Integrated management of soil and subsurface

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Programme

- Introduction
- Soil and subsurface: challenges
- Sustainable development
- Integrated management: ecosystem services
- Cases: IBC locations, Amersfoort / Amsterdam
- Discussion – remaining questions
Introduction

• Who am I?
• Link with soil and subsurface – KOBO network
• Who are you?
• Knowledge and images of soil and subsurface
Who am I?

- Senior lecturer Sustainable Development, Saxion University of Applied Sciences
- Member of KOBO network (Dutch Higher Education Network on Soil and Subsurface)
Soil and subsurface

• Definition
• Functions
• Challenges
• Policy
Interaction between spheres
Interaction between spheres (2)

- Plants absorb carbon dioxide (the main climate-altering gas) and produce oxygen instead.
- Dead leaves and plants add nutrients to the soil. Insects and animals burrow, helping the soil breathe.
- Trees and other plants slow the flow of rainwater to rivers, acting as a natural flood control.
Soil

- Interaction with biosphere (vegetation, bacteria, fungi, micro- and macrofauna)
- Up to 10 meters.
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Subsurface: part of the lithosphere interacting with human activities

- Energy provision and transport
- Supporting food production
- Resources extraction
- Storage / dumping of ‘waste’
- Subsurface infrastructure
- Up to 5 km
Challenges

• Scarcity of space, especially in urbanised areas
• Interaction between functions (known or unknown; positive or negative)
• Conflicts of interest between stakeholders
• Unknown or unwanted long term effects (local or elsewhere)
Problems / dilemmas in subsurface

- Gas extraction / earth quakes
- Impact of heat / cold exchange and Geothermy (deep extraction of heat)
- Impact of CO2 storage, oil storage, storage of polluted water
- Impact of shale gas extraction
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Problems / dilemmas in soil

- Loss of organic matter / soil fertility
- Over-fertilisation (N, P)
- Soil pollution and land use
- Soil subsidence / peat oxidation / salinisation
Soil subsidence in peat areas in the Netherlands
Erkens et al (2016)
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Peat digging and draining (Erkens, 2016)

Fig. 2 Schematic cross-section across the Dutch coastal plain in its most peaty development. A sandy coastal barrier is present in the west. On the landward side, a wedge of fine-grained elastic back-barrier deposits is enveloped in organic deposits. The land surface of AD 1000 represents a more or less pristine bog and fen landscape; the current land surface reflects the effects of a thousand years of cultivation. The current lowest areas are mined peat bogs (a), the remnants of which function as dykes (b). Fen areas (c) are primarily lowered by subsidence attributed to water table drainage, as indicated schematically by ditches. Hatching between the historic and present land surface indicates the volume loss of peat, the reconstruction of which is the first objective of the study.
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To deal with these issues, we need to...

- Understand the systems and their interactions, including complex long term processes
- Create awareness among experts and stakeholders about the role and importance of soil and subsurface
- Develop decision making tools, to deal with conflicting interests and long term impacts.
Sustainable Development

- Social quality
- Environmental quality
- Economic quality
- Process
- Spatial quality
- Here and now
- Elsewhere and later
## Combine qualities here/now and elsewhere/later

<table>
<thead>
<tr>
<th>Elsewhere</th>
<th>Attention for effects outside area</th>
<th>Elsewhere / later Sustainable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Here</td>
<td>Here / now</td>
<td>Future proof</td>
</tr>
<tr>
<td>Quality</td>
<td>Now</td>
<td>Later</td>
</tr>
</tbody>
</table>
UN Sustainable Development Goals

• UN Sustainable Development Goals
Tools for sustainable planning with respect to soil and subsurface

- Make use of the qualities and (ecological) services
- Understand the systems and interactions on different scale levels
- No transfer of problems to the future and to other areas / stakeholders
- Combining interests of different stakeholders
3-D planning: Dutch Layer approach

- Occupation layer
- Infrastructure / networks
- Subsurface / soil and geology
Ecosystem / Geosystem services

• Framework for decision making on subsurface issue
• Natural capital approach: we receive products and services *for free*, from ecosystems and the subsurface – but this can only continue if we do not deplete or disturb the resources
Ecosystem services

Provisioning Services
- Food
- Fresh water
- Fuelwood
- Fiber
- Biochemicals
- Genetic resources

Regulating Services
- Climate regulation
- Disease regulation
- Water regulation
- Water purification
- Pollination

Cultural Services
- Spiritual & religious
- Recreation
- Ecotourism
- Aesthetic
- Inspirational
- Educational
- Sense of place
- Cultural heritage

Supporting Services
- Ecosystem Functions

Nutrient Cycling | Evolution | Soil Formation | Spatial Structure | Primary Production

Modified, with additions, from the Millennium Assessment.
• Services create conditions for well-being of humans
• But this can only continue if the natural capital is managed in a sustainable way
Biodiversity and Ecosystem Services (BES)

**Ecosystem services**

**Supporting**
- Nutrient cycling
- Soil formation
- Primary production
- ...

**Provisioning**
- Food
- Fresh water
- Wood and fibre
- Fuel
- ...

**Regulating**
- Climate regulation
- Flood regulation
- Disease regulation
- Water purification
- ...

**Cultural**
- Aesthetic
- Spiritual
- Educational
- Recreational
- ...

**Constituents of well-being**

**Security**
- Personal safety
- Secure resource access
- Security from disasters

**Freedom of choice and action**
- Opportunity to be able to achieve what an individual values doing and being

**Basic material for good life**
- Adequate livelihoods
- Sufficient nutritious food
- Shelter

**Health**
- Strength
- Feeling well
- Access to clean air and water

**Good social relations**
- Social cohesion
- Mutual respect
- Ability to help others

Arrow colour: Potential for mediation by socioeconomic factors
- Low → Medium → Strong

