Policy recommendations for exchange of data

WP4 Output 4.1

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1 Introduction

This report represents the Output 4.1 (Policy recommendations for exchange of data) and is the result of Activity 4.1 Establishment of common ground for exchanging data for forecasting.

This Output is based on the related Deliverables D4.1.1 *Flood forecasting and IT expert recommendations*, D4.1.3 *Recommendations by data policy discussions*, D4.1.3 *Hydrocode mapping*, and D4.1.4 *Evaluation of questionnaire*. It is linked to Output 3.1 and the corresponding deliverables. This Output has strong interlinkages with Activity A4.2, and therefore Output 4.2 *Observed data exchange software*, since it is the basis for the software development, but also defines the conditions under which a smooth operation is possible and can be tested within the project before setting it to operation in Danube HIS.

According to the aims of this Output this document provides the recommendations necessary to elaborate the **data policy document** for the future Danube HIS by FP-EG and ICPDR, but also recommendations for the **technical operation** of the common data exchange platform. Therefore, this document consists of two parts:

Part A: Recommendations on data policy topics:

For the exchange of data between countries in the Danube catchment it is essential to achieve a consent of the conditions and regulations under which the exchange takes place. To establish this consent, communalities between existing data policy documents have been analysed. In addition, a survey among relevant stakeholders in the Danube catchment regarding data policy topics has been carried out. The findings of the analysis and survey have been discussed between the project partners.

In part A the main results of these data policy related activities are described.

From these results the recommendations for the content of the data policy document of Danube HIS have been derived, which are depicted in chapter 5.

Part A comprises chapters 2 to 5 of this document and is based on deliverable D4.1.3 (Recommendations by data policy discussions).

Part B: Recommendations on technical operation:

Besides a comprehensive data policy also coordinated technical specifications are essential for a smooth and flawless operation of Danube HIS in the future. Therefore, recommendations from flood forecasting and IT experts have been elaborated from an early stage of the project on before implementing the software to ensure high standards for the development of the software, and to avoid bottlenecks in the later operation.

These standards have to be compliant and compatible with already existing technologies used by data providers in all countries, but also ICPDR as the future operator of Danube HIS. Therefore, the technical recommendations are derived from an in-depth review of the existing technical capabilities of the hydrological and meteorological stakeholders in the Danube catchment.

These recommendations are based on deliverables D4.1.1 (*Flood forecasting and IT expert recommendations*), D4.1.4 (*Evaluation of questionnaire*), and Output 3.1. The technical recommendations are described in chapters 6 to 7 of this document.

The conversion and mapping of the data between national data formats and the common data format for exchanging data is another crucial topic to be solved. The basis here for is a common data model, which is designed in deliverable D4.1.1. It has been extended and finalized for operation during implementation of the software (Activity A4.2) and is described in deliverable D4.1.3 (*Hydrocode mapping*).

As proof of concept for the data exchange under real life conditions a webtool to retrieve and display the data from the developed common data exchange platform in an interactive map has been elaborated to show the potentials of daily operation and its stability, which is also part of deliverable D4.1.3 (*Hydrocode mapping*).

Part A: Recommendations on Data Policy Topics

2 Overview on data policy recommendations

The data policy sets up the legal framework, which defines the conditions and permissions which apply to use the data on the common data exchange platform.

An elaborated and comprehensive data policy is a prerequisite for all data providers, regardless of the country in which they operate. Different questions must be addressed in the data policy document, such as:

- Which data is provided?
- To which groups should the data be provided (general public, forecasting centres, universities, etc.)?
- Should the provision of the data be unrestricted and free of charge to these groups?
- Restrictions of data transfer to third parties / use in commercial products?
- Liability for the data?
- Additional conditions, like source of data has to be mentioned?

In Activity 4.1 data policy topics are discussed among the partners in the project consortium and recommendations are elaborated which should be implemented in the data policy document for the future Danube HIS elaborated by FP-EG and ICPDR.

The recommendations for the data policy of Danube HIS are derived from several sources, which are discussions on data policy topics with project partners, a survey among data providers in the countries of the Danube catchment, and existing data policy documents of hydrological/meteorological data exchange platforms. The recommendations have been discussed on the Workshop on Data Poli-

cy Topics on 27th May 2020 during the 4th Period Project Meeting as well as finalized on the Workshop on Data Policy Topics on 6th November 2020 during the 5th Period Project Meeting.

In chapter 3 the main findings of the analysis of existing data policy documents for data exchange platform are summarized, followed by an analysis of the results of the survey among data providers in chapter 4.

In chapter 6 the recommendations on the specific content of the data policy document for Danube HIS derived from these results are depicted. These recommendations serve the FP-EG and ICPDR to elaborate the data policy document for Danube.

3 Comparative analyses of existing data policy agreements

In order to get a comprehensive insight of how other data policy agreements are designed, which conditions have to be fulfilled and what has to be defined in them, already existing examples of agreements of data exchange platforms are analysed:

- ICPDR: draft of Danube HIS
- Sava HIS
- WMO: SEE-MHEWS-A

Table 1 shows an overview of the main policy areas of the three data policy documents and how those are addressed. These main topics are handled very similarly in the three data policy documents. Differences only exist in detail, which are described in the following.

Table 1: Comparison of three existing data policies (meaning of the symbols: ✓ yes, x no)

Policy Area	ICPDR: draft of Danube HIS	Sava HIS	WMO: SEE-MHEWS-A	Comment
Minimum of data to be exchanged defined?	✓	✓	✓	Danube HIS and SEE-MHEWS-A also define data covered by the policy in addition to the data to be exchanged
Free and unrestricted usage?	✓	✓	✓	According to WMO Resolution 25 (Cg-XIII) - Exchange of Hydrological Data and Products, and Resolution 40 (Cg-XII) - Policy and Practice for the Exchange of Meteorological and Related Data and Products
Free of charge?	✓	✓	✓	In general, nobody is supposed to pay for the data on the international platforms
Data Transfer handled by online platform?	✓	✓	✓	All policies aim to establish their own platforms for data exchange
Metadata included with data exchange?	✓	✓	✓	All policies include metadata in the data exchange

Policy Area	ICPDR: draft of Danube HIS	Sava HIS	WMO: SEE-MHEWS-A	Comment
Metadata defined?	✓	✓	✓	All policies refer to the metadata defined in the WMO Technical Regulations
Data transfer to third parties allowed?	x	x	x	Redistribution to third parties not allowed without consent of data provider
Liability of data provider?	x	x	x	No liabilities are acknowledged in the policies; data receiver is solely responsible for appropriate data handling

Minimum data and data covered
The kind of data shared is dependent on the various policies themselves, however there are some commonalities to be found in the way the data is treated. All policies define which data and information is to be shared by the signatories, either by supplying a complete list (ICPDR Danube HIS and Sava-HIS Data Policy) or by referring to external documents (SEE-MHEWS-A Data Policy) containing that information.

Data is covered by policy, but not provided by signatory
In case that certain data and information is covered by the policies but not already provided by the respective signatories, they are encouraged to take steps in the future for collecting and providing it in time.

Charge for data allowed?
Also, all data policies encourage sharing data without charging for it. Hence charging for the data itself is not intended.

This practice is in line with Resolution 25 (Cg-XIII) - Exchange of Hydrological Data and Products, and Resolution 40 (Cg-XII) - Policy and Practice for the Exchange of Meteorological and Related Data and Products. In this resolution the World Meteorological Organization encourages its members to provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services in support of the protection of life and property and for the well-being of all peoples.

"Free and unrestricted" means non-discriminatory and without charge.

"Without charge", in the context of this resolution means at no more than the cost of reproduction and delivery, without charge for the data and the product themselves.

Data format selected by policy?
The regulations concerning the data format differs in the policies. Either they are yet to be defined (ICPDR Danube HIS and SEE-MHEWS-A Data Policy) or there are no formats given by the policy in the first place (Sava HIS Data Policy).

Data Transfer
The transfer is usually handled by an online platform operated by an institution or by email[1]. In any case the data transfer is handled exclusively digital.

Is Metadata included with data exchange and is Metadata defined?
Concerning the metadata all data policies refer to the WMO Technical Regulations (WMO-No. 49). These contain a detailed list of metadata, however only some variables are mandatory. These minimal entries for metadata are listed in Table 2.

Table 2 Categories of the mandatory metadata according to the WMO Technical Regulations

Name/role name	Definition	Obligation/ Condition M: mandatory	Maximum occurrence	Data type
MD_Metadata				
fileIdentifier	unique identifier for this metadata file	M	1	Character String
contact	party responsible for the metadata	M	N	Class
dateStamp	date that the metadata was created or revised	M	1	Class
MD_DataIdentification				
citation	information about citing the resource(s)	M	1	Class
abstract	brief narrative summary of the content of the resource(s)	M	1	Character String
language	language(s) used within the dataset	M	N	Character String
topicCategory	main theme(s) of the dataset	M	N	Class
MD_Keywords				
keyword	commonly used word(s) or formalized word(s) or phrase(s) used to describe the subject	M	N	Character String

Is data transfer to third parties allowed?

All policies aim to use the data for their own purposes, in this case either publishing (ICPDR Danube HIS, Sava HIS) or generate official warnings (SEE-MHEWS-A) as well as publishing it on their respective online platforms in the cases of the ICPDR Danube HIS and Sava HIS data policies. In any case redistribution to third parties is not supposed to happen without the consent of the data provider.

Liability of data provider?
The question of liability is handled exactly the same in each data policy. In each case the policy assigns the responsibility of handling the data appropriately to the data receiver. The data provider is not liable for any direct or indirect damage caused by doing otherwise. This means that no policy is acknowledging any liabilities whatsoever in case they are claimed to arise.

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[1] It has to be mentioned that in case of real time measured data exchange by e-mail is not a practical solution because of the high update interval.

4 Results of the survey on data policy topics among data providers

The survey among data providers of the countries in the Danube catchment, which has been carried out, provides a detailed insight into data policy topics and into the corresponding situations in different countries. The current situation regarding existing national and bi-lateral data policies have been addressed in this survey as well as the perspectives for a data policy regarding the data exchange platform developed within the DAREFFORT project. Data providers from Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Moldavia, Romania, Serbia, Slovakia, Slovenia, Ukraine and in addition EFAS answered the questions.

4.1 Current situation regarding existing data policies

In the following it is summarized and analysed how major topics are addressed in existing data policies in the different countries.

Groups of data receivers addressed by data policies in the different countries are summarized in Table 3. Bulgaria, Croatia, Czech Republic, Hungary (OVF), Slovakia (SHMU), Slovenia, Ukraine and the EFAS considered all the above-mentioned groups in the data policy. Germany has also included all groups, but only bilateral contracts with companies are concluded for use and not for publication. Moldova has included hydrological forecasting centres, public authorities and general public in its data policy. Austria has only included general public, Hungary's OMSZ has not included any of the groups in its data policy. Serbia has included all groups except the hydrological forecasting centres, as they are part of the RHMSS. The SWME in Slovakia uses its measured data only internally, so they have no data policy in which they take other data receivers into account. The restrictions applying to the different data receivers in each country are summarised in Table 4.

