Land Surface Dynamics and Hydrologic Connectivity



The Sahel

Photos from futurechallenges.org, Lusile17.centerblog.net, & vega.isara.fr

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Topics

- Landscape degradation and desertification
- What is the link between landscape dynamics, energy and mass, the hydrologic cycle
- The importance of wetlands, lakes, riverine, forests, green spaces and landscape management and restoration



(Lake Tana Watershed Regreening Ethiopia's highlands: A new hope for Africa)



Ethiopia: Source: Insidene.com

Overgrazing and Deforestation in Ethiopia

Desertification and Landscape Change



The Sahara has Expanded by 10% since 1920

https://earthsky.org/earth/sahara-desert-is-expanding



Source: FAO; desertification in Africa

Wind Erosion

Desertification



Overgrazing

- Deforestation
- Wetland loss
- Soil loss by wind and water erosion

The Evaporation Process

Water must be available Energy to detach water molecules Wind to carry out water molecules Atmosphere must have space to hold water molecule or release



Abtew, W and A. Melesse. 2015. Chapter 3: Landscape Impact on Regional Hydrology and Climate. In: Melesse A. and W. Abtew (eds.). Landscape Dynamics, Soil and Hydrological Processes in Varied Climates, Springer.

Energy and Mass of Water



Surface Temperature of Forest and Drained Meadow with Road as seen by Thermovision Camera

Energy Balance

H + E = R - G

Sensible Heat + Latent Heat = R - G



Modified from: Eiseltova, M., J. Pokorny, P. Hesslerova and W. Ripl. 2012. Chapter 14: Evapotranspiration - A driving force in landscape sustainability. Irmak A (ed.) Evapotranspiration Remote Sensing and Modeling. InTech (open access book)

Energy Partitioning and Landscape Changes (Latent and Sensible Heat)

Energy Balance

$R \approx H + E + G$





The Sudd (<u>http://www.southsudan.</u> <u>net/the-sudd-swamp-in-south-sudan/</u>)



Africa (FAO)

Sahel (USGS)

Importance of Wetlands in Regional Hydrology and Wetland Restoration – The Everglades, Florida, USA



Land-Cover Changes, Energy Fractionation and Regional Hydrology



Average Sensible Heat, H (left) and Latent Heat, E (right) Flux (w m⁻²) for July – August



Source: Marshall, C.H, Pielke, R.A., Steyaert, L., Willard, D.A. 2004. The impact of anthropogenic land-cover change on the Florida Peninsula sea breezes and warm season sensible weather. Monthly Weather Review. 132:28-52

July-August Convective Rainfall Declining Trend in Florida



Source: Marshall, C.H, Pielke, R.A., Steyaert, L., Willard, D.A. 2004. The impact of anthropogenic land-cover change on the Florida Peninsula sea breezes and warm season sensible weather. Monthly Weather Review. 132:28-52

Summary Results of the Study which Applied Regional Atmospheric Modeling to the South Florida Region

When pre-1900 natural cover was replaced with 1993 landuse

- Spatial patterns of sensible and latent heat flux were altered significantly
- Drained and urbanized areas showed higher sensible and lower latent heat fluxes
- Land-cover change resulted in change in rainfall

Source: Marshall, C.H, Pielke, R.A., Steyaert, L., Willard, D.A. 2004. The impact of anthropogenic land-cover change on the Florida Peninsula sea breezes and warm season sensible weather. Monthly Weather Review. 132:28-52

Convective Rainfall over South Florida (July 1-2, 1998)



Combating Desertification



Jojoba plantation to combat desertification Thar Desert, India

photograph by Terrence Moore

Inner Mongolia, China; Source: Xinhua



Ethiopia Tree Planting Program (KTLACreator: ChrisVanLennepPhoto | Credit: Getty Images/iStockphoto) EcoWatch

Tree Planting Program in Ethiopia

Importance of Wetlands in Regional Hydrology: The Sudd in the Nile Basin



Wetlands in the Nile Basin – The Sudd



Robelo and El-Mogharaby. 2016. The Sudd. Springer Science+Business Media Dordrecht 2016 C.M. Finlayson et al. (eds.), The Wetland Book, DOI 10.1007/978-94-007-6173-5_23-5



Earth Observation Based Assessment of the Water Production and Water Consumption of Nile Basin Agro-Ecosystems

by <u>Wim G.M. Bastiaanssen 1,2,3,*,Poolad Karimi</u> 1,2,3,<u>Lisa-Maria Rebelo 1,Zheng Duan</u> 3,<u>Gabriel</u> Senay 4,Lal Muthuwatte 1 andVladimir Smakhtin 1, Remote Sensing MDPI

NBI launches wetlands project and forum to protect wetlands in the Nile Basin



The Nile Basin Initiative (NBI) Secretariat on 15th July 2016 launched the Nile Basin Transboundary Wetlands Project and the inaugural Nile Basin Wetlands Forum.

The goal of the Euro 6 million project is to strengthen the technical and institutional capacities of the NBI and its 10 Member States for sustainable management of wetlands and wetlands of trans-boundary significance in the Nile Basin.

The launch ceremony held in Entebbe, Uganda



Summary

Water, wetlands and forests modulate climate change and desertification

Restore and preserve wetlands, water bodies and forests