Enabling Transboundary Cooperation & Integrated Water Resources Management in the extended DRIN RIVER BASIN

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

IHMS

IGJEUM

HMS MACEDONIA

5th Annual Drin Stakeholders Conference
Montenegro, Podgorica, 21-22 November 2017

Hydrometeorological Institutes Cooperation, Monitoring, O&M and Hydrological Forecast

Vasko Stojov, HMS Macedonia

The Drin/Drim – Buna/Bojana River Basin always has been affected by floods, in the past, …

… but also recently 2010, and after…

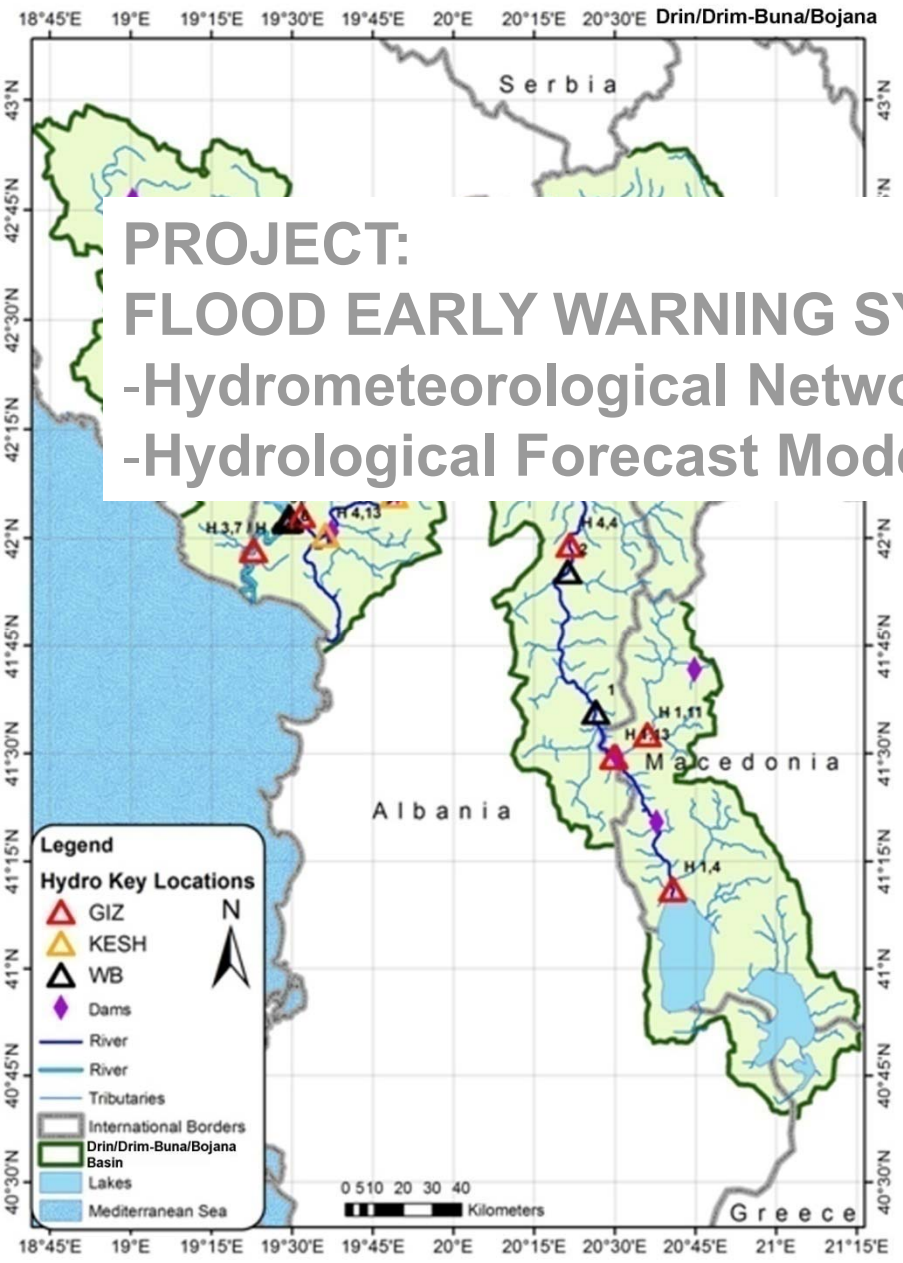
… people suffered in all region,
which provoke needs for closer cooperation between
the countries in the Drin/Drim-Buna/Bojana River Basin

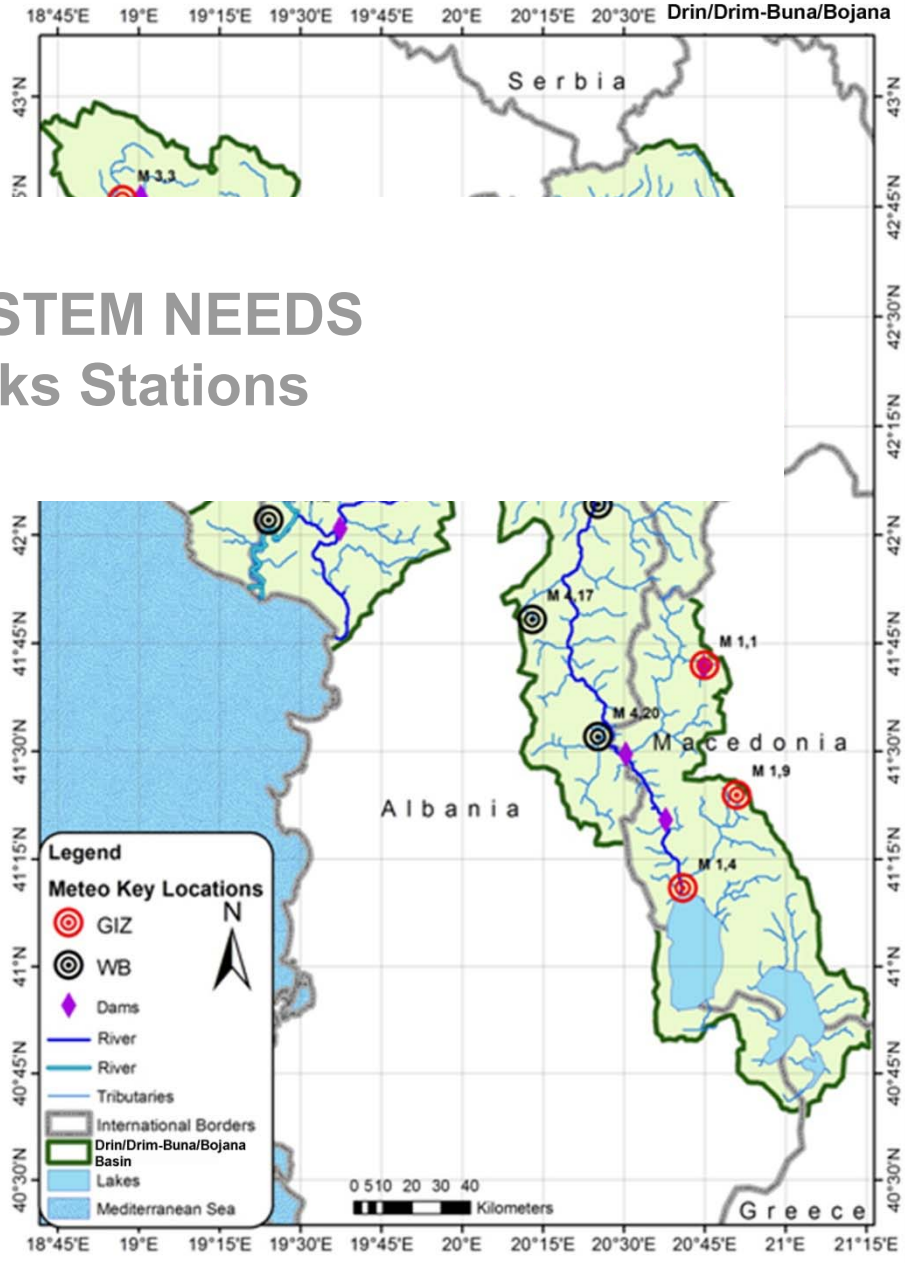
GIZ & Hydrometeorological Institutes
from the states in the region,
start mutual cooperation…

STRENGHTENING THE CAPACITIES OF THE HYDROMETEOROLOGICAL INSTITUTES IN THE RESPECTIVE COUNTRIES

PROJECT: FLOOD EARLY WARNING SYSTEM

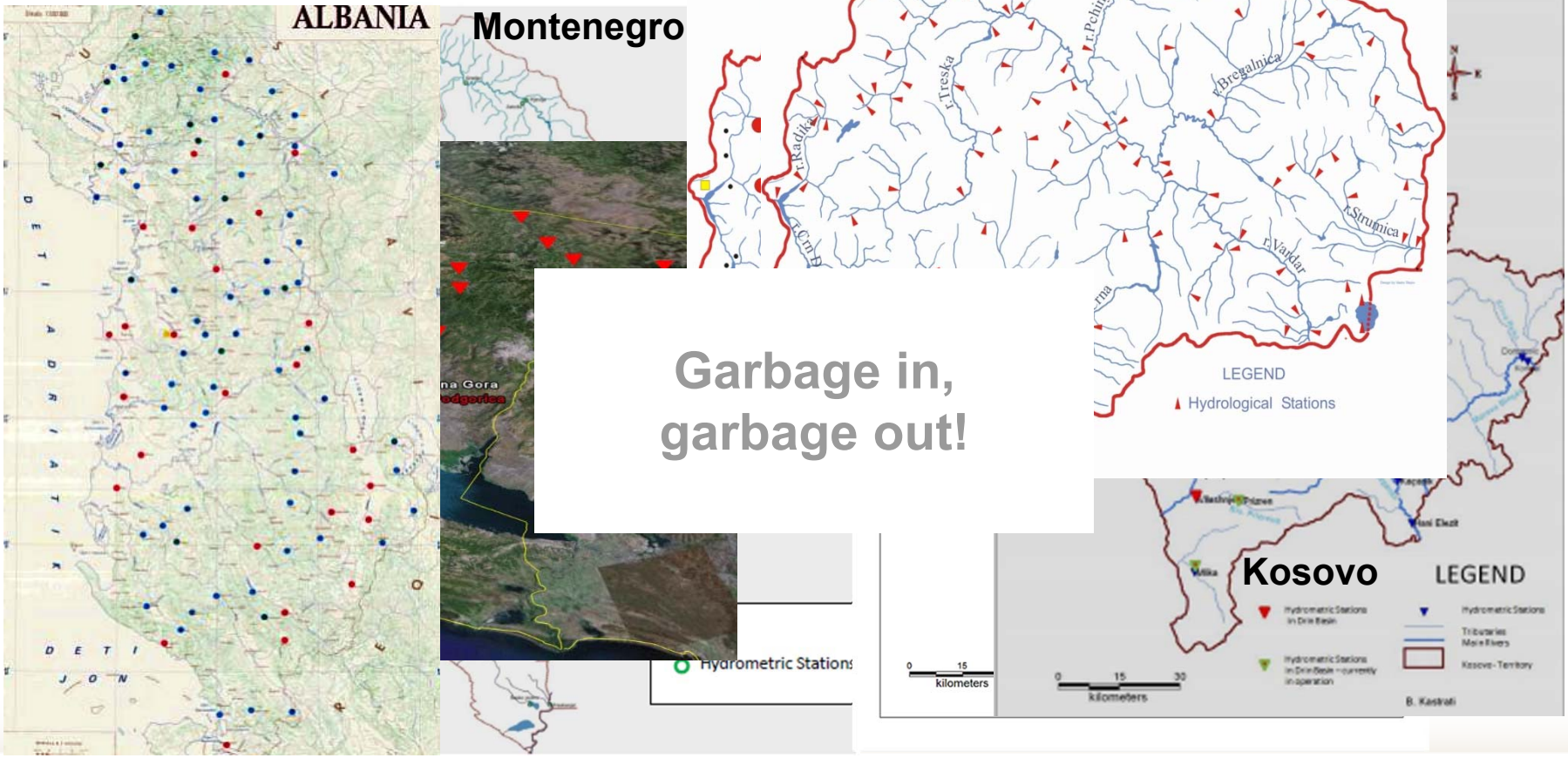
PROJECT:
FLOOD EARLY WARNING SYSTEM NEEDS
-Hydrometeorological Networks Stations
-Hydrological Forecast Model



