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Joint effect of changes in climate and landuse on runoff processes in selected basin in Slovakia

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Outline

- Motivation
- Methodology
- Case study

  - Description of hydrological models
  - Description of the basin
  - Calibration and validation
  - Scenario of climate change
  - Simulating runoff under changed
  - conditions
  - results

Motivation

- Most hydrological impact studies are based on global rather than regional climate models (IPCC, 2007)
- Global Circulation Models can reproduce climate features on a large scale reasonably well, but their accuracy decreases when proceeding from continental to regional and local scales because of the lack of resolution
- The climate change scenarios were constructed using the ALADIN – Climate regional model with a grid resolution of 10 km for the time horizons of 2021-2050 and 2071-2100.
- Different models for different case studies

Methodology

- The calibration (1981-1995) and validation (1996-2005) of the rainfall-runoff WetSpa model and KVHK model
- Simulation of the mean daily runoff series
- Processing the outputs of precipitation, air temperature and evapotranspiration from the ALADIN-Climate model
- Comparison of the differences between the seasonal runoff distribution in the reference period (1961 - 1990) and the two future time horizons (2021-2050 and 2071-2100)
- Comparison of Nash-Sutcliffe coefficients

Rainfall – Runoff KVHK MODEL vs. WetSpa MODEL

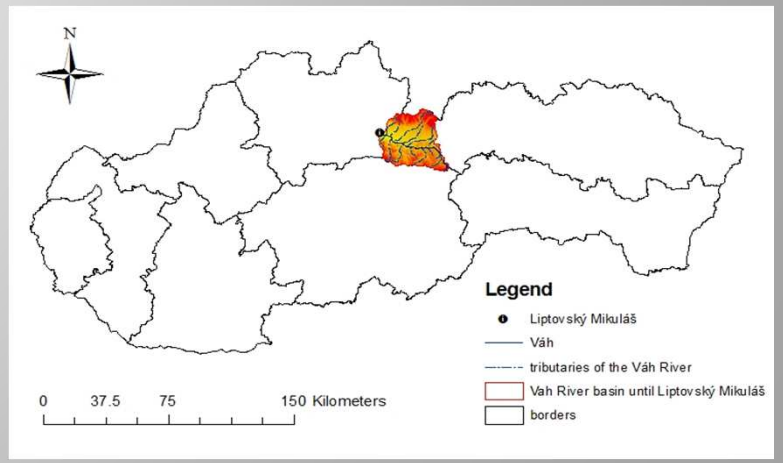
- **KVHK model**
- a conceptual model with centralized parameters developed at the SUT in Bratislava
- Modest for input data
- Time of calibration
- Processing the data as basin average
- Studies of landuse change

- **WetSpa model**
- GIS-based distributed watershed model developed at the Department of Hydrology and Hydraulic Engineering, Vrije University Brussels (Wang et al., 1997 and Batelaan et al., 1996)
- Processing the data
- Studies of landuse change
- Time of calibration
- Input data

Case study – Váh River basin up to Liptovský Mikuláš

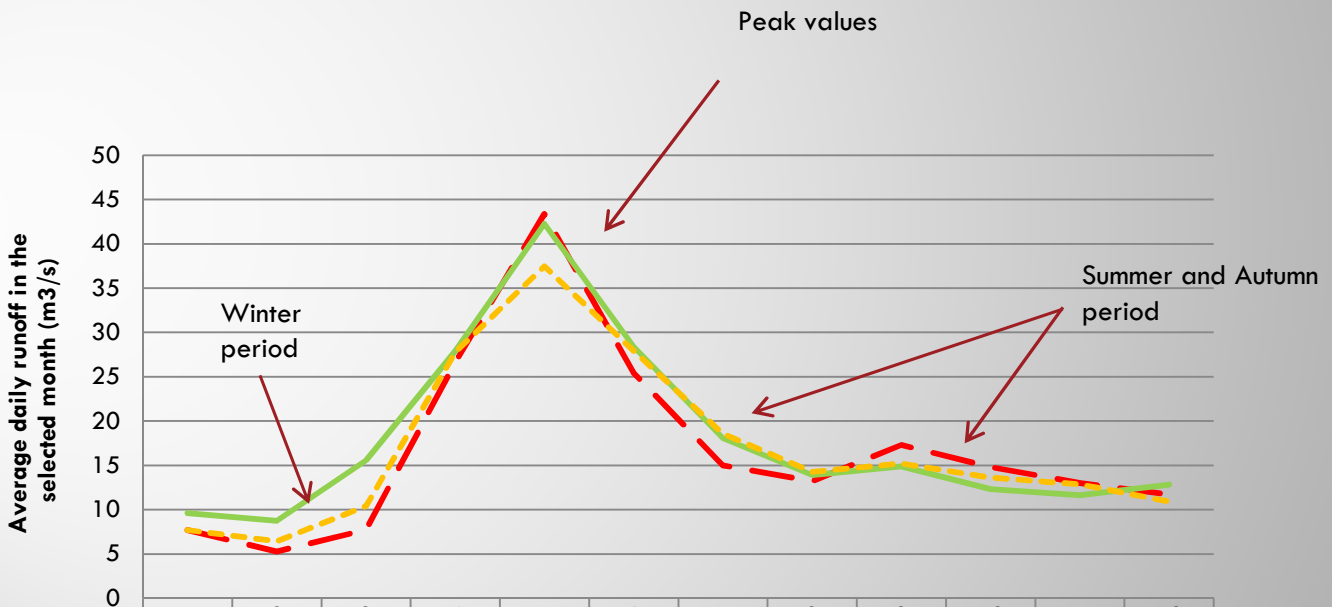
- Mountainous basin
- Located in the North of Slovakia
- 10°C -16°C in summer

