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Comparison of simulated discharge over Ogosta river basin using ground, satellite and merged data as precipitation input for the purpose of flood forecasting

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ABSTRACT

The hydrological processes are very complex and the hydrological and hydraulic models are the main components of the flood forecasting and warning systems. They identify the dominant hydrological processes, which influence water balance and result in conditions of extreme hydrological events. A variety of hydrological models (lumped, semi-distributed, distributed) exist nowadays. In this study the physically-based, fully distributed hydrological model TOPKAPI (TOPographic Kinematic APproximation and Integration) is applied. The model utilities three non-linear reservoir differential equations for the drainage in the soil, the overland flow on saturated or impervious soil, and the channel flow along the drainage network.

The precipitation has high spatial variability especially in convective events. The conventional methods of measuring the precipitation is using rain-gauges, which are sometimes quite far from one another. Thus it is of great importance to have precipitation in denser points especially in convective events as the one, which will be presented in this study (01 – 03 June 2019) for better hydrological simulations. One possible solution is merging conventional with satellite data.

CASE STUDY

The TOPKAPI model is applied over Ogosta river basin in the PhD thesis of Valeriya Yordanova. This basin is situated in the northwestern part of Bulgaria (Fig. 1). Its watershed is around 4280 km^2. In the upper part of the basin is situated one big damn (Ogosta damn), which significantly changes the river flow in the downstream part of the river. The watershed is under the influence of moderate continental climate: comparatively cold winter due to the arctic air masses, mild and rainy spring under the influences of air masses from the Atlantic ocean, comparatively dry and hot summer, and mild autumn. Generally the highest amount of precipitation falls in mountainous part of the basin and in the spring and beginning of summer, and the lowest amount of precipitation is in the summer and autumn and northern part of basin. The flow regime follows the pattern of the precipitation.
During the calibration process were used 21 meteorological stations (Fig. 1).

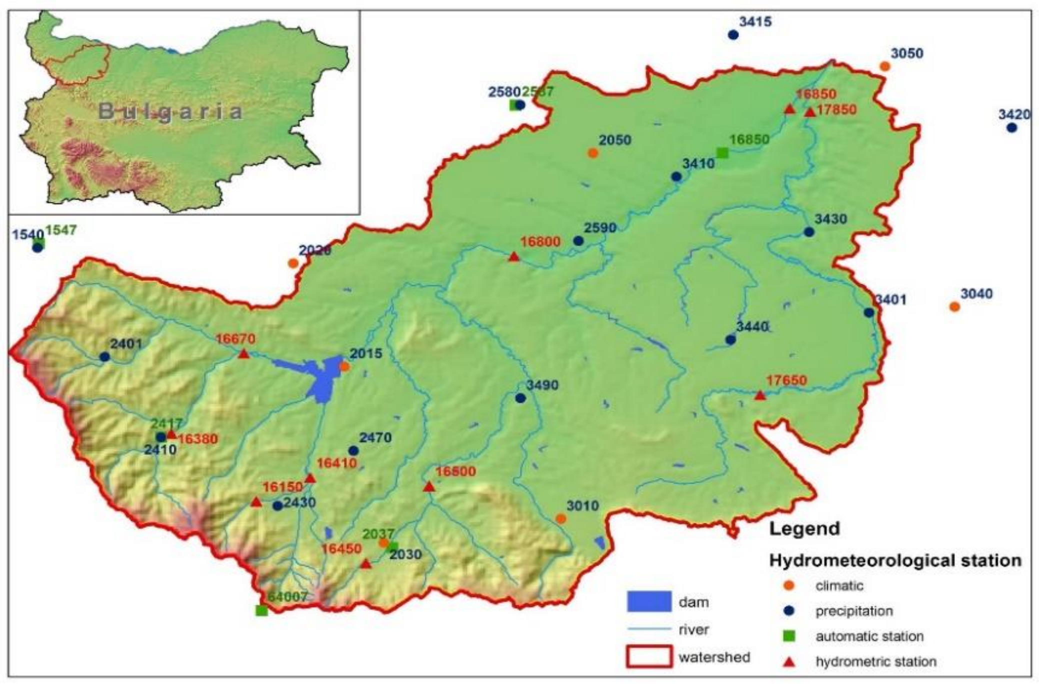


Fig. 1 Ogosta river basin, meteorological stations, hydrometric stations, DEM (digital elevation model) and the river network

