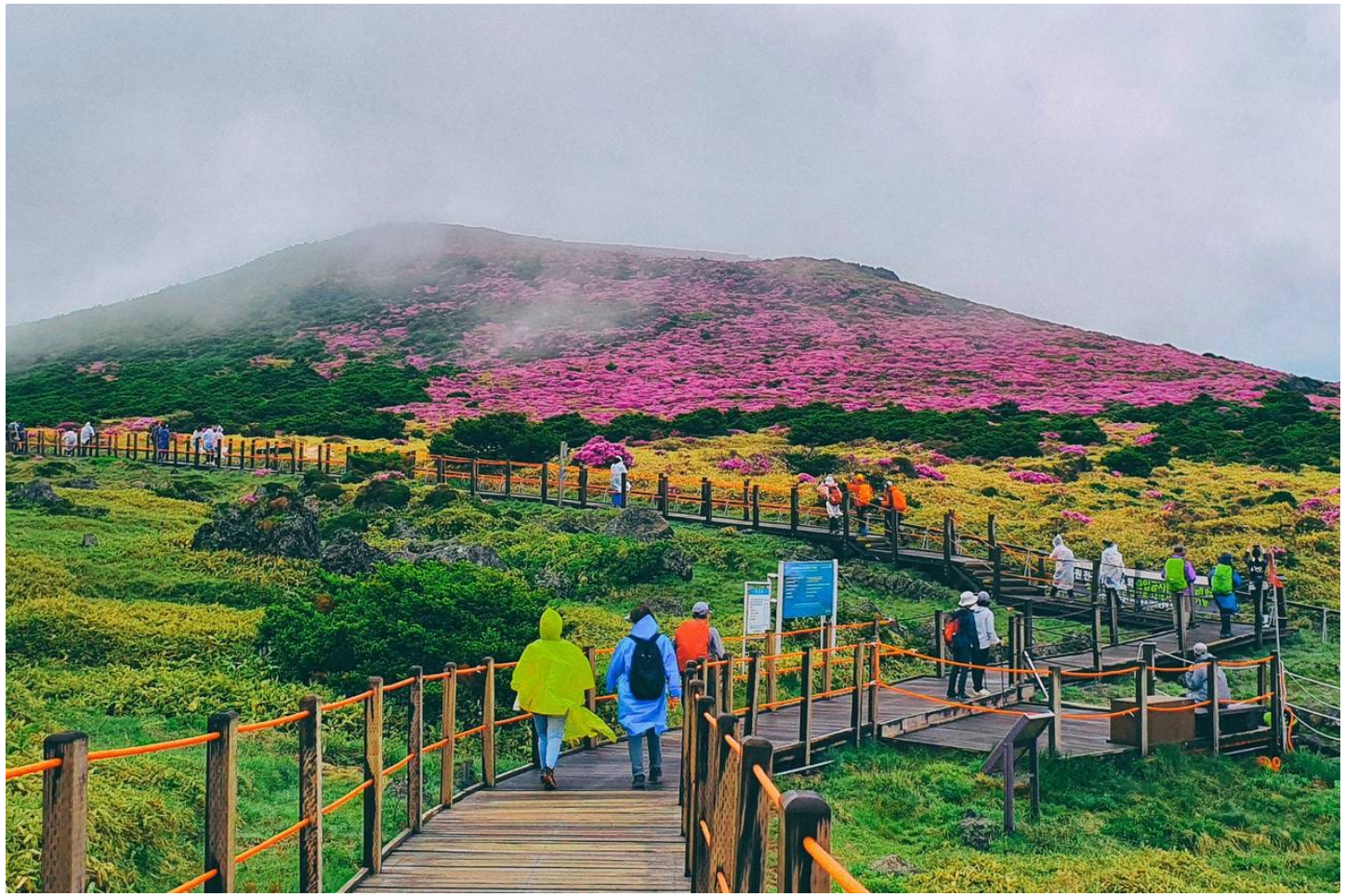


SWAT+
Future Plans

Jeju Island 2025

My Plans

- I retired from the US Department of Agriculture on January 1, 2025 after 41 years
- I am currently Senior Research Scientist with Texas A&M
- Nancy and I plan to continue to support SWAT for several years


2010 International SWAT
Conference & Workshops
DEVELOPMENT AND APPLICATION OF THE SWAT MODEL
2010 SWAT
Korea
August 2-3, 2010
SWAT Workshops
KICT, Ilsan, Korea
August 4-6, 2010
SWAT Conference
Mayfield Hotel, Seoul, Korea
Website: http://2010swat.org
KOREA INSTITUTE OF CONSTRUCTION TECHNOLOGY
21C Frontier R&D Program
Sustainable Water Resources Research Center
The Korean Environmental Science Society
SWAT


Modeling History
Time Line


2010 SWAT
Korea
2010 International SWAT Workshops
August 2-3, 2010 | Korea Institute of Construction Technology


2010 International SW
August 4-6, 2010 | Mayfield
KOREA INSTITUTE OF CONSTRUCTION TECHNOLOGY
21C Frontier R&D Program
Sustainable Water Resources Research Center
MAYFIELD
2010 International SWAT Conference & Workshops
SWAT Conference


2010 SWAT
Korea
2010 International SWA
August 4-6, 2010 | Mayfield Hotel

Dr. Kim, Nam Won (1958~2022)
Senior Research Fellow, KICT

- Development and Application of SWAT-K model (more 100 publications)
- Contributed to the dissemination and expansion of the SWAT model in Korea
- SWAT-K selected as one of the Ministry of Science and ICT's Top 100 Excellent Achievements
- Hosted the 2010 International SWAT Conference in Seoul, with 300 participants
- Promoted the distribution of Korea's soil property database
- Adopted SWAT as the national model for groundwater recharge analysis
- Proposed water management strategies for Korea through integrated surface water–groundwater analysis

U.S. Visit for the Promotion of SWAT-K(2005, Texas)

Discussion on 2010 Internatio)

KICT remains committed to advancing and promoting the SWAT model through conti

Community Model

- Over 600 papers on SWAT development/improvements
- Most do not get included in our main version that is distributed
- With current software development tools (GitHub), multiple developers can efficiently collaborate
- Still need key developer(s) as gatekeeper
- Developers need to commit time to learn GitHub and coordinate with other developers

