Energy Security and Human Development

Pathways to Sustainbility

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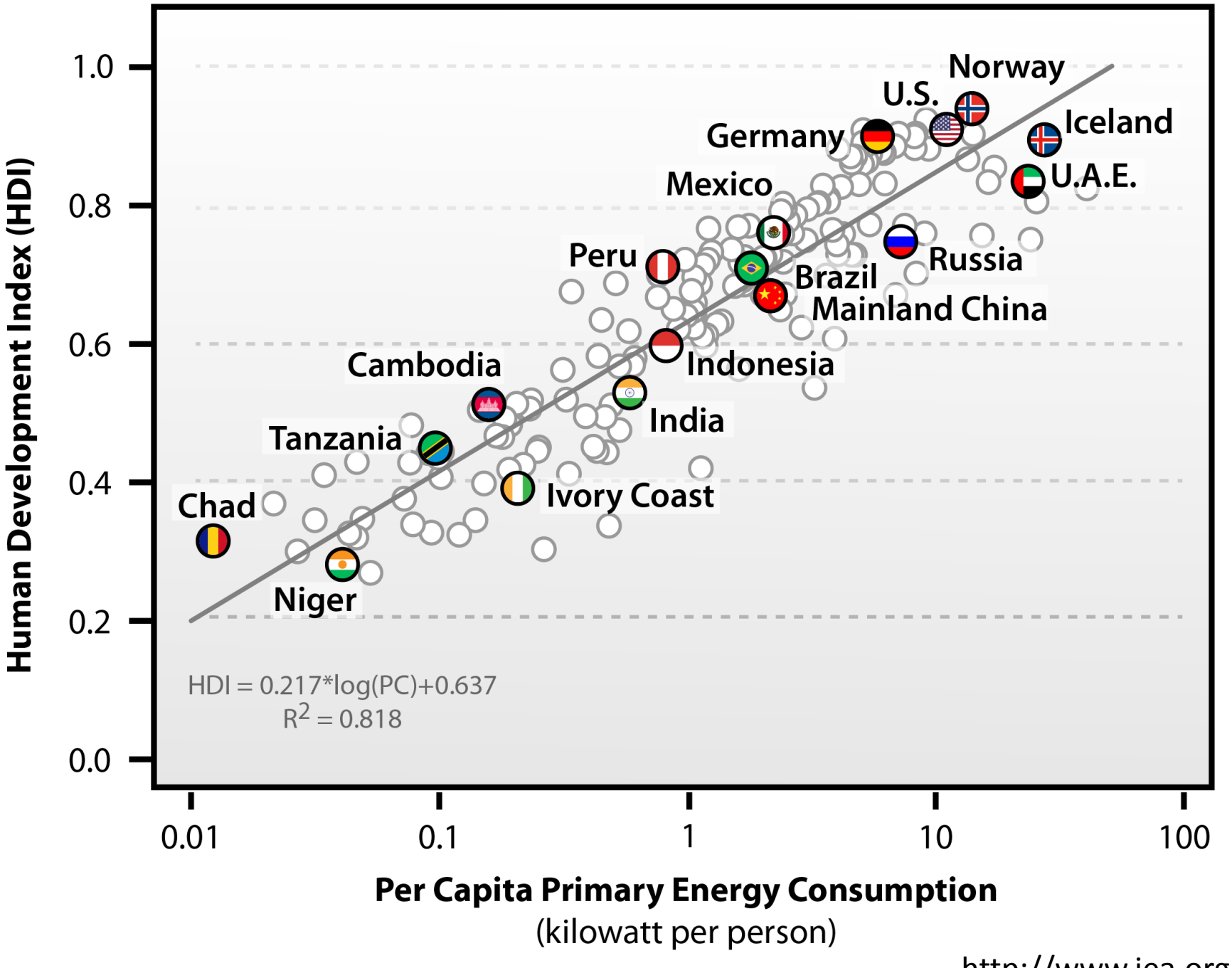
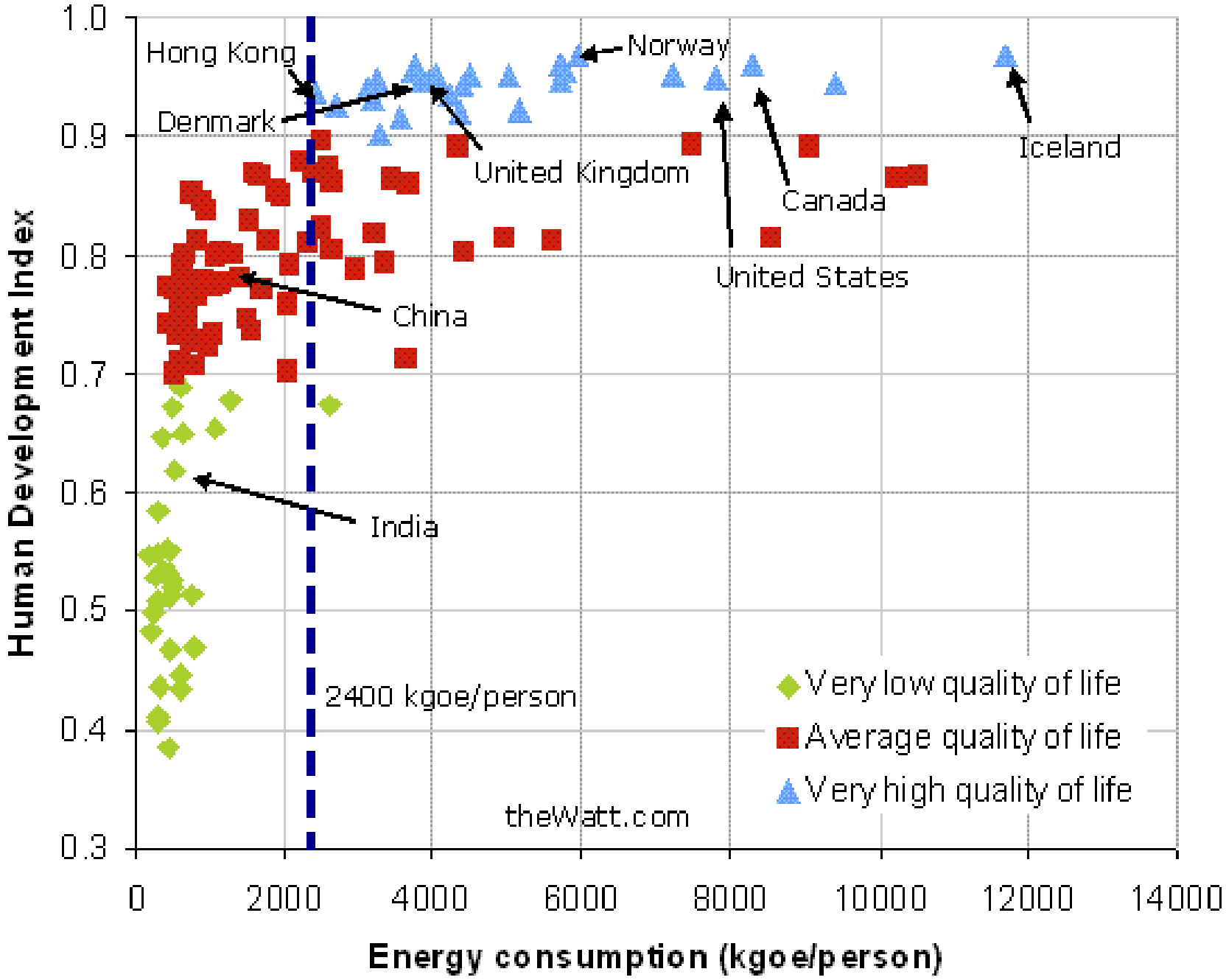
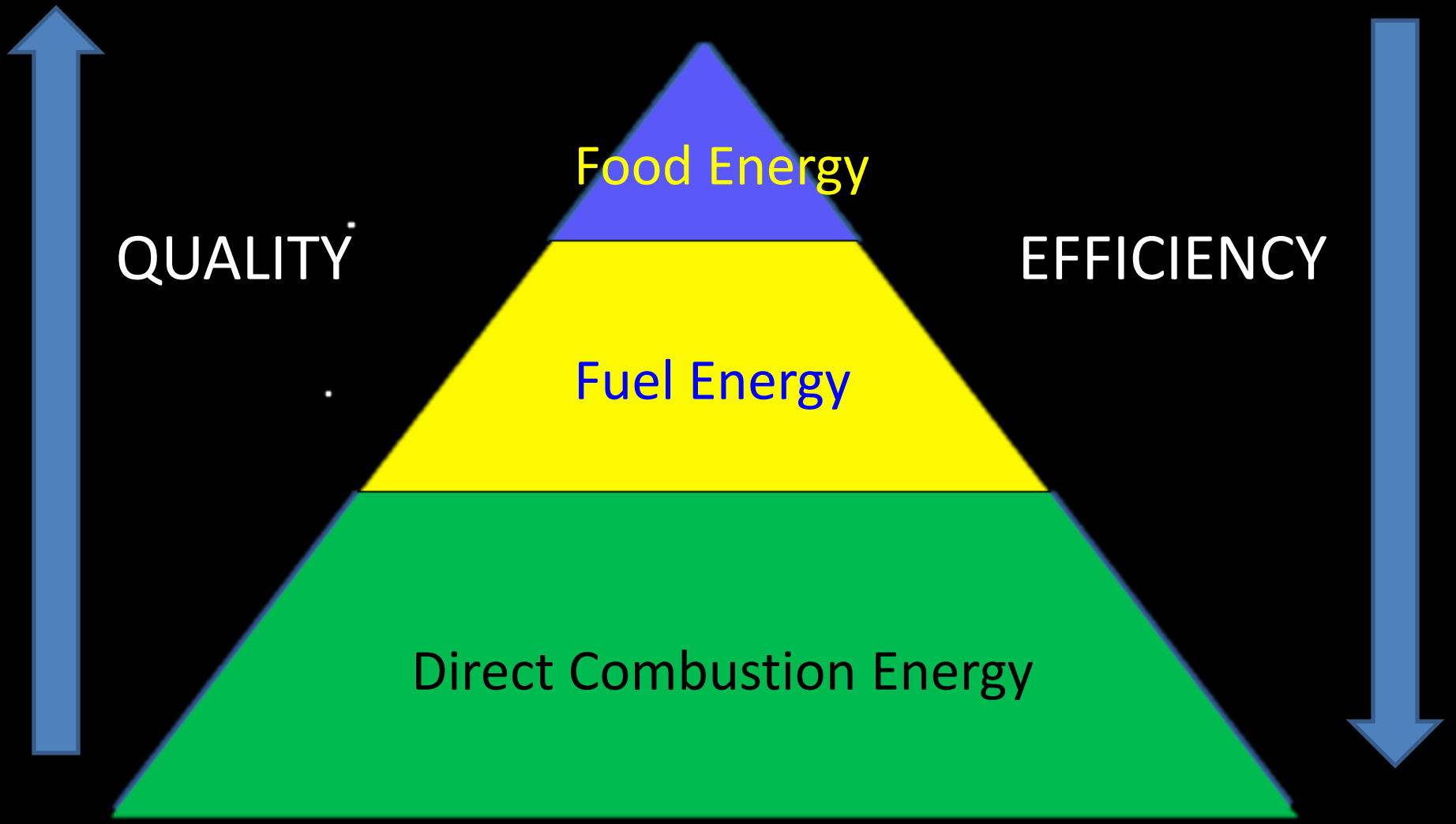
Energy Security

