VÝSLEDKY MEZINÁRODNÍCH VÝZKUMNÝCH PROJEKTŮ ISOSOIL A MODELPROBE

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ČZU ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE

AECOM

ISOsoil

ModelPROBE
Model driven Soil Probing, Site Assessment and Evaluation

- 11 subjektů ze sedmi evropských zemí pod vedením Stockholmské univerzity (Švédsko)
- výzkum možností využití izotopové analýzy k hodnocení biodegradace a původu znečištění
- vývoj software k hodnocení izotopových analýz
- projekty financovány v 7. rámcovém programu

- 19 subjektů z deseti evropských států pod vedením Helmholtzova centra pro environmentální výzkum (Německo)
- vývoj nástroje, který kombinuje neinvazivní a málo invazivní inovativní techniky průzkumu znečištěných lokalit tak, aby průzkumy byly přesnější, méně zatěžovaly životní prostředí a byly tak v souladu s principy trvale udržitelného rozvoje

Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
Stockholm University	SU	Sweden	1	36
ALS Laboratory Group AB	ALS	Sweden	1	36
Hellenic Centre for Marine Research	HCMR	Greece	1	36
Eidgenössische Technische Hochschule Zürich	ETH-Z	Switzerland	1	36
Masaryk University	MU	Czech Republic	1	36
Earth Tech CZ s.r.o.	ETCZ	Czech Republic	1	36
Technical University of Lodz	TUL	Poland	7	36
University of Bristol	UB	Great Britain	1	36
FQS Poland Sp. z.o.o.	FQS	Poland	7	36
Makolab SA	MLAB	Poland	7	36
IVL Swedish Environmental Research Institute	IVL	Sweden	1	36

Key limitations to current assessment of widespread organic contamination of soils and site specific characterization

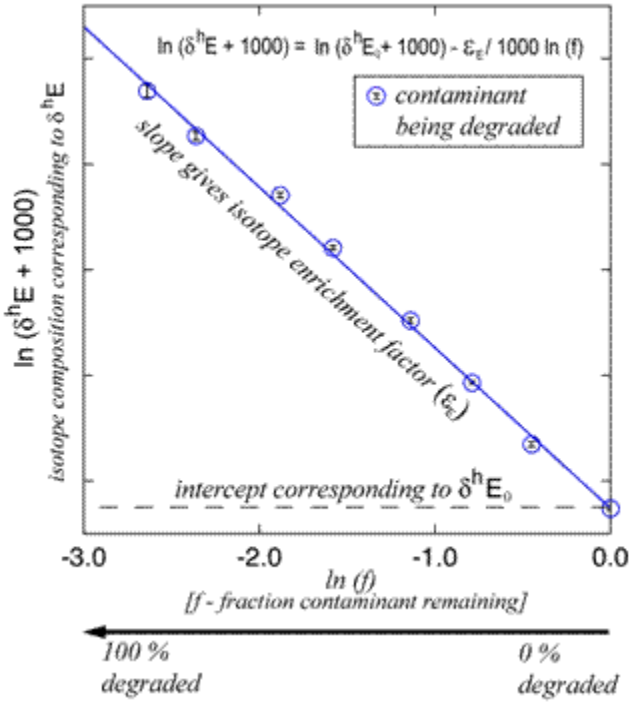
Conventional concentration-based approaches are insufficient to resolve important site-specific issues such as :

I. the extent of *in situ* degradation ("natural attenuation")
II. accurate source apportionment ("environmental forensics")

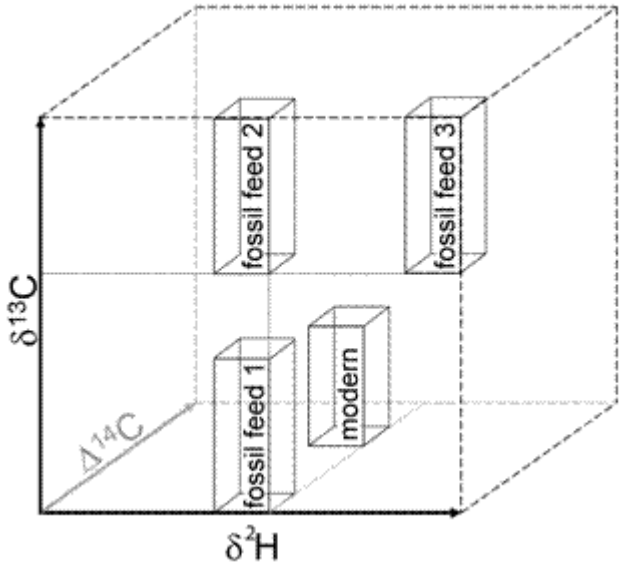
Solution:

- **Compound-specific isotope analysis (CSIA) for both degradation monitoring and source apportionment based on the molecular-isotopic composition of contaminants**

Monitoring biodegradace



Rozlišení zdroje kontaminace (fosilní/recentní – např. PAU)



Call Topic: *Improved technologies and tools for site characterization and monitoring of contaminated soils including chemical analysis*

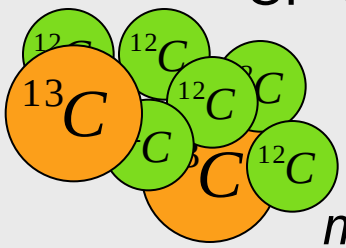
Expected Impact: *A precise and reliable site characterisation and monitoring design*

isoSoil Objectives

- Development of compound-specific isotope analyses (CSIA) of $^{13}C/^{12}C$, $^{2}H/^{1}H$, $^{15}N/^{14}N$, and $^{37}Cl/^{35}Cl$ as powerful novel tools for improved site-specific characterization and monitoring of microbial and abiotic degradation
- Establishment of generally applicable isotope enrichment factors for common soil contaminants and their microbial and abiotic degradation reactions
- Development of new analytical methods for higher throughput in CSIA of $^{37}Cl/^{35}Cl$ and $^{81}Br/^{79}Br$
- Development of web-based commercial software for end-user interpretation of CSIA results for "degradation monitoring"

