Danube Transnational Programme
DAREFFORT

Hydrocode Mapping

WP4 Deliverable 4.1.3

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1 Introduction and Summary

For exchanging hydrological and meteorological data between the countries in Danube catchment via the common data exchange platform HyMeDES EnviroNet it is essential to merge the different national data formats in a common data format. This common data format has been designed in Deliverable 4.1.1 *Flood forecasting and IT expert recommendations* and implemented in the common data exchange platform HyMeDES EnviroNet. During implementation and testing process smaller improvements have been made to the original design. This deliverable depicts the final state of the common data model for the project DAREFFORT.

In chapter 2 of this document the common data format is described, which his highly related to the original concept described in Deliverable 4.1.1 *Flood forecasting and IT expert recommendations.* Details of the data model can be found in the Appendix of this document. The data is delivered by national Data Providers in their national data formats and converted to the common data format by conversion plugins. The common data format consists of two parts: a common data base model which serves as data model to store the data on the HyMeDES EnviroNet platform, and a Water ML 2.0 based data model in which the common data can be retrieved from the HyMeDES EnviroNet platform via a web-API by end users such as forecasting centres.

As a proof of concept for the data model and the common data exchange platform HyMeDES EnviroNet a webtool has been implemented by work package leader STASA to show the data stored on HyMeDES EnviroNet platform interactively in a geographical map. This webtool is described in chapter 3. This webtool retrieves the data currently available on HyMeDES EnviroNet platform using the web-API in Water ML 2.0 format and shows this information in an interactive map.

The HyMeDES EnviroNet platform and data delivery from national data providers to the platform has been successfully tested in the period between September to end of October 2020. For most of the countries data delivery is running continuously since end of October 2020. Up to now over a period of about 90 days data of over 600 measuring stations has been delivered to the common data exchange platform HyMeDES EnviroNet, which is currently running on site of lead partner VIZITERV. In most cases the update frequency of the data is hourly. During the past three months the HyMeDES EnviroNet platform is running without interruption, and the data exchange works successfully without major issues.

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.

2 Common data format for data exchange via available IT technologies

As described in Deliverable 4.1.1 *Flood forecasting and IT expert recommendations*, the national data formats are converted via conversion filters into this common data format and then transferred to the database on the Distribution Node which serves the data in the common format to end users via a web access. The implemented common data exchange concept is shown in Figure **1**.

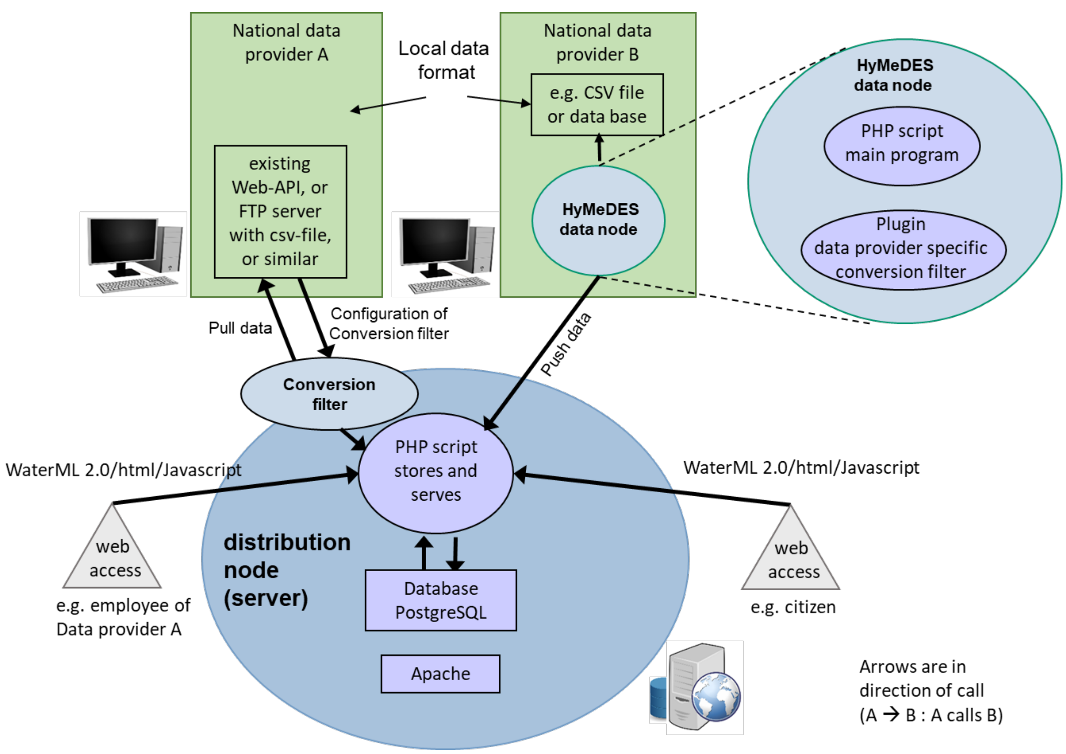

Figure 1 Data exchange concept for the common data exchange platform HyMeDES EnviroNet

As also described in Deliverable 4.1.1 *Flood forecasting and IT expert recommendations* the data exchange model conceptually covers hydrological data and meteorological data as well as ice data. Metadata associated with time series is also specified in the common data exchange model.

2.1 Data Base Format

The data is stored on the Distribution Node in a common database model, which is prepared to include further observed properties and statistical time intervals as they may be needed in future. The purpose of the described database is storage of hydrological and meteorological time series data. There are monitoring points (measuring stations) at which observed properties are measured. The monitoring points and observed properties with their attributes are also stored in the data base. Additionally, there are attributes and tables which do not directly serve the purpose of storing time series data but are intended as optional extensions to complete the database. They will be useful for daily work of hydrologists and meteorologists and for possible display on a web site.

The database consists of three parts: The hydro part for hydrological measurement and the meteo part for meteorological measurements, which are similar to the hydrological measurements, but strictly kept distinct. The third part covers administrative purposes like user rights management. The software used to implement the database is PostgreSQL.

The hydro part consists of 12 tables, the meteo part has six tables, and the administrative part has 14 tables. Most of the tables in hydro and meteo part are similar. For simplicity of description, table names of tables which exist in hydro and meteo parts are merged using "[hydro|meteo]". For example, *[hydro|meteo]point* would mean both, *hydropoint* and *meteopoint*. In hydro and meteo parts, the main entities are *hydropoint* and *meteopoint*. The entities store all meta data of water gauge stations and meteorological stations. Each station has a list of observed properties it measures and sends to the system (like water level or precipitation). The list of observed properties of a monitoring point, along with statistical data, is stored in the relation *[hydro|meteo]point_observed_property* (a m:n relation). The tables and entities are described in detail in the Appendix 1 of this document.

The list of observed properties known to the system is stored in the entity *[hydro|meteo]_observed_property*. Any monitoring point can have any number of observed properties which it measures. The naming scheme for observed properties is described in detail in section A1.1 "Observed property naming scheme". It was chosen to be easy to use and flexible for extensions, so observed properties can be added easily to the system.

Each monitoring point has an international code used to identify it, which consists of a country code, the national code and a suffix which denotes whether it is a hydrological or a meteorological monitoring point. The suffix serves to distinguish between monitoring points in case a monitoring point offers hydrological properties as well as meteorological properties. In this case, the monitoring point is stored as both, as a hydrological and as a meteorological monitoring point. The international code needs to be unique in the whole database. The national code of the monitoring point is the ID the data provider uses for the monitoring point in the data files it sends to the Distribution Node. It must be unique for the data provider, but it needs not be unique in the whole system.

For each monitoring point and each observed property there is exactly one time series which contains all measured data (table *[hydro|meteo]_time_series*). Processed data (yearbook data / verified data) is distinguished from real time data by setting the attribute *type* accordingly in the table *[hydro|meteo]_observed_property*.

Each time series has a *result_time* attribute. Result time is the time the data was processed last (as opposed to phenomenon time, which is the time the data refers to). The actual data pairs of the time series are stored in the entity *[hydro|meteo]_result*. Each result has the timestamp of when it was entered into database in attribute *created_at*. If a new value is given for the same time, it is added with a newer *created_at* timestamp. The old value still exists in the data base for reference, but only the newest value is returned as the output. Forecasted data is identified by the attribute *is_forecast*.

Along with time series data it is foreseen to store results of discharge calibration measurements in the hydro schema. Discharge calibration measurements are used to calibrate the river discharge measurement at the location of the water gauge station (tables *discharge_measurement* and *discharge_measurement_equipment*).

