HUMBOLDT-KOLLEG 2018
„SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE:
CONNECTING RESEARCH, EDUCATION, POLICY AND PRACTICE“
Belgrade, September 19-22, 2018

BOOK OF ABSTRACTS

(with Kolleg Agenda)

Editors: Mirko Komatina, Dragan Nonić, Branimir Jovančićević

Belgrade, 2018

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„Sustainable Development and Climate Change:
Connecting Research, Education, Policy and Practice“
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УНИВЕРЗИТЕТ
У БЕОГРАДУ
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Од 16. октобра 1990. године Хумболтов клуб Србије окупља стипендисте и добитнике награде „Фондације Александар фон Хумболт“ у Србији. Знања и искуства стечена у Немачкој током својих последокторских усавршавања, руководство и чланови Клуба користе у циљу развијања науке у Србији кроз подстицање научног подмлатка и промовисање науке у друштву. Активности Клуба су бројне. Предавања еминентих научника из Србије и иностранства о актуелним научним темама омогућавају стални контакт Хумболтоваца. На предавања се позивају младе колеге, потенцијални апликанти за престижну Хумболтову стипендију. На тај начин они су у прилици да се упознају са могућностима усавршавања у Немачкој, са предностима које таква усавршавања пружају, и да при томе процене своје шансе за добијање стипендије.

Међу најважнијим активностима Хумболтовог клуба Србије су и оне које се односе на организовање научно-стручних скупова. Конференцију „Одрживи развој и климатске промене: повезивање истраживања, образовање, политике и праксе“ („Sustainable Development and Climate Change: Connecting Research, Education, Policy and Practice“), Клуб организује од 19. до 22. септембра 2018. године у Београду. Одговоре на постављени задатак покушаће да дају еминентни истраживачи из природних и хуманистичких наука: у коликој мери су климатске промене последица деловања човека на животну средину, или су оне само последица турбулентних, али нормалних, појава у развоју Земље као планете?

Учесници скупа су пре свега Хумболтовци из Србије и других, махом суседних, земаља. И овом приликом свој допринос ће дати научници из Немачке. Велики број младих научника који су потенцијални добитници престижне стипендије кроз своје радове и дискусије покушаће да допринесу успеху конференције. Посебно драги гости су, свакако, званичници Фондације Александар фон Хумболт из Бона и представници немачких дипломатских и других институција у Београду и у Србији. Посвећеност међународној сарадњи, Универзитет у Београду је још једном показао тиме што је у организовању ове конференције узео активно учешће. Поред дефинисаних научних циљева, организатор има жељу да промовише и поспеши сарадњу међу Хумболтовцима, не само у Србији већ и у региону, и да друштву, а пре свега младим истраживачима, приближи и јасније представи користи усавршавања у Немачкој кроз рад Фондације Александар фон Хумболт.

У име чланова Научног одбора и организатора овог скупа изражавам наду да ће конференција испунити очекивања. Користим прилику да се захвалим „Фондацији Александар фон Хумболт“ која је и овог пута подржала организовање Конференције.

Београд, септембар 2018. год.

Бранимир С. Јованчићевић,
председник Научног одбора Конференције

Мирко Коматина,
Председник Хумболтовог клуба Србије

Since October 16, 1990, the Humboldt Club of Serbia has gathered scholars and winners of the Alexander von Humboldt Foundation in Serbia. Knowledge and experience acquired in Germany during their postdoctoral studies, the management and members of the Club use in developing science in Serbia by encouraging scientific research and promoting science in society. Club activities are numerous. Lectures by eminent scientists from Serbia and abroad on current scientific topics enable constant contact between Humboldtians. Young colleagues, potential applicants for the prestigious Humboldt Scholarship are invited to the lectures. In this way, they have the opportunity to become familiar with the study opportunities in Germany, with the benefits of such advanced study, and to assess their chances of obtaining a scholarship.

Among the most important activities of the Humboldt Club of Serbia are those related to the organization of scientific-professional meetings. The Club is organizing the conference „Sustainable Development and Climate Change: Connecting Research, Education, Policy and Practice" from September 19 to 22, 2018 in Belgrade. Responses to the task will be tried by eminent researchers from natural and humanistic sciences: to what extent are climate changes resulting from man's action and impact on the environment, or are they only a consequence of turbulent, but normal, phenomena in the development of the Earth as a planet?

The participants of the conference are primarily Humboldtians from Serbia and other, mostly neighboring countries. On this occasion, scientists from Germany will also contribute. A large number of young scientists who are potential winners of a prestigious scholarship will try to contribute to the success of the conference through their articles and discussions. Certainly dear guests are, of course, members of Alexander von Humboldt Foundation from Bonn and representatives of German diplomatic and other institutions in Belgrade and Serbia. The University of Belgrade once again demonstrated its commitment to international cooperation by active participation in organizing this conference. In addition to the defined scientific goals, the organizer has the desire to promote and accelerate cooperation among the Humboldtians, not only in Serbia, but also to bring closer to society, and above all young researchers, the benefits of training in Germany through the work of the Foundation Alexander von Humboldt.

On behalf of the members of the Scientific Committee and the organizer of this event, I express my hope that the conference will meet expectations. I take the opportunity to thank the Alexander von Humboldt Foundation, who once again supported the organization of the conference.

Belgrade, September, 2018

Branimir S. Jovančićević,
Chairman of the Scientific Committee of the Kolleg

Mirko Komatina,
President of the Humboldt-Club Serbia

Seit dem 16. Oktober 1990 hat der Humboldt Club im Serbien Stipendiaten und Preisträger der Alexander von Humboldt Stiftung in Serbien versammelt. Erworbene Kenntnisse und Erfahrungen während ihrer Postdoc Ausbildung im Deutschland werden vom Management und den Mitgliedern des Clubs bei der Entwicklung der Wissenschaft in Serbien genutzt, durch Forschungs Förderung und Förderung der Wissenschaft in der Gesellschaft. Clubaktivitäten sind zahlreich. Vorträge renommierter Wissenschaftler aus Serbien und Ausland zu aktuellen wissenschaftlichen Themen ermöglichen den ständigen Kontakt zwischen den Humboldtianern. Junge Kollegen, potenzielle Bewerber für das renommierte Humboldt Stipendium werden zu den Vorträgen eingeladen. Auf diese Weise haben sie die Gelegenheit sich über die, Ausbildungsmöglichkeiten in Deutschland und mit den Vorteilen einer solchen Fortbildung bekantzumachen und ihre Chancen eine Stipendium zu erhalten abzuschätzen.

Zu den wichtigsten Aktivitäten des Humboldt Clubs im Serbien gehören die Organisierung von wissenschaftlich-fachlichen Treffen. Der Club organisiert die Konferenz „Nachhaltige Entwicklung und Klimawandel: Verbindung von Forschung, Bildung, Politik und Praxis“ („Sustainable Development and Climate Change: Connecting Research, Education, Policy and Practice“) die von 19. bis 22. September 2018 in Belgrad stattfindet. Renommierter Forscher in den Natur- und Humanwissenschaften werden versuchen die Antworten auf die Aufgabe zu geben: in welchem Umfang ist der Klimawandel Folge der Einwirkung der Menschen und anthropogenen Einflüsse auf die Umwelt, oder ist es nur eine Folge der normalen turbulenten Phänomene in der Entwicklung der Erde als Planet?

Die Teilnehmer der Treffen sind in erster Linie Humboldtianer aus Serbien und anderen, meist benachbarten, Ländern. Bei dieser Gelegenheit werden auch Wissenschaftler aus Deutschland beitragen. Eine große Anzahl von jungen Wissenschaftlern, die potenziellen Gewinner der angesehen Stipendium, werden versuchen durch ihre Artikeln und Diskussionen zum Erfolg der Konferenz beizutragen. Besonders liebe Gäste sind natürlich die Mitglieder der Alexander von Humboldt Stiftung aus Bon und Vertreter der deutschen diplomatischen und anderen Institutionen in Belgrad und Serbien. Der Universität in Belgrad hat erneut engagement für internationale Zusammenarbeit gezeigt durch aktive Teilnahme an der Organisation dieser Konferenz. Zusätzlich zu den definierten wissenschaftlichen Zielen, der Veranstalter hat den Wunsch das Zusammenarbeit zwischen Humboldtianer, nicht nur in Serbien, zu fördern und zu beschleunigen, und auch der Gesellschaft und vor allem jungen Forschern die Vorteile der Ausbildung in Deutschland durch die Arbeit der Alexander von Humboldt Stiftung näher zu bringen.

Im Namen der Mitglieder des wissenschaftlichen Ausschusses und des Organisators dieser Veranstaltung hoffe ich, dass die Konferenz die Erwartungen erfüllen wird. Ich nutze die Gelegenheit der Alexander von Humboldt Stiftung zu danken, die die Organisation der Konferenz erneut unterstützt hat.

Belgrad, September 2018.

Branimir S. Jovančićević,
Vorsitzender des Wissenschaftlichen Ausschusses der Konferenz

Mirko Komatina,
Präsident des Humboldt-Clubs Serbien

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Presenters:

Walter Leal	The sustainable development goals: An opportunity to foster a better understanding of sustainability challenges
Pim Martens	Our sustainability challenges: Animal well-being, health and climate change
Jose Pinto-Bazurco	Legal challenges for implementing the Paris agreement in developing countries
Martin Kaltschmitt	Renewables within the energy supply system - Trends and developments

Session 2 (Day 3, Friday, 21st September)
Chairperson: Davide Pettenella (ITA)
Presenters:

Michael Pregernig	Sustainability, science and society: The need for a multi-perspectivist research approach
Daniela Kleinschmit	Achieving sustainable development: bioeconomy as the way forward

Session 3 (Day 4, Saturday, 22nd September)
Chairperson: Slobodan Savić (SRB)
Presenters:

Mile Ivanda	Sustainable economical advancing in developing countries by science development
Mihai Dima	The climate challenge: Lessons from the past and implications for the future

THE SUSTAINABLE DEVELOPMENT GOALS: AN OPPORTUNITY TO FOSTER A BETTER UNDERSTANDING OF SUSTAINABILITY CHALLENGES

Walter LEAL[1], Shiv K. TRIPATHI[2], José Baltazar Salgueirinho Osório DE ANDRADE GUERRA[3], Ricard GINÉ-GARRIGA[4], Violeta ORLOVIĆ LOVREN[5], Jessica WILLATS[6]

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The United Nations "Agenda for Sustainable Development 2030", adopted in 2015, consists of 17 Sustainable Development Goals (SDGs), addressing globally important issues of economic development, health, equity and the quality of life in both developing and developed countries. Despite the global agreement on the measures to be taken towards the balance between economic development and environmental protection, there are still many disparities which need to be taken into consideration both within and between industrialised and developing countries.
While there is a large agreement of the relevance of the SDGs, it is still unclear how they may help to address present and future sustainability challenges. The paper contributes to understanding of the SDGs, and its potential to overcome some of existing challenges in pursuing sustainable development.

Key words: sustainability, sustainable development goals, challenges, industrialized and developing countries

OUR SUSTAINABILITY CHALLENGES: ANIMAL WELL-BEING, HEALTH AND CLIMATE CHANGE

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If we look at the many sustainability indicators that have been developed over the years, it is striking to see that animal and human health and wellbeing hardly plays a role. The reason that ‘health’ and ‘sustainability’ are not often mentioned together in one sentence is likely to be found in the fact that the sustainability debate has been hijacked in recent years by industry and governments. In this paper, human-animal relationships will be linked to concepts and tools from sustainability science and some examples – climate change, biodiversity- will be discussed.

Keywords: sustainability science, anthrozoology, health, climate, biodiversity

LEGAL CHALLENGES FOR IMPLEMENTING THE PARIS AGREEMENT IN DEVELOPING COUNTRIES

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One of the most relevant consequences of the Paris Agreement entering into force is that it creates an international framework that encourages its member countries to come up with low carbon development strategies. Over the last decades, these types of strategies are being implemented more commonly in industrialized countries, partly because these possess the necessary economic and technologic development and adequate infrastructure to apply them efficiently. Most developing countries, on the other hand, do not have similar established means of implementation, which implies that this new approach will represent a stronger effort in their fulfillment of the agreement. The main goal of this investigation is to evaluate the effectiveness of national laws and policies in developing countries in achieving both mitigation and adaptation actions. In order to do this, the study includes a review of the political and legal frameworks of a selection of developing countries (Chile, Colombia, México and Peru) with the objective of presenting the challenges and the options these countries have related to setting up measures that would support a low carbon development, as well as climate change adaptation. So far, most of the countries that have been studied have come up with legal or political frameworks that would encompass emission reductions, contributing in this way to the achievement of the Paris targets. This investigation also takes into account the role that developing countries have in international climate change negotiations, and how appropriately they represent their national circumstances at the multilateral level. This is an important factor, because many countries base their climate policy on the objectives set by international instruments. The view of this research is that these countries could benefit from strengthening their international participation, because the decisions that are being made in these negotiations could certainly be relevant to their national interests, but also because these countries make a legal commitment to implement those decisions at a national level. The arrangements for the international climate change negotiations have found a way to accommodate some of the challenges and the needs for developing countries, and the disadvantages they face when compared with their developed partners. Nevertheless, industrialized countries tend to be better equipped to face complex and long negotiations. The result is that, in some cases at least, countries that may not have the

ideal capacity and representation during the negotiations end up giving their agreement to decisions, and furthermore sign, ratify and implement these agreements.

Keywords: climate change, Paris Agreement, developing countries

RENEWABLES WITHIN THE ENERGY SUPPLY SYSTEM - TRENDS AND DEVELOPMENTS

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In recent years, renewable sources of energy gain more and more importance within numerous energy supply systems realised on a global scale. This is true for developing and for developed countries as well as especially for emerging economies. Against this background the goal of this contribution is to assess the various trends as well as the ongoing developments influencing and determining the future role of renewable sources of energy within saturated as well as growing energy supply systems from a global point of view. Therefore, first the global energy system is presented briefly with a special focus on the role of renewable sources of energy. Based on this, important trends and tendencies are discussed and assessed visible in recent years within (a) the area of newly developed energy technologies, (b) the mobility sector, (c) the field of information technology, (d) selected national and especially multi-national regulatory frameworks as well as (e) the demands defined by the environment respectively by the local citizen. By analysing the results of such an assessment within these various areas it becomes obvious that most of the ongoing developments support an increased use of renewable sources of energy already today and with an accelerating importance in the years to come. Due to these developments most likely the globally existing numerous energy systems permanently under evolution to meet the changing needs are on a development pathway towards improved sustainability criteria in the years to come – assuming that an increasingly higher share of renewables within the overall energy system is equivalent to enhanced sustainability criteria. And due to economic reasons this development is very robust and ongoing on a global scale.

Keywords: renewable sources of energy, energy systems, trends and developments in energy

SUSTAINABILITY, SCIENCE AND SOCIETY: THE NEED FOR A MULTI-PERSPECTIVIST RESEARCH APPROACH

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Governance for sustainability is confronted with a number of intricate problems stemming from a plurality of interests, values, and worldviews, complex linkages across scales, and challenges of long-term orientation. On top of that sustainability governance is faced with a special knowledge challenge, since 'facts' are often only of a provisional nature with scientific expertise being increasingly contested by various types of counter-expertise and more local forms of knowledge. Consequently, sustainability governance has to perform a delicate balancing act: On the one hand, there is a need for more 'evidence-based policy-making'; on the other hand, there are critical voices who argue that if problems are increasingly spelled out in technical terms this might lead to a simultaneous scientification and de-politicisation of governance. Scholars argue that in order to strike a balance between effective scientific policy advice and democratic inclusivity new research approaches, and maybe even new types of science, are needed. In a first step, this paper systematically introduces and compares recent initiatives and programs that strive to incentivize research for the "grand societal challenges". On a global level, the newly founded network "Future Earth" plays an important role as a gatekeeper - both in terms of relevant research topics and new research principles. There is also a related focus in EU research agendas, especially in the context of the Urban Europe program; and there are vibrant activities on the country-level, especially in the Scandinavian and the Benelux countries but recently also in Germany. All those initiatives share a number of principles; they especially aim to make tangible contributions to societal transformations towards sustainability and they strive to do so by means of research that is based on transdisciplinarity and experimentation as core research approaches. In a second step, this paper provides a critical reflection on those new types of research approaches. This reflection is based, on the one hand, on a review of literature from the fields of sustainability science and science and technology studies; on the hand, it draws on experiences that the author has made in designing, implementing, and researching respective formats. Relevant questions to be addressed are: How are different bodies of sustainability-related knowledge constructed, negotiated and verified among scientific

and non-scientific actors? Under what circumstances can science and technical expertise provide policy-relevant knowledge? How much influence and authority does science hold and how much accrue to other modes of knowing and deciding? Which roles do non-scientific actors and the public play and how are their inputs integrated in a political as well as an epistemological way? This paper concludes by discussing - in a critico-constructive way - to what extent and under which conditions pioneering cases of new knowledge production can live up to their high normative expectations and what kind of structural adaptations - in research funding, academic infrastructure etc. - it might need.

Keywords: sustainability, transformation, governance, science-policy, transdisciplinarity

ACHIEVING SUSTAINABLE DEVELOPMENT: BIOECONOMY AS THE WAY FORWARD

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Bioeconomy is a political concept supported by the OECD, the European Union (EU), but also by many countries worldwide. It highlights sustainable development as the overarching goal addressing major societal and economic challenges and at the same time creating a more favourable environment. The bioeconomy in itself however cannot be considered as self-evidently sustainable. Visions about the relationship between bioeconomy and sustainability differ substantially as bioeconomy strategies do when addressing sustainable development. Starting out from the concept of Environmental Policy Integration, the integration of environmental concerns are considered crucial to ensure Sustainable Development. However, comparative studies in Europe have identified that environmental concerns are integrated in bioeconomy policies to a different degree. In particular, countries with a strong forest sector and with forest resources substantially contributing to the national GDP only present weak linkages to sustainable development and ecological goals. Challenges and opportunities for governance systems to use the bioeconomy for a "road" towards sustainable development can be uncovered and fostered.

Keywords: bioeconomy, sustainable development, policy integration, governance challenges

SUSTAINABLE ECONOMICAL ADVANCING IN DEVELOPING COUNTRIES BY SCIENCE DEVELOPMENT

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Science is more connected to research centers in developed countries of Europe and America and technology budgets receive little support from the government as well as from the private sector. Science in developing countries has to adapt and develop appropriate technologies and to serve as adviser in government, industry and agriculture. The economical advancing by science has to be established through three mutually strongly interconnected phases: a) basic research, b) technological development and c) production and marketing. In a globalizing world with strong competitiveness, the such goals could be achieved by special governmental programs dedicated: 1) to recognize, adapt and further develop of high added value technological products already present on the world market, 2) to develop areas in which the country is significantly better than their competitors because of a better trained work force, favourable natural resources, or scientific and technological capabilities, 3) to strengthen education and 4) to expand the role of science as advisers in both government and industry. Such established programs could also prevent the brain-drain that mainly results when scientists face indifference and poor financial support from their governments. Regarding this approach of increasing the role of science in society development, some important parameters related to the Croatian Center of Excellence for Advanced Materials and Sensing Devices will be presented and its influence on the technological advancing will be discussed.

Keywords: science, development, economy, technology

THE CLIMATE CHALLENGE: LESSONS FROM THE PAST AND IMPLICATIONS FOR THE FUTURE

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Extreme climate variations could influence the human perception and behaviour, with significant impact on anthropogenic emissions of greenhouse gases and global temperature. The prominent anormal character of some present climate conditions is better understood when they are placed in a long term context. I present results of recent studies emphasizing climatic conditions which appear as extreme in an extended temporal perspective. The corresponding physical processes and impact are also described. The implications and consequences related to severe climate anomalies are discussed.

Keywords: extreme climate conditions

SESSION: Life and natural sciences perspective on sustainable Development and climate change

Sub-session: The Milanković theory and climate
Chairpersons: Luka Popović (SRB), Slobodan Marković (SRB)
Presenters:

Slobodan Marković	Milanković's theory and future climate
Luka Popović	Milankovitch theory of climate changes: astronomical aspects
Natalija Janc	The correspondence between Milanković and Mišković on the topic of scientists and their work

Sub-session: Climate change modelling and natural disasters
Chairpersons: Tarmo Soomere (EST), Aleksandar Lipkovski (SRB)
Presenters:

Aleksandar Lipkovski	Mathematical modelling in sustainable development and climate change
Ana Vuković	Climate change modelling as a support tool for sustainable development planning
Tarmo Soomere	Concealed changes in waves and winds that may lead to an ecological dead-zone of shelf seas
Piero Bellanova	Tracing toxic flood events in sedimentary archives - the potential of organic indicators

MILANKOVIĆ'S THEORY AND FUTURE CLIMATE

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The Global Pleistocene stratigraphy reflects the effect of the three astronomical cycles as defined by Milanković in his famous Ice Age theory. The geological cycles of various sedimentological marine and continental records have the same climatic rhythm. These distant and, from many points of view, different climate records, such as deep sea sediments, lake sediments, loess-paleosol sequences, speleothems, and ice sheets reflect the same distribution of time sequences. Milanković cycles are also registered in older geological deposits. Therefore, forthcoming changes in Milanković's orbital parameters can be regarded as a solid basis for valid predictions of future climate changes on Earth, or at least on a multimillennial scale.

Keywords: Milanković theory, Earth, climate change, Pleistocene

MILANKOVITCH THEORY OF CLIMATE CHANGES: ASTRONOMICAL ASPECTS

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In this talk we give a short overview of Milankovitch theory, which is based on the three Earth orbital variations: i) changes in the Earth orbital eccentricity; ii) change in the tilt of the Earth's axis (Obliquity); and iii) Precession - the change in orientation of the Earth's rotational axis. Milankovitch formulated a mathematical model that takes into account these three long-term Earth orbital variation and calculated the insolation latitudinal differences for 600,000 years in past (prior the year 1800).
Using this model, with the close collaboration with German Climatologist Vladimir Koppen, he explained the growth and retreat of the Ice Ages, i.e. found correlation between the radiation changes in ice sheet growth and decay.
The theory shows that in a long-period, the astronomical aspects have to be taken into account in the climate change.

Keywords: Astronomy, Milankovitch theory, Earth motion, climate change

THE CORRESPONDENCE BETWEEN MILANKOVIĆ AND MIŠKOVIĆ ON THE TOPIC OF SCIENTISTS AND THEIR WORK

Natalija JANC[1], Luka Č. POPOVIĆ[2], Slobodan B. MARKOVIĆ[3], Milivoj B. GAVRILOV[3], Vojislava PROTIĆ-BENIŠEK[2], Vladimir BENIŠEK[2]

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In their correspondence from 1924 to 1952, Milutin Milanković and Vojislav Mišković often discussed the work of scientists who had new and significant breakthroughs. They also gave overviews of published papers, among them being Alfred Wegener's paper "Climates of the Geological Past," Robert Sayles' paper "The Dilemma of the Paleoclimatologists," Wolfgang Soergel's paper about loess stratigraphy, as well as Erich Schoenberg's paper on the temperature of planets, among other topics. Milanković and Mišković evaluated some of these articles in relation to theories they themselves were advancing. In their correspondence, they also discussed their own papers.

Keywords: History of Science, Astronomy, Geology, Climate change, Milankovitch theory

MATHEMATICAL MODELLING IN SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

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Natural and social phenomena could be well explained by mathematical methods. An important milestone in the theory of climate changes is the insolation theory, discovered by the Serbian mathematician Milutin Milanković. However, modelling must also take into account another aspect of natural phenomena: sudden and dramatic changes in the condition of the studied system (which can be continuous, discrete or mixed) occurring on small changes of control parameters. This behaviour is modelled using catastrophe theory, a mathematical theory developed in the 1970's by Christopher Zeeman and René Thom. It lies on the boundary between the general mathematical theory of bifurcations, which was first considered by Henri Poincaré at the end of the 19th century and the theory of singularities, which began with Hassler Whitney and reached its peak in the Russian school of Vladimir Arnold. If the observed phenomenon is described by a dynamic system evolving in time, we are talking about catastrophe. The term was introduced by Thom. Classifying the singularities of real functions has led to the idea that a polynomial part of the local expansion of a function plays a key role in its behaviour, and in this way the theory is connected with algebraic singularities. The most famous theorem of catastrophe theory is the Thom's classification theorem. The catastrophe theory, Thom's classification theorems, and the applications of this theory in natural, medical and social sciences will be the topic of this talk.

