The land-water-climate nexus

- what are links to energy (and how can they be modelled)?

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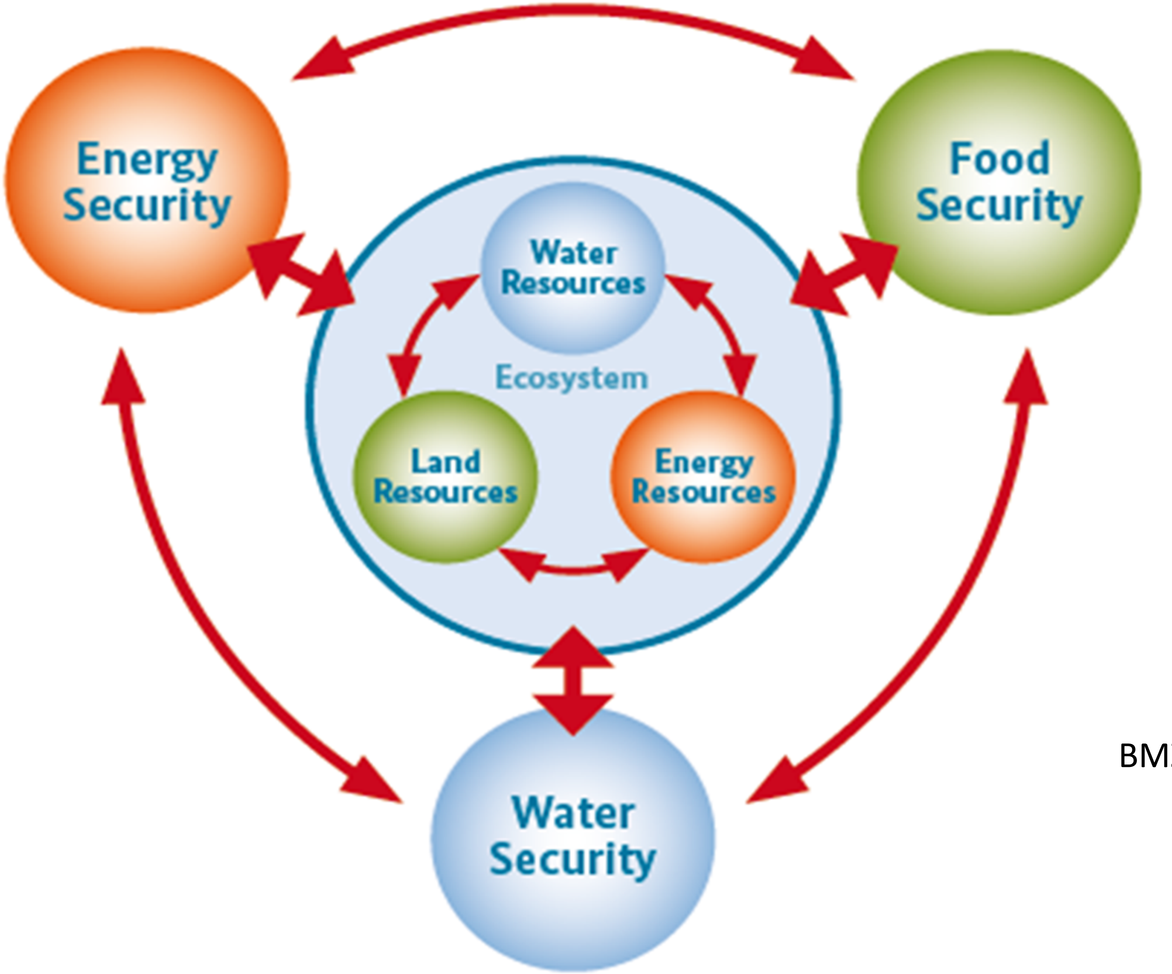
2: Stockholm Environment Institute

SEI STOCKHOLM ENVIRONMENT INSTITUTE

wholeSEM Conference
Cambridge
6 July 2015

PIK

The “Nexus”



BMZ 2014

a nexus or integrated approach for improving
human food-, energy- and water-security,
while reducing pressure on natural resources and ecosystems
(see e.g. Green Economy Strategies or SDGs)

The "Nexus"

a nexus approach to the Sustainable Development Goals (SDGs)

"evidence-based integrated implementation of the SDGs" (zero draft)

- water & water security (SDG # 6)
- energy & energy security (7)
- climate (13)
- land / terrestrial ecosystems (15)
- food security, agriculture (2)

-> identification of interlinkages and feedbacks
between goals & targets, as well as between sectors & resources,
fostering synergies and managing tradeoffs

The “Nexus”

nexus assessments:

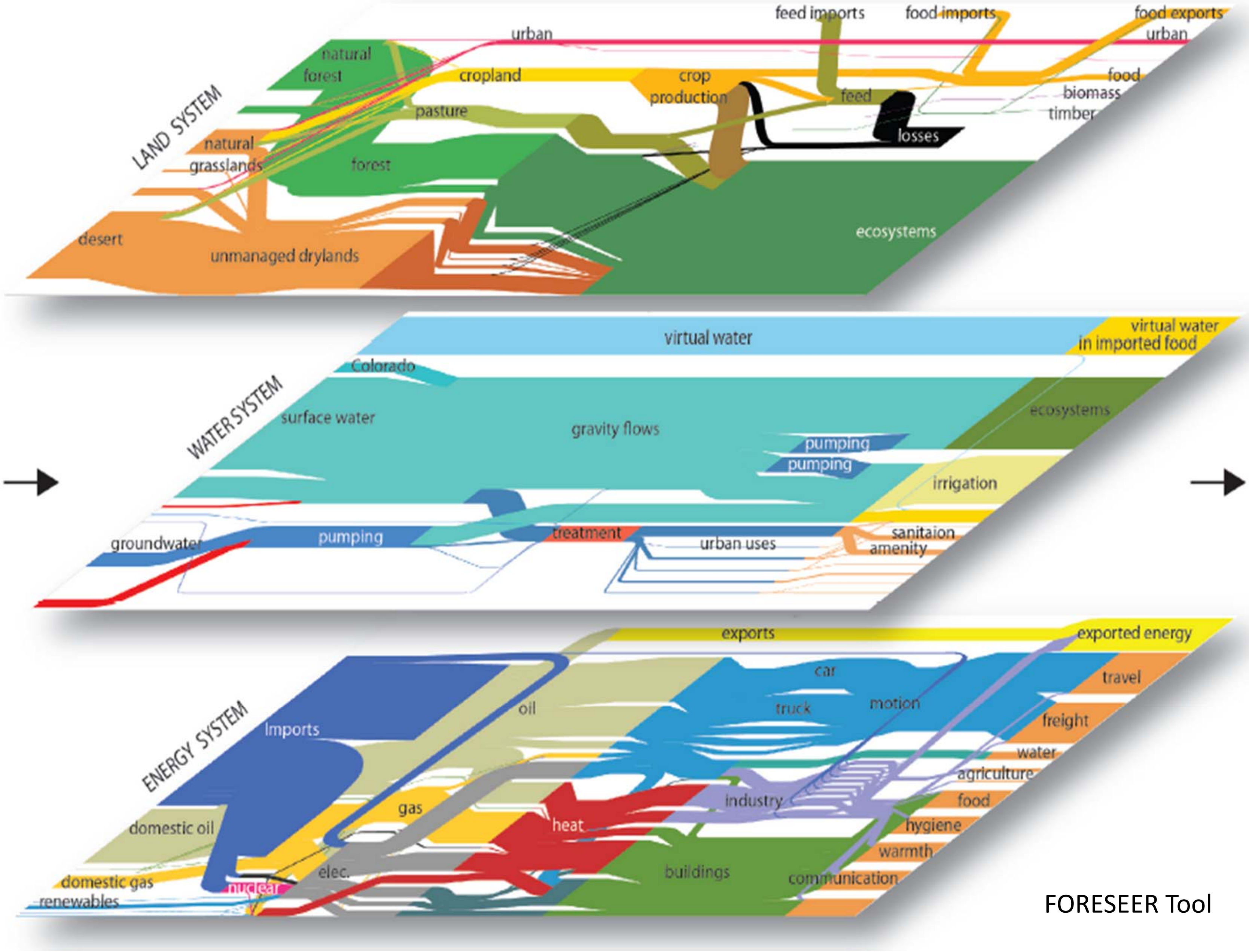
quantification of interlinkages and feedbacks
between land, water, and energy resources
in space and time

from current resource availabilities, demands,
use efficiencies and interlinkages (e.g. via Sankey diagrams)

to scenarios, e.g. of climate & land use change:
integrated model-based scenario analyses

