REGIONAL BOARD FOR WATER MANAGEMENT IN KRAKÓW

Usefulness of weather radar data for rainfall-runoff modelling in small catchment

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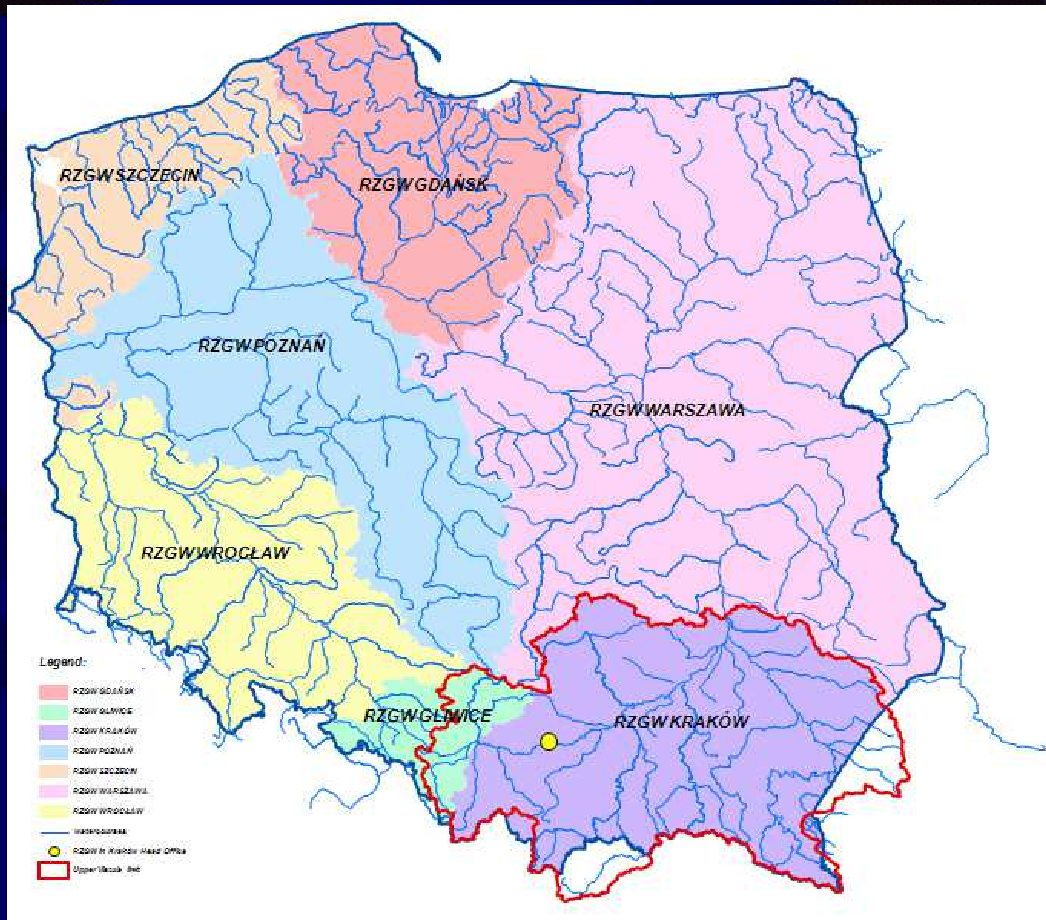
RZGW Kraków

Regional Board for Water Management in Cracow (Poland)

Upper Vistula water region - location

The Regional Board for Water Management in Kraków is located in south-eastern Poland. It covers nearly entire Upper Vistula river basin, parts of the Strwiąż (Dniester basin) and the Czarna Orawa (Danube basin).

The RZGW Kraków area of activity covers 43,767 sq. km.



Area of activity

RZGW tasks

The major role of the RZGW in Krakow is water management within the area of its activity. The main objectives are:

- development of protection of ground and surface waters with the aim of achieving and maintaining good status of these waters and ecosystems, in accordance with the requirements of the Water Framework Directive,

- creation of conditions to meet the legitimate needs of the population and the economy (industry, agriculture, navigation, hydro-power engineering, recreation) while respecting the principles of sustainable development of water use,

- protection of people and property from hazards that may occur as a result of extreme events (flood, drought).

OKI department

The activity of the RZGWs related to flood issues is executed by Coordination and Information Centres for Flood Protection (OKI).

OKI tasks include:

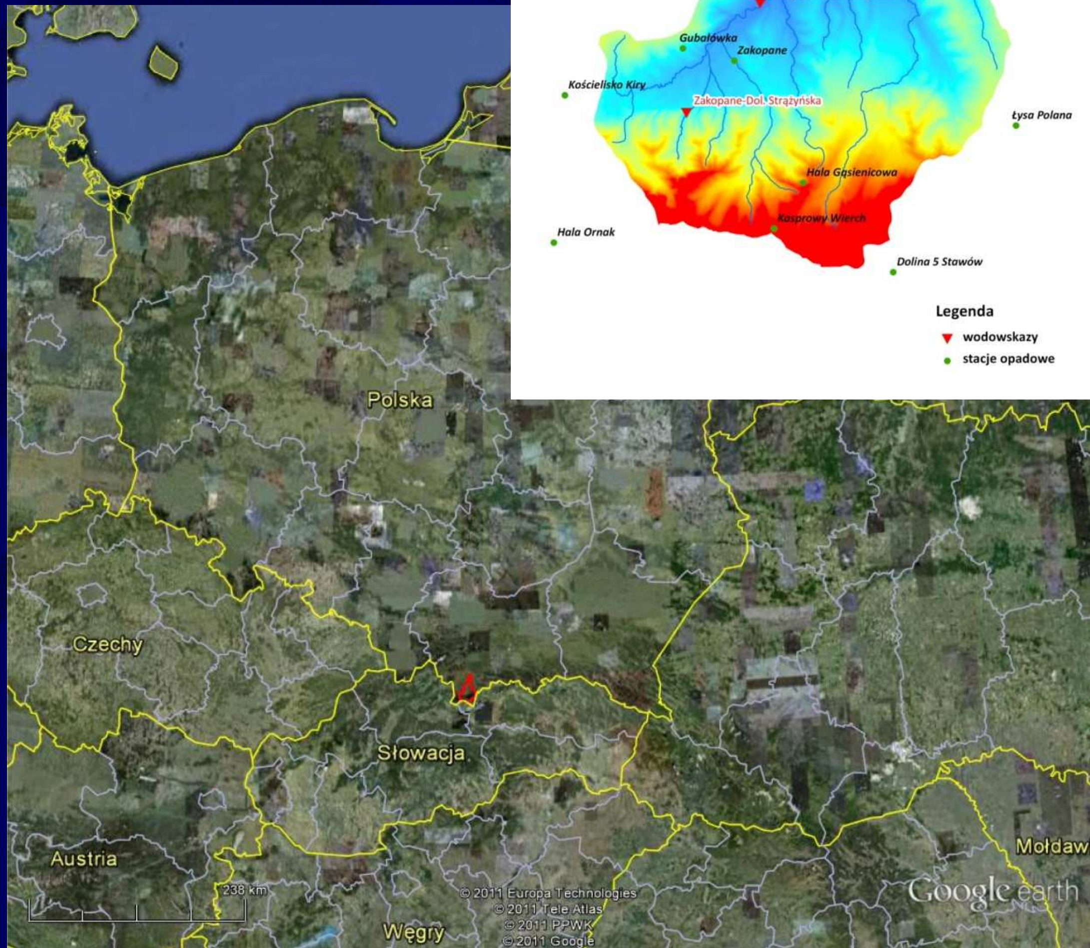
- Monitoring of flood condtions and management of reservoirs
- Informing crisis management centers about current flood conditions
- Determination of flood zones with local authority
- Informing public and private investors about flood risk areas
- Making decisions allowing construction of water installations.

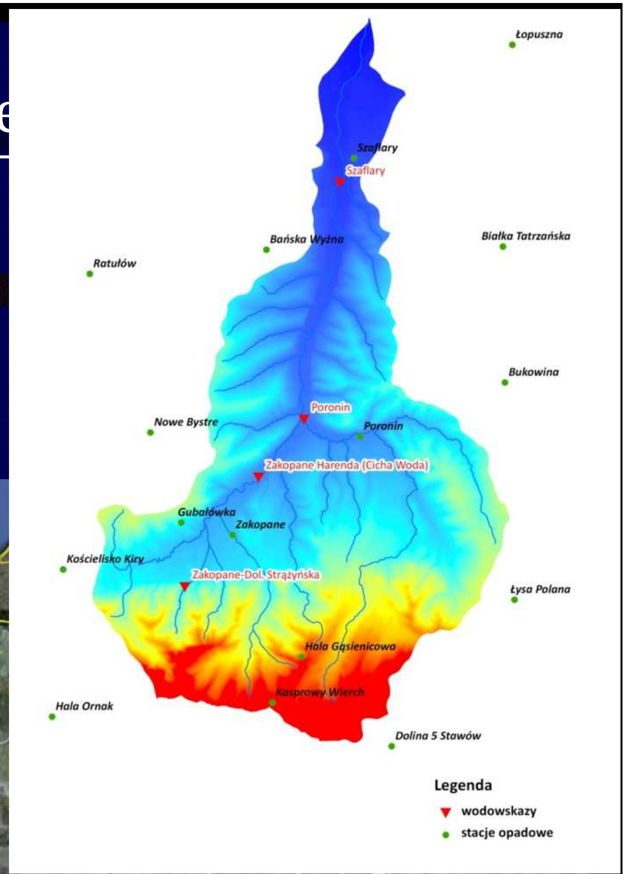
Usefulness of weather radar data for rainfall-runoff modelling in small mountainous catchment

Catchment model characte

The Bialy Dunajec River is a tributary of the Dunajec River with catchment area of around 226 km^2. Its source is located on 1254 m above sea level.

The upper part of the Bialy Dunajec River has mountaineous characteristics. The valley is narrow with steep slopes.





Hydrological model

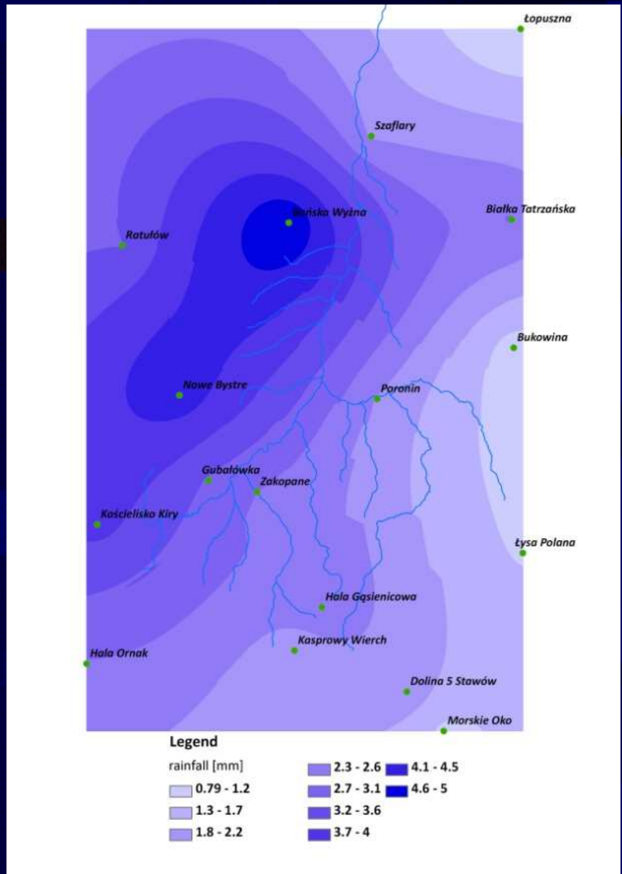
Hydrographs were simulated by means of:

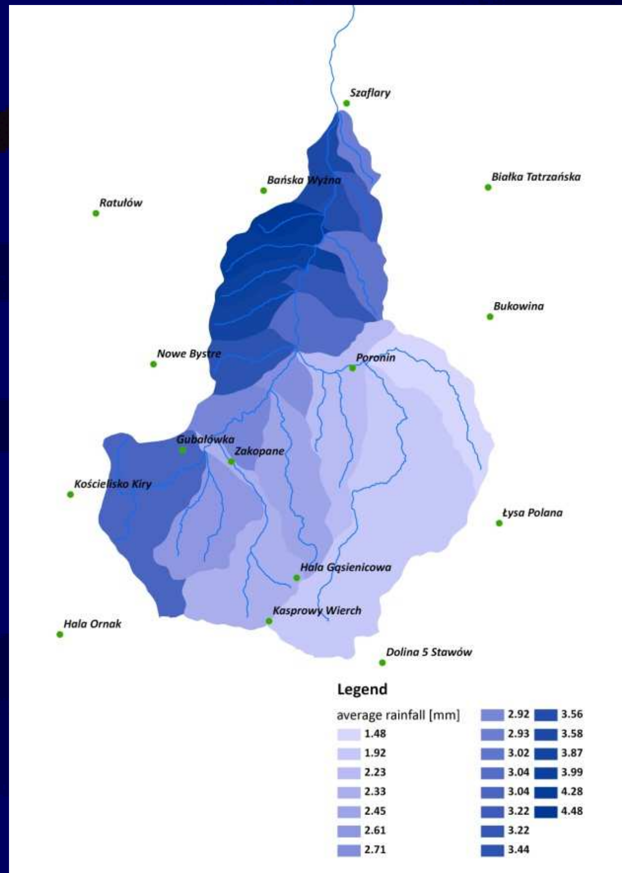
- model SCS UH,
- HEC-HMS software,
- effective rainfall (calculated by CN – SCS method).

Study area:

- The Bialy Dunajec River, from source to Szaflary water gauge,
- Catchment divided into 21 sub-basins.

Input data: rain gauges

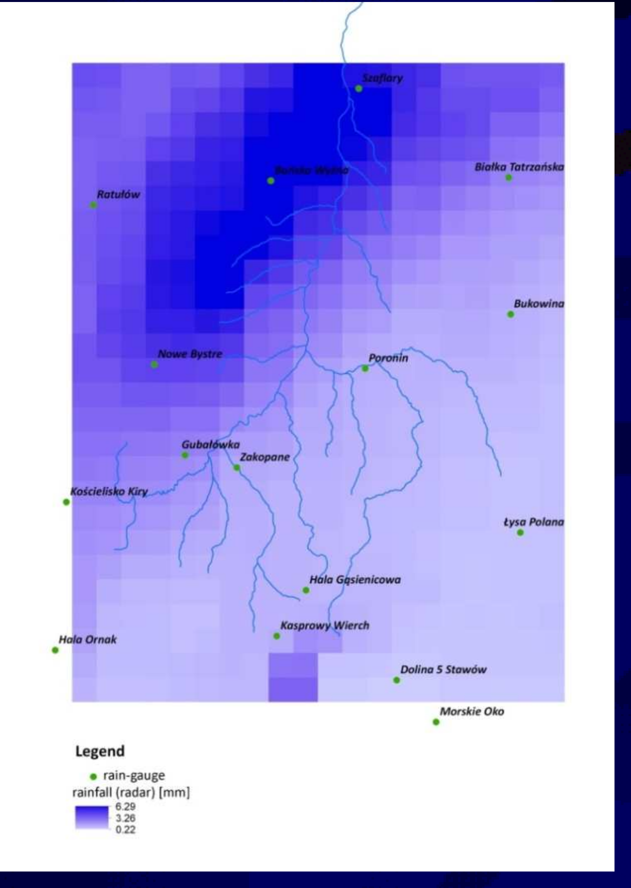


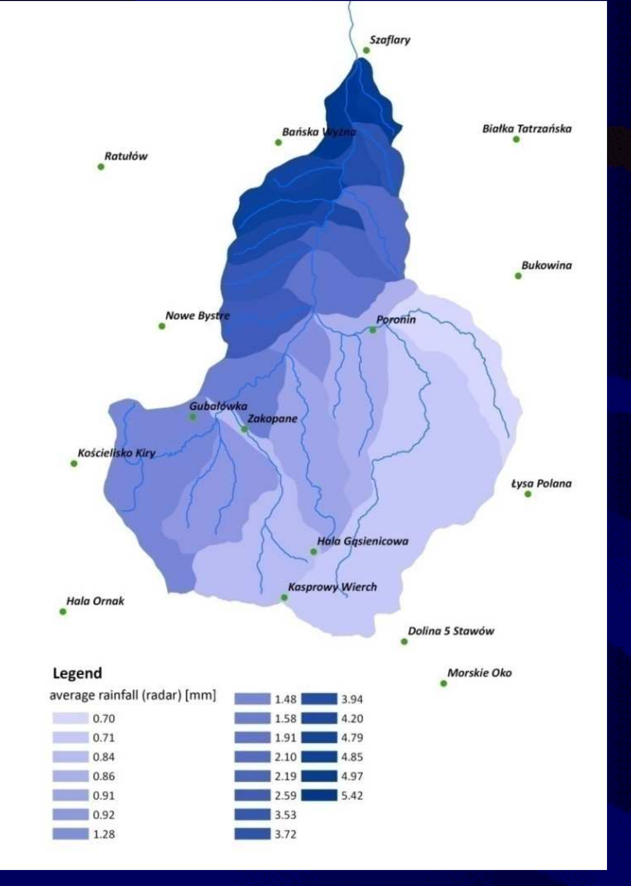


Stages of rain gauge data preparation:

- ❑ Spatial interpolation of raingauge rainfall by means of Kriging method,
- ❑ Calculation of average rainfall for each modelled sub-basin.