- Availability – sufficient, sustainable quantities
- Access – infrastructure and affordability
- Usability – quality to meet desired needs
- Stability – resilient supply chains, storable commodities, & good governance


Human Development Index (HDI)
1.0
0.8
0.6
0.4
0.2
0.0
0.01
0.1
1
10
100
Per Capita Primary Energy Consumption
(kilowatt per person)
Norway
U.S.
Iceland
Germany
U.A.E.
Mexico
Russia
Peru
Brazil
Mainland China
Indonesia
Cambodia
India
Tanzania
Ivory Coast
Chad
Niger
HDI = 0.217*log(PC)+0.637
R2 = 0.818


Human Development Index
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
2000
4000
6000
8000
10000
12000
14000
Energy consumption (kgoe/person)
Hong Kong
Denmark
United Kingdom
Norway
Canada
United States
Iceland
China
India
2400 kgoe/person
theWatt.com
Very low quality of life
Average quality of life
Very high quality of life

Energy Quality & End Use



Sustainability Transitions

A multi-level perspective:

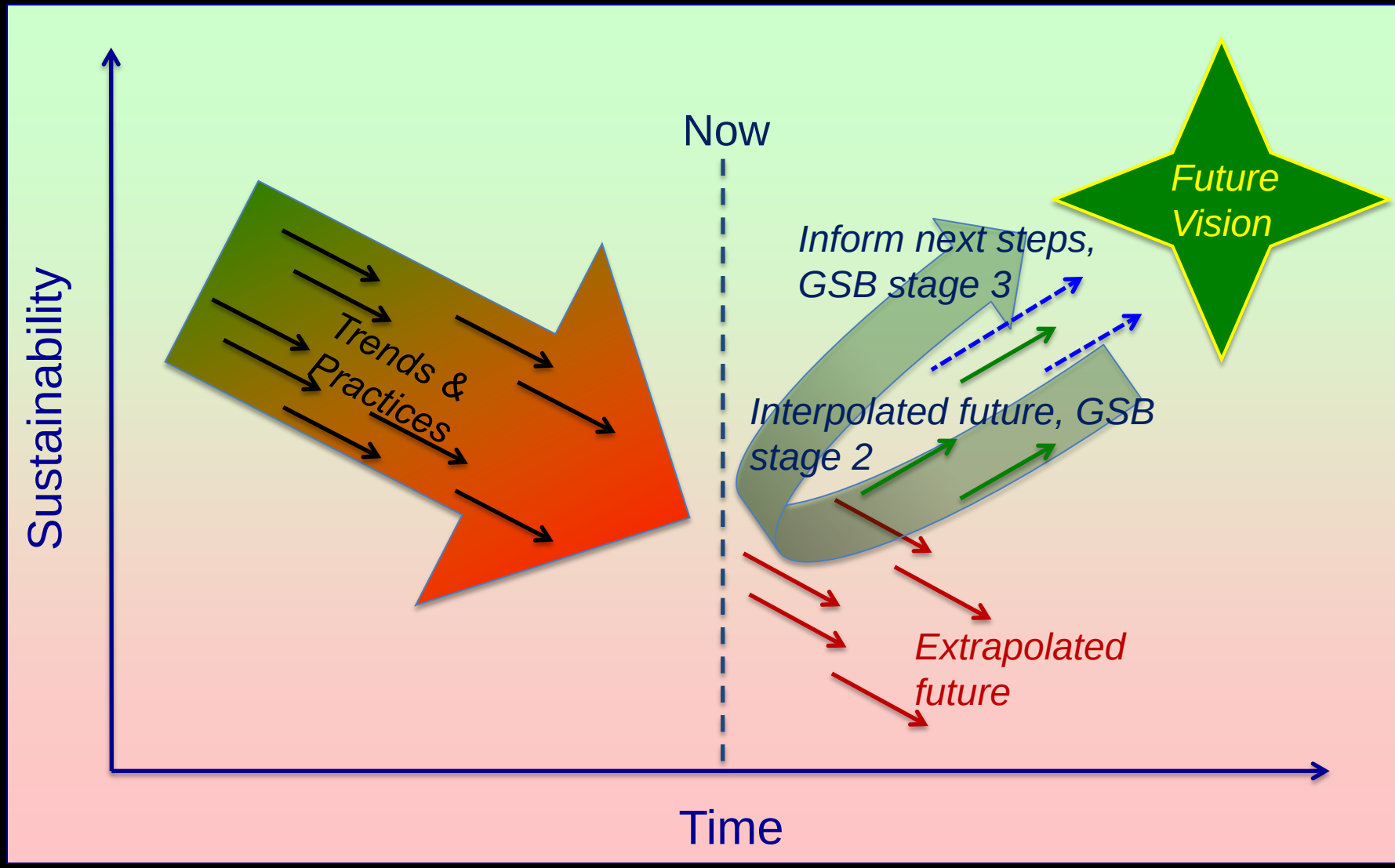
- Niche opportunities – Innovation
  - Drop-in fuels, Aviation biofuels?
- System Integration – Transitional
  - Ethanol in the US?
- Regime Change -Transformational
  - Ethanol in Brazil?

Adapted from C. Hinrichs, *Agriculture and Human Values*, 2014

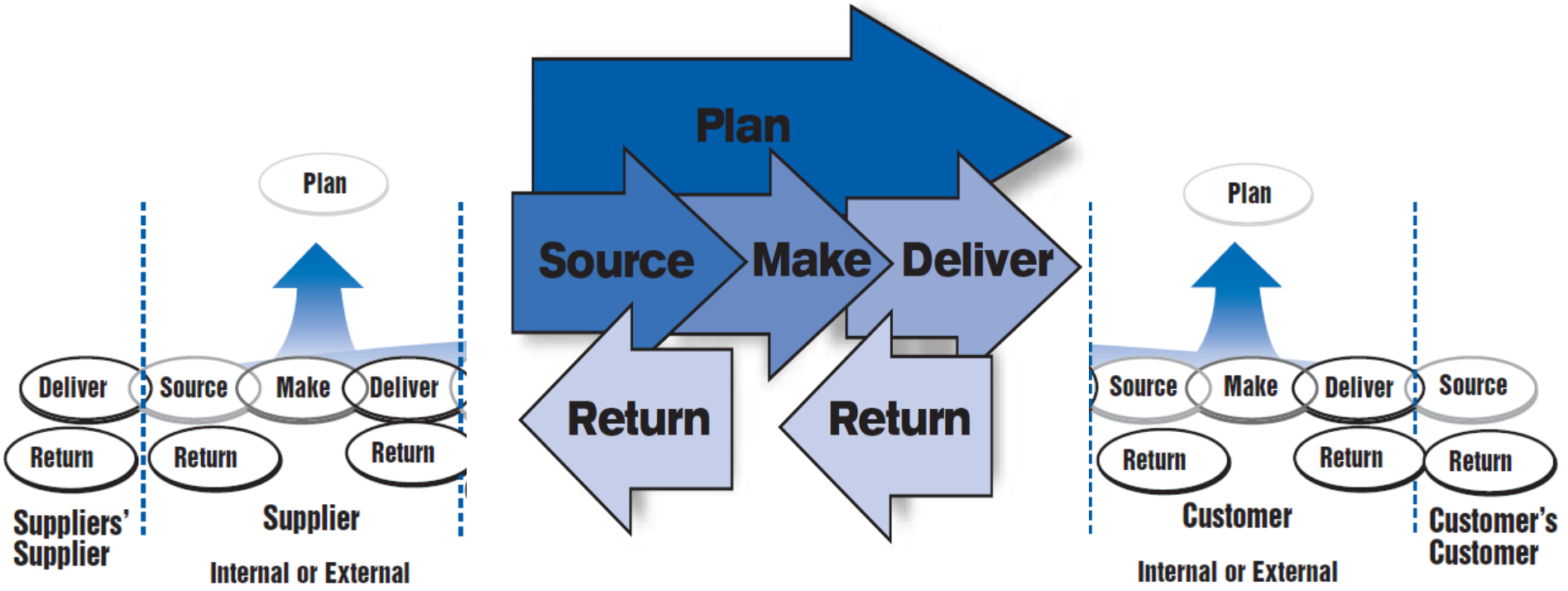
A Knowledge Systems Framework

- Stakeholder Engagement
- Values clarification
- Systems definition
- Data and models
- Forecasting, Backcasting, and Transition Planning
- Implementation Science
  - ~~C~~ommunication, decisions, business models
- Action – *both individual and collective*
  - Governance, policies, markets, commercialization
- Monitoring and Evaluation
- Iteration and Improvement

