Modeling the impact of rubber expansion on carbon stocks in the mountainous landscape of South-West China

Sergey Blagodatsky, Moritz Laub, Xueqing Yang, Rong Lang, Carsten Marohn, Hongxi Liu, Jianchu Xu, Georg Cadisch

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SURUMER

Sustainable Rubber Cultivation in the Mekong Region

Project duration: 2011 – 2016/17

- **C sequestration in plant biomass**
- **C sequestration in soil**
- **Erosion and land management**
- **Integrated land use change impact assessment –**

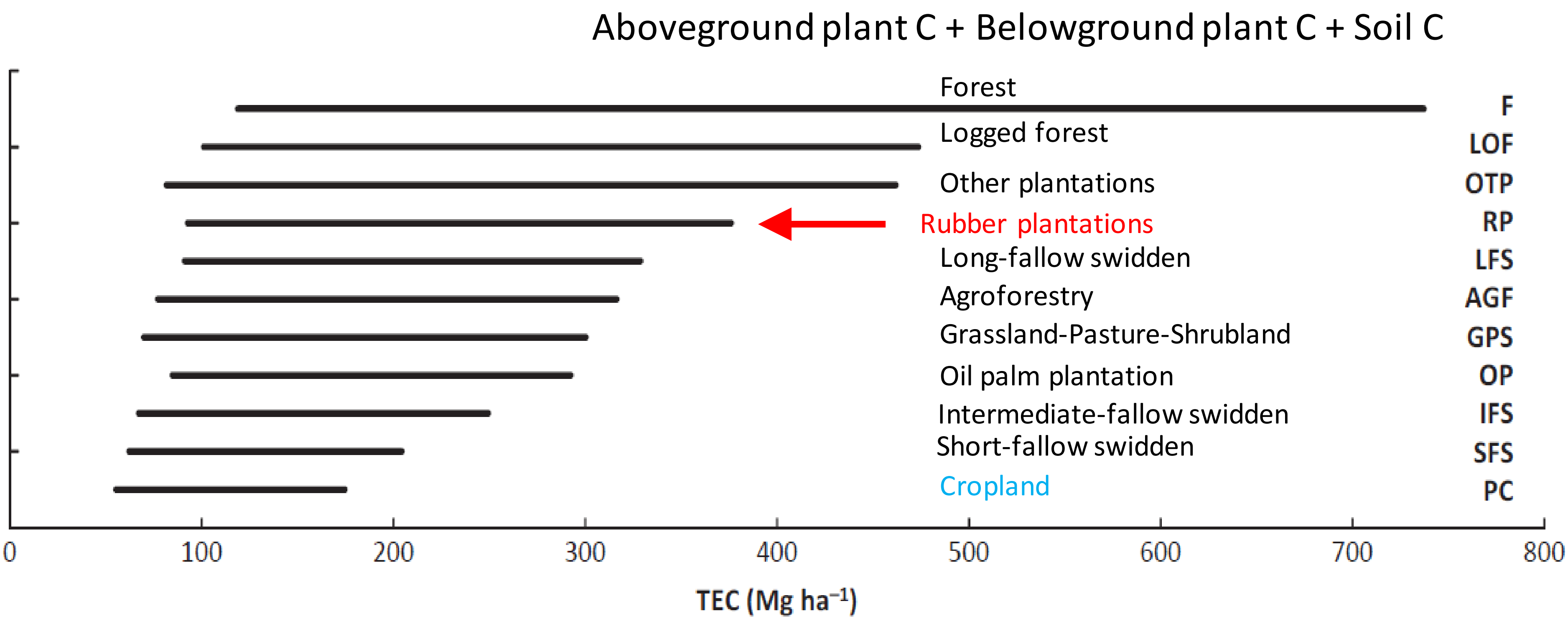
upscaling and modeling

MITIGATION

ADAPTATION

SURUMER

✓Arable land conversion to plantations and agroforestry systems is a promising option for soil C sequestration in tropics and subtropics (Don et al., 2011, Ziegler et al.,2012). It is less studied than soils in temperate climate.



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Soil carbon dynamics driven by land use change

Deforestation

"Reforestation"

Forest

Arable land

Rubber plantation

Loss 0.5 to 2 Mg ha^{-1} y^{-1}

Gain < 1 Mg ha^{-1} y^{-1}
???

Restoration of C stocks are slower!

See, for example, Paustian et al., 2016 in Nature

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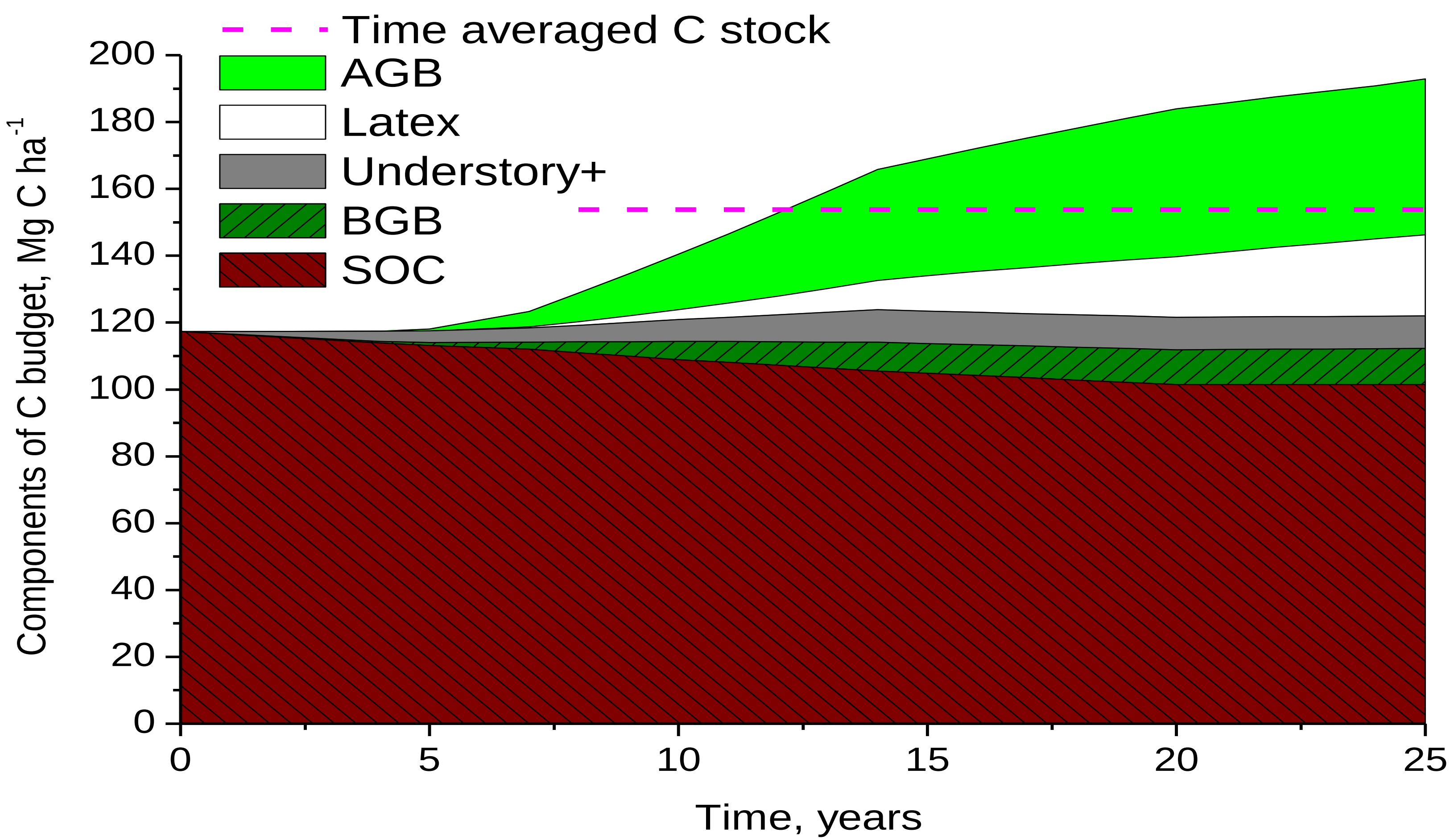
C stock dynamics of rubber plantations