The Water-Land-Energy Nexus

RESOURCES →



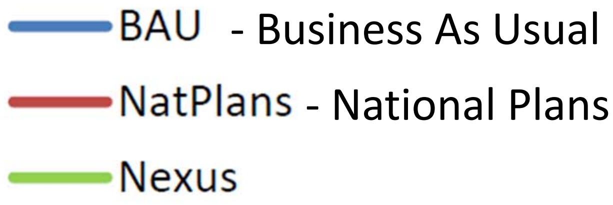
→ FOOD and OTHER SERVICES

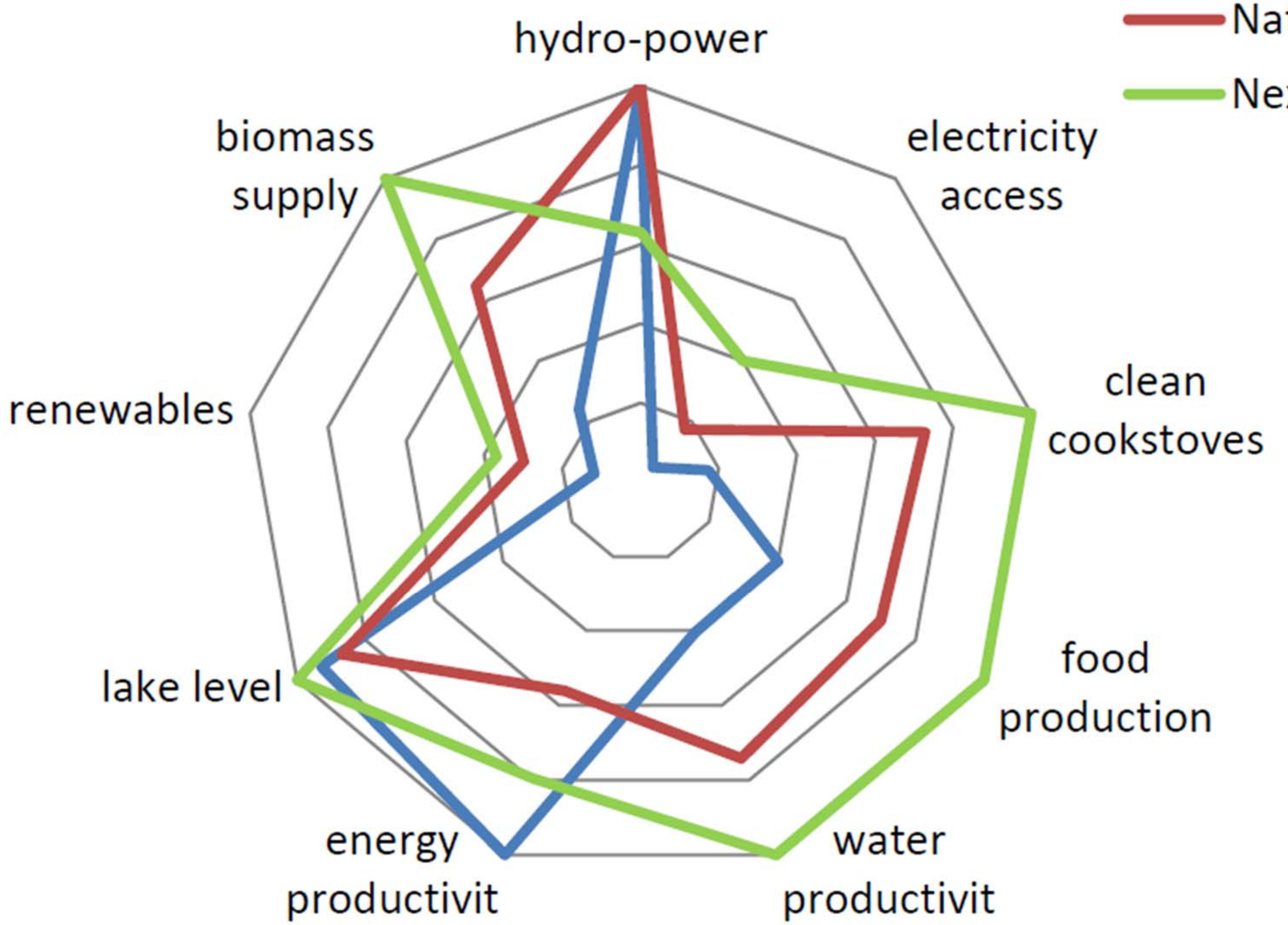
FORESEER Tool

The Water-Land-Energy Nexus

place-based nexus assessment, using SEI's linked WEAP and LEAP tools, e.g. in the upper Blue Nile in Ethiopia

synergies & tradeoffs for different scenarios:



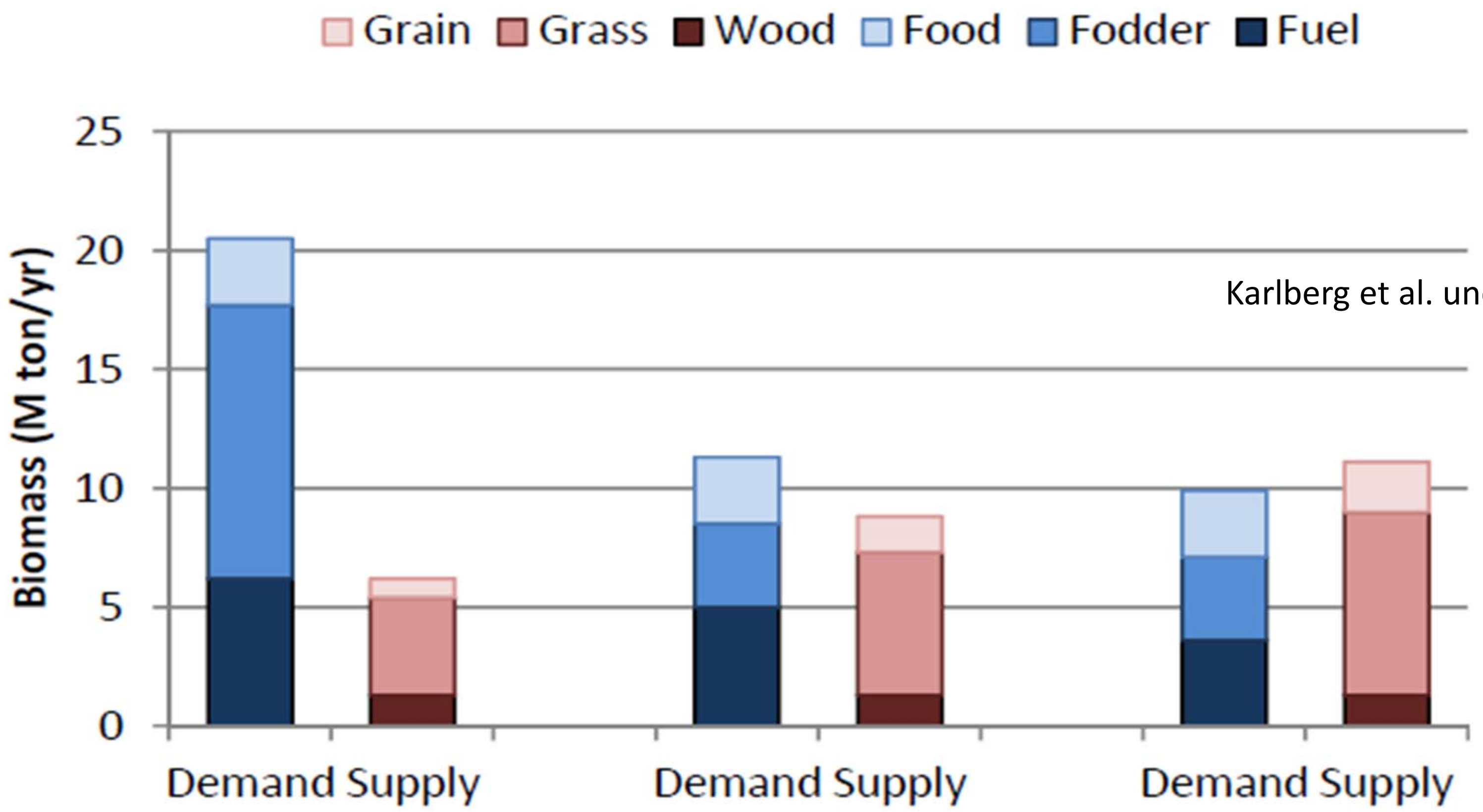


Karlberg et al. 2015

The Water-Land-Energy Nexus

place-based nexus assessment, using SEI’s linked WEAP and LEAP tools e.g. in the upper Blue Nile in Ethiopia

biomass consequences of the different scenarios:



Karlberg et al. under revision

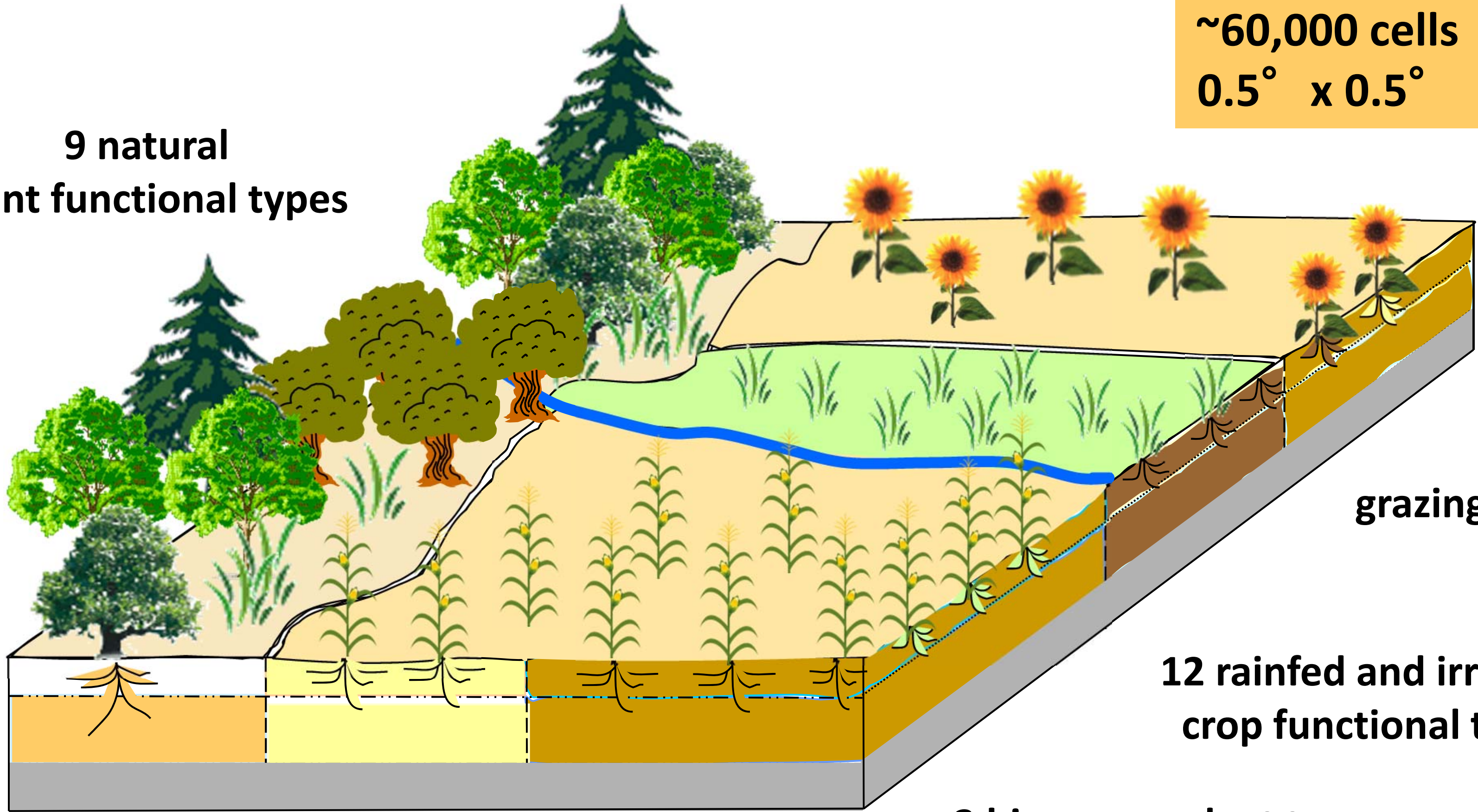
-> nexus tools to be used by policy makers themselves

Global integrated modeling

LPJmL:

a global biosphere - land – water model,
simulating biophysical and biogeochemical processes
consistently across different (agro-) ecosystems

LPJmL



outputs:

