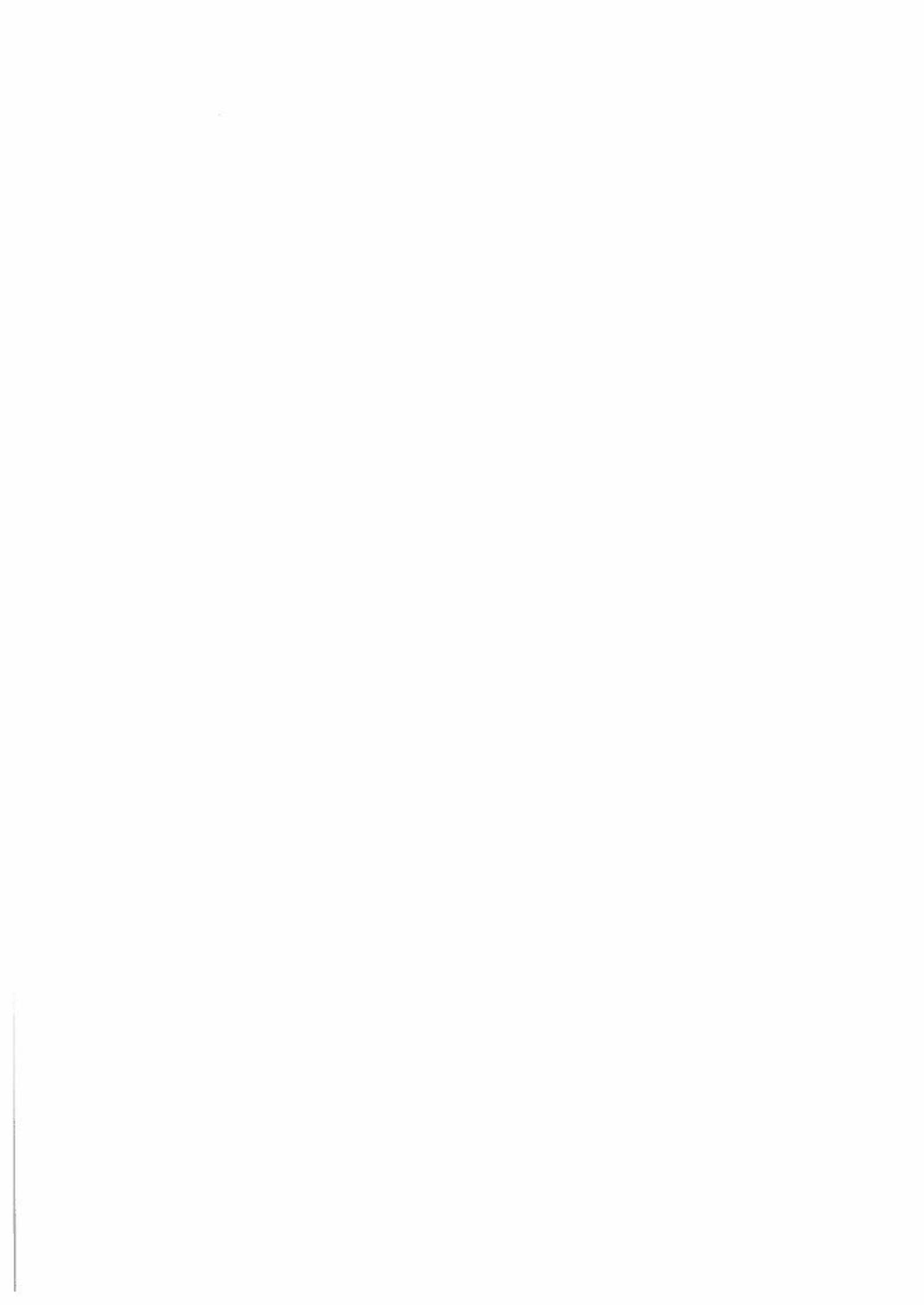
A list of attendance is enclosed.

The meeting was chaired by DI Johannes Moser, head of the working subgroup on the Carinthian side. Both sides agreed that the working language of the meeting is English.

## 1.2 Adoption of the agenda

The following agenda was adopted:

1. Hydrological data for 2017
2. Suspended load of Drava river
3. Water balance 2017 (report of Carinthia)
4. Data exchange, operation of the forecasting services and communication during floods
5. Flood forecasting model of the Drava river
6. Exchange of experience and good practices
7. Miscellaneous



### 1.2.1 Hydrological data for 2017

Hydrography of Carinthia:

- gauging station Lavamünd / KW Lavamünd MQ=213 m<sup>3</sup>/s
- Lavant / Pegel Krottendorf: MQ = 9,83 m<sup>3</sup>/s
- mean discharge of the Drava River at Lavamünd Grenze: MQ=223 m<sup>3</sup>/s
- highest flood discharge of the Drava River at Lavamünd Grenze: 12.12.2017; HQ=1190 m<sup>3</sup>/s (HQ<sub>1</sub>=990 m<sup>3</sup>/s)

Verbund:

- Drava at the powerplant Lavamünd (without Lavant): MQ= 213 m<sup>3</sup>/s

ARSO:

- gauging station Črneče: determination of mean annual discharge is unsatisfied
- highest flood discharge of the Drava River at Črneče: 12.12.2017; HQ = 1147 m<sup>3</sup>/s

DEM:

- Drava at hydropower plant Dravograd MQ = 223 m<sup>3</sup>/s

### 1.2.2 Suspended load of Drava River

Austrian side presented the results of analyses of suspended load for the year 2017. ARSO doesn't have data of monitoring of suspended load on the Drava River in the frame of national monitoring. The monitoring on the Drava River is performed by DEM company on four measuring sites of hydropower plants. For the year 2017 data did not achieve acceptable data quality.

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

Suspended load for 2017 of Drava at Lavamünd Ort: 0,11 million tons. It fits with results of Verbund.

Suspended load for 2017 of Drava at Lavamünd Grenze 0,17 million tons.





### 1.2.3 Waterbalance 2017 (Carinthia)

Carinthia:

	2017 (mm)	1981-2010 (mm)	Deviation of annual values from the period (%)
Precipitation	1340	1198	+11,9
Flow rates	558	593	-5,7
Evapotranspiration	612	582	+5,2

### 1.2.4 Data exchange, operation of forecasting services and communication during floods

The system of SMS messages and E-mails works well and the communication during high waters between forecasting services is good. The automated dissemination procedure is operational and is not experiencing any problems.

ARSO is the only contact institution for hydrological data transfer between Carinthia and Slovenia and data for DRAVA-model of ARSO.

If data are used for other projects in Slovenia, ARSO can transfer Carinthian data to those users. An agreement with the Carinthian hydrological service for those data transmissions to other organisations is necessary.

