PannEx: Towards a Regional Hydroclimate Project in the Pannonian Basin

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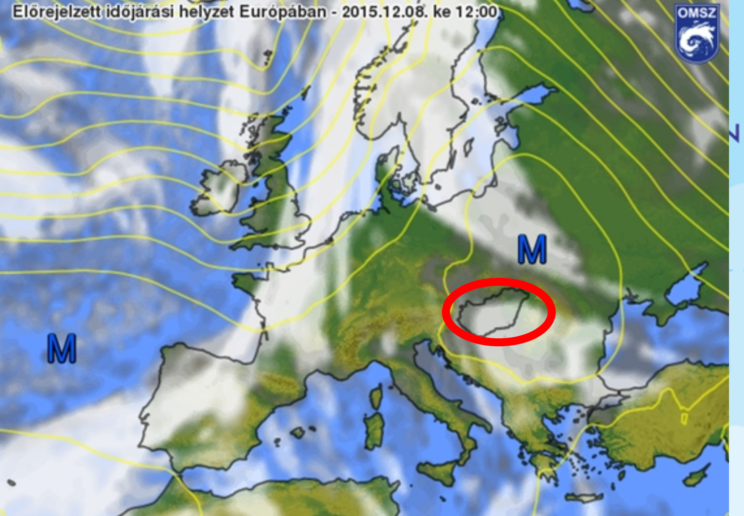
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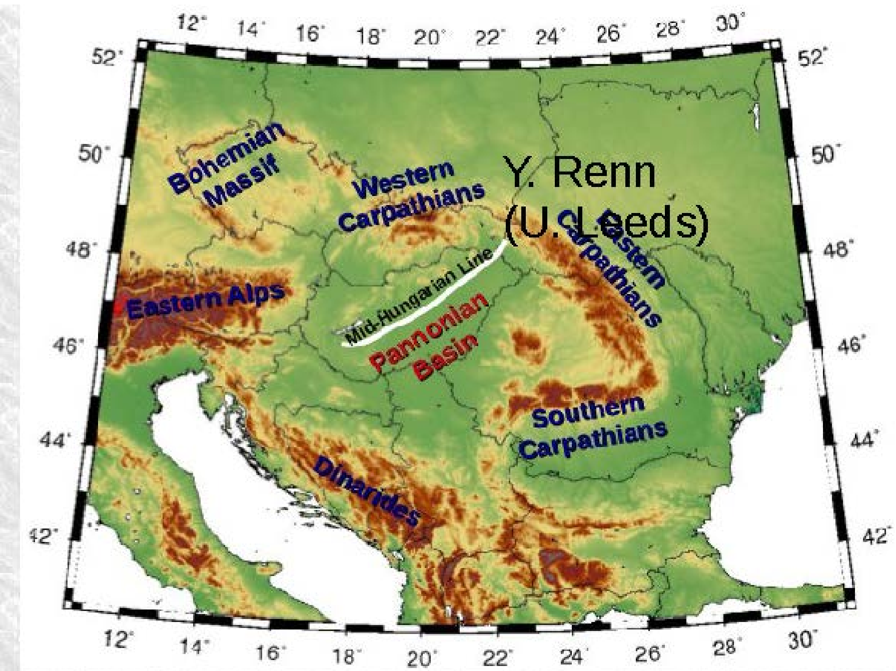
STOCKHOLM
HELSINKI
MINSK
Carpathians Mts
Ural Mountains
Caucasus
Alps
Pyrenees
Scandinavia
Lapland
British Isles
Kola Peninsula
Caspian Depression
Anatolia (Asia Minor)

