

*Hydrology and Hydraulic models application
for emergency preparedness planning in
catchments with constructed dams*

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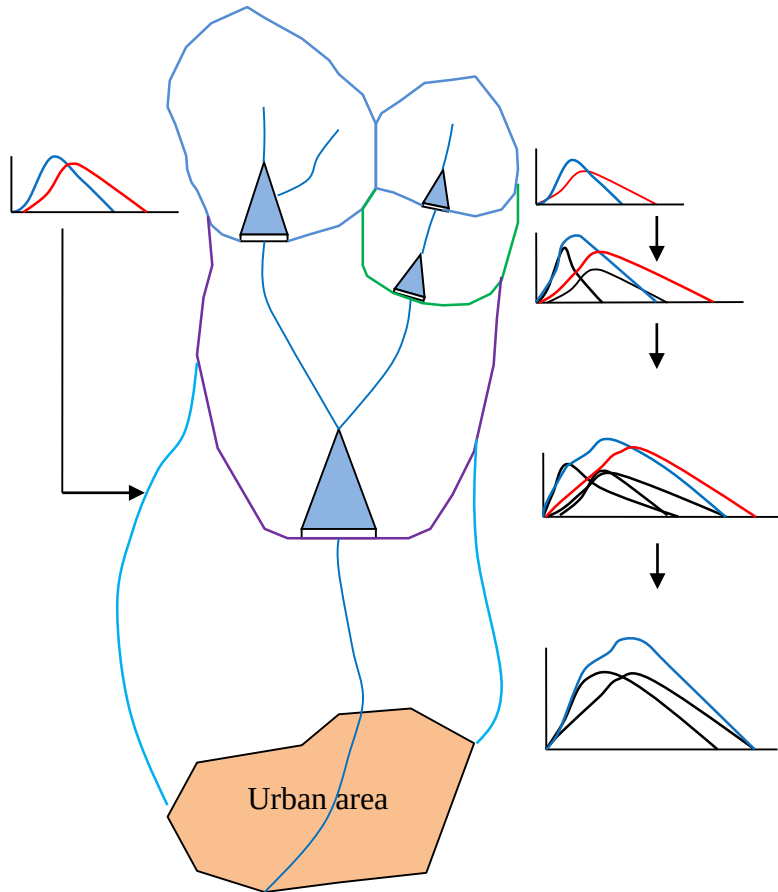
Research focus – ungauged catchment with constructed dams

General objective - to take the attention on the possible, useful hydrology and hydraulic surveys for emergency planning and response improvement

Content:

- ☐ Information for emergency planning and decision making in emergency situations
- ☐ Concept for offline early warning system in catchment with dams
- ☐ Demonstration of the Concept application
- ☐ Conclusion and follow-up

Emergency planning looks for answers of the follow questions:



How to interpret the rainfall forecast
in a catchment with dams?

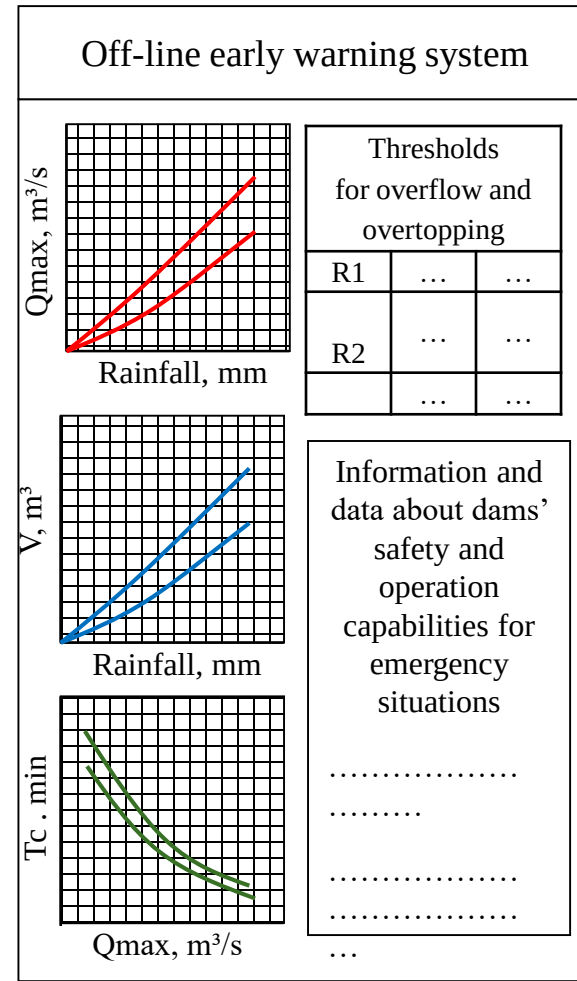
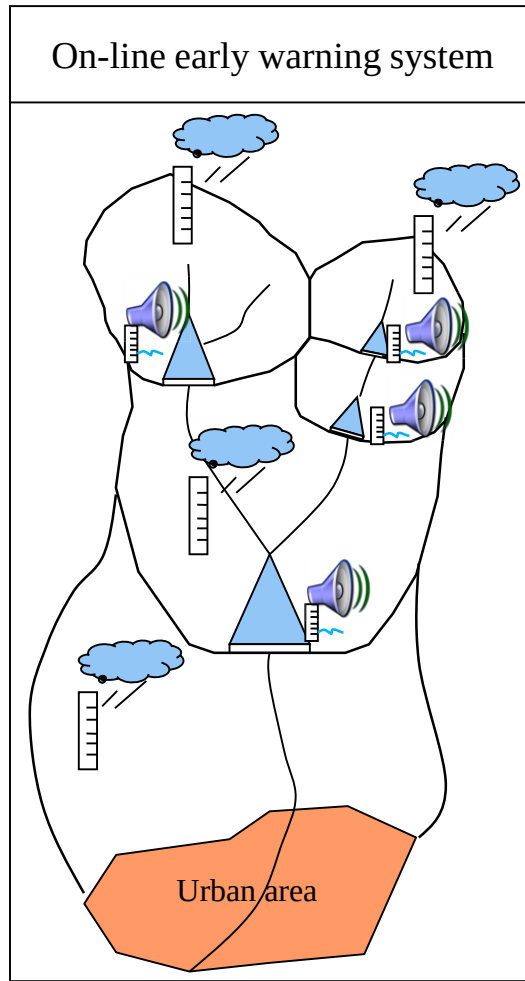
Can the operators expect **emergency**?

If, Yes...

Is the **overflow/overtopping** means
increasing **emergency downstream**?

