HUSZPO HRVATSKA UDRUGA STRUČNJAKA ZAŠTITE PRIRODE I OKOLIŠA

TREĆA REGIONALNA KONFERENCIJA O PROCJENI UTJECAJA NA OKOLIŠ
THIRD REGIONAL CONFERENCE ON ENVIRONMENTAL IMPACT ASSESSMENT
Vodice, Hrvatska / Croatia • 13.-16. rujna 2017. / September 13th-16th, 2017

Josip RUBINIĆ[1], Gordana GORETA[2], Snježana MALIĆ LIMARI[3], Najla BAKOVIĆ[4,5], Maja RADIŠIĆ[1]

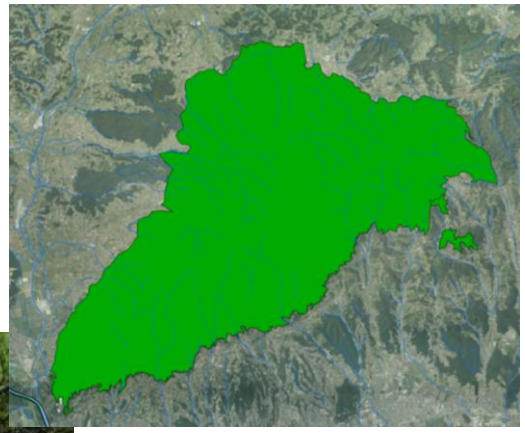
Importance of Hydrological Assessment of Climate Change Impacts in Protected Areas – Examples of Krka National Park and Medvednica Nature Park

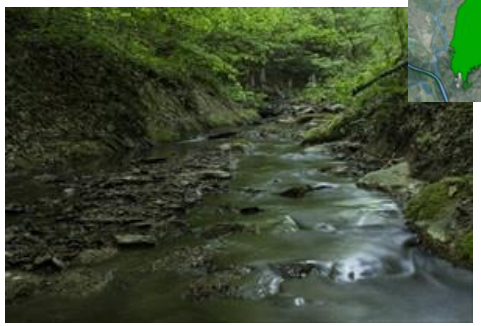
Važnost hidroloških procjena utjecaja klimatskih promjena u zaštićenim područjima – primjer NP Krka i PP Medvednica

[1]**Faculty of Civil Engineering in Rijeka**, R. Matejčić 3, Rijeka, Croatia (*jrubinic@uniri.hr, maja.radisic@gradri.uniri.hr*) • [2]**Public Institution Krka National Park**, Trg Ivana Pavla II 5, Šibenik, Croatia (*gordana.goreta@npk.hr*) • [3]**Public Institution Medvednica Nature Park**, Bliznec 70, Zagreb, Croatia (*snjezana.malic-limari@pp-medvednica.hr*) •, [4]**DVOKUT-ECRO Ltd.,** Trnjanska 37, Zagreb, Croatia (*najla.bakovic@dvokut-ecro.hr*) • [5]**ADIPA** - Society for Research and Conservation of Croatian Natural Diversity, Orehovečki ogranak 37, Zagreb, Croatia

Introduction

- Water is the underlying phenomenon of all protected areas since all ecosystems are water dependent
- Each area has a specific hydrologic distribution that shows spatial and temporal variations
- It's important not to limit our attention only on the appearance of surface water

