LUCCi Land Use and Climate Change Interactions in Central Vietnam

KIT Karlsruher Institut für Technologie

Analyzing the impacts of climate change on attainable groundnut yields under rainfed conditions in Central Vietnam

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Introduction

- In Central Vietnam studies of the impacts of climate on agricultural productivity are rare due to missing data such as climate, soil, crop management.
- Complex interactions between plants and climate need physically-based approaches, particularly if non-linear feedbacks are considered as induced by climate change
- The regional crop model GLAM (Challinor et al., 2003) is applied to model the complex crop-climate interactions.
- Groundnut, predominantly grown in the winter-spring season under rainfed conditions, is one of the major staples (often processed to cooking oil)

Setup of the regional crop model GLAM

GLAM set up for groundnut driven by WRF-ERA Interim **(Fig. 1)** for the period 2004-2012, using:

- Shortwave solar radiation, maximum and minimum temperature, and precipitation;
- Soil texture from the Harmonized World Soil Database (HWSD) for each grid cell;
- Yield information derived for each grid cell based on observed provincial yields (Quang Nam Statistical Yearbook).
- Planting date: Crop planted if soil water content exceed half of soil water holding capacity.

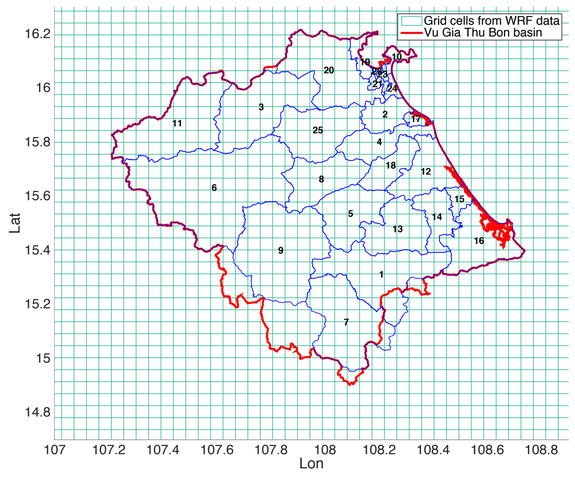

Fig. 1: Provinces in the VGTB and raster grid for GLAM simulations

1 Bac Tra My	14 Phu Ninh
2 Dien Ban	15 Tam Ky
3 Dong Giang	16 Nui Thanh
4 Duy Xuyen	17 Hoi An
5 Hiep Duc	18 Que Son
6 Nam Giang	19 Lien Chieu
7 Nam Tra My	20 Hoa Vang
8 Nong Son	21 Cam Le
9 Phuoc Son	22 Thanh Khe
10 Son Tra	23 Hai Chau
11 Tay Giang	24 Ngu Hanh Son
12 Thang Binh	25 Dai Loc
13 Tien Phuoc	

Calibration of GLAM

- Two sets of crop specific parameters (including thermal durations, rate of change of harvest index, transpiration efficiency, max. rate change of LAI, etc.) are applied:
  - Parameters used for India (P1)
  - Parameters used for China (P2)