Keywords: catastrophe theory and its applications

CLIMATE CHANGE MODELING AS A SUPPORT TOOL FOR SUSTAINABLE DEVELOPMENT PLANNING

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Success in sustainable development planning relies on implementation of trustworthy information in strategies for future practice. In global warming world, with detected accelerated trend of climate change, there is a necessity for faster implementation of science into policy- and decision-making. Climate change modelling became unavoidable component in scientific research related to climate system processes and human livelihood. To consider climate conditions as a dynamical component with significant variability and to require high quality data on this issue became the topic of imperative significance for mainstreaming in sectorial strategies and legislation. To overcome the complexity of interactions and knowledge gaps related to combating climate change, modelling of relations between climate parameters and sectorial/environmental/livelihood components are developing, with hope to speed up implementation of science into practice. Pillar of such activities are climate models results, which reflect current and future state of climate and its dynamics of change. Formulas of relations between analysed component and meteorological and/or climatological parameters, derived from the observed data, are than applied on future climate results. In this way, risk and vulnerability assessments are complemented with future climate data, and followed by evaluation and prioritization of mitigation/adaptation measures. The main tasks required from the scientific community, which promotes use of high resolution multi-model and multi-scenario data (statistically corrected and verified on the past case studies), are constant improvement of the information quality and further development of relation-formulas in order to enable assessments of wider spectra of weather/climate dependent components.

Keywords: climate change, climate modelling, sustainable development

CONCEALED CHANGES IN WAVES AND WINDS THAT MAY LEAD TO AN ECOLOGICAL DEADZONE OF SHELF SEAS

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Properties of surface waves, wave-induced transport and extreme water levels serve as naturally integrated measures of changes to the driving forces of seas and oceans. Records of some of the world's longest time series of visual wave observations in 1946-2014 in the eastern Baltic Sea reveal a substantial decrease in the wave heights until about 1970 and considerable decadal variations occurred since then.
The simulated wave-driven net sediment transport along the eastern coast of this sea reveals a major alteration at the end of the 1980s. This change is associated with an abrupt turn of the geostrophic air-flow over the southern Baltic Sea by about 40° in 1987-1988.
Simultaneously, the extreme water levels in most of the Baltic Sea basin have increased at an average rate of ~4 *mm/yr*, that is, much faster than the global sea level rise. The increase rates reach 10 *mm/yr* on the eastern shores of the sea. The spatial patterns of changes in water level extremes and patterns of changes in the average offshore wave heights signal a rotation of strong wind directions rather than an increase in the wind speed in the entire basin.
While the alterations of wave properties and a rapid increase in the water level maxima mostly lead to moderate economic losses, the impact of the rotation of large-scale air-flow may serve as an alternative explanation for a radical decrease in the frequency and magnitude of major inflows of saltier oxygen-rich water into the Baltic Sea since the mid-1980s. This decrease is a specific feature of climate change in the northern Europe that threatens the entire ecosystem of the Baltic Sea and its services and is far beyond the reach of technologies used for the adaptation to the climate change.

Keywords: climate change, wind waves, water level

TRACING TOXIC FLOOD EVENTS IN SEDIMENTARY ARCHIVES - THE POTENTIAL OF ORGANIC INDICATORS

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Recurring and devastating coastal hazards such as storms, river floods and tsunamis are unpreventable and immanent in times of climate change and rising sea levels. However, science-based and sustainable mitigation measures can prevent immense destruction and protect lives in case of an event. Therefore, new methods need to be developed to gain more information on the mechanisms, deposits and environmental impact of the diverse toxic flood event types on individual coastlines. Here, not only recent events but also information from historical floods as deposited in sedimentary archives can be used to learn from the past.
We present insights from a new organic-geochemical approach to investigate such deposits. A variety of natural and anthropogenic organic markers such as polycyclic aromatic hydrocarbons, pesticides and other anthropogenic markers have been used showing significant concentration increases and a broader variety of imported compounds in event deposits. The particular dimension of event related pollution, however, is depending on other factors, such as the grain size distribution, the permeability and the content of organic matter. Therefore, multi-proxy analyses including standard methods extended by new geochemical markers are necessary. Multi-proxy, high-resolution studies can be used to expand our current knowledge of maximum inundation distances, distribution patterns (by mapping) or pollution sources (by their high source specificity). The better the understanding of past events by the application of diverse methods, the better the hazard assessment and preparedness of an endangered coastal area.

Keywords: coastal hazard, toxic floods, anthropogenic markers, organic geochemistry, tsunami

SESSION: Smart cities, infrastructure and energy - Technical sciences outlook on sustainability issues

Sub-session: Advanced materials
Chairpersons: Srećko Stopić (DEU), Snežana Bošković (SRB)
Presenters:

Goran Vladisavljević	Carbon capture by solid adsorbents
Svetlana Dmitrović	Spider silk as a sustainable material for development novel functional biocomposites
Srećko Stopić	Carbonisation of olivine under high pressure in an autoclave
Dejan Zagorac	Energy landscapes and structure prediction of green materials: influence on sustainable development and climate change
Vladimir Srdić	Advanced materials in reduction of climate change
Branko Matović	Sustainable development and climate change: synthesis nanometric materials using the Ouzo effect for immobilization radionuclides

Sub-session: Energy efficiency and sustainability
Chairpersons: Attila Imre (HUN), Dragi Antonijević (SRB)
Presenters:

Jean-Pierre Djukic	The chemical network approach of multistep synthesis, an „Holly Grail“ of sustainable development: Challenges and examples
Branimir Jovančićević	Oil - useful fossil fuel, but also the cause of climate change
Franz Winter	New simulation tool for the optimization and projection of a city’s waste incineration

Silviya Boycheva	Adaptation of fossil-fuel thermal power plants to meet the challenges of the climate change: A review of the technological platforms for low-carbon emission
Attila Imre	Improving the efficiency for low-temperature thermodynamic cycles used for the utilization of geothermal and waste-heat
Ivana Ivančev Tumbas	Fate of pharmaceuticals and personal care products in water treatment - Case study on caffeine and benzophenones
Dragi Antonijević	Energy efficiency and sustainability of biofibres-based thermal insulation
Milica Perić	Implementation of the life cycle assessment (LCA) methodology for the promotion of renewable energy sources, climate change mitigation and pollution prevention

Sub-session: Robotics and electric vehicles and sustainability issues
Chairpersons: Zlatan Stojković (SRB), Gojko Joksimović (MNE)
Presenters:

Paul Nicolae Borza	Hybrid electric energy storage systems and their application toward energetic global optimized solutions
Aleksandar Rodić	Advanced robotic technologies in risk prevention and environmental protection for the sustainable regional development of the region
Atanas Kočov	MCDM for defining indicators for implementing electric vehicles in Western Balkan countries (WBC's) for environmental sustainability
Zlatan Stojković	Sustainable development of the power system - The impact of artificial intelligence
Tünde Varga	Use of digitally designed books in the training of automotive specialists

Sub-session: Challenges of sustainable energy and climate change
Chairpersons: Neven Duić (HRV), Ana Kostov (SRB)
Presenters:

Dragana Đorđević	Energy production in Serbia: Environmental problems and challenges for the future
Neven Duić	Sustainable development and energy transition

Uroš Tomić	Lifestyle-specific differences in energy consumption behaviour of private households
Sohail Ahmad	Spatially contextualized analysis of energy use for commuting in India
Ilija Batas Bjelić	The mitigation of the economic impacts from the fuel price shocks: Serbian case
Nebojša Manić	The multi-component kinetic modelling of biomass thermochemical conversion process
Dóra Szalay	Influence of climate change on lignocellulose biofuel production depending on legislation

Sub-session: Sustainable and climate smart urban planning
Chairpersons: Christoph Schneider (DEU), Nataša Tomić Petrović (SRB)
Presenters:

Christoph Schneider	Urban climate under change: challenges for public health, infrastructure and eco-system services in the city
Jörg Musiolik	Speeding up the sustainable transition of cities? Exploring systemic changes in the smart cities of Vienna, Amsterdam and Santander
Nataša Tomić-Petrović	Sustainable transport and the right to healthy environment as the challenge in the time of climate changes
Nevena Vasiljević	From the landscape point of view: policy, planning research and education about urban landscape sustainability and resilience
Tijana Crnčević	Sustainable planning in the context of climate change: Examples in Serbia
Marija Lalošević	Implementation of green roofs in Belgrade as a part of sustainable development and climate change mitigation
Ioannis Katsoyiannis	Water reuse as a secure pathway to tackle water scarcity

CARBON CAPTURE BY SOLID ADSORBENTS

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Increased CO_2 emissions from fossil fuel combustion has led to global warming, which caused adverse ecological effects. As a result, strict regulations of CO_2 emissions have been imposed and increasing attention has been paid to cost-effective technologies for carbon capture and storage (CCS). Post combustion capture (PCC) is the most feasible solution for CO_2 capture, as it can easily be fitted to existing power plants without any major modification. Carbon capture using liquid absorbents such as monoethanolamine (MEA) is the most established PCC process, but requires high energy consumption for MEA regeneration after CO_2 absorption. Furthermore, alkyl amines are corrosive and toxic liquids that can decompose or evaporate, which render them environmentally unsafe. Porous solid adsorbents such as silica, activated carbons, and zeolites are promising alternatives to liquid amines for CO_2 capture, due to lower heat of adsorption, nonvolatility and higher chemical and thermal stability. The performed life cycle assessment (LCA) revealed a low environmental impact of solid sorbents compared to conventional materials.

Keywords: CO_2 capture, life cycle assessment, solid CO_2 sorbents, post combustion capture

SPIDER SILK AS A SUSTAINABLE MATERIAL FOR DEVELOPMENT NOVEL FUNCTIONAL BIOCOMPOSITES

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The colossal development of technology nowadays is generating a growing problem regarding environmental pollution. Additionally, conventional polymers that are used in technological and biomedical application are non-biodegradable and with limited mechanical properties. A new direction of thinking in science is turned to development of sustainable materials with low ecological footprint, and nature-inspired materials are the logical solution. Spider silk (SS) is a natural polymer with extraordinary mechanical properties that is biocompatible and biodegradable, and it has been used as a template for synthesis of three novel biomaterials: SS-calcite composite, SS coated with europium doped ceria nanoparticles, and SS coated with superparamagnetic γ-Fe_2O_3 nanoparticles. SS-calcite composite was synthesized by simple method using biomineralization approach and pure rhombic-shaped calcite crystals homogeneously dispersed trough 3D spider mesh were obtained. SS coated with Eu doped nanoceria was easily obtained by time and cost effective precipitation synthesis procedure. The SS fibers were homogeneously coated with Eu doped CeO_2 nanoparticles with average nanoparticle size of 3 *nm* due to a great affinity of ceria to oxygen rich functional groups of SS proteins. Eu3+ was introduced as an activator ion in ceria crystal lattice and luminescent properties of the obtained composite were investigated by excitation spectra. SS coated with superparamagnetic γ-Fe_2O_3 nanoparticles was obtained with similar precipitation technique. Maghemite nanoparticles were uniformly distributed on the surface of SS fibers and magnetic properties of obtained composite were described. These three novel composites open new possibilities for spider silk based materials in various fields, especially for biomedical application.

Keywords: spider silk, calcite, ceria, europium, maghemite

CARBONISATION OF OLIVINE UNDER HIGH PRESSURE IN AN AUTOCLAVE

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Nowadays huge amounts of the greenhouse gas (GHG) carbon dioxide are produced due to anthropogenic emissions. These emissions play a big role in global warming. Their impact on climate change to both the atmosphere and our lives has already been urged and it is nowadays well known (IPCC2005). During the previous decades, concentration of GHG, especially CO_2 in the atmosphere was continuously elevating. An urgent action to control the GHG emission and its consequences is needed. Carbon capture and storage (CCS) or utilization (CCU) technologies are a promising method to tackle this issue getting more and more attention by the researcher. By carbonization of CO_2 in mineral phases, CO_2 react with magnesium or calcium oxide to produce carbonates (mainly calcite and magnesite), a stable compound in geological timeframes (over millions of years). The subject of this work is an indirect carbonization (in water) of an olivine (Mg_2SiO_4) under elevated temperature in a high pressure autoclave. The influence of different reaction parameters such as fraction size, solid/liquid ratio and content of MgO in ore were studied. An injection of some additives such as sodium hydrogen carbonate, oxalic acid and ascorbic acid in water solution had a positive influence on the formation of magnesium carbonate at high pressure (117 *bar*) and temperature (175°C). The experiments showed a capability to bind more than 300 *g* of CO_2 per *kg* of input material. The process generates marketable products, a carbonate and an amorphous silica, which can be used in the concrete industry or many other applications.

Keywords: Climatic change, Carbonization, olivine, high pressure, concrete

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ENERGY LANDSCAPES AND STRUCTURE PREDICTION OF GREEN MATERIALS: INFLUENCE ON SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

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One of the greatest challenges of the modern civilization, if not the greatest, is progressive climate change, closely connected to the fast technological and industrial development of mankind. Modern way of living enforce new technologies, where, on one hand, scientist and engineers exploit large number of advanced materials, and on the other hand, have strong impact on environment and climate. In order to help achieve sustainable development, protect environment and slow down the effect of the climate changes, our laboratory for theoretical investigation of materials (L-TIM) has invented numerous green materials. They have been investigated using energy landscape and structure prediction methods, where known or unknown industrial and technological material has been modified on atomic and molecular scale. In this way, we are able to produce green materials with improved properties compared to conventional materials which are not only ecological, but economical, having important role in the climate change and sustainable development.

Keywords: green materials, energy landscape, structure prediction, climate

ADVANCED MATERIALS IN REDUCTION OF CLIMATE CHANGES

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In recent years the increasing energy consumption has become the main problem associated with climate changes. Thus, different ways to harvest ambient energies have been developed such as solar energy, wind energy, flowing water, waste heat, electromagnetic waves, etc. Among them, mechanical vibration energy harvesting has become very important. It is mostly based on piezoelectric materials, which can directly convert applied mechanical energy into electric energy. Piezoelectric devices, fabricated by advanced techniques, have simple architectures and can be directly integrated into different micro-electro-mechanical-systems (MEMS) with estimated power in the μW-mW range and with different amplitudes and frequencies. These energy harvesting devices could replace batteries or some other complex power microsystems with potential applications range from health monitoring to automotive sensing. The most common piezoelectric material is $Pb(Z_{r1-x}T_{ix})O_3$ (PZT) due to its excellent dielectric and piezoelectric properties. Some relaxor-ferroelectrics, such as $Pb(Mg_{1/3}Nb_{2/3})O_3$–$PbTiO_3$ or $Pb(Zn_{1/3}Nb_{2/3})O_3$–$PbTiO_3$, have also attracted considerable research attentions. However, new developments in the field of lead-free piezoelectric ceramic materials have been initiated, as in 2003 the European Union included PZT in its legislature to be substituted as a hazardous substance by safe materials. Thus, very popular $BaTiO_3$ with tetragonal perovskite structure at room temperature and large piezoelectricity has considered for energy harvesting, but narrow working temperature range (up to 0-120°C) limited its application. Another important piezoelectric material is $Bi_{0.5}Na_{0.5}TiO_3$ and has been considered as one of the most promising candidate materials for the replacement of Pb-based ceramics. It has high Curie temperature (320°C) and interesting piezoelectric and ferroelectric properties. Our recent investigations have been focused on perovskite lead-free materials based on doped $BaTiO_3$ and $Bi_{0.5}Na_{0.5}TiO_3$ ceramics. Different fabrication techniques have been used and most of the research activities have been directed to preparation of thin films and complex structures.

Keywords:

SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE: SYNTHESIS NANOMETRIC MATERIALS UCING THE OUZO EFFECT FOR IMMOBILIZATION RADIONUCLIDES

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Climate change, more commonly known as global warming, is caused by the emission of heat trapping gases produced by vehicles, power plants, industrial processes and deforestation. Nuclear power is one of the lowest emitters of greenhouse gases available. Many still argue that nuclear power is an answer to climate change, forgetting that they are passing the waste buck to future generations. Radioactive ^{90}Sr is one of the important fission products with a long half-life and high fission yield. It is considered as one of the most dangerous products of nuclear fission for human beings due to its a half-life of many years. ^{90}Sr could remain harmful even after their conditioning and disposal into a geological repository. In the treatment of liquid radioactive wastes, such as ^{90}Sr, are major radionuclides can be selectively removed and immobilized into durable host materials by in an appropriate safe process. In this work immobilization of Sr long-lived fission product (LLFP) was evaluated using stable isotope instead of radioactive isotope. Nanoemulsion technique was applied for synthesis calcium - strontium hydroxyapatite as the inert matrix for transmutation of LLFP at room temperature. X-ray powder diffraction analysis accompanied with Rietveld refinement reviled that synthesized powder were single-phase hydroxyapatite and they displaying solid solutions over the full range of relative concentrations. Fourier transform infrared (FTIR) spectroscopy showed that the obtained phases belong to A-type substitution. The carbonate amount substituting the hydroxide group in the synthesized apatite was estimated from the corresponding CO_2 weight loss in the range 600-1100°C and empirical formula were calculated. These results were confirmed by the Rietveld refinement analysis. Scanning electron microscopy analysis reveals that the synthesized hydroxyapatite particles were spherical in shape and that their sizes were in the nanometer range. Nanoemulsion strategy procedure provides a simple pathway for immobilization of Sr isotopes as a single-phase Sr hydroxyapatite at room temperature.

Keywords: nuclear power, climate change, isotopes, immobilization

THE CHEMICAL NETWORK APPROACH OF MULTISTEP SYNTHESIS, AN „HOLLY GRAIL“ OF SUSTAINABLE DEVELOPMENT: CHALLENGES AND EXAMPLES

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The H2020 framework of the European Union has defined a general roadmap for a redefinition of the processing design aiming not only at progressively discarding the recourse to fossil ressources but also at rationalizing and optimizing production processes from the standpoint of natural ressources and ecological impact. In a 2015 document[1], the Netherlands Institute for catalysis Research (NIOK) provided a comprehensive digest of the main tasks and objectives to be met for the 10 years to come: “understanding complexity in catalytic systems”, “theory and modeling of realistic catalytic systems”, “chemoselectivity” and “development of sophisticated characterization tools”. This communication will outline through worked examples[2] the key role that chemical networks[3] may play in designing a new approach of catalysis first based on a reasoned mapping of the potentials of lineages of catalysts and in their application to actual so-called one pot multistep syntheses.

Keywords: tandem catalysis, organometallics, networks

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OIL - USEFUL FOSSIL FUEL, BUT ALSO THE CAUSE OF CLIMATE CHANGE

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From the beginning of the twentieth century, the main fuel for operation of internal combustion engines is the oil, ie. the products of its refinery processes. For more than a century, oil has been considered as the most important fossil fuel and material of general importance. From the very beginning, the processes of production of crude oil (drilling of oil wells), the ways of its transportation to refineries, refining processes (rectification, cracking, reforming, adsorption, desulfonation, solvent extraction, etc.), as well as the modes of transport of processing products have been perfected. The same applies to machines, and all engines that use oil as a fuel. Nevertheless, accidents in which oil and its refinery products reach the environment are very common. Therefore, organic compounds from petroleum are considered as widely distributed pollutants of soil, ground and surface water and atomosphere. It can be said that the study of their fate in the environment has become an important separate scientific discipline. In this paper we will talk about the ways in which oil pollutants reach the environment. Special attention will be dedicated to those polluting substances from the oil which come into the atmosphere, and ways that affect the disturbance of ecochemical balance in terms of increasing its temperature, ie. its global warming.

Keywords: crude oil, hydrocarbons, pollutants, atmosphere, global warming

NEW SIMULATION TOOL FOR THE OPTIMIZATION AND PROJECTION OF A CITY'S WASTE INCINERATION

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If waste can neither be avoided nor recycled, waste incineration is a favorable treatment option to use the energy of the waste, if performed with state-of-the-art flue gas cleaning technologies. The energy can be used for district heating and/or electricity production. Apart from utilization of energy, the mass and volume of the solid residues are reduced by about 80% and landfilling therefore consumes less space. In addition, waste incineration can be viewed as a method to concentrate and separate different fractions of the waste such as metals, and urban mining becomes an interesting option. However, it is important to optimize waste incineration of a city, community or region, and this is done before a new waste incinerator is built. With the newly developed simulation tool (SimWasteCity), dynamic scenarios involving several incineration plants with different incineration technologies, such as grate furnaces, fluidized beds and rotary kilns, in cities of different population densities can be predicted. Using this tool, it is possible to forecast the amount and composition of the different fractions and residues that are formed during the waste incineration process, such as bottom ash, fly ash, ferrous and non-ferrous metals, filter cake and gypsum. In addition, it is possible to predict the amount of heat and electricity produced, the emissions in the flue gas and the amount of metals recovered by urban mining. The tool is highly flexible and allows the user to change various configurations, such as flue gas cleaning and incineration technologies.

Keywords: waste incineration, simulation, projection, urban mining

IMPROVING THE EFFICIENCY FOR LOW-TEMPERATURE THERMODYNAMIC CYCLES USED FOR THE UTILIZATION OF GEOTHERMAL AND WASTE-HEAT

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The increasing need of energy combined with the desire to obtain it in a less polluting way forces researchers to find better ways for electricity production from existing sources. One of the potential ways is the utilization of low-temperature heat sources, including geothermal and waste heat. Geothermal one is especially interesting, because the Pannonian Basin (southern Hungary and northern Serbia) is one of the best regions for geothermal sources with relatively high (above or around 90°C) temperature. There are two major problems with low-temperature heat sources; first, traditional energy conversion cycles using high pressure steam cannot be used to utilize them and second, the small difference between the temperature of heat source and environment limits efficiency. To solve the first problem, Organic Rankine Cycle (ORC) can be used replacing water with an organic working fluid with low boiling point. To solve the second problem, optimal working fluid and process layout should be found for each source. In our project, a working fluid database has been created for pure fluid ORCs. For better applicability of the database and for easier selection of working fluids, we introduced a novel classification of fluids using characteristic points of the temperature – specific entropy diagrams. Using our classification, one can pick a set of desirable “isentropic” working fluids for a given heat source and select the most appropriate of them by using other, non-thermodynamic criteria.

Keywords: organic Rankine cycle, geothermal heat, working fluid

FATE OF PHARMACEUTICALS AND PERSONAL CARE PRODUCTS IN WATER TREATMENT - CASE STUDY ON CAFFEINE AND BENZOPHENONES

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Pharmaceuticals and personal care products are large group of emerging environmental contaminants. Nearly 4000 active pharmaceutical ingredients are being used worldwide. Global occurrence was confirmed for more than 600 substances in recent water monitoring initiatives. Wastewater has been indicated as a dominant emission pathway. In addition to human and veterinary drugs, huge diversity of chemicals is used for improvement of daily life (e.g. detergents and cosmetics ingredients). They are found in wastewater, surface and groundwater, and some even in the tap water. The presentation gives an overview of water treatments efficiency for their removal. Special focus will be on our recent results for widely used caffeine (CF) and two UV filters, benzophenone (BP) and benzophenone-3 (BP-3). Biodegradation in Danube river water was confirmed to be rapid. Various non-oxidative advanced treatments were tested with wastewater treatment plant effluent and Danube river water: adsorption on powdered activated carbon, coagulation, combination of those processes, and ultrafiltration in combination with either activated carbon or coagulation. Experiments were performed with spiked water samples at concentration levels of 1.5 $\mu g/L$ (effluent) and 30 $\mu g/L$ (river water). It was found that the removal efficiency (3-99%) depends on the substance, water matrix, the process applied and the type of the process material used. The lowest efficiency was found for caffeine. Environmentally relevant concentrations were lower. The highest detected concentrations in effluent were 0.15 $\mu g/L$ (BP), 0.42 $\mu g/L$ (BP-3) and 12 $\mu g/L$ (CF). In river water they were 0.23 $\mu g/L$, 0.62 $\mu g/L$ and 0.70 $\mu g/L$, respectively.