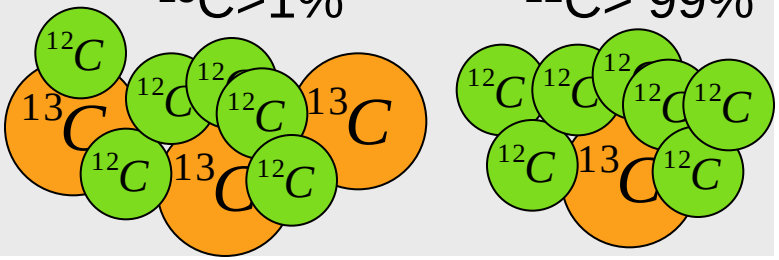
Stable Isotope
Fractionation

“natural conditions”
substrate
^{12}C:^{13}C = 99:1



microorganisms

residual substrate + product
^{13}C>1% ^{12}C> 99%

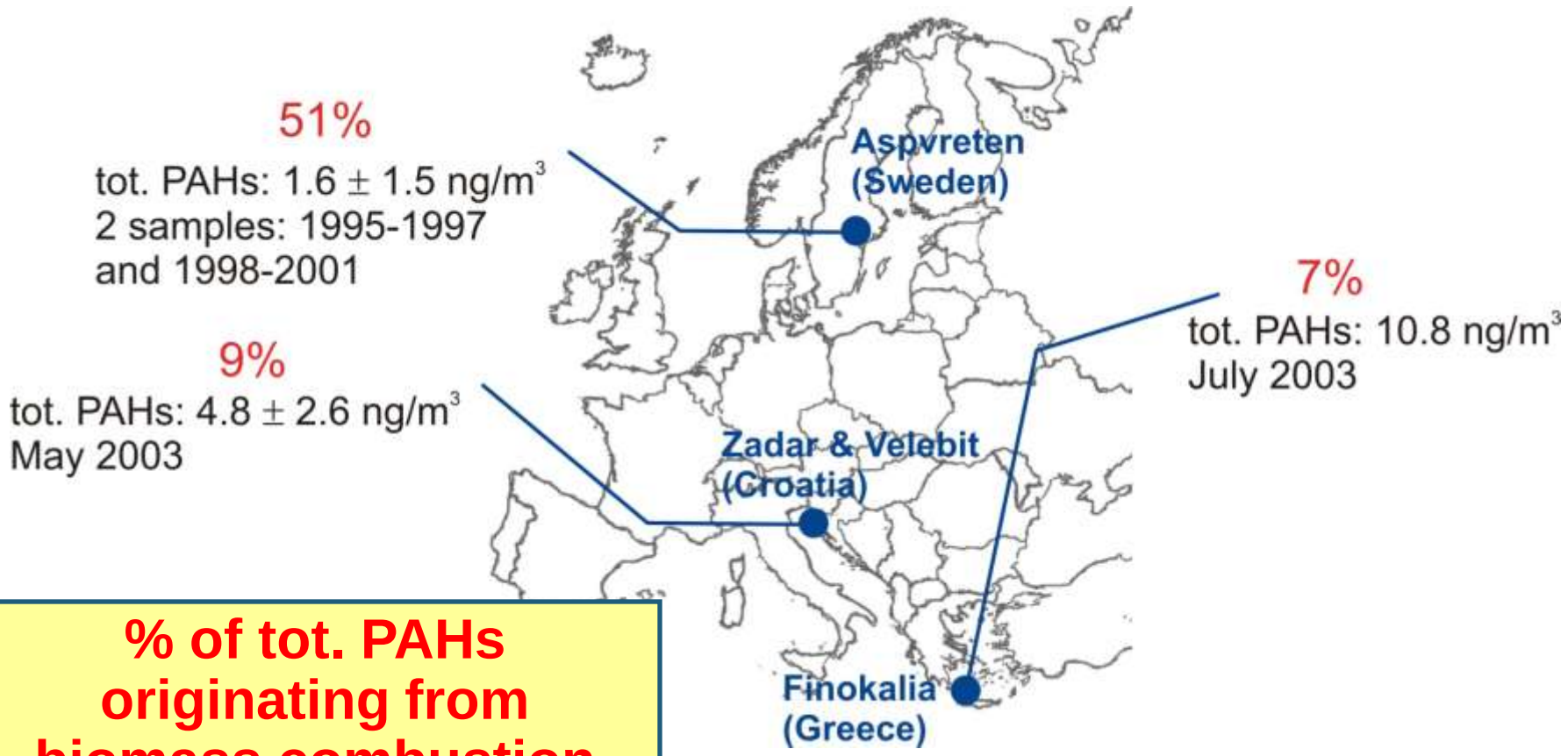


Method for:

qualitative and
quantitative
characterization of
biodegradation
in the field

Fischer et al. 2007 EST 41, 3689-3696
Fischer et al. 2008 EST 42, 4356-4363
Fischer et al. 2009 RCM 23, 2439-2447
Vogt et al. 2008 EST 42, 7793-7800
Rosell et al. 2007 EST 41, 2036-2043