- Area: 1108,51 km^2 (5% of the Váh River basin)
- 2494 – Kriváň – highest peak



Calibration of both models

- N-S for WetSpa model = 0.68
- N-S for KVHK model = 0.77



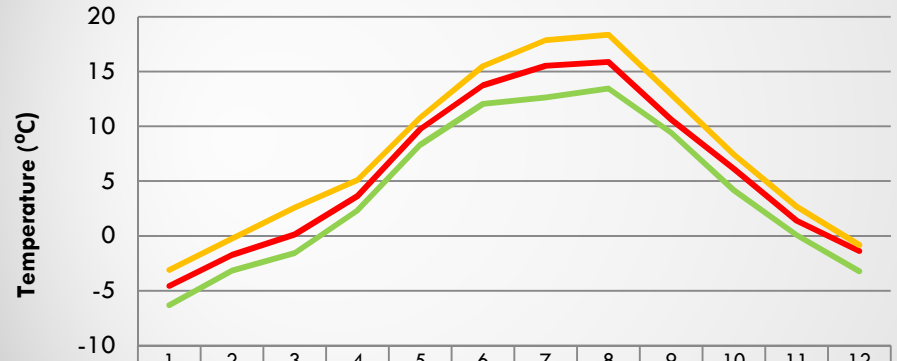
	1	2	3	4	5	6	7	8	9	10	11	12
calibrated Q_Wetspa	7,70	5,30	7,72	26,64	43,38	25,43	14,99	13,21	17,31	14,83	13,00	11,70
measured Q	9,60	8,75	15,58	27,92	42,25	28,38	18,06	13,91	14,87	12,34	11,64	12,84
calibrated Q_HBV	7,71	6,43	10,40	27,79	37,45	27,93	18,57	14,25	15,23	13,61	12,86	10,91

Climate change scenario – ALADIN-Climate

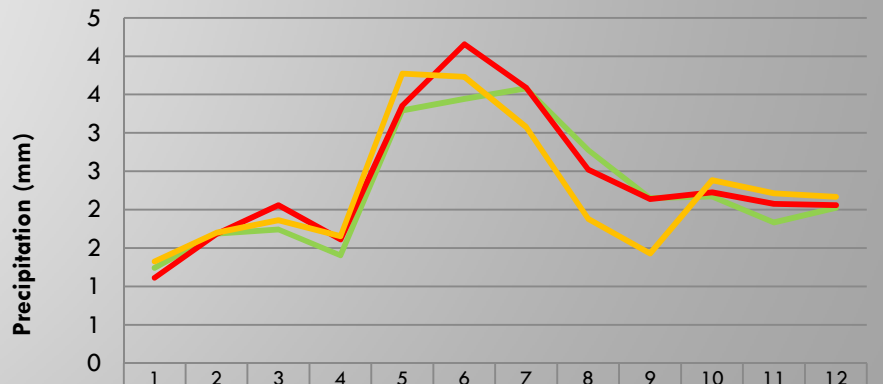
- developed by an international consortium of several European countries, North Africa, and led by France
- used as a tool for short-term weather forecasting
- nowadays it is also used for climate change research purposes
- regional climate model ALADIN-Climate/CZ was created under the Sixth Framework European Union project CECILIA (EU FP6 project CECILIA) to provide information in high resolution on future climate conditions on the territory of Central Europe
- based on the APREGE GCM global model and the A1B emission scenario (Štěpánek, 2008)
- resolution of 10 km

Results

- development of the precipitation and air temperatures according to the ALADIN-Climate Model