Keywords: personal care products, water treatment, caffeine, benzophenone

ADAPTATION OF FOSSIL-FUEL THERMAL POWER PLANTS TO MEET THE CHALLENGES OF THE CLIMATE CHANGE: A REVIEW OF THE TECHNOLOGICAL PLATFORMS FOR LOW-CARBON EMISSIONS

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Carbon dioxide (CO_2) is considered as the main green-house gas because of its enormous emissions into the atmosphere causing the global warming effect. The main CO_2 emitters are the thermal power plants (TPPs) supplied by fossil fuels. Recently, law regulation limits and the quotas market are implemented to control the carbon emissions from the energy branch. In the very near, carbon capture and sequestration technologies (CCS) will be the main option to meet the straitening ecological requirements. Because of the climate change disasters, CCS technologies are developed extremely fast in the last decade. The mitigation of carbon emissions from TPPs is based on CO_2 separation and concentration in a pure of other flue gas components flow, and its subsequent compression below the triple point to liquifying. Three main technological directions in CCS are outlined, as follows: post-combustion capture (PCC), pre-combustion capture (integrated gasification combined cycle, IGCC), and modified combustion (oxy-fuel technology). PCC approach is compatible with the existed TPPs, while the implementation of the other two technological approaches requires of new generation plants. The concept of PCC is based on the selective separation of CO_2 from the flue gases and consecutive desorption in a concentrated flow. The CO_2 chemisorption by amines is the most studied technology, however it possesses serious disadvantages derived from the toxicity of the amines and the high energy consumption for desorption. The main challenges of the PCC technologies are the obtaining of low-cost solids with well-developed surface for implementation of physical adsorption.

Keywords: low-carbon technologies, physisorption, post combustion capture

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ENERGY EFFICIENCY AND SUSTAINABILITY OF BIOFIBRES-BASED THERMAL INSULATION

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Energy efficiency of residential and commercial buildings is acutely important as this sector is responsible for approximately 40% of overall energy consumption and around 35% of CO_2 emissions (in the European Union). The construction sector has intense environmental footprint due to exploitation of non-renewable material and energy resources, land use and generation of waste materials during construction and demolition. It is therefore important to develop sustainable building structures, practices and materials with minimal resources and energy use. Utilization of energy efficient, sustainable and resource-saving building materials is of particular importance. The study is carried out to investigate possibilities and evaluate effects of application of biofibres-based structures as non-constructive and/or insulating materials in current building practice. Focus is on natural, dominantly cellulose, fibres, traditionally used in the past (hemp, reed, straw, flax, rice hulls, cotton stalks, sunflower, cattail, bagasse, etc) as well as on some promising grass/reed cultures, such as Miscanthus x Giganteus. The experimental examinations of thermal and mechanical properties decisive for the performance of thermal insulation have been undertaken. Expectedly, the thermal conductivity, as the material characteristic primarily responsible for Operational Energy Consumption, has been found mostly worse than in commonly used, mass produced, thermal insulation materials such as expanded or extruded polystyrene, glass or mineral wool, etc. On the other hand, conclusions of Life Cycle Analysis and examination of Embodied Energy advocates the utilization of designated natural biofibres-based thermal insulation as more sustainable and in the long run (Cradle to Grave) energy efficient alternative to the conventional insulation materials.

Keywords: energy efficiency, sustainability, insulation, material properties, biofibres

IMPLEMENTATION OF THE LIFE CYCLE ASSESSMENT (LCA) METHODOLOGY FOR THE PROMOTION OF RENEWABLE ENERGY SOURCES, CLIMATE CHANGE MITIGATION AND POLLUTION PREVENTION

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Human population growth and prosperity are continuously causing resources depletion, climate change and the environmental pollution. This entails the use of RES as mandatory. The most used tool for helping decision-makers favour the use of RES over the fossil fuels is the Life Cycle Assessment (LCA). In Serbia, use of LCA for the RES assessment together with the use of RES in general is negligible. With this regard, two LCA studies/scenarios analysing the environmental suitability of bioenergy crop Miscanthus giganteus as a RES in Serbian conditions are presented in this study: 1) production and use of Miscanthus briquettes for household heating and 2) production of pyrolytic diesel. Both Miscanthus scenarios were compared to corresponding fossil fuel scenarios, i.e., coal, firewood and diesel. The results reveal pollutant emissions caused by diesel fuel combustion in outdated agricultural machinery and high share of fossil fuels used for electricity production as a most burdensome activities in Miscanthus briquettes life cycle. However, compared to wood and coal, Miscanthus briquettes scenario is a more environmental friendly option for household heating, due to much lower emissions of pollutants. In the second scenario comparison, production of pyrolytic diesel from Miscanthus emits less carbon dioxide and methane only in a case when hydrogen used for the fuel upgrading and stabilization is externally produced, but have higher emissions of particulate matter (60%), sulphur oxides (30%) and nitrous oxides (56%) due to higher total power consumption. With this regard, the establishment of Miscanthus giganteus bioenergy plantations in Serbia is highly recommended.

Keywords: life cycle assessment, renewable energy sources, miscanthus, briquettes, pyrolytic diesel

SUSTAINABLE DEVELOPMENT AND ENERGY TRANSITION

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Transition to decarbonised energy systems is becoming more attractive with fall of investment costs of renewables and volatile prices and political insecurity of fossil fuels. The renewable energy resources are bountiful, especially wind and solar, while integrating them into current energy systems is proving to be a challenge. The limit of cheap and easy integration for wind is 20% of yearly electricity generation, combined with solar may reach 30%, while still pending on improving transmission capacities and flexibilization of conventional power plants. Going any further asks for implementation of really free energy markets (involving day ahead, intraday and various reserve and ancillary services markets, as well as coupling with neighbouring markets through PCR mechanism), demand response, coupling of wholesale and retail energy prices, and it involves integration between electricity, heat, water and transport systems. The cheapest and simplest way of increasing further the penetration of renewables is integrating power and heating/cooling systems through the use of district heating and cooling (which may be centrally controlled and may have significant heat storage capacity), since power to heat technologies are excellent for demand response. Electrification of personal car transport allows not only for huge increase of energy efficiency, but also, electric cars due to low daily use may be excellent for demand response and even for storage potential, through vehicle to grid technology. That will allow reaching renewable share of 80% in energy system, but the remaining 20%, part of transport and industrial processes that cannot be electrified, and backup of power system in times when neither wind nor solar are available, may be more an uphill battle without technology breakthrough. Biomass can probably cover half of that demand, and carbon dioxide from biomass combustion or atmosphere may be hydrogenised using hydrogen produced from excess renewables, resulting in electric fuels, like e-methane, e-methanol and e-DME.

Keywords: renewable energy, power to heat, demand response, electromobility, carbon capture and ulitisation

LIFESTYLE-SPECIFIC DIFFERENCES IN ENERGY CONSUMPTION BEHAVIOUR OF PRIVATE HOUSEHOLDS

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Many countries, especially in Europe, committed to the decarbonisation of their societies implying both “greening” their energy mix and reducing their energy consumption. Thereby, private households represent an important intervention point, since they account worldwide for around 30% of total energy consumption. It is increasingly recognised that energy-saving interventions targeting private households have to be tailored in order to achieve the desired effect. Tailoring in turn requires an appropriate segmentation concept. This study examines the appropriateness of a generalist, theory driven lifestyle typology (Otte’s lifestyle typology) as a segmentation concept for tailoring energy-saving interventions. This is done on a large Swiss dataset (around 5000 households) for three very different energy-related behaviours (showering frequency, endowment with information and entertainment electronics and flying frequency) both within a bivariate (ANOVA, Kruskal Wallis) and multivariate analysis (linear regression with lifestyle dummies and the most important control variables). The results show that there are significant lifestyle-specific differences regarding all three energy-related behaviours suggesting that generalist, theory-driven lifestyle typologies, such as the Otte’s one, could be an interesting segmentation concept for tailoring energy-saving interventions. This is particularly true for low-cost behaviours and behaviours related to construction logic of the typology.

Keywords: energy-saving, private households, lifestyles, tailored interventions

SPATIALLY CONTEXTUALIZED ANALYSIS OF ENERGY USE FOR COMMUTING IN INDIA

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Effects of overmotorization, including GHG emissions, air pollution, and congestion deteriorate local and global environment significantly and thus pose a threat for sustainable development. In this context, there is a growing interest in understanding the role of built and socioeconomic environments in commuting emissions. Existing empirical evidence examining the association between built and socioeconomic environments and commuting emissions are limited and mostly stationary in nature. This study contributes to the literature by developing a nested typology of commuting emissions and Geographically Weighted Regression (GWR) model for capturing the impact of built and socioeconomic environments on commuting emissions, demonstrating its benefits over simple methods. Taking India's recent census data on commuting (home to/from work) with other census variables as starting point, empirical results confirm that commuting emissions are positively associated with spatial pattern of urbanization, commuting distance, and negatively associated with density, after controlling socioeconomic status. Moreover, typology reveals that districts with high-income, highly urbanized, with higher 4-wheeler mode shares have higher commuting emissions. Similar type of districts (high-income and high urbanization level) with lesser dominant of 4-wheelers can cut over half of the emissions (–53 *kg* CO_2 per cap/year). Further the GWR model demonstrates that the influences of these explanatory variables, particularly urbanization and travelled distance, on commuting emissions do vary over space. Our results demonstrate that differential policy measures and interventions in spatial context are required, rather than one-size-fits-all approach, for promoting low-carbon commuting in India.

Keywords: commuting emissions; spatial analyses; India; geographically weighted regressions

THE MULTI-COMPONENT KINETIC MODELLING OF BIOMASS THERMOCHEMICAL CONVERSION PROCESS

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Biomass is widely available RES with potential for conversion to energy through thermochemical processes such as pyrolysis, gasification, combustion or torrefaction. Thermal decomposition studies for biomass materials using simultaneous thermal analysis (STA), over a wide temperature range (from RT up to 900°C), at different heating rates and under controlled atmosphere could provide reliable data for further conversion process improvement. In order to facilitate this progress, an advanced multi-component kinetic numerical model based on STA experimental results is developed and validated. The presented method was utilized for determination of effective activation energies, pre-exponential factors and the fractional contribution of the structural pseudo-components of biomass (cellulose, hemicellulose and lignin). A novel approach is introduced in order to determine the content of actual pseudo-components of tested biomass samples that are included in its composition. Comparative study of obtained kinetic results strongly indicated that the multi-component kinetic modelling method could be employed to predict the experimental biomass structural composition and thermal degradation issues.

Keywords: biomass, pyrolysis, STA, multi-component kinetic model, pseudo-component

ENERGY PRODUCTION IN SERBIA: ENVIRONMENTAL PROBLEMS AND CHALLENGES FOR THE FUTURE

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Over 70% of the electricity in Serbia comes from Coal Fired Power Plants (CFPPs). There are six CFPPs which use low caloric coal - lignite as a fuel, located in the vicinity of the main lignite deposits of Kolubara and Kostolac basins. Coal combustion is a significant emission source of CO_2 that is green house gas (GHG). In addition lignite from these deposits contains various trace elements harmful to human health and the environment, among which are As, Be, Co, Cr, Mo, Mn, Ni, Pb, Se, Sb, V, Hg including radioactive elements U, Th, Ra and Rn. About 32,000,000 *t/year* of lignite are burning at combustion temperature of around 2000°C and higher and generate about 6,000,000 *t/year* of ash of which significant fraction is fly ash. Diameters of emitted fly ash particles correspond to respirable particles fraction of atmospheric aerosols (PM_{10}) enriched by many toxic elements including those emitted in the gaseous phase such as Hg, Rn and partly As. Elements emitted as a vapour are more dangerous than those in particles. Significant threats to surface and underground water pollution come from lignite ash in transport processes to ash disposals since the largest fraction of elements was associated with the mobile and bioavailable forms. Serbia has many other possibilities for clean and carbon zero energy production like production of biogas from biomass with which Serbia is one of the richest countries, using solar, geothermal and wind energy, etc. The most important approach must be towards energy efficiency in all sectors.

Keywords: lignite, harmful elements, clean energy

THE MITIGATION OF THE ECONOMIC IMPACTS FROM THE FUEL PRICE SHOCKS: SERBIAN CASE

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The exposure to the risks of the crude oil price volatility for an net-importer country such as Serbia are neglected in its energy policy which has to be first and most important level of structural response to this inherent feature. The shocks in the past, and the current challenges, are not intended to be solved in long-term and sustainable way. The energy transition in Serbia have to be based on locally available and climate friendly energy sources, energy efficiency measures, new technologies, but not only in the area of fiscal policy and taxation of fuels. Having in mind the importance of fuels on the expense/revenue sides of the national budget, this paper will analyze two energy policy scenarios in two fuel price outlooks regarding impacts to the national budget, and further economic development. The economic impacts of the fuel prices volatility will be quantified: by sector of the transport for agriculture, commercial and household sectors, to determine their vulnerability to the shocks. The elasticity of the sectors to respond to these impacts will be qualified. Then, the possible pathways of an economically, and socio-environmental effective distribution of the impacts within these sectors will be suggested to the decision makers. Finally, the potential of long term mitigation of these impacts by the terms of an energy climate policy and energy transition scenarios will be discussed.

Keywords: energy transition, national budget, taxation, fuel prices, sustainable energy

INFLUENCE OF CLIMATE CHANGE ON LIGNOCELLULOSE BIOFUEL PRODUCTION DEPENDING ON LEGISLATION

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For biofuel and food production the impacts of climate change must be increasingly taken into account. Stringent regulation and increasing fuel consumption are the major challenge for the sustainable biofuel production. The 2009/28/EC provides 10% share of renewable energy in the total energy use of transport by 2020, binding for all EU Member States (RED). The question is how can we apply the directive for countries with different agricultural conditions? The 2015/1513/EC (iLUC) limits the share of biofuels from crops grown on agricultural land to 7% by 2020. RED II is phasing down food and feed-based biofuels by lowering the cap from 7% in 2021 to 3.8% in 2030. So, our prediction are made until 2030, based on the fuel usage trends. Until 2025, the size of agricultural land legally utilized in accordance with the legislation will be higher than currently. Between 2025 and 2030 a slow decline is expected. If we count the effects of climate change, the size of demanded area may multiply increase in drought years. Comparison was made with the EU countries, whereby utilized agricultural land was taken into account in proportion to the total agricultural area of the EU. Total fuel consumption was also reported in the proportion of total EU fuel consumption. The results show that there are countries where the agricultural area is limited compared to other countries for the production of authorized quantities of cereal-based biofuels, see the Netherlands. However, in these countries has been launched towards industrial production of lignocellulose biofuels.

Keywords: agricultural food production, biofuel production, climate protection, legislation, fuel crops

HYBRID ELECTRIC ENERGY STORAGE SYSTEMS AND THEIR APPLICATION TOWARD ENERGETIC GLOBAL OPTIMIZED SOLUTIONS

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Nowadays the electric energy storage systems (EESS) play an important role in developing of environmental friendly applications. From one side these applications avoid the pollution and from the other side save significantly energetic resources. Unfortunately, the variety of electrochemical storage cells, their parameters and constraints, their behaviors made difficult to apply them. There are no “ideal” storage cells. The behavior of storage cells, devices and systems is very complex and the interdependencies between the storage system parameters and the applications requirements are deeply related. The paper made an updated review of the principal storage cell and their features. Also, are illustrated the intimate dependencies between the structural design of electric energy storage systems and provided features for stationary and also for mobile applications. An important feature of EESS, the life span, must be considered during design process and also must be assess in order to proof the system’s reliability and performances. For an e-bike, in condition of standard traffic constraints is proposed a solution based on a hybrid energy storage system (HESS) that can significantly improve the overall performances and also put in evidence the role played by control functions in order to reach highly reliability and span life. The testing system is described. Also, we propose a methodology that permits calculation of a “distance” between optimized and current EESS solution allowing in standard or specific traffic conditions optimization of control functions for the e-bike.

Keywords: storage, energy, supercapacitors, batteries, intelligence

ADVANCED ROBOTIC TECHNOLOGIES IN RISK PREVENTION AND ENVIRONMENTAL PROTECTION FOR THE SUSTAINABLE REGIONAL DEVELOPMENT OF THE REGION

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The whole world and even the European continent from year to year, faced with increasing challenges and threats caused by climate change, natural disasters and industrial risks with major consequences for the economy and society. The degree of risks unfortunately are increasing despite measures taken. European countries are trying to find a proper system answers and solutions to the current risks in order to enhance global security and prevent catastrophic disasters. The answers to the aforementioned risks are generally in the field of implementation of the environmental measures to reduce industrial pollution, construction of appropriate protecting infrastructure (dams, canals, wipers) and the application of modern technologies. This presentation relates to the use of modern devices for remote control and monitoring, prediction of natural disasters and rescue activities. Environmental robotics is the branch of science which is a strong contribution to the aforementioned activities using the remotely controlled, or autonomous service robotic systems of different types. Modern robotic technology is scientific answer to the growing challenges of changed conditions of life using the latest technical and technological solutions in the field of wireless communications, remote control and navigation, information systems, sensorics, mechatronics and artificial intelligence. Robots for environmental tasks are designed to perform a variety of delicate and dangerous tasks of humans in situations when it comes to hazardous situations, or expect such events, dangerous to our environment. In this presentation we will consider some of the following robotic devices: Unamnned Ground Vehicles (UGV), Unmanned Aerial Vehicles (UAV) or Unamnned Underwater Vehicles (UUV). The above-mentioned robotic systems are used to perform environmental tasks on the ground, in the air or under water. Within the scientific presentations we will focus on the original robotic projects realized in the Robotics department, Mihajlo Pupin Institute in Belgrade. The aim of this research projects is to raise the level of the regional sustainable development and prevention of risks to the population from various natural and industrial disasters that can happen such as: fires, floods, earthquakes, accidents of industrial plants, etc.

Keywords:

MCDM FOR DEFINING INDICATORS FOR IMPLEMENTING ELECTRIC VEHICLES IN WESTERN BALKAN COUNTRIES (WBC'S) FOR ENVIRONMENTAL SUSTAINABILITY

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The dynamic development of the societies and cities is significantly based on the role of transport. That means a number of issues need to be addressed in order to reduce emission, keep traffic noise on acceptable level, increase energy efficiency and mitigate long term threats. One of the solutions is the implementation of electric and hybrid cars. This problem can be solved thanks to the sustainable mobility concept, in which transport needs are limited at the stage of planning spatial development from one side or in implementation of solutions based on electric& hybrid cars. This leads toward research for defining the indicators which would provide information to the policy makers for creating solutions for sustainable transportation and enviromental protection. One of the scientific methods used in the research conducated in 6 Western Balkna countries is the AHP methodology and multi criteria decesion making process for defining four pilars of indicators, social, economic, cultural, enviromental indicators for possible impmentation of different types of cars toward the fulfilment of the sustainability goals for the region of WBC's. WBC's as developing countries are still on the first stage in the process of defining indicators for policy making based on scientific methodology. This paper presents the scientific approach towards decision-making and policy creation for introduction of electric vehicles. The first step, identification of indicators, suitable for the electric vehicles, and developing countries region, has been taken. The paper shows a proposal for indicators on a state/region level, but also such list for personal/company need. The list of indicators is prepared based on wide and deep references analysis, and also on view of big number of experts in the region.

Keywords: sustainable development, transport, electric vehicle, indicator, environmental policy

SUSTAINABLE DEVELOPMENT OF THE POWER SYSTEM - THE IMPACT OF ARTIFICIAL INTELLIGENCE

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This paper describes a fuzzy expert system for demand side management and storage of electrical energy. Presented fuzzy expert system is used for automatic decision making about energy consumption in smart homes with photovoltaic system and battery storage. Fuzzy expert system logic favours renewable energy production and optimise energy consumption in order to increase financial gain. The inputs of the fuzzy expert system are insolation, the price of electricity and the power of controllable and uncontrollable load. Input data can be directly measured, imported from grid measurements or predicted and presented in the form of fuzzy sets. The paper clearly presents fuzzification of inputs, defining rule base and defuzzification of outputs. The outputs of the expert system are decisions, i.e. answers to the question what to do with energy production and with controllable load. The first output decides to store, sell or use produced energy. The second output is used to lower the consumer costs by controlling consumption. The third output decides how to satisfy your own consumption. The expert system is analysed for real hourly values of input variables in a single day. Results and formed fuzzy expert system can be used as good orientation for smart houses and renewable energy producers.

Keywords: demand side management, renewable energy, energy storage, smart grid, fuzzy logic

USE OF DIGITALLY DESIGNED BOOKS IN THE TRAINING OF AUTOMOTIVE SPECIALISTS

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In 2015, the European automotive industry received a major blow and since that time, the sales of diesel vehicles in Europe are decreasing. The question arises how to prevent similar trends in the industry in the future? In addition to the technical tasks, the training of specialists in the form of continuing education seminars is becoming increasingly important. The teaching of the latest legislative requirements and the most modern ways to reduce emissions and consumption can actively contribute to increasing the quality of environment and climate protection in the automotive engineering. Our primary task is to strengthen the role of books in the education - whether traditional or digital. The aforementioned two formats have many advantages and disadvantages of aesthetic, functional and methodological aspects, but their basic purpose is the same: obtaining effective knowledge and acquiring a deeper knowledge that allows us to absorb or get emotionally involved with the content, so we can easily recall it later. Exemplary examples are the information blocks and expressions that have appeared in visual communication. Taking advantage of the digital reading environment, the use of interactive charts seems almost trivial, with which we can specifically add text blocks or summarize in full visualizations. This method has already been tested in two seminars, in the SAE Society of Automotive Industry Mexico seminar in 2016 and in the seminar of the Opel Hungary company Szentgotthárd in 2017. Both events focused on the decreasing fuel consumption and exhaust gas emissions in the automotive technology.

Keywords: digital education, climate protection, automotive industry, training of specialists, education, digital book

URBAN CLIMATE UNDER CHANGE: CHALLENGES FOR PUBLIC HEALTH, INFRASTRUCTURE AND ECO-SYSTEM SERVICES IN THE CITY

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About 50% of the world's population live in cities. In the course of the 21st century this number will increase, overall planetary human population will increase, and the overall size of urbanized regions will also become larger. While the challenges regarding public health in cities may be very different in different parts of the world, principal fields of action related to the urban atmosphere are similar everywhere. These are related to the combined exposure of dwellers to heat or cold stress, air pollution from gaseous substances and particulate matter as well as noise. While cold stress may be an issue in some parts of the world, in general, it is expected to become less of a problem during coming decades as consequence of climate change. Mitigating the urban heat island through greening cities and other measures is considered an adaptive measure to both the urban growth and urban densification and climate change. Interestingly, measures that are designed to improve urban air quality and noise mitigation quite often are also helpful for both climate change adaptation and mitigation. The same holds true vice versa. Therefore, strengthening urban eco-system services and establishing sustainable transportation and green infrastructure can substantially enhance urban resilience towards heat stress. Specific research is needed to model and to evaluate combined effects of noise exposure, air pollution and heat stress at high spatial resolution in order to support city planners and administrations in their efforts for implementing measures in accordance with the United Nations Sustainable Development Goals.

