Accounting for Natural Capital in Agriculture

Presented by

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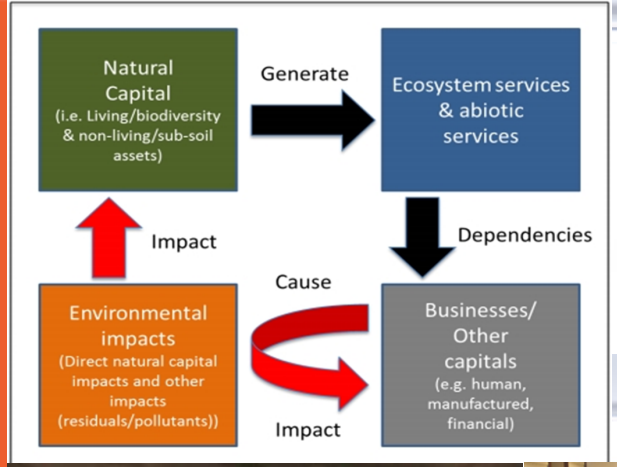


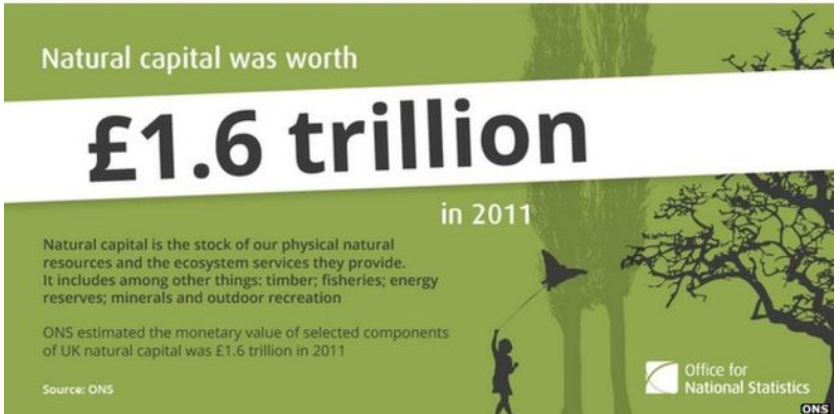
Why account for natural capital?

- Global value of flow of services from natural capital: some 125-150 USD trillion per year in 2011 (Costanza et al. 2014).

- Implies a value of the stock of natural capital of some 3,000 (@ 5% discount) to 15,000 (@ 1% discount) USD trillion.

- Easily the most valuable asset on the planet!

1. Natural capital was worth £1.6 trillion in 2011



Current state of affairs around NCA

- The System of Environmental Economic Accounting (SEEA) is gaining international acceptance.

