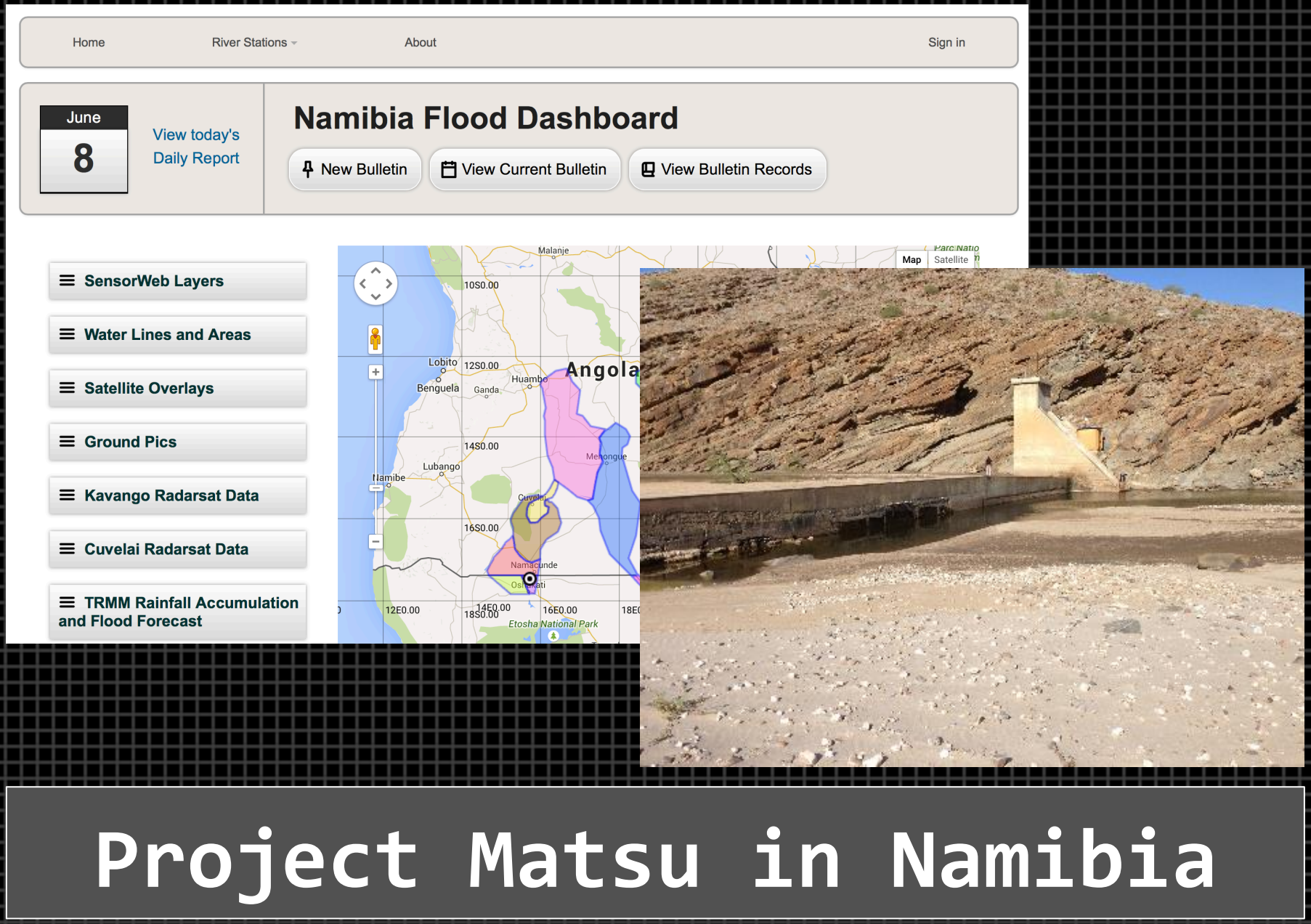


Project Matsu in Namibia

Race Clark

The National Weather Center

QPE – QUANTITATIVE PRECIPITATION ESTIMATES

- Merging satellite, rain gauges, and weather radars
- Expertise with PERSIANN, CMORPH, TRMM, MRMS
- Improvements to ground radar and satellite estimates

HYDROLOGIC MODELING

- EF5
- CREST
- HyPRO
- Data assimilation
- Coupling with snow models and landslide models
- Global, regional, and local modeling

FLASH (FLOODED LOCATIONS AND SIMULATED HYDROGRAPHS) PROJECT

- Suite of flash flood forecasting tools in United States
- Includes hydrologic models and other rainfall-driven tools

Hydrometeorology and Remote Sensing Laboratory

SERVIR is a joint venture between NASA and USAID (United States Agency for International Development)

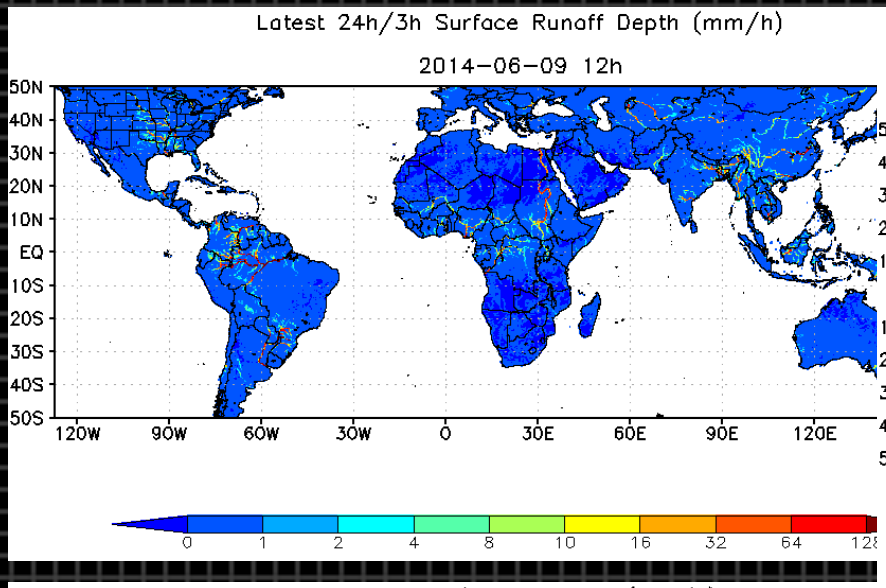
- Satellite-based observation data
- Science applications
- Improve environmental decision making in developing nations