True Community Model

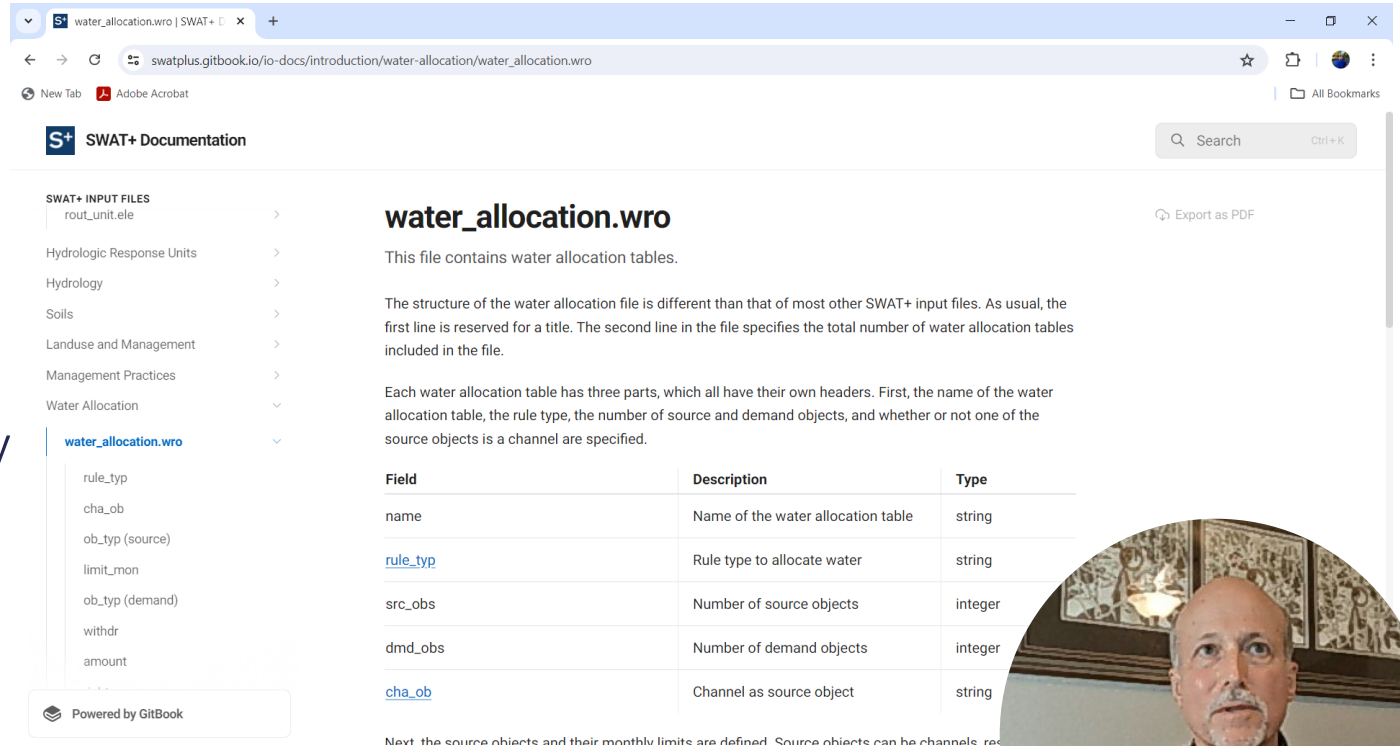
- Olaf David – Set up a SWAT+ GitHub site. Archive, compare and merge, document, automate output comparison with previous versions. Will require time and good communication between model developers.

SWAT+
SOIL & WATER ASSESSMENT TOOL

Documentation

Git Books

- Katrin Bieger (Katie Medoza) developed input/output documentation in GitBooks
- Translated the SWAT2012 theoretical documentation into Git Books
- Integrate theory and i/o and ultimately link code documentation
- Easy to update – multiple contributors



New SWAT+ Developments

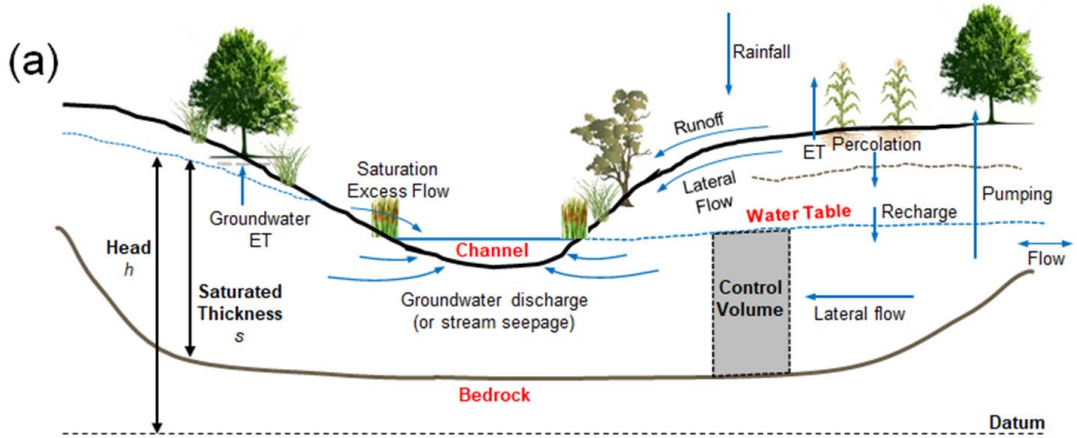
- Groundwater, salt, metals
- Water allocation
- Carbon
- Rice paddies
- National and Global Applications

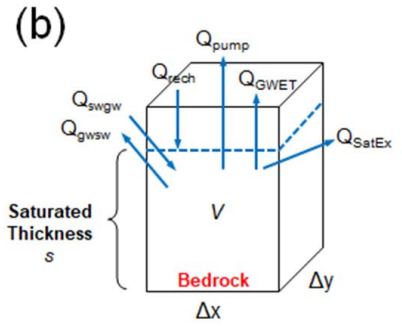
SWAT+
SOIL & WATER ASSESSMENT TOOL

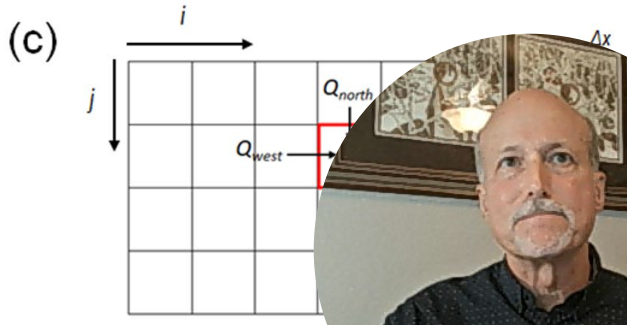
Groundwater Model

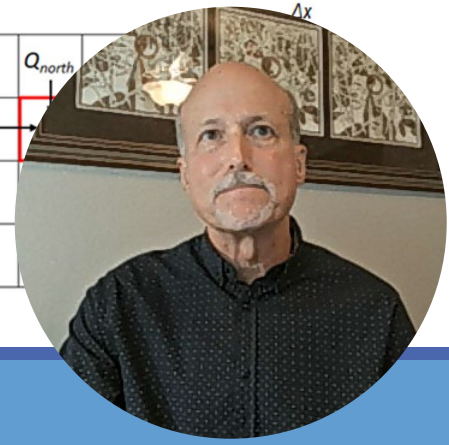
GWFLOW – Ryan Bailey

- Physically-based spatially-distributed groundwater flow module called *gwflow*
- Groundwater head and storage are solved using a water balance equation for each grid cell.
- Adds 2-3X to run times
- Interface and global data are available