Generally, enumerable properties like the station classification or bank of river are stored in their own entity as human-readable strings, associated to an index which is used to refer to the property (i.e. it is an 1:n relation). All human-readable strings are in English language and encoded in UTF-8. The host of the Distribution Node needs to define the possible observed properties, station classifications, riverbanks, and waterbodies in the Graphical User Interface of the Distribution Node.

All times and dates are stored as timestamps and consist of a date and a time in UTC. The UTC offset of a monitoring point, and thus the offset of all times in time series associated with that monitoring point, is specified in the attribute *utc_offset* of the table *[hydro|meteo]point*.

Elevations above sea level like the z coordinate of a monitoring point or the gauge zero (for hydrological stations) and altitude (for meteorological stations) are relative to a reference which is specified in *vertical_reference* in *[hydro|meteo]point*. There are various vertical reference systems used in the Danube basin. An example of a reference system is European Vertical Reference Frame 2007 (EVRF2007).

Flood warning levels stored for a hydrological station do only have a local meaning, as there is no common standard on flood warning. Warning levels are stored for reference only, as interpretation is different from country to country. Each warning level is characterized with a short description as a label and a long description for detailed information in table *warning_level_info*. Also, a colour for display can be assigned to each warning level. There may be any number of warning levels per monitoring point and per observable property (specified in table *hydropoint_warning_level*). Warning level limits (the values of the observed property above which the warning level is issued) can be assigned to each monitoring point for each observed property separately.

Logging of changes in the database (with date and user who changed it) is done in the table *event_logs*. Operators of monitoring points (organizations like data providers), users and groups can be defined in their respective tables. Operator and users can be members in various groups. Membership is stored in the tables *operator_groups*, *operator_users* and *users_groups*. Permissions like login, read and update can be defined in the table *permissions* and assigned to users and groups using the tables *user_permissions* and *group_permissions*. Measurement access rules are defined in table *measurement_access_rules* and assigned to groups in table *group_measurement_access_rules*. The measurement access rules allow to grant a group access to specific monitoring points, for specific observed properties and a specified time back into past.

Documents and images of monitoring points are not stored in the data base.

Separation of meteorological and hydrological monitoring points and data was chosen to enhance consistency of data base. The design avoids inconsistent states like a meteorological monitoring point having warning levels, or a discharge measurement done at a meteorological monitoring point or hydrological monitoring points measuring meteorological observed properties. A combined monitoring point is entered as both, a hydrological and meteorological monitoring point.

2.2 Common Output Format

To disseminate hydrological and meteorological data to data receivers, WaterML 2.0 Part 1 – Timeseries (abbreviated as WaterML 2.0 in the following) as a standardised data exchange format has been chosen (OGC standard). This document defines the data format and its connection to the DAREFFORT database.

Upon a request by a registered data receiver (for example, one of the organizations also providing data or a website), the HyMeDES EnviroNet distribution node responds by sending a WaterML 2.0 file. The form of the request must contain the observed properties the receiver is interested in (e.g. water level, discharge, precipitation, daily/hourly), and the start and end time of the time interval the receiver is interested in. European code of a monitoring point is the ISO 3166-1 ALPHA-2 two-letter country code followed by the national code of the monitoring point. The European code is suffixed with the type of the monitoring point, "_HYDRO" or "_METEO". An example of a request is:

https://<server_name>/download?token=abcdef&type=hydro&country[]=HR&symbol[]=Q_mean_hourly&start=2019-01-01T00:00:00Z&end=2019-03-31T00:00:00Z

The WaterML 2.0 file which is sent as the response to a request contains information on the requested monitoring points (specified by type and country) like their names, coordinates and time zone offset. It also contains meta information on the time series like unit and types of observed properties. Finally, it contains the time series data. A WaterML 2.0 file may contain data for several monitoring points and several observed properties.

A WaterML 2.0 file as generated by HyMeDES EnviroNet is an XML file in UTF-8 encoding. All dates and times are in UTC in ISO 8601 format. It complies with the WaterML 2.0 standard, which utilizes the GML 3.2 (Geography Markup Language) standard and the Observations and Measurements 2.0 standard, which are developed by the Open Geospatial Consortium (OGC). Coordinates are specified in EPSG 4326, which is equivalent to WGS 84. The order of the coordinates is latitude, then longitude. As with XML in general, tags are case-sensitive.

To provide the European code of a monitoring point, a code space must be defined in WaterML 2.0. A code space is just a URI as a unique identifier, which serves to distinguish between different naming schemes like a namespace in some programming languages. It is recommended that the code space URI should be under control of the organization generating the WaterML 2.0 file. The exact URI to use is specified in the configuration of the HyMeDES EnviroNet software.

In Appendix 2, section A2.1 of this document a mapping of the relevant database fields to the WaterML 2.0 output file is described in detail.

2.3 WaterML 2.0 output format template and example

In the following, a template for a response to a request for time series data is shown. The template is filled with example values for a water gauge station in Zagreb. At each location which is variable, the corresponding attribute of the database is specified in an XML comment. This template complements the mapping shown in the section before.

The WaterML 2.0 file begins with the XML declaration and the first tag, a “wml2:Collection” tag, which includes namespaces and the XML schema. Metadata on the document follows, which includes generation system and generation date.

There may be time series of many monitoring points with different observed properties in a WaterML 2.0 file. Each monitoring point / observed property combination has its own “wml2:observationMember” section. In this section, the monitoring point is described with its identifier, name, coordinates and time zone. The start and end time of the time series of the observed property is defined in this section, also the result time when data was generated. The observed property is set here also.

Each “wml2:observationMember” section has a “om:result” section. It consists of a default for all points of the time series, which declares the unit the values are in. A list of all points (time / value pairs) in the time series follows. There may be any number of “wml2:observationMember” sections in the WaterML 2.0 file.

The template was checked with a GML validator (some fields required by GML have been left out, because they are pointless for this application) and imported successfully in HydroDesktop 1.8, a software typically used by hydrologists to examine time series data.

Template for WaterML 2.0 output format:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<wml2:Collection xmlns:wml2="http://www.opengis.net/waterml/2.0"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:om="http://www.opengis.net/om/2.0"
      xmlns:sa="http://www.opengis.net/sampling/2.0"
      xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:sams="http://www.opengis.net/samplingSpatial/2.0"
      xsi:schemaLocation="http://www.opengis.net/waterml/2.0 http://schemas.opengis.net/waterml/2.0/waterml2.xsd">

    <wml2:metadata>
        <wml2:DocumentMetadata>
            <wml2:generationDate>2019-04-11T11:53:00Z</wml2:generationDate>
            <wml2:version xlink:href="http://www.opengis.net/waterml/2.0" xlink:title="WaterML 2.0"/>
            <wml2:generationSystem>HyMeDES EnviroNet</wml2:generationSystem>
            <!-- generation system string is configurable -->
        </wml2:DocumentMetadata>
    </wml2:metadata>

    <wml2:observationMember>
        <om:OM_Observation>

            <om:phenomenonTime>
                <gml:TimePeriod>
                    <gml:beginPosition>
                        2019-01-01T00:00:00Z<!—hydro_time_series.phenomenon_time_begin-->
                    </gml:beginPosition>
                    <gml:endPosition>
                        2019-03-31T00:00:00Z<!—hydro_time_series.phenomenon_time_end-->
                    </gml:endPosition>
                </gml:TimePeriod>
            </om:phenomenonTime>

            <om:resultTime>
                <gml:TimeInstant>
                    <gml:timePosition>
                        2019-03-31T00:00:00Z<!—hydro_time_series.result_time-->
```

```
        </gml:timePosition>
    </gml:TimeInstant>
</om:resultTime>

<om:procedure>
    <wml2:ObservationProcess>
        <wml2:processType
            xlink:href=http://www.opengis.net/def/processType/WaterML/2.0/Sensor
            xlink:title="Sensor"/>
    </wml2:ObservationProcess>
</om:procedure>

<om:observedProperty xlink:href="http://www.icpdr.org/DanubeHIS/observedProperty/Q_mean_hourly"
                     xlink:title="Hourly mean of river discharge"/>

