Agro-ecosystem: Complexity and biodiversity at various scales and its importance for the agricultural production system

Felix Herzog

Paris, 29.04.2015
T1: To what extent can biodiversity better support agro-ecosystems / agricultural production systems in terms of multi-functionality and outcomes in a global change context?

T2: Which policies and governance systems can promote the emergence and support of agro-ecosystems / agricultural production systems benefiting from and beneficial to biodiversity and ecosystem services?
The „big picture“:
Peak oil – peak child


→ Produce more with less

48 mio. sqkm (1/3 of Global land area)

Source: FAO
2013 – 14 Joint Call

**BASIL:** Landscape-scale biodiversity and the balancing of provisioning, regulating and supporting ecosystem services

**Eco-serve:** Sustainable provisioning of multiple ecosystem services in agricultural landscapes

**ECODEAL:** Enhancing biodiversity-based ecosystem services to crops through optimized densities of green infrastructure in agricultural landscapes

**Ecofruit:** Managing ecosystem services for fruit production in different European climates

**PromESSinG:** Management concept for Central European vineyard ecosystems: Promoting ecosystem services in grapes

**STACCATO:** SusTaining AgriCultural ChAnge Through ecological engineering and Optimal use of natural resources

**TALE:** Towards multifunctional agricultural landscapes in Europe: Assessing and governing synergies between biodiversity and ecosystem services

**VineDivers:** Biodiversity-based ecosystem services in vineyards: analysing interlinkages between plants, pollinators, soil biota and soil erosion across Europe

**CP³:** Civil-Public-Private-Partnerships and collaborative governance approaches for policy innovation to enhance biodiversity and ecosystem services delivery in agricultural landscapes

**BEEHOPE:** Honeybee Conservation centres in Western Europe: an innovative strategy using sustainable beekeeping to reduce honeybee decline.
Ecosystem services and dis-services to agriculture

Wei Zhang, Taylor H. Ricketts, Claire Kremen, Karen Carney, Scott M. Swinton

Supporting services:
- Soil structure and fertility
- Nutrient cycling
- Water provision
- Genetic biodiversity

Regulating services:
- Soil retention
- Pollination
- Dung burial
- Natural control of plant pests
- Food sources & habitat for beneficial insects
- Water purification
- Atmospheric regulation

Ecosystem dis-services:
- Pest damage
- Competition for water from other ecosystems
- Competition for pollination

Provisioning services:
- Food, fiber, and fuel production

Non-marketed services:
- Water supply
- Soil conservation
- Climate change mitigation
- Aesthetic landscapes
- Wildlife habitat

Ecosystem dis-services:
- Habitat loss
- Nutrient runoff
- Pesticide poisoning of non-target species

Feedback effect of dis-services from agriculture to agricultural input (e.g., removal of natural enemy habitat can encourage pest outbreaks)
**Agro-industrial approach**

Adapt the environment to the crop

**Agro-ecological approach**

Adapt the cropping system to the environment
What is agro-ecology?

“… the effort to mimic ecological processes in agriculture“
Plot - Farm - Landscape
Plot level intensification: Efficient ressource capture
Plot level intensification: Agroforestry LER > 1

Flower strips for pest control

- Natural enemies / Service providers
- Pests / Plant damage

Agro-ecosystems: Complexity and biodiversity at various scales | biodiversa, Paris, 29.04.2015
Felix.Herzog@agroscope.admin.ch
Significant reduction of cereal leaf beetles in wheat

*Oulema melanopus* L.:

- Larvae feed on leaves of cereals
- Major cereal crop pest in Europe (spreading in N-America)
Plot – Farm – Landscape
Farming enterprise: Major decision making unit!
Farms are often spatially disaggregated

Farm management units in Norway

© Fjellstad
Farms are often spatially disaggregated

Olive farm in Spain

© G. Moreno
Gains to species diversity in organically farmed fields are not propagated at the farm level

Plot — Farm — Landscape
Landscape level
Landscape context explains arthropod communities

Wild bees, true bugs, carabid beetles, hoverflies and spiders

Landscape fragmentation

Landscape composition (habitat amount)

Landscape configuration (connectedness)

→ Usually not differentiated
Cherry tree landscape experiment

Adjacent

Isolated

Isolation

Landscape habitat amount (%)
Agro-ecosystems: Complexity and biodiversity at various scales | biodiversa, Paris, 29.04.2015