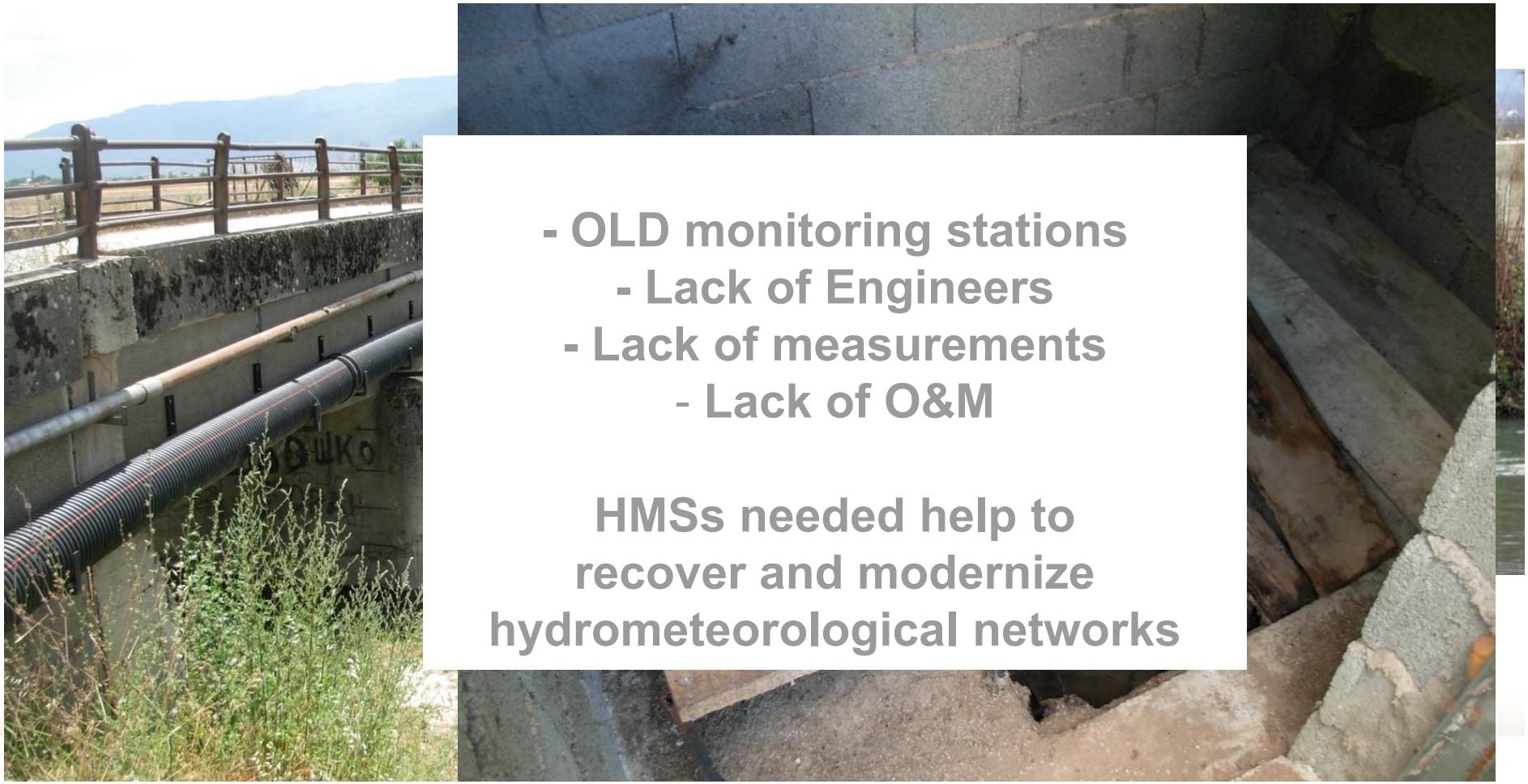


Hydrometeorological networks in Drin/Drim-Buna/Bojana Basin

National hydrological and meteorological networks

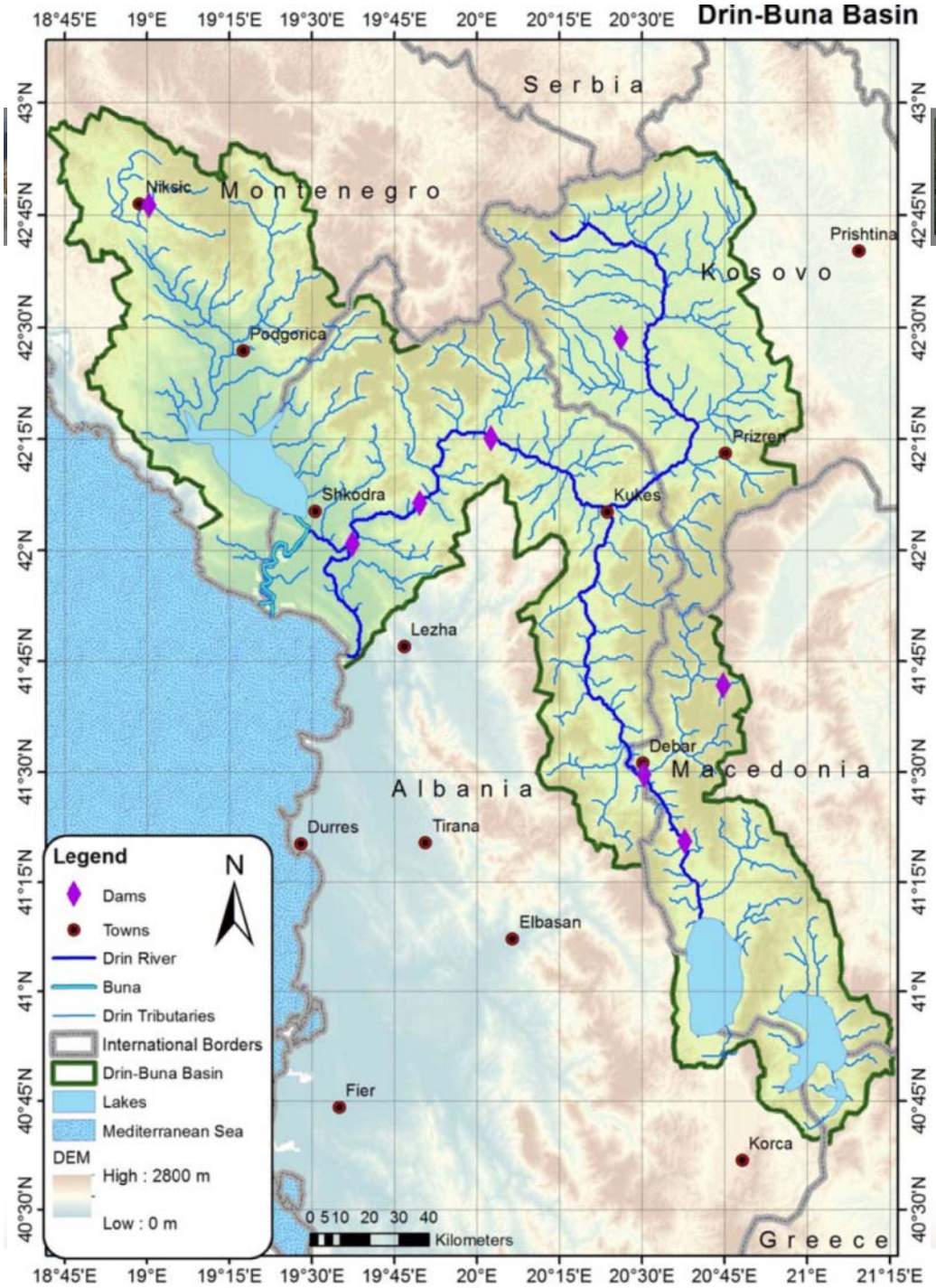


Hydrometeorological Institutions – GAPS and NEEDS

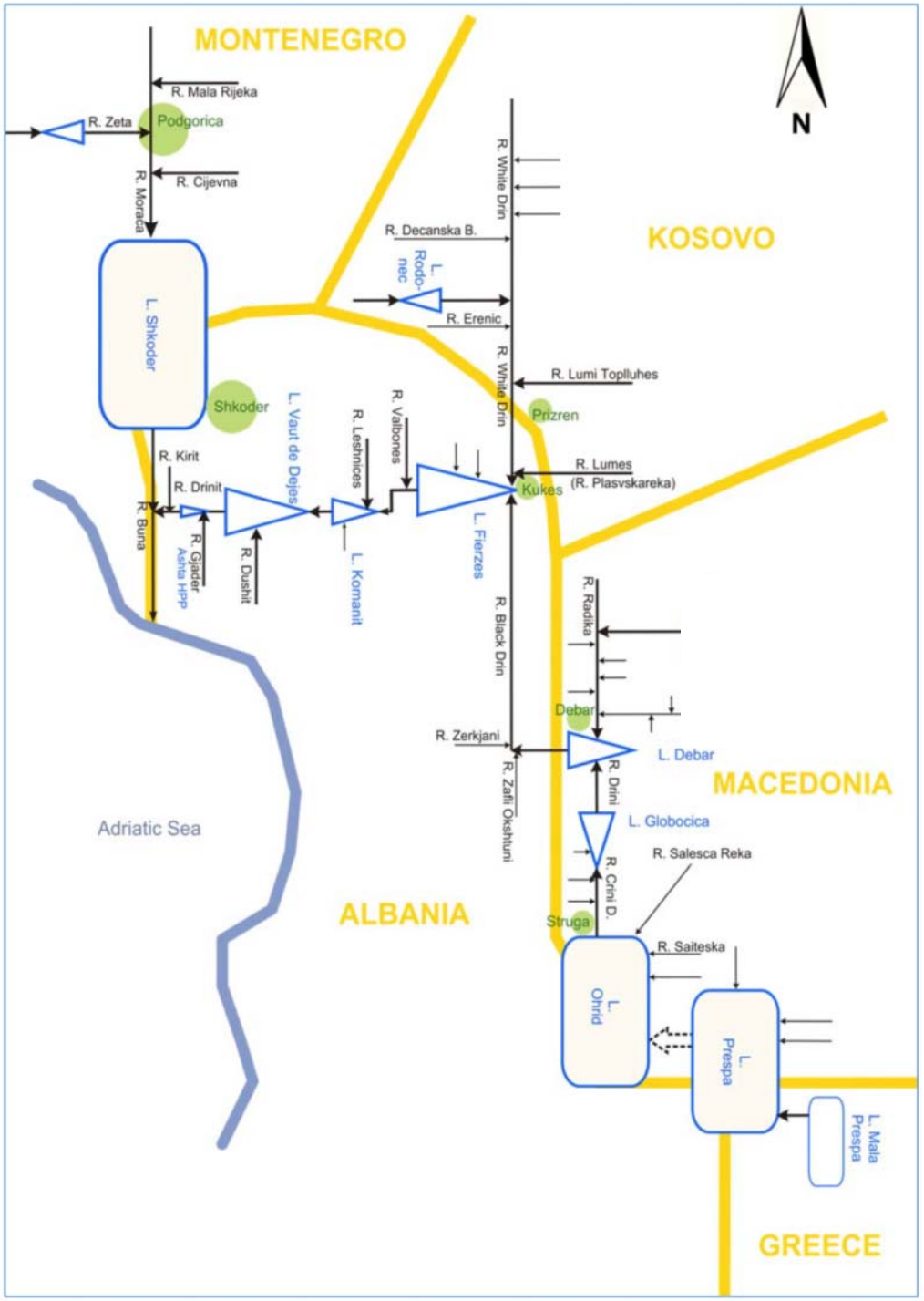


- OLD monitoring stations
- Lack of Engineers
- Lack of measurements
- Lack of O&M

HMSs needed help to recover and modernize hydrometeorological networks

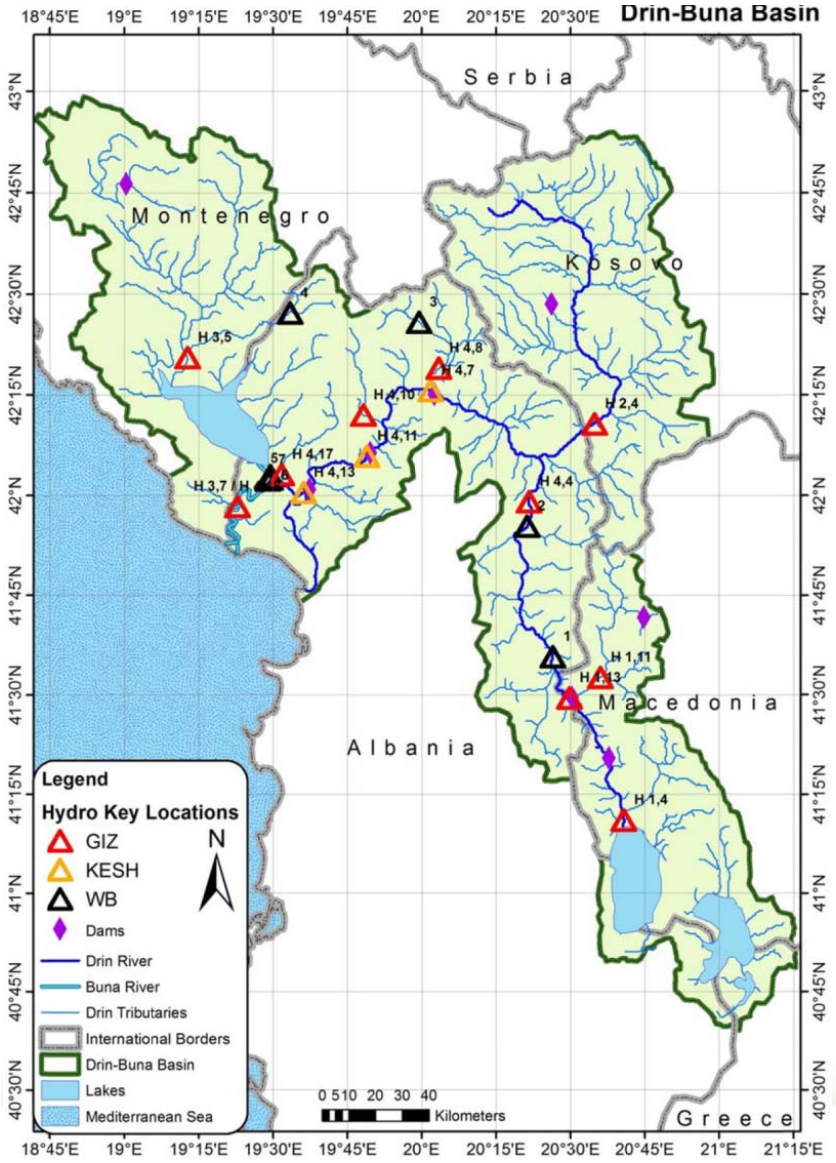


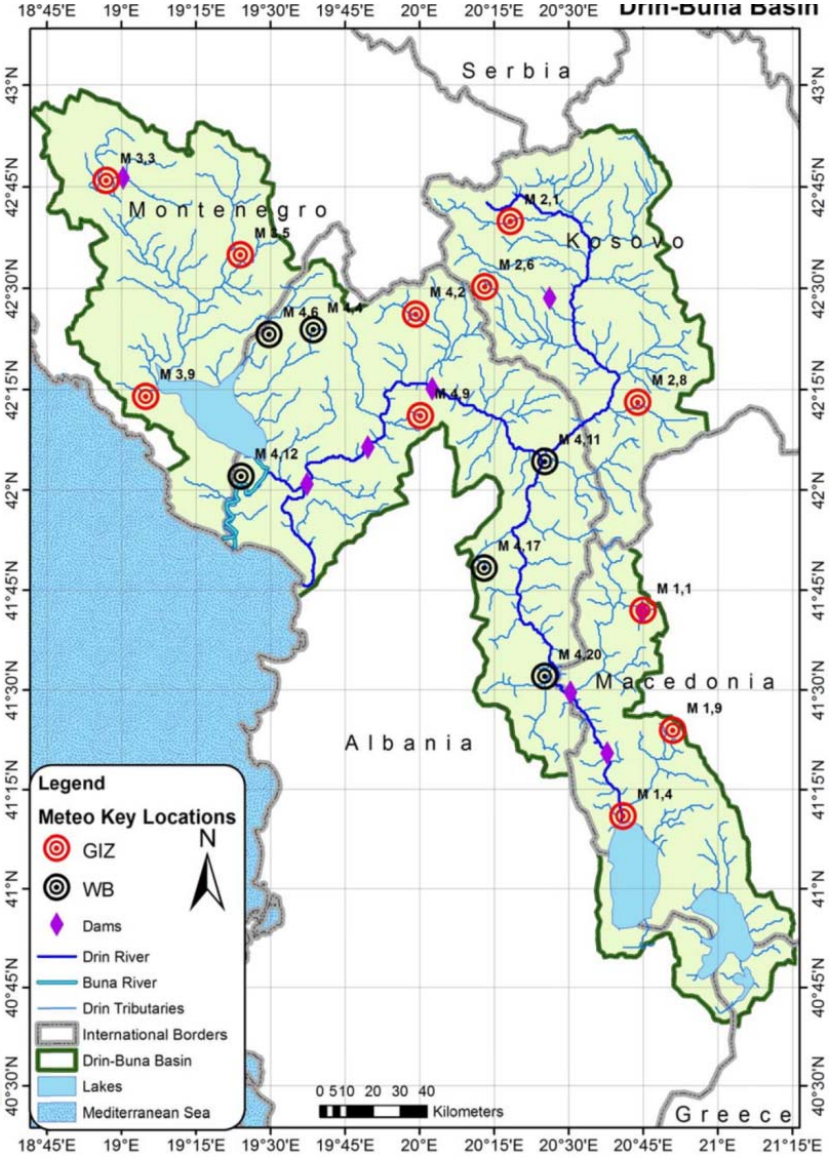
GIS MAPS Drin/Drim-Buna/Bojana River Basin



Scheme of Drin/Drim-Buna/Bojana River Basin

BASIC Hydrological & Meteorological Networks

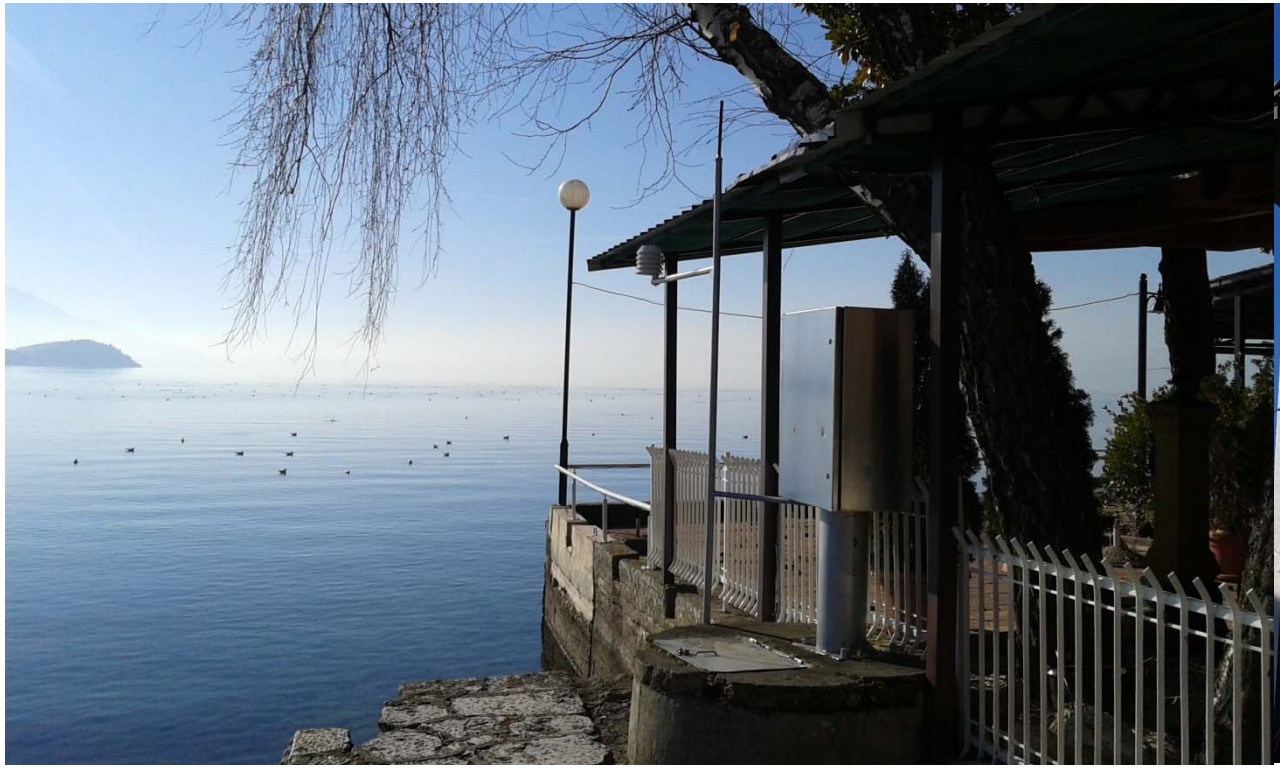




GIZ Donation - Start of modernization

NEW RIVER MONITORING STATIONS

NEW LAKE MONITORING STATIONS

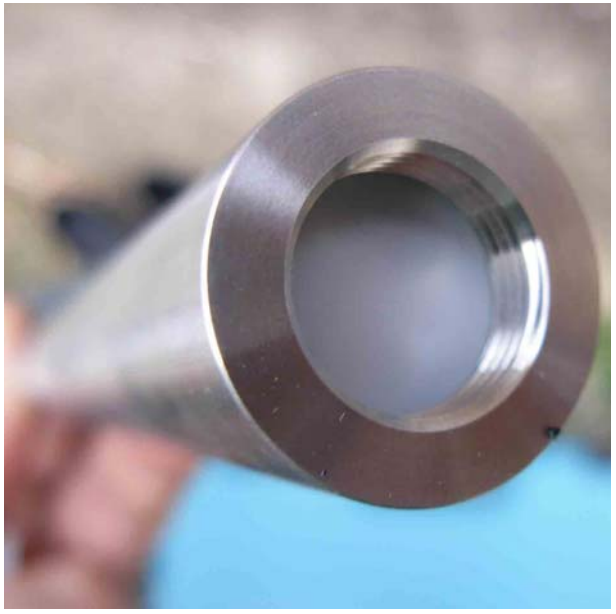


NEW METEOROLGI

INSTALLATION
-power supply
-equipment

SONDES – Pressure & Temperature sensors
Devices for measuring hydrological data

Sonde for measuring
H (cm) & T (°C)

