Discussion Contribution

"THE SUBSTANTIAL ROLE OF WATER IN THE CLIMATE SYSTEM OF THE EARTH"

(to the UN Climate Change Conference in Copenhagen on 7 - 18 December 2009)

by Jan Pokorny, Michal Kravcik, Juraj Kohutiar and Martin Kovac[1]

It is expected that the UN Climate Change Conference in Copenhagen on 7 - 18 December 2009 will establish a global climate agreement for the period beyond 2012 when the first commitment period under the Kyoto Protocol expires. As the "Negotiating Text"[2] calls for openness to proposals, we strongly suggest that the following principles be included in the text:

1. **Water in all its forms has a substantial role in the climate system of the Earth.**
2. **Draining of water from land through deforestation, forms of agriculture and urbanization, contributes to climate change.**
3. **Restoration of water and vegetation on disrupted landscapes is the key mitigating and adaptive measure to combat the part of climate change caused by human drainage of water from the land.**

[1] J.Pokorny, ENKI, o.p.s., Dukelska 145, 37901 Trebon, Czech Republic, enki@enki.cz; M.Kravcik & J.Kohutiar, NGO People and Water, Cermelska 24, 04001 Kosice, Slovakia, ludiaavoda@ludiaavoda.sk; M.Kovac, Association of Towns and Communities of Slovakia, Bezrucova 9, 811 09 Bratislava, Slovakia, www.zmos.sk. Partnership and common background stem from the project "Water for the Recovery of the Climate - A New Water Paradigm", 2007, www.waterparadigm.org

[2] "Negotiating Text"and a "A text on other issues outlined in document FCCC/KP/AWG/2008/8", Ad Hoc Working Group, 8th Session, http://unfccc.int/resource/docs/2009/awglca6/eng/08.pdf

GENERAL COMMENTS:

Preparatory conferences[3] and documents released by the UN demonstrate the firm resolution of participating parties to fight climate change and its consequences.

However,

- their attention is limited to anthropogenic CO_2 emissions (and a few other greenhouse gases) as the only form of human impact on climate; they do not discuss or even mention the role of water vapour, the most widespread greenhouse gas in the atmosphere;
- preparatory document sections related to CO_2 sequestration by soil and vegetation[4] overlook, partly or completely, other substantial climate services provided by healthy landscapes, particularly evaporation, which is the most important energy transformation on Earth; water evaporation converts incoming solar net radiation into latent heat thus moderating the accumulation of sensible heat at the earth's surface;[5]
- the amount of sensible heat gained as a consequence of draining land is appreciably larger (at least on the local level) than from greenhouse gas increases during the industrial period;[6]
- there is accumulating scientific evidence of climate impacts due to the human disruption of terrestrial vegetation and water cycles;[7]
- the mitigating/adaptive effects of water and vegetation on climate change are explicitly or implicitly reflected in several international documents on the topic.

Not accounting for these water and vegetation impacts can lead to unreliable estimates of energy flow,, leave policy makers and the general public unaware of the scale of water and land mis-management consequences, and possibly limit adequate attention to the human induced impacts on climate change.. The failure of current mathematical models to reflect sufficiently the evaporation related energy processes in ecosystems must not be

[3] E.g.: Conference "Climate Change: Global Risks, Challenges and Decisions" at the Bella Center by the University of Copenhagen on 10-12th March 2009; or negotiating meeting in Bonn from 1 to 12 June 2009
[4] "A text on other issues outlined in document FCCC/KP/AWG/2008/8"
[5] e.g. M. Kravčík, J. Pokorný et al. - Water for the Recovery of the Climate - A New Water Paradigm, 3rd Chapter, 2007, www.waterparadigm.org
[6] approx. 1.6 Wm^{-2} according to International Panel on Climate Change, 2007
[7] e.g. http://climatesci.org/ or http://www.bioticregulation.ru/;

the reason to ignore these fluxes.[8] Research and restoration of water and vegetation resources (e.g. through comprehensive programs of rainwater conservation, wetland re-establishment, reforestration, etc) on large disrupted areas deserve as much or even more attention than greenhouse gas mitigation already receives. Not least, omission of the interaction between land management and climate change undermines the prospect of "A shared vision for long-term cooperative action."[9]

