Review of PhD. Thesis of Hanna Huryna, MSc,
(Faculty of Science, University of South Bohemia in České Budějovice, Czech Republic)

Effect of different types of ecosystems on their meteorological conditions and energy balance components.

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The submitted thesis is printed in Ph.D. Thesis Series of University of South Bohemia in České Budějovice, Faculty of Sciences (No. 16. 2014, 171 pp.). The main part of the thesis is formed by 4 published papers. Contribution of Hanna Huryna made to those papers is clearly formulated.

Introduction
The thesis consists of Introduction (22 pages) with references (21 pages). The introduction starts with briefly formulated aims of the research. Radiation distribution both shortwave and long wave with tables of air emissivity, thermal conductivity of different types of soil as well as albedo values are given. Author clearly explains the principles and main methods of evaluation of energy balance of vegetative surfaces and the tight connection between solar energy and water fluxes. On basis of physics the author shows role of vegetation in hydrological cycle and stresses cooling (air-conditioning) effect of vegetation. The explanation is supported by relevant literature covering broad scale from physics of solar radiation to meteorology, climatology, role of vegetation in water cycle and local climate to case studies of radiation balance and water cycle.

Methods and study area description
are given on 16 pages. Advanced instrumentation, localities in Třeboň Biosphere Reserve are described and a brief critical overview of methods used for measurements of evapotranspiration is described. In this chapter author lucidly summarizes and explains methods of calculation of energy balance and evapotranspiration and statistical routines used in the following published papers. She clearly defines her role in the team work: data processing, calculation of energy fluxes, interpretation of results including study of relevant literature.

The main part of the thesis consists of four already published publications, papers 1 and 2 were presented at internationals conferences and published in the following books, the papers 2 and 4 were reviewed in a standard way of scientific journals. All four papers deal directly with the thesis topic and are based on data measured in Třeboň region. Progress from monitored data evaluation to processes evaluation and ecological interpretation of estimated energy fluxes is evident when reading the 4 papers published from 2010 till 2015.

1) **Huryna H**, Pokorný J (2010) Comparison of reflected solar radiation, air temperature and relative air humidity in different ecosystems: from fishponds and wet meadows to concrete surface. In: Vymazal J (ed.) Water and nutrient management in natural and constructed wetlands. Springer Netherlands, Dordrecht, pp 308–326
2) Pokorný J, Brom J, Čermák J, Hesslerová P, **Huryna H**, Nadezhdina N, Rejškova A. (2010) Solar energy dissipation and temperature control by water and plants. International Journal of Water 5(4): 311-337

3) **Huryna H**, Pokorný J, Brom J (2013) The importance of wetlands in the energy balance of an agricultural landscape. Wetlands Ecology and Management 21(6). DOI 10.1007/s11273-013-9334-2
4) **Huryna H**, Hesslerová P, Pokorný J, Jirka V, Lhotsky R (2014). Distribution of solar energy in agriculture landscape – comparison between wet meadow and crops. In: Vymazal J (ed.) The Role of Natural and Constructed Wetlands in Nutrient Cycling and Retention on the Landscape. 103 – 122, Springer Netherlands, Dordrecht, DOI 10.1007/978-3-319-081177-9_1

Summary and Conclusions form the last part of the thesis. Author separately evaluates temperature, air humidity, energy fluxes at sunny days (solar energy income over 6kWh.m^{-2}.day) in order to compare ability of ecosystems to use high income of solar energy i.e. to buffer temperature differences.

I have a few comments and couple questions in this issue:

1. You have measured the reflection of shortwave solar radiation during clear sky (1.85 kWhm^{-2}d^{-1} of concreting the surface, 1.53 kWhm^{-2}d^{-1} of dry meadows, 1.49 kWhm^{-2}d^{-1} of pasture and 0.59 kWhm^{-2}d^{-1} of the pond). My question is whether is it possible to quantify the effect of on landscape structure change and energy flow and whether it can be introduced into the methodology of processing spatial plans and development plans.

2. States that air saturated with water at 40 ^{0}C contains 50 g m^{-3} water vapour , which corresponds to 62200 ppm (volume). Obviously, it follows that, when the air contains less water vapour , there is less water particles, thus less ppm. Experts on Climate Change, expressed the view that climate can gather very dramatic changes if CO_2 in the atmosphere increases for more than 400 ppm. H_2O and CO_2 in the atmosphere as greenhouse gases. There is one serious controversy:. If the climate change is really caused by an increase in greenhouse gases in the atmosphere, then drying of countryside which is linked with decrease of GHG would have positive effect? What is your opinion about this controversy? Climate change is reduced when content of GHG , H_2O molecules goes down and this happens in dry landscape. On the other hand landscape drying results in low CO_2 sequestration because of low primary production i.e. low photosynthesis How do you explain effect of drainage on climate on the basis of your experiments?