Blagodatsky *et al.* 2015, Agriculture, Ecosystems & Environment

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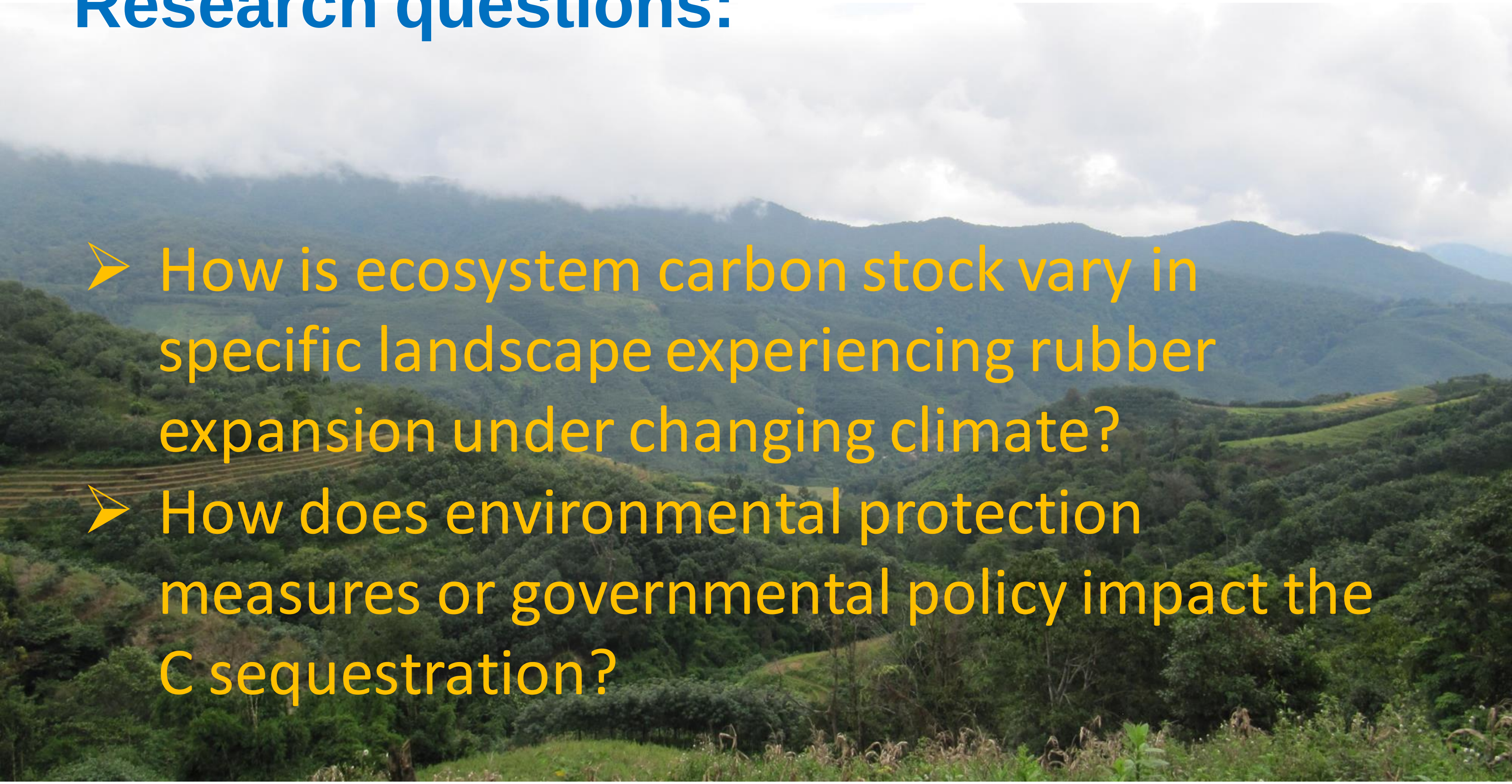
Research questions:



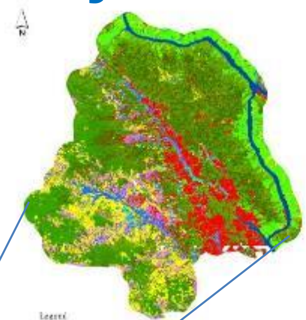
- How is ecosystem carbon stock vary in specific landscape experiencing rubber expansion under changing climate?
- How does environmental protection measures or governmental policy impact the C sequestration?

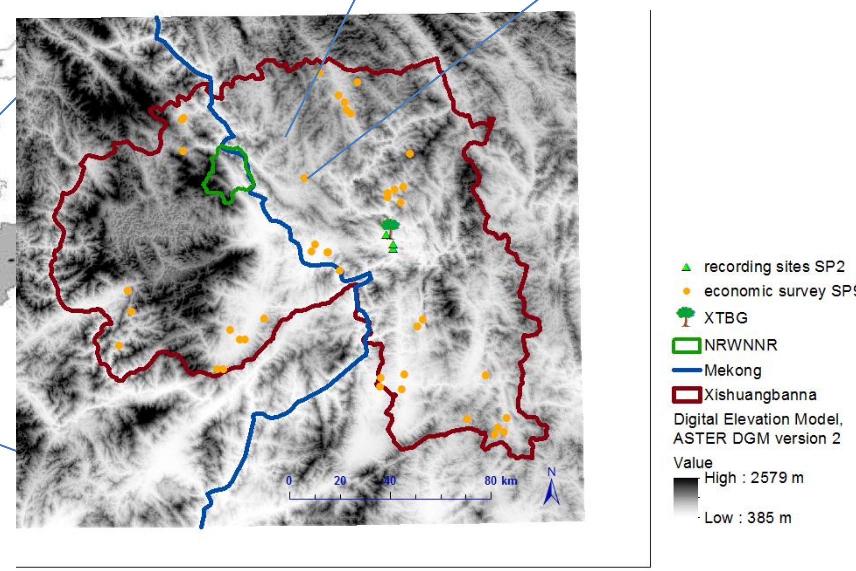
Area: 266 km^2
Annual rainfall: 1100~1600mm
Average temperature:
18~22℃