SPECIFIC COMMENTS:

1. There is no doubt that water has a substantial role in the climate system of the Earth. Water makes Earth unique among other planets. Due to water, temperatures on Earth are relatively stable and maintained within the range suitable for life. Where water is lacking in the soil and in the atmosphere, extreme thermal conditions usually predominate. Water has the largest measured heat capacity of all substances naturally existing on Earth. Water is also exceptional because it can occur naturally in all three states, solid, liquid and gas at temperatures common on Earth. As water changes state, it takes in or gives up a large amount of thermal energy. At 20°C, the evaporation of one cubic meter of water to vapour consumes 680 kWh. Evaporation plays a crucial role in the dissipation of solar net radiation by converting it into latent rather than sensible heat. The transformation of water's solid or liquid forms into vapour gives it high mobility, and relatively large volumes are able to quickly shift in the horizontal and vertical directions. Due to this ability to bind, transfer and release energy, water moderates temperature differences on Earth. Water vapor which rises higher into the atmosphere, condenses under the influence of cooler temperatures thus releasing thermal energy and returns back to the ground in the form of rain. This ingenious cycling mechanism,is the dominant process transferring surplus thermal energy from the earth's surface to the upper atmosphere. Clouds play an important role in the Earth's energy balance by regulating solar radiation.[10] Clouds reflect part of the shortwave solar radiation, thus limiting its entry into the atmosphere and to the surface of the Earth. They also capture part of the longwave (thermal) radiation from the

[8] e.g. Marco Schmidt - Global climate change: the wrong parameter, RIO 9 – World Climate & Energy Event, 17-19 March 2009, Rio de Janeiro, Brazil
[9] Title of the 1st part of the "Negotiating Text"
[10] see e.g. http://www.theglobalcoolingproject.com/science/science.shtml

Earth which would otherwise escape into space; they thus have a warming effect as well. However, the dominant effect of water and water vapour is protection of the Earth from excessive warming and moderation of temperature differences and climate extremes.

2. Urbanization, deforestation, and some forms of agriculture are generally accompanied by land drainage. Changes in land use and cover affect biophysical surface fluxes in several ways. If there is insufficient water on land, large flows of solar energy cannot be transformed into the latent energy of evaporated water but are instead converted into sensible heat. Each year, about 54750 km² of the earth's surface is used for new urban developments. If water evaporation from this area decreases 200mm, about 6,751,040 GWh of sensible heat is added per year. If the decreased evaporation on 127000 km² of annually deforested areas is also taken into account, about 17,374,000 GWh of sensible heat is added.[11] This amount of heat is equivalent to the annual global electricity generation.[12] The amount would be even higher if the further decline of precipitation due to the loss of evapotranspiration was taken into account. Substantial amounts of sensible energy are added from global land surfaces already cleared for agriculture or human settlements (croplands, pasture, and urban areas cover nearly 35% [55 million km2] of continental surfaces[13]). The spatial and temporal distributions of temperature over the earth's surface can be monitored by infrared (remote) sensing (See Annex 1-4).[14] The interaction of so-called dry "hot plates" (agricultural-urban land) with cooler, moist regions (higher elevation or latitude) results in concentrations of clouds and rainfall over the latter regions. Other climate extremes triggered by "hot plates" are floods, longer periods of drought or extreme heat, forest fires, lower groundwater reserves, decrease in soil fertility and biodiversity, etc. Temperature distributions associated with patterns of water and vegetation on a land may provide a more direct and logical explanation for regional climate extremes than the increase of the almost homogeneous content of CO_2 in the atmosphere.

