Accounting for Agricultural Natural Capital

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CAES Agri-Environmental Policy and Programs Conference
February 15, 2019

Alberta Land Institute Agricultural Natural Capital Project

- Test a Framework for Accounting for the Value of Agricultural Land Stocks and Flows in Canada's System of National Accounts
  - elaborate an agricultural land account framework;
  - feasibility of measuring land assets in physical and monetary terms
  - Test the framework

Objectives

- Why Agricultural Land Accounts?
- History of National Accounting
- Example of a Land Account for Alberta
- Challenges and Opportunities

Land Conversion

Land Fragmentation

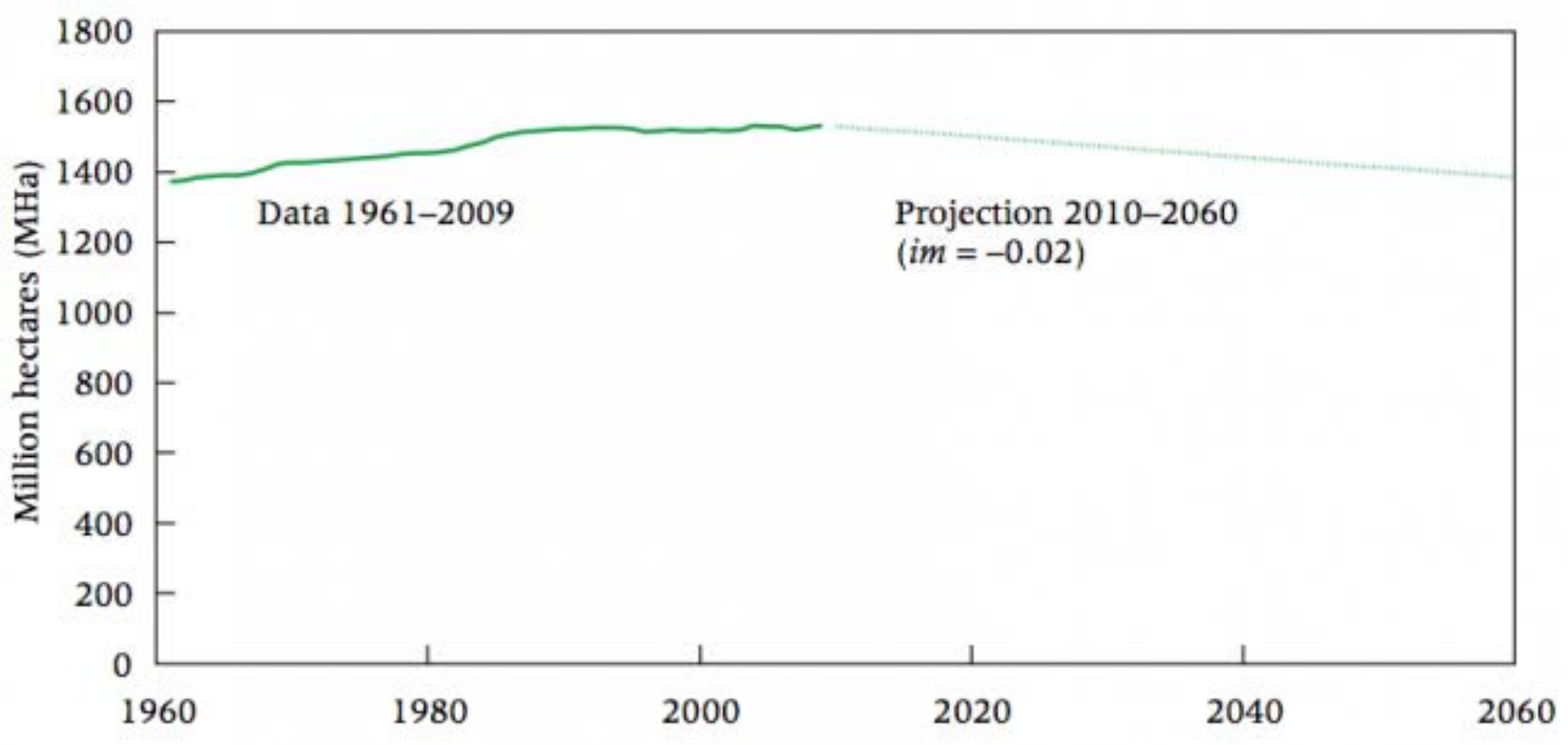
Top challenges to global food systems are about how we manage natural capital

1. Sustainably improve agricultural productivity to meet increasing demand
2. Ensure a sustainable natural resource base
3. Address climate change and intensification of natural hazards

Source: The Future of Food and Agriculture- Trends and Challenges. FAO, May 2017.

Food Security and Global Trends in Agricultural Land

Peak Farmland



Jesse H. Ausubel, Iddo K. Wernick, Paul E. Waggoner (2013) – Peak Farmland and the Prospect for Land Sparing. Population and Development Review, Volume 38, Issue Supplement s1, pages 221–242, February 2013. DOI: 10.1111/j.1728-4457.2013.00561

