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## A data base on radar-based heavy rainfall information of the past 20 years in Germany

### Une base de données de pluies fortes enregistrées par radar sur les 20 dernières années en Allemagne

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#### RÉSUMÉ

Les données radar depuis 2001 sur toute l'Allemagne ont été organisées en deux bases de données différentes pour permettre l'accès facile aux informations sur les pluies fortes. Un outil accessible par web a été développé pour l'analyse d'événements pluvieux ainsi que pour la mise en disposition de données d'entrée pour des modèles hydrologiques. Cette solution propose un accès aux données actuelles, des événements de l'année courante et des données vérifiées, mises à jour une fois par an. Les deux approches des bases de données sont d'une part une vue orientée objet qui permet de requérir des caractéristiques de chaque événement et d'autre part une vue axée site sur un point, une ville ou un bassin versant, permettant l'établissement de statistiques correspondantes. La première base de données utilise le produit CatRaRE du Service Météorologique Allemande, et la deuxième base de données est réalisée avec HydroNET. Une représentation visuelle des séries chronologiques, d'images radar et de leur animation sont disponibles ainsi que des possibilités de télécharger des données. Le site web est envisagé de devenir accessible par le public après un test effectué par les administrations de l'eau des différents états fédéraux en Allemagne.

#### ABSTRACT

For the complete coverage of Germany, radar data since 2001 have been organised in two data bases to allow for easy access to heavy rain events. Thus, a web-based tool has been developed which can serve for rain event analysis as well as production of input data for hydrological simulation models. The web-based solution provides access to the most recent data, rain events up to one year old and post-processed events being updated once per year. Two different views are available: an object-oriented approach to heavy rain events with the CatRaRE data base of the German Weather Service, and a location-oriented approach with the HydroNET data base where time series of data with extreme properties can be retrieved. The first approach permits a good analysis of each event over its full extent, and the second approach produces statistics for a given location (point, city, catchment). Visual representation of time series, radar images and animations are available as well as data download facilities. The web platform is planned to be made public after a test phase by the water administration of the different federal states in Germany.

#### KEYWORDS

Event data base, Heavy rain, Radar climatology, Rainfall statistics, Weather radar.

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## 1 INTRODUCTION

After two decades of radar-based rainfall observations, there have been two different approaches to get easy access to information on heavy rainfall events during this time. One algorithm was developed in North-Rhine Westphalia (NRW) by the authors and was launched in 2017 (Strehz et al., 2019), the other one was developed by the German Weather Service DWD (Lengfeld et al., 2021) and operational since 2018. Both approaches have now been combined for the benefit of all hydrological users in a web-based “Heavy Rain Documentation” application of the German LAWA (German Working Group on water issues of the Federal States and the Federal Government represented by the Federal Environment Ministry).

## 2 DATA BASE APPROACHES

### 2.1 The HydroNET event data base

The data base for NRW was developed as a HydroNET application ([www.hydronet-scout.de](http://www.hydronet-scout.de)) and is capable to answer questions like:

- What were the 10 highest rainfall events at this location?
- Has there been a 100-year storm at this location or its vicinity 10 km around?
- How many events have there been with more precipitation than 30 mm in one hour in NRW?

Therefore, the choice mechanism of this data base is using pre-analysed time series for exceedances (rainfall events) for 12 predefined durations ranging from 5 minutes up to 6 days. By pre-calculating the entire radar data archive the system is able to quickly answer all user queries. The data from the resulting events can be viewed as time series, radar images (cumulated or individual), or downloaded. Moreover, the events can be shifted to another location and then downloaded, allowing for a hydrological model to evaluate the consequences of a given event at a different location.

### 2.2 The CatRaRE event data base

The CatRaRE event data base is an object-oriented data base where each event is defined as an object. Each object has several attributes such as average and maximum rainfall amount, location of maximum amount, area in km<sup>2</sup>, heavy rain index, shape file of the extent, average imperviousness, population density, and others.

In this way, the CatRaRE data base allows for many geographic analyses and also provides information for different federal states in Germany.

### 2.3 Combination of approaches

For LAWA, both approaches are relevant: the possibility to inspect the values of single points as well as the characterisation of complete events. Therefore, both approaches were combined:

- There is a possibility to request the registered events for a point for a given duration time (5 minutes to 6 days)
- There is the possibility to inspect observed events (see Figure 1) and investigate the data of single points through a request to the HydroNET data base.