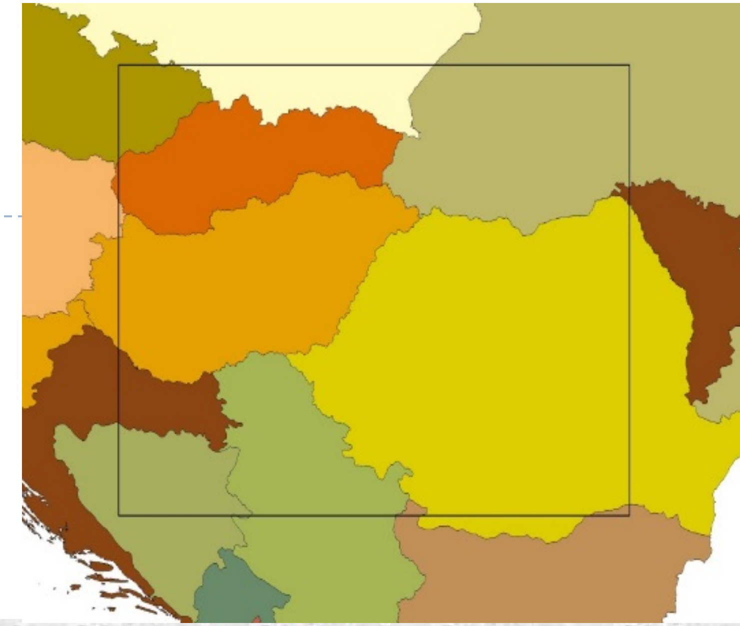
Physical motivation

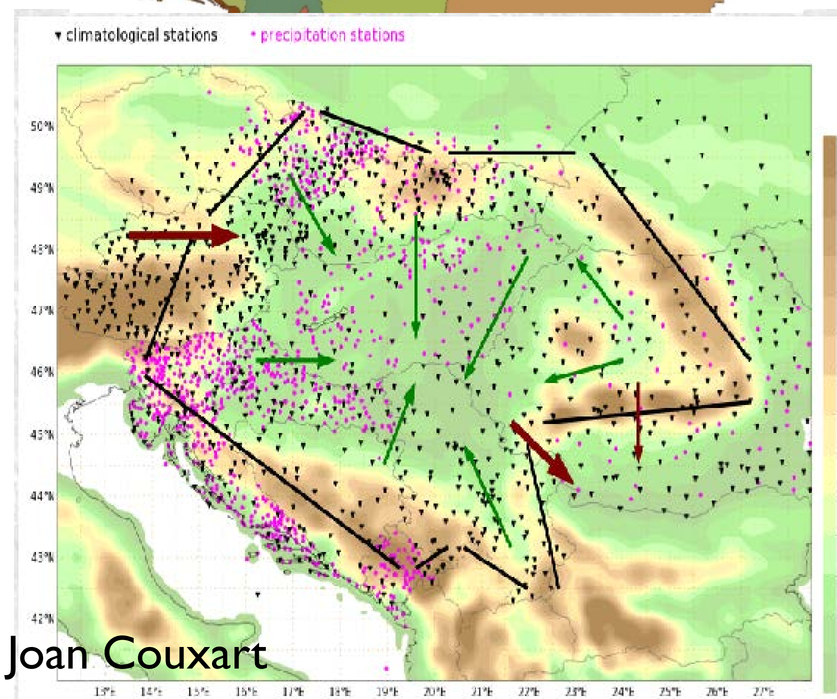


- A closed basin with only one outflow, the wind gates
- large low central plain (100 m asl) surrounded by mountains with elevations nearing 2000 m asl
- being a very good test area for many geophysical processes (natural or human-induced)
- The Pannonian basin is a transition area between mediterranean, atlantic and continental climates

Opportunity

- The area is fragmented in many different countries, sometimes with difficult communication amongst them
- Several research institutions and universities are well recognized, some recent activities of networking are established, but the recognition of them is not widespread
- Countries are in good position to apply EU research funding.
- Pannonian Basin lies in between the HyMeX and Baltic Earth areas with opportunity for future collaboration





Joan Couxart

Initiation of PannEx as an RHP

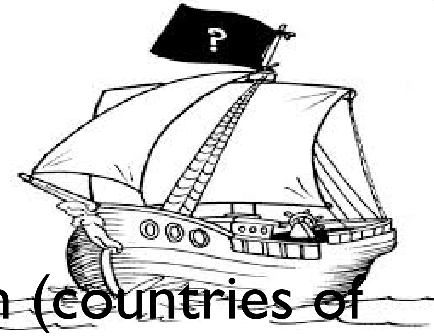
- The GEWEX-promoted workshop on the „Climate System of the Pannonian Basin" took place at the Faculty of Agriculture of the University of Osijek, **9 - 11 November 2015**
- Organized by the Hydrometeorological Service of Croatia, the University of Osijek, the University of Zagreb and the GEWEX Hydrological Panel

1st PannEx WS Osijek

~Half year

2nd PannEx WS Budapest, 1-3 June

Results of the 1st Workshop



- 50 attendees from institutions of the Pannonian Basin (countries of Croatia, Hungary, Serbia, Slovakia, Romania, Czech Republic and Austria) were present
- state of the art of research of meteorology, climatology, hydrology, agronomy and other environmental issues in the region
- explore the status of the networks and the different recent transnational initiatives related to the regional Climate System
- discussion on the opportunity and the likely subjects of interest of the potential PannEx RHP flagship science questions and cross cut subjects
- a Core Group formed
- a preliminary agreement was reached on that the first draft of a white book will be discussed in Budapest in June 2016

International Planning Committee

- Branka Ivancan-Picek (DHMZ, Croatia) *member of the GEWEX SSG from 2017 January*
- Monika Lakatos (OMSZ, Hungary) *PannEx chair*
- Adina Croitoru (University of Cluj-Napoca, Romania)
- Danijel Jug (University of Osijek, Croatia)
- Vladimir Djurdjevic (University of Belgrade, Serbia)
- Tamás Weidinger (Eötvös Loránd University at Budapest, Hungary)
- Ivan Guettler (DHMZ, Croatia) *PannEx secretary*
- *Joan Couxart UIB and Jan Polcher GHP co-chair Laboratoire de Meteorologie Dynamique, Paris – members of PannEx Scientific Committee*