Keywords: climate change, urban climate, air pollution, noise

SPEEDING UP THE SUSTAINABLE TRANSITION OF CITIES? EXPLORING SYSTEMIC CHANGES IN THE SMART CITIES OF VIENNA, AMSTERDAM AND SANTANDER

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Cities are established socio-technical systems which are currently undergoing transition. In this situation, smart city concepts may offer a new way to accelerate the transitions towards a sustainable level. In this paper we selected three widespread smart city strategies: an extended energy strategy, an innovation platform strategy, and an ICT technology strategy. Based on a literature review we selected Amsterdam, Vienna, and Santander and chose to combine literature- and desktop research with interviews for a case study approach. In order to analyze the systemic changes at a city level we draw on concepts from the literature on sustainability transitions. Our results show that the extended energy strategy in Vienna could be characterized by the cooperation of established actors and slight changes in their roles and competences under some new guiding institutions, the innovation platform strategy in Amsterdam may lead to the entry of new actors with complementary competences and a higher degree of innovativeness. The ICT strategy in Santander may be strong in introducing new actors and systemic changes through technology implementation. In comparison in Santander the transition process is more radical as the roll out of technologies is complemented by innovation of administrative processes and a change of the management practice of the city. We conclude that especially the ICT strategy might enable new forms of urban planning and city management with various effects on urban sustainability.

Keywords: sustainable transitions, smart city initiatives, digitalisation, urban innovations

SUSTAINABLE TRANSPORT AND THE RIGHT TO HEALTHY ENVIRONMENT AS THE CHALLENGE IN THE TIME OF CLIMATE CHANGES

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The certainty of the existence of climate change is reflected in the steady increase in emissions of greenhouse gases, primarily carbon dioxide, which are associated with observed temperature increase on the planet. International research (International Panel for Climate Change - IPCC) confirmed an average increase in temperature on the planet Earth in the last 100 years of about 0.74°C, as well as its accelerate growth in this century. The average upward trend in average annual air temperature in Serbia is around 0.6°C/100 years. European Commission's plans envisaged a radically different transport system by 2020, with a single European transport area, open markets, greener infrastructure and low-carbon technologies. Transport emissions rose by 24% between year 1990 and 2008, amounting to 19.5% of total EU greenhouse gas emissions, according to the Commission's estimates. As a result, the transport sector will have to reduce its emissions by at least 45-60% below 1990 levels if the EU is to keep up with its climate change objectives for 2050. Emissions will be the main factor to consider in designing the transport system of the future. This paper is devoted to the prevention and precaution in the struggle against contamination caused by transport and traffic. Having in mind our duty to protect and improve the environment for present and future generation, the analysis of legal regulation against pollution caused by transport and traffic in the Republic of Serbia is given together with proposals for further action in this field.

Keywords: climate change, environment, transport, Serbia

FROM THE LANDSCAPE POINT OF VIEW: POLICY, PLANNING RESEARCH AND EDUCATION ABOUT URBAN LANDSCAPE SUSTAINABILITY AND RESILIENCE

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The 21st century is now known as the urban century. For the world to be sustainable and resilient, cities must be an essential part of the solution. The paradigm of landscape architecture, form McHarg's design in harmony with nature and not against it to Ahern's novel urban landscapes, is based on the resilience thinking and principles: multifunctionality, modularity, diversity, connectivity, adaptability. The theory of resilience is an ecological theory that talks about the ability of landscape, as a complex system, which is constantly changing and adapting to change, and at the same time continue to develop, while retaining its essential integrity, structure and function (the landscape character). The landscape perspective in urban planning, management and policy is a current focus in Europe, as part of the European Landscape Convention (ELC) adopted in the year 2000 by the European Council. In addition to theoretical reflection on the principles of the urban landscape planning and design, this paper describes the implementation of the ELC in Serbia as a premise of the modern concept of landscape architecture. Based on the contributions to the Serbian Government Counsel of Landscape Convention Advisers activities and the analysis of the landscape architect education and scientific research for the purpose of sustainable development of urban landscapes, I want to discuss the implication of integrative landscape scale approach. Finally, the results suggest landscape scale approach to planning and design which provide essential ecosystem services to support urban sustainability and resilience (the application of the multifunctional green infrastructure and urban pocket concept). This is the landscape architects' answer on live discussion: what makes a sustainable city?

Keywords: European landscape convention, landscape approach, urban landscape planning and design, green infrastructure, urban pockets

SUSTAINABLE PLANNING IN THE CONTEXT OF CLIMATE CHANGE: EXAMPLES IN SERBIA

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Within the last decades, special efforts at the global, regional and local levels around the globe have been put towards creating conditions to achieve sustainability within the planning process. However, taking into consideration that in recent years the impacts of climate change - floods, droughts, temperature extremes and increased fire risk in - have been ever more visible, it has been necessary to "find" adequate solutions for their reduction and mitigation. In that context this paper emphasizes the contemporary global framework regarding the issues of climate change and covers the strategic frameworks, information bases and necessary instruments, together with an overview of the current circumstances in the Republic of Serbia. Further, by presenting selected case studies in spatial and urban planning in Serbia, the paper provides an overview of the current state regarding the issue of climate change, especially regarding coverage of adaptation and mitigation measures. Taking into account the current legal and planning framework, the paper's conclusions stress that such coverage is present, confirming that contemporary planning in Serbia promotes an integral approach in relation to climate change issues.

Keywords: sustainable planning, climate change, mitigation, adaptation, Serbia

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IMPLEMENTATION OF GREEN ROOFS IN BELGRADE AS A PART OF SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE MITIGATION

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Cities can be designed to be climate-conscious and energy efficient not only to contribute to urban sustainability, but also address global climate change issues at the local level. Green or vegetative roofs present a feasible strategy for climate-conscious urban design and also are the part of green infrastructure in cities. Green infrastructure has been broadly studied as a strategic approach and part of the solution for reducing heat and pollution in urban environments and should be strategically implemented in urban environments and utilized in urban and architectural design. Green infrastructure is among the most effective tools in the fight against climate change. The paper presents implementation of green roofs in Belgrade as a part of sustainable development and climate change mitigation. For this research, the impact of vegetative roof systems on the urban environment in the Belgrade climatic zone was studied using the software tool, ENVI-met. This study reports the positive microclimatic effects of green roofs and provides a solid scientific basis for understanding the use of vegetative roofs on existing and planned buildings. It also affords evidence for promoting the use of green roofs among the academic community, decision makers, residents and investors living and working in the Belgrade climatic zone. The results obtained offer evidence showing the potential of applying natural elements - vegetative roofs - in the urban rehabilitation and creation of sustainable and attractive cities, contributing to ecologically, economically, and socially sustainable urban development.

Keywords: green roof, sustainability, green infrastructure, urban microclimate, ENVI-met

WATER REUSE AS A SECURE PATHWAY TO TACKLE WATER SCARCITY

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Access to adequate supplies of water is central to a sustainable future and climate change is expected to exacerbate water scarcity problems in several European regions. Recycling of water is considered as an adaptation measure to save resources through reuse mainly for not-for-drinking uses, although in some countries such as in Singapore, recycled water is used for drinking water as well. Sources of water to be recycled include domestic water from baths, showers and sinks as well as treated wastewater. Wastewater reuse can be a valuable option for water supply in areas where water is limited. The present presentation will analyse the problems that Europe is facing regarding water scarcity, it will show model predictions for the future of European and Mediterranean countries and will analyse good practices which are implemented in European countries and elsewhere.

Keywords: water, scarcity, reuse, treatment

SESSION: Sustainable development and climate change global issues (Social sciences, humanities, law and economy)

Sub-session: Sustainable development and global citizenship
Chairpersons: Gordana Jovanović (SRB)
Presenters:

Endre Kiss	The actual dialogue between nature and society or on the mutual protection of nature and society
Michael Böcher	Scientific knowledge transfer for sustainability in a new age of politics
Gordana Jovanović	Conditions of socio-cultural sustainability
Radmilo Pešić	Climate change adaptation - Missing links with the finance
Anđelka Mihajlov	Sustainable development goals implementation - EU accession interface in the context of the Western Balkan more efficient and coherent sustainable development pathways
Dragoljub Todić	Regional aspects of climate change law
Miloš Došen	Entrepreneurship in the age of climate change

Sub-session: Role of higher education in sustainable development
Chairpersons: Violeta Orlović Lovren (SRB), Marija Maruna (SRB)
Presenters:

Zoran Hadži-Velkov	Role of University for the Western Balkans smart growth
Marian Jaskula	Science and education in the face of challenges of sustainable development
Violeta Orlović Lovren	Assessing sustainability in higher education: one methodological approach and many challenges

Marija Maruna	The role of the academy in strengthening local institutional capacities to address the SDGs
Nataša Petrović	Higher education responses to climate change and climate change risk assessment

BETWEEN GLOBAL CONFLICTS AND MUTUAL PROTECTION OF NATURE AND SOCIETY

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The long history of human culture frequently contains the motive of how the natural disasters are the clear vengeance of the gods, because the sins of the humanity became extreme. Nature and society are always standing with each other in a secret dialogue. Modern societies step for step became conscious of their own furious political, economical and intellectual dynamics and experienced the nature in this contrast as something which laws are of timeless eternity. No intellectual with the family name (Max) Südfeld will change more his na-me as a protest to (Max) Nordau, because the semantics of South and North lost their „eternal“ cultural meaning. It's also no longer a privilege of Nietzsche, to require a „dangerous life" for the future creative individuals. The path from Nietzsche to Beck is the raise of a global risk society and sustainable development. The actorial action radius of the diverse global protagonists remain of high importance. This actorial freedom can promote the framework of an optimal sustainable development, but it can favour also the mutual rivalry within globalization, which generates and accelerates global conflicts. At the same time, the nature became real global actor, probably the most powerful actor of all. It is not about the fact, that this change is historical in the history of the nature. This change is historical also in the history of the humanity. Until now, we protected the nature against the society, now we must also the society protect against the nature. The decisive change is the transformation of the idea of nature protection in a practice of mutual and double protection of nature and society. In the singular misson of this double protection is crucial, that global actorial freedom consciously concentrates on the sustainable development..

Keywords: globalization, Ulrich Beck, actorial side (of globalization), climate change, mutual protection of society and nature

SCIENTIFIC KNOWLEDGE TRANSFER FOR SUSTAINABILITY IN A NEW AGE OF POLITICS

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Achieving sustainability is an important question of how relevant political decisions from the global to the local level are based on latest scientific findings. Especially natural scientists often claim that politicians neglect their sustainability-related findings whereas political actors state that science that they need has to be timely, practically usable and directed towards their current political problems. Newer discussions in science and public media even state that we can observe a "new age of politics" in which politics simply ignores scientific facts which leads to so-called "post-truth"-politics in which science-based solutions more and more get replaced by ideological or by – from a scientific perspective – "wrong" policies. Climate policy is a very good example for these discussions. An irony is that, despite these central controversies, sustainability policy solutions are more and more dependent on the availability of interdisciplinary science-based expertise. The contribution will take up the crucial question of how science can play a major role in informing sustainability policy solutions. It argues that there is not a "new age of politics" but that we have to understand central differences between science and politics in order to find advanced knowledge about the conditions under which scientific knowledge transfer can be successfully utilized in sustainability policies.

Keywords: scientific knowledge transfer, sustainability, policy, politics, science-policy interface

CONDITIONS OF SOCIO-CULTURAL SUSTAINABILITY

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The aim of this paper is to argue for socio-cultural sustainability as a pre-condition for both environmental and economic sustainability. This requires questioning the discourses of sustainability dominated by environmental issues. Further, I shall argue that sustainable sustainability requires thinking and acting simultaneously globally and locally. Therefore, it will be claimed that one of the urgent tasks of education should be to foster changes in ways of thinking about society, culture, nature and individuals and their interrelations. Changes are required already at basic epistemological levels, as argued by Gregory Bateson. Contrary to dominant Western epistemology which assumes dichotomies between subject and object, individual and society, cognition and emotions, culture and nature, a revival of holistic participatory epistemology is needed (Charles Taylor). Such an epistemology should be followed by changes in dominant instrumental attitudes toward other individuals, groups, nature and eco-system in general. In accordance with Habermas' understanding that consequently developed theory of knowledge is necessarily also a theory of society, and relying on support of historical investigations, it follows that epistemological patterns are homologous with conceptions of individuals and society. There cannot be any sustainability without building a fundamental and global culture of peace, solidarity and responsibility. Accordingly, Hans Jonas defined moral imperative of our time - our present thinking and acting should take into account life of future generations. This is not possible within the order of neo-liberalism which promotes priority of private economic interests at the expense of other people and environment. A sustainable world must be different.

Keywords: society, culture, individual, epistemology, education

CLIMATE CHANGE ADAPTATION - MISSING LINK WITH THE FINANCE

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The paper deals with adaptation problems of a small developing country faced with a lack of funding a lack of public awareness and a too short average parliamentary cycle. An average political cycle in most of the countries, four of five years long, simply do not put adaptation high on the national priority lists. Full outcomes of adaptation projects sometimes are to be expected in a number of decades, while the necessary investments are to be ongoing from now up to the end of the century. Therefore most of the politicians are reluctant to put climate change adaptation high on their agenda. With a low policy priority, and with a low public awareness, in countries that might be in the highest risk group, climate change issues are systematically underestimated in public finance. Climate change problems are often shifted either on individual consumers and local budgets, or on the international arena in a constant intention to gather foreign financial support. Most of the analysis is based on the Republic of Serbia experiences in adaptation policy. The emphasis is put on the Serbian Green Fund functioning and its inadequate role in the adaptation projects. In final part of the paper a set of suggestions has been put forward in order to make the Green Fund more capable to support investments in climate change adaptation in a number of targeted sectors, like agriculture and forestry, public health, urban planning, water management electricity production etc.

Keywords: climate change adaptation, state budget, green fund

SUSTAINABLE DEVELOPMENT GOALS IMPLEMENTATION - EU ACCESSION INTERFACE IN THE CONTEXT OF THE WESTERN BALKAN MORE EFFICIENT AND COHERENT SUSTAINABLE DEVELOPMENT PATHWAYS

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Western Balkan region priority (commitment) and almost all current focus is accession to EU. Sofia Priority Agenda for the EU and the Western Balkans (2018) includes increase of connectivity, support to socio-economic development (and putting a special focus on youth) and enhance support to education. With this in focus, SDGs implementation is not receiving appropriate attention. The goals and targets in the SDGs are addressing complexity of sustainable development. By examples, the linkage between processes: EU accession and SDGs implementation (examples include climate change and circular economy issues[2], as well as education snapshots) will be presented. SDGs implementation is not "isolated working package" and could be merged with implementation of EU acquis, when properly understand and manage. The inter-linkage agenda isn't a new agenda; however with this paper we will develop co-benefit path for SDGs implementation and EU accession (of candidate and potential candidate countries of Western Balkan), tackling by outreach messages education curricula and science in practice.

Keywords: EU accession, Western Balkan, sustainable development, SDGs implementation, co-benefit method

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[2] Research is performed within EC supported project: ENV-net factoring the environmental portfolio for Western Balkans and Turkey in the EU policy agenda.

REGIONAL ASPECTS OF CLIMATE CHANGE LAW

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The first part of the paper analyzes the question of how the existing system of international multilateral treaties in the field of climate change, or of the relevance to climate change, relates to regional specificities. The paper points to the most important provisions of international treaties in the field of climate change and environment related to regional issues and specificities. The second part of the paper is dedicated to understanding the perspective of the countries in the region of Southeast Europe toward international treaties in the field of climate change and the environment. A review of the membership of countries from this region in relevant international treaties is provided. The paper's initial standpoint is that the existing system of international treaties in the field of climate change, or of the relevance for climate change, should be strengthened by a clearer formulation of obligations and opportunities for expressing regional specificities. It is noted that there are certain elements in the system of international treaties in this area which indicate the importance of regional specificities. However, on the example of Southeast European countries, where there is a high level of uniformity of membership in international treaties, the need for further elaboration of rights and obligations from existing international treaties is noted, in accordance with the specificities of the region. This highlights the importance of reviewing the general question of the global and regional relation, in particular through the prism of efforts to improve the efficiency of the existing system of international treaties.

Keywords: climate change, international environmental law, international law on climate change, regional specificities, South Eastern Europe

ENTREPRENEURSHIP IN THE AGE OF CLIMATE CHANGE

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Climate change is the most profound challenge that humanity faces. Mitigation and adaptation efforts that are made neither have sufficient impact, not speed needed to secure safe future. One of least referred topics in context of climate change is the potential of entrepreneurship to contribute to global climate action. Entrepreneurship development is a very propulsive topic, which governments, academia, investors, corporations see as a main engine of future economic growth, source of innovation and employment. However, the whole entrepreneurship paradigm lacks the context of leveraging on opportunities brought by climate change and environmental protection; but the trend is two-direction –environmental communities do not see entrepreneurship well fit in broader context, as well. Potential reason for that might be due to relatively negative perception of entrepreneurship, but in fact entrepreneurship is going through huge transformation driven by behaviour of economic agents. Climate change solutions advocated by scientists and NGOs will be created and deployed by entrepreneurs who have broader perception of value creation, and who develop business models based on sustainability. These business models are aligned with needs of customers, communities and nature; and consider various dimensions of co-creation and co-destruction of value. Variety of ways how entrepreneurship can contribute to climate action deserves attention and broader consideration.

Keywords: entrepreneurship, climate change, sustainable development business models

ROLE OF UNIVERSITY FOR THE WESTERN BALKANS SMART GROWTH

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The research and transfer of knowledge have pivotal roles for the sustainable socio-economic development of any country. This is particularly true for the Western Balkan (WB) countries, since they need to "catch-up" rapidly with the European Union by embracing the principles of knowledge-based economy and smart growth. In the research domain, the WB research output in recent several years converges toward (and sometimes even exceed) the "EU average", when considering: (1) the number of published papers in Scopus database per registered researcher, and (2) research & development expenditure per published paper in Scopus database. Still, in order to maintain this trend, it is essential to improve and harmonize the science systems of the WB countries with those of developed EU countries. The fundamental challenge is tackling the "seniority vs. meritocracy" issue, which is one of the key reasons for the problem of massive "brain drain" from the Western Balkans. In doing so, these countries must embrace the welcoming culture of outstanding young scholars from within and abroad, and guarantee international quality and merit-based criteria for evaluation and recruitment into the universities and other research institutions in the Western Balkans.

Keywords: EU cohesion policy, scientific research metrics, science system, brain drain, merit-based academic staff recruitment

SCIENCE AND EDUCATION IN THE FACE OF CHALENGES OF SUSTAINABLE DEVELOPMENT

[Experiences of the Jagiellonian University in Cracow and Activity of Polish Humboldtians]

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Hearing the term sustainable development, we think in the first row about the famous report of Roma Club published in 1972 in the book “Limits to growth” analyzing the future of mankind in the face of the increase in number of inhabitants of the Earth and natural resources that are being depleted. Although at the beginning of that work, the authors stipulated that the model they constructed was “as any model, imperfect, over-simplified and unfinished”, yet it became an inspiration for many political movements related to the concepts of sustainable development and environmentalism. It caused both criticism or catastrophic visions of the future, as well as unfortunately some manipulations and until now it generates debates and has been a subject of many publications. For this reason the reliable education at all its levels plays an extremely important role. The best places for the research and such open discussion are of course the universities, scientific societies and non-governmental organizations. Education as one of the important parts of the society (especially important for the sustainable development) is not only the education of young people but also permanent later education like as the long-life learning, the university of third age, etc. The paper presents the Jagiellonian University in Cracow being the oldest Polish university with over 654 years of history and his structure as well as achievements and famous pupils as for example Nicolaus Copernicus. Over 100 Polish Humboldtians are graduated from the Jagiellonian University and have significant contribution to the development of world science and to the discussion about our future, about our perspectives, chances and dangers.

Keywords: sustainable development, education, Jagiellonian University, Societas Humboldtiana Polonorum

ASSESSING SUSTAINABILITY IN HIGHER EDUCATION: ONE METHODOLOGICAL APPROACH AND MANY CHALLENGES

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Last decades reveal increasing interest and volume of research on integrating sustainable development in universities. According to the research evidence, the best results in integration of sustainability are achieved if all its aspects (environmental, social, economic) are incorporated into all segments of functioning of higher education institutions (teaching, research, cooperation, administration, infrastructure). In order to assess the level of integration of sustainability in all the faculties of the University of Belgrade, the working group established within the Coordination body of the Inter University Sustainable Development Research Program (IUSDRP) initiated analysis of existing methodologies and its potential for implementation in this specific context. As a result of the analysis, the STARS methodology (the Sustainability Tracking, Assessment & Rating System, ASHE) has been selected as a self-assessment tool, and survey developed based on the indicators related to research, curricula, teaching and cooperation (“Academics”, “Engagement”).Indicators related to Operations and Planning and Administration are going to be covered by using already existing evidence as well as by developing the separate research instrument. Having in mind that reality of the specific context of the University of Belgrade doesn’t cover all the indicators, the main challenge in this process was to select those appropriate and to translate it successfully through the questions. Once performed, despite the limitations, this assessment should help faculties in identifying the gaps and in setting up the goals for initial steps - or improvements - in integration of sustainability in their work.

Keywords: Sustainability in higher education, assessment methodology, STARS, University of Belgrade, IUSDRP

THE ROLE OF ACADEMIA IN STRENGTHENING LOCAL INSTITUTIONAL CAPACITIES TO ADDRESS SDGs

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Sustainable cities and communities as the Goal 11 set in the 2030 Agenda for Sustainable Development, has led to the New Urban Agenda, a development framework for cities in upcoming decades. It highlights governance as crucial to managing the tremendous challenges that lie ahead. Although influenced by universal recommendations stemming from the Agenda, the concept of governance hinges on its grounding in the local context. This is a critical issue for Serbia where traditional urban governance practices are obsolete and new ones are yet to arise. A key innovator and resource for educating future professionals, academia is a major asset in building sufficient capacity to create a new sustainable urban development framework. In addition to the new knowledge and skills provided through the educational process, professional capacity development benefits more broadly from modes of learning rooted in local problems and involving collaboration with local institutions. An innovative methodological approach for training future professionals has been tested with several generations of students in the Integrated Urbanism master's programme at the Faculty of Architecture, University of Belgrade, which took place in co-operation with numerous Serbian local governments. Through various forms of interaction between students, teachers, local officials, and professionals, the courses have reviewed possibilities for localising urban development SDGs. The resulting pedagogical model has allowed capacity-building for all participants, and so created new forms of professional partnerships in which multi-disciplinary and multi-level co-operation are the foundations of successful governance for sustainable cities and communities.

Keywords: New Urban Agenda, pedagogical model, urban governance, collaborative learning, coproduction of knowledge

HIGHER EDUCATION RESPONSES TO CLIMATE CHANGE AND CLIMATE CHANGE RISK ASSESSMENT

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Considering the importance of climate change issues as the integral part of present day's students' body of higher environmental knowledge for sustainable development, as well as a needful part of their everyday social and personal life, this paper will be focused on the scientific research of the needed organized academic environmental education activities (e.g. promotion action on climate change) in achieving learning objectives of adequate climate change knowledge. Our paper relied on growing body of research and case studies that have predefined environmental education and its objectives in education for sustainable development, with deep understanding of environmental issues such as climate change as well as developing skills for active participation in their solving. Beside this, a growing number of educators are facing the challenges of modern higher education, such as keeping students motivated and increasing the knowledge and awareness on specific problems. For the purpose of our research, we surveyed students of the University of Belgrade - Faculty of Organizational Science, Serbia. An analysis of the results was carried out using the SPSS 24 software package. Our climate change orientated case study was an excellent way to make students interested in the core of this important global environmental issues. Our results also pointed out the effectiveness of the proposed project application in improving the students' scientific environmental knowledge for sustainable development.

