ARDA FORECAST

Greece-Bulgaria 2007-2013
INVESTING IN OUR FUTURE

Warning system for floods in Arda river basin - advances and achievements

Eram Artinyan, Kamelia Krumova, Snezhana Balabanova, Georgy Koshinchanov, Petko Tsarev

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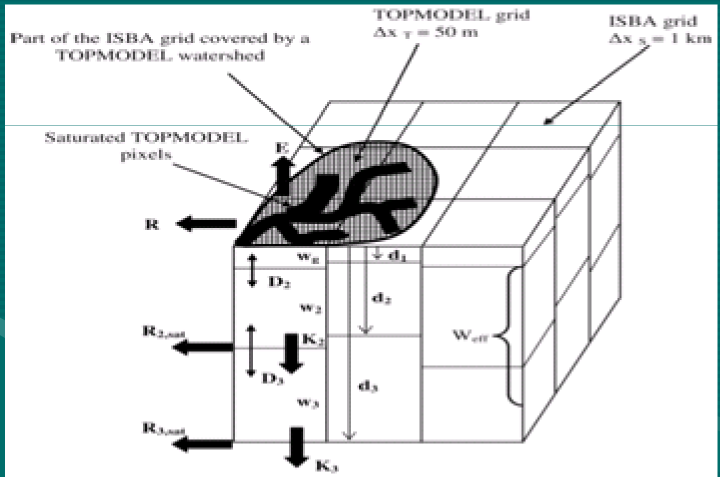
- Project modeling platform, forecasting technology concepts and composition \hot-points with hydrologic model and overland flow with hydraulic model\
    - The model used – coupled SURFEX-TOPMODEL
    - Calibration
    - Real time runs arrangement – data used, forecasting products – outputs
    - Hot-point approach
    - Hydrological thresholds – discharge >> level at 1%,5%,50% return periods
- Sensitive area approach: purpose to treat flood risk in the vulnerable zone – with hydraulics model, the forecasting model produces discharges to recognize the flood risk scenario. The predefined scenarios are produced by the hydraulic model.

Modeling platform for hydrological analysis and forecast

- Based on ISBA- TOPMODEL coupled model
- Surface scheme uses interpolated input data from telemetric stations and forecasted fields of precipitation, air temperature and moisture, etc. from ALADIN & ECMWF forecasts (5 days ahead) atmospheric models



- <u>Initialization of forecast run</u> is done after running the system with measured precipitation and temperature input fields

It computes <u>evapotranspiration, surface runoff Qr [mm] and drainage D [mm]</u>

Qr and D are transferred to the <u>hydrological model for routing</u>

<u>Discharges [m^3/s] are computed at predefined cross-sections at 3h step</u>

Calibration of ISBA and TOPODYN parameters

SURFEXv7.2 and the included TOPODYN hydrological model have the following 5 parameters to be calibrated in relation with river flow generation:

a) b – parameter of the variable infiltration capacity (VIC) scheme. The parameter is valid on the level of SURFEX (ISBA) grid cell

b) wdrain – subgrid drainage value as single value for the domain or a file.

c) f - parameter for the exponential profile, values for each catchment

d) c - depth ratio for the exponential profile, values for each catchment

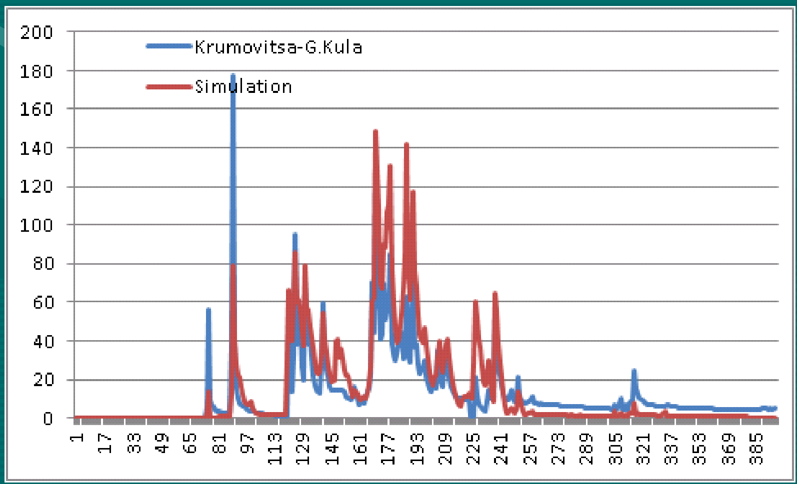
e) Speed of water in river, values for each catchment

