Making soil protection goals based on the ecosystem services concept operational in ecotoxicological risk assessments

On behalf of ECPA:

Patrick Kabouw, BASF – Ecotoxicology
Gregor Ernst, Bayer CropScience – Environmental Safety
Soil is special

- Soil delivers important ecosystem services (EsS)
- Biodiversity close to endless
- “The black box soil”
- Soil is very heterogenic

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number of Individuals per footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>$10^{12} - 10^{14}$</td>
</tr>
<tr>
<td>Fungi</td>
<td>$10^{9} - 10^{12}$</td>
</tr>
<tr>
<td>Algae</td>
<td>$10^{6} - 10^{9}$</td>
</tr>
<tr>
<td>Protozoa</td>
<td>$10^{7} - 10^{9}$</td>
</tr>
<tr>
<td>Nematodes</td>
<td>$10^{4} - 10^{6}$</td>
</tr>
<tr>
<td>Mites</td>
<td>$2 \cdot 10^{2} - 4 \cdot 10^{3}$</td>
</tr>
<tr>
<td>Springtails</td>
<td>$2 \cdot 10^{2} - 4 \cdot 10^{3}$</td>
</tr>
<tr>
<td>Earthworms</td>
<td>up to 5</td>
</tr>
</tbody>
</table>

Protection of soils is not an easy task
General Protection goals

Thematic Strategy for Soil Protection

“Soil stores, filters and transforms many substances, including water, nutrients and carbon.” “These functions must be protected”

EU Biodiversity Strategy

“To halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020”

Chemical regulations require

No “unacceptable”, “undesirable”, “harmful” or “adverse effects” on “biodiversity”, “ecosystems” or “the environment as a whole”
Specific protection goals

General protection goals need to be translated into specific protection goals

General protection goal
Ecosystem services, functions, and biodiversity

Specific protection goal
(e.g. earthworm populations should be protected)

Specific protection goal
(e.g. no unacceptable effects on organic matter degradation)

Specific protection goal
(e.g. no unacceptable effects on nutrient cycling)

Check if specific protection goals matches general protection goals
Protection goals
-The start of every risk assessment-

1. General Protection goal
   - Protection goals: Need to be specified and agreed

2. Specific Protection goal
   - Translation into Specific PG

3. Acceptability criteria
   - Define sound scientifically based criteria for acceptability of effects on a Specific PG

4. Testing
   - Tests need to be validated – connected with Specific PG

5. Triggers
   - Triggers need to match Specific PG

Testing and Trigger need to match realistic protection goals
Ecosystem services

Heterogenous ecosystems

Cultural services
- Educational values
- Inspiration

Supporting services
- Soil formation
- Primary production
- Nutrient cycling

Provisioning services
- Food
- Fiber
- Genetic resources

Regulating services
- Erosion regulation
- Disease regulation
- Pest regulation

Need to set a spatial focus

Different EsS provided by different land uses
Specific protection goals

Different specific protection goals in-field & off-field

Important ecosystem services for sustainable agricultural production need to be protected

→ Maintenance of soil fertility - nutrient cycling
          - soil structure
          - erosion protection

Focus: in-field

Different specific protection goals for biodiversity based on the land use

Can’t protect everything everywhere all the time
How to protect ecosystem services

- Directly measure ecosystem services
- Reduce uncertainty in risk assessments

Measure parameter which are directly linked to EsS

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Soil relevant EsS
Soil formation & nutrient cycling
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Extrapolation

```
Indirectly measure “key drivers”
Soil organisms
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Novel testing methodologies - ECPA project -

Alternative functional soil tests are explored → direct linked to EsS which we want to protect

Functional relevance of effects on structure?

<table>
<thead>
<tr>
<th>Test system</th>
<th>Relevance for ESS</th>
<th>Standardization</th>
</tr>
</thead>
<tbody>
<tr>
<td>C- &amp; N- transformation</td>
<td>+++ (nutrient cycling)</td>
<td>+++</td>
</tr>
<tr>
<td>Litterbag</td>
<td>+++ (organic matter degradation, nutrient cycling)</td>
<td>+++</td>
</tr>
<tr>
<td>Minicontainer</td>
<td>+++ (organic matter degradation, nutrient cycling)</td>
<td>-</td>
</tr>
<tr>
<td>Bait lamina</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Soil micro-arthropods</td>
<td>??</td>
<td>+</td>
</tr>
</tbody>
</table>

Literature search → Field trial
Novel testing methodologies
-ECPA project-

Field trial: 2015 – 2016

- Control
- Methamidophos: 600 g a.s./ha
- Methamidophos: 3000 g a.s./ha
- Lindane: 2.5 kg a.s./ha
- Lindane: 7.5 kg a.s./ha

- Litterbag test
- Minicontainer test
- Bait lamina test
- Soil micro-arthropods

The Minicontainer test can represent a suitable alternative functional test system
How to protect biodiversity → Landscape level

Different specific protection goals for biodiversity in-field & off-field

→ Differentiation in …

• Taxonomical resolution, ecological/functional relevance
  (e.g. functional groups vs species/community)

• Temporal dimension (acceptable recovery times)

<table>
<thead>
<tr>
<th></th>
<th>In-field</th>
<th>Off-field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect</td>
<td>Organisms with high functional relevance</td>
<td>Biodiversity</td>
</tr>
<tr>
<td>Attribute</td>
<td>Functional groups and key drivers</td>
<td>Species &amp; communities</td>
</tr>
<tr>
<td>Temporal scale</td>
<td>Year</td>
<td>Weeks</td>
</tr>
</tbody>
</table>
How to protect biodiversity?

**Tier 1 risk assessment**

\[ \text{TER} = \frac{\text{Toxicity}}{\text{Exposure}} \]

**Options for refinement**

**Scenario specific effect modeling**
- Identify areas and/or scenarios of low and potential high risk
- Find suitable sites for higher tier testing

**Intermediate tiered testing**
- Testing under a more realistic exposure regime
- Natural soil testing
- Studies assessing the potential for recovery

**Risk mitigation**
- no-spray buffers
- Use restrictions based on results of scenario specific modeling

**Higher tier studies**
- Field effect studies with relevant key drivers
Conclusions

- Different level of protection depending on land use
- Protect important ecosystem services in-field
- Functional tests allows us to better link risk assessment with protection goals derived from EsS
- Protection of biodiversity: focus off-field
More information

- Poster Dinter: A Comparison of Functional and Structural Soil Testing for Risk Assessment of PPPs
- Poster Ernst: Measure soil functions directly related to Ecosystem Services
- Poster Bergtold: Protection goals
- Poster Coulson: Re-calibration of the earthworm tier 1 risk assessment of plant protection products
Thank You