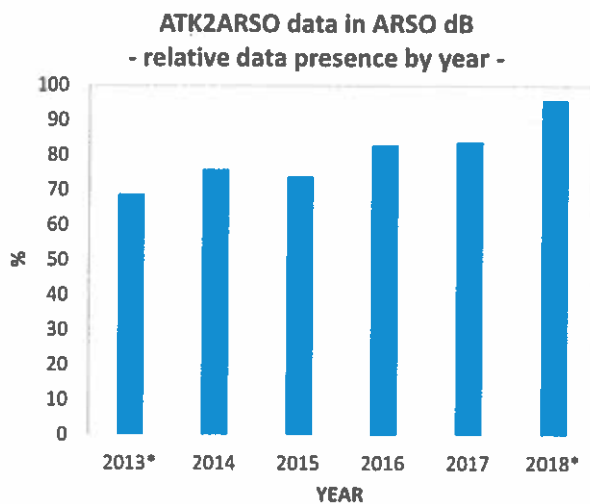
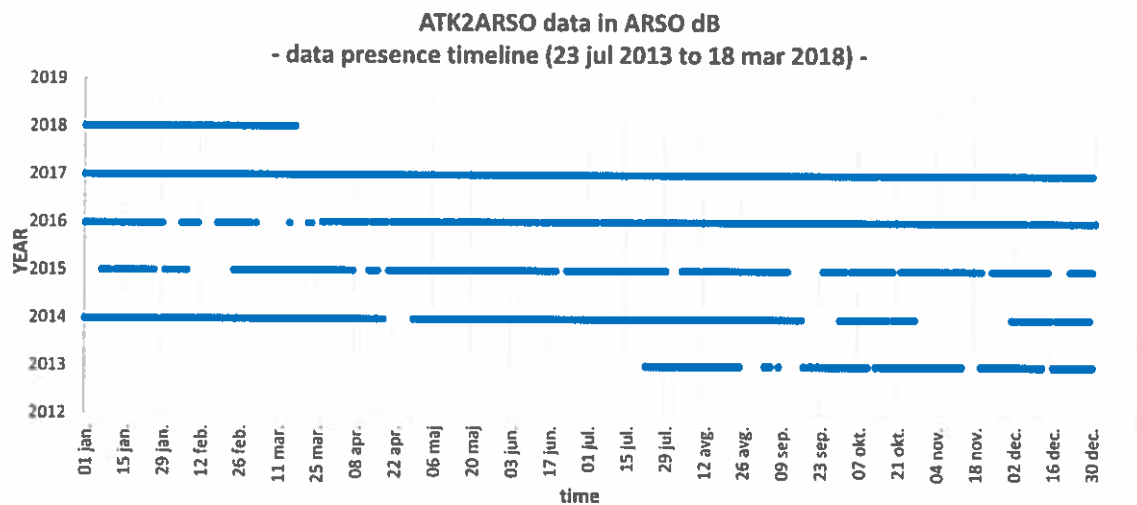
ARSO presented a deep analysis of the data acquired through the operative hydrological and meteorological data exchange with HD Kärnten established in 2013. The presence of the Carinthian data in the ARSO database is increasing from year to year, longer outages are becoming really rare events, and in the last years it exceeds 80% in total. For the purposes of flood forecasting and hydrological modelling it is desirable that this number approaches 99%. Therefore, ARSO proposes to upgrade the data exchange protocol so each exchanged file would be consisted of data records for the past 24 hours (currently 1 hour in the ATK2ARSO exchange and 30 min for the ARSO2ATK exchange).

Additionally, for the Drava flood forecasting model that is currently being built at ARSO there is a need of additional real-time data from the meteorological and hydrological station of HD Kärnten network as well as of historical time series.



It was concluded that:

- the additional station data would be included in the exchange after ARSO sends the station wish list to HD Kärnten (Sašo Petan to Christian Kopeinig)
- both sides will work together with their IT specialist to upgrade the data exchange in both directions (ATK2ARSO and ARSO2ATK) to 24 h trailing data records.





## 1.2.5 Flood forecasting model of Drava River (ARSO)

Last year (April 2017) Carinthia sent following data and information to ARSO for their own model of Drava River:

### COORDINATE SYSTEM

All coordinate values are in the so called Austrian "Bundesmeldenetz" coordinate system (Meridianstreifen M31). I am not a specialist in surveying, so I can't give you a detailed description how to transform these values to your local system. But I think there are a lot of tools for this task available.

You can find more information to this system at the following link (it's only in German, I couldn't find it in English):

[https://de.wikipedia.org/wiki/%C3%96sterreichisches\\_Bundesmeldenetz](https://de.wikipedia.org/wiki/%C3%96sterreichisches_Bundesmeldenetz)

### GIS (SHP) LAYERS OF THE DRAVA CATCHMENT

#### Drava subcatchment delineation:

File: subcatchment\_delineation.zip

Note: In the moment I haven't found files for Rabland, Urlaken, Tschepaschlucht, Weinländer, Gassen, St.Veit and Villach.

Instead of Rabland, which is a small catchment, I have attached Lienz-Falkensteinsteig. The station is located close upstream the inflow of the Isel river. We will produce the missing files as soon as possible,

#### Drava catchment river network:

File: river\_network.zip

Note: Here I have also a ".prj-File" included. Maybe it is helpful for coordinate transformation.

#### Monthly values of the potential evapotranspiration:

We have only data of actual evapotranspiration, not of potential evapotranspiration. But we have also data of monthly soil moisture, so it should be possible to re-calculate the potential evapotranspiration for each month (approximately, because the system does this for each time step). In our system it is done by the following rule:

$$E_{act} = E_{pot} * (BF/LP) \text{ if } BF < LP \text{ else } E_{act} = E_{pot}$$

BF is the Bodenfeuchte/soil moisture, LP is a factor defined in the file 8\_LP.txt (attached, I hope this helps you).

Filename conventions:



Example: AET\_Tag\_SUM\_1Monat\_Mittel\_7\_1981-2011: average actual evapotranspiration for July of the period 1981 – 2010, sum of daily values for 1 month (I know, a little bit complex...).

The raster data are in (very old) ArcView - ASCII format. For more details concerning this format please take a look at

[https://en.wikipedia.org/wiki/Esri\\_grid](https://en.wikipedia.org/wiki/Esri_grid)

## HISTORICAL TIMESERIES

Note: Our station in Villach is new; we are only measuring water levels there (there is influence of the power plant Rosegg). I have added Amlach/Drau and Federau/Gail instead. In Lavamünd our data of Lavamünd Ort are better than Lavamünd Grenze. Here I have added Lavamünd Ort and Krottendorf/Lavant.

## LIST OF AUTOMATIC RAIN GAUGES

File: "Precipitation\_StationList.xls"

Note: Our department operates only stations inside Carinthia, we have no stations in Eastern Tirol (Upper Drau and Isel catchment area). That's why I have added also stations of ZAMG and HD Tirol to the list. Please contact these Organizations directly for data transmission. We are not allowed to pass this data on third parties.

ARSO presented in short their work on the establishment of the Drava River hydrological model. They have presented the general modelling approach, the chosen catchment division and the data sources used. The first calibration of the model is already done for the period between 2007 and 2013 using mostly daily data that were acquired from the eHYD portal and prepared by HD Kärnten. Their plan is to prepare the operative setup of the model as soon as possible and that is the reason the upgrade of the current data exchange with additional HD Kärnten station is so important. During the early operation of the model they plan to verify the calibration on the period after 2014 with historical hourly time series. Finally, ARSO representatives stressed out that all operative model results would be made available to HD Kärnten as soon as they would be available.

As a conclusion, ARSO invited the HD Kärnten representatives to visit ARSO in June 2018 for a deeper insight and discussion on the Drava model that is being established at ARSO. The date will be fixed after a proposal of several possible days done by Sašo Petan.







### 1.2.6 Exchange of experience and good practices

Common discharge measurements in 2018 will be at fixed dates, proposed by Hydrography of Carinthia (HD Kärnten) at least two weeks in advance, starting in springtime. The main goal is to calibrate side-looking Doppler current profilers, namely H-ADCP in gauging station Črneče (ARSO) and OTT SLD in gauging station Lavamünd Grenze (KTN). HD Kärnten need to arrange OTT SLD beforehand.

Considering troubles and frequency of discharge measurements made so far, flows lower than 150 m<sup>3</sup>/s and higher than 800 m<sup>3</sup>/s are the most important. Low flows, their stability and duration, need to be agreed with HP plant managers from both countries, Slovene DEM and Austrian Verbund. Discharge measurements of high flows can effectively be planned using



Flood forecasting model of the Drava River. In both cases, all participants will have to establish certain procedure how to make common measurement work in monthly/yearly practice.