The PannEx **F**lagship science **Q**uestions and **C**ross **C**ut subjects

FQ1: Adaptation of agronomic activities to weather and climate extremes

FQ2: Understanding of air quality under different weather and climate conditions

FQ3: toward a sustainable development

FQ4: water management, droughts and floods

FQ5: Education, knowledge transfer and outreach

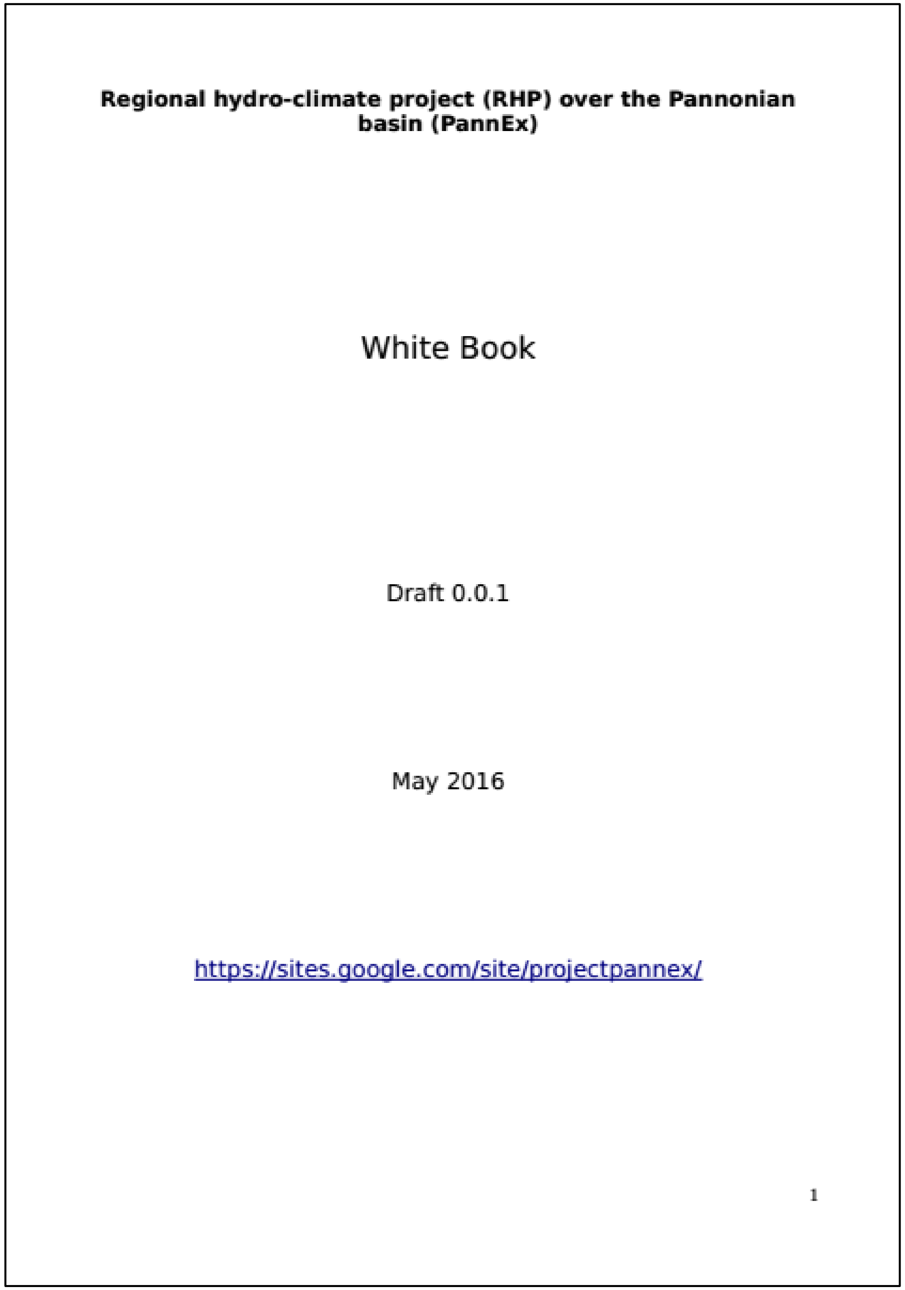
CC1: Data/knowledge rescue and consolidation

CC2: Process modelling

CC3: Development and validation of modelling tools

Guidelines for drafting the PannEx WB

- WB specifies the main science issues to be addressed
- The observations and tools needed to advance our know-ledge
- Time scales should range from weather to climate
- The research should be large enough to require around 10 years
- FQ and CC need to be flashed, the rational of these questions and the strategy to address them
- Should scope out the temporal and spatial scales too
- Outline the scientific potential of each discipline on which we can rely
- Collabo-ration with EU or other communities will be needed
- Benefits of the outcome of the work for other scientific activities or socio-economical decisions



