PROJECT RESULTS

EDUCATION

Title: Serbian-Austrian-Italian (SAI) partnership Forcing Excellence in ecosystem research

Acronym: SERBIA FOR EXCELL

Grant number: 691998

Coordinator: Prof dr Branislava Lalic

Coordinator institution: Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

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End date: 31.12.2018

The aim of the SERBIA FOR EXCELL is the upgrade of knowledge, skills and social capacity of PFNS in the field of environmental sciences, with special focus on agrometeorology and related ecosystem sciences (such as plant physiology, crop management).

The main tool for reaching that aim is establishment of the AgMnet+ research network at PFNS in collaboration with leading international research institutions BOKU and UNIFI. As a strategy to improve S&T capacities of PFNS, AgMnet+ is introducing the concepts of small study groups of PFNS, BOKU and UNIFI students and joint study teaching material in English and native languages. BOKU and UNIFI partners are implementing goal-driven measurement, modelling training and project writing in the selected research fields for AgMnet+ members. Intensive exchange of short term scientific visits, guest lectures and students visits among partner institutions are contributing to improve eligibility of AgMnet+ members for participation on EU projects, increased number of papers in peer-review journals and increased citation.

Strategic partnership with BOKU and UNIFI, initiated by this project is significantly enhancing the research and innovations capacities of PFNS and upgrading the knowledge and skills of both of its students and researchers.

SERBIA FOR EXCELL SUMMER SCHOOLS

Summer School 1

$A_gM_{net}^+$ INTERNATIONAL SUMMER SCHOOL IN AGROMETEOROLOGY AND CROP MODELLING – 2016

Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia
27 Jun – 1 July 2016

The objective of the summer school was to **provide attendees with a comprehensive overview of agrometeorological applications and crop modelling, the basics of numerical weather prediction (NWP) and NWP's application in agrometeorology**. The programme was open to graduate students (with at least one university degree), PhD candidates, early-stage researchers and professionals willing to broaden their knowledge.

Internationally recognized scientists and specialists gave the lectures as well as practical and lab work. Exercises related to crop modelling (such as AquaCrop model) and NWP (WRF-ARV model) application took place in parallel sessions. The main emphasis was on using NWP model products, which are not commonly used but can be very useful in agricultural production. We had 38 participants in 3 exercise groups (crop modelling, NWP and agrometeorological measurements) from 12 countries.

Summer School 2

$A_gM_{net}^+$ INTERNATIONAL SUMMER SCHOOL IN AGROMETEOROLOGY AND CROP MODELLING – 2017

Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

10– 14 July 2017

SS2 included lectures and exercises related to the following topics:

a) Parameterization of processes in soil-vegetation-atmosphere transfer schemes. Application of numerical weather prediction (NWP) in agronomy;

b) Crop modelling background – the principles behind the models;

c) Managing and generating model input data;

d) The structure of the crop model (AquaCrop, APSIM). How to run crop models, calibration and validation procedures;

e) Crop model applications for impact studies;

f) Agrometeorological measurements and applications.

Models that were considered during SS2 were AquaCrop, APSIM and WRF ARW limited area models. Participants had the opportunity to take a class in agrometeorological measurements as well. We had 35 participants from 11 countries.

GUEST LECTURES

Soil-plant-atmosphere interaction

April 2016, at PFNS

Josef Eitzinger, Institute of Meteorology, University of Natural Resources and Applied Life Sciences, BOKU

Several lectures were performed by Prof Eitzinger at PFNS on 11 and 12 April 2016, together with the PFNS SERBIA FOR EXCELL team, for students attending courses in meteorology and crop modelling. The themes of the lectures were (1) the simulation of the soil-crop-atmosphere environment and basic principles in that field and (2) climate change impact modelling using crop models. Attendees were introduced to crop models in general as well as their structure and working principles.

Agrometeorology and agrometeorological modelling

October 2016, at PFNS

Anna Dalla Marta, Department of Agrifood Production and Environmental Sciences, University of Florence, UNIFI

Anna Dalla Marta had several guest lectures at PFNS from 17–20 October 2016, together with the PFNS SERBIA FOR EXCELL team. The themes of the lectures were agrometeorology, agrometeorological modelling in three parts and agrometeorological elements. During the courses, PFNS students learned about basic principles in agrometeorology, agrometeorological measurements and agrometeorological modelling. The lecture on agrometeorological elements included everything from historical points-of-view to new, state-of-the-art measurement techniques.