By far the safest and most applicable discharge measurement method in general is cableway system. To make the most effect out of common measurements we should use the newly established, modern equipment at gauging station Lavamünd Grenze. Therefore, ARSO is extremely grateful and looking forward to this year's cooperation and progress.

### **1.2.7 Miscellaneous**

Prepared by:

DI Johannes Moser / Dr. Mira Kobold

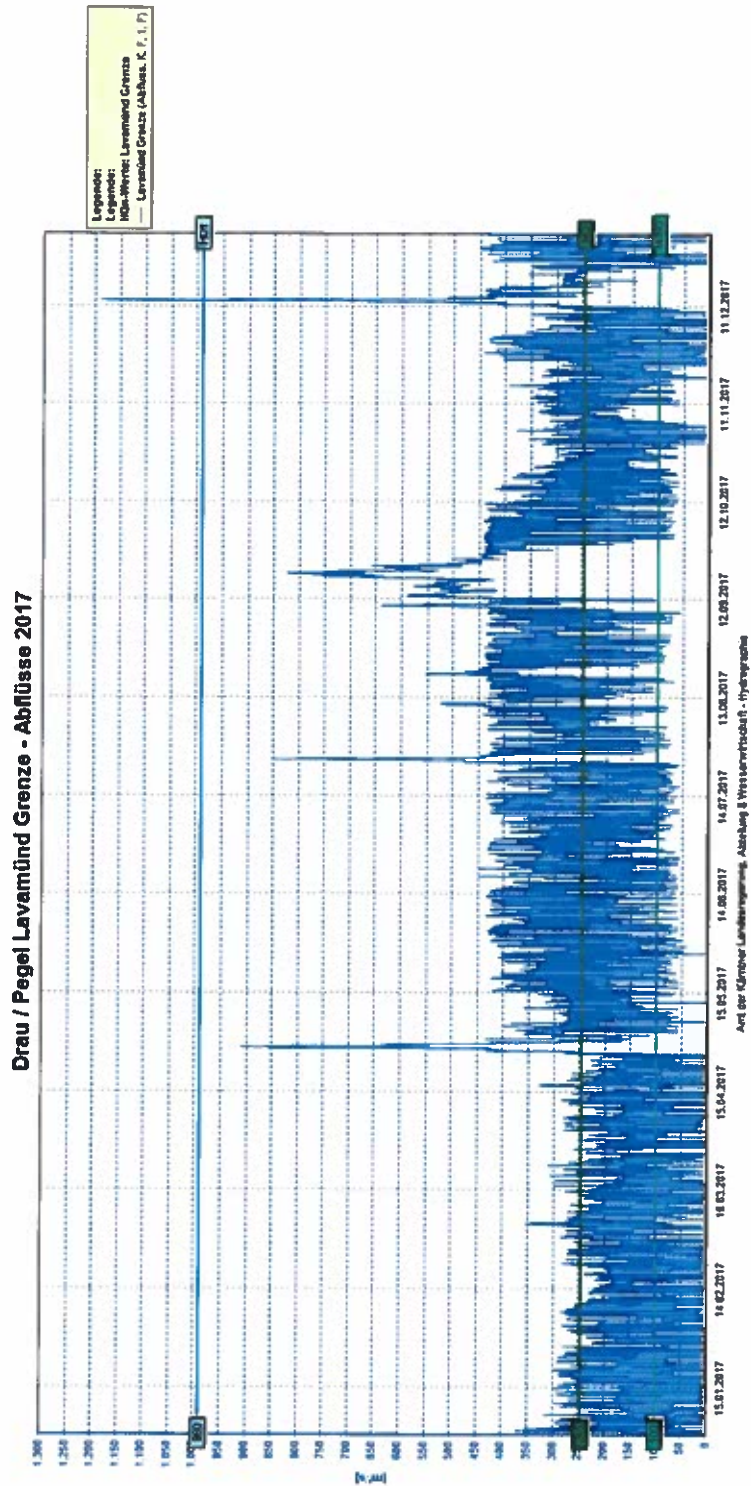


## 2 DATA - HD KÄRNTEN

- Discharges 2017: Drava: Lavamünd Grenze
- Suspended load 2017
- Suspended load 2009 – 2017
- Water balance of Carinthia 2017