## 3 RADAR DATA

While the radar dataset for NRW has been derived from extensive post-processing of radar and more than 1000 rain gauge data time series (Treis et al., 2016), the RADOLAN RADKLIM dataset of the DWD uses approximately 1000 stations for the whole of Germany (Winterrath et al., 2018).

For the combined Germany-wide solution, the DWD dataset has been selected because these data are uniformly available for all of Germany. The RADKLIM dataset is updated once per year, and therefore a different solution for more rapid intermediate information has been found.

To include the most recent data, an online adjustment of the Germany-wide composite is performed by the SCOUT software. The result is being replaced when the "official" data adjusted by DWD arrive. These data correspond to those that the DWD publishes on its Open Data portal.

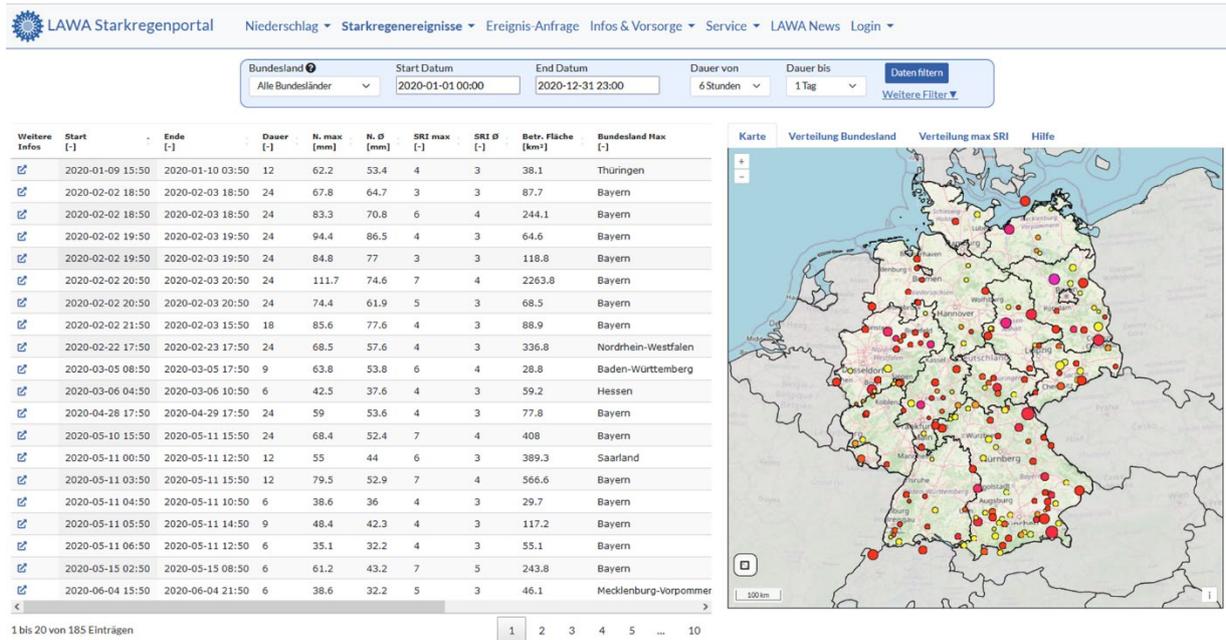


Figure 1: View of the events (object-oriented view). The table on the left and the map display on the right are directly linked