vegetation dynamics, fractional land cover

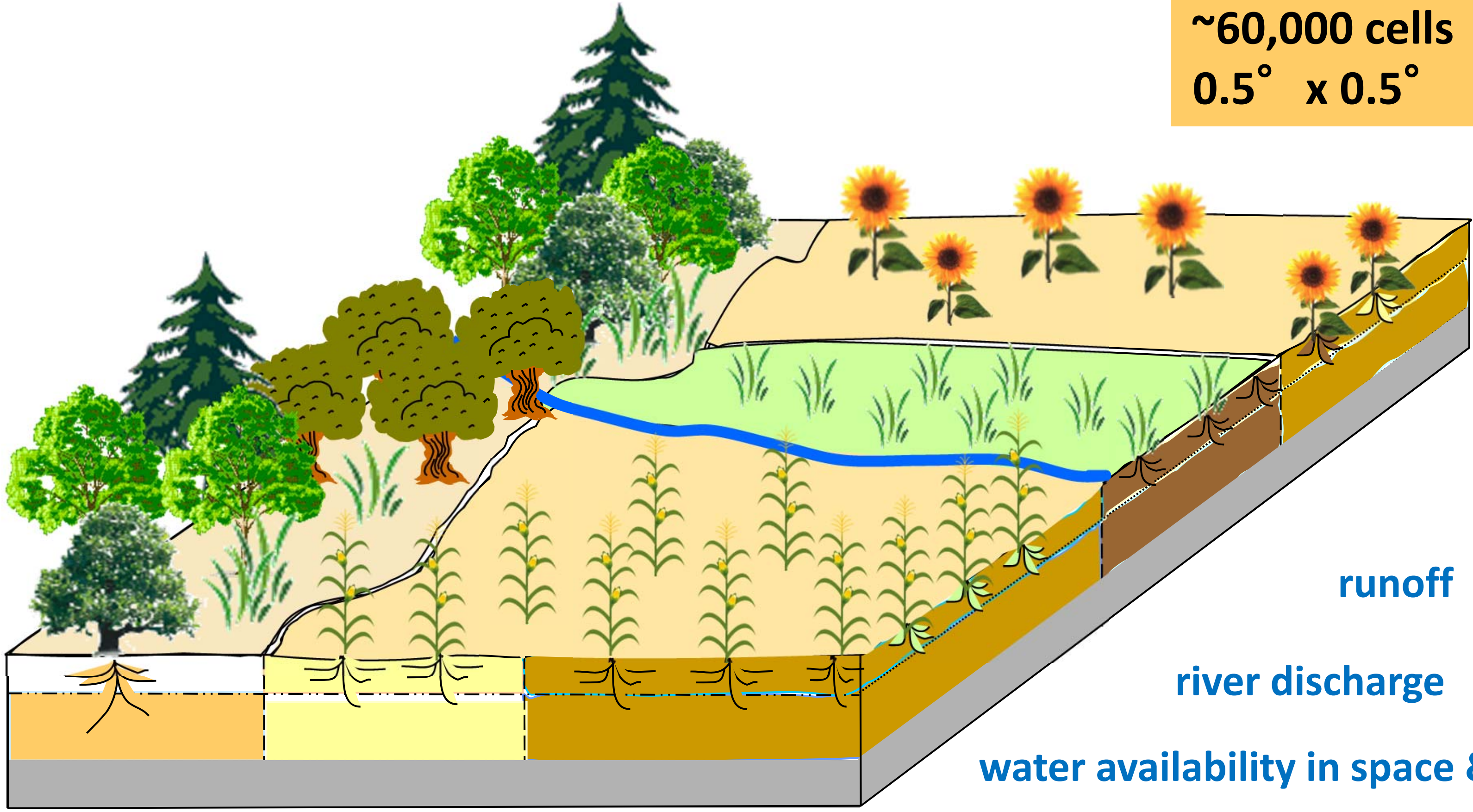
terrestrial (soil & vegetation) carbon fluxes and stores

biomass production and agricultural yields

Sitch et al 2003; Gerten et al. 2004; Bondeau et al. 2007; Rost et al. 2008, Waha et al. 2012 .

LPJmL

~60,000 cells
0.5° x 0.5°



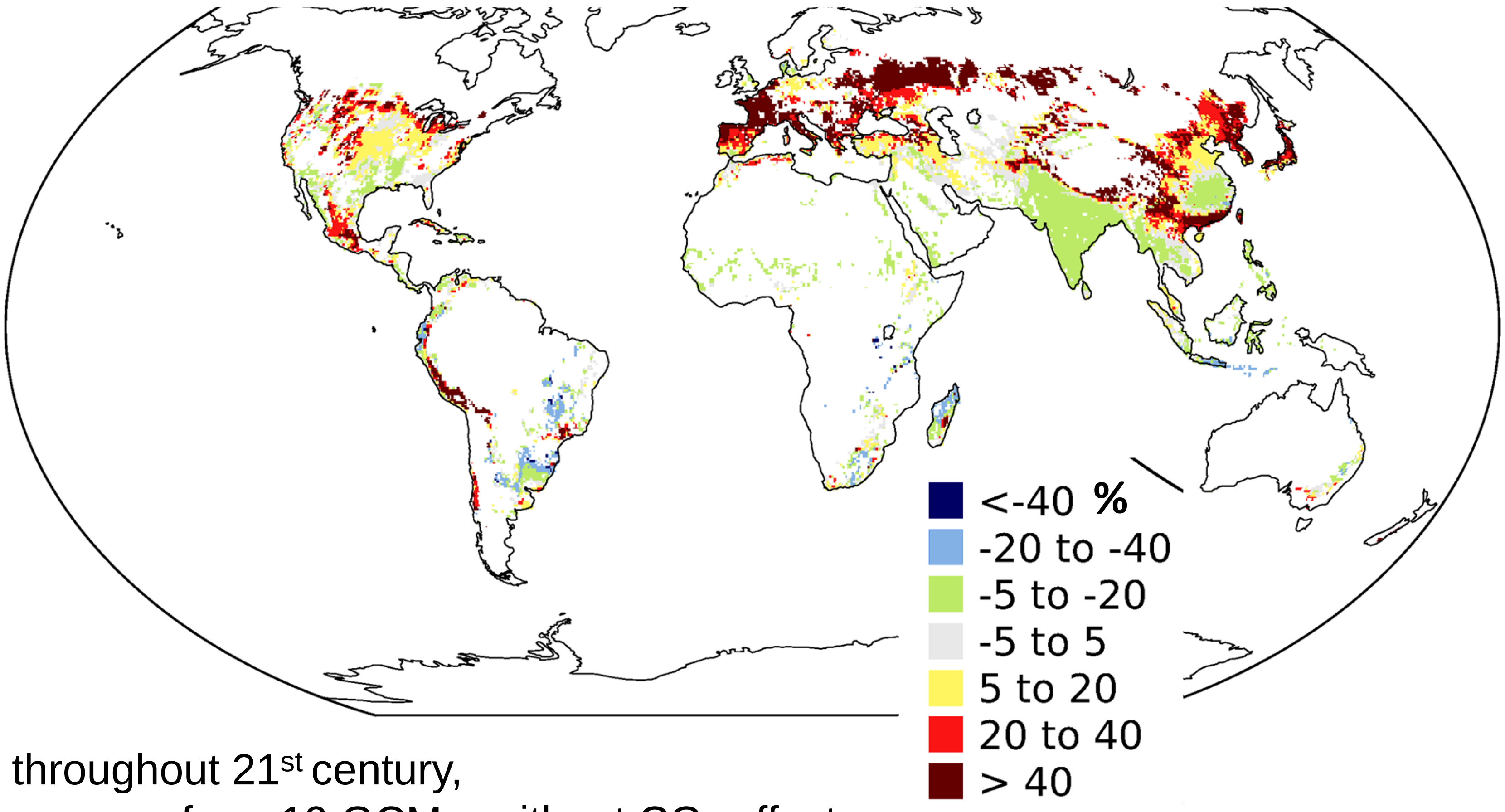
outputs: vegetation (including crop) water demand and water productivity

Sitch et al 2003; Gerten et al. 2004; Bondeau et al. 2007; Rost et al. 2008, Waha et al. 2012 .