Keywords: higher environmental education for sustainable development, climate change, climate change knowledge, climate change risk assessment

SESSION: The role of forests and agriculture in sustainable development and climate change mitigation and adaptation

Sub-session: Effect of climate change on forest ecosystems
Chairpersons: Axel Albrecht (DEU), Ratko Ristić (SRB)
Presenters:

Axel Albrecht	Tree species suitability under climate change - An example from Southwest Germany
Dominik Sperlich	Ecological and economic implications of admixing silver fir in beech stands - A case study from the Black Forest
Marko Smiljanić	Comparison of the intra-annual growth in the beech mixed stands from North East of Germany: implication for climate change adaptability
Vojislav Janković	Impact of climate change on forests: A case study of ice-breaks in Eastern Serbia
Ratko Ristić	The role of forest ecosystems in the process of disaster risk reduction, mitigation and adaptation to effects of climate changes
Nada Dragović	The role of education in soil erosion and torrent control in Serbia: Current state and requirements due to climate changes
Mirjana Todosijević	The economic assessment of the impact of climate change on crops in Serbia

Sub-session: Sustainable management of protected areas
Chairpersons: Zuzana Sarvašová (SVK), Slobodan Puzović (SRB)
Presenters:

Zuzana Sarvašová	Limitations for forestry in protected areas in Slovakia

Liviu Nichiforel	The harmonization of Natura 2000 plans with forest management planning in Romania: what impacts, what solutions?
Vukan Lavadinović	Human dimensions in wildlife management - A tool to ensure sustainability
Slobodan Puzović	Protection of nature as a potential of sustainable development of local communities in Serbia and tool for the reduction of negative impacts of climate changes
Ilija Đorđević	Organization of protected area management in Serbia: Diversification from public to private managers
Predrag Šumarac	Sustainable management in national park Kopaonik - Case study of division and relevance of tourists charges
Ivana Vasić	Implementation of European charter on sustainable tourism in special nature reserve Gornje Podunavlje

Sub-session: Toward environmental sustainability - Bioeconomy and ecosystem services
Chairpersons: Helga Pülzl (AUT), Dijana Vuletić (HRV)
Presenters:

Helga Pülzl	Ready to govern? Ideas, interests and institutions - The bioeconomy frontier
Marko Lovrić	Mapping European research capacities and activity in the field of forest bioeconomy
Nataša Lovrić	South-East European forest based sector bioeconomy outlook
Makedonka Stojanovska	Research & education and policy & practice - A pathway to sustainable development in Western Balkan region
Dijana Vuletić	Sustainability under the question - Climate change effects on evaluation and provisioning of ecosystem forest services
Davide Pettenella	Marketing ecosystem services: From business ideas to the real market
Slavica Petrović	European ecolabels for wood furniture
Aleksandar Vasiljević	Renewable energy sources in forestry

Sub-session: Climate change and biotechnology in agriculture and forestry
Chairpersons: Aleksa Obradović (SRB), Milan Mataruga (BIH)
Presenters:

Aleksa Obradović	Biological control of plant pathogenic bacteria - A way toward sustainability and safer food

Ágnes Cséplő	Functional characterization of CDPK Related Kinase (CRK) family in *Arabidopsis thaliana*
Jelena Milovanović	Meeting the SDGs with climate smart agriculture: The adaptation and mitigation potentials in a changing climate
Milan Mataruga	The impact of climate change on transfer of forest genetic resources in Bosnia and Herzegovina
Marina Nonić	Climate change and conservation of forest genetic resources
Vladan Ivetić	Maintaining the environmental sustainability in changing climate by functional forest restoration

Sub-session: Forests and climate change policy and governance
Chairpersons: Bernhard Wolfslehner (AUT), Mersudin Avdibegović (BIH)
Presenters:

Bernhard Wolfslehner	Forests and climate change: the challenges for science-policy transfer
Roderich von Detten	Climate change as the normal case of emergency - Forestry or the management of the unknown
Bogdan Popa	A comparative analysis of climate change adaptation and mitigation initiatives for forest sectors in Romania and Moldova
Franc Ferlin	Experiences in promotion sustainable development in the forestry sectors of Slovenia and the West Balkans
Mersudin Avdibegović	Forestry and climate change in Bosnia and Herzegovina: challenges for environmental, socio-cultural and economic sustainability
Jelena Nedeljković	Climate change governance in selected European countries: Forestry and nature conservation perspective
Mirjana Stanišić	Policy measures in forestry and nature protection for climate change mitigation in selected EU and the Western Balkan countries
Zoran Poduška	“Waldsterben” phenomena in forest research and policy in Serbia

Sub-session: Private and urban forests in changing climate
Chairpersons: Laura Bouriaud (ROU), Špela Pezdevšek-Malovrh (SVN)
Presenters:

Laura Bouriaud	Governance-related indicators and the regulation of private forestry: a comparative analysis across Europe

Špela Pezdevšek-Malovrh	Adaptation of private forest owners management to climate changes - Is there an opportunity for new forms of cooperation?
Anže Japelj	Expectations of forest owners and the general public towards provision of forest ecosystem services within sustainable forest management: a case study of Slovenia
Todora Rogelja	Policy framework conditions forestry based social innovations: the case of Slovenia
Ivana Živojinović	Using Q-method to reveal urban forestry perspectives toward climate change adaptation
Vladimir Stojanovski	Can the urban greenery be an instrument for combating climate changes in municipality Centar - Skopje

BIOLOGICAL CONTROL OF PLANT PATHOGENIC BACTERIA – A WAY TOWARD SUSTAINABILITY AND SAFER FOOD

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Plant diseases caused by bacteria are very difficult to control once the pathogen becomes established in the field. Bacterial variability, mutation or gene transfer in the pathogen when confronted with plant resistance genes or bactericides, high multiplication rate end an efficient spread inside plant tissues and in environment, contribute to lower effectiveness of control strategies mostly relaying on synthetic bactericides. Use of antibiotics in plant protection followed their successful application in clinical and veterinary medicine. However, occurrence of antibiotic resistance in pathogenic bacteria caused restrictions in use of these bactericides. Copper based compounds were widely recommended as preventive treatments in control of bacterial diseases. An excessive copper application resulted in bacterial resistance development and environmental pollution, compromising its use in agriculture. Therefore, an extensive research has focused on identifying alternatives, based on natural control mechanisms, such as microorganisms that could be used as biocontrol agents in plant protection. Several studies indicated possibility of using biological agents as natural enemies in control of plant pathogenic bacteria. They are based on antagonizing or superparasitic properties of the beneficial microorganisms, and their interaction with pathogenic bacteria. Among those already accepted in practice, bacteriophages were reported as prospective bacterial control agents. However, these experiments showed that although bacteriophages are the most numerous biological agents on the planet, their efficacy was greatly dependent on their susceptibility to environmental conditions (desiccation, UV light) and ability to maintain their population on plant surfaces. In spite of the inconsistent efficacy during early application attempts, recent results renewed interests in phage therapy. An interesting approach was developed in use of combined phage and *Pantoea agglomerans* treatment in control of *Erwinia amylovora*, causal agent of fire blight of pomaceous fruits. Phage lytic activity and antagonistic effect of *P. agglomerans* provided plant protection with efficacy comparable to streptomycin. So far, the best results were achieved in tomato protection from bacterial spot. Application of selected phage strains formulated with skimmed milk and sucrose, combined with the application of systemic acquired resistance inducers, provided an effective tomato protection from bacterial spot pathogen even in areas with

climatic conditions favorable for the disease. Such application of bacteriophages, integrated with other protective treatments, represents the first example of practical and routine use of bacteriophages in plant protection. Being host specific, phages could control target bacterium only, without affecting beneficial microbiota. Using the host specific phage "cocktails" would prevent resistance development and would provide sustainability to the control of pathogenic bacteria. Also, phages, as widespread and naturally occurring agents, may be used in conventional, as well as in organic plant production systems, without the risk of contaminating food and the environment.

Keywords: biocontrol, bacteria, plant diseases, food, environment

FUNCTIONAL CHARACTERIZATION OF CDPK RELATED KINASE (CRK) FAMILY IN *ARABIDOPSIS THALIANA*

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The plant specific CDPK (Ca^{2+}-dependent serine/threonine protein kinases) superfamily exists of several subfamilies like CDPK and the structurally closely related CRK (CDPK-Related Kinase) families. CDPK subfamily is widely involved in regulation of several abiotic and biotic stress responses in diverse plant species which is up to now relatively well documented. However, functional role of CRK subfamily (CRKs) which contains eight members in *Arabidopsis thaliana* (At) is less characterized. Study of one member of AtCRKs pointed out that inactivation of AtCRK5 causes reduced root growth, enhanced lateral root formation and root gravitropic defect. Furthermore, the plasma membrane localized AtCRK5 is required for proper polar localization of the auxin efflux transporter PIN2 in *Arabidopsis* roots. Here we present the functional analysis of T-DNA insertion mutants of *Arabidopsis* CRK family members and the over-expressing transgenic lines tagged with Green Fluorescent protein (GFP). Most AtCRK family members with C-terminal GFP tag exhibit plasma membrane localization in roots as it was predicted by their N-terminal myristolyation sites. We also characterized their response to gravitropic processes during roots/hypocotyls bending. Delayed root gravitropic and hypocotyl bending in most of the Atcrk T-DNA insertional mutants was observed when compared to that of wild type (Col-0). Reactions of AtCRK5 mutant roots under paraquat treatment strongly suggest that this member of CRK subfamily is probably involved in regulation of oxidative stress responses. AtCRK1 was found to be photo sensible in continuous light revealing its potential regulatory role in maintenance of cellular homeostasis during continuous light conditions.

Keywords: CDPK-related kinase (CRK) family, plasma membrane localization, gravitropic response, *Arabidopsis thaliana*

MEETING THE SDGs WITH CLIMATE SMART AGRICULTURE: THE ADAPTATION AND MITIGATION POTENTIALS IN A CHANGING CLIMATE

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Climate Smart Agriculture (CSA) is an approach that requires site-specific assessments to be able to identify sustainable agricultural practices suitable for a specific agro-ecological zone. The CSA main trait is interdisciplinarity with the aim of achieving multiple benefits and trade-offs leading to strengthening of rural livelihoods. As such, the CSA contributes to most of Sustainable Development Goals (SDGs) and especially to SDG 2: Zero hunger, SDG 7: Affordable and clean energy, SDG 13: Climate action, SDG 15: Life on land, as well as to SDG 17: Partnership for the goals. The CSA recognizes 6 packages of mechanisms for contribution to SDGs achievement: (1) Soil management, (2) Water management, (3) Sustainable livestock production, (4) Forest management, (5) Aquaculture and (6) Energy management. The author presents each package through practical examples identified during the implementation of several projects in Serbia, in which the author had an active participation. Packages (1) and (2) are presented through Sustainable Land Management (SLM) practices identified for Serbia. Related to the Package (3), the concept of High Nature Value Farming (HNVF) and potential areas identified in Serbia are presented. Packages (4), (5) and (6) can be compiled through examples of modelling tools application for carbon sequestration estimation under different forest management practices and simplified ecosystems of perennial crop Miscanthus x giganteus, an attractive agro-energy crop suitable for short rotation plantations establishment in riparian buffer zones. The author acknowledges support of the Ministry of Education, Science and Technological Development of the Republic of Serbia through the project TR31078.

Keywords: climate smart agriculture, examples from projects, Serbia

THE IMPACT OF CLIMATE CHANGE ON TRANSFER OF FOREST GENETIC RESOURCES IN BOSNIA AND HERZEGOVINA

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Even though the knowledge about transfer of forest genetic resources (FGR) has a long history, it was only in the beginning of the 21st century when FGR was remarked in the light of the climate change. New technologies of wood processing, wood as a functional and interior decoration element, and wood as biomass represent current trends directing the interest in increasing areas under natural forests, planted forests and plantations. As a conequence we face greater demands in terms of transfers of forest reproductive material, and therefore of genetic resources. The monitoring activities of climate parameters indicate that the average temperature in B&H for the previous period was higher than 1,2°C with an even more unfavorable scenario until the year of 2100. At the same time, the long tradition of seeding and nursering have not recognized climate change as an important segment in defining transfer of forest genetic resources. It is a well-known fact that the significant number of developing countries (including B&H) do not have or lose national systems of organized production and trade in forest reproductive material due to the lack of long-term investments in developing this area of interest. These issues can pose a big problem for the transfer of FGR in B&H. Taking into account the current situation and international activities, this paper provides relevant guidelines and recommendations for further steps which are necessary in defining this topic within scientific and professional areas of interest, and among decision makers.

Keywords: transfer forest genetic resources, climate changes

CLIMATE CHANGE AND CONSERVATION OF FOREST GENETIC RESOURCES

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Today we are witnessing the effects of various factors that threaten forest genetic resources, which in extreme cases can lead to the disappearance of not only the genes, but also the entire populations or species. Rapidly changing climates represent considerable threats to forest trees, which are among the most essential, but also very sensitive, natural resources. Some important features necessary for adaptation of forest trees to changed environmental conditions are not sufficiently covered by breeding programs, such as resistance to: drought, disease, pests, fire, as well as phenotypic plasticity and „carryover effect“. Considerations of the intensity of potential upcoming climate changes and threats to the survival of forest tree species under new conditions indicate the necessity of human intervention in order to improve the adaptability of populations. The synthesis of genetics, evolution and ecology, as well as qualitative (molecular) and quantitative genetics is necessary in order to preserve the adaptability of forest tree species during the process of global climate change. Particular attention should be given to alternatives to genetic adaptability, such as phenotypic plasticity, which should be included among the priority selection criteria in processes of conservation and breeding. Climate changes must be one of the key factors in creating conservation strategies of forest tree species, both at the individual and population levels. This paper provides an overview of conservation priorities, based on elaborated challenges and adaptive mechanisms of trees, as well as proposed measures which could balance changes in environmental conditions.

Keywords: conservation priorities, measures, adaptation, forest trees

MAINTAINING THE ENVIRONMENTAL SUSTAINABILITY IN CHANGING CLIMATE BY FUNCTIONAL FOREST RESTORATION

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There is no consensus on definition of forest restoration and the topic is widely discussed. Many definitions are offered, from different aspects and with various goals. Although it is more convenient to aim on recreation of historical condition or maintaining the current status, foresters should aim on creation of sustainable ecosystems in the future, uncertain conditions. Functional restoration, aiming to restore ecosystem functions rather than to restore a structure referenced in the past, is a logical approach for many restoration programs. Manipulation of composition, structure, and processes in degraded ecosystems emphasize the role of silviculture practice, as well as the role of comprehensive planning. This paper offers a review of methods suitable for functional forest restoration in South-Eastern Europe.

Keywords: functional restoration, reclamation, reconstruction, adaptation, forest establishment

TREE SPECIES SUITABILITY UNDER CLIMATE CHANGE – AN EXAMPLE FROM SOUTHWEST GERMANY

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Since tree species composition is a central characteristic of forest ecosystems it is of prime importance to estimate tree species suitability under climate change. In a first step, we calculated the species suitability of the four existing main tree species in Southwest Germany (*Fagus sylvatica*, *Quercus petraea*, *Picea abies*, *Abies alba*) based on traditional site mapping data and climate sensitive species distribution models using European Level 1 occurrence data. We found clear decreasing suitability for all four species under the SRES scenario A_1B by the year 2050. And as a consequence of these potentially dramatic shifts we conducted a literature review as a second step, screening 25 potentially alternative tree species for their suitability under future climatic conditions. For this purpose, we collected published information on 35 meaningful criteria for each of these species describing their potential yield, wood properties, ecosystem services, risks and cultivation techniques. Finally we compared their suitability with a Multi-Criteria Analysis resulting in a ranked suitability list. The method allows weighting the different criteria to take stakeholder preferences into account. However, we calculated a non-weighted all-equal average. As a result, we found a range of domestic, naturalized and to-be-introduced species in the top of this ranking list (i.e. *Carpinus betulus*, *Betula pendula*, *Robinia pseudoacacia*, *Liriodendron tulipifera*). The presented results are only a coarse first estimate of potentially promising tree species under climate change.

Keywords: existing tree species, alternative tree species, species distribution model, multicriterial analysis, literature review

ECOLOGICAL AND ECONOMIC IMPLICATIONS OF ADMIXING SILVER FIR IN BEECH STANDS – A CASE STUDY FROM THE BLACK FOREST

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The share of European beech (*Fagus sylvatica* L.) has been gradually increased in German forests due to transformation policies as part of a “close-to-nature” approach in forest management plans. European beech is, however, a drought susceptible species and climate change scenarios project an increase in severity and frequency of drought events in many parts of Germany. Site-adapted admixture of Silver fir was identified as a potential species to dampen drought effects. With a process-based forest growth simulator, we quantified growth, productivity and economic value of a sample stand of European beech and Silver fir in the Black Forest with and without climate change scenarios. Simulations were then repeated for mixed-forest scenarios (beech:fir ratios of 55:45, 65:35, 85:15). The establishment costs of mixed stands were outweight by the added value of the more profitable Silver fir when admixed at a stand age of 60 or earlier. Total cumulative growth of beech was reduced between 15-35% depending on the applied climate change scenario translating into an economic loss of 15-33% in net present value of beech stands (NPV). Admixture of Silver fir dampened the negative effect on beech growth under climate change scenarios and reduced the economic losses with the greatest effect in the mixing ratio of 55:45. We stress that, beside the ecological and silvicultural feasibility of potential species mixtures, the economic implications have to be thoroughly assessed to provide a valid basis for investment decisions in forest conversion strategies.

Keywords: climate change adaptation, mixed forests, net present value, productivity, forest growth model

COMPARISON OF THE INTRA-ANNUAL GROWTH IN THE BEECH MIXED STANDS FROM NORTH EAST OF GERMANY: IMPLICATIONS FOR CLIMATE CHANGE ADAPTABILITY

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Adaptation of the forest ecosystems to the climate change is one of the big currently open questions in forest growth science. One hypothesized consequence of the current rates of climate change is that trees growing at polar boundaries of species distributions will in general move and extend their growing seasons. However, to our knowledge, the seasonal shift was seldom looked at the intra-annual level, mainly due to the lack of the available multi-year intra-annual growth data. To overcome the lack of long data problem, we have opted to compare most extreme local years with patterns similar to the expected ones from climate change models to the tree intra-annual growth data. We monitored four species in total from three mixed beech stands in Northeastern part of Germany with dendrometers and temporal resolutions of five minutes for last five years, to obtain intra-annaul growth data. We hypothesised that all trees will start growing earlier and have longer growth periods in years with milder and drier winters, with null hypothesis being no difference. With our dataset, we were unable to falsify null hypothesis, by looking at the most extreme years currently available. Therefore, our results indicate that individual trees will indeed shift their growing season earlier, as well as to extend the season further into the year.

Keywords: Beech mixed stands, dendrometers, seasonal shift, climate change

IMPACT OF CLIMATE CHANGE ON FORESTS: A CASE STUDY OF ICE-BREAKS IN EASTERN SERBIA

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In Serbia are notable the consequences of climate change, which include an increase in mean annual temperatures, a decrease in precipitation, an increase in the frequency and length of climatic extremes, the occurrence of natural disasters (floods, droughts, etc.). Changes in temperature and precipitation caused by climate change have significant effects on forests. As the case study in this paper are analyzed the icebreakers that happened at the end of 2014 in eastern Serbia. The aim of this paper is to study the damage caused by the climate change in state and private forests, as well as the organization of their rehabilitation. In addition, the aim is to examine the attitudes of forestry engineers towards the impact of climate change on forest ecosystems, natural disasters and the damage they have caused. For the purpose of research, primary and secondary data were collected and analyzed. Primary data was collected through a survey (a total of 62 respodnents), and a secondary one from the Public Enterprise (PE) “Srbijašume” and the Statistical Office of the Republic of Serbia. The collection of primary data was carried out in March 2017, and the questionnaire consisted of 15 questions, of which 13 were analyzed in this paper. The results show that forest damage from natural disasters, as well as their participation in the total forest damage in Serbia, are increasing and that this increase can be associated with lower temperatures and higher amount of precipitation (snow-breaks, ice-breaks, floods, etc.). The research also found damages from ice-breaks in eastern Serbia, occured on the surface of 19,419.78 *ha* in state and 23,886 *ha* in private forests. With the remediation plan, it is envisaged that 712.242 m^3 of timber will be harvested in state forests on the surface of 12,935.65 *ha* in the period 2014-2020. In private forests, it was estimated that 266,065 m^3 needs to be harvested.

Keywords: climate change, natural hazards, forestry, forest professionals, Serbia

THE ROLE OF FOREST ECOSYSTEMS IN THE PROCESS OF DISASTER RISK REDUCTION, MITIGATION AND ADAPTATION TO EFFECTS OF CLIMATE CHANGES

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Forests are a very important component of environment with regulative and protective functions, especially in the domains of mitigation and adaptation to effects of climate changes, water supply, flood prevention, erosion control, balancing the hydrologic cycle, biodiversity sustainning, rural development. Floods, mud flows, landslides, forest fires and drying of forests have recently caused significant damages in some regions of Serbia, as a consequence of ongoing climate changes as well as due to over exploitation or mismanagement of mountain forest ecosystems. Upland and downland areas of watersheds are facing problems due to misuse of soil. Activities such as logging, improper road construction, clearcuts and fragmentation change the autochtonous forest cover of upland areas, leaving the soil unprotected by rain drops, surface runoff and erosion. Sustainable watershed management includes biological, biotecnical, technical, social, economic, administrative and institutional measures, even political activities. The central question is whether the public interest in soil and water conservation, within forest ecosystems, should prevail over the right of private and public landholders to use and misuse soil.

Keywords: disaster risk reduction, climate changes, flood prevention, erosion control, adaptation, mitigation

THE ROLE OF EDUCATION IN SOIL EROSION AND TORRENT CONTROL IN SERBIA: CURRENT STATE AND REQUIREMENTS DUE TO CLIMATE CHANGES

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The organized works on soil erosion and torrent control in Serbia has been carried out since the beginning of the last century. The education of experts for this activity is carried out at the Faculty of Forestry of the University of Belgrade, and the study programs are harmonized with the programs of the universities of the countries of Central Europe and the Balkans. In the last decades, we are the witness of many consequences of climatic changes that cause great material damage and often loss of human lives. The massive floods that took place in 2014 in Serbia caused damage to 1.7 million euros. The study of climate change, its consequences, as well as measures for mitigation and adaptation, has been carried out intensively at many faculties and institutes within scientific projects. Even the climate change represents a global problem, universities in the EU and through the world have failed to include education about them in their study programs. The implementation of this knowledge in the existing study programs of forestry and other related disciplines of universities in Serbia is insufficient.

Keywords: torrent control, climate change, study program, university

THE ECONOMIC ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE ON CROPS IN SERBIA

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Yield losses in agriculture induced by climate change are a serious concern. Crop production is affected by climate change, and it will have to adapt to changed climatic regimes in order to maintain stable food production, its security and the sustainability of natural resources. The principal objective of this paper is to review the role of global climate models and crop growth models for the study of climate change impacts on crop growth, yield and economical impact. The assessment of future climate conditions in Serbia was done using the EBU-POM regional climate model. Analysis of the results was made for the future period from 2001-2030 and from 2071-2100 compared to the base period 1961-1990 and for two IPSS/SRES scenarios middle A_1B and extreme A_2. We have used the DSSAT-CSM model to study the climate change impact on winter wheat, maize and soybeans in the region of the Republic of Serbia in the A_1B and A_2 scenarios. According to climate scenarios, corn yields are the most sensitive to temperature changes (ranging from –6% to 71%). In the case of irrigated corn, yield variation is considerably lower (–7% to 6%). Soil irrigation would show a large increase in soybeans, which, according to the A_1B scenario goes up to 67%. Wheat, as the most dominant species in Serbia, according to the A_1B scenario, yields ranging from –16% to 21%, while according to the A_2 scenario yields range from –10% to 6%. That situation will also reflect on the economic trends of these crops.

