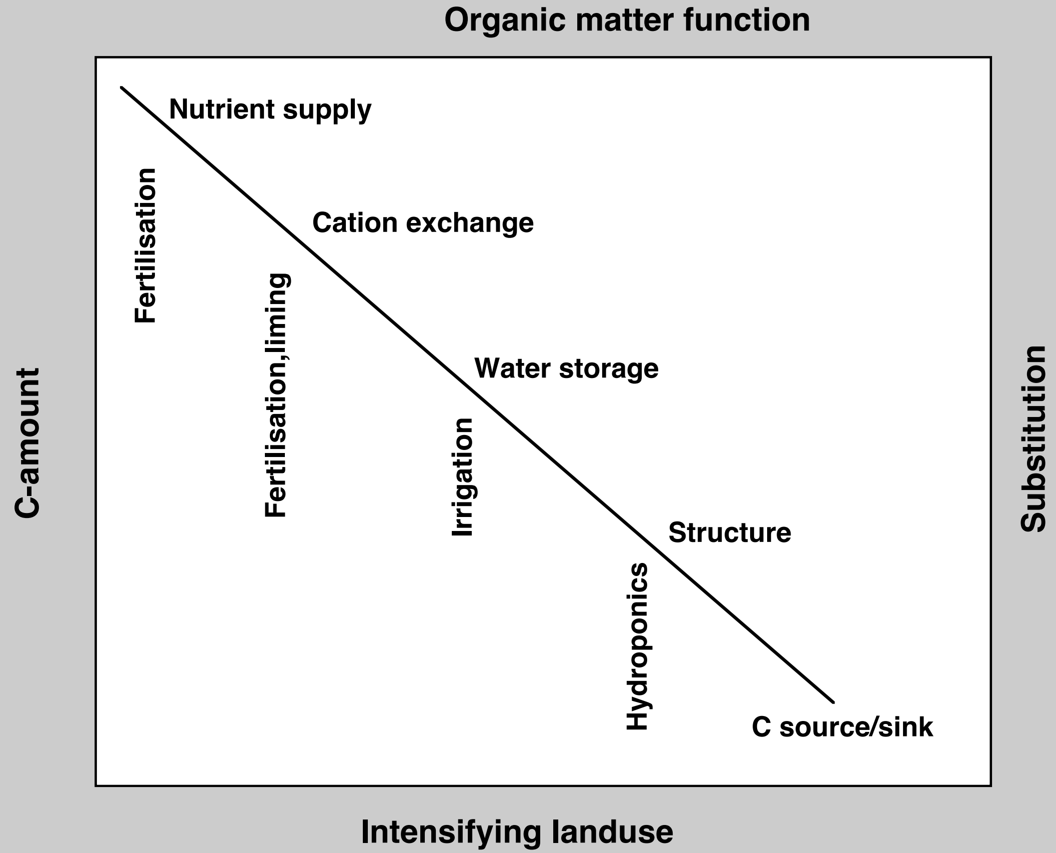
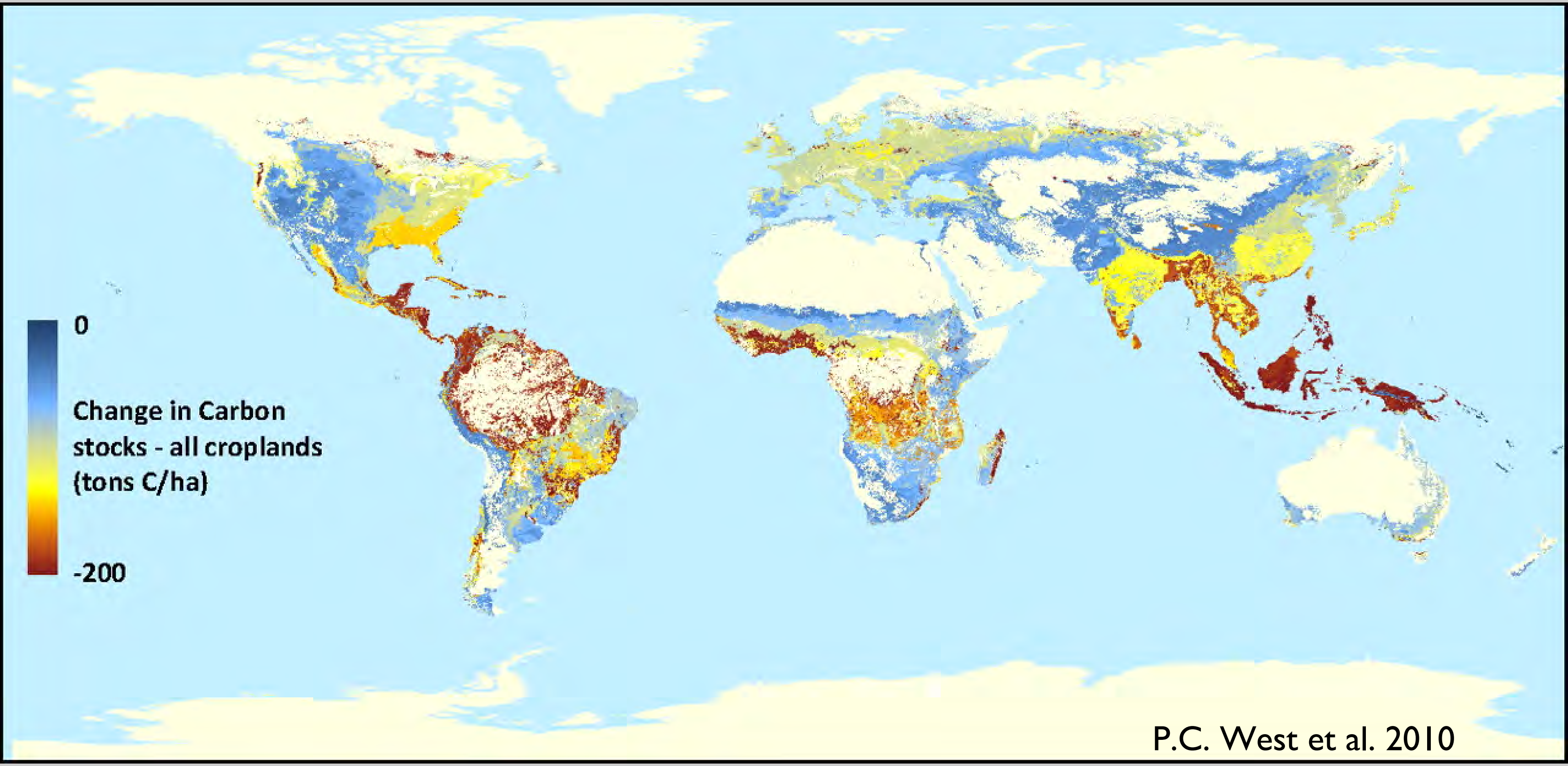
resource appropritation
is fundamental for production