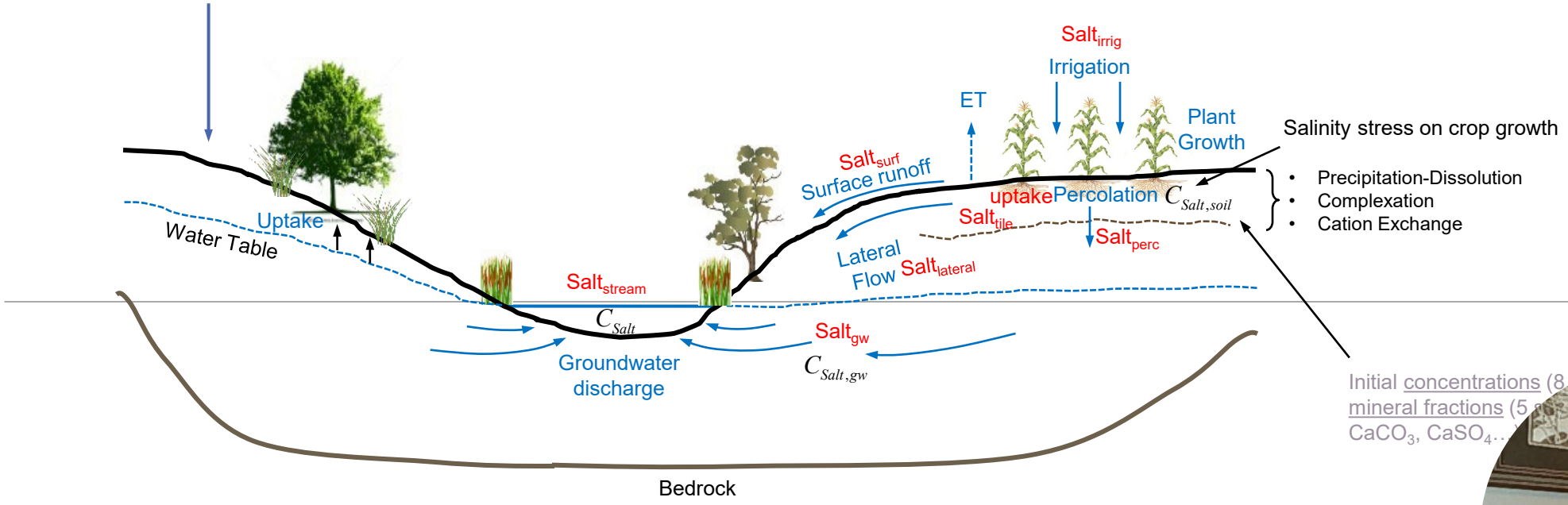
Ryan T Bailey, Katrin Bieger, Jeffrey G Arnold, David D Bosch
"A new physically-based spatially-distributed groundwater flow module for SWAT+"

SWAT+
SOIL & WATER ASSESSMENT TOOL

Watershed Salt Transport

External Loadings

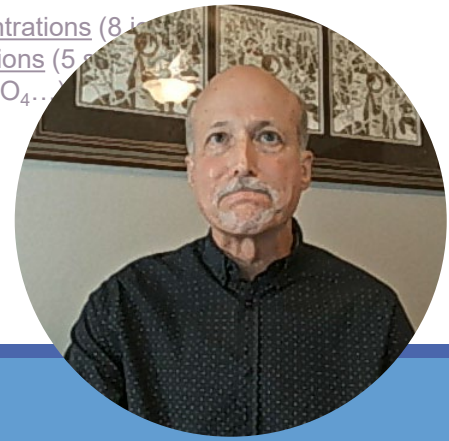
1. **Atmospheric Deposition** (rainfall)
2. **Road Salt** (winter weather)
3. **Point Sources** (e.g. WWTP, industry)



Initial concentrations (8 i
mineral fractions (5
$CaCO_3$, $CaSO_4$..

Salt = SO_4, Ca, Mg, Na, K, Cl, CO_3, HCO_3

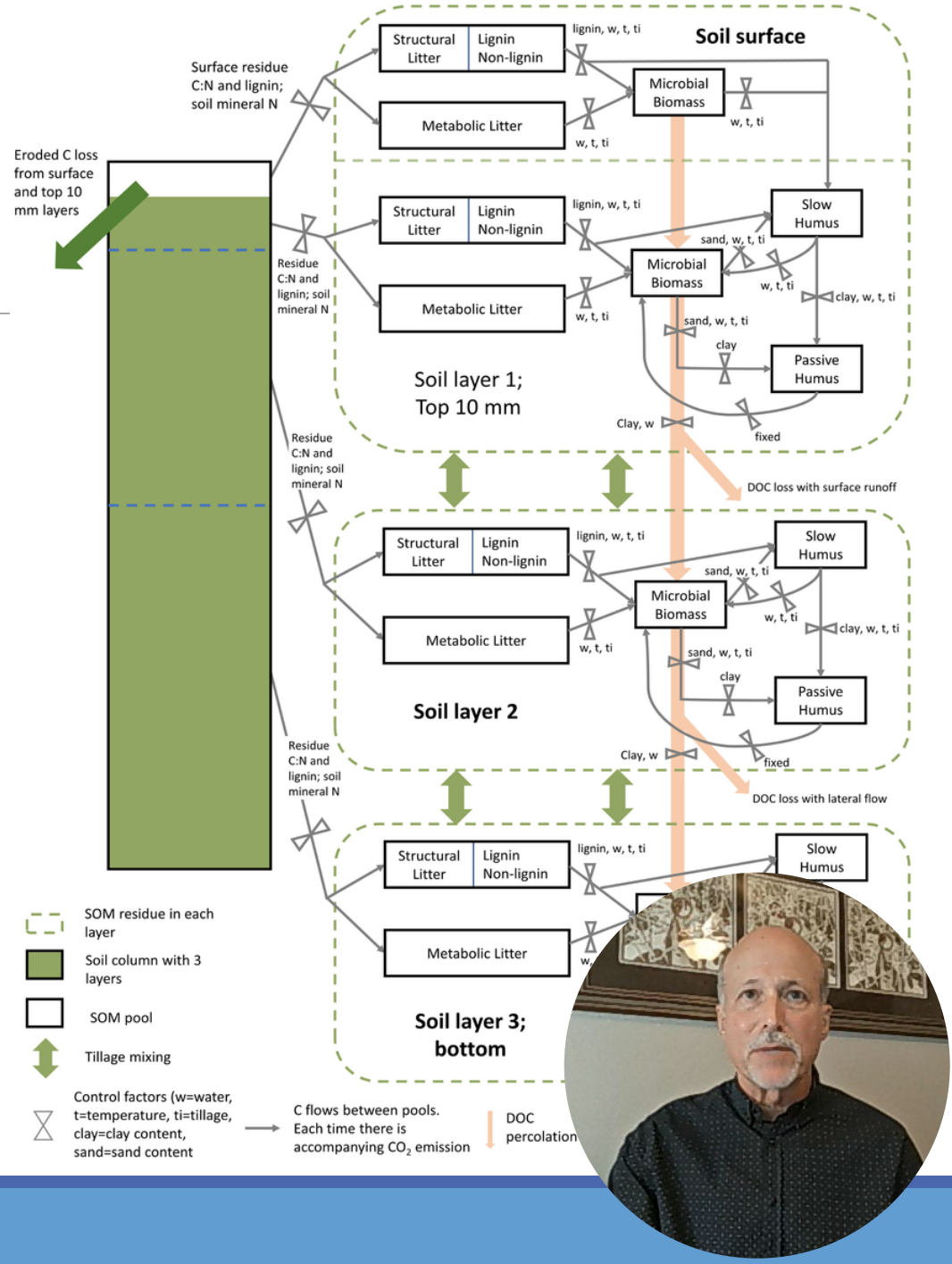
Also: salt mass and concentration in reservoirs/ponds/wetlands



