The July-Flood in Germany
with focus on the Ahr-Basin and challenges in forecasting

State Environmental Agency Rhineland-Palatinate (LfU RP)
Flood Forecasting Center in Mainz
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EFAS-Meeting 28/10/2021

Outline

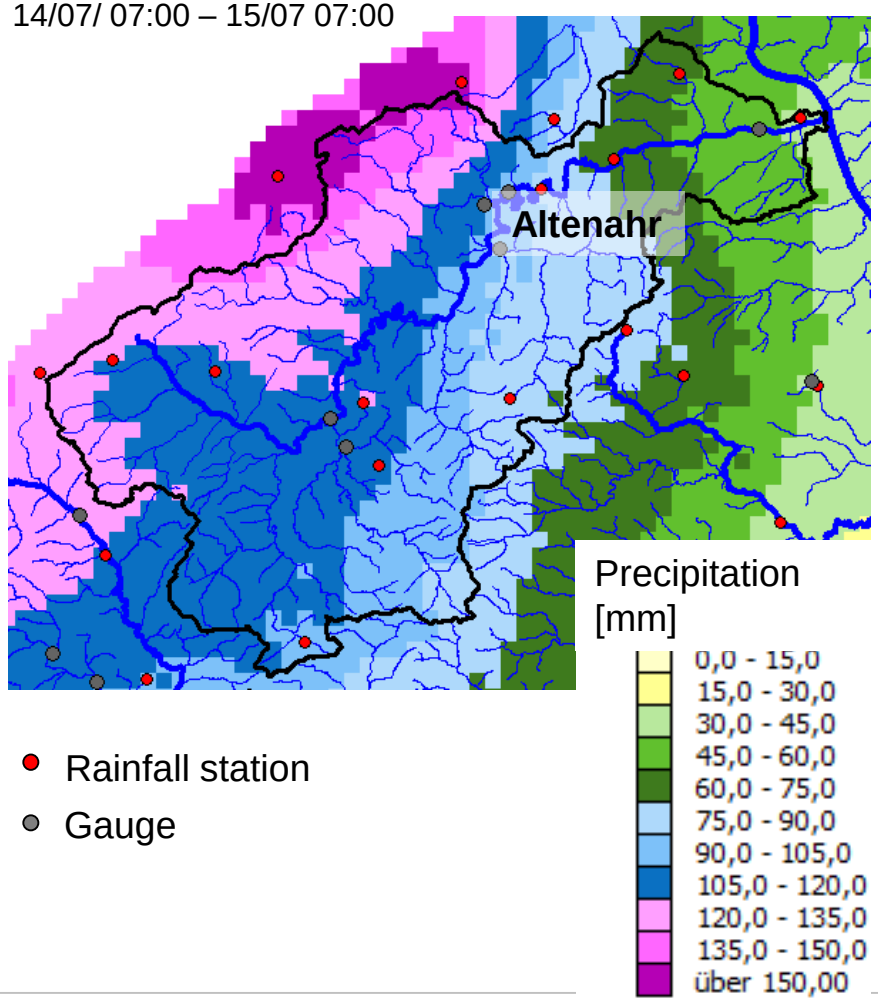
1. Introduction
2. Service at Flood Forecasting Center in Mainz
3. Forecasting methods
4. Challenges in forecasting
5. Warnings around 14/07/2021
6. Conclusions

Introduction

The Ahr-Flood 14 & 15 July 2021

Daily precipitation in the Ahr-Basin

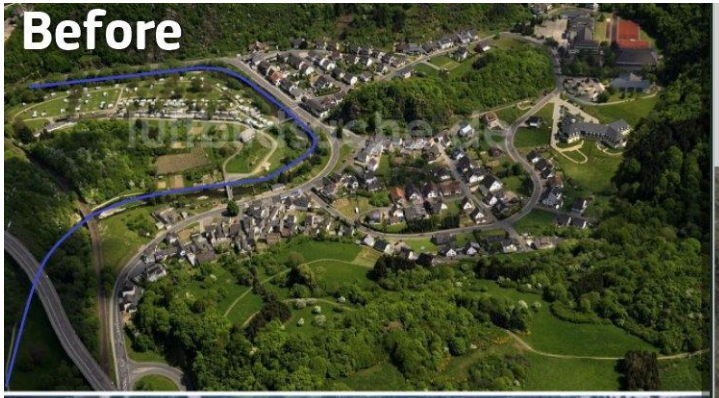
14/07/ 07:00 – 15/07 07:00

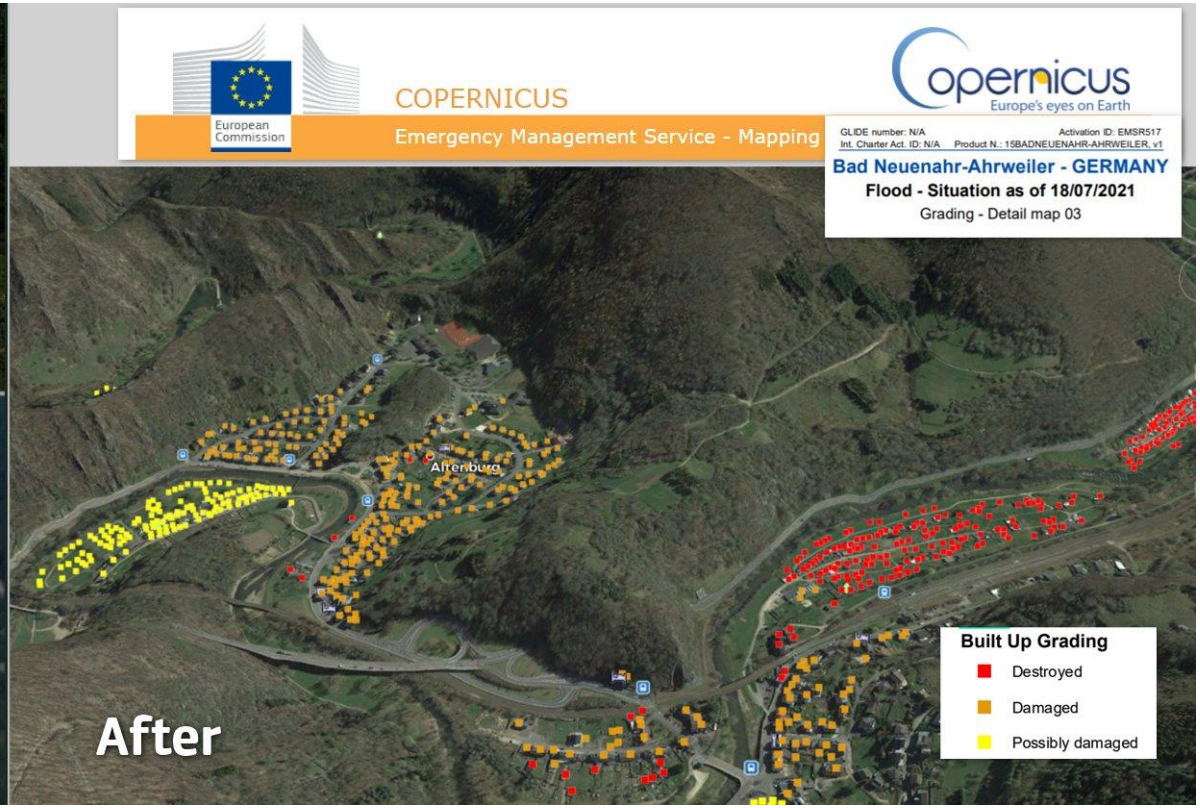


- Low mountain range basin in the eastern Eifel, river Ahr: 85 km
- Extreme precipitation on wet soils
- Gauge Altenahr (764 km²): Increase of water level of about 9 m in 12 h (2-3 m due to blocked bridges)
- Interrupted data transfer, 3 gauges completely destroyed
- Return period of flood > 1.000 (based on 80 year long measurement timeseries)
- About 130 fatalities
- Civil protection prepared for a 100-year-flood (4-5 m water level)
- Historical floods (1804, 1910) were not in memory and not used in statistics