resource limitation
is a risk for productivity

soil organic matter supports agricultural production



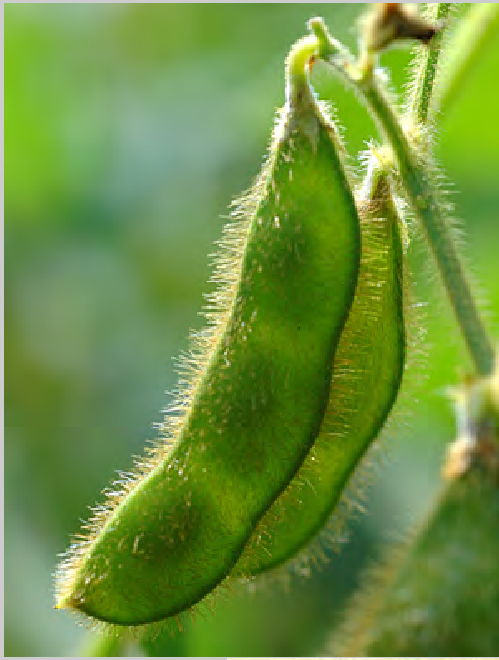
(Tiessen, Woomer, Izac)


0
Change in Carbon stocks - all croplands (tons C/ha)
-200
P.C. West et al. 2010

THANKS TO HIS STUBBORNNESS, THE WASTE ON THIS TRUCK CAN BE USED TO FUEL IT.
Patrick Foody Sr. is a determined man. Some 30 years ago, he had a visionary idea. He would produce ethanol, a vital ingredient in transportation fuels, from agricultural wastes like cereal straws and cornstalks. Contemporaries doubted him. Initial attempts were costly. Still, Pat and his colleagues at Iogen Corporation pressed on. After much dogged persistence, and with help from Shell, they found ways to make large-scale production a commercial reality. It may be a while yet before alternatives such as EcoEthanol™ can become a major source of energy. But by seeking out partners like Pat, we're hoping to bring that day a step closer. Visit www.shell.com/biofuels for more information.

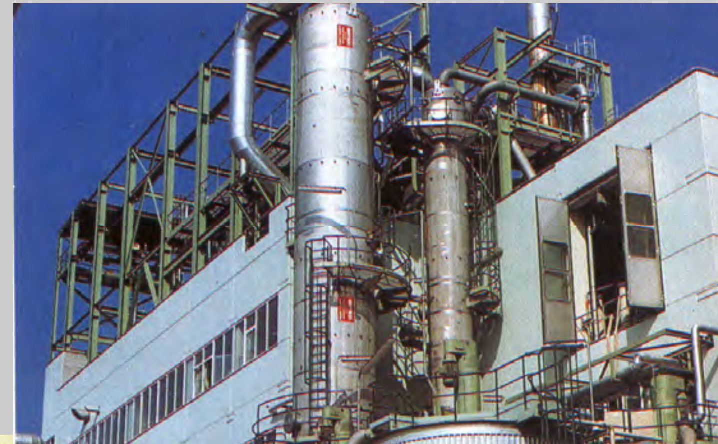
… waste?