Trends in Agricultural Land for EU

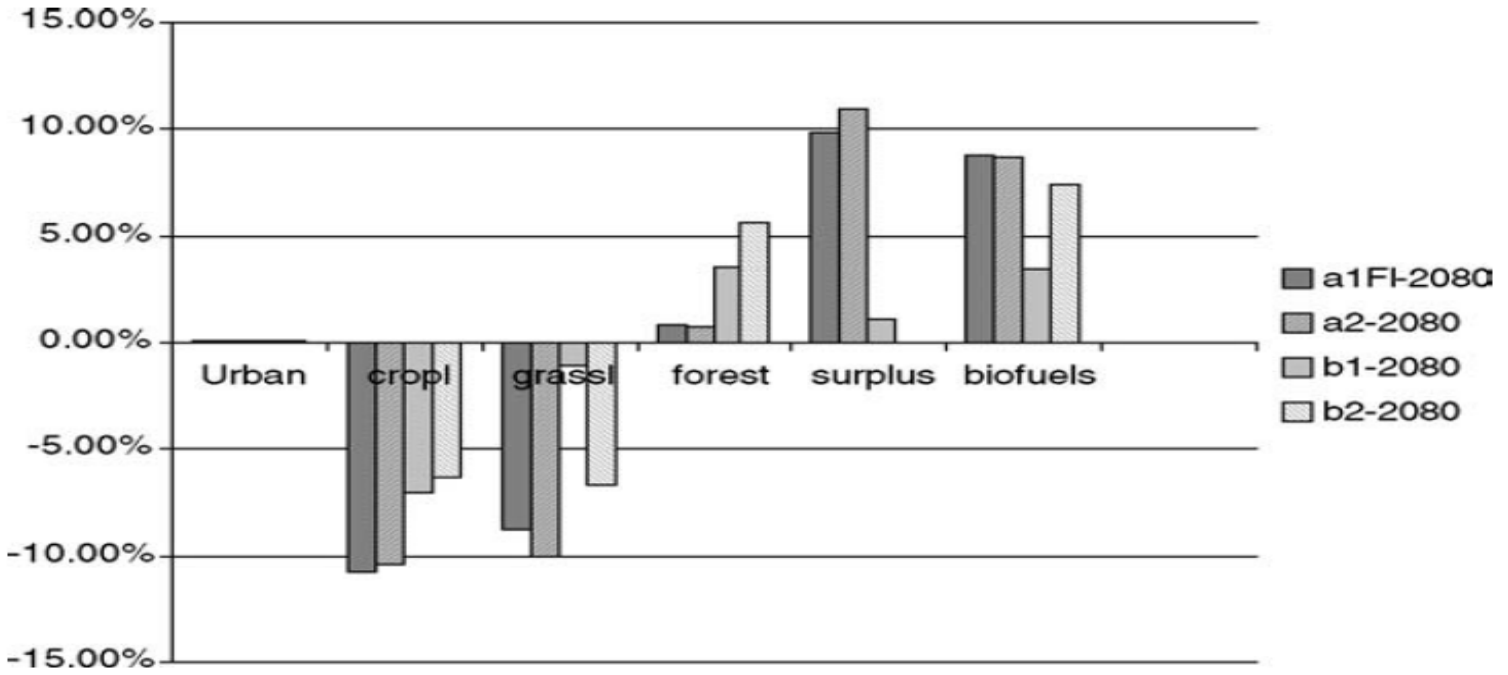
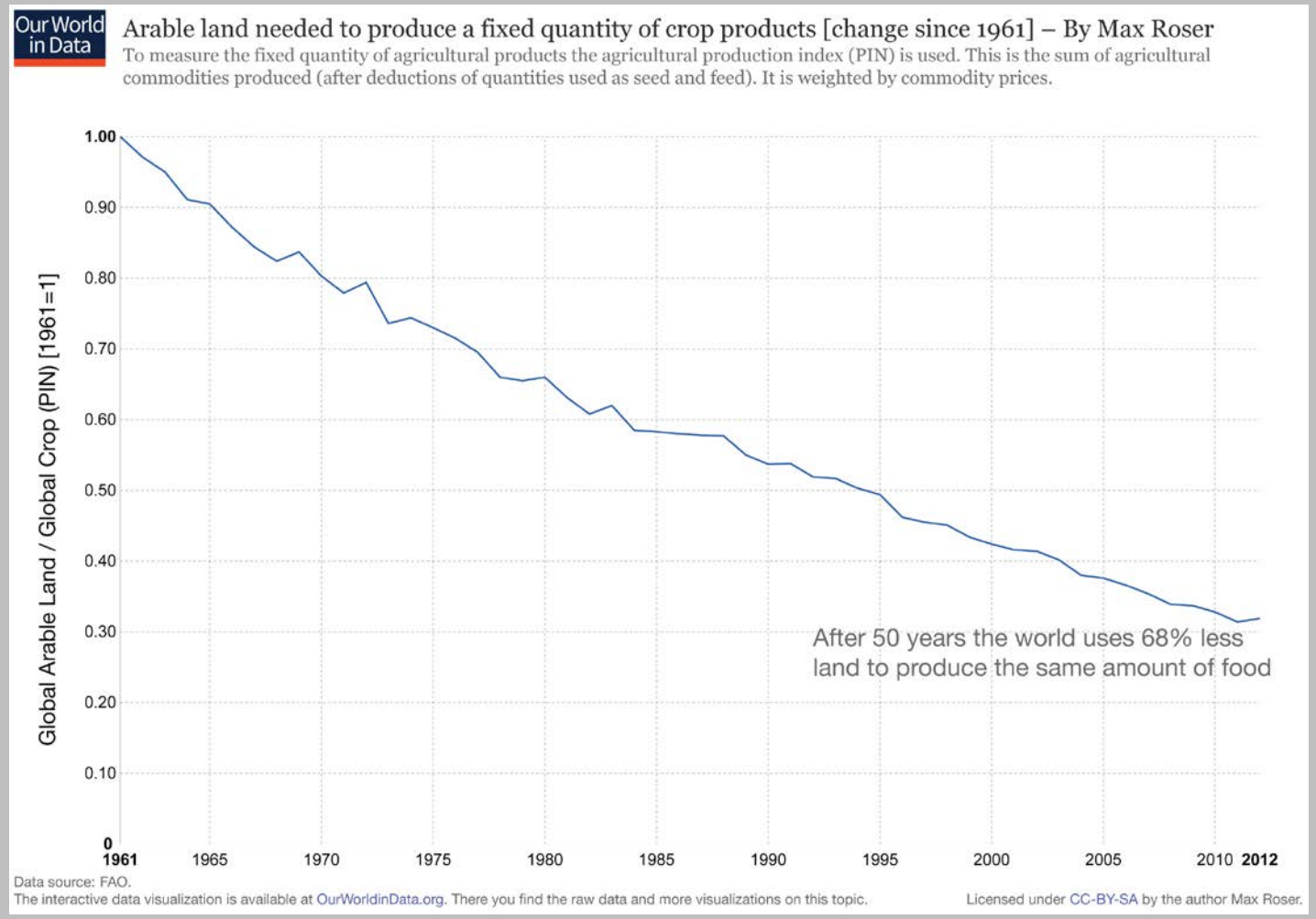


Fig. 2. Aggregated land use change trends in 2080 for Europe for the A1FI, A2, B1 and B2 (HadCM3) scenarios (the *y*-axis represents the absolute area as a percentage of the total European land area).