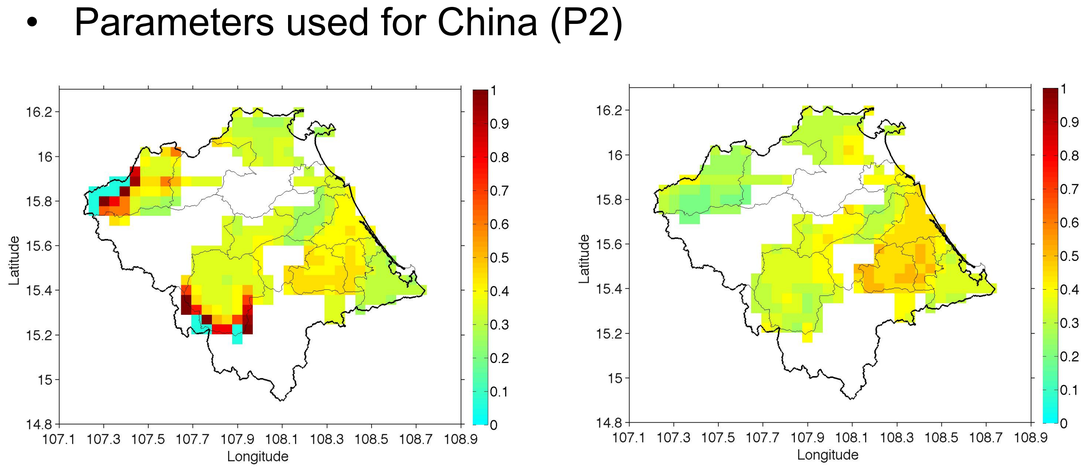

Fig. 2: *Yield Gap Parameter (YGP)* [0, ...,1] for groundnut indicating the deviations between simulated and observed yields; YGP based on the parameter set P1 (left) and P2 (right). High (low) values show high (low) deviation. The YGP is calibrated locally (grid specific).

→ The YGP **(Fig. 2)** is an input data bias correction parameter and represents effects which are not explicitly modelled (pests, diseases, non-optimal management).

GLAM simulation results (2004 - 2012)

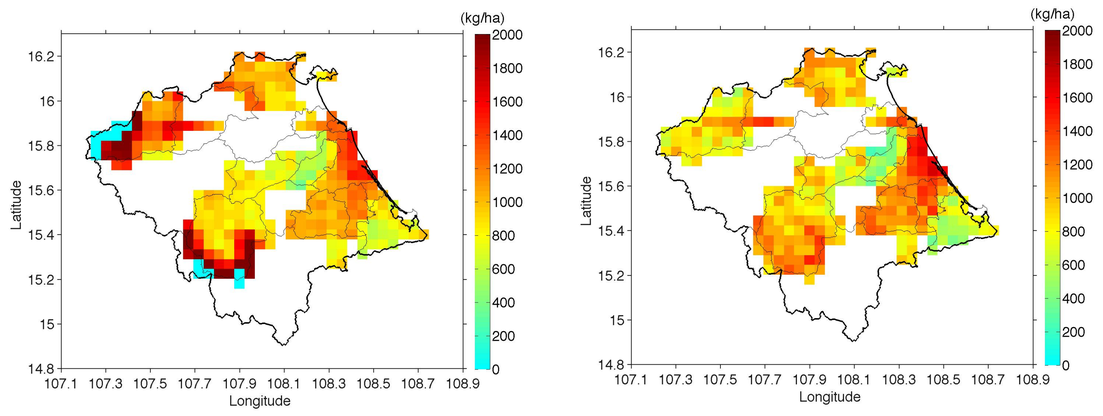

Fig. 3: Simulated mean yield (2004-2012) for groundnut using parameter set P1 (left) and P2 (right).

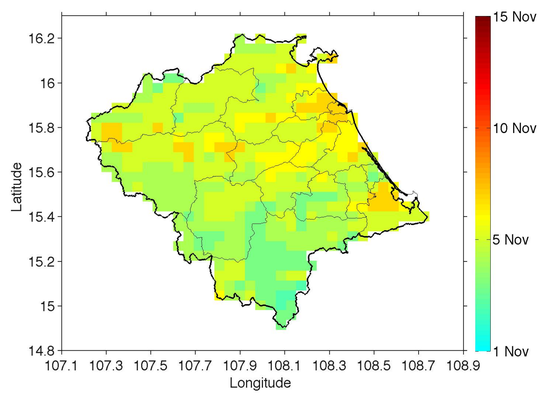

Fig. 4: Simulated planting dates following the GLAM standard routine (soil water content criterion).