LPJmL

some results:

Change in irrigation water demand with cc
on presently irrigated areas



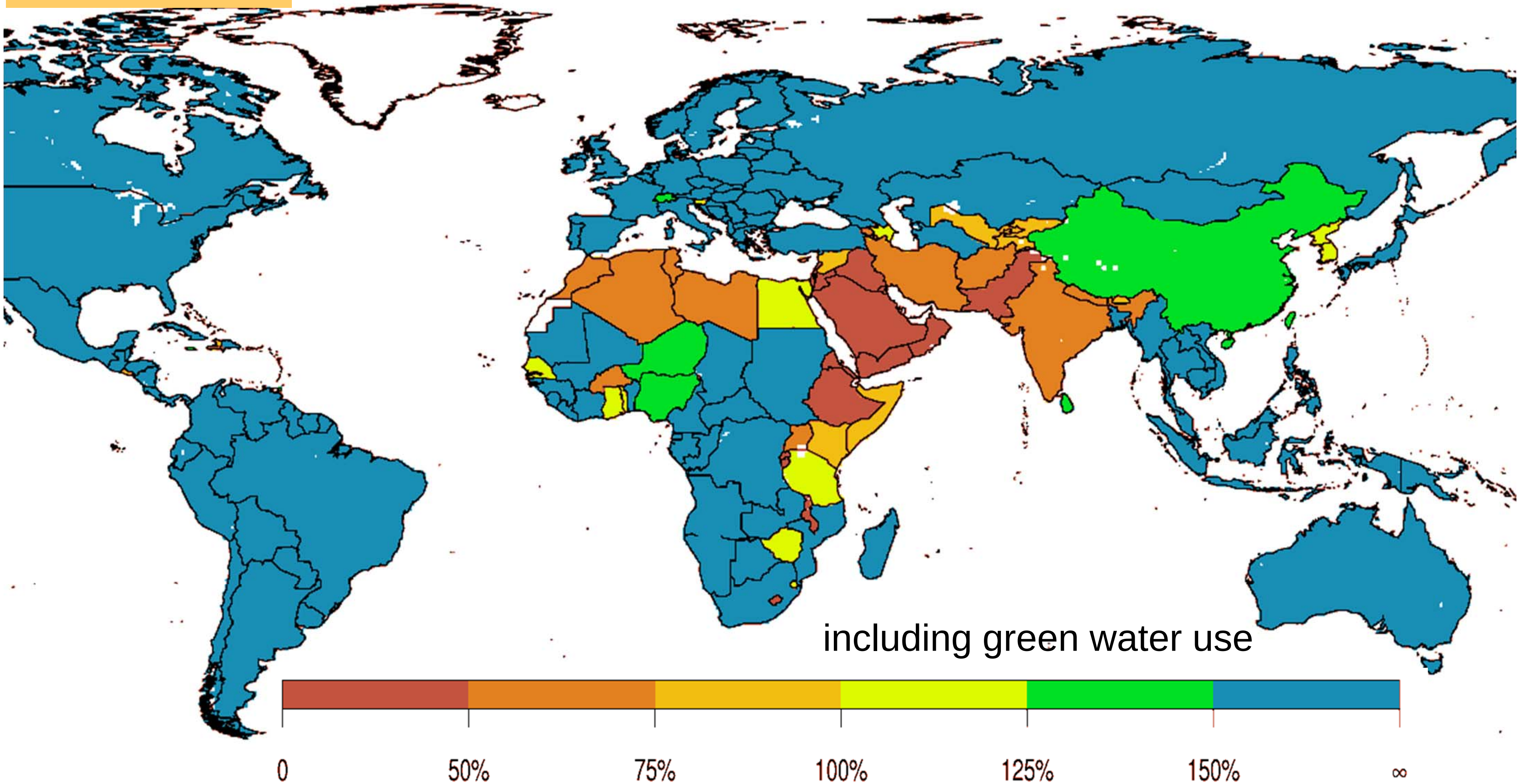
throughout 21st century,
average from 19 GCMs, without CO_2 effects

Konzmann et al. 2013

LPJmL

some results:

Water constrained food self sufficiency

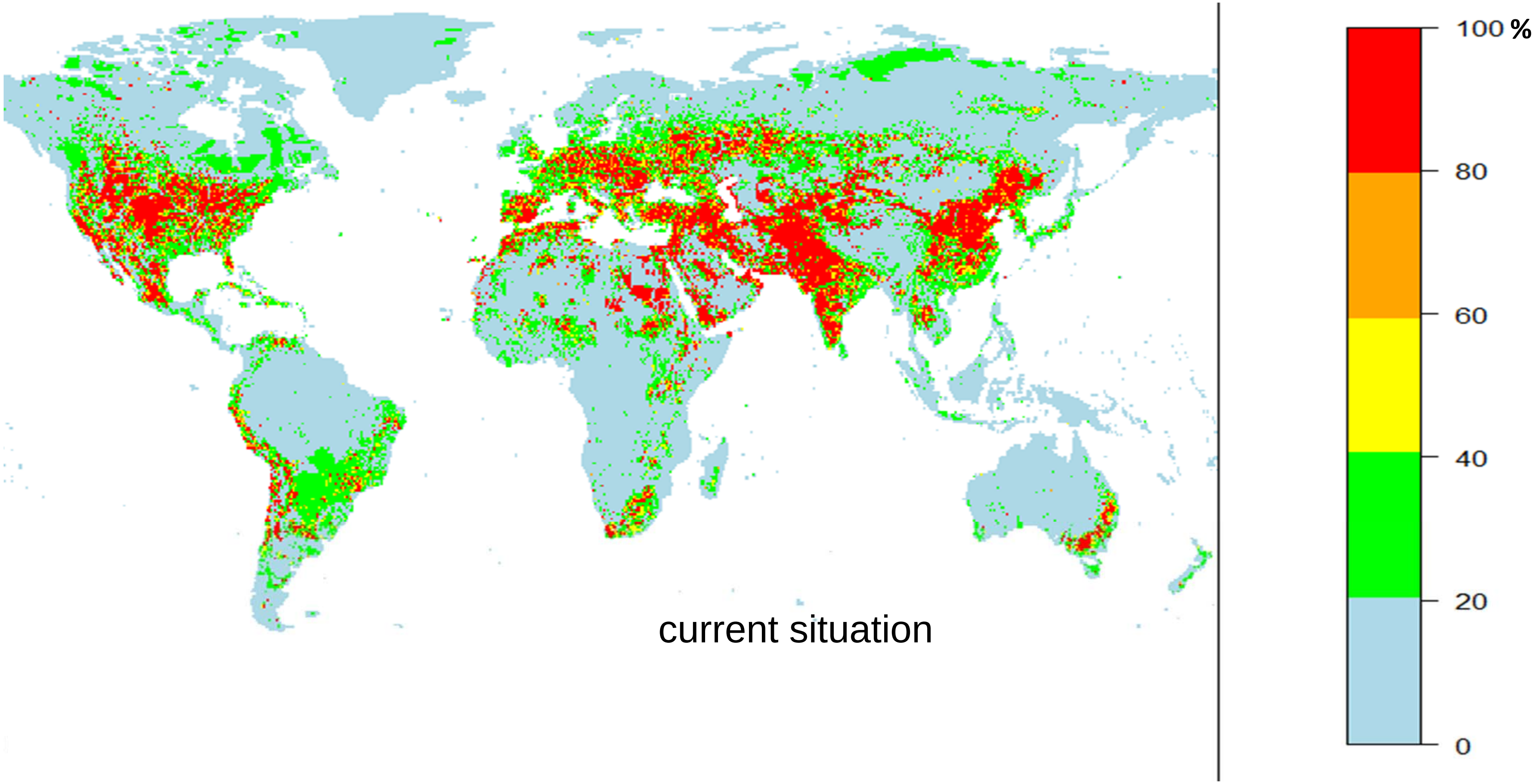


Gerten et al. 2011

LPJmL

some results:

Water resources criticality, accounting for withdrawals & environmental flow requirements