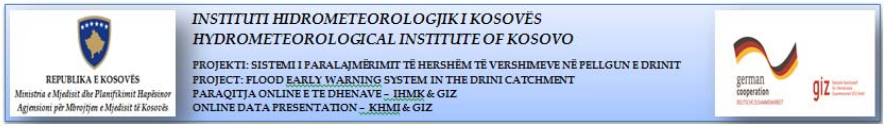


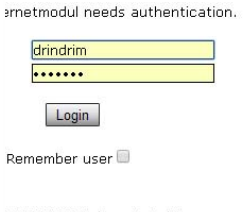
Membranes of the sonde

Instruments for collecting and transmitting data

Data Logger MDS-5
for collecting data with GSM/GPRS modem for transmitting data

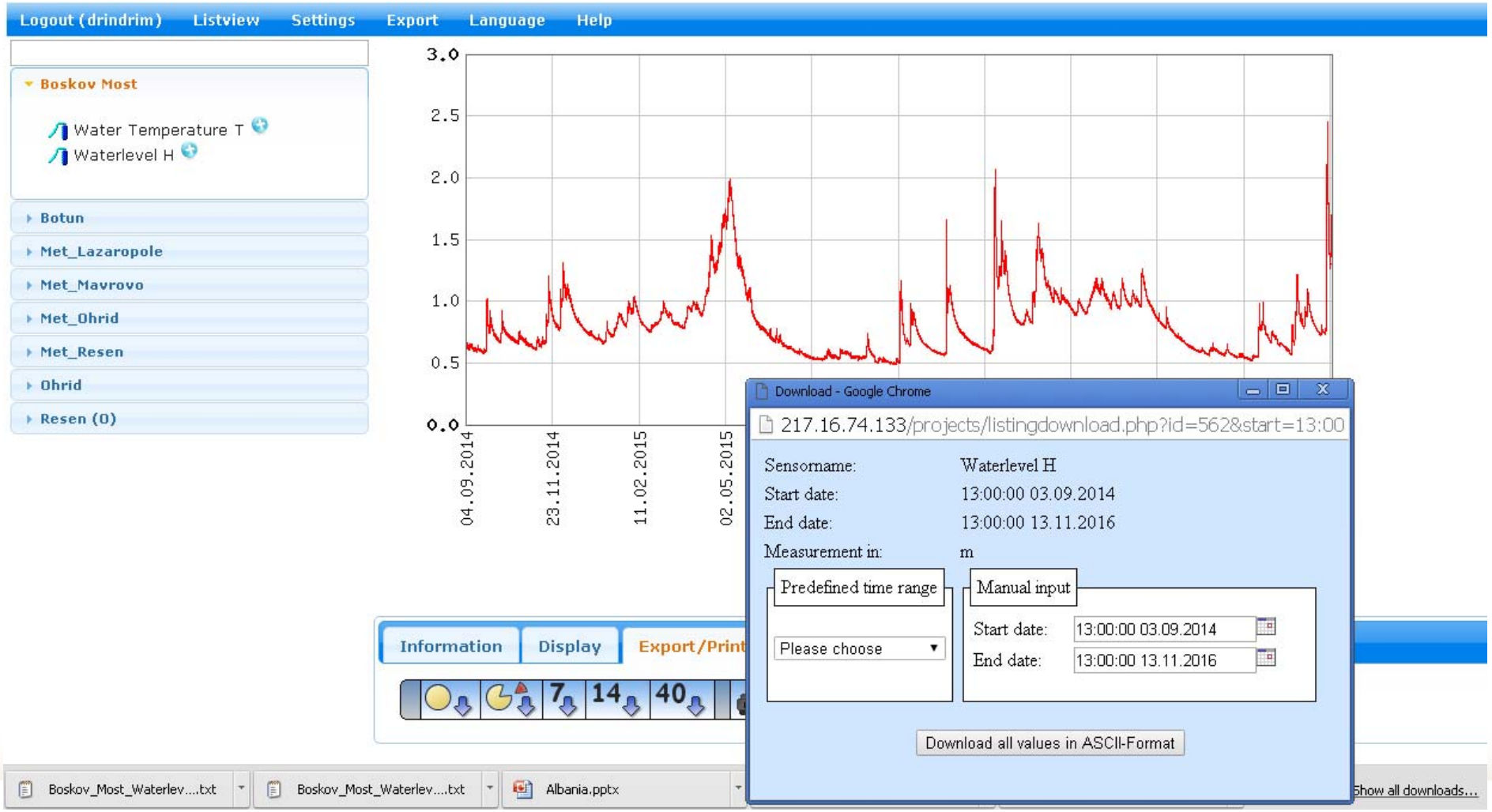
…portals to exchange data



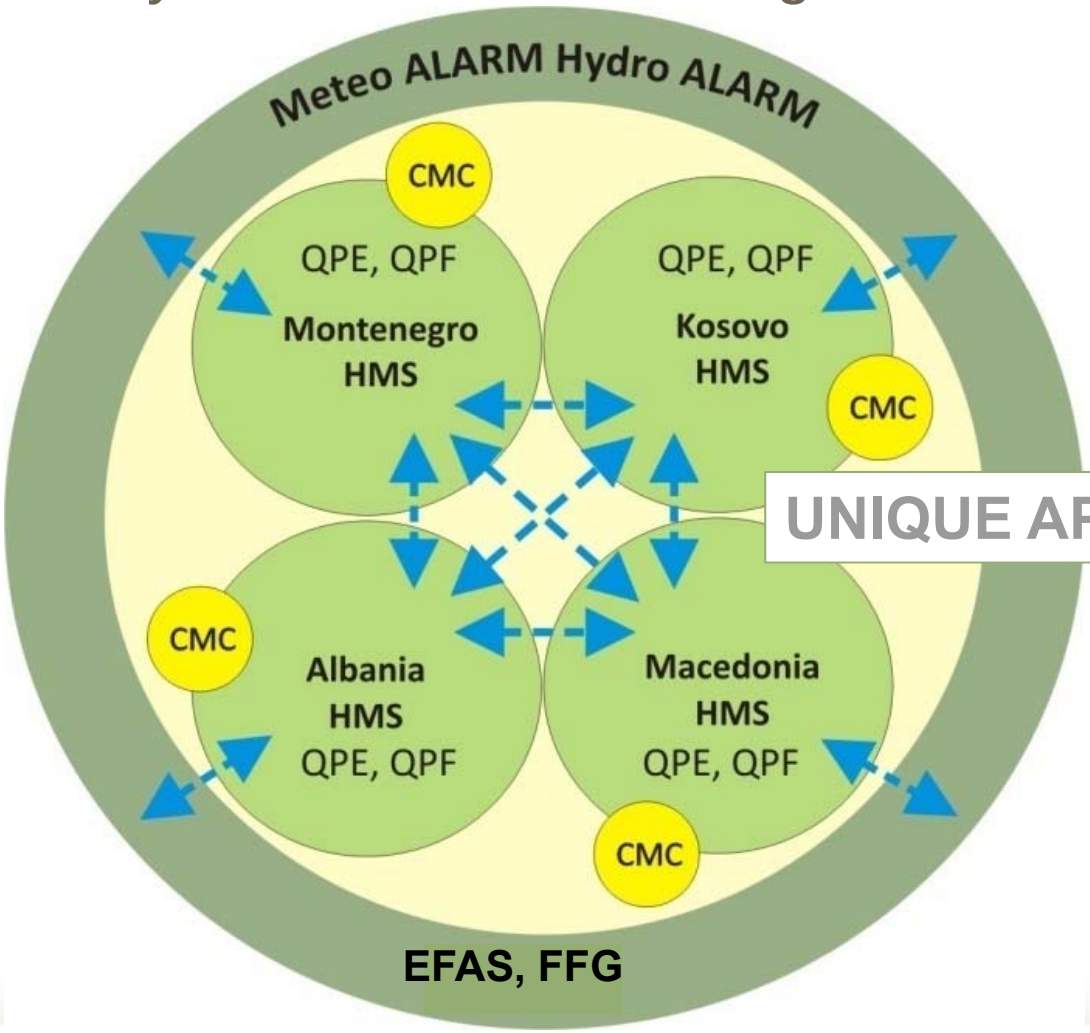


Iotok	Sliv	Početak rada	Kota "0" (mnm)	Površina sliva (km^2)	Vodostaj (cm) min	Vodostaj (cm) max	Proticaj (m^3/s) min	Proticaj (m^3/s) max
rača	Skadarsko jezero	1948	24.60	31.40	18	1226	7.93	2073

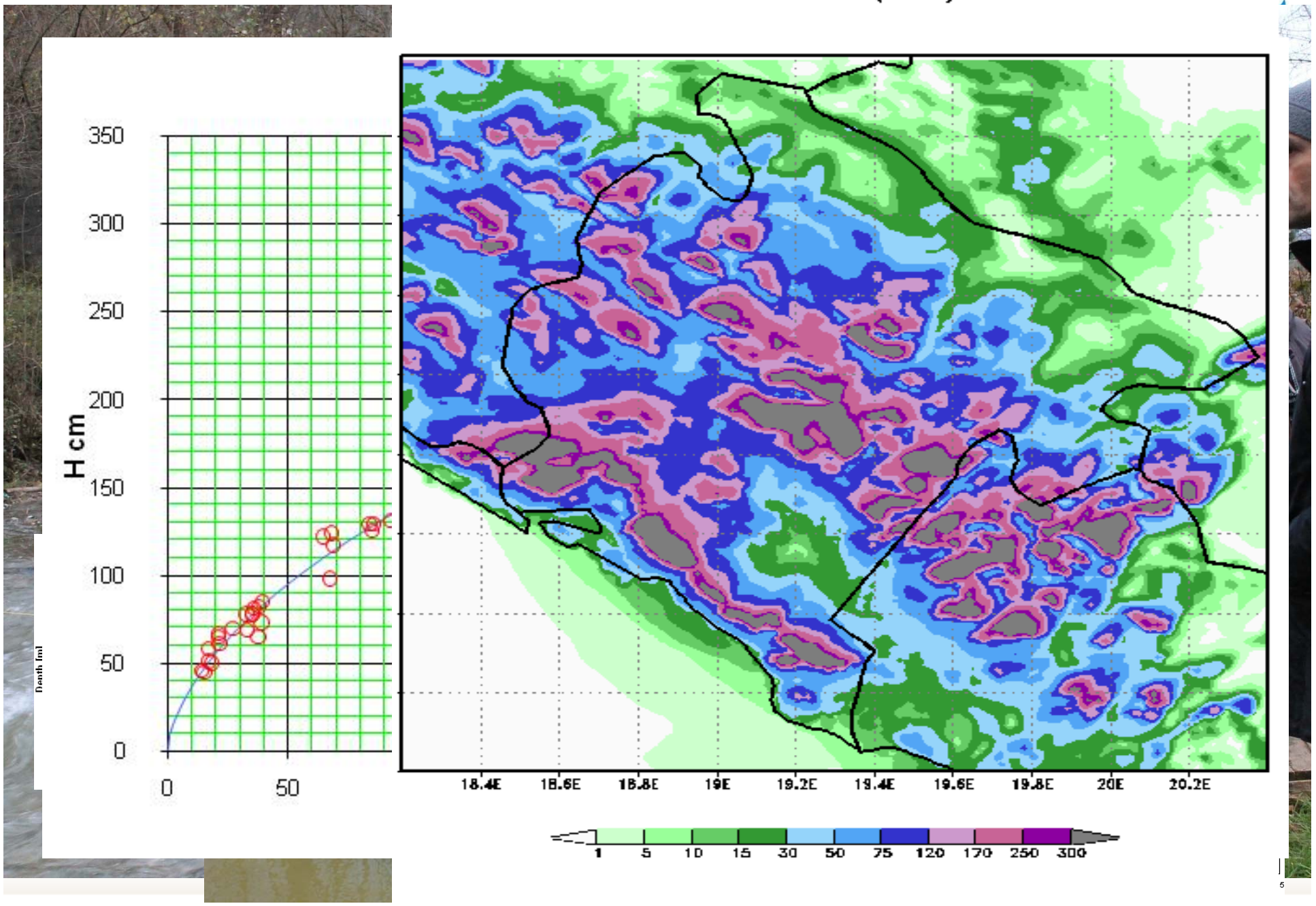
Internetmodule towards UNIQUE APPLICATION



Step forward: System for data exchange



UNIQUE APPLICATION


WRF A7
24h Acc.Prec.
initialisation: 2010.11.08. 00:00 utc
valid(+48h): 2010.NOV.10 00:00 utc
H cm
350
300
250
200
150
100
50
0
0
50
18.4E
18.6E
18.8E
19E
19.2E
19.4E
19.6E
19.8E
20E
20.2E
1
5
10
15
30
50
75
120
170
250
300
GrADS: COLA/IGES
2010-11-10-16:58

MEMORANDUM FOR COOPERATION

between

Institute of Geosciences Energy, Water and Environment (Albania)

and

Hydrometeorological Institute (Kosovo)

and

Hydrometeorological Service (Macedonia)

and

Institute of Hydrometeorology and Seismology (Montenegro)

on

Cooperation and Data Exchange for Flood Warning in the Drin/Drim – Buna/Bojana River Basin

MEMORANDUM FOR COOPERATION

Organisations - Parties

State	Name of organisation	Abbreviation
Albania	Institute of Geosciences, Energy, Water and Environment (Albania)	IGEWE
Kosovo	Hydrometeorological Institute (Kosovo)	KHMI
Macedonia	Hydrometeorological Service (Macedonia)	HMSM
Montenegro	Institute of Hydrometeorology and Seismology (Montenegro)	IHMS

MEMORANDUM FOR COOPERATION

Official protocol for signing document

MEMORANDUM FOR COOPERATION

Parameters to be exchanged

Parameter		Temporal Resolution (Statistic)	Units
P1	Water level	hourly	Cm
P2	River Discharge	hourly	$m^3 s^{-1}$
P3	Water Temperature	hourly	^oC
P4	Precipitation	hourly	mm
P5	Air Temperature	hourly	^oC
P6	Relative Humidity	hourly	%
P7	Wind (Speed and Direction)	hourly	m/s and deg.
P8	Snow Depth	hourly	cm
P9	Evaporation	hourly	mm
P10	Solar Radiation	hourly	$J m^{-2}$
P11	Atmospheric Pressure	hourly	hPa

MEMORANDUM FOR COOPERATION Stations

State	River	Station
AL	Drini i Zi	Kovashica
AL	Drin i Zi	Skavica
AL	Drin	Fierzë Dam
AL	Valbonë	Dragobi
AL	Valbonë	Gri
AL	Drin	Koman Dam
AL	Drin	Vau i Dejës Dam
AL	Kiri	Ura e Mesit
AL	Drin	Bahcallek
AL	Cijevna	Tamare
AL	Lake Shkodra	Shirokë
AL	Buna	Liqeni i Shkodres
AL	Buna	Fabrika Cimentos
AL	Buna	Dajç
AL	Drini i Zi	Shupenzë
AL	Drini i Zi	Peshkopi
AL	Drini i Zi	Fushë Lurë
AL	Drini i Zi	Kukës
AL	Drini i Zi	Krumë
AL	Valbonë	Cërrnicë
AL	Drin	Theth
AL	Drin	Pukë
AL	Lake Shkodra	Bogë
AL	Lake Shkodra	Rapsh
AL	Buna	F. Paqes

State	River	Station
MK	Golema Reka	Resen
MK	Lake Ohrid	Ohrid
MK	Sateska	Botun
MK	Crn Drim	Ložani
MK	Crn Drim	Globocica Dam)*
MK	Radika	Boškov Most
MK	Crn Drim	Debar Dam)*
MK	Crn Drim	Spilje
MK	Crn Drim	Ohrid
MK	Sateska	Slivovo
MK	Radika	Štirovica
MK	Radika	Mavrovo
MK	Radika	Lazaropole

State	River	Station
XK	Bistriça e Pejës	Rugova
XK	Drini I Bardhë	Gjonaj
XK	Bistriça e Pejës	Pejë
XK	Eriniku	Junik
XK	Bistrica Prizrenit	Prizren

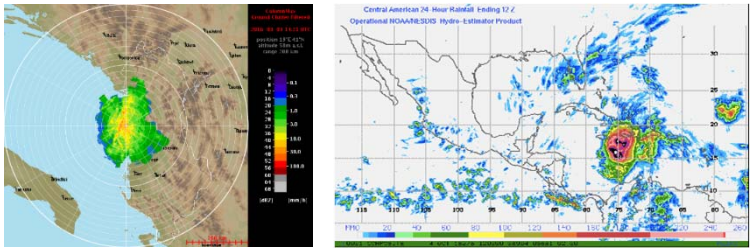
State	River	Station
ME	Morača	Pernica
ME	Morača	Zlatica
ME	Zeta	Danilovgrad
ME	Morača	Podgorica
ME	Lake Skadar	Plavnica
ME	Lake Skadar	Vranjina
ME	Lake Skadar	Ckla
ME	Bojana	Fraskanjel
ME	Morača	Dragovica Polje
ME	Morača	Podgorica
ME	Zeta	Nikšić
ME	Zeta	Danilovgrad
ME	Lake Skadar	Virpazar

…step forward
HOW TO DO FLOOD FORECASTING?

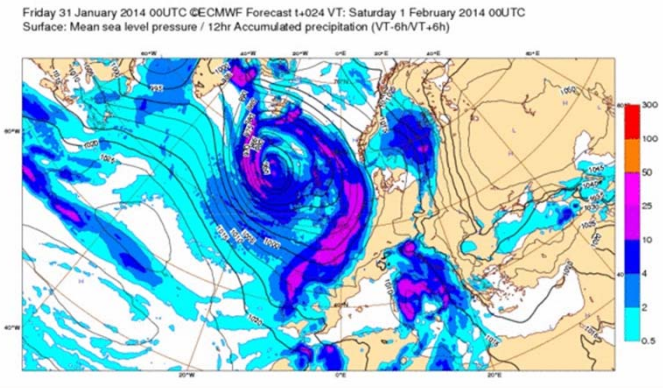
Available information?

Ground Data

Radar and Satellite Data



Meteo Services (Meteorological Forecasts)



…step forward

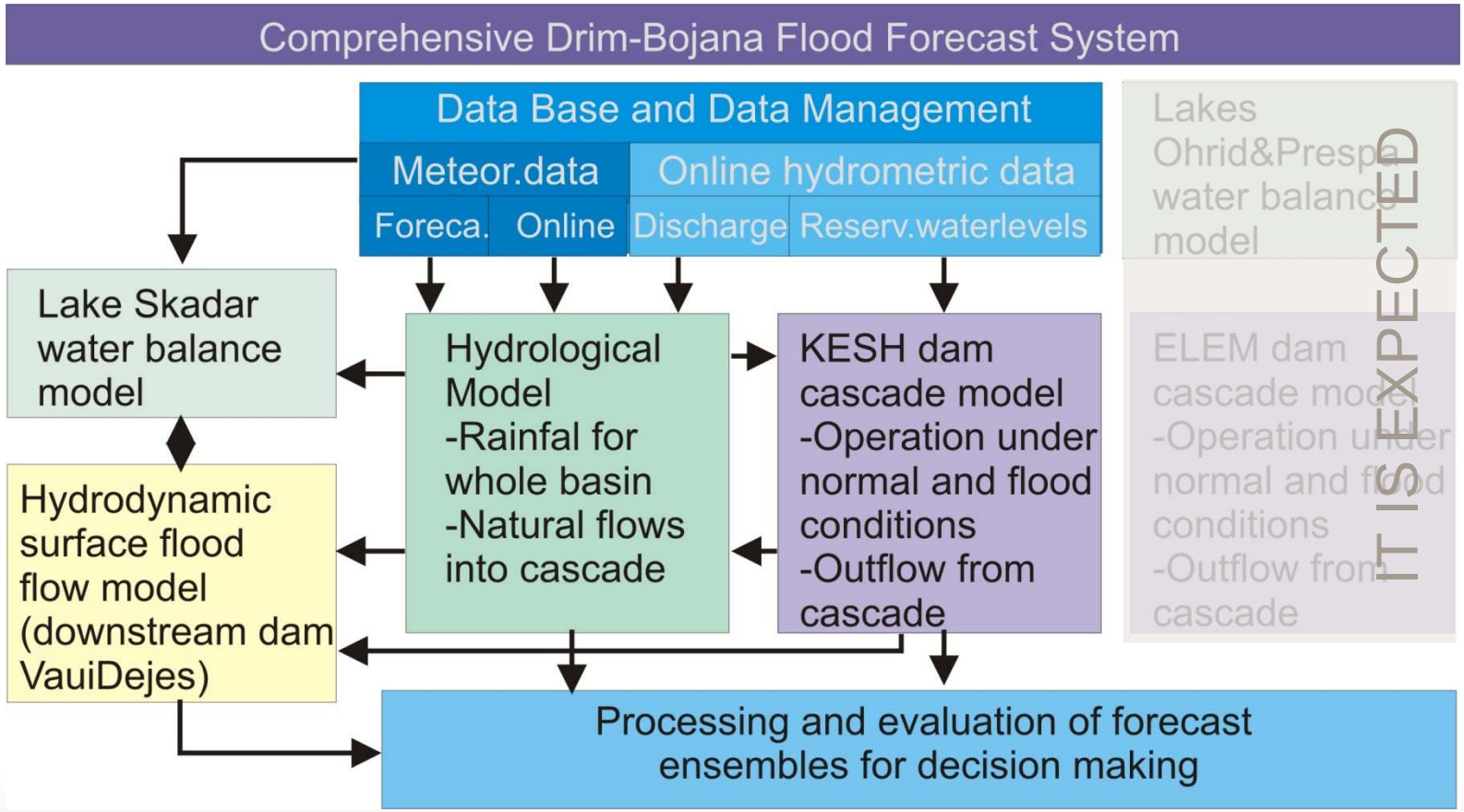
Technische Universität Braunschweig, Germany
Department of Hydrology and Water Management

PANTA RHEI FLOOD FORECAST MODEL

Design
Drin/Drim-Buna/Bojana
FLOOD FORECAST SYSTEM
DB FFS

1. Concept of DB-FFS

1.1 General structure of DB-FFS



1. Concept of DB-FFS

1.2 Basic procedure of execution of a DB FFSystem

Loading of historic data
- Online stations

Fine calibration
- For key hydrometric stations
- For reservoir water levels

Loading of meteorological forecast data
- Meteo. forecasts 1
- Meteo. forecasts 2
- Meteo. forecasts 3

Simulation of flood forecast
- Define ensemble (number of meteo. forecasts)
- Perform simulation(s)

Processing and display of results
- By PANTA RHEI (preliminary)
- By Result Manager (detailed)
- Select and submit representative results for authorities and public
- Save results on server

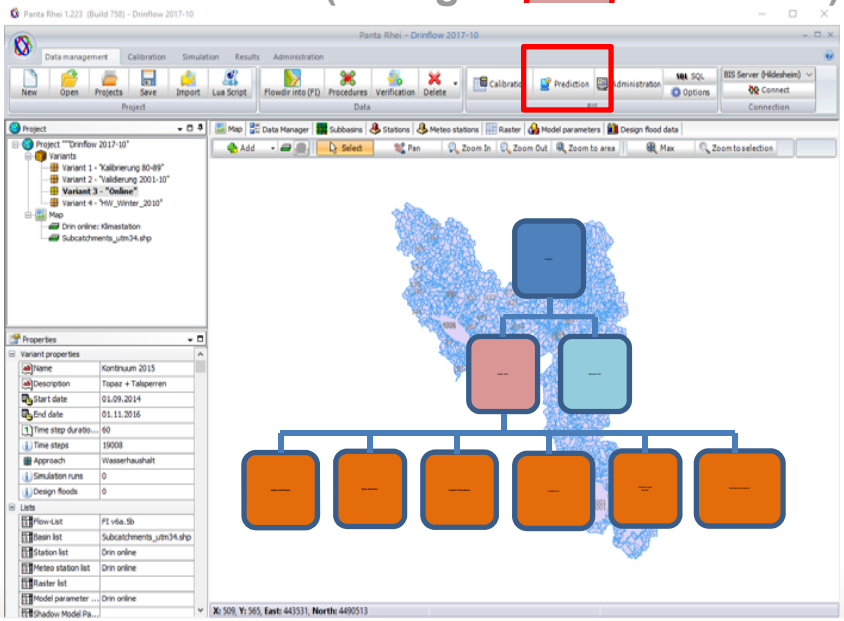
2. Working with DB-FFS

2.1 Loading of historic data

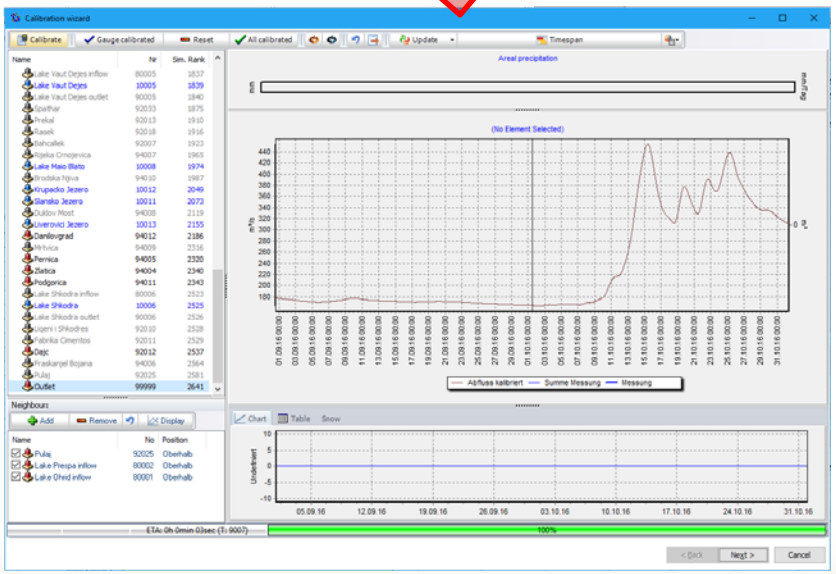
Start / loading
Project
Forecast Wizard

Start the Forecast Wizard

DB-FFS programs + data (background information)