Meteorological data

December 2017, at UNIFI

Branislava Lalić, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

Branislava Lalic held a lecture on the subject of meteorological data sources, forecasting and verification. The lecture was open to all students at the University of Florence and was geared especially toward those in the Erasmus Mundus Masters in Tropical Biodiversity and Ecosystems (TROPIMUNDO) course on tropical climatology and those in the University of Florence Masters in Natural Resource Management for Tropical Rural Development course on agronomy and soil science.

Long-term weather forecasting

December 2017, at UNIFI

Ana Firanj Sremac, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

Ana Firanj Sremac held a lecture on the use of long-term weather forecasting in crop modelling—a case study in Serbia and Austria. Students were introduced to the subject of weather forecasting on different time scales and the advantages of using forecast products in real-life problem solving. The course was for all students attending the course on tropical climatology and the course on agronomy and soil science.

Intercropping systems

December 2017, at UNIFI

Svetlana Vujic, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

Svetlana Vujic held a lecture on legume-based intercropping systems. The students were introduced to the principals of intercropping, the species that are used and management practices. Together with lecturers, students explored the positive aspects of involving intercropping systems in regular agricultural practices. The course was for all students attending the course on tropical climatology and the course on agronomy and soil science.

Cover crops

December 2017, at UNIFI

Branko Cupina, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

Branko Cupina held a lecture on the role of cover crops in enhancing the sustainability of cropping systems. The basic function of cover crops was presented together with the advancements that the introduction of cover crops can bring to agricultural practices. The course was for all students attending the course on tropical climatology and the course on agronomy and soil science.

Interaction between Sun radiation and canopy

December 2017, at PFNS

Philipp Weihs, Institute of Meteorology, University of Natural Resources and Applied Life Sciences, BOKU

In the meteorology course taken in the first year of pursuing different studies at PFNS, Philipp Weihs held a lecture on the subject of the interaction between solar radiation and canopies. The lecture had elements of theory and practice and included a large number of field measurements.

Osmotic and heavy metal stress

March 2018, at BOKU

Ivana Maksimovic, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

During her stay at BOKU, Ivana Maksimovic held a lecture on the subject of the impacts and responses of osmotic and heavy metal stress. The lecture was given to Masters students in the course on crop production in the tropics and subtropics. This course covered the major bio-physical and socio-economic factors that determine crop production and natural resource use in the tropics and subtropics.

Sugar beet tolerance to drought

March 2018, at BOKU

Marina Putnik-Delic, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

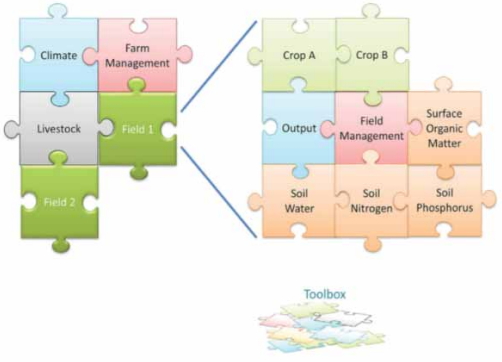
During her stay at BOKU, Marina Putnik-Delic held a lecture titled "Physiological and Molecular Aspects of Sugar Beet" for the Masters students who had chosen the course "Crop production in the tropics and subtropics". During the lecture, students learned about drought and its direct, practical impact on the sugar beet.

APSIM model application

March 2018, at PFNS

Ahmad M. Manschadi, Division of Agronomy, University of Natural Resources and Applied Life Sciences, BOKU

Ahmad M. Manschadi from BOKU gave a course for PhD students and young researchers on the use of the Agricultural Production Systems sIMulator (APSIM). The main focus of the training was APSIM application in nitrogen and forage crop modelling. The student response was great, so we had workshop-like lectures.



Meteorological data: sources, representativeness & use

May 2018, at BOKU

Branislava Lalic, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

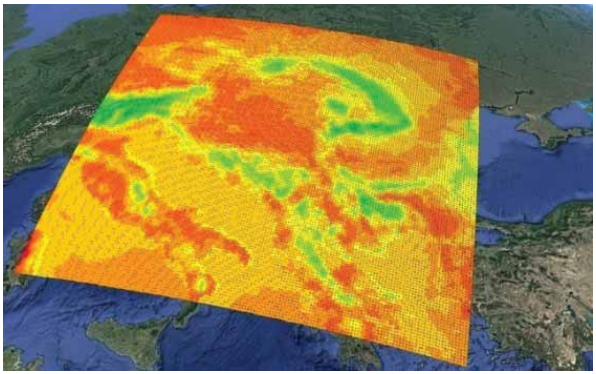
The course on meteorological data presence, availability, accuracy and importance in agricultural practice was given by Prof Branislava Lalic at BOKU for the students in the course on meteorological measurements.