3. You indicate that 1 kg of dry biomass contains 0.4 kg of C and production of biomass depends on water availability. . About 1 milion hectares of land including small and large wetlands were drained in the second half of 20th century. Are you able to estimate roughly how much CO_2 was released due to the drainage and what is the change of solar energy distribution?
4. In many parts of published materials you reported on decrease in evaporation and temperature rise. For example, the conversion of tropical forests to pasture in the Amazonia resulted a in evaporation decrease by 12% and increase the temperature of 2,5 ^{0}C. Are you able on bases of your results to quantify relationship between

reduction of evapotranspiration, reduction of photosynthesis and biomass production, temperature increase and increase of CO_2 for Amazonia?

5. You state that in the USA fell total wetland area was reduced by 50%. What does it mean in terms of reduction of biomass and reduced carbon sequestration and CO_2 increase in the atmosphere? This can be quantified?
6. Worldwide, there is about 40% of dry land on the continents. From the perspective of your research, what does it mean if in these territories water is returned and photosynthesis (primary production) and carbon sequestration restore? . What would this mean for the climate of the planet Earth?

7. Based on the research that you did, what would you recommend to politicians at local, regional, national, continental and global work in addressing climate change?

The work raises a number of completely new contexts regarding the state of water and vegetation in shaping climate that may have a significant impact on strategic decision making in solving the climate problem and should be admitted to the defense work.

In Košice, January 20th 2015
Michal Kravčík, v.r.

Review of PhD thesis

Hanna Huryna: Effect of different types of ecosystems on their meteorological conditions and energy balance components

The thesis deals with role of vegetation in the dissipation of solar energy and the associated stabilization of local climates. This topic has been neglected so far among mainstream researchers of climate change, yet it has a great potential value for wise water management at the levels of ecosystems and landscapes. A further challenge is the need of an interdisciplinary approach, comprising both the insight into biological processes and the competence to relate them to the underlying physical principles. This challenge extends not only to the author of the study but also to its reviewers, because each of the scientific fields draws on different background training. I evaluate the thesis as a plant biologist studying plant processes at the levels of whole plant, plant stands and ecosystems.

The topic of the thesis brings inspiration to classically trained plant physiologists, who traditionally study plant processes as determined by "external and internal factors". In other words, they regard plants as passive products of their genotypes and environment. Unlike traditional plant physiology, plant ecology deals with the feed-backs within and between different the ecosystem components. Within its theoretical concepts, it is open to considering also the effects of plants on their surroundings, but this view is seldom taken seriously in ecological applications.

The thesis is organised in a standard manner. It consists of seven chapters, of which the first is a literature review, the second describes methods and study area. Chapters 3-6 are based on papers previously published as book chapters (Chapters 3 and 6) or as articles in international scientific journals (Chapters 4, 5). The content of Chapter 5 has been published in Wetlands Ecology and Management, a journal with impact factor (IF=1.218).

Chapter 1, Introduction, sets out research aims and reviews current knowledge of the research topic on the basis of a respectable set of about 200 references. It addresses a broad range of aspects including the physical principles of ecosystem energy balance, the role of evapotranspiration in the dissipation of solar energy and, finally, the role of various types of land-cover in the hydrological cycle.

Chapter 2 describes the study area and methodology. The computation of the energy balance and evaporation rates is described in particular detail. I appreciate consideration of methodological principles and constraints, which is necessary for the correct interpretation of the results, but is often neglected by field biologists gathering data with technical devices.

Chapters 3-6 are based on four separate scientific papers, covering particular aspects of the four study aims. They provide results on the energy balance for various types of land cover, including wetlands well saturated with water, agricultural grassland and arable land with different crops, and, last but not least, dry (concrete) surfaces. Woody vegetation is also briefly mentioned, though it is not central to the study. As all four papers have already been published, it is useless to comment on details such as the distribution of data sets among them. Although at first sight it seems that they partly overlap, a closer view shows that they represent a series, in which each subsequent paper brings some new aspects in data evaluation and interpretation.

Chapter 7, Summary and conclusion, gives good overview of main results, organised according to methodological approaches. The synthesis deserves appreciation not only for its own scientific value, but also as an output not always present in PhD studies composed from a set of separate papers. Although each of the four papers included has a Discussion section, I would have appreciated a general discussion included in the last chapter of the study. It is not an obligatory requirement for the PhD studies composed from a set of papers, but in this particular case, it would have given the opportunity to relate the whole study to the current scientific context outlined in Chapter 1.

The formal aspects fully meet the requirements for a PhD study. This concerns the general layout, consistency in reference formatting and quality of artwork. The only slight weakness I could find is the English, which is somewhat clumsy in hitherto unpublished Chapters 1, 2 and 7 and complicates understanding in places.

In conclusion, the thesis represents a piece of valuable research, clearly demonstrating the need to consider vegetation not only as water consumers, but rather as a valuable tool stabilising the hydrological cycle and microclimate at ecosystem and landscape scales. The knowledge has considerable potential for practical application. Although Hanna Huryna was lucky to join a well-established team, she took all advantage of this opportunity. Her contribution to the team work is clearly explained in comments to the publications included and is sufficient for a PhD. study. She has proven both diligence and competence in gathering, analysis and presentation of scientific data of considerable complexity. Further, she organised the results into a coherent set of information and provided their synthesis. It is therefore my pleasure to recommend the thesis for defence and, when successfully completed, to award the candidate a PhD degree.