Cross-section	Nash
Arda - Rudozem	0.58
Arda - Taran	0.64
Arda - Vehtino	0.82
Vurbitsa – V.Dol	0.80
Vurbitsa - Gruevo	0.86
St.Kladenets inflow	0.89
Krumovitsa	0.51

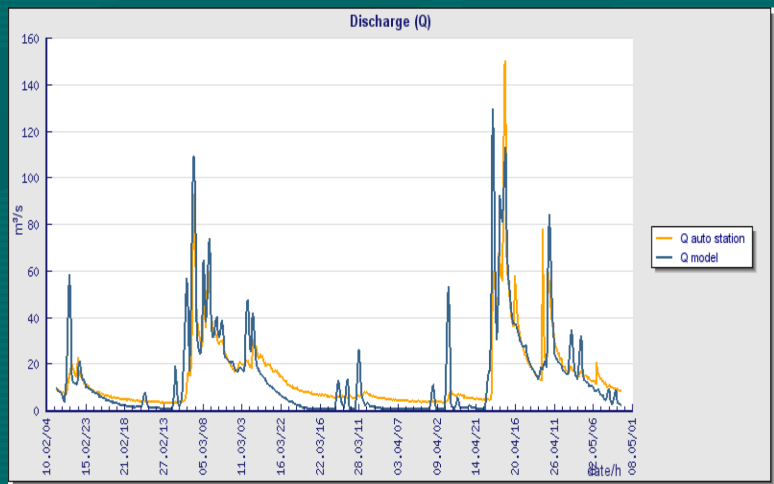
- Calibration was made by use of statistical methods: correlation, Nash coefficient, BIAS
- Only gauged cross-sections parameters were calibrated. The remaining cross-sections receive the nearly located cross-section parameters.

Calibration results and discussion

- Data series of daily average measured stream flow discharges for 13 month period were used for the statistical comparison – NIMH doesn't store hourly discharges as historical information – this should be addressed.
- The first two parameters b and wdrain were set uniform for the entire domain. B was selected 0.65 above the default 0.5 used in ISBA because of the mountain character of the basin. Wdrain is important for the low flow period.
- For the next three parameters a computing cycle was prepared in order to test several hundreds of combinations of the parameters.
- Results are representative for the whole year – mixed low flow and high flow. A separate calibration should be made only for high flow period.



