Using Satellite Data in Hydrologic Modeling

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XVth Rencontres du Vietnam
2nd VSEO Remote Sensing of Inundation, Flooding and Wetland

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- Hydrologic Modeling
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Objectives of the Presentation

- To introduce the role of hydrologic modeling and hydrologic model.
- To show the potential of satellite data for hydrologic model to overcome the current data issues in hydrologic modeling.
- To introduce briefly the typical hydrologic model: Soil Water Assessment Tool (SWAT).

Presentation Structure

- Hydrologic Modeling
  - Roles
  - Hydrologic Model
- Data Issues in Hydrologic Modeling
  - Availability
  - Resolution
- Alternative sources from Satellite Data
- Soil Water Assessment Tool (SWAT)
- Conclusions
Why do we need hydrologic model?

- To analyze, understand, and explore solutions:
  - sustainable water management
  - to support decision makers and operational water managers.
  - process understanding and scenario analysis

Hydrologic Modeling

Known input

- precipitation
- upstream flow

Unknown output

- runoff
- downstream flow

Model concepts
What is the hydrological model?

HYDROLOGIC MODELS

- Stochastic Model
- Deterministic Model
- Process Description
  - Empirical
  - Conceptual
  - Physical

Spatial Discretization

- Lumped
- Semi-distributed
- Distributed

Hydrologic Modeling

A.

B.

C.
Hydrologic Modeling

Key variables of hydrologic models

- Precipitation
- Landuse
- DEM

Structure of the MIKE SHE model (adapted from DHI 2014a)
Knowledge or Data is powerful?
- Availability:
- Spatial and temporal scale.

Good Model and Good input??

What kinds of data can be provided by Satellite?

Potential of Satellite Data in Hydrologic Modeling

- Rainfall Estimation
- Soil Moisture Estimation
- Water Level Estimation
- Water Quality
- Landuse
- DEM
- ....

Almost data can be found in Satellite Data Stores

Challenges?
Potential of Satellite Data in Hydrologic Modeling

- **Satellite Rainfall:**
  - **APHRODITE:** (Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation) daily gridded precipitation is the only long-term (1951 onward) continental-scale daily product that contains a dense network of daily rain-gauge data for Asia including the Himalayas, South and Southeast Asia and mountainous areas in the Middle East.
  - **CFSR:** (Climate Forecast System Reanalysis) is a third generation reanalysis product. It is a global, high resolution, coupled atmosphere-ocean-land surface-sea ice system designed to provide the best estimate of the state of these coupled domains over this period.

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Potential of Satellite Data in Hydrologic Modeling

- **Satellite Rainfall:**
  - **PERSIANN:** The Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks- Climate Data Record
  - **TRMM Precipitation:** The Tropical Rainfall Measuring Mission (TRMM), a joint mission of NASA and the Japan Aerospace Exploration Agency, was launched in 1997 to study rainfall for weather and climate research.
Potential of Satellite Data in Hydrologic Modeling

APHRODITE: PR: 20070620

daily precipitation analysis interpolated onto 0.5deg grids [mm/day]

Legend
- : Meteorological gauge
- : Rain gauge
- : Stream gauge
- : Shores
- : 2.56 degree grid
- : 3.38 degree grid
- : 5 degrees grid
- : 7 degrees grid

(DN Khoi 2016)
Potential of Satellite Data in Hydrologic Modeling

(DN Khoi 2016)
Potential of Satellite Data in Hydrologic Modeling

DEM

Land Use

Water extent monitoring
Potential of Satellite Data in Hydrologic Modeling

LAO dam break end July 2018

Europe satellite image, Sentinel.1, Nguyen Duy Tien 2018

Potential of Satellite Data in Hydrologic Modeling

Bản đồ phân bố tổng chất rắn lỏng - TSS (mg/l) tại sông Tiền và Hậu

(Nguyen LD, 2018)
Satellite is very potential input sources for hydrologic modeling but due to some unreliable factors, using with cares now.

=> Expectation:

- High spatial and temporal resolution
- More reliable data for input and validation
Brief Introduction SWAT

- Soil Water Assessment Tool (SWAT) is a distributed hydrological model and can be used to estimate the long-term impact of land management practices on runoff, sediment loads, and loss of nutrients at different scales.
- SWAT is a public domain model jointly developed by USDA Agricultural Research Service (USDA-ARS) and Texas A&M AgriLife Research, part of The Texas A&M University System
- First version released in early 1990s
- [https://swat.tamu.edu/](https://swat.tamu.edu/)
- [https://swat.tamu.edu/workshops/instructional-videos/](https://swat.tamu.edu/workshops/instructional-videos/)
Brief Introduction SWAT

Where:
- $SW_f$ is the final soil water content (mm H2O),
- $SW_0$ is the initial soil water content on day $i$ (mm H2O)
- $t$ is the time (days),
- $R_{day}$ is the amount of precipitation on day $i$ (mm H2O)
- $Q_{surf}$ is the amount of surface runoff on day $i$ (mm H2O)
- $E_a$ is the amount of evapotranspiration on day $i$ (mm H2O)
- $w_{seep}$ is the amount of water entering the vadose zone from the soil profile on day $i$ (mm H2O)
- $Q_{gw}$ is the amount water return flow on day $i$ (mm H2O).
Brief Introduction SWAT

By using the given setup SWAT model, the participants can be:

- Analyze the impacts of landuse change on hydrologic response.
- To compare the effect of various sources of landuse, satellite rainfall, DEM,… on hydrologic simulation results
Thank you very much for your attention!

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