^{14}C Source Apportionment of PAHs in Ambient Air

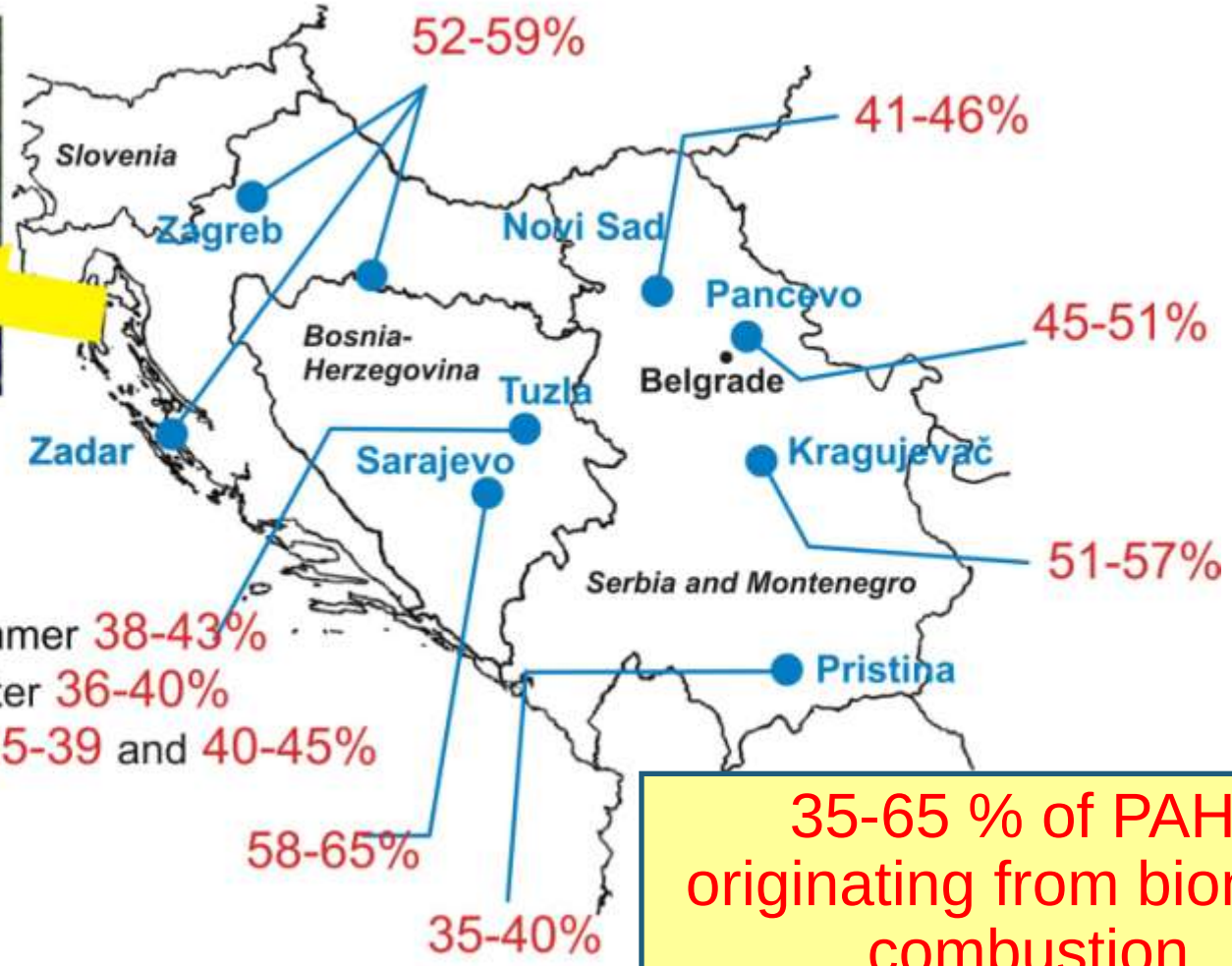


% of tot. PAHs originating from biomass combustion

Results from Hi-Vol samples

Mandalakis et al. *Environ. Sci. Technol.* **2005**, 39, 2976-2982.