## 2.1 Discharges 2017 Drava River: Lavamünd with Lavant (Lavamünd Grenze)

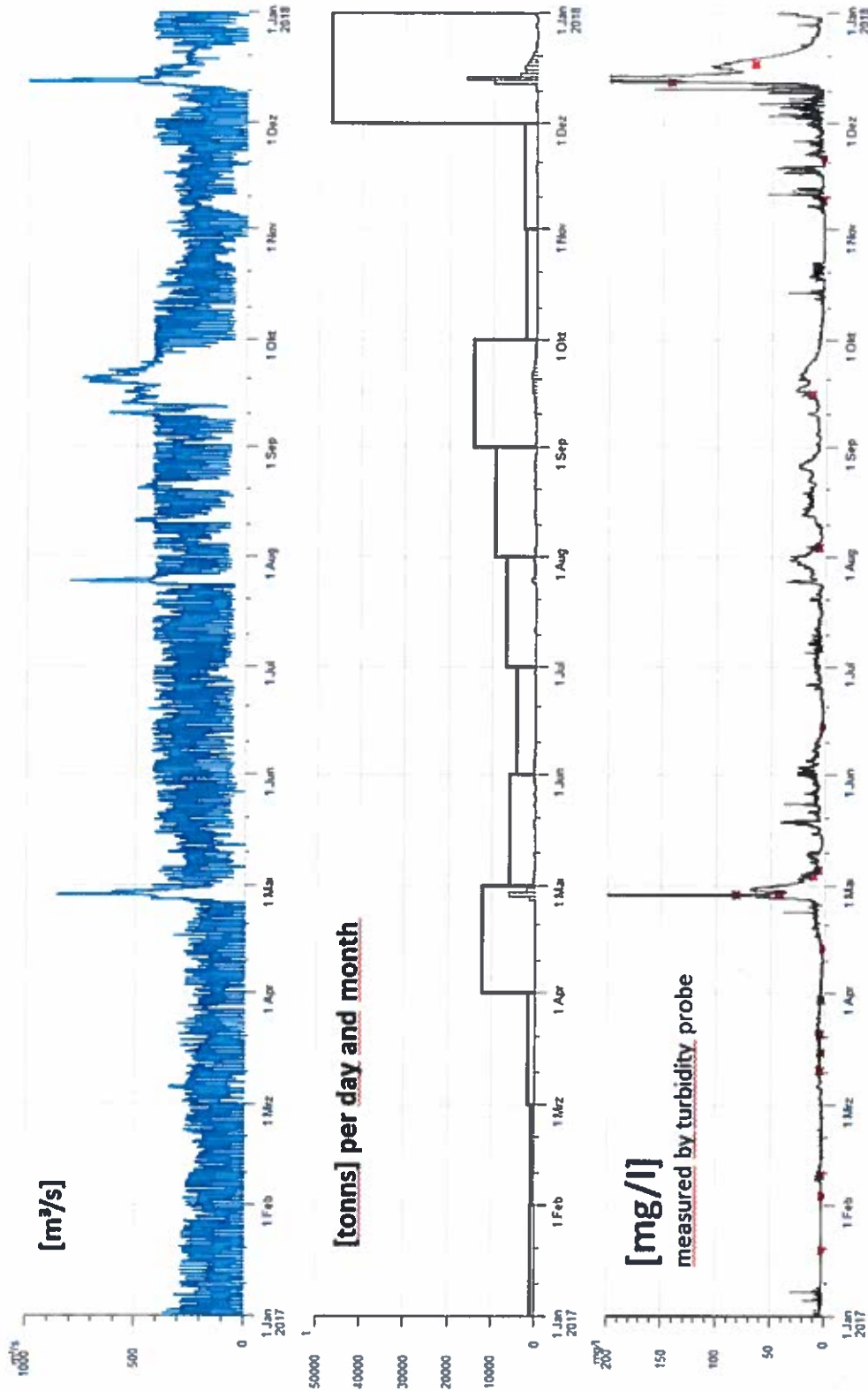






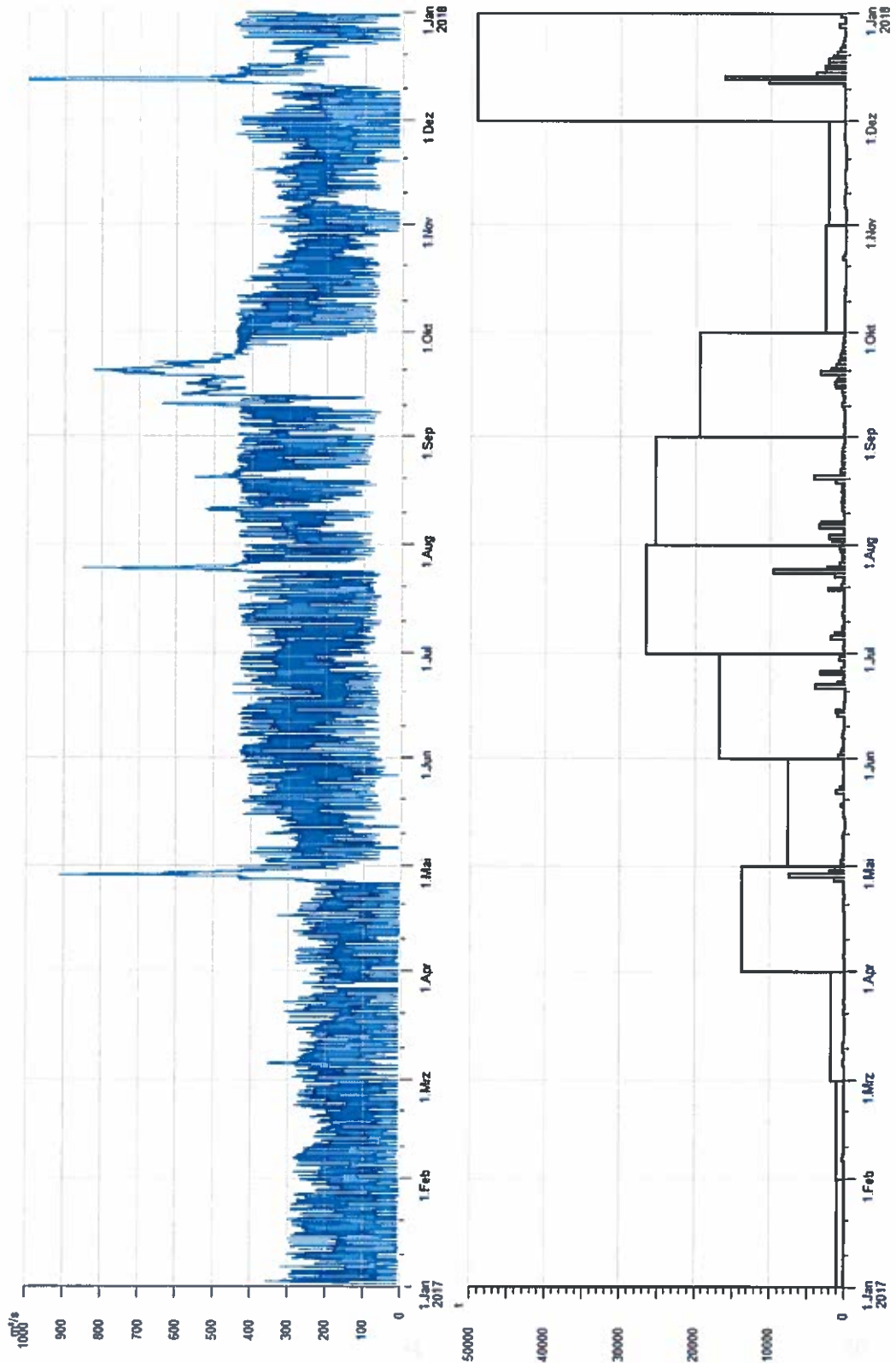
## 2.2 Suspended load 2017

Lavamünd Ort 2017 (without Krottendorf / Lavant)





Lavamünd Grenze 2017 (with Krottendorf / Lavant)





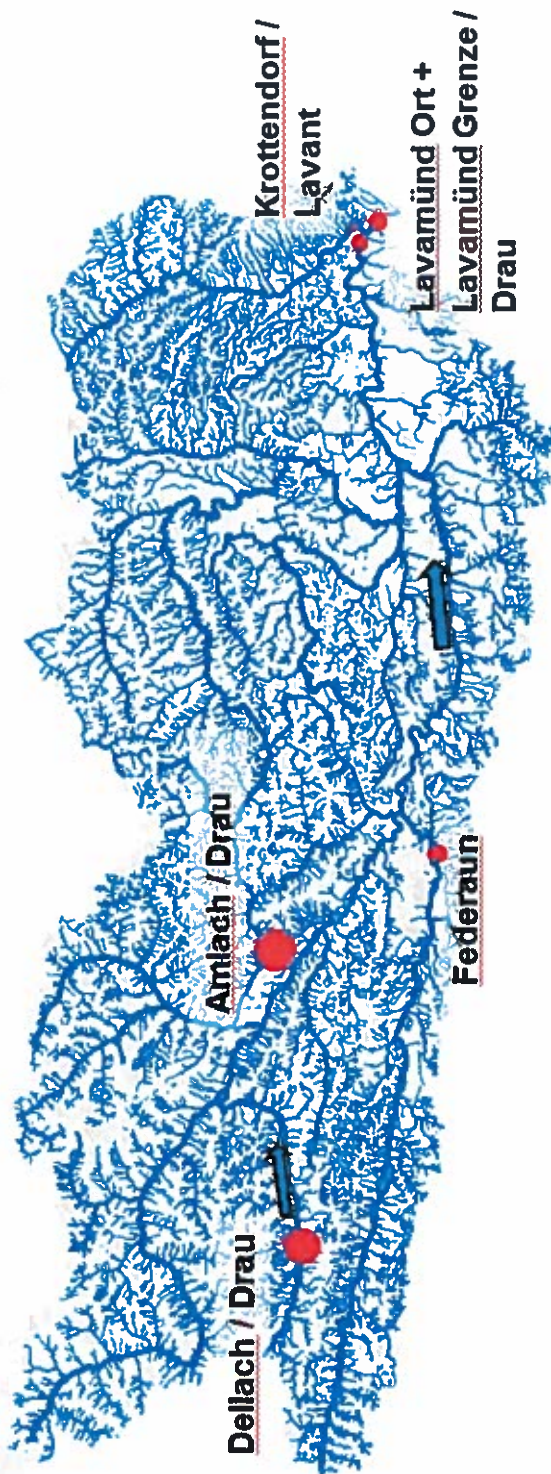
## 2.3 Suspended load 2009-2017

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### suspended load [ million tons] 2009 - 2017