Input data: radar





<u>Stages of radar data preparation:</u>

- ❑ Correction of volume (3-D) data by means of RADVOL-QC software of IMGW,
- ❑ Correction of precipitation product (2-D), especially adjustment of 1-h accumulations with rain gauge data,
- ❑ Complement of gaps in data.

Calibration of the model

Model calibration:

flood in 2007

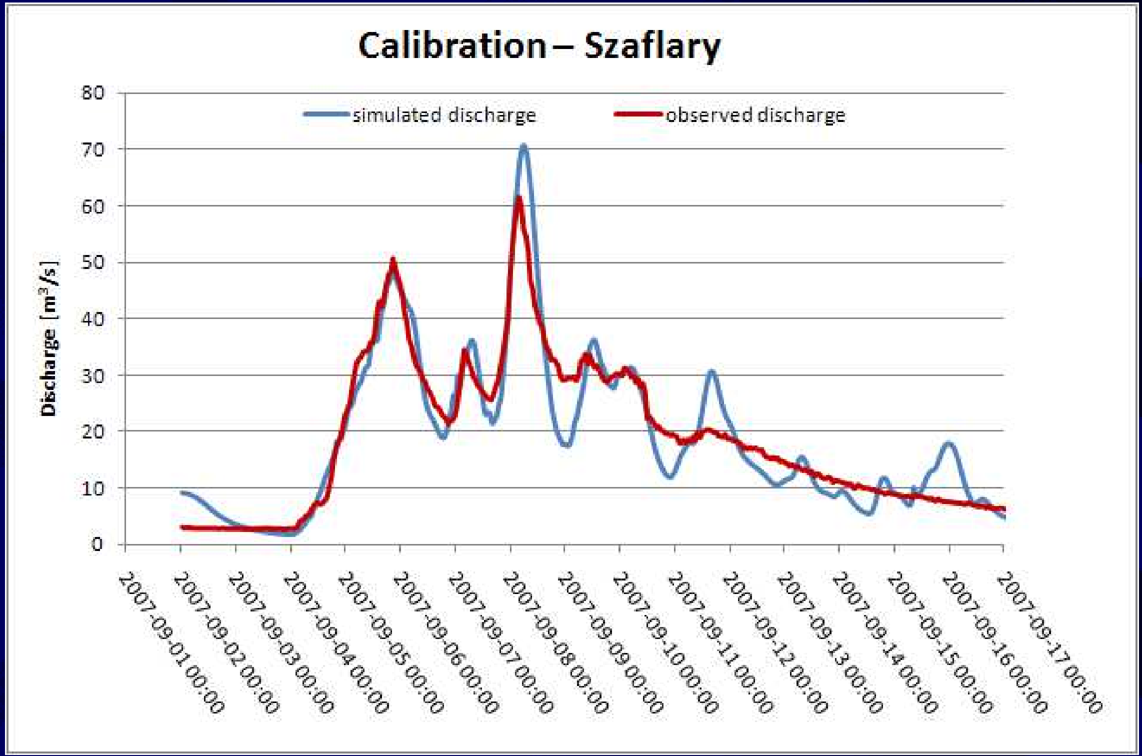
Determination of model parametres:

Comparison of hydrographs:
simulated (blue) and observed (red)

Calibration results (Szaflary):

$\Delta Q = +13\%$

$\Delta t = 120$ min



Verification of the model

Model verification:

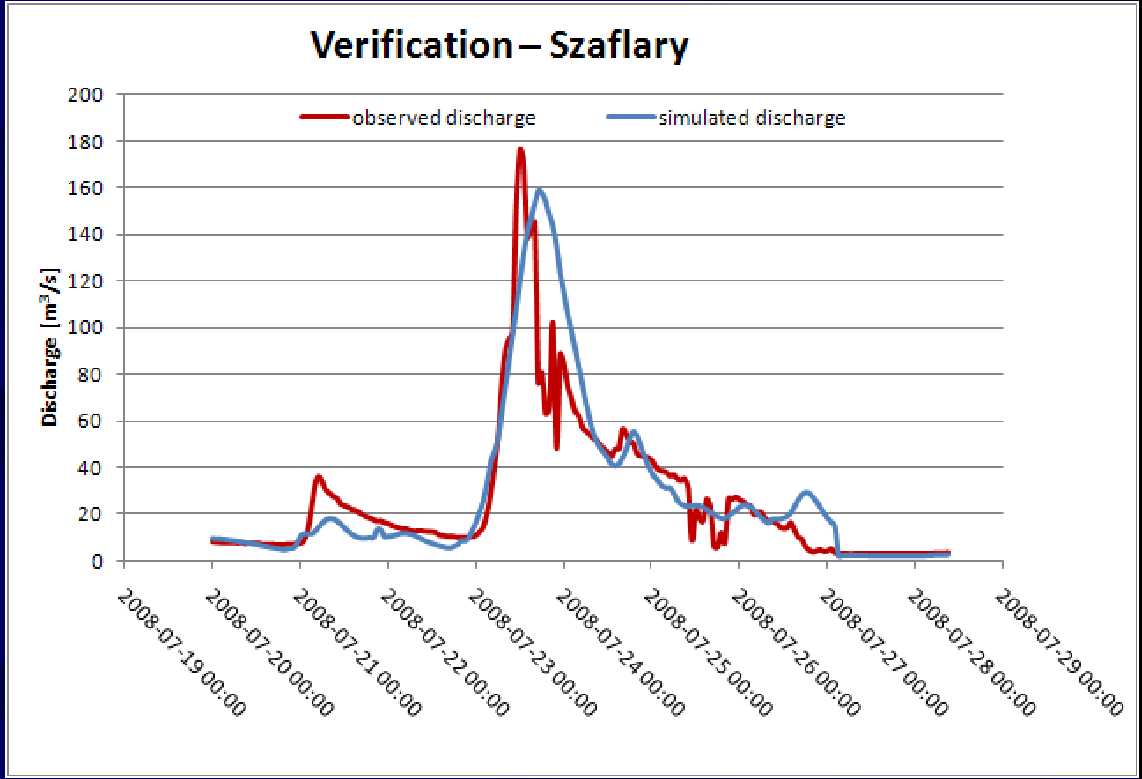
flood in 2008

Comparison of hydrographs:
simulated (blue) and observed (red)