Future Vision Point of Reference: Extrapolated and Interpolated Resource Futures

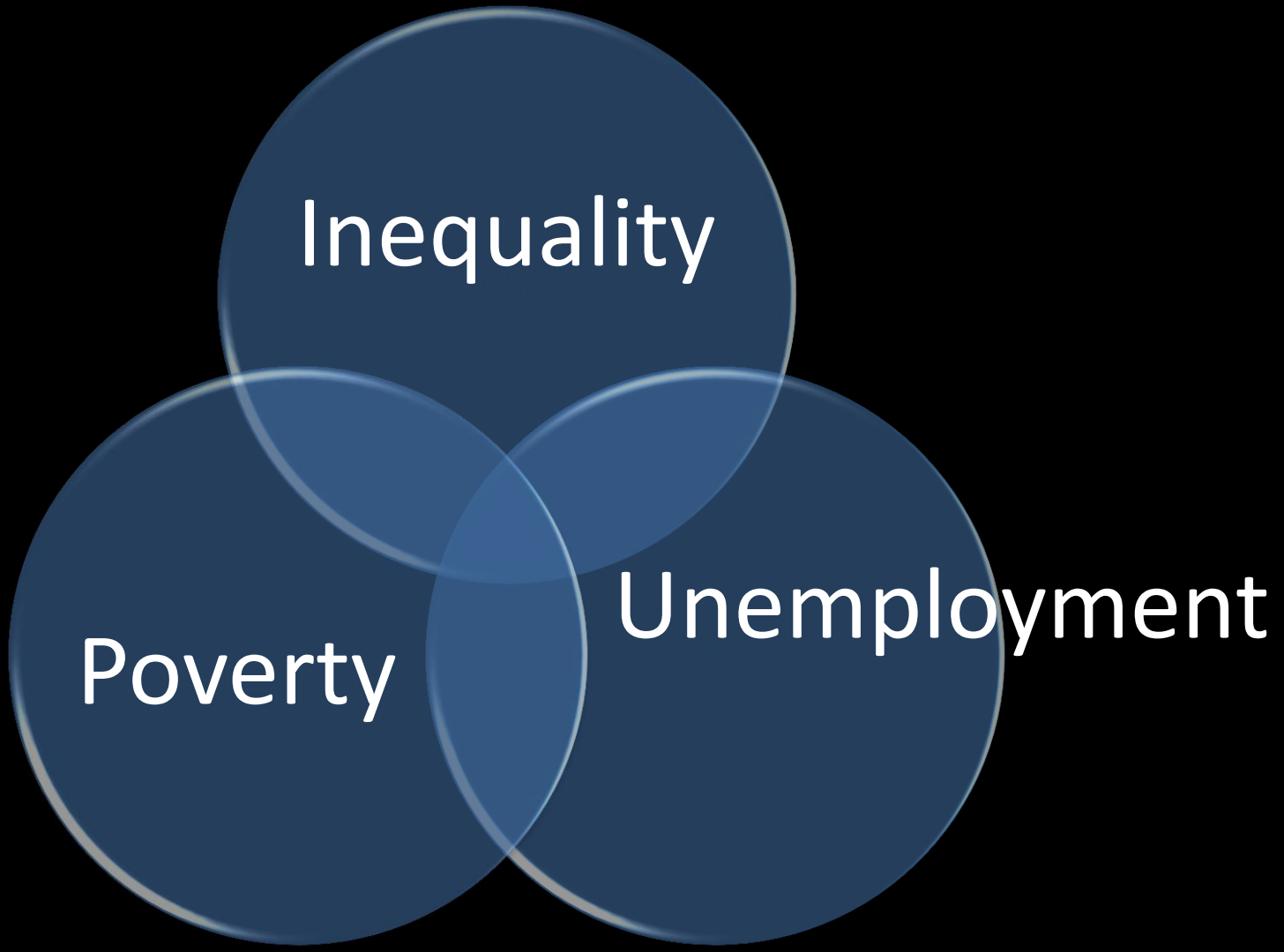


Supply Chain Stakeholders

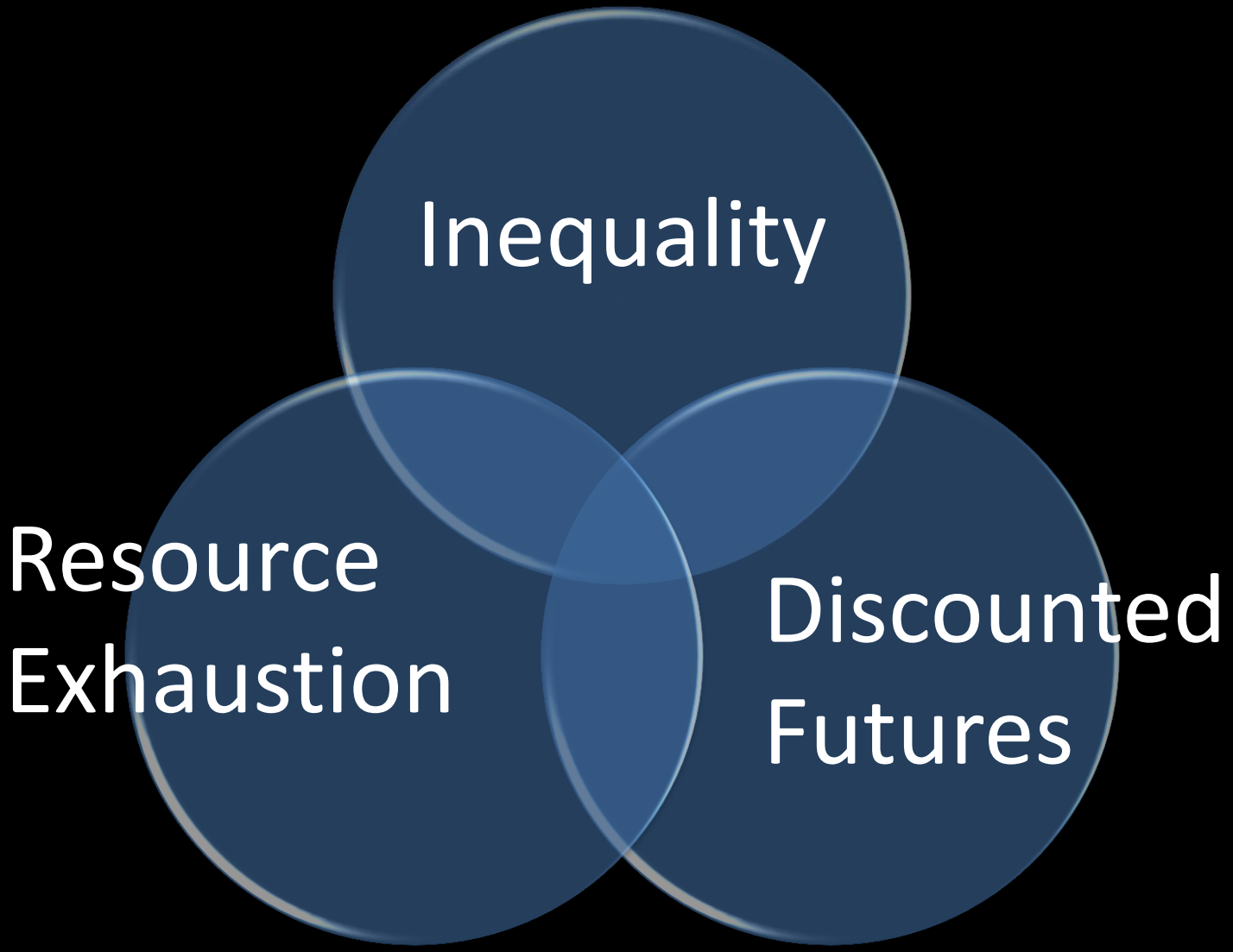


Producers and suppliers of biomass feedstocks	Biomass Conversion Facility	Downstream Operators