nitrogen-fixation

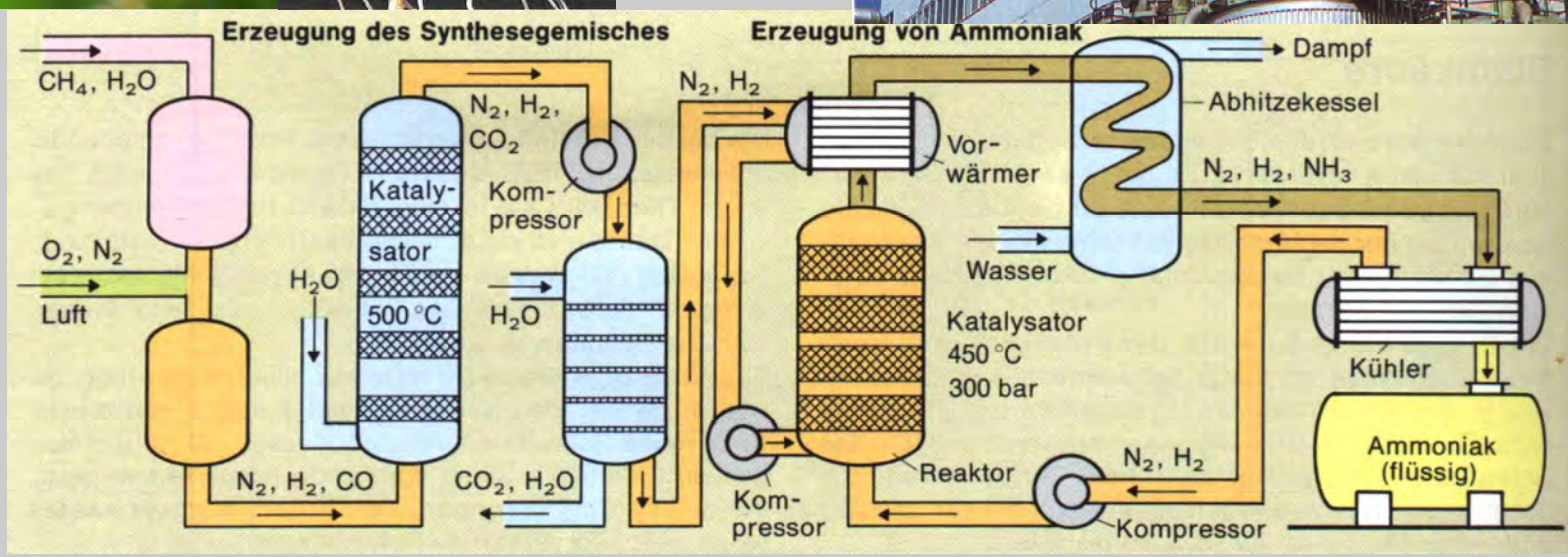


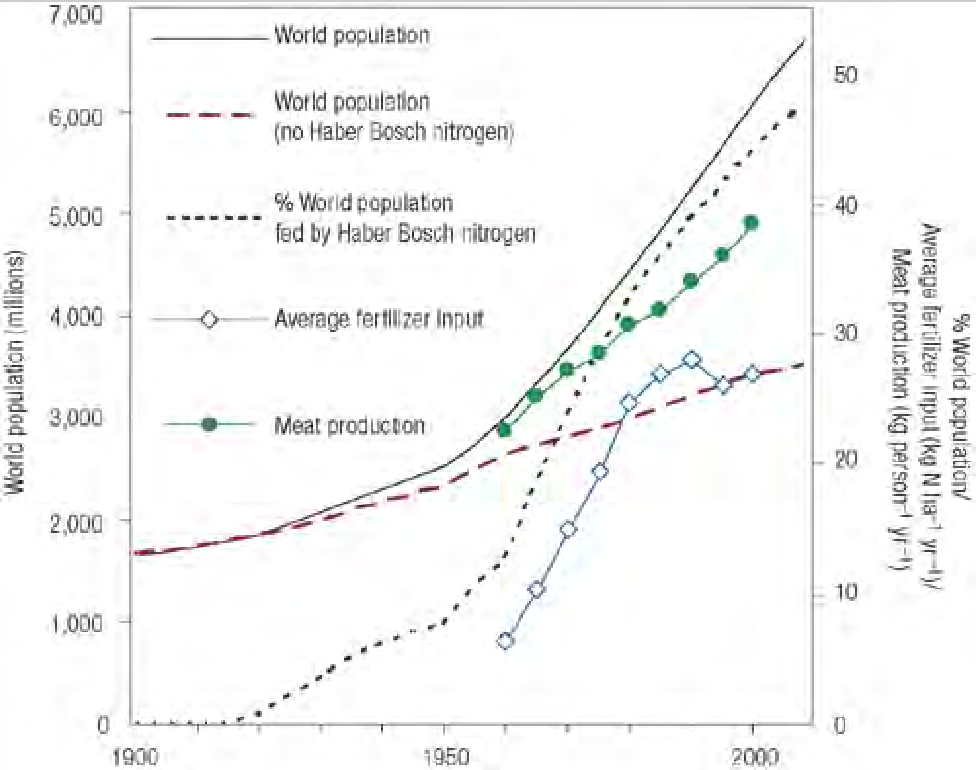
symbiotic

industrial

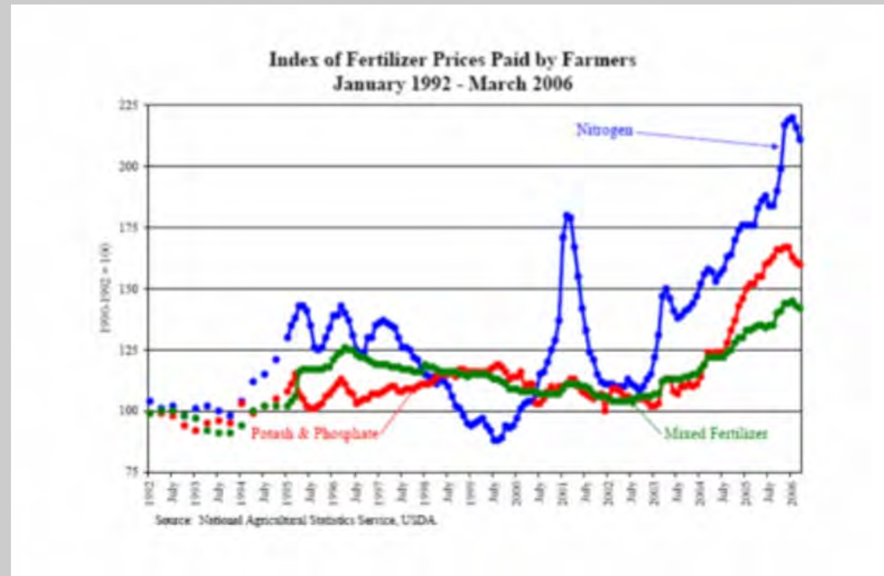


air is
free,
but...



