Importance of Wetlands for Regional Hydroclimate and Ecology: Impact of Draining the Sudd Wetlands in the Nile Basin with Comparison to the Everglades

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Nile Talk Forum
FIU
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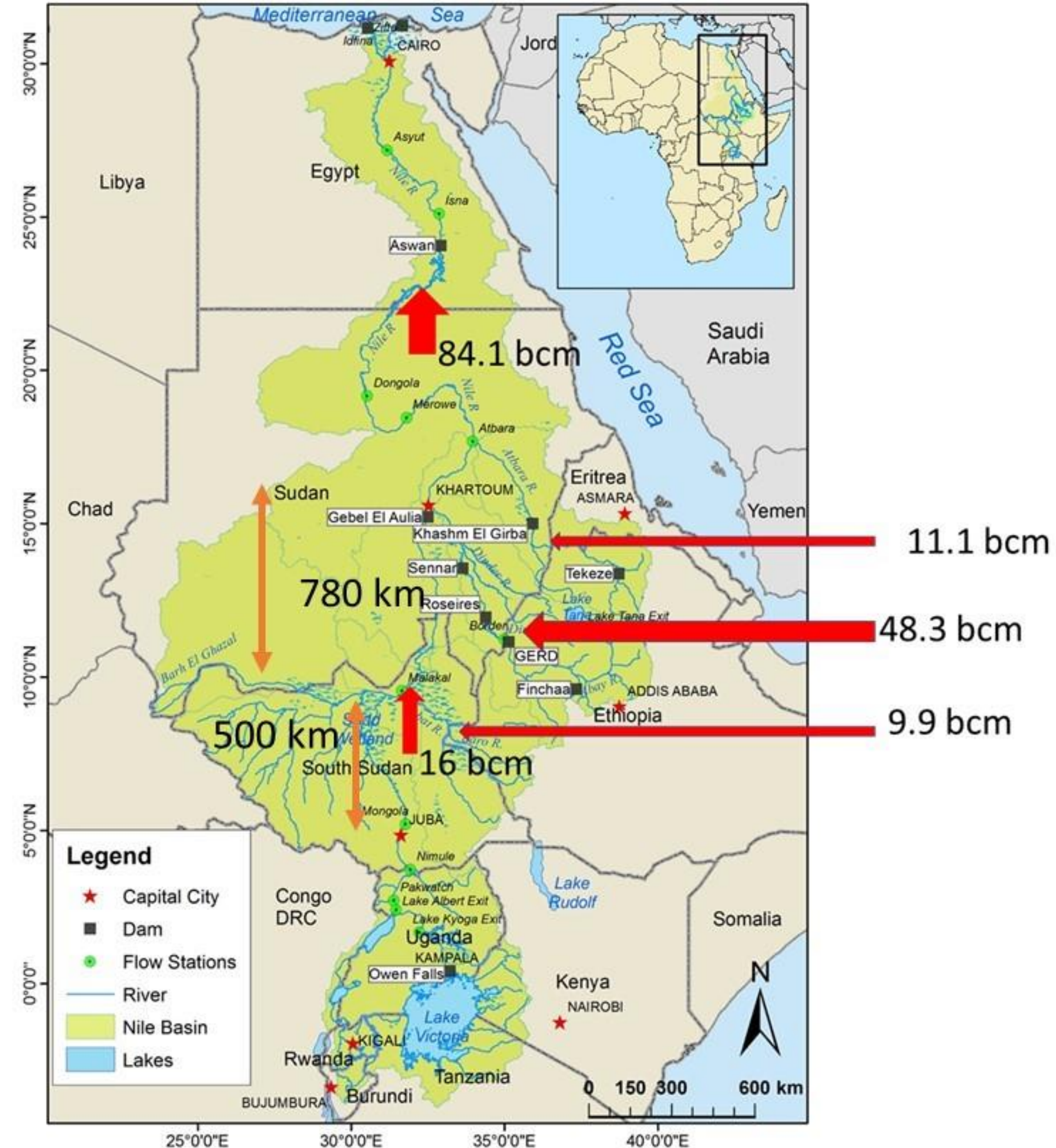
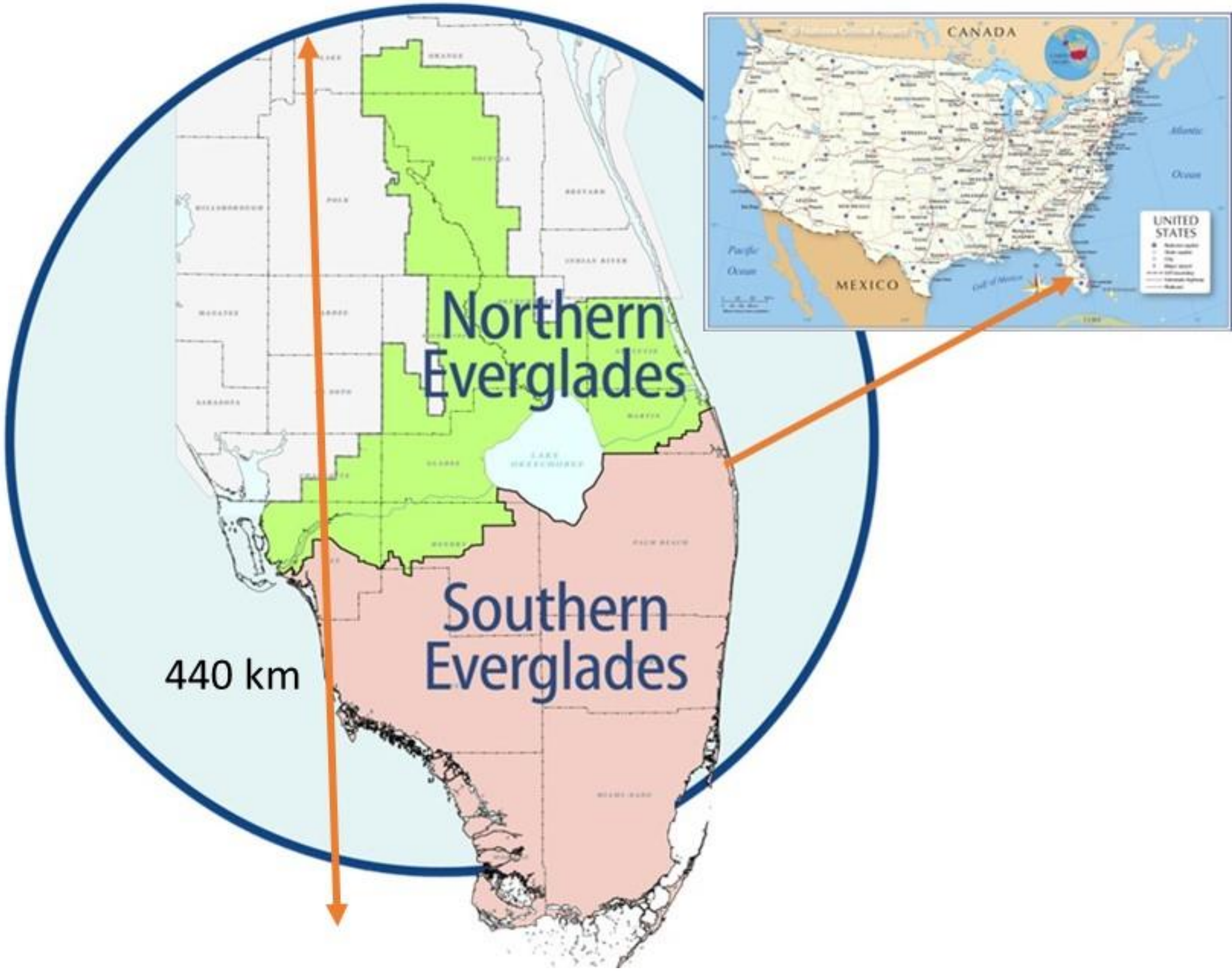
The Sudd in South Sudan and the Everglades in USA