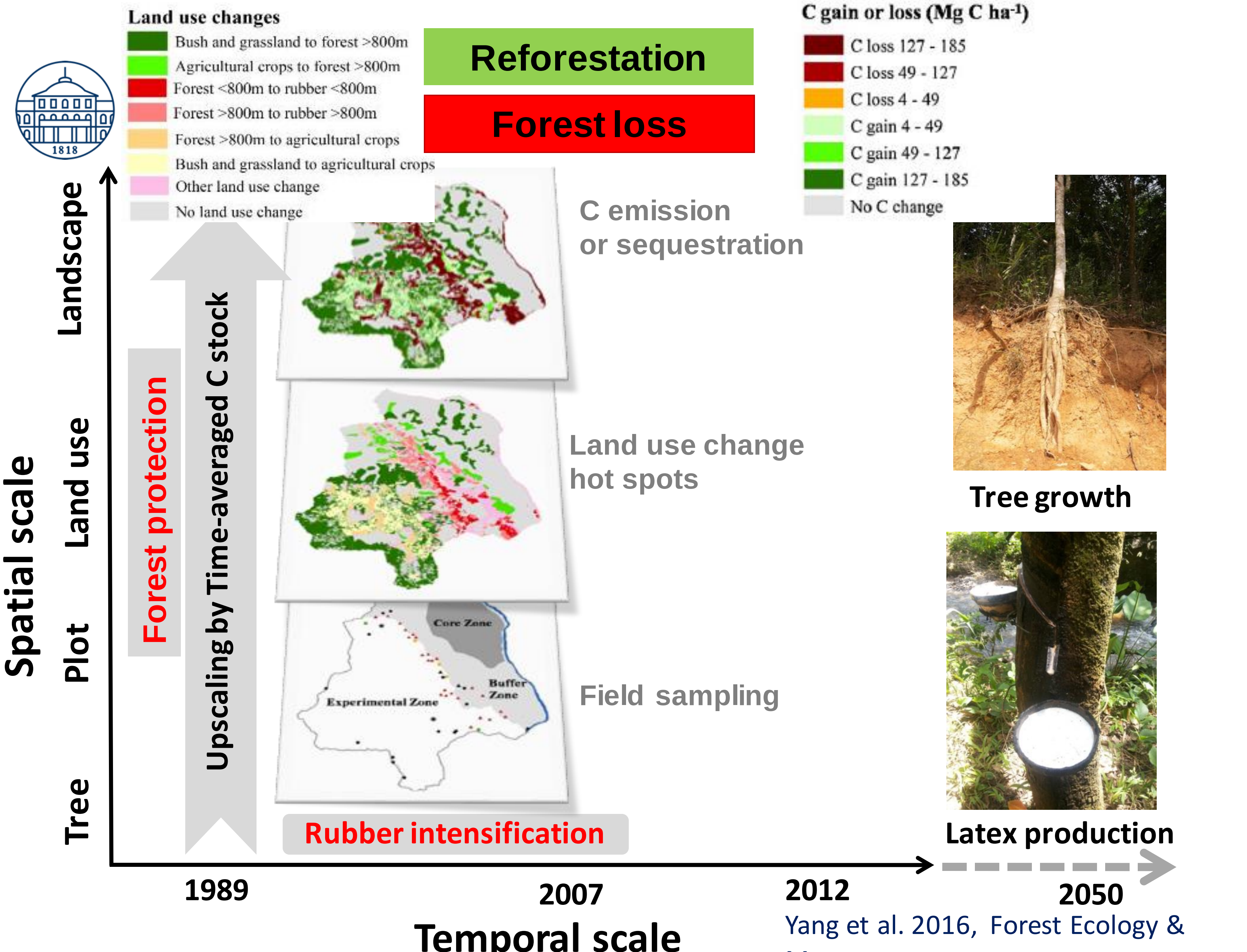
Case study

Naban River Watershed Nature Reserve (NRWNR)

Xhishuanbanna







Yang et al. 2016, Forest Ecology & Management

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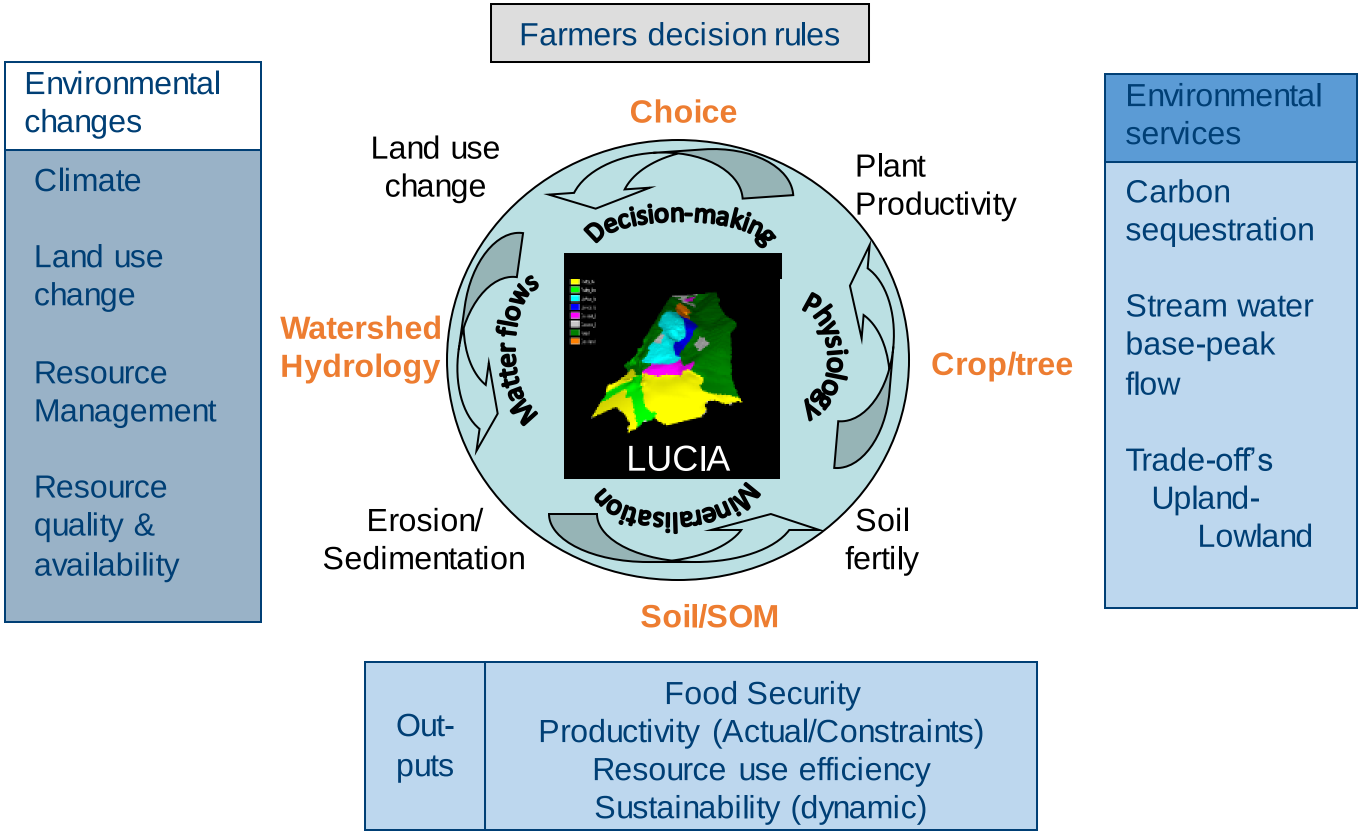
https://lucia.uni-hohenheim.de/en#

Integrated framework for trade-off assessment
LUCIA: Land Use Change Impact Assessment



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Land Use Change Impact Assessment Model (LUCIA)