M.D.A. Rounsevell et al. / Agriculture, Ecosystems and Environment 114 (2006) 57–68

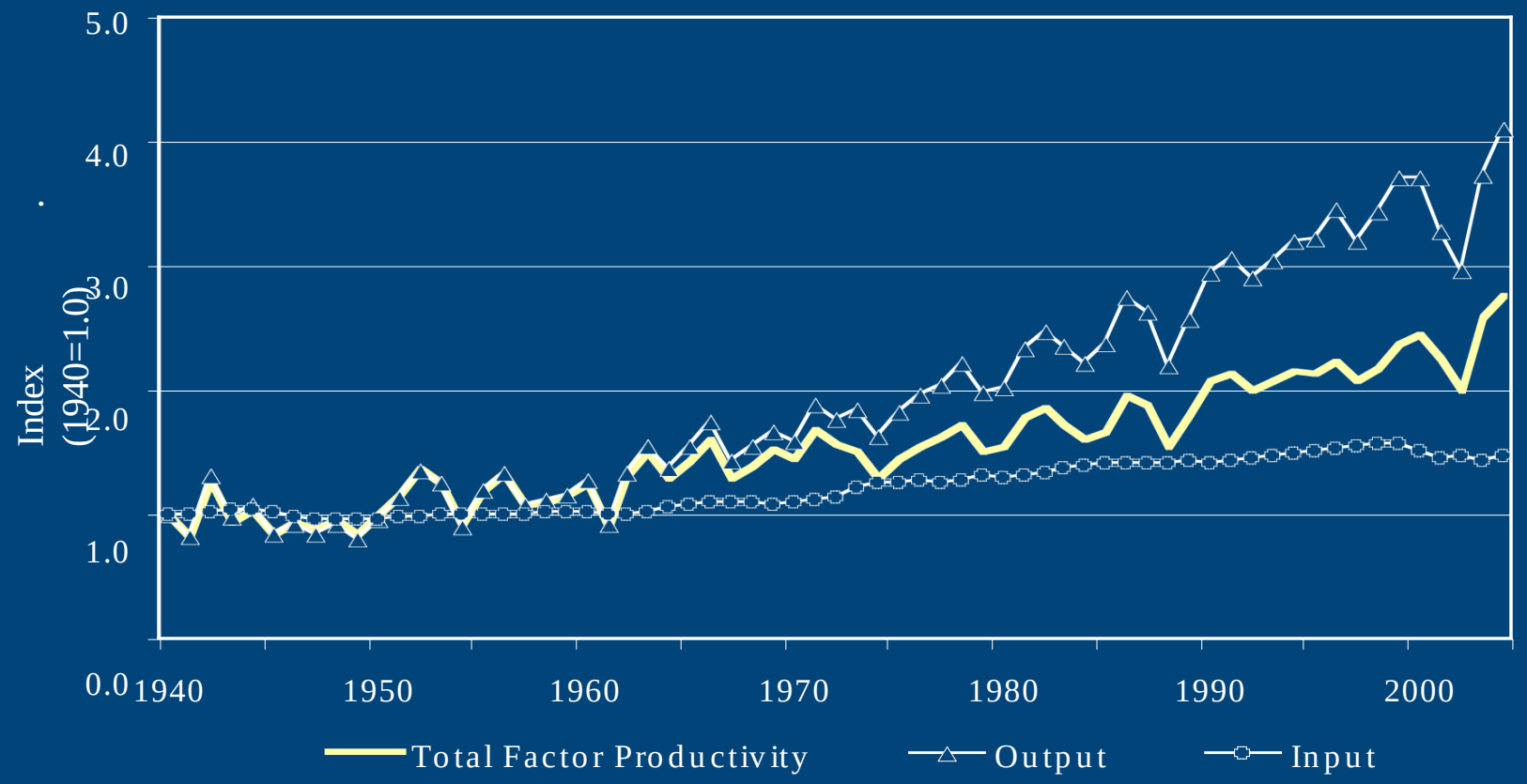
The 20th Century Agricultural Revolution



- Genetic Engineering
- Fertilizer
- Irrigation

Max Roser (2016) – 'Land Use in Agriculture'. Published online at OurWorldInData.org

Prairie Aggregate Agriculture Input,
Output and Productivity: 1940-2004



Canadian and Prairie Agricultural Productivity: Measurement, Causes, and Policy Implications, Terry Veeman, Jim Unterschultz, and Bryce Stewart, CAES Conference, Saskatoon, Saskatchewan, Canada June 4-6, 2007

