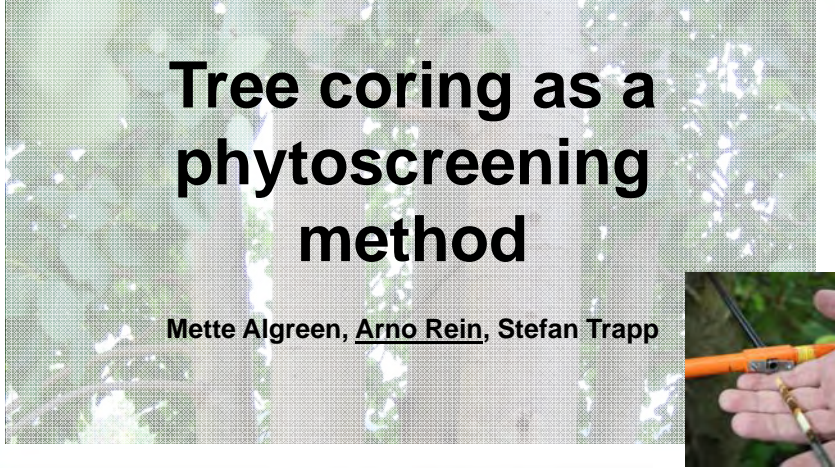



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# Tree coring as a phytoscreening method

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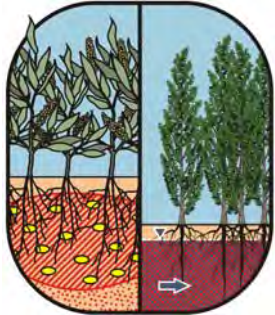
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## I. Introduction



- ✔ Pollutants in soil & GW can be transferred into vegetation
- ✔ **Vegetation** as indicator for subsurface pollution
- ✔ The potential of **tree core sampling** is tested to obtain **screening information** over extended contaminated sites & for monitoring of remediation and/or natural attenuation



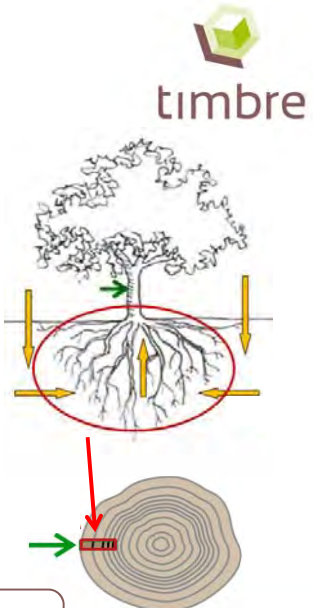
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## I. Introduction

- Each **tree** is a combination of a **well, pump & sampler**
- Represent a large soil area
- TREE CORE SAMPLE** taken from the stem
- Advantages of the method: low-invasive, simple, fast sampling, cost-effective
- Can be applied in areas inaccessible for heavy equipment


*Root depth 3-8 m in average*  
*"Standard plant" transpires approx. 1 L/d (temperate climate zone)*



The diagram shows a tree with its root system. A red circle highlights the root system, and a green arrow points to the stem. Below the tree, a cross-section of a tree trunk is shown with a red arrow pointing to a core sample. The logo 'timbre' is in the top right corner.


## II. Methodology

- Wood is sampled with an **increment borer** (commonly used tool by foresters): tree cores of about 6cm length are taken
- Samples** are **prepared & analysed** with common methods





The photographs show an increment borer being used on a tree trunk. A tree core sample is shown below it. Two glass vials are shown at the bottom, labeled 'Organics' and 'Metals'. The logo 'timbre' is in the top right corner.



## II. Methodology




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- 🌿 = **semi-quantitative method**
  - 🌿 Variability with wood type, wood mass not constant
  - 🌿 Plant concentration not linearly related to soil / GW
  - 🌿 Range of sensitive parameters varying with tree species, location, season, meteorological conditions
- 🌿 **Not possible:** exact calculation of concentrations (in tree stems from soil / GW or vice-versa)
- 🌿 **Possible:** valuable information concerning plume extension and characterisation







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## III. Tree coring for chloroethenes



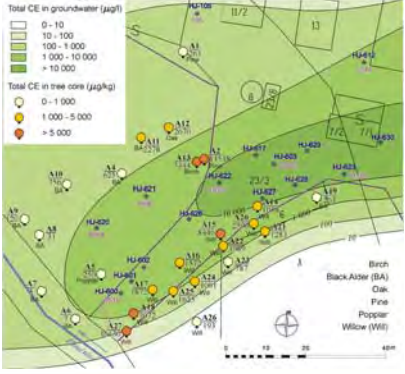
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- 🌿 Tree core sampling: repeatedly & successfully applied to delineate plumes of chlorinated solvents (PCE, TCE,...) (\*)
- 🌿 (\*) e.g. Larsen et al. 2008:
- 🌿 GW vs. trees: similar maps concerning plume area, direction & centre (PCE, TCE, cDCE)
- 🌿 New hot spot discovered: high conc. in trees, confirmed by MIP