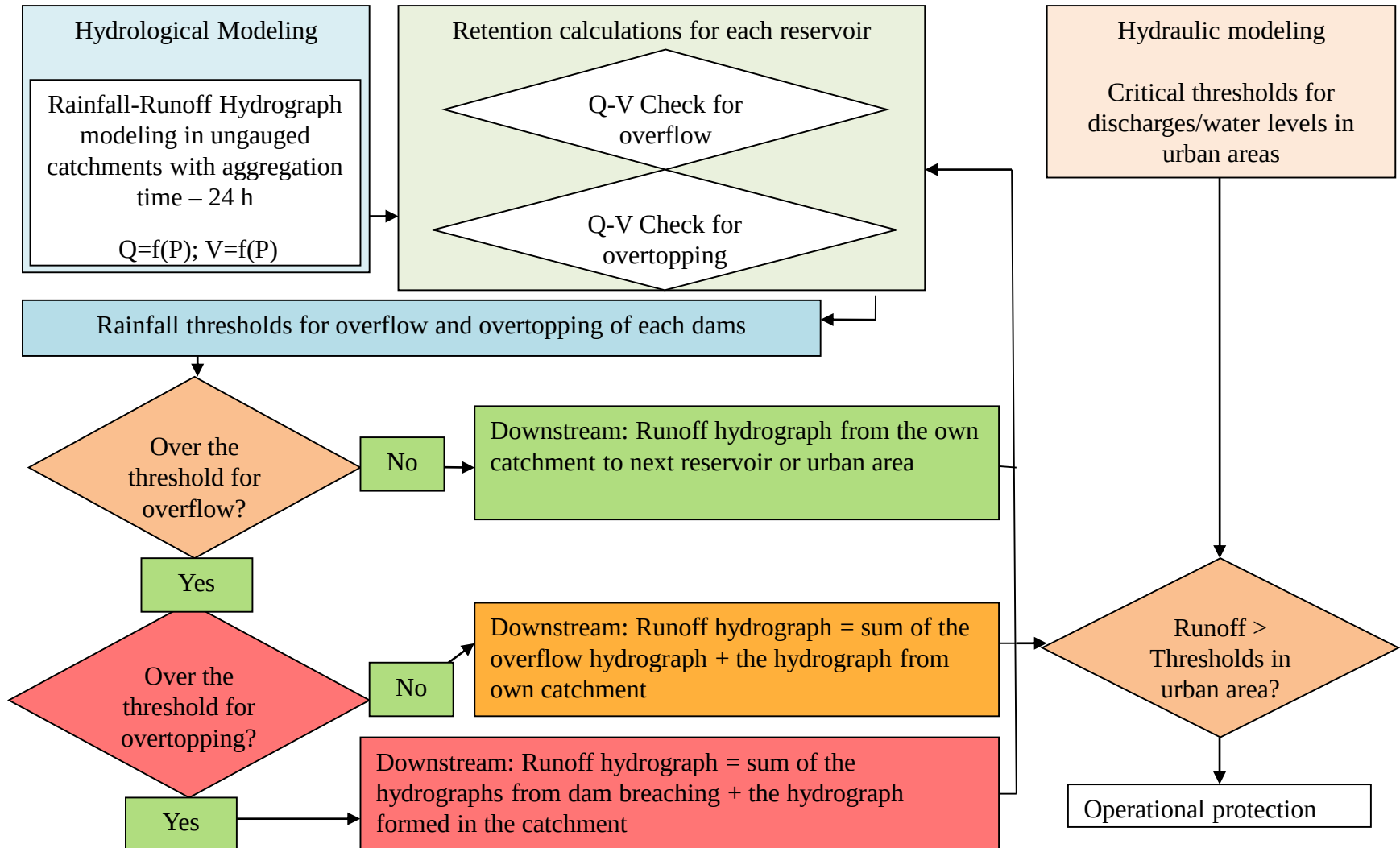
What's the **travel time** between the
dams and to the urban area?

Answers gives both early warning systems:



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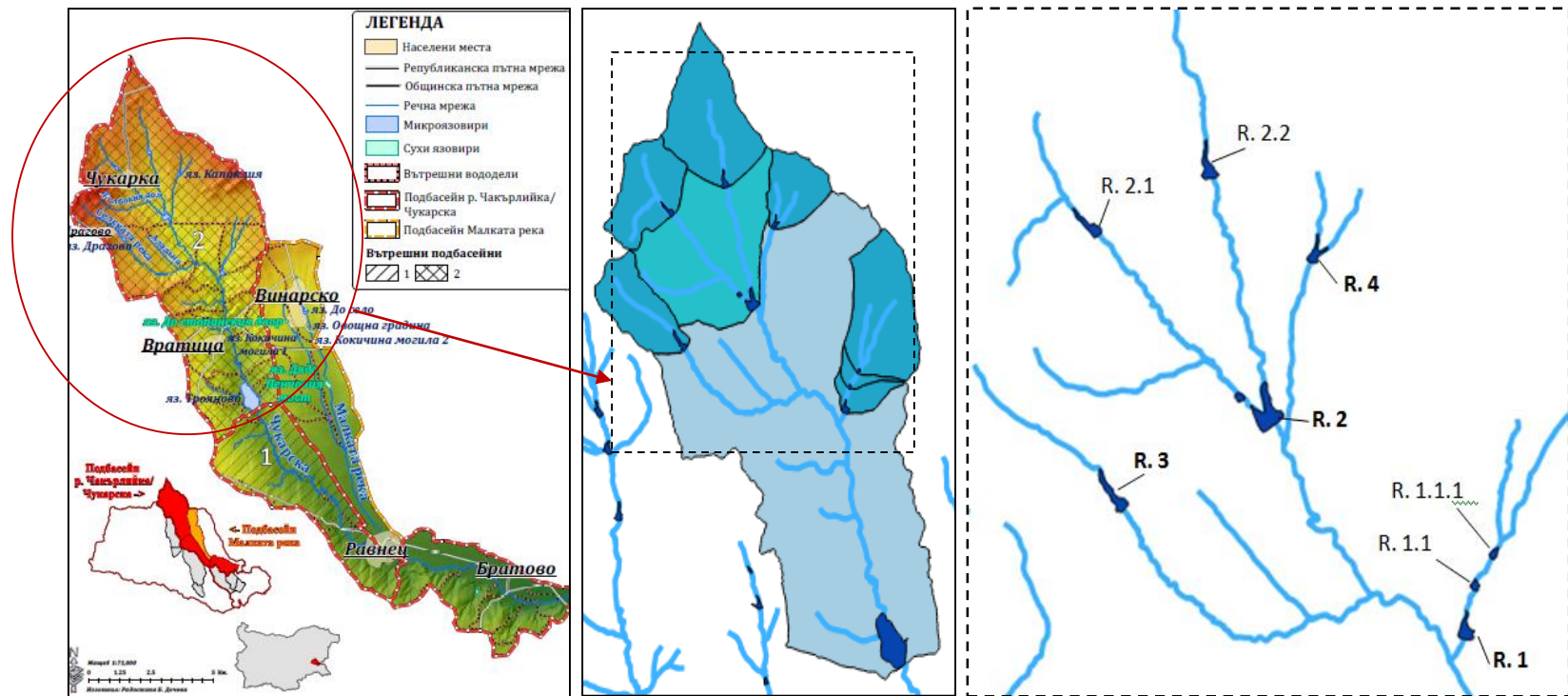
Concept for off-line early warning in catchment with dams



