IMPACT OF WATER QUALITY/QUANTITY ON AGRICULTURAL POLICY

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International Workshop on Innovation in Modelling Coupled Natural and Human Systems Related to Water

Tübingen, May 31 & June 1, 2017

www.ifpri.org/topic/water-policy

IN PARTNERSHIP WITH:

Growing water stress

RESEARCH PROGRAM ON Water, Land and Ecosystems

LED BY IWMI International Water Management Institute

Water stress risk

36%	population	52%
39%	grain production	49%
22%	global GDP	45%

TODAY

Total population living in water scarce areas

2.5 BILLION PEOPLE

Global GDP generated in water scarce regions

US$9.4 TRILLION

By 2050

Total population living in water scarce areas

4.7 BILLION PEOPLE

↑90%

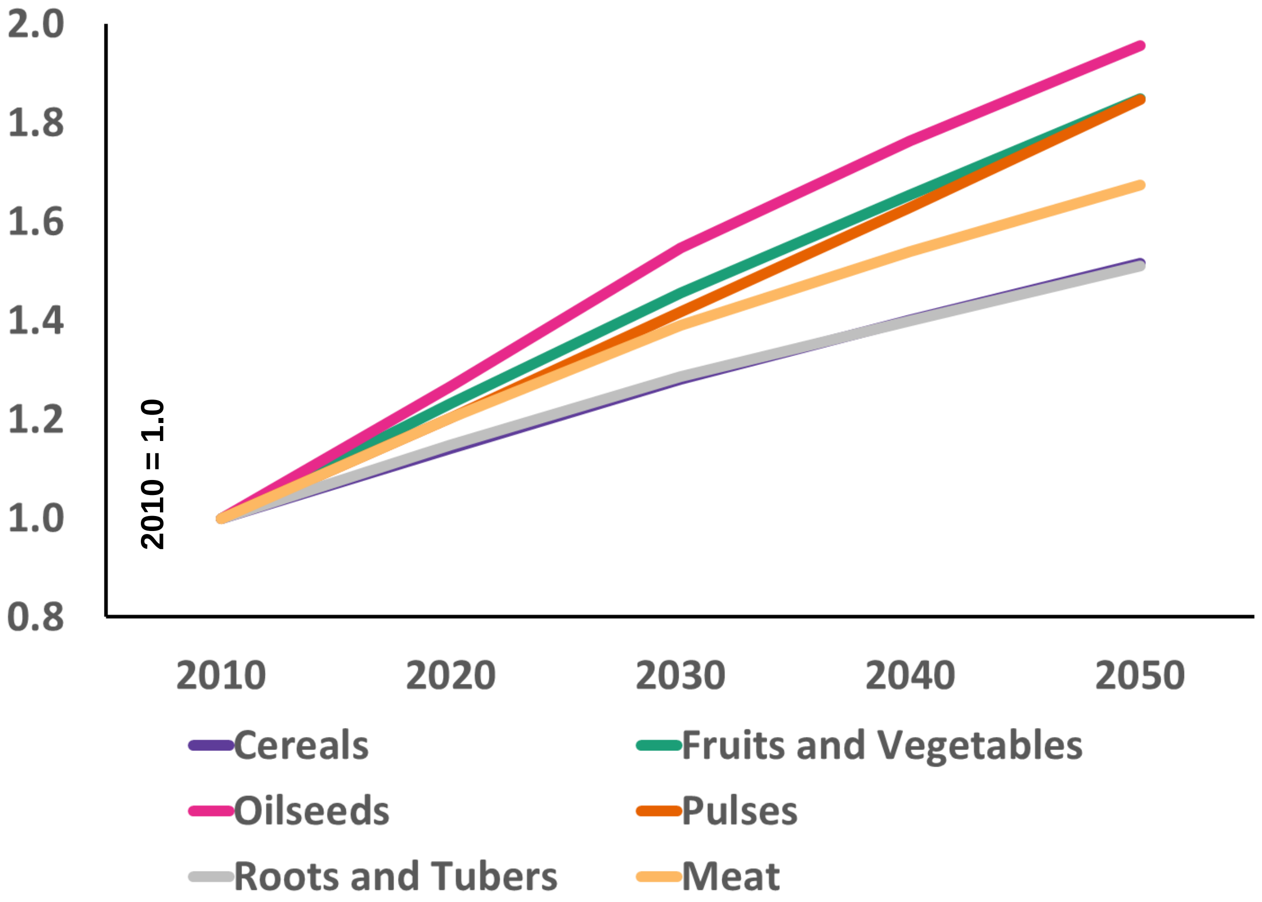
Global GDP generated in water scarce regions

US$63 TRILLION

↑570%

Source: Ringler et al. (2016)

Growing demand for more water intensive calories (meats/fruits/ vegetables) surpasses demand for R&T and cereals (SSP2, NoCC)



Source: IFPRI, IMPACT version 3.2, September 2015

Key Questions on the Agriculture-Water Interface

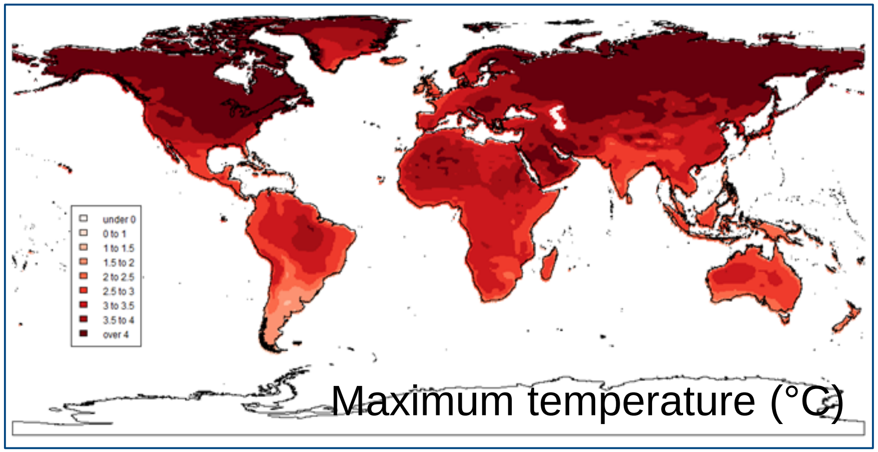
1. When and where is water the limiting constraint to food production and food security and what are policies to address this?