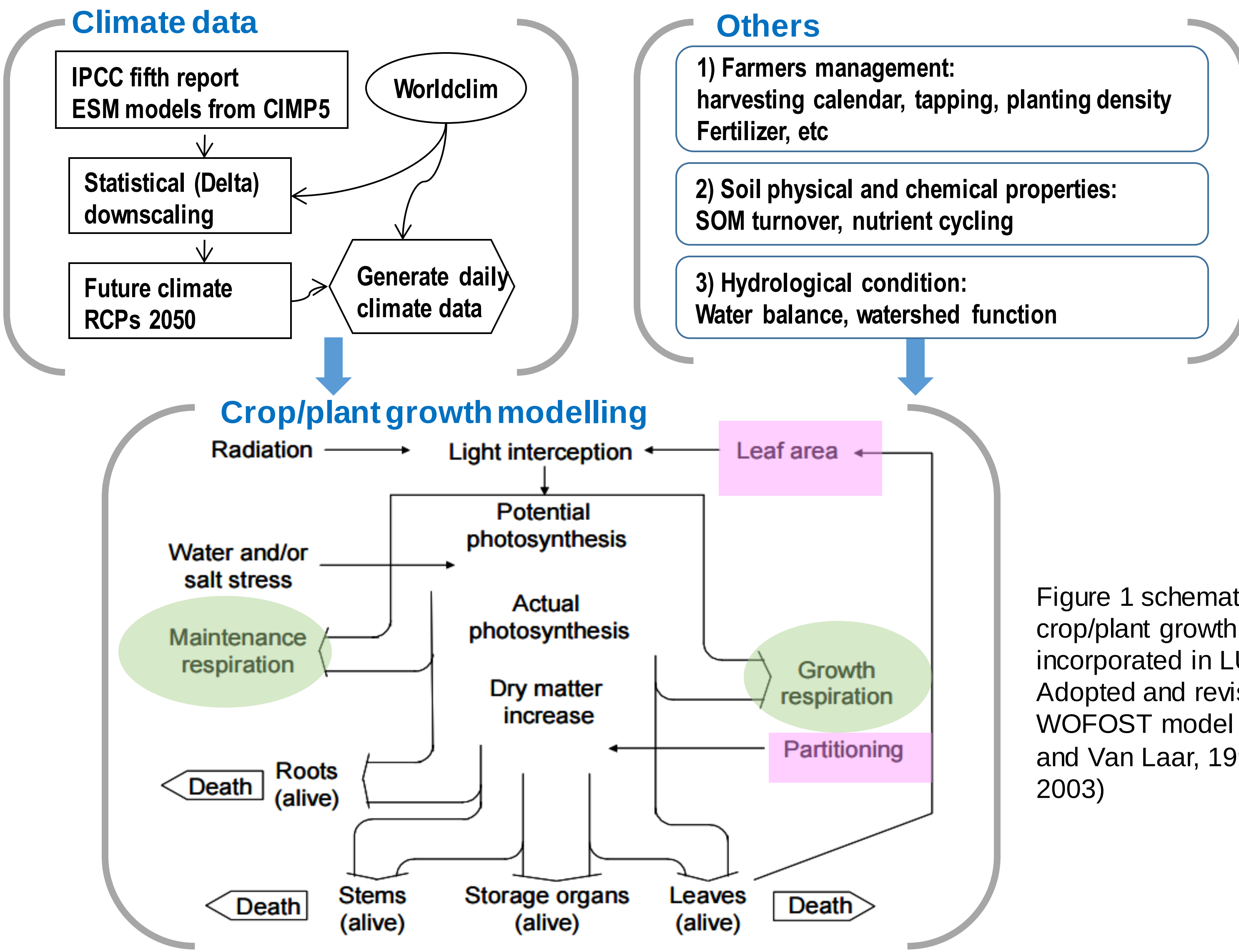
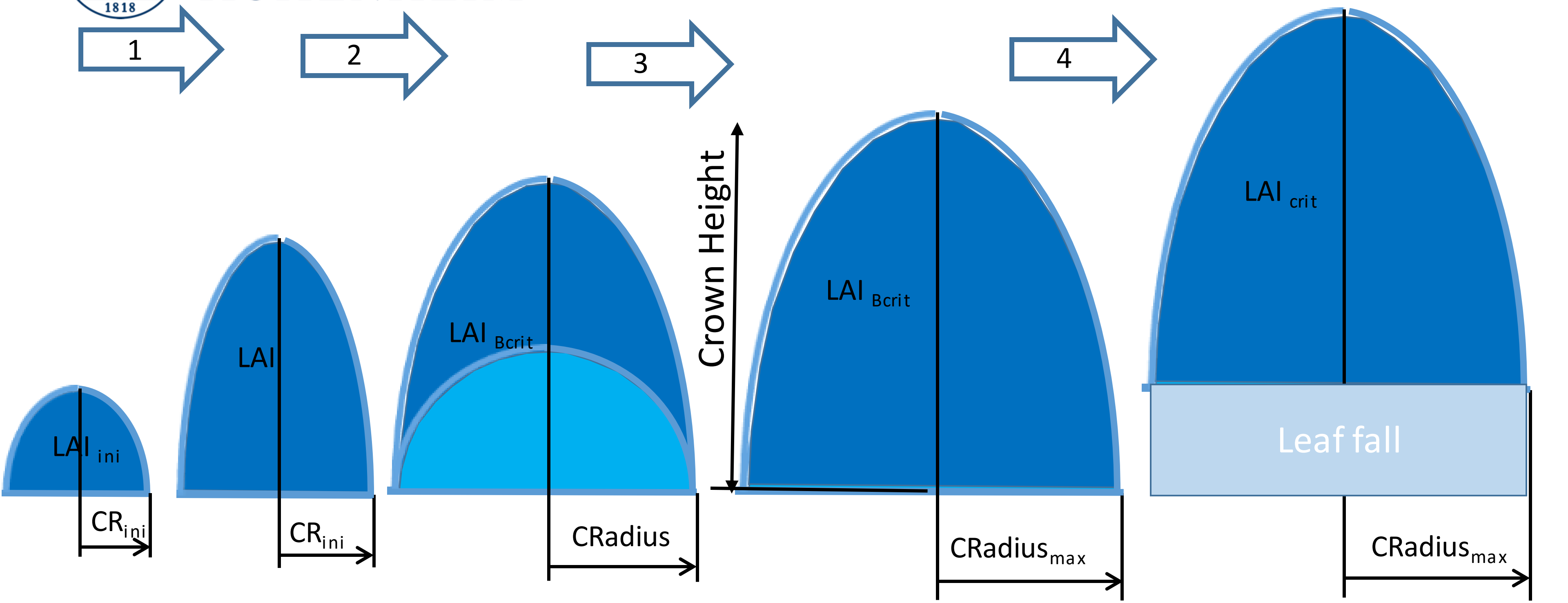


Figure 1 schematization of crop/plant growth processes incorporated in LUCIA. Adopted and revised from WOFOST model (after Kropff and Van Laar, 1993; Supit 2003)

Crown development



Step 0: Initial LAI (LAIini) and initial CrownRadius (CRini=leaf and petiole length, [m])
Step 1: LAI expansion while maintaining CRini
Step 2: After reaching critical branching LAI (LAIBcrit) crown starts expanding lateraly
Step 3: Lateral expansion until reaching maximum crown radius (Cradiusmax)
Step 4: After reaching maximum crown radius (Cradiusmax) LAI expands to critical LAI (LAIcrit) thereafter crown move upwards shedding leaves at lower positions