Table 3 Groups of data receivers which are addressed by existing data policy documents (meaning of the symbols: ✓ yes, x no, - no specification)

country / institution	Hydrological Forecasting centres	Universities	Public research institutions	Private research institutions	Public authorities	Companies (e.g. harbours, power suppliers, shipping companies)	General public
Austria	x	x	x	x	x	x	✓
Bulgaria	✓	✓	✓	✓	✓	✓	✓
Croatia	✓	✓	✓	✓	✓	✓	✓
Czech Republic	✓	✓	✓	✓	✓	✓	✓
Germany	✓	✓	?	?	✓	✓ bilateral contract for use but no publication	-
Hungary OVF	✓	✓	✓	✓	✓	✓	✓

country / institution	Hydrological Forecasting centres	Universities	Public re-search in-stitutions	Private re-search insti-tutions	Public authorities	Companies (e.g. har-bours, power suppliers, shipping companies)	General public
Hungary OMSZ	X	x	x	x	x	x	x
Moldova	✓				✓		✓
Romania[1]	✓	✓			✓		✓
Serbia	x hydrologi-cal forecast-ing centres is part of RHMSS	✓	✓	✓	✓	✓	✓
Slovakia SHMU	✓	✓	✓	✓	✓	✓	✓
Slovakia SWME	-	-	-	-	-	-	-
Slovenia	✓	✓	✓	✓	✓	✓	✓
Ukraine	✓	✓	✓	✓	✓	✓	✓
EFAS JRC	✓	✓	✓	✓	✓	✓	✓

Table 4 Restrictions which apply for the different kinds of data receivers

country / institution	Answer (short)
Austria	No restrictions
Bulgaria NIMH	daily operational hydrological and meteorological data are free of charge, histori-cal data are charged according to price list of NIMH (for some free of charge, for some available for a limited time, for some charged)
Bulgaria EAEMD	Responsible for stations located along the Danube River: water levels published for the last seven days are free of charge, historical data is provided at a price list of the agency on their site.
Croatia	data is provided based on request for a certain purpose, no charge for certain groups (public authorities, public and private research institutions)
Czech Republic	in general, the restrictions consider non-commercial use and no legal liabilities
Germany	formal obligation has to be fulfilled
Hungary OVF	usage within limits of the relevant legislation, only with citation of source
Hungary OMSZ	Separate agreements apply on a case-by-case basis for different institutions
Moldova	Data selected from hydrometric stations are presented in daily hydrological fore-casting, and they are disseminated on website, so everybody has access

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[1] Romania has no explicit data policy, but rules based on regulations and agreements

country / institution	Answer (short)
Romania	data from selected representative hydrometric stations, from interior rivers and the Danube, are presented in daily hydrological forecasting report, and they are disseminated on website, so everybody has access. In general, raw historical hydrometric stations data are not for sale, but processed data and estimation of different hydrological parameters are provided under commercial contracts. For universities, in general for PhD studies, Romania provides data for a group of selected stations, and for a limited historical period, and for selected parameters, based on a signed agreement.
Serbia	treatment very much dependent on the legal framework the data is exchanged under, if published hydrological and meteorological data and information are used, it is mandatory to cite their source. The user can sell or lend to third parties only with the consent of the RHMSS
Slovakia SHMU	in general, they sell data products and services, but based on law or contracts they can cooperate or provide services for selected and defined purpose with no charge.
Slovakia SWME	restrictions on data receivers do not apply to SWME ice data
Slovenia	Open data policy, publication requires. All measured meteorological and hydrological data and basic analysis and forecast are available for any use free of charge. The source must be cited, no commercial use and no transfer to third parties is allowed and no liability for data.
Ukraine	Hydrological forecasting centres and the public- no restrictions. Others- by prior arrangement
EFAS JRC	Full open access allowing also for commercial use of archived data. Real-time forecast data is restricted to public authorities and universities.

Table 5 summarises the restrictions that apply to data receivers when using the data for personal use. Following restrictions have been mainly mentioned:

- the source of the data must be cited if data is used in products or publications (Croatia, Hungary (OVF), Serbia, Slovenia, Slovakia SHMU and Ukraine)
- no commercial use allowed (Czech Republic, Germany, Hungary (OVF), Hungary (OMSZ) and Slovakia (SHMU))
- no transfer to third parties allowed (Hungary (OVF), Slovakia (SWME, SHMU)
- no liability for data (Czech Republic, Serbia and Slovakia SHMU)

Table 5 Restrictions for data receivers in using the data for own (non-commercial / commercial) product?

country / institution	restrictions for data usage?
Austria	no
Bulgaria	~ the restrictions for data receivers are the same as in Table 4
Croatia	✓source of used data in their product must be specified
Czech Republic	✓non commercial use, no guarantee for real-time data quality, no responsibility of data provider in case of misinterpretation of data

country / institution	restrictions for data usage?
Germany	✓ only non-commercial use permitted
Hungary OVF	✓ citation always necessary, public use requires written permission, no transfer to third parties
Hungary OMSZ	✓ No commercial use is allowed
Moldova	✓ Public data are free, but special information requires a contract
Romania	✓ data receivers can use the received data / parameters / products only for the initial declared / agreed use / purpose.
Serbia	✓ citation always necessary, data receivers use received data and information at own responsibility / liability
Slovakia SHMU	✓ set in licence agreement
Slovakia SWME	~ data purchased by SWME from SHMI cannot be provided to third parties
Slovenia	✓ citation always necessary
Ukraine	✓ citation always necessary
EFAS JRC	no

In Table 6, Table 7 and Table 8 detailed information about which hydrological, meteorological and other products are free of charge and for whom are summarized. The following dimension of data types are considered: Hydrological measured data, Hydrological historical data (processed data/year books), Hydrological forecasts, Meteorological measured data, Meteorological historical data (processed data / year books), Meteorological forecasts, Flood warning levels, ice data.

Hydrological measured and forecasted data are available free of charge in Bulgaria, Czech Republic, Germany, Hungary OVF, Moldova, Serbia, Slovakia SHMU, Slovenia and Ukraine, but partially only as online data and not for data exchange. For the other countries they are partially free of charge, depending on the user group, the stations, and the time period.

Also, historical hydrological data are free of charge in most countries under certain conditions. However, this strongly varies (details in Table 6): In Austria, Bulgaria, Croatia, Slovakia SHMU and Ukraine it depends on the user group, in the Czech Republic on the time period, in Germany, Hungary OVF, Moldova, Serbia and Slovenia they are always free of charge.

In the case of meteorological data, the regulations for the measured data and the forecast data can also be well summarised. In Bulgaria, Czech Republic, Hungary OMSZ, Moldova, Serbia, Slovakia SHMU, Slovenia and Ukraine these data are free of charge (for Slovakia, this applies only to online data, not to data exchange). In Germany and Croatia, the measured data are public and free of charge. Forecast meteorological data in Croatia depends on the product, in Germany they are free of charge for forecasting centres. In Austria meteorological measured data are free of charge for public and research, meteorological forecasts are not free of charge.

Whether historical meteorological data are public and free of charge depends on the user group (Table 7). Data is mainly free of charge for public, but also for forecasting centres and research.

The accessibility and dissemination of warning levels is handled similarly in different countries. Except in Bulgaria where these data are not available free of charge to anyone, in Austria, Croatia,

Czech Republic, Hungary OVF, Moldova, Serbia, Slovakia, SHMU, Slovenia and Ukraine the warning levels are publicly available.

The dissemination regarding ice data is very different from country to country. In some countries there is no systematic tracking of ice data (in Croatia, Czech Republic, Slovenia, Bulgaria the government takes responsibility for this), in Germany, Hungary OVF, Serbia, Slovakia SHMU, Slovenia and Ukraine it is available free of charge to all. In Austria it is not available free of charge. More details can be found in Table 8.

In addition, data policy requirements for the frequency of data updates, liability and other issues mentioned have been addressed in the survey. The results are shown in Table 9. The update frequency requirements vary from five minutes to daily. Some countries have no restrictions on the update frequency. There are also different views on liability and in some countries, there are additional requirements.

Table 10 summarises the restrictions that currently apply to the exchange of data with foreign countries. All countries that participated in the questionnaire state that data use is free of charge, with different additions. Data redistribution is not allowed for most countries/data providers. In Serbia it is possible in agreement with the RHMSS. At the SWME in Slovakia, ice data is disseminated through a website in the TELEDAN project. The exact requirements and additions can be reviewed in Table 10.

Table 6 Which hydrological products are free of charge and for whom? (meaning of the symbols: ✓ yes, x no, - no specification)

country/ institution	topic	Hydrological measured data (near real time)	Hydrological historical data (processed data/year books)	Hydrological forecasts
Austria	free of charge?	yes	yes	yes
	for whom	public, research	public, research	public, research
	comments		Yearbook data for download on the internet	Forecasts on the internet
Bulgaria	free of charge?	yes	yes	yes
	for whom	For everybody	Public authorities	For everybody
	comments	daily operational hydrological data published on the website of the NIMH	processed hydrological data are free for public authorities; hydrological historical data in year books are free for everybody	-
Croatia	free of charge?	✓ partially	yes/no depends for whom	✓
	for whom	to all, but for different station selection	free for research and government institutions. It is charged for commercial use.	only available to forecasting centres
	comments	NRT data availability depends on its use and is considered specific to each case. For example, public has access to certain station selection and power suppliers to additional. Most of NRT data is available on public website for the last 15 days, but not for some investor stations.	-	only DHMZ and Croatian waters have access to forecasting results. Also a portion of model results goes to Sava FFWS platform for forecasting centres from other countries which have access to the platform.
Czech Republic	free of charge?	✓	✓	✓
	for whom	all users	some data are free for all users	all users
	comments	near real time data are published online	currently data series from 1981 are free of charge (daily averages); situation is changing, because an open data policy is prepared	hydrological forecasts are published online; some additional forecasts are shared only with water authority companies and some municipalities (concerns forecasts for non-official forecasting profiles, preliminary results etc.)
Germany	free of charge?	✓	✓	✓
	for whom	information free via internet and app, data on demand (depends if data exchange and publication is of public interest)	open data online free of charge for download	information published online free of charge via website and app
	comments	-	-	-

country/ institution	topic	Hydrological measured data (near real time)	Hydrological historical data (processed data/year books)	Hydrological forecasts
Hungary OVF	free of charge?	✓	✓	✓
	for whom	Everyone	Everyone	Everyone
	comments	-	-	-
Hungary OMSZ	free of charge?	-	-	-
	for whom	-	-	-
	comments	-	-	-
Moldova	free of charge?	✓	✓	✓
	for whom	Everyone	Everyone	Everyone
	comments	-	-	-
Romania	free of charge?	(✓)	-	(✓)
	for whom / comments	all the data from the hydrological network from the Romanian Water Administration branches are free of charge for the hydro-logical forecasting centre		Daily hydrological forecast reports and hydrological warning messages are free for everybody. Special forecasts prod-ucts, hydrological parameters are provided in general under commercial contracts.
Serbia	free of charge?	✓	✓	✓
	for whom	everyone - all interested parties	everyone - all interested parties	everyone - all interested parties
	comments	data are available on RHMSS internet presentation – last 7 days.	data are available on RHMSS internet presentation – from 1990.	data are available on RHMSS internet presentation.
Slovakia SHMU	free of charge?	✓	no	✓
	for whom	the public	for the bodies of state and public administration, the court and the National Council of the Slovak Republic	the public
	comments	water levels and temperatures published online, hourly data for past 24 hours --> only reading, no download	on demand	published as graphs online
Slovakia SWME	free of charge?	x	x	x
	for whom	x	x	x

country/ institution	topic	Hydrological measured data (near real time)	Hydrological historical data (processed data/year books)	Hydrological forecasts
	comments	-	-	-
Slovenia	free of charge?	✓	✓	yes/yes
	for whom	everyone	everyone	everyone/forecasting centres
	comments	-	-	daily reports and warning products containing hydrological forecasts free of charge for everyone, numerical values from model simulations available to professional users only
Ukraine	free of charge?	✓	✓	✓
	for whom	organizations of the Hydrological Service of Ukraine, state institutions, Public	organizations of the Hydrological Service of Ukraine, public	organizations of the Hydrological Service of Ukraine, state institutions, public
	comments	others are paid	others are paid	others are paid
EFAS JRC	free of charge?	NA	NA	✓
	for whom	-	-	all
	comments	-	-	real-time forecasts restricted to public authorities and research, forecasts older than 1 month are free