Spatial resolution: CCSRA-PAHs in Balkan Air

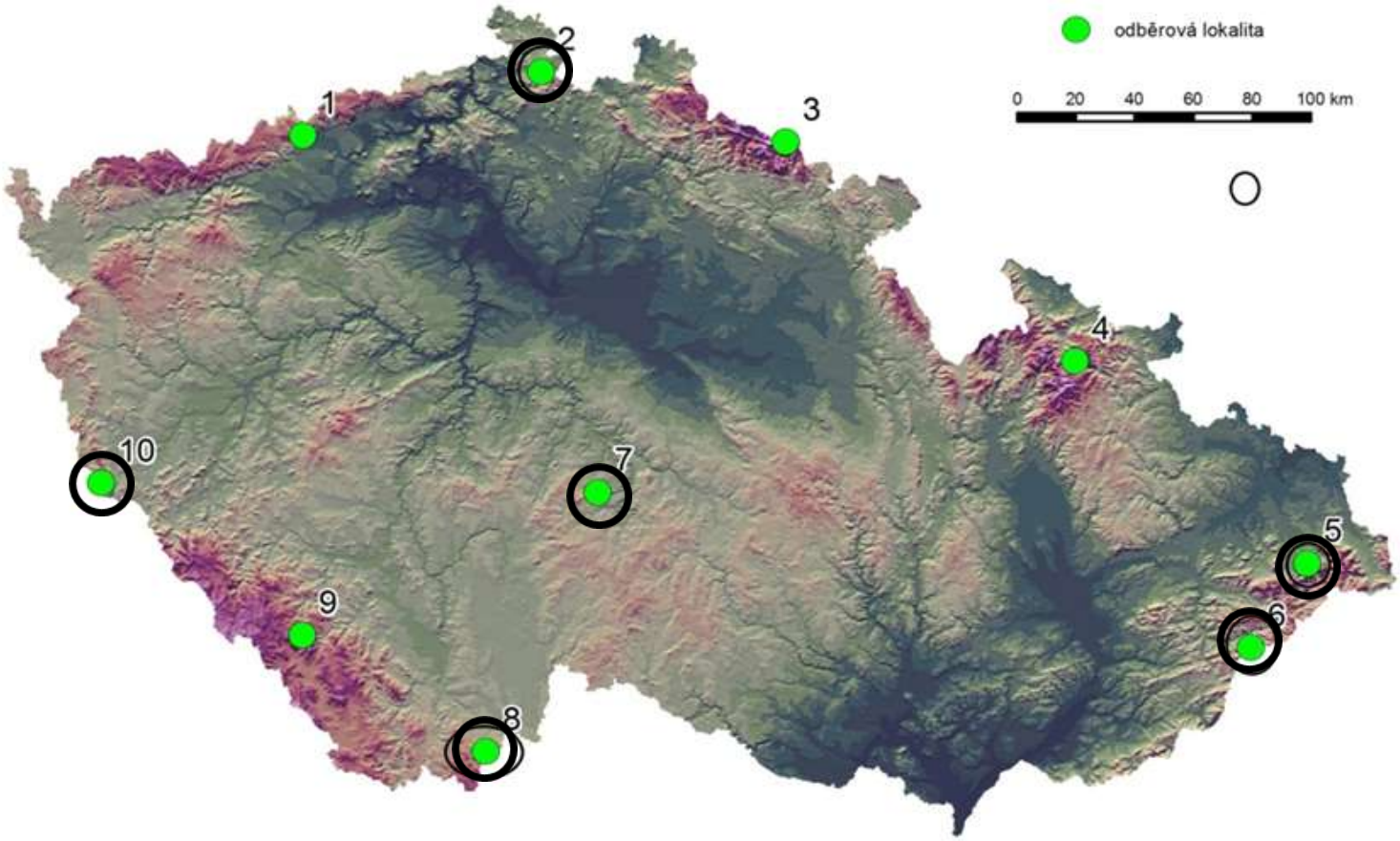


35-65 % of PAHs originating from biomass combustion

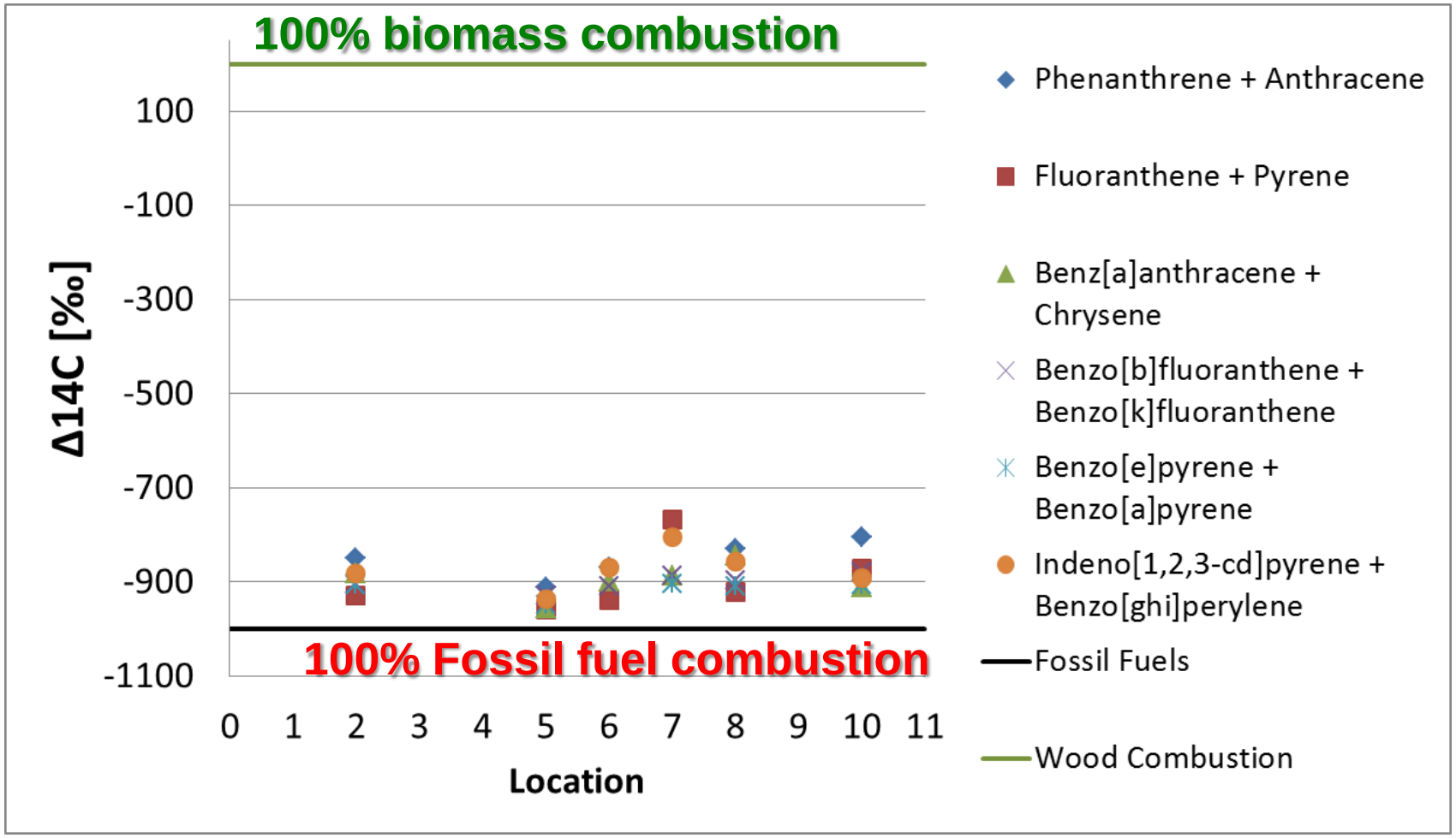
Passive sampler campaign July-December 2004

Zencak et al. (2007) *Environ Sci. Technol.*, *41*, 3850.