Demonstration of the Concept application

Object: catchment of Chukarska river, **1 big reservoir** and **8 small reservoirs**

Downstream urban area: Ravnec village



Preliminary circumstances:

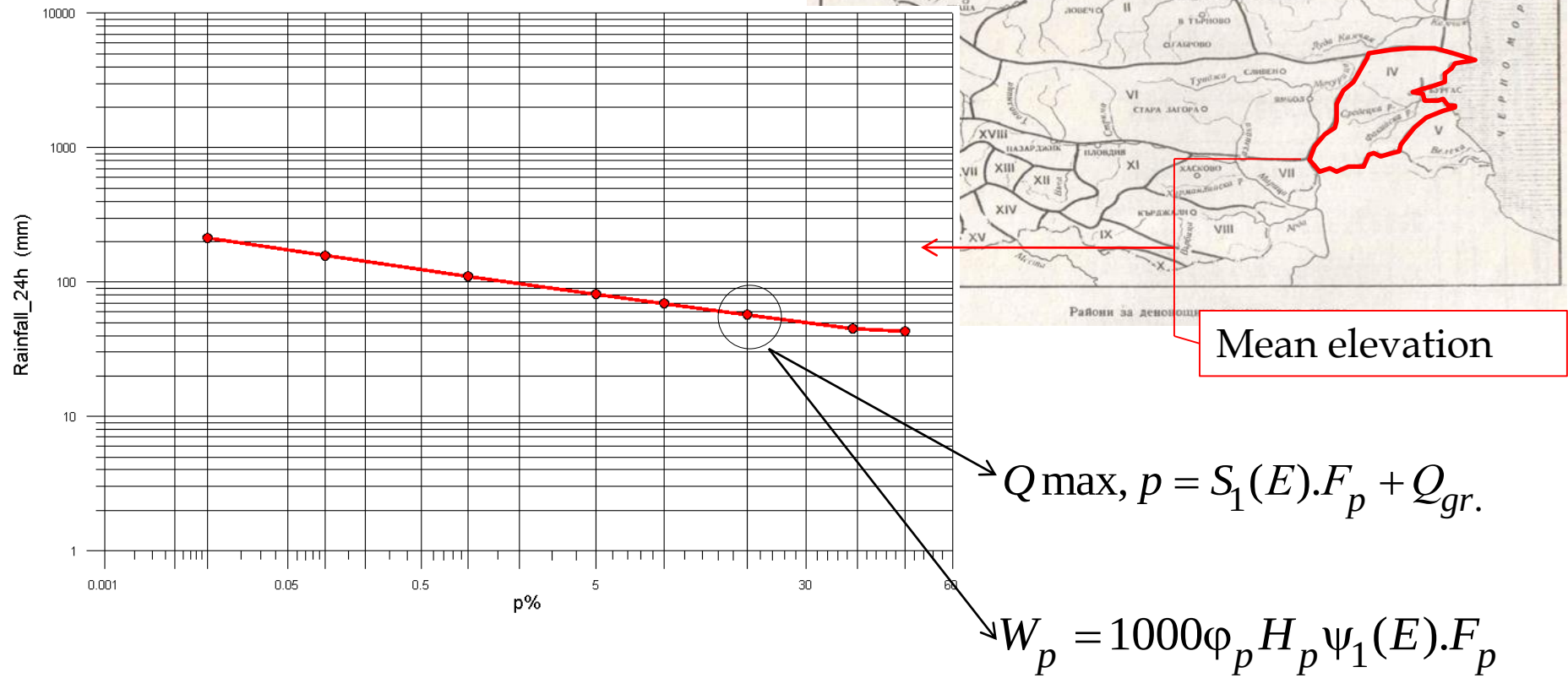
- ☐ **No gauges and no measures for water levels in the reservoirs;**
- ☐ **Limited technical information for the small dams**

Methods used a base:

- ☐ **Methodology of prof. Strahil Gerasimov for characteristics of maximum runoff determination for rivers in Bulgaria, 1978 г.**
- ☐ **Method for dam breaching** – part of the Bulgarian methodology for flood hazard and risk assessment.

Hydrology modeling by the Methodology of Gerasimov

Rainfall probability curve of the catchment

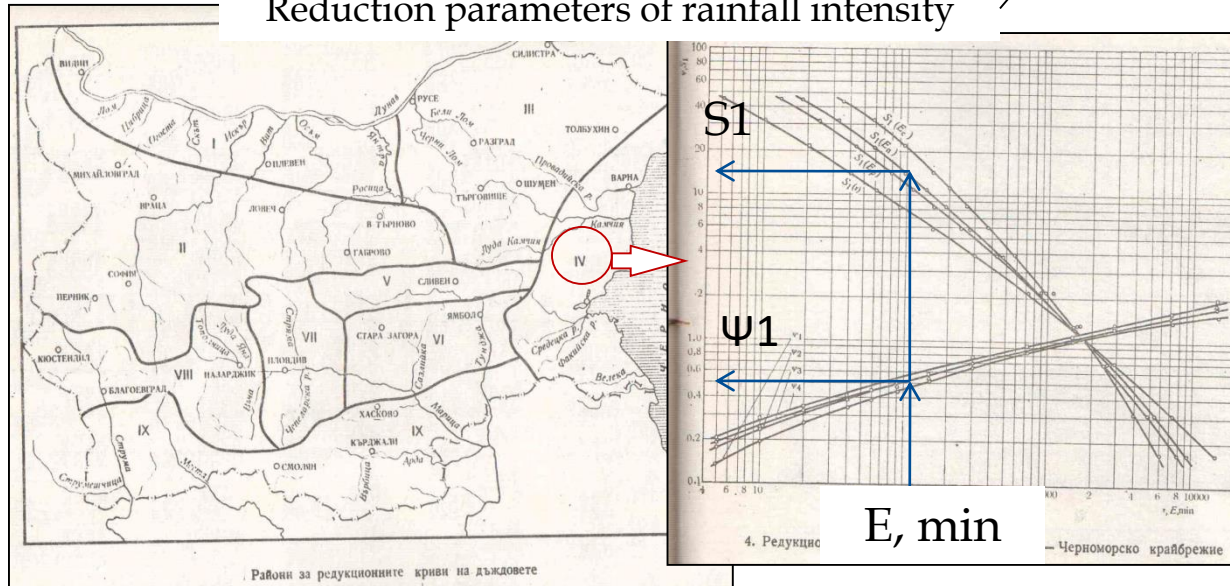


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$$Q_{\max} = S_1 \cdot F_p + Q_{gr.}$$

$$W = 1000 \varphi_p H_p \psi_1 \cdot F$$

Reduction parameters of rainfall intensity



Conditional time of concentration

$$F_p = \frac{r \varphi_p H_p}{100} F \quad \text{- Conditional runoff volume}$$

F – catchment area, km²

φ_p – conditional runoff coefficient

r – coefficient for existing water objects

H_p – 24 h rainfall with probability p%, [mm]