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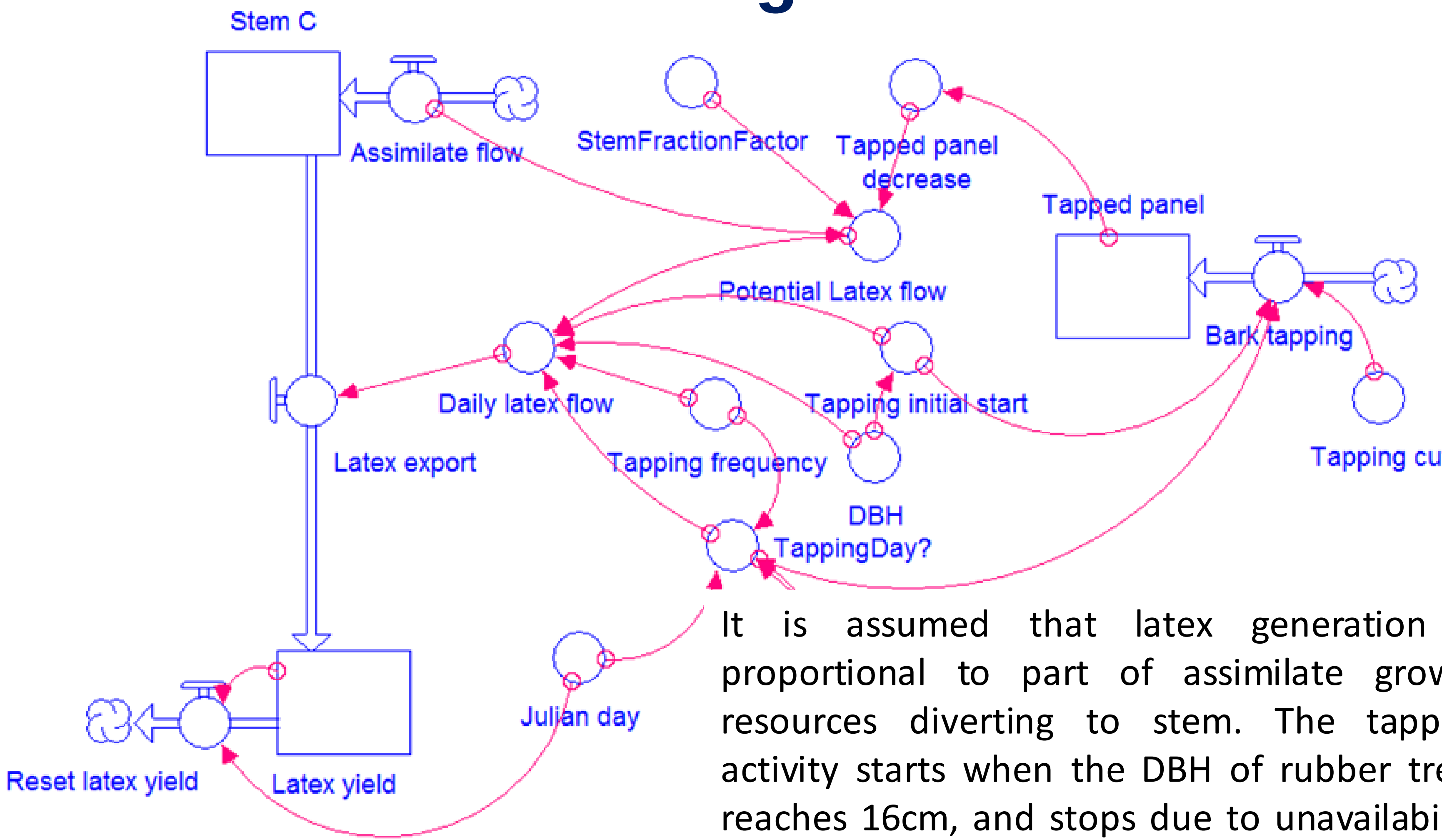
Latex simulation framework depicted in STELLA® modeling shell



It is assumed that latex generation is proportional to part of assimilate growth resources diverting to stem. The tapping activity starts when the DBH of rubber trees reaches 16cm, and stops due to unavailability of tapping panel.

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Description of the modeling scenarios

How future change in temperature and precipitation will affect the carbon sequestration and latex production in rubber plantations?

Management:

Elevation (Highland> 900m, Lowland ≦ 900m)

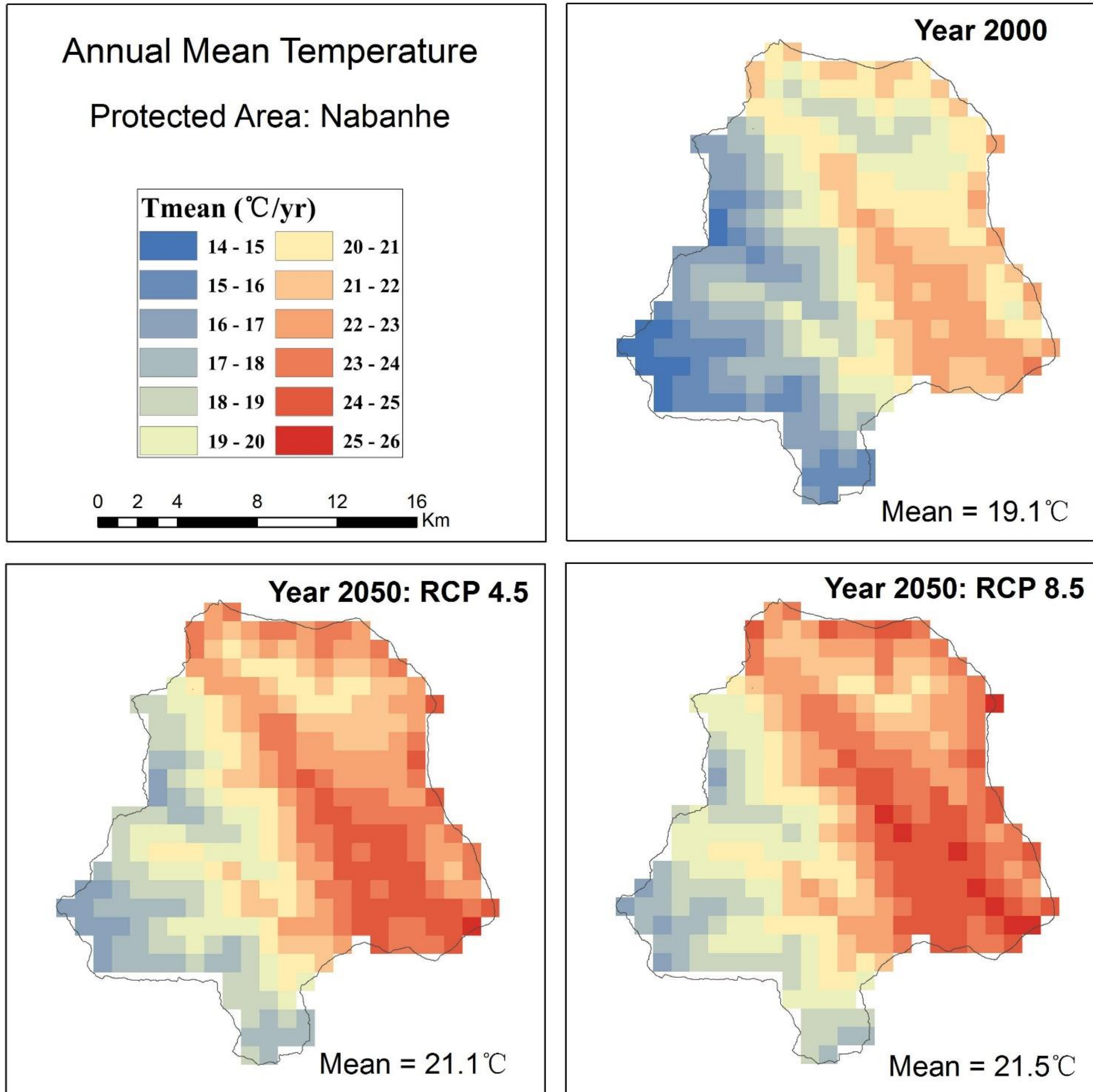
Climate change scenarios:

RCP 2.6 (Tem. : + 1.6 ℃
Pre.: + 2.1 %)

RCP 4.5 (Tem. : + 2.0 ℃
Pre.: + 2.4 %)

RCP 8.5 (Tem. : + 2.4 ℃
Pre.: + 2.5 %)

Zomer et al., 2015



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Climbing the mountain fast but smart: Modelling rubber tree growth and latex yield under climate change

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Total biomass and cumulative latex yield predicted by LUCIA after 40-year rotation length

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Rubber monoculture – Soil degradation