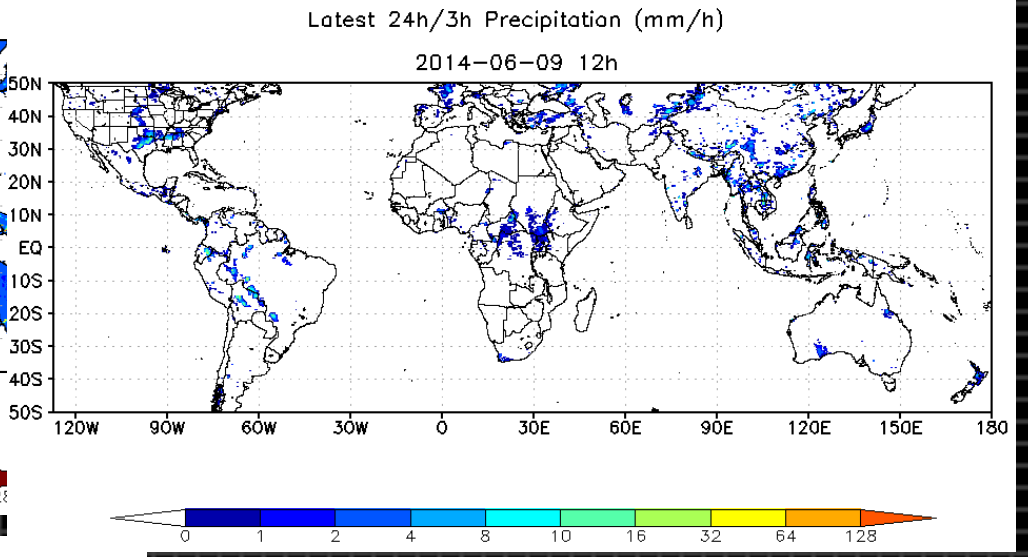
Centers throughout the world

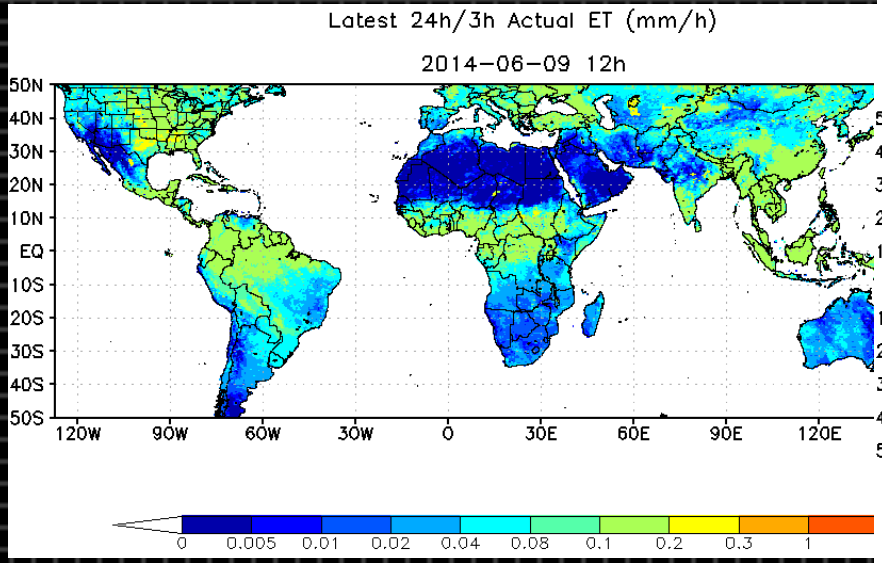
- Marshall Space Flight Center in Huntsville, Alabama
- CATHALAC in Panama
- RCMRD in Kenya
- ICIMOD in Nepal