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[11] Schmidt, Global Climate Change: The Wrong Parameter

[12] World net electricity generation was 18.0 trillion kilowatthours in 2006

[13] J. A. Foley et al. - Green surprise? How terrestrial ecosystems could affect earth's climate, Front Ecol Environ 2003;

[14] For example the satellite Landsat provides temperature data with spatial resolution 120m or 60 m (pixel size 120 x 120m)

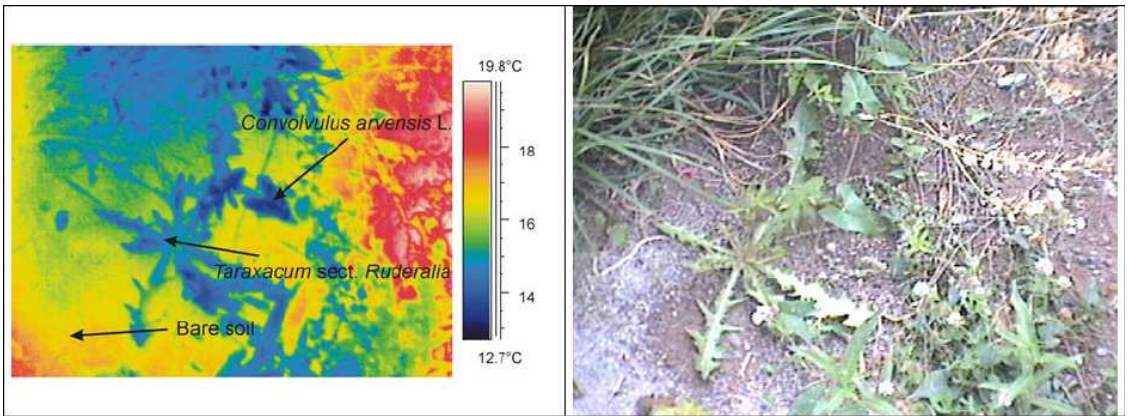
3. The mitigating/adaptive effects of water and vegetation on climate change are explicitly or implicitly reflected in international documents on the topic. Some, like the Ramsar Convention in Changwong, insist on communicating a message to the Conference in Copenhagen: *"[The Conference of the Contracting Parties]… Encourages Contracting Parties and other organizations to undertake, where possible, studies of the role of wetlands in carbon storage and sequestration, in adaptation to climate change, including for flood mitigation and water supply, and in mitigating the impacts of sea level rise, and to make their findings available to the Convention, the UNFCCC and other relevant processes."*[15] At the recent World Water Forum in Istanbul, session discussions on healing disrupted water cycles and climate systems concluded that: "*Terrestrial ecosystems fulfil essential functions in the water cycle and provide ecosystem services of great benefit for water management. Realization of these benefits requires pro-active coordination of land- and water management. Sustainable utilization of ecosystem services may represent a cost-effective strategy with multiple benefits for land, water and climate compared with investments in structural measures."*[16] The European Commission, in a recent White Paper on Adapting to Climate Change claimed: *"Strategies focused on managing and conserving water, land and biological resources to maintain and restore healthy, effectively functioning and climate change-resilient ecosystems are one way to deal with the impact and can also contribute to the prevention of disaster…working with nature's capacity to absorb or control impact in urban and rural areas can be a more efficient way of adapting than simply focusing on physical infrastructure. Green Infrastructure can play a crucial role in adaptation in providing essential resources for social and economic purposes under extreme climatic conditions. Examples include improving the soil's carbon and water storage capacity, and conserving water in natural systems to alleviate the effect of droughts and to prevent floods, soil erosion and desertification."*[17] A document accompanying the White Paper[18] is more specific, i.e. *"Ecosystems play a direct role in climate regulation via physical,*

[15] 10th Meeting of the Conference of the Parties to the Convention on Wetlands (Ramsar, Iran, 1971), Changwon, Republic of Korea, 2008, Resolution X.24-Climate change and wetlands;
[16] WWF, Resolution Session 3.3.1, Istanbul, 2009
[17] White Paper - Adapting to climate change: Towards a European framework for action, 1st April 2009, p.5
[18] COMMISSION STAFF WORKING DOCUMENT accompanying the WHITE PAPER Adapting to climate change: Towards a European framework for action, 1st April 2009,