Application of different NWP products in agricultural production

May 2018, at BOKU

Ana Firanj Sremac, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

Lectures about the application of different time- and space-scale meteorological forecasts in crop and plant disease modelling were presented by Ana Firanj Sremac. The students learned about basic crop and plant disease modelling, the principles of forecasting, and the use of weather forecasts as inputs for models during the course of meteorological measurements.



Meteorological data: sources, representativeness & use in tropical regions

November 2018, at UNIFI

Branislava Lalic, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

The main focus of the lecture was the challenges of tropical weather monitoring and forecasting. Students learned about tropical weather systems on synoptic and other scales, sources of meteorological data and different measurements and reanalysis data. The other part of the lecture was devoted to weather forecasting, time and spatial scales and forecasting products that are available to the general public.

Legume-based intercropping systems

November 2018, at UNIFI

Svetlana Vujic, Department of Field and Vegetable Crops, Faculty of Agriculture, PFNS

University students learned about the theory of the simultaneous growth of two or more crop species in the same field without necessarily sowing and harvesting them together. The lecturer presented the basic principles of intercropping, intercropping patterns, concepts, practical uses, advantages and disadvantages with a focus on the use of legumes.

Climate impact on xylem tissue in woody plants

November 2018, at UNIFI

Mirjana Ljubojevic, Department of Fruit Science, Viticulture, Horticulture and Landscape Architecture, Faculty of Agriculture, PFNS

Mirjana Ljubojevic gave a lecture on the climate impact on xylem tissue in woody plants, from practical and breeding perspectives. Students learned about secondary growth in woody plants, how important the trunk characteristics are, xylem functioning and its significance for plant survival and the impact of constant environmental changes on xylem hydraulic properties. The focus of the presented research was cherry trees.

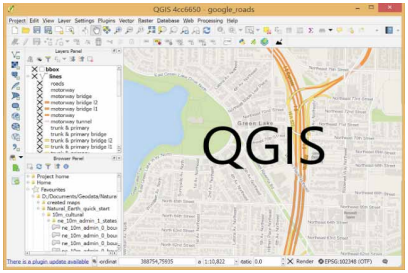
EXPERT TRAININGS

Topic	Training activities	Expected outcome
Agrometeorological measurements and data analysis	Content: Theory and practice of measurement methods and techniques, data handling and quality checking, data analysis of measured parameters, scaling problems. Methods: Lectures, measurement exercises and field practicum.	Improved skills and ability to organise specific measurement tasks at home institution
Crop modelling (theory and training)	Content: Theory of crop growth processes; Crop model structure and handling for 2 representative models: DSSAT, AquaCrop Methods: Lectures, simulation exercises	Understand interactions in the soil-crop-atmosphere system affecting plant growth; Ability to simulate crop growth and related processes such as crop water use
Ecophysiological monitoring	Content: Measuring physiological and morphological parameters of plants Methods: Lectures, measurement exercises and field practicum	Better understanding of plant-soil-atmosphere interactions
Agrometeorlogical index models and impact algorithms	Content: Types of indices and software; Monitoring methods of agrometeorological processes and risks (drought, weather extremes, pests and disease, frost, soil erosion etc.) Methods: Lectures, modelling exercises	Ability to apply index models and algorithms for monitoring
From theory to practice in agrometeorology	Content: Operational implementation of tools for stakeholders, reality checks, gathering and using stakeholder feedbacks Methods: Lectures, field visits	Ability to understand complexity of real-world problems for improving/tailoring own research
Project development and management	Step-by-step project preparation	Submitted projects

TRAININGS AT PFNS

QGIS

May 2018



Lectures about installation and work under QGIS were prepared and delivered by Mina Petric (Avia-GIS) and Ana Firanj Sremac at PFNS. During the training, participants passed through the basic principles and work of the QGIS platform. The training was delivered through a series of practical examples in which students learned how to create maps and present their data.

Scientific writing course

May 2018

During the 22nd and 23rd of May 2018, Steve Quarrie (Faculty of Biology, Belgrade University) and Dusan Petric gave lectures on the rules of scientific writing.