<om:featureOfInterest>
    <wml2:MonitoringPoint>
        <gml:description>
            Sava at Zagreb<!--hydropoint.location-->
        </gml:description>
        <gml:identifier codeSpace="http://www.icpdr.org/DanubeHIS/monitoringPoint">
            HR3121_HYDRO<!--hydropoint.eucd_wgst-->
        </gml:identifier>
        <!-- gml:identifier code space is configurable -->
        <gml:name>Zagreb<!--hydropoint.name--></gml:name>
        <sa:sampledFeature xlink:title="Zagreb"/> <!-- hydropoint.name -->
        <sams:shape>
            <gml:Point>
                <gml:pos srsName="urn:ogc:def:crs:EPSG::4326">
                    45.78448 15.95335
                    <!--hydropoint.lat hydropoint.long (in WGS 84)
                        [Latitude Longitude] -->
                </gml:pos>
            </gml:Point>
        </sams:shape>
        <wml2:timeZone>
            <wml2:TimeZone>
                <wml2:zoneOffset>+02:00<!--hydropoint.utc_offset--></wml2:zoneOffset>
            </wml2:TimeZone>
```

```
            </wml2:timeZone>
        </wml2:MonitoringPoint>
    </om:featureOfInterest>

    <om:result>
        <wml2:MeasurementTimeseries>
            <wml2:defaultPointMetadata>
                <wml2:DefaultTVPMeasurementMetadata>
                    <wml2:uom code="m³/s"/><!—hydro_observed_property.unit -->
                    <wml2:interpolationType
                        xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/Continuous"
                        xlink:title="Instantaneous"/>
                    <!--<wml2:interpolationType
                         xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/AverageSucc"
                         xlink:title="Average in succeeding interval"/>-->
                    <!--<wml2:interpolationType
                         xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/TotalSucc"
                         xlink:title="Total in succeeding interval"/>-->
                    <!--<wml2:interpolationType
                         xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/MinSucc"
                         xlink:title="Minimum in succeeding interval"/>-->
                    <!--<wml2:interpolationType
                         xlink:href="http://www.opengis.net/def/waterml/2.0/interpolationType/MaxSucc"
                         xlink:title="Maximum in succeeding interval"/>-->
                </wml2:DefaultTVPMeasurementMetadata>
            </wml2:defaultPointMetadata>
            <wml2:point>
                <wml2:MeasurementTVP>
                    <wml2:time>2019-01-01T00:00:00Z<!—hydro_result.time--></wml2:time>
                    <wml2:value>22.1242<!—hydro_result.value--></wml2:value>
                </wml2:MeasurementTVP>
            </wml2:point>
            <wml2:point>
                <wml2:MeasurementTVP>
                    <wml2:time>2019-01-01T01:00:00Z<!—hydro_result.time--></wml2:time>
                    <wml2:value>21.4129<!—hydro_result.value--></wml2:value>
                </wml2:MeasurementTVP>
            </wml2:point>
            <!-- More data points omitted -->
```

```
                    <wml2:point>
                        <wml2:MeasurementTVP>
                            <wml2:time>2019-03-31T21:00:00Z<!—hydro_result.time--></wml2:time>
                            <wml2:value>21.4212<!—hydro_result.value--></wml2:value>
                        </wml2:MeasurementTVP>
                    </wml2:point>
                    <wml2:point>
                        <wml2:MeasurementTVP>
                            <wml2:time>2019-03-31T23:00:00Z<!—hydro_result.time--></wml2:time>
                            <wml2:value>22.4532<!—hydro_result.value--></wml2:value>
                        </wml2:MeasurementTVP>
                    </wml2:point>
                </wml2:MeasurementTimeseries>
            </om:result>

        </om:OM_Observation>
    </wml2:observationMember>

    <!-- Further wml2:observationMember objects may follow if multiple monitoring points and/or
         observable properties were requested -->

</wml2:Collection>
```

2.4 Possible custom extensions of the output format

For future use and custom applications, there is more information in the database than the information required as a response to a request for time series data of monitoring points. If required, this information can be added to WaterML 2.0 files.

Additional information not covered by the definition of the WaterML 2.0 output format can be transferred by defining custom fields in WaterML 2.0. The tag “om:NamedValue”, which is within a “sa:parameter” tag, can be used to define a custom field. The name of the field is defined by the “om:name” tag with the attribute “xlink:href”, which refers to a URI describing the field uniquely, and the attribute “xlink:title”, which is a human-readable name of the field. To set the value for the field, the tag “om:value” is used.

There may be numerical fields (like the catchment area) and string-valued fields (like the catchment). An example follows.