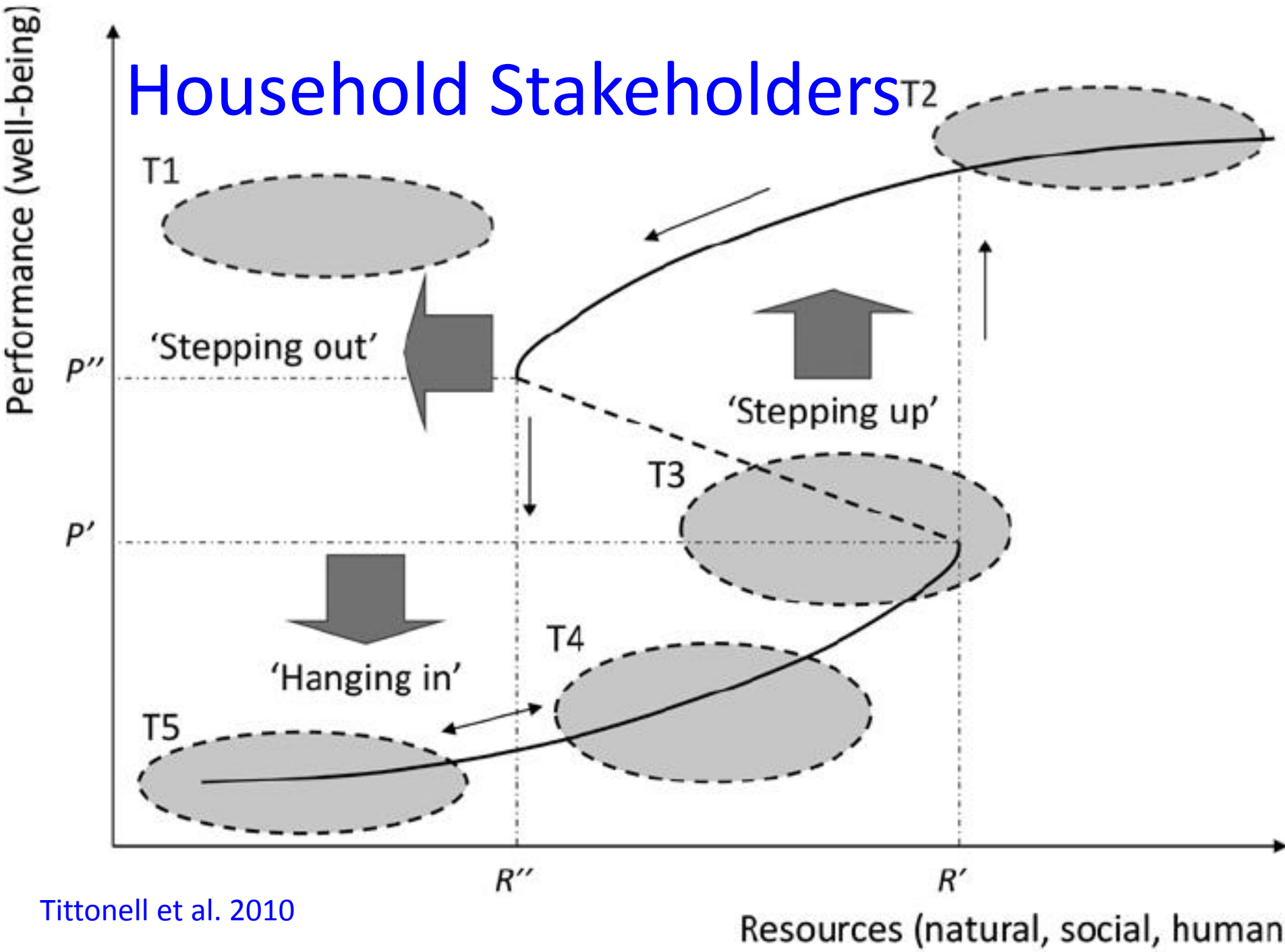
Government Stakeholders



Failures of Neoclassical Economics

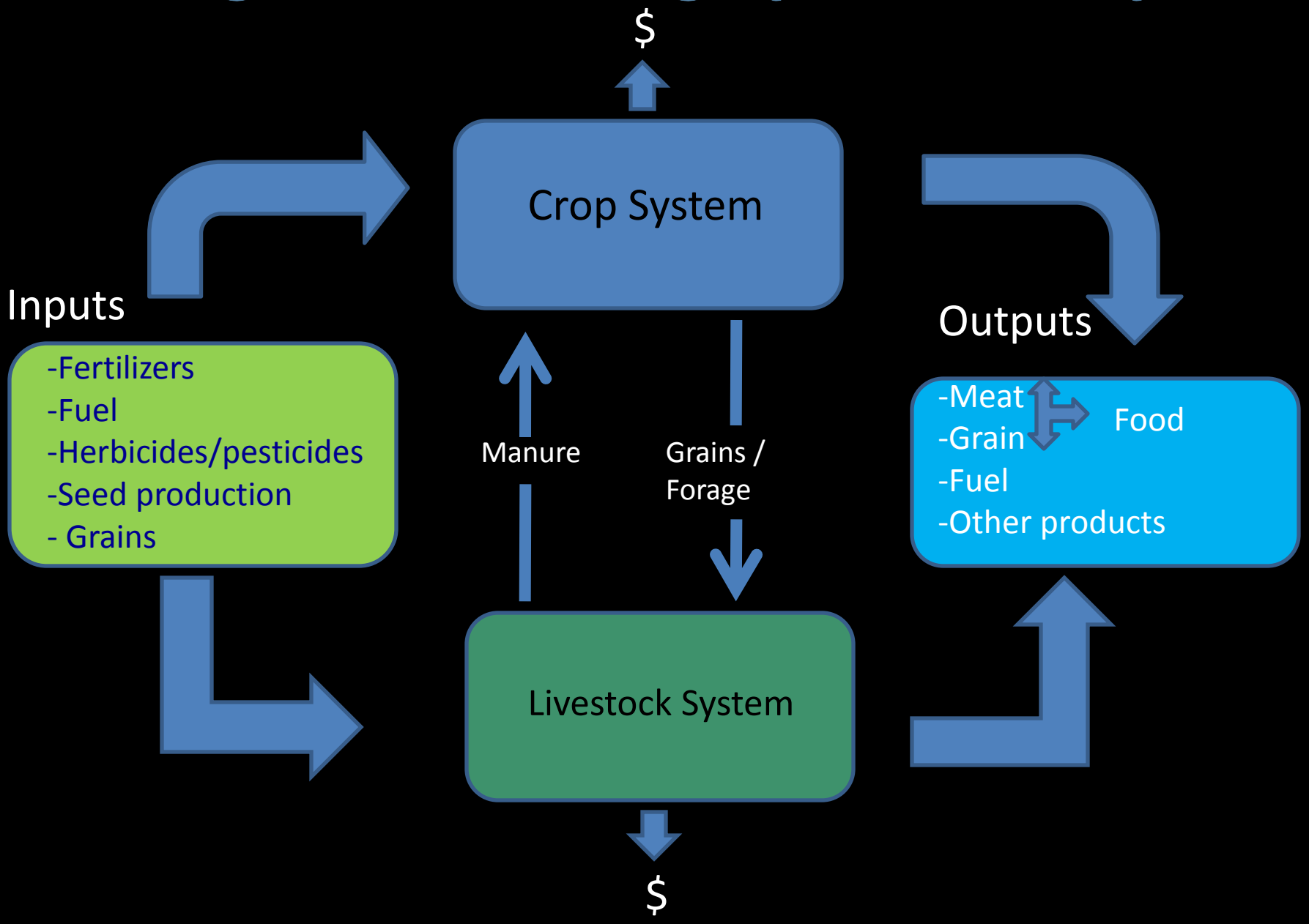


Household Stakeholders

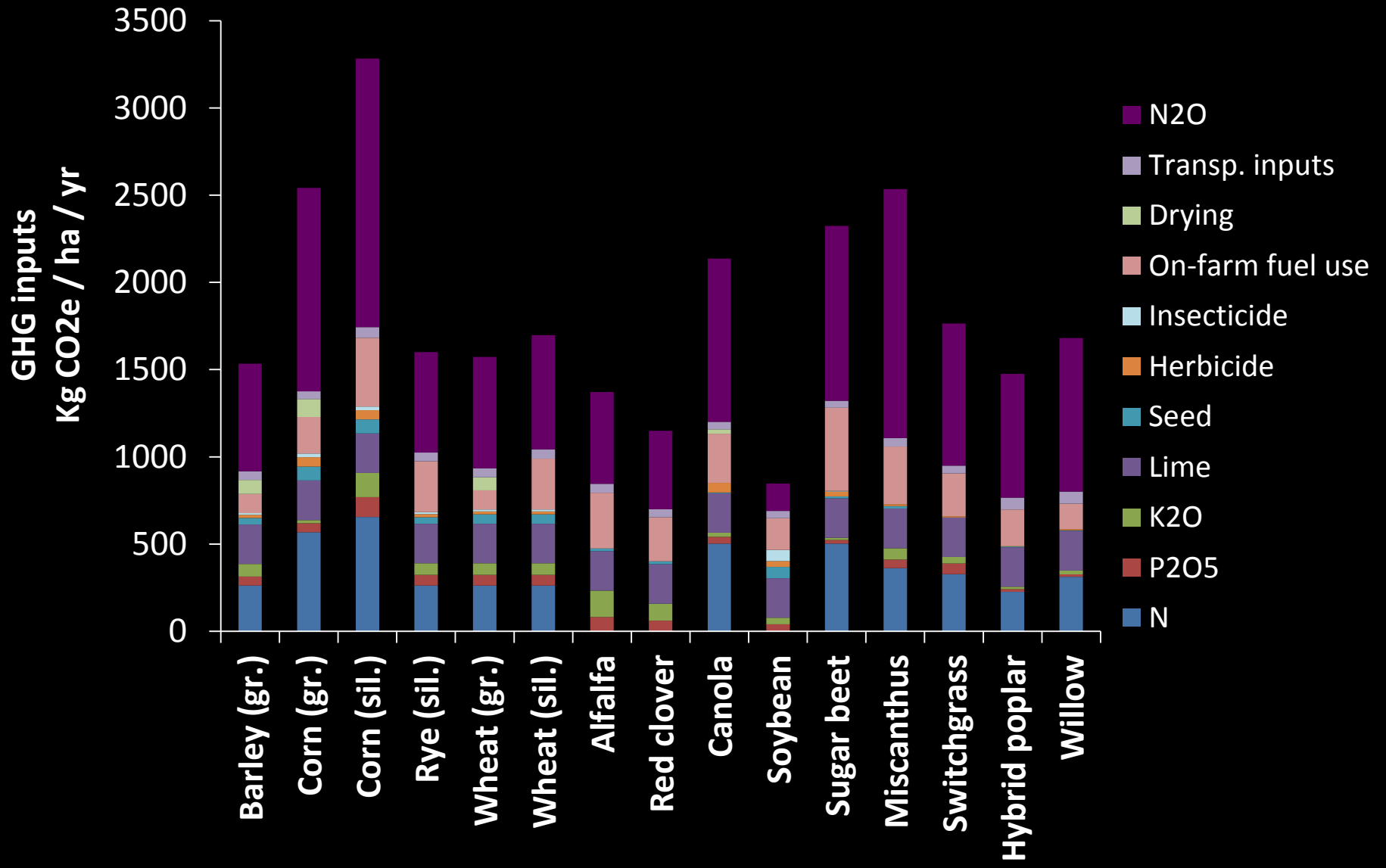


Tittonell et al. 2010