Steve Quarrie's career as a scientist conducting research in the fields of organic chemistry, biochemistry, plant physiology, quantitative genetics, hydrology, agro-economics, rural development, and education has spanned more than 50 years. He has 73 scientific papers in SCI-listed journals and over 4500 citations and an h-index of 33. The course was held for students and young researchers at the Faculty of Agriculture in Novi Sad. A large number of students responded.

Horizon 2020 project management

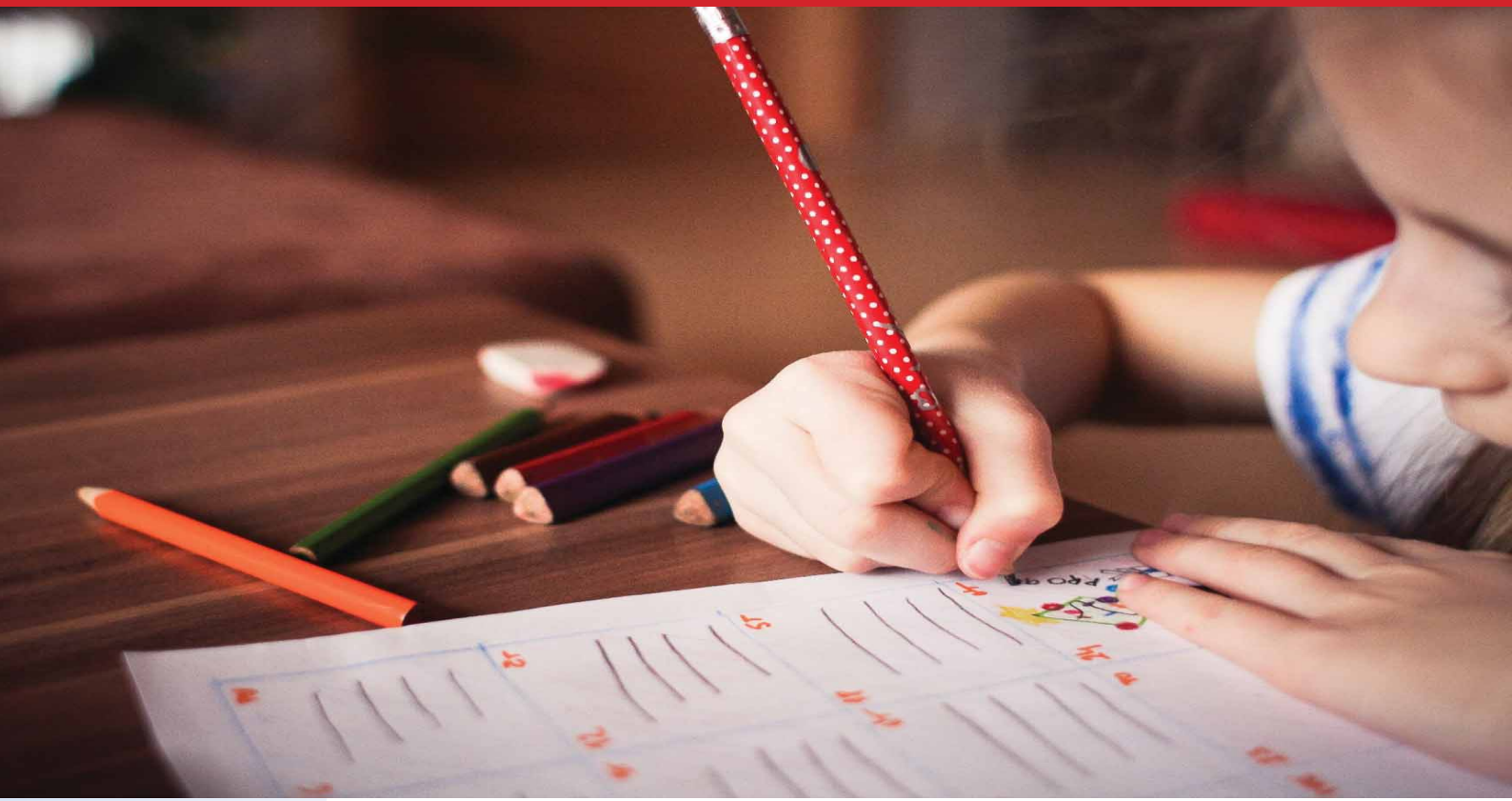
November 2018

Marija Šola Spasić (School of Electrical Engineering, University of Belgrade) and Branislava Lalic gave a training course on Management of Horizon 2020 projects for researchers and administrative staff at PFNS.