<u>Gaugingstation</u>	<u>Average</u>		<u>Sum</u>		<u>catchment</u>	
	<u>per year</u>	<u>2017</u>	<u>2009 - 2017</u>	<u>area</u>	<u>2009 - 2017</u>	<u>Sum</u>
	Mil. t	Mil. t	Mil. t	km <sup>2</sup>	Mil. t	Mil. t
<u>Dellach / Drau</u>	0,48	0,87	3,8	2.198,6		
<u>Amlach / Drau</u>	0,56	0,74	5,1	4.713,5		
<u>Federaun / Gail</u>	0,22	0,20	1,9	1.304,9		
<u>Lavamünd Ort / Drau</u>	0,18	0,11	1,6	11.051,8		
<u>Krottendorf / Lavant</u>	-	0,06		954,50		
<u>Lavamünd Grenze/ Drau</u>	-	0,17		12.030,0		





## 2.4 Average suspended load per year

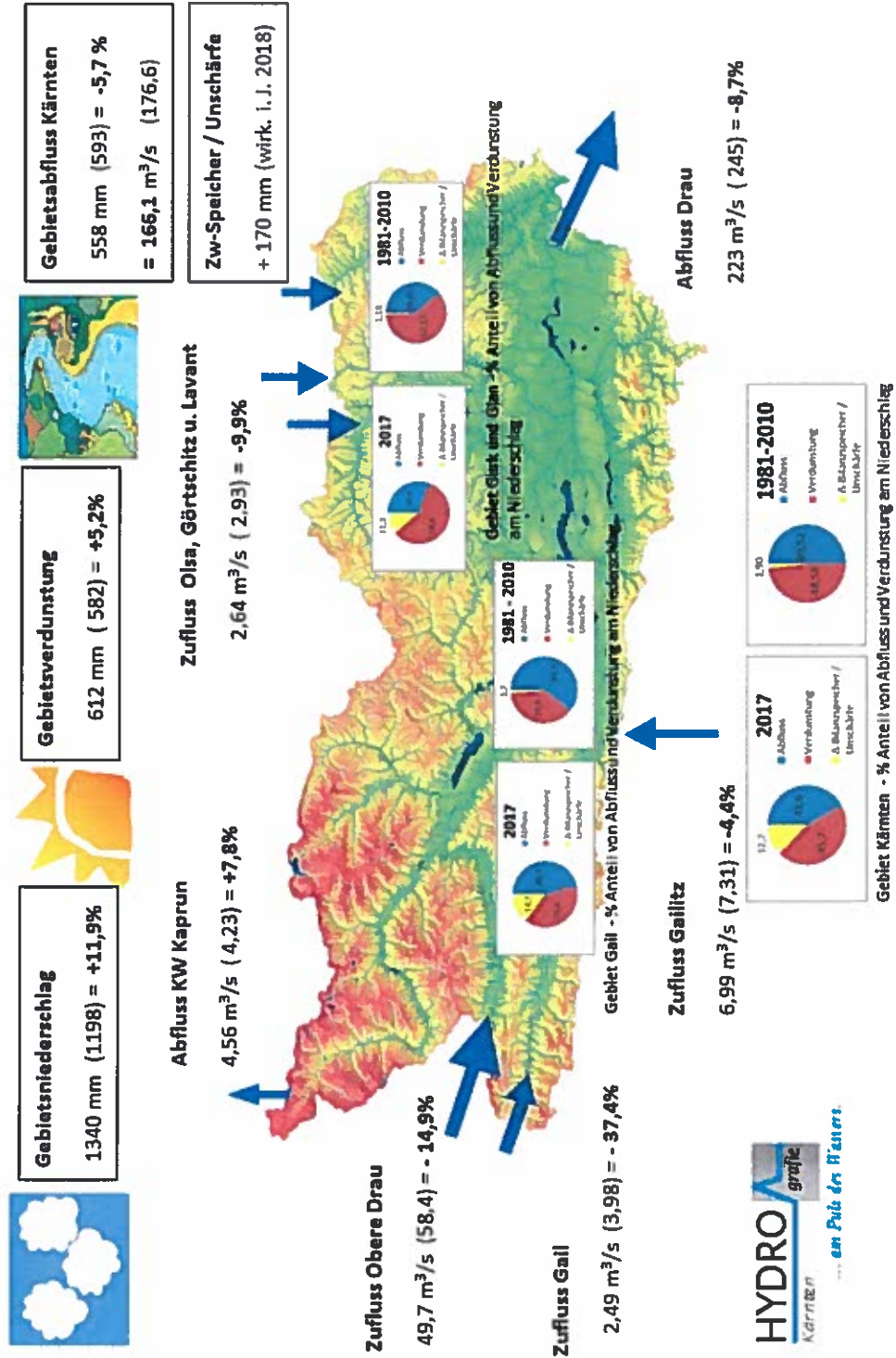






## 2.5 Water balance of Carinthia 2017

### Wasserbilanz Kärnten 2017 - im Vergleich zum Durchschnitt 1981-2010



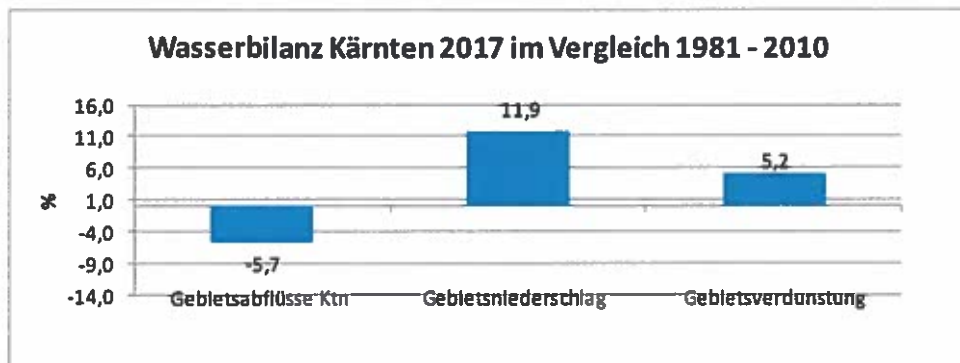
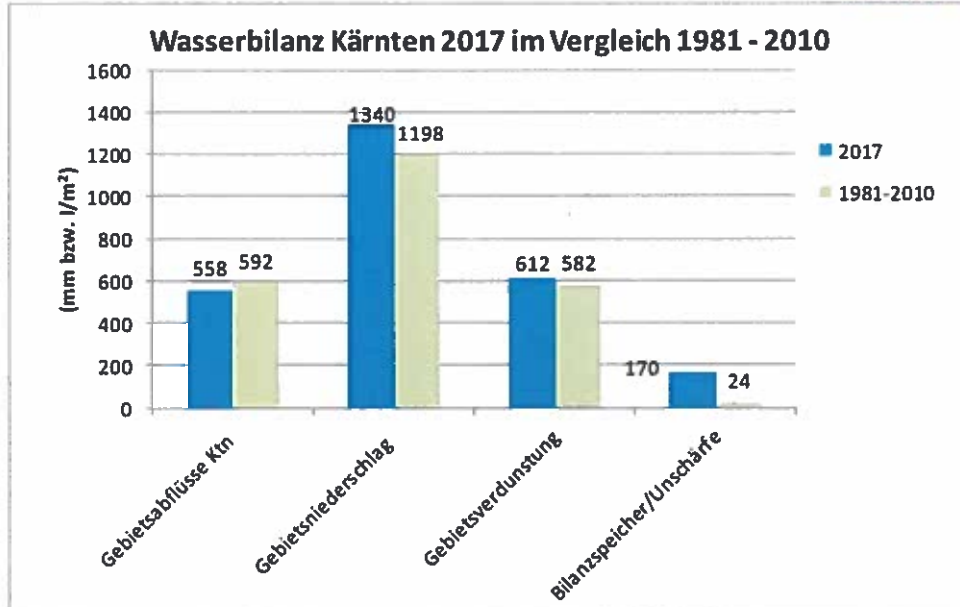