SWAT+
SOIL & WATER ASSESSMENT TOOL

Carbon Model

- Xuesong Zhang (USDA-ARS) developed and is supporting SWAT-C. Complete watershed carbon budget with transport in channels, reservoirs, and aquifers
- Soil carbon budget and sequestration and plant growth and management impacts are included in SWAT+
- SWAT+ carbon has been tested under different cropping systems, tillage treatments, and cover crops
- Future SWAT+ development will include complete watershed budget

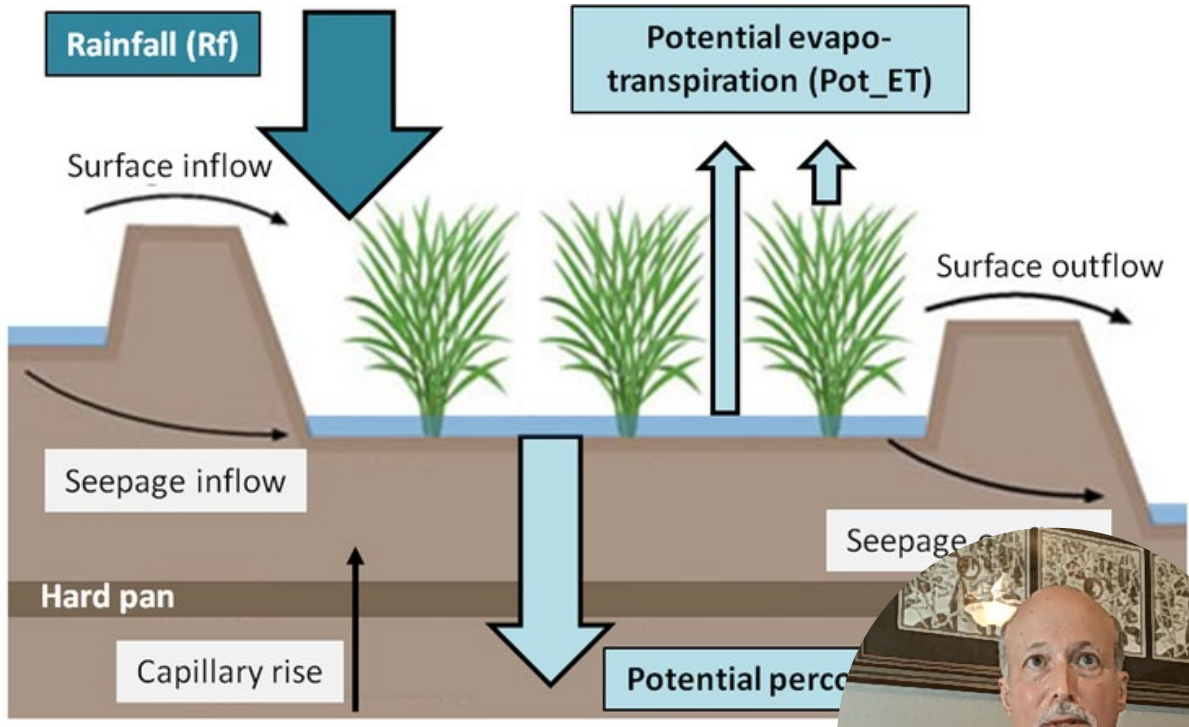


SWAT+
SOIL & WATER ASSESSMENT TOOL

Rice Paddy Management

Rice Paddy

- Jaehak Jeong is leading the modeling effort. Phil Gassman helped assemble the international team
- Management – puddling, transplanting, nutrient and pesticide applications
- Dynamic changing of weir height
- Integrating with Water Allocation model



SWAT+
SOIL & WATER ASSESSMENT TOOL

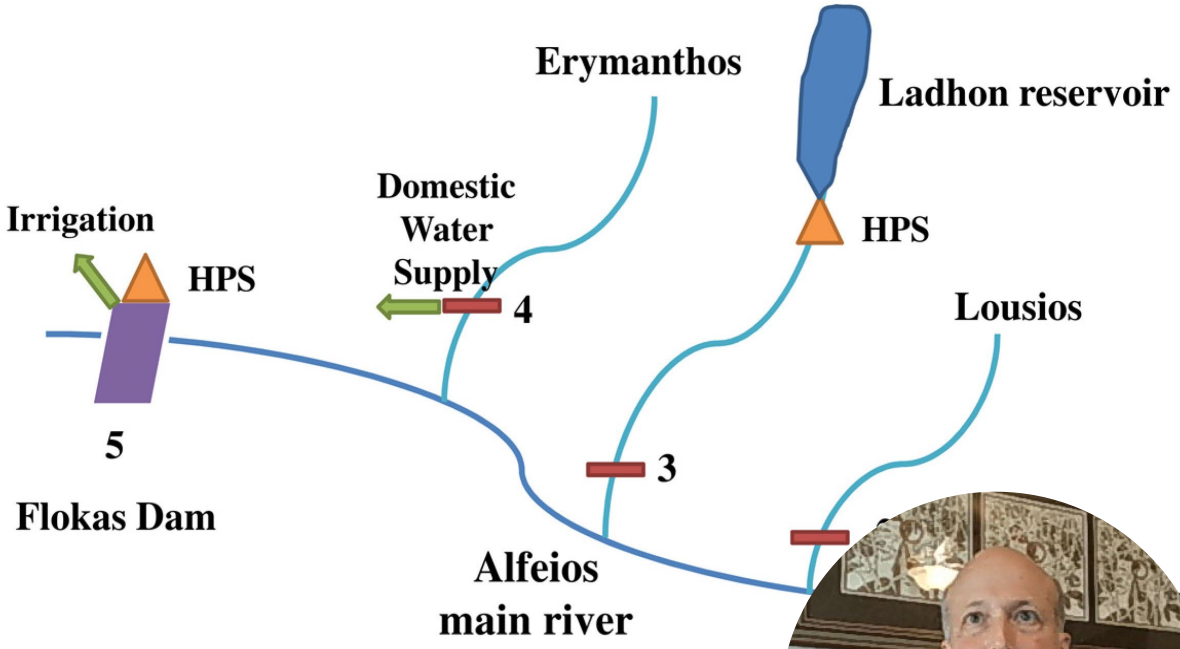
Water Allocation

Demand Objects

- Municipal and Industrial – input constant daily amount or decision table to specify daily withdrawals
- HRUs for irrigation – based on irrigation demand. Triggered by water stress or soil moisture deficit in decision table.