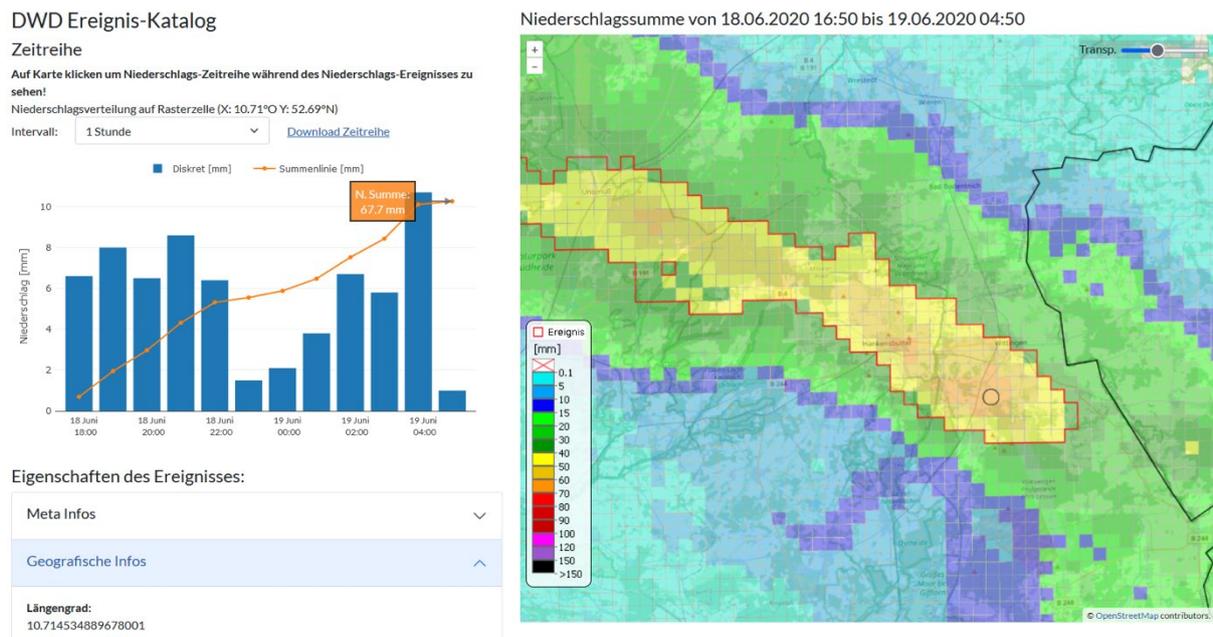


Figure 2: View of a single event. The time series on the left and the map display on the right are directly linked

## 4 FUNCTIONS OF THE NEW SOLUTION

### 4.1 Documentation of events

#### 4.1.1 Event selection

Event selection as shown on Figure 1 is using the event definition from CatRaRE where all events above a given threshold are available. This threshold is 25 mm in one hour and corresponds to DWD warning level 3. Only events above this value are represented and have a unique ID. This ID helps to organize the event attributed as well as the connection to the HydroNET data base.

Events can be filtered for a time period, area, maximum number of events, so that the table and map on the web site shown above will change accordingly.

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### 4.1.2 Event presentation

Each event is displayed as shown in Figure 2. Thus, the delimitation of the event, its areal extent and spatial heterogeneity become obvious. For each pixel, the corresponding time series can be presented in different temporal resolutions.

The presented data can be downloaded. Both, the capability of showing the related time series and the possibility to download data are using the HydroNET data base.

### 4.1.3 Event analysis

The object-oriented events have been analysed for return period and heavy precipitation index so that their severity can be assessed. Other items are the topographic position index (TPI) as average value for the event area or the weather type. Such supplementary data provide the means for further analysis of each event and allow for a better comparison between individual events.

### 4.1.4 Request for events in defined areas

Additionally, to the predefined events, individual requests for any user-defined point or any area are possible through the HydroNET data base. Such a request will produce the time series and the image for the selected area and duration time, similar to Figure 2. A main difference to the predefined events is that the event properties are not available because they were not part of the object-oriented data base CatRaRE.

## 4.2 Further components of the web platform

Additionally, to the above-described functionalities, the portal allows for image animations, has several panels with hints how to prepare for flash floods and how to react in such conditions. Furthermore, links to important related web sites and institutions are given.

## 5 CONCLUSIONS AND WAY AHEAD

A combination of two approaches for radar data event organisation of the Germany-wide radar data since 2001 has been accomplished, linking the advantages of both approaches.

The current heavy precipitation documentation which has been produced for LAWA has received positive feedback from the LAWA project group. Therefore, it shall be made available to the public, ultimately.

Possible extensions of the data base include the upload of damage information by authorized users, link of such information to the events from the CatRaRE analysis, closer connection to the websites of the federal states, improved explanatory texts on extreme events and protection possibilities.

The current version is accessible to users upon request to the LAWA project group.

## ACKNOWLEDGEMENTS

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