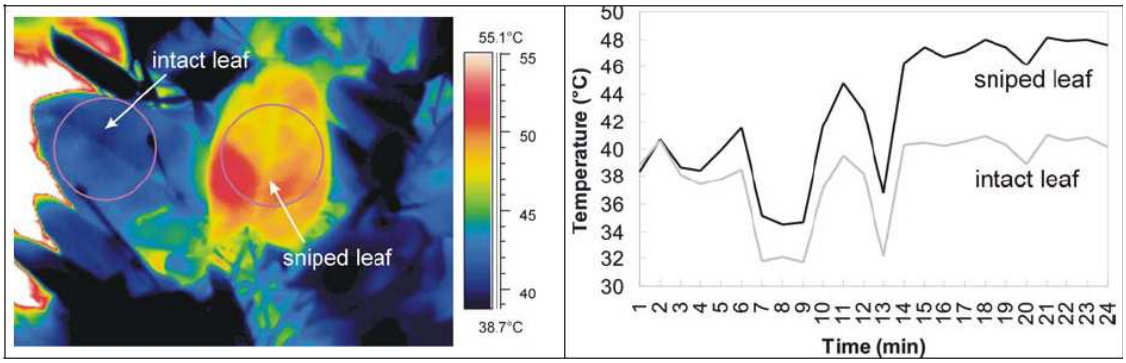
biological and chemical processes that control the fluxes of energy, water, and atmospheric constituents including greenhouse gases."[19] This document also specifies useful measures for different policy areas.[20]

[19] ibid, Part 2.1.3
[20] ibid, Tables 5 – 14;

ANNEX 1 – VEGETATION IS COOLED BY TRANSPIRATION [21]



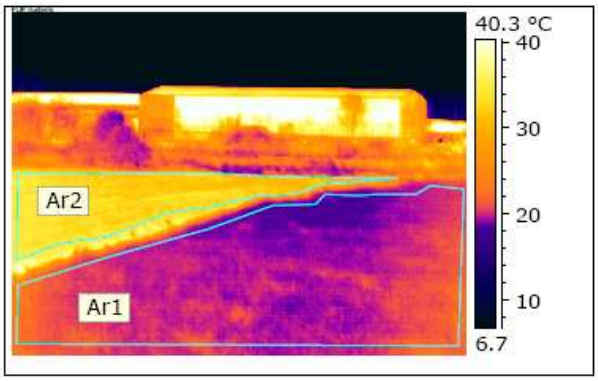
Photographs of thin vegetation in the infrared spectrum and in the visible spectrum
The bare surface of the ground is visibly warmer than the surface of the leaves cooled by transpiration (Trebon, Czech Republic, July 12, 2002, 10:00 a.m.). It is obvious that the cooling effect of transpiration is stronger than the effect of albedo.



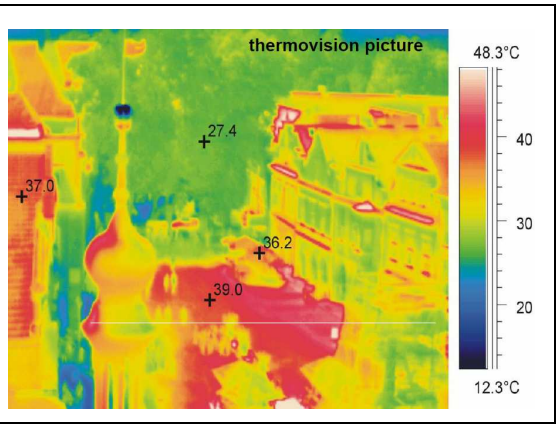
Distribution of temperatures in an intact and snipped leaf (Convolvulus arvensis L., July 27th 2004, 12:00). The leaf was snipped and left for 24 minutes on the original place in the vegetation. The oscillation of temperature is due to changing cloud cover.

[21] Jan Pokorny et al. - The Role of Vegetation in Water Cycling and Energy Dissipation, Proceedings of the 1st Natural Sequence Farming Workshop. 'Natural Sequence Farming: Defining the Science and the Practice', Bungendore, Australia, 2007

ANNEX 2 –TEMPERATURES IN CITIES AND ON FARMLAND DEPEND ON WATER AND VEGETATION[22]