Table 1 Precipitation data over the Ogosta river basin used in the simulation for the selected period (blue – conventional stations, green – automatic stations, yellow – satellite product)

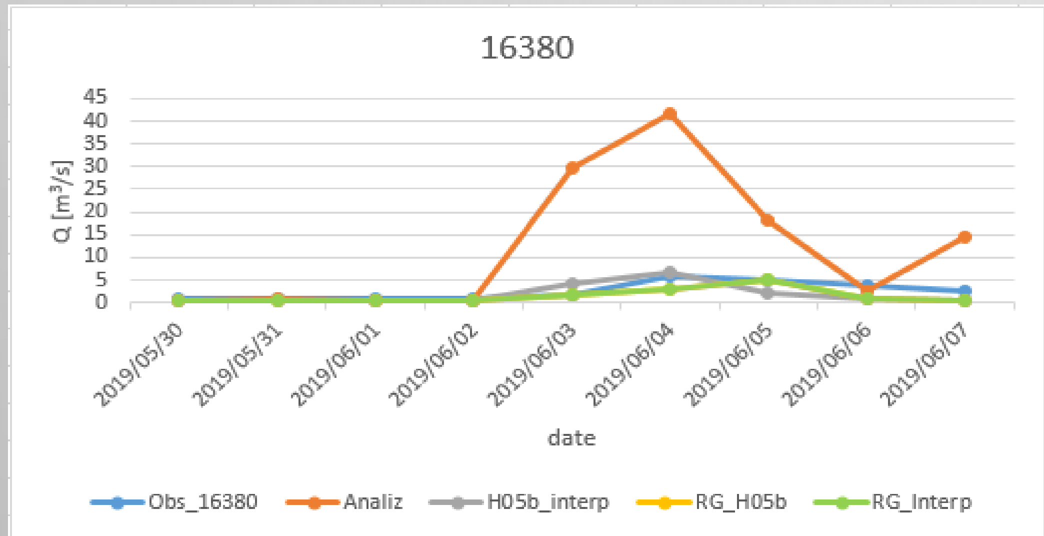
station/product	max 24 hours precipitation, [mm]	72 hours precipitation, [mm]
1540	50.3	67.3
2015	24.1	38.2
2021	21.6	26
2030	31.5	49.5
2401	36.6	60.4
2410	31.8	54.2
2430	43.2	82.2
2470	21.8	29.1
64210	48.3	76.7
2037	29.8	44.2
2417	16	24.4
64007	29.6	40.1
H05b	26	45