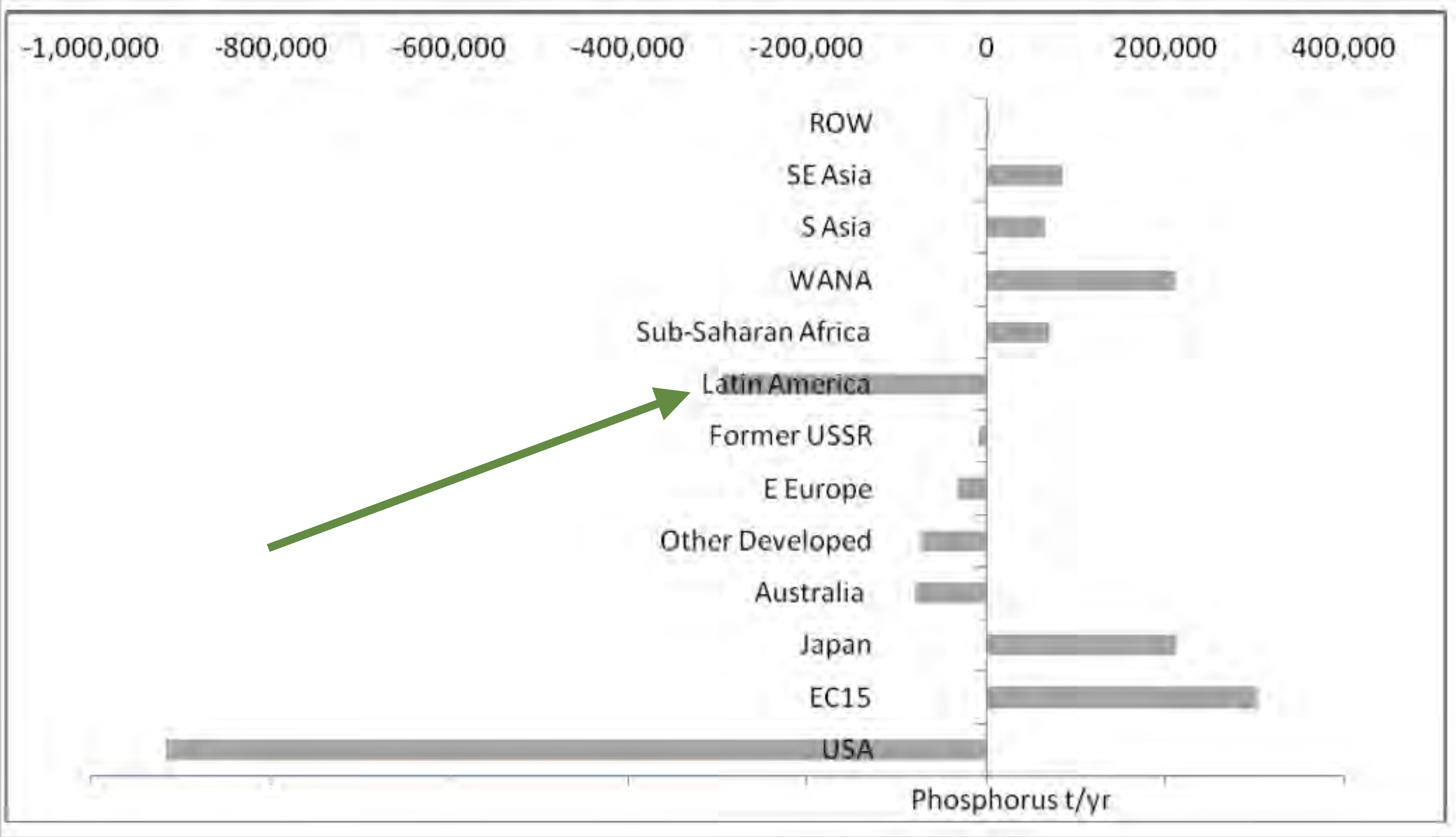


Effect of the Haber-Bosch process on world population.
Erisman, et al. Nat. Geosci. 2008, 1: 636-630.



120 Mt NH_3 per year @ >30Gjoule per t => 1% of world enery consumption

regional phosphate flows in net trade of agricultural commodities (projected to 2020)



(Craswell et al. 2004)

production and reserves of rock phosphate

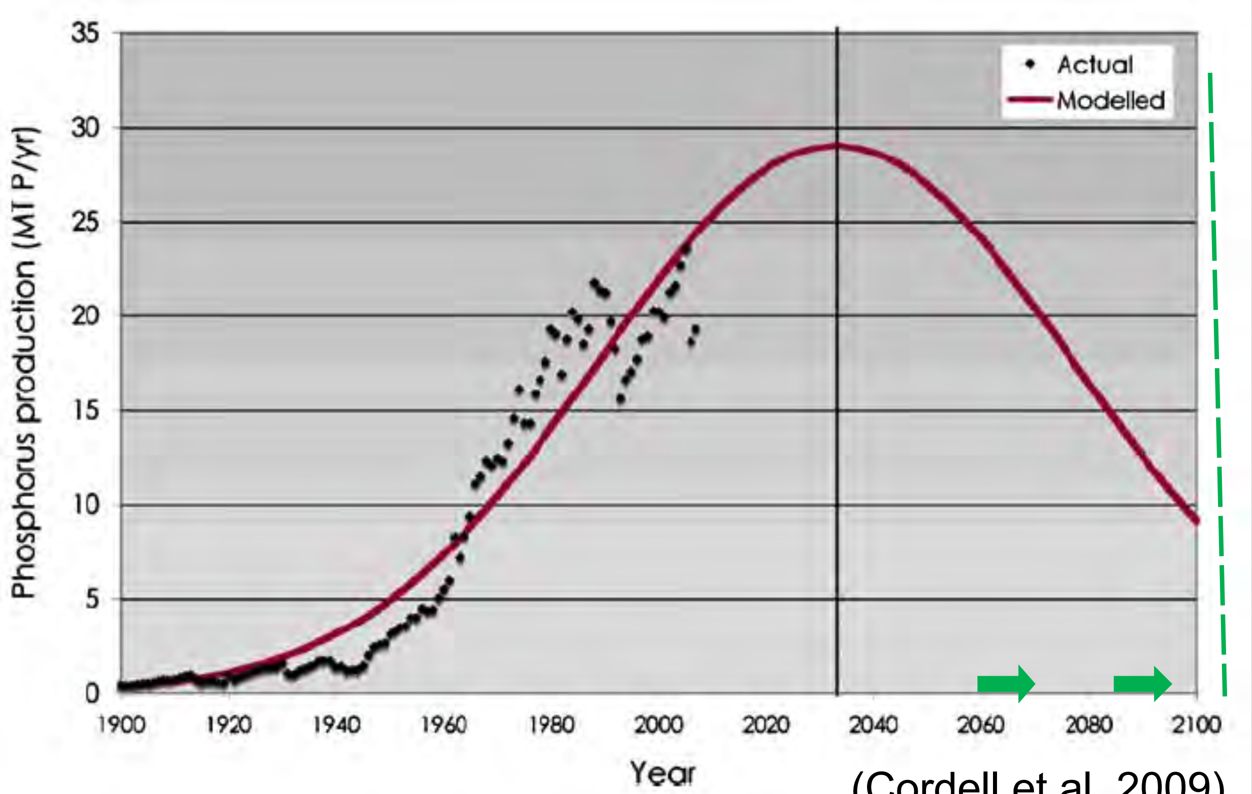
	Proportion of global total P rock (%)		
Country	2008 annual production	Reserves	Reserve base[1]
China	30	28	21
United States	19	8	7
Morocco/Western Sahara	17	38	45
Russia	7	1	2
Tunisia	5	<1	1
Brazil	4	2	<1
Jordan	3	6	4
South Africa	1	10	5
Global total P rock (Mt)	167	15,000	47,000