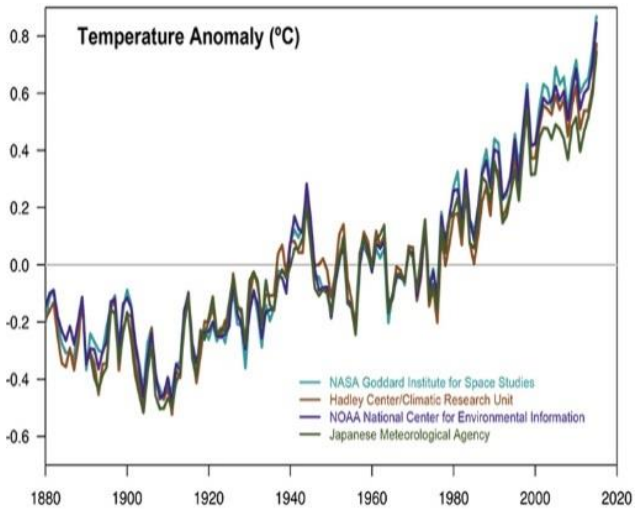


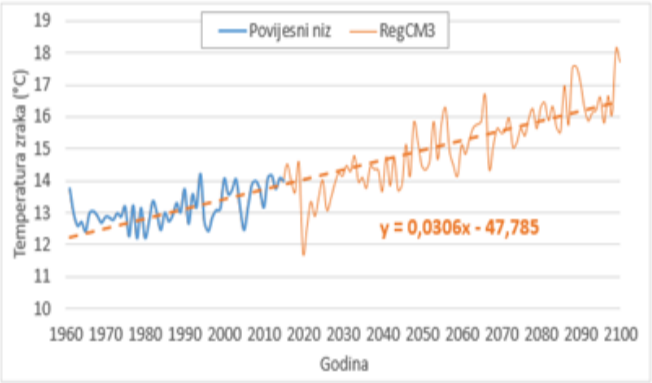


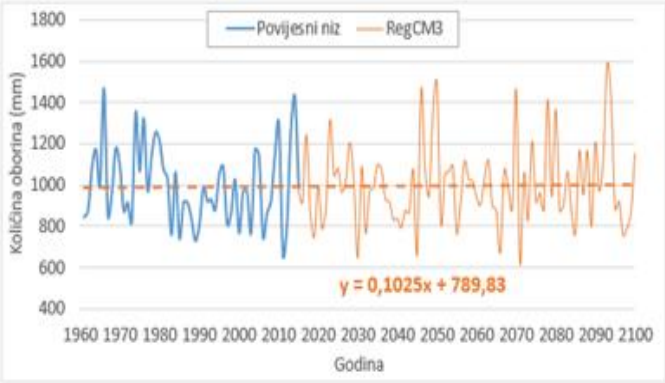
Climate conditions and trends

- Modelling of potential climate changes and **their impact on water resources** was made within earlier and present EU and domestic projects in Croatia: CCWaterS, DrinkAdria, Hydrological research of the Krka river, Hydrodynamics of Plitvice Lake …)

- This includes the ongoing project "**Croatian Climate Change Adaptation Strategy for the period until 2040 and view to 2070**"



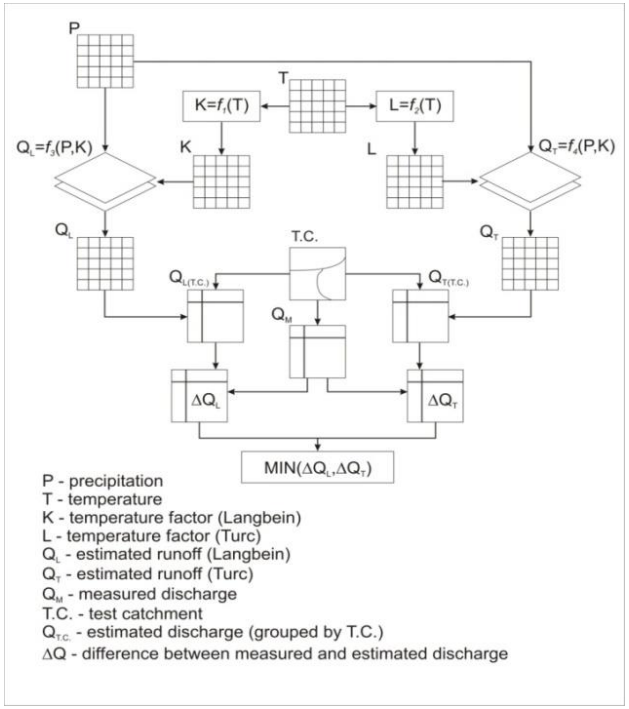


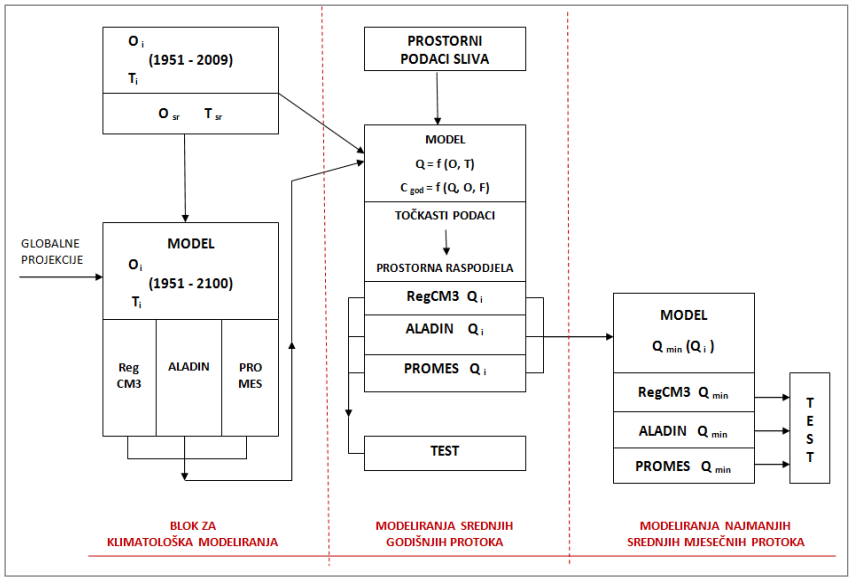


Historical (1961-2015) and model-generated (2016-2100) mean annual temperatures and total annual rainfall for NP Krka