Introduction
Flooded areas an damages

Copernicus EMS was activated on 13/07/2021 via BBK by the federal states RP, BW und NW.





https://twitter.com/CopernicusEMS/status/1417758807351078913

Flood Forecasting Center in Mainz

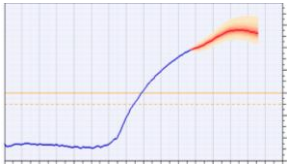
- In Germany according to Federal Water Act flood protection is in the responsibility of the federal states
- Flood Forecasting Center in Mainz → flood forecasting and notification for the Rhine (in cooperation with BfG) and all other rivers in Rhineland-Palatinate according to Flood Notification Ordinance
- Team of 24 persons working in different groups and different functional positions depending on situation
- from 08/07 - 19/07/2021 24h-service with shift-working (up to 9 persons per shift)

Flood Forecasting Center

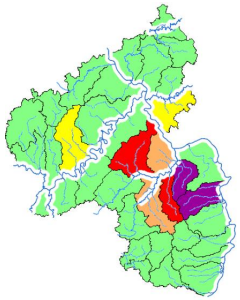
Notification chain and alerting tools

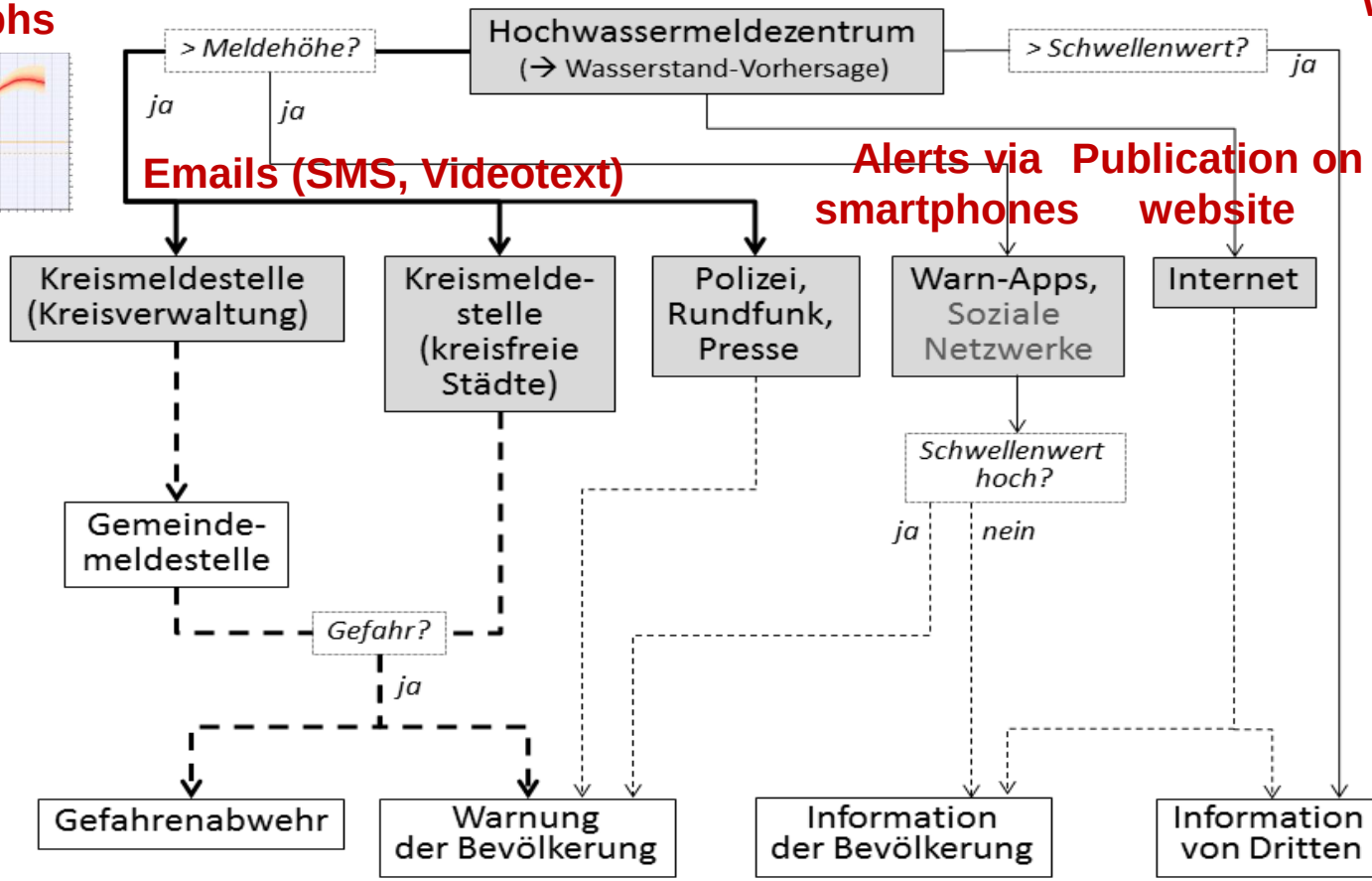
RheinlandPfalz
LANDESAMT FÜR UMWELT

Hydrographs



Warning map

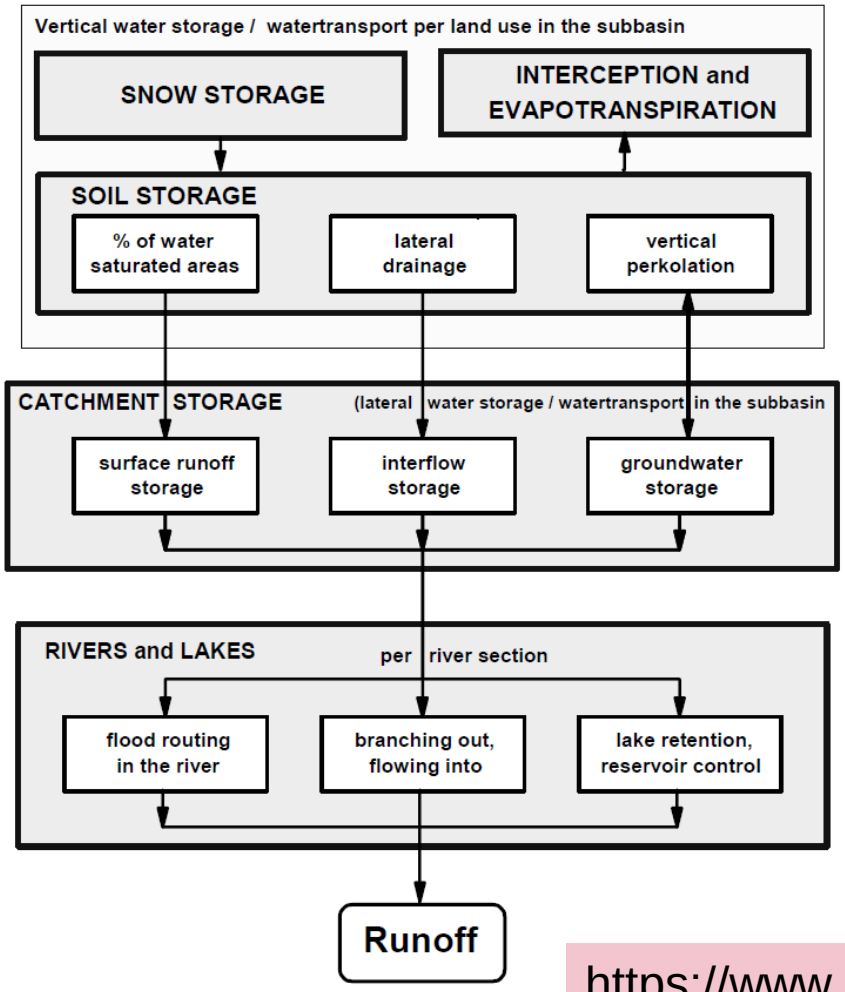


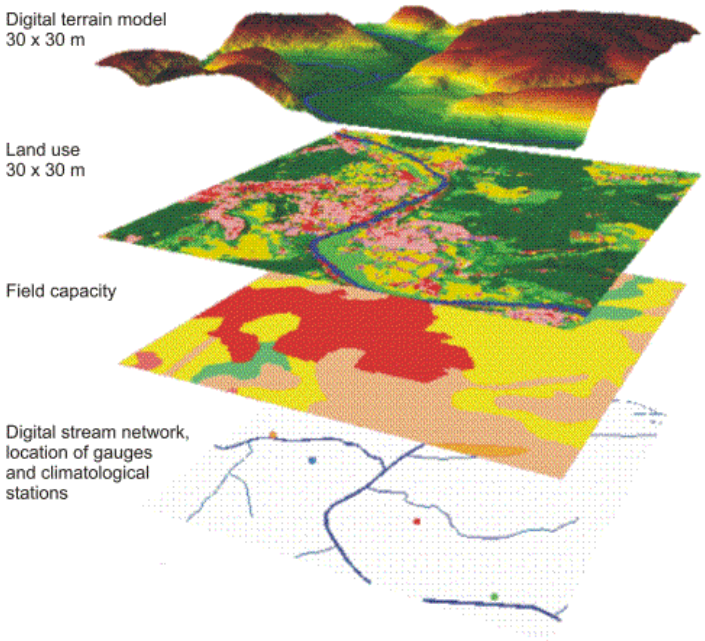


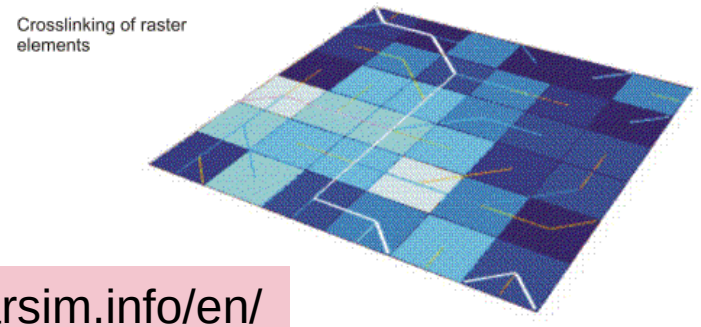
Notification chain for large rivers
Information and alerts for small (and large) rivers
Cannot be controlled by HVZ Mainz

Forecasting Methods

Waterbalance-Model LARSIM (Large Area Runoff Simulation Model)







https://www.larsim.info/en/

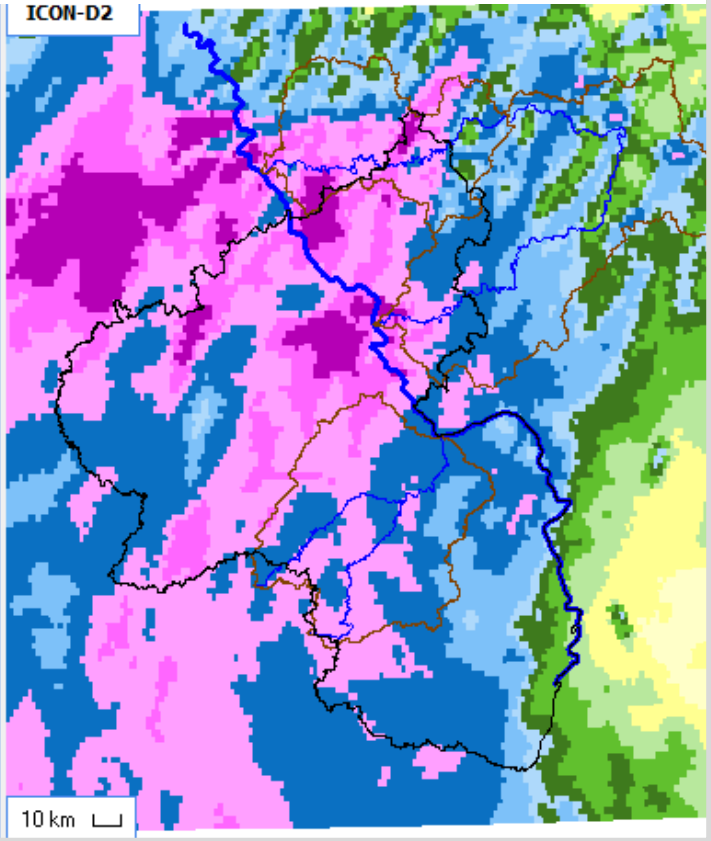
Forecasting-Methods

Time-variant Input-Data

current measurement data
(precipitation, air temperature, discharge, …)
+
26 weather forecasts

DWD METEO FRANCE ECMWF

Precipitation forecast



Forecasting-Methods:
Forecast of discharge

current measurement data
(precipitation, air temperature, discharge, …)
+
26 weather forecasts