Table 7 Which meteorological products are free of charge and for whom? (meaning of the symbols: ✓ yes, x no, - no specification)

country/ institution	topic	Meteorological measured data (near real time)	Meteorological historical data (processed data / year books)	Meteorological forecasts
Austria	free of charge?	yes	no	no
	for whom	public, research		
	comments	Precipitation from selected measuring points		
Bulgaria	free of charge?	yes	yes	yes
	for whom	For everybody	Public authorities	For everybody
	comments	daily operational meteorological data published on the website of the NIMH	processed meteorological data are free for public authorities; meteorological historical data in year books are free for everybody	-
Croatia	free of charge?	✓	yes/no depends for whom	yes/no
	for whom	public	free for research and government institutions. It is charged for commercial use.	some weather forecasts are published for public, but some are made specifically for contracted parties.
	comments	data from automatic meteorological stations is published on DHMZ website	-	special weather forecast is made for i.e., transportation authorities.
Czech Republic	free of charge?	✓	✓	✓
	for whom	public, forecasting centres	some data are free for all users	forecasting centres, public
	comments	data from meteorological stations and from meteorological radars are published online; direct data transfer with other forecasting centres established	currently data series from 1981 are free of charge (daily averages); situation is changing, because an open data policy is prepared	-
Germany	free of charge?	✓	✓	✓
	for whom	information free of charge via internet DWD (s. DWD) and LfU (hnd.bayern.de)	open data DWD (s. DWD) and LfU (Gkd.bayern.de)	free of charge for forecasting centres
	comments	shared data DWD/LfU	shared data DWD/LfU	for public request via DWD
Hungary OVF	free of charge?	-	-	-

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country/ institution	topic	Meteorological measured data (near real time)	Meteorological historical data (processed data / year books)	Meteorological forecasts
	for whom	-	-	-
	comments	-	-	-
Hungary OMSZ	free of charge?	✓	✓	✓
	for whom	public	public	public
	comments	14 station's hourly data	6 station's daily data	products on the website
Moldova	free of charge?	✓	✓	✓
	for whom	everyone	everyone	everyone
	comments	-	-	-
Romania	free of charge?	(✓)	-	(✓)
	for whom / comments	meteorological data and meteorological forecasts needed for real-time activities from the National Meteorological Administration are free of charge for the hydro-logical forecasting centre		
Serbia	free of charge?	✓	✓	✓
	for whom	everyone - all interested parties	everyone - all interested parties	everyone - all interested parties
	comments	data are available on RHMSS internet presenta-tion.	data are available on RHMSS internet presentation – from 1990.	data are available on RHMSS internet presen-tation.
Slovakia SHMU	free of charge?	✓	no	✓
	for whom	the public	for the bodies of state and public administration, the court and the National Council of the Slovak Republic	the public
	comments	graphs and tables in selected station --> for per-sonal use only	on demand	graphs online --> for personal use only
Slovakia SWME	free of charge?	x	x	x
	for whom	x	x	x
	comments	-	-	-
Slovenia	free of charge?	✓	✓	✓
	for whom	everyone	everyone	everyone
	comments	-	-	-
Ukraine	free of charge?	✓	✓	✓

country/institution	topic	Meteorological measured data (near real time)	Meteorological historical data (processed data / year books)	Meteorological forecasts
	for whom	organizations of the Hydrological Service of Ukraine, state institutions, public	organizations of the Hydrological Service of Ukraine, state institutions, public	organizations of the Hydrological Service of Ukraine, state institutions, public
	comments	others are paid	others are paid	others are paid
EFAS JRC	free of charge?	NA	NA	NA
	for whom	-	-	-
	comments	-	-	-

Table 8 Which other products are free of charge and for whom? (meaning of the symbols: ✓ yes, x no, - no specification)

country/institution	topic	Flood warning levels	Ice data	Others (please specify)
Austria	free of charge?	-	no	-
	for whom	-	no	-
	comments	Warnings on the internet	no	-
Bulgaria	free of charge?	no	-	-
	for whom	For everybody	-	-
	comments	-	executive agency for exploration and maintenance of the Danube river (EAEMD) reports ice events in observer stations (described by recommendations of the Danube Commission)	-
Croatia	free of charge?	✓	x	-
	for whom	public	there is no systematic tracking of ice data on Croatian rivers	-
	comments	they can be found in documents regarding flood defence plans published on the website of Croatian Waters.	only some ice events are registered, some not in digital form.	-

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country/institution	topic	Flood warning levels	Ice data	Others (please specify)
Czech Republic	free of charge?	✓	-	-
	for whom	public, local authorities	-	-
	comments	warnings available online; flood committees and others interested in flood protection are also informed through sms and email	-	-
Germany	free of charge?	✓	✓	-
	for whom	information published online free of charge via website and app	provided by elwis	-
	comments	-	-	-
Hungary OVF	free of charge?	✓	✓	-
	for whom	Everyone	Everyone	-
	comments	-	-	-
Hungary OMSZ	free of charge?	-	-	-
	for whom	-	-	-
	comments	-	-	-
Moldova	free of charge?	✓	✓	-
	for whom	Everyone	Everyone	-
	comments	-	-	-
Romania	free of charge?	-	-	-
	for whom	-	-	-
	comments	-	-	-

country/institution	topic	Flood warning levels	Ice data	Others (please specify)
Serbia	**free of charge?**	✓	✓	
	for whom	everyone - all interested parties	everyone - all interested parties	
	comments	data are available on RHMSS internet presentation.	data are available on RHMSS internet presentation.	
Slovakia SHMU	**free of charge?**	✓	✓	✓
	for whom	Public, civil protection bodies and others by Act no 7/2010 Coll on Flood protection	the public	the public, civil protection bodies, ….?
	comments	flood warnings	daily hydrological report online	
Slovakia SWME	**free of charge?**	x	✓	x
	for whom	x	for example, the Transport Authority of Slovakia	x
	comments	-	-	-
Slovenia	**free of charge?**	✓	-	-
	for whom	everyone	-	-
	comments	-	-	-
Ukraine	**free of charge?**	✓	✓	-
	for whom	all recipients	organizations of the Hydrological Service of Ukraine, state institutions, public	-
	comments	-	others are paid	-
EFAS JRC	**free of charge?**	NA	NA	NA
	for whom	-	-	-
	comments	-	-	-

Table 9 Requirements on data policy to receive data (meaning of the symbols: ✓ yes, x no, - no specification)

country/ institution	Frequency of data updates (e.g. hourly, daily)?	Liability topics?	Others?
Austria	Department I / 3 receives data from the hydrographic services in the federal states. The co-operation is regulated in the Water Law Act	no	
Bulgaria		WMO requirements	
Croatia	mostly hourly (for data from meteorological or hydrological stations or from hydrological model of upstream countries)	received data is used on their own responsibility and for the purpose of their own model developments	received data is not republished
Czech Republic	-	no specific requirements for data policy, data just must be somehow compatible with their own databases	data quality is important, e.g. for knowing if it can be combined with their own data
Germany	usually between 5 minutes and an hour	yes, work in progress	-
Hungary OVF	no restriction	no data transfer to third parties	-
Hungary OMSZ	as frequent as possible upon on agreement	no	-
Moldova	daily	-	-
Romania	-	-	-
Serbia	there is no restriction on the frequency of data received.	the responsibility for the use of the data is on the user's side.	-
Slovakia SHMU	hourly	-	received data is only used for official duty
Slovakia SWME	SWME obtains most of the data from SHMI. In this case, SWME uses 2 types of SHMI data: 1. Publicly available data on the SHMI website (regularly updated at specific hourly intervals) 2. Data that SWME purchases depending on the specific internal needs of the enterprise. Data are updated according to specific needs. Data cannot be provided to third parties.		
Slovenia	yes	-	-
Ukraine	results of hydrological observations at standard (manual) hydrological stations: twice a day (preferably every hour) meteorological: every three hours in terms of WMO (preferably every hour)	Ukrainian law, Water Code of Ukraine, guidelines for hydrological and meteorological observations and data processing, codes for transmitting observation results	-
EFAS JRC	at least daily	-	derived products should be freely accessible, data should have no cost

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Table 10 Restrictions applying currently regarding data exchange with other countries (meaning of the symbols: ✓ yes, x no, - no specification)

country/ institution	Is data use free of charge?	Can data be redistributed by foreign institutions?	Are there other restrictions?
Austria	Rules for the exchange of data with the neighbouring countries are essentially laid down within the framework of the border water commissions		
Bulgaria	✓ within WMO and some stations in scope of Flood Forecasting and Early Warning System in Maritsa and Tundja catchment	x	-
Croatia	✓ data exchange with other countries is arranged in bilateral agreements with forecasting institutions from other countries free of charge	x data should be used only for their purposes	x
Czech Republic	✓	x	-
Germany	✓Meteorology: contract with ZAMG Austria since 2020: precipitation free data exchange (no forecasts), Hydrology: free exchange between certain forecasting centres in Germany and Austria about discharge and forecasts	x	-
Hungary OVF	✓	x	-
Hungary OMSZ	✓WMO resolution 40 essential data is free of charge	x	no
Moldova	✓Yes, according with the bilateral agreements between countries	no	-
Romania	✓Yes, for the data agree to be exchanged, according with the bilateral agreements	no	no
Serbia	✓ data exchange with international and regional institutions is free of charge with a previously signed memorandum of cooperation or data policy. data exchange is also free of charge, if there are bilateral agreements on interstate water cooperation or during the projects in which participates RHMSS.	✓ only with previously consent of the RHMSS	✓ for published hydrological and meteorological data and information, it is mandatory to cite the source
Slovakia SHMU	✓ if based on international contract	no	✓data can only be used for agreed purpose
Slovakia SWME	✓ TELEDAN project provides ice data to other countries	✓TELEDAN project disseminates ice data through project website	x
Slovenia	✓	✓	✓if additional, value-added information is included in bilateral exchange with a foreign institute, no redistributed to 3rd parties allowed
Ukraine	✓exchange is free; exchange of hydrometeorological observations and forecasts with neighbouring countries regulated by bilateral cooperation programs, regulations and orders of co-operative countries	✓usage within country is allowed	-
EFAS JRC	NA	NA	NA

4.2 Perspectives of data policy for data exchange with other countries in Danube river basin

The second part of the survey emphasizes on data policy perspectives for data exchange with other countries in the Danube River Basin.

Since the majority of the data providers in the countries are hydrological and meteorological institutes which provide their data to others but also will receive data from other countries via the common data exchange platform, they have been asked about the data policy topics from two different perspectives: As data receivers and as data providers.

The results provided by the countries' institutions are summarized in the following.

What is expected regarding data policy from the perspective of <u>data receivers</u>?

Table 11 shows which kind of hydrological, ice and meteorological measured data from other countries can be used by the institutes as data receivers today.

All hydrological institutes can use hydrological data from other countries in their daily work. Water level and discharge are mentioned as useful parameters by all countries.

Ice data from other countries can be partially used by the institutes. In Austria, Czech Republic, Germany, Moldova, Slovakia SHMU, Slovenia and by EFAS ice data from other countries would not be useful in their daily work.

Meteorological data from other countries can be used by almost all institutions. Nearly all of them mention precipitation and some of them air temperature as useful parameters.

SWME in Slovakia added for all three data types that they would use the data in their daily work if the data were processed uniformly from all countries involved in the project and would be sufficiently up-to-date (at specific hourly intervals).

A main topic for data policy is the question if the data should be made available free of charge. Generally speaking there is a difference between internal usage of data and redistributing data.

For internal use, all respondents of the survey expect to receive the data free of charge based on an agreement with the other countries. But most of the institutes would agree to charge for data, if the data is redistributed by data receivers. Only SWME from Slovakia and OMSZ from Hungary expect that if data is redistributed it should be also free of charge if this is stated in the existing data policy of the other country (more details in Table 12).