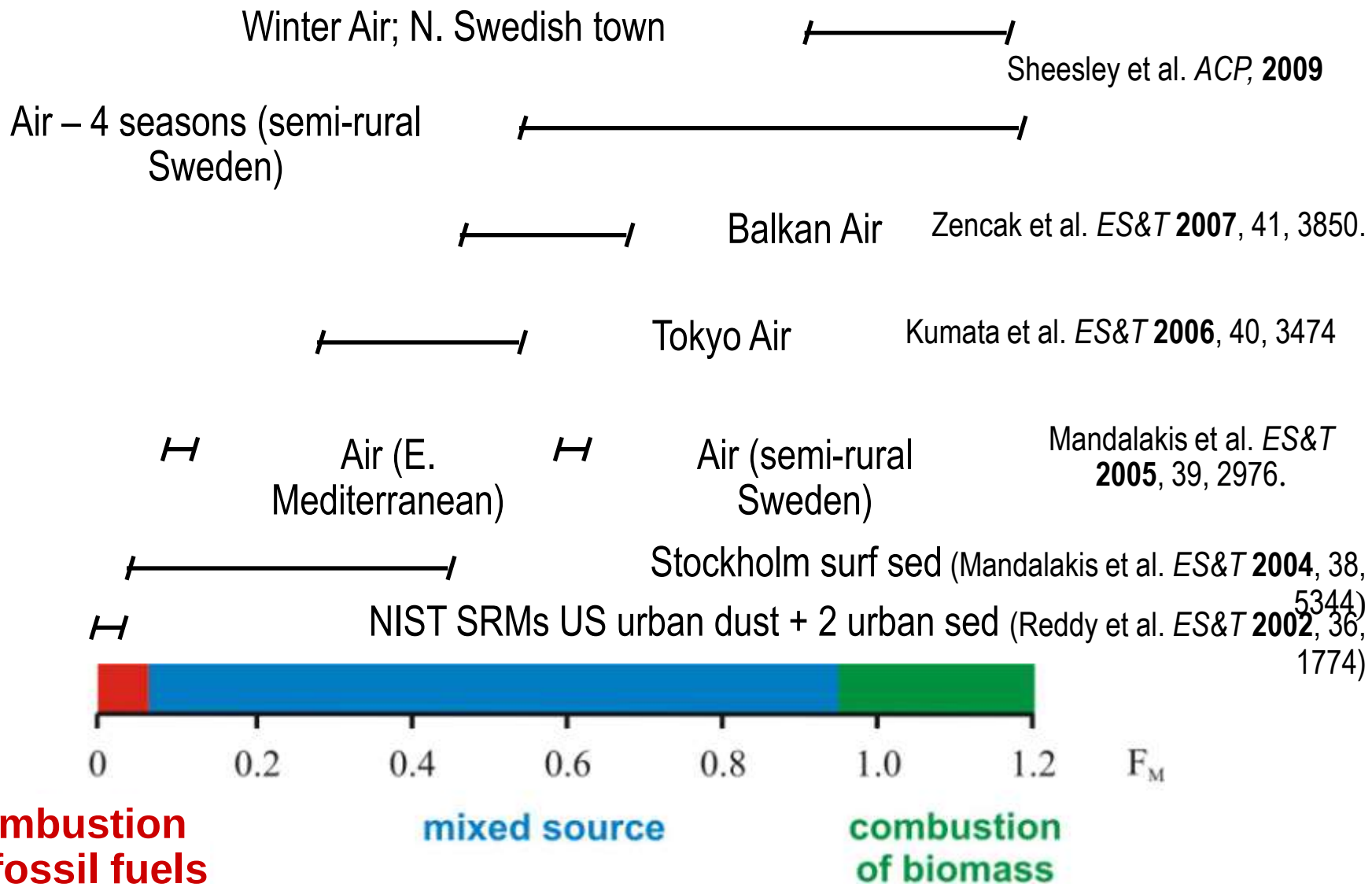
Isosoil 14C/13C-PAH soil sites



Δ^{14}C-PAHs in the Czech Republic



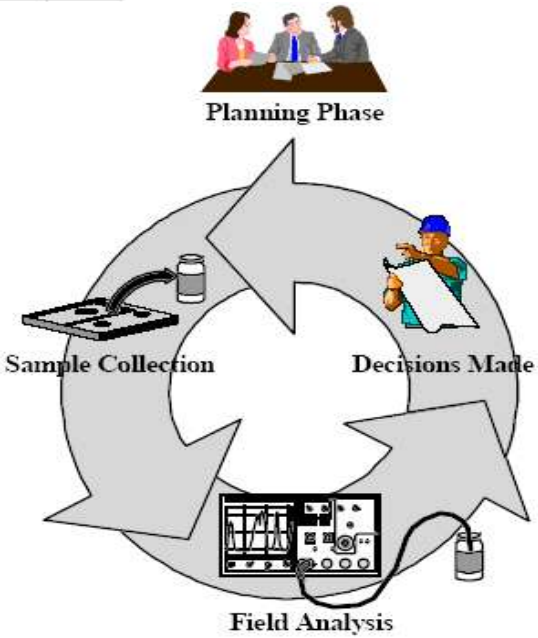
Natural abundance ^{14}C of environmental PAHs



ModelPROBE

Beneficiary Number *	Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
1 (coordinator)	Helmholtz Centre for Environmental Research	UFZ	Germany	1	48
2	University of Padua	UPD	Italy	1	48
4	Institute of Methodologies for Environmental Analysis, Italian National Council of Research (CNR)	CNR	Italy	1	48
5	Technical University of Denmark	DTU	Denmark	1	48
6	Earth Tech CZ Ltd.	ETC	Czech Republic	1	48
8	University of Lancaster	ULanc	UK	1	48
9	University of Aarhus, National Environmental Research Institute	AU-NERI	Denmark	1	48
11	Université Catholique de Louvain	UCL	Belgium	1	48
12	University of Rome	URom	Italy	1	48
13	Saint-Petersburg State University	USP (SpbSU)	Russia	1	48
14	CREATEC, Potenza	CREATEC	Italy	1	48
15	Christian Albrechts University of Kiel	CAU	Germany	1	48
16	University of Bonn	UBO	Germany	1	48
17	DELTARES (GeoDELFT)	DLS	The Netherlands	1	48
18	MPBF Mess- und Probenahmetechnik Berndsen und Falß GbR	MPBF	Germany	1	48
19	Institut de Physique du Globe de Paris	IPGP	France	1	48
20	Federal Environment Agency of Austria, Vienna	UBA-A	Austria	15	48