Keywords: climate change, crops, economical impact

READY TO GOVERN? IDEAS, INTERESTS AND INSTITUTIONS - THE BIOECONOMY FRONTIER

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Thirty years have passed since the publication of the Brundtland report and the importance of the notion of sustainable development has slightly faded despite the fact that the UN adopted Sustainable Development Goals and a new Agenda until 2030. In the meantime, a new concept “bioeconomy” has risen from the ashes like a phoenix starting from mid-2000. More and more countries including the European Union are developing bioeconomy strategies and investing large research funding amounts into related projects. The European Commission for instance has stated in its 2012-bioeconomy strategy, “Bioeconomy is Europe’s response to key environmental challenges the world is facing already today”. From a United States point of view, bioeconomy “…has emerged as […] priority because of its tremendous potential for growth as well as the many other societal benefits it offers”. By the end of October 2013, a google search for the term “bioeconomy” produced 350,000 hits. In June 2018 the same term produced 913.000 hits. Has the importance of bioeconomy increased? This paper reviews the political science literature to take stock of current bioeconomy policies and to assess whether integration attempts respectively frontiers are developing / shifting within or beyond the bioeconomy discourse. Based on document analysis, expert interviews, social-network analysis and an analytical framework that builds on ideas, interest and institutions, this paper concludes that old and new frontiers exist. In addition, in the face of new global challenges bioeconomy policies do however seem less novel from their governance perspective and less integrative than others do.

Keywords: bioeconomy, ideas, interests, institutions, governance

MAPPING EUROPEAN RESEARCH CAPACITIES AND ACTIVITY IN THE FIELD OF FOREST BIOECONOMY

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The EU has taken a strategic turn towards bioeconomy (EU 2020 Strategy), which has also influenced the EU research and development orientation, by putting more emphasis on bioeconomy related research and activities (EU Bioeconomy strategy). To remain relevant and competitive the European forest research should be responsive to address these structural changes. This means that it should develop capacities and research infrastructures which will be able to address questions relevant in the new policy setting. Although a number of forest research capacity mapping exercises have been conducted at EU level it remains unclear how far the bioeconomy research is addressed in these mapping exercises. An overall synthesis based on updated information on forest bio-economy research and innovation covering the complete forest-based systems is thus missing for Europe. Such a synthesis would serve several important purposes: 1) It would be an important baseline for future strategic advice strengthen coordination in research and innovation work between the EU, member states and stakeholders; 2) it would be of great use for alignment and for reference in the design and framing of European and national calls within the area, and 3) it would constitute an important strategic document in relation to the developing overall European bioeconomy strategy. A typology of forestry and its supply-chain topics in the context of bioeconomy is developed from input of five senior experts. Data on research capacities and research activity connected to it is drawn from six previous mapping exercises in the field and from CORDIS data set of all projects that have been supported through EC's Framework Programmes. Results show that research capacities increase both along the forestry supply-chain and from South-East to North-West of Europe; however, each region has capacities in each segment of the supply chain. Actors from the Easter Europe are very scarcely connected to actors from Western and Northern Europe within the context of EC's framework programmes. Financing of forestry research increases with the passage of time and along the supply chain. There are more capacities than financing in the beginning of the supply chain, and there are less capacities than financing towards its end. Share of industrial actors receiving funds for forestry research projects greatly increases in topics related to primary and secondary processing.

Keywords: bioeconomy, research capacity, mapping, CORDIS

SOUTH-EAST EUROPEAN FOREST BASED SECTOR BIOECONOMY OUTLOOK

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The European forest-based sector is undergoing major changes, while at the same time, the role of a forest-based bioeconomy is politically discussed. That might have influence on the forest-based sector in the South-East European (SEE) countries while potentially pushing them to follow recent market changing trends and implement this concept in their respective countries, in order to positively contribute to their rather weakened economy both on national and regional level. The aim of the study is to critically explore expected changes in the SEE sector, more specifically in Croatia, Serbia and Macedonia, through an outlook towards 2030 and 2050, as well as how these relates to the understanding of bioeconomy by relevant stakeholders. The study employs a two-round Delphi method, conducted by face-to-face expert interviews and survey with 20 experts representing different sectors and societal perspectives across the SEE. In addition, all strategic and legislative documents directly or indirectly discussing forest-based bieoconomy were analyzed and referred to when analyzing the interviews and statements as well as for making the arguments towards the consensus survey. In total, 15 statements based on initial explorative interviews were evaluated by the panel in one follow-up round of web-based questionnaire. The study is important since it investigates for the first time how forest based sector representatives in their respective countries define bioeconomy and how they see the future of the bioeconomy in SEE region.

Keywords: SEE- bioeconomy; consensus-based Delphi; foresight; forest-based sector; future trends

RESEARCH & EDUCATION AND POLICY & PRACTICE - A PATHWAY TO SUSTAINABLE DEVELOPMENT IN WESTERN BALKAN REGION

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The framework for forest policy research & education, at global and EU level has been changing as a result of new paradigms in educational policy as well as modified roles of forests and forestry in many countries. As society's demands for goods and services from forests increase, there is a corresponding increase in demand for high quality research & education which can help shape forest policies for sustainable management of natural resources. But, the main point is that this knowledge must be utilized in designing and implementing decisions by policy makers and practitioners. This analysis describes two aspects: modern forest policy topics and their involvement in the education and research programs in Western Balkan (WB) countries; and cooperation of scientists and decision makers & practitioners for their implementation. When we are at forest policy in WB region, as a path toward sustainability, it can be outlined that it`s serious approach started after 2000, more concretely, as a separate modern curriculum in the high education, within the project FOPER I (2004-2009) and FOPER II (2009-2013). The project designed and implemented an international masters' programme and professional training in Forest Policy and Economics, increased training for university teachers and regional researchers as well as professional training. It also created six Collaborative Regional Research Teams, and developed a Doctoral College to support FOPER MSc students working on doctoral degrees. This was a great step forward strengthening education and research in the region and contributed a lot toward sustainability, not only in WB countries, but also globally.

Key words: forest policy, research & education, sustainable development

SUSTAINABILITY UNDER THE QUESTION – CLIMATE CHANGE EFFECTS ON EVALUATION AND PROVISIONING OF ECOSYSTEM FOREST SERVICES

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By this review study we would like to add to the understanding of relationship between climate change and sustainability of ecosystem services. Ecosystem services defined by Millennium Ecosystem Assessment (2005) can be supporting, provisioning, regulating and cultural and sustainability is defined as „Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (1992, Bruntland Report for the World Commission on Environment and Development). Climate change effects are already altering the functions of ecological systems and putting provision of ecosystem services under the stress. Many Climate models predict more frequent extreme weather events which will increase vulnerability and posed management challenges which represent a threat to society and Human Well-being calling for urgent attention of policy makers and scientists. Need for evaluation of ecosystem services is directly connected to gravity of threats to these services and their role in Human Well-being. These relationships influence effectiveness of resource management decision-making concerning ecosystems which are often strongly influenced by ecosystem services entering markets where non-marketed benefits stays out of the picture and consequently being degraded or even lost. These non-marketed benefits are often high and sometimes more valuable than the marketed ones. Many of them are public goods or common pool resources, so conventional markets are not the best frameworks to manage them. However, there are many research and evaluation methods which can be and are applied, but there is need for new approach to take these values into account.

Keywords: ecosystem services, evaluation, climate change, sustainability

MARKETING ECOSYSTEM SERVICES: FROM BUSINESS IDEAS TO THE REAL MARKET

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The global demand for regulating and cultural Ecosystem Services (ES), i.e. the intangible natural capital-related services, is increasing at a rate that is higher than that of provisioning ES. Traditional policy tools such as command and control measures, subsidies and tax reliefs seem inadequate to satisfy this growing demand. Market-based policy tools associated to innovative businesses can support the supply of intangible ES creating value and supporting employment especially in rural areas. To design and implement nature-based business solutions, from an initial entrepreneurial idea to a real market opportunity, require a complex set of competences, skills and capacities. They include, for example, the development and use of new technologies (within the broad spectrum of Industry 4.0 opportunities), the valuing of social capital (e.g., trust, relationships and networks among people, organizations and institution) and an innovative approach to investments (impact-investment). Investors and society at large are increasingly sensitive to impacts generated by investments in terms of environmental, social and governance (ESG) issues: while financial profitability remains a key-factor, ESG impacts are increasingly regarded as relevant criteria for assessing and choosing investment options and innovative entrepreneurs have to take these trends into consideration. However, despite promising scenarios for nature-based solutions and marketing of ES, there are still several gaps, including lack of specific training opportunities for young people. Results from a recent survey show that less than 10% of European university courses in the primary sector offer specific training on entrepreneurship, while some technical reports point out that nature-based businesses have often limited capacities and resources invested in marketing activities. Initiatives like business and impact acceleration programs can help filling these gaps. Our contribution shares the potential and challenges of an initiative recently developed to support the creation of business opportunities based on ES and natural capital assets, i.e. the ECOSTAR Nature-Accelerator, an international project supported by the European Erasmus+Knowledge Alliance program to guide a group of start-ups from their ideas to new market opportunities. The project impacts, strengths and weaknesses are presented, in order to draw lessons and provide useful inputs to replicate, improve and, in case, upscale this experience in the future.

Keywords: marketing, ecosystem services, entrepreneurship, forest resources

RENEWABLE ENERGY SOURCES IN FORESTRY

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Abstract: High prices of fossil fuels and political decisions in the direction of increasing energy security and mitigation of climate changes have provided a strong stimulus for the development of renewable energy sources in general, especially of energy obtained from wood. The main objective of the paper is analysis of possible potentials for the production of forest biomass in Serbia as well as measures that need to be taken in order to ensure sustainable use. Planning documents, business reports, analysis of the local wood market, as well as database on the condition of forests were used for estimating production potentials of forest biomass.
Serbia has not great reserves in forest biomass, but there is a potential for its future production. The condition of forests is not satisfactory because 30% of the territory is covered with insufficiently stocked and devastated forests. Problem of the placement of poor quality wood obtained from these devastated forests can be expected to be overcome with the development of woody biomass market. Not only the forest, but also abandoned agricultural and other land represents a potentially significant source of biomass through activities of afforestation and planting plantations for biomass production.
The paper concluded that Serbia has unused potentials for forest biomass production. However, intensification of forest biomass use requires the establishment of system measures for control and supervision in the chain of use as well as the adaptation of the planning and forest management pattern. It must not be allowed for the increase of woody biomass demand to lead to the increased pressure on forests and exceeding of allowed cuts. In that case, positive effects of biomass use on one side could lead to the degradation of forests on the other.

Keywords: biomass, forest biomass, forest use, devastated forests

FORESTS AND CLIMATE CHANGE: THE CHALLENGES FOR SCIENCE-POLICY TRANSFER

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Climate change has been identified as one of the major drivers affecting future forestry, and the role of forest in a bioeconomy. The modes of response comprise both adaptation and mitigation, and require respective strategies on political and forest management levels. However, the scientific discourse on how to best accommodate these demands is heterogeneous and not generally agreed upon. Science-policy transfer is an approach to inform policy-makers about the state-of-knowledge in a balanced way. In the context of climate change, it is important to acknowledge synergies and trade-offs of adaptive management, the role of carbon storage, the impacts of foresting long-living wood products along different temporal perspectives. It is imperative for any climate change strategies to reflect on the socio-economic dimensions of forests, e.g. forest owners and public demands, and safeguard a sustainable provision of forest ecosystem services. The complexity arising from this set-up requires sound policy support that facilitates awareness-rising and serious policy-making and debate. The presentation will give insight into the crucial matters around climate change and forests, and will provide lessons learnt from similar science-policy transfer activities.

Keywords: climate change, adaptation, mitigation, policy support

CLIMATE CHANGE AS THE NORMAL CASE OF EMERGENCY - FORESTRY OR THE MANAGEMENT OF THE UNKNOWN

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Climate Change is a touchstone for long-term forest management since there is deep uncertainty concerning its future effects and impacts. Also in retrospect, the claim of foresters to steer and manage forests in the long term ("sustainability strategy") is in a striking contrast to the indication of our forests presenting themselves, in effect, as a multiform conglomerate of planned and unforeseen, expected and accidental features. If one accepts the fact that the future is generally unknown and our images of the future are mere fictions, which stem from experiences and knowledge from the past, a comparative view on the way how forest sciences and practice deal with the challenge of climate change shows how different both realms deal with uncertainty regarding the future. The paper presents results from a review of current scientific publications on climate change adaptive forest management as well as results from various qualitative studies on actual decision making in forest management: In the sciences, working with future models has become an established approach: based upon various suppositions and simplifications, they first and foremost inform about established basic assumptions and expectations instead of leading to reliable prognoses. In contrast, long-term decision making in practical forest management is informed by the fundamental experience that future will prove "different" and unexpected. As it turns out, the management of the unknown following the principle of sustainability cannot be based on a long-term strategy, but needs to be based on a permanent process of an intelligent muddling through.

Keywords: sustainability; strategic planning; long-term management; uncertainty; decision making; climate change

A COMPARATIVE ANALYSIS OF CLIMATE CHANGE ADAPTATION AND MITIGATION INITIATIVES FOR FOREST SECTOR IN ROMANIA AND MOLDOVA

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This study emerged from multiple similarities between the two countries in forest management approach, as well as the climate change vulnerability and the need for identifying new cooperation opportunities in climate change matters. In both countries, forest sector has held the initiative and the institutional strength for participating in the global effort for actively reducing the GHG emissions and adapting to climate change. Based on assessing a significant amount of relevant documentation - scientific studies, projects reports, planning and strategic documents etc., the paper presents the historic dynamic of climate change commitments, specific to political groups and economic integration for developed/transition economies (Romania is a member of EU with consolidated economy while Republic of Moldova has an transition economy), how the responses evolved in the last 15 years and how they can develop in the future. The analysis demonstrates that bringing the ambition levels to close values is possible through Paris Agreement, considering the advantages generated by the rural development – a common goal for both countries. Romania and Moldova are among the pioneers of implementing governmental mechanisms under Kyoto protocol (Joint Implementation for Romania and Clean Development Mechanism for Moldova), with remarkable results - in Republic of Moldova, the forest land increase with 8% due to these projects - including a high scientific and institutional climate change projects implementation capacity. Nevertheless, in both countries, there is a need for more active involvement of public decision makers towards elaboration and implementation of realistic and pro-active plans for climate change mitigation and adaptation.

Keywords: climate change, forest, Republic of Moldova, Romania

EXPERIENCES IN PROMOTION OF SUSTAINABLE DEVELOPMENT IN THE FORESTRY SECTORS OF SLOVENIA AND THE WEST BALKANS

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Under above topic, the author's 25 years of experiences (as decision maker, researcher, international advisor and expert) in introducing and/or promoting sustainable forest management principles and mechanisms - through creation of forestry and hunting policies and legislation, sustainable organisational framework of the sectors, national forest programmes, criteria and indicators for sustainable forest management, various sectorial studies, for example the one on national forest financing, as well as building of capacities of local foresters, usually within appurtenant national forestry development projects or international forestry institution programmes - will be presented. The experiences range from forestry sectors of Slovenia through the three West Balkan countries (Bosnia and Herzegovina, Serbia and Montenegro) with long sustainable forestry traditions - the longest in Slovenia, where the first forest management plans, based on sustainability of forest yields, were elaborated in 1771. Certain sustainable forest management and development approaches, mechanisms and knowledge, introduced through the mentioned activities in these countries, will be presented and discussed. Based on these, it could be concluded that all the countries now have - apart from common forestry tradition under the former state - contemporary forestry policies and legislation, strategies, forestry organisation, support and financing systems, and a range of educated forestry professionals, wearing to certain extent the author's "footprint", created during the last two decades.

Keywords: sustainable forest management, sustainable development, forest policy, Slovenia, West Balkans

FORESTRY AND CLIMATE CHANGE IN BOSNIA AND HERZEGOVINA: CHALLENGES FOR ENVIRONMENTAL, SOCIO-CULTURAL AND ECONOMIC SUSTAINABILITY

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While climate related sectors, such as agriculture, forestry and tourism are important pillars of national economy, Bosnia and Herzegovina, as potential candidates for EU accession, is motivated to respect some strategic agreements and goals related to reduction of GHG emission, increasing energy efficiency and energy production from renewable sources. At the same time, the newest analyses refer to great impact of global warming to all Western Balkans countries. This paper deals with environmen-tal, social and economic impacts of climate change on forest sector in Bosnia and Herzegovina, particularly analyzing issues such as: forest fires, landslides, floods, drinking water supply, forest dieback, impacts on wood-processing industry, efficiency of forest management, potentials of energy from forest biomass, internal and external migrations and loosing of working places in rural areas. The critical analysis of both, applied and missed options related to adaptation and mitigation measures, clearly points to need for shifting paradigm in national forest policy, towards respect-ing of forest governance principles, bioeconomy orientation and decarbonisation as strategic vision. Due to the complex character of climate change impacts as well as the lack of human, institutional and financial resources, cross-sectoral approach and regional cooperation among all Western Balkans countries seems to be key preconditions to face climate change and natural hazards.

Keywords: forest policy, climate change, Bosnia and Herzegovina

CLIMATE CHANGE GOVERNANCE IN SELECTED EUROPEAN COUNTRIES: FORESTRY AND NATURE CONSERVATION PERSPECTIVE

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Climate change (CC) is an emerging topic in forestry and nature conservation, as it is one of the most significant social, economic and environmental problems today. The risks and negative effects imposed by CC are more evident and are increasing. CC governance refers to a wide scope of activities related to both mitigation and adaptation and requires their coordination between numerous sectors. In addition, dealing with CC is an issue that requires comprehensive, overarching strategies, addressing both national context global targets. In this context, six selected countries (Germany, Austria, Slovenia, Bosnia and Herzegovina, Croatia, Serbia) which have recently experienced natural disasters in forests (windbreaks, ice-breaks, floods, etc.) have been studied. The focus of this research is the analysis of: (i) the perceptions and attitudes of key actors in forestry and nature conservation towards CC governance, and (ii) the current state-of-the-art of CC regulatory and institutional frameworks. The research employed the qualitative methods approach. Primary data were collected in the period November 2016-May 2017 by semi-structured interviews with 43 key actors from different public administrations, management bodies and enterprises, educational organisations and NGOs involved with forestry and nature conservation. In selected countries there are complex regulatory and institutional frameworks for CC governance. However, the need for integrating CC issues into all sectoral policies is clearly recognized and emphasized, both in the analyzed documents, and by the respondents. In addition, a variety of institutional and organizational models related to CC governance were determined in selected countries. The research also revealed diverse forms of cooperation such as information exchange, education, and financial cooperation.

Keywords: climate change governance, regulatory and institutional framework, cooperation, forestry, nature conservation

POLICY MEASURES IN FORESTRY AND NATURE PROTECTION FOR CLIMATE CHANGE MITIGATION IN SELECTED EU AND THE WESTERN BALKAN COUNTRIES

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The global concern on the increase of the greenhouse gasses emissions, resulted in the development of a variety of policies and measures for climate change mitigation (CCM) at international, European Unon (EU) and national level. Provision of different policy measures to institutions and organizations in forestry and nature protection for CCM are urgent tasks for many national governments. The aim of the paper is to analyze policy measures in relation to the CCM that are at the disposal to a number of institutions and organizations in forestry and nature protection in selected EU Members States and the Western Balkan countries (Germany, Austria, Slovenia, Croatia, Bosnia and Herzegovina and Serbia). All mentioned countries are rich in natural resources and their capability to influence carbon balance is pereceived as high. Furthermore, these countries experienced extreme climate and weather events in past decade, which makes this issue as even more urgent for exploring. Collection of primary data was carried out using interviews with main actors in forestry and nature protections sector. Secondary data were collected from internal reports and CCM-related strategic and legislative documents. The CCM has been reviewed through the replacement of nonrenewable energy resource by biomass, carbon sequestration and use of wood products. EU provides a robust framework of policy measures and funds, indirectly supporting implementation of CCM in the forestry sector. The regulatory and economic measures are prevailing in all countries, whereas carbon sequestration measures are mostly supported. Existence of organized system for implementation of policy measures for CCM is not fully recognized in all countries.

Keywords: climate change mitigation, policy measures, carbon sequestration, forestry, nature protection

“WALDSTERBEN” PHENOMENA IN FOREST RESEARCH AND POLICY IN SERBIA

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Forest decline become loci communes in public discussion and important political issue starting from 1980s. At that time one of the main problems in German forests was mortality of white fir trees (Tannensterben) while in Serbia it was *Pinus* species decline. Tree mortality is an important but one of the least understood processes of forest dynamics. First articles on forest decline can be traced for over 250 years following with recent dendrochronological research were shown that it occurs in a time span for over 700 year. Large-scale forest decline observed in late 1970s have been quickly popularized by the media, supported by environmental groups with strong public response to the scenario of novel forest diseases called “Waldsterben” latter on officially “Waldschäden“. Concern to the allegedly new syndrome of forest health decline has been put on political agenda at ministerial level (H1, L2, CLRTAP). In Serbia monitoring of forest vitality is prescribed by Law on Forestry. The umbrella of scientific institutions and responsible Ministry was established as focal center for forest vitality assessment. Annual surveys to study the development of the new forest decline caring out in 40 countries on 235,895 trees including 2,973 trees in Serbia. At least 200 factors were identified and six general hypotheses were advanced but without strong evidence on suspected causes. Now scientific community regales in public funds for research what was called “Waldsterben” phenomena. The same community becomes aware of need for reorganization of monitoring network and survey methods toward new bioeconomy needs of society. We propose Cox model and standardized Composite index of tree vitality.

Keywords: forest decline, reorganization, new monitoring strategy

LIMITATIONS FOR FORESTRY IN PROTECTED AREAS IN SLOVAKIA

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Nature conservation policy is restricting forestry activities in protected areas. In frame of the project Research and Development for Innovation and Support of the Competitiveness of the Forestry Sector, financed from the budget chapter of the Ministry of Agriculture and Rural Development of the Slovak Republic (element 08V0301) major conflicts and barriers limiting the use of forests in protected areas in Slovakia were investigated. The conflict between nature conservation and wood production is necessary to solve by political instruments. The paper describes the current legislative, economic, and social issues related to forestry in the protected areas of the Slovak Republic. Based on case studies from the Czech Republic, Poland, Austria, Switzerland, France and Germany alternative policy instruments and nature protection systems are analyzed. Selected features of the best practices were used as an inspiration for compromises in the process of balancing forestry and nature conservation in order to maintain the interest of the various stakeholders. In order to provide arguments for possible solutions to unlock the potential of forests in protected areas within the intentions of the green economy an innovated process model was created.

Keywords: nature conservation, wood production, conflict, policy instruments, process model

THE HARMONIZATION OF NATURA 2000 PLANS WITH FOREST MANAGEMENT PLANNING IN ROMANIA: WHAT IMPACTS, WHAT SOLUTIONS?

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Natura 2000 network (N2000) is the core pillar in the European Union's (EU) biodiversity conservation policy. The establishment of the N2000 network is meant to add special management measures for the forests included in the N2000 sites. Nevertheless, existing studies point to important challenges and conflicts in setting and implementing N2000 management plans. In Romania, according to the legal requirements, the provisions of the Natura 2000 plans superpose the provisions of forest management planning. Thus, all forest management plans have to be adapted to the requirements of Natura 2000 plans. In this context, the aim of this analysis is to identify in how far the implementation of the Natura 2000 management plans result in general and practical requirements and recommendations for forest management planning. In order to do so, the content of 50 management plans N2000 have been analysed considering a list of keywords as to identify 1) changes of the functions assigned to forests; 2) additional restrictions referring to regeneration process, juvenile stand tending, thinning, sanitation cuttings, regeneration cuts, clear-cuts; 3) imposed measure for biodiversity/habitat trees, death wood, riparian buffer zones, marginal habitats; 4) restrictions on harvesting activities. The results of the analysis show that the technical references to forest management planning are scarcely integrated in the Natura 2000 management planning. The additional provisions refer mainly to the need to preserve death wood and biodiversity trees and to temporary restrictions of forest harvesting.

