



Functional approaches to quantifying the response to land use change of multiple ecosystem service delivery

Sandra LAVOREL
Laboratoire d'Ecologie Alpine, Grenoble, France






Assessing the vulnerability of ecosystem services

- Global context:
 - Assessing the vulnerability to global change of regions and people who live there
 - Millennium Ecosystem Assessment: vulnerability is linked with changes in the delivery of ecosystem services
- Regional context: changing land use in European mountain areas
 - Chronically less productive and/or socio-economic limits to profitability
 - High biodiversity
 - Multifunctional landscapes :
 - agricultural production
 - biodiversity maintenance
 - and a diverse range of other services, e.g. tourism

Extensification results in decreased plant diversity. Which other services do local people lose?






Components of vulnerability to global change


➤ Exposure

- 4 equiprobable scenarios of land use driven by climate




➤ Sensitivity

- Projections of biodiversity and ecosystem properties



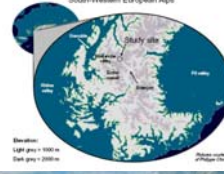

➤ Acceptability


- Changes in multiple services valued by local stakeholders

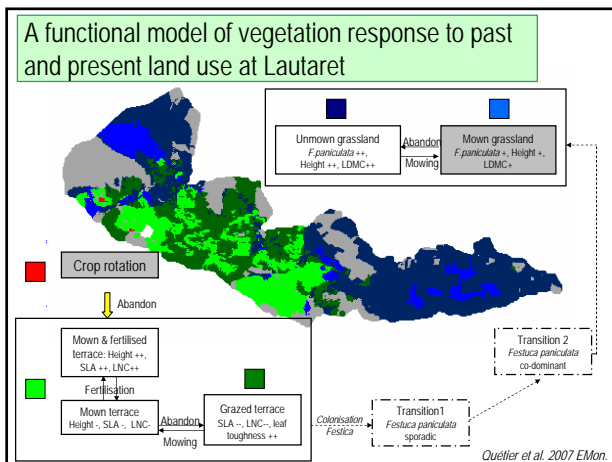
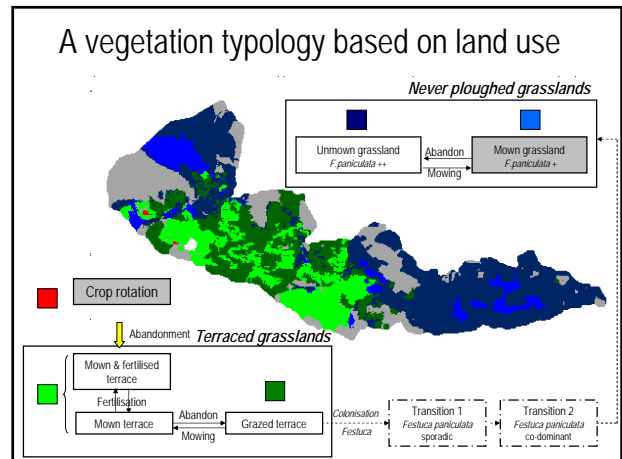
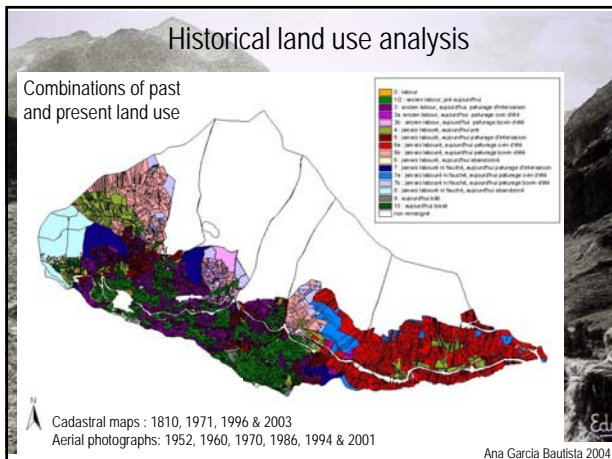


Components of the vulnerability assessment

| | LAND USE | ECOSYSTEM | VALUATION |
|--------------|---------------------------|---------------------------------------|-----------------------------|
| Observations | Past and present land use | Biodiversity and ecosystem properties | Ecosystem services |
| Models | Land use scenarios | Biodiversity and ecosystem scenarios | Ecosystem service scenarios |
| | <i>Exposure</i> | <i>Sensitivity</i> | <i>Acceptability</i> |





Ecosystem services identified by stakeholders at Lautaret and links to ecosystem functions