[1] Reserve base: P rock with a 'reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics'

strategics

(Jasinski 2009)

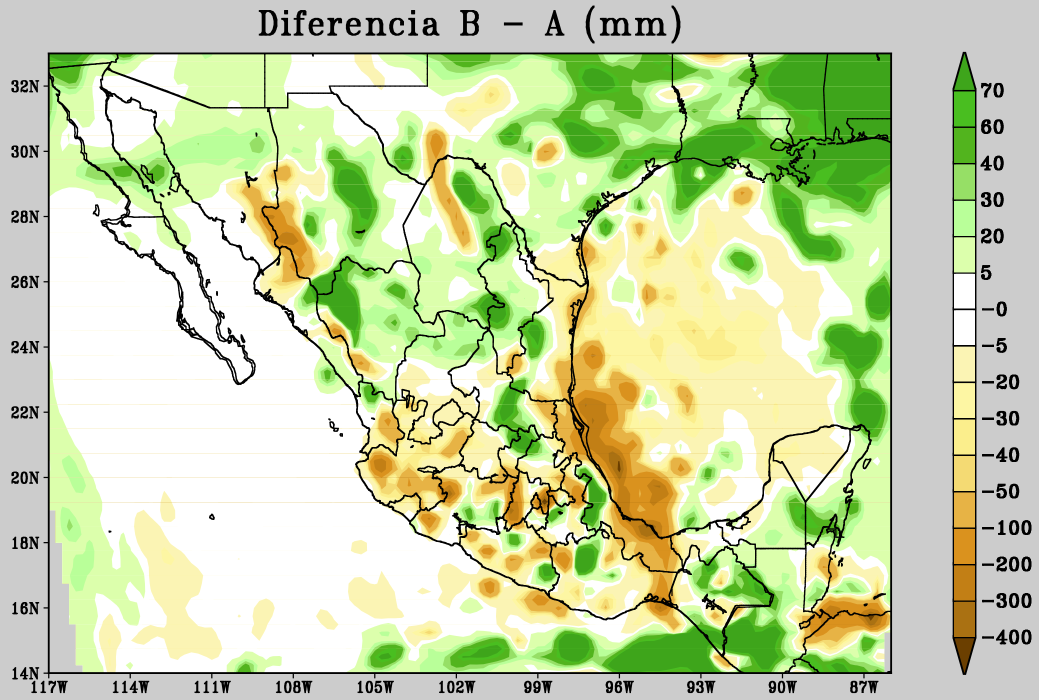
peak phosphorus



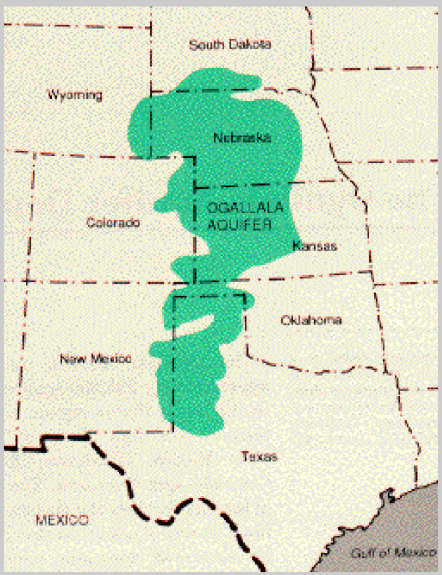
(Cordell et al. 2009)