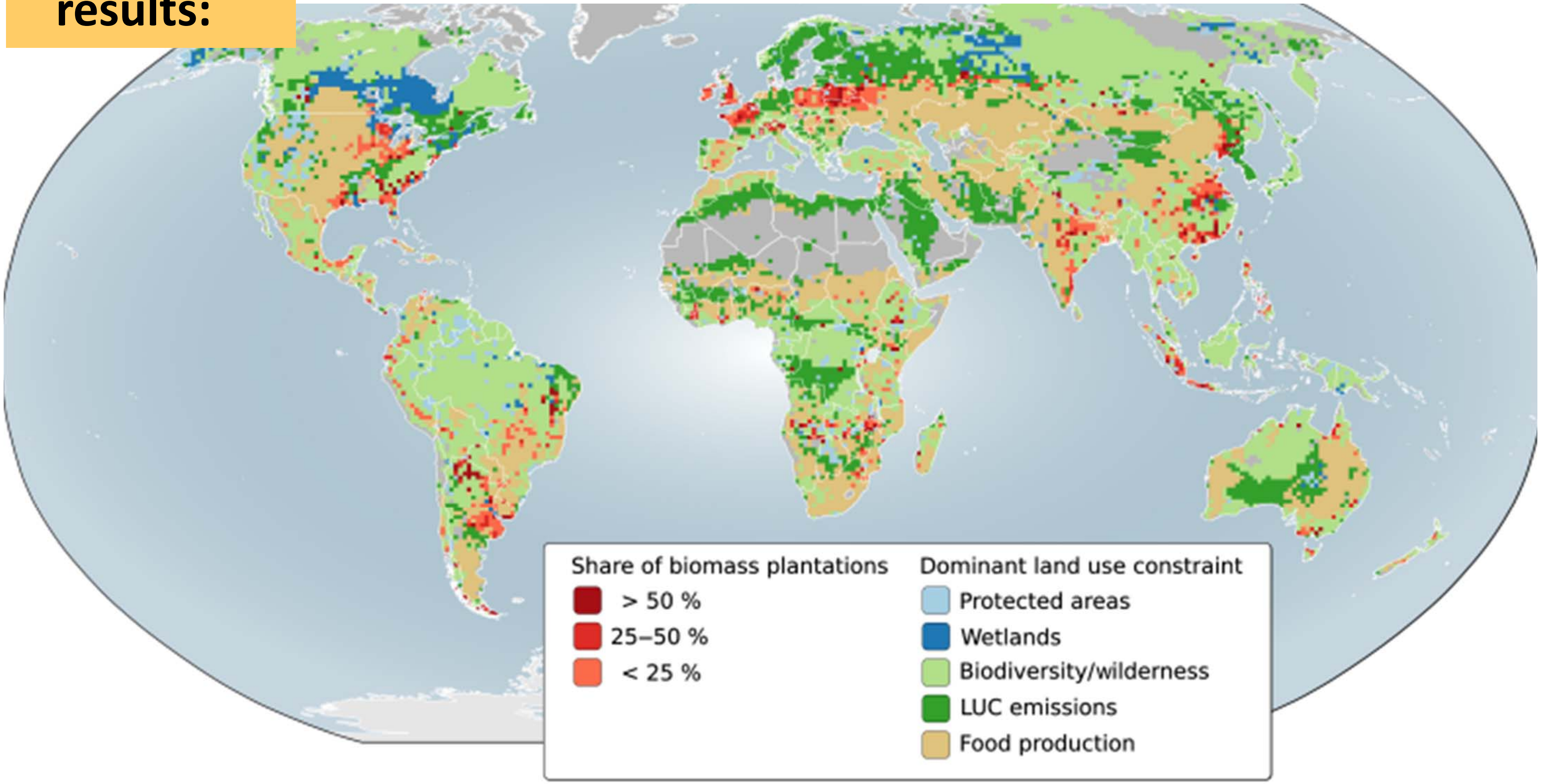
current situation

Pastor et al. 2014

LPJmL

some results:

Land availability and bioenergy production

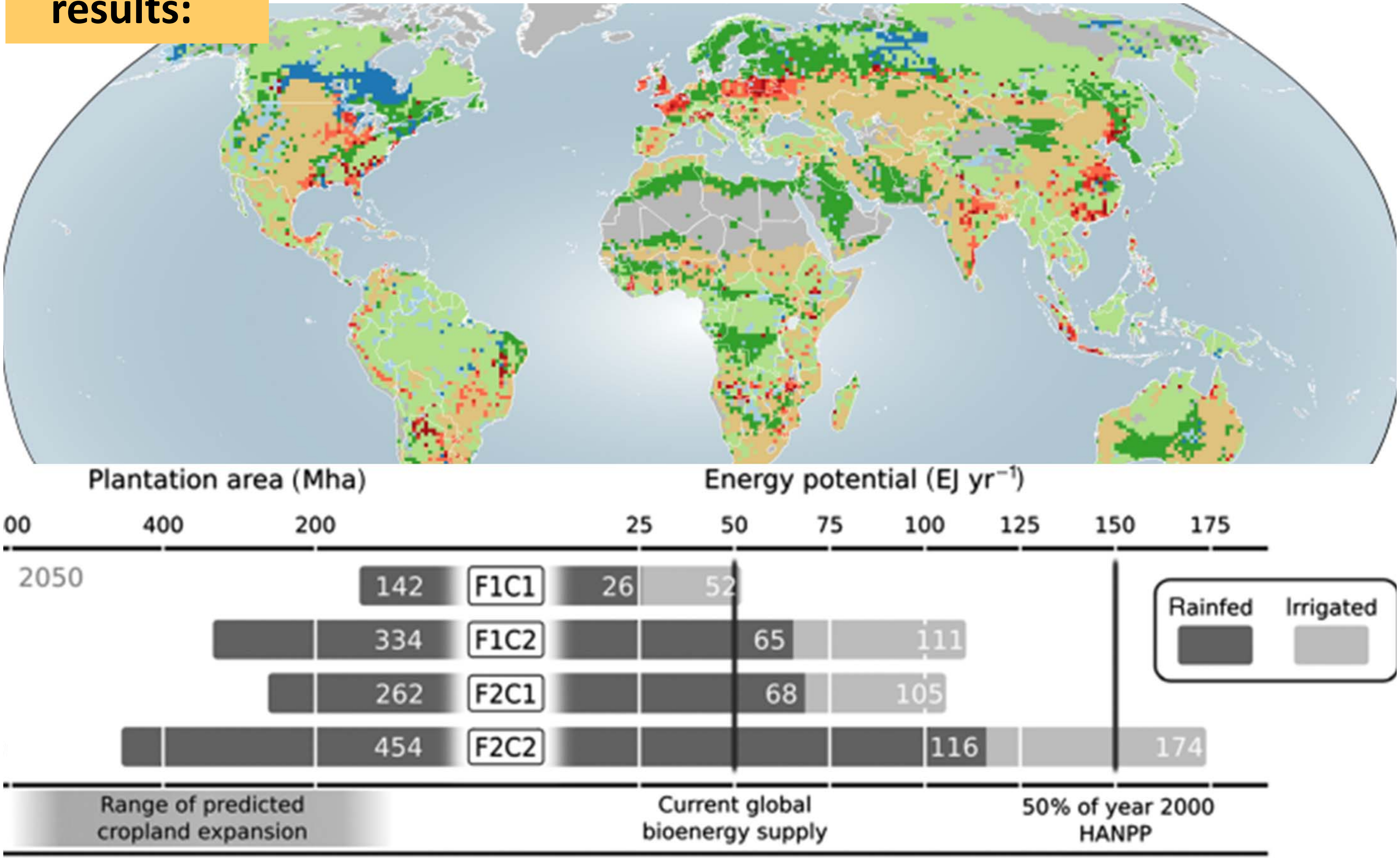


Beringer et al. 2011

LPJmL

some results:

Land availability and bioenergy production



Linking LPJmL to an energy model

general objectives of such a harmonized model framework:

assessing interlinkages and feedbacks
between energy-, food- and eco-systems,
as mitigated through land and water

identifying systemic risks and
opportunities for co-management of resource,
sustainable production systems,
and improved co-allocation of water and land

Linking LPJmL to an energy model

quantifying:

water and land requirement of climate protection
for different mitigation / energy pathways,
compatible with water and land requirements
for food and other biomass

energy requirements (and climate effects) of future food
and other biomass demands
and for agricultural intensification options
such as additional irrigation and fertilizer use

Linking LPJmL to an energy model

examples:

additional water (and land) demand
for climate mitigation via bioenergy or CCS

carbon storage potential of new land uses

additional energy demand
for climate adaptation via desalination

feasibility of new hydropower schemes
under climate change

land and water intensity of climate smart agriculture