Ecosystem services conditions and trends

John Dymond, Anne-Gaëlle Ausseil and Alex Herzig
Concept
# Ecosystem Services Classification

## Provisioning Services
*Products obtained from ecosystems*
- Food & fibre
- Fuel
- Genetic resources
- Biochemical, natural medicines & pharmaceuticals
- Ornamental resources
- Freshwater

## Regulating Services
*Benefits from regulation of ecosystem processes*
- Air quality maintenance
- Climate regulation
- Water regulation
- Erosion control
- Water purification & waste treatment
- Human disease regulation
- Biological control
- Pollination
- Storm protection

## Cultural Services
*Non-material benefits obtained from ecosystems*
- Cultural diversity
- Spiritual & religious values
- Knowledge systems
- Educational values
- Inspiration
- Aesthetic values
- Social relations
- Sense of place
- Cultural heritage values
- Recreation & ecotourism

## Supporting Services
*Services necessary for the production of all other ecosystem services*
- Soil formation & retention
- Nutrient & water cycling
  - Primary production
- Production of atmospheric oxygen
- Provisioning of habitat

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Based on Millennium Ecosystem Assessment (2005)
Provision of fresh water
Dissolved reactive phosphorus (mg/litre)
Climate regulation
Anthropogenic fluxes of GHG

Sources and sinks

Animal numbers

CenW
Trend analysis (e.g. GHG)
Anthropogenic vs natural ecosystems

<table>
<thead>
<tr>
<th></th>
<th>Gg CO2e/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>30,000</td>
</tr>
<tr>
<td>Energy/industry</td>
<td>40,000</td>
</tr>
<tr>
<td>LULUCF</td>
<td>-10,000</td>
</tr>
<tr>
<td>Terrestrial ecosystem</td>
<td>-20,000</td>
</tr>
</tbody>
</table>

- Anthropogenic
- Methanotrophs
- Shrublands
- Erosion sink
Provision of food and fibre
Food and fibre

Meat

Milk

Wood

Wool
Provision of natural habitat
<table>
<thead>
<tr>
<th>Land Cover Type</th>
<th>Historic Area (Mha)</th>
<th>Current Area (Mha)</th>
<th>Area Lost between 1990-2008 (ha)</th>
<th>% Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indigenous forest</td>
<td>23.2</td>
<td>6.5</td>
<td>51,000</td>
<td>28%</td>
</tr>
<tr>
<td>Tussock grasslands</td>
<td>8.2</td>
<td>3.5</td>
<td>71,000</td>
<td>43%</td>
</tr>
<tr>
<td>Freshwater wetland</td>
<td>2.4</td>
<td>0.2</td>
<td>?</td>
<td>10%</td>
</tr>
</tbody>
</table>
Land-use change and ecosystem services

- Soil conservation planting in hill country
- Soil, water, and carbon tradeoffs with exotic forest
- Opportunities for restoration of indigenous forest
- Lifestyling and urbanisation on high class land
Afforestation scenario

Legend
- Afforested areas
- Bare ground
- Pasture
- Indigenous forest
- Planted forest
- Scrubland
Results

-10% -5% 0% 5% 10% 15% 20% 25% 30%

Food
Fibre
Climate regulation
Fresh water provision
Erosion control
Water regulation
Habitat provision
Soil, water, and carbon tradeoffs

Erosion control
Water regulation
Climate regulation
Plant exotic forest on grassland
Erosion rates decrease under forest
Water yield decreases under forest
(1) Marginal value of avoided soil erosion = $1 per tonne

(2) Marginal value of irrigation water = $1 per cubic metre

(3) Marginal value of sequestered carbon = $73 per tonne
Value of marginal ecosystem services provided by afforestation of pasture
Opportunities for indigenous forest restoration

- Provision of natural habitat
- Climate regulation
- Provision of food
Maintenance of high quality soil
## Urbanisation between 1990 and 2008

<table>
<thead>
<tr>
<th>Region</th>
<th>high-class land (kha)</th>
<th>high-class land occupied by new urbanisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northland</td>
<td>27.8</td>
<td>0%</td>
</tr>
<tr>
<td>Auckland</td>
<td>62.9</td>
<td>4%</td>
</tr>
<tr>
<td>Waikato</td>
<td>287.0</td>
<td>0%</td>
</tr>
<tr>
<td>Bay of Plenty</td>
<td>37.1</td>
<td>1%</td>
</tr>
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<td>Taranaki</td>
<td>87.1</td>
<td>0%</td>
</tr>
<tr>
<td>Manawatu/Wanganui</td>
<td>148.2</td>
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</tr>
<tr>
<td>Gisborne</td>
<td>40.6</td>
<td>0%</td>
</tr>
<tr>
<td>Hawkes Bay</td>
<td>92.5</td>
<td>0%</td>
</tr>
<tr>
<td>Wellington</td>
<td>36.3</td>
<td>0%</td>
</tr>
<tr>
<td>Tasman</td>
<td>16.0</td>
<td>1%</td>
</tr>
<tr>
<td>Nelson</td>
<td>0.3</td>
<td>11%</td>
</tr>
<tr>
<td>Marlborough</td>
<td>37.7</td>
<td>0%</td>
</tr>
<tr>
<td>West Coast</td>
<td>0.3</td>
<td>0%</td>
</tr>
<tr>
<td>Canterbury</td>
<td>319.5</td>
<td>1%</td>
</tr>
<tr>
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</tr>
<tr>
<td>Southland</td>
<td>183.6</td>
<td>0%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1464.8</td>
<td>0.5%</td>
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</table>
# Lifestyle blocks

