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

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Natural capital is the stock of our physical natural resources and the ecosystem services they provide. It includes among other things: timber, fisheries, energy reserves; minerals and outdoor recreation

ONS estimated the monetary value of selected components of UK natural capital was £1.6 trillion in 2011

Source: ONS
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

Farm

Human capital  Financial capital  Natural capital  Inputs/technology  Built capital

Water  Pasture  Soil  Vegetation

Farm output
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

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output</th>
<th>Natural capital characteristics (e.g. soil attributes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total grazing area</td>
<td>Number of cattle sold (Total live-weight of cattle)</td>
<td>Soil pH</td>
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<tr>
<td>Area under fodder crops</td>
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<td>Organic carbon</td>
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<td>Labour</td>
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<td>Phosphorus (Oslen)</td>
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<td>Fertiliser</td>
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<td>Phosphorus (Colwell)</td>
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<td>Other inputs</td>
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<td>Potassium</td>
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<tr>
<td>Number of cattle purchased/stock (total live-weight of cattle)</td>
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<td>Sulphur</td>
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- 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).

\[
SQ^t(s^t, s^{t+1}, x^t, y^t; g_s) = \overrightarrow{D}^t_s(x^t_0, s^{t+1}, y^t_0; g_s) - \overleftarrow{D}^t_s(x^t_0, s^t, y^t_0; g_s);
\]

\[
SQ^{t+1}(s^t, s^{t+1}, x_0^{t+1}, y_0^{t+1}; g_s) = \overrightarrow{D}^{t+1}_s(x_0^{t+1}, s^{t+1}, y_0^{t+1}; g_s) - \overleftarrow{D}^{t+1}_s(x_0^{t+1}, s^t, y_0^{t+1}; g_s);
\]

\[
SNCI (s^t, x^t_0, y^t_0, s^{t+1}, x_0^{t+1}, y_0^{t+1}; g_s) = \frac{1}{2}[SQ^t(s^t, s^{t+1}, x^t_0, y^t_0; g_s) + SQ^{t+1}(s^t, s^{t+1}, x_0^{t+1}, y_0^{t+1}; g_s)]
\]

- 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

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Interface for on-going data collection

- Individual farm input-output data
- Data platform/Dashboard
- Data processing using GAMS programming
- Input-output data from other farms
- SNCI for individual farm
- Outputs of SNCI model for all farms

Field Data collection using on-the-go sensor
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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