Serious downstream effects of erosion, which has a landscape focus.
• Soil management: reduce erosion potential; increase organic matter content of the soil.
soils can sequester 0.6-1.2 Gt/C on world level (Lal, Hillel). Ignored potential. Example of effects of management on %C in prime agr. land in the Netherlands (Fluvaquent).

<table>
<thead>
<tr>
<th>Bulk density</th>
<th>org.matter</th>
<th>Kg m-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-tech arable land (left)</td>
<td>1.68</td>
<td>1.7</td>
</tr>
<tr>
<td>Organic farming (middle)</td>
<td>1.47</td>
<td>3.3</td>
</tr>
<tr>
<td>Permanent meadow (right)</td>
<td>1.38</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Prepare “storylines”: for each soil type! This is the most common sandy soil in the Netherlands.

- **A**: BD = 1.30 kg/m-3  
  OM = 8.1% (old grassland)
- **B**: BD = 1.36 kg/m-3  
  OM = 6.3% (reseeded grassland)
- **C**: BD = 1.48 kg/m-3  
  OM = 4.8% (arable land, often maize)

OM = 3.40-1.54 x Maize +0.19 x Old +0.55 xGWC. (R2=0.75) (50 farms)
But..plants bind only C when they grow! So N, P, K micronutrients and water are also important. Applies to food crops but also to e.g. green manure, meant to increase C.
Climate Problem: The concentration of CO2 has increased by 35% from 280 ppm in 1750 to 377 ppm in 2004 and is presently increasing with 1.8 ppm/year. Adding contributions of other greenhouse gases (CH4, N2O) we assume that, as a result, temperatures may rise by 1.5-5.8C in 2100.

Hypothesis: By strongly reducing greenhouse-gas emissions by adsorption of C in soil we may be able to restrict the temperature rise to 2C by 2100, which appears bearable.

Issue here: How can soils and soil management contribute to reducing greenhouse-gas emissions? Estimates are that at a maximum of 50ppm CO2 can be reduced in 150 yrs.
**Water problem:** widely polluted surface- and groundwater has severe health effects; also excessive extraction of groundwater. Volume of wastewater produced is six times the water in all rivers of the world (*google: world water quality*). 2.5 billion people without drinking water and sanitation.

**Hypothesis:** increasing the soil organic matter content will improve filtration of percolating water, stabilize structure= more infiltration.

**Issue here:** how to increase organic matter content of the soil and avoid soil degradation and erosion.
Purification depends on travel times in the soil: longer times means more contact and better purification.

Fig. 3—Removal of poliovirus (added to septic tank effluent) in sand-columns at two different flow regimes (after Green & Cliver, 1974).
Purification of wastewater in structured soils is complicated: rapid movement occurs when water flows through the cracks around the structural elements: little purification. It’s perfect when water flows through the elements.
Removal of fecal bacteria in structured silt loam soil: effects of flow through and around the peds
**Food problem:** agricultural production has to increase by 70% to feed 9 billion people in 2050, who require more calories because of higher prosperity. 70% will live in (mega)cities; 50% now. At this time 880 million people are undernourished (google world food security 2050). Biofuels aggravate the problem!

**Hypothesis:** improving soil quality by increasing organic matter content (more water and nutrient holding capacity) and by combatting soil degradation and erosion, soils can perhaps deliver the necessary food. Soils are key!

**Issue here:** can this be done, also in relation to requirements of other major environmental issues?
**Biodiversity loss:** extinction rate of species is now 1000 times as rapid as the natural background rate. Serious concern that ecosystems may collapse, with dramatic consequences for a.o. agriculture. *(google: global biodiversity loss).*

**Hypothesis:** soil conservation and maintaining or increasing the organic matter content of soil can be a significant factor in combatting ecosystem decline.

**Issue here:** can soils really contribute here or are other factors causing biodiversity loss more significant?
Figure 1. The global carbon cycle showing carbon stocks in reservoirs (in Gt C = 1 Pg C = $10^{15}$ g C) and carbon flows (in Gt C yr$^{-1}$) (Source: GLOBE Carbon Cycle 2007)
Unfortunately, climatologists, hydrologists, agronomists and ecologists talk more to each other than to their colleagues.

But only a comprehensive analysis, including tradeoffs between different objectives, can be successful in arriving at realistic decisions.

For soils, soil conservation, avoiding degradation and erosion, is crucial plus increasing soil quality by increasing the organic matter content of topsoil.

Sequence of relative soil impact on the major issues: (1) food, (2) water, (3) climate and (4) biodiversity.

But what is our approach?
Why is it that we know so much and that so little of this knowledge is applied in the policy arena and in practice when dealing with “wicked” environmental problems? Close the knowledge chain!

Realize true transdisciplinarity, stay involved with KENGi partners. Appoint knowledge brokers (Extension 2.0) in the research team. It takes time!!!

So what’s the message!

• Soils are key elements when discussing food- and water security, climate change and biodiversity loss. Soil conservation, avoiding erosion and soil degradation and increasing the soil organic matter content are significant contributions to alleviate the four major environmental problems of the future. **So: organic matter in soils is an important issue and deserves attention!**

• In decreasing order of significance: (1) food; (2) water; (3) climate, and (4) biodiversity.

• We know what to do but we don’t get it done! The research community has got to get its act together! Close the knowledge chain and invest in true transdisciplinarity: be prepared to face blood, sweat and tears.