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<th>high-class land (kha)</th>
<th>high-class land occupied by lifestyle blocks</th>
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</thead>
<tbody>
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<td>Northland</td>
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<tr>
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<td>87.2</td>
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<td>Wellington</td>
<td>36.3</td>
<td>12%</td>
</tr>
<tr>
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<td>16.0</td>
<td>24%</td>
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<td>Nelson</td>
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From the UK National Ecosystem assessment

Figure 5 Relative importance of Broad Habitats in delivering ecosystem services and overall direction of change in service flow since 1990. This figure is based on information synthesized from the habitat and ecosystem service chapters of the UK NEA Technical Report (Chapters 5–16), as well as expert opinion. This figure represents a UK-wide overview and will vary nationally, regionally and locally. It will therefore also inevitably include a level of uncertainty; full details can be found in the Technical Report. Arrows in circles represent where there is high evidence for or confidence in the direction of service flow amongst experts; arrows in squares represent where there is less evidence for or confidence in the direction of service flow. Blank cells represent services that are not applicable to a particular Broad Habitat.
Optimising ecosystem services
Maximising Ecosystem Services – Central North Island

*Reconfigure* land-use pattern such that …

… nitrate leaching *is* **minimised**

*Constraint:*
  * Agricultural output as at 2008*

… erosion *is* **minimised**

*Constraint:*
  * Agricultural output as at 2008*

… nitrate leaching **AND** erosion *are* **minimised**

*Constraint:*
  * Agricultural output as at 2008*
Nitrate Leaching
[kg N / cow * a]
- < 16
- 16 - 17
- 17 - 18
- 18 - 19
- >= 19

Erosion [t/(ha*a)]
- Dairy
  - 0.0000 - 1.5336
  - 1.5336 - 3.0429
  - 3.0429 - 5.6665
  - 5.6665 - 14.3064
  - 14.3064 - 31.5084

Nitrate Leaching
Soil Erosion
Objective: min soil erosion
min nitrate leaching

Constraints: $\mathbb{S} = \mathbb{S} (2008)$
n. l. $\leq 6573809$ [kg/a]

<table>
<thead>
<tr>
<th>Land-Use</th>
<th>Area</th>
<th>Nitrate Leaching</th>
<th>Erosion</th>
<th>Milk Solids</th>
<th>Wood</th>
<th>Meat</th>
<th>Wool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>-7</td>
<td>-8</td>
<td>-14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Land-Use 2008

Optimised Land-Use
Waitaki catchment

Land use

Land cover
## Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land use options</strong></td>
<td>Dairy, sheep &amp; beef, conservation land</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Maximise clean water provision</td>
<td>Maximise habitat provision</td>
<td>Maximise water regulation</td>
</tr>
<tr>
<td><strong>Criteria constraint</strong></td>
<td>Maintain current food production levels from dairy and sheep &amp; beef</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spatial constraint</strong></td>
<td>Dairy and sheep &amp; beef in suitable areas</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Potential ES

Habitat provision (no unit)

Water yield (mm/yr)

Nitrate leaching (kg N/ha/yr)

Food production ($/ha)
Results: clean water

Current land use

Optimised clean water

Legend:
- Dairy
- Deer
- Forestry
- Horticulture
- Natural areas
- Sheep and beef
- Arable
- Other
- Water

Legend:
- Dairy
- Other
- SB in tussock
- SB in grassland
- CL in shrub or alpine grass
- CL in tussock

% change

Clean water | Habitat provision | Water yield

-20 | 0 | 60
Results: habitat provision

Current land use

Optimised habitat

% change

Legend:
- Dairy
- Deer
- Forestry
- Horticulture
- Natural areas
- Sheep and beef
- Arable
- Other
- Water

Legend:
- Dairy
- Other
- SB in tussock
- SB in grassland
- CL in shrub or alpine grass
- CL in tussock

Clean water
Habitat provision
Water yield
Results: water regulation

Current land use

Optimised water regulation

% change

- Clean water
- Habitat provision
- Water yield
Spatial Optimisation Use-Cases

Where are the most suitable areas for URBAN DEVELOPMENT?

*Objectives*: min env. *impact*; min *costs*; max *value*; min distance to *hospital*;
*Constraints*: maintain agricultural output; target number of houses;
   avoid high class land

What is the most efficient ALLOCATION OF WATER?

*Objectives*: max agricultural *output*; min supply *costs*
*Constraints*: water cap; budget cap

What are the most suitable areas for BIODIVERSITY OFFSETTING?

*Objectives*: max *ecosystem services*; min development/maintenance *costs*
*Constraints*: suitability zones; target biodiversity value; connectedness with current conservation estates;

...
At http://lris.scinfo.org.nz

- Launched August 2010
- Data download facility
- Free
- 130+ data sets
- Aimed at GIS professionals
- Easy to use
- Many formats supported and different projections
- Comes with supporting materials
- Strong standards-based metadata component
- Requires registration
- New – web services
A new multi-layer digital soil spatial information system for New Zealand

- Soil classes and attributes with resolution at least equiv. to 1:50,000
- High quality on-screen maps
- Search by coordinates/location/address
- Link to soil fact sheets
- Metadata, legends and explanatory information
- High quality hard copy cartography (PDF)

At http://smap.landcarereresearch.co.nz
- S-map Online like features +
- Targeted at interested lay person but of value to experts also
- Broad range of environmental data can be viewed over different base maps and context data
- Information pop-ups instead of factsheets
- Reporting facility

At http://ourenvironment.scinfo.org.nz