↓

waterbalance model LARSIM

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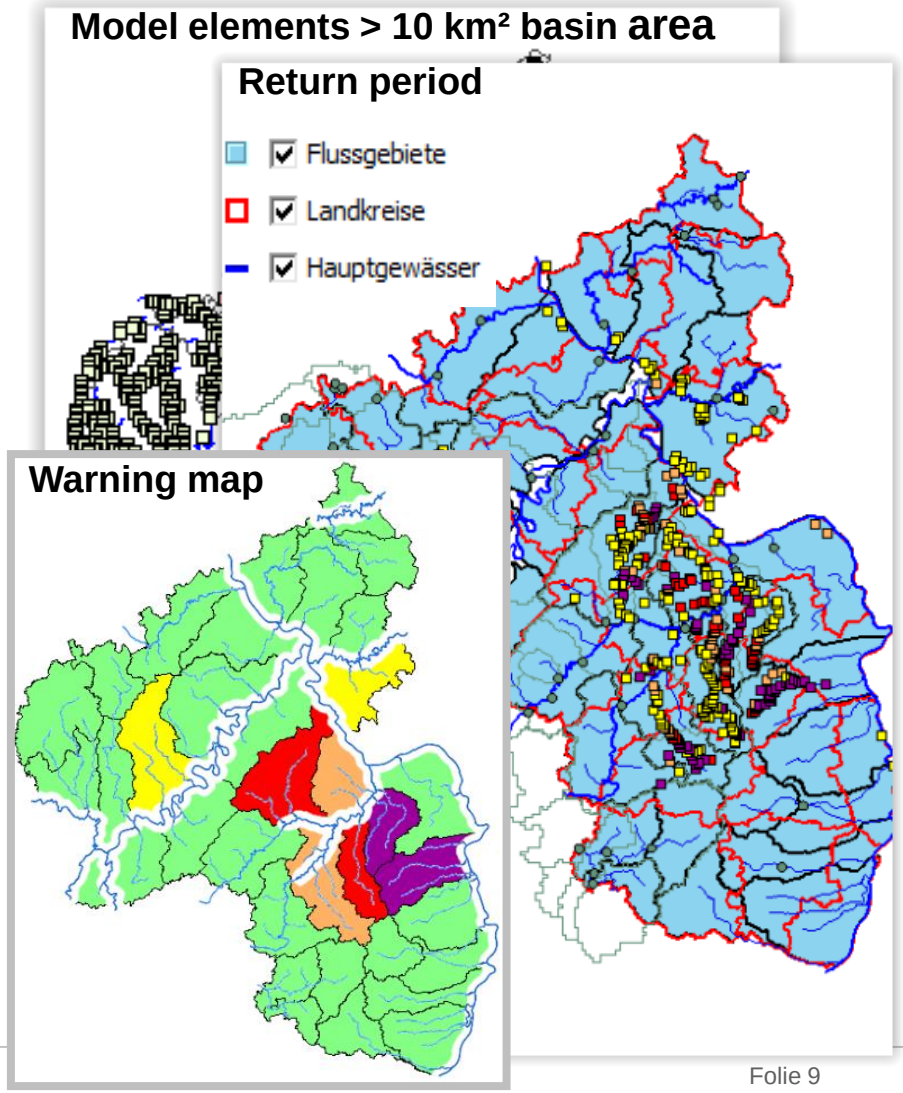
discharge for every model element for the next 10 days



Forecasting-Methods:
Forecast of waterlevel

current measurement data
(precipitation, air temperature, discharge, …)
+
26 weather forecasts

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Waterbalance model LARSIM

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Discharge for every model element for the next 10 days

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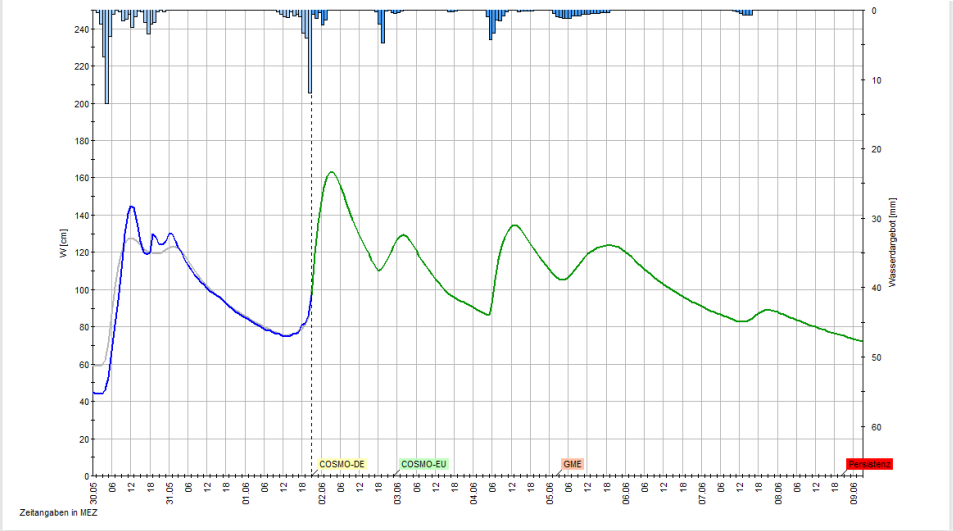
Water level at gauging station