DB-FFS Forecast Wizard window for operator‘s daily work



2. Working with DB-FFS

2.1 Loading of historic data

Start / loading
Project
Forecast Wizard

AUTOMATED downloading data series from MCH servers

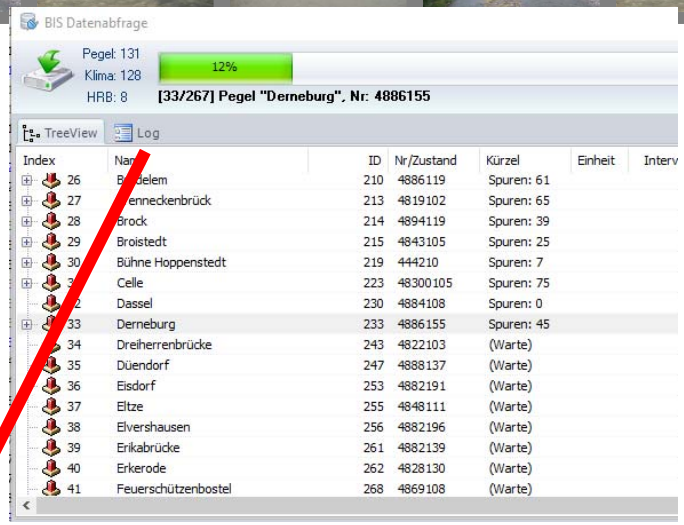
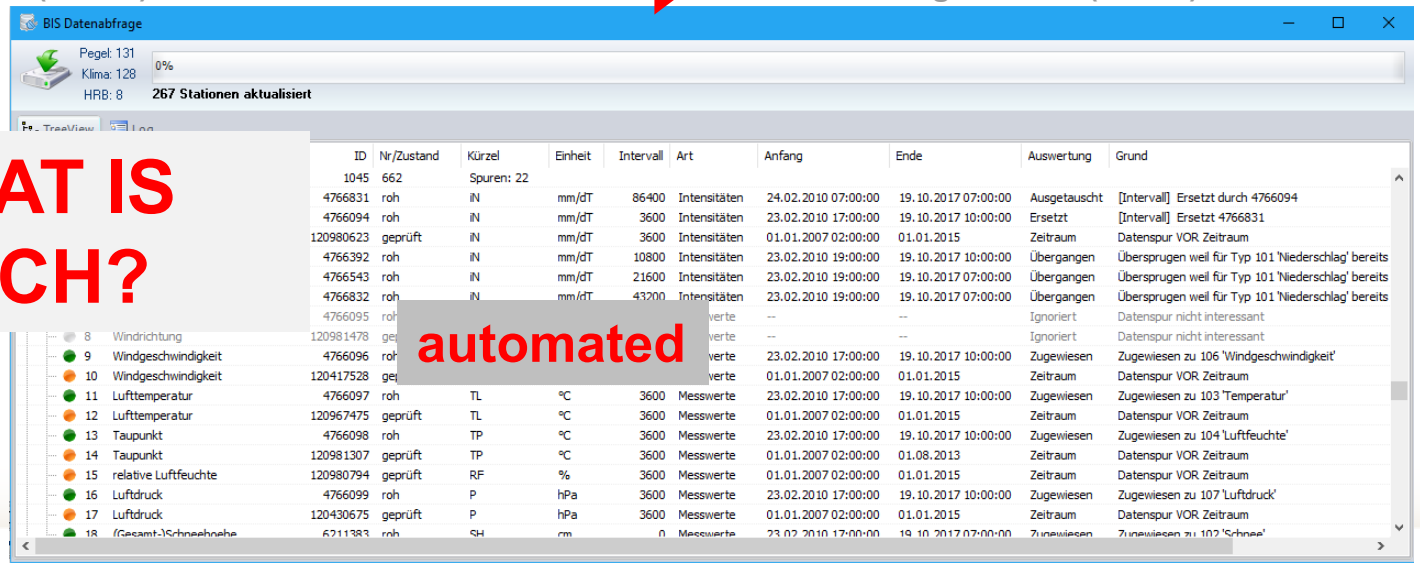


Fig. Download process of historic series (meteo, hydro) is displayed with progress bar (above). All download information can be checked in the log window (below)



WHAT IS MCH?

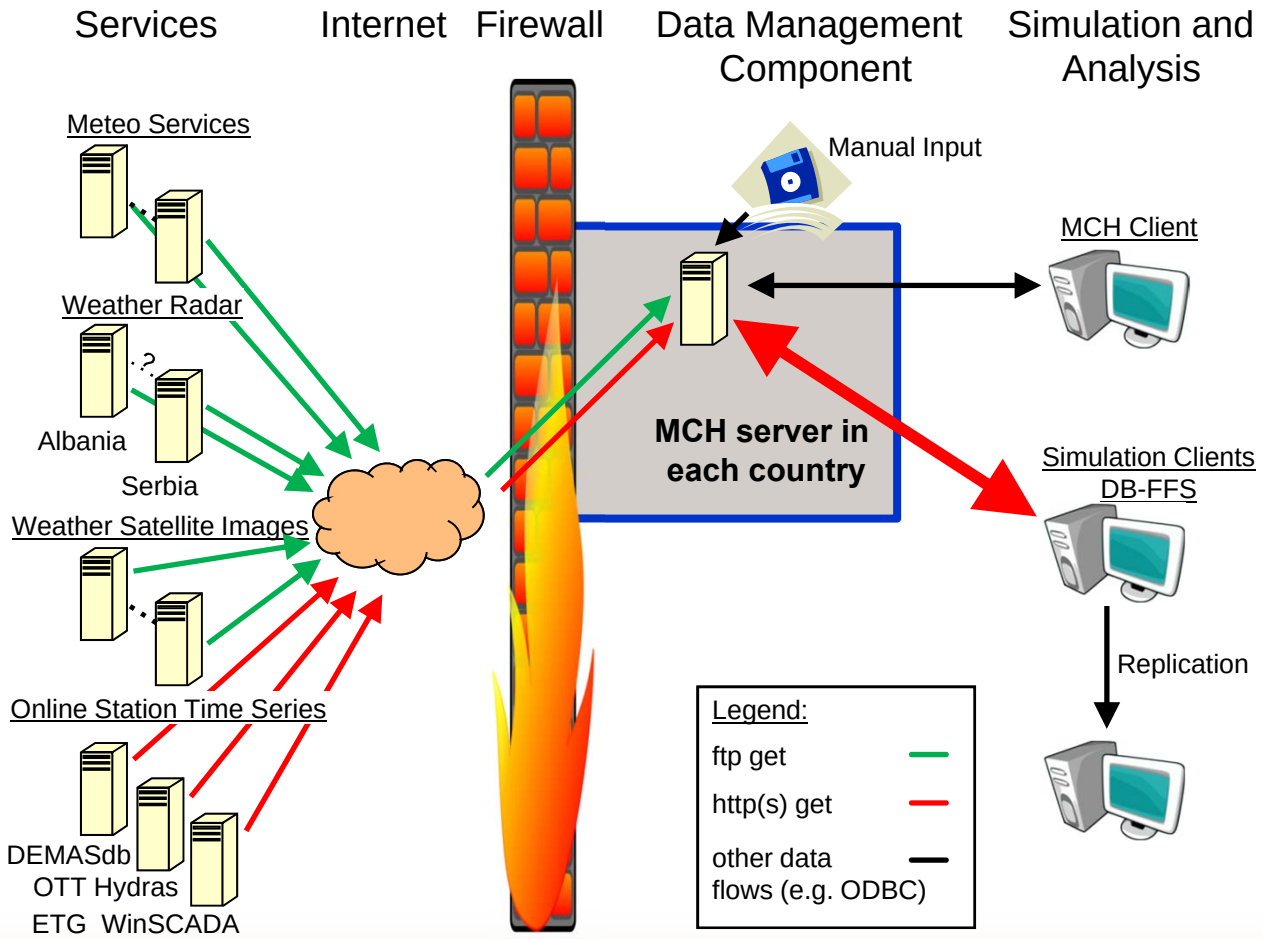
automated

What is MCH?

- MCH – Meteorological, Climatological and Hydrological DataBase Management System;
- MCH is database management system (DBMS) based on open source DataBase and software;
- Developed in Mexico, has been transferred to WMO in 2011.
  - ➢ MCH is based on MySQL

installed in 4 HMSs

Proposed System Architecture



2. Working with DB-FFS

2.1 Loading of historic data

Start / loading
Project
Forecast Wizard

AUTOMATED
download of series from MCH servers starts
+ Satellite precip. raster (Hydro Estimator) download/import starts

Hydro Estimator Satellite data cover the whole world. For the DB-FFS they need to be projected, cut to the project area and imported into the DB-FFS internal database. This is done automatically, once the satellite data are downloaded from US NOAA-Servers.

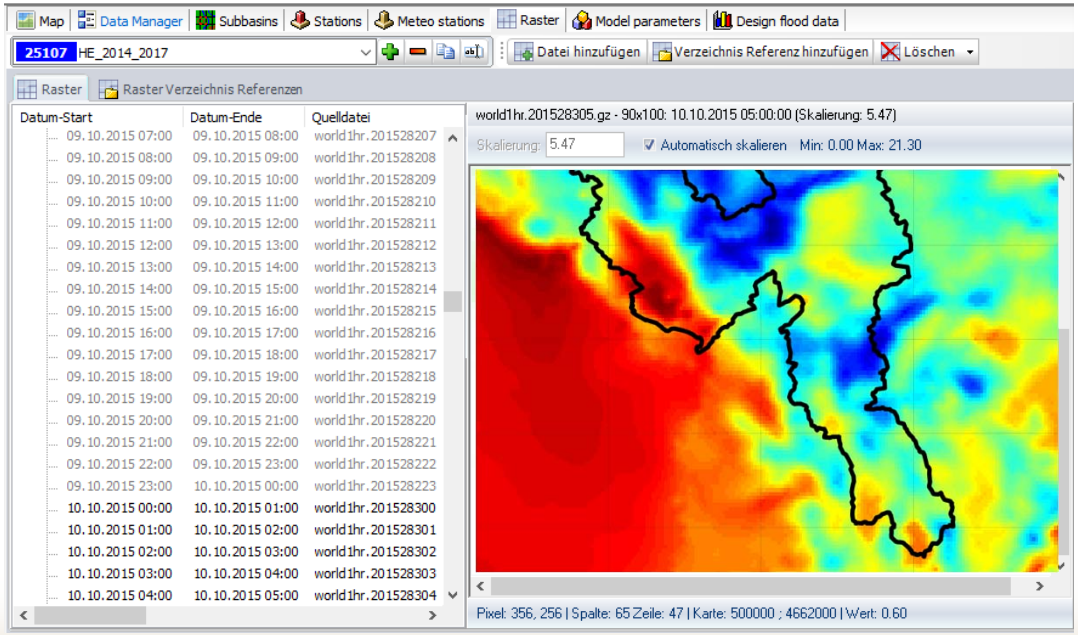


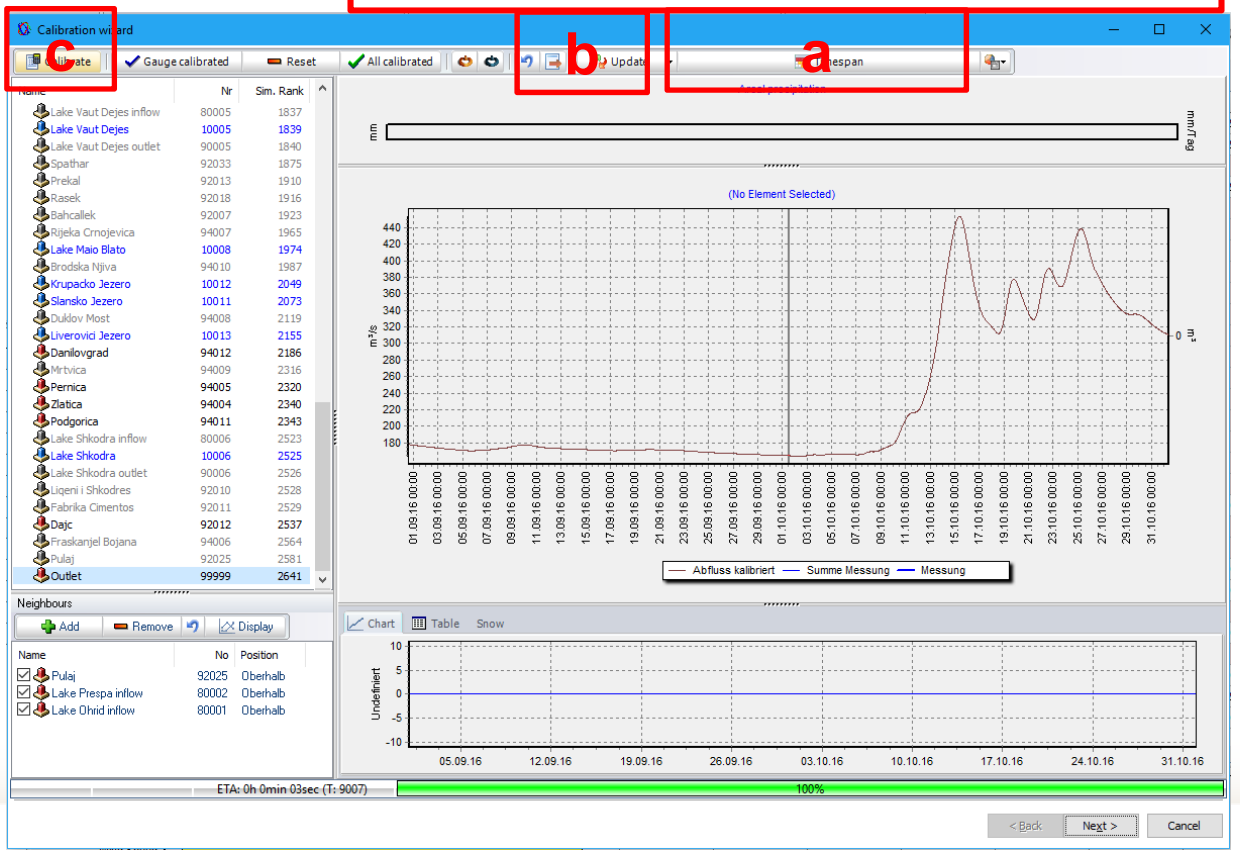
Fig. Imported satellite data can be loaded for display.
Satellite data are loaded automatically during simulation runs.

2. Working with DB-FFS

2.1 Loading of historic data

Start / loading
Project
Forecast Wizard

Step-by-step
a) Select historic simulation time period
b) Update historic period series
c) Perform fine calibration



2. Working with DB-FFS

2.2 Fine calibration

MAIN INTERFACE

In Detail...

Start / loading Project
Forecast Wizard
- **Data update**
- **Data check**
- **Fine calibration**
  - **discharge**
  - **water levels**