# Data Hydrographie Kärnten

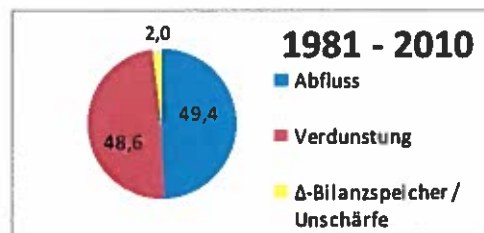
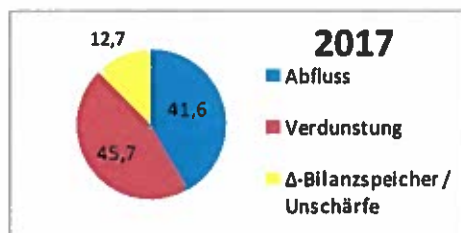
Working subgroup for Hydrology for the Drava River

## Wasserhaushalt Kärnten

Bilanz 2017 im Vergleich zur Periode 1981 - 2010



% -Anteile des Abflusses und der Verdunstung am Niederschlag 2017 und der Periode 1981-2010



Zu- und Abflüsse (m³/s):	2017	1981-2010
Ktn Zuflüsse MQ:	61,82	72,62
Ktn Abflüsse MQ:	227,9	248,8
Ktn Gebietsabfluss MQ:	166,1	176,2

Grenze Slo/Drau:	2017	1981-2010
NQt (m³/s):		51
HQ (m³/s):	1190	1672
HQ <sub>100</sub> = 2800 m³/s		

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

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



### Wasserbilanz von Kärnten

Überblick der letzten Jahre



Vergleichsperiode (Werte in mm):

	Niederschlag	Verdunstung	Abfluss	ZW-Speicher / Unschärfe
1981 - 2010	1198	582	592	23

Einzeljahre (Werte in mm)

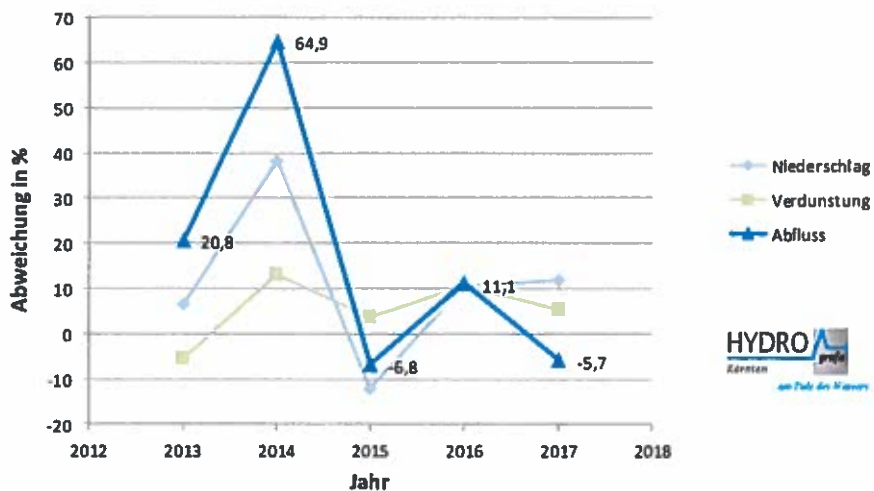
Jahr	Niederschlag	Verdunstung	Abfluss	ZW-Speicher / Unschärfe
2013	1278	550	715	13
2014	1655	658	976	21
2015	1055	604	552	-101
2016	1326	642	658	26
2017	1340	612	558	170

Anmerkung: Wasserzischenspeicherung (- aus Vorjahr; + fürs nächste Jahr)

Vergleich zu 1981-2010 (Werte in Prozent %)

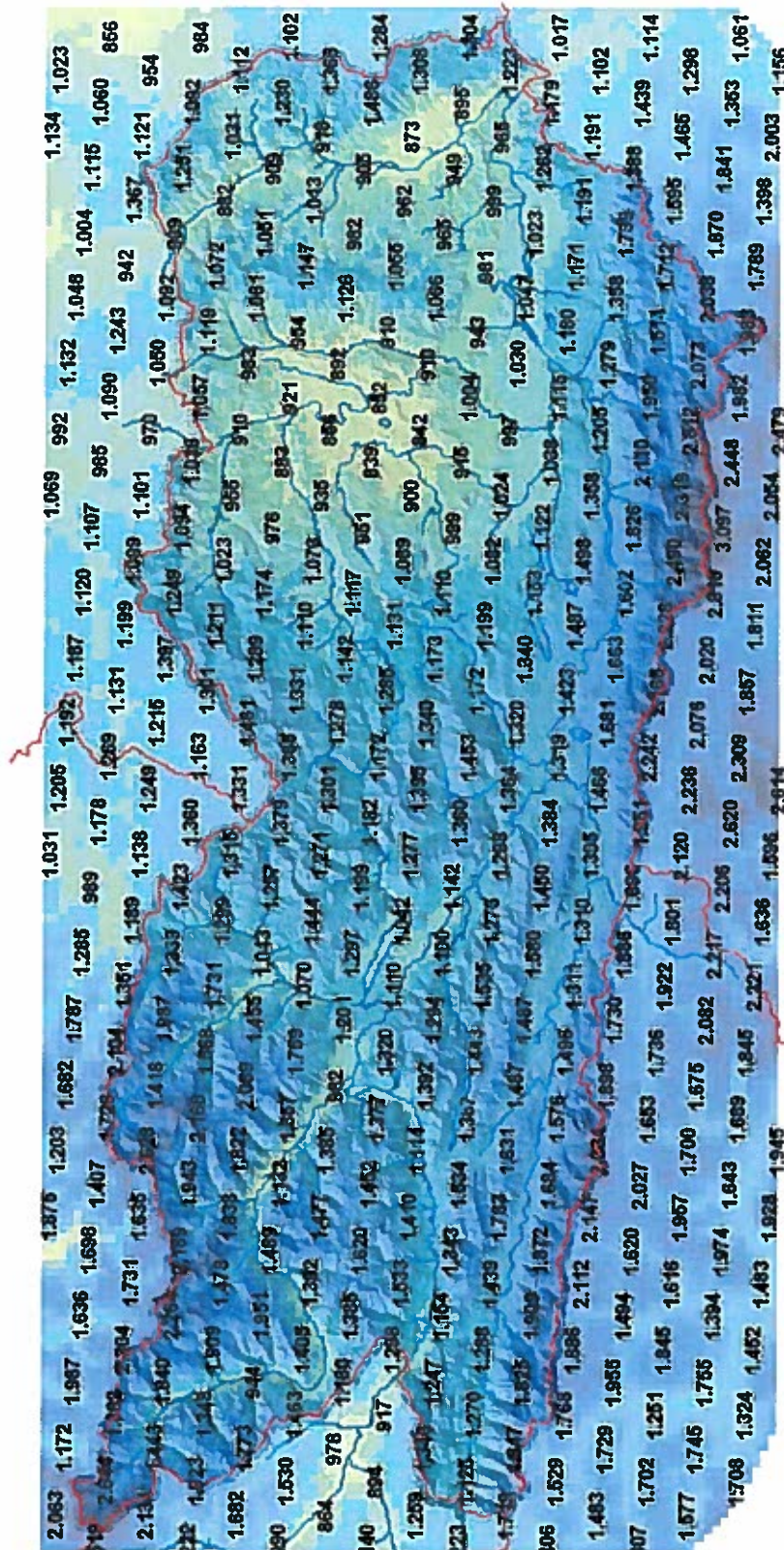
Jahr	Niederschlag	Verdunstung	Abfluss
2013	6,7	-5,5	20,8
2014	38,1	13,1	64,9
2015	-11,9	3,8	-6,8
2016	10,7	10,3	11,1
2017	11,9	5,2	-5,7