Simulation and forecast at gauging station

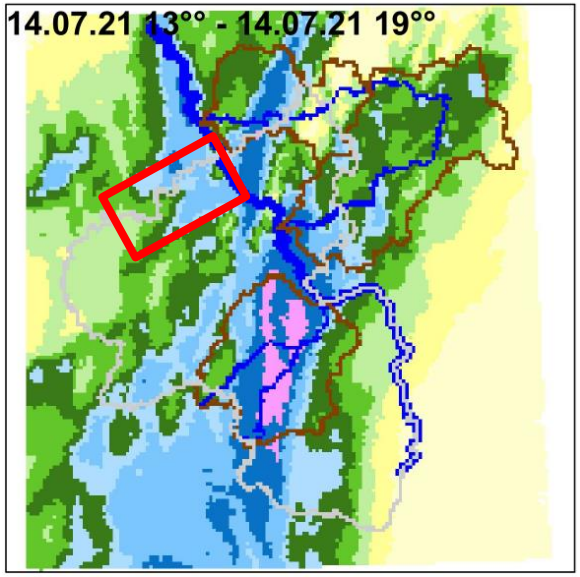


Challenges in forecasting:
Short term weather forecasts

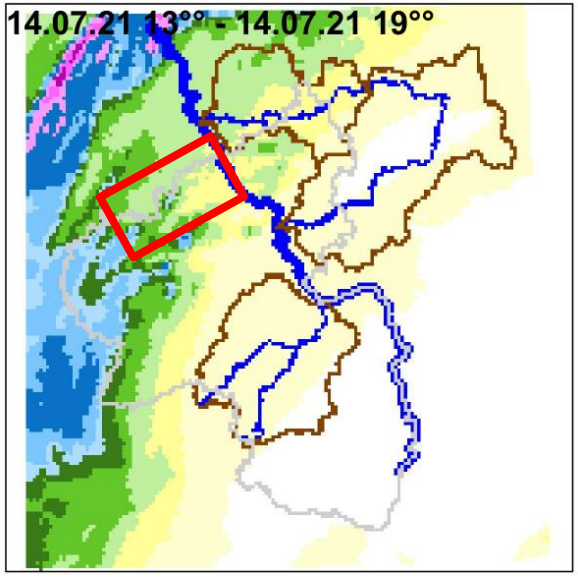
Predicted rainfall for 14/07 14 to 20 h

ICON-D2 of DWD

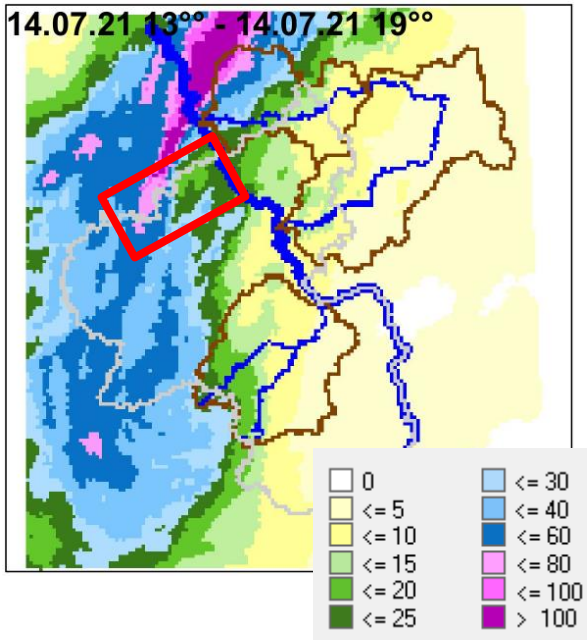
13/07 14 h



14/07 02 h



14/07 08 h



Precipitation in Ahr basin

Analysis of ICON-D2-Ensemble-Predictions since 13/07 20 h:

Median of precipitation forecast: 50 - 90 mm /15 hours

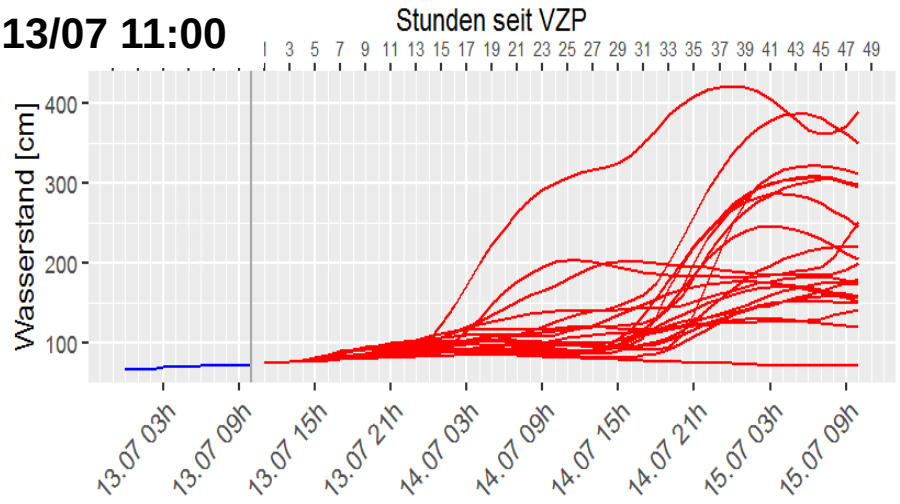
Measured: about 100 mm / 15 hours

Challenges in forecasting:
Uncertainty in flood forecast (gauge Altenahr)

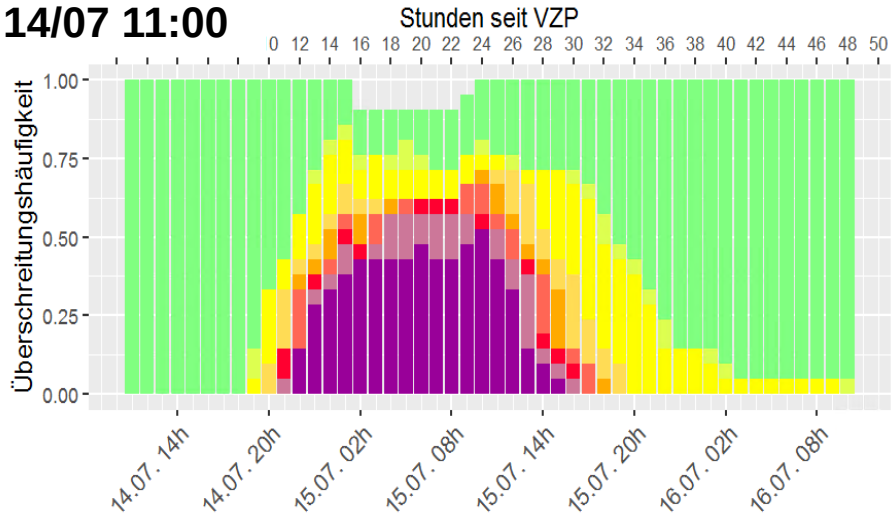
RheinlandPfalz
LANDESAMT FÜR UMWELT

Spaghetti-Plots

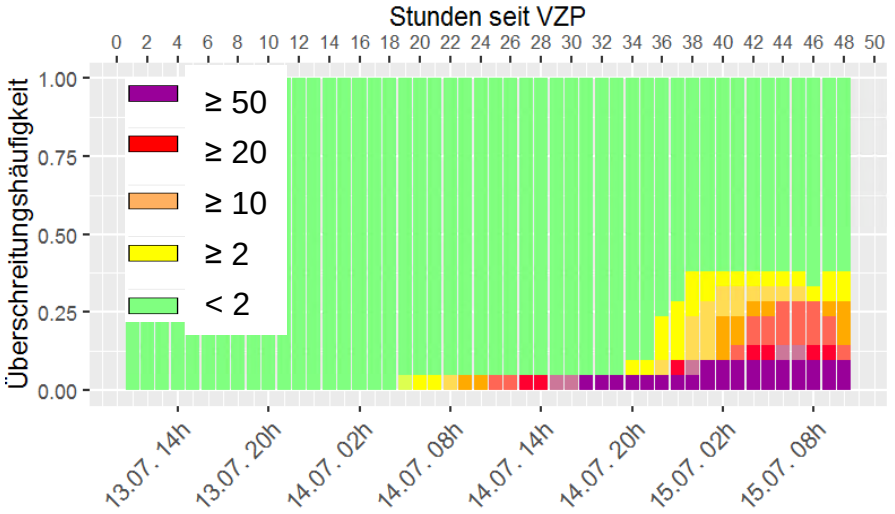
13/07 11:00



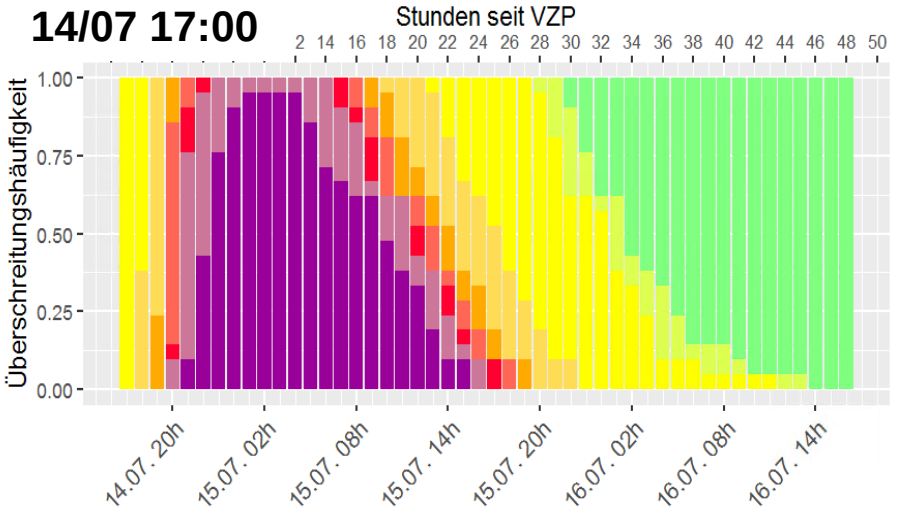
14/07 11:00



Exceedance frequency of return period



14/07 17:00



Challenges in forecasting:
Missing or erroneous data

- No data transmission for 20 of 36 gauges in the Eifel region due to interruption of mobile communication network / power supply
- 4 gauges are completely destroyed