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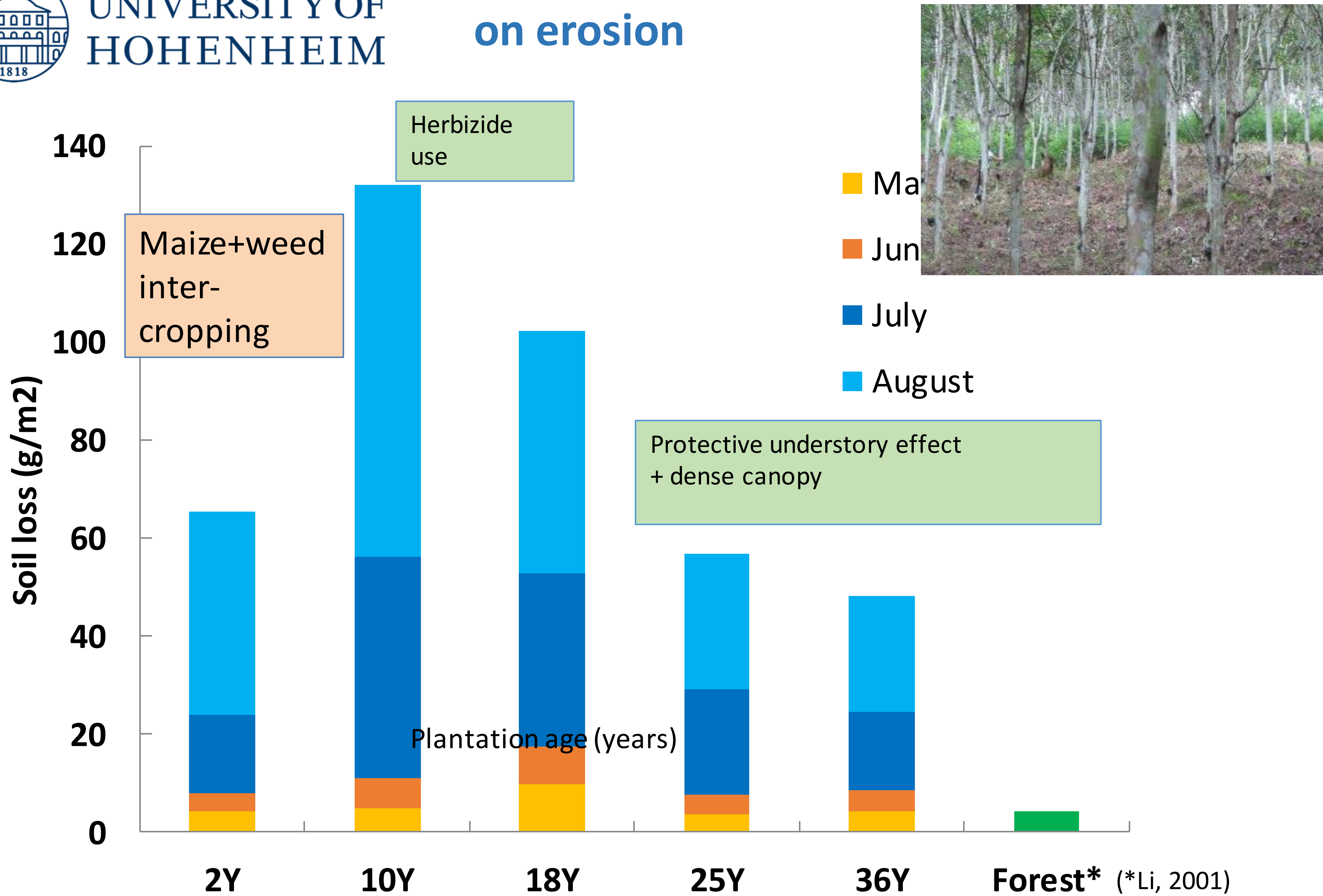
Impact of land use change to rubber on erosion



Hongxi Liu *et al.* 2015

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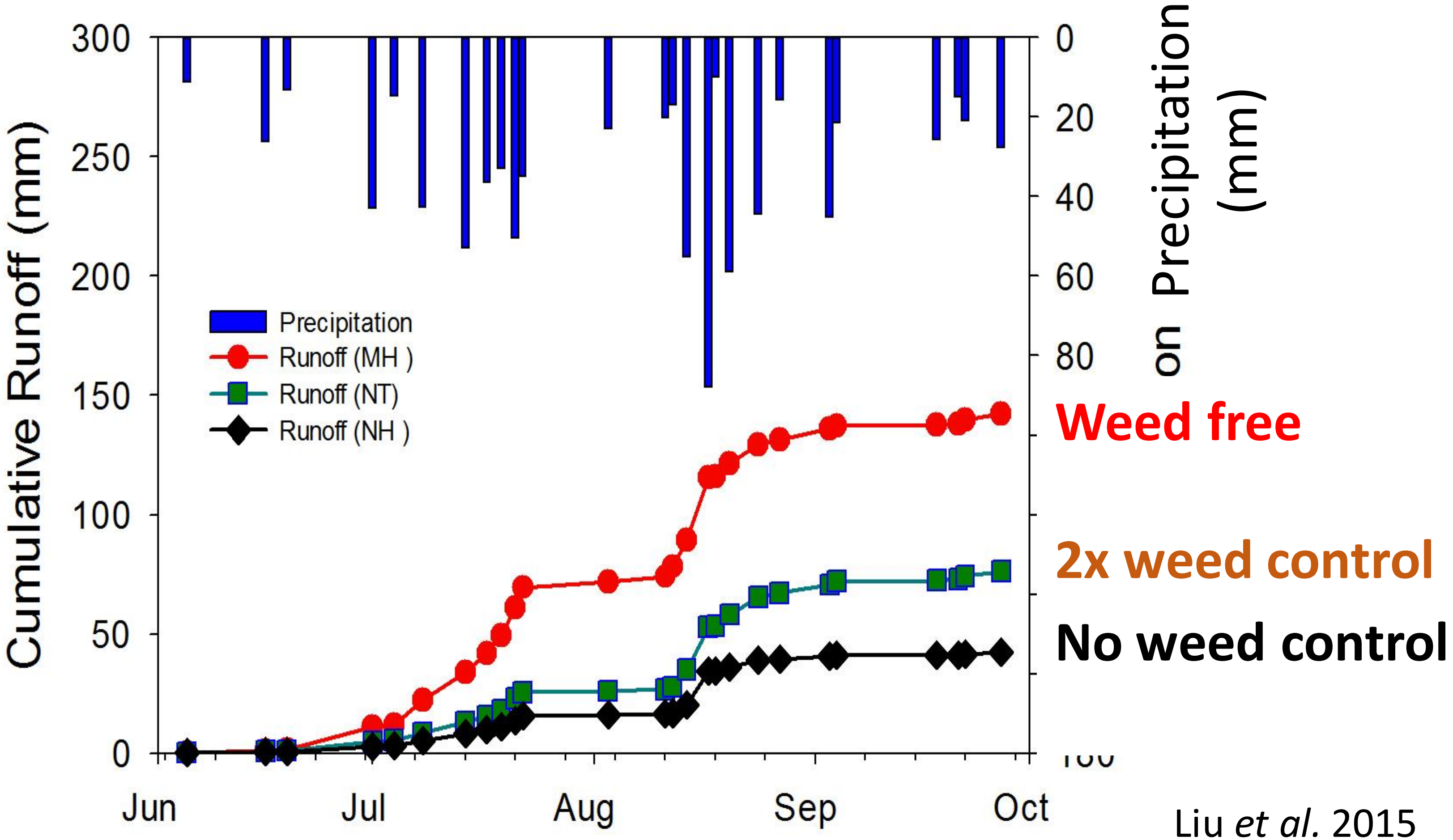
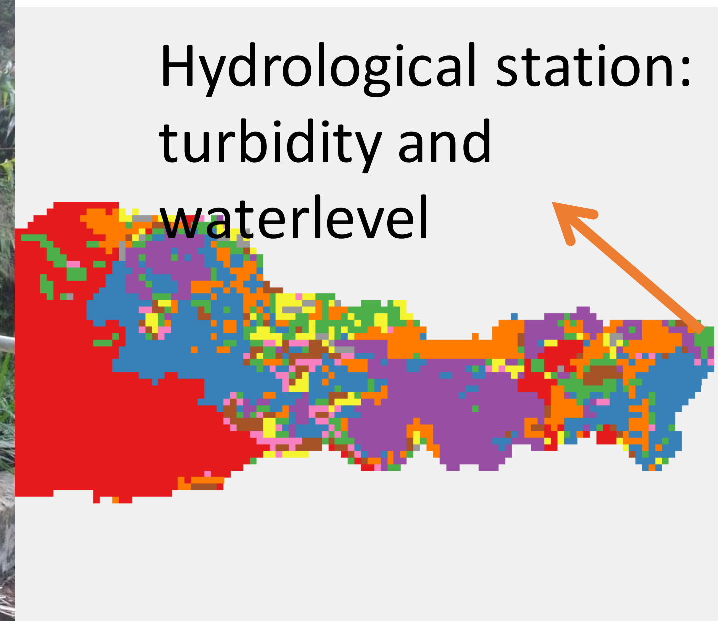
Runoff production under rubber with different weed treatments