Regional hydro-climate project (RHP) over the Pannonian basin (PannEx)

White Book

Draft 0.0.1

May 2016

https://sites.google.com/site/projectpannex/

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The suggested structure for each FQ and CC

- Background
- Knowledge gaps and relevance
- Potential activities
- Expected outcomes

Ver.0.0.1. is ready, length is 99 pages

FQ1: Adaptation of agronomic activities to weather and climate extremes

FQ1 chapter – group of writers - Coordinator: Danijel Jug (*status 2016-05-31*)			
Contributors	Field of expertise	Country	Contact
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FQ1 (Flagship Questions) identified in Osijek:

[Adaptation of agronomic activities to weather and climate extremes]

- Weather scale predictions of yields and plant phenology
- Response to climate change (farming practices, crop types, pests and diseases)
- Water management and irrigation
- Land and soil use changes
- Perception of agricultural stakeholders and evolution of European policies
- Preserving ecological services

Background

- Climate change strongly impacts the Pannonian Basin and it is one of the main factors affecting the entire agroecosystem, recognized also as an element which will have a significant weight on the form, scale and spatial and temporal impact on agricultural productivity

- Agricultural production is the sector most vulnerable to climate change and biodiversity due to direct dependence of the weather conditions

- Climate change affects agriculture:

directly – plant level: effects of increasing CO_2 at crop productivity and resource use efficiencies, effects of temperature, precipitation, radiation and humidity at crop development and growth and damages caused by extreme events like heat waves, floods and hail

indirectly – system level: changing suitability of different crops such as northward expansion of warm-season crops, changes in crop nutrition and occurrencies of weeds, pests and diseases and environmental pollution or degradation of the main resources

- Recent climate changes are showing raise of the temperature and more inconsistency in precipitation patterns in Pannonian basin region

Knowledge, gaps and relevance

- With regional differences agriculture is affected by ongoing climate change in the Pannonian region increasingly, for example:

- extreme weather events such as drought, dry winds, wet spells, intensive precipitation, frosts, heat and cold waves,
- soil salinization,
- decline of SOM (soil organic matter),
- better weeds response in growth and reproduction (compare to crops),
- decrease of crop growth and development because of higher air temperatures,
- increasing spatial and interannual yield variability due to extreme weather,
- annual rainfed summer crops with high water demand (e.g. sugar beet) are already disappearing in some regions by climatic reasons (where irrigation systems or water is not available or economic),
- potential increasing of soil erosion,
- change of pest and disease occurrence; pests are generally considered by farmers as the second important danger beside of drought,
- shortening of the cropping cycle, effecting field work timing.

Potential activities

- Define and implement adequate and effective measures to face climatic changes is an imperative
- Precisely predict the time and place of a negative or positive impact of climate change on agriculture, as well as consequences for the crop and soil management
- Conduct certain activities to develop adaptable agricultural production which will affect other key elements of crop production:
  - plant nutrition,
  - soil quality,
  - irrigation,
  - plant breeding,
  - crop protection,
  - environmental considerations,
  - etc.
- Continuous implementation of field testing (of the most important agronomic traits of crops, such as yield and quality, in a series of comparative experiments on a number of locations along with the continuous monitoring of climatic conditions is an essential activity of future programs

FQ2: Understanding air quality under different weather and climate conditions

Stearing Group:

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1. Introduction and motivation

Air quality is highly dependent on weather and therefore is sensitive to climate change. Globally the future climate is expected to be more stagnant, due to a weaker global circulation and a decreasing frequency of mid-latitude cyclones

– importance of cooperation
- measuring
- data sets
- modelling

In order to understand and predict the variety of the different atmospheric processes and to found out the particularities of the climate system appropriate i) measurement ii) database and iii) modeling background is required.

4. Key questions

4.1 How does a warmer climate affect air quality and human health?

4.2 Interaction of air quality and water cycle

4.3 Interactions with agricultural practices (soil, water and air)

In the rapidly changing world one of the main task is to optimize the efficiency of the agro cultivation
(where and what kind of changes – crop type, tillage etc.- is necessary) according to the ecological model scenarios.

4.4 Surface layer processes (energy budget, fluxes, deposition, profiles)

4.5 Physics and chemistry of the boundary layer; improving forecasts

Modelling background, harmonisation, test measurements, ensemble forecast

4.6 Refinement of emission inventories

Top-down and bottom-up methodology

4.7 Perception of populations, urbanisation

An integrated approach to addressing the scientific questions is necessary to develop an integrated policy perspective.