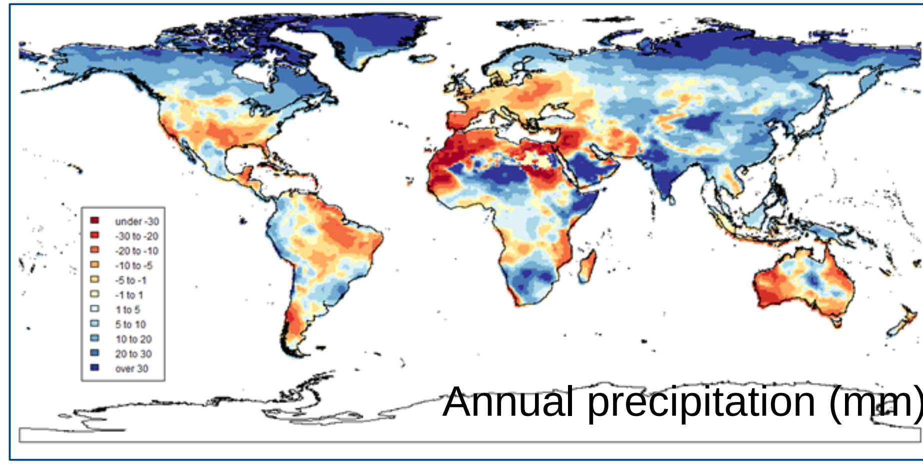
2. How can we improve crop per drop (WUE) without increasing water consumption? (broad view—from policies to technologies to breeding to post-harvest losses, etc.)

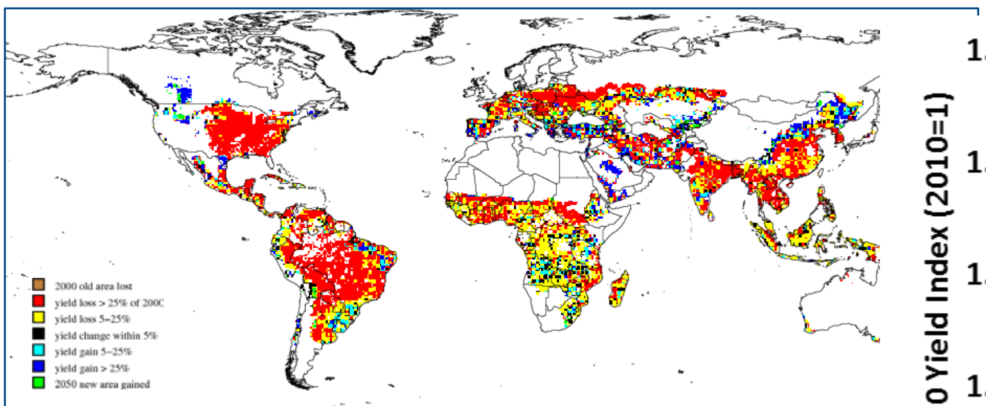
3. How does climate change (CC) affect water & agriculture and how does agriculture affect CC? (How does climate mitigation [f.ex. biofuels/avoided deforestation/CSA] and adaptation [f.ex. high-efficiency irrigation] affect water for food?)
   - Which irrigation technologies and systems are climate resilient/-'proof'?
   - How much water do renewables use?

Climate change affects water for food

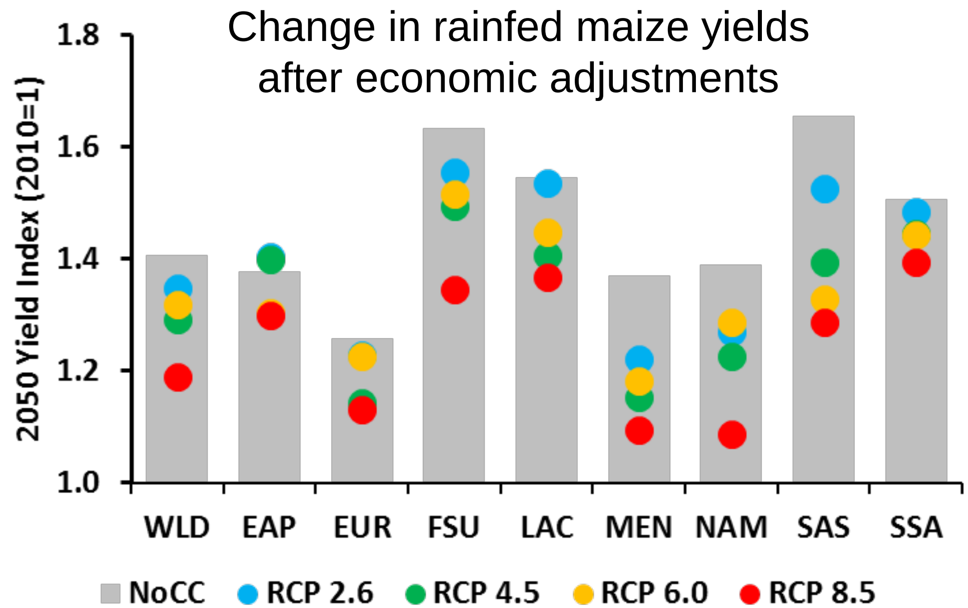
The case of maize yields using HadGEM (RCP8.5), DSSAT, and IMPACT (SSP2)







Change in rainfed maize yields before economic adjustments



Source: IFPRI, IMPACT version 3.2, November 2015

Key Questions on the Agriculture-Water Interface

4. What is the impact of groundwater use and depletion on global and regional food security. What is the role of solar power in accelerating depletion and what are sustainable management mechanisms?