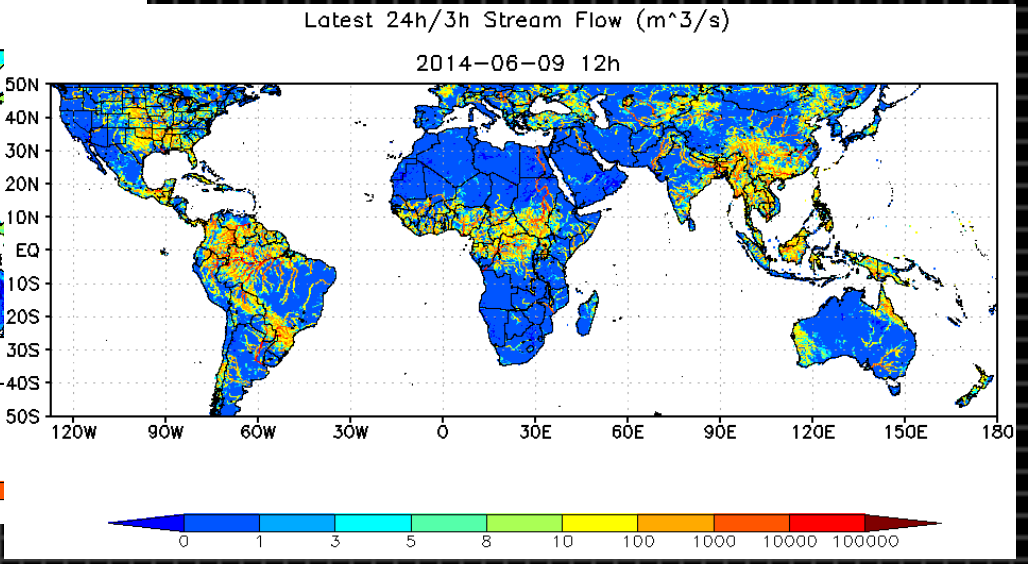
Floods, fires, droughts, frost

Project Background









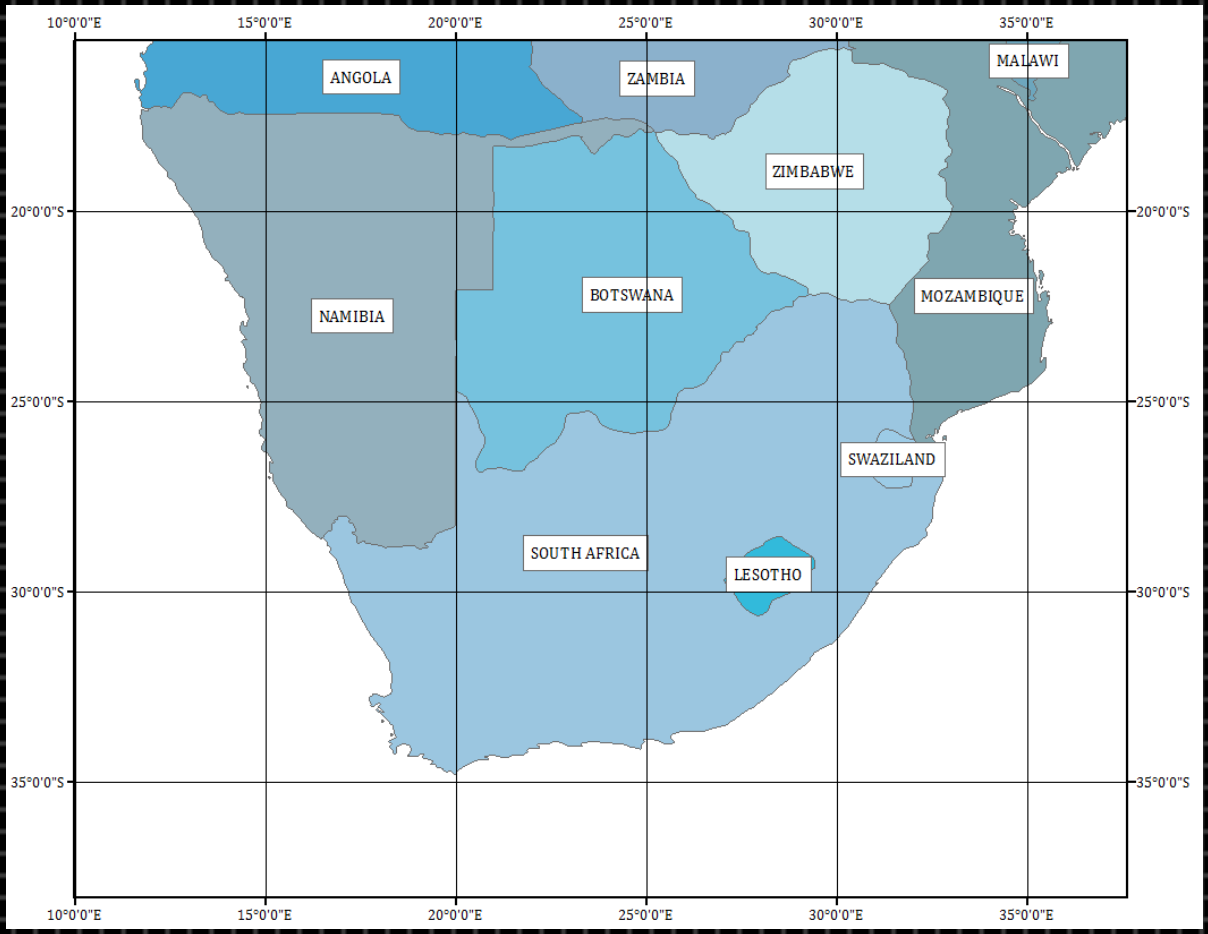
Global Hydrologic Modeling

Southwestern coast of Africa

German colony until WWI

South African protectorate until 1990 (called Southwest Africa)

Apartheid lifted and free elections begin



Where Is Namibia?

Namibia is famous for unspoiled wilderness and natural beauty

Gamsberg Pass

…vast deserts…

View from atop Dune 7, Walvis Bay, Namibia

…And abundant animal life!

Warthogs, a crocodile, and rhinos outside Windhoek, Namibia

NASA SERVIR started working Namibia in 2009

EO-1 satellite used to collect scenes of flooding

OU develops the CREST hydrological model

OU invited to use CREST to predict floods in Namibia/compare model results to EO-1

Project History

Challenges

Lack of computing resources and experience

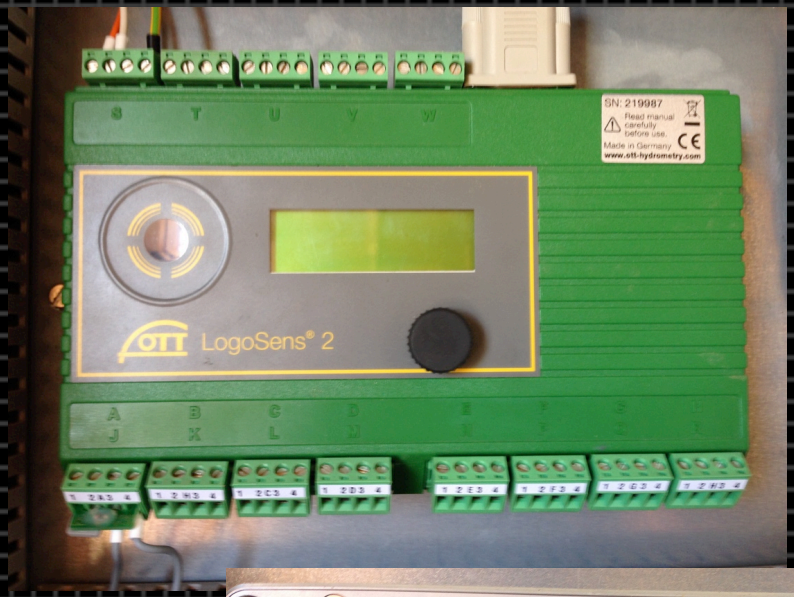
- Old equipment
- Inconsistent maintenance

Communication difficulties

- Essentially no Internet access

Lack of hydrological and meteorological observations

Remote locations



Opportunities

Passion and drive for success in management

Strong personal relationships

E.U. and U.S. investment

Stable politics

Willingness to learn

Namibia Flood Dashboard

- Hosted on OSDC
- NASA GSFC responsible for design and maintenance, as well as satellite imagery
- OU contributes model output
- Namibian government contributes bulletins and observations
- NGOs provide other interesting datasets

Namibia Hydrological Services
Private Bag 13184
Ministry of Agriculture, Water and Forestry
Government Office Park
Namibia

Enquiries:
Ms Pauline Mufeti
Tel :(+264) 61 208 7191
Fax :(+264) 61 208 7256
Email: MufetiP@mawf.gov.na &
hydrologynamibia@gmail.com

HYDROLOGY NAMIBIA

HYDROLOGICAL SERVICES NAMIBIA- DAILY FLOOD/ HYDROLOGICAL DROUGHT BULLETIN: 09 JUNE 2014

Water Levels

See figures in the table below with readings from our Telemetry Stations, site informants, and the satellite-based SADC Hydrological Cycle Observing System (SADC-HYCOS) Data Collection Platforms (DCPs). You can read more about SADC-HYCOS here http://sadchycos.dwaf.gov.za/about%20us.aspx.

River	Site	waterlevels (m)			
		one week before	one day before	Today	normal for
		01-Jun-2014	08-Jun-2014	09-Jun-2014	09-Jun
Zambezi	Katima Mulilo	4.87	4.42	4.35	3.13
Chobe	Ngoma Gate	3.80	3.46	3.45	
Kwando	Kongola			2.81	2.59
Kavango	Rundu	5.35	5.10	5.07	4.69
	Mukwe	3.44	3.32	3.30	
Cuvelai North East	Shahaingu	0.42	0.42	0.42	
Cuvelai North west	Shanaibwengendje	0.35	0.35	0.35	
	Shapoko	0.49	0.49	0.49	
Cuvelai South West	Shashuli	0.03		0.14	
	Otwana	0.01		0.00	
Cuvelai Main	Okatana	0.33	0.28	0.27	
Kuiseb River	Gobabeb	0.00	0.00	0.00	
	Schlesien	0.00	0.00	0.00	
Orange	Upington (**)	0.77	0.64		
Kunene	Ruacana	2.31	2.27	2.17	
	Ruacana flow (m^3/s) (++)				