Table 11 Possibility of usage of data from other countries in daily work (meaning of the symbols: ✓ yes, x no, - no specification)

country/ institution	Hydrological data	Ice data	Meteorological data
Austria	✓ Hydrographic runoff data	-	-
Bulgaria	✓ Water levels, water discharges	✓ Water temperature	✓ precipitation
Croatia	✓ water levels, discharges from nearby stations and hydrological model outlet results from upstream countries (all of that data is already in use)	✓ appearance of ice and ice cover type/percentage on border rivers to compare with conditions at stations in HR	✓ near real time data from automatic weather stations: rainfall, temperature.
Czech Republic	✓ water level, water flow, hydrological forecast	x	✓ weather forecast (precipitation, station data)
Germany	✓ discharge, water-level, forecasts	x	✓ precipitation, forecasts, climate (wind, snow, air-temperature, etc.)
Hungary OVF	✓ data from neighbouring countries already in use; water level, discharge, water temperature, water level forecast and discharge forecast are usually exchanged	✓ ice conditions from other countries are used in daily work	✓ data from neighbouring countries already in use; most important exchanged parameters: precipitation, temperature, snow depth and snow water equivalent
Hungary OMSZ	-	✓ All kind of ice data	✓ All kind of meteorological data
Moldova	yes	no	yes
Romania	✓ water level, discharge	✓ Any information regarding ice on river phenomena description / characteristics	✓ precipitation, air temperature, snow depth, snow water equivalent
Serbia	✓ water level, discharge, water temperature and ice data. Also hydrological forecasts.	✓ data on ice phenomena coded in accordance with recommendations and technical regulations of the WMO; data are exchange within the hydra bulletins - WMO GTS.	✓ precipitation, air temperature, snow depth, air humidity, air pressure, wind direction and speed, meteorological phenomena
Slovakia SHMU	✓ water level, discharges, hydrological forecasts	-	✓ hourly measured precipitation and temperature (exchange data under framework of WMO and other international organizations)
Slovakia SWME	✓ would use the data in its daily work if the data were processed uniformly from all countries involved in the project and would be sufficiently up to date (at specific hourly intervals)		
Slovenia	✓ discharge, water level	-	✓ precipitation, air temperature
Ukraine	✓ levels, water discharge, precipitation, water temperature, data on the Danube River transfers, daily data	✓ ice phenomena and their intensity, thickness of ice cover and height of the snow on ice	✓ all observational results are governed by WMO documents (WMO Circular Exchange)
EFAS JRC	✓ hydrological data from all countries and regions in Europe are collected	x	✓ meteorological data from all countries and regions in Europe are collected

Table 12 Would the institution expect to receive this data for free from other countries in case of internal usage or redistribution of data

country/ institution	internal usage?	Redistributing this data?
Austria	**yes** exchanged with neighbouring countries (Germany, Italy, the Czech Republic and Switzerland)	no
Bulgaria	**yes** based on agreement between countries	no
Croatia	yes	no
Czech Republic	yes	no
Germany	yes	no
Hungary OVF	**yes** receives data free of charge from neighbouring countries through bilateral agreements	no
Hungary OMSZ	**yes** if other county's data policy authorises so	**yes** if other county's data policy authorises so
Moldova	yes	no
Romania	**yes** for elaborating hydrological forecasting and warning products	no
Serbia	yes	no
Slovakia SHMU	yes	no
Slovakia SWME	yes	yes
Slovenia	yes	no
Ukraine	yes	yes
EFAS JRC	yes	no

What is expected regarding data policy from the perspective of <u>data providers</u>?

From the perspective of data providers, the following results for the data policy recommendations can be retrieved from the survey.

In Table 13 it is summarised for which institutions in other countries data could be provided. In Slovakia, the SWME cannot provide data for institutions in other countries, but SHMU can. Austria could not answer this question. All other institutions would provide data to hydrological forecasting centres, also to universities, except SHMU and SWME in Slovakia. Croatia would not provide data to public researching institutes, SHMU in Slovakia would, but depending on the purpose. For private research institutions, public authorities, companies (e.g. harbours, power suppliers, shipping companies) and general public, Croatia, and Ukraine would not provide data. SHMU in Slovakia could provide only own outputs in case of public authorities and general public. In addition, SHMU could provide data for research purposes if SHMU is informed about the research topic and the future use and agrees with it.

Table 13 To which institutions could data be provided in other countries (meaning of the symbols: ✓ yes, x no, - no specification)

country/ institution	Hydrological Forecasting centres	Universities	Public research institutions	Private research institutions	Public authorities	Companies	General public
Austria	-	-	-	-	-	-	-
Bulgaria	✓	✓	✓	✓	✓	✓	✓
Croatia	✓	✓	x	x	x	x	x
Czech Republic [1]	✓	✓	✓	✓	✓	✓	✓
Germany [2]	✓	✓	✓	✓	✓	✓	✓
Hungary OVF	✓	✓	✓	✓	✓	✓	✓
Hungary OMSZ	✓	✓	✓	✓	✓	✓	✓
Moldova	✓	✓	✓	✓	✓	✓	✓
Romania	✓	✓	✓	✓	✓	✓	✓ mainly for hydrological forecasts and warnings
Serbia [3]	✓	✓	✓	✓	✓	✓	✓
Slovakia SHMU	✓	depending on the aim of the research in consultation with the SHMU			only in own outputs	x	only in own outputs
Slovakia SWME [4]	-	-	-	-	-	-	-
Slovenia [5]	✓	✓	✓	✓	✓	✓	✓
Ukraine	✓	✓	✓	x	x	x	x
EFAS JRC [6]	✓	✓	✓	✓	✓	✓	✓

[1] Maybe different conditions would be used for each kind of institution (commercial/ non-commercial/ scientific…). On the other hand, they intend to share only data, which are free of charge, so they will not insist on any restrictions.

[2] Open data, no restrictions via use gkd.bayern.de, nid.bayern.de, hnd.bayern.de, data provided only for non-commercial use.

[3] The data available on the internet presentation can be downloaded and used free of charge with the previous restrictions. If the institutions/party addresses the request and if it is necessary workers engagement for the preparation of data, in that case, data issuance is charged according to the valid regulation.

[4] SWME ice data could probably also be made publicly available on the project's website

[5] Slovenian hydrological and meteorological data are freely accessible to all through the web site of the Slovenian Environment Agency

[6] They only distribute forecast data, no measured data. Forecast data can be distributed with restrictions.

Another question to the data providers is if different restrictions apply to data receivers in their country compared to data receivers in other countries. The answers are shown in Table 14. In almost all countries there are no differences for foreign institutions compared to domestic institutions regarding restrictions for using the data. Only in Bulgaria different restrictions apply for foreign institutions based on individual agreements between the countries and Bulgaria.

Table 14 Do different restrictions apply for data receivers in other countries compared to data receivers in own country

country/ institution	Answer
Austria	no
Bulgaria	yes
Croatia	no
Czech Republic	no
Germany	no
Hungary OVF	no
Hungary OMSZ	no
Moldova	no
Romania	Not clearly defined at this moment
Serbia	no
Slovakia SHMU	no
Slovakia SWME	no
Slovenia	no
Ukraine	no
EFAS JRC	no

The last question of the survey is if it is possible for the data providers to offer the data free of charge for other countries. In Table 15 the answers are shown. For most data providers it is possible to provide the data free of charge. However, there are individual comments on this topic by many data providers which are documented in the footnotes of Table 15. For the SHMU and SWME in Slovakia it depends on the agreement if they are able to provide data free of charge.

Table 15 Is it possible to provide the data free of charge for other countries?
(meaning of the symbols: - no specification)

country/ institution	Answer
Austria	-
Bulgaria [1]	yes
Croatia [2]	yes
Czech Republic	yes
Germany	yes
Hungary OVF	yes
Hungary OMSZ [3]	yes
Moldova	yes
Romania [4]	Depending on agreement

country/ institution	Answer
Serbia [5]	yes
Slovakia SHMU [6]	yes
Slovakia SWME [7]	yes
Slovenia	yes
Ukraine	yes
EFAS JRC	yes

[1] based on agreement between countries

[2] if agreed in project agreement or other kind of agreement between countries, as it is already the practice

[3] if government restrictions allow

[4] In general, providing data to other countries is done only based on bilateral agreements, and/or specific other agreements (e.g. partnership agreement within EFAS). For the meteorological data, the National Meteorological Administration has more extensive data exchange, as established mainly under WMO regulations and agreements.

[5] under the conditions specified in the preceding answers (Table 4 and Table 10)

[6] it would depend on the agreement

[7] based on the experience from the TELEDAN project, ice data from SWME could probably be provided free of charge for other countries

4.3 Other topics of data policy which should be addressed

Following additional comments and recommendations have been derived from data policy discussions:

ICPDR plans to implement a user registration for Danube HIS to have an overview/control over the data receiver.

EFAS provides General Terms and Conditions for data usage online: https://www.efas.eu/terms-and-conditions and https://www.efas.eu/en/data-access. Please note that EFAS is in the phase of updating the specific data access.

LfU in Germany states that data transfer and any data presentation on- and offline requires the user to cite the data source in a distinct manner as follows: "Data source: Bayerisches Landesamt für Umwelt, www.lfu.bayern.de"

The institute NIMH Bulgaria is in the process of "open data" implementation. Things are changing in the institute and with that some of the answers to the questionnaire could change in the future. But the impacts on DAREFFORT project will be only positive, which means that more data can be shared in the future.

From the experience of WMO in negotiations of data policy documents following additional topics should be considered for the implementation of the data policy of the common data exchange platform:

- In addition to the list of minimal parameters, an option of additional parameters should be considered

- Although there are different kinds of restrictions for forecasts and for measurements, it could be helpful to consider also forecasted data in addition to measured data in the data policy

- In some countries there may be third party providers of the data, which are not considered yet

- In the ongoing process of implementing the data policy after the project, higher level authorities should be involved at an early stage. For some countries even involving the government might be necessary

5   Recommendations for the data policy document of Danube HIS

From the evaluations presented in chapters 3 and 4, as well as the discussions within the project consortium during the workshops on data policy topics the following recommendations are derived, which are the partners proposals for the data policy document which will be elaborated by the FP-EG and the ICPDR.

Availability of data

It is recommended to make the data of the common data exchange platform available unrestricted and free of charge. Annotation: SHMU (Slovakia) would like to restrict this to the partners in the Dareffort project. Those are foremost the hydrological forecasting centers and data providers in Danube catchment.

This is in line with the WMO Resolution 25 (Cg-XIII) – "Exchange of Hydrological Data and Products", and WMO Resolution 40 (Cg-XII) – "Policy and Practice for the Exchange of Meteorological and Related Data and Products".

In these resolution WMO encourages its members to provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services in support of the protection of life and property and for the well-being of all peoples

"Free and unrestricted" means non-discriminatory and without charge.

"Without charge", in the context of this resolution means at no more than the cost of reproduction and delivery, without charge for the data and the product themselves.

Specific usage like using the data in commercial products or redistribution the data to third parties can be restricted, depending on the purpose and/or user group (see below).

Provision of data

A minimum set of parameters should be defined. Following parameters can be regarded as commonly agreed within the DAREFFORT consortium regarding measured data: **water level, discharge, water temperature** as hydrological real time parameters and **precipitation** as meteorological real time parameter.

In addition to the minimal set of parameters it can be recommended to foresee an option to expand this list by additional parameters in the future.

A common update time interval of the parameters which the data providers provide the data to the platform should be defined, at least as a recommendation. For real time measured data this could be hourly, and for historical data daily (updated once a year).