Integrated Farming System Analysis

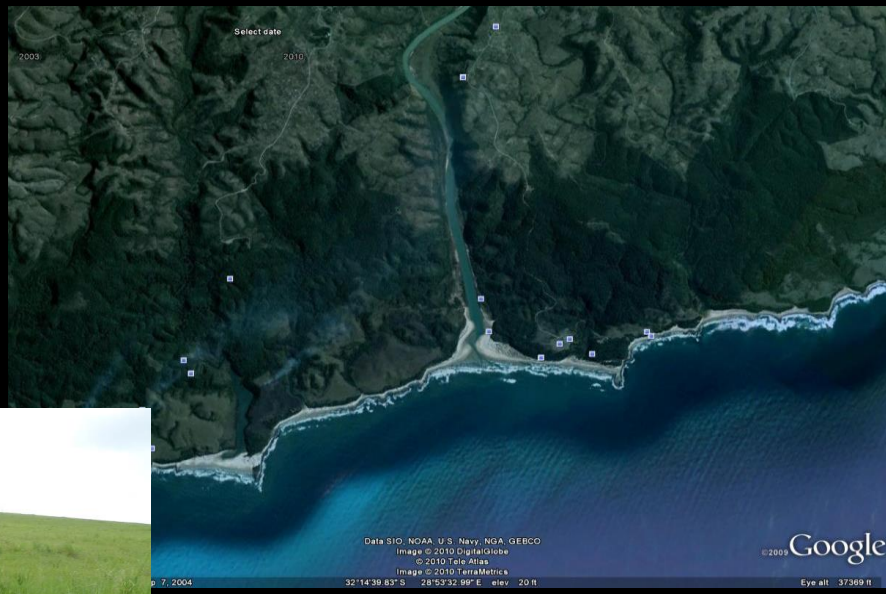


Greenhouse Gas Emissions of Food and Energy Crops



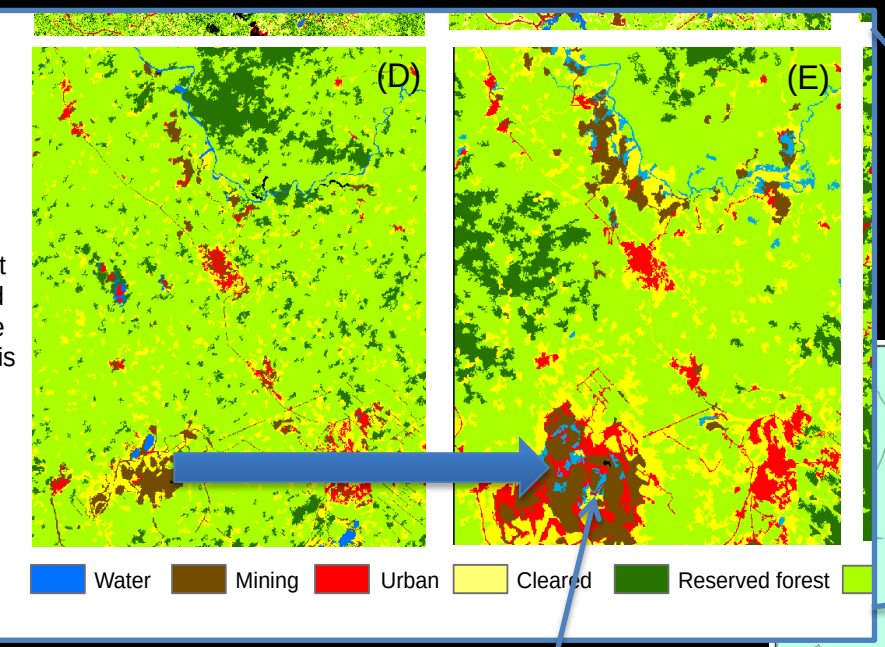
Large-scale grassland fertilization experiment