Keywords: Natura 2000, forest management planning, Romania, biodiversity

HUMAN DIMENSIONS IN WILDLIFE MANAGEMENT: A TOOL TO ENSURE SUSTAINABILITY

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Wildlife management is commonly considered to be area of interest for conservation biologists. However experiences from North America show that social component is equally important as biological in managing game species, especially if goal is to ensure its sustainable development. In Republic of Serbia hunting sector is in charge for game and wildlife management, which is traditionally evaluated and monitored by its natural components. Such approach completely ignores the most important stakeholders in the hunting sector – hunters, their opinions, beliefs and needs. Thus aim of this research was to test applicability of social studies in game management and compare its findings with traditional approach. Knowledge and experiences from both methods have been compared in order to identify (dis)advantages of both methods and provide adequate recommendations for decision makers and game researchers for future analyses.

Keywords: Human Dimensions, wildlife management, Serbia, sustainability

PROTECTION OF NATURE AS A POTENTIAL OF SUSTAINABLE DEVELOPMENT OF LOCAL COMMUNITIES IN SERBIA AND A TOOL FOR THE REDUCTION OF NEGATIVE IMPACTS OF CLIMATE CHANGES

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Areas with preserved natural and cultural heritage, including landscape diversity, represent a growing factor in the sustainable development of the local governments in Serbia, contrary to the previously widespread opinion, particularly of the decision-makers, that nature protection is one of the reasons of economic lag of certain regions. Increasingly, there are initiatives from the local level, particularly by civil sector, regarding the valorization of natural values of some localities for the designation of new protected areas, as well as improving the manage-ment efficiency of the existing protected areas, especially those of special national and international importance. Data about the current state and changes in the number and structure of protected areas in Serbia have been analized, as well as types of protected area managers, management effectiveness and methods, and also initiatives from the civil sector, local governments, expert and scientific institutions directed towards the improvement of the status in the sector of nature protecti-on and sustainable use of natural resources. The interests and potenti-als are primarily recognized through the development of eco-ethno tourism, recreation and education programs, as well as the deve-lopment of the traditional use of space and resources in accordance with the defined capacity. The harmonization of sectoral policies is being encouraged and also the prevention of the imposition of unilate-ral interests and solutions, particularly in the sectors of energy, infras-tructure, agriculture and water management. The exceptional impor-tance of preserved forest and aquatic habitats, particularly in large river basins, is emphasised in the flood and drought risk management. These two disasters are, among others, caused by climate changes.

Keywords: nature protection, local communities, sustainable devel-opment, climate changes mitigation

ORGANIZATION OF PROTECTED AREA MANAGEMENT IN SERBIA: DIVERSIFICATION FROM PUBLIC TO PRIVATE MANAGERS

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Protected areas contribute to the environmental, social and economic goals of sustainable development through support of ecosystem functioning, promotion of sustainable use of renewable resources and provision of space for tourism and recreation. Management of protected areas represents interaction between different actors from local to international level, with complex roles and responsibilities. Managers of protected areas can be different organizations from public and private sector. The aim of this study is to determine organizational structures of management of protected areas, within different groups of managers. As the research method in data collection phase, structured interviews with standardized survey questionnaire were used. Observing the territorial organization of nature protection in public enterprises (PE) that manage national parks (NP), it is conducted through four PE that manage NP (PE "NP Fruška Gora", PE "NP Đerdap", PE "NP Kopaonik" and PE "NP Tara"). Within NP there are a number of sectors that represent the basic organizational units and which are further subdivided into different departments. The management of protected areas by PE "Srbijašume" directly in the field is carried out through 15 forest estates and 26 forest management units belonging to these estates, while PE "Vojvodinašume" manages protected areas though 4 forest estates and 10 forest management units. Within other managers, the strategic, operational, and executive levels are within one company. Regarding the organizational structure of protected area management, within PE that manage NP, PE "Srbijašume" and PE "Vojvodinašume", there are separate organizational units that deals with the management of protected areas, which is not the case with the other PE and other managers from public sector (e. g. touristic organization, limited liability companies, military institution, etc.). Within managers from private sector (e.g. NGOs, join-stock companies, churches and monasteries, etc.), there are (in half of cases), separate organizational units dealing with the aforementioned tasks.

Keywords: organization, protected areas, managers, Serbia

SUSTAINABLE MANAGEMENT IN NATIONAL PARK KOPAONIK- CASE STUDY OF DIVISION AND RELEVANCE OF TOURISTS CHARGES

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Among many problems that protected areas are facing around the globe, improper and insufficient financing is still dominant and very frequently recognized as most important one. Plausible way to tackle this kind of problem for protected areas managers is developing the sustainable funding strategy where diversified funding portfolio is one among four key principles for this kind of accomplishment. Sustainable funding strategy presents important pillar for reaching sustainable management in protected areas. Due to rich biodiversity, preserve nature, distinguish nature features, cultural and historical values many protected areas are hot spot for tourism activities. Tourism or tourists sector is one of the fastest growing service sector in the world. This continuous growing trend provides great opportunity for protected areas to capture and tap part of the revenue from tourism in order to diversify their financing strategies for fulfillment of their main goal - preservation of nature and its biodiversity for future generation. Purpose of this paper was to provide information for protected areas managers and practitioners about entrance fees collection model established in National park Kopaonik as a new revenue source. This research, conducted as a case study, presents a legal framework for usage of tourist charges (direct and indirect ones) for protected areas financing in Serbia, their division and their relevance for sustainable funding strategy and sustainable management in National park Kopaonik.

Keywords: protected areas, financing, entrance fees

IMPLEMENTATION OF EUROPEAN CHARTER ON SUSTAINABLE TOURISM IN SPECIAL NATURE RESERVE GORNJE PODUNAVLJE

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Sustainable tourism intends to reduce tensions and disagreements in the interactions between the tourism industry, visitors, the environment and local communities. The European Charter for Sustainable Tourism in Protected Areas (ECST) awarded by Europarc Federation is a practical management tool that enables Protected Areas (PA) to develop tourism sustainably. The core element of the Charter is working in partnership with all relevant stakeholders. The aim of all Charter projects and activities is the protection of the natural and cultural heritage and the continuous improvement of tourism in the PA in terms of the environment, local population and businesses as well as visitors. The Special Nature Reserve „Gornje Podunavlje“ managed by Public Enterprise „Vojvodinašume“ has been awarded with the ECST in 2014. PE „Vojvodinašume“ as PA manager expects to use Charter as the best tool in achieving the ecological, socio-cultural and economic goals of this destination. It is expected that the entire space which was proclaimed as part of the UNESCO Transboundary Biosphere Reserve Mura-Drava-Danube attract more tourists and that the managing and organization of the destination will contribute to the better use of all tourist resources. The Strategy of sustainable tourism development in the SNR „Gornje Podunavlje“ as a required Charter document, reflects the desire of the PA manager to initiate the development of tourism in a way that will not degrade natural and cultural values. Strategy is the result of field work, research, meetings and consultations within the Stakeholders Forum, which has also adopted this document.

Keywords: sustainable tourism, Gornje Podunavlje, Charter, resources, stakeholders

GOVERNANCE-RELATED INDICATORS AND THE REGULATION OF PRIVATE FORESTRY: A COMPARATIVE ANALYSIS ACROSS EUROPE

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The property rights index (Nichiforel *et al.*, 2018) was proposed as an indicator of forest sector governance. The index shows a differentiation amongst studied European countries explained mostly by the freedom to take decisions in forest operational management and the freedom to restrict public access in forests. We propose a further interpretation of the property rights index (PRI) meaning in the frame of the French cognitive approach of public policies. Thus, we have tested the PRI reliability as governance indicator in checking its consistency with several other governance indicators. Significant correlations appear between the PRI and the corruption index (0.79); International Property Rights index (0.79) and index of economic freedom (0.62), showing that richer and less corrupted the country, fewer restrictions apply on private forestry. In a second step, we have checked the correlation of PRI with relevant forest resource related and economic related indicators. It appears that PRI is significantly correlated with forest productivity (net increment per hectare) and with GDP per capita. Also, the PRI is significantly correlated with the share of public forests (0.65), in the sense that higher the share of public forests, stronger are the restrictions on private forestry. These correlations are discussed in the frame of paradigm changes suggested in the cognitive approach of public policies: while nation-wide policies rooted the forest private sector development within free-market-like paradigms, domestic forest policies reshaped the content of the property rights according to long-term planning and regulatory paradigms dominating the policy arena.

Keywords: property rights index, forest governance, cognitive approach, freedom of decision, private forest owners

ADAPTATION OF PRIVATE FOREST OWNERS MANAGEMENT TO CLIMATE CHANGES - IS THERE AN OPPORTUNITY FOR NEW FORMS OF COOPERATION?

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In the last years there is increased frequency and intensity of natural disasters, causing ice and windbreaks at a large scale, following by bark beetle attacks in Slovenia. Therefore, climate change is a key driver of current forest policy in Slovenia and requires changes in forest management practice. The 80% of Slovenian's forest area are privately owned where small and fragmented properties prevail. Thus understanding private forest owners' management, and their attitudes to uncertainty and changes, is essential for the success of climate change adaptation policies. The study was conducted in two phase. First the analysis of forest management of private forest owners after the natural disaster has been conducted and the differences between private forest owners who cooperate and those who not was investigated. In the second phase semi-structured interviews with private forest owners have been done to analyse the role of different institutions and forms of cooperation. The results imply that for private forest owners natural disaster causes several losses resulting from either the costs additional to those of normal management or the reduced income. Private forest owners who cooperate realized more cuttings and their response time was shorter. Moreover, they see an opportunity in forest management cooperation, but this cooperation can be difficult to achieve as owners rarely have similar forest management objectives. Therefore, active policy instruments that encourage good practices need to be implemented for helping private forest owners to respond to the consequences of climate change.

Keywords: climate change, natural disasters, private forest owners, forest management, cooperation

EXPECTATIONS OF FOREST OWNERS AND THE GENERAL PUBLIC TOWARDS PROVISION OF FOREST ECOSYSTEM SERVICES WITHIN SUSTAINABLE FOREST MANAGEMENT: A CASE STUDY OF SLOVENIA

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Initiatives like MEA, TEEB, Ecosystem Services Partnership and EU Biodiversity Strategy to 2020 are pushing for integration of ecosystem services into sectorial management and establishment of environmental accounts. To do so effectively data on ecosystem goods and services are needed, especially on societal demand for ES. This information is crucial to assure multifunctional ecosystem management. In case of forestry such data is largely missing, thus we designed a nation-wide public survey, which was to establish public expectations/needs towards forests and perceptions of forests owners for how to meet those needs. A computer-assisted web interview was designed with quantitative format questions, based mainly on Likert-scale responses to statements (short version) and an additional willingness-to-pay questions (long version). The survey was administered in 2017 with an overall of 801 complete responses, from which 164 for the long version of the questionnaire. In general, supportive forest ecosystem services were indicated as most important, followed by provision and cultural ones. More than 4/5 of respondents felt that free access to forests needs to be preserved, and that forestry must focus primarily on environment protection and then on economic growth and societal equity. In case of forest owners, more than half don't know if their management is affected by public's enjoyment of ES, however almost 2/3 feel they would need to be compensated for providing ES in their forests. A bit less than 2/3 of respondents are willing to pay more than 0 €/annum for visiting forests, with more than a third at 10 €.

Keywords: forests, ecosystem services, public survey, owners

POLICY FRAMEWORK CONDITIONS FOR FORESTRY BASED SOCIAL INNOVATIONS: THE CASE OF SLOVENIA

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From 2010, social innovation (SI) gained the attention of the European Union (EU). As EU emphasized market-economic aspects of SI over social, social enterprise (SE) became associated or even equaled with SI. Many European countries adopted new or amended existing policies to accommodate the newly used concept of SI. Equalling SI with SE bears the danger of policy framework that does not comprehensively target non-market SI initiatives. SI and SE might not be the same, as social innovation necessarily includes civil society engagement and not the market orientation. Slovenia, as EU country, flowed the trend and adopted new policy framework on SE. Our aim is to investigate if Slovenian policy framework conditions comprehensively address market and non-market SI initiatives. We analyzed 16 documents from cohesion, social entrepreneurship, rural development, and forestry policy looking for the way they address SI. We found out that single policy containing the term SI is the cohesion one. The term SI appears in the statements in the introductory part, but the operational parts contain exclusively the term SE. A comprehensive, but restrictive regulatory framework for regulating SE is in the force since 2011. Although the framework imposes regulatory and economic barriers, Slovenian SE database had 252 SE registered until 2017 from which one was registered for forestry-related services. Rural Development Program explicitly addresses SI exclusively through the measures targeting SE. Implicit measures suitable for non-market SI initiatives are sectoral measures targeting cooperation and networking. Forest policy programs do not mention SI nor SE, but the measures for supporting establishing of private forest owners' associations are suitable for non-market-oriented SI initiatives. We conclude that existing policy framework conditions do not comprehensively address SI initiatives. Policy framework supports the establishment of SE, as a single possible type of SI. Institu-tionalization of SE targets exclusively market-oriented SI initiatives. Non-market, forest-based SI initiatives cannot access the resources that social entrepreneurship policy offers. Because of that, RDP and forestry measures targeting

cooperation and networking are more suitable for supporting non-market-oriented forest-based SI initiatives.

Keywords: social innovation, forestry, policy conditions, social enter-prise, Slovenia

USING Q-METHOD TO REVEAL URBAN FORESTRY PERSPECTIVES TOWARD CLIMATE CHANGE ADAPTATION

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Climate change has arrived on the political agenda as a major driver of environmental change, and is listed among the top five risks for the next ten years. It has an impact on economic and natural systems, as well as human health. Cities have a significant role in this, both as drivers of climate change, and as areas of impact. Urban forests are becoming increasingly recognized in regulating problems posed by climate change in cities. However, appropriate responses to climate change are usually lacking in their management. Climate change adaptation in relation to urban forests has been studied less often in comparison to climate change mitigation. Adaptive capacity of forests to climate change consists of adaptive capacity of forests as an ecological system and adaptive capacity of related socio-economic factors. The latter determines the capacity of a system and its actors to implement planned actions. Both the public and policy-makers are concerned about the observed impacts and anticipated future consequences of climate change. This paper studies social and policy aspects of adaptation processes in urban forests of Belgrade (Serbia). It assesses the perceptions of urban forestry stakeholders towards climate change adaptation based on Q-method interviews. The views of respondents were clustered into three distinct perspectives: (a) 'Management-oriented perspective', (b) 'Sceptics', (c) 'General-awareness perspective'. Awareness of urban forestry stakeholders towards climate change adaptation is characterized by assumptions and uncertainties, which are the result of poor knowledge, lack of data of local impacts and weak communication. The results indicate the need for empowering various stakeholders, improving organizational relations and introducing various means of education and information-sharing mechanisms.

Keywords: stakeholder awareness, urban forest management, climate communication, institutional and human capacity

CAN THE URBAN GREENERY BE AN INSTRUMENT FOR COMBATING CLIMATE CHANGES IN MUNICIPALITY CENTAR - SKOPJE

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“December 2017, Skopje the most polluted city in the world” had occupied the headlines in newspapers and TV news in Macedonia. The civil organizations had organized protest for right for breathing pushing big pressure to the local government of Skopje. The Municipality Centar is one of the 11 municipalities in Skopje that represent the heart of Skopje where a lot of ministries, embassies, agencies, international agency are located. The location of City Park makes the municipality Centar to be green heart of Skopje. The perception of the citizens is considered as very important factor in addressing and defining environmental problems. The citizens’ perception sometimes is used for evaluation of the local government. Occupying the central place in this research the citizens’ perception was used for identification of environmental problems in City Park - Skopje and recommendation for improvement of the current situation. The results have shown that absorption of gasses, CO_2 sequestrations, production of O_2 were considered as the most improtant environmental functions of the urban greenery while the trees, lawns, tree alleys, flowers are the most important natural elements. The culture of the visitors, retain of the urban greenery area, law for urban greenery were identified as very important in City Park mitigation for the effects of climate changes. The findings from citizens’ perception indicated that urban greenery has positive influence on combating climate changes. Local government should organize events where citizens will be informed about the maintenance and management of urban greenery.

Keywords: urban greenery, citizens’ perception, governance, climate change

SESSION: Climate change and health

Chairpersons:
Ljiljana Gojković-Bukarica (SRB), Jasmina Marković-Lipkovski (SRB)

Presenters:

Ljiljana Gojković Bukarica	The influence of climate change on human cardiovascular function
Martina Bosić	Influence of climate factors change on the incidence of skin tumours
Radmila Novaković	Mediterranean climate, Mediterranean diet, health
Natalia Kulikova	Climate- and season-dependent therapy in the A.C. Celsus's treatise "De Medicina"

THE INFLUENCE OF CLIMATE CHANGE ON HUMAN CARDIOVASCULAR FUNCTION

Ljiljana GOJKOVIĆ-BUKARICA[1*], Miloš GOSTIMIROVIĆ[1], Jovana RAJKOVIĆ[1], Ana BUKARICA[2], Radmila NOVAKOVIĆ[1], Vladimir ĐOKIĆ[1]

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Climate change is considered to have great impact on human health. The heat waves have been associated with excess morbidity and mortality of cardiovascular diseases (CVD) across various populations and geographic locations. The important role in heat-induced cardiovascular damage has endothelial dysfunction. It has been noticed that hot weather can impair tone and structure of the blood vessels via interfering with variety of biological factors such as nitric oxide synthesis, cytokine production and systemic inflammation. On the cellular level, higher ambient temperature is limiting storage of energy (ATP) and O2, increasing amount of free radicals and toxic substances and inducing neuronal apoptotic signal transduction, which leading to a stroke. Also, due to dehydration, the high temperature values increase blood viscosity, promote thrombogenesis that has strong impact on patients with atherosclerosis. During chronic exposure to cold or hot weather the cardiovascular function can be decreased, leading to a higher risk of developing heart attack, malignant cardiac arrhythmias, thromboembolic diseases and heat-induced sepsis like shock. It has been shown that changes in ambient temperature through increasing blood pressure, blood viscosity, and heart rate, contribute to cardiovascular mortality. The majority of deaths due to heat waves specially affect individuals with pre-existing chronic cardiovascular disease. This population can experience a decline in health status, since extreme ambient temperature affects pharmacokinetic parameters of many cardiovascular drugs. Increased mortality from ischemic or hemorrhagic stroke can also be related to extreme temperature variations. Preserving cardiovascular function in context of extreme climate changing tends to be particularly challenging.

Keywords: climate change, cardiovascular system, heat-related mortality

INFLUENCE OF CLIMATE FACTORS CHANGE ON THE INCIDENCE OF SKIN TUMOURS

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Human activity in past decades resulted in increase in ultraviolet radiation (UVR) and mean temperature with adverse effects on human population health. Human skin, as the most exposed organ to the environment, shows a high sensitivity to climate changes (CC). Here we review the effects of CC on the skin cancer incidence (SCI). UVR is the main cause of both melanoma and non-melanoma skin cancer (NMSC), due to its DNA damaging and immunosuppressive effects. It is predicted that worldwide SCI could rise from 9% to 300% till 2050, depending on the level of ozone depletion. In Australia, which is the most affected populated area by ozone depletion, skin cancer accounts for more than 80% of all diagnosed cancer types. In central Serbia, the number of newly diagnosed NMSC cases per year has almost doubled since 1999 till 2015. The contribution of NMSC to overall cancer incidence has increased. In 1999, NMSC accounted for 6.1% and 8.7% newly diagnosed cancer cases in men and women, respectively, compared to 11.6% and 11.5% in 2015. This increase could be a result of improved diagnostic methods and raised cancer awareness. Worldwide increase in SCI is also associated with lower socioeconomic status and behaviour change due to increase in ambient temperature (i.e., frequent outdoor activities and wearing light clothing). In conclusion, skin cancer is an important problem in the terms of the cost to the health system and the relation between SCI and CC should be clarified to navigate correct models of skin cancer prevention.

Keywords: climate change, health, ultraviolet radiation, skin cancer, prevention

MEDITERRANEAN CLIMATE, MEDITERRANEAN DIET, HEALTH

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There are five Mediterranean zones around the world that are located near the west coasts of continents between 30° and 40° latitude. It is characterized by cold, wet winters and hot summers with varying periods of drought. The vegetation is similar in each region with plants which contains many good-to-health polyphenols such as resveratrol. Polyphenols are compounds which constitute the active substances and they modulate the activity of a wide range of enzymes and cell receptors. They have a role in the prevention of various diseases associated with oxidative stress, such as cancer and cardiovascular and neurodegenerative diseases. Plants that are rich in polyphenols are important part of Mediterranean diet. This diet is more than defined diet, it represents the plurality of various factors such as: high amounts of olive oil and olives, fruits, vegetables, cereals, legumes, and nuts, moderate amounts of fish and dairy products, and low quantities of meat and meat products. Wine in moderation is acceptable, also. Furthermore, that is combination of Mediterranean food cultures and lifestyles. The Mediterranean climate is a part which contributes very much to the Mediterranean lifestyle and diet. However, despite its increasing popularity worldwide, adherence to the Mediterranean diet model is decreasing for multifactorial influences – life styles changes, food globalization and economic. Recent climatic changes have resulted in negative health effects impact in direct ways (heatwaves, flooding, drought) and in indirect ways (food availability). Climate change is an international priority that must be tackled from all angles, one being consideration of our daily diet.

Keywords: Mediterranean climate, Mediterranean diet, health, polyphenols

CLIMATE- AND SEASON-DEPENDENT THERAPY IN THE A.C. CELSUS'S TREATISE "DE MEDICINA"

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Seasons and health - this problem interested mankind from the early periods of the history of its existence. Philosophers, scientists, and, first and foremost, healers were thinking on it. Physicians of antiquity took into account the season of the year, the terrain (place), climate, age and living conditions of people when determining and treating a particular disease. The great physician of antiquity Hippocrates wrote the essay "On Airs, Waters and Localities", where he examined the question of the seasonality of certain diseases. Roman science and medicine took the baton from Greece and gave a place of honor to the climatic conditions and seasons. Philosopher Lucretius, scientist Pliny the Elder and physician A.C. Celsus examined these problems in their writings. The paper concentrates on the climate- and season-dependent medicinal therapy presented by ancient encyclopedist Aulus Cornelius Celsus (about 25 BC - 50 BC) in his Latin treatise De Medicina, which is the only surviving part (eight books) of the encyclopedia of this author. At the same time, develops a general view of knowledge about nature, seasons and climate and their influences on a human health. In general, the analysis of the Celsus's work gives an idea of the level of development of medicine and the features of scientific knowledge in the ancient Rome in the 1st century AD.