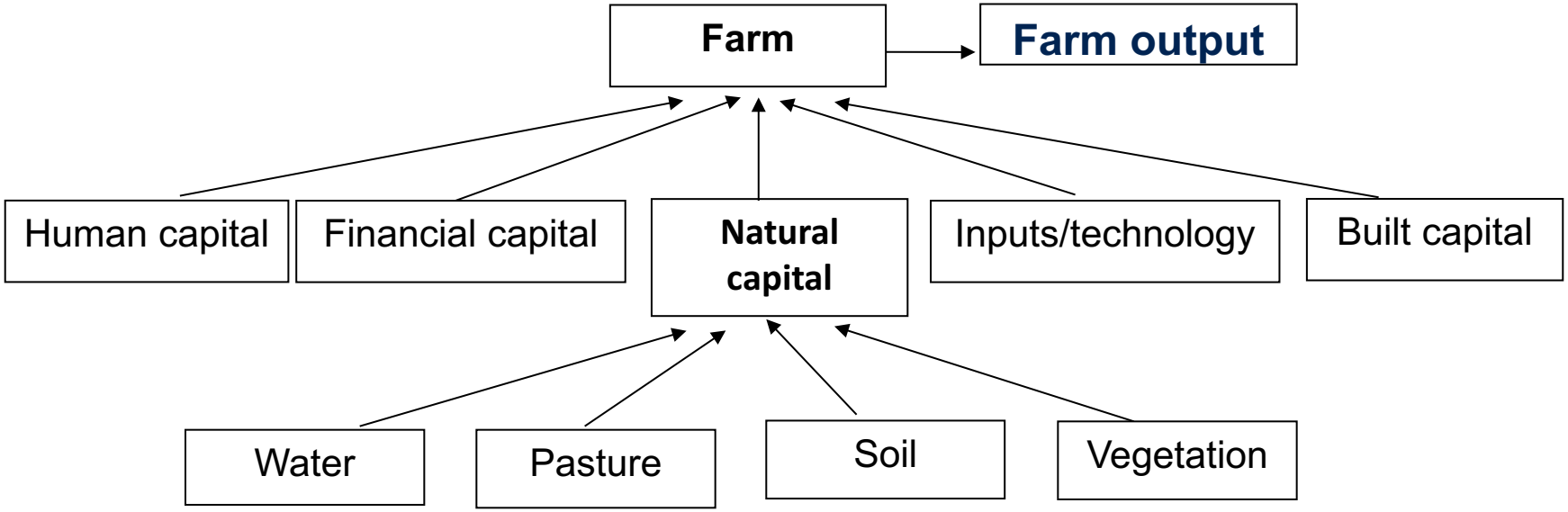
- No substantial efforts have so far specifically focused on micro or local level.

However…

- The local level is where management of natural capital stock matters the most, especially in agriculture.

- Value of services from natural capital in agriculture: some 6000 USD/ha/year (Costanza et al. 2014) => value of the natural capital stock 120-600k USD/ha

NCA Model for a Farm – an example



A Question: How to evaluate the dynamics of natural capital on farms?

Answer:

- By evaluating an observable function of the change in attributes of particular natural capital type (e.g. soil).
- Agricultural productivity is such an observable function.
- Natural capital as a factor of production.

So, we…

- Propose a method for evaluation of the dynamics of soil natural capital on farm.
  - An appropriate conceptual framework and practical techniques for assessing the dynamics of on-farm natural capital do not currently exist.
- Test the proposed method by empirically quantifying the change in soil natural capital over time.
  - Using environmentally adjusted productivity and efficiency measurement approaches.
- Propose a protocol for ongoing data collection from farmers.
  - Data are not available. However, the advent of IT technology (e.g. sensing, widespread use of mobile devices) could help in gathering data ('big data' in agriculture).

Empirical study: Cattle farms in Tasmania; Data

Inputs	**Output**	**Natural capital characteristics (e.g. soil attributes)**
Total grazing area	Number of cattle sold (Total live-weight of cattle)	Soil pH
Area under fodder crops		Organic carbon
Labour		Phosphorus (Oslen)
Fertiliser		Phosphorus (Colwell)
Other inputs		Potassium
Number of cattle purchased/stock (total live-weight of cattle)		Sulphur
		Calcium
		Magnesium
		Sodium
		Aluminium And others……

- Data collected through a questionnaire plus historical soil test reports at a field level
- Repeated observations on 19 fields on 5 farms, over various years.

Estimation of Directional Distance Functions

- Use of Data Envelopment Analysis (DEA) or Activity Analysis Model to construct a production frontier.
- For each field, estimate the value of Directional Distance Functions that are the components of the Soil Natural Capital Indicator (SNCI).