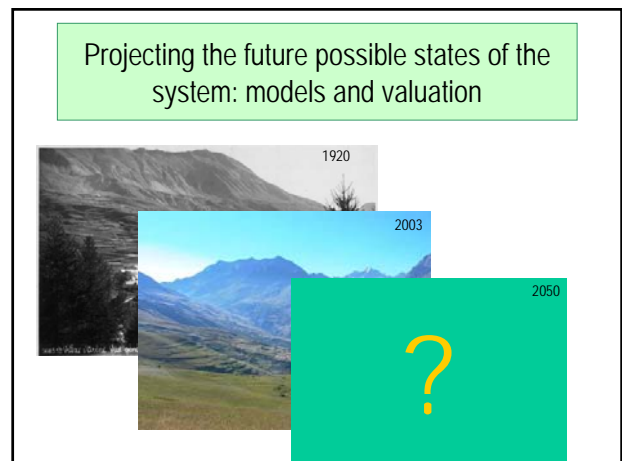
| Stakeholder | Ecosystem Service | Stakeholder Descriptions of Ecosystem Attributes | Modelled Relevant Ecosystem Attributes |
|-------------------------|---|---|--|
| Local farmers | Grass quantity for hay & grazing | Above-ground biomass in mown grasslands Sward height | |
| | Forage quality | Palatability for grazing | |
| | | Crude protein content | |
| National Park Authority | Flowering diversity for aesthetic value | Relative abundance of legumes | |
| Visitors and locals | Conservation of biodiverse grasslands | Plant diversity | Simpson's biodiversity index |
| Locals | Appropriate stewardship of cultural landscape features Snow-gliding risk | Large accumulations of dead grass | Spring litter in un-mown grasslands |

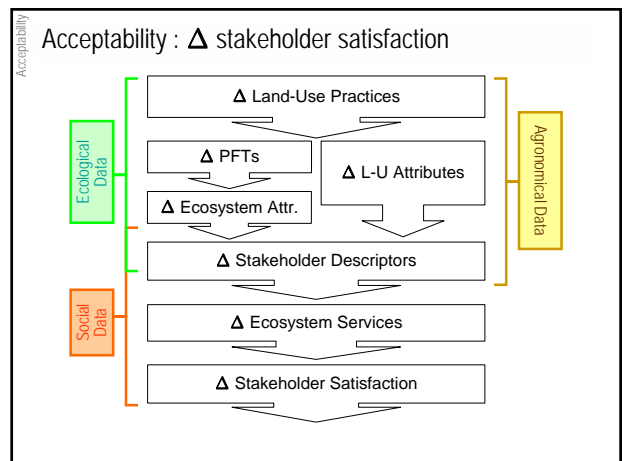
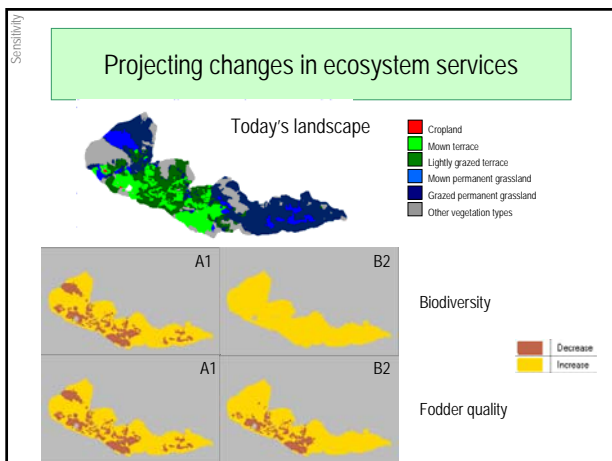
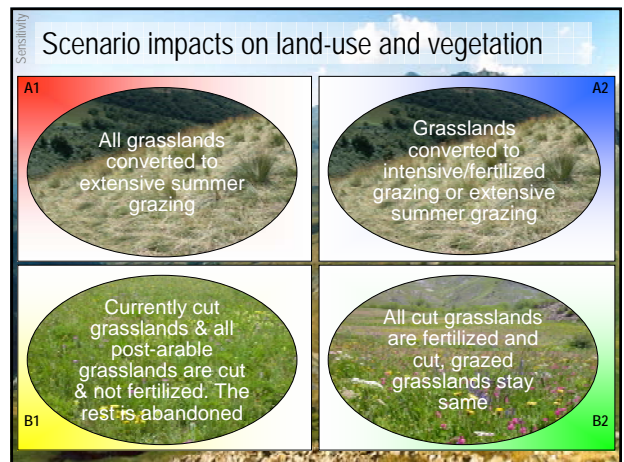
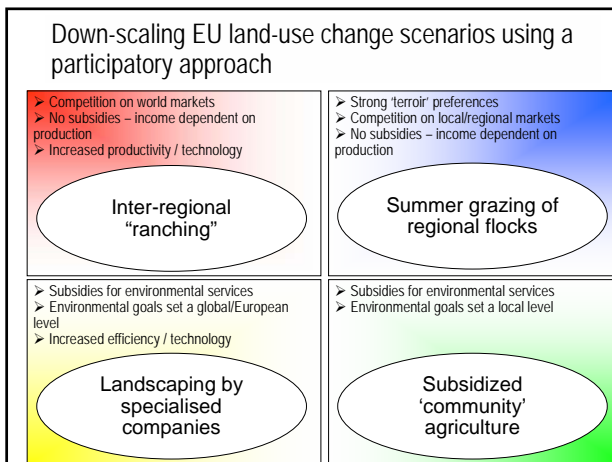
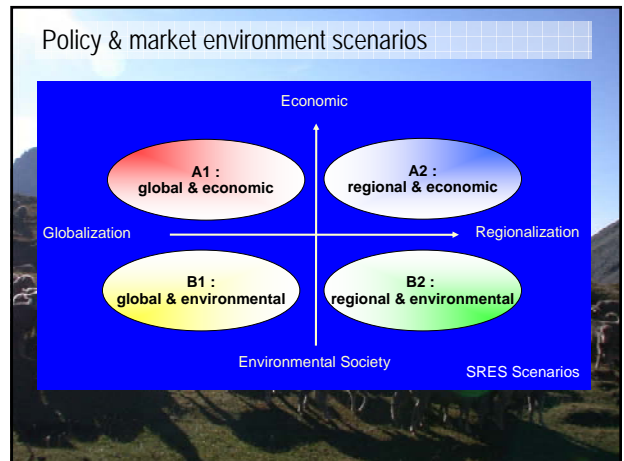
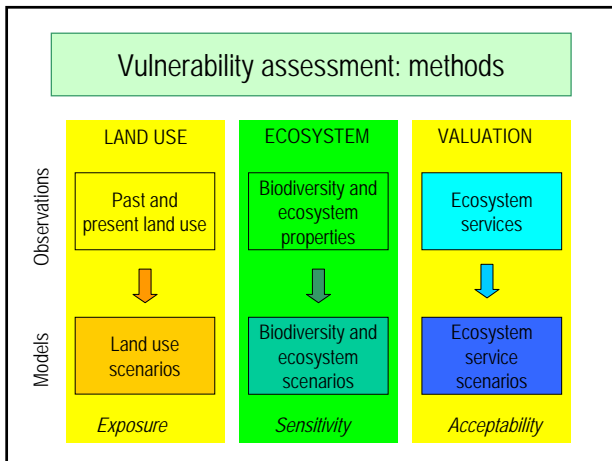
Quétier et al. 2007 Ecol. Appl.