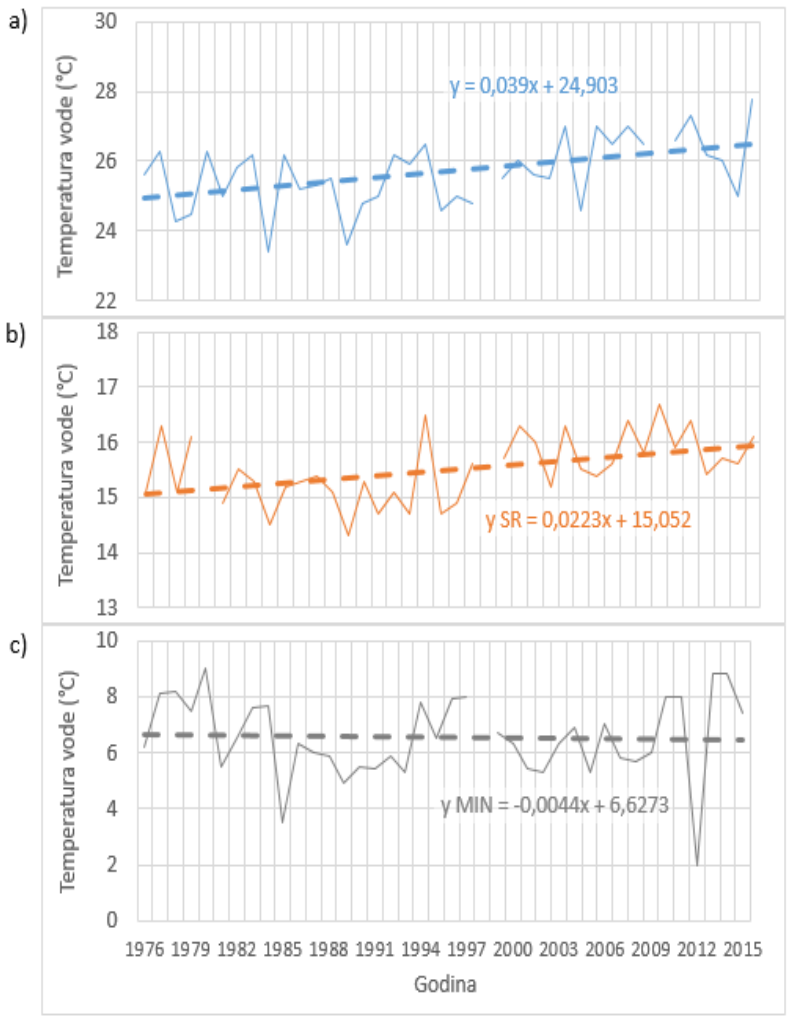
Hydrological modelling of potential climate change impact

- Based on climatological models of temperatures and rainfall, and using artificial intelligence / machine learning (neural networks and decision trees) it is possible to model-generate series of influential hydrological indicators (discharges, water levels, water temperature …)