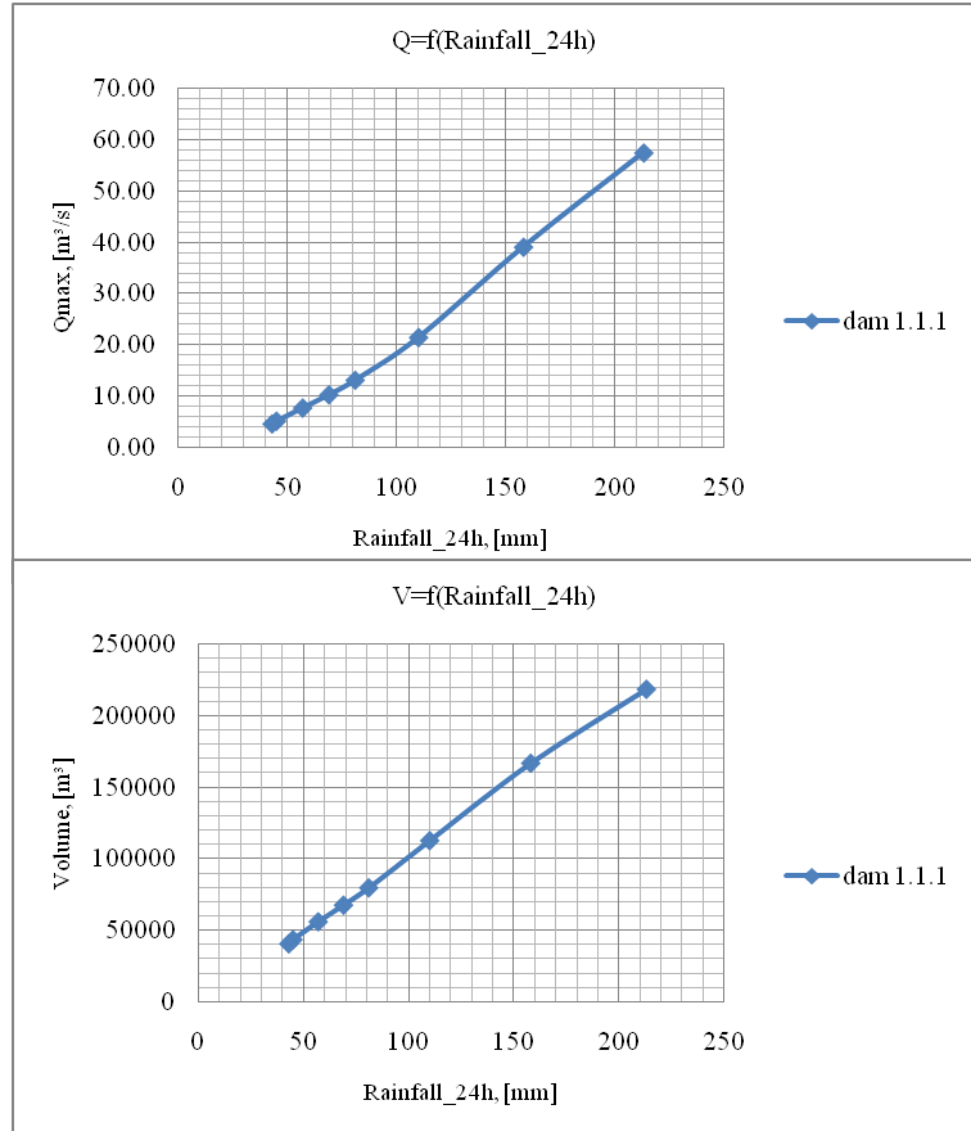
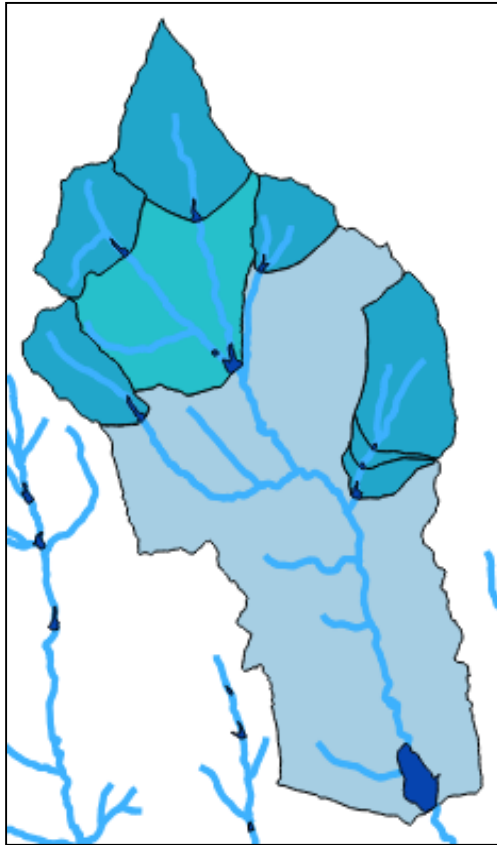
- Length of the stream;
- Average slope of the stream ;
- Conditional runoff coefficient;
- Conditional runoff volume
- Category of natural regulation capability of the catchment
- Category of soils water permeability