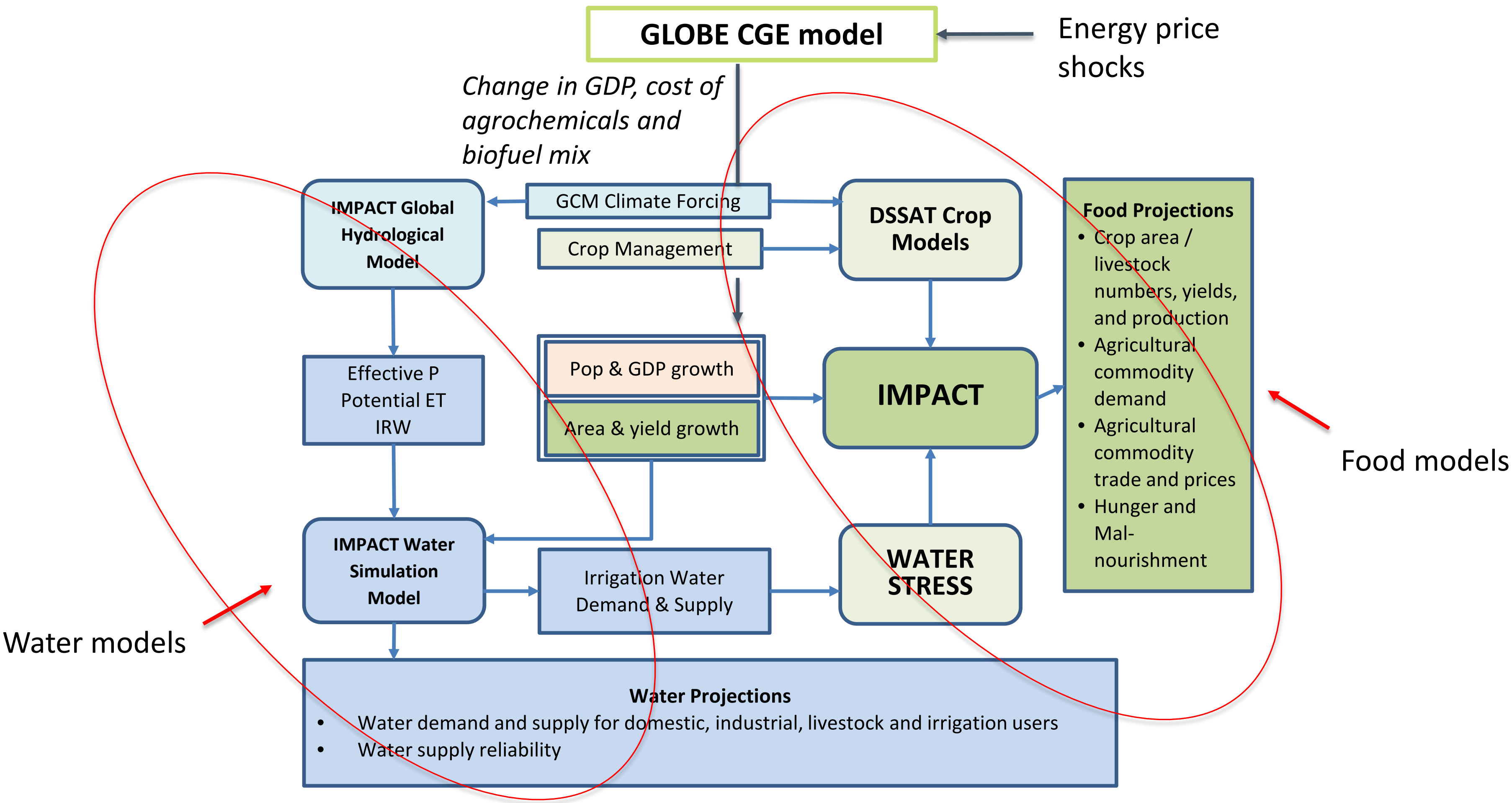
5. How can we stem rapidly growing agricultural water pollution?

6. Given growing natural resource scarcity what Food, Energy and Water Solutions can reduce natural resource use and increase efficiency?
   - Does hydropower production reduce water availability for irrigation?
   - How do regional power pools affect water for food?
   - What are energy needs of modern irrigation systems?

Key Modeling Tools at IFPRI for Water for Food Modeling

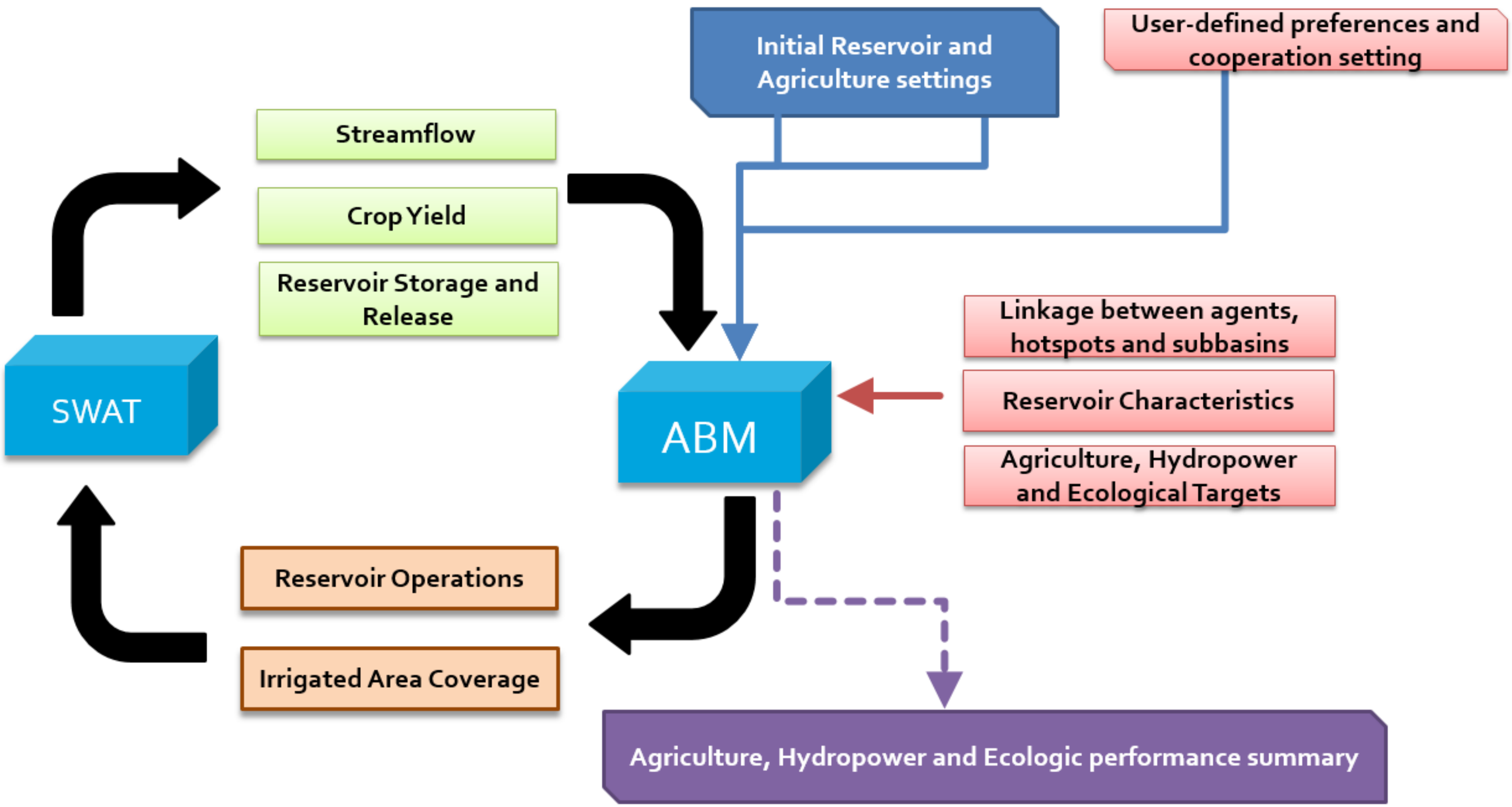
1) Partial agriculture equilibrium model linked with global CGE model, global gridded crop modeling system and water supply and demand projections model (water supply/demand, food supply and demand) (global and regional)
2) Some form of HEM (f.ex. ABM-SWAT combination or GAMS-based optimization) (basin level)
3) SWAT hydrological model (irrigation potential assessment, water pollution, ecosystem services, sedimentation and HP productivity) (watershed to global level)
4) CGE model linked to energy and water models (national level) (national to global levels)