(+) information by courtesy Riaan Bester
(++) information by courtesy Kambungu Steven
(') information by courtesy Simone Micheletti
(-) information by courtesy NamPower – averaged flow through turbines (plus any flow over diversion weir)
(--) reading downstream in river – affected by daily fluctuations resulting from NamPower operations for flows < 300 m3/s
(*) information by courtesy DWA South Africa – Orange/Vaal confluence
(**) information by courtesy DWA South Africa

A useful site for a range of disaster related information in Namibia:
Directorate Disaster Risk Management http://www.ddrm.gov.na/

Feel free to share with us any hydrological information in your areas. Please put new information under a separate heading/subject. We would also like to thank everyone that has been sending us data, and please continue to do so

You can also view past and present daily flood bulletins and other flood information on Namibia at NASA's Namibia Flood Dashboard http://matsu.opencloudconsortium.org/namibiaflood

matsu.opencloudconsortium.org/namibiaflood

CREST: The Next Generation

EF5 (Ensemble Framework for Flash Flood Forecasting)

- C instead of FORTRAN
- Multiple model cores using same input data enables probabilistic forecasting
- Informative error handling
- Cross-platform
- Better flow routing and calibration schemes

Developed by OSDC PIRE fellow Zac Flamig

A New Training Course

Heavily focused on hands-on activities

Designed to encourage core competencies, starting with the basics

Logical progression of tasks leading up to final goal: obtain data, process data, run model, calibrate model, visualize output, and interpret output independently

Use of open-source software and free data

Developed by OSDC PIRE fellow Race Clark

EF5 Training Outline
30 Mar – 2 Apr 2015

Day 1 – Monday, 30 March 2015

1.1 WELCOME
- Group photo; exchange contact information; training goals; system requirements; EF5 and CREST basics; training course contents and organization; OU, HyDROS, and NASA-SERVIR
- Installing QGIS and TauDEM

1.2 INTRODUCTION TO HYDROLOGICAL MODELS
- The water cycle; defining hydrological processes; modeling hydrological processes; types of hydrological models
- Create hydrographs for Wang Chu River example

1.3 EF5 OVERVIEW
- Features of EF5; model structure; control file options; warm-up and model states; model evaluation indices
- Evaluate Wang Chu River example

1.4 DEM DERIVATIVES
- Topographical information; sources of DEMs; creating your own
- Create DEM and derivatives for Okavango River example

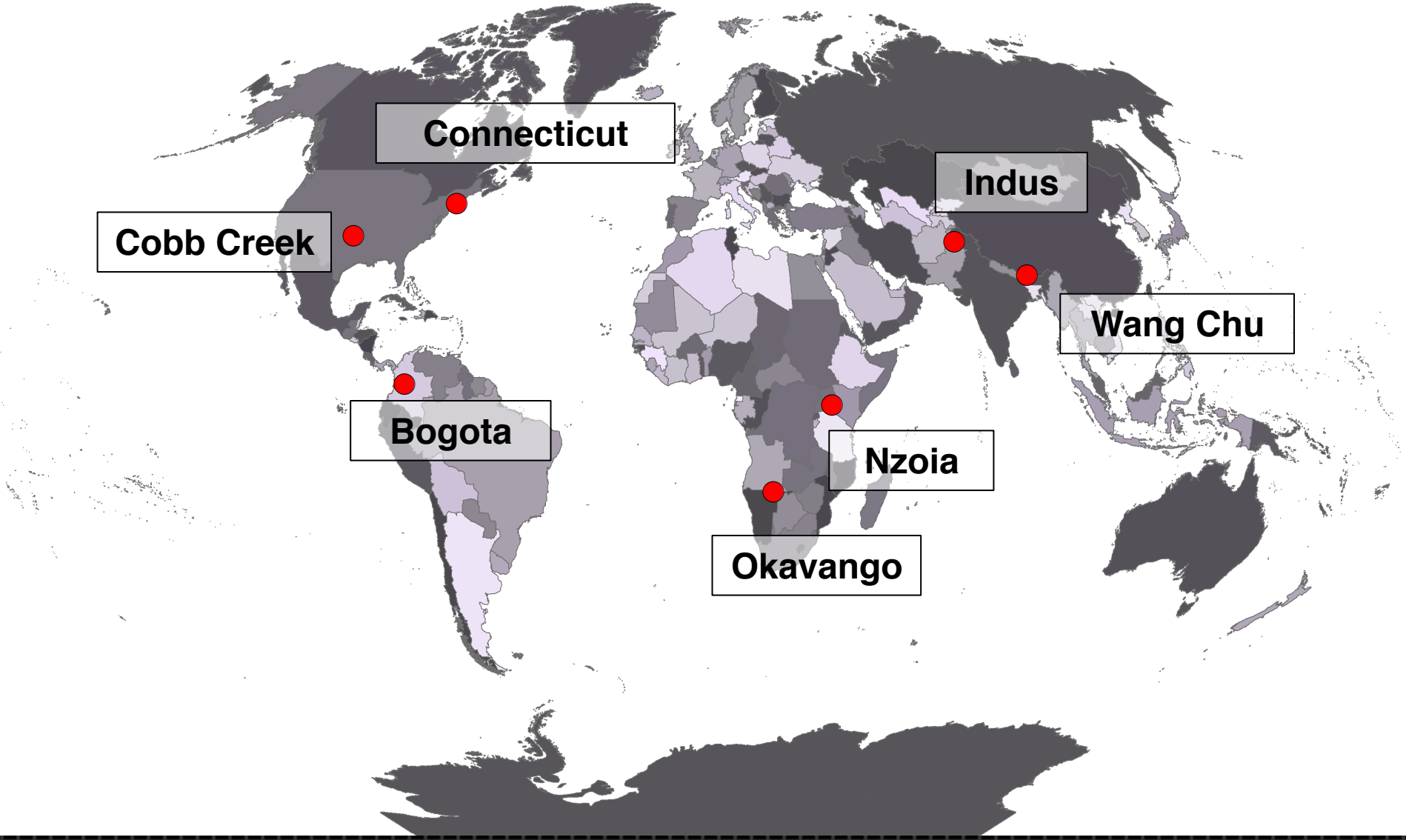
Day 2 – Tuesday, 31 March 2015

2.1 RAINFALL AND PET
- Sources of rainfall and PET data; remote sensing vs. rain gauges; how satellite estimates of rainfall work
- Download and visualize rainfall and PET data for Okavango River example

2.2 MANUAL CALIBRATION
- Description of all EF5 parameters; function of parameters; manual calibration strategies; distributed and lumped parameters
- Manually calibrate EF5 for Okavango River example

2.3 AUTOMATIC CALIBRATION
- Discussion of automatic calibration algorithms; use of calibration and validation periods; connecting physical characteristics to model parameters
- Use EF5 in calibration mode on Okavango River example

2.4 INTERPRETING AND USING MODEL OUTPUT
- Using model data to make forecast decisions; confidence and uncertainty; how EF5 is used around the world for forecasting and monitoring; FLASH, EOS, RCMRD and other projects