Water and Environment Consulting

Wikipedia

http://genealogytrails.com/fla/miamidade/nativeamericans.html

Everglades

https://www.semtribe.com/stof/culture/chickee/images/default-source/c
culture/chickee/chickee5?itemIndex=5

Wikipedia

https://www.youtube.com/watch?v=WNQUYBbJFo4

The flagship species of the Sudd Flooded Grasslands ecoregion is the white-eared kob. Image credit: Creative Commons

Sudd

https://www.oneearth.org/ecoregions/sudd-flooded-grasslands/

Kissimmee River (Northern Everglades) in U.S.A. before Channelization and Sudd of South Sudan (Nile Basin)

SFWMD

Visit South Sudan Facebook

Wetland Drainage: The Everglades in USA and the Sudd in South Sudan

The Kissimmee River was "channelized" to manage its water flow. Over the course of nine years (1962-1971), the meandering river was cut and dredged into a straight canal (C-38) with six water control structures. Two-thirds of the original floodplain was drained (https://www.sfwmd.gov/sites/default/files/documents/bts_krr_phase_1.pdf)

Jonglei Canal construction in Sudd swamp; digger has been in place since 1983 (Public Domain, https://commons.wikimedia.org/w/index.php?curid=605612)

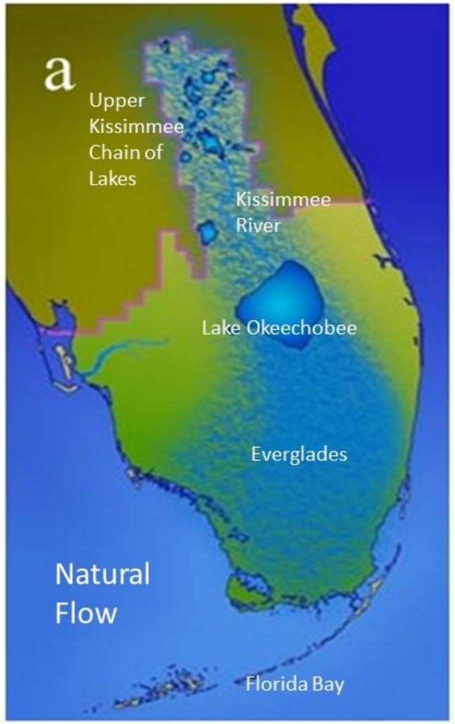
Kissimmee River and Flood Plain Before and After Drainage: The Planned Jonglei Canal in the Sudd of South Sudan

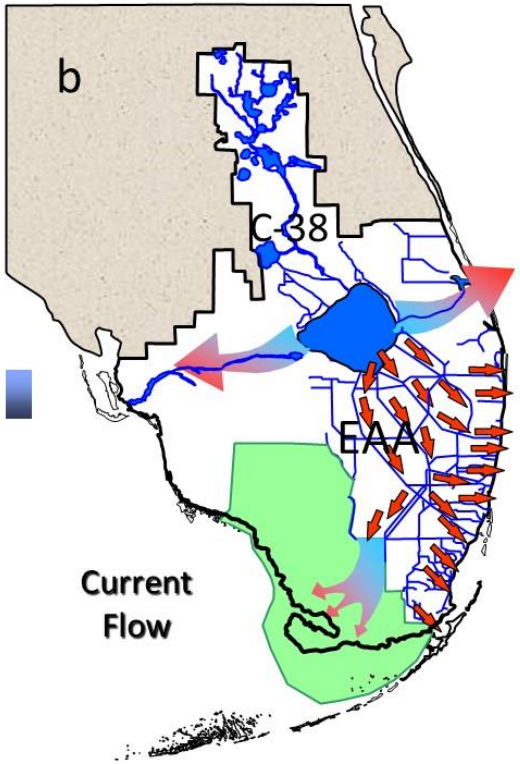
9 m deep canal

Area varies 30,000 to 130,000 km^2

Source: Terra Mater https://www.youtube.com/watch?v=_-RHx9bDL4I

The Everglades Drainage and Water Control System





3,200 km levees and canals
160 drainage basins
600 water control structures
90 pump stations
Lakes, impoundments, ponds

Importance of Wetlands

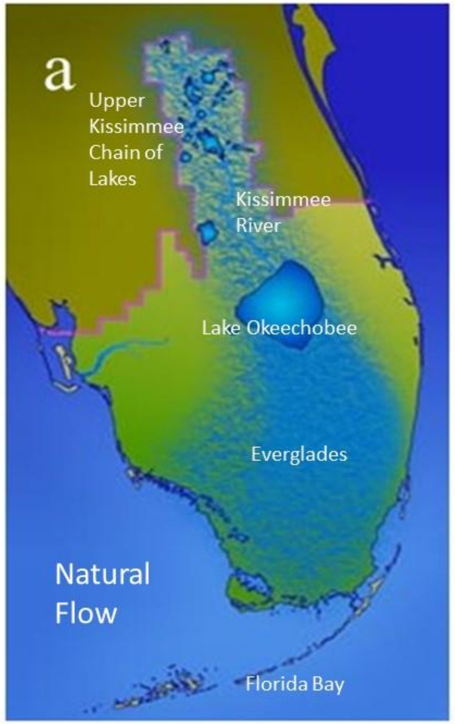
- Carbon, Nutrients, Metals Sequestration
- Environmental Cooling
- Role in Hydrologic Cycle
- Ecology, Fauna and Flora
- Cultural and Food Supply Importance to Inhabitants
- Maintain Regional Topography and Hydraulics
- Flood Control
- Water Storage
- Recharge Groundwater