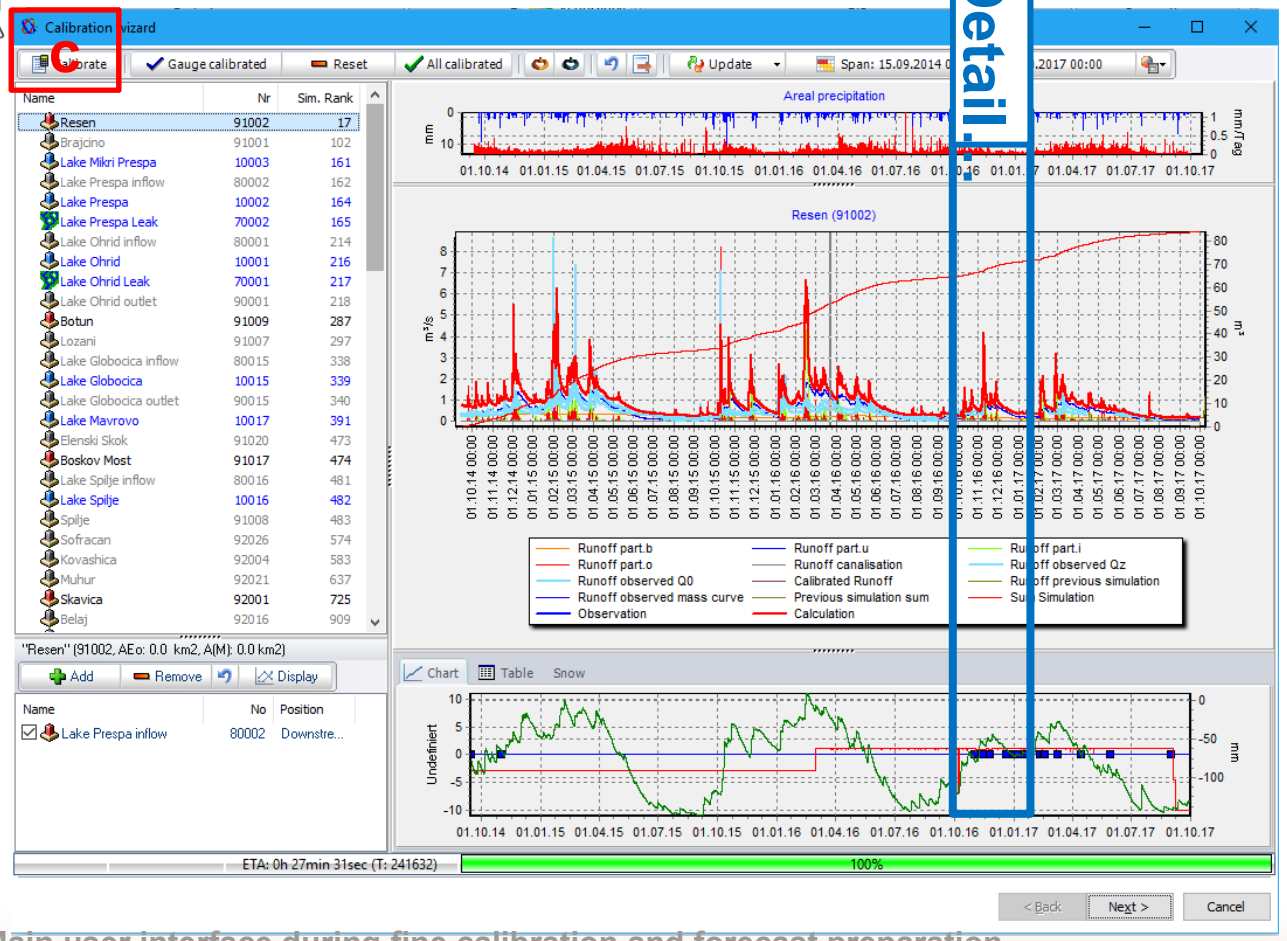
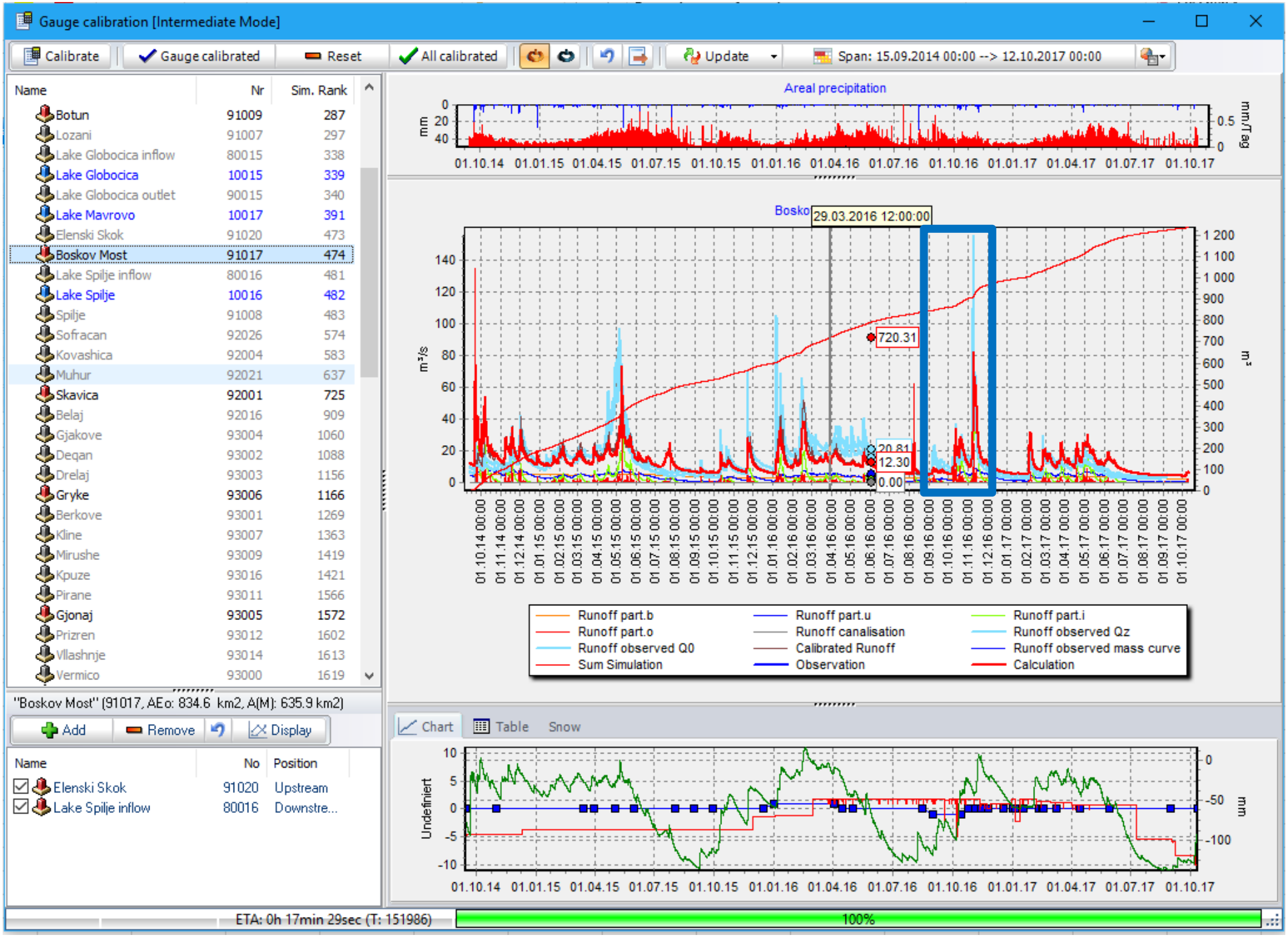
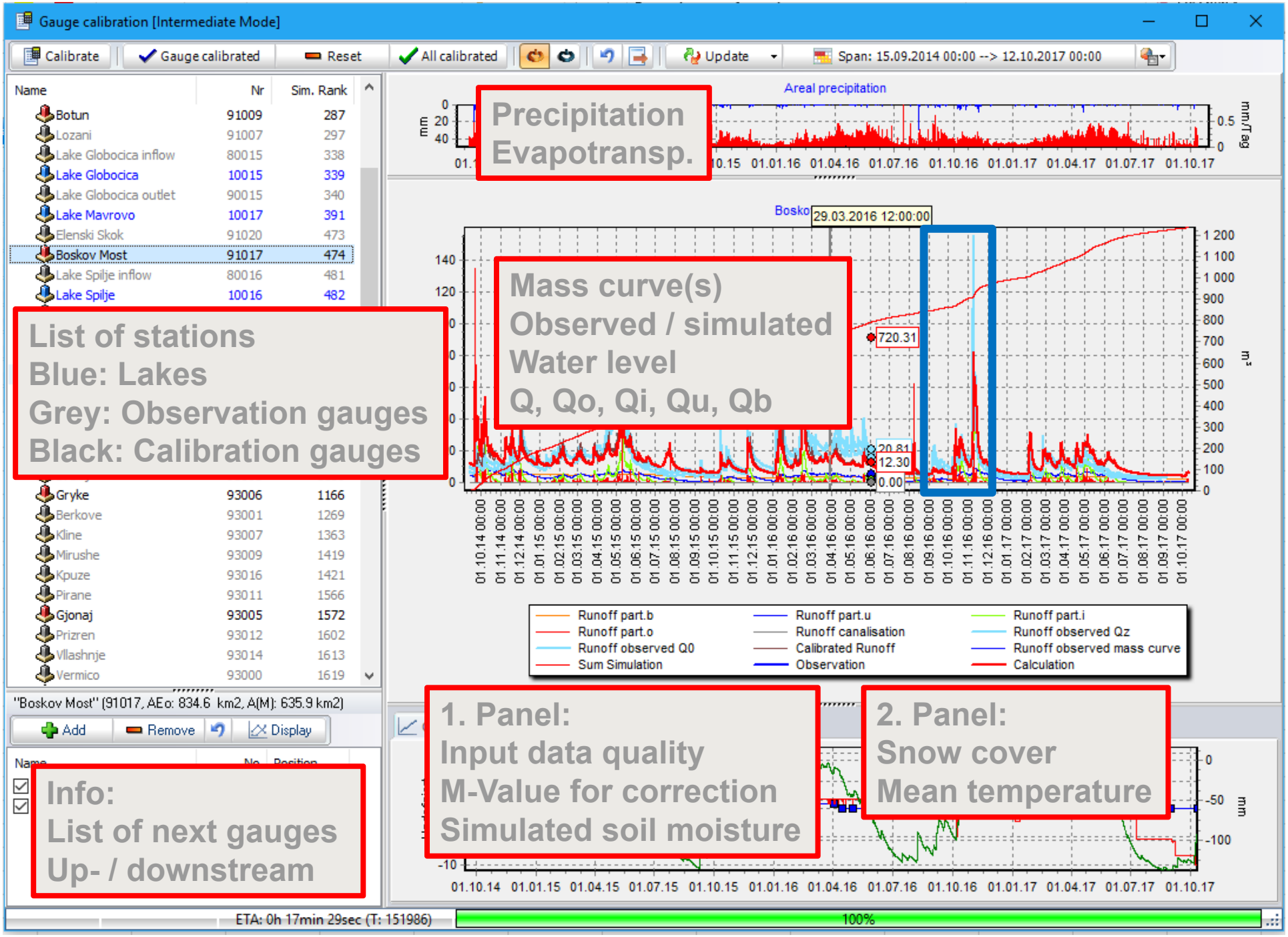


Fig. Main user interface during fine calibration and forecast preparation.
Shown here: simulation of complete period from 09/2014 – 10/2017


Gauge calibration [Intermediate Mode]
Calibrate
Gauge calibrated
Reset
All calibrated
Update
Span: 15.09.2014 00:00 --> 12.10.2017 00:00
Name
Nr
Sim. Rank
Botun 91009 287
Lozani 91007 297
Lake Globocica inflow 80015 338
Lake Globocica 10015 339
Lake Globocica outlet 90015 340
Lake Mavrovo 10017 391
Elenski Skok 91020 473
Boskov Most 91017 474
Lake Spilje inflow 80016 481
Lake Spilje 10016 482
Spilje 91008 483
Sofracan 92026 574
Kovashica 92004 583
Muhur 92021 637
Skavica 92001 725
Belaj 92016 909
Gjakove 93004 1060
Deqan 93002 1088
Drelaj 93003 1156
Gryke 93006 1166
Berkove 93001 1269
Kline 93007 1363
Mirushe 93009 1419
Kpuze 93016 1421
Pirane 93011 1566
Gjonaj 93005 1572
Prizren 93012 1602
Vllashnje 93014 1613
Vermico 93000 1619
"Boskov Most" (91017, AEo: 834.6 km2, A(M): 635.9 km2)
Add
Remove
Display
Name
No
Position
Elenski Skok 91020 Upstream
Lake Spilje inflow 80016 Downstre...
Areal precipitation
mm
mm/Tag
01.10.14 01.01.15 01.04.15 01.07.15 01.10.15 01.01.16 01.04.16 01.07.16 01.10.16 01.01.17 01.04.17 01.07.17 01.10.17
Bosko
29.03.2016 12:00:00
720.31
20.81
12.30
0.00
m³/s
m³
Runoff part.b
Runoff part.u
Runoff part.i
Runoff part.o
Runoff canalisation
Runoff observed Qz
Runoff observed Q0
Calibrated Runoff
Runoff observed mass curve
Sum Simulation
Observation
Calculation
Chart
Table
Snow
Undefiniert
mm
ETA: 0h 17min 29sec (T: 151986)
100%


Gauge calibration [Intermediate Mode]
Calibrate
Gauge calibrated
Reset
All calibrated
Update
Span: 15.09.2014 00:00 --> 12.10.2017 00:00
Name
Nr
Sim. Rank
Botun 91009 287
Lozani 91007 297
Lake Globocica inflow 80015 338
Lake Globocica 10015 339
Lake Globocica outlet 90015 340
Lake Mavrovo 10017 391
Elenski Skok 91020 473
Boskov Most 91017 474
Lake Spilje inflow 80016 481
Lake Spilje 10016 482
Gryke 93006 1166
Berkove 93001 1269
Kline 93007 1363
Mirushe 93009 1419
Kpuze 93016 1421
Pirane 93011 1566
Gjonaj 93005 1572
Prizren 93012 1602
Vllashnje 93014 1613
Vermico 93000 1619
"Boskov Most" (91017, AEo: 834.6 km2, A(M): 635.9 km2)
Add
Remove
Display
Areal precipitation
mm
mm/Tag
Bosko
29.03.2016 12:00:00
720.31
20.81
12.30
0.00
m³
Runoff part.b
Runoff part.u
Runoff part.i
Runoff part.o
Runoff canalisation
Runoff observed Qz
Runoff observed Q0
Calibrated Runoff
Runoff observed mass curve
Sum Simulation
Observation
Calculation
ETA: 0h 17min 29sec (T: 151986)
100%
Precipitation
Evapotransp.
List of stations
Blue: Lakes
Grey: Observation gauges
Black: Calibration gauges
Mass curve(s)
Observed / simulated
Water level
Q, Qo, Qi, Qu, Qb
1. Panel:
Input data quality
M-Value for correction
Simulated soil moisture
2. Panel:
Snow cover
Mean temperature
Info:
List of next gauges
Up- / downstream

2. Working with DB-FFS

2.3.1 Overview on planned quantitative meteorological forecast

Presentation NMM-E v3.8.1 (with bc ECMWF, GFS/NCEP), *common numerical meteorological forecast system for common flood forecast system*

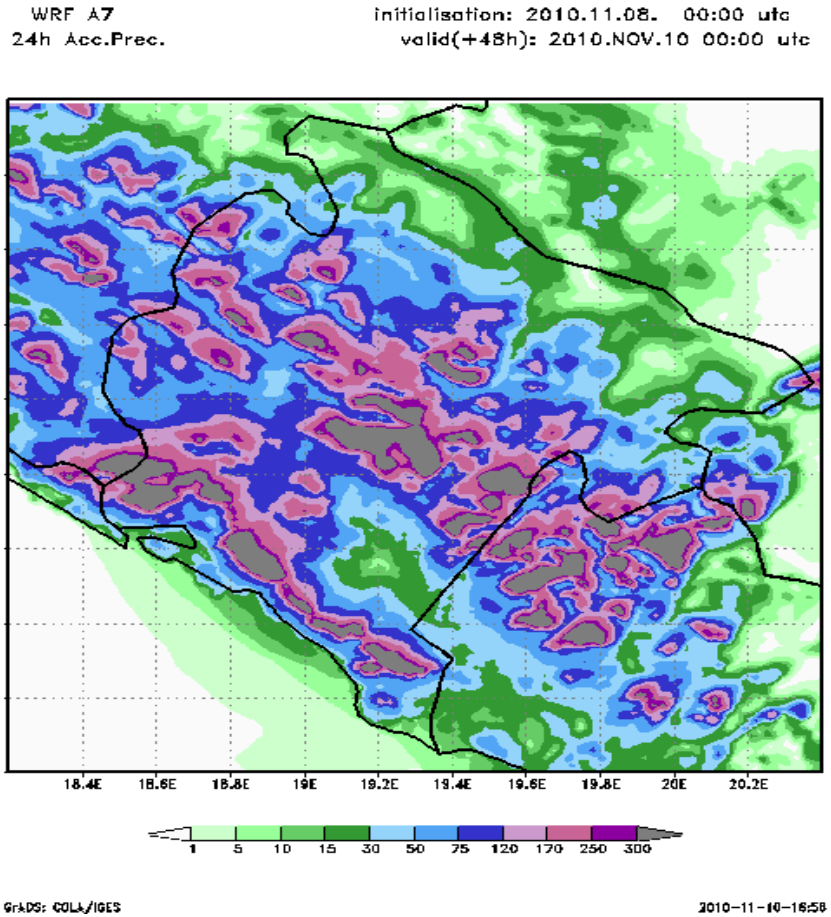
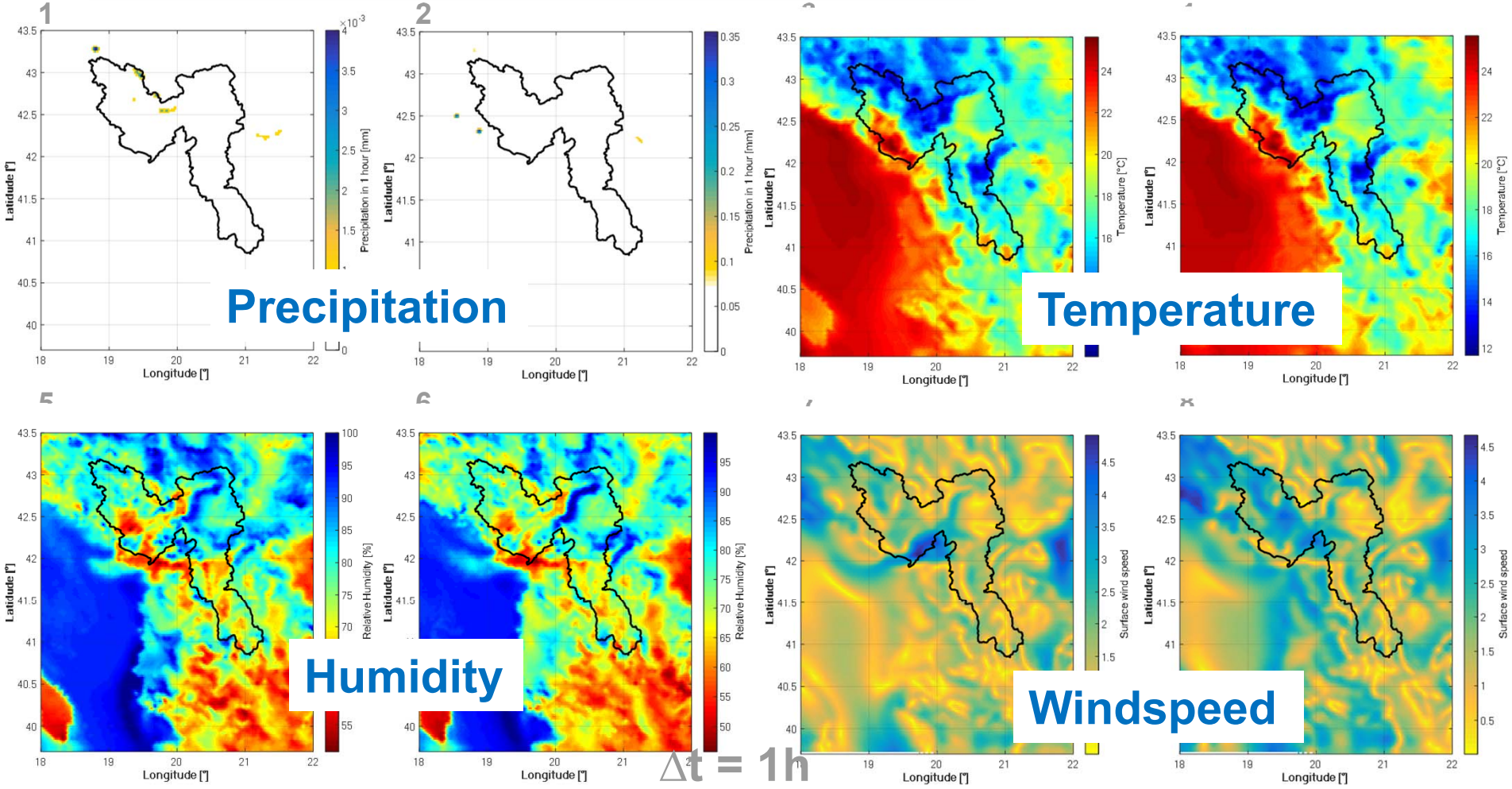


Fig. Example of the result of numerical model WRF for Weather condition of November 2010. which caused the floods

(source by A.Marcev, IHMS Montenegro)

2. Working with DB-FFS (IfW)

2.3.2 Contribution by IfW



2. Working with DB-FFS

2.4 Simulation of flood forecast

Start / loading Project
Forecast Wizard
- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
  - **select ensemble**
  - **perform simulation(s)**

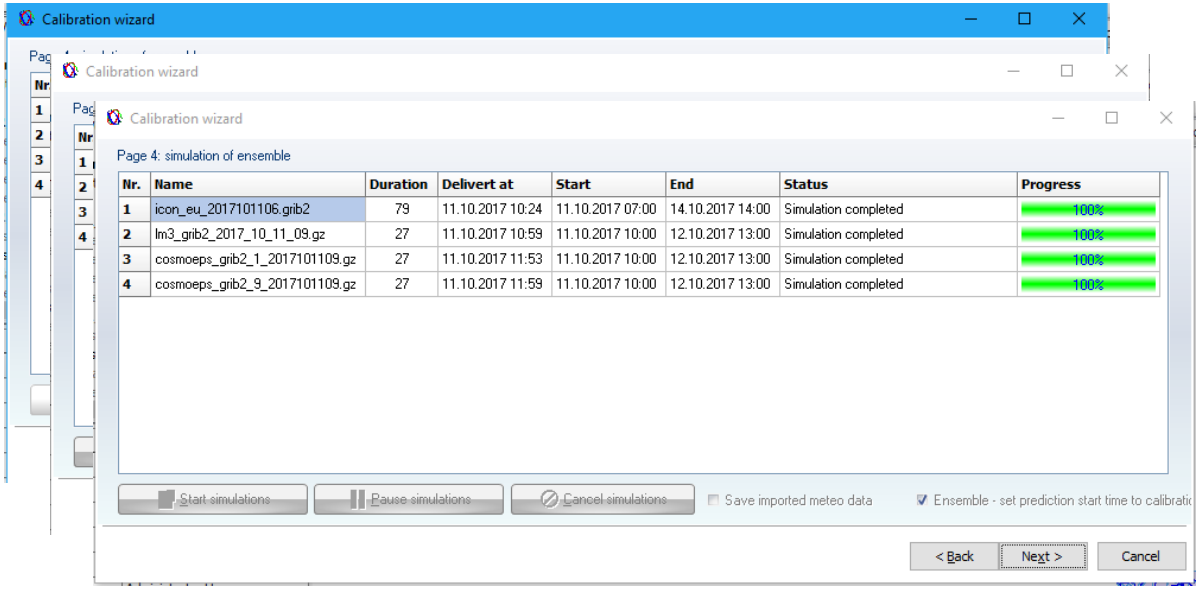


Fig. List of flood forecast scenarios: start the simulation run(s)

2. Working with DB-FFS

2.5 Processing and display of results

Start / loading Project
Forecast Wizard
- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
- **Show results**

How can forecast results be displayed and analysed?