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$$Q=f(P)$$

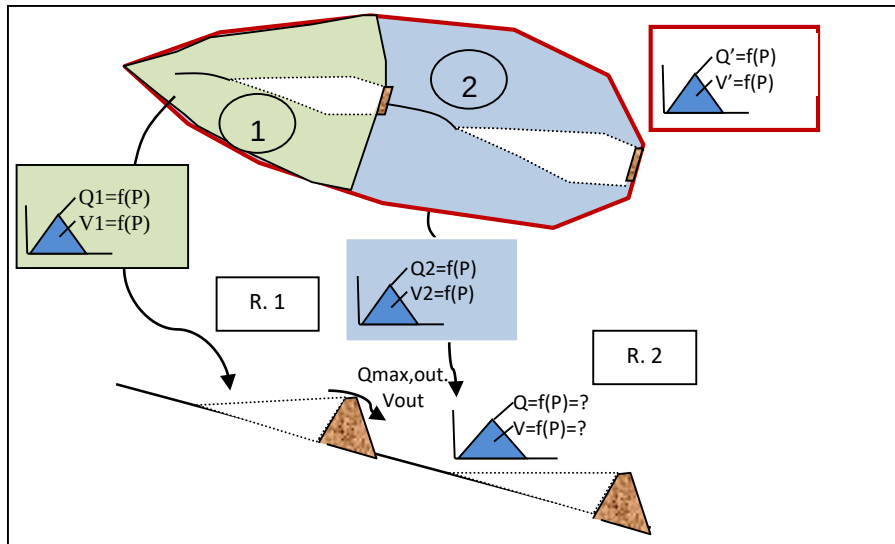
$$V=f(P)$$

Formed in each catchment
to a dam

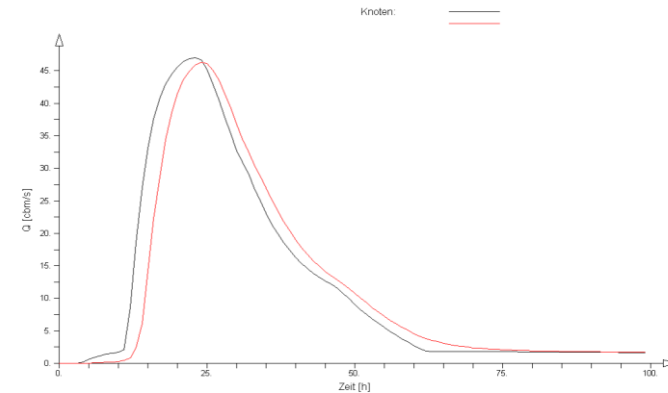


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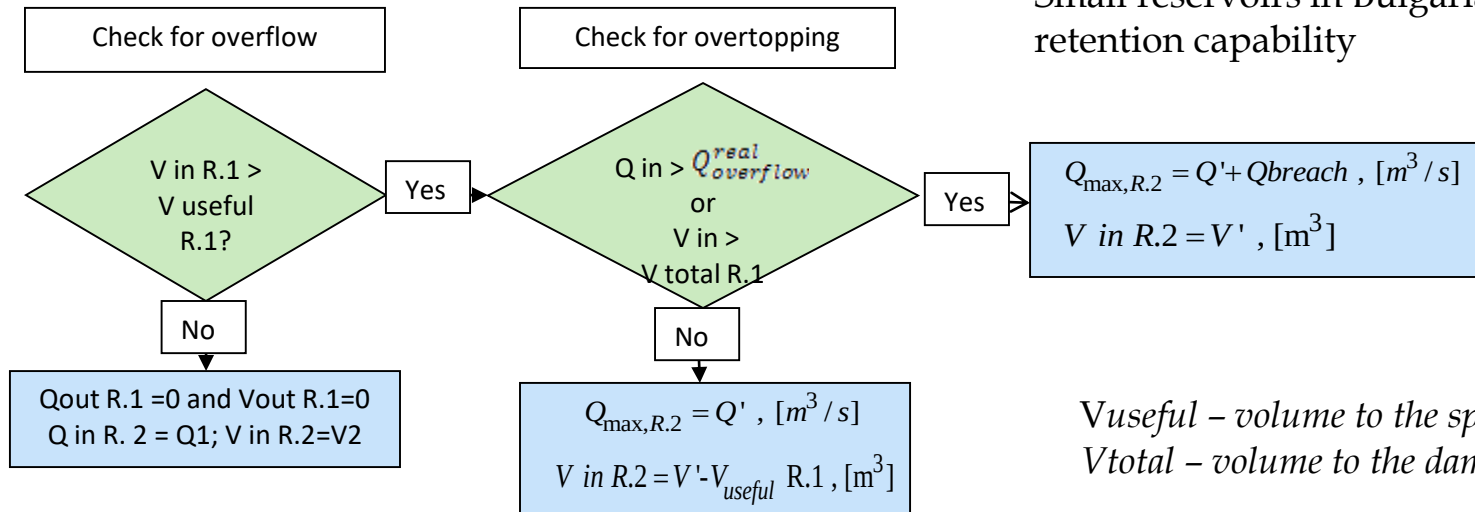
Scenario "Empty reservoirs"