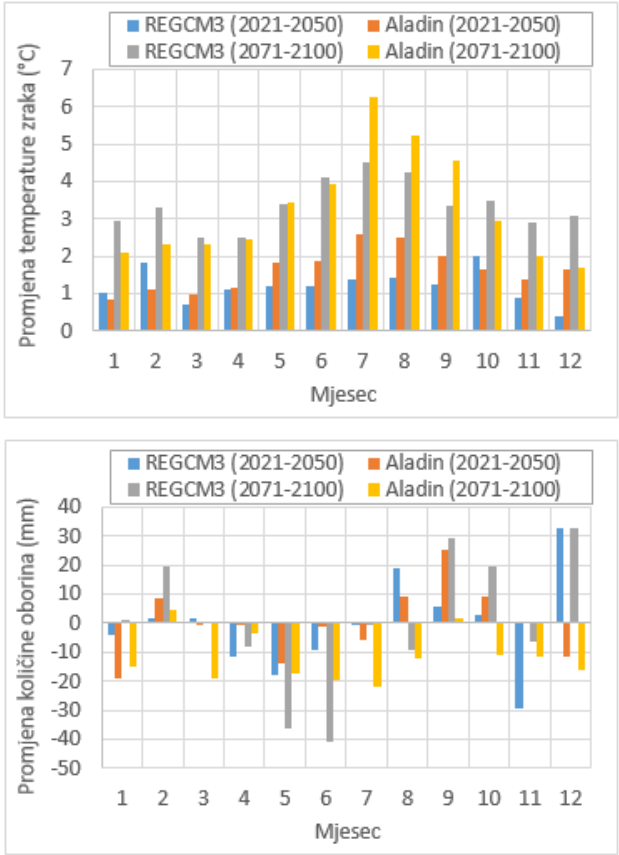




NP Krka - Climate conditions and trends

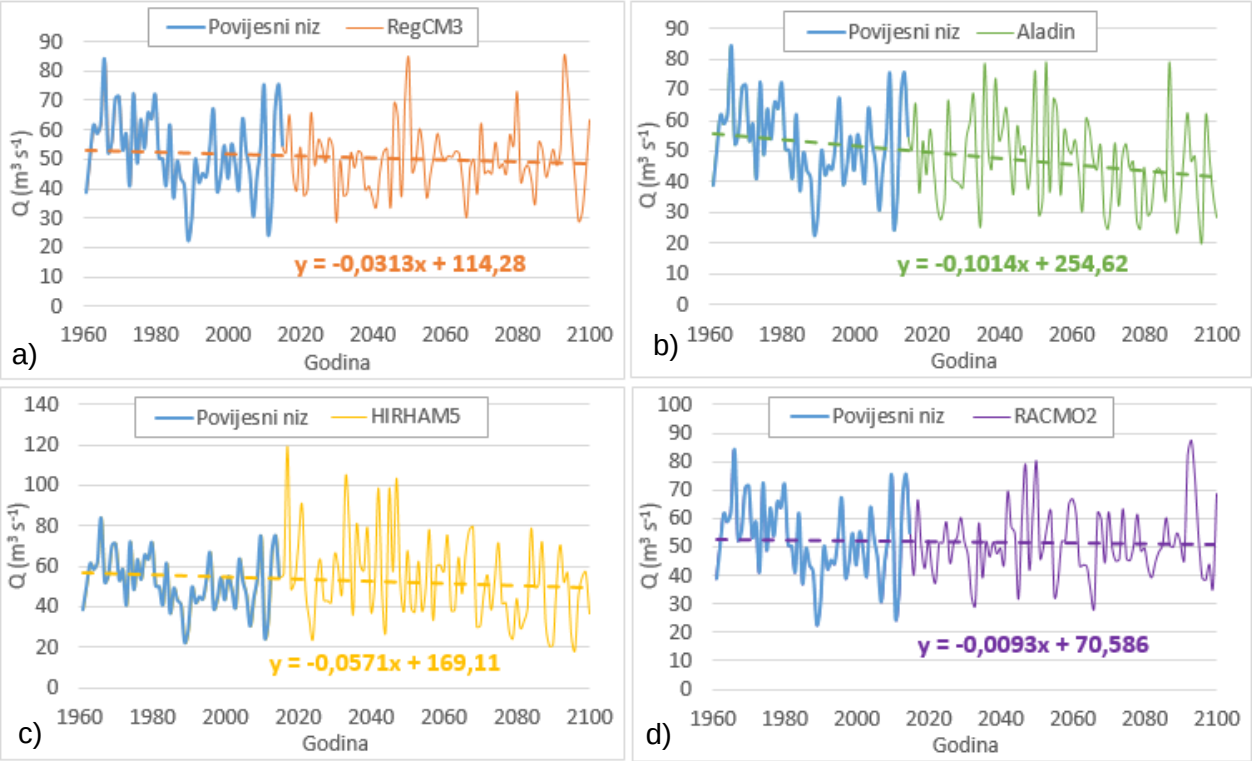


Trends of maximum, average and minimum annual water temperatures of river Krka at Skradinski buk station