Felix.Herzog@agroscope.admin.ch
N° of flower visits

Fruit set (%)
Ecosystem services and dis-services to agriculture

**Supporting services:**
- Soil structure and fertility
- Nutrient cycling
- Water provision
- Genetic biodiversity

**Regulating services:**
- Soil retention
- Pollination
- Dung burial
- Natural control of plant pests
- Food sources & habitat for beneficial insects
- Water purification
- Atmospheric regulation

**Provisioning services:**
- Food, fiber, and fuel production

**Non-marketed services:**
- Water supply
- Soil conservation
- Climate change mitigation
- Aesthetic landscapes
- Wildlife habitat

**Ecosystem dis-services:**
- Pest damage
- Competition for water from other ecosystems
- Competition for pollination

- Habitat loss
- Nutrient runoff
- Pesticide poisoning of non-target species

Feedback effect of dis-services from agriculture to agricultural input (e.g., removal of natural enemy habitat can encourage pest outbreaks)

Neglecting dis-services: «Major weakness of ES approach» (Lele et al. 2013)

<table>
<thead>
<tr>
<th>Period</th>
<th>Yield (kg/ha)</th>
<th>Weeds</th>
<th>Animal pests</th>
<th>Diseases</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1964/65¹</td>
<td>1250</td>
<td>9.8</td>
<td>5.0</td>
<td>9.1</td>
<td>23.9</td>
</tr>
<tr>
<td>1988–90²</td>
<td>2409</td>
<td>12.3</td>
<td>9.3</td>
<td>12.4</td>
<td>34.0</td>
</tr>
<tr>
<td>2001–03</td>
<td>2691</td>
<td>7.7</td>
<td>7.9</td>
<td>12.6</td>
<td>28.2</td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1964/65¹</td>
<td>2010</td>
<td>13.0</td>
<td>12.4</td>
<td>9.4</td>
<td>34.8</td>
</tr>
<tr>
<td>1988–90²</td>
<td>3467</td>
<td>13.1</td>
<td>14.5</td>
<td>10.8</td>
<td>38.3</td>
</tr>
<tr>
<td>2001–03</td>
<td>4380</td>
<td>10.5</td>
<td>9.6</td>
<td>11.2</td>
<td>31.2</td>
</tr>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1964/65¹</td>
<td>1029</td>
<td>4.5</td>
<td>11.0</td>
<td>9.1</td>
<td>24.6</td>
</tr>
<tr>
<td>1988–90²</td>
<td>1583</td>
<td>11.8</td>
<td>15.4</td>
<td>10.5</td>
<td>37.7</td>
</tr>
<tr>
<td>2001–03</td>
<td>1702</td>
<td>8.6</td>
<td>12.3</td>
<td>7.9</td>
<td>28.8</td>
</tr>
</tbody>
</table>
Neglecting dis-services: «Major weakness of ES approach» (Lele et al. 2013)

"ecosystem* AND service*"
16’786 REFs
- 13 also «dis-service»

ISI WoS 2005 - 2014

"crop* AND disease*"
67’125 REFs

"crop* AND pest*"
53’523 REFs
biodiversa
Collaborative research

**BASIL**: Landscape-scale biodiversity and the balancing of provisioning, regulating and supporting ecosystem services

**Eco-serve**: Sustainable provisioning of multiple ecosystem services in agricultural landscapes

**ECODEAL**: Enhancing biodiversity-based ecosystem services to crops through optimized densities of green infrastructure in agricultural landscapes

**Ecofruit**: Managing ecosystem services for fruit production in different European climates

**PromESSinG**: Management concept for Central European vineyard ecosystems: Promoting ecosystem services in grapes

**STACCATO**: SusTaining AgriCultural ChAnge Through ecological engineering and Optimal use of natural resources

**TALE**: Towards multifunctional agricultural landscapes in Europe: Assessing and governing synergies between biodiversity and ecosystem services

**VineDivers**: Biodiversity-based ecosystem services in vineyards: analysing interlinkages between plants, pollinators, soil biota and soil erosion across Europe

**CP³**: Civil-Public-Private-Partnerships and collaborative governance approaches for policy innovation to enhance biodiversity and ecosystem services delivery in agricultural landscapes

**BEEHOPE**: Honeybee Conservation centres in Western Europe: an innovative strategy using sustainable beekeeping to reduce honeybee decline.
biodiversa

Collaborative research

- Interdisciplinary and International
- Transaction costs …

… but added value!

I ENJOY

KOALATATIVE RESEARCH
Thank you for your attention

Agroscope  good food, healthy environment