Result of verification (Szaflary):

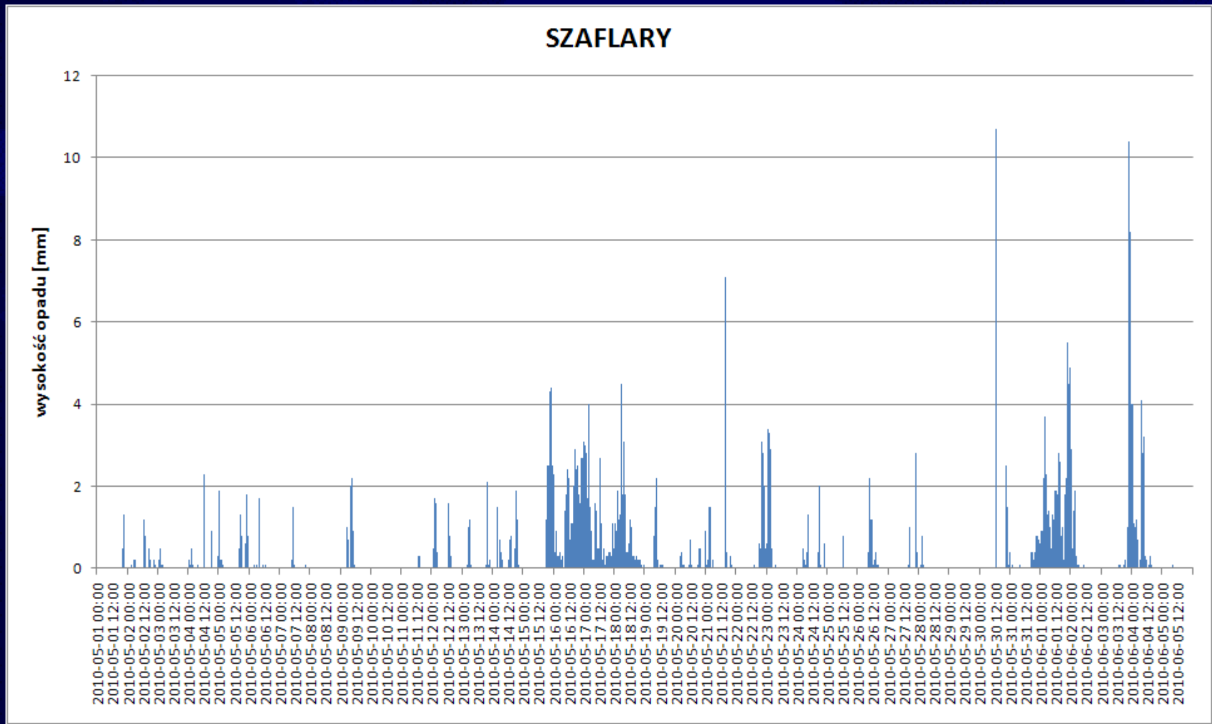
ΔQ = -10%

Δt = 5 h



Results (2010 flood)

Hyetograph: for Szaflary rain gauge: flood in 2010



Results (2010 flood)

Szaflary level gauge (2010):

The river discharge simulated from **raingauges** (red) and observed (blue)

Simulated discharge:

17th May 2010 09:00 AM, Q = 115.5 m³/s

2nd Jun 2010 00:00 AM, Q = 153.4 m³/s

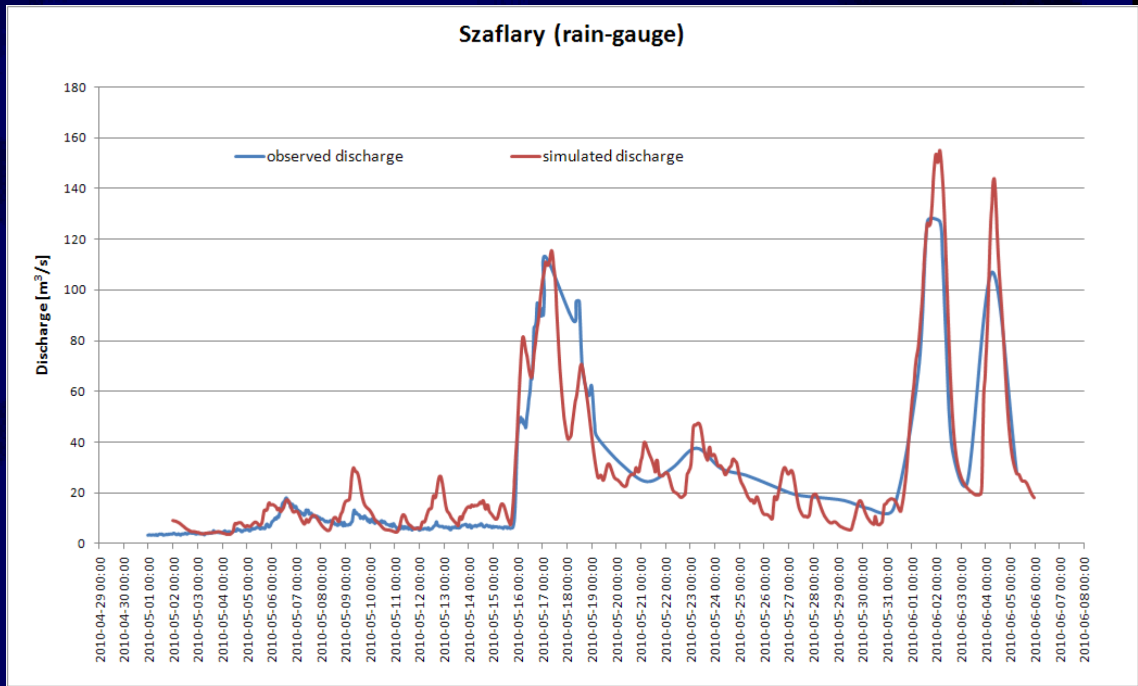
4th Jun 2010 07:00 AM, Q = 142.7 m³/s

Observed discharge:

17th May 2010 03:00 AM, Q = 113.6 m³/s

2nd Jun 2010 03:00 AM, Q = 127 m³/s

4th Jun 2010 06:00 AM, Q = 107 m³/s



RZGW

Results (2010 flood)

Szaflary level gauge (2010):

The river discharge simulated from
raw radar data (red)
and observed (blue)

Simulated discharge:

17th May 2010 02:00 AM, Q = 19.3 m^3/s

2nd Jun 2010 04:00 AM, Q = 44.8 m^3/s

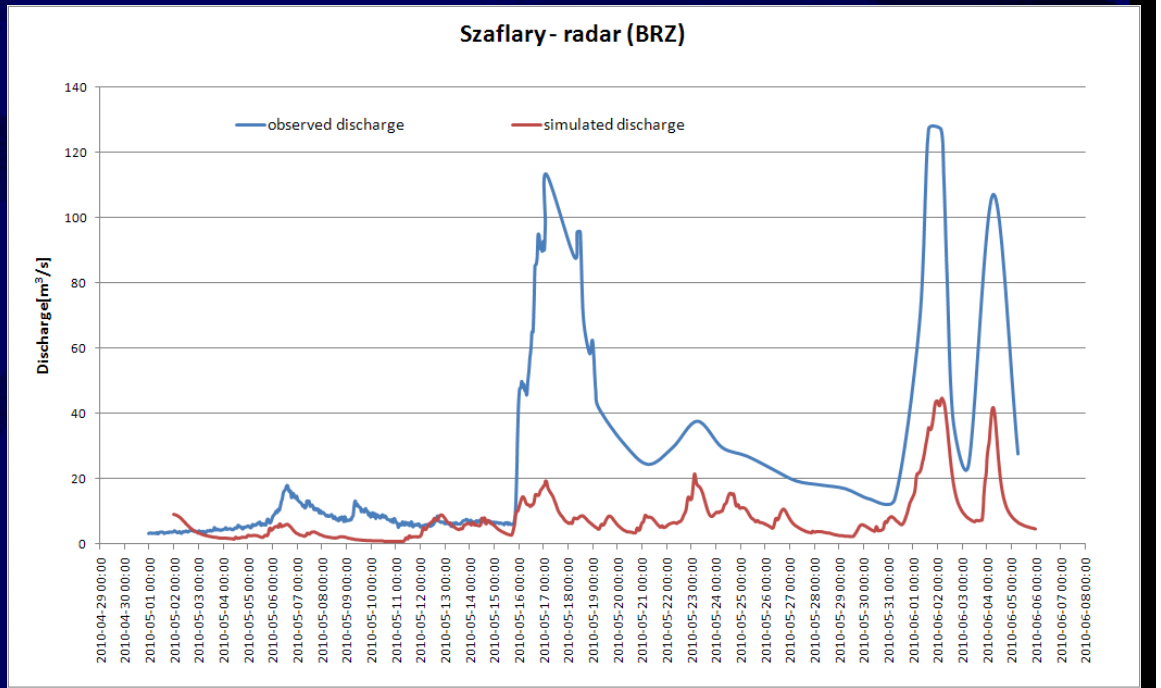
4th Jun 2010 06:00 AM, Q = 41.9 m^3/s

Observed discharge:

17th May 2010 03:00 AM, Q = 113.6 m^3/s

2nd Jun 2010 03:00 AM, Q = 127 m^3/s

4th Jun 2010 06:00 AM, Q = 107 m^3/s



RZGW

Results (2010 flood)

Szaflary level gauge (2010):

The river discharge simulated from **corrected radar data** (red) and observed (blue)

Simulated discharge:

17th May 2010 03:00 AM, Q = 23.6 m³/s

2nd Jun 2010 04:00 AM, Q = 50.0 m³/s

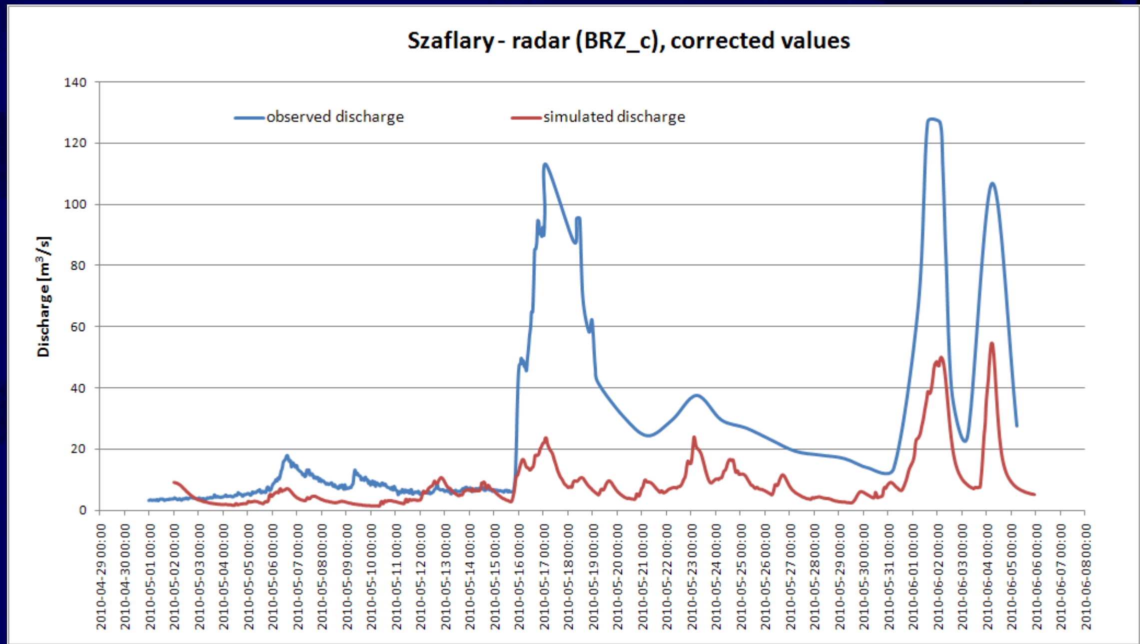
4th Jun 2010 05:00 AM, Q = 54.5 m³/s

Observed discharge:

17th May 2010 03:00 AM, Q = 113.6 m³/s

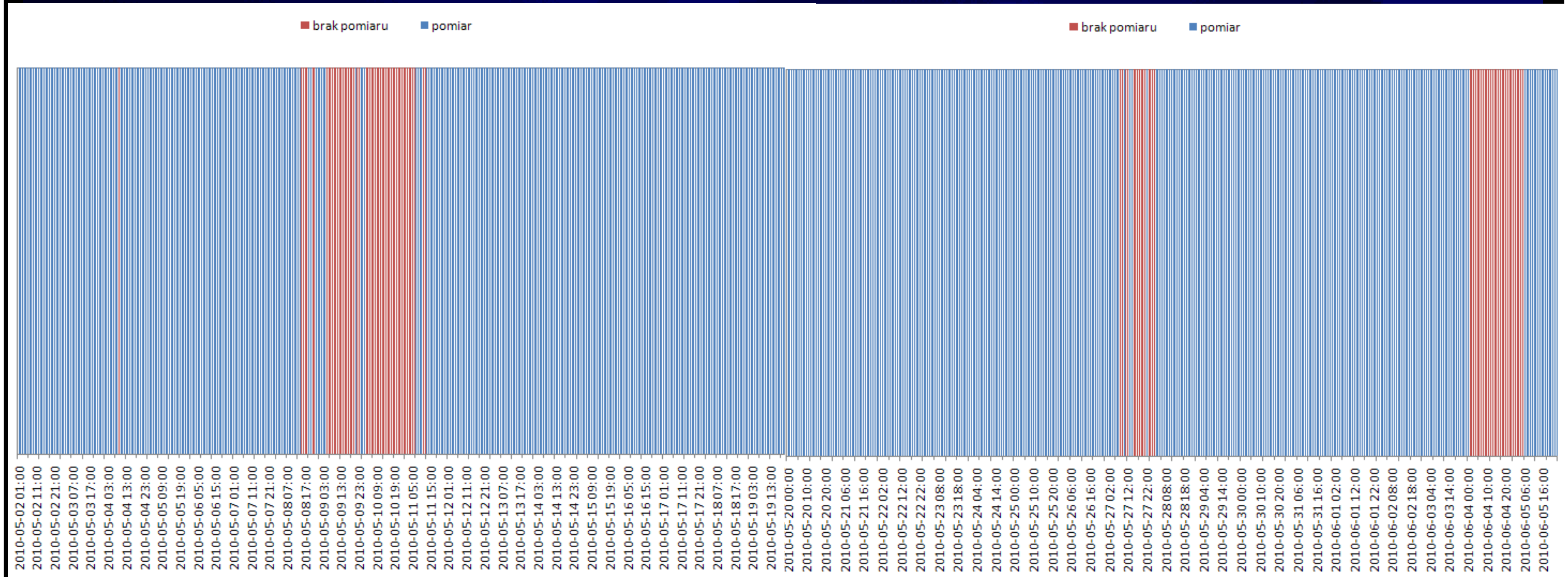
2nd Jun 2010 03:00 AM, Q = 127 m³/s

4th Jun 2010 06:00 AM, Q = 107 m³/s



Results (2010 flood)

Gaps in radar data (red)



Results (2010 flood)

Szaflary level gauge (2010):

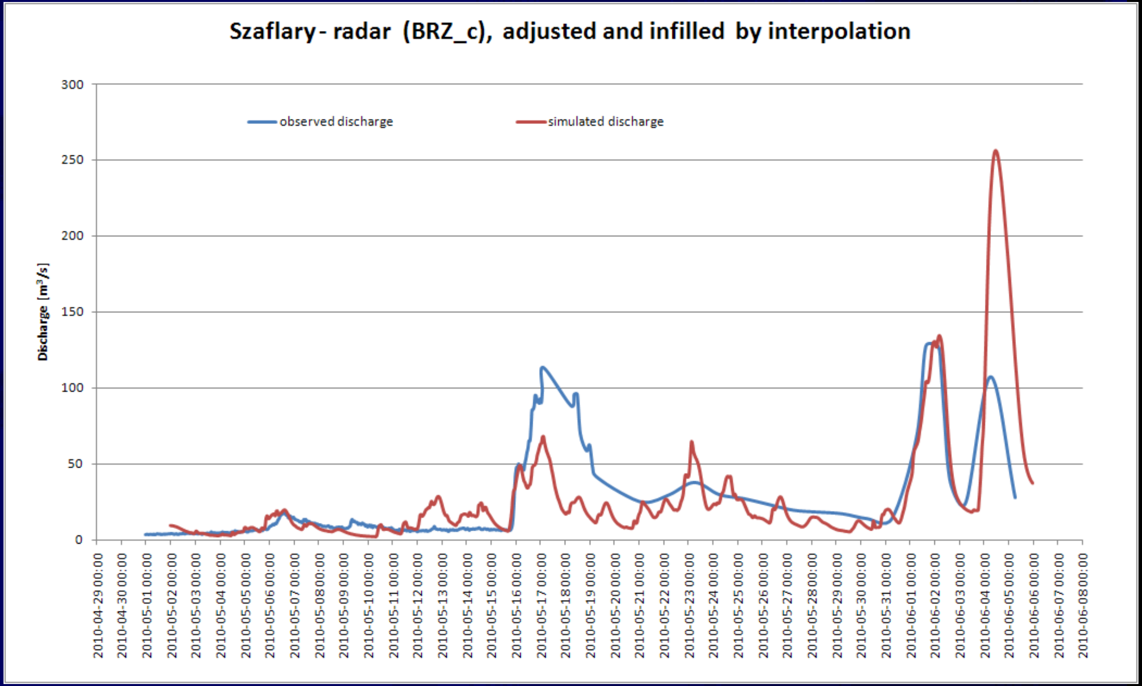
The river discharge simulated from
radar data after 3-D and 2-D (adjustment) corrections,
with gaps complemented with interpolated radar data (red)
and observed (blue)