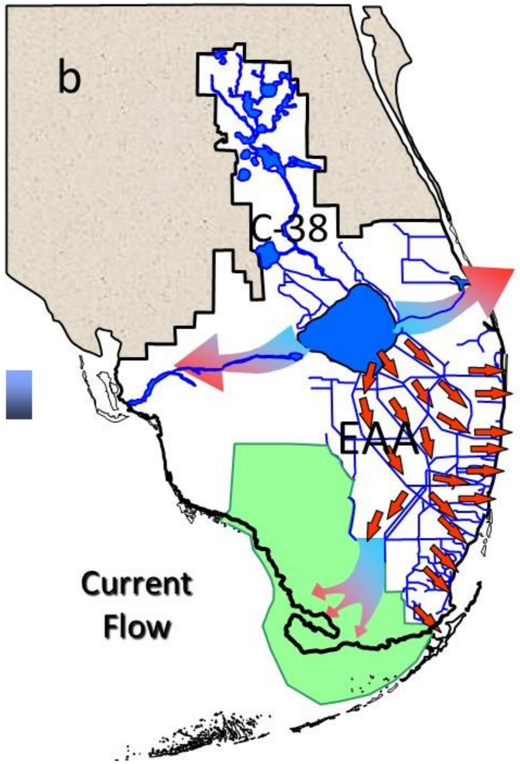
Comparison of the Everglades in the U.S.A. and Sudd in South Sudan

- The Everglades is Affected by Drainage and Change in Landscape
- We can Predict What Could Happen if the Sudd is Drained
- In the Everglades, Billions of Dollars is being Spent to Restore Damages Done by Drainage (Hydropattern, Water Quality, Ecology, Protected Species Preservation)

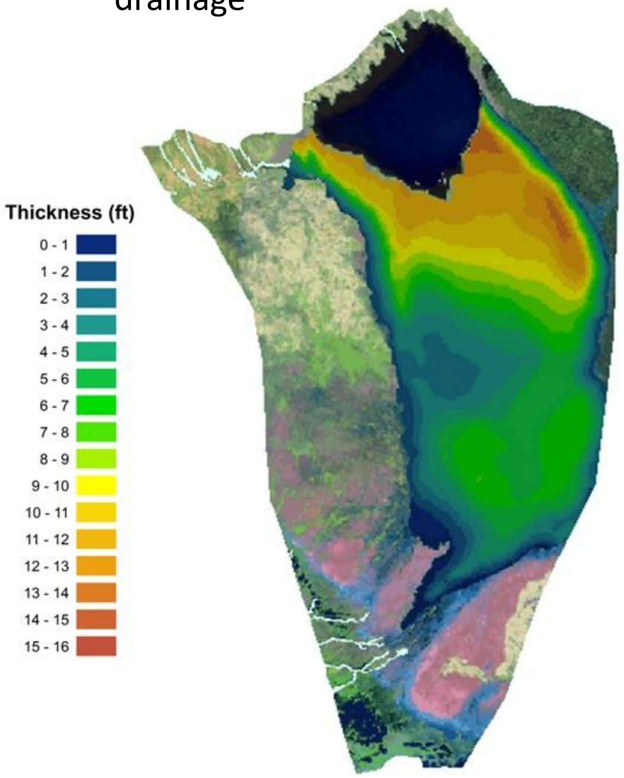
Drainage and Flood Control South of Lake Okeechobee in the Everglades

The Kissimmee-Okeechobee-Everglades System Before and After Drainage Hydraulics, Topography and Peat Thickness