-> Default analysis: a warn level map and all hydrographs can be displayed

-> Detailed analysis: features (graphs, maps, tables) will be part of the Result Manager (post-processing module)

2. Working with DB-FFS

2.5 Processing and display of results

Start / loading Project
Forecast Wizard
- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
- **Show results**
  - **Map view**

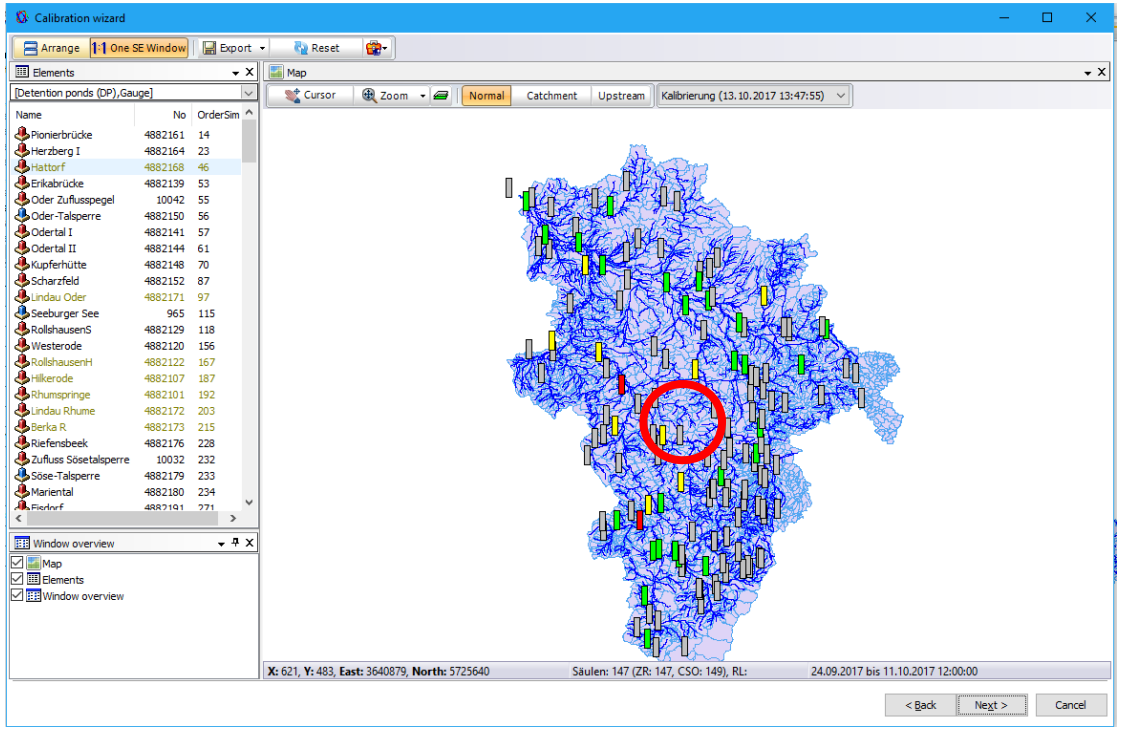


Fig. Warn level map
Overview of maximum discharge / water level coded as warn level symbol (1=yellow, 2=orange, 3=red; grey=no warn level set)

2. Working with DB-FFS

2.5 Processing and display of results

Start / loading Project
Forecast Wizard
- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
- **Show results**
  - **Map view**
  - **Graph view**

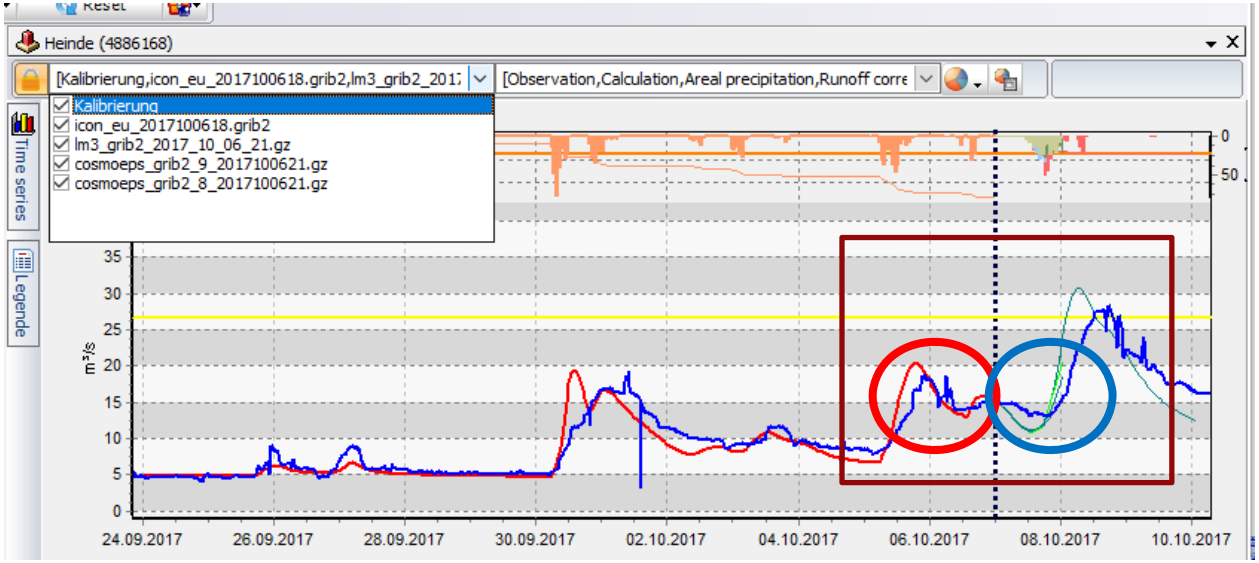


Fig. Sample from German flood forecast model: Forecasted hydrographs of a gauge. Shown are calibration and a scenario of 4 forecasts: „Icon“, „lm3“, „cosmoeps“ red=simulation, blue=observation; right hand: forecasted flood Q and offset forecasted flood dQ

2. Working with DB-FFS

2.5 Processing and display of results

Start / loading Project
Forecast Wizard
- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
- **Show results**
  - **Map view**
  - **Graph view**

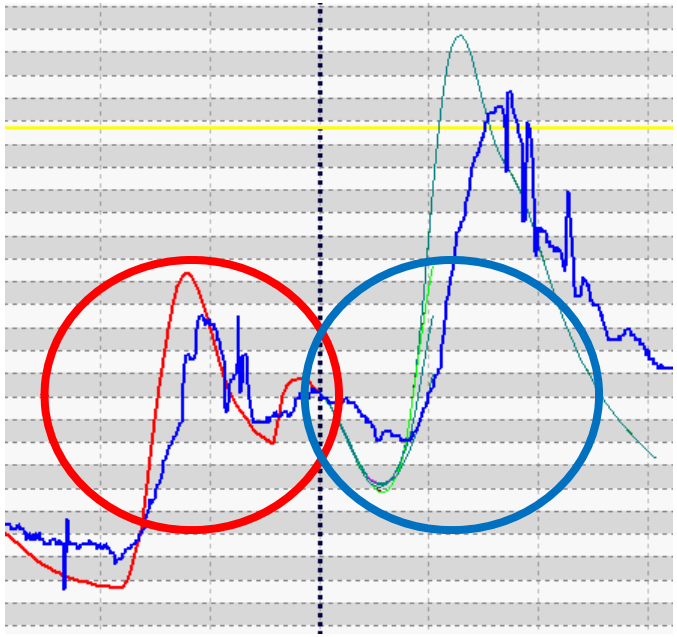


Fig. Zoom into previous image:
Red circle: possible problem during flood forecast simulation:
offset between simulation and observation
Blue circle: ensemble result variation

2. Working with DB-FFS

2.5 Processing and display of results

Start / loading Project
Forecast Wizard

- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
- **Show results**
  - **Map view**
  - **Graph view**

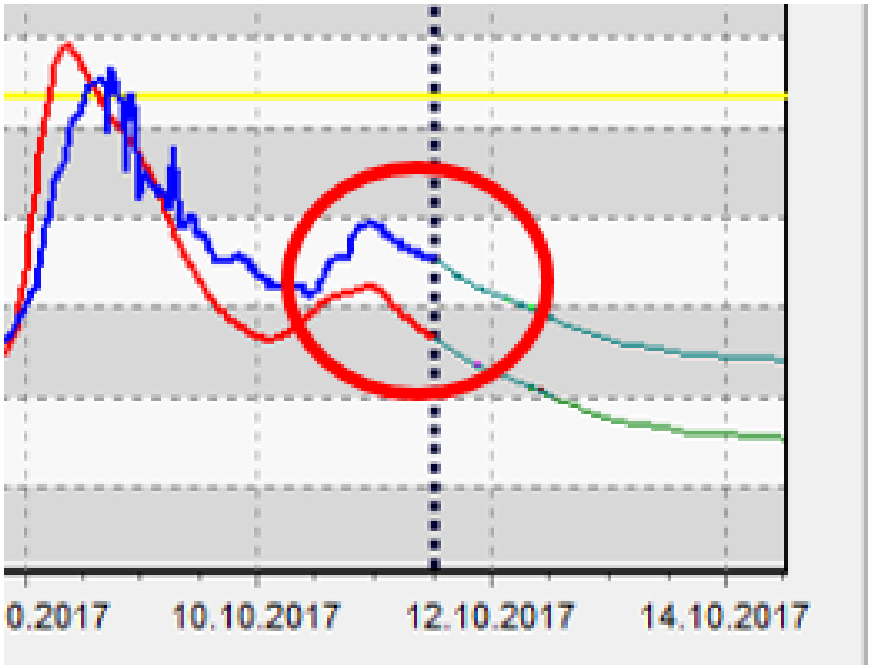
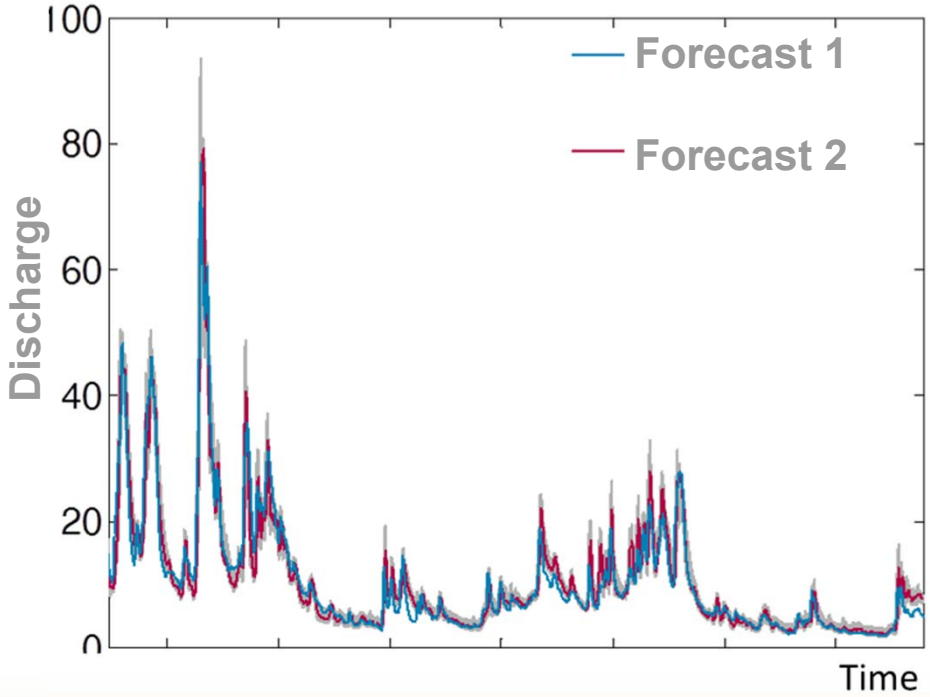


Fig. If end of calibration looks like this (too high deviation)
-> re-calibration is recommended!

2. Working with DB-FFS (IfW)

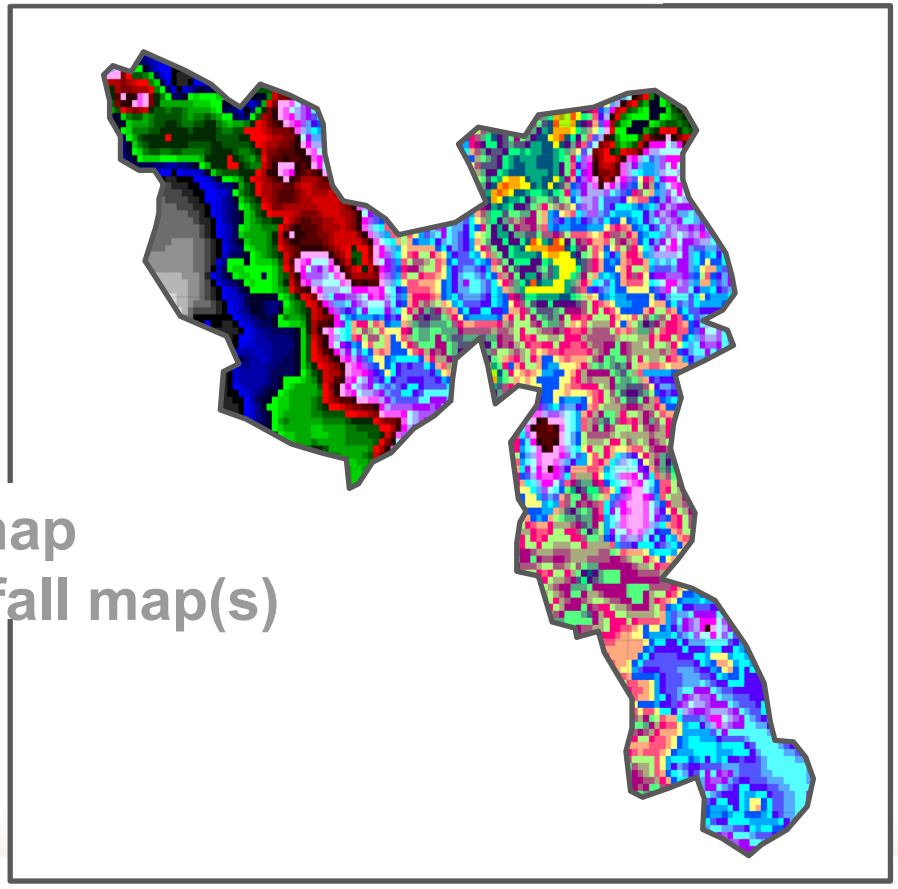
2.5 Processing and display of results

- **Hydrographs of forecasted flood ensembles**



2. Working with DB-FFS (IfW)

2.5 Processing and display of results

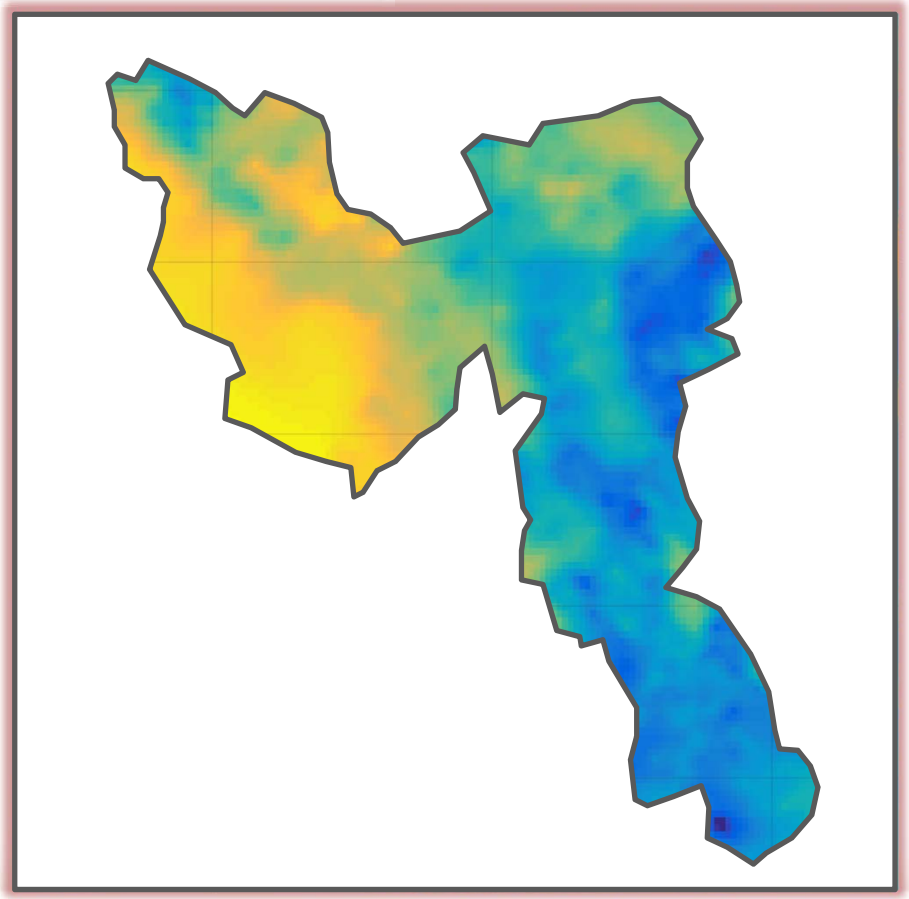


- Online rainfall map
- Forecasted rainfall map(s)

2. Working with DB-FFS (IfW)

2.5 Processing and display of results

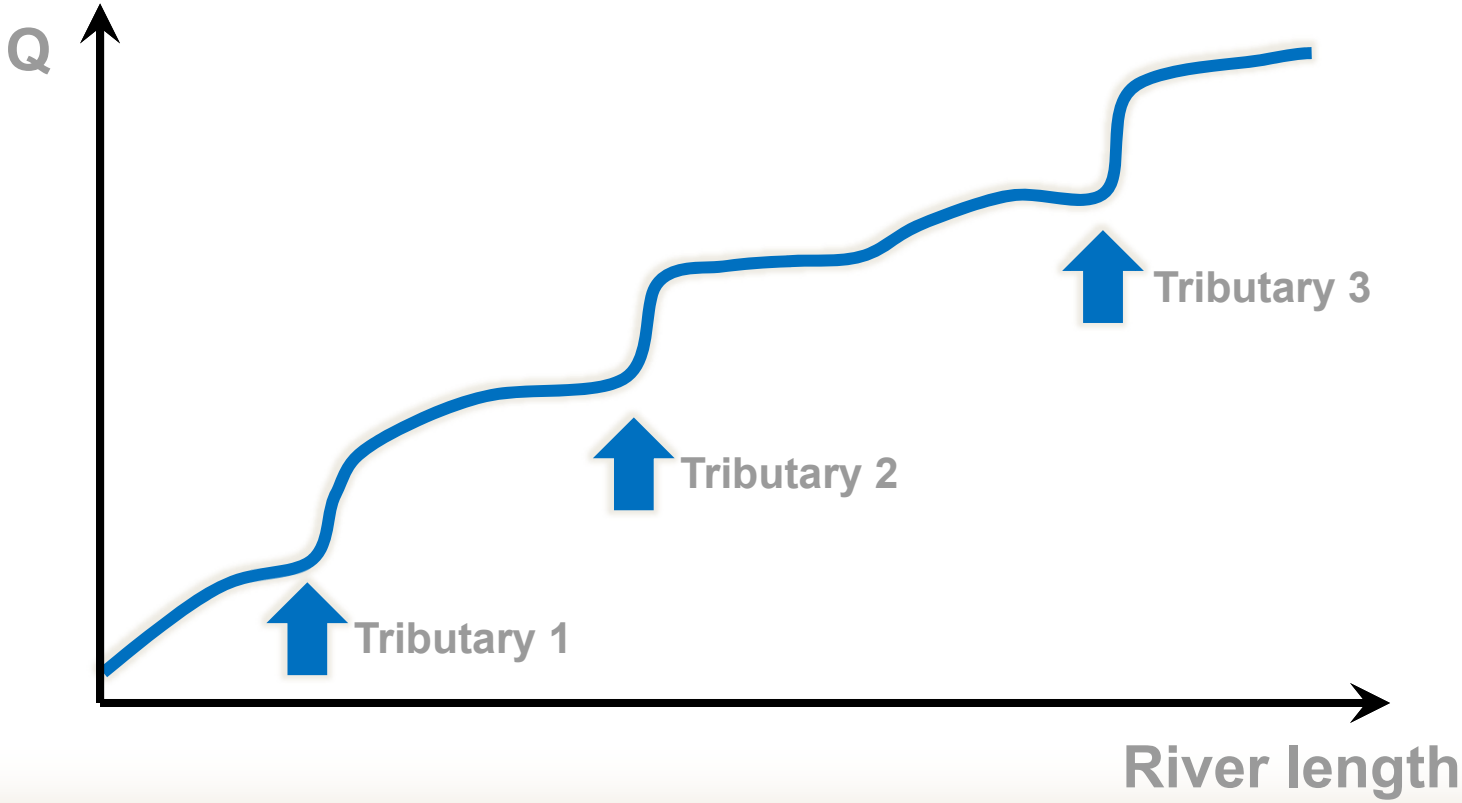
- Soil moisture map



2. Working with DB-FFS (IfW)

2.5 Processing and display of results

- **Longitudinal flood section**



2. Working with DB-FFS

2.5 Processing and display of results

Start / loading Project
Forecast Wizard

- **Data update**
- **Data check**
- **Fine calibration**
- **Meteo forecast**
- **Show results**
- **Upload results**

