# HYVIC (Hydroclimate Project for Lake Victoria Basin)

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# Presentation Outline

- 1.HyVic hydroclimatology & background2.HyVic research agenda3.HyVic timeline
- 4.HyVic research themes progress during the 2014-2015 year
- 5.HyVIC capacity development initiative
- 6.HyVIC Coordination

## **Climatology**





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## **Climatology** Lake Water Currents & Temperature Patterns

Climate Model Near Lake Surface Air flow



Climate Model Lake Surface Temperature



#### Satellite TRMM Rainfall

### Potential Major Sources of Uncertainty in Current Climate Models

1. Climate projections not adequately take into account land cover changes (due to urbanization) influence on regional climate

 Climate models do not have realistic representation of lake
D hydrodynamics interaction with regional climate

3. Climate models do not have realistic formulation of ground water hydrology influence on regional climate

4. Climate models do not have sufficient spatial resolution to resolve critical climate change interactions



Forecast of urban expansion around LV by 2030 (Seto et al., 2012 PNAS) Lake circulation & surface temperature (Semazzi et al., 2012)



Any of these factors could impact the climate projections

## **Inspired by East African Community Feasibility Study**

HYVIC has been inspired by the East African Community feasibility study that made the recommendation for the creation of HYVIC: : "Enhancing Safety of Navigation and Efficient Exploitation of Natural Resources over Lake Victoria and Its Basin by Strengthening Meteorological Services for Lake Victoria"

"... we suggest creation of the **Regional** Hydroclimate Project (HYVIC) GEWEX ..."... 2012

The feasibility study was funded by the EAC [Semazzi et al; http:// climlab.meas.ncsu.edu/Final Report LVBC.pdf] EAC Feasibility Study Authors: Fredrick Semazzi (lead), Sandra Yuter, James Kiwanuka-Tondo, Lian Xie, Casey Burleyson, Bin Liu, Kara Smith, Pascal Waniha (NC State University; USA); Lynn Rose (Atmospheric Technology Services Company, Norman, OK; USA); Ruben Barakiza (Institut Geographique du Burundi), Peter Ambenje (Kenya, Meteorology Department), Anthony Twahirwa (Rwanda Meteorological Service), Hamza Kabelwa (Tanzania Meteorological Agency), Ronald Wesonga (Uganda Meteorological Department), Laban Ogallo and Joseph Mutemi (University of Nairobi and ICPAC, Kenya) and Francis Kirudde (Uganda, UMEME).

EAC=Burundi, Rwanda, Kenya, Uganda, Tanzania



**HyVic : Hy**droclimate project for Lake **Vic**toria (HYVIC) Regional Hydroclimate Project (RHP)

- A framework for global cooperation

- HyVic primary objective is to provide underpinning understanding of the climate over Lake Victoria Basin (LVB) and improve its predictability and projections to support decision making in the region

## **HyVIC Science Plan Components**



HyVIC Research Theme-1: Translational Research Interface with Applications HyVIC Research Theme-2: Severe Weather and Water Currents (collaboration with WWRP-LVP) HyVIC Research Theme-3: Lake Victoria Basin Water Budget HyVIC Research Theme-4: Regional Earth System Modeling (REaSM) & Prediction/Projections HyVIC Research Theme-5: Observation of the Hydroclimatological System

# HyVic Timeline

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# HyVic Funding

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WISER-DFID- the 'last mile" HyVic (DFID funding)

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**HyCristal:** Integrating **Hy**dro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in East Africa – First Major Funded Project Inspired by HyVic **(NERC funding)** 

**HyNEWS** Consortium - A coordination platform for regional cooperation

April201

HyVic: Hydroclimate project for Lake Victoria (HYVIC) Regional Hydroclimate Project (RHP) – A coordination platform for global cooperatio

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## HyVIC Research Theme-1 Translational Research Interface with Applications

- 2 HyCristal project pilots (Funded by NERC)
- **3 WISER program pilots (to be Funded by DFID)** 
  - Water resources
  - Fisheries & crop agriculture
  - Renewable energy

DFID WISER FUNDING .... Optimization of hydroelectric power generation ... "water release rule" at source of the Nile



RegCM downscaled rainfall for **2071-2100** used as input for the Tate et al (2004) WBM to **0** compute the LL. (Smith, 2011); evaporation is **13.5% above present level based on A2** scenario. Thus projection is 2 meters above present lake levels. (Kara et al, 2013)<sup>Bartlett Learning, LLC</sup> www.jblearning.com

## DFID WISER FUNDING (exploration of wind energy)



HyVic Team Meets the Hon Minister for Karamoja Affairs



Flooding around northwest side of Lake Victoria

#### Flooding near Kampala, Uganda



- Lake level projections based on RegCM regional climate model projected rainfall
- using the agreed curve water release rule of the
- hydroelectric dam at the source of River

.eaend

and

Current Lake

## DFID WISER FUNDING Wetlands (impacts on road Infrastructure)

Potential Flooding Around Lake Victoria







#### **BIOLOGICAL SYSTEMS**

... changes in habitats for marine life including fish...