Global PE-CGE linked modeling framework

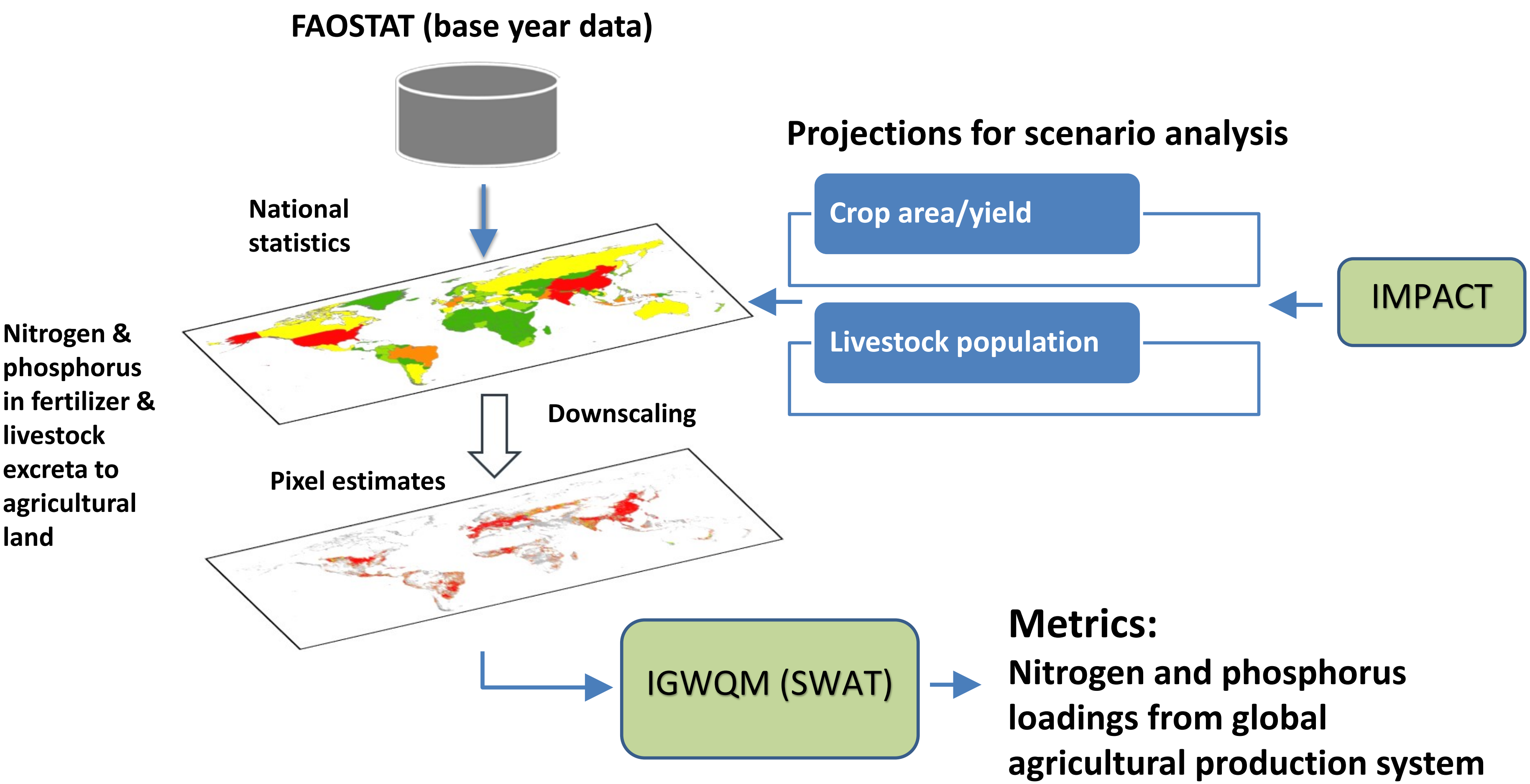


Source: Ringler et al. 2016

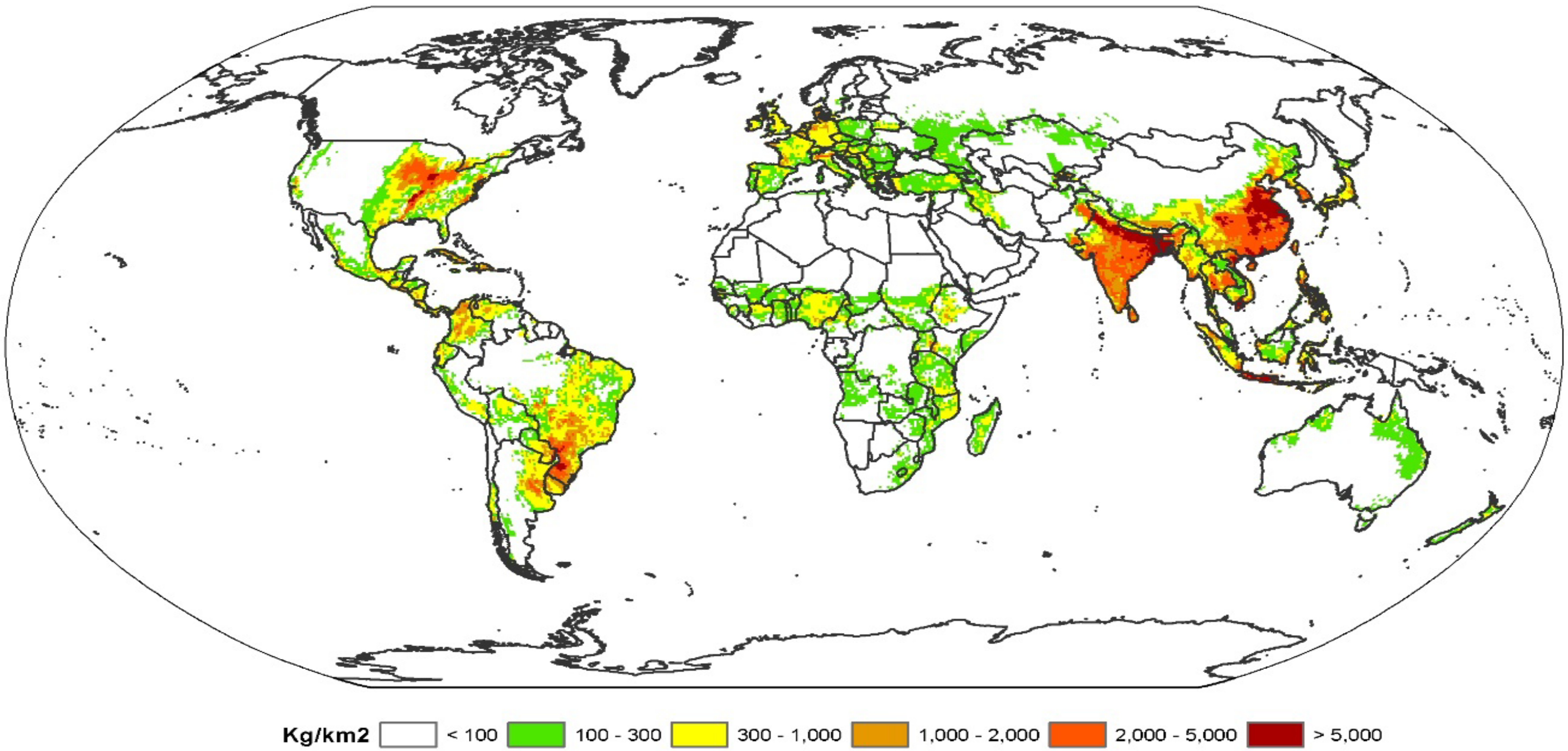
ABM-SWAT basin model for ecosystem/services modeling



Global Agricultural Water Pollution Assessment: Modeling Framework