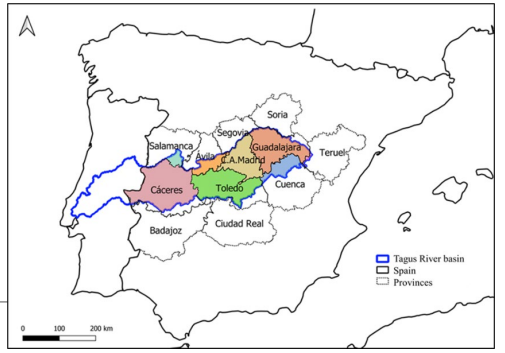
Link to Sources

- Take water from multiple source objects – reservoirs, channels, aquifers
- Input fraction from each source – 75% gw, 25% res
- Can source compensate if other sources are limiting



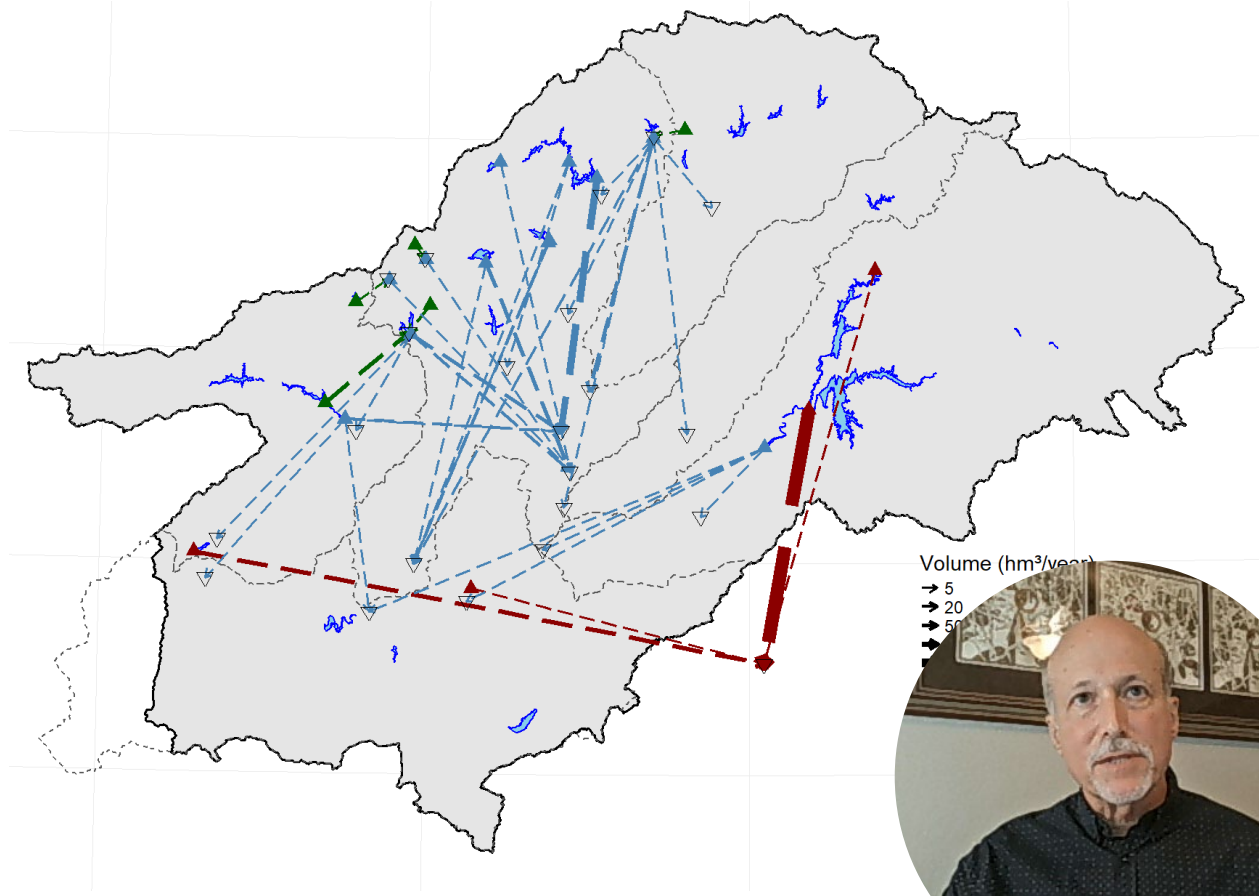
SWAT+
SOIL & WATER ASSESSMENT TOOL

Water Allocation Application



Tagus River Basin in Spain

- 50 regulated reservoirs and 30 water transfers
- Divert water outside to southern Spain for irrigation
- Transfers for human consumption → 17 points (channels) were defined according to the WWTP discharge location and volumes