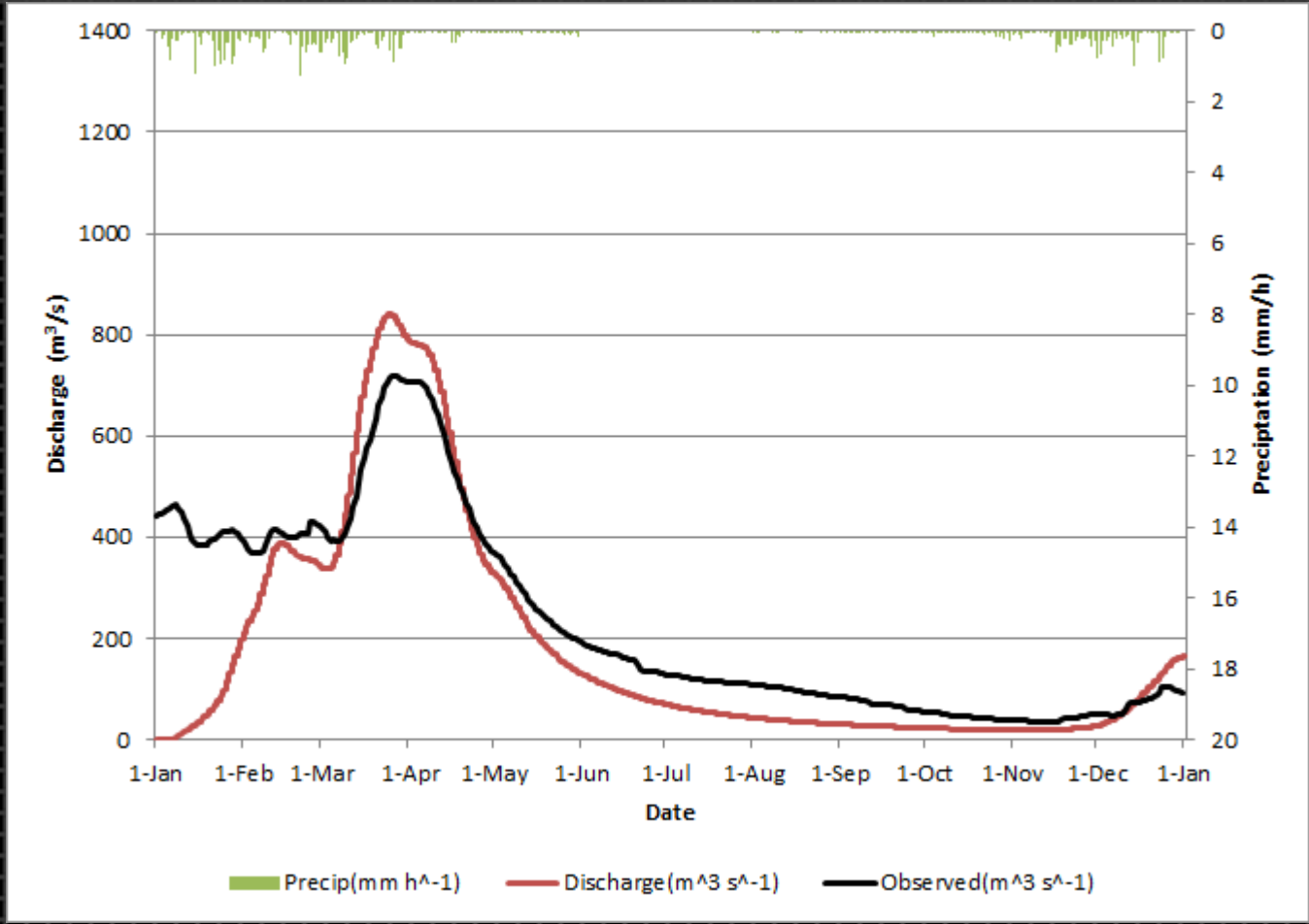
EF5

Training Examples

Simulation Quality

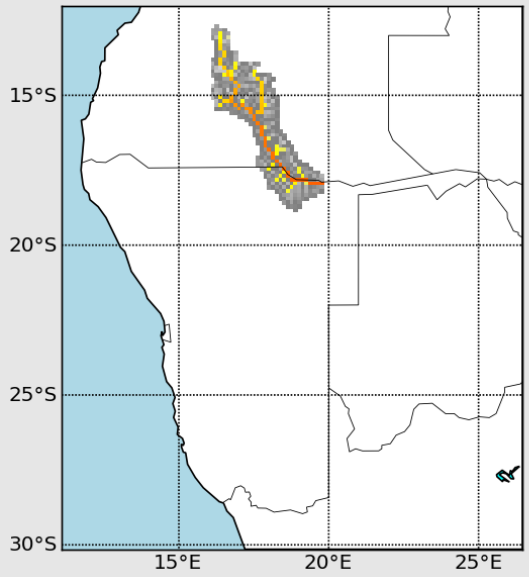
Okavango River at Rundu, Namibia, for 2007

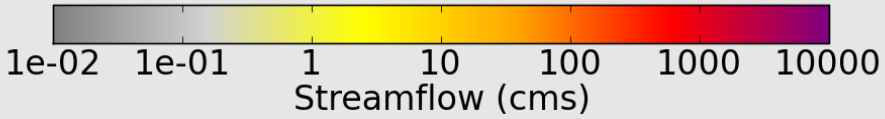
NSCE > 0.8 (very good)

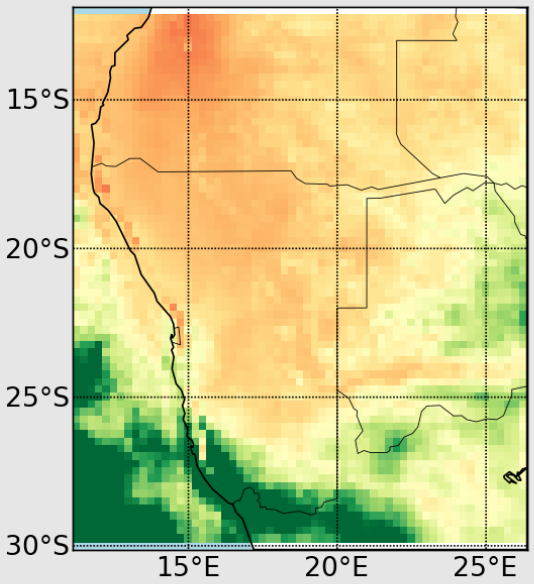


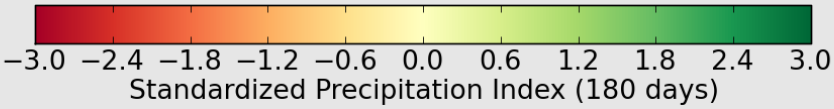
Real-time Forecasts in Namibia

flash.ou.edu/namibia









Where do we go from here?