Wasserhaushalt Kärnten  
Jahres-Abweichungen in % zu Periode 1981-2010





Niederschlagsverteilung von 1.1.2017 7.00 Uhr bis 1.1.2018 7.00 Uhr



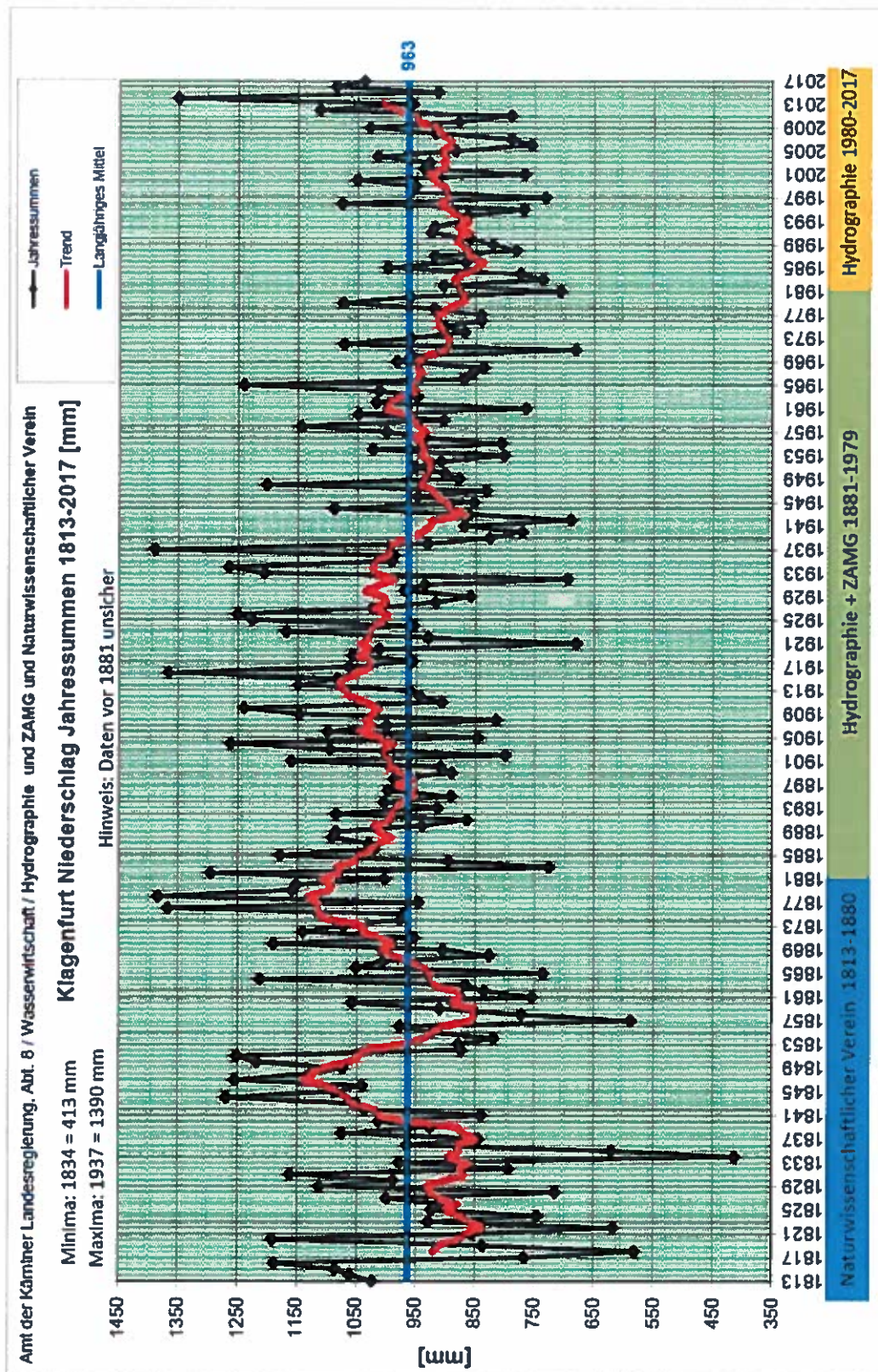
Amt der Kärntner Landesregierung - Abteilung 8 / Wasserwirtschaft / Hydrographie