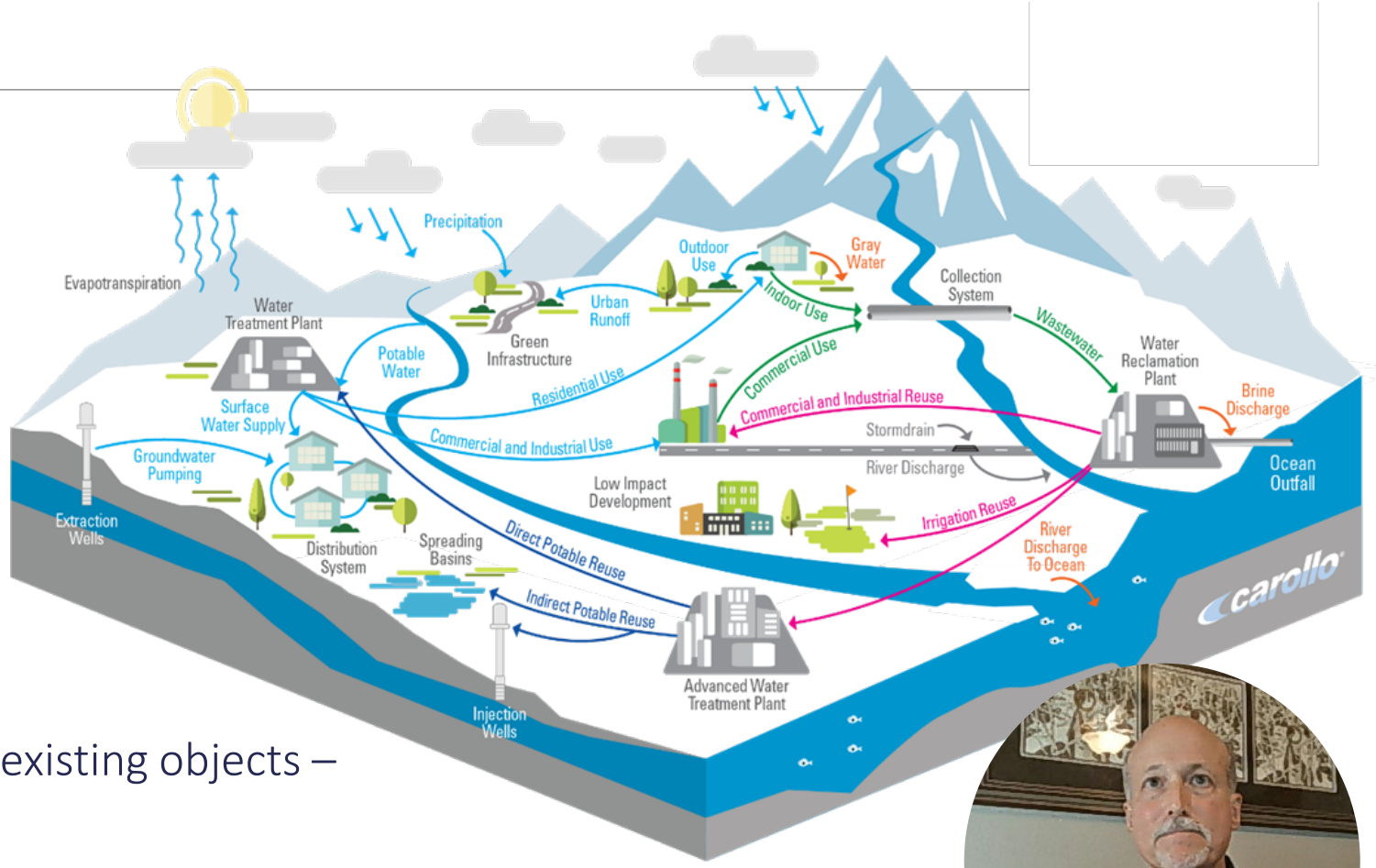
Alejandro Sanchez-Gomez

Sánchez-Gómez, A., Arnold, J.G., Bieger, K. *et al.* Modelling Water Management using SWAT+ : Application of Reservoirs Release Tables and the New Water Allocation Module in a Highly Managed River Basin. *Water Resour Manage* **39**, 2357–2399 (2025). https://doi.org/10.1007/s11269-024-04071-9

SWAT+
SOIL & WATER ASSESSMENT TOOL

Urban Water Allocation

- 0_src → outside basin source
- 0_dmd → outside basin demand/transfer
- wtp → water treatment plant
- use → Industrial/domestic use
- stor → storage
- ⟹ → pipe



Link to Sources

- Overlay and connect urban objects on existing objects – channels, reservoirs, hrus
- Specify WWTP and Use concentrations
- Integrated land use and water supply planning model

SWAT+
SOIL & WATER ASSESSMENT TOOL

Manure Allocation

Status - Conceptual

- Cibin Raj – Penn State
- Started with Water Allocation module

Source Objects

- Feedlots, Confined Animal Feeding Operations
- Composting centers

Manure Applications

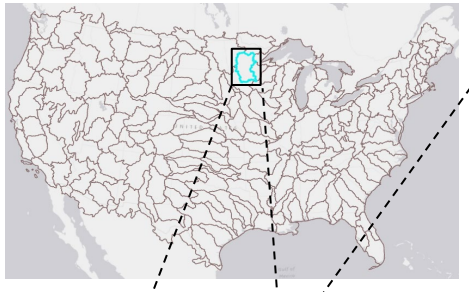
- Use decision tables to condition applications
- Condition on soil phosphorus concentrations
- Condition on distance from source

US National Model

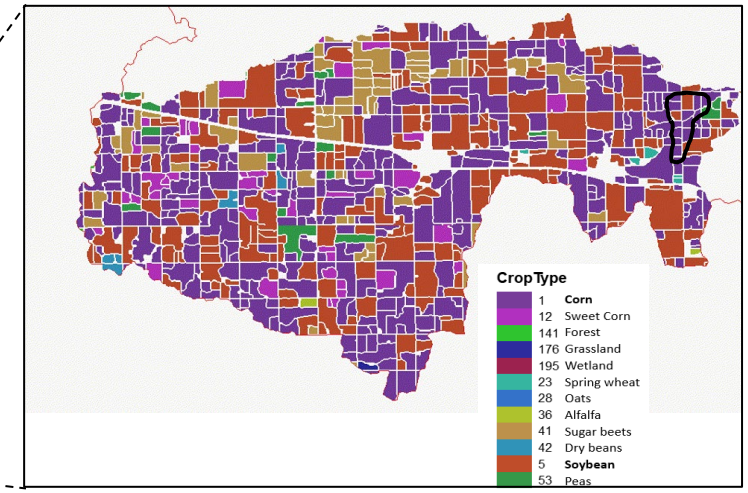
SWAT+
SOIL & WATER ASSESSMENT TOOL

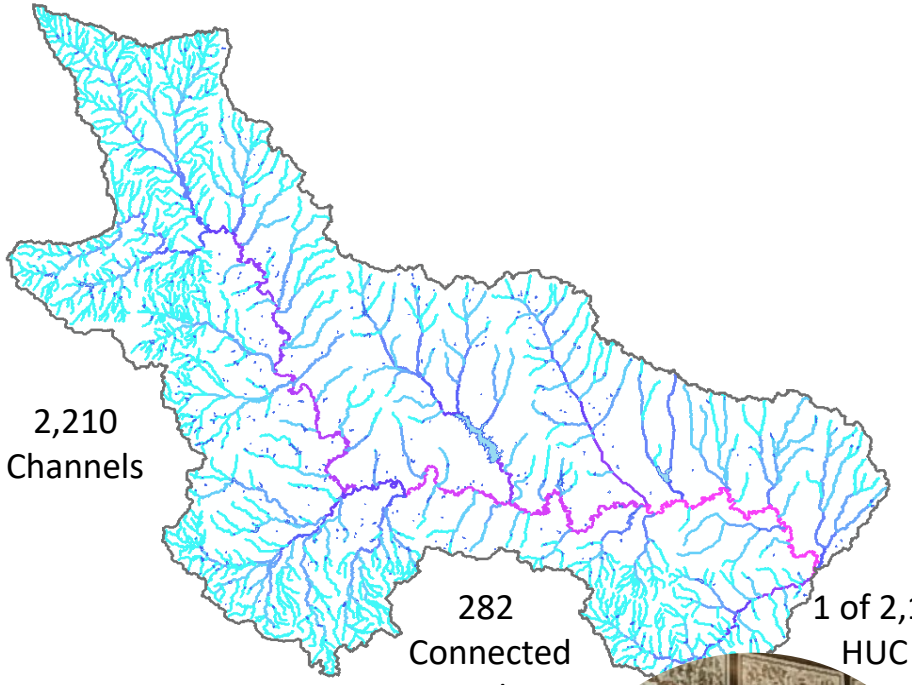
- A highly detailed national modeling framework to predict the effects of land use and management on the environment.
- Joint ARS/NRCS/Texas A&M effort