gauge Altenahr

Challenges in forecasting:
Highest values ever, lack of data and experience

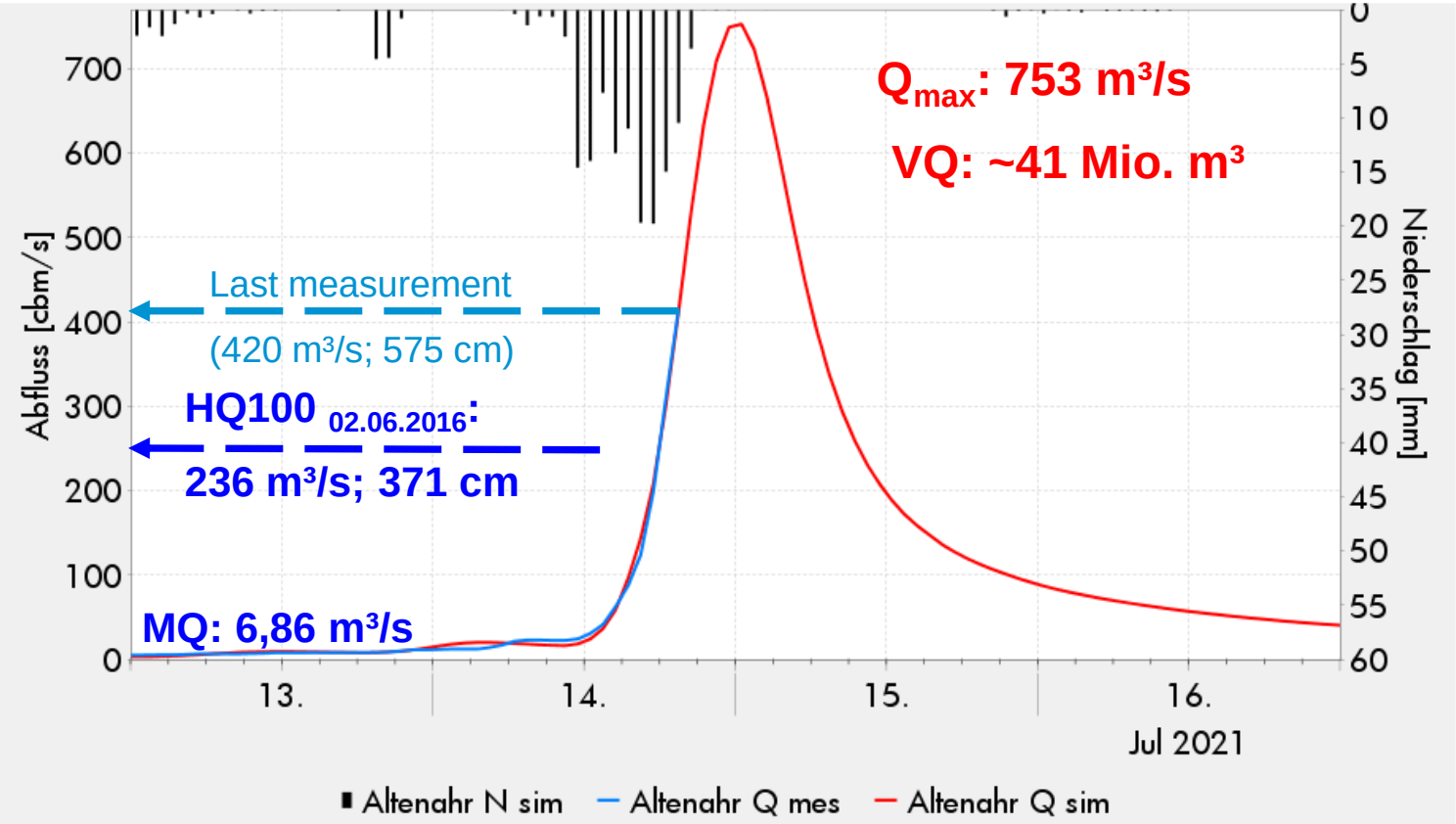
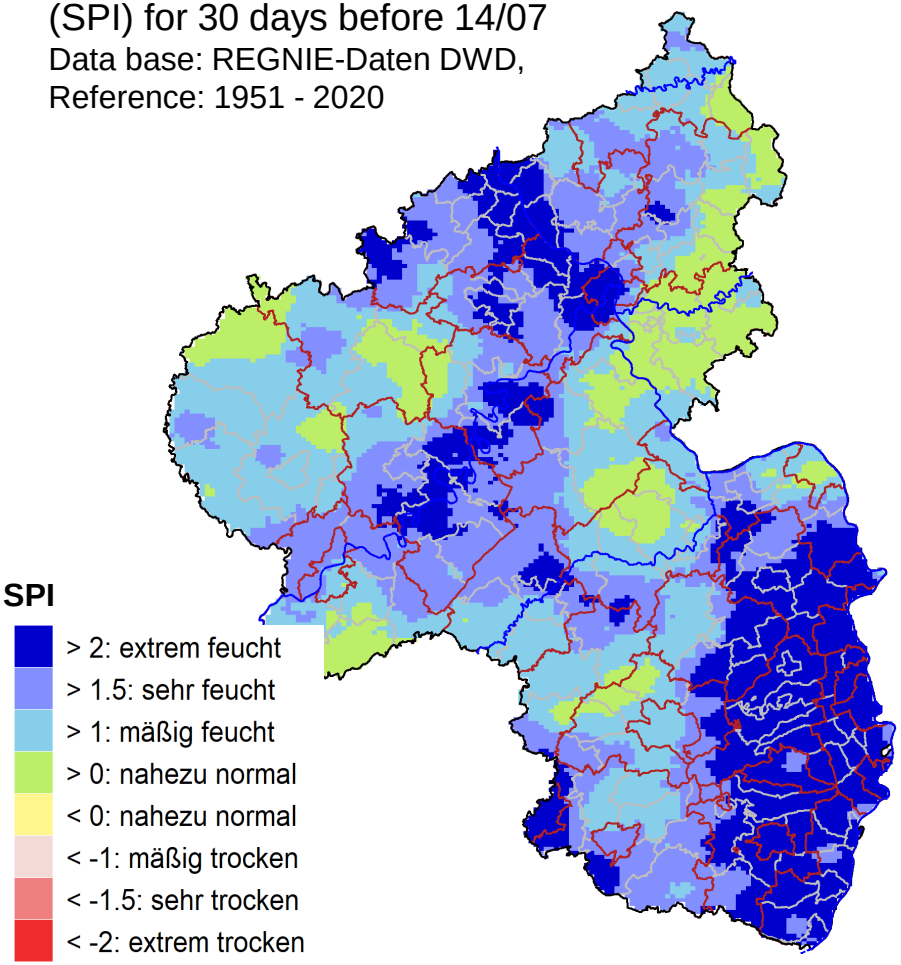


Bild 14 Gemessener (blau) und simulierter Abfluss ohne Niederschlagskorrektur (rot) am Pegel Altenahr/Ahr, Zeitraum 13.07. – 16.07.2021; Niederschlag: itwh75.