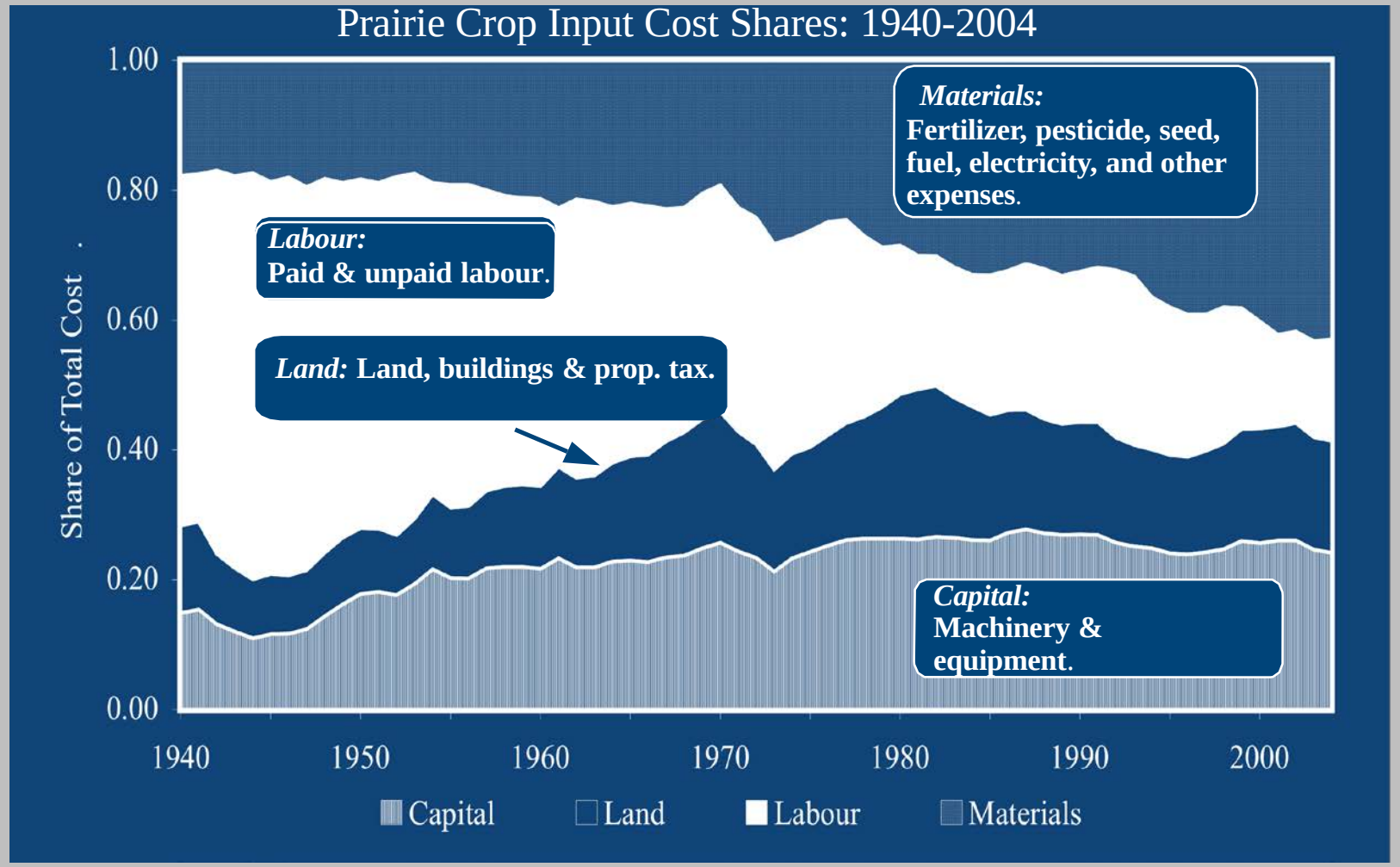
Prairie Productivity Growth Results

Provincial Livestock and Crops Annual Compound % Productivity Growth Rates

	Crops		Livestock	
	1940-2004	1990-2004	**1940-2004**	1990-2004
Alberta	**1.65**	-0.05	**0.54**	0.90
Sask.	**1.76**	0.40	**0.59**	3.61
Manitoba	**2.12**	1.75	**0.97**	4.21
Prairies	**1.77**	0.51	**0.65**	2.27

Canadian and Prairie Agricultural Productivity: Measurement, Causes, and Policy Implications, Terry Veeman, Jim Unterschultz, and Bryce Stewart, CAES Conference, Saskatoon, Saskatchewan, Canada June 4-6, 2007

Crops Input Use



Canadian and Prairie Agricultural Productivity: Measurement, Causes, and Policy Implications, Terry Veeman, Jim Unterschultz, and Bryce Stewart, CAES Conference, Saskatoon, Saskatchewan, Canada June 4-6, 2007

Agricultural Land Accounting

- Is the value of agricultural land increasing or decreasing?
- How does land fragmentation from oil and gas and other industrial installations on agricultural land affect agricultural productivity?
- How does the substitution of dependable for marginal agricultural lands affect agricultural productivity and input use? And is this trajectory sustainable?
- Is environmentally adjusted productivity in Alberta agriculture improving over time?

National Accounts 1665-1930*

- Petty and King (1665, 1696)
  - Prove that the state could raise larger revenues more equitably and less burdensome from taxes to finance war and peacetime needs;
  - Explore more equitable and less burdensome forms of taxation;
  - A “Piece of Politicall Knowledge, of all others, and at times, the most usefull, and Necessary”
- Comprehensive concepts of income, production, expenditures, and value added;
- Disaggregated by social and sectoral categories
- First example of thinking about non-agricultural sector contributions to wealth
- Used time series to estimate future taxes and expenditures

