

VIC-Cropsyst Modeling

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Motivation

Rice production in the Mekong is getting impacted by climate extremes, and sea-level rise (and salinity).

Impact livelihood of rice-farmers.

Managing rice production and livelihood of rice-farmers under changing climate and increasing human-activities is a challenge.

Strategies:

Climate-rice

Alternative crops

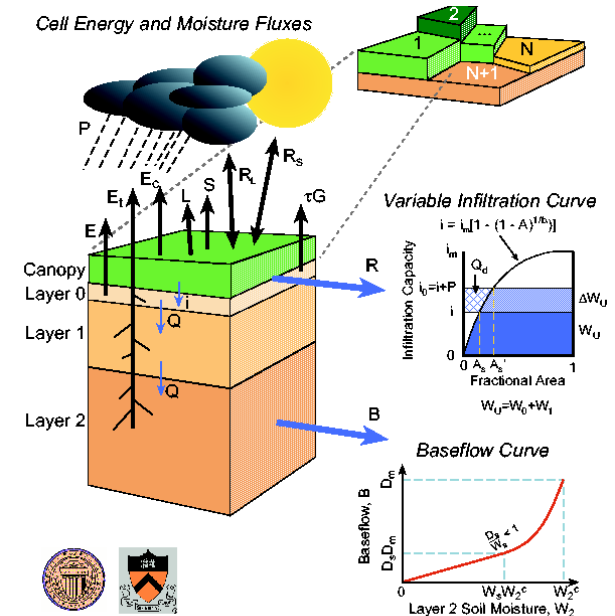
Managing cascade operations, including rice



VIC-CropSyst

VIC

- Liang et al. 1984
- Open Source, Easily accessible from github.
- Land surface model- can simulate soil moisture, runoff, evapotranspiration.
- Applied to global efforts (NASA LDAS, etc).
- Applied in the Mekong basin (Haddeland et al. 2006, Bonnema and Hossain (2017,2019))



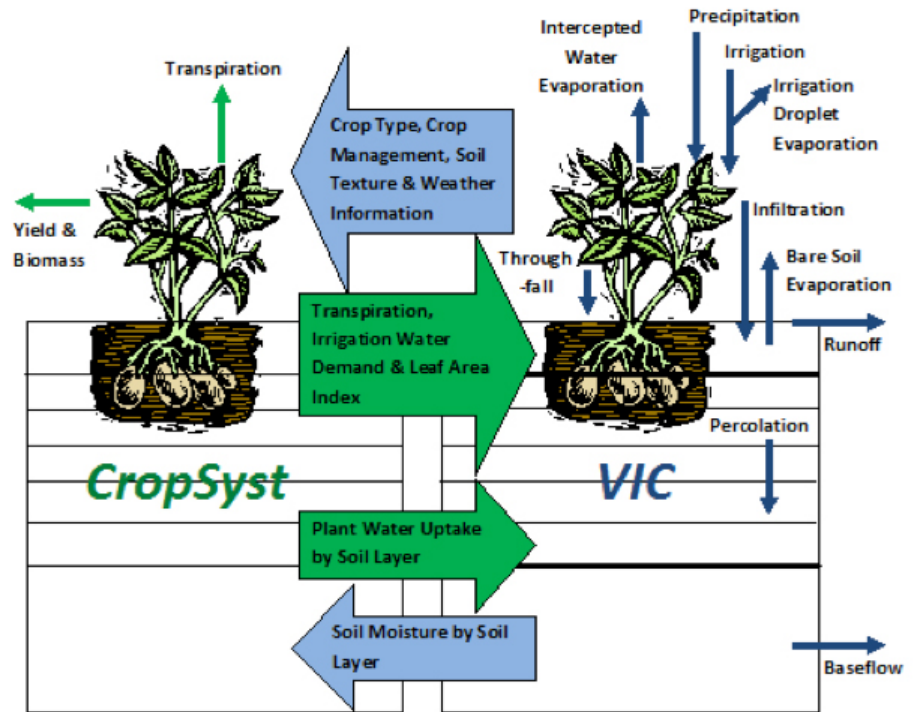
Schematic diagram of VIC-3L model (source: Gao et al. 2009, Cherkauer et al. 2003)

CropSyst

- Stockle et al. 1996
- Easily accessible from Washington State University
- Generic crop model
- Multi-year, multi-crop model
- Daily-time step crop growth model.
- To study effect of crop management practices on crop productivity
- Simulates: soil-water budget, crop phenology, crop growth, biomass production, crop yield.