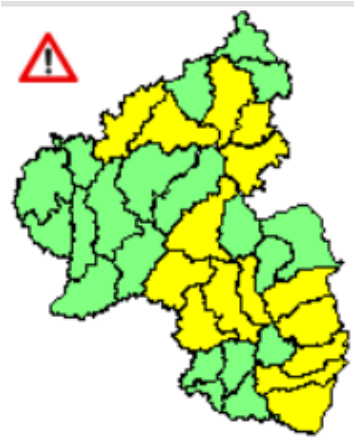
Warnings:
Indication on wet soils

Standardised precipitation index

(SPI) for 30 days before 14/07
Data base: REGNIE-Daten DWD,
Reference: 1951 - 2020

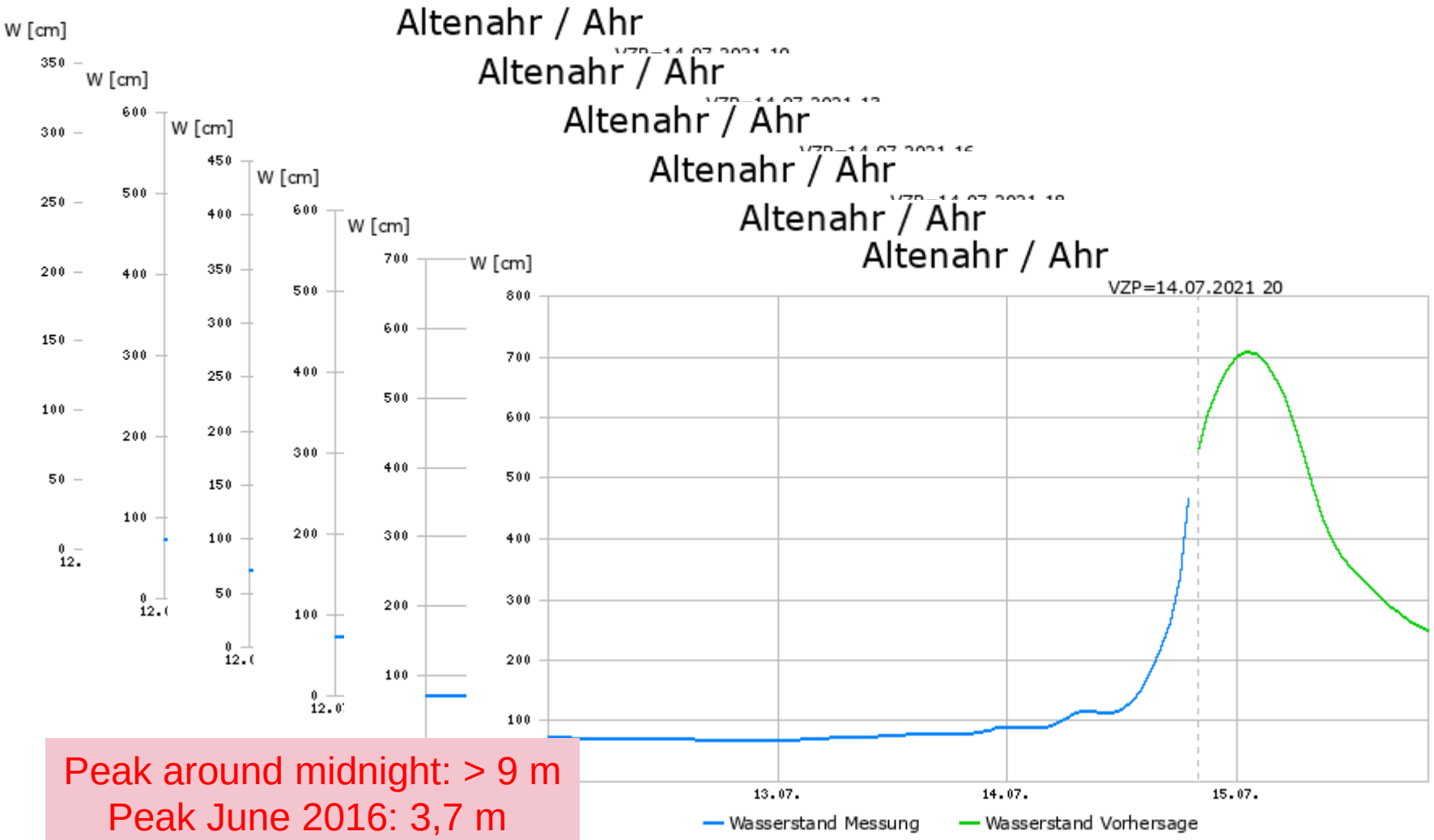


Warning triangle on homepage



Flood danger indication due to wet soils and warnings of the DWD since 12/07/2021