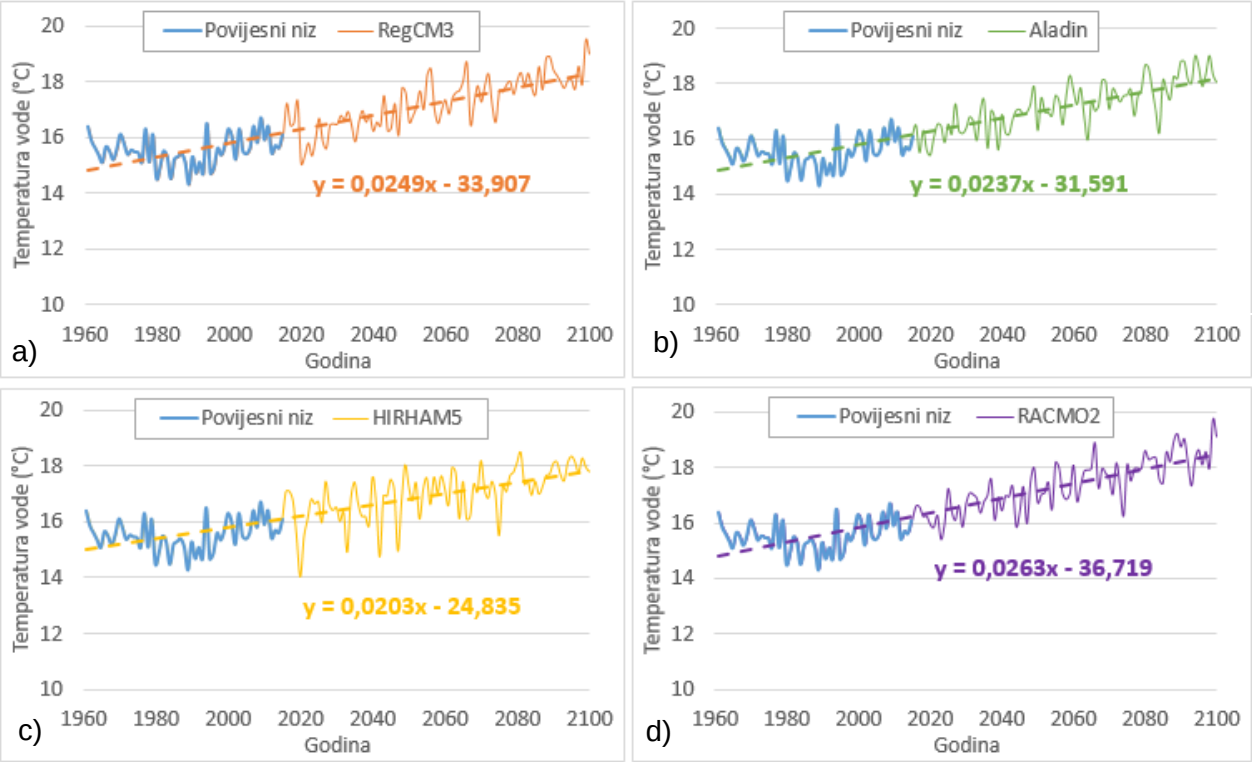
Model-generated mean monthly temperature and total monthly rainfall for two characteristic future periods compared to the reference historical period (1961-1990) for NP Krka

NP Krka - Results of hydrological models of potential climate change impact on discharges and water temperature of river Krka



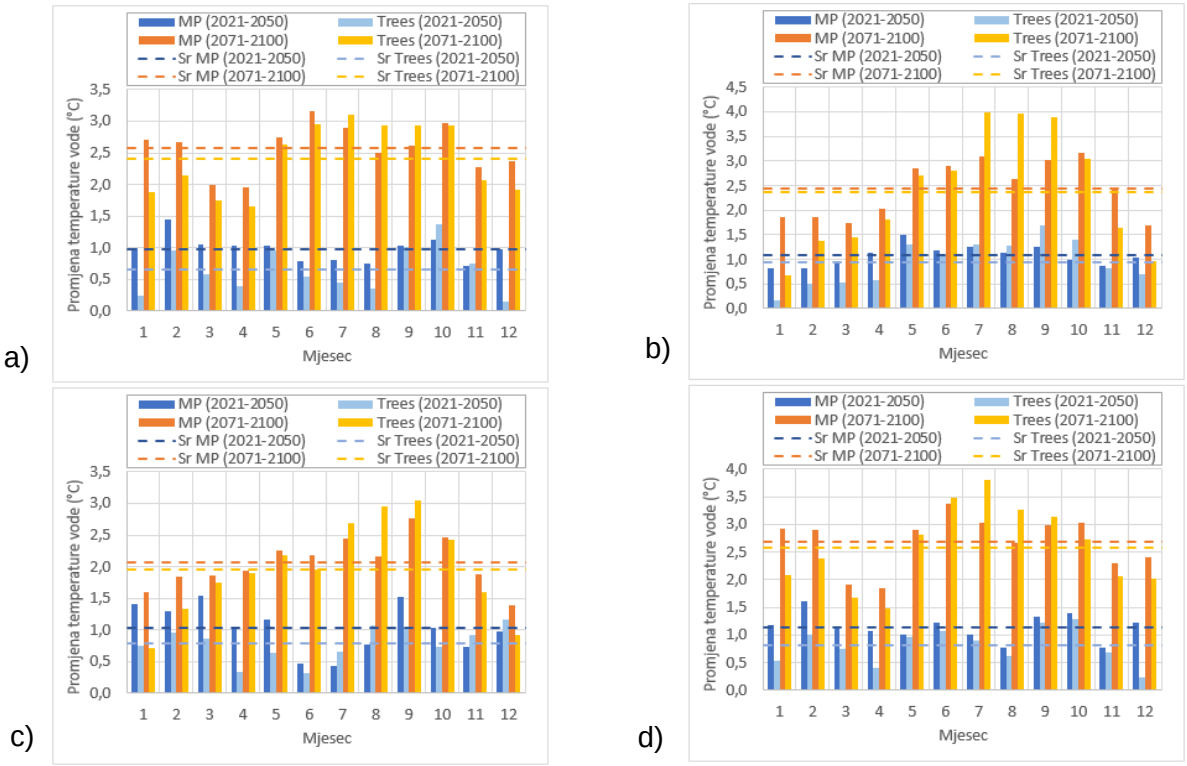
*Historical time series and projected time series of **average annual discharges** of Skradinski buk station generated using different climate models (1961-2050) with accompanying trends: a) REGCM3, b) ALADIN, c) HIRHAM5, and d) RACMO2 models (Trees M5P)*