```
<wml2:MonitoringPoint>
      <sa:parameter>
            <om:NamedValue>
                  <om:name
                  xlink:href="http://www.icpdr.org/DanubeHIS/namedValu
                  e/Catchment_area"
                           xlink:title="Catchment area"/>
                  <om:value xsi:type="gml:MeasureType"
            uom="km²">22.1</om:value>
            </om:NamedValue>
      </sa:parameter>
      <sa:parameter>
            <om:NamedValue>
                  <om:name
                  xlink:href="http://www.icpdr.org/DanubeHIS/namedValu
                  e/Catchment"
                           xlink:title="Catchment"/>
                  <om:value xsi:type="gml:CodeType">Danube</om:value>
            </om:NamedValue>
      </sa:parameter>
</wml2:MonitoringPoint>
```

3 Webtool with interactive map to explore the common data

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 a webtool has been implemented. 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 **2**) and all meteorological stations (see Figure **3**) which are defined on the common data exchange platform HyMeDES EnviroNet. By zooming in and out the geographical locations of the stations can be explored.

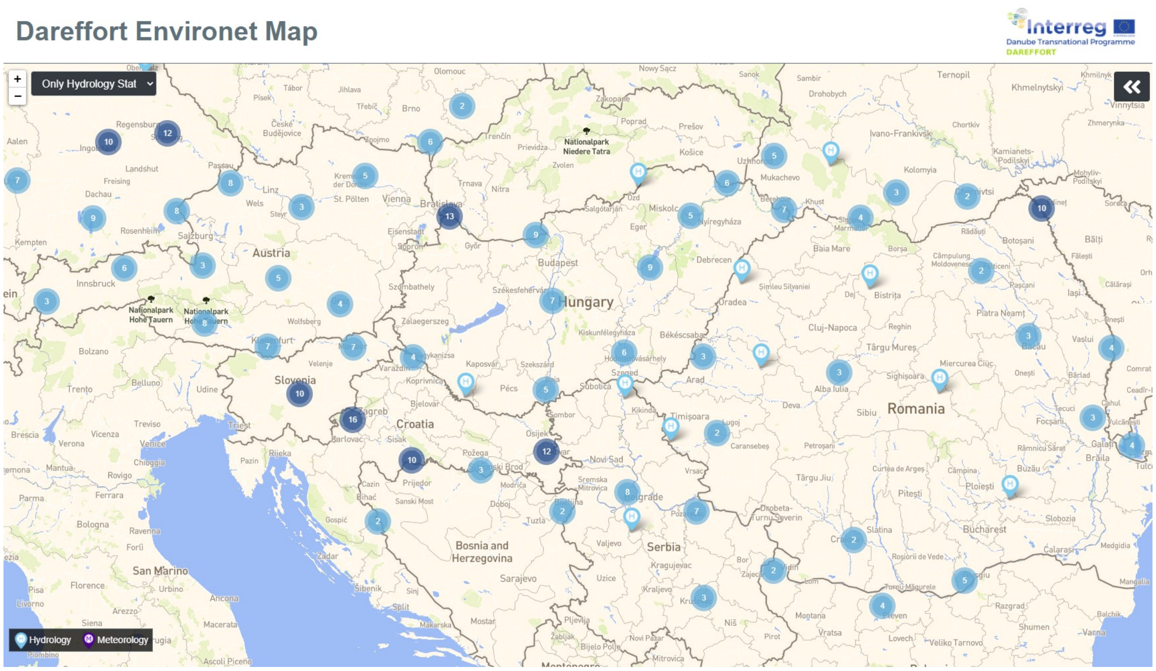

Figure 2 Overview of the hydrological stations (the number in the circles are the number of stations in this area).

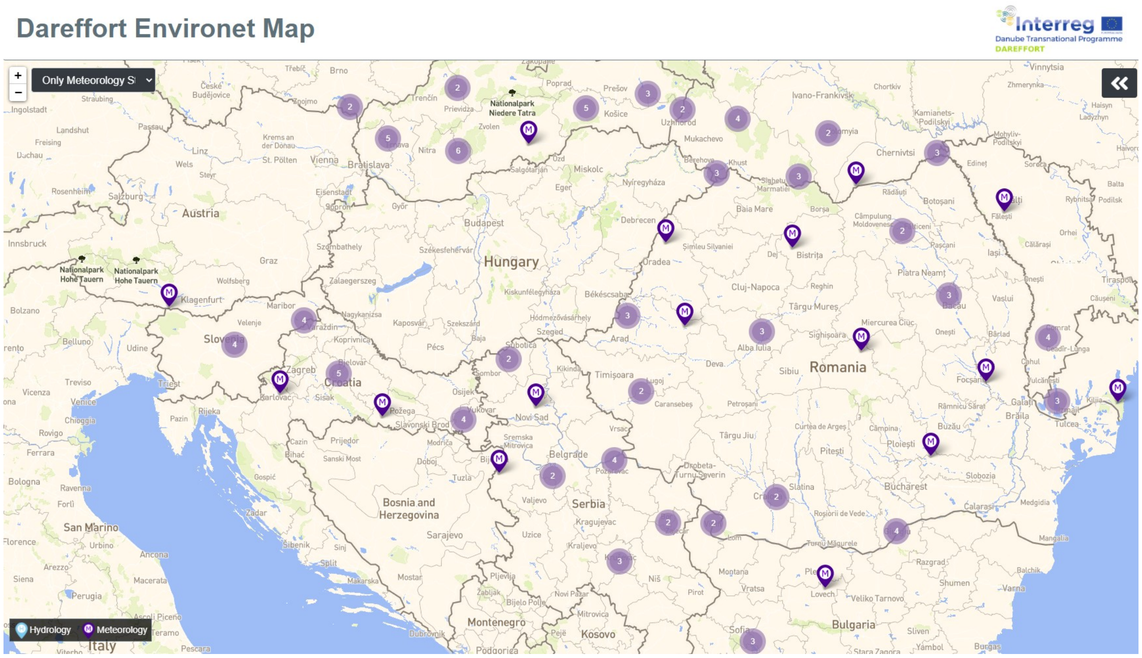

Figure 3 Overview of the meteorological stations (the number in the circles are the number of stations in this area).

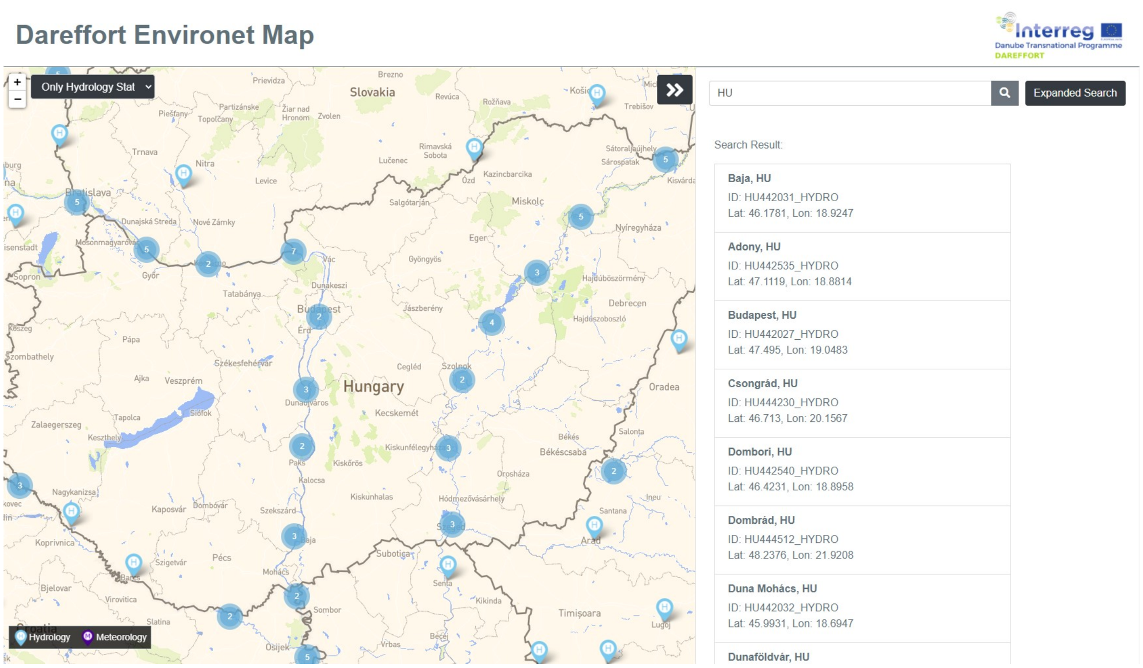

Figure 4 Search for specific stations (in the example all hydrological stations in Hungary (HU).

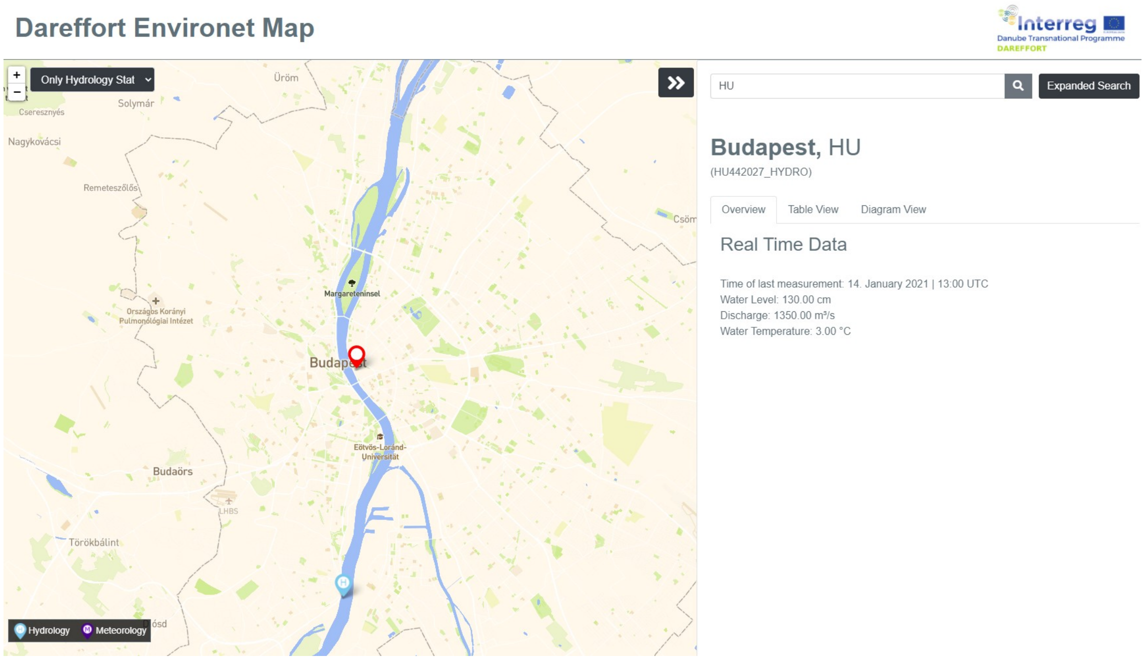

Figure 5 Example of a hydrological station in Budapest with its current information

There is a search functionality implemented, shown in Figure **4**, 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 depicted (Figure **5**).

By selecting “Table View” in the information sheet of the station, a history of recorded real time measurements is shown (Figure **6**). 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 **7** to Figure **9** 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.

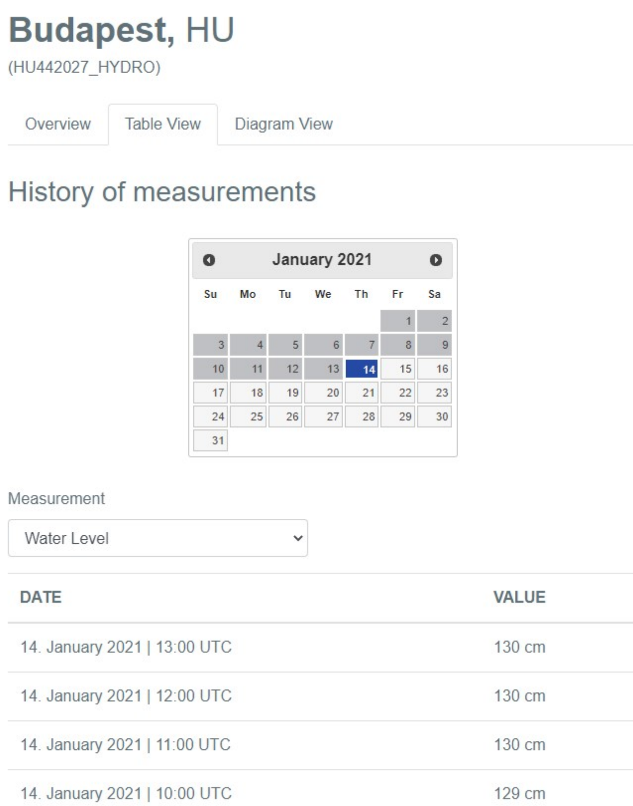

Figure 6 Selection of dates and parameters to display for the station.

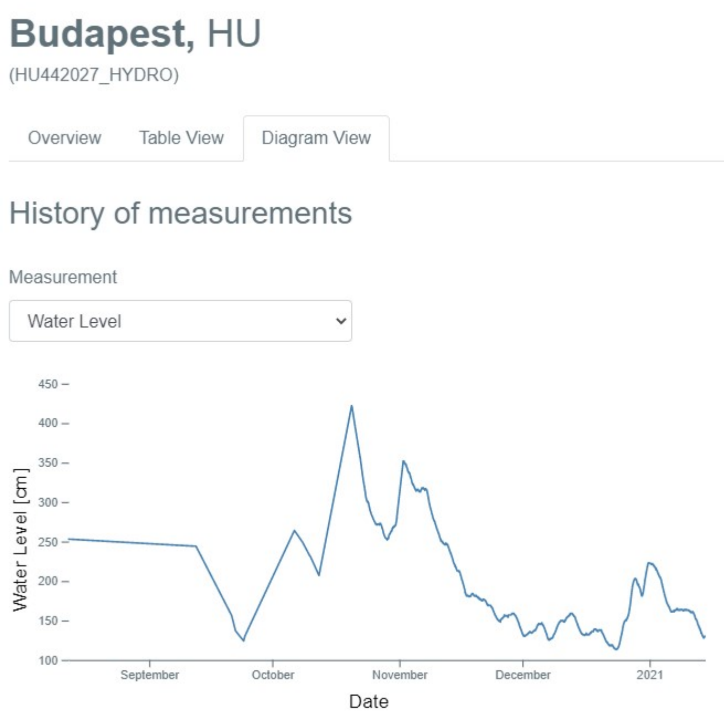

Figure 7 Time series of parameter water level for hydrological station Budapest (HU442027_HYDRO).*

Figure 8 Time series of parameter discharge for hydrological station Budapest (HU442027_HYDRO).*

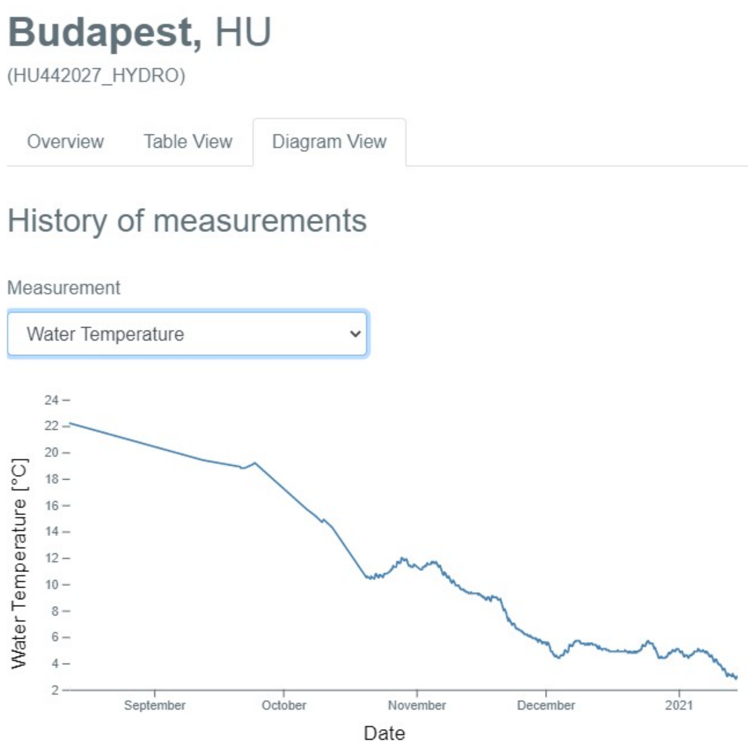

Figure 9 Time series of parameter water temperature for hydrological station Budapest (HU442027_HYDRO).*

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

Appendix 1 Common Data Base Model

A1.1 Observed property naming scheme

The name of an observed property is just a string which in principle can be chosen freely. To have a common scheme throughout the whole data base and for the WaterML files disseminated to data receivers, a convention for naming observable properties is specified in this section.

The observed property name consists of three components separated by an underscore ("_"). The first component is the symbol of the observed property, the second is its statistical characterization and the third component is the statistical aggregation time interval. Components two and three can be omitted which designates the current value (instantaneous measurement) of the observed property.

Each observed property is either real time or processed, which is indicated by a flag in the database. The first component of the observed property name is the symbol of the observed property. In the following table symbols for observed properties are defined. Symbols and units follow the recommendations of WMO specified in the document "Guide to hydrological practices". Please note that the symbols are case-sensitive.

Symbol	Meaning and unit of measurement
h	Water level [cm]
Q	River discharge [m³/s]
tw	Water temperature [°C]
Ag	Ice coverage [%]
dg	Ice thickness [cm]
Dn	Ice cover duration [day]
P	Precipitation [mm]
ta	Air temperature [°C]
U	Relative humidity (moisture) [%]
p	Atmospheric pressure [hPa]
R	Solar radiation [W/m²]
E	Evaporation [mm]
dn	Snow depth [cm]
wn	Snow water equivalent [mm]

The symbol may be followed by the statistical characterization of the observed property which is the second component of observed property name. If statistical characterization is omitted, the observed property is the current / instantaneously measured value. Defined statistical characterization strings and their meanings are shown in the following table.

Statistical characterization string	Meaning
min	Minimum value
max	Maximum value
mean	Mean / average value
median	Median value / 50th percentile
total	Integrated sum / total value
	Current value

If there is a statistical characterization of the observed property, the aggregation time interval must follow. The aggregation time interval is the time interval the statistical characterization refers to. This forms the third component of the observed property name. Predefined time interval strings with their meanings are shown in the following table.

Time interval string	Meaning
hourly	One hour
hhourly	Half an hour
qhourly	Quarter of an hour
minute	One minute
5minutes	Five minutes
12h	Twelve hours
daily	One day
monthly	One calendar month
annual	One calendar year

The naming scheme was arranged to allow users and data providers a maximum of flexibility on defining observed properties they want to provide. The observed property names are easy to read by humans and aimed to be self-explanatory. Arrangement of the components ensures that data receivers can request observed properties using a simple wildcard scheme. Some examples follow:

Observed property name	Meaning
h	Current water level (instantaneous measurement)
Q_mean_daily	Daily mean of river discharge
tw	Current water temperature
tw_max_hhourly	Maximum value of water temperature within 30 minutes
Q_max_annual	Maximum discharge within one year
h_min_annual	Minimum water level within one year
h_mean_monthly	Monthly average of water level
P_mean_annual	Average precipitation within one year

A1.2 Detailed description of tables

A1.2.1 Hydro part

In this section the tables (mainly entities) for hydrological measurements are described. Detailed specifications of all attributes can be found in section A1.3 “Attribute and table reference for hydrological data”.

hydropoint (entity)

This table is the central table of hydro part. All data characterizing a water gauge station are stored as attributes in this table. Each station has a classification. The classification can be used to store whether it is a regular station or a project station of some special project. The classification points to the table *hydrostation_classification*, in which it resolves to a human-readable string.

Each water gauge station is located on the specified side of a river or on a bridge. Information on the operator of the station is stored as a reference to a separate entity *operator*. The European code, which links it to the stations stored in the DanubeGIS database, is stored along with the local national code of the station. The European code is built by prepending the national code with the country code (according to ISO 3166-1 ALPHA-2). The appended suffix “_HYDRO” separated with an underscore denotes that it is a water gauge station.