$Q \text{ in reservoir} \approx Q \text{ out reservoir}$



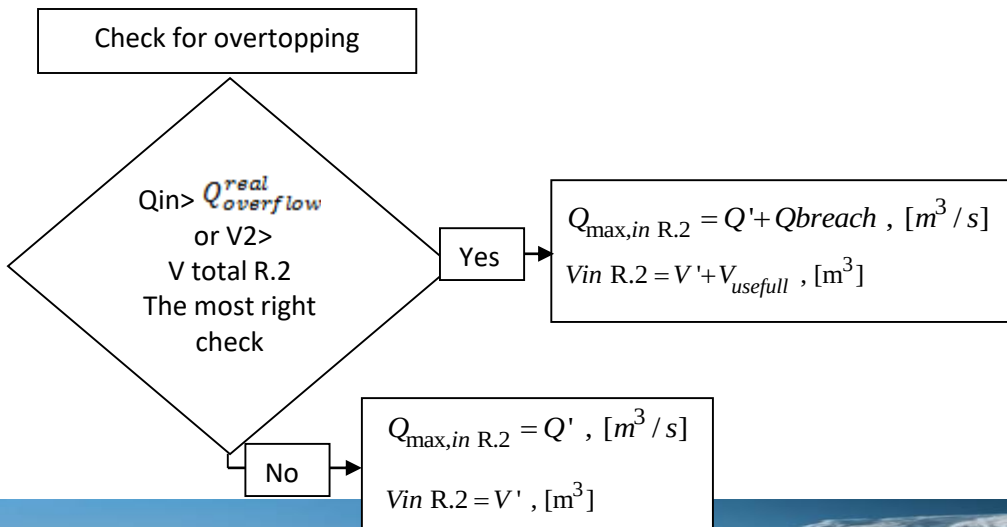
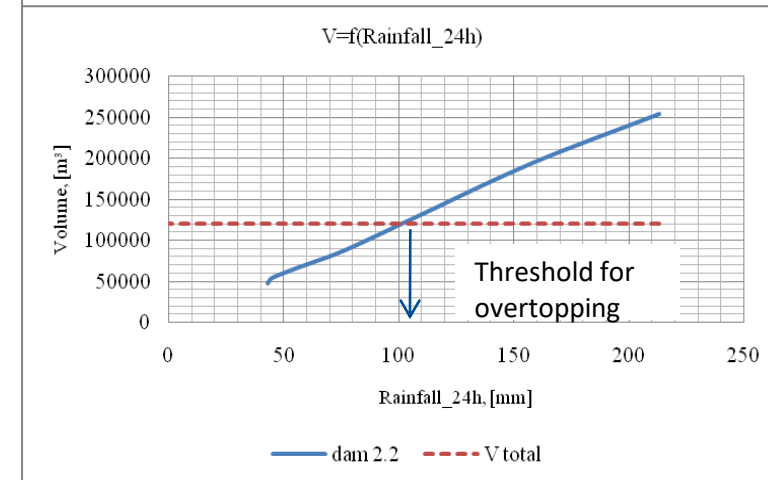
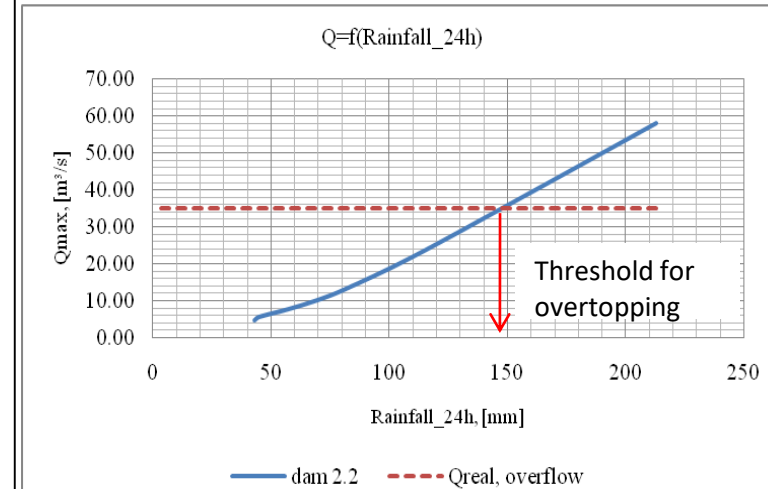
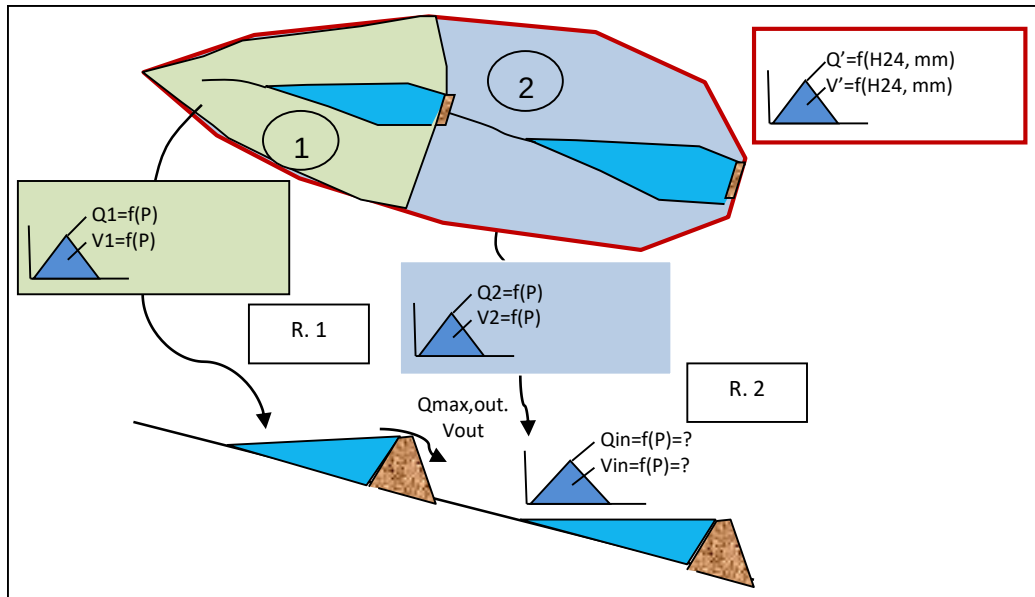
Result from previous survey:
Small reservoirs in Bulgaria with Small retention capability



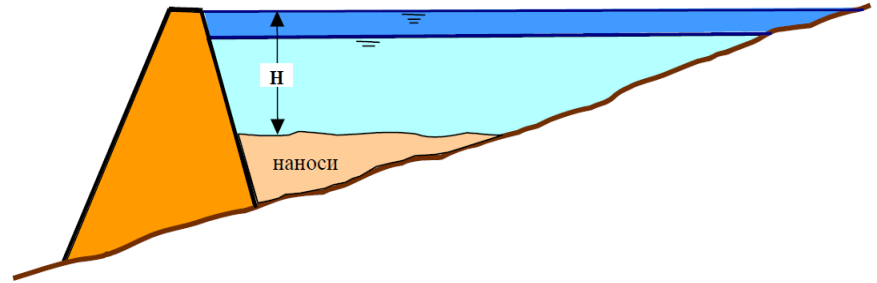
Vuseful – volume to the spillway crest
Vtotal – volume to the dam crest

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Scenario "Filled reservoirs"



Method for dam breaching according to the Bulgarian methodology for flood hazard and risk assessment