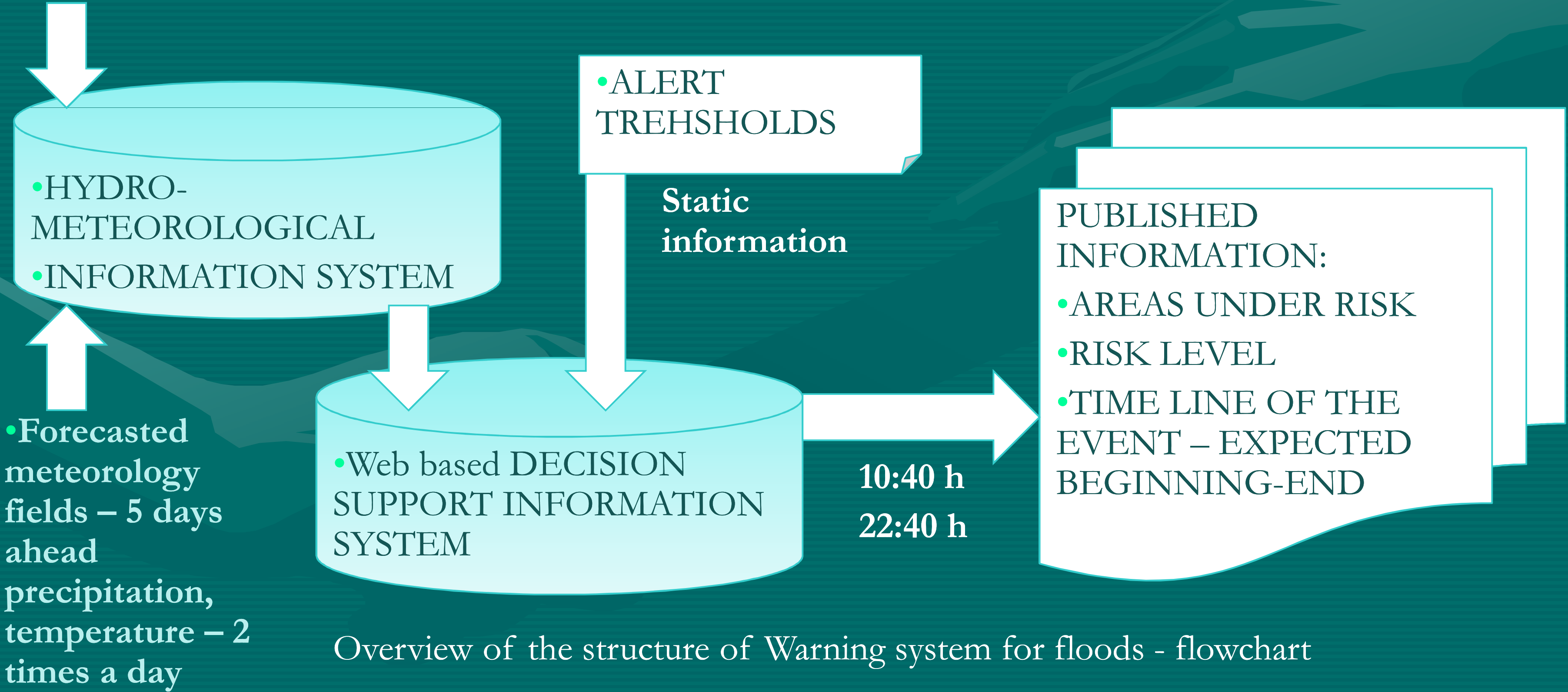
Calibration – R2=0.73



Validation – R2=0.86

Real time runs arrangement – data used, forecasting products – outputs

- 14 telemetric stations measuring water level in rivers and reservoirs, precipitation intensity, air temperature in Bulgaria and Greece – in real time



Overview of the structure of Warning system for floods - flowchart

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Hot-point approach

Hot-points: 17 areas for which flood warnings will be issued - combination of areas under high flood risk and of human infrastructure like settlements, roads, industrial buildings etc. The area most important for the Greek part is BG/GR border.

Why? Only most endangered areas with historically proven high flood risk level are selected (following the "Preliminary flood risk assessment" - EU directive 2007/60).

Problems:

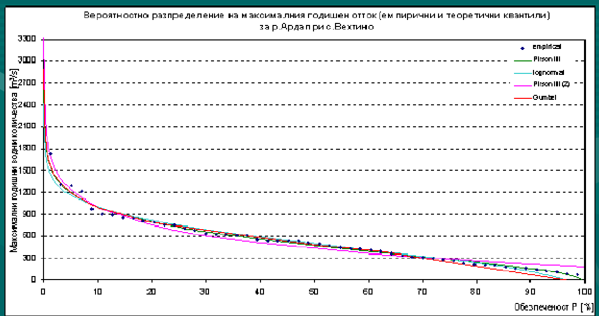
- Floods may occur elsewhere
- Floods may arrive because of human actions or mistakes
- Model & forecasts may be wrong for particular cases: local heavy showers in summer

Hydrological thresholds – discharges with 1%, 5%, 50% probability of the yearly maximum