$$SQ^{t}(s^{t}, s^{t+1}, x_0^{t}, y_0^{t}; g_s) = \vec{D}_s^{t}(x_0^{t}, s^{t+1}, y_0^{t}; g_s) - \vec{D}_s^{t}(x_0^{t}, s^{t}, y_0^{t}; g_s);$$

$$SQ^{t+1}(s^{t}, s^{t+1}, x_0^{t+1}, y_0^{t+1}; g_s) = \vec{D}_s^{t+1}(x_0^{t+1}, s^{t+1}, y_0^{t+1}; g_s) - \vec{D}_s^{t+1}(x_0^{t+1}, s^{t}, y_0^{t+1}; g_s);$$

$$\boldsymbol{SNCI}\ (s^{t}, x_0^{t}, y_0^{t}, s^{t+1}, x_0^{t+1}, y_0^{t+1}; g_s) =$$

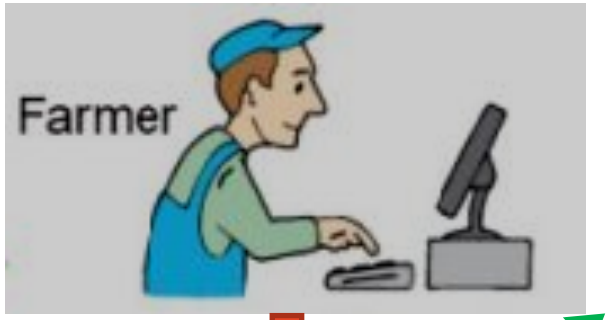
$$\frac{1}{2}[SQ^{t}(s^{t}, s^{t+1}, x_0^{t}, y_0^{t}; g_s) + SQ^{t+1}\ (s^{t}, s^{t+1}, x_0^{t+1}, y_0^{t+1}; g_s)]$$

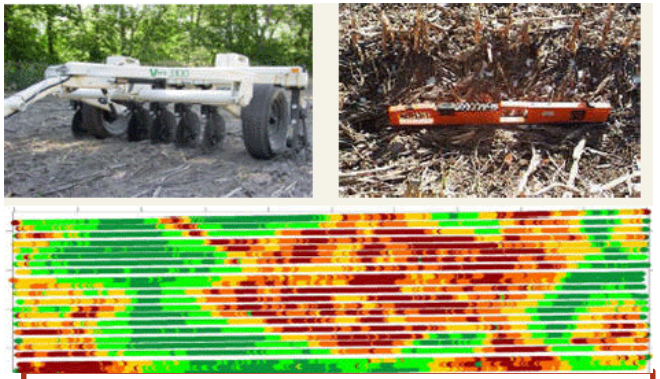
- Use the estimated DDFs to compute the SNCI score for each field
- SNCI reflects the changes in the capacity of nature to contribute to agricultural production

Estimated values of SNCI Indicators across groups of fields, various years

Farmer ID	Observations	Group1 (2000-2011)	Group2 (2002-2007)	Group3 (2009-2012)	Group4 (2010-2015)
1	Field1			0.503	
1	Field2			0.044	
1	Field3	0.425			
1	Field4			-0.075	
1	Field5	0.781			
2	Field6	0.312			
2	Field7	0.199			
2	Field8	0.331			
2	Field9		0.558		
2	Field10		0.022		
3	Field11				-0.001
4	Field12				0.007
4	Field13				-0.001
4	Field14				0.033
4	Field15				0.028
4	Field16				0.003
4	Field17				0.019
5	Field18			-0.730	
5	Field19		-0.250		

Interface for on-going data collection





Field Data collection using on-the-go sensor

Individual farm Input-output data

Data platform /Dashboard

Input-output data from other farms

SNCI for individual farm

Data processing using GAMS programming

Outputs of SNCI model for all farms

Conclusions

- The role of natural capital is increasingly recognised, and NCA at an aggregate level is already being applied.
- Assessing the dynamics of natural capital at a local level (e.g. farms) is a challenging task, but it is required for adequate management of NC.
- The dynamics of natural capital on farms can be assessed in several ways.
- One approach is through estimating the relationship between NC attributes and agricultural productivity.
- The developed SNCI can serve the purpose of tracking NC on farm over time.
- ‘Big data’ in agriculture can help with necessary data gathering.

Thank you!

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