The monitoring stations for which the data providers provide the data to the platform should be defined in the data policy and could correspond to the list of hydrological stations and meteorological stations compiled earlier in the DAREFFORT project. This list should be made adjustable in the future (e.g. by placing it into the appendix of the data policy).

The data format in which data is provided to the data receivers should be defined and is WaterML 2.0.

Following groups should be considered as data receivers:

Hydrological forecasting centers: Access should be unrestricted and free of charge for internal usage. This is agreed by all participants of the survey.

Universities / Public research institutions: Access should be unrestricted and free of charge for internal usage. In case of publications and research projects the data source has to be cited, SHMU (Slovakia) in addition would like to be asked for agreeing from case to case.

Private research institutions: Access should be unrestricted and free of charge for internal usage. In case of publications and research projects the data source has to be cited, SHMU (Slovakia) in addition would like to be asked for agreeing from case to case. In case of commercial use of the data please see below.

General public: Access should be unrestricted and free of charge for private usage.

Companies (e.g. Harbors, Power suppliers, shipping companies): Access should be unrestricted and free of charge for internal usage. This is agreed by most countries, SHMU (Slovakia) askes for agreement with the national data providers from case to case. In case of commercial use of the data please see below.

Restrictions of data transfer to third parties / use in commercial products

Re-distribution of the data by third parties should be prohibited or only allowed by written permission of the data provider.

Usage of the data in commercial products could also be prohibited or only allowed by written permission by the data provider and could be charged.

Usage of the data in non-commercial products could be allowed by written permission of the data provider.

Because all the countries have already different regulations regarding re-distribution or commercial use, it could be necessary to also receive written permission from the countries from which the data is used.

Liability for the data

It is recommended to make the data receiver responsible for appropriate data handling, and inter-pretation of the data. The data provider should not be made liable for the accuracy of the real time and other data provided. Data providers should <u>not</u> be liable for any loss or damage, cost or claims arising directly or indirectly from the use of the data.

Additional recommendations

The origin of the data should be cited in any case when using the data. This is common practice.

In the ongoing process of implementing the data policy after the project, higher level authorities should be involved at an early stage.

It is also recommended to use the already existing data policies (see chapter 1) as a template / to orientate towards them, as they are very similar in structure and thus seem to be common practice.

It is recommended to implement a flexible data policy solution, which enable data provider to handle with the different groups according to the different national data policies and reflect possible changes of the national data policy.

Part B: Recommendations on Technical Operation

6   Data Reporting Recommendations

In Deliverable 4.1.1 (*Flood forecasting and IT expert recommendations)* technical information from all countries have been collected to elaborate the technical requirements and recommendations which have been taken into account for the implementation of the common data exchange platform. These technical information from all countries are provided as a separate Annex *Technical Facts of Each Country* to this document.

One main finding is that for data exchange of real time data in the DAREFFORT project and for future Danube HIS there are two types of data delivery: FTP-server or Web-API.

In most countries data delivery methods, which already exist for hydrological and meteorological real time data are used, these are Austria, Croatia, Germany, Hungary, Moldova, Serbia, Slovakia, and Slovenia. In case of Austria there is an existing Web-API by which discharge can be retrieved. This Web-API will be enhanced to retrieve additional hydrological and meteorological parameters in the near future. In other countries appropriate data exchange formats have been defined, these are Bulgaria, Czech Republic, Romania, and Ukraine.

6.1   Data exchange with providers

Real time hydrological data

Based on the technical information for real time hydrological data it is recommended for data providers to use an FTP-Server or Web-API for the data exchange. Because of the very different data formats individual conversion filter for each country are required (see chapter 7.3).

The minimal common update interval for the hydrological parameters is daily. For automatic stations there is a minimal common update interval of one hour. The long-term goal should be to achieve an update interval of at least one hour for the agreed parameters of the data policy. Parameters exchanged by all countries are **water level, discharge** and **water temperature** which are the minimum of agreed parameters.

The exchange of additional available parameters is welcomed. The common data model of the data exchange platform described in the separate Annex *Data Model for Common Data Exchange* is flexible to define additional parameters.

Ice data is provided on a very heterogonous level regarding periods, parameters and update intervals, but can be provided analogous to the other parameters.

Two countries of the Sava catchment are not involved in the DAREFFORT project: Bosnia and Herzegovina, and Montenegro. Those countries can be easily connected to the common data exchange platform since they are already delivering data to Sava HIS, and the same IT technologies can be used, but the selection of stations to be involved for Danube HIS will be different.

Real time meteorological data

As with hydrological data, an FTP server or a Web API is recommended for data exchange of the real time meteorological data with a request individually adapted to the country.

The data should be updated at least daily, better would be hourly on the long term. In addition to precipitation, other parameters such as air temperature and snow cover can also be provided.

Only **precipitation** can be delivered in all countries using the data exchange interface at the moment, which meets the draft specifications of minimal set of meteorological data foreseen to be exchanged in future Danube HIS. However, more parameters could be provided by most of the countries, therefore it could be a possible to exchange **air temperature** in addition in the future, since Austria and Bulgaria are the only two countries which do not foresee to provide this information now.

Grid data is not available in each country. It is recommended to upload grid data in the existing data format. They can then be downloaded again in the same format.

An alternative approach to provide meteorological real time data could be to use the GTS network (Global Telecommunication System) of WMO. WMO collects meteorological real time data within the framework of its GTS network (Global Telecommunication System). The national weather service of each country which is member of WMO sends data to WMO in BUFR format, which is a complex binary format. BUFR is an abbreviation of "Binary Universal Form for the Representation of meteorological data". Currently, WMO is setting up WIS (WMO Information System) on top of GTS to extend WMO members' ability to disseminate data.

However, this alternative is not the recommended one, because binary data formats like BUFR format used by WMO, are not human readable which makes it very difficult for non-IT-experts to double check the data in case of data transfer issues or errors. Therefore, it is more flexible and easier to maintain to use the individual, but human readable national data exchange interfaces described above. In addition, meteorological stations for which data is sent to GTS differ from those selected for Danube HIS.

Processed hydrological data

Processed/historical hydrological data should be uploaded or made available on an FTP server using a defined template csv file, because most of the countries already use this method for exchanging processed data.

Processed meteorological data

Like the processed/historical hydrological data, the processed/historical meteorological data should also be uploaded as a defined template as a csv file or made available via an FTP server.

6.2 Metadata

Metadata of the measuring stations is delivered as csv file in a tabular format. This ensures that changes of metadata can be uploaded easily to the platform. Also, individual new stations can be added in this way or manually in the graphical configuration interface.

6.3 Data storage and dissemination

Duration of persistent storage of real time data

Currently regular practice is to publish processed data once a year. Therefore, the duration of storage of the real time data should be at least one year to avoid temporary data gaps in the database as far as possible. On the other hand, real time / unprocessed data should not be available indefinitely, because of possible data incorrectness.

Duration of persistent storage of processed data

For the processed data, an unlimited collection and storage of the data is recommended.

Dissemination of data

The technical aspects of data deliverable formats and software interfaces will be described in chapter 7 below.

7 Specifications of the common data exchange service

In the following the specifications of the common data exchange service referred to Danube Hydrological and Meteorological Common Data Exchange Service **(HyMeDES EnviroNet)** are described, as they have been recommended in deliverable 4.1.1. The suffix "EnviroNet" stands for environmental information network which indicates the software service is able to deal with a variety of environmental data and could be easily extended in the future.

The architecture of HyMeDES EnviroNet serves to establish a stable, common ground to collect and make available existing hydrological data from data providers and handle all the conversion, transport, security and standardisation requirements attached to that goal.

To achieve the aims of the project, the hydrological and meteorological data provided in each country in the Danube basin has to be converted to the common data exchange format (HyMeDEM), stored and distributed in an appropriate way.

Since there are many partners involved in this process, especially data providers, it is necessary to implement a decentralised and modularised solution. This ensures that horizontal growth is possible easily with respect to data providers, the maintenance effort is kept to a minimum for each partner, and the accessibility and availability of data for the end users is maximised.

The data conversion is recommended to take place decentralized on site of the data providers to ensure that they can apply changes in their national formats to the conversion rules on their own without involving the central host. The data from national data providers collected and converted to the common data exchange format are stored in a centralised storage solution, from which the data will be distributed to clients. The centralised service is necessary and preferred over cloud based or distributed software solutions to achieve a stable running and broadly accepted solution on the long run. Besides compliance to ICPDR IT-infrastructure as the foreseen operator of the future Danube HIS, it is necessary to ensure to have a broadly accepted and renowned institution / organisation like ICPDR to be in responsibility of running the system, also with respect to data policy agreements which have to be agreed on for the future use of Danube HIS.

To achieve these aims the requirements for the software architecture of HyMeDES EnviroNet are:

- data from national data providers are exchanged using existing data exchange interfaces where available, in order to keep the effort for the national data providers as low as possible in order to enhance the acceptance. This implies that the national data providers only host their own data, not the data of other countries,

- data has to be converted into the common data exchange data model HyMeDEM by the common data exchange service and comprised to a common data pool (common data base) according to the HyMeDEM data model,

- the common data exchange service provides the common data pool to clients,

- the development of the software has to be based on established coding standards and to be well commented to be easy maintainable,

- the common data exchange service is a web driven application, light-weight, and easy to implement and to maintain,

- to make the system as open and platform independent as possible the core structure only uses simple and proven web technology (server side: HTTPS, PHP, Cron/Task scheduler, client side [for configuration and administration]: Html5, JavaScript),

- the software is open source,

- data security: authentication is verified using appropriate encryption methods,

- the interaction will be managed by Web APIs,

- using plug-ins (plug-in libraries) is encouraged,

- no direct writing interaction with the underlying databases is allowed (only access via API), reading data from the database can be allowed for special use cases,

- missing data can be imported as csv-files triggered by data provider,

- to be compliant with ICPDR future developments regarding Danube HIS following IT infrastructure has to be supported (all of them are open source):

    - web server: Apache
    - PostgreSQL with PostGIS extension
    - sharing geospatial data: GeoServer
    - interoperability with the DanubeGIS
    - compatible user management system (e.g. CIS)

In order to avoid a bunch of different software solutions for each data provider and distribution purposes there is only one HyMeDES EnviroNet software service which consists of several modules and can run in different modes according to the functionality which is needed for the specific purpose. An overview about the platform architecture is shown in Figure 1.

According to the different roles in the common data exchange service HyMeDES EnviroNet can act in two different main modes, which are described in detail in 7.1 and 7.2.

In the first mode the software is used as **distribution node** which collects data from national data providers and stores the data in the HyMeDEM data model in a database. As distribution node HyMeDES EnviroNet can provide the data in Water-ML 2.0 format via a web-API to clients. The distribution node will be part of Danube HIS in the future and it is foreseen that ICPDR will host this HyMeDES EnviroNet distribution node after the project. Therefore, the technical specifications have to be kept compliant to ICPDR future developments (see also detailed description above).
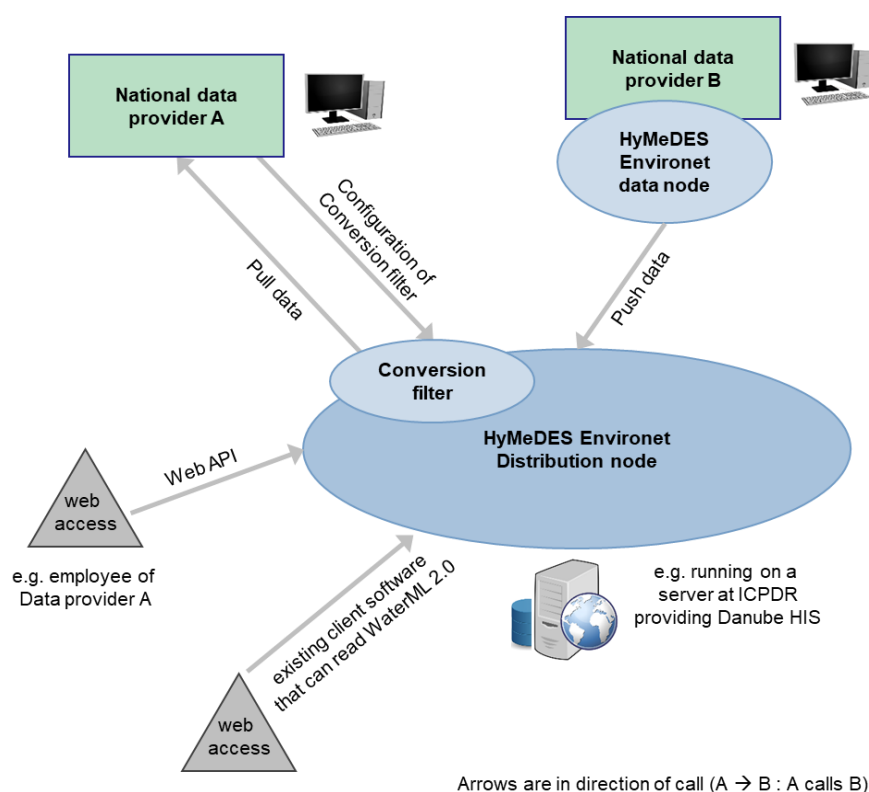
Figure 1   Schematic overview of use cases of HyMeDES EnviroNet.