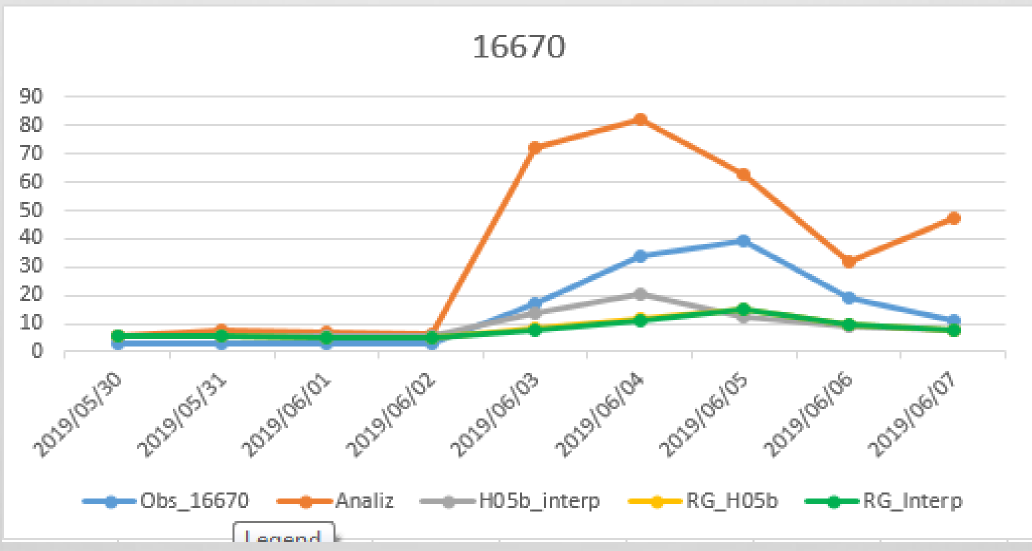
METHODOLOGY

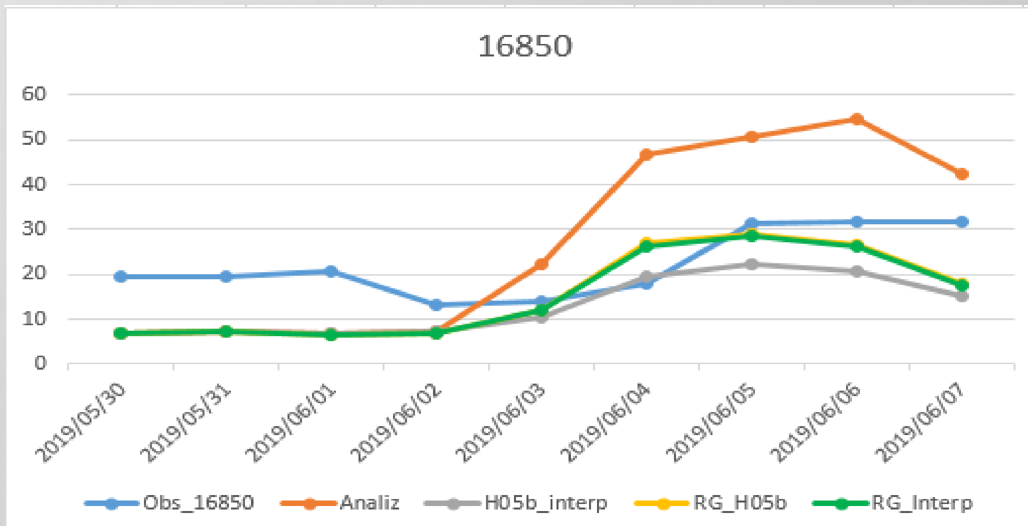
In this study will be shown model simulations using the following type precipitation data:

- Data from 21 conventional stations (Fig. 1) – used in the process of calibration;
- Data from automatic stations interpolated into the 21 meteorological stations used for the model calibration (Table 1 – green rows);
- Data from HSAF project. H05b product is selected for this paper. This is Accumulated precipitation by merging MW images from operational sun-synchronous satellites and IR images from GEO satellites (i.e., product P-IN-SEVIRI). The data from this product are again interpolated in the locations of the 21 meteorological stations (Table 1 - yellow row);
- Merged data from automatic stations and H05b product, interpolated in the locations of the 21 meteorological stations using kriging method Generalized Additive Model (GAM).

RESULTS







The results show that the model overestimates the peak discharges, when simulations are performed with conventional ground data (red line). It is also seen that the simulation with satellite product generally underestimates the discharge. The simulations with interpolated data from automatic stations also show better simulations in the lower part of the basin. This could be explained with the fact that in the lower part of the country there are more automatic stations than in the upper (mountainous) part, which leads to better distribution of the rainfall. Another fact is that the model was calibrated with precipitation values in locations with raingauges and specific high waves. When we use a blended spatial interpolation /yellow line/, the new blended data is very closely to the interpolated, GAM – Krigin interpolated values /green line/. The model was calibrated using precipitation data in specific locations, not spatial interpolated data. In a new calibration of the model, from the spatial interpolation can be generated more "extra" points, which can be used to enter more detailed precipitation in the hydrological model.

CONCLUSION

The results from this study show that the data from the HSAF cannot be applied alone for hydrological modelling especially in case of simulation of floods. Better results are achieved when using combination of satellite and ground data.
In this paper the simulations are performed on a 24 hours time step and the simulation results are compared with observed discharges at 8 o'clock in the morning. This is quite big step, especially when simulating and forecasting flash floods (which range is usually less than 10 hours). Our future work will be focused in decreasing the time step in order to better simulation of the time and magnitude of the flood peaks. Another focus will be the use of blended precipitation (automatic stations and satellite data) to better describe the spatial variability of the precipitation especially in convective situations.