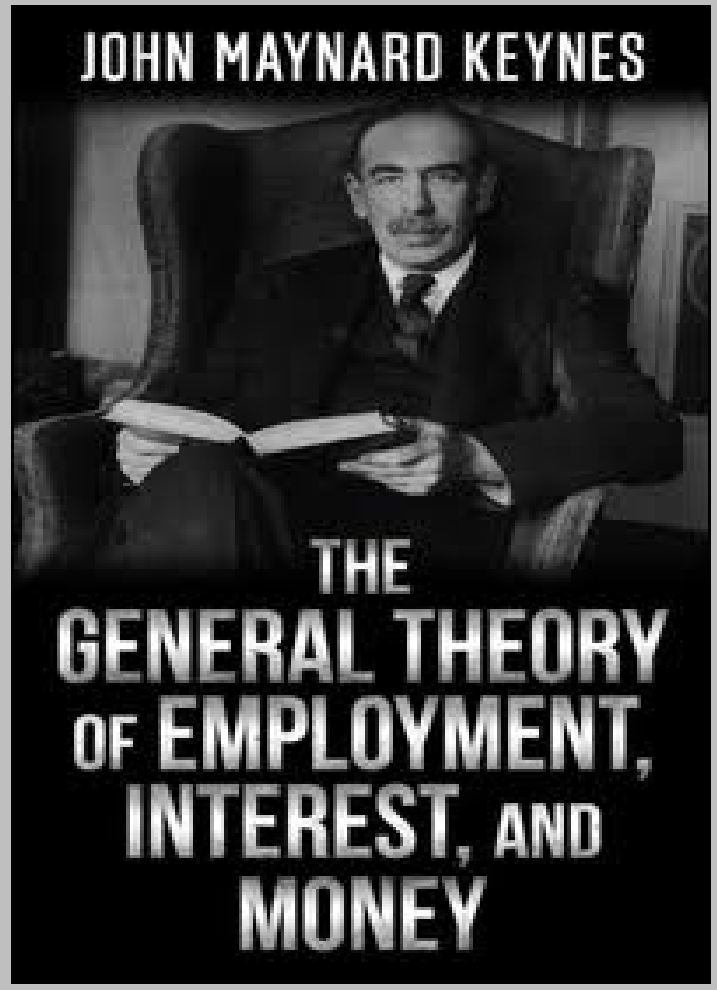
*Bos, 1992

National Accounts 1930-1947

- 3 innovations in economic theory:
- input-output analysis (Leontief);
  - Specifically links inputs and outputs
  - Supply Chain analysis (primary, secondary, tertiary inputs)
  - Examine the impacts of economic shocks to the economy
- econometric modeling of business cycles and the national economy (Tinbergen, Kuznets, etc.)
  - Demand for time series data
- Keynesian revolution and the development of macroeconomic theory.

National Accounting 1930-1947

- 1937 – publication of the "General Theory" and birth of Macro-Economics
- Macro-economic identities established a direct link between national accounting identities and economic theory
  - Policy variables (IS (Government)-LM (Monetary Policy) –BP (Exchange Rates)
- Post WWII – international efforts to standardize terms and concepts; first UN publication in 1947 becomes the UN Standard in 1968



Production Boundary Controversies

Including Natural capital in the System of National Accounts

Natural capital in SEEA CF and the SEEA-EEA

- **SEEA Central framework (UN Statistical Commission 2012)** focus is on individual components of the environment that provide materials and space to all economic activities.
  - Physical flow accounts (emissions, etc.)
  - Natural resource accounts (Resource use & stocks)
  - Environmental activity accounts (environmental taxes, restoration, permits, mitigation)
  - Mix of Physical and Monetary (Exchange Values)
  - Units include business, households
- **SEEA Experimental Ecosystem Accounts:** focus on the benefits obtained from ecosystems and biodiversity
  - expand resource depletion to include ecosystem degradation
  - Expand measures of flows to ES and their benefits
  - Unit of measure is “ecosystem”

Relevant Questions

SEEA-CF

- Is environmental input use efficient/ decoupled
- What is the net productivity of agricultural land and contribution of agriculture to income;

SEEA-EEA

- How will changes in land use and degradation of ecosystems compromise wealth
- What is the net contribution of ecosystem services to well being and welfare

Alternative Approach

UK Natural Capital Assessment

- Focus on value of natural capital and ecosystem services to inform policy and policy reform (Bateman et al. 2014)
- Use “welfare” measures of value
  - Greenhouse Gas
  - Recreation Value
  - Urban Green Space
  - Biodiversity

SEEA-Agriculture Base Accounts

Table 3.4. Data domains and base accounts

Data domains	Base accounts
Agricultural products and related environmental assets	Physical flow account for crops Physical flow account for livestock products Asset account for livestock Asset account for plantation crops
Forestry products and related environmental assets	Physical flow account for timber and non-wood forest products Asset account for forests Asset account for timber resources
Fisheries products and related environmental assets	Physical flow account for fish and aquatic products Asset account for fish and other aquatic resources
Water resources	Asset account for water resources Physical flow account for water abstraction Physical flow account for water distribution and use
Energy	Physical flow account for energy use
Greenhouse gas emissions	Physical flow account for greenhouse gas emissions
Fertilizers, nutrient flows and pesticides	Physical flow account for fertilizers Nitrogen and phosphorous budgets* Physical flow account for pesticides
Land	Asset account for land use Asset account for land cover
Soil resources	Asset account for soil resources
Other economic data	Monetary supply and use table for agricultural, forestry and fisheries products Extended production and income account for agricultural, forestry and fisheries activities

* These have been developed outside the SEEA framework, but they are a form of asset accounting for these elements.

DRAFT

Prototype Agricultural Land Account for Alberta

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Midsummer Analytics

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Prototype land-use change matrix, Alberta, 1990-2010

	To		Total loss/gain	Loss/gain as a share of 1990 area
	Settlements and roads	Cropland		
From	km2			percent
Cropland	385	n/a	**4935**	3.8%
Managed grassland	52	2745	**-2797**	-5.9%
Forest and trees	769	2250	**-3019**	-1.0%
Wetlands*	348	326	**-673**	-0.5%
Total loss/gain	**1554**	**4935**		

*Defined as open wetland, forest wetland, treed wetland, herb wetland and shrub wetland

- Cropland was the biggest land gain between 1990 and 2010
  - Most gains in cropland came from conversion of managed grassland
  - Conversion of forest and other treed areas and, to a lesser extent, wetlands also contributed
- Managed grassland was the biggest land giver
  - Nearly all managed grassland converted went into cropland

Prototype change in agricultural land area by region account, 1990-2010

Region and agricultural land type	Total area (km2)			
	1990	2010	Difference 1990 - 2010	% change 1990 - 2010
Calgary-Edmonton corridor* - Cropland	24,230	25,028	799	3.3
Calgary-Edmonton corridor - Grassland Managed	1,379	1,126	-253	-18.4
Calgary-Edmonton corridor - Total agland	***25,609***	***26,154***	***545***	***2.1***
Non-corridor - Cropland	107,270	111,406	4,136	3.9
Non-corridor - Grassland Managed	46,415	43,872	-2,543	-5.5
Non-corridor - Total agland	***153,686***	***155,278***	***1,593***	***1.0***
Alberta - Cropland	131,500	136,435	4,934	3.8
Alberta - Grassland Managed	47,794	44,998	-2,797	-5.9
Alberta - Total Agland	***179,294***	***181,432***	***2,138***	***1.2***

*Defined as: Sturgeon County, Strathcona County, Edmonton, Parkland County, Leduc County, Brazeau M.D., Wetaskawin County, Ponoka County, Lacombe County, Red Deer County, Mountain View County, Rocky View