Semazzi et al, 2011

Read infracting and development plan should take climate projections information into account in their developmental plan (black lines are the existing road network) www.jblaming.com

56.000 Meters

# **DFID WISER FUNDING** (Fisheries and Crop Agriculture)



## Increased dependence on the small pelagic clupeids in Lake Victoria as climate intensifies

## **NERC Funding: Urbanization Planning Sector**



ikiMap

Due primarily to high rural to urban migration, Kampala's population has grown at an average rate of 5.6 percent annually since the 1960s; Stunning growth between 1974 & 2008. (UNEP) share your maps





Urban extent circa 2000

Shinyanga,

Tanzania

Burundi



### WRF Simulated change due to 2030 projected urbanization



HyVIC Research Theme-2 High Impact Weather and Water Currents (collaboration with WWRP-LVP)

# SWNDP and SWFDP

(3000-5000 Lost Every Year)

### Near-Term Plan (WWRP Lake Victoria Project): Use Lightning and Other Satellite Products for Nowcasting

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NATURE

knows of the two places. Does the sort of coal make a difference, or the length of time it is kept before consumption ? Or is much of the London dirt dust from other sources than coal fires, dispersed more widely than in the damper Manchester atmosphere? A. E. Boycorr.

Medical School, University College Hospital, London, W.C., August 28.

PROF. BOYCOTT'S statement is rather surprising; but I cannot think that the explanation is to be found in the larger amount of domestic smoke in Manchester. in the larger amount of domestic smoke in Manchester, Our power way to be a start of the start of the start of the start London dirt is due to the larger amount of dust not arising from smoke, as Prof. Boycott suggests. Any difference in the quality of coal used in Manchester and London would scarcely have the effect he de-

The point is an interesting one and I think could be settled by microscopic examination of specimens from the two towns. Soot is easily identified in this way. J. B. Сонем. Thwaite Cottage, Coniston Lake, Lancashire, September 1, 1922.

#### Waterspouts.

WATERSPOUTS on Lake Victoria are very commonly seen from Entebbe, but at a long distance away, and though I have worked on the lake shores for nearly four years it was only two days ago that I first saw one near enough to be of real interest.

one near enough to be of real interest. I was in camp on the north end of Braylla, the standard standard standard standard standard standard about goo yards from the shore of a small bay. At daybreak on June 30 there were very lowering black clouds and every indication of an immediate heavy storm. While looking out from the tent I suddenly saw that a waterspout was travelling obliquely to-wards us, and as it eventually came to within about roo yards of the shore a very good view was obtained for about five minutes before it came to an end.

The pedicle arose from a well-marked circular area on the water, which was otherwise only faintly rippled by the preliminary puff of wind before the approaching storm. This circular area was evidently very violently dis-

turbed as a cloud of vapour, greatly agitated, rose from it for a little distance. The pedicle was extremely narrow at its lower end,

Into pendide was extremely nation actions over east, and not quite straight, being should be into a column which went up into the low cloud; the core of this column was much less dense than the periphery, and the violent upward spiral ascent of the water could be clearly

So far I have described nothing unusual, but the following was quite new to me and seemed of great interest.

Surrounding the central core, but separated from it by a clear narrow space, was a sheath, the lower end of which faded away some distance above the water. The profile of this sheath was undulating, it being thicker in some places than others. A curious point is that this sheath *seemed* to pulsate rhythmic-ally, but I could not say whether the appearance of pulsation might not have been an illusion caused by waves travelling up its outer surface.

This pulsation gave an uncanny suggestion of a live thing, which was aided by the violent spiral move-ment upwards in the central core, the clouds of vapour boiling round its base, and the movement of

NO. 2760, VOL. 110]

SEPTEMBER 23, 1922

the whole across the water—indeed, we watched it spellbound until the pedicle dissolved away at the bottom, and the ascent of the part above brought the phenomenon to an end My wife watched with me, and is in entire agreement about the curious appearance of pulsation of the outer

sheath. Fig. 1 is a reproduction of a pencil drawing which



may give some idea of what we saw. I cannot estimate the height to which the column rose. Its cessation was followed by violent rain and thunder.