the potential for critical feedbacks

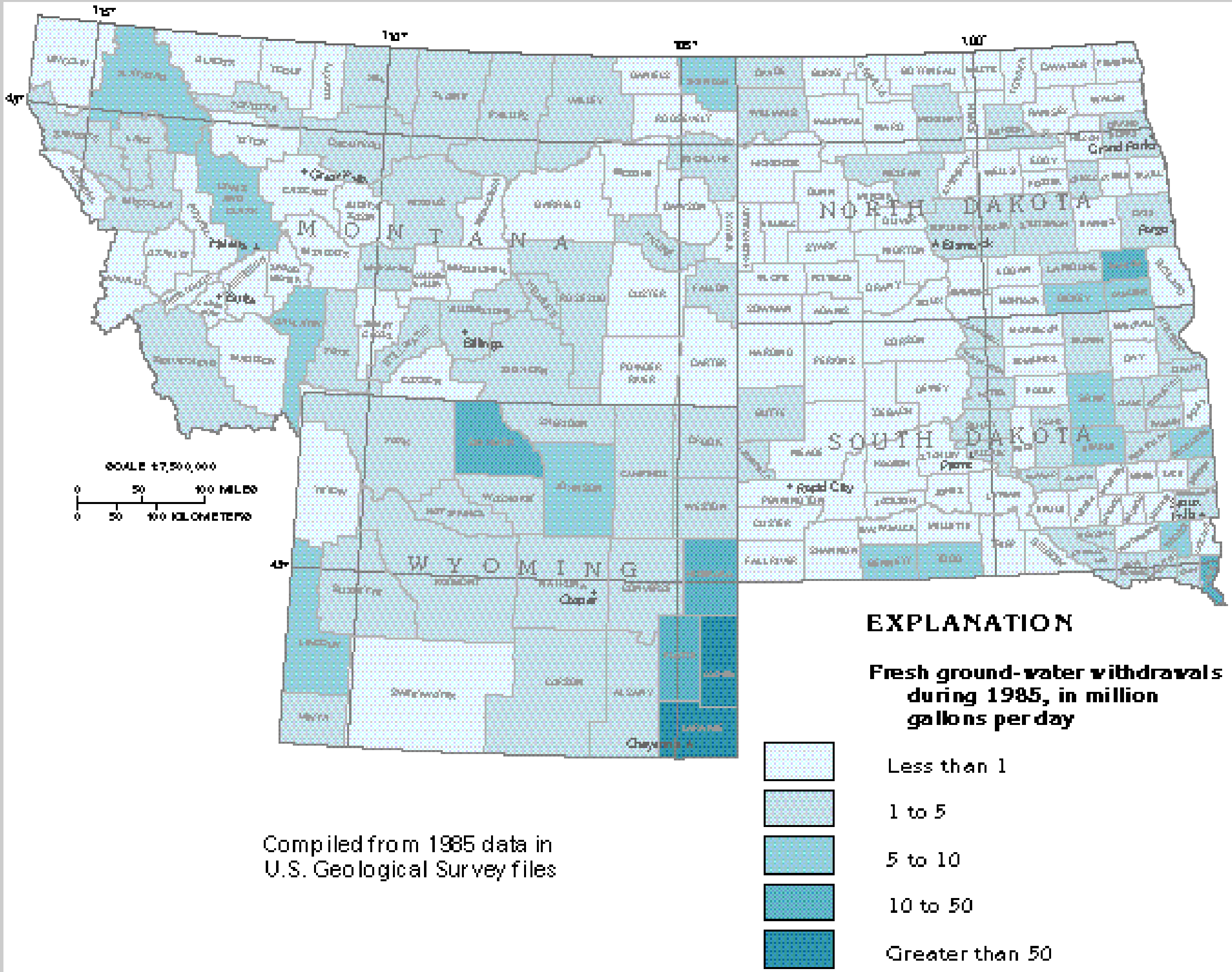
precipitation difference between simulations for landcover change (forest to pasture)