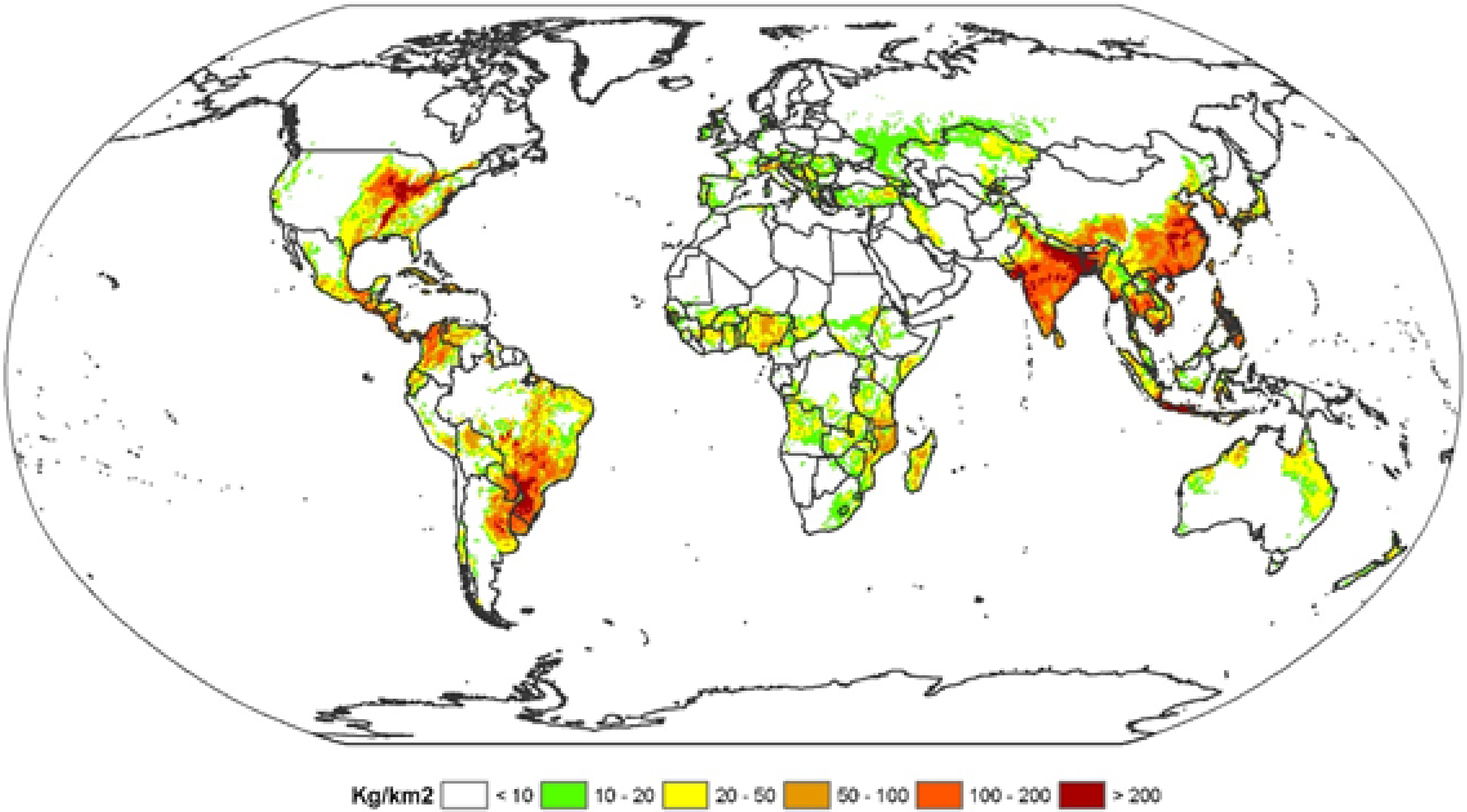
Estimated nutrient loading intensity, agriculture, base period (Nitrogen, kg/km^2): 46 mt/yr



Brazil/India/China account for 3/4

Source: Xie and Ringler (under review).