Environmental Science & Technology 42, 1711-1717, 2008

**Using Tree Core Samples to Monitor Natural Attenuation and Plume Distribution After a PCE Spill**

MORTEN LARSEN,<sup>1</sup> JOEL BURKEN,<sup>1</sup> JIŘINA MACHÁČKOVÁ,<sup>2</sup> OLDRICH GOSEWINKEL KARLSON,<sup>2</sup> AND STEJAN TRAPP<sup>1\*</sup>






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## IV Tree coring for heavy metals

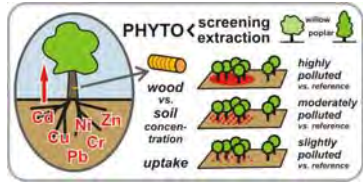


- 🌿 Former waste dumping site Møringa, Norway (\*)
- 🌿 3 sites in Denmark (\*\*)
  - Valby, strongly polluted (former sludge disposal site)
  - Frederiksværk, moderately polluted (former steel work)
  - Hillerød, slightly polluted (former wood proofing area)
- 🌿 Former steel mill, TIMBRE test site Hunedoara, Romania

🌿 **Tree core sampling at the test (polluted) sites & at reference sites (assumed unpolluted)**

🌿 **[some metals/elements may be present as background; some are essential to plants]**

🌿 ICP-OES; sample digestion with HNO<sub>3</sub>, sand bath



(\*) Algreen et al. 2011, International Journal of Phytoremediation, 14: 305–319  
(\*\*) Algreen et al., submitted

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## IV Tree coring for heavy metals

- 🌿 **Difference between contaminated area and reference**
  - 🌿 Mean concentrations in contaminated areas mostly > reference
  - 🌿 Significant: **Møringa**: for **all trees** and **As, Cr, Pb**  
for **willow trees** and **As, Cr, Pb, Cd, Zn**
  - 🌿 **Danish sites**: Pb, Cr below detection limit
  - 🌿 Cd, Cu, Ni, Zn significantly elevated in willows (highly polluted site)
  - 🌿 poplars: Cd, Ni, Zn sign. as well, but difference less clear; insignificant for Cu
  - 🌿 **Hunedoara**: sign. differences seen for Cd, Cu, Ni, Zn, Cr, Mn (UNDER WAY)
- 🌿 **Correlation between soil & tree core concentration**
  - 🌿 **Møringa**: All tree species: correlation (mostly) positive, but not significant
  - 🌿 **Willows** only (Salix caprea): **significant rank correlation** for **As, Cd** and **Pb**, but negative trend for Pb (probably atmospheric influence at reference site)
  - 🌿 **Danish sites**: also no linear relation (\*), but rank correlation
  - 🌿 (\*) bioconcentration factors were increasing with decreasing concentration in soil: conc. in wood seem to approach background level: elevated levels in wood only at rather high concentrations in soil


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## V Tree coring for BTEX , PAH and other compounds




- 🌿 **Huneodara site:** **BTEX** (benzene, toluene, ethylbenzene, xylen) and **naphthalene** could be detected in some trees growing at a high risk zone
- 🌿 Further analyses, including other PAHs, and evaluations of results under way
- 🌿 Tree core sampling campaign planned for Sept 2012 at TIMBRE site **Szprotawa**, Poland (**BTEX and fuel constituents**)



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## VI Joint sampling strategy

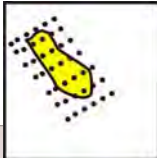
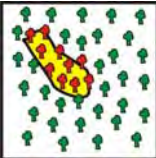


- 🌿 **Joint sampling campaign** with **direct push (DP)**
- 🌿 AIM: methodology tests (trees vs. soil / GW)
- 🌿 & test / application of **JOINT SAMPLING STRATEGY:**


↓

↓

① **PRE-SCREENING with tree core sampling** → ② **with information from 1: DP-based investigation in AREAS OF CONCERN**



- 🌿 Can be done in an iterative / adaptive manner
- 🌿 **ADVANTAGE: potential to save considerable costs**



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## VII Conclusions



- 🌿 **Tree core sampling = low-invasive, fast & cost-effective**
- 🌿 **Semi-quantitative prescreening method** useful for initial screening of large areas, or for areas difficult to access with heavy equipment  
(elevated concentrations in wood indicate elevated conc. in subsurface and call for further evaluation with more quantitative methods)
- 🌿 **Repeatedly and successfully applied for chlorinated solvents**
- 🌿 **Heavy metals & toxic elements:** uptake underlies natural variations and depends on tree species and soil properties
  - differences between contaminated areas and (nominally) unpolluted reference site not always statistically significant; **promising results with willows and poplars**
  - natural occurrence (detect alone does not indicate soil pollution)
  - required: comparison to wood from unpolluted reference site, with same species and similar soil conditions
- 🌿 **BTEX and naphthalene detected in tree cores**
- 🌿 Feasibility investigations in progress, including further compounds



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## Acknowledgements



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**Thanks for your  
attention !**

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