Liu *et al.* 2015

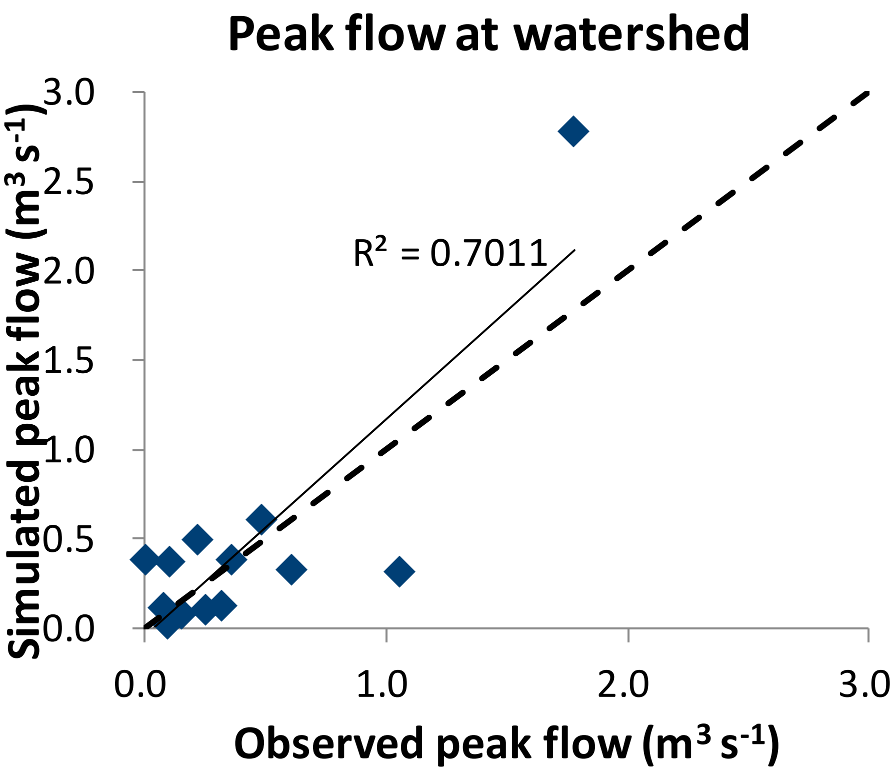
Watershed scale - Land use in mosaic cover Nanhuicang watershed in NNWNR

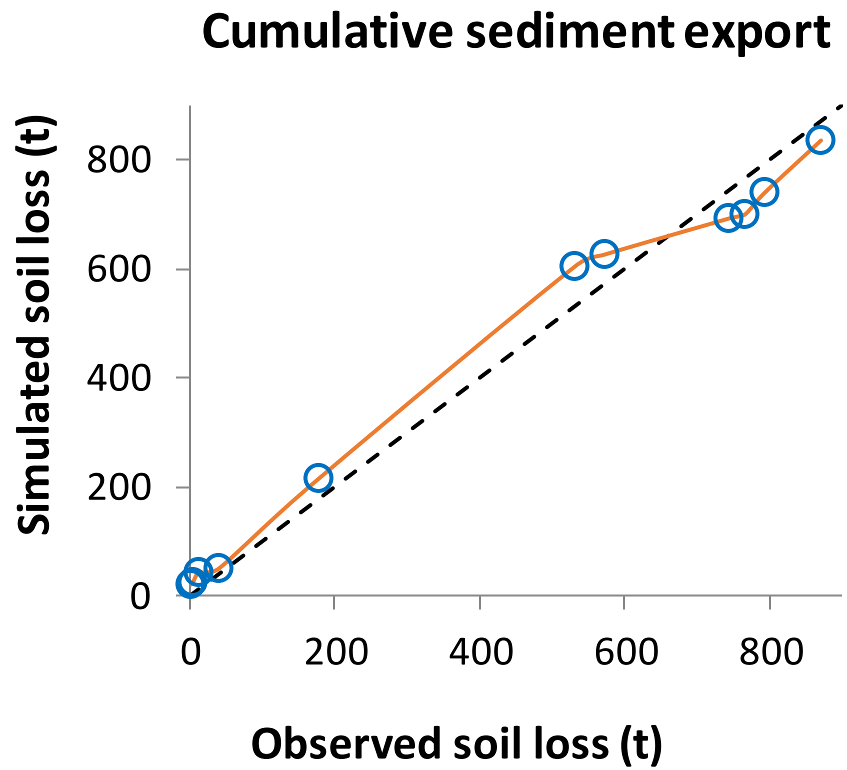


Hydrological station: turbidity and waterlevel

- Rubber plantation: 11%

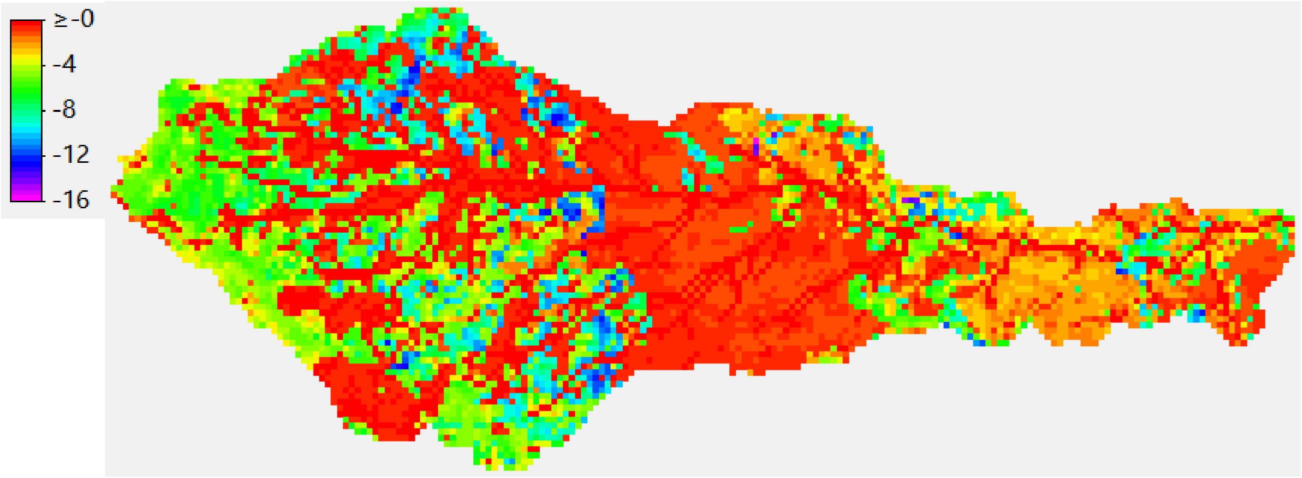
Watershed calibration (preliminary)