- Managed grassland in the Calgary-Edmonton corridor showed the biggest change from 1990 to 2010
  - Much larger loss of managed grassland in percentage terms than in the rest of the province
- Overall, Alberta gained 2,138 km^2 of agricultural land, though there was a net loss in managed grassland
  - Both the Calgary-Edmonton corridor and the rest of the province showed overall increases in agricultural land
  - The increase in the Calgary-Edmonton corridor was greater in percentage terms than elsewhere

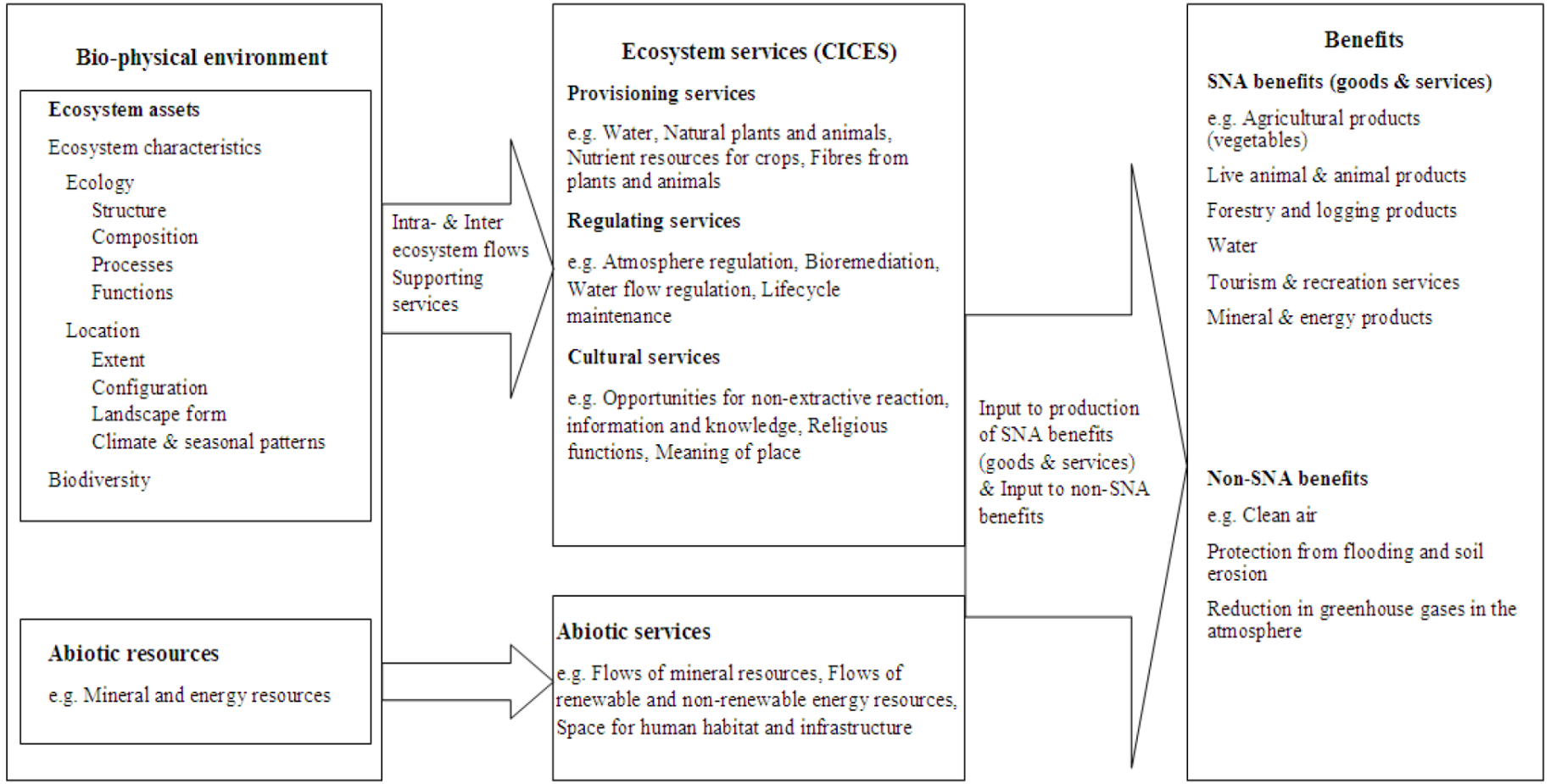
Prototype cropland quality change account, Alberta, 1990-2010

		Cropland Losses		Cropland Gains					
		To settlements and roads		From forest and trees		From managed grassland		From wetlands	
CLI Class*	CLI description	(area km^2)	As percent of total cropland area lost	(area km^2)	As percent of total cropland area	(area km^2)	As percent of total cropland area	(area km^2)	As percent of total cropland area
Class 1	No significant limitations in use for crops	50	13	42	1	23	0	5	0
Class 2	Moderate limitations that restrict the range of crops or require moderate conservation practices	109	28	294	6	490	9	36	1
Class 3	Moderately severe limitations that restrict the range of crops or require special conservation practices	103	27	618	12	677	13	56	1
Dependable land total		**263**	**68**	**954**	**18**	**1190**	**22**	**96**	**2**
Land with limiations (Class 4 and below) total		**123**	**32**	**1296**	**24**	**1555**	**29**	**230**	**4**

*CLI - Canada Land Inventory Soil Capability Classification for Agriculture

- Overall, the trend from 1990 to 2010 was to a poorer mix of cropland in Alberta
  - The majority of cropland *lost* from 1990 to 2010 (68%) was *dependable* (CLI classes 1-3)
  - The majority of cropland *gained* (58%) had *severe to very severe limitations* for agriculture (CLI classes 4 and below)
  - 263 km^2 of *dependable* cropland was lost
    - Only 123 km^2 of cropland with *limitations* was lost
  - 3080 km^2 of cropland with *limitations* was gained
    - Only 2240 km^2 of *dependable* cropland was gained