Konvenční přístup



Přístup ModelProbe

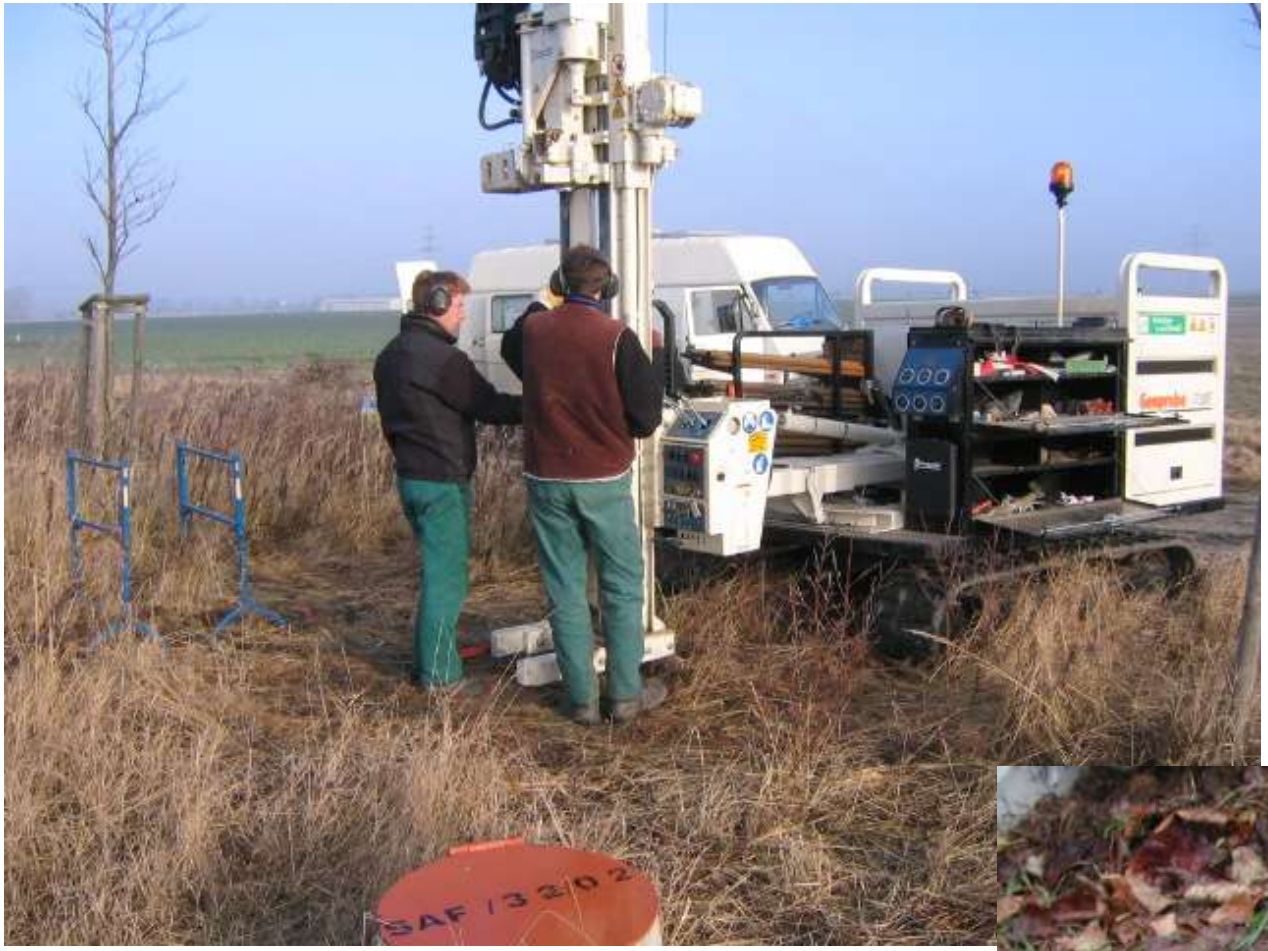
Site survey using tree monitoring technique

Why Trees?

- a ”standard plant” transpires approx. **1 liter/day/m²**
- wood adsorbs compounds