PannEx – FQ3 Toward a sustainable development

Current drafting team: Vladimir Djurdjevic, Imelda Somodi, Ákos Bede-Fazekas, Wantuchné Dobi Ildikó, Birone Kircsi Andrea, Maja Telišman Prtenjak, Andreina Belušić, Alica Bajić, Kristian Horvath, Maja Božićević Vrhovčak, Tijana Nikolic, Sonja Trifunov (+ few more expected)

Subtopics:

1. Preserving ecological services
2. Hydropower potential evolution
3. Wind and solar energy potential
4. Biomass production and conflict with agronomic needs
5. Building the infrastructure for forecasting and coordination of the energy prod.
6. Evolution of the energy needs (cooling and heating) in a warmer climate

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At the United Nations Sustainable Development Summit on 25 September 2015, world leaders adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) with 169 associated targets. WMO pointed out that National Meteorological and Hydrological Services and the broader WMO community, including WCRP, could contribute to the SDGs at the national and international levels (WMO, 2016).

1. Preserving ecological services

Pannonian region is recognized by European Environmental Agency as one out of eleven biogeographical regions in Europe.

Outcomes/Proposed activities:

- Provide essential information on weather and climate, air quality, hydrological and soil conditions that are needed relevant to ecological services and biodiversity in the region.

- Develop a common set of indicators that can be relevant for ecological services and biodiversity monitoring.

- Comprehensive analysis of potential impact of climate change on natural habitats in the Pannonian region.

- Explore possibilities for development of different nature-based mitigation strategies, which can help to improve eco-services but also to reduce future risks related to climate change .

- Identification of areas vulnerable to climate change and human water use.

- Identifying restoration priorities with maintenance of water cycling as a target.

- Understand the impact of past climate change and agriculture practices on hydrological cycle (especially related to soil moisture dynamics), water quality. Better understanding of this impact can help to develop better future strategies.

2. Hydropower potential evolution

Relevant information about the potential impacts of future climate change on river runoff and consequently on power production needed long-term planning and estimation of potential risks due to changes in annual mean runoff or changes of the annual redistribution.

Outcomes/Proposed activities:

- Develop comprehensive and detail analysis of changes in different elements within hydrological cycle in region relevant to hydropower production, based on wide spectrum of information from observed condition in the past to the future changes using climate change scenarios
- Assess future changes in hydropower potential, based on the changes within hydrological cycles, for already exiting HPP.
- Assess future hydropower potential, based on the changes within hydrological cycles, for HPP that are planed according to national plans and national energy development strategies.
- Estimate negative impacts on the riverine ecology and general impact on environment, especially under the potentially changed future climate condition (low flow, shortage in summer precipitation etc.)
- Assessment of impact from water temperatures increase on power plant cooling process and potential reduction of efficiency for thermal power plants (nuclear and fossil).

3. Wind and solar energy potential

The increased importance of renewable energy can be explained by the crucial role of reducing greenhouse gas emissions as well as by diversifying and improving the security of the energy supply and substituting finite and depletive fossil resources.

Outcomes/Proposed activities:

- Develop comprehensive and detail analysis of **wind** and **solar** potential for power production in the region, based on wide spectrum of information from observed conditions in the past (*in situ observations*, gridded climatology, reanalysis, RCM hindcast) to the possible future changes using climate change scenarios.
- Estimate possible future risks related to the adverse weather and climate events (super-cell storms, hail, strong winter winds, floods, icing, heat waves and high temperatures etc.).
- Estimate potential negative impacts on the environment, especially in the case of not well-planed development (to avoid negative outcomes).
- Estimate of air-pollution reduction after closing fossil thermal power plants (PM, SOx, etc.,). Reduced emissions of pollutants, beside positive impact on human health, also have impact on radiation budget (maybe this topic can be interesting?!)

-- Harmonization of high-resolution wind atlases in region

4. Biomass production and conflict with agronomic needs

Biomass production can have significant implications for the natural environment, such as biodiversity and the water, nutrient and carbon cycles, affecting ecosystem functioning and resilience in diverse ways. It is very important, therefore, to apply resource efficiency principles to developing bio-energy production.

Outcomes/Proposed activities:

- Understand extent and complexity of bio-energy's environmental overall impact in Pannonian region in the context of current production capacities and impacts of potential future climate change.

- Understand impact on water resources, since agriculture is the major source of nitrogen pollution of European water bodies, including lakes, rivers, ground water and the European seas.

- Understand impact on soil, since farming exposes soils to water and wind erosion, and can lead to soil compaction and salinisation if inappropriate farming practices are used.

5. Building the infrastructure for forecasting and coordination of the energy production

All renewable energy power production (except geothermal) depends on weather and climate condition. Especially, wind and solar production is highly dependant from day-to-day weather variability.

Outcomes/Proposed activities:

- Proposal for observational network upgrade and optimization, especially because of possible improvements in assimilation cycles for short range forecast for wind and solar.
- Development of inter-institutional multi-model ensemble prediction products specially developed for renewable power sectors needs.
- Experiments with super hi-resolution (~1 km) non-hydrostatic models over areas with dense wind farms facilities.
- Development of seamless prediction forecast products from days to seasons relevant for hydro power production and agricultural activities related to the biomass production.
- Specially designed experiments/case studies related to the improvement of different physical parameterization (e.g. surface turbulence for wind, radiation for solar, surface hydrology for hydro) relevant for solar/wind/hydro power production.