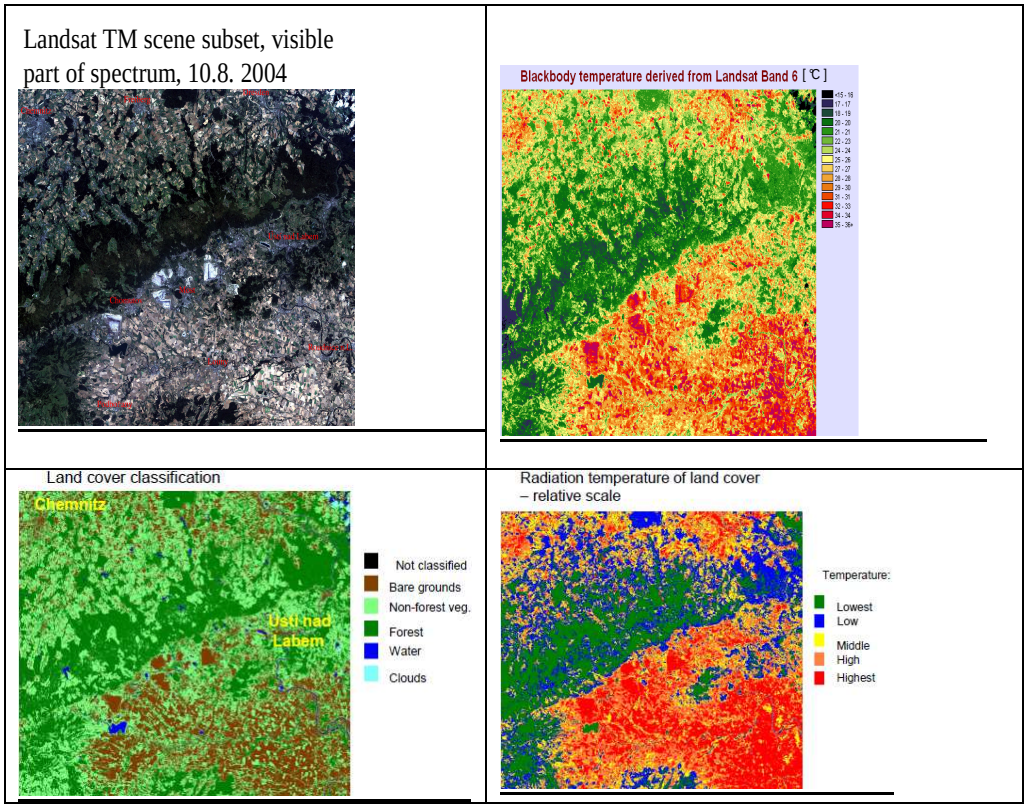
Surface temperatures of grassland and ploughed field exhibit the difference 12.7°C (South Bohemia, April 27th 2008, 1:43 pm).

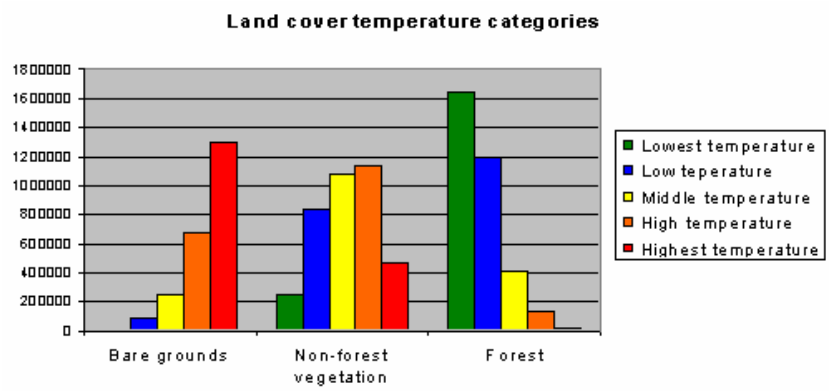


The cooling effect of vegetation documented on an infrared picture of the town square of Trebon (Czech Republic). Pavement and roofs of the houses in the square are close to 40°C, while the temperature of the trees in the park is under 30°C.

[22] All pictures are courtesy of ENKI ops. and were acquired within National Research Programme, 2B06023, Development of Method for Estimation of Energy and Matter Fluxes in Selected Eosystems (2006 – 2011), Ministry of Education, Youth and Sports of the Czech Republic.