resource use - resource depletion



reliance on finite ground water resources

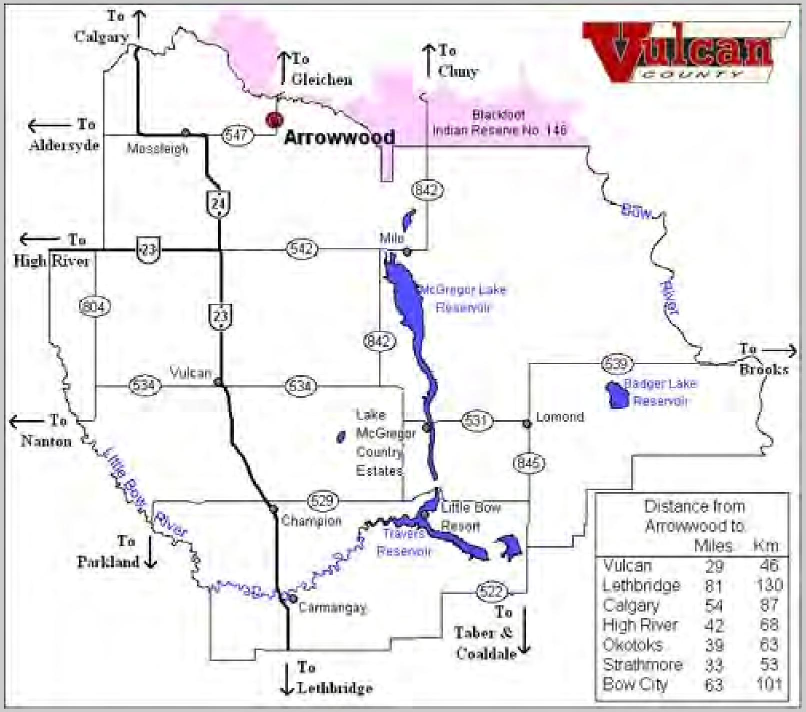


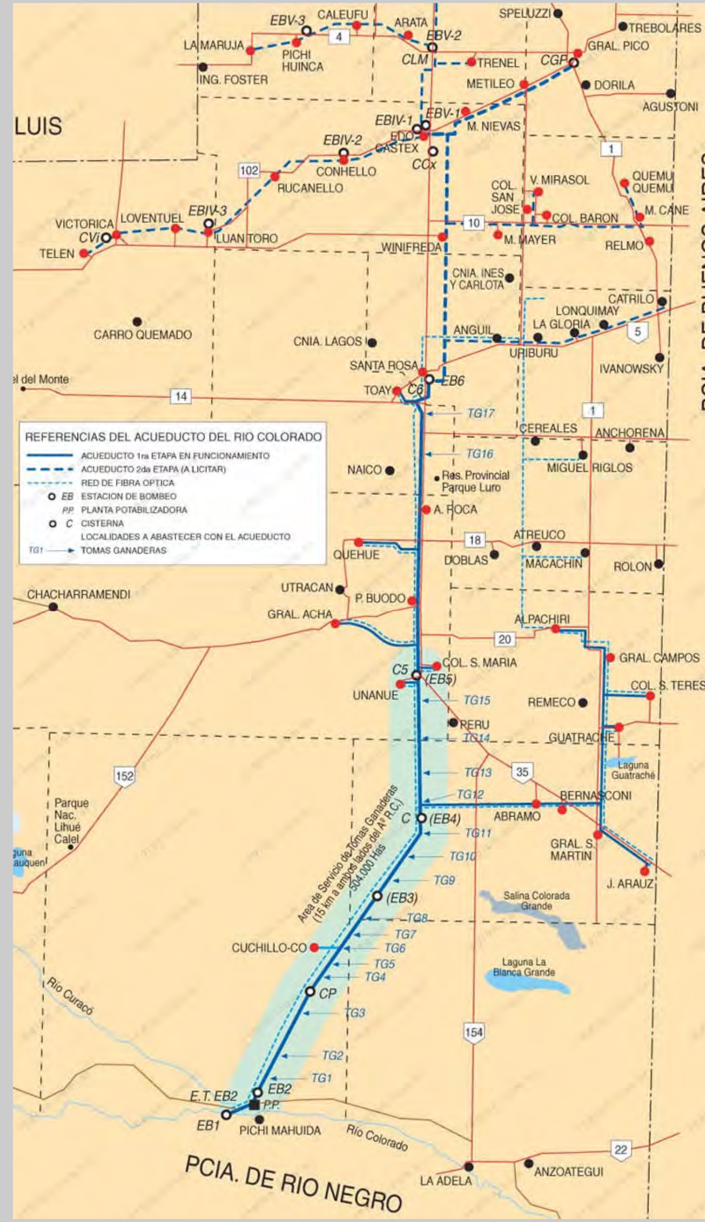
lo inesperado:

en la cuenca del Plata de Argentina
el aumento de lluvias resulta en una mayor demanda de riego

surface water use

we must learn from each other





adaptation

needs legal and programmatic frameworks for:

integrated management of water basins
multiple use and recovery of water resources
protection of fragile zones

replacing fossil emission-intensive products
is an opportunity for agriculture:

The U.S. and Europe want to replace 25-30%

of petroleum transportation fuel with **biofuels** by 2025

"using corn ethanol amounts to burning
the same amount of fuel twice to drive a car once"
(Engineering Dept. U of California)

corn ethanol displaces petroleum
<u>but</u> only 5 to 26% of its energy balance is renewable
the rest is primarily natural gas and coal
soils organic matter loss makes the equation worse

sugar cane is more efficient,
particularly when bagasse is used for fuel

considerations

the high nutrient content of food crops is a contaminant in energy production

cellulosic alcohol
cost-effective depolymerization of celluloses in *crop residues* is a challenge
and removing too much organic matter from agriculture endangers sustainability