Explaining ecosystem service delivery at Lautaret

| Ecosystem services | Ecosystem properties | Step 1: Abiotic factors | | Step 2: CWM traits | | Step 3: Trait distribution | |
|--|---|-------------------------|---------|--------------------|---------|----------------------------|---------|
| | | Variable | p-value | Variable | p-value | Variable | p-value |
| Fodder production | Aboveground net primary production (ANPP) | NNI | 0.004 | - | - | FDvg_VH | 0.040 |
| | Specific aboveground net primary production (SANPP) | NNI | 0.045 | - | - | FDvg_LNC | 0.091 |
| | Standing aboveground biomass (AGB) | - | - | - | - | FDvg_LHS | 0.089 |
| Snow gliding prevention | Standing litter biomass (Litt) | - | - | VH | 0.002 | FDvg_VH | 0.10 |
| | Cultural heritage | - | - | LNC | 0.012 | - | - |
| Habitat for butterflies | Litter decomposability (Decomp) | - | - | LTS | 0.046 | - | - |
| | - | - | - | LNC | <0.001 | - | - |
| Maintenance of soil fertility | Available nitrate (NO3) | - | - | Lig:N | <0.001 | - | - |
| | Denitrification potential (Den P) | - | - | RL | 0.044 | - | - |
| Sustained green fodder production through summer | - | - | - | LNC | 0.001 | FDvg_LHS | 0.026 |
| | Soil water content (SWC) | WHC | <0.003 | RL | 0.034 | - | - |
| - | AGB | <0.001 | LA | 0.043 | - | - | |
| - | - | - | - | RL | 0.001 | - | - |