ANNEX 3 – LAND COVER DETERMINES TEMPERATURE DISTRIBUTION IN A REGION





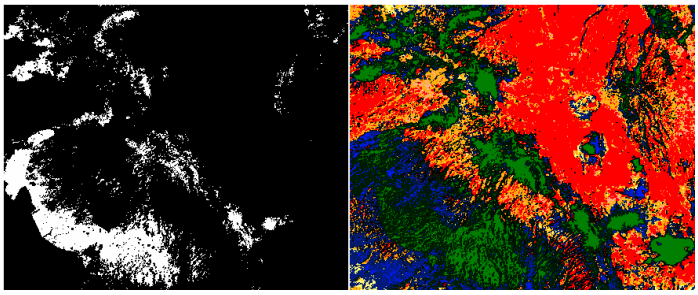
Scenes of Central Europe region (North Bohemia, East Germany/Saxony, approx. 100 x 85 km) show how land cover affects temperature distribution. The highest temperatures are evident on bare land (open cast mines, arable land, cities) whereas healthy forest shows the lowest temperature. Forest and water are relatively cooler during day hours although they have lower albedo than bare land.[23]

[23] Hesslerová, P. – Pokorný, J. The synergy of solar radiation, plant biomass and humidity as an indicator of ecological functions of the landscape: a case study from Central Europe, *Integrated Environmental Assessment and Management*, 2009; Hesslerová, P. Landscape functioning assessment based on solar energy dissipation. *Acta Universitatis Carolinae Geographica.* In Print.

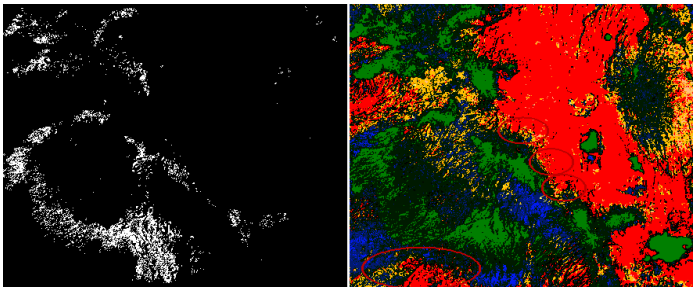
ANNEX 4 – DEFORESTATION CONTRIBUTES TO WARMING

Satellite picture of Mau Forest (white): **Temperature map of Mau Forest area:**

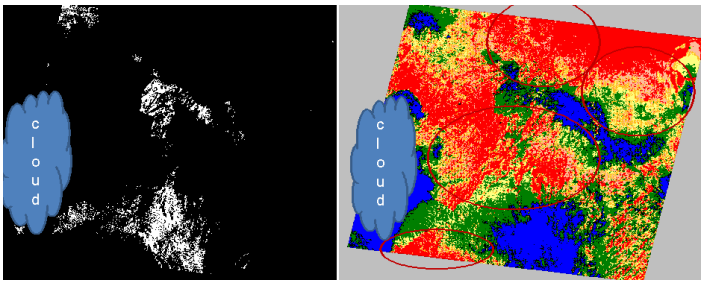
28.1.1986



27.1.2000



5.8.2005



Mau forest area changes
1986 – 48 000 ha
2000 - 36 000 ha
2005 – 16 500 ha

- lowest temperature
- low temperature
- middle temperature
- high temperature
- highest temperature

Cutting of forest results in a significant increase of temperature. The satellite images of central Kenya (subset size 124 x 125 km) show time series of forest decline in Mau Forest Region and its effect on temperature for years 1986, 2000, 2005. Increase of temperature on clear cuts is evident.[24]

[24] Hesslerová, P. – Pokorný, J. Effect of Mau forest clear cut on temperature distribution and hydrology of catchment of lakes Nakuru and Naivasha. In: *Kröpfelová, L., Vymazal, J. (eds.) 7th International Workshop on Nutrient Cycling and Retention in Natural and Constructed Wetlands, 22 – 25 April 2009, Třeboň, s. 40 – 44;* T. J. Baldyga et al. - Assessing land cover change in Kenya's Mau Forest region using remotely sensed data. *African Journal of Ecology* 46, 2007, p. 46–54