Tree core sampling

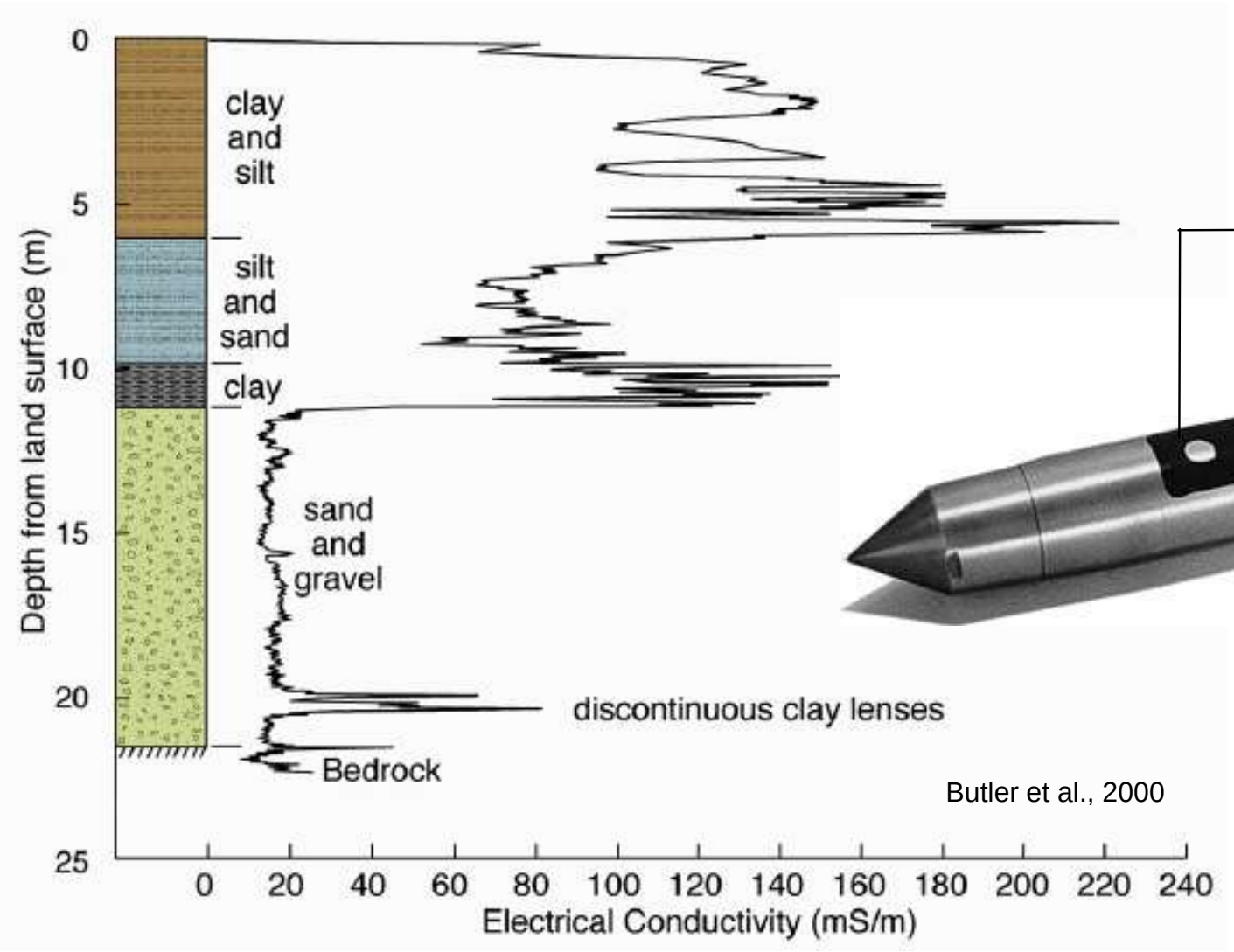
Analysis of wood

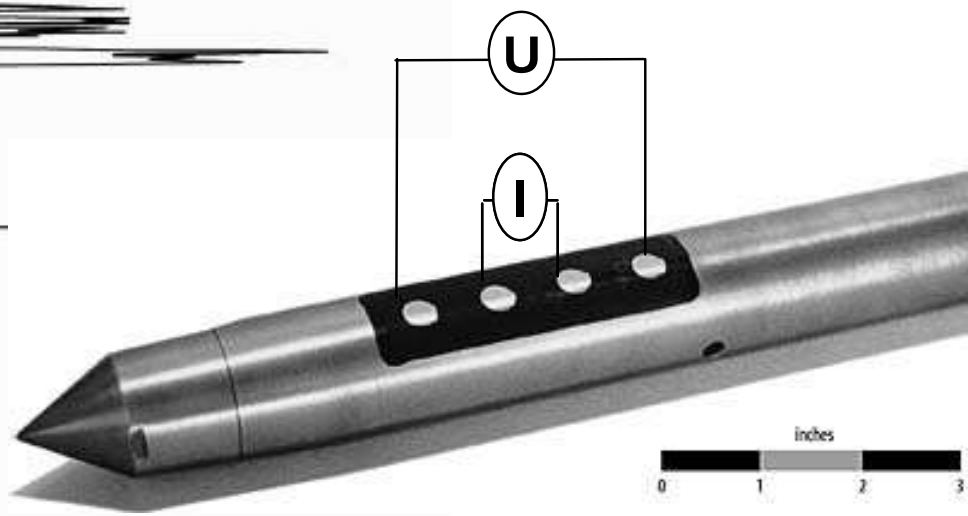


using Direct Push equipment

Direct Push-Technologies

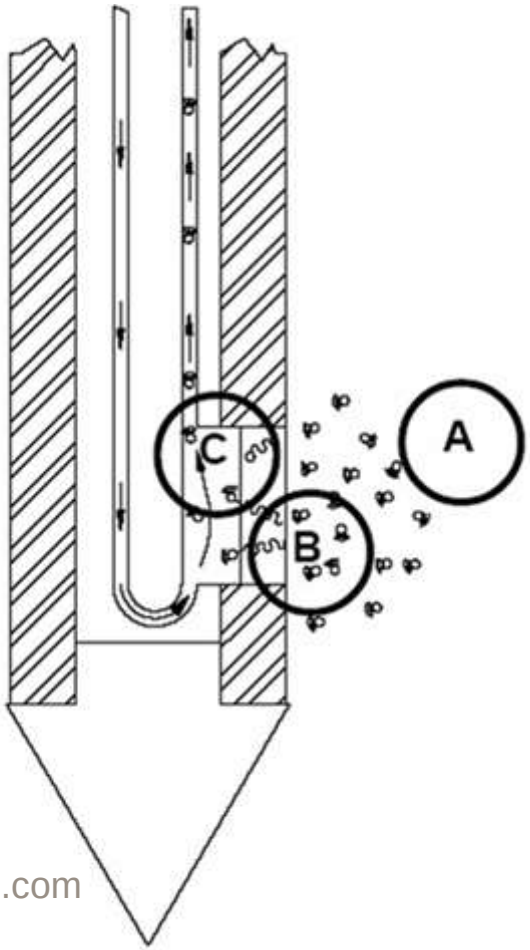
In situ measurements → EC-profiling



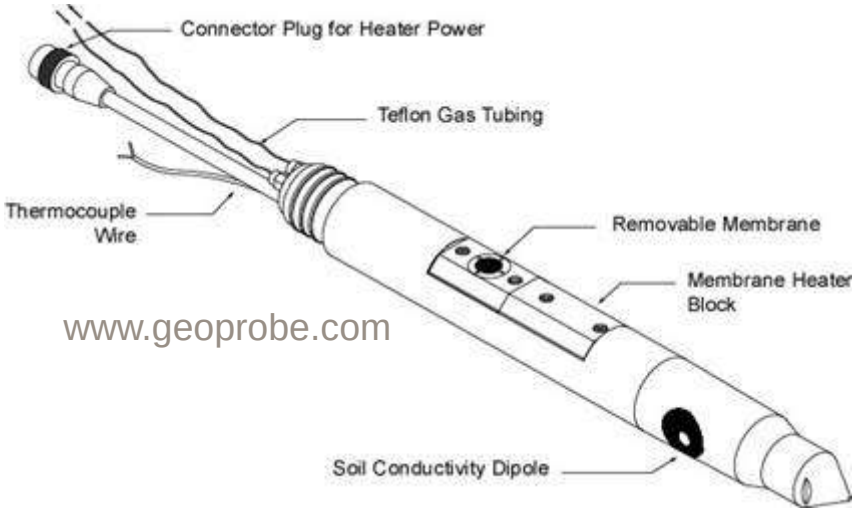