The second operation mode is called **data node**. Data nodes are used by data providers who want to send their data actively to the distribution node. Communication with the distribution node is realized via https. In the data node **conversion filters** (plug-ins) are used to convert the data from national data format to the common HyMeDEM data format. The conversion filters are tailored to the national data formats.

The conversion filters can also run directly in the HyMeDES EnviroNet distribution node and pull the data from the data providers' servers. In this case the data providers have to ensure that the data to

be exchanged can be accessed via a Web-API or an FTP-server, providing an access account for Hy-MeDES EnviroNet.

To keep the maintenance effort in balance between data providers and host of the data exchange service, configuration of the conversion filters is manageable by the national data providers. Necessary maintenance tasks are limited to situations in which data providers make significant changes like adding new stations to future Danube HIS, changing server addresses or making changes to the data exchange protocol, e.g. by assigning national data fields to corresponding HyMeDEM entities. The conversion plugins running directly in the HyMeDES EnviroNet distribution node are accessible by the data providers for configuration.

In addition, to keep the maintenance effort low, especially if a national data provider makes changes in the local data format or Web API, the conversion plugins are configurable by easy maintainable configuration files, without making changes in the source code. This ensures that national data providers can maintain their conversion plugins as easy as possible. No programming skills are required to maintain the conversion filters.

Data security is ensured by authentication using appropriate encryption methods (separate tool for generating key pair on data providers side). The public key list for authentication should be managed by the host of HyMeDES EnviroNet distribution node in the future, which is foreseen to be ICPDR.

An advantage of the DAREFFORT's HyMeDES EnviroNet engine is to provide data that can be validated to be original. This is proven by the use of a public key infrastructure that makes it technically impossible to falsify measurement data after it was entered. Authentication is verified using appropriate encryption methods. There is a separate tool for generating key pairs for data providers.

An alternative to the centralized data hosting solution would be to get the data one-by-one by streaming or scraping information directly from the sources from data providers. The problem with this is that the more sources there are, the more of a problem it becomes that data sources can be changed or go offline without notice. Then users have to adapt and keep their scripts up to date, after noticing the change, not to mention the possibly different formats that users need to work with. Therefore, the centralized data hosting solution provided with HyMeDES EnviroNet is preferred.

Nevertheless, there are use cases in which for example a forecasting service wants to retrieve data from specific data providers not using the HyMeDES EnviroNet data exchange service or Danube HIS in the future. This could be the case if additional data has to be accessed which is not provided by the centralized server. In such a case it will be possible to install the HyMeDES EnviroNet data exchange service at the forecasting service, making use of the existing conversion filters, and optionally enhanced by the additional specific data entities which should be exchanges in addition. This use case is described in more detail in section 7.6.

7.1   HyMeDES EnviroNet Distribution Node

The HyMeDES EnviroNet Distribution Node is the back bone of the common data exchange platform. It has to be ensured that the distribution of the commonly shared data is possible using one Hy-MeDES EnviroNet Distribution Node, which will likely be the case in foreseeable future. The distribution node stores all data which is received from data providers in a local data base. The data can be

received via conversion filters (see below) running as plugins either on data providers side or on side of the distribution node.

The synchronisation with the national data providers is done according to the update frequency of the national systems.

The use case for the distribution node will be to act as main access points to the common data base. Regarding the scope addressed by DAREFFORT project it is not a requirement to have more than one distribution node for sub-serving ICPDR in the development of Danube HIS (as described in WP4).

Also, for maintaining the system by ICPDR after the project end, it is foreseen that there is no more than one distribution node.

The distribution node manages following topics:

- receives data from national data providers via conversion filters (see below)

- answers to API requests for data access, e.g. of clients who want to retrieve data in the common data exchange format (WaterML 2.0)

- verification of data accesses

- initiation of network level maintenance and administration tasks

- management of authentication of data nodes (see below)

- administer access control policies and user rights

- has a copy of all the data from all data sources available

- logging data transactions

The data is stored on the distribution node in a PostgreSQL data base. Data is disseminated by the distribution node to third-party users in WaterML 2.0 timeseries format after authentication via an API.

7.2 HyMeDES EnviroNet Data Nodes

Data nodes can add new data to the data distribution node and initiate their addition with an appropriate authentication method. Data nodes can be used by data providers to actively send their data to the distribution node. In this sense they act as a new data source for the network.

It is important that data nodes do not store any data but only convert the local data format to the commonly agreed data format (HyMeDEM) and send it to a distribution node. This enhances acceptance of national data providers to install a data node.

Therefore, the typical use case for a data node is to be used by a data provider to convert the local data to the common data format and to send it to the distribution node (project partner or later after the project end a third-party institution).

Data nodes will be kept extremely light weight. They consist of a PHP-Script for managing the communication with the distribution node and the conversion filter with data provider specific settings.

7.3 Conversion Filters (plugins)

The original data formats of the data providers are converted to the HyMeDEM data model by using conversion filters which are tailored to the data providers data exchange format and transfer method (in general web-API or FTP).

The conversion filters are plugins running either on data provider side or on side of the distribution node.

Each data provider involved in the DAREFFORT project has a conversion filter with provider specific conversion rules.

They can be configured via text files by data providers. In case that the data provider specific conversion filter runs on side of the distribution node, it has to be accessible from outside for configuration.

The conversion plugins have to be easy to maintain, so that an average database user can administrate and adjust the plugins.
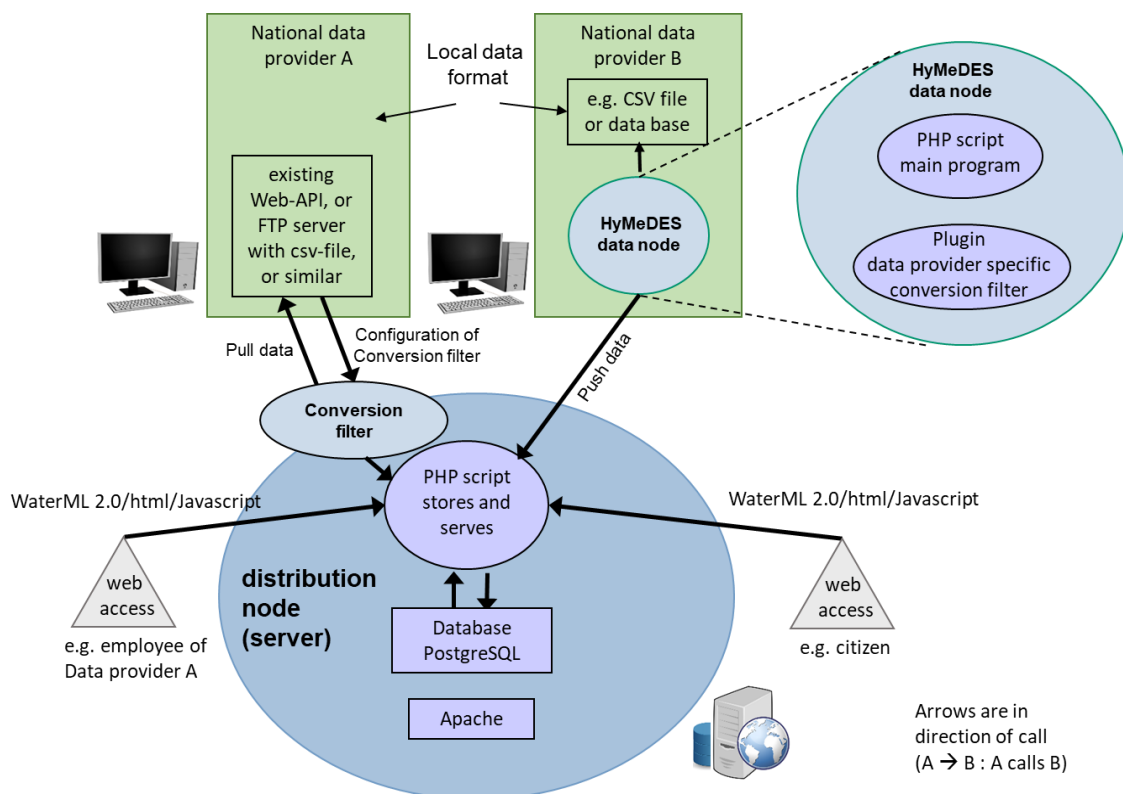
Figure 2   Required components of HyMeDES EnviroNet (distribution node, data nodes, conversion filters) and data exchange concept

7.4 User rights management

The assignments of different access rights to the data in HyMeDES EnviroNet Distribution Node are managed via an access control list. The granularity of access control is by station, parameter, type of data and temporal for unprocessed data, as agreed during the Software Developers' Conference in Vienna, February 2019.

7.5 Server infrastructure requirements

To keep the budget required to install and maintain a central server in the future as low as possible, existing infrastructure must be used. This poses some conditions onto software to use. Therefore, the software is coded lightweight in PHP, and the following packages are used: web server (distribution node only) is Apache and the data base on distribution node is PostgreSQL. Webserver and data base are packaged into a Docker container, so the only software to install, if any, is Docker Engine (version >= 19) with Docker Compose (version >= 1.25) and Git to pull the source code.

Server requirements HyMeDES EnviroNet distribution node:

- PHP, minimal version: 5.6.40, recommended max. 7.3.x (included in Docker container)

- Apache, minimal version: 2.4.6, recommended max. >= 2.4.6 (included in Docker container)

- PostgreSQL, minimal version: 9.6.12, recommended max. 11.2.x (included in Docker container)

- Cron/Task scheduler

Use case data pushed to server (conversion filter running on data providers side in a data node)

- PHP, minimal version: 5.6.40, recommended max. 7.3.x (included in Docker container)

- Client Web browser for configuration of conversion filter

- Cron/Task scheduler

Use case data pulled by server (conversion filter running on the distribution node)

- access provision for data pulling from external party (via FTP or existing Web-API)

- client web browser for configuration of conversion filter

Maintenance of conversion filters have to be done by data providers if they change their internal formats.

7.6   Outlook on alternative use cases

Separate distribution nodes

There are use cases in which the installation of a separate distribution node could be useful, for example if a forecasting service wants to retrieve data from specific data providers not using the HyMeDES EnviroNet data exchange service or Danube HIS in the future. This could be the case if additional data has to be accessed which is not provided by the centralized server.

In such a case it will be possible to install the HyMeDES EnviroNet data exchange service at the forecasting service and to use the existing conversion filters, enhanced by the additional specific data entities which should be exchanged in addition (see Figure **3**).

