The Impacts of Climate Change on River Regimes in the Croatian Part of the Danube River Basin

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Content

1) Research area

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Research area - Danube river basin in Croatia



A= cca 34000 km² (60 % of Croatia); P= cca 2,9 mil. (2/3 of Croatia)



Pannonian lw Peripannonian Dinarides

Black sea b. (DANUBE RB) Main rivers: Sava (largest by Q tributary of Danube), Drava, Kupa



Variations of continental climate (Cfa and Cfb of Köppen clasiffication

From around 200 mm/year to more than 3500 mm/year!

Climate elements change in Croatia

Temperature:

On meteo. stations in Croatia in the last 100 years **INCREASE** of av. annual temp. between 0,2 and 0,7 °C Last 50 years \rightarrow **INCREASE** of winter temperatures Around 1990 \rightarrow sudden JUMP in av. annual temp.

Precipitation (last 50 years):

DECREASING of av. annual precipitation in mountains DECREASING of snowfall precipitation in elevations below 1200 m.

Evapotranspiration:

For the lowland (eastern part) of Croatia INCREASE of the potential evapotransp. in the last 50 years

Research data and methods

Data:

yearly and monthly $Q_{av} \rightarrow$ from Hydrological and Meteorological Service of Croatia

<u>Methods:</u> Linear trends; Seasonal Kendall-Theil (Sen) nonparametric trend test

comparison of module (Pardé) coefficients between the standard thirty years period (1961-1990) and the last twenty years period (1990-2009)



15 hs \rightarrow 50 years (1960-2009)

44 hs on 31 rivers → 20 years (1990-2009)





Sl. 13. Vrijednost srednje godišnje promjene protoka u proljeće (% u odnosu na medijan razdoblja) u razdoblju 1990.-2009. i njegova statistička značajnost (α=95%)



- descending trend \rightarrow 9 stations

-ascending trend
→ Kupa river catchment >
2 %

- increase on rivers with more pronounced snowmelt component

- for March increasing trend stat. significant on 22 hs





- descending trend
 →East and West part
- ascending trend
 →North

Sl. 15. Vrijednost srednje godišnje promjene protoka u ljeto (% u odnosu na medijan razdoblja) u razdoblju 1990.-2009. i njegova statistička značajnost (α=95%)



Sl. 16. Vrijednost srednje godišnje promjene protoka u jesen (% u odnosu na medijan razdoblja) u razdoblju 1990.-2009. i njegova statistička značajnost (α=95%)





WINTER

- descending trend
 →North and East
 (continental pluviometric regime)

- ascending trend
→ Kupa river basin

Sl. 18. Vrijednost srednje godišnje promjene protoka zimi (% u odnosu na medijan razdoblja) u razdoblju 1990.-2009. i njegova statistička značajnost (α=95%)



Conclusions:

Descending trend of mean annual discharge of rivers in Croatian part of Danube river basin in the last 50 y. and even more pronounced descending trend on most of rivers in the last 20y.(1990-2009) \rightarrow INTENSIFICATION?

REDISTRIBUTION of discharge between months (change of max and min months) \rightarrow amplitude between months is getting smaller.

Biggest changes on rivers with higher snowmelt comp.

Smaller catchments are more sensitive to recent (climate) changes.

Conclusions:

Changes on the scale of Croatia can be in most cases explained with the changes of climate components.

Results for the Danube river basin fit with ones from upstream countries (Slovenia, Austria, Switzerland, Germany)

Indicative results, for some rivers alarming! \rightarrow a need for smaller (catchment) scale researches where we can be more precise and include more in detail the human impact.



Thank you very much!

oder

Vielen Dank!

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