Keywords: A.C. Celsus, ancient medicine, season-dependent therapy

POSTER SESSION

Presenters:

Denitza Zgureva	Computational modelling of static and dynamic adsorption of CO_2 onto fly ash zeolites
Nevena Marković	“Emotional cartography” - A critical perspective on mapping spatial narratives
Boško Milovanović	Spatial and temporal variability of air temperatures and precipitation in serbia for the period 1961-2010
Aleksandra Lekić	Optimal control for DC-DC converters
Ana Kostov	Lead-free alloys for ecological solder manufacturing
Vesela Radović	How to avoid the tyranny of the multiple environmental risk caused by climate change in the Republic of Serbia
Dušan Todorović	Modelling of selected waste biomass downdraft gasification
Miloš Radojević	Comparison of experimental methods for characterization of raw biomass as a key factor for sustainable biomass utilization
Dragan Gačić	The impact of climate change on red deer (*Cervus elaphus* L.) management in Serbia and slovenia
Jasmina Gačić	Climate changes and natural disasters
Dragica Stanković	Ecoremediation in the function of sustainable development
Violeta Babić	Forestry under climate change: Vulnerability overview on regional and national level
Boris Radić	Predicting the unpredictable: contemporary methods for mountain landscapes assessment under the ski resort impacts
Aleksandar Petrović	Global warming - Challenge to the modern enology
Stefana Babović	Socio-cultural sustainability of villages in South-eastern Serbia
Nenad Radaković	Sustainable development and climate change in the forests of National park “Đerdap”

Predrag Petrović Water oxidation pathways modeled on a cobalt oxide phosphine dimer catalyst

COMPUTATIONAL MODELLING OF STATIC AND DYNAMIC ADSORPTION OF CO_2 ONTO FLY ASH ZEOLITES

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Currently, 85% of the global energy production takes place in fossil fuelled Thermal Power Plants (TPPs) supplied by coal, fuel oil, and natural gas. Those fuels are responsible for roughly 40% of the total CO_2 emissions, while among them the coal-fired TPPs have the largest environmental impact. Recently, the targets for limiting of CO_2 emissions into the atmosphere drive an intensive development of innovative technological solutions. One of the broadly studied approaches is the CO_2 adsorption onto solids. The synthesis of novel sorbents would improve the process' parameters in terms of economical feasibility, safety, and ecology. The applicability of established mathematical models for description of the adsorption of CO_2 in static and dynamic conditions is a precondition that will facilitate the process scaling from laboratory to pilot and industrial installations. This study represents the results from computational modelling of static and dynamic adsorption of CO_2 onto the surface of zeolites obtained by alkaline activation of coal fly ash (FAZ). The static adsorption is experimentally investigated in 25 points in the relative pressure range P/P_0=0.001–0.03 at 273.15 *K*. The characteristic energy of CO_2 adsorption was evaluated applying the model of Dubinin-Ashtakov as the obtained results for different FAZ samples varied in the range 16.44–36.39 *kJ/mol*. The correlation *R* up to 0.9998 was achieved describing the adsorption isotherms by Langmuir model varying parameters at different FAZ samples: b=0.0279–0.1669 $1/kPa$ and V_0=0.8054–3.3286 *mmol/g*. The mass and heat transfer in dynamic conditions for the system CO_2-FAZ is computed by LDF model, as the dynamic adsorption capacity and the maximal temperature were used as validation parameters. A maximal deviation of 2.97 % between the experimental and the computation study was obtained.

Keywords: fly ash, zeolite, carbon dioxide, adsorption

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“EMOTIONAL CARTOGRAPHY” - A CRITICAL PERSPECTIVE ON MAPPING SPATIAL NARRATIVES

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The act of mapping has historically imposed not only physical but also imagined boundaries on the landscape and its communities, with numerous examples of “power-knowledge” relations. This paper elaborates on Emotional Mapping, an additional concept in cartography that deals with emotional responses to space, in a broad sense - people’s memories, experiences, perceptions, the sense of place and community. The paper reviews how it is practiced and thought about, both within and outside the academia. In an attempt to explain the current state of understanding on the topic, as well as possible future trends and methods, the paper provides a critical insight into the practical application of the notion, the corresponding cartographic practices, techniques and tools. It encompasses a wide range of approaches, from traditional land use mapping to the Participatory GIS, Counter-Mapping, Deep Mapping, and other forms of New Cartographies, to the art of Remote Sensing and participatory reflection and action methods. Correspondingly, the author rethinks the potential of Emotional Geographies and Cartographies, as an emerging field, which might enhance the re-subjectivization of space and the decolonization of mapping practices and technologies. As such, the paper argues for the concept of Deep Emotional Mapping as a methodology for (re)mapping, i.e. (re)presentation of “unseen”, “invisible”, “absent” or “repressed” landscapes. Ultimately, by acknowledging the value of effective engagement with local voices and knowledge(s), this approach advocates the integration of local (spatial) narratives, likewise local sustainability concepts and practices, in decision-making processes, towards the negotiation of place, thus, sustainable governance.

Keywords: emotionalscape, critical cartography/GISci, affective heritage maps, spatial humanities

SPATIAL AND TEMPORAL VARIABILITY OF AIR TEMPERATURES AND PRECIPITATION IN SERBIA FOR THE PERIOD 1961-2010

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Average air temperatures and annual sums of precipitation in Serbia were analysed in this paper for the period 1961-2010. Latitude, longitude and altitude of 421 precipitation stations and 64 climatological stations and terrain features in their close environment (slope and aspect of terrain within a radius of 10km around the station) were used to develop a regression model on which spatial distribution of air temperatures and precipitation were calculated. The root mean square error (RMSE) and mean absolute error (MAE) are used to validate the results of developed regression model. Air temperature and precipitation trends were analyzed using Sen's estimation, while the Mann-Kendall test was used for testing the statistical significance of the trends. The whole territory of Serbia has practically experienced a statistically significant rise in the average annual air temperature, while about 15% of the precipitation stations recorded statistically significant (significance level of p=0.05) increase/decrease in annual precipitation.

Keywords: air temperatures, precipitation, Sen's slope estimation, Mann-Kendall test, Serbia

OPTIMAL CONTROL FOR DC-DC CONVERTERS

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The main idea of this paper is to design and implement optimal control for a DC-DC converter. This converter is chosen as a representative type of the switching systems. Optimal control design and computation with respect to related switching surfaces or switching times have been developed and adjusted so it can be digitally implemented to control the DC-DC converter. Although the optimal control related to switching times/surfaces using different cost functions and design considerations has been considered before and published in a number of scholarly publications, there has been no implementation in control of DC-DC converters. The main reason is a very demanding calculation that needs to be performed during every switching period, which is short in duration. Thus, this work focuses on increasing the speed of calculations and reducing the number of operations per switching period. The main contribution is the implementation of the algorithm using a microcontroller or a DSP. The advantages of this control design are that it provides a robustly stable converter with shorter startup transient while reducing the switching losses. The experimental results to verify these claims are provided. Furthermore, the results are compared to the already known and widely adopted nonlinear control methods such as: sliding mode control, control using polytopic and quadratic Lyapunov functions.

Keywords: switching converters, DC-DC converters, nonlinear control, optimal control

LEAD-FREE ALLOYS FOR ECOLOGICAL SOLDER MANUFACTURING

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Although the European Union's directive about environment protection as WEEE and RoHS has been carried out in 2003, lead solders are still in used in Serbia. In the aim to respect the European and world directives and laws, it is necessary to reduce a quantity of toxic element and to establish lead and cadmium free solders in production. In this paper it was presented lead-free alloys, which are used for ecological solders manufacturing and various applications. Lead-free solders in commercial use may contain tin, copper, silver, bismuth, indium, zinc, antimony, and traces of other metals. Different elements serve different roles in the solder alloy. The most attractive world lead-free alloys are so-called SAC alloys (Sn-Ag-Cu) and alloy which possesses some application in electronics is Sn-In-Ag alloy. So, the best solution is used the best properties of the both alloys Sn-In-Ag and Sn-Ag-Cu and made a new Sn-In-Ag-Cu alloy. In that case, indium content in alloy should not be high, in the aim to avoid partial melting of alloy, which is not good for practical application. The second reason is economical. High content of indium make higher price of solder. According to the above mention, the best results are reaching by the used solders with the follow content: 50-90% Sn, 10-30% In, till 10% Ag and till 2,5% Cu. Besides alloys based on indium, it could be used solder alloys based on gold. This kind of alloys is especially used in multi-integrated electrical circuits with dense packages. Au-In-Sb-Ga and Au-In-Sb alloys belong to the group of possible solder materials with gold and indium.

Keywords: solder, alloys, lead-free

HOW TO AVOID THE TYRANNY OF THE MULTIPLE ENVIRONMENTAL RISK CAUSED BY CLIMATE CHANGE IN THE REPUBLIC OF SERBIA

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Global climate change impacts through the 21st century on human civilisation are many. Those changes are a threat for economic and political instability in the most sensitive parts of the Serbia. The main aim of this article is to present interdisciplinary, multi-scale and collaborative approaches among state and regional officials because they often lack information about the size and likelihood of the existing environmental risks. Hence, imperative has to be in handling critical environmental risks and turn risks woes into opportunities. Authors focused on local government strategies in response to environmental risk, and explained the long-term development of efforts to manage interactions between the society and the environment. The article method is adequate for the social science. A comparative analysis on various environmental risks (i.e., air pollution, water and soil contamination, and extreme weather events linked with climatic change) are based on data of the recently affected territory (region and cities in Eastern and Western part of the Serbia). Gained results proved that cumulative impacts of environmental risks are difficult to manage. The stakeholders have to urgently apply “the precautionary principle” because all actions should be taken to correct a problem as soon as there is evidence that environmental degradation may occur, not after the degradation has already occurred. Results create a realistic picture of the consequences of the environmental risks, plans of preventive measures based on environmental risk assessment, and initiated further researches aimed to maximize the positive economic benefits, and reduce population suffering.

Keywords: climate change, environmental risk, human security, wellbeing

MODELLING OF SELECTED WASTE BIOMASS DOWNDRAFT GASIFICATION

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Gasification of waste biomass has double benefit since it presents efficient and environmentally friendly procedure to produce energy. Modelling of gasification of demolition wood and coffee waste, and their mixtures, in downdraft gasifier is investigated. Air is exclusively used as gasification agent. A model for waste biomass gasification has been developed using “Engineering Equation Solver” (EES). The downdraft gasification model, prepared within this study, is an analytical semi-empirical model that can be used as a tool to analyse the general trends of biomass downdraft gasification. The main characteristic and advantage of this model is that involves main gasification sub-processes (drying, pyrolysis, gasification). Also, model is capable of dealing with wide variety of biomasses (based on elemental and ultimate analysis) and to predict its behaviours during a gasification process (yield and composition of the products - producer gas, charcoal and tar). Different gasification process parameters (temperature, equivalence ratio, air preheating) are varied and discussed in order to define optimal (qualitative and quantitative) yield of producer gas for each of biomass and their mixture.

Keywords: downdraft gasification, biomass, demolition wood, coffee waste, semi-empirical model

COMPARISON OF EXPERIMENTAL METHODS FOR CHARACTERIZATION OF RAW BIOMASS AS A KEY FACTOR FOR SUSTAINABLE BIOMASS UTILIZATION

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Obtaining experimental data of proximate analysis for solid biomass fuel by standard methods can be hard and time consuming process, even though those data could be the key for estimating the possibility of biomass sustainable utilization. Thermogravimetric analysis (TGA) is recognized as the possible alternative to experimental tests done by standard methods, but not only in terms of determining the data of proximate analysis. For example, TGA could also provide the mass fraction of biomass base components and yet define the structural composition in that manner. This work presents TGA experimental data of proximate analysis for five different solid biomass samples (corn cob, wheat straw, hazelnut shell, chemically treated and chemically untreated sawdust) with several different approaches performed by sixty measurements. Obtained results are compared with proximate analysis data acquired by standard methods. The apparatus Netzsch STA 449 F5 Jupiter was used for the experiment and two key measurement options have been changed for all samples – instrument calibration and sample temperature control (STC). The STC is an adjustment option of Netzsch which defines how the heating rate will be reached (by the sample temperature, or furnace temperature). Each measurement was repeated three times in order to get repeatability of obtained results.

Keywords: TGA, biomass, proximate analysis, instrument calibration, sample temperature control

EUROPEAN ECOLABELS FOR WOOD FURNITURE

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In order to protect the environment, eco labelling of products has become popular during last decades, not only in Europe, but also in the rest of the world. Ecolabel is a sign to the customer that the certified product has less harmful impact to environment than the other products from the same category. Indoor wood furniture is one of the categories of products that can be eco certified. Besides its impact on the environment, this kind of product also has significant influence on human health. Because of that, the basic purpose of this research was identification of the most important requirements which indoor wood furniture has to fulfill in order to be eco certified. For the purpose of the research, general scientific methods were used, such as method of content analyses, comparative and genetic analyses, methods of induction, deduction and synthesis. It was established that during testing of wood furniture in order to award ecolabel, the following criteria are usually checked: the origin of raw wood material, the quantity of free formaldehyde in chemical products used in production of furniture, the presence of chemical products in furniture which are classified as environmental hazard, toxic, carcinogenic and mutagenic, such as VOC emissions and odours. In addition to the above mentioned, there are some specific requirements for awarding ecolabels, which refer to used wood species or materials for furniture production Bearing in mind the significance of ecolabels to environment, and, in the case of furniture, to human health, their use is expected to expand following years.

Keywords: furniture, wood, wood based materials, ecolabel, VOC emissions

THE IMPACT OF CLIMATE CHANGE ON RED DEER (*Cervus elaphus* L.) MANAGEMENT IN SERBIA AND SLOVENIA

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The aim of this paper is to carry out a comparative analysis of the current state and management of red deer populations in Serbia and Slovenia. The annual harvest of red deer in Serbia is significantly lower compared to Slovenia (1,035, i.e. 5,866 individuals in 2015, respectively). This can be explained by a better hunting legislation and hunting organization, and a modern system of monitoring and management in Slovenia, where management is adaptive and based on several indicators. Unlike in Slovenia, management in Serbia is based on estimating the spring count of the population and its structure. The majority of red deer in Serbia is located in fenced hunting areas or parts of hunting areas, while red deer in Slovenia is exclusively free in a natural environment. Red deer is one of the key species in the areas where forests are the dominant type of vegetation, which is why it is necessary to study and understand its ecological role in a wider context. Climate change affects many red deer populations in Serbia. The most significant changes are the ever more frequent floods in the hunting grounds by the Danube and Sava Rivers, as well as forest fires and droughts in the Deliblatska sands area. There are no similar problems in Slovenia, so the number and distribution of red deer is continuously increasing, which can be one of the consequences of climate change (higher feeding capacity due to more frequent yields of broadleaf seeds and warmer winters, and consequently higher reproduction).

Keywords: forest, game, management, population, flood

CLIMATE CHANGES AND NATURAL DISASTERS

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Modern society, faces the challenges, threats and dangers that jeopardize its functioning and require special attention in order to reduce their impact and possible economic, social and security problems. Last few decades two topics - climate change and natural disasters, have attracted great attention both practitioners and the public. As climate change has been identified as one of the drivers of disaster risk a platform for reducing possible consequences at global level is set out in strategic documents. All recommendations for achieving the set goals emphasize the vulnerability reduction at the local and community levels through the improvement of resilience and adaptability, particularly in developing countries. Changes in climatic conditions, as well as an increased frequency of hydro-meteorological disasters, have been observed in the territory of Serbia, however, the scope of the consequences must be seen through the vulnerability and resilience of the community. The aim of the paper is to analyze the strategic, legal and planning documents related to both issues and to link with social vulnerability to natural hazards through the risk perception which determines the readiness and adaptability of the society. The results of the pool survey showed that respondents were familiar with the meaning and scope of the term of natural disaster, that they had previous experiences with certain types of natural disasters, that they were afraid of natural disasters, that they do not possess knowledge about local natural hazards, as well as functional knowledge about correct response and behavior in case of natural disaster.

Keywords: climate changes, natural disasters, risk perception, vulnerability

ECOREMEDIATION IN THE FUNCTION OF SUSTAINABLE DEVELOPMENT

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Accumulation and toxic effects of heavy metals is extremely important in all environmental media. Their entrance has negative influence on environment and human health in general. The aim of this paper was to investigate the bioaccumulation potential of certain woody and herbaceous plant species for zinc (Zn), manganese (Mn), nickel (Ni), lead (Pb) and iron (Fe). To determine the content of these heavy metals in the leaves of the plants we selected one herbaceous species (dandelion - *Taraxacum officinale* F.H.Wigg.) and four woody species (norway maple - *Acer platanoides* L.; silver linden - *Tilia tomentosa* Moench; black pine - *Pinus nigra* Arnold; common hornbeam - *Carpinus betulus* L.). Plants were selected in the area of Lipovica forests near Belgrade city. The concentration of heavy metals in plants is determined by atomic absorption spectrophotometry (AAS). Based on the obtained results, it can be concluded that all of the investigated elements in all plant species at the Lipovica forest site, with minor or larger deviations, are not a threatening factor in this area in the period 2017-2018.

Keywords: heavy metals, accumulation, pollution, plant species

FORESTRY UNDER CLIMATE CHANGE: VURNELABILITY OVERVIEW ON REGIONAL AND NATIONAL LEVEL

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Disturbance of energy exchange between the Earth and outer space, induced by increasing emissions of green-house gases and consequently accelerated global warming cause climate change beyond natural variability. The speed of climate change and frequency of extreme events is increasing. Humanity is combating this issue by implementing measures to ensure sustainable development and preserve the natural environment. Forestry is a highly vulnerable sector because of its low speed of changes, high sensitivity to the effects of pests and plant diseases due to xerothermization of climate (reduction in temperature and precipitation). The risks that emerge from negative climate change impacts are reflected in financial loss due to the decrease in wood mass and quality, and in environmental degradation and deterioration, both resulting in the reduced comfort of living conditions in the biosphere. Taking measures to preserve forest ecosystems is urgent and requires long-term planning. Thereby, forestry is considered as one of the key vulnerable sectors, besides agriculture, water management and healthcare. National and regional (EU, South East Europe, Western Balkan) documentation, related to combating climate change, highlights the adaptation of forestry as imperative and provide recommendations for priority measures. One of the adaptation measures, which requires long-term planning and is highly sensitive to quality of vulnerability assessments under future climate, is: selection of tree species and their varieties with higher tolerance to altered climate conditions, but also adaptable to optional climate conditions. Implementation of this measure requires extensive and interdisciplinary analysis that ensures success, since this action is not reversible and requires large funding.

Keywords: climate change, forestry, vulnerability, adaptation

PREDICTING THE UNPREDICTABLE: CONTEMPORARY METHODS FOR MOUNTAIN LANDSCAPES ASSESSMENT UNDER THE SKI RESORT IMPACTS

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The changes that arrived with the informally called Anthropocene epoch have permanently changed the face of the planet Earth. With the increase in the planet's population, hunger-based civilization has invaded natural areas in the quest for space and resources. As a primary result of such activities, vital natural resources have been degraded, consequently reducing the quality of life of human communities. Particularly noticeable are landscape degradation processes that carry the risks of loss of production power of the land, but also the threat to human lives and infrastructure from more frequent natural disasters. Under these circumstances, it is necessary to invest in finding methods and techniques that enable the predictability of processes that are induced by anthropogenic activity. Landscape ecology as a science whose basic task is to analyze and monitor the changes in the landscape structure and impact of these transformations on the status of natural processes and functions offers this possibility. The application of GIS techniques through landscape ecology principles enables quantitative analysis of the spatial development scenarios which is one of the obligatory elements of the environmental impact assessment studies. Construction of a new ski resorts is an attractive activity in a transitional societies which is unfortunately often derived without precise and comprehensive impact assessments which makes environmental conflicts unpredictable. On the example of planned Besna Kobila ski resort (Vranje, Serbia), we will demonstrate the meaningful and purposefully methods which are the part of landscape ecology approach which can rise level of predictiveness of proposed spatial solutions.

Keywords: landscape degradation, impact assessment, GIS, ski resort

GLOBAL WARMING - CHALLENGE TO THE MODERN ENOLOGY

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A numerous papers have been published dealing with the influence of global warming on the chemical composition and sensory characteristics of grapes and wines. High temperature values shorten the time needed for grape harvest. The all parts of the berries could not reach the full maturity and the concentration of sugar in the grapes is on the rise. The acidity of grapes often decreasing along with an undesired increase in pH. All of this affect grape harvesting before the berry achieves full technological maturity, which is primarily related to the skin and seeds. The insufficient maturity of grape influences the chemical composition and quality of the wine. The wine have not the required intensity of color. In the case of long maceration, there is a risk of increasing extraction of bitter tannins. In this situation, the oenologists have to use the technological process that is applied under conditions of incompletely mature grapes or they have to wait for the full maturity of grapes and then apply technological procedures to reduce alcohol content and pH. Thus, the variability of the climate from year to year influences the quality of grapes, and therefore the quality of the wine.

Keywords: global warming, wine, phenolyc maturity

SOCIO-CULTURAL SUSTAINABILITY OF VILLAGES IN SOUTHEASTERN SERBIA

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The Southeastern Serbia is the most undeveloped region in the country and this is the reason why we choose it - to highlight the problem of development in this area. Sustainability implies economic, environment and social development. Social development is still the least represented, both in scientific papers, and in particular solving the problems of development. The subject of this paper is the five villages of Southeastern Serbia which belong to the municipalities of Leskovac and Vladičin Han - Tegovište, Velika Sejanica, Kukavica, Crveni Breg, Ostrovica, and socio-cultural conditions in them. The following indicators were used to present socio-cultural sustainability: number of inhabitants, age structure of population, economic structure of population (the ratio of the dependent and active population), education, availability of health services, income and traffic infrastructure. The results showed that in the observed area there is a poor socio-cultural basis for further development. This condition is caused by unfavourable demographic situation and the weak development of the economy. In order to sustainably develop the region it is necessary to create new jobs through opening new factories, state subsidies to agriculture or to start their own business, which would attract the younger population in these areas.

Keywords: social development, Southeastern Serbia, villages, indicators

CLIMATE CHANGE IMPACT ON THE FORESTS OF NATIONAL PARK "ĐERDAP"

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Current global climate change is mainly caused by an increase in the amount of greenhouse gases, and in particular carbon dioxide (CO_2) in the atmosphere. Forests have enormous significance in reducing CO_2 concentrations in the air and creating oxygen, and this ecological function of forests is directly related to the balance of assimilation. Climate changes impact on the forests in NP "Đerdap" were determined on the basis of changes in the bioindicators of the integrated influences of all factors - change in radial growth. In this study, the radial growth of sessile oak (*Quercus petraea* agg. Ehrendorfer 1967) is used as a tree species with noticeable annual rings. On a sample of 400 increments obtained from 200 dominant trees, correlation analyzes were conducted between changes in the radial growth of sessile oak and known climatic elements - air temperature and precipitation from the nearest meteorological stations. The results of the conducted correlation analysis between standard local chronologies and data on air temperature and precipitation have shown that the radial growth of sessile oak in NP "Đerdap" is more affected by precipitation. Such results are the basis for the formation of an information database, which can be used, among other things, for the definition of sustainable development through management plans for forests stands.

Keywords: climate change, National park "Đerdap", forest, radial growth, sessile oak

WATER OXIDATION PATHWAYS MODELED ON A COBALT OXIDE PHOSPHINE DIMER CATALYST

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In recent studies it was established that Co-dppe (dppe=1,2-bis (diphenylphosphino) ethane), can serve as an effective catalyst in water oxidation (WO) reaction. Exact structure and the mechanism of the catalysis is still a mystery due to the amorphous nature of this catalyst. DFT calculations were used to design a simplified model of the system, and investigate different mechanisms of this reaction examining relative energy of the intermediates. WO reaction was explored through three possible pathways differing in the way O_2 is formed and removed from the system. The study focused on the influence of the dppe ligand, since experimental evidence indicated that it plays decisive role in the catalysis. Results showed that the energy cost of the water oxidation reaction was decreased after the introduction of dppe ligand due to decisive changes in the thermochemistry of the reaction intermediates.

Keywords: DFT, water oxidation, co catalyst, Green chemistry

Annex

KOLLEG AGENDA

Wednesday, 19th September	
Registration	14:00 – 19:00
Welcoming sessions	15:00 – 19:15
Cocktail dinner	at 19:15
Thursday, 20th September	
Registration	08:30 – 18:00
Opening ceremony	09:00 – 10:00
Coffee break	10:00 – 10:30
Plenary session	10:30 – 12:30
Lunch	12:30 – 13:30
Parallel sessions	13:30 – 15:30
Coffee break	15:30 – 16:00
Parallel sessions	16:00 – 18:00
Conference gala dinner	at 20:00
Friday, 21st September	
Registration	08:30 – 15:30
Plenary session	09:00 – 10:00
Coffee break	10:00 – 10:30
Parallel sessions	10:30 – 12:30
Lunch	12:30 – 13:30
Parallel sessions	13:30 – 15:30
Belgrade city tour	at 15:30
Free evening	
Saturday, 22nd September	
Registration	08:30 – 15:00
Plenary session	09:00 – 10:00
Parallel sessions	10:00 – 12:00
Coffee break	12:00 – 12:30
Parallel sessions	12:30 – 14:30
Closing ceremony	14:30 – 15:00

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