ERA5 data

November 2018

Ljiljana Dekić (Republic Hydrometereological Service of Serbia), Miloš Lompar (Republic Hydrometereological Service of Serbia) and Branislava Lalic gave a course on publicly available ERA5 data at PFNS. The course was organized for all PFNS and AgMnet+ staff. During the training, participants learned about the Copernicus database, reanalysis data, and data requests and downloads. The practical work included basic Python programing and the use of produced codes for data assimilation and visualization.



CHILDREN'S UNIVERSITY AND ROUND TABLES

Children's University 2017

June, 2017

During the course of two days—June 9 and June 12, 2017—a Children's University was held at PFNS by members of the SERBIA FOR EXCELL team. Children from the elementary school "Tvrdjava" in Novi Sad were placed into two age groups.

Younger group: 2nd–4th grade; Children: 12

Topic: What is climate change? (The ice melting and increasing the sea level.) What are science and scientific research?

Experiment: How much does the melting of ice floating in water increase the level of the liquid versus the ice that is on the shore and flows into the water? (Materials: clay, water, ice, laser)

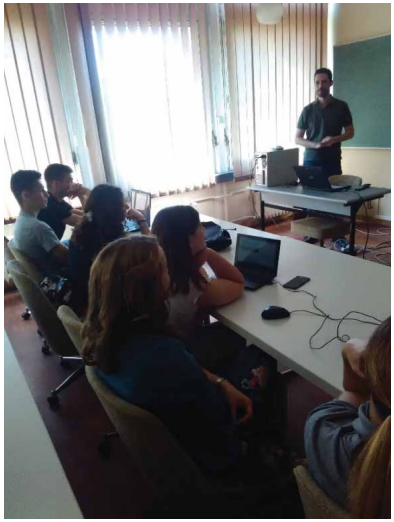
Older group: 5th–7th grade; Children: 14

What is climate change? Why is the atmosphere heating up? What is the greenhouse effect? What are science and scientific research? What are pseudo-science, proto-science, and the process of concluding science?

Experiment: A computer model of the interaction of the earth, the atmosphere, solar radiation and CO2.

The model that was used can be found at this link.

Children's University 2018



May 2018

In the framework of SERBIA FOR EXCELL, we organized a second lecture at PFNS for children from the primary school on the subject of climate change.

On this day, we worked with an older group that was familiar with computer use.

The goal was to show the students how they can select from among the mass of different information the information that is real and important and how they can change their perspectives and think outside the box.

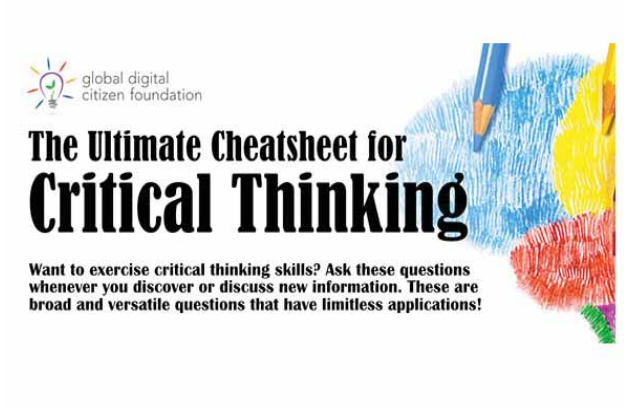
Round table on critical thinking with high school students

At Jovan Jovanović Zmaj Grammar School in Novi Sad, with 3rd year students, we organized a roundtable on critical thinking.

Approximately 20 students attended the event, and the discussion lasted 1.5 hours. As a starting point, we presented two opposite sides in the climate change debate (alarmist vs. denialist). We went through several prominent arguments from both sides and analysed how and to what extent the sides distort scientific facts. Towards the end, we discussed general critical thinking skills: what are they and how can they be applied?

Round table on critical thinking with faculty students - "Education and/or critical thinking"

SERBIA FOR EXCELL organized a roundtable meeting on "Education and/or critical thinking", which took place at PFNS. Attendees included PFNS PhD students, Prof Dušan Petrić, and Prof Branislava Lalić, while the roundtable was moderated by Dr Igor Balaž. The main topics were:



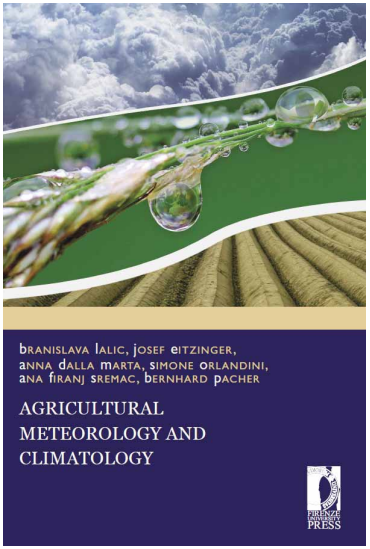
- What is critical thinking?
- Do typical education practices nurture critical thinking?
- If not, or if insufficiently, what is the cause?
- What are the risks and benefits of critical thinking?