Forest Carbon stock assessment

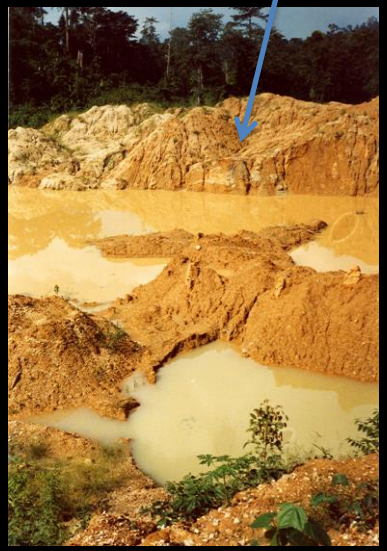


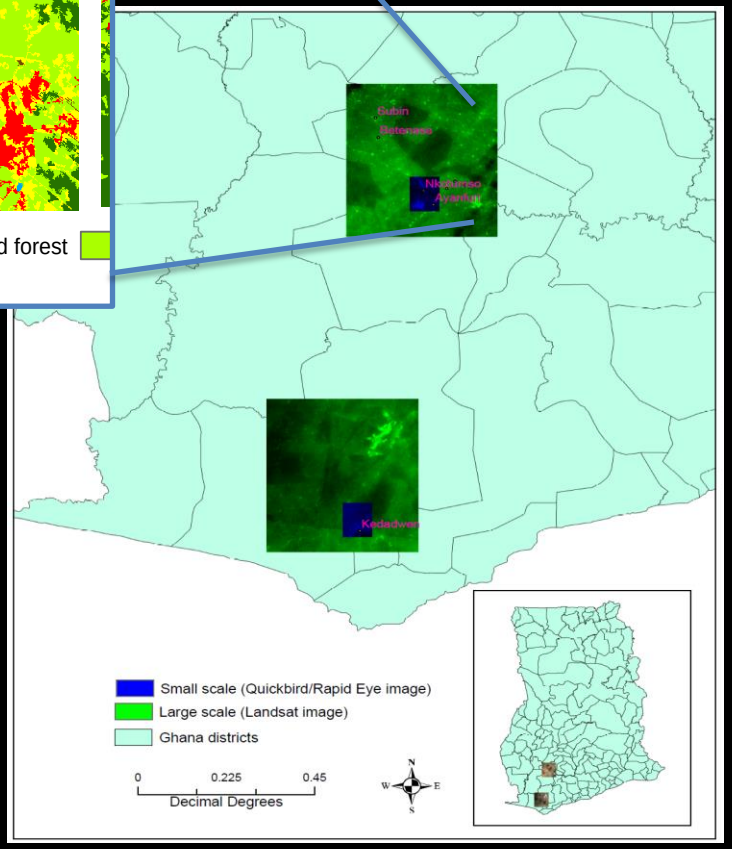
Parks & People

Geospatial patterns of land use in Africa

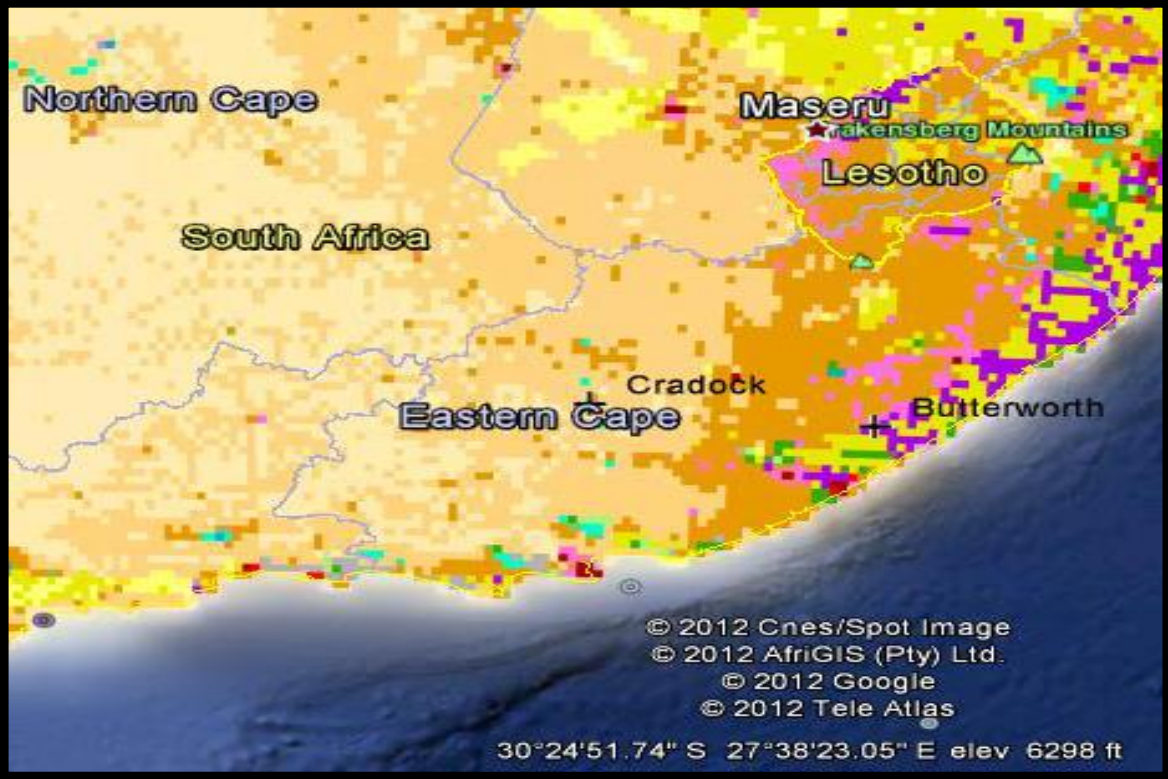


Linking land use change to human health, Ghana





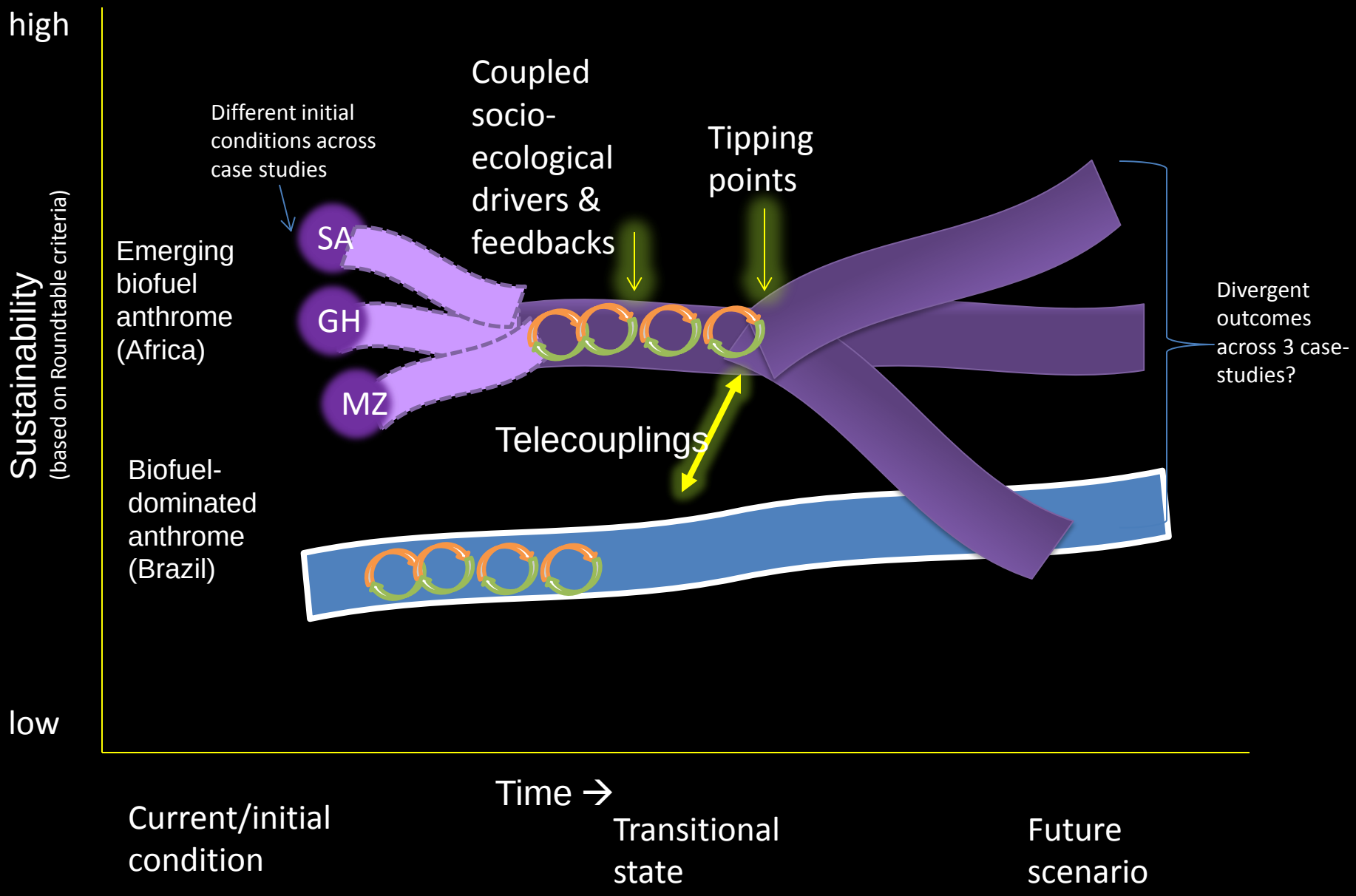
Mapping Biofuel Anthromes



Coupling social land use + biophysical template
to map potential socio-ecological landscapes
for biofuel productivity

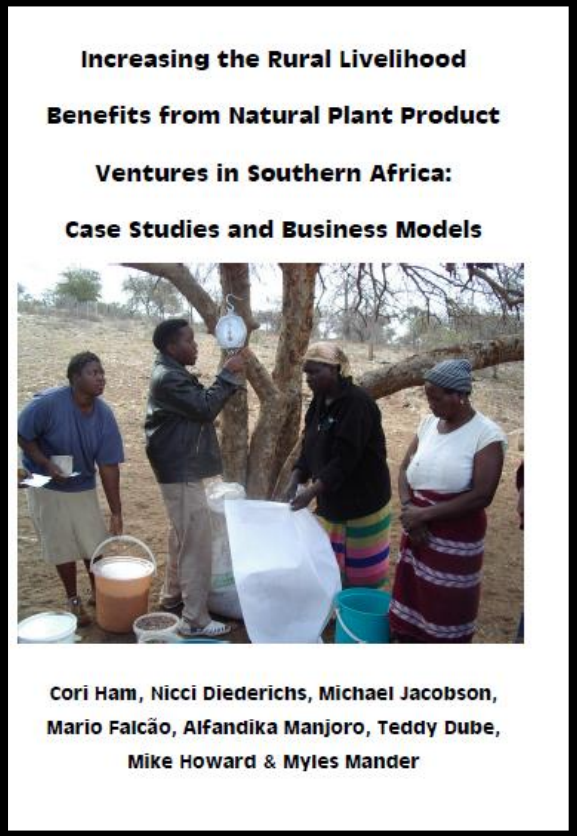
Ellis et al. 2011

Mapping Socio-ecological Transitions



Community natural resource management and agroforestry