NP Krka - Results of hydrological models of potential climate change impact on discharges and water temperature of river Krka



*Historical time series and projected time series of **average annual water temperature** of Skradinski buk station generated using different climate models (1961-2050) with accompanying trends: a) REGCM3, b) ALADIN, c) HIRHAM5, and d) RACMO2 models (MP)*

NP Krka - Results of hydrological models of potential climate change impact on discharges and water temperature of river Krka

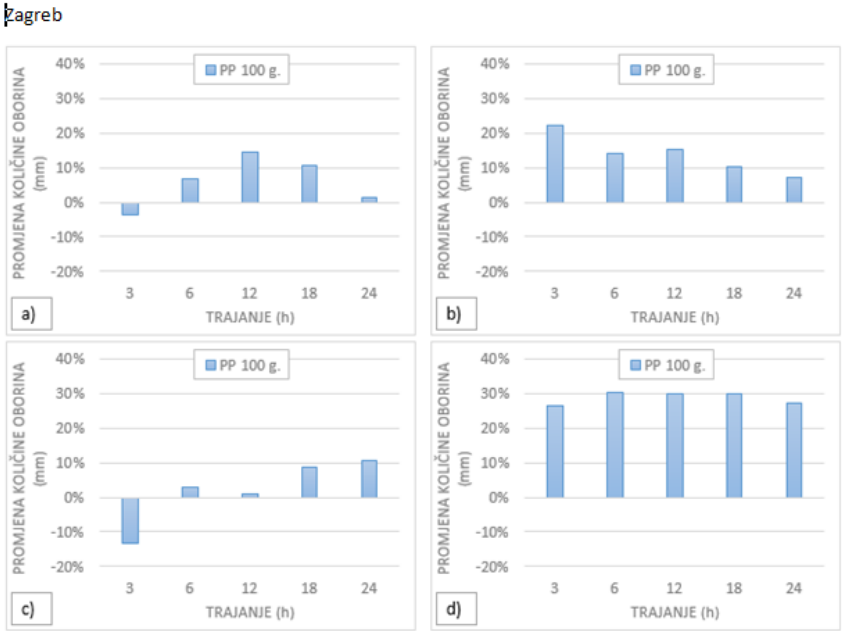


*Intra-annual distribution of **water temperature** for periods 2021-2050 and 2071-2100 (Multilayer Perceptron and TreesM5P), expressed in °C relative to the historical series of average monthly water temperatures (1976-2015) using different models: a) REGCM3, b) ALADIN, c) HIRHAM5, and d) RACMO2*

PP Medvednica – Waters and trends

- Zagreb residents usually become aware of the existence of the Medvednica streams only when floods caused by their torrential waters occur

FIGURE 1. & 2. Flood of Vrapčak on Jarun, 12.2.2014.



- Assessment of change to strong short-term precipitation (DHMZ, 2017), have a wide range of possible changes that go up to 30% of their growth, depending on the models used.
- This will certainly show an increased risk of floods when modelling the hydrological effects of large waters appearances.