Each water gauge station can be characterized by its coordinates in the coordinate reference system EPSG 4326 (WGS 84) as longitude and latitude in decimal degrees. The coordinates *long* and *lat* are official ones which may diverge slightly from the real position on a map. For displaying the station on a map, the attributes *maplong* and *maplat* are foreseen. If they are NULL, the official coordinates are used. Each water gauge station has a vertical reference which is used to define the sea level relative to which its z coordinate and gauge zero are specified.

Observed properties like water level and discharge, which are measured by the water gauge station, are stored as a m:n relation in the table *hydropoint_observed_property*. There may be any number of observed properties per station. Minimum and maximum values of that property at that station and the corresponding times of occurrence are also stored in the *hydropoint_observed_property* table. Further statistical data, like percentiles, are not stored in the database.

Measured data pairs are grouped in time series (table *hydro_time_series*) which relate the data pairs to the observed property and the water gauge station at which they were observed.

hydro_observed_property (entity)

This is the second important table of the hydro schema. It stores a list of observed properties like water level and discharge. An observed property is defined by its name, a human readable description and the unit it is measured in. The name of the observed property is a string which has the form specified in section A1.1 “Observed property naming scheme”.

Only hydrological properties (including ice data) are stored in the observed property list of the hydro part. For monitoring points also measuring meteorological properties, a separate entry for the monitoring point is added to the meteo part.

All observed properties are stored as time series data, and additional bookkeeping is done of minimum and maximum values per monitoring point and observed property. For example, if the property under consideration is Q_max_annual, annual maximum values are stored in a time series for each water gauge station, and the total maximum value over all years for a water gauge station is stored in the table *hydropoint_observed_property*.

As a definition, the associated timestamp for an observed property which covers a time interval (like a month) is at the beginning of the time interval. An annual value for discharge for the year 2019 has the timestamp 1st Jan 2019 00:00:00 UTC. Times for longer intervals like years and months are set to midnight in UTC, while timestamps for values with shorter time intervals have their real start time in UTC.

hydropoint_observed_property (n:m relation)
This table relates water gauge stations to observed properties, which are measured at the specified station. There can be any number of observed properties associated to a water gauge station. Minimum and maximum values and the associated timestamps of their occurrence are also stored for each observed property and water gauge station. These values are updated automatically on data insertion. The time interval the minimum and maximum values refer to is the time interval specified in hydro*_time_series* by the attributes *phenomenon_time_begin* and *phenomenon_time_end*.

hydrostation_classification (entity)
This table is a list of possible classifications of water gauge stations. Classifications may be defined as needed, for example, stations may be classified whether they are regular stations of the measuring net or stations belonging to some project (project stations). Classifications are human-readable strings.

riverbank (entity)
Here the possible locations of a water gauge station relative to the river are defined. Possible locations are the strings “left”, “right” and “bridge”. “left” and “right” are relative to downstream direction of the river, “bridge” is used if the station is on a bridge or an island.

hydro_time_series (entity)
This table has a list of all hydrological time series. A time series is a coverage of observations of a certain property (like water level). For each water gauge station and observed property there is exactly one time series. Time series are not split. All observations of a certain property at a certain water gauge station are in one time series.

Time series entity holds all data common to all data pairs in the series. This is the water gauge station at which the data pairs were observed, the property that was observed, the phenomenon time start and end of the time series (these are the times of the observations) and the result time (this is the time when the time series was last updated).

Data pairs belonging to a time series are assembled in table *hydro_result*.

hydro_result (entity)
This table holds all values and timestamps for all observed hydrological properties. This includes real time data, processed data and forecasts. Each data pair belongs to a time series, which is a reference to the table *hydro_time_series*. Attribute *created_at* is used to store the date of insertion into database. An observation never is deleted, if a value needs to be corrected, a new entry with the current

timestamp of creation is inserted into the table. If there are multiple entries for the same time of observation, only the one with the newest creation timestamp is returned as the result.

The time of observation is specified in UTC. If the observed property covers a certain time interval, the associated timestamp is set on the beginning of the time interval. For observed properties which cover a long interval, for example a month, the time part of the timestamp is set to midnight in UTC. See also the rules in the description of *hydro_observed_property*.

discharge_measurement (entity)
This table serves the purpose to store discharge calibration measurements. Such field measurements are carried out to determine and calibrate q-h-curves which are used for discharge measurement. Measured parameters are stored in this table together with the water gauge station the measurement was done at, the operator who did the measurement and the equipment used for measurement. The latter is an index into the table *discharge_measurement_equipment*. Foreseen for future use.

discharge_measurement_equipment (entity)
List of equipment used for discharge calibration measurements. Entries are free-text human-readable names of the equipment in English. This table is used by *discharge_measurement* to characterize the equipment the measurement was done with. Foreseen for future use.

warning_level_info (entity)
This table defines available warning levels for each data provider. For each warning level it stores a short description meant for labelling, a long description for detailed information on the warning level and a colour for displaying warning levels, for example in a chart. There may be any number of warning levels defined, as defined by country specifications. The meaning of the levels and how they are defined is solely up to the country at which the water gauge station is located. Additionally, there is a global warning level defined for the whole system with three states: "normal", "warning", "severe". Each data provider specific warning level is grouped into one of these states.