6. Evolution of the energy needs (cooling and heating) in a warmer climate

Negative trend in heating demand already can be observed, in the period 1980-2009 the number of heating degree days (HDD) has decreased by 13 %, on average for whole Europe. In the Pannonian region this trend was between -10 and -20% (EEA).

Outcomes/Proposed activities:

- Assessment of current trends in heating/cooling demands, and their relation to observed trends in temperature and other relevant parameters.

-Assessment of cooling demands during extremely high temperatures and prolonged heat waves in the past (e.g. heat wave during July 2007), in residential and service sectors, with estimate of possible excessive pressure on energy production system.

-Assessment on changes in heating/cooling demand in the future following different climate change scenarios, together with demand on energy production, or redistribution of energy production during the year.

- Proposal to upgrade relevant metrics to monitor cooling and heating needs (currently Heating and Cooling degree days common in use)

FQ4: water management, droughts and floods

	Evolution of precipitation and temperature (weather) extremes and risk assessment
	Understanding the water cycle of the Pannonian basin (hydrological perspective)
	Hydrometeorological forecasting and early warning systems
	Anthropogenic influence (dams, reservoirs...) on the hydrological cycle
	Regulation of Danube and tributaries: management of floodplains

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Evolution of precipitation and temperature (weather) extremes and risk assessment

Background:

The warm extremes and related heat waves have become more frequent, longer, more severe and intense in the entire Carpathian Region

Precipitation: the observed trends are not significant and inconsistent

An increase in short term precipitation in many regions

Knowledge gaps and relevance: there is a demand of sub-daily scale examinations due to lack of the reliable and representative data for understanding of the nature and drivers of global and regional precipitation extremes and changes on different time scales which are relevant for the societies.

Survey and developments of definitions and methodologies for calculating extreme weather and climate events, such as heat waves and cold waves have **to reflect on the final application (**such as agricultural, hydrological, or risk management; or for weather and climate monitoring purposes and early warning systems and climate watches)**.**

Identification of more complex extreme indices considering duration, intensity and persistence of the extremes events is needed.

The identification of regional extremes that influence wider region, even the whole territory of the Danube catchment could support the risk assessments.

Understanding the water cycle of the Pannonian basin (hydrological perspective)

Knowledge gaps and relevance

there is a need to carry out the water balance modeling for large number of representative catchments area using a uniform method, the generalization of catchments modeling, so would make possible a more reliable regional comparison the water cycle

Potential activities: The review of water balance modeling made in past, namely the presentation, comparison and evaluation of method used in water balance modeling. **Choose a uniform method proposed for the calculation of catchments scale evaporation**

Expected outcomes: Using a series of monthly catchments water balance many water management tasks (water retention, drought management, runoff control) can be projected more reliably, can be detected the natural and/or anthropogenic changes in water cycle

Drought

Knowledge gaps and relevance: Drought monitoring and forecasting remains on the agenda – if not purely due to academic challenge, also due to constant requirements from the users. For this reason, despite doubts on practical and even theoretical possibilities, **long term drought forecasting** remains as one of important tasks and challenges. On the other hand – following requirement that **drought monitoring systems should be more connected to drought impacts – more emphasis should be put to remote sensing**.

Anthropogenic influence (dams, reservoirs...) on the hydrological cycle

Knowledge gaps and relevance: There is not any appropriate method to separate the antropogenic and climatic effects in the hydrological characteristics, which make to difficult to detect and to prove the climate change impact in the past, to support the climate change itself in the past and to project the climate change in the future.

Potential activities: Developing method to separate the antropogenic and non-antropogenic effects, including the climatic effects in the changing hydrological regime – Assessing the possibilities of the use of hydrological system-wide modelling for detection of change in hydrological regime – The extension of study results in to non studied catchments and rivers inside of Pannon Basin – The evaluation of the effects of change in hydrological cycle and hydrological regime, particularly on the existing ecosystems.

Expected outcomes The lesson learning from the past regarding to antropogenic effects on hydrological regime would be useful in the processes of the projection of the water management measures in the future, promotes the sustainable development, also the better projection of climate change impact assessments.