National Extent



Field Based Computational Units





Scope and Scale

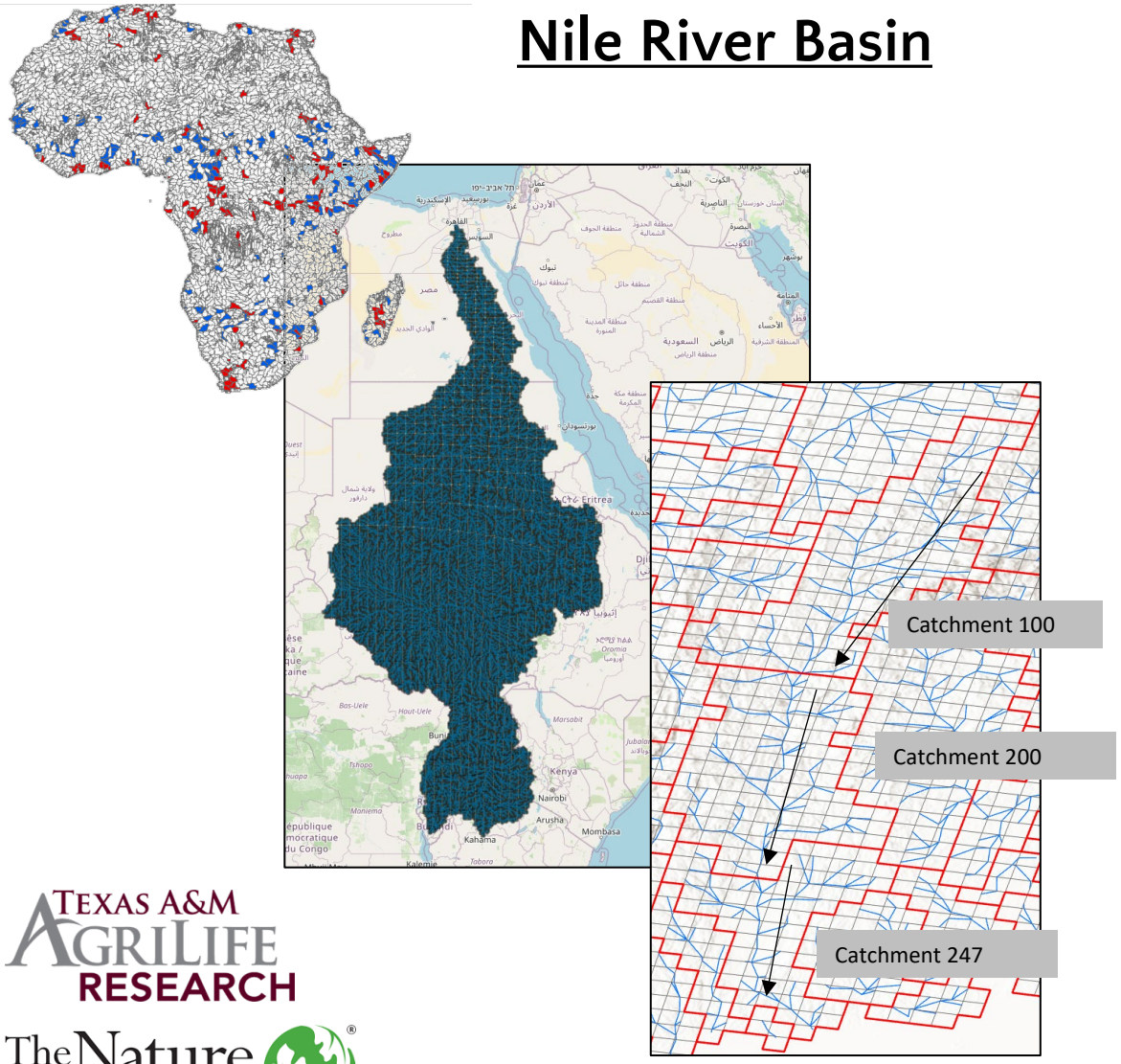
- 2,120 SWAT+ Models
- 86,000 Subbasins
- 7.5 Million HRUs

- National Hydrography
million digitized reache

Predicted Streamflow, Sediment, Nitrogen, Phosphorus

Global Gridded SWAT 2012

Nile River Basin



Arun Bawa – leading the Temple team

Africa- available on Global HAWQS

https://global.hawqs.tamu.edu

Subbasin: 10 km X 10 km

Catchment: ~10,000 km^2

HRUs: 6 HRUs in each subbasin

DEM: SRTM 90m

Landcover: GlobCover 2009

Soil: FAO HWSD

Weather: CHIRPS & CHIRTS

Calibration- MODIS ET/monthly/subbasin

Validation: GRDC stream Dis

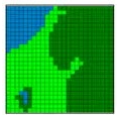
TEXAS A&M AGRILIFE RESEARCH

The Nature Conservancy

SWAT+ Global Model

Set up using CoSWAT Framework

Framework Automatically pulls Data



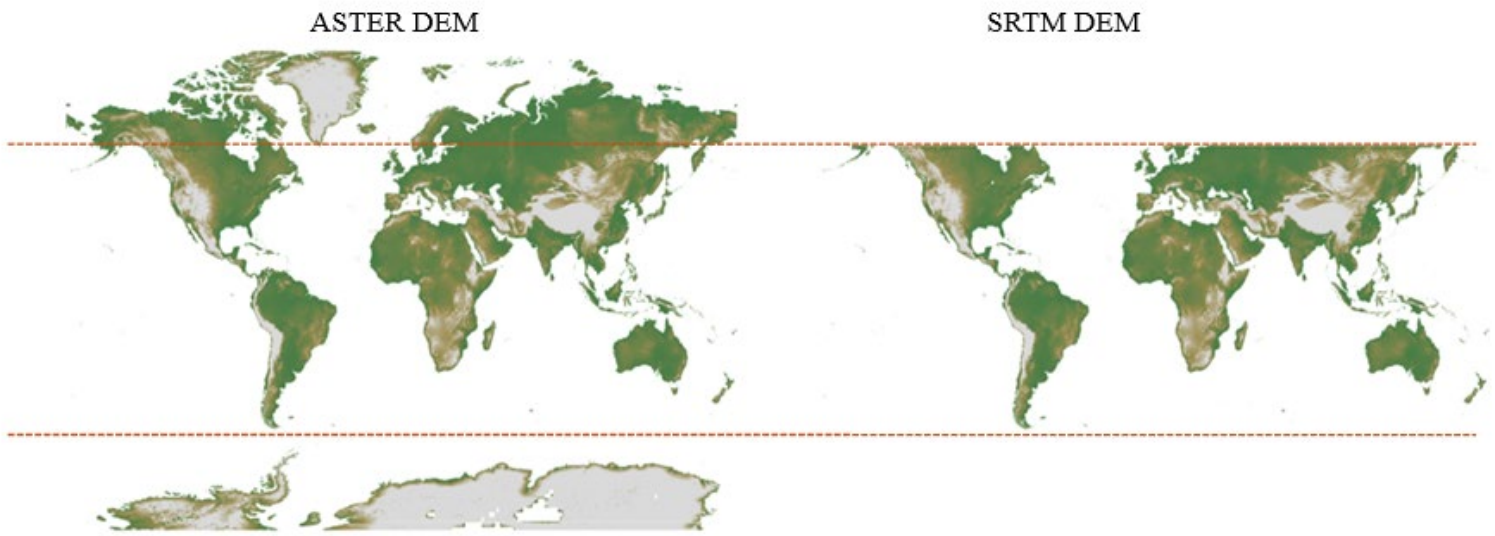
Aster DEM

ESA Land Use

FAO Soil

Weather Forcing from ISIMIP

2km resolution available
(1km in works) – about 3m HRUs



James Celray – leading the Temple team

Ann van Griensven

A High-Resolution Global SWAT+ Hydrological Model for Impact Studies. Celray James Chawanda, Ann van Griensven, Albert Nkwasa, Jose Pablo Teran Orsini, Jaehak Jeong, Soon-Kun Choi, Raghavan Srinivasan, Jeffrey G. Arnold