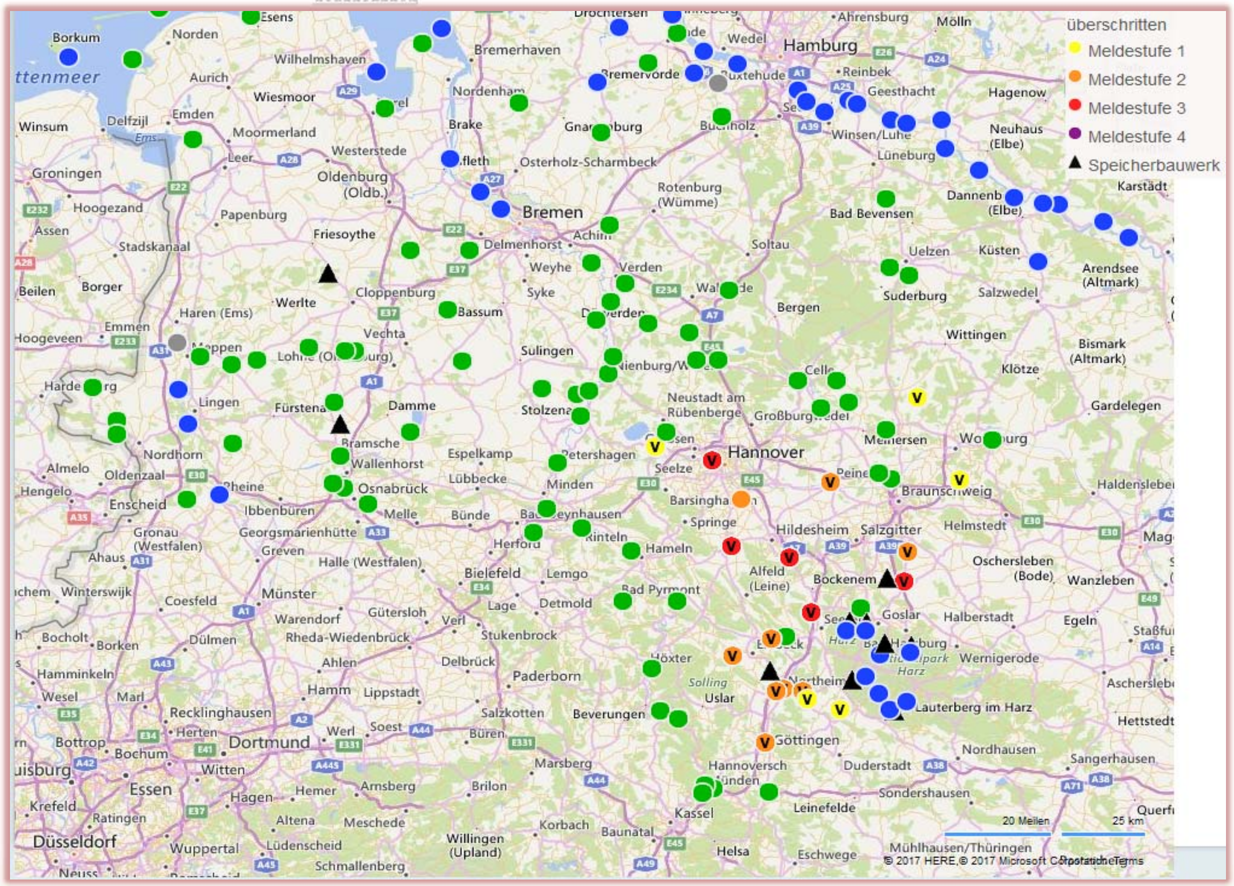
How does the detailed analysis look like?

-> The Result Manager has a GIS like user interface. The forecast simulation results (hydrographs, tables, raster) will be imported and then be ready for map and graph display.

2. Working with DB-FFS

2.5 Processing and display of results

- **Example: Flood in Germany July 2017**
- **Forecast center uses PANTA RHEI model**
- **Map showing all gauging stations and in colour their specific warning level regarding flood forecast**



2. Working with DB-FFS

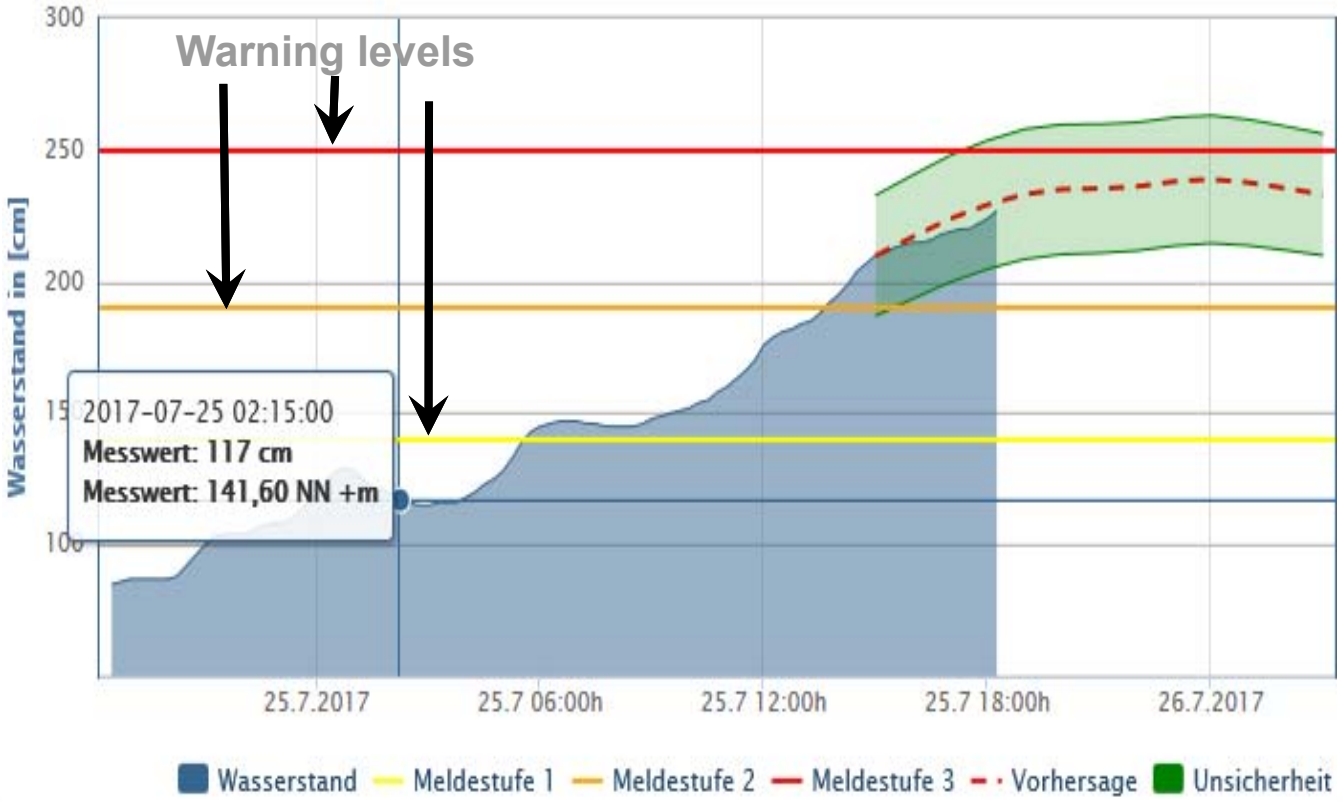
2.5 Processing and display of results

- Example: Flood in Germany July 2017
- Forecast center uses PANTA RHEI model
- Every gauge can be selected to obtain further details

→ Main properties

→ Water level

Water level: Measurement (blue) and forecast (red, dotted) and forecast uncertainity (green)



IS IT ENOUGH DB-FFSystem?

Different floods

-River floods
-Flash Floods
-Urban Floods

How to alert our self from other floods ?

OTHER TOOLS FOR FLOOD forecasting

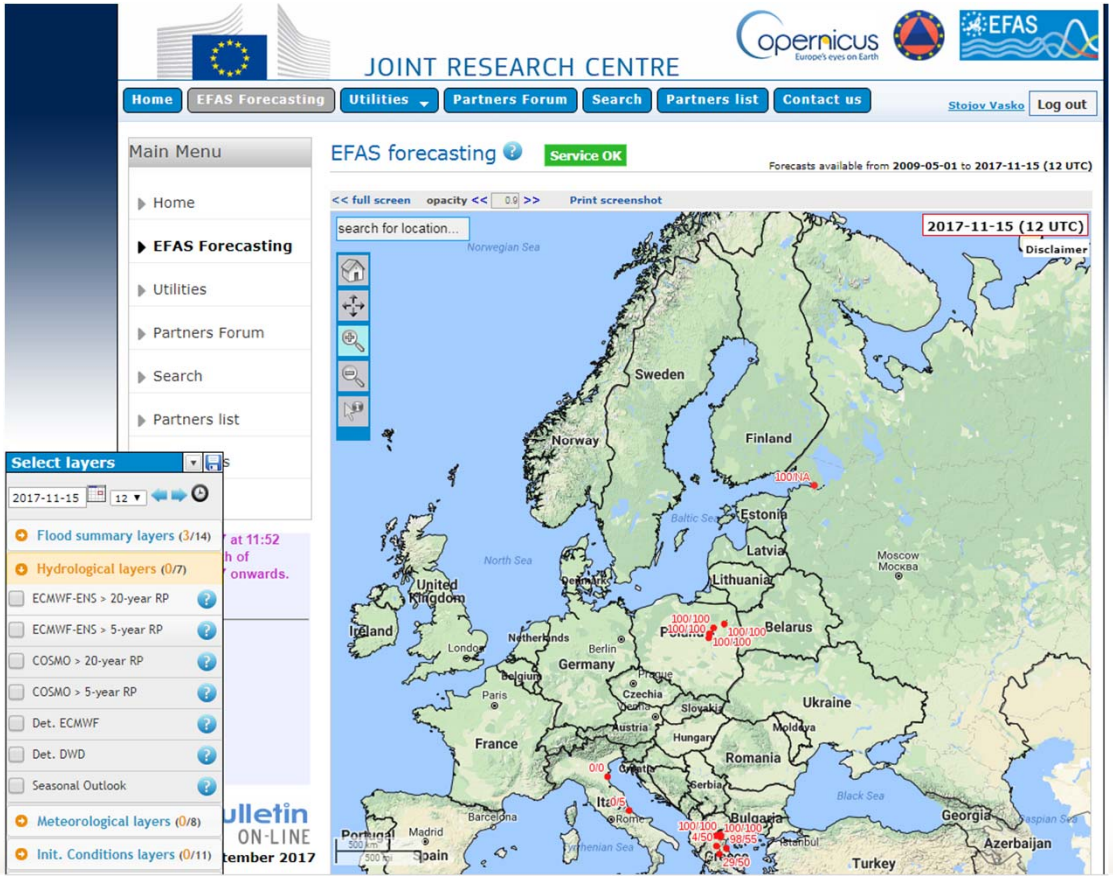
European Flood Awareness System (EFAS)

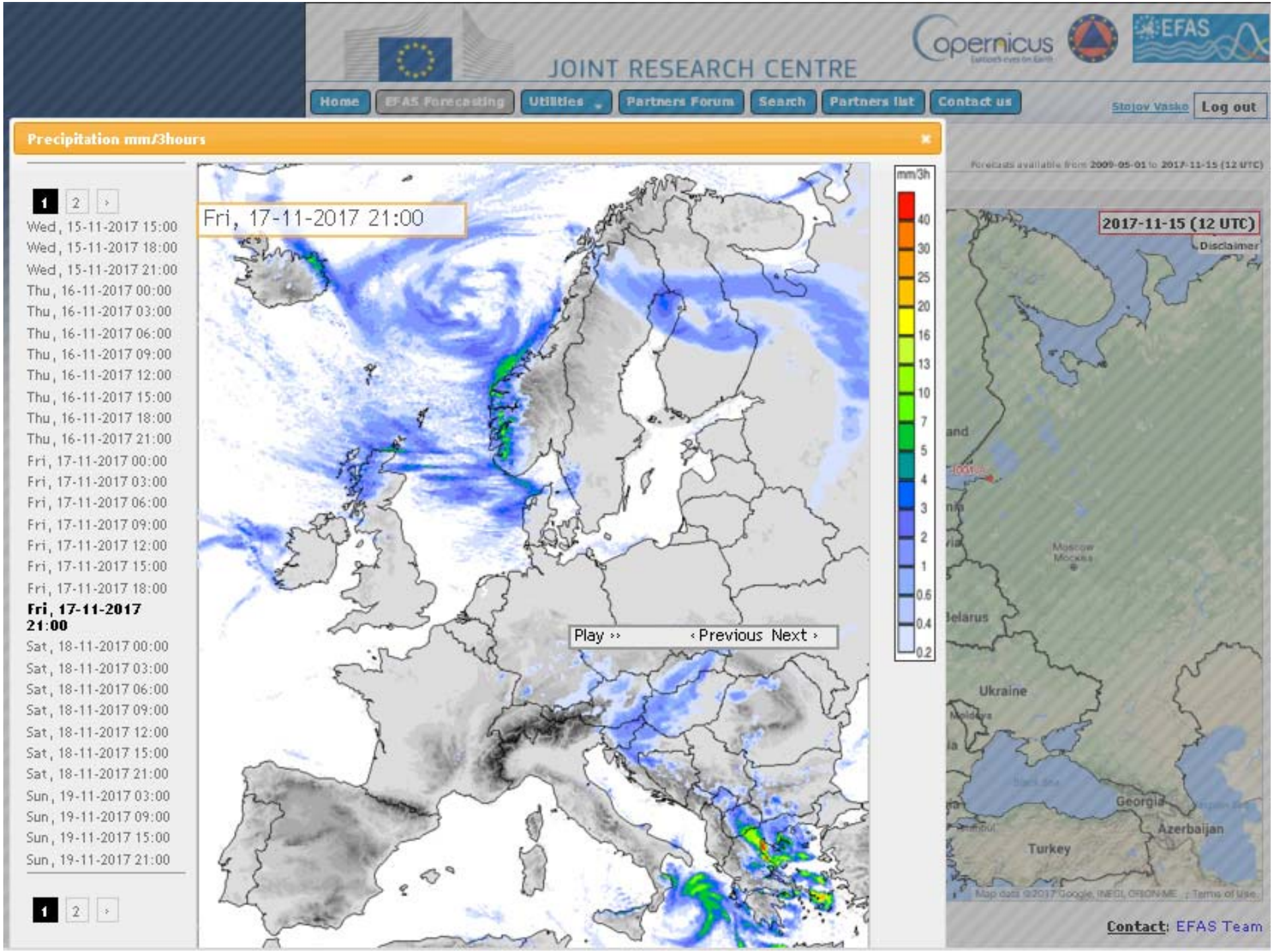
EFAS is the first operational European system for monitoring and forecasting floods across Europe.
It provides complementary, flood early warning information up to 10 days in advance to its partners:
the National/Regional Hydrological Services

Flood Warnings - General information for bigger catchments

EFAS

Text alerts

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Copernicus
EFAS
Home
EFAS Forecasting
Utilities
Partners Forum
Search
Partners list
Contact us
Stojov Vasko
Log out
Precipitation mm/3hours
Forecasts available from 2009-05-01 to 2017-11-15 (12 UTC)
1
2
Wed, 15-11-2017 15:00
Wed, 15-11-2017 18:00
Wed, 15-11-2017 21:00
Thu, 16-11-2017 00:00
Thu, 16-11-2017 03:00
Thu, 16-11-2017 06:00
Thu, 16-11-2017 09:00
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40
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20
16
13
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5
4
3
2
1
0.6
0.4
0.2
2017-11-15 (12 UTC)
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Contact: EFAS Team


Flash Flood

SEE FFGS – Product Console

SEEFFG - Southeast Europe Flash Flood Guidance System

Current Date: 2017-11-16 09:00 UTC Product Date: 2017-11-16 07:00 UTC

Year: 2017 Month: 11 Day: 16 Hour: 07 REGION: REGIONAL Submit

-1 Month | -1 Day | -6 Hours | -1 Hour | +1 Hour | +6 Hours | +1 Day | +1 Month

Prev 6-hr Interval (06 UTC) | Reset to Current | Next 6-hr Interval (12 UTC)