FQ5. Education, knowledge transfer and outreach

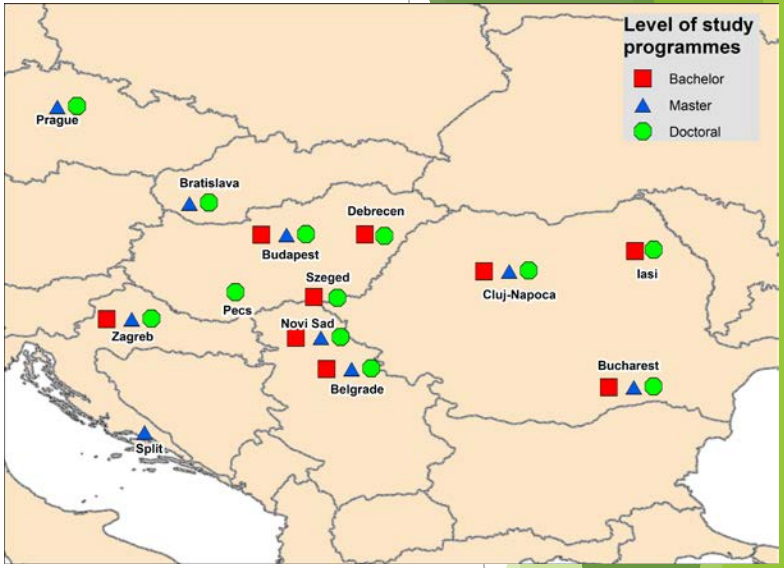
Adina-Eliza Croitoru

Babeș-Bolyai University of Cluj-Napoca, Romania

3. Higher education in meteorology and climatology in PannEx region: present status

- A quick overview has been done until now for six countries in the region:
  - Croatia*
  - Czech Republic
  - Hungary
  - Romania
  - Serbia
  - Slovakia

  * Countries are listed in alphabetical order.



- Twelve universities provide higher education in Meteorology, at different levels (Bachelor, Master, and Doctoral study programs) in the PannEx area:
  - two in Croatia: University of Zagreb and University of Split;
  - one in Czech Republic: Charles University in Prague;
  - three in Hungary: Eötvös Loránd University, University of Debrecen, and University of Szeged;
  - three in Romania: University of Bucharest, Babes-Bolyai University of Cluj-Napoca, and Al. I. Cuza University of Iasi;
  - two in Serbia: University of Belgrade and University of Novi Sad;
  - one in Slovakia: Comenius University in Bratislava.

Domain where higher education in Meteorology is affiliated

5. Development of higher education in meteorology under the framework of PannEx project

Cooperation between universities in order to harmonize the study programs at different levels can be developed under the framework of PannEx program.

Actions to be done:

- Harmonization of the study programs at all levels (Bachelor, Master and PhD.) in participating countries according to the WMO - No. 1083 (*Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology. Volume I – Meteorology*) and national regulations ;
- Establishing protocols for organizing exchanges of professors among the universities in PannEx area;
- Establishing protocols for organizing exchanges of MSc. and PhD. students among the universities in PannEx area.

2. Development of higher education in meteorology under the framework of PannEx project

Actions to be done:

- Organizing two PhD. "schools" per year: e.g. one virtual, on modelling and theoretical topics, and one by personal presence, on observational techniques organized as a "summer school" by one of the universities of countries participating in the project;
- Encouraging students to choose PhD. and MSc. dissertations on topics similar to those of PannEx project and/or
- Involving students in research activities;
- Organizing one training school per year for employees in Meteorology and Hydrology services by universities in cooperation with NMHSs in the PannEx countries;
- Due to low number of students for each study program in meteorology, in some cases, we need lobby to maintain them, as usually the universities and Ministries of Education considers them as financially unsustainable.
- Developing protocols for hiring procedures in Met Services at national level, by considering WMO recommendations.

Knowledge transfer

Knowledge transfer will be focused in few directions:

- From professor to young generations of students (BSc, MSc. and PhD students);
- From researchers in other regions of Europe or of the world (where similar projects were or are under development) to PannEx countries researchers;
- From PannEx researchers to stakeholders in the PannEx region
- From stakeholders to researchers in PannEx in order to identify new directions to be studied so can improve the community needs for scientific based information (e.g. in workshops we can organize a session for stakeholders) ;
- Defining early-on protocols on how to share data and algorithms related to PannEx activities (we should stress open-data and open-code approach)
- Defining metadata for our modeling and observational products
- Developing a platform for data upload-download

Outreach

to scientific community

- Organizing special issues in national and international journals once per year on various topics and subtopics: Quatenary International, Idojaras, Geographia Technica, Riscuri si catastrofe, Geofizika, Hrvatski meteorološki časopis etc.
- Organizing PannEx sessions in high visibility international conferences (e.g. EGU and EMS);
- Organizing PannEx sessions in regional conferences (e.g. Air and Water – Components of the Environment);
- Contributing in various ways to GEWEX and WCRP visibility in all our activities.

Outreach to public authorities and decision makers

- Delivering *Special Reports* to the public authorities at local/regional/national level focusing the main results of the research activities in the project in the field of agriculture, health, atmosphere protection etc

Outreach to large community

- Organizing active project webpage on social media (e.g. Facebook, Twitter, Google+ profiles): new content added periodically
- Preparing and releasing *Newsletters* to community (to be delivered 2 or 3 three times per year in the media)
- Inviting media to PannEx workshops
- Organizing press conference during PannEx meeting events

The cross cut issues reflect the GEWEX science questions:

- 1. Observations and Predictions of Precipitation
- 2. Global Water Resource Systems
- 3. Changes in Extremes
- 4. Water and Energy Cycles and Processes

CC1: Data/knowledge rescue and consolidation

Meteorological data

– Observed: strict data national data policy of meteorological services often blocks international data exchange. CarpatClim and DanubeClim datasets are freely available and they can be the base of the researches in the frame of the PannEx.