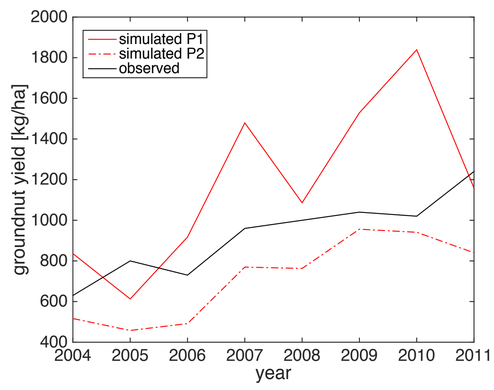

Fig. 5: Observed vs. simulated groundnut yields for Tai Gian (Province #11) using parameter set P1 (solid red line) and P2 (dashed-dotted red line).

→ High yield variations for groundnut modelled in the VGTB basin **(Fig. 3)**

→ Provinces 9 & 11: Highest deviations based on the two different parameter sets P1 and P2 **(Fig. 3)**

→ Planting dates range from Nov, 1st in the South to Nov, 8th in the coastal regions **(Fig. 4)**.

→ GLAM is generally able to model trends of observed groundnut yields under rainfed conditions **(Fig. 4)**.

→ Further improvement of the parameterization still required.

Project changes of groundnut yields

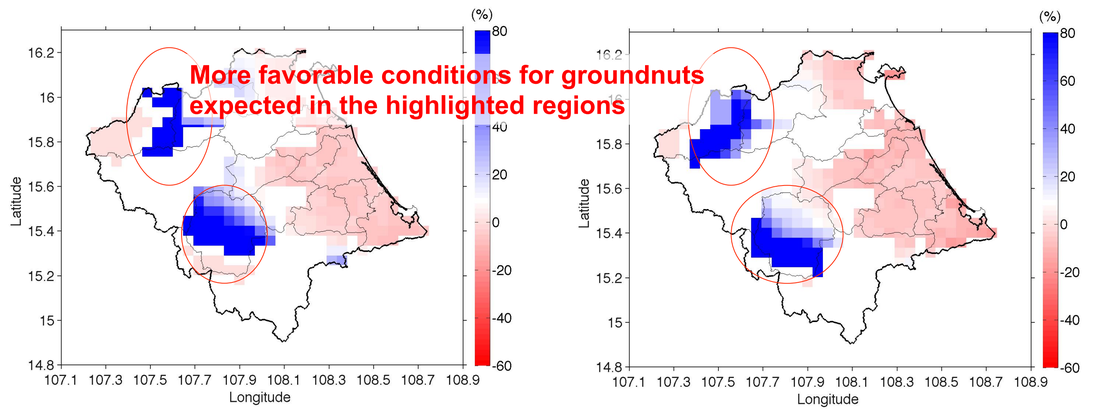

Fig. 6: Projected groundnut yield changes for 2001-2030 compared to the baseline period 1971-2000 using the ECHAM5 data and the A1B emission scenario based on parameter set P1 (left) and P2 (right).

Outlook

Depending on future funding opportunities:

- **Field experimentations** (e.g. together with Hue University) to improve model parameterizations.
- **Improving attainable yields** for the VGTB basin by implementing the *Optimized Planting Date* algorithmus for groundnut (Laux et al., 2010; Waongo et al., 2014).
- Using future climate ensemble projections to quantify future attainable yields for **better adapted agricultural management options**.

- Challinor, A.J., T. Osborne, L. Shaffrey, H. Weller, A. Morse, T. Wheeler, P.L. Vidale. 2009. Methods and resources for climate impacts research. Bull. Am. Meteorol. Soc., 90, pp. 836–848.
- Laux, P., G. Jäckel, R.M. Tingem, H. Kunstmann. 2010. Impact of climate change on agricultural productivity under rainfed conditions in Cameroon – A method to improve attainable crop yields by planting date adaptations. Agric. For. Meteorol., 150, pp. 1258–1271.
- Waongo, M., P. Laux, S.B. Traoré, M. Sanon, H. Kunstmann. 2014. A crop model and fuzzy rule based approach for optimizing maize planting dates in Burkina Faso, West Africa. J. Appl. Meteorol. Climatol., 53 (2014), pp. 598–613.

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