Structure of SEEA-EEA



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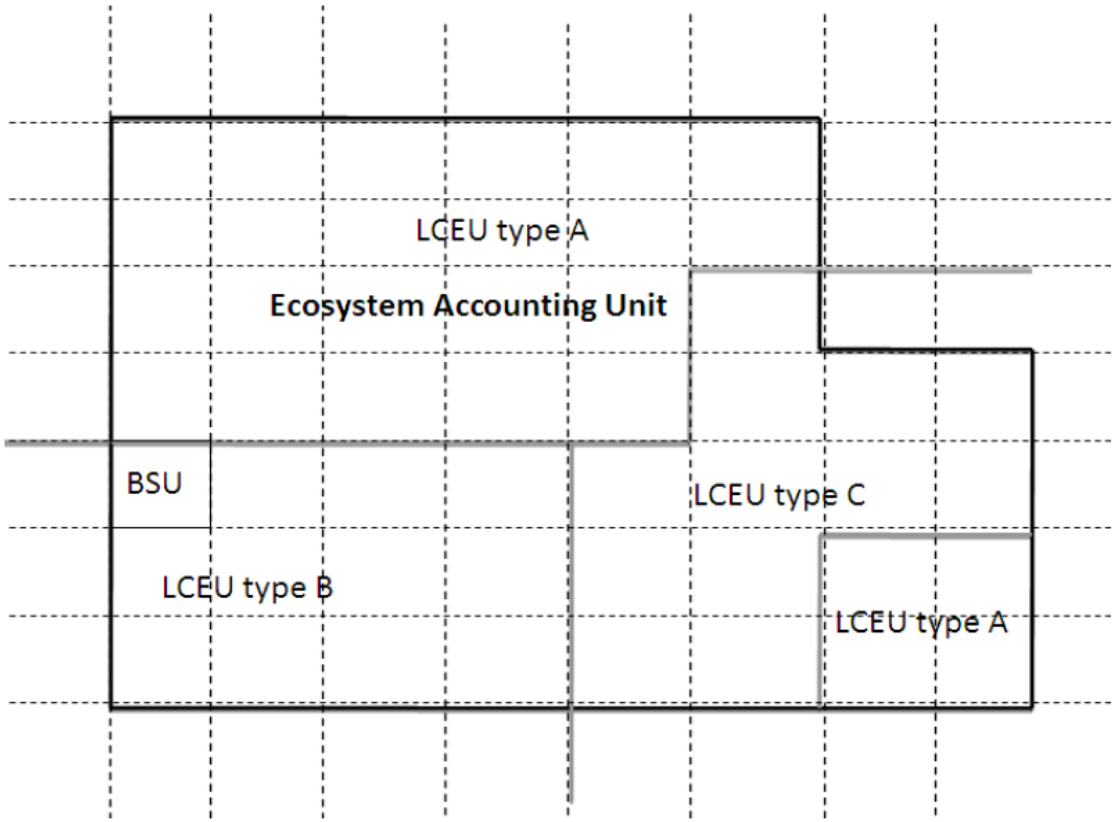
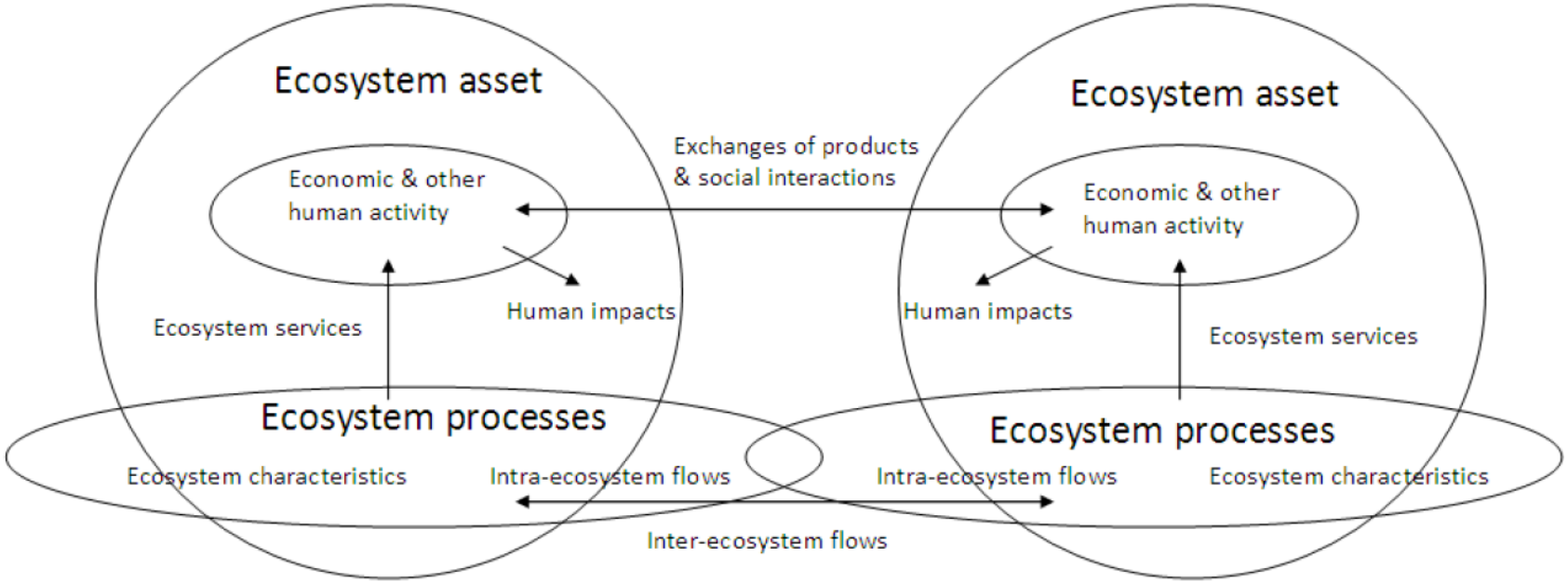
Units in the SEEA-EEA