- Homogenized, harmonized, gridded
- unified methods
- 1961–2010, daily, ~10 km res
- 13 ECVs, 37 drought indices and climate indicators

Hydrological, agronomical, economical etc. data

CC2: Process modelling (I): Definition

Purpose: An adequate treatment of the basic mechanisms intervening transversally in all Flagship Questions.

Methodology: Challenge the present schemes in models using observational data obtained in the region and try to improve them if possible.

Actors: Combined efforts of Meteorological and Hydrological Services, Universities and Research Centers.

Data: Use available data bases and generate new specific data sets for well identified key questions.

CC2: Process modelling (II): Processes

i) Quantifying surface energy and water budgets: needs good data/representation of radiation, precipitation, atmospheric-boundary layer turbulent fluxes and soil measurements.

ii) Atmospheric chemistry: identify anthropic and natural sources of compounds and understand their chemical and physical evolution in air and precipitation.

iii) land_surface interactions: measure with detail the upper layers of the soil and its interactions with the atmospheric surface layer, including biological and agronomic processes.

iv) precipitating systems: characterize precipitation events due to frontal passages or to convective systems, and inspect the evolution of the regimes at several time scales.

v) crop modelling; evaluate crop reaction to changing climate conditions and inspect alternatives.

vi) hydrological modelling: measure and model river flow, basin-scale ETP, superficial and underground runoff and assess on the impact of new dams or irrigation channels.

CC3: Development and validation of modelling tools

Potential activities

4-a) convective-permitting (~1-3km) RCM simulations over PB.

4-b) evaluation of NWP and RCM models using specific observations produced by PannEx.

4-c) development of the seamless prediction system over the PB.

4-e) development and evaluation of RCM (and NWP) models with online and offline coupling with crop, hydrological, air chemistry and dynamic vegetation models.

4-f) the use (and contribution to development) of OpenIFS and its evaluation over PB

4-g) all modeling activities may be jointly organized as a special ECMWF research projects
where specific disk and CPU time quota can be acquired.

4-e) climateprediction.net-type of experiments over the PB

CC3: Development and validation of modelling tools

Expected outcomes

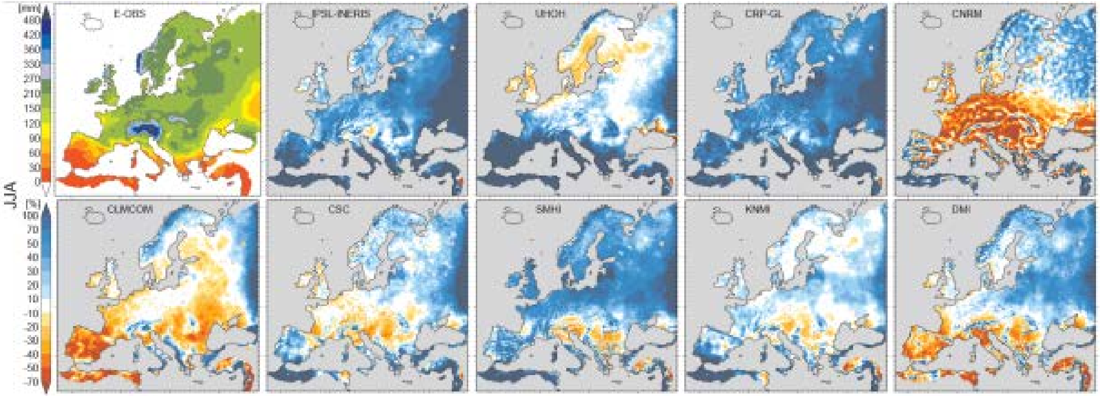
5-a) Reduction of model systematic errors (from weather to climate models) over the PB.For example, most RCMs still have dry bias during summer over PB

5-b) Description of the uncertainties of weather to climate prediction systems on all time-scales over the PB

5-c) Active contribution of PannEx-CC3 researchers to WCRP/CORDEX

5-d) Active contribution of PannEx-CC3 researchers to WCRP/GEWEX

5-e) Active contribution of PannEx-CC3 researchers to other PannEx-CCs and PannEx-FQs



From Fig. 3 in Kotlarski et al. (201

Vision of the Science Plan

- Science Plan will be developed based on the White Book afterwards
- PannEx community needs to work on defining the objectives and the methodologies which could be used to reach the goals
- What type of observation (geophysical, ecological, economical, social, ...) and modelling efforts need to be undertaken

Thank you for your kind attention!

https://sites.google.com/site/projectpannex/home