VIC-CropSyst

- Malek et al. 2017
- Acquired from Washington State University.
- Fully coupled hydrological-agricultural tool
- CropSyst is plug into 3-layer VICv4.1.2.e to simulate dynamic vegetation.
- CropSyst simulates transpiration (not VIC).
- Includes Irrigation module



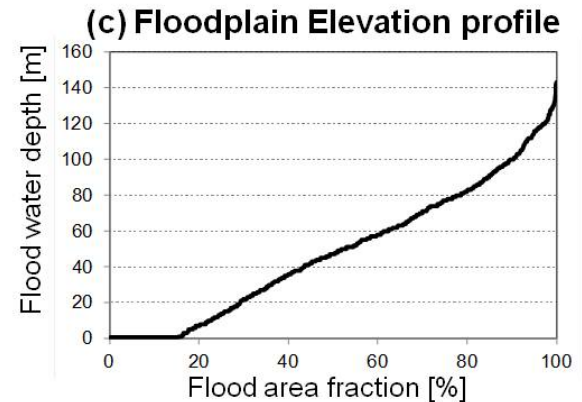
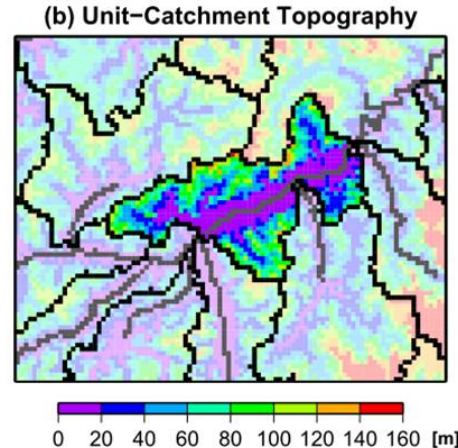
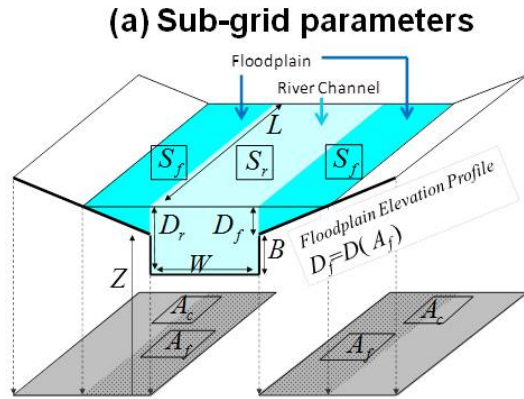
Cropsyst Application for Rice

- Confalonieri et al. (2005) applied Cropsyst for flooded rice in Italy after calibration they reported they were able to simulate flooded rice yields with 22% RMSE, but when they compare to WARM, CropSyst under perform
- Confalonieri et al. (2005) also show that success of model depends on representation of flooding on air temperature.
- Cropsyst (Singh et al. 2011) has been applied for direct-seeded rice in India

To my knowledge, VIC-Cropsyst has not been applied to rice and in the Mekong basin.

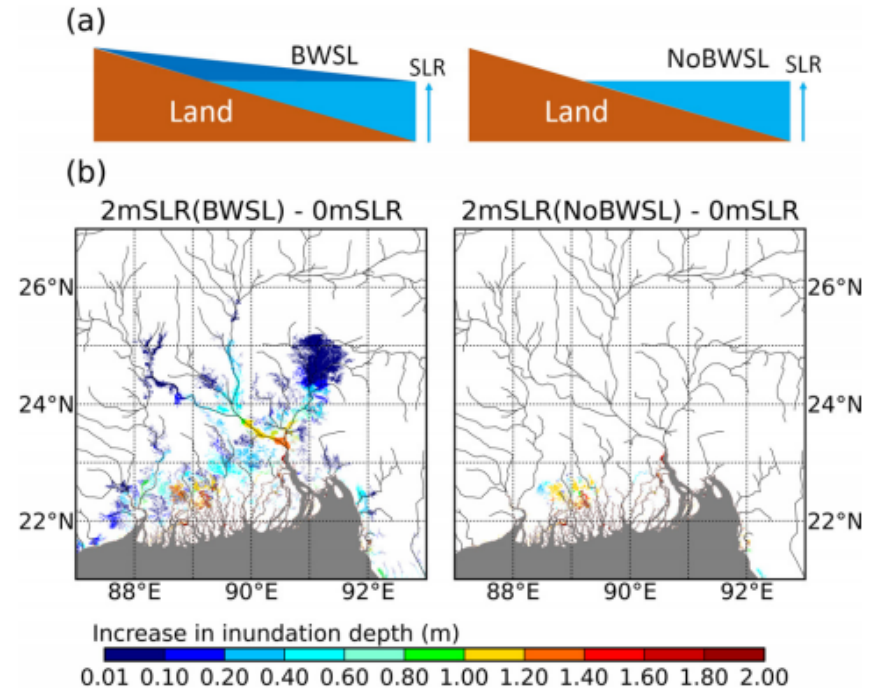
CaMa-Flood (Yamazaki et al., 2011)