Whereas the technical capability of HyMeDES EnviroNet is available to address this use case, separate data exchange agreements could be necessary between the forecasting centre and the specific data providers, depending on the specific use case.

This separate distribution node is completely independent from Danube HIS server but may acquire data from it and use the same conversion filters. Even different and additional observable properties can be defined for this distribution node.

The server requirements to install this distribution node are the same as described in caption 7.5.
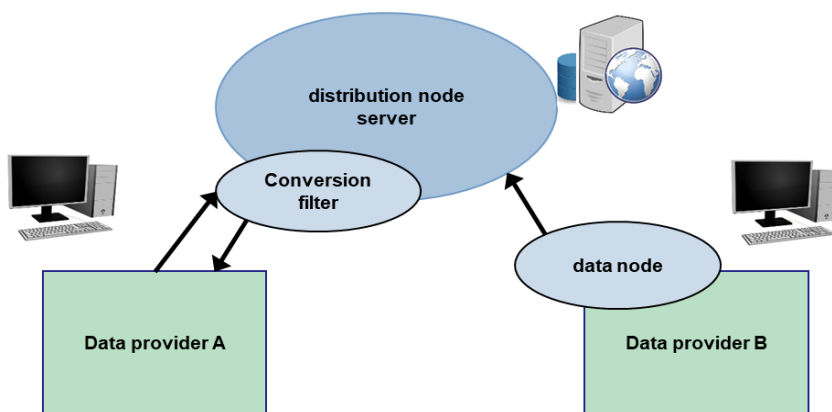
Figure 3   Additional distribution node installed e.g. by a forecasting centre to receive specific data from several data providers in the common exchange format

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8 Graphical user interface requirements and recommendations

A graphical user interface (GUI) is implemented within the DAREFFORT project for following purposes:

- configuration tasks of HyMeDES EnviroNet Distribution node

- configuration tasks of HyMeDES EnviroNet Data node

- meta data management: manual upload of meta data of measuring stations, manual editing of measuring stations

- manual upload of processed / historical hydrological and meteorological data

The GUI is available via a platform independent web-interface, developed in Html5 and Javascript/CSS. To ensure a platform independent design which is easy to use also on mobile devices like tablet computers it is a requirement and recommended that common rules for responsive web design are followed during development. Therefore, it is recommended to use open source Javascript/CSS-library Bootstrap for development of the GUI.

Compatibility to following browsers is recommended: Google Chrome, Mozilla Firefox, Safari, Microsoft Edge, Internet Explorer 11 and Opera.

The language of the graphical user interface is English. The texts of the GUI should be written in easy-to-understand language.

9 User manual requirements and recommendations

The user manual for the common data exchange service has to address several different target groups and user roles as well as user levels.

In the horizontal dimension the following target groups which may use the software have to be considered:

1. **Data providers** who deliver their data to the distribution node of HyMeDES EnviroNet

2. The **host of the distribution node** (ICPDR)

3. **End users** who retrieve the common data in WaterML 2.0 format (e.g. forecasting centres, universities, public bodies, …)

4. **Software developers**

Within the target groups organizations there can also be several user roles and levels:

1. **IT experts**: e.g. administrators who install the distribution or a data node, generate keypairs, or configure the conversion filters

2. **Normal users**: e.g. users who add a measuring station, upload processed data

It can be expected that the technical and IT skills of the groups will be very different. Therefore, it is recommended to design the user manual in a modular way, by subdividing the manual in several independent parts (modules). This way, a user with a specific role can pick up the specific parts of the manual according to his role.

With this in mind the following modular structure[3] is appropriate which also takes into account the concrete implementation of the software in Activity A4.2. Each part should be implemented as standalone document, addressed to the user groups listed in brackets:

1. **General Part** (all target groups and roles):

   a. Introduction, Aims, and Overview over HyMeDES EnviroNet

   b. Modules of the user manual

   c. Short overview over the architecture of HyMeDES EnviroNet

   d. Technical Requirements

   e. Software license

   f. Glossary

2. **Technical Documentation of the Database Data Model**:
   (target groups: host of distribution node, software developers | user level: IT experts)

   Description of the data base model

3. **Technical Documentation of the WaterML 2.0 format**:
   (target groups: host of distribution node, end users, software developers | user levels: IT experts and normal users)

   Description of WaterML 2.0 format and entities

4. **Technical Documentation of the Software (installation, configuration, source code and API)**:
   (target group: software developers | user level: IT experts)

   a. internal API reference

   b. conversion filter API reference

   c. REST / web interface

   d. Source code documentation created from doxygen

   e. Short documentation of original national data formats used for conversion

   f. Description of key generation

   g. Step-by-step guide for installation distribution node and data node

   h. description of using the API to retrieve common data in WaterML 2.0, (how to download data?)

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[3] The structure differs from the original proposal of deliverable 4.1.1 of October, 25th 2019 because of the concrete implementation of the software, which makes installation of data node and distribution node easier to describe than originally foreseen. Also, configuration of conversion filters is done by text files, therefore a description of the GUI for conversion filters is obsolete.

5. **Configuration Guide for conversion filters**:
   (target groups: data providers | user level: IT experts, maybe normal users)

   Description of how to make changes to the conversion filters after installation

6. **GUI description for maintenance:**
   (target group: data providers, host of distribution node | user level: normal users)

   Description of the graphical user interface (GUI)

In general, the following guidelines are considered for implementation of the user manual:

- short and precise descriptions

- the text should be easy to read

- when writing the text, the target group should be kept in mind regarding the use of technical language

- the guides in the manual should be implemented using step-by-step descriptions

The proposed modular concept of the user manual also supports its integration or parts of it into the e-learning tool developed in WP 5.

It is recommended that the user manual should be available as electronic documents in PDF format.

The user manual is written in English language. Project partners are encouraged at least to translate part 6 of the user manual GUI description for maintenance into their native language to ensure that maintenance tasks can be done without language barriers by the staff of the data providers.

10 Proof of concept for establishing, operating and maintaining future Danube HIS

In order to demonstrate the capabilities of the common data exchange based on the HyMeDES EnviroNet Platform implemented in Activity 4.2 and the common data model described above under real life conditions, a webtool has been developed. As a proof of concept, this webtool acquires the data stored on the HyMeDES EnviroNet Platform via the implemented API in WaterML 2.0 format and shows the information in an interactive map of the Danube catchment.

The Map can be accessed at http://dareffort.stasaapps.de

The map can be accessed by project partners with username *dareffort*, and password *Dareffort2020Stasa!*

The interactive map is based on OpenStreetMap, showing all hydrological stations (see Figure **4**) and all meteorological stations (see Figure **5**) which are defined on the common data exchange platform EnviroNet. By zooming in and out the geographical locations of the stations can be explored.
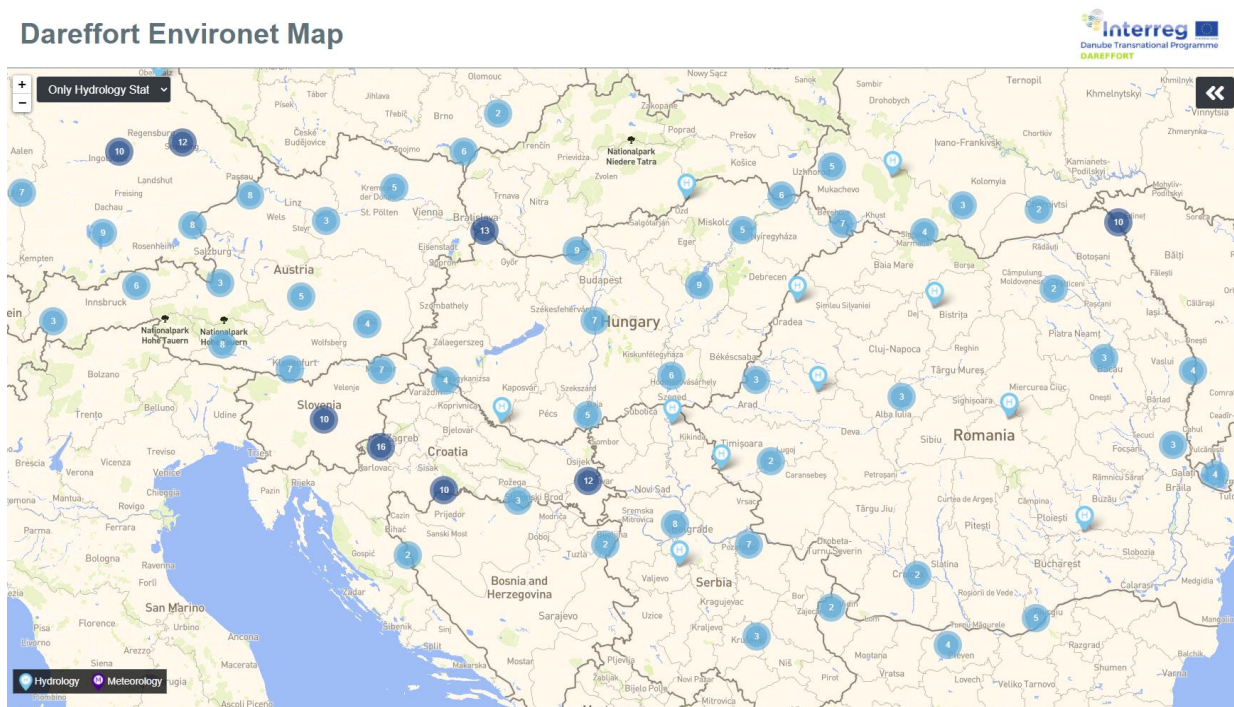
Figure 4   Overview of the hydrological stations (the number in the circles are the number of stations in this area).
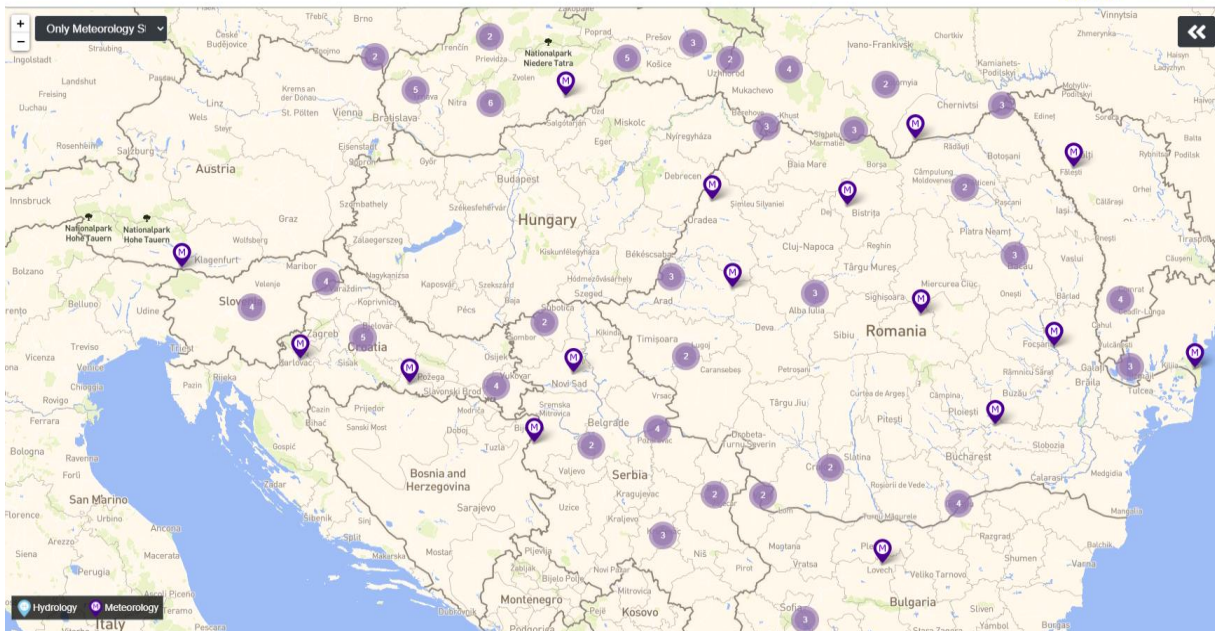
Figure 5   Overview of the meteorological stations (the number in the circles are the number of stations in this area).