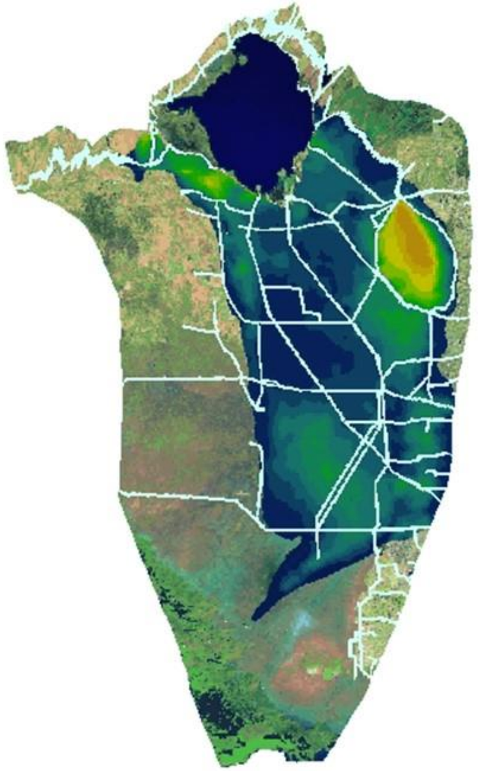




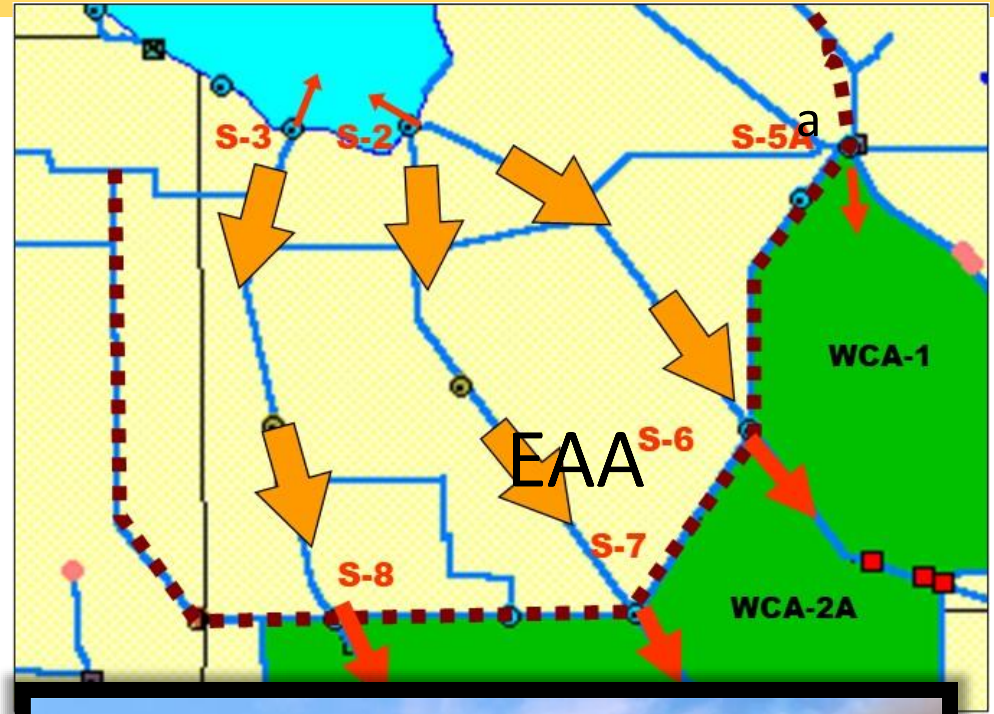
- Muck (peat) thickness before drainage



Muck (peat) thickness after drainage



Everglades Agriculture and Soil Subsidence (1924 -2003)



Wetland Drainage Results in Peat Soil Subsidence and Topographic Change

(Drainage and Soil Loss in Holm, England)

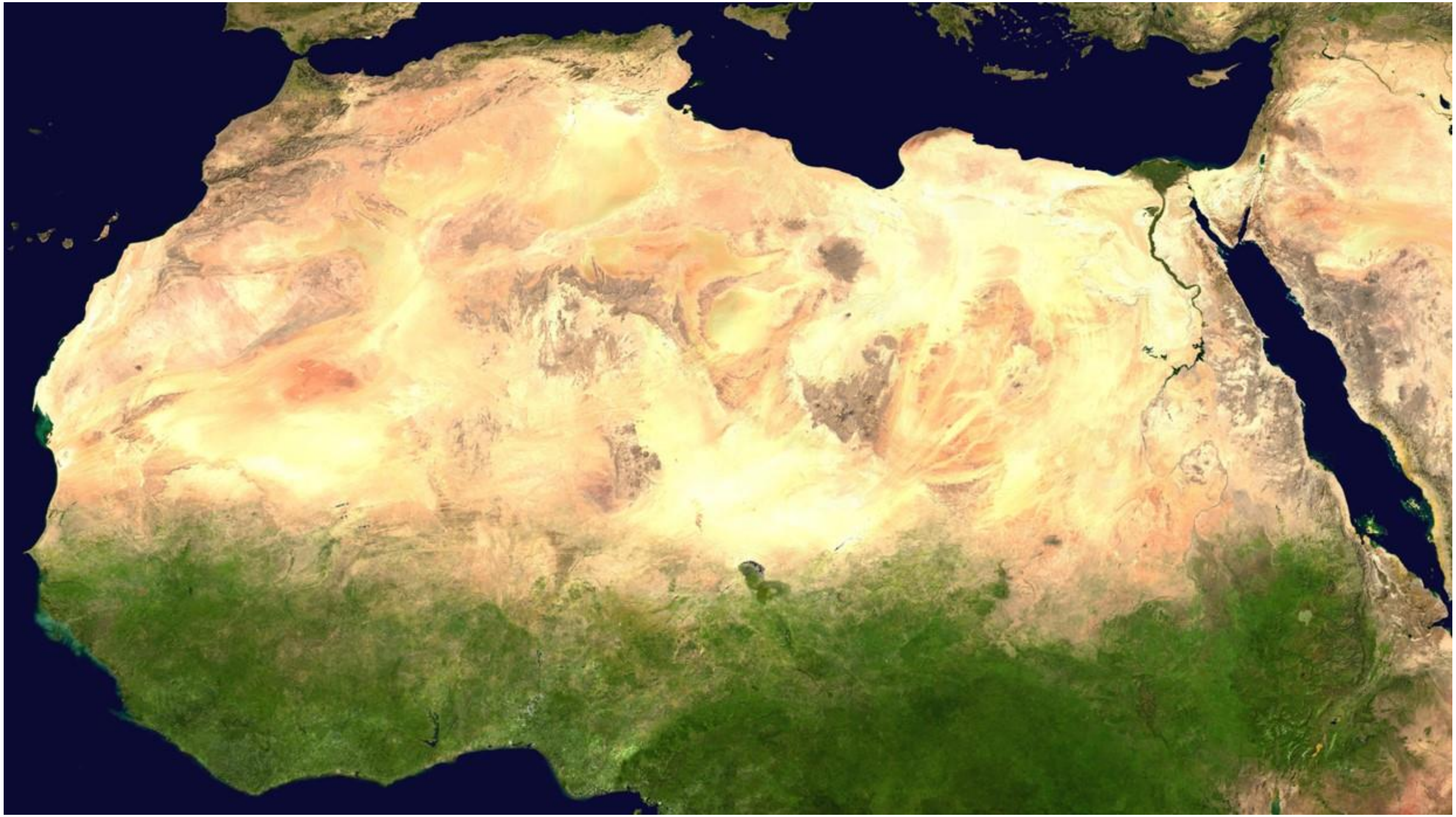
iStock

Graduated post sunk in Fens in Holm, England in 1848 with 4.5 m soil subsidence by 1992 (Photo by George H. Snyder, Snyder 2004)