- Yamazaki et al., 2011
- Global hydrodynamic model.
- River networks divided into unit catchment.
- parametrizes sub-grid topography, improving flood inundation dynamics.
- Yamazaki et al. (2014) simulated flood dynamics in bifurcated channels in the Mekong delta



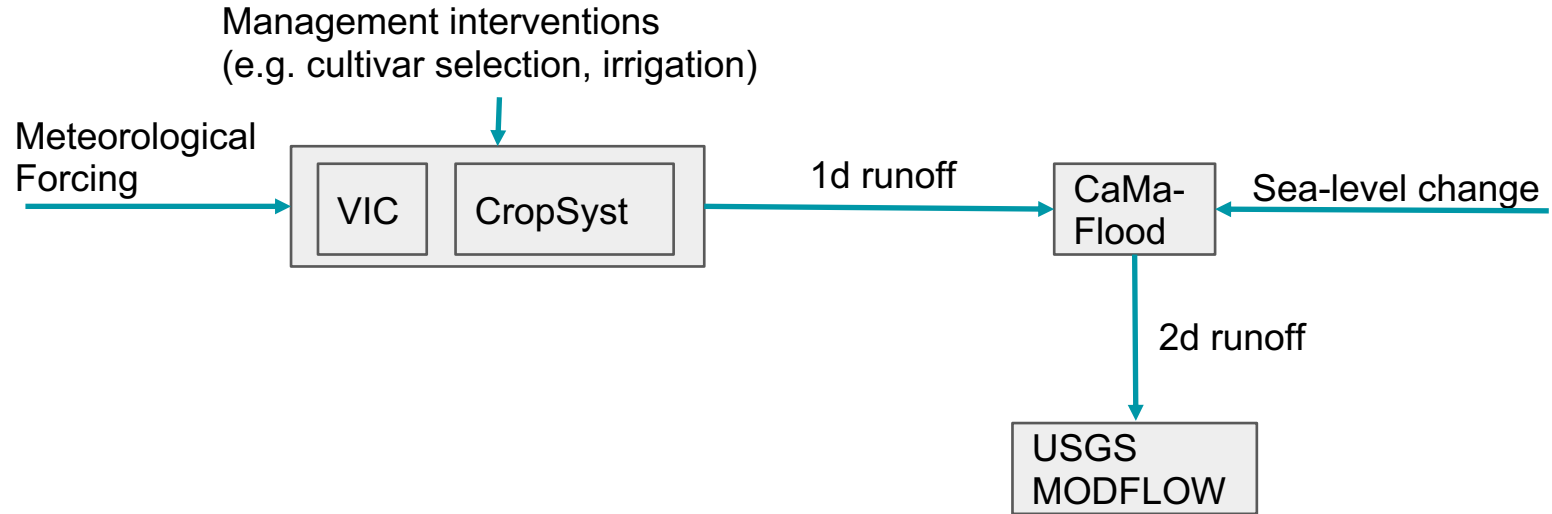
CaMa-Flood: Simulate Sea-level change

- Ikeuchi et al. (2015), experimented to study effect of sea-level rise (with and without back-water effect) in Ganges-Bhramaputra-Meghna delta using CaMa-flood.



Source: Ikeuchi et al. 2015, ERL

Proposed Modeling Framework



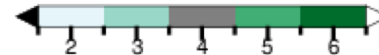
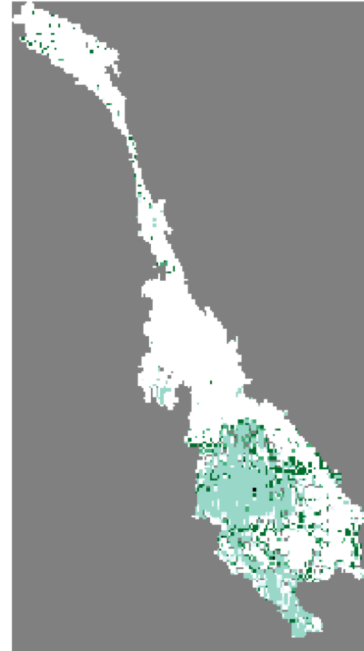
Parameterization of RICE

LULC was taken from Prof Hossain, which is developed based on MODIS.