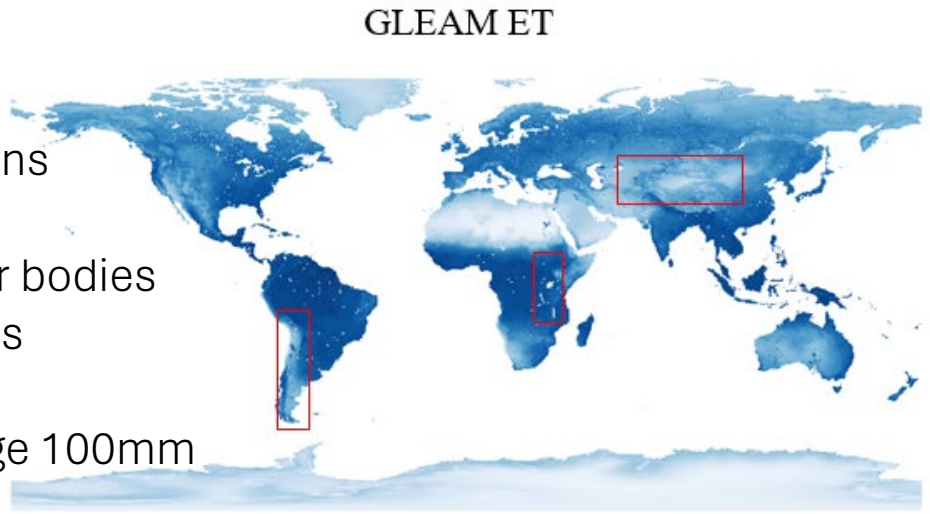
SWAT+ Global Model

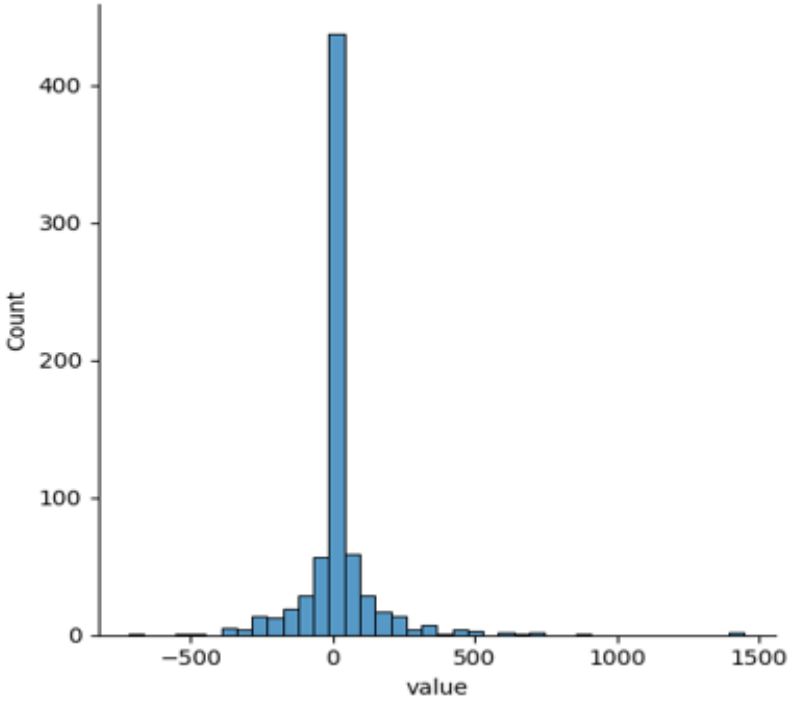
Default performance

Captures ET Spatial Patterns

Struggles in large water bodies and mountainous areas

78.54% within the range 100mm ET difference

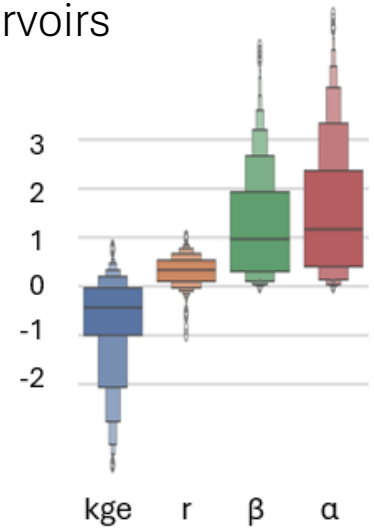


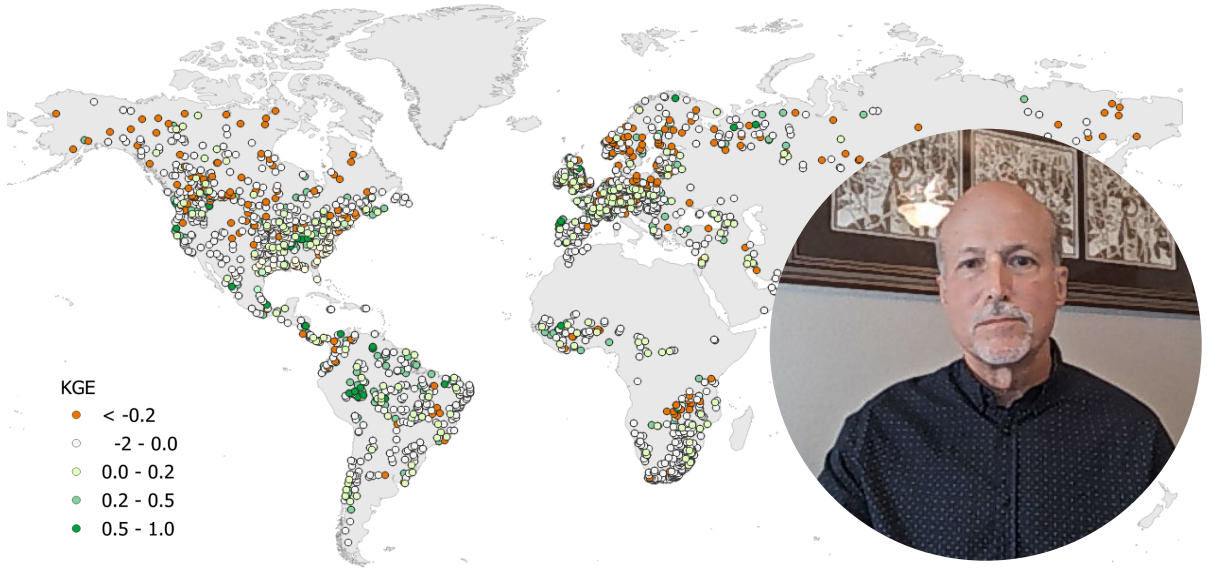


Good performance upstream of reservoirs

No Reservoirs in version

No Calibration





Thank you – I appreciate everyone's efforts and collaboration