Draining the Sudd of the Nile Basin

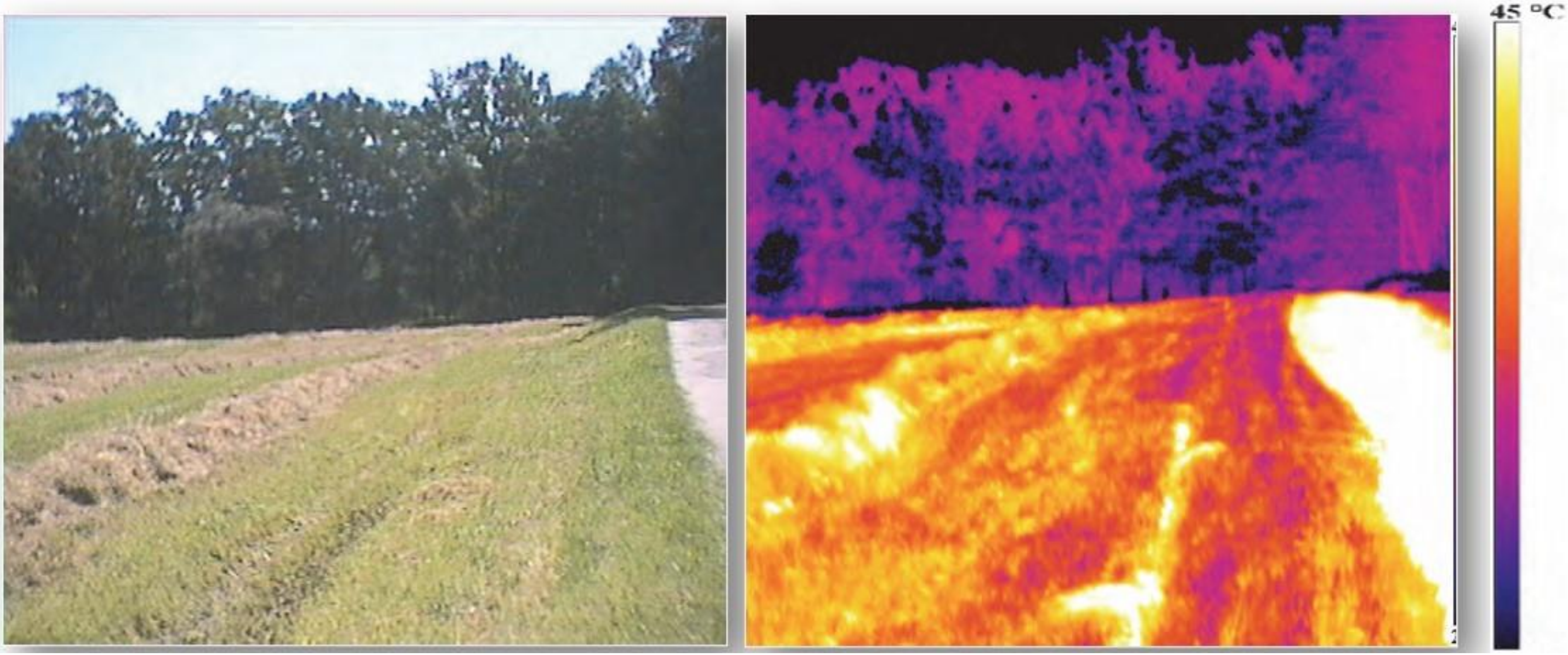
- Environmental Cooling and Climate Change
- Carbon Sequestration Capacity will be Lost - (160 gC m^{-2} yr^{-1}, North America data)
- Release Carbon, Nutrients and Metals from Storage
- Hydrologic Cycle will Change and Dry Conditions can be Initiated
- Impact on Ecology, Fauna and Flora
- Cultural and Food Supply Importance to Inhabitants could be Lost
- Regional Topography and Hydraulics will Change
- Flood Storage and Attenuation will be Reduced Potentially with Flood Aggravation to the Sudan

The Sahara is Expanding (Credit: NASA)



Environmental Cooling

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

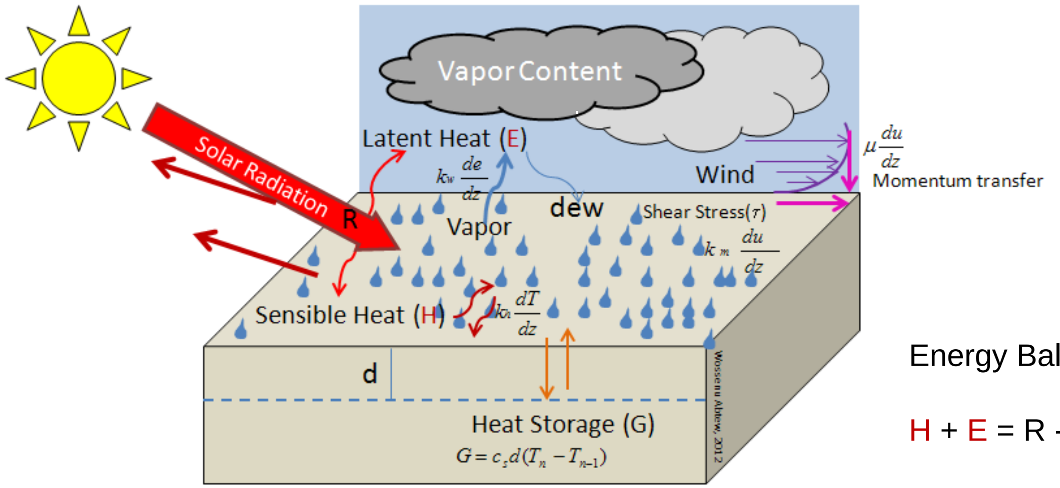


Eiseltova, M., J. Pokorny, P. Hesslerova and W. Ripl. 2012. Chapter 14: Evapotranspiration - A driving force in landscape sustainability. Irmak A (ed.) Evapotranspiration Remote Sensing and Modeling. InTech (open access book)

Abtew, W and A. Melesse. 2016. *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, New York

Energy Partitioning and Landscape Changes (Latent and Sensible Heat))

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



Energy Balance

H + E = R - G

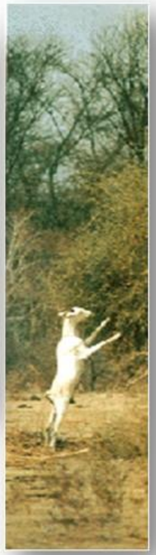
Abtew, W and A. Melesse. 2015. *Chapter 3: Landscape Impact on Regional Hydrology and Climate.* In: Melesse A. and W. Abtew (eds.). *Landsca Dynamics, Soil and Hydrological Processes in Varied Climates*, Springer (in press).

Energy Balance

R = H + E + G

E > H

The Everglades



Sahel (USGS)

H > E

Africa (FAO)

Wetland Drainage Results in Wetland Carbon Sequestration Capacity Loss and Release of Carbon from Storage

- Carbon Sequestration
  - Riverine wetlands with lotus sequester (160 gC m^{-2} yr^{-1}), (Bernal and Mitch 2012) this is 1.6 ton C ha^{-1} yr^{-1} for Sudd estimate 13 million tons per year

- Carbon Release from Storage
  - Oxidation of 1000 metric ton of dry peat releases 472 tons of carbon (Amanda A De La Cruz, 1986. Tropical wetlands as a carbon source. Aquatic Botany 25:109-115)