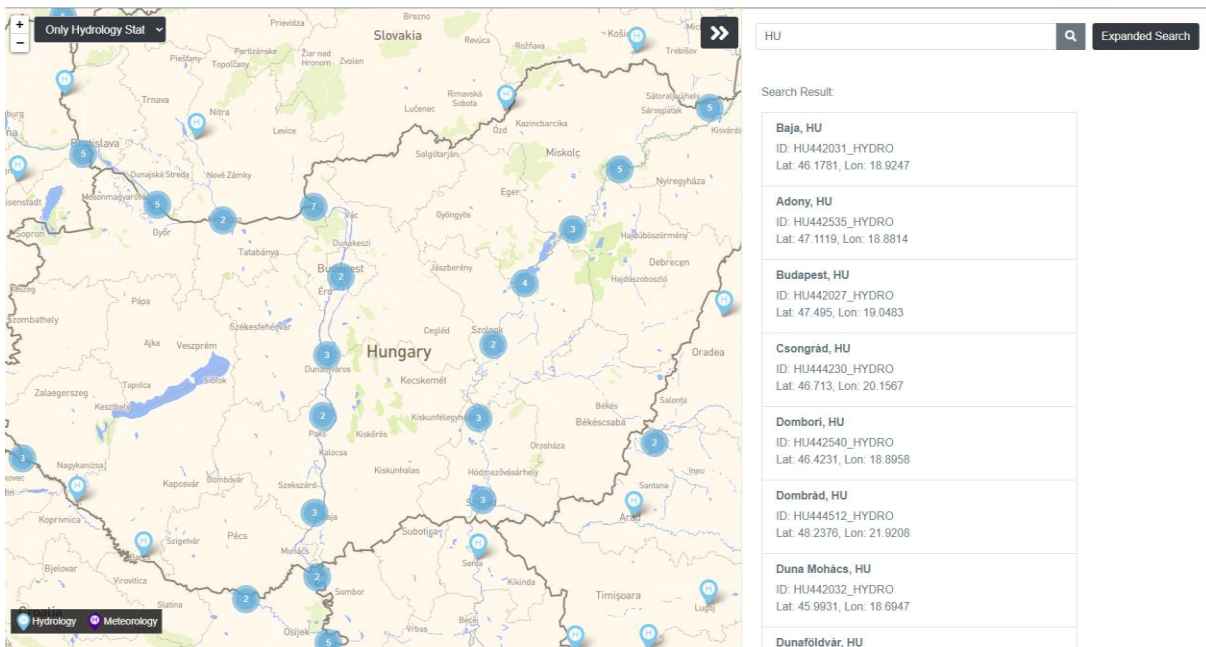

Figure 6   Search for specific stations (in the example all hydrological stations in Hungary (HU).
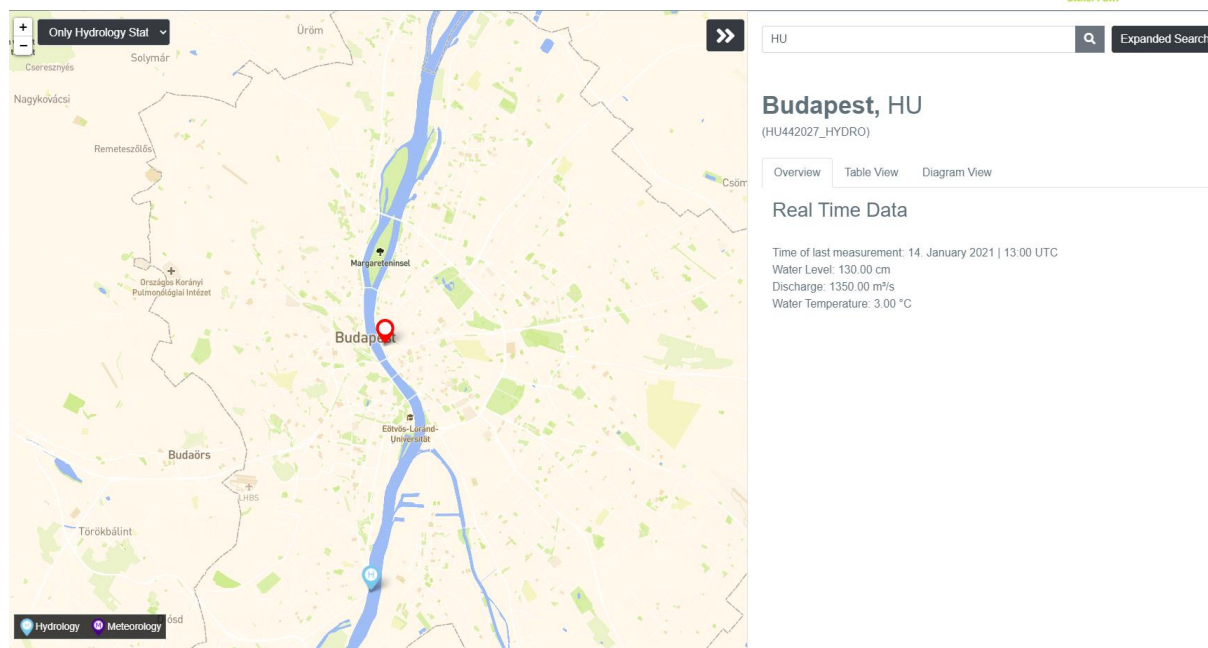

Figure 7   Example of a hydrological station in Budapest with its current information

There is a search functionality implemented, shown in Figure **6**, with which stations can be found by their attributes like station name, international id or country name (ISO code). For example, if "HU" is entered in the search field, all stations in Hungary are listed in the result table. Nevertheless, in the map all stations regardless of the search result are shown. By clicking on a specific station in the map or in the search result table, the map is zoomed on the location of the station and relevant information of the station is shown (Figure **7**).

By selecting "Table View" in the information sheet of the station, a history of recorded real time measurements is shown (Figure **8**). It is possible to select a specific date in the calendar function to view the data for this date in the table. In the "Diagram View" the history of measurements can be depicted in graphs which show the time series of the selected parameter, as shown in Figure **9** to Figure **11** for water level, discharge and water temperature as an example for a hydrological station in Budapest, Hungary.

The HyMeDES EnviroNet platform and data delivery from national data providers to the platform has been tested in the period between beginning of September to end of October 2020, and therefore the data delivery was not running continuously during that time. For most of the countries data delivery is running continuously since end of October 2020. Up to now, during a period of about 90 days data of over 600 measuring stations have been delivered regularly, in most cases hourly, to the Distribution Node of the common data exchange platform HyMeDES EnviroNet.
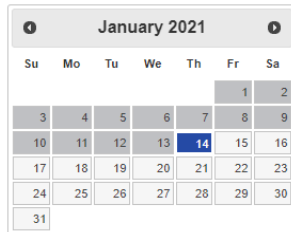
In the time of continuous operation during the past three months only minor issues occurred which could be fixed in short time. The first three months of operation of the HyMeDES EnviroNet platform show that with the common data exchange concept, conversion of national data formats to the common data format and the software developed in Dareffort project is working in practical application under real live conditions.

Budapest, HU

(HU442027_HYDRO)

Overview   Table View   Diagram View

History of measurements

	January 2021					
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	**14**	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Measurement

Water Level

DATE	VALUE
14. January 2021 | 13:00 UTC	130 cm
14. January 2021 | 12:00 UTC	130 cm
14. January 2021 | 11:00 UTC	130 cm
14. January 2021 | 10:00 UTC	129 cm

Figure 8   Selection of dates and parameters to display for the station.

Budapest, HU

(HU442027_HYDRO)

Overview   Table View   Diagram View

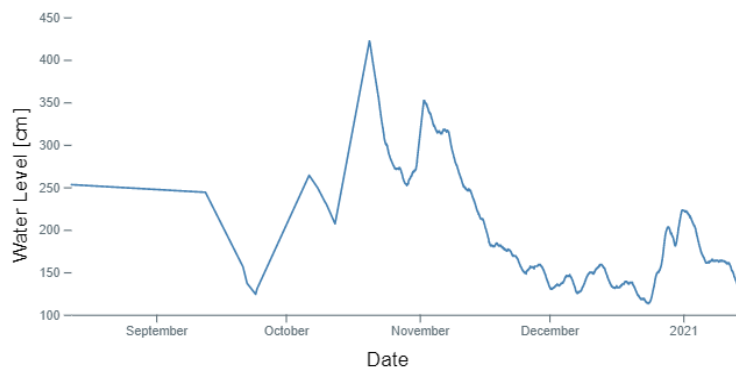## History of measurements

Measurement

Water Level

Figure 9   Time series of parameter water level for hydrological station Budapest (HU442027_HYDRO).*

DAREFFORT - Danube River Basin Enhanced Flood Forecasting Cooperation
The project is co-funded by the European Union

Budapest, HU

(HU442027_HYDRO)

Overview   Table View   Diagram View

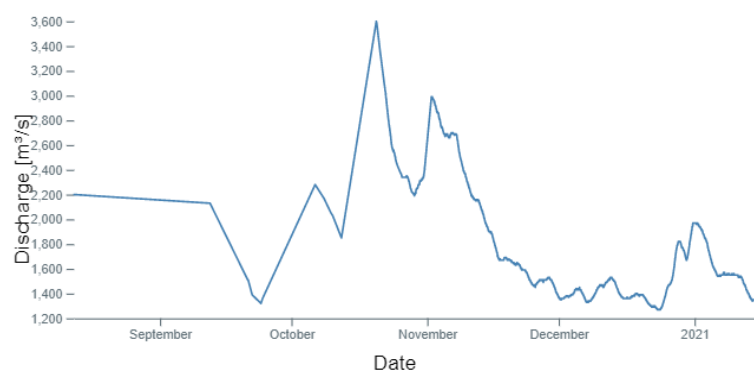### History of measurements

Measurement

Discharge

Figure 10   Time series of parameter discharge for hydrological station Budapest (HU442027_HYDRO).*

Budapest, HU

(HU442027_HYDRO)

Overview   Table View   Diagram View

History of measurements
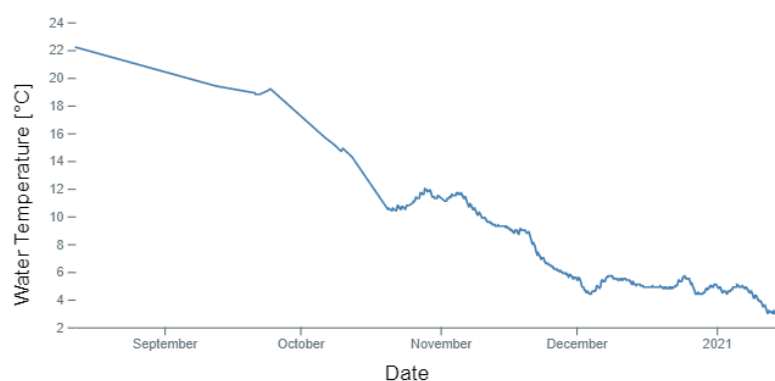
Measurement

Water Temperature

Figure 11   Time series of parameter water temperature for hydrological station Budapest (HU442027_HYDRO).*

*In the time end of October 2020 the Data delivery to the common data exchange platform EnviroNet has not been running continuously, therefore there are missing values in the time series, and the data points in between are connected with a straight line.

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