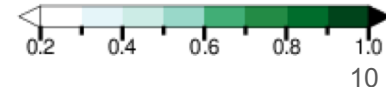
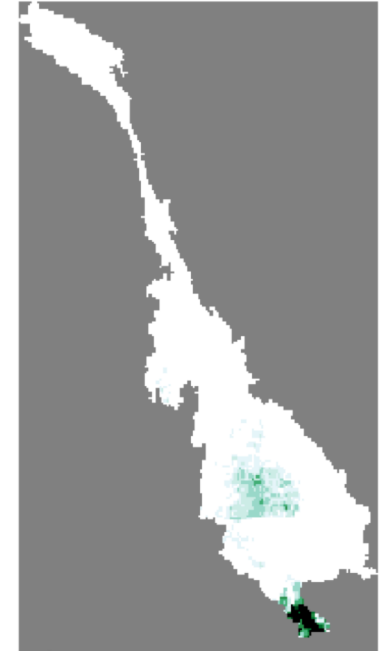
Vegetation parameter: Rice class was added to existing LULC classes. Wherever rice is (harvested area fraction >0.2 , based on Monfreda et al. 2008 dataset for the year 2000) cropland is replaced with rice.

Crop parameter: Cropping calendar was taken from MIRCA 2000.

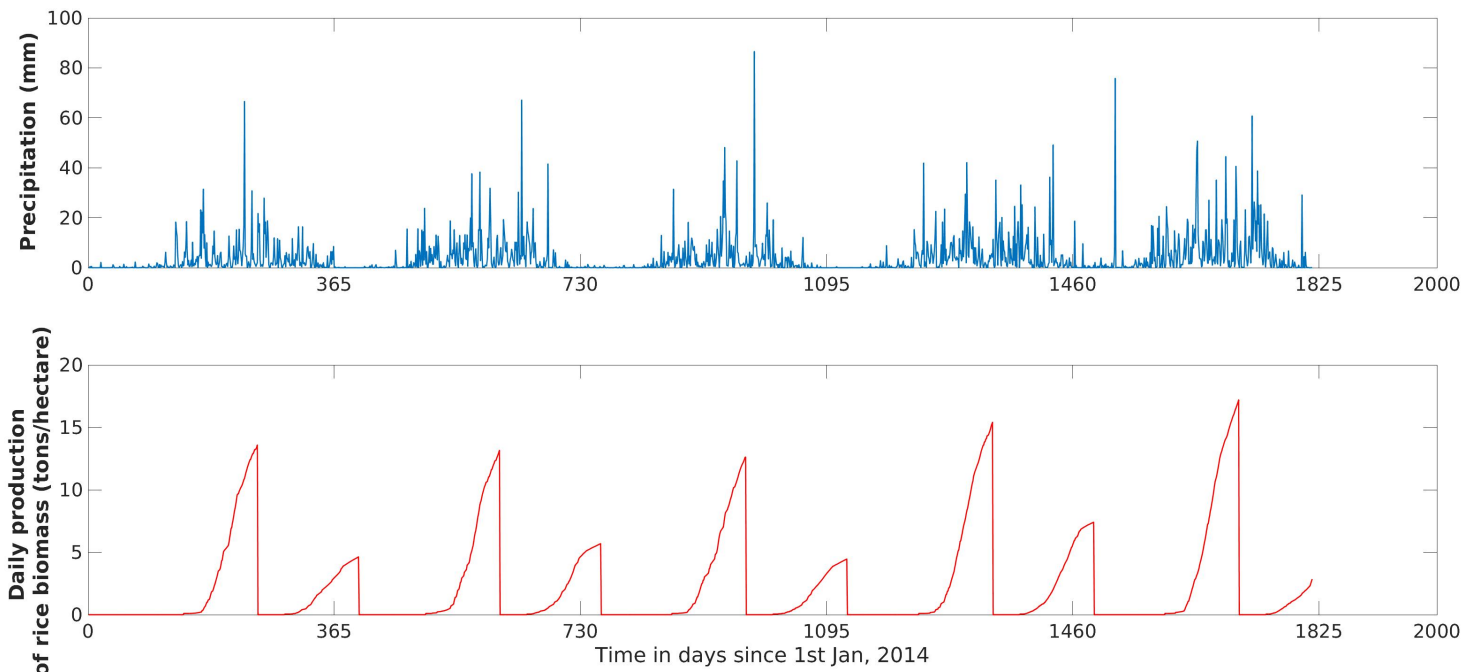
MODIS (Hossain)



Monfreda et al. (2008)



Simulation at a Sample grid



Calibrating VIC-CropSyst using rice-yield data.