PP Medvednica – Waters and trends

- Medvednica streams are characterised by an **extraordinarily high gradient of average annual discharge decrease (approximately 1%)**

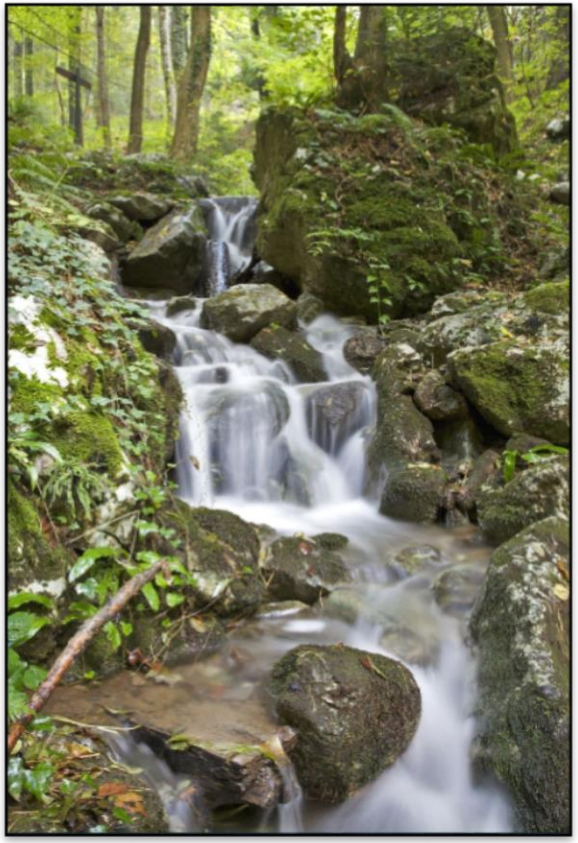
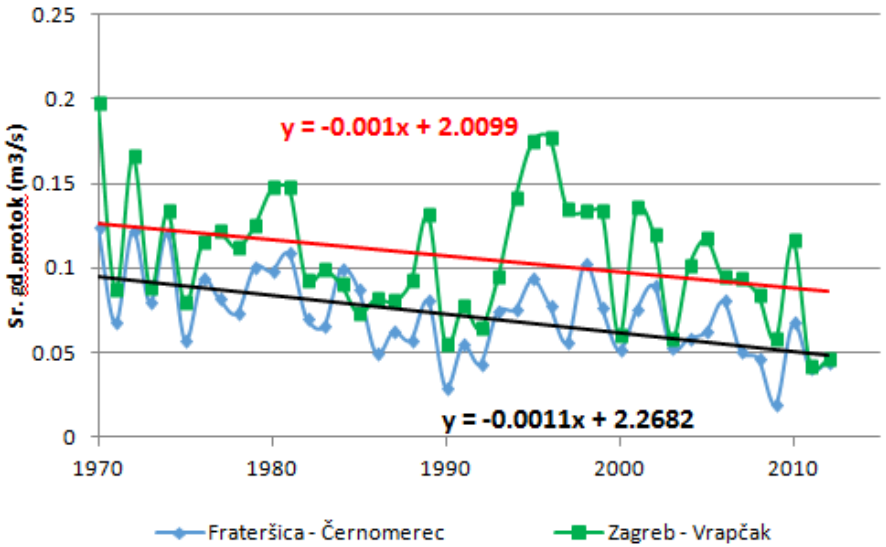


FIGURE 3. Spring at Medvednica Mt.



- **GOAL**: Research and forecast (quantified) hydrological changes through history and in the future

Climate change and ecosystems

- It is hard to predict **impact of climate change** in ecosystems due to large number of **biotic** and **abiotic interactions**

  - **Organisms** have the specific ecological niche
  - **Ecosystems** have a different responses