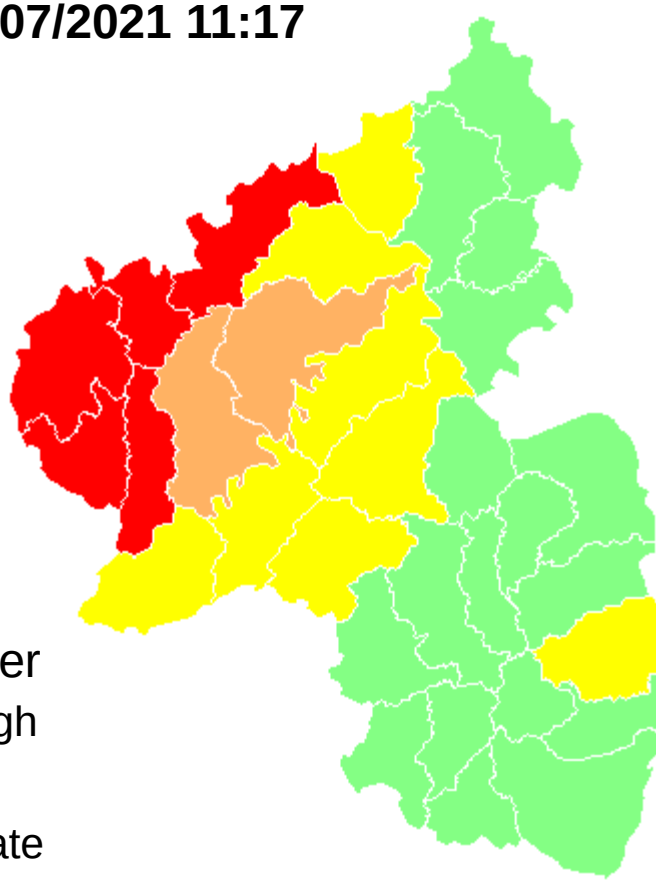
Warning:
Forecasts at gauge Altenahr



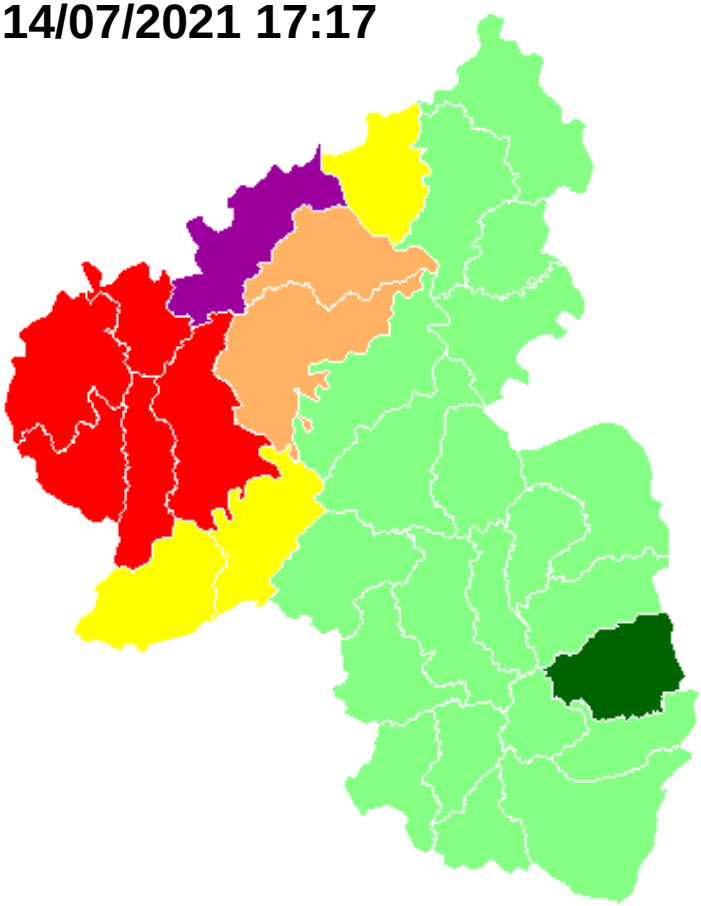
Peak around midnight: > 9 m
Peak June 2016: 3,7 m

Warning:
Region-specific warning for next 24 h

14/07/2021 11:17



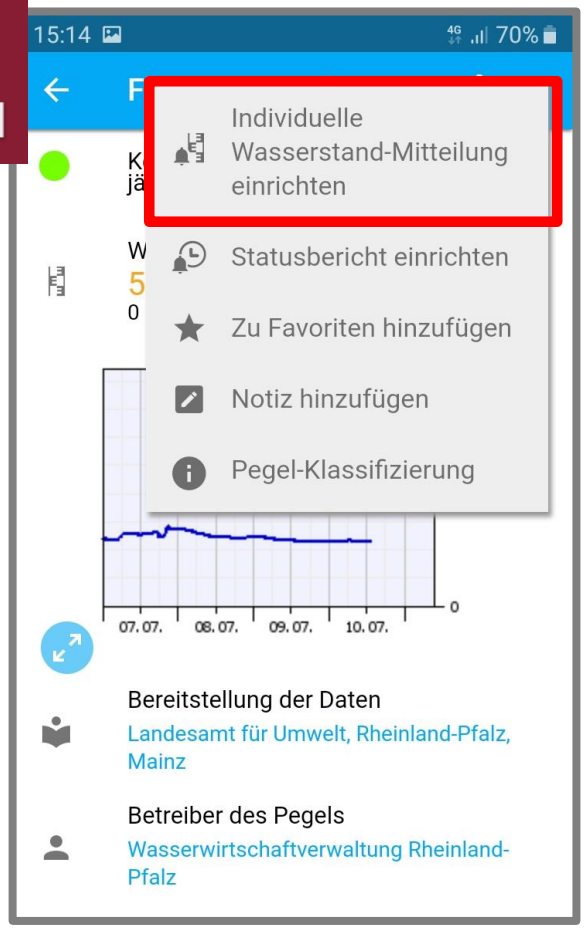
14/07/2021 17:17



Flood danger
- very high
- high
- moderate
- low
- very low

Warning:
Alerting via Smartphone-Apps

Meine Pegel



KATWARN

Meldung:
ACHTUNG: An der Ahr und ihren Zuflüssen ist die Hochwassergefahr sehr groß. Innerhalb der nächsten 24 Stunden ist mit Sturzfluten und Überflutungen zu rechnen. Erdrutsche sind möglich. Es sind Verkehrsbehinderungen zu erwarten.
Verhaltenshinweise:
Halten Sie sich nicht in Kellern, Tiefgaragen und tieferliegendem Gelände auf. Informieren Sie sich über die Medien und behalten Sie das Wetter- und Abflussgeschehen im Auge. Sichern Sie flussnahe Gebäude vor Wassereintritt. Achten Sie unbedingt auf Ihre eigene Sicherheit und die Anweisungen lokaler Einsatzkräfte.

Warning:
EFAS Notifications

4 notifications for the Rhine

13. Juli 2021 11:24 Flood Notification - River: Nahe - Type: Informal*
13. Juli 2021 11:25 Flash Flood Notification - Trier, Koblenz Region
14. Juli 2021 07:43 Flood Notification - River: Moselle - Type: Formal*
14. Juli 2021 07:46 Flood Notification for Luxembourg-River: Sauer - Type: Informal*
14. Juli 2021 11:31 Flash Flood Notification for GERMANY–Rheinhessen-Pfalz Region

as predicted
false alarm
more severe

Flash Flood Notification – Trier, Koblenz:
Percent of affected area susceptible to landslides:
Very High: 0%, High: 21%, Moderate: 44%

Extremity Level	Symbol	Exceedance Probability (P) Class	Exceedance Probability shown beside triangle
Medium		P(RP2 > 15%) & P(RP5 <= 5%)	RP 2
High		P(RP5 > 5%) & P(RP20 <= 10%)	RP 5
Severe		P(RP5 > 5%) & P(RP20 > 10%)	RP 20

Return period:

2

5

20

Conclusions

- We need a coordinated approach to deal with very extreme events (our part: e.g. higher warn levels, considering historical events)
- Everybody must be able to deal with (early) false alarm, that is a good exercise for moderate to extreme situations
- Uncertainty and probability information must be comprehensible to civil protection
- Civil protection has to transfer water level forecast in local vulnerability (hydrologic warning → impact warning)
- Flood-endangered areas have to be re-defined (including historical floods) and communicated (against resistance from various sides)
- Predicting and handling natural disasters will always be a challenge! A “normal” flood is only little training for an extreme.

As last remark

What civil protection needs

- Actual measurement data (esp. precipitation and water level)
- Water level forecasts at gauges as early and reliable as possible
- Potential flooding areas
- Very clear and easily understandable information
- „Single Voice Messages“ (no confusing information)

- Local alarm and emergency planning is not yet based on probabilistic data!
- Concering people in danger: A warning without instructions for behavior is very little helpful especially in extreme situations!
- Survey after the Ahr flood: most people received warnings but the magnitude of the disaster was not imaginable!

Thank you for your attention

www.hochwasser-rlp.de

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Norbert.Demuth@lfu.rlp.de 0049-6131-6033-1710

Flood forecasting
24h/7d is teamwork!