hydropoint_warning_level (n:m relation)
This table stores the warning levels limits for each water gauge station for each observed property for which warning levels exist. A warning level limit is the value of the observed property above which the warning is issued. The values are just for internal reference as warning level definition and systems differ from country to country. In this table, the values of the observed property when the warning is issued are defined, and a reference to the warning level specified in table *warning_level_info*.

A1.2.2 Meteo part

In this section the tables (mainly entities) for meteorological measurements are described. Detailed specifications of all attributes can be found in section **Fehler! Verweisquelle konnte nicht gefunden werden.** "**Fehler! Verweisquelle konnte nicht gefunden werden.**".

meteopoint (entity)
This table stores all metadata of meteorological stations. It is equivalent to the corresponding table in hydro part. The difference is that a meteorological station is not necessarily located at a river, thus the attributes *bank*, *river_kilometer*, *catchment_area* and the European river code are missing. Instead, a meteorological station is in the basin of a river, which is specified with the attribute *river_basin*.

The international code of a meteorological station is suffixed with the string "_METEO" to differentiate it from a hydrological station with the same international code.

As with hydrological stations, observed properties like precipitation which are measured by the meteorological station are stored in the table *meteopoint_observed_property*, which establishes a n:m relation between the monitoring points and the observed properties.

meteo_observed_property (entity)
This is the second important table for meteorological data. It stores a list of observed properties like precipitation and air temperature. An observed property is defined by a name, a human readable description and the unit it is measured in. The observed property naming scheme is defined in section "Observed property naming scheme".

Only meteorological properties are stored in the observed property list of the meteo part. For monitoring points also measuring hydrological properties, a separate entry for the monitoring point is added to the hydro schema.

meteostation_classification (entity)
This table is a list of possible classifications of meteorological stations. Classifications may be defined as needed, for example stations may be classified whether they are regular stations of the measuring net or stations belonging to some project (project stations). Classifications are human-readable strings.

meteo_time_series (entity)
This table has a list of all meteorological time series in the schema. A time series is a coverage of observations of a certain property (like precipitation). For each meteorological station and observed property there is exactly one time series. Time series are not split. All observations of a certain property at a certain meteorological station are in one time series.

The further description of the corresponding table in hydro part also applies here. Data pairs belonging to a time series are assembled in table *meteo_result*.

meteo_result (entity)
This table holds all values and timestamps for all observed meteorological properties. This includes real time data, processed data and forecasts. Each data pair belongs to a time series, which is a reference to the table *meteo_time_series*. The time of observation is specified in UTC. If the observed property covers a certain time interval, the associated timestamp is set on the beginning of the time interval. For observed properties which cover a long interval like a month, the time part of the timestamp is set to midnight in UTC. See also the rules in the description of *hydro_observed_property*.

meteopoint_observed_property (n:m relation)
This table relates meteorological stations to the observed properties, which are measured at the specified station. There can be any number of observed properties associated to a meteorological station. Minimum and maximum values and their associated timestamps are also stored for each observed property and meteorological station. These values are updated automatically on data insertion. The time interval the minimum and maximum values refer to is the time interval specified in meteo_*time_series* by the attributes *phenomenon_time_begin* and *phenomenon_time_end*.

A1.2.3 Administrative part

operator (entity)
This table defines all organizations operating monitoring points. An operator is characterized by its official name and address. International phone number and e-mail address of the contact person responsible for operating the stations are specified. It is possible to store the URL to official homepage of the operating organization and other information. All attributes are human-readable strings.

Groups and users are stored similarly in their respective tables. Membership of operators and users in groups are stored in m:n relation tables *operator_groups*, *operator_users* and *users_groups*.

A1.3 Attribute and table reference for hydrological data

Abbreviations
PK = Primary Key, unique key, may be multiple fields together,
FK = Foreign Key, a link to the table with the following name,
UK = Unique Key, link to external database (DanubeGIS)
All times and dates stored in database are in UTC.

Table	Attributes	Type	Description
hydropoint	PK: id	Integer	Identifier of the water gauge station
	FK: station_ classificationid	Integer	Classification of water gauge station
	FK: bankid	Integer	Side of the river the measuring station is located in downstream direction
	FK: operatorid	Integer	Information on the operator of measuring station
	UK: eucd_wgst	Varchar(64)	International code of water gauge station (Link to DanubeGIS database). [country] & [NCD_WGST] & "_HYDRO"
	UK: waterbodyeuropean_ river_code	Varchar(64)	International code of river or canal to which the water gauge station belongs. Same as River.EUCD_RIV in DanubeGIS
	ncd_wgst	Varchar(64)	National code of water gauge station (the way the data provider names the station in the data transfer files)
	vertical_reference	Varchar(32)	Reference Vertical Datum identifier, e.g. European Vertical Reference Frame 2007 (EVRF2007)
	long	Numeric(20,10)	Coordinates of water gauge station: EPSG 4326 (WGS 84) Longitude [°]
	lat	Numeric(20,10)	Coordinates of water gauge station: EPSG 4326 (WGS 84) Latitude [°]
	z	Numeric(20,10)	Coordinates of water gauge station: Height [m]
	maplong	Numeric(20,10)	Coordinates of water gauge station for display on map (longitude)
	maplat	Numeric(20,10)	Coordinates of water gauge station for display on map (latitude)
	country	Varchar(2)	Country code of water gauge station ISO3166-1 ALPHA-2 (e.g. "DE")

Table	Attributes	Type	Description
	name	Varchar(128)	Locally used name of water gauge station
	location	Varchar(255)	Closest commune or landmark
	river_kilometer	Numeric(20,10)	Location at river the water gauge station is located, distance from mouth
	catchment_area	Numeric(20,10)	Drainage basin area of water gauge station [km^2]