	1	2	3	4	5	6	7	8	9	10	11	12
T_6190	-6,32	-3,17	-1,56	2,33	8,32	12,05	12,64	13,46	9,40	4,17	0,07	-3,21
T_2150	-4,56	-1,73	0,13	3,65	9,74	13,75	15,52	15,86	10,61	6,12	1,39	-1,38
T_7100	-3,11	-0,24	2,60	5,09	10,78	15,50	17,87	18,35	12,88	7,41	2,69	-0,82

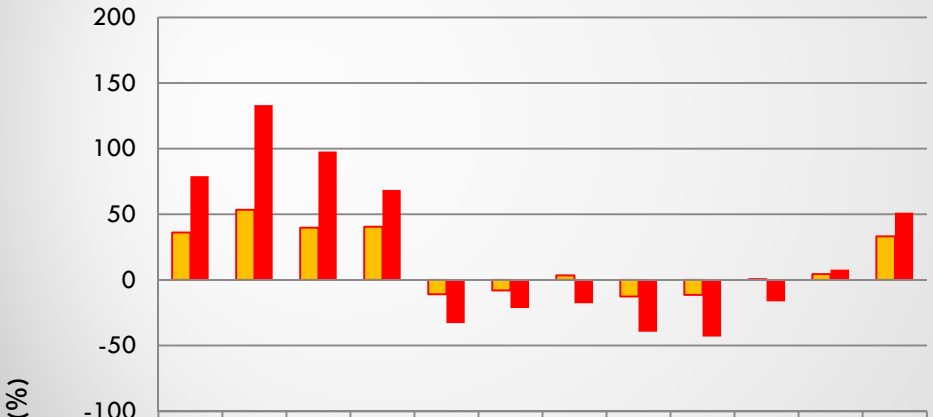


	1	2	3	4	5	6	7	8	9	10	11	12
P_6190	1,24	1,69	1,74	1,40	3,29	3,44	3,58	2,78	2,15	2,17	1,84	2,03
P_2150	1,11	1,69	2,06	1,61	3,36	4,16	3,59	2,52	2,14	2,23	2,07	2,06
P_7100	1,33	1,70	1,86	1,66	3,77	3,73	3,08	1,88	1,43	2,38	2,21	2,17

Results

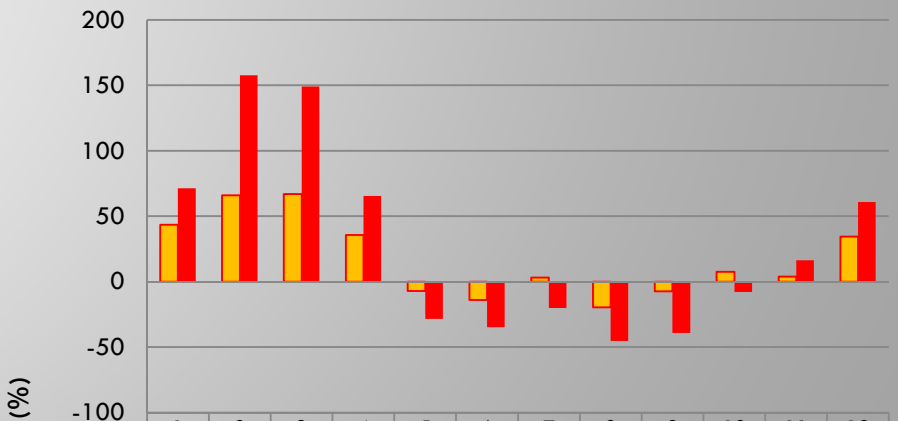
- Percentage change in average daily runoff in selected months for the future time horizons in comparison with the reference period

KVHK



	1	2	3	4	5	6	7	8	9	10	11	12
Aladin_2150	36,13	53,52	39,91	40,5	-11	-7,87	3,439	-12,5	-11,3	0,535	4,578	33,26
Aladin_7100	79,08	133,1	97,8	68,7	-32,9	-21,5	-17,8	-39,5	-43,2	-16,3	7,905	51,2

WetSpa



	1	2	3	4	5	6	7	8	9	10	11	12
Aladin_2150	43,53	65,84	66,92	35,64	-7,08	-14,1	3,144	-19,5	-7,44	7,577	3,768	34,48
Aladin_7100	71,33	157,7	149,2	65,48	-28,5	-34,9	-20,2	-45,4	-39,2	-7,81	16,29	60,79

Conclusion

- Which model is better to use?

- Depends on the type of study:
- Long-term changes
- Studies of high flows (floods)
- Studies of low flows
- More concrete studies:
  - landuse change
  - effect on the bioty of the river (the lowest flow is the most important)

Thank you for your attention