Estimated nutrient loading intensity, base period (Phosphorous, kg/km^2): 2.7 mt/yr

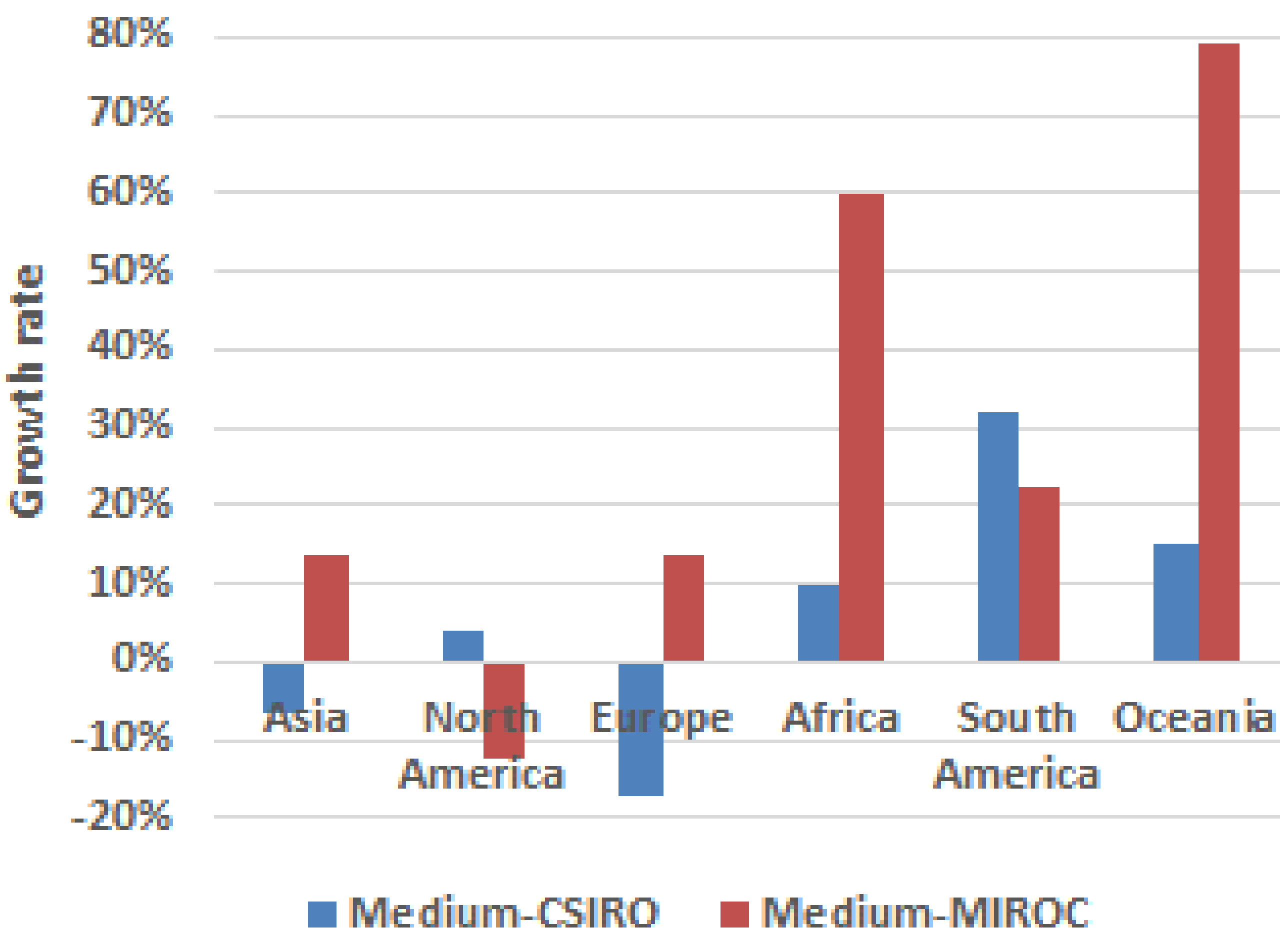


Brazil/India/China account for 72%

Uniting agriculture and nature for poverty reduction

Source: Xie and Ringler (under review).