Two examples from Africa

1. What makes a successful natural product enterprise?



2. Intercropping fertilizer trees for soil fertility and multiple products, including potentially biofuels

Faidherbia spp intercropping in Zambia

Boabab oil cooperative

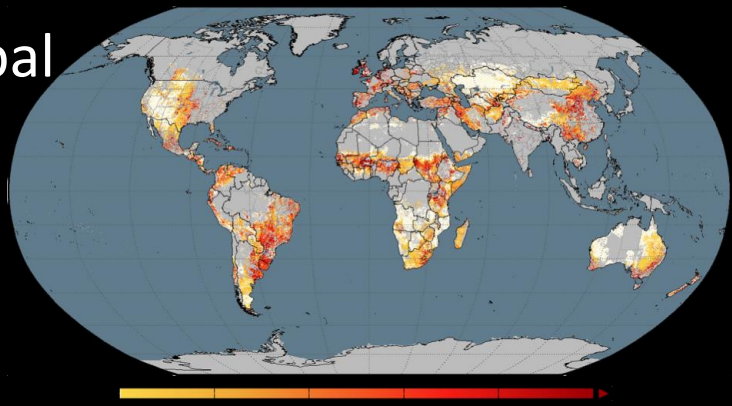
Can this work?

Intercropping Eucalyptus and sugar from Cecon, E, 2008 and Pinto, L. F. G., M. S. Bernardes, J. L. Stape, and A. R. Pereira. 2005

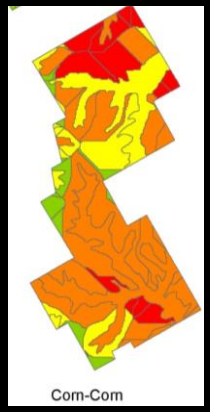
Multi-scalar, multi-method approach

Patch

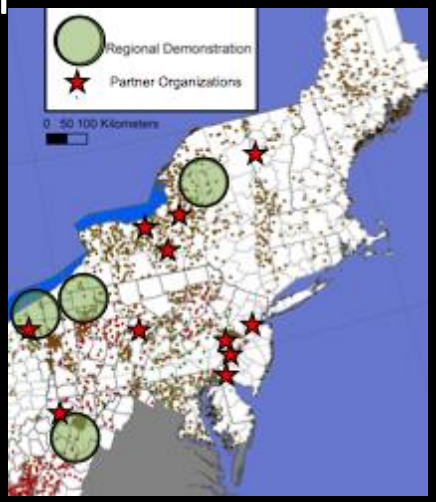
Global



Landscape



Region



Multi-Region