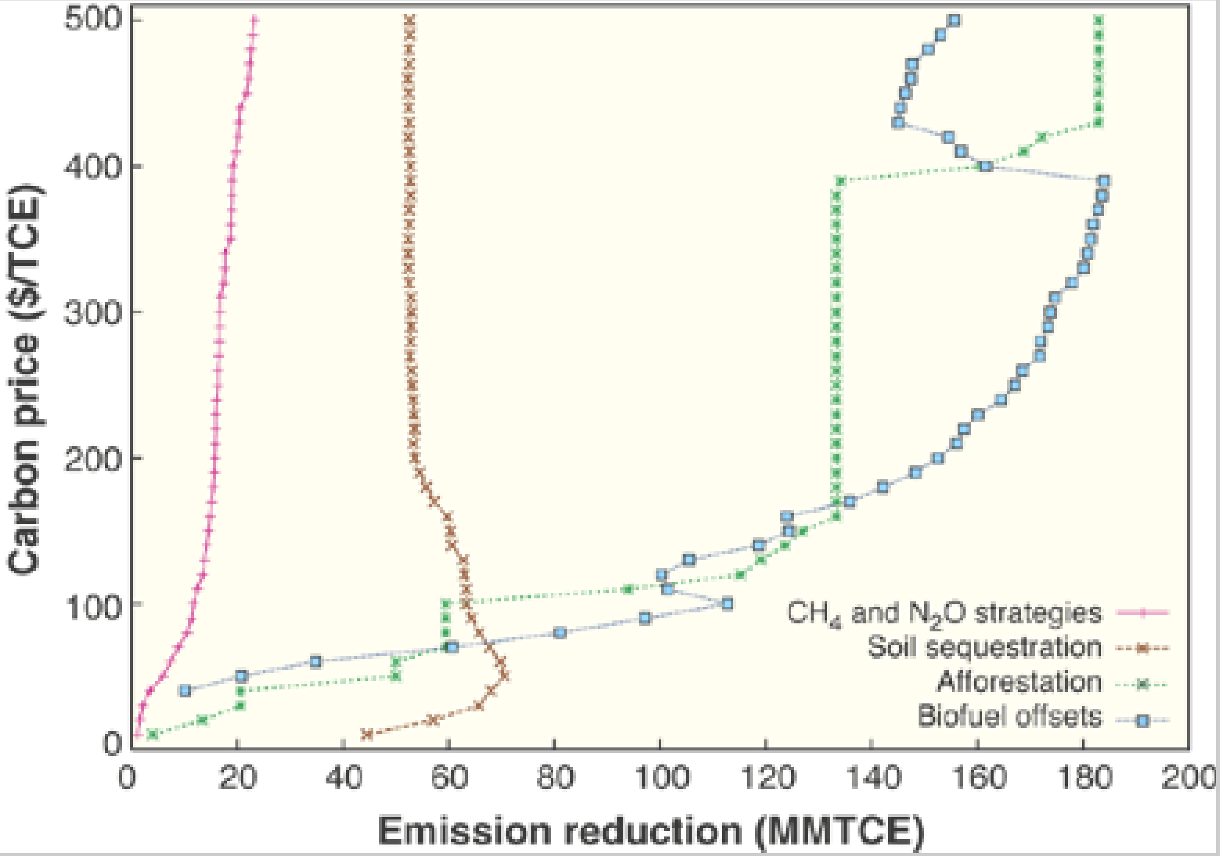
Evaluations of biofuel policy must

- include carbon cost of production / fertilization

- include coproduct credits,

- measure performance relevant to policy goals:
    - reduce greenhouse gas emissions
    - reduce petroleum inputs
    - maintain land quality & ecosystem services
    - maintain food affordability

Competitive economic potentials for agricultural and forest mitigation strategies in the USA



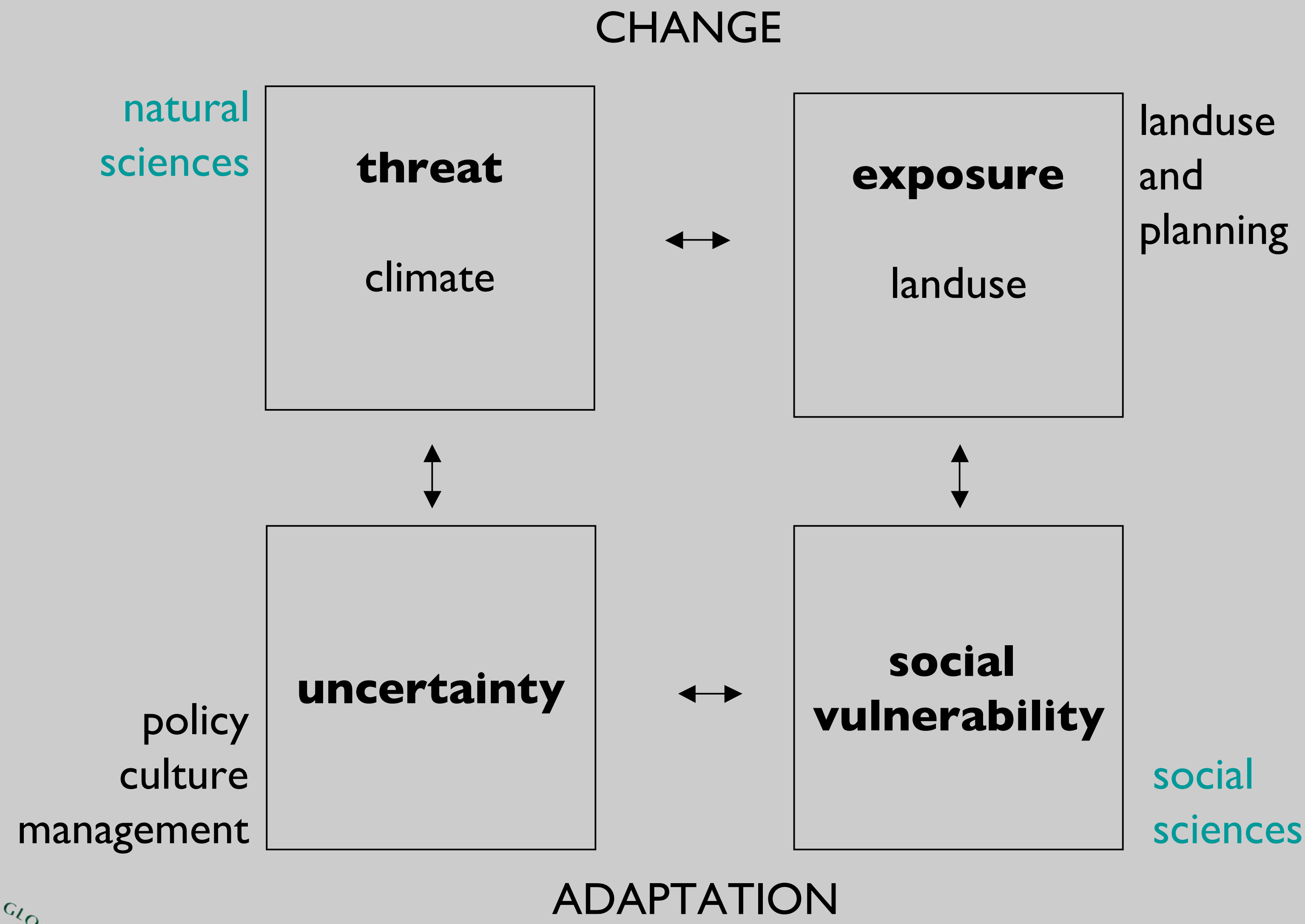
BA McCarl, UA Schneider (2000)

conservation tillage

+ productivity increases

science integration

to resolve complexity of change


CHANGE
natural
sciences
threat
climate
exposure
landuse
landuse
and
planning
uncertainty
policy
culture
management
social
vulnerability
social
sciences
ADAPTATION

(A. Murgida)

CAN DO

HOW TO

natural
sciences

landuse
and
planning

policy
culture
management

social
sciences

the science of change <=> adaptation
'can do' <=> 'how to'