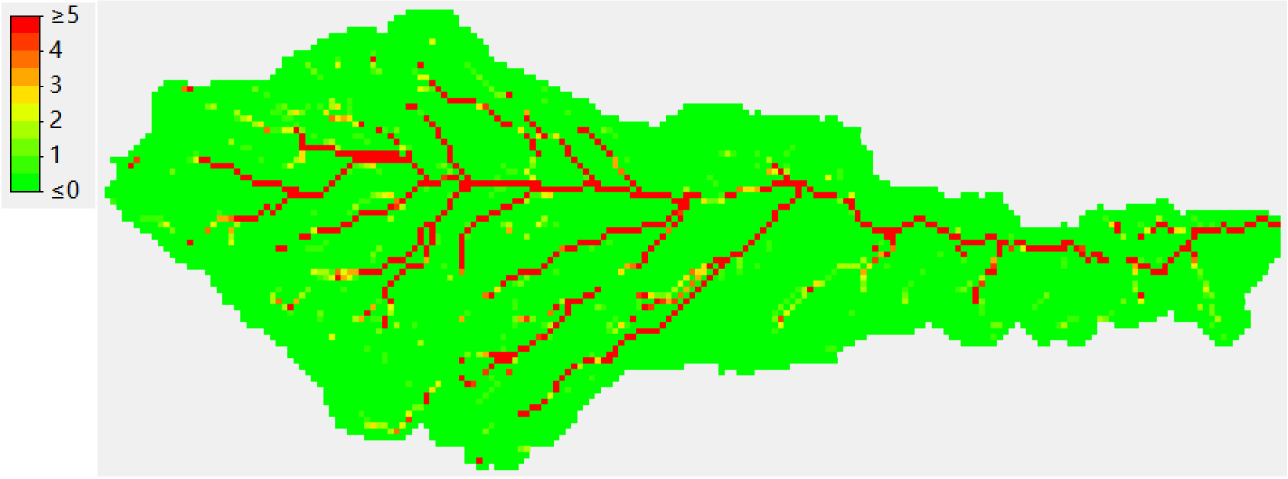


Erosion and deposition at watershed

Net erosion - Hs

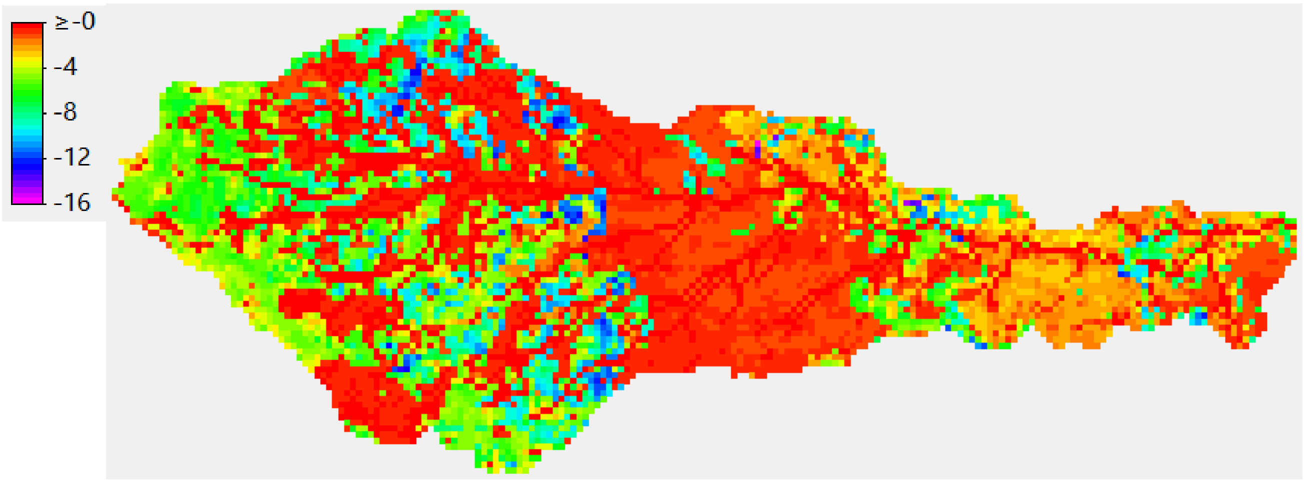


Net deposition —— stream bed deposition

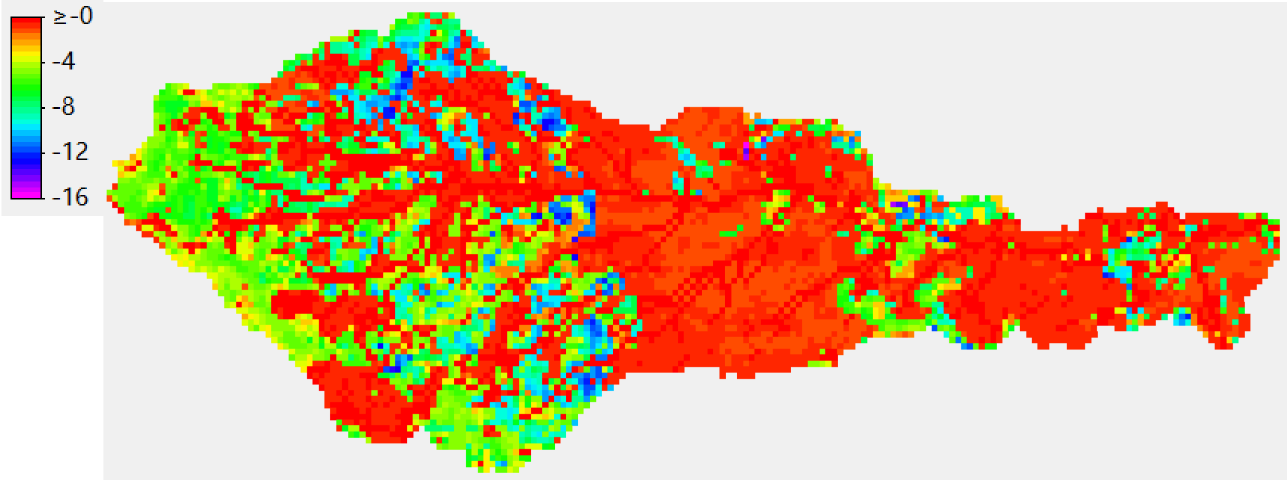


Erosion and deposition at watershed

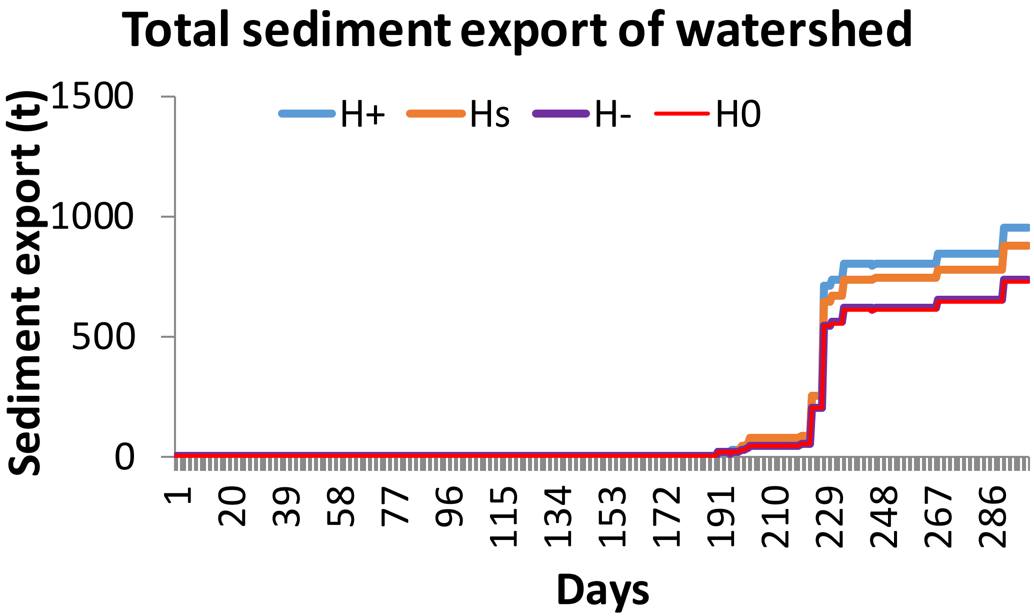
Net erosion - Hs



Net erosion – H-



Management effects on watershed scale



	No herbicide (H_0)	Once herbicide per year (H-)	Twice herbicide per year (Hs)	Clear herbicide (H+)
Cumulative soil loss (t)	**716**	**736**	886	972
Changes in %	**-24%**	**-23%**	-8%	-

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Thank you for attention!

Acknowledgements:

Naban River Watershed National Nature Reserve