G. D. HALE CARPENTER Uganda Medical Service Entebbe, Uganda, July I.

DR. HALE CARPENTER'S letter brings out one feature which has never, to my knowledge, been noted in a watersport, namely, the sheath, separated from the main body of the whirl by a clear space. Wegener, in his book on 'Wind- und Wasser-hosen in Europa," gives illustrations of a large number of watersports, sive illustrations of a large number of watersports. but in no case is there mention of two trunks one within the other. The nearest approach to the phenomenon noted by Dr. Hale Carpenter is the not infrequent occurrence of waterspouts which show two clearly defined parts, an upper thick column with a lower whirl of much smaller thickness.

lower whirl of much smaller thickness. The accepted explanation of waterspouts ir that they consist of whirls in rapid rotation with a dis-duces a rapid lowering of pressure within the which and consequently a lowering of temperature, which may easily be sufficient to bring the air in the whirl down below its dew point. This is sufficient to explain the main features of the typical waterspont. The amount by which the temperature is lowered decreases outward from the 'axis' of the whirl, while the difference between the air-temperature and dew point normally increases downward from the cloud level. The thickness of the visible column or zone of condensation therefore diminishes downward, giving the form of an inverted cone of irregular shape. Near the water the air is again near satura-tion, and the difference between air temperature and dew point is small, so that the base of the whirl is



#### Water Spout Entebbe-Uganda (Dec 14, 2009; potential hazard for marine navigation over Lake Victoria

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HyVIC Research Theme-3 Lake Victoria Basin Water Budget (no new developments to report)

# **Energy & Water Budgets**



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# HyVIC Research Theme-4 HyVic Regional Earth System Modeling (REaSM) and Climate Predictions/Projections

## **NSF FUNDING**

## **Develop Regional Earth System Modeling Capacity in East**



ning, LLC www.jblearning.com

## Decadal Climate Variability East African Climate Change Paradox

Low-pass intered rainian (~ royr), when average over Oreater right of Annea



Persistent past decline & projected reversal and increase

Phenomenon known as the East African climate change paradox

Could have profound implications on LVB sustainable development for more than 35 - 40 million people 24

# The problem is of profound importance because of the following high level science questions

- (i) need to know whether indeed the reversal will occur,
- (ii) the timing of when it will materialize and
- (iii)whether these two factors can be determinable at acceptable levels of confidence to inform the management of the leading regional social-economic sectors - including agriculture, fisheries, water resources, tourism, energy, urban development, transportation, bio-diversity conservation, construction and disaster risk management

## ONE COMPONENT PF THE PARADOX Abrupt decline in the

## East African long rains since the 1980s



Anomalous MAM rainfall (from GPCP; mm/day) - (Lyon and DeWitt, 2012)

# What are the main attributions factors for the decline?

# What is the Cause of this Multi-Decadal Drought?



Composite of Rainfall for dry (1985-2000) minus wet (1970-1985)-MAM

## Major Controversy Regarding Attribution of the Multi-Decadal Drought

Williams & Funk (2011): Anthropogenic warming forced rapid warming of Indian Ocean SSTs; extended the warm pool & Walker circulation westward; resulting in a subsidence anomaly & drying over East Africa... anthropogenic greenhouse warming.

**Rowell et al (2015):** East Africa "climate paradox" – potential role for anthropogenic aerosol.

Lyon and DeWitt (2012); Lyon et al. (2014); Yang et al (2014): On the contrary, linked the decline with a shift to warmer SSTs over the western tropical Pacific and cooler SSTs over the central and eastern tropical Pacific ... natural variability – Pacific Decadal Oscillation

Semazzi et al (2015): The decadal variability of the cessation is dominated by AMO stationary Rossby wave; AMO contribution on MAM total season is same order of magnitude but less than Indo-Pacific Pacific ...natural variability – North Atlantic Oscillation (NAO)

## May EOF1 (AMO-like) geopotential at 300mb Composite (negative/positive AMO/EA rainfall)



Semazzi et al; Nature Communication (2015, in revision)

# East African Rainfall and AMO



# Rainfall May EOF1 loading for the EA region, (right) Rainfall EOF1 for EA region and AMO time series.

8-10 Oct. 2014, Marrakech Morocco 30 © 2011 Jones & Bartlett Learning, LLC www.jblearning.com

## May Anomaly flow, 1951-2010 Composites



## East African Rainfall and AMO



Rainfall May EOF1 loading for the EA region, (right) Rainfall EOF1 for EA region and AMO time series.