Figure 2.4 Stylised depiction of relationships between BSU, LCEU and EAU



The SEEA-Experimental Ecosystem Accounts

Figure 2.1 Basic model of ecosystem stocks and flows



SEEA EEA 2012

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Data and Measurement Issues

- Agreement must be reached on two elements of basic statistical infrastructure:
  - The classification of ecosystem goods and services (EGS) provided and/or used by agriculture
  - The spatial units of measure to be used for reporting statistics
    - The SEEA provides a starting point for this but it has not been widely tested and remains provisional
- Spatially explicit data are required to measure the flows of EGS in "physical" terms
  - Crop/livestock production, blue and green water use, fertilizer use, pesticide use, pollination, soil erosion, water quality, air quality
- Spatially detailed data on willingness-to-pay for EGS
  - Is there an opportunity to create a repeatable survey on WTP for key ecosystem services

Statistics Canada - Human Activity and the Environment Reports

- 2013 – Measuring Ecosystem Goods and Services
  - Measured potential of ecosystem to deliver goods and services; much of it based on changes in potential derived from a few key indicators (land use modification)
  - Extraction of biomass – provisioning services
  - Wetland or natural area extent
- 2014 – Agriculture and the Environment
  - Data arranged by Ecozones , Drainage Regions, Administrative Boundaries
  - Aggregates data from multiple sources
  - Land use, farm practises (outputs, inputs, intensities, adoption rates)
- 2015 – Changing Metropolitan Areas
  - Land use in urban areas
  - Population characteristics
  - Values of infrastructure (housing e.g.)
- Other Products – AAFC Agri-environmental indicators (e.g. excess nutrient maps)

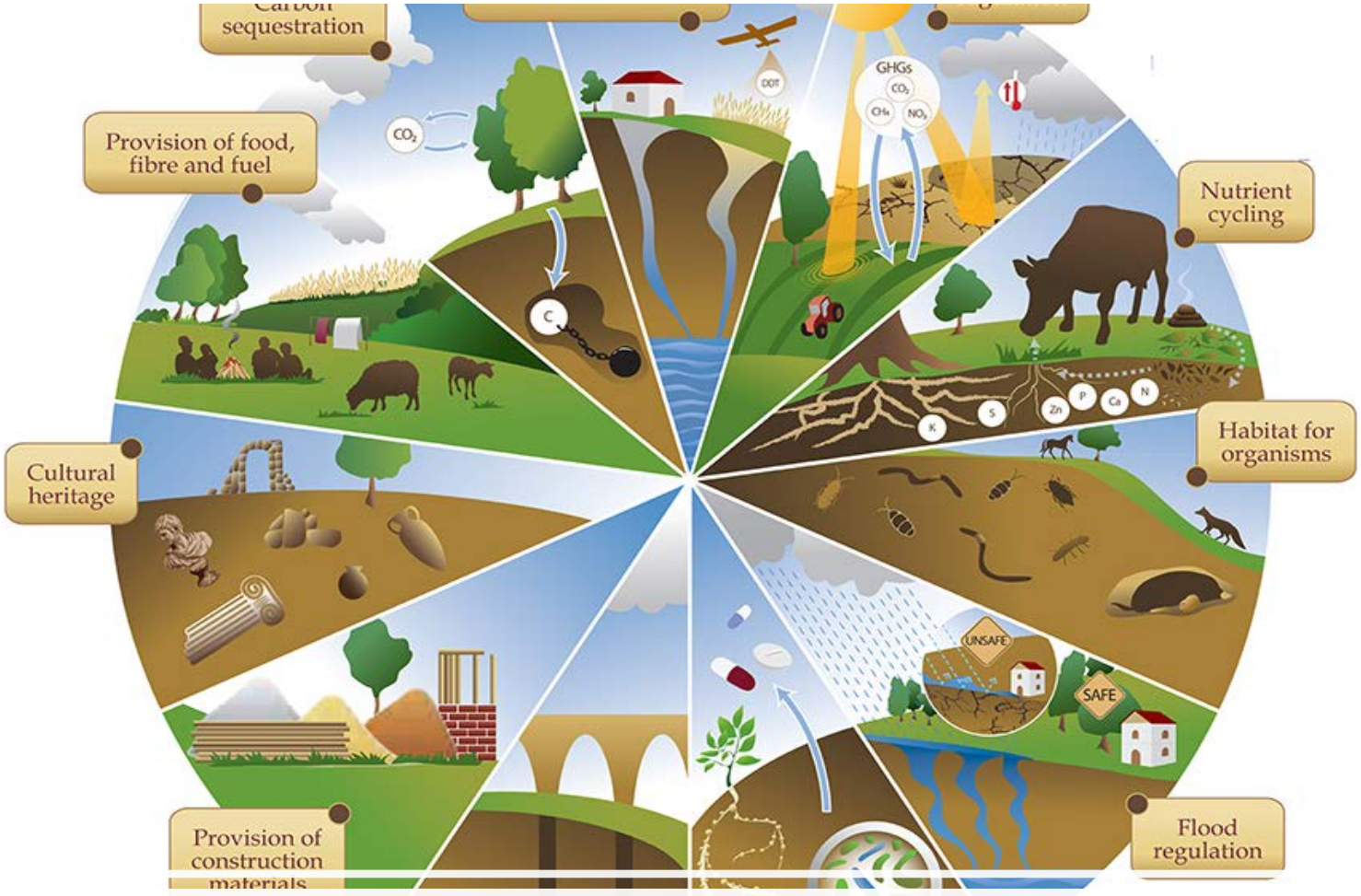
Conclusions

1. Priorities for research – supply chain analysis starting with one ES (water)
   - – Spatially Explicit
     - Upstream production – downstream benefits
2. Data Challenges
   - – Agri-Environmental indicators
     - Quality versus quantity; not linked to production or consumption units

Conclusions

3. Lack of Theoretical Foundations
    - What are the accounting identities
    - Weak vs. Strong Sustainability
        - How to value tradeoffs between built and natural infrastructure
        - Conversion of ag land in peri-urban areas e.g.
    - Weak policy foundations
4. How to address land use tradeoffs/deal with technological change

21 C Agricultural Revolution



Accounting for the Future Farm

Baveye et al. 2016

Thank you