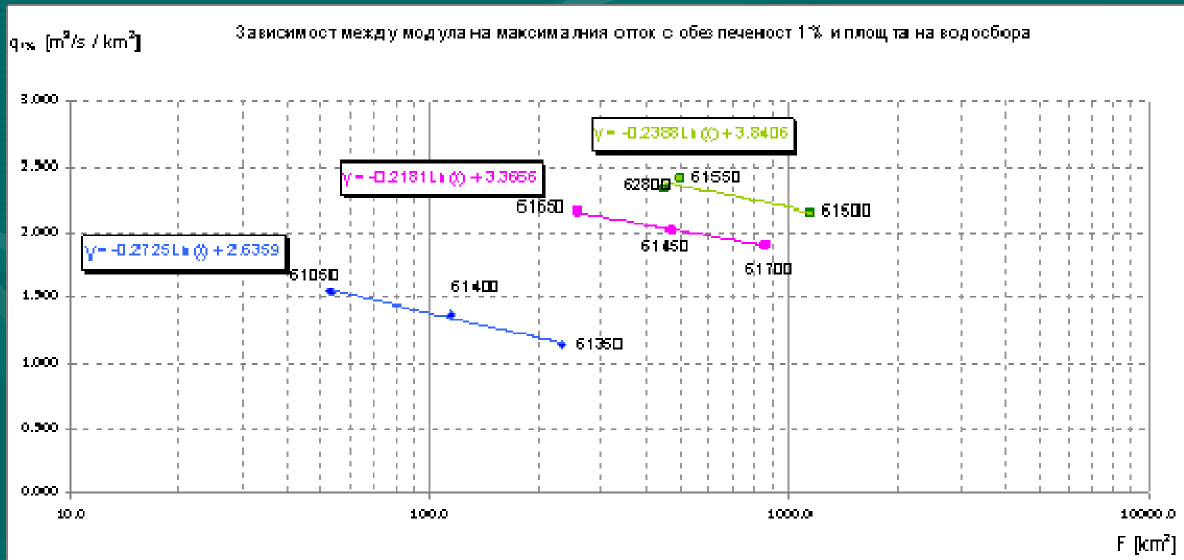
Regionalization procedure consists of determining two coefficients (for each set of sub-basins) that permit expressing maximum discharge with certain probability as function of the watershed area where hydrological measurements are not available

The first coefficient „a" is described as function of the basin area - f(A_E), and coefficient „b" is the relation for each probability period of the averages of the <u>measurement station.</u> The result is verified with data from stations. Errors are below 7%.

Empirical points (a , b) are drawn on a graph.



•Theoretical and empirical curves of probability of yearly maximums Arda r. at Vehtino



•Empirical curves of dependency between of yearly maximums 1 % probability and the basin area – three distinct regions appear.

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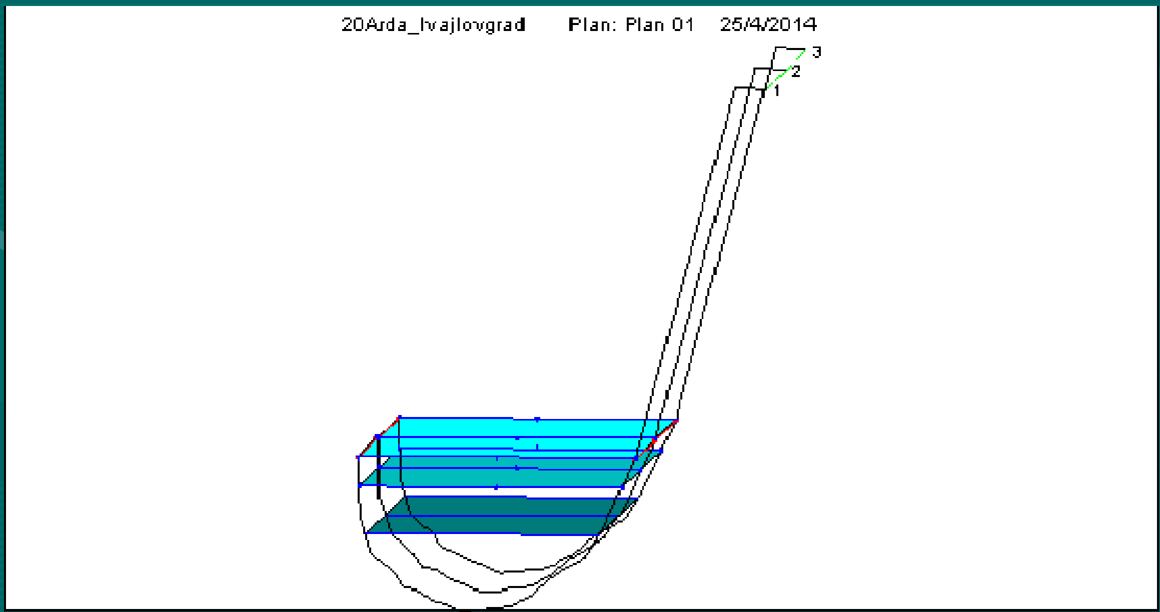
Levels with 1%, 5%, 50% probability of the yearly maximum