Land Cover Change and Hydroclimate

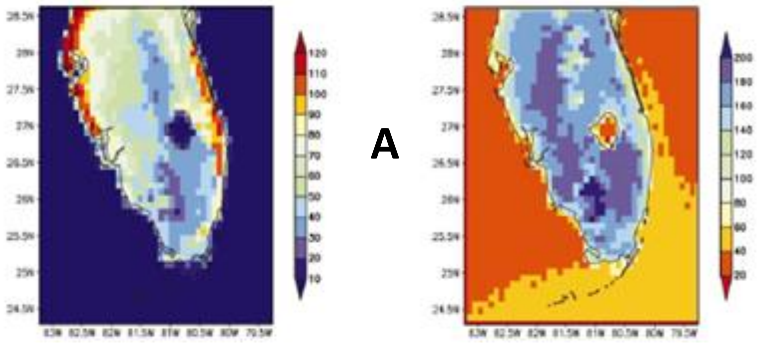
Average Sensible Heat, H (left) and Latent Heat, E (right) Flux (w m^{-2}) for July – August

Energy Balance

H + E = R - G

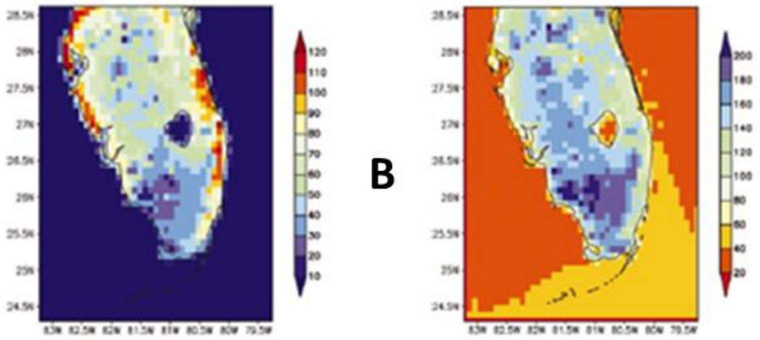
Pre 1900 land cover

H (Sensible) E (Latent)



A

1993 land cover



B

B-A

H increased

E decreased

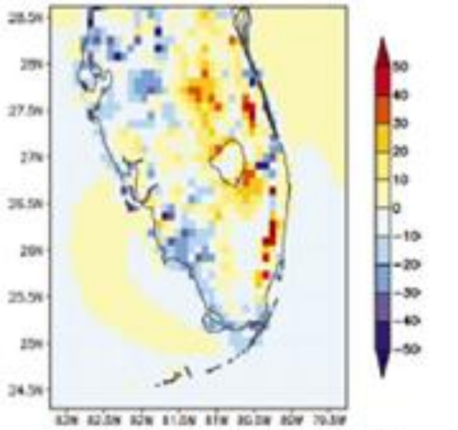


FIG. 9. Same as Fig. 7, except for Jul–Aug 1989.

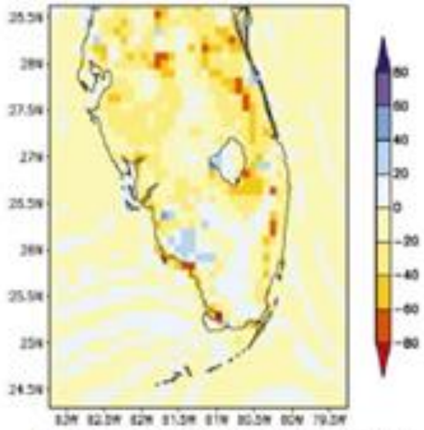
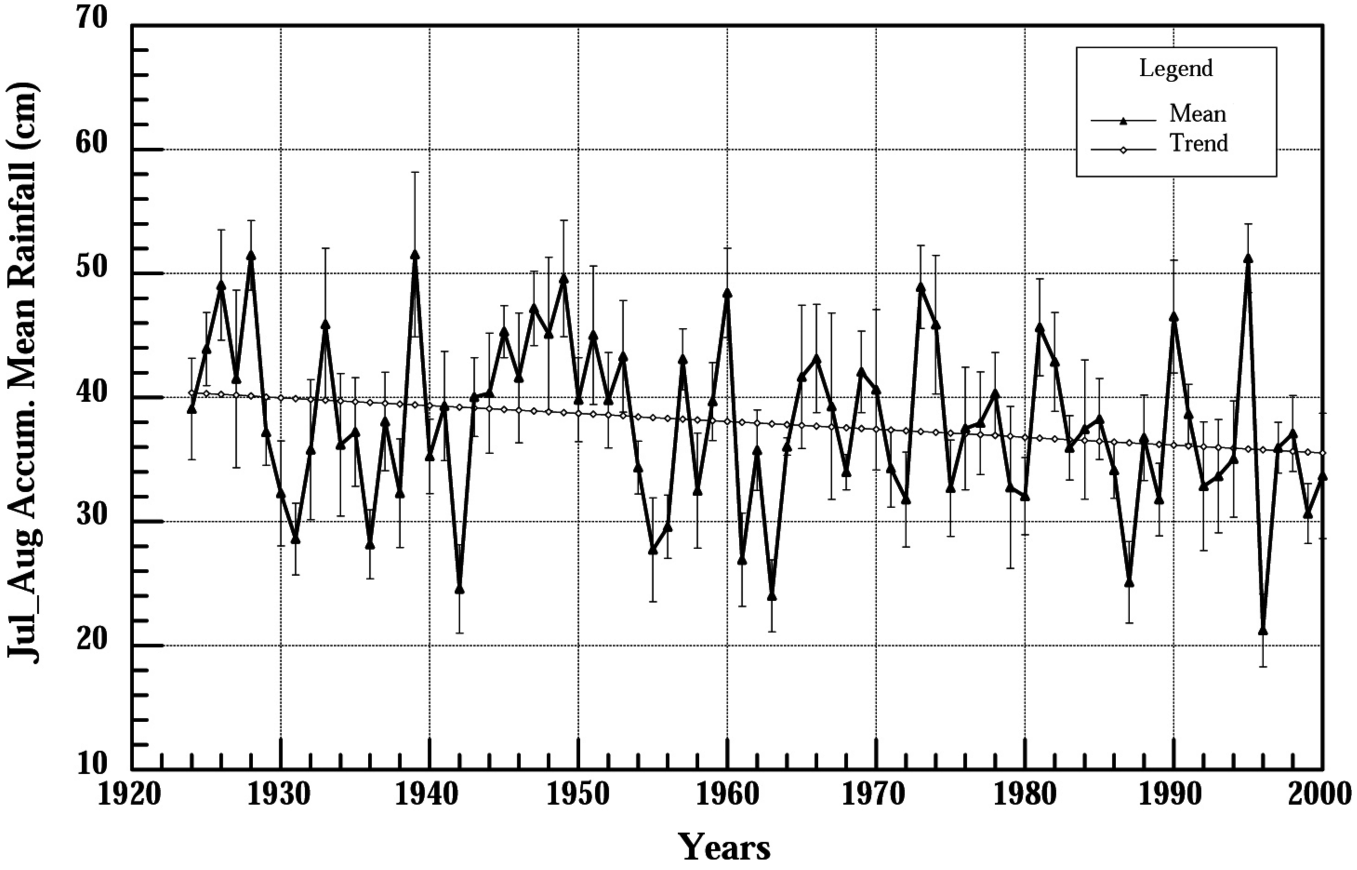
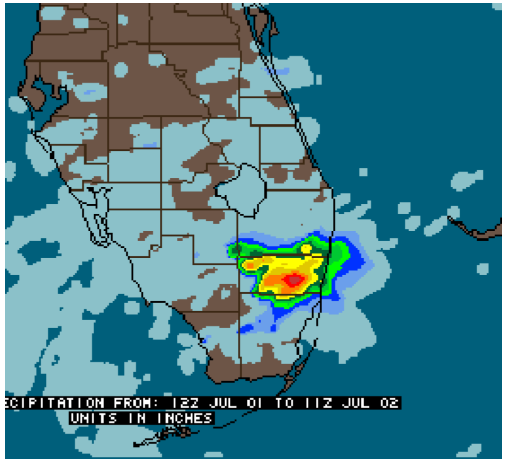