	gauge_zero	Numeric(20,10)	Gravity-related altitude of the zero level of the gauge above the sea level [m]
	start_time	Timestamp	Starting time of activity for this water gauge station (UTC). See is_active
	end_time	Timestamp	Ending time of activity this water gauge station (UTC). See is_active
	utc_offset	Integer	Time zone the water gauge station belongs to UTC+X [min], disregarding daylight-saving time
	is_active	Boolean	Whether station is active. Instead of deleting the station and all the associated data, this flag is set to false and the data is kept
hydrostation_ classification	PK: id	Integer	Identifier
	value	Varchar(255)	String to describe current classification of water gauge station within hydrological network (e.g. "project station", "basic-network station")
riverbank	PK: id	Integer	Identifier
	value	Varchar(255)	String to describe side of river "left" / "right" / "bridge" in downstream direction.
hydro_time_ series	PK: id	Bigint	Identifier
	FK: mpointid	Integer	Water gauge station the time series was measured with
	FK: observed_ propertyid	Integer	Observed property in time series
	phenomenon_ time_begin	Timestamp	Starting phenomenon time of time series (UTC)
	phenomenon_ time_end	Timestamp	End phenomenon time of time series (UTC)
	result_time	Timestamp	Result time, when time series was processed (UTC)
hydro_observed _property	PK: id	Integer	Identifier
	symbol	Varchar(32)	Abbreviation of observed property (e.g. "h_max_daily" for daily maximum of water level)
	type	Smallint	Real time: 0, processed: 1
	description	Varchar(64)	Human readable description of observed property (e.g. "Daily maximum of water level")
	unit	Varchar(12)	Unit of parameter, e.g. "cm"
hydropoint_ observed_ property	PK, FK: mpointid	Integer	Water gauge station which supports observations of property
	PK, FK: observed_ propertyid	Integer	Observed property supported by water gauge station
	last_update	Timestamp	Time of last update of this parameter at this water gauge station (UTC)

Table	Attributes	Type	Description
	min_value	Numeric(20,10)	Minimum value of parameter in time series measured at this water gauge station
	min_value_time	Timestamp	Time at which minimum value was measured (UTC)
	max_value	Numeric(20,10)	Maximum value of parameter in time series measured at this water gauge station
	max_value_time	Timestamp	Time at which maximum value was measured (UTC)
hydro_result	PK: id	Bigint	Identifier
	FK: time_seriesid	Bigint	The time series the data pair belongs to
	time	Timestamp	Phenomenon timestamp of measured property (UTC)
	value	Numeric(20,10)	Value of the measured property
	created_at	Timestamp	Time of entry in data base
	is_forecast	Boolean	True, if data is forecast. Else false.
discharge_ measurement	PK: id	Integer	Identifier
	FK: operatorid	Integer	Operator of the discharge calibration meas-urement
	FK: discharge_ measurement_ equipmentid	Integer	Equipment used for measurement
	FK: mpointid	Integer	Water gauge station for which discharge cali-bration measurement was done
	date	Timestamp	Date of discharge calibration measurement (UTC)
	q	Numeric(20,10)	Discharge at time of measurement [m³/s]
	h	Numeric(20,10)	Water level at time of measurement [cm]
	width	Numeric(20,10)	Width of water surface [m]
	area	Numeric(20,10)	Area of cross-section [m²]
	wetted_perimeter	Numeric(20,10)	Wetted perimeter [m]
	depth_max	Numeric(20,10)	Maximum depth [m]
	velocity_max	Numeric(20,10)	Maximum velocity [m/s]
	velocity_average	Numeric(20,10)	velocity average [m/s]
	temperature	Numeric(20,10)	Water temperature at time of measurement [°C]
discharge_ measurement_ equipment	PK: id	Integer	Identifier
	description	Varchar(255)	Description of equipment of discharge calibra-tion measurement
warning_ level_info	PK: id	Integer	Identifier
	short_description	Varchar(64)	A short textual description of the meaning of the warning level, as a label
	long_description	Text	Detailed description of the meaning of the warning level
	FK: operatorid	Integer	Data provider for which the warning level info applies
	colour	Varchar(16)	HTML colour code for display of warning level (e.g. #FF5733)
	glob-al_warning_groupid	Integer	Global warning group this level belongs to. 1: normal, 2: warning, 3: severe

Table	Attributes	Type	Description
hydropoint_ warning_level	PK, FK: mpointid	Integer	Identifier of water gauge station for which warning level value is defined
	PK, FK: observed_ propertyid	Integer	Id of observed property for which warning level applies
	PK, FK: warning_ level_infoid	Integer	Id of warning level info
	value	Numeric(20,10)	Value of the specified observed property, above which the warning level is issued for specified water gauge station.
waterbody	PK, UK: european_ river_code	Varchar(64)	International code of river or canal. Same as River.EUCD_RIV in DanubeGIS.
	cname	Varchar(255)	Name of river

A1.4 Attribute and table reference for meteorological data

Table	Attributes	Type	Description
meteopoint	PK: id	Integer	Identifier of the meteorological station
	FK: meteostation_ classificationid	Integer	Classification of meteorological station
	FK: operatorid	Integer	Information on the operator of mete-orological station
	UK: eucd_pst	Varchar(64)	International code of meteorological station (Link to DanubeGIS database). [country] & [NCD_PST] & "_METEO"
	ncd_pst	Varchar(64)	National code of meteorological station
	vertical_reference	Varchar(32)	Reference Vertical Datum identifier, e.g. European Vertical Reference Frame 2007 (EVRF2007)
	long	Numeric(20,10)	Coordinates of meteorological station: EPSG 4326 (WGS 84) Longitude [°]
	lat	Numeric(20,10)	Coordinates of meteorological station: EPSG 4326 (WGS 84) Latitude [°]
	z	Numeric(20,10)	Coordinates of meteorological station: Height [m]
	maplong	Numeric(20,10)	Coordinates of meteorological station for display on map (longitude)
	maplat	Numeric(20,10)	Coordinates of meteorological station for display on map (latitude)
	country	Varchar(2)	Country code of meteorological station ISO 3166-1 ALPHA-2 (e.g. "DE")
	name	Varchar(128)	Locally used name of meteorological station
	location	Varchar(255)	Closest commune or landmark
	river_basin	Varchar(64)	Name of river basin to which meteoro-logical station belongs
	altitude	Numeric(20,10)	Gravity-related altitude of the zero level of the gauge above the sea level [m]. Same as gauge_zero for water gauge stations.
	Start_time	Timestamp	Starting time activity of this meteoro-

Table	Attributes	Type	Description
			logical station (UTC). See is_active
	end_time	Timestamp	Ending time of activity of this meteoro-logical station (UTC). See is_active
	utc_offset	Integer	Time zone the meteorological station belongs to UTC+X [min], disregarding daylight-saving time.
	Is_active	Boolean	Whether station is active. Instead of deleting the station and all the associ-ated data, this flag is set to false and the data is kept
meteostation_ classification	PK: id	Integer	Identifier
	value	Varchar(255)	String to describe current classification of meteorological station within mete-orological network (e.g. “project sta-tion”, “basic-network station”)
meteo_time_ series	PK: id	Bigint	Identifier
	FK: meteopointid	Integer	Meteorological station the time series was measured with
	FK: meteo_ observed_ propertyid	Integer	Observed property in time series
	phenomenon_ time_begin	Timestamp	Starting phenomenon time of time series (UTC)