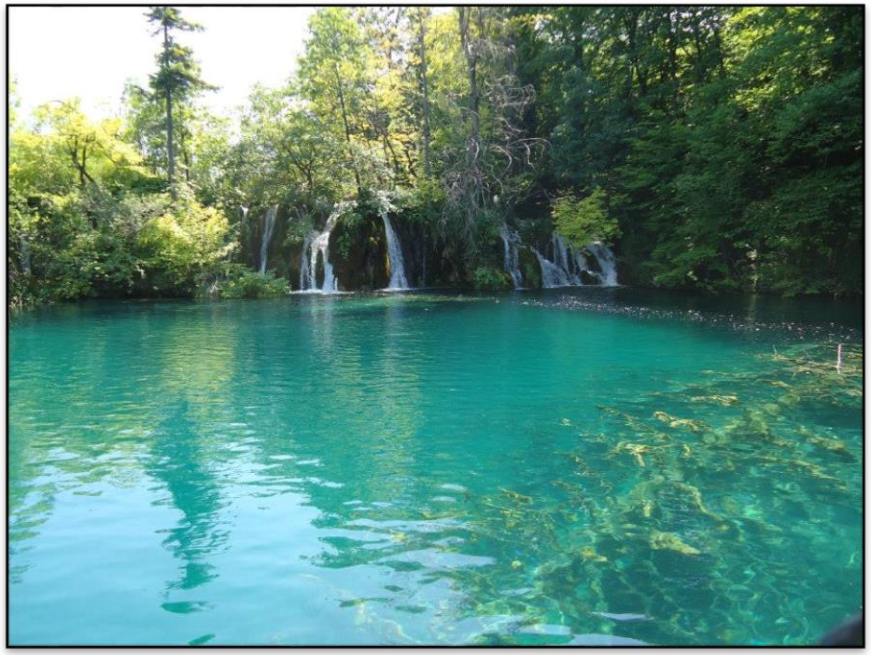


FIGURE 4. Plitvice Lake National Park

FIGURE 5. Frog from Lonjsko Polje Nature Park

Climate change impact assessment in Krka National Park

- Travertine-forming and subterranean communities

- **Predictions:**
  - Changes in population density
  - Vanishing of old species
  - Appearance of new species/ invasive species
  - Migrations/changes in spatial distributions

- **Sensitive species:**
  - Travertine-forming species
  - With small populations, populations with limited spatial distribution
  - Highly specialized species

- **Impact on water chemistry and physical characteristics:**
  - Increase of CO_2 concentrations
  - Increase of water temperature
  - Changes in hydrological conditions

- Location of tufa deposition **will change → destruction of old travertine depositions**

HIDROBIODINAMIC balance

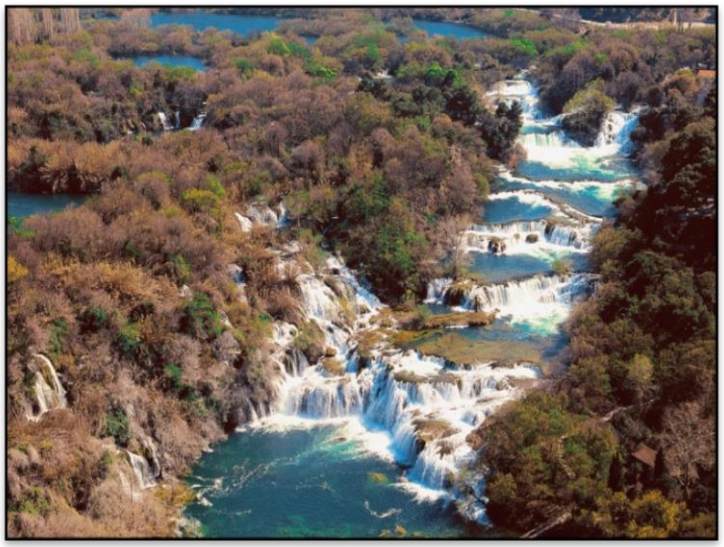


FIGURE 6. Travertine bariers on Krka river

FIGURE 7. Fosil travertine

Climate change impact assessment in Medvednica Nature Park

- ***Project:***
  Climate change in the national and nature parks of the Republic of Croatia: management and development options (FZOEU, IRMO, 2016.-2017.)

- Medvednica Nature Park was selected as a case study
  The problem during impact assessment was data deficiency!

- **For the next stage it is needed to:**
  • Research general relationship between hydrological conditions and ecosystems
  • Develop a hydrological prediction models

FIGURE 8. Medvednica Nature Park forest

Conclusions

- **Climate change in Croatia are showing these trends:**
  - Increase of air and water temperatures, strong short-term precipitation, increasing frequency of flood events
  - Stagnation or decrease of total annual precipitation
  - Decreasing mean annual discharges, small waters …

- **Precision of climate and hydrological models depends on:**
  - Future development of our civilization and effectiveness of CO_2 reduction
  - Input data of historical measurements
  - How sophisticated models shall we use (recommendation is to use model from domain of artificial intelligence such as neuron networks and regression trees)

- **Hydrological conditions have to be included in biological modeling due to their importance as abiotic factor (as showed in an example of Krka River and Medvednica Mt.)**

- **It is very important to research the impact of climate change on hydrological conditions in protected areas because they can serve us as an model that we can apply on other areas**

Thank you for your attention!

Josip RUBINIĆ, Gordana GORETA, Snježana MALIĆ LIMARI, Najla BAKOVIĆ, Maja RADIŠIĆ

Importance of Hydrological Assessment of Climate Change Impacts in Protected Areas – Examples of Krka National Park and Medvednica Nature Park