FIG. 10. Same as Fig. 8, except for Jul–Aug 1989.

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

Hydrologic Impact of Draining Wetlands and other Landscape Change
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

Channelization of the Sudd Could Worsen Flooding in the Sudan -
Sudan Floods 2020, 2021, and 2022 Despite GERD Filling

Source: https://news.yahoo.com/ 4 September 2022

Khartoum (2022)

South Florida (2008)

- During 1960 to 1964 increase in Lake Victoria discharge was observed
- Mongola flow doubled and flow at Malakal increased by 1.5 times

(Source: Mefit-Babtie Srl. 1983. Development Studies of the Jonglei Canal Area, Range Ecology Survey, Final Report, Volume 2, Background. Khartoum. Sudan)

Restoration – Costly Process

Degrading of the spoil pile in the Reach 3 construction area.

Restoration – Reversing Damages done by Drainage
Kissimmee River Flood Plain After Drainage and After Restoration

Refill Canals and Restore Flood Plain (36 km out 92 km)

Remove Flow Control Structures and pools to restore floodplain

Looking south at the Phase I restoration area river channel and floodplain at Montsdeoca.

Kissimmee River Flood Plain Before and After Restoration

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

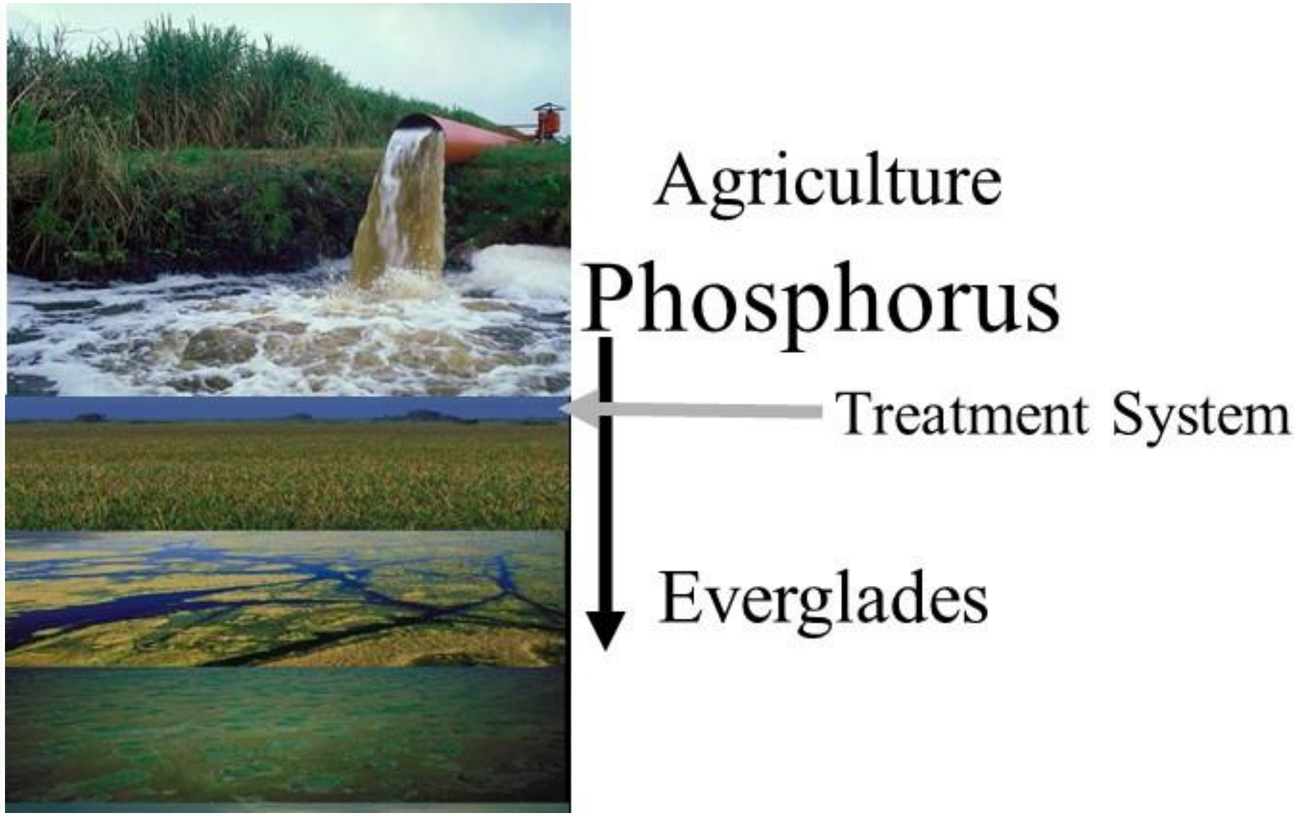
Floodplain Vegetation Response

Pre-restoration

Post-restoration

Restoration of Regional Wetlands Hydrology and Water Quality

- Improve Hydropattern through Water Management Changes
- Build Constructed Wetlands for Water Quality Improvement
- Protect Wildlife
- Build more Storage