Diaz, Lavorel et al. 2007 PNAS





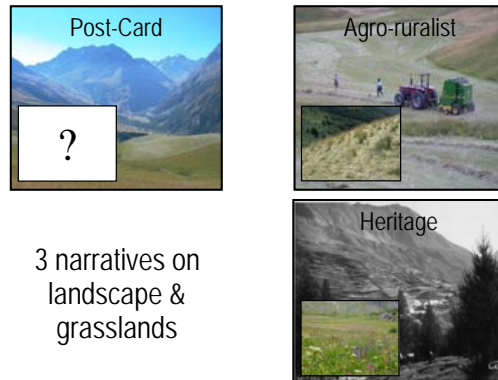
Comparing projections using a static versus dynamic approach

| %Change in Ecosystem Properties | Static Approach Using SAT grassland typology | | | | Dynamic Approach using PFF based modeling | | | |
|---------------------------------|--|--------|---------|---------|---|--------|---------|---------|
| | A1 | A2 | B1 | B2 | A1 | A2 | B1 | B2 |
| Grass Height (cm) | -1.4% | 7.56% | 5.52% | 4.92% | 19.96% | 10.01% | 6.93% | 8.23% |
| Stem Ground Biomass (t/ha) | 12.57% | 8.15% | -7.76% | 0.79% | 8.73% | 6.26% | 0.00% | 2.53% |
| % Legumes | -8.73% | -8.73% | 12.30% | 3.85% | -8.81% | -9.20% | -1.96% | -5.13% |
| % Intermediate grasses | 6.26% | 5.24% | 0.00% | 0.00% | 89.10% | 29.47% | 7.86% | 13.72% |
| % Pasture grasses | 20.51% | 33.29% | -3.63% | 1.82% | 13.26% | -0.03% | -0.02% | -2.02% |
| Species Number | -3.95% | 1.86% | -1.85% | 2.36% | 14.89% | 4.70% | 5.27% | 5.26% |
| Biodiversity Comparison | -3.49% | -1.27% | 1.66% | 0.20% | -4.20% | -2.76% | -0.20% | -1.46% |
| Land grazing intensity | 38.61% | 10.61% | 17.20% | 23.00% | 38.61% | 10.61% | 17.20% | 23.00% |
| Land cover | 100.00% | 98.14% | 100.00% | 100.00% | 100.00% | 98.14% | 100.00% | 100.00% |

| %Change in Ecosystem Service | Static Approach Using SAT grassland typology | | | | Dynamic Approach using PFF based modeling | | | |
|------------------------------|--|----|----|----|---|----|----|----|
| | A1 | A2 | B1 | B2 | A1 | A2 | B1 | B2 |
| Forage Quality | - | + | - | + | - | + | - | + |
| Forage Quantity | + | + | - | + | + | + | + | + |
| Testimony to past | + | + | - | + | + | + | - | 0 |
| Biodiversity | - | 0 | 0 | + | + | + | + | + |
| Colour variety | - | + | + | 0 | - | - | 0 | - |
| Well-kept grass | - | + | + | + | - | + | + | 0 |

Dynamic effects

Ecosystem services as common narratives

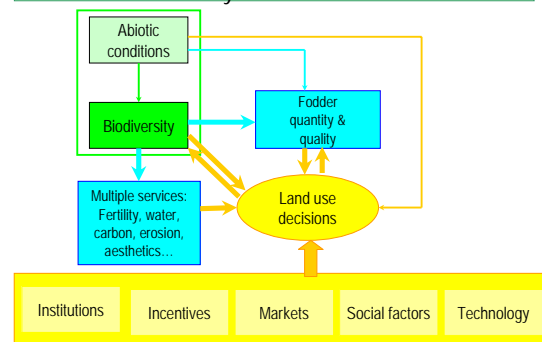


Step 4: Scenario outcomes projected by ecological models or through social surveys

| Modelling evaluation: projection | Acceptability Outcome | Scenarios | | | |
|----------------------------------|-----------------------|-----------|----|----|----|
| | | A1 | A2 | B1 | B2 |
| | post-card | - | - | + | + |
| | agro-rural | - | 0 | 0 | + |
| | heritage | 0 | 0 | 0 | 0 |

| Direct evaluation: interviews | Scenario Preferences | Scenarios | | | |
|-------------------------------|-------------------------------------|-----------|-----|-----|-----|
| | | A1 | A2 | B1 | B2 |
| | Post-Card | - | - | + | + |
| | Agro-Rural | - | - | - | +/- |
| | Heritage | - | - | +/- | + |
| | Other socio-economic considerations | - | + | - | + |
| | Overall | - | +/- | +/- | + |

The next step: Coupling human and ecological systems through ecosystem services



Thank you for your attention