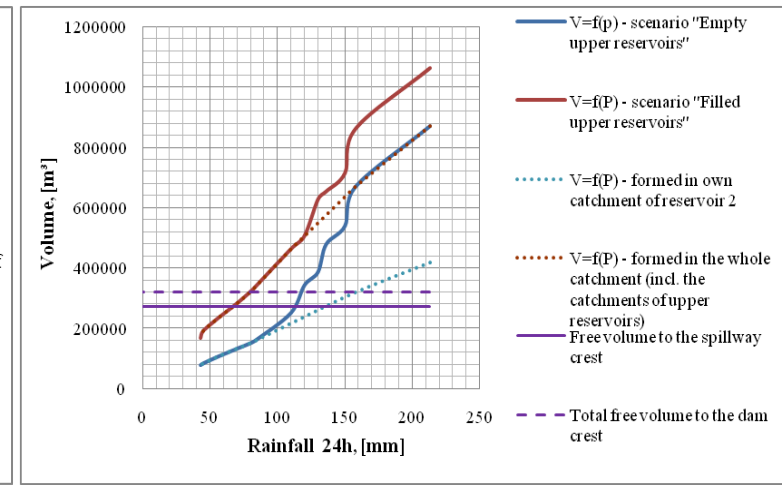
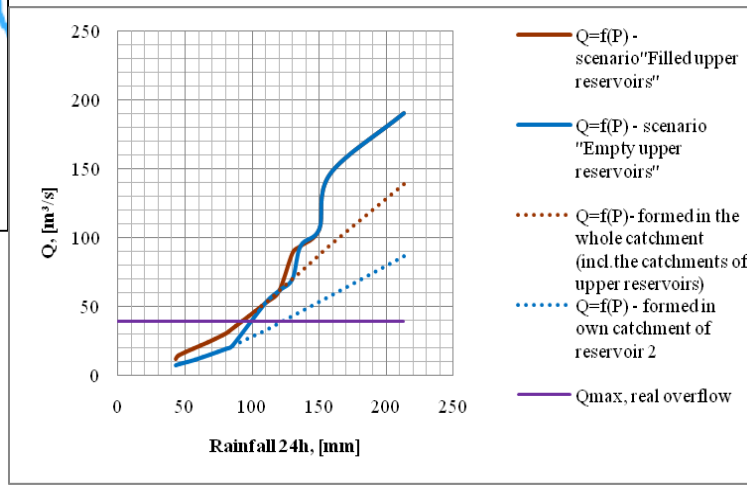
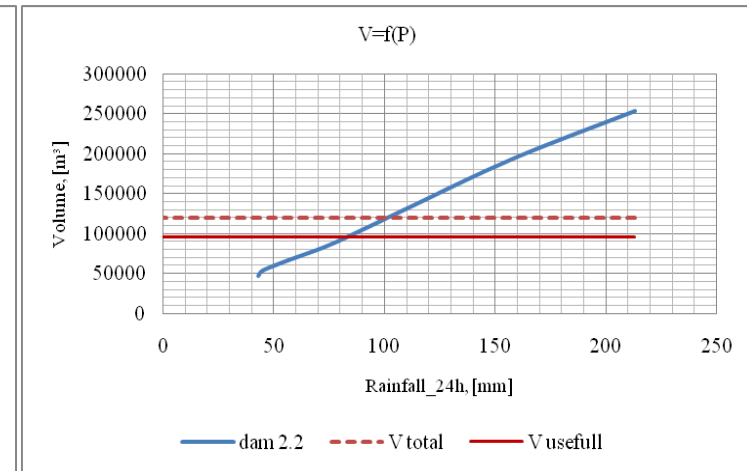
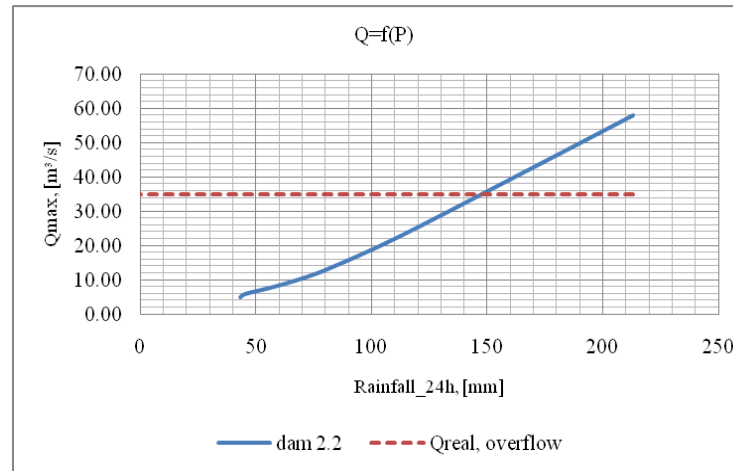
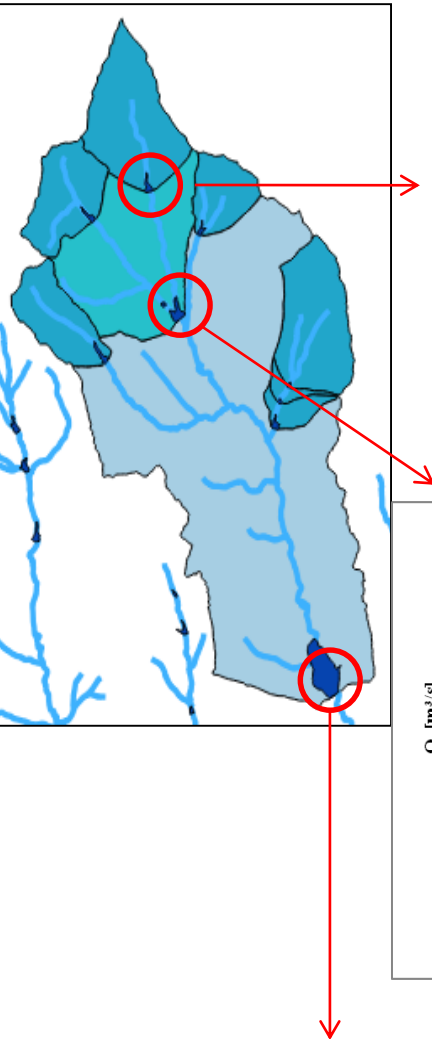
$$Q_{\max, \text{breach}} = 1,856 \cdot H^{\frac{5}{2}}, \left[\text{m}^3 / \text{s} \right]$$