Simulated discharge:

17th May 2010 03:00 AM, Q = 67.7 m^3/s
2nd Jun 2010 04:00 AM, Q = 134.2 m^3/s
4th Jun 2010 11:00 AM, Q = 256.1 m^3/s

Observed discharge:

17th May 2010 03:00 AM, Q = 113.6 m^3/s
2nd Jun 2010 03:00 AM, Q = 127 m^3/s
4th Jun 2010 06:00 AM, Q = 107 m^3/s



Results (2010 flood)

Szaflary level gauge (2010):

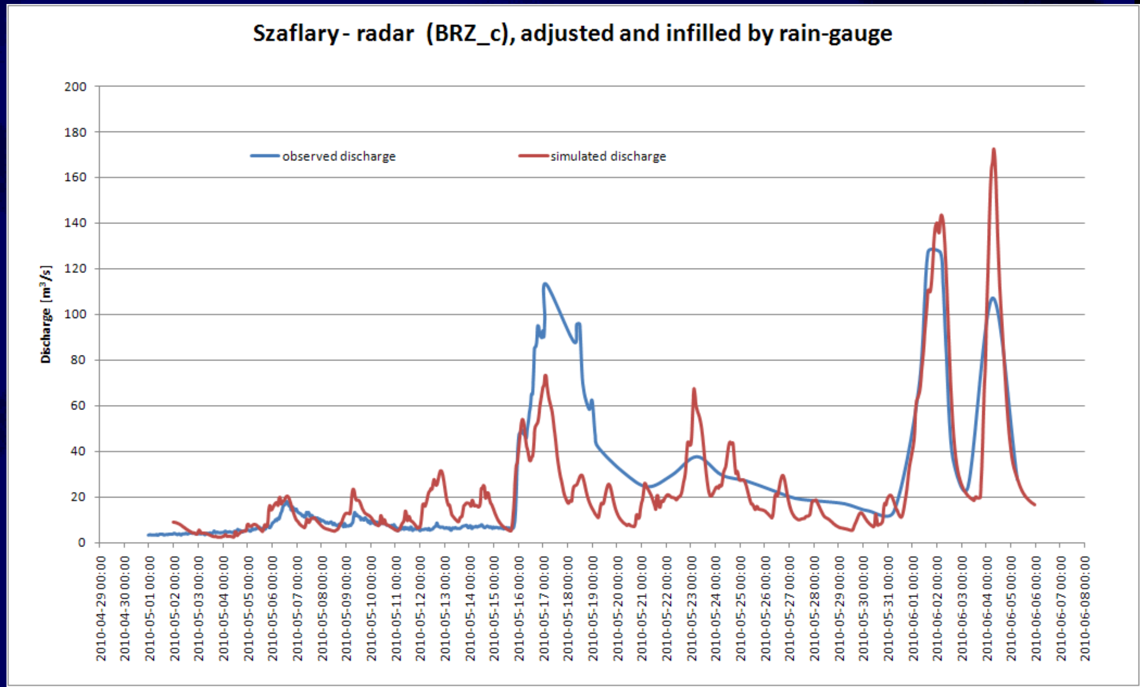
The river discharge simulated from
radar data after 3-D and 2-D (adjustment) corrections,
with gaps complemented with interpolated rain gauge data (red)
and observed (blue)

Simulated discharge:

17th May 2010 03:00 AM, Q = 73.32 m³/s
2nd Jun 2010 04:00 AM, Q = 143.6 m³/s
4th Jun 2010 07:00 AM, Q = 172.5 m³/s

Observed discharge:

17th May 2010 03:00 AM, Q = 113.6 m³/s
2nd Jun 2010 03:00 AM, Q = 127 m³/s
4th Jun 2010 06:00 AM, Q = 107 m³/s



Summary and conclusions

Conclusions:

- The rainfall-runoff model using data from rain gauges as input reflects the first flood peak to a high degree. The next two peaks are simulated in lower quality. This is obtained with rather dense rain gauge network.
- The best simulation using radar data was obtained if the data were: corrected at 3-D (RADVOL-QC) and 2-D (adjustment) stages, and with gaps complemented with interpolated rain gauge data.
- From performed analysis it is impossible to draw unambiguous conclusion about the usefulness of precipitation data from weather radar for hydrological modelling.
- It is recommended to carry out more tests, especially on data after more advanced quality control.

Summary and conclusions

Comments from „radar-hydrologist”:

- Using radar data as input to hydrological simulations and forecasts needs more advanced work on surface precipitation estimation.

- Although radar can observe small-scale precipitation field properties, the uncertainty in quantitative estimation is still relatively high.

- At present, the main trends are:
  - more advanced combination of radar data with rain gauges,
  - introduction of probabilistic rainfall inputs and outputs (runoff forecasts).

Thank you
for your attention!

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