For each hot-point was measured a cross-section profile and for that profile with hydraulic formulas, starting from the discharges were computed the water levels corresponding to the predefined thresholds: 1%, 5% and 50% probability of the yearly maximum discharge.

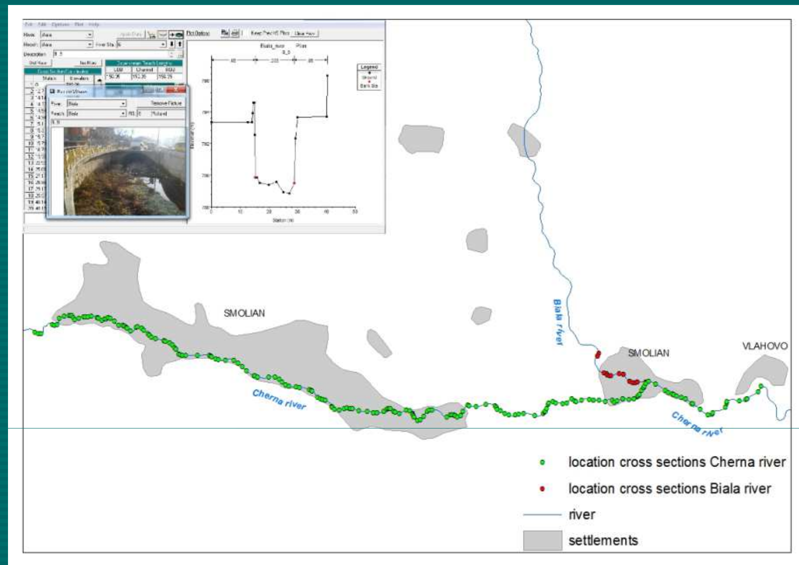


Discharges and elevations with 1%, 5% and 50% probability maximum discharge after Ivaylovgrad reservoir

5135.019	Q Total (m3/s)	W.S. Elev (m)
50%	1009	69.02
5%	2865	71.88
1%	4440	73.7

Sensitive area approach

Purpose: to treat flood risk in the vulnerable zone. Firstly a static set of hydraulic scenarios is prepared with HEC-RAS for discharges with different return periods. Then the computed TOPMODEL discharges for Smoyan's rivers Cherna and Bjala are compared to the specific return period scenarios. This permits to provide more detailed forecasting information on flooded areas in the town of Smolyan.



Scheme of the zone for hydraulic modeling – Smolyan

PRESENTATION OF Mrs Balabanova

PRESENTATION OF
Mr. Nyagolov & Tsarev

Flow transformation:
Arda river reservoir cascade

Reservoir	Capacity $[10^6 m^3]$	Watershed area$[km^2]$
Kardzhaly	497.13	1882.0
St. Kladenets	387,7	3707.5
Ivaylovgrad	156,7	5127.6

The cascade reservoirs strongly reduces the floods peak through <u>retention and redistributing of river-flow in time</u> but mean annual inflow is $1.6x10^9$ m^3 - larger than their total capacity of 10^9 m^3. <u>Most of the inflow occurs in winter and spring. That creates situations when overflowing occurs.</u>

Because of these reasons for Ivaylovgrad reservoir overflowing is not an extraordinary event. Its spillway is constructed to conduct 5800 m^3/s (0.01% probability).