Dam breach flow routing

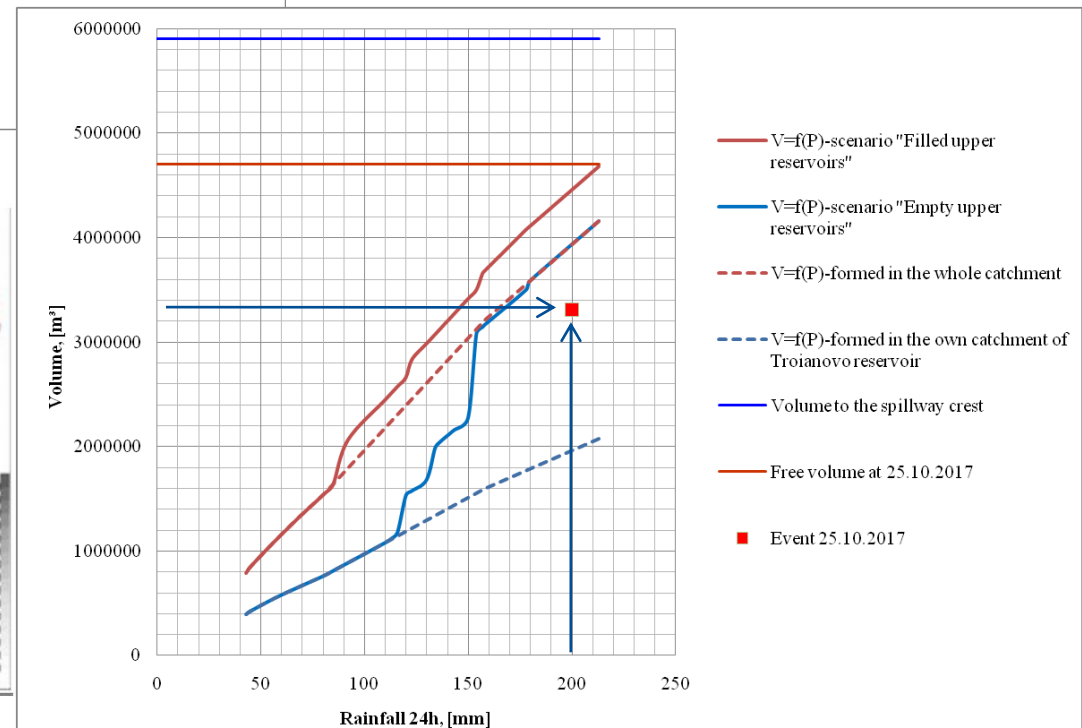
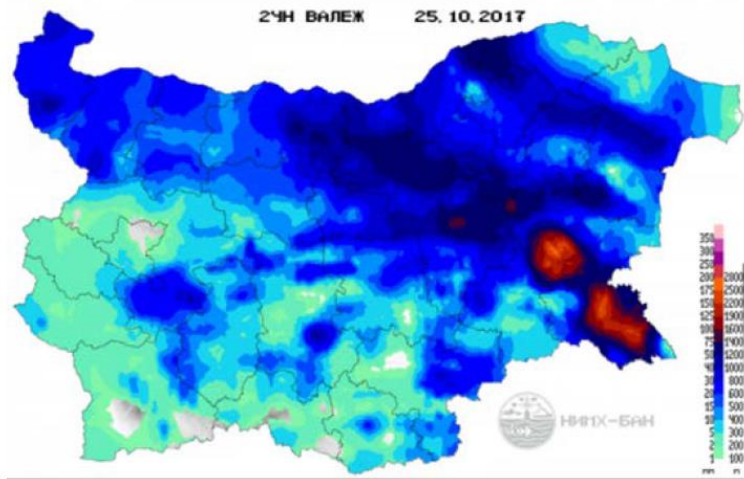
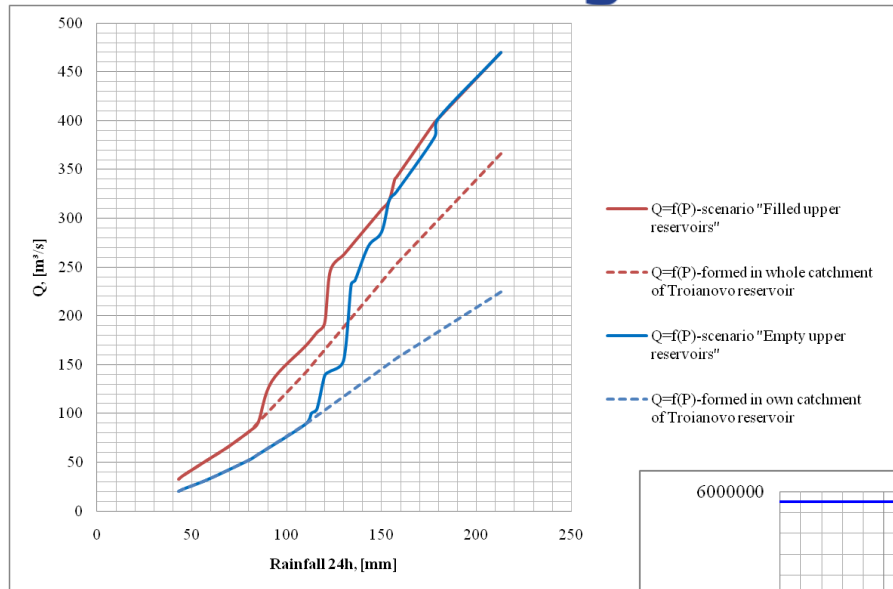
S (km)	0.5	1.0	2.0	5.0	10.0	12.0
ΔQ (%)	4.0	7.0	12.0	21.0	29.0	32.0

$\Delta Q = f(S)$, % ; S – distance from a dam to next point of interest

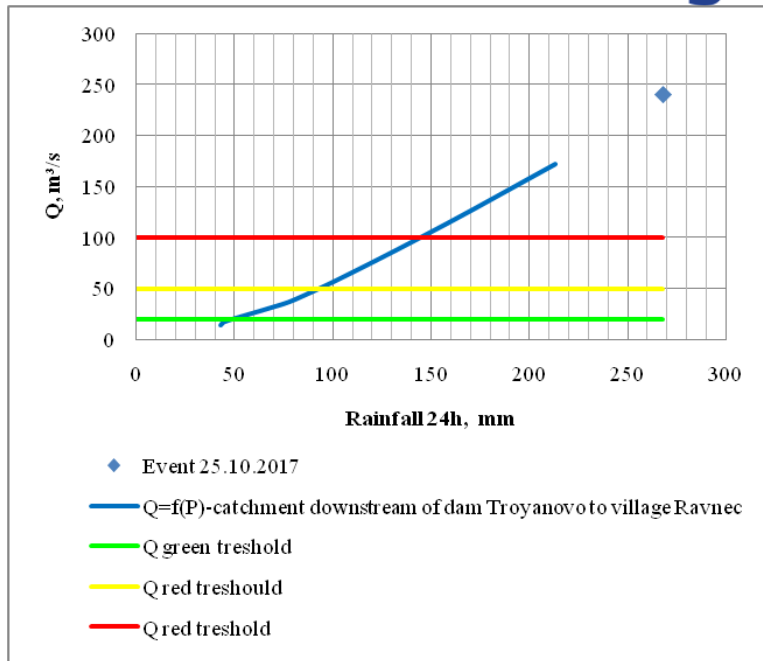
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Thresholds	Q , m ³ /s	Depth/Velocity at the houses
Green zone	≤ 20 m ³ /s	No flood
Yellow zone	≤ 50 m ³ /s	Depths $\leq 0,5$ m
Red zone	≤ 100 m ³ /s	Depths $\leq 1,2$ m; Velocity $\leq 0,2$ m/s



Conclusions: Offline systems could be decisions for ungauged catchments as well catchment with rapid response.

The existing adopted methods in Bulgaria are not enough for sure off-line early warning system

Necessary Follow-up researches :

1. On-line or off-line early warning depend on the catchments characteristics?
2. Check of the Bulgarian methodology for regionalization from 1978 with the nowadays hydrological data
3. Reservoirs classification depend on their retention capacity. Looking for standardized decision for overflow.
4. Dams breaching in a function of both: hydrological hazard and their technical and operational safety.
5. Standardized approach for the hydrographs routing

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THANK YOU FOR THE ATTENTION!