	phenomenon_ time_end	Timestamp	End phenomenon time of time series (UTC)
	result_time	Timestamp	Result time, when time series was pro-cessed (UTC)
meteo_ observed_ property	PK: id	Integer	Identifier
	symbol	Varchar(32)	Abbreviation of observed property (e.g. “P_total_daily” for daily total of precip-itation)
	type	Smallint	Real time: 0, processed: 1
	description	Varchar(64)	Human readable description of ob-served property (e.g. “Daily total of precipitation”)
	unit	Varchar(12)	Unit of parameter, e.g. “mm”
meteo_result	PK: id	Bigint	Identifier
	FK: meteo_time_ seriesid	Bigint	The time series the data pair belongs to
	time	Timestamp	Phenomenon timestamp of measured property (UTC)
	value	Numeric(20,10)	Value of the measured property, NULL for not available
	created_at	Timestamp	Time of entry in data base
	is_forecast	Boolean	True, if data is forecast. Else false.
meteopoint_ observed_ property	PK, FK: meteopointid	Integer	Meteorological station which supports observations of property
	PK, FK: meteo_	Integer	Observed property supported by mete-

Table	Attributes	Type	Description
	observed_ propertyid		orological station
	last_update	Timestamp	Time of last update of this parameter at this meteorological station (UTC)
	min_value	Numeric(20,10)	Minimum value of parameter in time series measured at this meteorological station
	min_value_time	Timestamp	Time at which minimum value was measured (UTC)
	max_value	Numeric(20,10)	Maximum value of parameter in time series measured at this meteorological station
	max_value_time	Timestamp	Time at which maximum value was measured (UTC)

A1.5 Attribute and table reference for administrative data

Table	Attributes	Type	Description
operator	PK: id	Integer	Identifier
	name	Varchar(255)	Name of organization which operates water gauge station
	address	Varchar(255)	Address of operating organization
	phone	Varchar(255)	Phone number of operating organiza-tion
	email	Varchar(255)	Email address of operating organization
	url	Varchar(255)	Website of operating organization
	other_info	Varchar(255)	Information on the operator not fitting in above fields
groups	PK: id	Integer	Id of group
	name	Varchar(255)	Unique name of group
users	PK: id	Integer	Identifier
	name	Varchar(255)	The name of the adminstration user
	username	Varchar(255)	The username for login
	email	Varchar(255)	E-mail address of admin user
	password	Varchar(255)	Hashed password
	loggedin_at	Timestamp	Date and time of last login
	deleted_at	Timestamp	Mark deleted users with this field (soft-delete)
operator_groups	PK, FK: groupsid	Integer	Id of group
	PK, FK: operatorid	Integer	Id of operator which is in group
operator_users	PK, FK: usersid	Integer	Id of user
	PK, FK: operatorid	Integer	Id of operator which has user
users_groups	PK, FK: usersid	Integer	Id of user which is in group
	PK, FK: groupsid	Integer	Id of group
event_logs	PK: id	Integer	Identifier of the event
	event_type	Varchar(50)	Identifier of the event type
	data	Text	Information on the event
	created_at	Timestamp	Date of event
	user_id	Integer	Identifier of user
	operator_id	Integer	Identifier of operator

Table	Attributes	Type	Description
group_ measurement_ access_rules	PK: id	Integer	Identifier
	FK: measurement_ access_rule_id	Integer	Id to access rule for group
	FK: group_id	Integer	Id of group
permissions	PK: id	Integer	Identifier
	name	Varchar(255)	Permission unique name
public_keys	PK: id	Integer	Identifier
	FK: usersid	Integer	Id of user to which key belongs
	public_key	Text	ASCII armored public RSA key
	revoked	Boolean	Whether key was revoked
	revoked_at	Timestamp	Time of key's revocation
user_permissions	PK, FK: permissionsid	Integer	Id of permission enabled for the user
	PK, FK: usersid	Integer	Id of user
group_ permissions	PK, FK: permissionsid	Integer	Id of permission enabled for the group
	PK, FK: groupsid	Integer	Id of group
measurement_ access_rules	PK: id	Integer	Identifier
	FK: operator_id	Integer	Id of Operator for which rule applies
	monitoringpoint_ selector	Text	Text list of accessible monitoring points
	observed_ property_selector	Text	List of accessible observed properties

Appendix 2 Common Output Format

In the next sections a mapping of the relevant database fields to the WaterML 2.0 output file is described.

A2.1 Mapping from database to WaterML 2.0 output format

The following table shows the location at which a particular attribute in the database is put in the WaterML 2.0 file. In the left column there is the name of the table (for meteo or hydro part differently), in the second column the name of the attribute in the table. The third column describes the WaterML 2.0 tags in which the content of the field is enclosed. For some tags, the values are not specified as the contents of the tag, but as an attribute to the tag. In these cases, this is denoted as an extra comment in the third column. For some cases, also an example or description of the contents is shown.

Table name	Attribute name	WaterML 2.0 Tag Hierarchy
hydropoint, meteopoint	name	wml2:Collection, wml2:observationMember, om:OM_Observation, om:featureOfInterest, wml2:MonitoringPoint, gml:name
	location	wml2:Collection, wml2:observationMember, om:OM_Observation, om:featureOfInterest, wml2:MonitoringPoint, gml:description
	EUCD_WGST (hydro), EUCD_PST (meteo)	wml2:Collection, wml2:observationMember, om:OM_Observation, om:featureOfInterest, wml2:MonitoringPoint, gml:identifier [codeSpace must be specified as xsd:anyURI]
	lat, long	wml2:Collection, wml2:observationMember, om:OM_Observation, om:featureOfInterest, wml2:MonitoringPoint, sams:shape, gml:Point, gml:pos (EPSG 4326, order latitude, longitude)
	utc_offset	wml2:Collection, wml2:observationMember,

Table name	Attribute name	WaterML 2.0 Tag Hierarchy
		om:OM_Observation, om:featureOfInterest, wml2:MonitoringPoint, wml2:timeZone, wml2:TimeZone, wml2:zoneOffset
hydro_result, meteo_result	time	wml2:Collection, wml2:observationMember, om:OM_Observation, om:result, wml2:MeasurementTimeseries, wml2:point, wml2:MeasurementTVP, wml2:time (ISO 8601: 2011-11-21T13:05:00Z)
	value	wml2:Collection, wml2:observationMember, om:OM_Observation, om:result, wml2:MeasurementTimeseries, wml2:point, wml2:MeasurementTVP, wml2:value
hydro_time_series, meteo_time_series	phenomenon_time_begin	wml2:Collection, wml2:observationMember, om:OM_Observation, om:phenomenonTime, gml:TimePeriod, gml:beginPosition (ISO 8601: 2011-11-21T13:05:00Z)
	phenomenon_time_end	wml2:Collection, wml2:observationMember, om:OM_Observation, om:phenomenonTime, gml:TimePeriod, gml:endPosition (ISO 8601: 2011-11-21T13:05:00Z)
	result_time	wml2:Collection, wml2:observationMember, om:OM_Observation, om:resultTime, gml:TimeInstant, gml:TimePosition (ISO 8601: 2011-11-21T13:05:00Z)
hydro_observed_ property, meteo_observed_ property	symbol	wml2:Collection, wml2:observationMember, om:OM_Observation, om:observedProperty as attribute “xlink:href”

Table name	Attribute name	WaterML 2.0 Tag Hierarchy
	description	wml2:Collection, wml2:observationMember, om:OM_Observation, om:observedProperty as attribute “xlink:title”
	unit	wml2:Collection, wml2:observationMember, om:OM_Observation, om:result, wml2:MeasurementTimeseries, wml2:defaultPointMetadata, wml2:DefaultTVPMeasurementMetadata, wml2:uom as attribute “code”

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