## Upwelling Response to Atlantic AMO Forcing

Dry Composite-Warm AMO Phase SST and Surface Wind Vectors Wet Composite-Cold AMO Phase SST and Surface Wind Vectors



## **Potential Role of Land Surface**

Urban extent circa 2000

Shinyanga

Tanzania

Burundi



ikiMap

Due primarily to high rural to urban migration, Kampala's population has grown at an average rate of 5.6 percent annually since the 1960s; Stunning growth between 1974 & 2008. (UNEP) share your maps







WRF Simulated change due to 2030 projected urbanization



# HyVIC Research Theme-5 Observation of the Hydroclimatological System

# Limnological and Meteorological Observational Campaign (Inception WISER Funding Phase)

- Six moorings, each mooring will contain sensors for temperature, irradiance meter, relative humidity, a pressure gauge, bottom-mounted acoustic Doppler current profiler (ADCP), and Sonde carrying photosynthetically active radiation (PAR), dissolved oxygen (DO), turbidity, pH, chlorophyll, phycocyanin sensors.
- This in-situ data will be combined with remote sensing data from Observations from Moderate Resolution Imaging Spectroradiometer (MODIS),Advanced Very High Resolution Radiometer (AVHRR), Sea-viewing Wide Field-of-view Sensor (SeaWiFS), and Tropical Rainfall Measuring mission (TRMM) to examine surface temperature, aerosol optical depth, rainfall, primary production at local (50 km), regional (1,500 km) and continental scales (3,000 km). Two ship surveys will be conducted per year in January and July.
- Boat-based observations for lake surface temperature and other variables 36 © 2011 Jones & Bartlett Learning, LLC

## **HyVIC Capacity Development**

## Status of Scientific Research Capacity Publications (IPCC-AR5)



# National Climate Legislation and Strategies in 2007 and 2012



... but legislate what?

° 201 AR5=WGP3

#### Middle East and Africa, only region with no Climate Policy Legislation

#### TS.4 Mitigation policies and institutions

### **Building Climate Science Technical Capacity** & Interface with Policy Makers for Climate Services



# HYCRISTAL and WISER Funding – Capacity Building Activities

- Researchers and students attached with the HyCristal project
- Post-doc and graduate fellowships
- University curriculum
- Training workshops and clinics in modeling, impacts and decision making
- Interdisciplinary teams of 12 researchers working together continuously for an average 6 months at the RCC and Met Services Departments to develop practical strategies for climate risk management. The research teams will typically consist of a core team of graduate students, and researchers coming from the countries in the region which include participants from the National Meteorological and Hydrological Services (NMHSs), RCC staff, representatives of the application sectors and policymakers in government and the private sector.

## **HyVIC Coordination**

### **International Steering Committee**

**Fredrick Semazzi (lead), North Carolina State University-USA**, Sam Benedict (GEWEX ICPO, TBC), Peter J. van Eleven (GEWEX ICPO, TBC), Paul Joe (Environment Canada), Norman Miller (Earth Sciences Division, Berkeley National Laboratory and the Department of Geography,

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UK, GHP (Baltex, HyMex), Kamazima Lwiza (Stoney Brook University), Joseph Awange (Curtin University Australia)



# HyVic Network Wer





# **HyNEWS Consortium**

(Formed by the EAC Council of Ministers) – Regional Ownership

#### - LVB-HyNEWS (Lake Victoria Basin - HydroClimate to Nowcasting for Early Warning Systems)

 Formed to enhance the coordination, visibility and sustainability of HyVic, SWNDP (Severe Weather Nowcasting Development and Demonstration Project) and EAC NEWS (Navigation Early Warning System).

- LVB HyNEWS Executive Council: Heads of NMHS, EAC/LVBC coordinator and AMCOMET Secretariat (invited observer).

- LVB HyNEWS Task Force: Projects' PIs and five NMHS technical contacts act as a day-to-day coordinating

team.



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# HyVic Coordination (continued ...) Institutional Coordination (Continental)

- Africa Climate Research For Development Coordination Platform (**CR4D**); outcome from ACC2013



#### African Climate Conference – October, 2013 46

## Summary of help sought from the GHP

- 1. Funding to enhance activity in basic hydroclimate research
- 2. Capacity development (training, research, facilitates) is a major limiting factor for climate services. (CCKE proposal is pending)
- 3. Closer collaboration on energy and water budgets with HyMex
- 4. Closer collaboration on decadal variability dominant modes of variability with HyMex
- 5. Seek closer collaboration on cross-cutting initiatives (e.g mountain precipitation)
- 6. Formation of HyVic RHP.

# There are enormous challenges ahead But together we can make it!