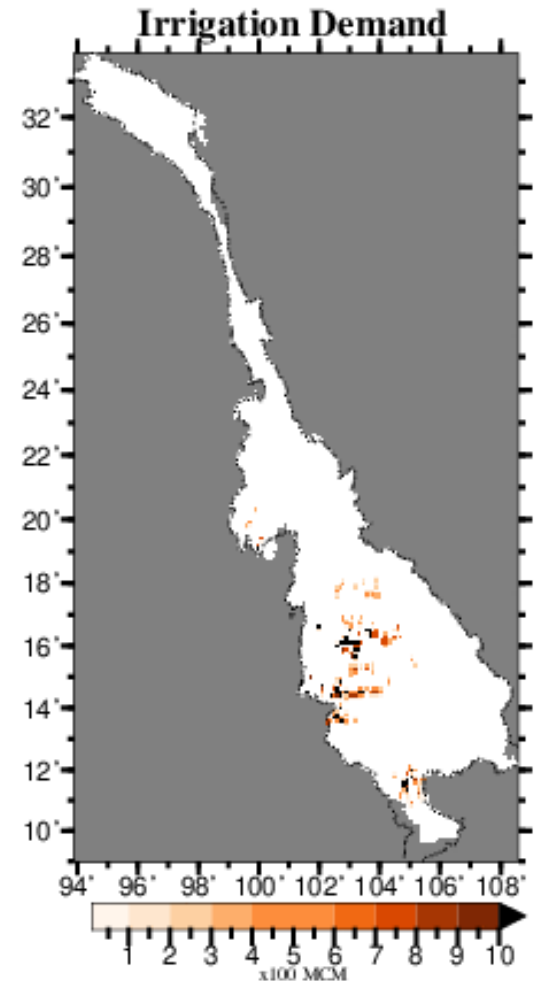
- Available data for delta region in Vietnam
 - 1) Commune-level single, double, triple rice yield data for 2013-2016.
 - 2) Province-level yield stats 1995-2017

Single rice yield in Kien Giang (quintal/ha)

Years	Observed	Simulated after calibration.
2014	36.02	38.07
2015	36.01	37.63
2016	8.86	35.78

Simulated Irrigation Demand for Rice

Fig: Simulated mean annual Irrigation demand in the Lancang-Mekong basin.



CaMa-Flood in Brazos, Texas

- Set-up CaMa-Flood in Brazos.

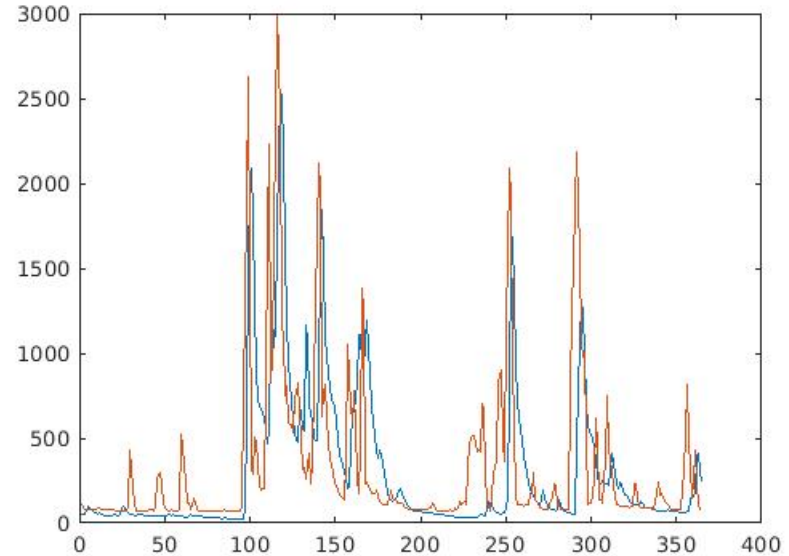


Fig: Calibration of VIC3L-CaMaFlood at the Hempstead station in Brazos.

Thank you

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