# Data Hydrographie Kärnten

Working subgroup for Hydrology for the Drava River



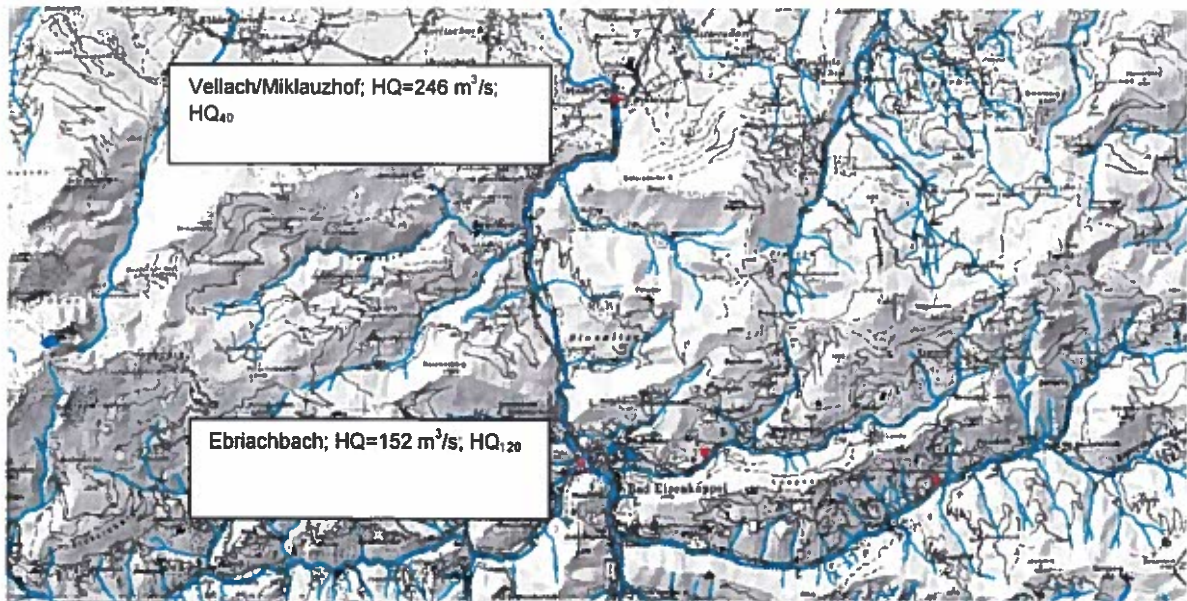


## 2.6 Hydrological Events

### FLOOD EVENT 12.12.2017

Area / Schwerpunkt: Gebiet Eisenkappel

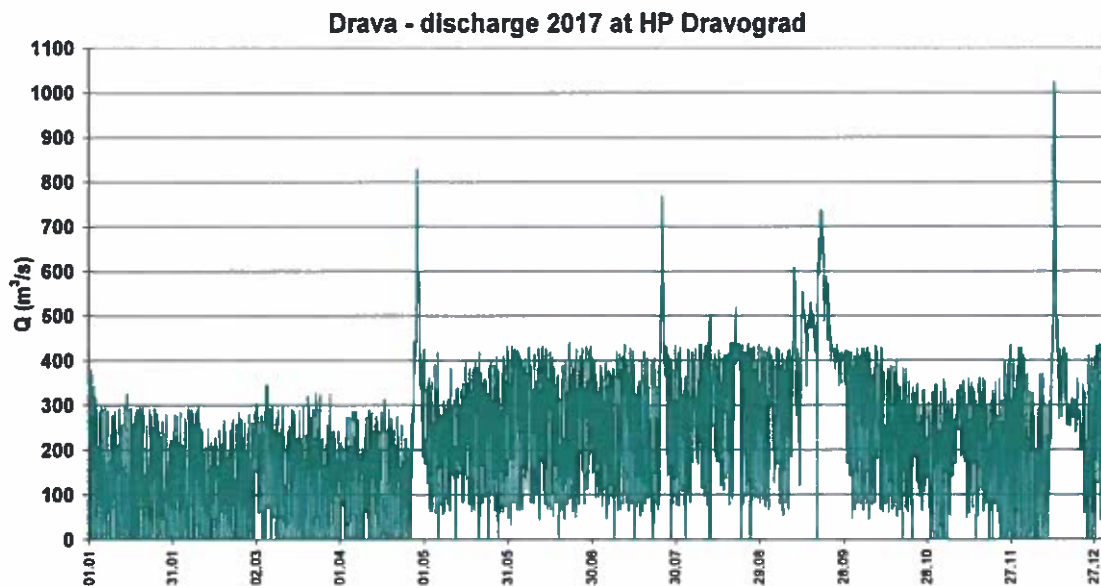
A great storm, very much rainfall and snowmelt.





## 3 DATA - SLOVENIAN ENVIRONMENT AGENCY (ARSO)

### 3.1 Discharges 2017 for the Drava River: hydropower plant (HP) Dravograd



Hydropower plant Dravograd on the Drava River:

Mean value discharge 2017 :      MQ = 223,2 m<sup>3</sup>/s

Highest discharge 12.12.2017:      HQ = 1024 m<sup>3</sup>/s

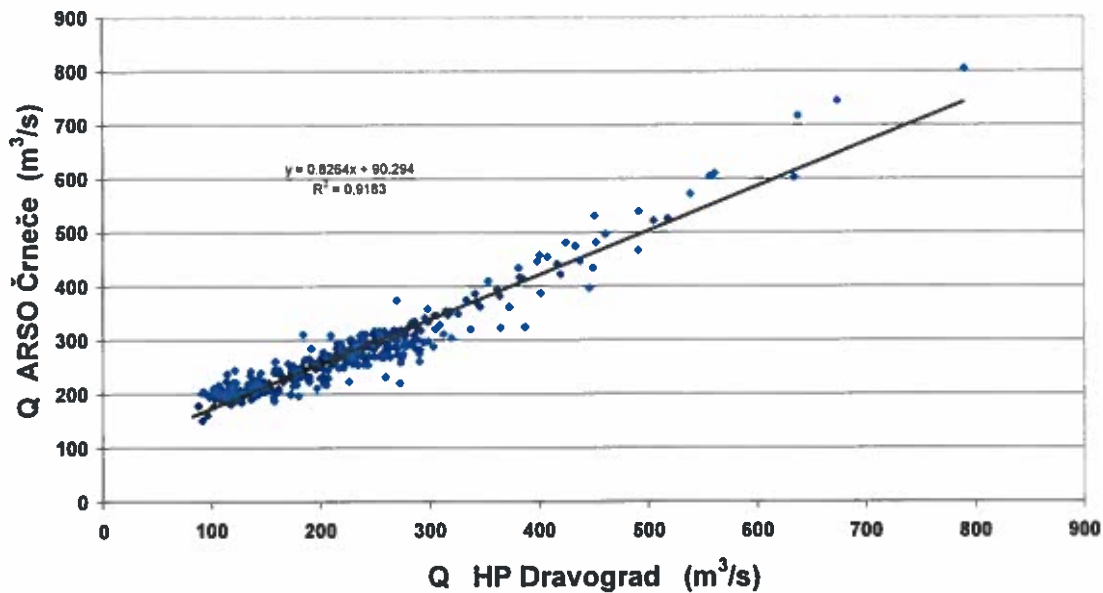
Correlation between mean velocity measured with fixed ADCP and mean velocity measured with ADCP on boat (hydrometric measurement) at gauging station Črneče is not very good.

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

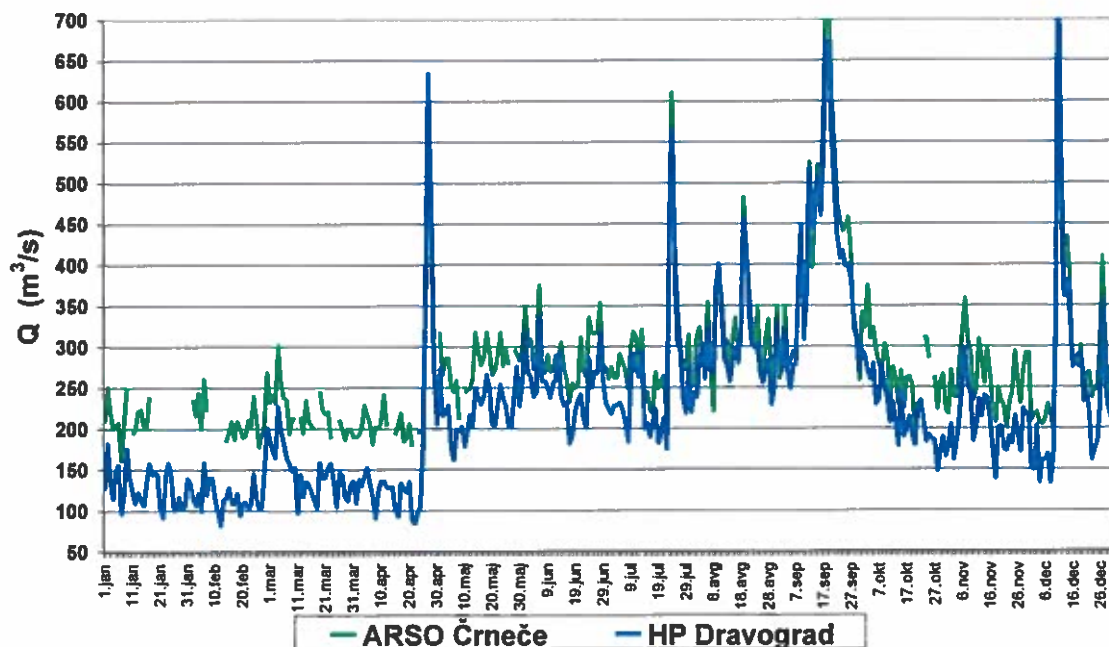


# Data ARSO Slovenia

## Working subgroup for Hydrology for the Drava River



Drava - discharge 2017 at g.s. Črneče and HP Dravograd








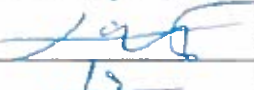
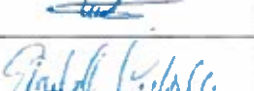

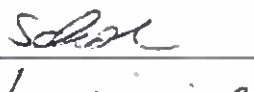




## 4 ATTENDANCE LIST

4th meeting of the sub-group for hydrology for the Drava river; workinggroup  
water-management; Drava commission

Klagenfurt, 20. March 2018

### ATTENDANCE LIST

Name	Organization	Signature
Johannes Moser	HD-Ktn	
Sašo Kreslin	DEM	
MIRA KOBOLD	ARSO	
SAŠO PETAN	ARSO	
Boydan LALIC	ARSO	
ROMAN TRBEK	ARSO	
Elisabeth Gutschli	HD-Ktn	
Karoline Ogertschneig	VERBUND	
VERENA CH. SCHUBS	VERBUND	
CHRISTIAN KOPEINIG	HD-KTN	