České Budějovice 26th January 2015

Prof. RNDr. Hana Čížková, CSc.

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Review of PhD. Thesis of Hanna Huryna, MSc,

(Faculty of Science, University of South Bohemia in České Budějovice, Czech Republic)

"EFFECT OF DIFFERENT TYPES OF ECOSYSTEMS ON THEIR METEOROLOGICAL CONDITIONS AND ENERGY BALANCE COMPONENTS".

1. The Topic and the Structure of the proposed thesis

The topic of the work is very actual and it is concentrated on investigation of the influence of structure of land cover on a local climate. The proposed work is structured in 7 chapters without appendices. The first chapters "Introduction" and "Method and Study area description" are proposed as proper parts of the thesis and they contain a theoretical and methodological background for the thesis. Both the chapters represent very comprehensive analysis of the studied problems. The introduced relations, dependencies and laws are relevant for the next chapters and they are very richly completed with citations. (The first chapter contains more than 220 referred sources, the second chapter more than 50.) The chapters 3, 4, 5, and 6 are based on texts published in years 2010 – 2014 as papers in journal with impact factor (*Wetlands Ecology and Management*), in reviewed journal (*International Journal of Water*) and in books edited and published in Springer. In three of these scientific publications is the author of the thesis the first author.

The thesis as a whole represents very serious research in problems of energy flows in ecosystems, in problems of set up of energy balances and in the influence of structure of land cover on the development of various ecosystems.

The approach, the applied methods and the achieved results are excellent, supported by confrontation with opinions of scientific authorities in the studied field and completed with adequate measurements and observations.

2. The Objective of the thesis and the achieved results

The objective of the thesis is explicitly formulated in pages 1 and 2. The objective has 4 main sub objectives that are easy to check. I declare with pleasure that all items of the thesis objectives *were satisfied.*

Prof. Ing. Jiří B í l a, DrSc., Institute of Instrumentation and Control Engineering, Faculty of Mechanical Engineering, Czech Technical University in Prague, Technická 4, 166 07 Prague 6

- Aim 1: "To estimate the temperature and air humidity difference between different land cover types."

Theoretical base for this aim is done in Chapter 1. Practical results completed with measurements in six types of land covers (fishponds, wet meadows, pasture, barley field, village and concrete surface) in characteristic parts of Třeboň basin (e.g. in village Domanín) are introduced in "Chapter 3 Comparison of reflected solar radiation, air temperature and relative air humidity in different ecosystems: from fishponds and wet meadows to concrete surface". The results of this chapter are very convincing and they emphasize a significant difference in average temperature (and relative humidity) measured above (0.3 m) wet meadow and concrete surface.

- Aim 2 "To evaluate the role of vegetation in solar energy balance and energy distribution of some typical ecosystems of the Czech Republic",

  Aim 3 "To determine the evaporative fraction of the studied land cover types" and

  Aim 4 "To discuss the role of plant cover types on the global hydrological cycle"

  are processed partially in Chapters 4, 5, 6.

  Theoretical dependencies are introduced in Chapter 1 and than gradually in Chapters 4, 5 and 6 in a relevant places of need.

  To illustrate importance of conclusions in these chapters I choose three interesting dependencies from Chapter 4.:

- While global warming is commonly attributed to atmospheric CO2, the research shows that water vapor has a concentration two orders of magnitude higher than other greenhouse gases. It is a critical fact that landscape management protects the hydrological cycle with its capacity for dissipation of incoming solar energy,
- Plants stands supplied with water (in a healthy ecosystem) are able to respond to incoming solar energy to an order of hundreds of W m^{-2}. Such ecosystems cool themselves.
- It is difficult to understand why the IPCC (International Panel for Climate Change) does not give more attention to the climatic effects of ecosystem processes.

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3. Notes and Critique

A. I quote a part of the text in page 113: "The water cycle is continuously driven by the Sun´s irradiation and it plays a key role in the dissipation of solar energy and in the cycling of matter. Ecosystems, like other living systems, are dissipative structures in terms of non-equilibrium thermodynamic (Capra 1996, Schneider and Sagan 2005); they tend to release heat and to use solar energy for self-organization. "
Unfortunately – the way how ecosystems use the released heat for self-organization is not described in needed details in the thesis. I ask, please, the author of the thesis to explained it within the framework of the defense.

B. I have a small comment to assertion introduced in page 163 below: "Evaporative fraction displayed that during dry spells, at the wet meadow more than 100 % of available energy was released through evapotranspiration."
It is possible?

4. Conclusions

I have studied the proposed thesis and I carefully judged its merits. I have respected the novelty contained in achieved results and I appreciate highly the contribution of the thesis to the field of Natural and Ecological Sciences.

I recommend to propose the thesis for the defense.

In Prague, 21st December 2014 Prof. Ing. Jiří Bíla, DrSc.