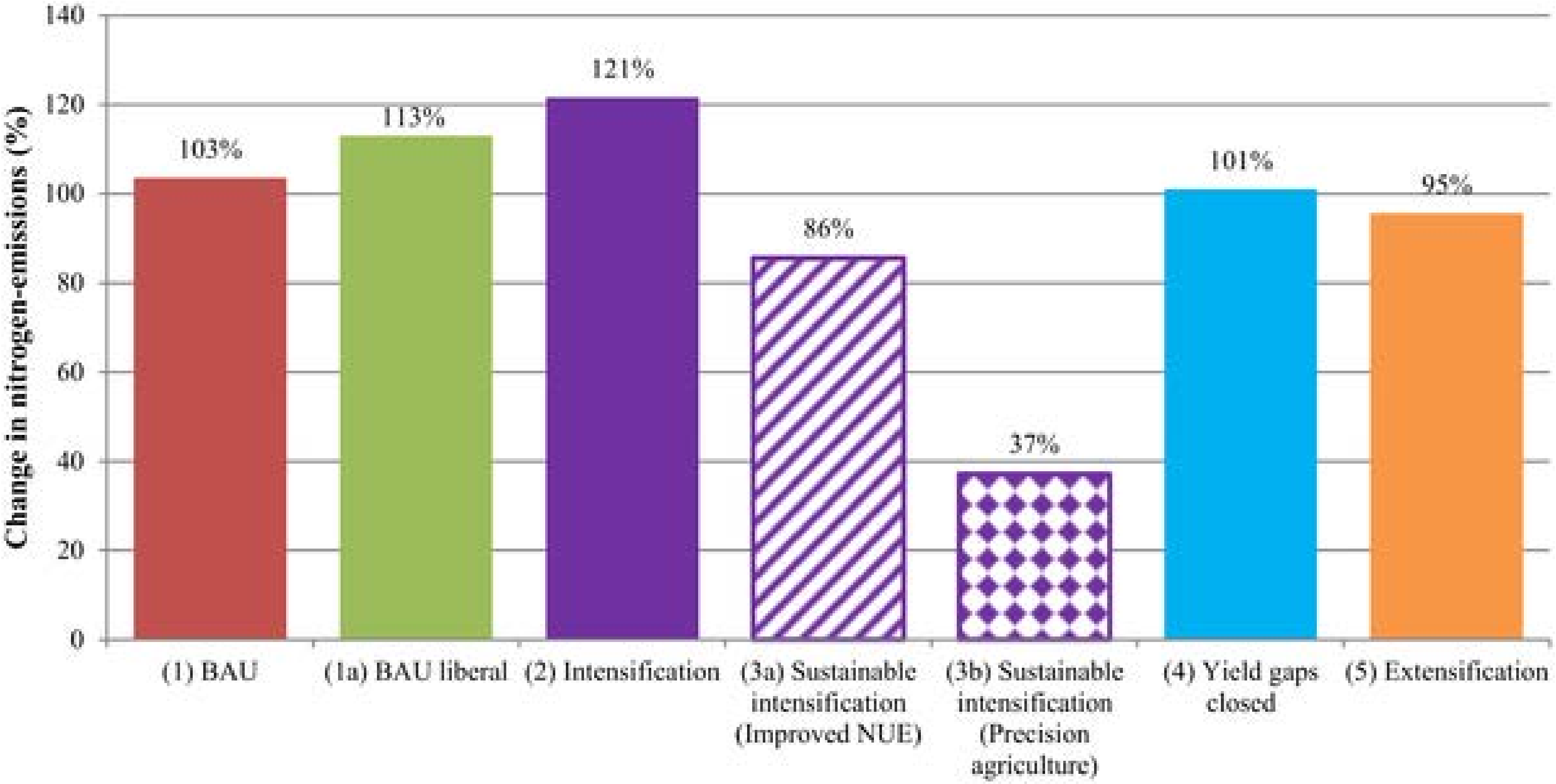
Growth in P loadings, projected 2000-2050



Source: Xie and Ringler (under review).

Opportunities for agricultural nutrient pollution reduction

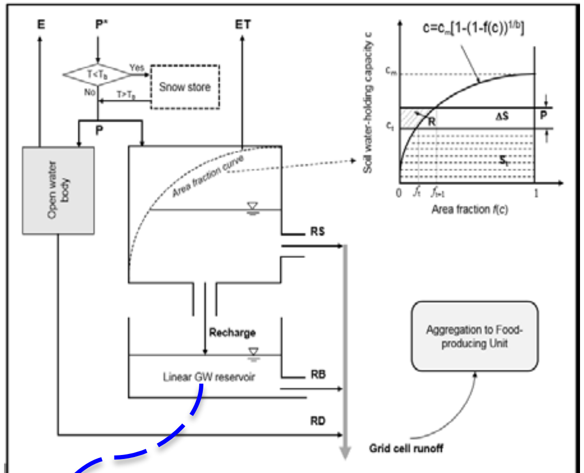
Changes in nitrogen-emission rates in Latin America and the Caribbean between the base year 2000 and 2050 (in%).



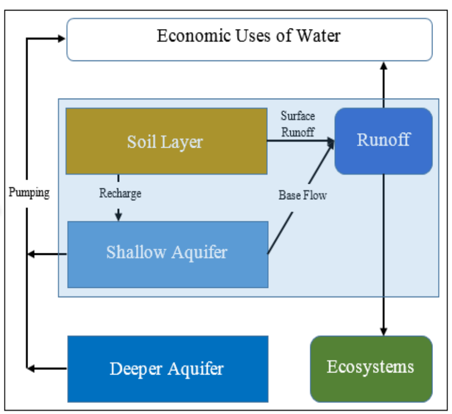
Source: Flachsbarth et al. 2015.