Although we planned that the round table take about one hour, actual duration was 2 hours, since participants were very interested in the topic. The final conclusion was that students and PhD students have little opportunity to express their opinions.

BOOKS

Book

"Agricultural Meteorology and Climatology"



Branislava Lalic, Josef Eitzinger, Anna Dalla Marta, Ana Firanj Sremac, Simone Orlandini, Bernhard Pacher

Florence University Press, ISBN 978-88-6453-795-5

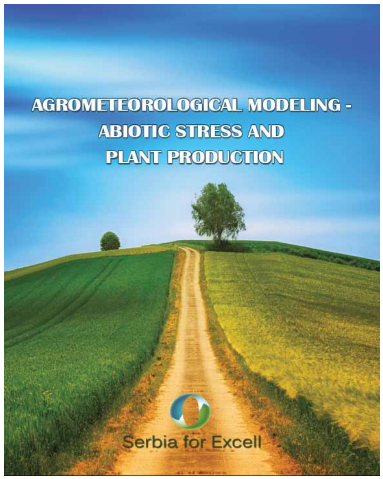
Agricultural Meteorology and Climatology is an introductory textbook for meteorology and climatology courses at faculties of agriculture and for agrometeorology and agroclimatology courses at faculties whose curricula include these subjects. Additionally, this book may be a useful source of information for practicing agronomists and all those interested in different aspects of weather and climate impacts on agriculture. In times when scientific

knowledge and practical experience increase exponentially, it is not a simple matter to prepare a textbook. Therefore we decided not to constrain *Agricultural Meteorology and Climatology* by its binding pages. Only a part of it is a conventional textbook. The other part includes numerical examples (easy-to-edit worksheets) and recommended additional reading available on-line in digital form. To keep the reader's attention, the book is divided into three sections: *Basics*, *Applications and Agrometeorological Measurements with Numerical Examples*.

During the project, the book titled *Agricultural Meteorology and Climatology* was also translated into Serbian, German and Italian, which makes it useful for a wide range of users. All versions are available online on the project web page.

Teaching material

"Agrometeorological modeling-abiotic stress and plant production"



Group of authors

ISBN 978-86-7520-445-9

Teaching material for students was prepared in English and Serbian language. The content is connected to three topics (1) (Agro)meteorology, agroclimatic indices and models, agrometeorological measurements and weather forecasting, (2) Agrometeorological modeling, soil - atmosphere gas fluctuations, Austrian drought monitoring system, effects of abiotic stress on crop production (drought, excessive salinity and heavy metal pollution) and (3) Crop management in changing climate (examples for forage crops).

This material will be used as additional teaching material during the following courses at the University of Novi Sad, Faculty of Agriculture:

1st cycle (undergraduate studies, B.Sc. level):

Meteorology, Crop modeling, Plant Physiology, Ecotoxicology

and environmental protection, Forage crops in organic agriculture, Growing of cereals and pulses, Growing of industrial plants and Organic field crop production

2nd cycle (M.Sc. level):

Bioremediation, The role of cover crops in organic farming

High school book

"The Guide to Meteorology and Atmospheric Physics for High School and Freshmen Students"

Snežana Bulajić, Branislava Lalić

ISBN 978-86-7520-443-5

The contents of this book correspond to the subject of physics in secondary schools. The topics were selected to bring students closer to meteorology and atmospheric physics. Topics that are described are also part of the subject of meteorology in the first year of the Faculty of Agriculture, where the book will be used as an additional textbook.

Serbian: "Vodič kroz meteorologiju i fiziku atmosfere za srednjoškolce i brucoše"

German: "Eine Einführung in die Meteorologie und Physik der Atmosphäre. Für Schüler der Mittelstufe und Studenten im ersten Jahr"

Italian: "Guida alla meteorologia e alla fisica dell'atmosfera per studenti delle scuole superiori e del primo anno universitario"

Serbia for Excell

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