Arrow width: Intensity of linkages between ecosystem services and human well-being
- Weak → Medium → Strong
From ecosystem services to geosystem services

- Not only biosphere and soil, but also (abiotic) deeper subsurface
- Adds issues like energy transition, deep water extraction and resource extraction
- Helps to develop an integrated perspective on the system
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From ecosystem services to geosystem services

**Figure 1. Natural capital overview diagram. Adapted after EU (2013)**
Figure 2. Framework linking land use and the subsurface.
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From services to benefits and value

Figure 4. The Geosystem Services Cascade (adapted Braat & de Groot, 2012).
• Sub-surface vision Apeldoorn

• Towards a sustainable use of soil and subsurface in spatial planning
From services to qualities: subsurface vision Apeldoorn

<table>
<thead>
<tr>
<th>Carrier qualities</th>
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</thead>
<tbody>
<tr>
<td>Carrying capacity (strength) for constructions on the surface</td>
</tr>
<tr>
<td>Subsurface construction (tunnels, parking garages etc)</td>
</tr>
<tr>
<td>Subsurface pipelines (oil, gas, water, wastewater, others)</td>
</tr>
<tr>
<td>Cables and other small infrastructure (electricity, data, etc)</td>
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</tbody>
</table>
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**Information qualities**

- Geological values
- Archaeological values
- Landscape and cultural history values
- Unexploded bombs (2nd World War)
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Regulation qualities

Clean and healthy soil

Living soil (organic matter, bacteria, funghi, microfauna)

Water storage capacity in the soil

Water filtering and cleaning capacity in the soil

Area-specific groundwater management
Impact on decision making

- Ecosystem services will be available for ever and for free …
- If used in a sustainable way (no pollution, no over-exploitation)
- Knowledge of sub-surface processes is used for on-surface planning decisions
Area specific groundwater management
Mutual benefits

- Heat and cold exchange systems = renewable energy
- Soil pollution cleaned by water movements caused by HCE systems
- → plan HCE downstream the pollution flow in the subsurface
IBC

- Areas with soil pollution, with NO plans for complete sanitation
- Removal of pollution is too difficult, too expensive.
- Leads to limited options for land use
- IBC = Isolate, manage / control; monitor
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IBC:

IBC-Maatregel

Isoleren
Beheersen
Controleren
Steps

- Identify problems and options for solutions
- Determine potential for redevelopment
- Identify / create drivers for redevelopment
- Combine interests
- Determine overall strategy and specific measures
Integrated analysis: 5 dimensions approach

- Environment (physical and stakeholders)
- Legal
- Policy and governance
- Technical
- Financial
Approach

• For each dimension: problem inventory and development of solutions
• Involvement of experts AND stakeholders in all stages of the process
Determine potential for redevelopment

- Urban vs rural
- Bare land vs built up area
- Steady pollution vs moving pollution
Identify / create drivers for redevelopment

- (Expected) health risks
- Complaints (noise, smell, landscape)
- Interested stakeholders (business, creative sector, environment experts)
- Money (maintenance too expensive; investors with a possible business case)
Combine interests

Mutual Gains Approach

• Identify interests, ideas and dreams
• Look for options to combine interests and create mutual benefit
Determine strategy

- Develop area
- Reconsider sanitation approach
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- Branding / creating new image
- Apply technical / chemical experiments
- Develop concepts for temporary use
CASUS: VETGASFABRIEK AMERSFOORT
Voormalige Vetgasfabriek, Amersfoort
Overzichtstekening

Legenda
- Voormalige bassins
- Brongebied 1e WVP
- Brongebied 2e WVP
- Gerealiseerde ontwikkeling
- Geplande ontwikkeling
- Locatie Vetgasfabriek
- Infiltratiesloot
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Strategy

- Remove moving soil pollution gradually (long term approach)
- Accept limitations in land use
- Add functions in line with these limitations (urban garden; use of historic trains; neighbourhood park; housing / work space / parking lots where possible)
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Urban garden

Waarom is dit idee geschikt voor op IBC-locaties?

- Veel urban gardens werken met het idee ‘container gardening,’ dit houdt in dat het tuinieren gebeurt in emmers en bakken. De planten maken nooit contact met de grond, wat zeer geschikt is voor locaties met vervuilde grond. 
- Het is ook een geschikt idee voor tijdelijk gebruik voor een locatie. Als de locatie in permanent gebruik genomen zal worden kan de ‘tuin’ makkelijk verplaatst worden naar een andere locatie in de stad.

Bibliotheek: (Veeer, 2017), (Veeer, 2017), ( Tumblr, 2018)
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Re-use of old trains
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Urban park
Amsterdam, De Ceuvel

Seriously polluted area in Amsterdam north

Redevelopment into center for circular economy, as a result of a design contest
Main features

- Houseboats on land;
- Vegetation for phytoremediation;
- Research and knowledge exchange with respect to circular economy;
- Restaurant / place to relax;
- Temporary use;
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- https://www.youtube.com/watch?v=D5eu3lH3BP4
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Success factors

• Creativity / originality
• Dreams / expertise / perseverance
• Design and communication skills (Branding)
• Creative and open minded visitors
• Influence on surrounding area (Buiksloterham)
Conclusion

• Soil and subsurface: many invisible and unknown functions
• impact on planning and decision making often underestimated
• Integrated approach necessary for sustainable development of subsurface and ‘visible functions’.