Product Console - Main Table

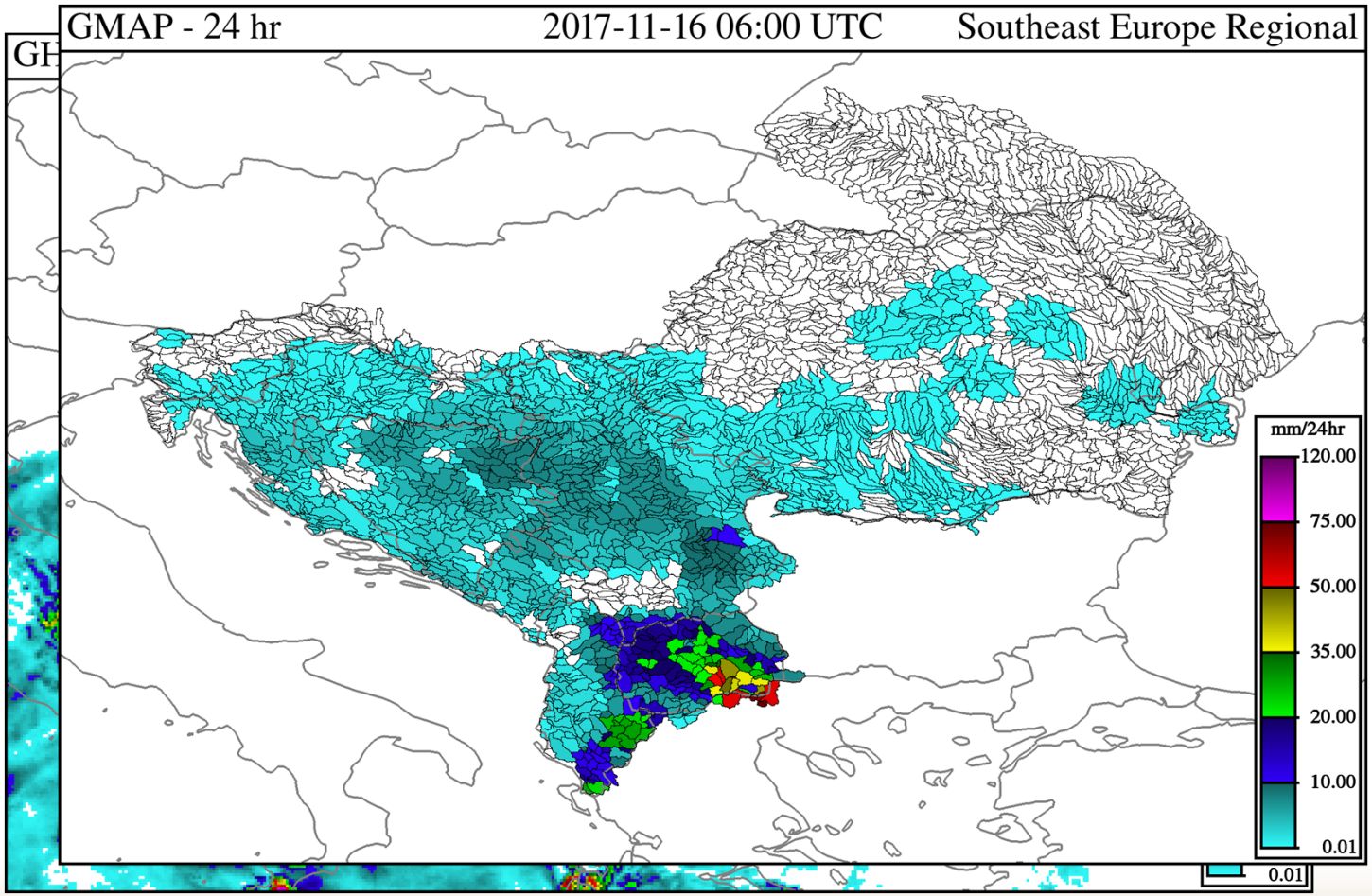
DT	MWGHE Precipitation	GHE Precipitation	Gauge MAP	Merged MAP	ASM	FFG	IFFT	PFFT	ALADIN Forecast	FMAP	FFFT
01-hr	2017-11-16 07:00 UTC Text: view	2017-11-16 07:00 UTC Text: view		2017-11-16 07:00 UTC Text: view		2017-11-16 06:00 UTC Text: view	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 07:00 UTC	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view
03-hr	2017-11-16 07:00 UTC Text: view	2017-11-16 07:00 UTC Text: view		2017-11-16 07:00 UTC Text: view		2017-11-16 06:00 UTC Text: view	2017-11-16 03:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 07:00 UTC	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view
06-hr	2017-11-16 07:00 UTC Text: view	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 07:00 UTC	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view
24-hr	2017-11-16 07:00 UTC Text: view	2017-11-16 07:00 UTC Text: view	2017-11-16 06:00 UTC Text: view	2017-11-16 07:00 UTC Text: view					2017-11-16 07:00 UTC	2017-11-16 07:00 UTC Text: view	

Composite Product: text , CSV , CSVT SFTP data transfer (requires SFTP Client): EXPORTS/REGIONAL/2017/11/16

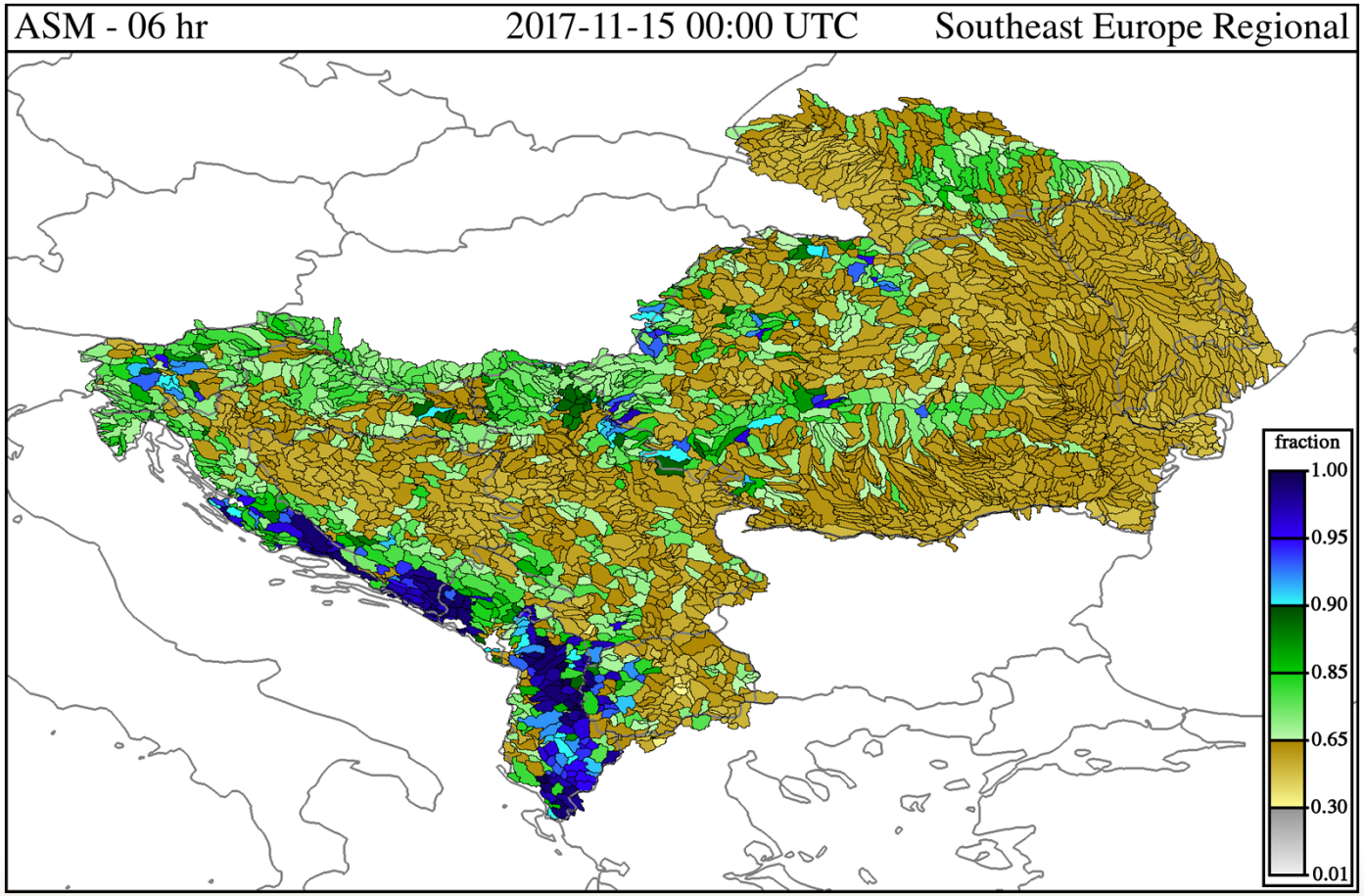
Surfmet Gauge Observations at 2017-11-16 06:00 UTC

Station Identifier	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag
11001	Wolfsegg	0.00	-1.00	Southeast Europe Regional	48.1	13.6833333333	634	Enabled
11008	Rohrbach	0.00	0.60	Southeast Europe Regional	48.5666666666	14	602	Enabled
11010	Linz / Hoersching-Flughafen	0.00	-0.80	Southeast Europe Regional	48.2333333333	14.1833333333	298	Enabled
11012	Kremsmuenster	0.00	0.30	Southeast Europe Regional	48.05	14.1333333333	383	Enabled
11018	Amstetten	0.00	0.15	Southeast Europe Regional	48.1166666666	14.8666666666	274	Enabled
11019	Allentsteig	0.00	-1.05	Southeast Europe Regional	48.6833333333	15.3666666666	598	Enabled
11020	Zwettl	0.00	-0.30	Southeast Europe Regional	48.6166666666	15.2	506	Enabled
11021	Litschau	0.00	-0.85	Southeast Europe Regional	48.9666666666	15.0333333333	564	Enabled

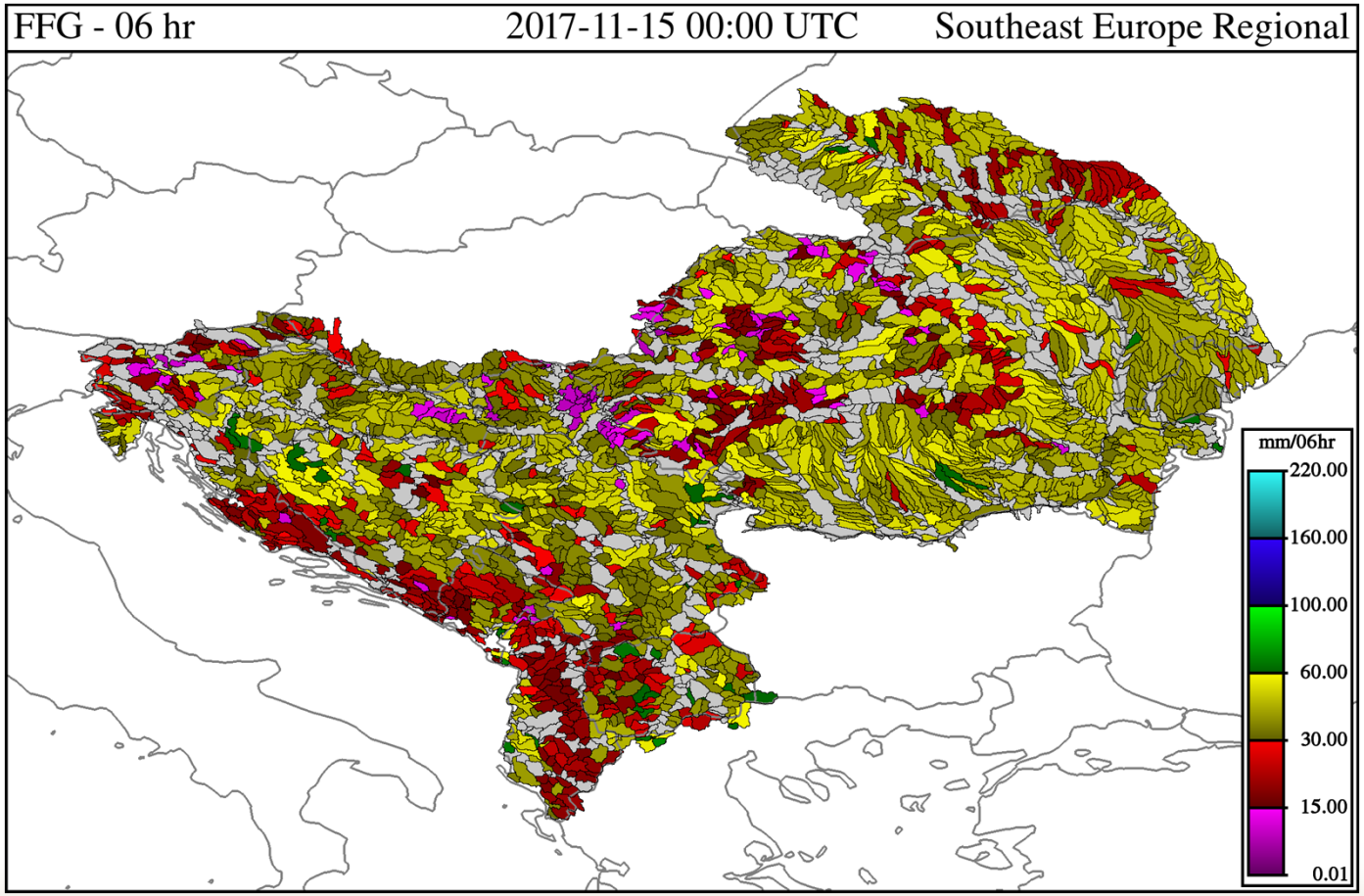
SEE FFGS – Precipitation



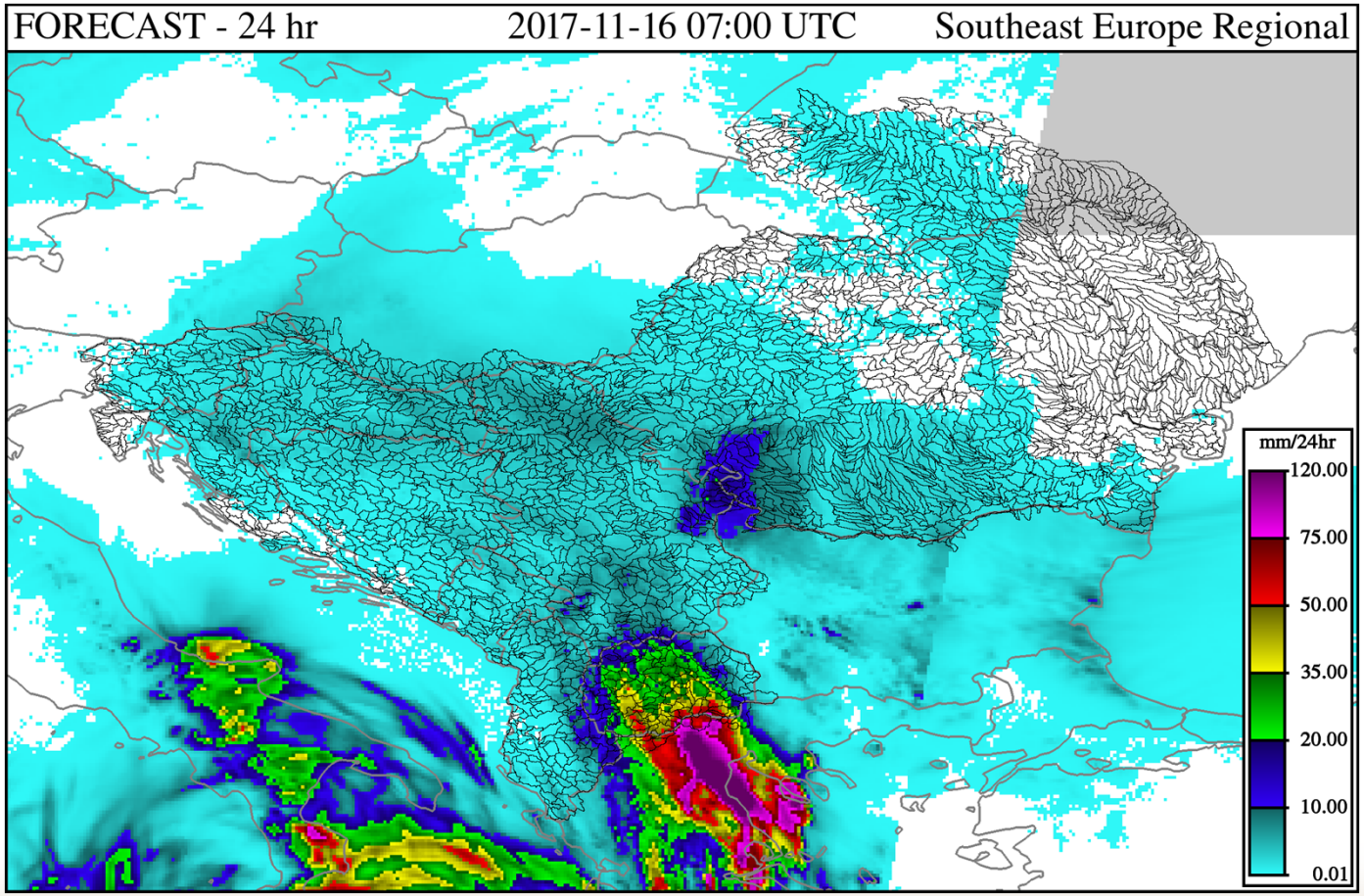
SEE FFGS – Soil Moisture



SEE FFGS – FFG


FFG - 06 hr
2017-11-15 00:00 UTC
Southeast Europe Regional
mm/06hr
220.00
160.00
100.00
60.00
30.00
15.00
0.01

SEE FFGS – Forecast (Aladdin)



WHAT IS REALITY?

- **With Drim Bojana-Flood Forecasting System, EFAS, SEE-FFGS**

Flood forecasting

in the Drin/Drim-Buna/Bojana River Basin

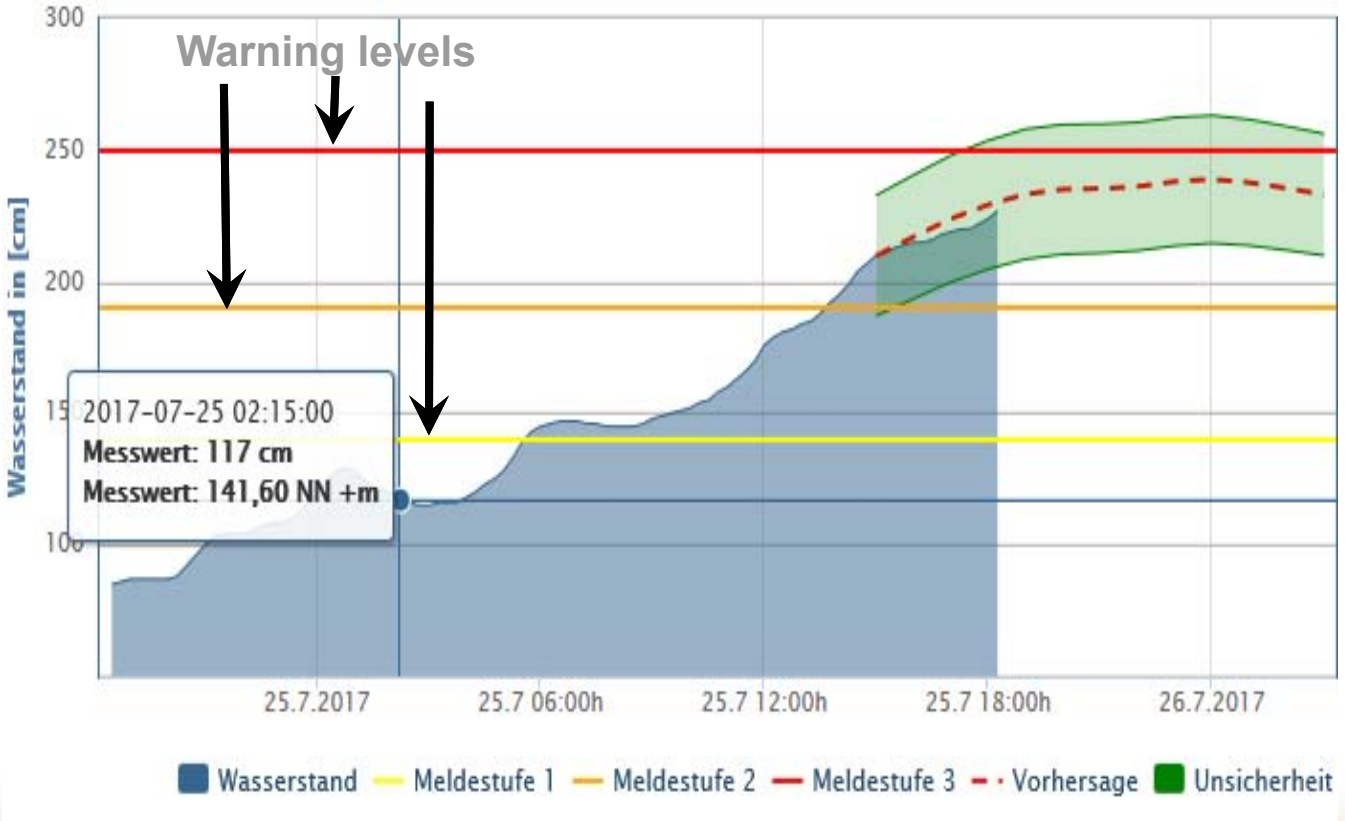
will be on higher level, but is it enough?

NO

FLOODS ARE OUR REALITY

FLOOD MANAGEMENT

WARNING LEVELS DESIGN
for Drin/Drim-Buna/Bojana River Basin



EUROPEAN FLOOD DIRECTIVE

FLOOD
RISK and HAZARD Maps

Structure measures

Non Structure measures

Learn to live with floods…

…thank you for your attention

Thank you for slide support to:

Gerrit Bodenbender
Günter Meon
Gerhard Riedel
Phillip Kreye
Angel Marchev
Amparo Samper
Michael Haase
Faton Sopi
Nikoleta Bogatinovska
Keti Bushinoska

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Hydrometeorological Service, Republic of Macedonia