Constructed Wetlands

- Stormwater Treatment Areas (STAs), 25,100 ha

Can Rivers and Wetlands Dry Up?
2022 – The Year the Value of Water is Recognized

- Unpredicted Drying of Rivers and Water Bodies
- Rhine and Danube in Europe, the Loire in France, the Tiber and Po in Italy, La Vinuela Reservoir in Spain, Lake Mead (the Colorado) in the USA is alarming.
- Iraq's mighty Tigris river is drying up (https://www.aljazeera.com/gallery/2022/9/21/photos-iraq-mighty-tigris-river-is-drying-up)

Loire River in France in 2022 drought (Reuters, August 22, 2022)

Rhine River (20 August 2022, AP)
https://www.youtube.com/watch?v=hfPuSCDZmp4. Accessed 27 August 2022)

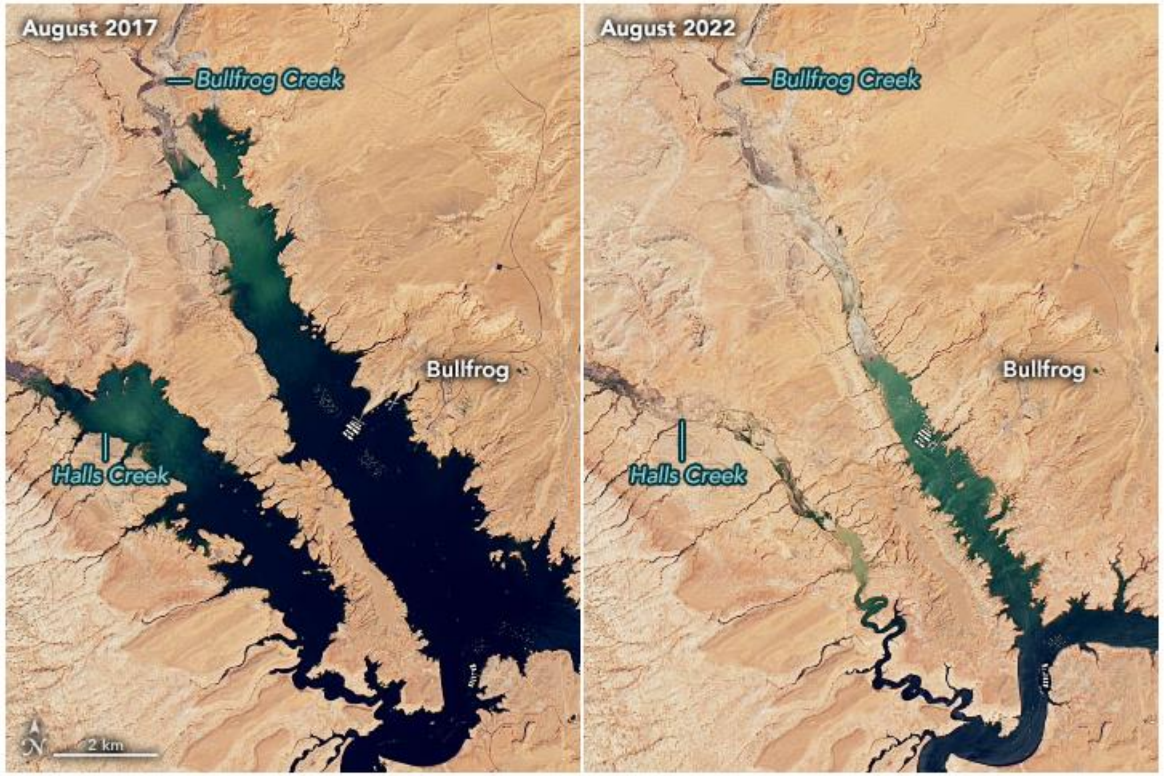
International River Agreements and the Non-stationarity of Streamflow Data

Global Drought Showed the Non-stationarity of Streamflow Data

Transboundary river agreements should take notice of the 2022 drought impact on major rivers and water bodies; beware of volumetric water share agreement that is based on historical river flow data

Water Treaty between USA and Mexico: The Colorado and Rio Grande Rivers

- The 1940s, however, were a time of unusual water abundance on the treaty rivers. When American and Mexican engineers drafted the 1944 water treaty, they did not foresee today's prolonged megadrought (Varady, R.G., Gerlak, A.K., Mumme, S.P. The Conversation, July 1, 2021 - https://theconversation.com/megadrought-along-border-strains-us-mexico-water-relations-160338)



August 16, 2017 - August 6, 2022

https://earthobservatory.nasa.gov/images/150249/lake-powell-still-shrinking

How a 100-year-old miscalculation drained the Colorado River

An epic drought in the West is drying up the river. But that's only part of the story.

By Benji Jones@BenjiSJones Sep 23, 2022, 8:00am EDT

Can you Talk About Climate Change Draining the Sudd?

The Burden of Climate Change Mitigation and Credit: Economic Value of Carbon Sequestration by Wetlands and Greeneries

- A study of Nova Scotia, Canada wetlands economic valuation of carbon sequestration (Gallant et al. 2020)
  - Average sequestration is 6.45 tons CO_2 ha^{-1} yr^{-1}
  - Value : \$124 - \$373 ha^{-1} yr^{-1}
  - Carbon sequestration value for Nova Scotia wetlands - C\$10 billion (55,000 km^2)

  - South Sudan should get credit for preserving the Sudd (at least US\$18 billion) – the tropics are more productive than temperate Nova Scotia
  - Ethiopia should get credit for the green initiative (reforestation, urban greening, and irrigation expansion)
  - Africa should organize and actively participate to defend itself from unproportional burden of climate change mitigation and get mitigation credits for natural system of climate change mitigation (wetlands, forests, irrigation expansion, green space expansion, etc.)
  - Hydropower, solar power, geothermal power and any replacement for fossil energy shall get credit for climate change mitigation

Economic and Social Benefits of Sudd for South Sudan

Planned Use of the Resource without too Much Negative Impact

- Tourism, Recreation and Managed Hunting
- Planned Settlement and Economic Activities
- Food Production (Fishing etc.)
- Carbon Credit
- Sale of Water

Summary – Potential Outcomes of the Sudd Drainge

- Havoc in the Lives of the Habitants, Flora and Fauna
- Ecosystem Change
- Hydroclimate Change with Regional Impact
- Wildfire, Peat Fire with Regional Impact
- Droughts and Floods
- Change in Topography with Hydraulic Impact
- The Need for Continuous Investment in Levees, Canals and Water Control Structures
- Loss of Right for Nile Water

Current South Florida


?
SOUTH FLORIDA WATER MANAGEMENT DISTRICT