IMPACT Groundwater Module

GW pumping from "GW reservoir" in the Global Hydrological Model

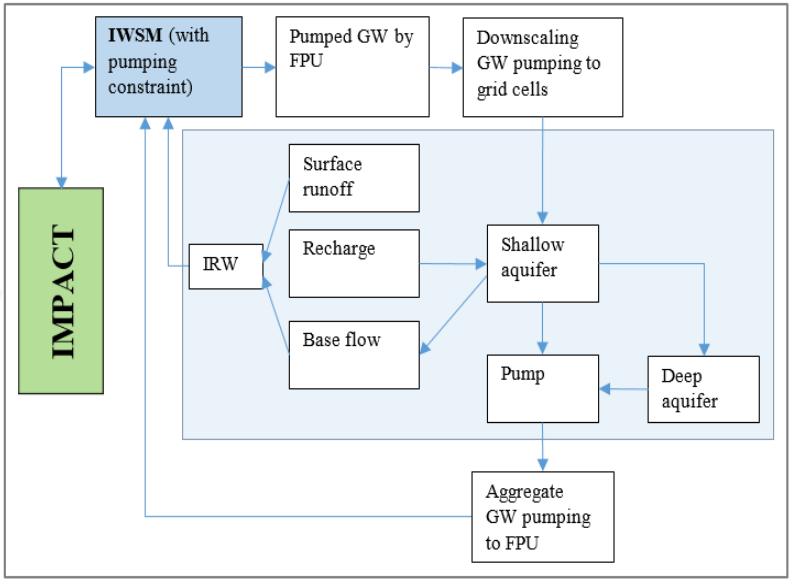


Two sources to pump GW: conceptual shallow & deep aquifers

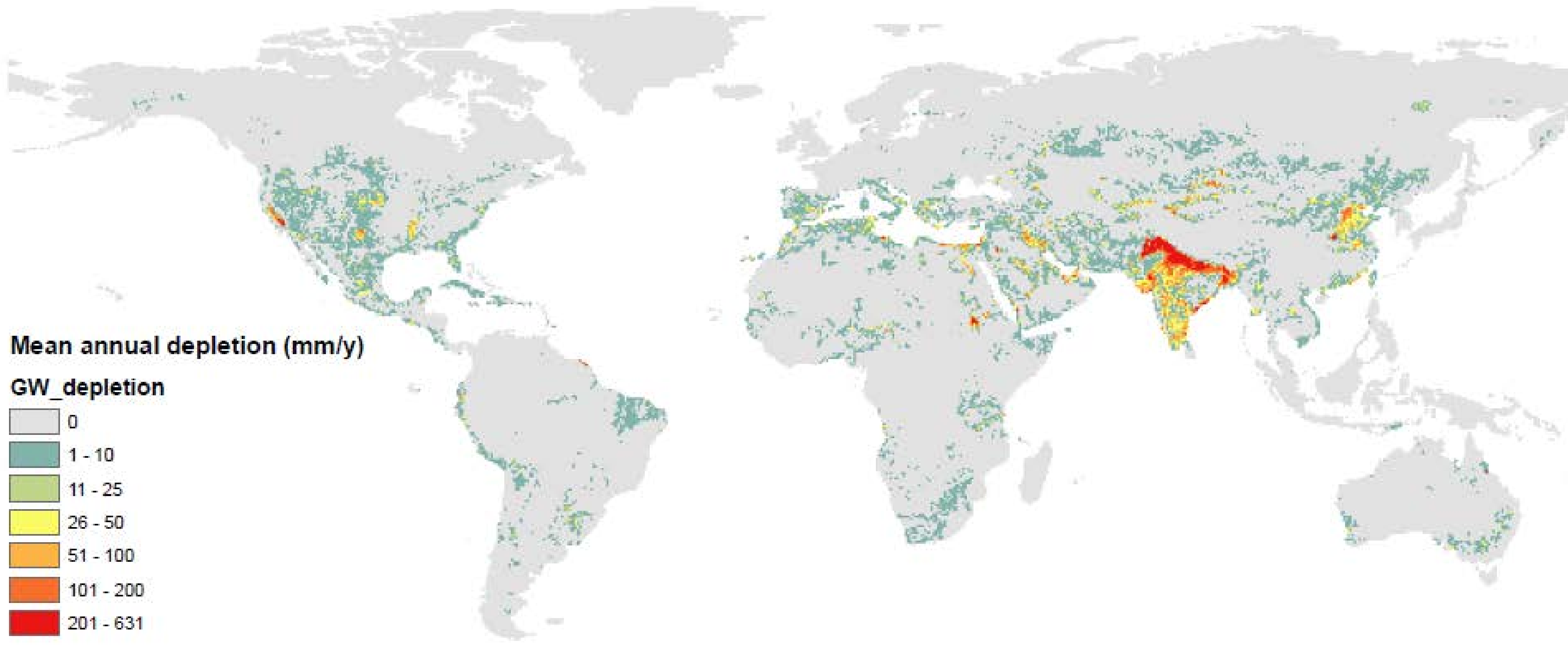


Procedures of GW pumping simulation in the integrated model:

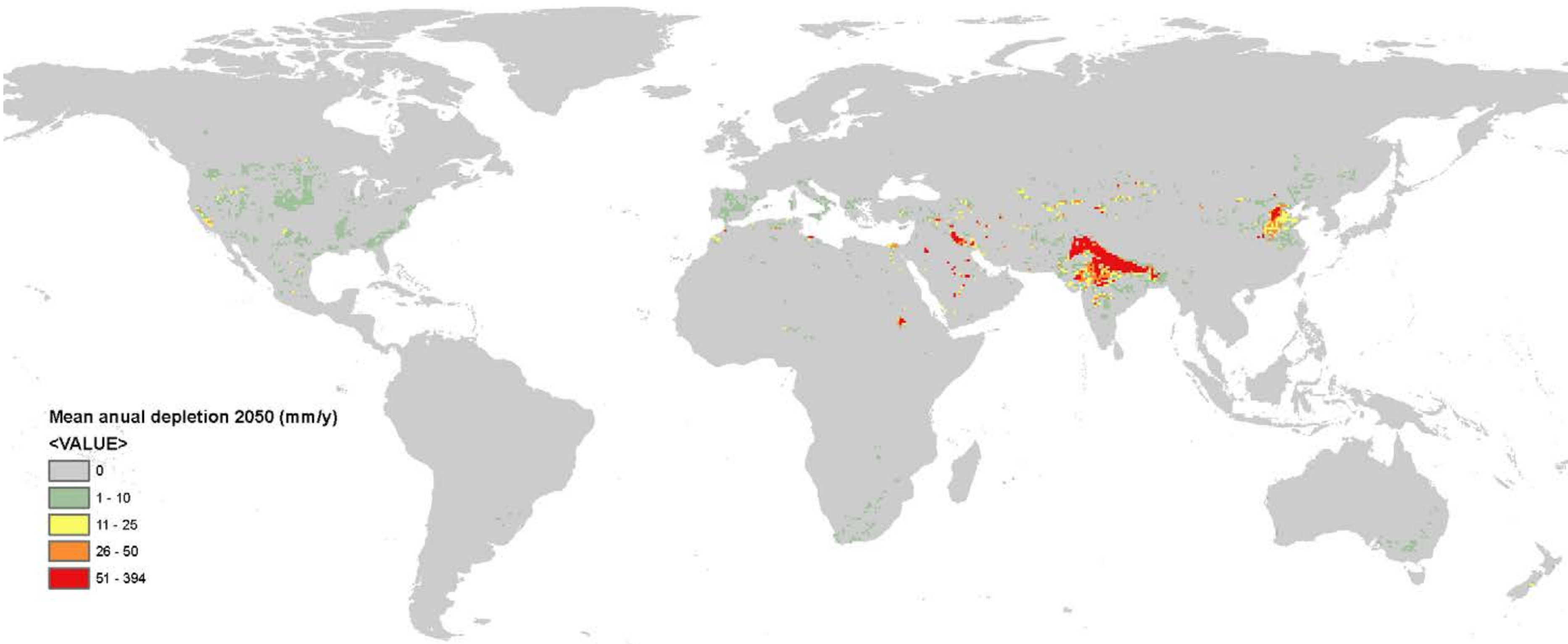
1. Run the global water resource model IWSM and extract projected GW pumping by FPU
2. Downscale FPU-level GW pumping to 0.5 degree grid cells
3. Run the global hydrological model by applying gridded GW pumping demand to GW reservoir balance in the IGHM. Pumping from deep aquifer is trigged only when shallow aquifer storage is depleted.
4. Aggregate the sum of pumping from shallow and deep aquifers at grid cell level to FPUs.
5. Re-run the IWSM water resource model using updated GW pumping.



Simulated groundwater depletion in the base year, 2005



Simulated groundwater depletion, maize, 2050



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