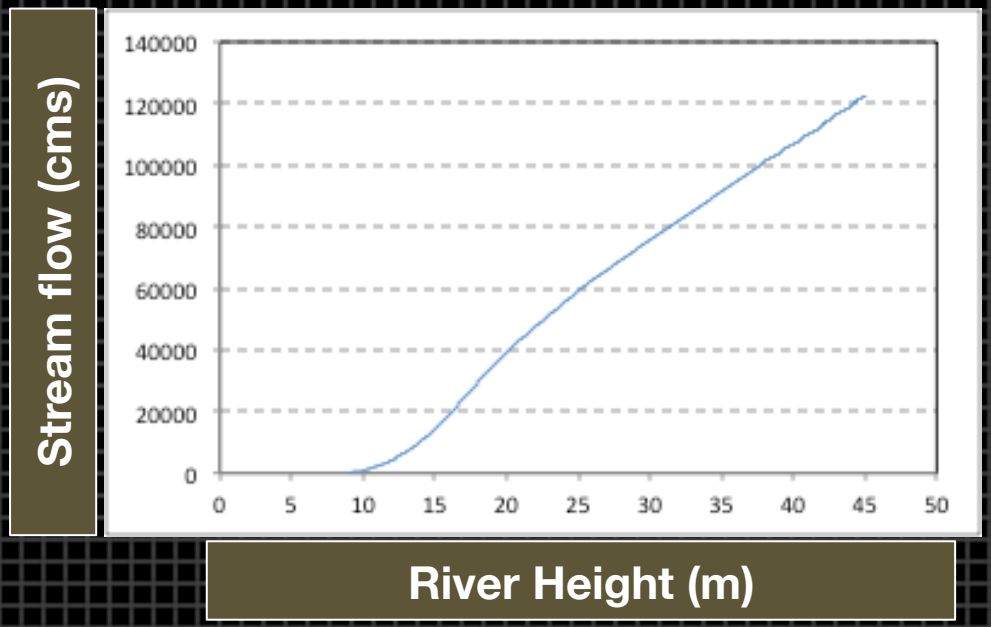
Namibia Flood Dashboard

Provide real-time stream flow forecasts to the Dashboard

Obtain rating curves from Namibian government (or produce them with new 30-m DEM from NASA)

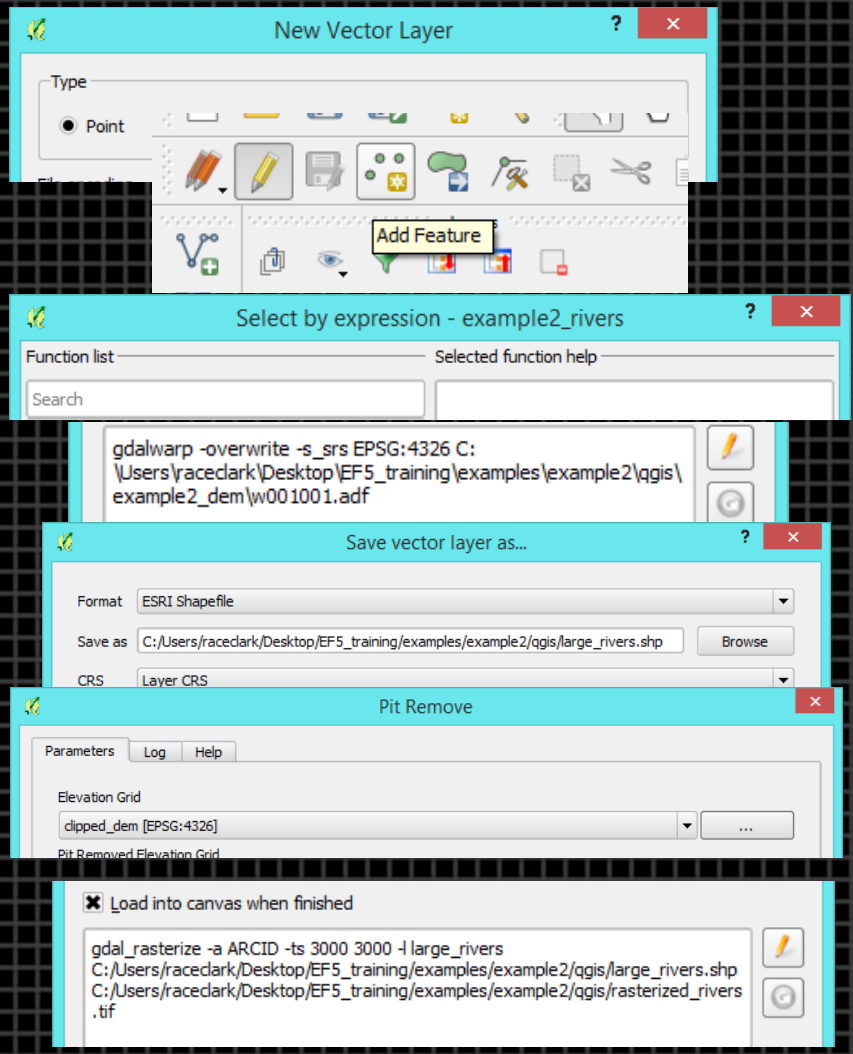
Convert flow to depth and then use EF5's inundation model to forecast and plot flood extent

Cross-validate with EO-1 images on Dashboard



Current GIS Workflow

- DEM resampling (`gdalwarp`)
- DEM correction (`Pit Remove`)
- River vector filtering (`Select by attribute`)
- Convert rivers to raster (`gdal_rasterize`)
- Drainage basin outlining (`Create vector layer`)
- Burn river networks (`Raster calculator`)
- Create flow direction map (`D8 Flow Directions`)
- Create flow accumulation map (`D8 Contributing Area`)
- Check for accuracy



Can we automate it?

Yes! A script could call each GDAL process and ask the user for the subjective inputs

- Depth of burned rivers
- Edges of model domain in latitude and longitude
- Threshold for filtering out small rivers

Would save hours of work for new users, but only 10-15 minutes of work for power users

End goal: personalized hydrological modeling on demand anywhere in the world

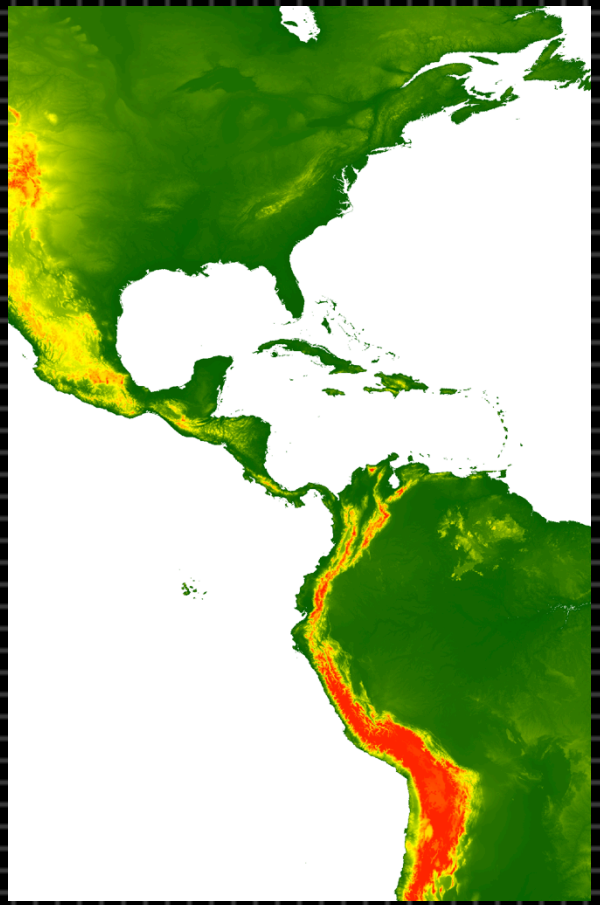
What do we need?

Global satellite rainfall data (NASA TRMM or alternatives)

Global DEM from spaceborne radar (SRTM-2 project)

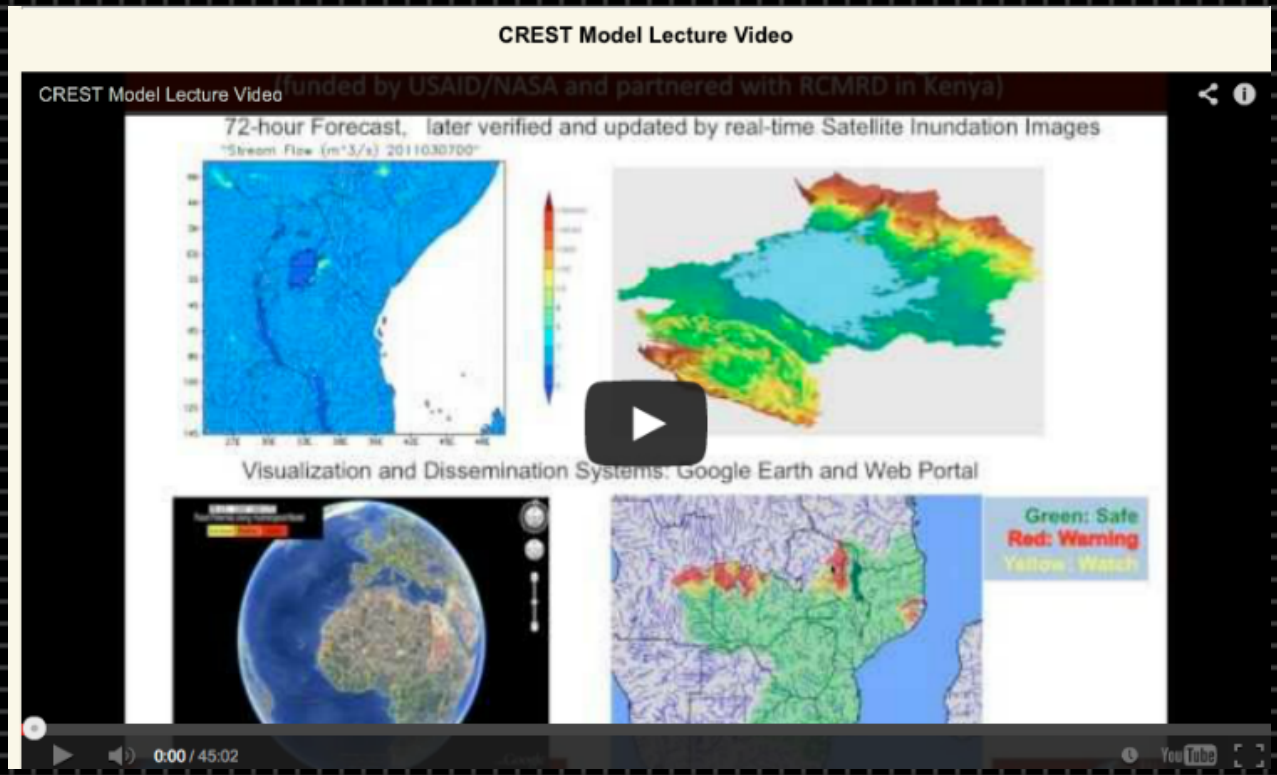
Global average potential evapotranspiration (USGS or FEWSNET)

Global *a priori* model parameters (soil type, texture, other data sets)



In-person training is great, but expensive, time-consuming, and not possible everywhere (security)

Working on securing funding/sponsorship to produce a MOOC at the University of Oklahoma



Remote Training

Gauge station along typically dry river bed (has water usually less than 10 days per year)

Middle of Namib Desert but near coast

Source of groundwater for Walvis Bay

Namwater operates a station, tanks, and several boreholes

Inhabited by Topnaars – live in desert, speak click language, sell *nara* seeds

120 km SE of Walvis Bay

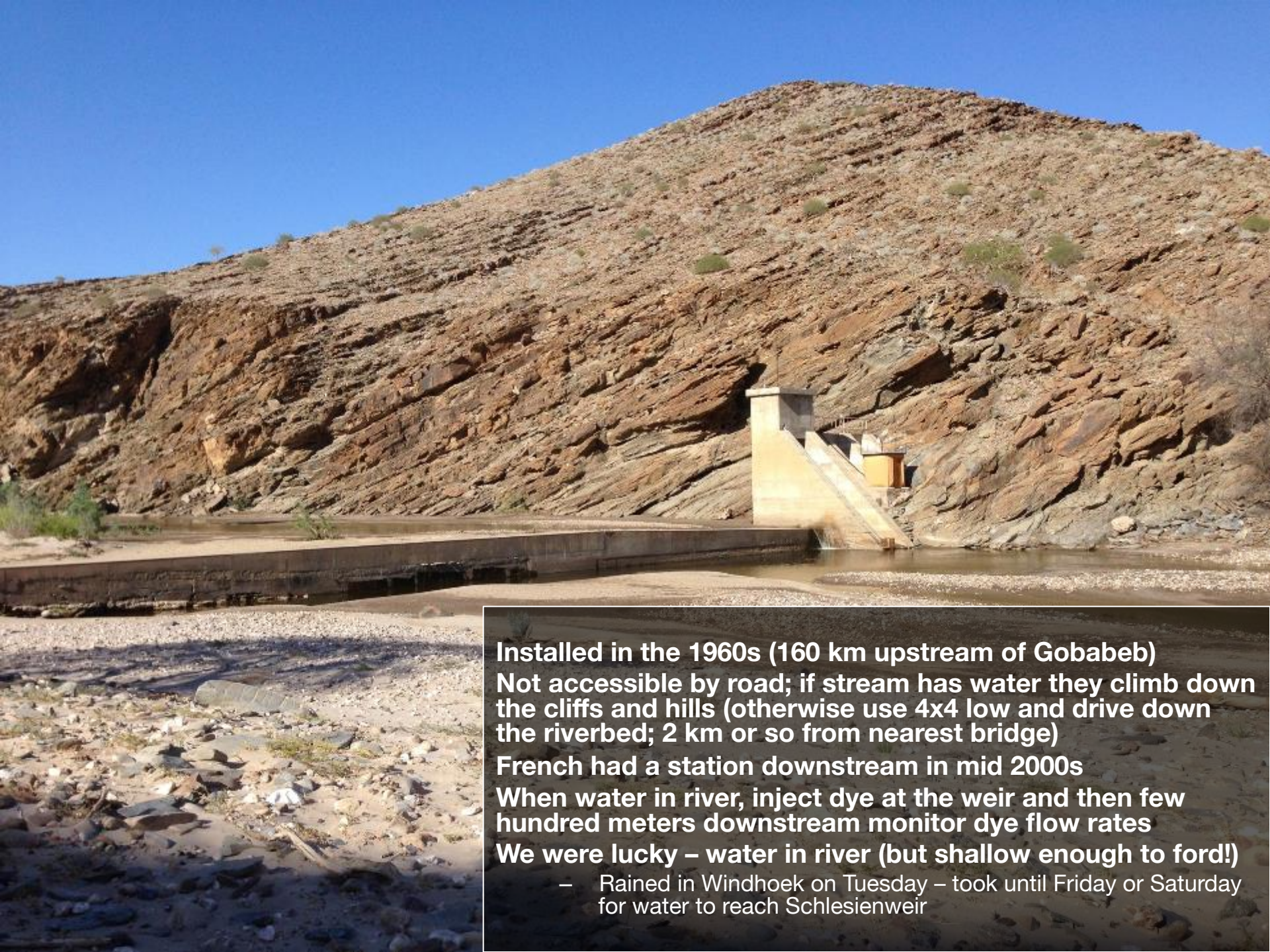
A river gauge station operated by Hydrology Dept (and another for Namwater)

Gauge installed in the 1970s; telemetry since 2012

Communicates via EUMETSAT

Water has not ever reached the gauge house but record gauge datum is over 3 meters

Tourism Dept/Desert Research Foundation has a research station nearby



Installed in the 1960s (160 km upstream of Gobabeb)

Not accessible by road; if stream has water they climb down the cliffs and hills (otherwise use 4x4 low and drive down the riverbed; 2 km or so from nearest bridge)

French had a station downstream in mid 2000s

When water in river, inject dye at the weir and then few hundred meters downstream monitor dye flow rates

We were lucky – water in river (but shallow enough to ford!)

- Rained in Windhoek on Tuesday – took until Friday or Saturday for water to reach Schlesienweir


CALIBRATION CERTIFICATE

Station name: Chlesien Weir No: 299170

Type of float: Flat yellow Cable length: 960 m

Distance from floatstock to calibration mark: 753 m

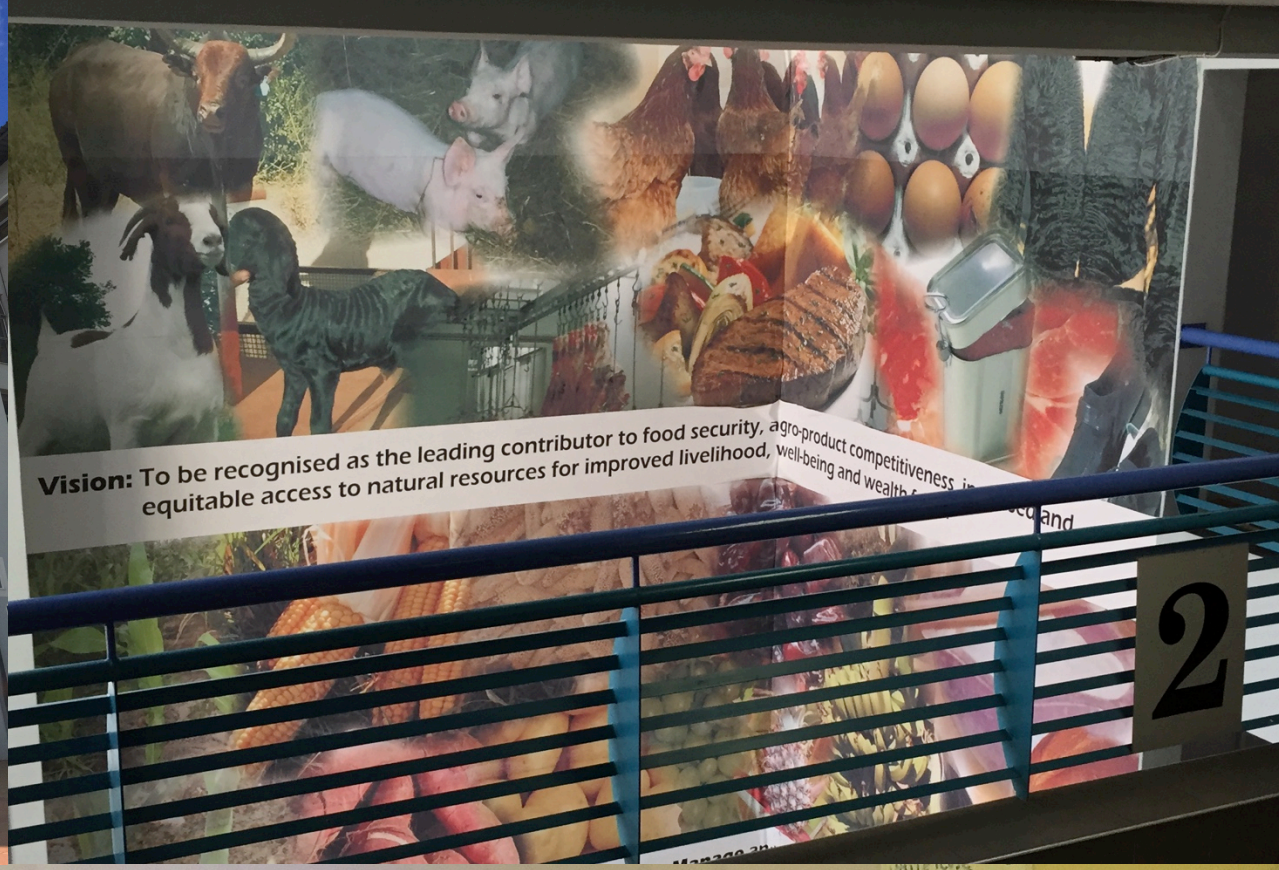
CALIBRATION LEVEL 0.21m

PEN POSITION LOWEST RECORDING LEVEL 0.06m

Calibrated by: [illegible] + RdK Date: 22-10-86


Kuiseb Pass


MINISTRY OF AGRICULTURE
WATER AND FORESTRY
NO SMOKING ZONE


Vision: To be recognised as the leading contributor to food security, agro-product competitiveness
equitable access to natural resources for improved livelihood, well-being and wealth
2


EF5
Welcome to EF5 Training
University of Oklahoma/HyDROS
Module 1.1