Butler et al., 2000

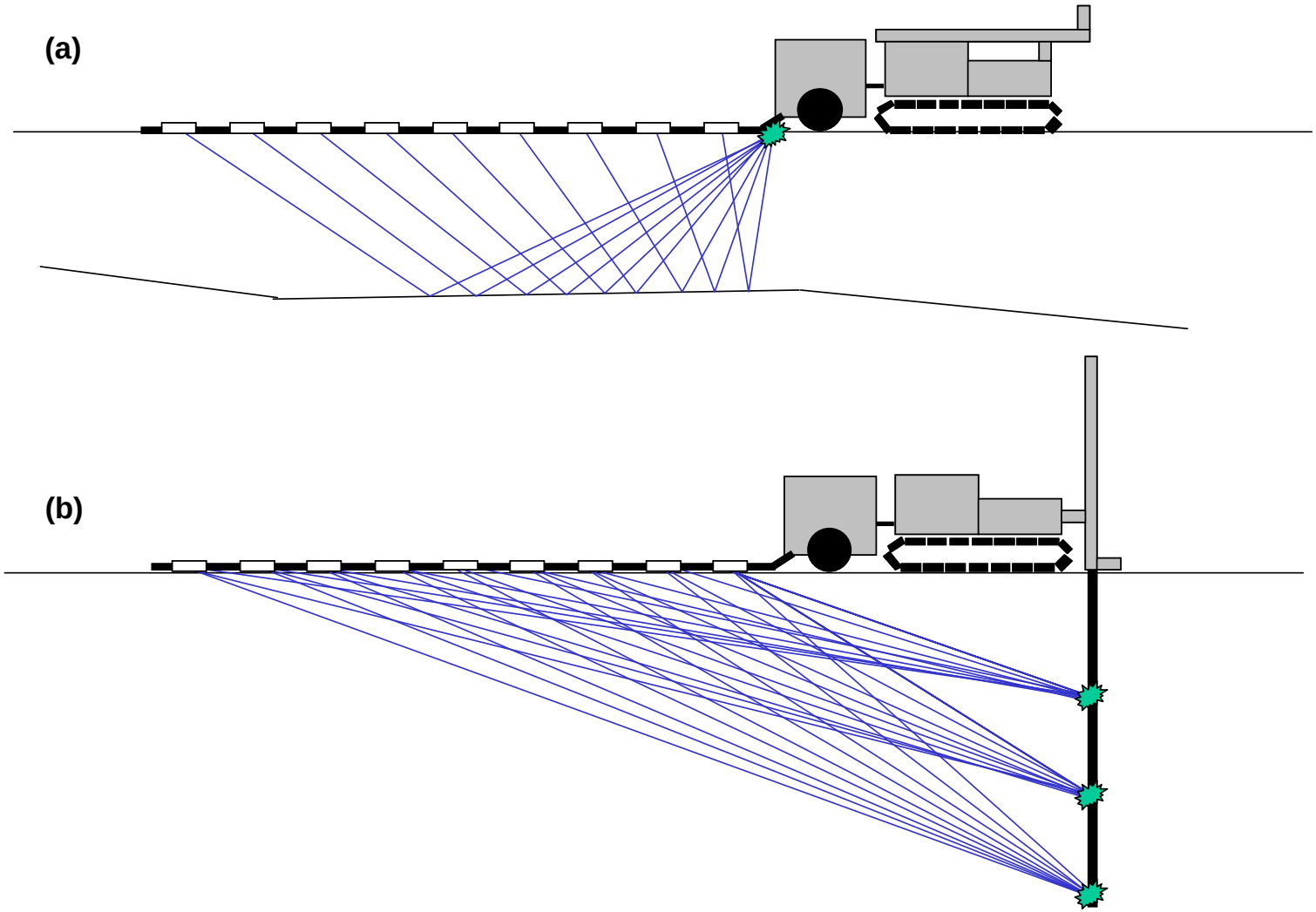
MIP - Membrane Interface Probe



www.geoprobe.com

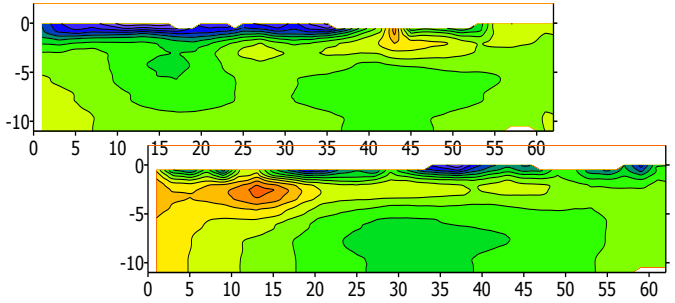


www.geoprobe.com

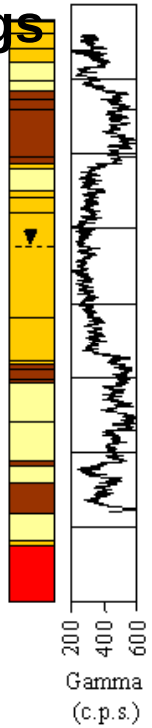

(a)
(b)

WP 2+3: Geophysical imaging and data fusion

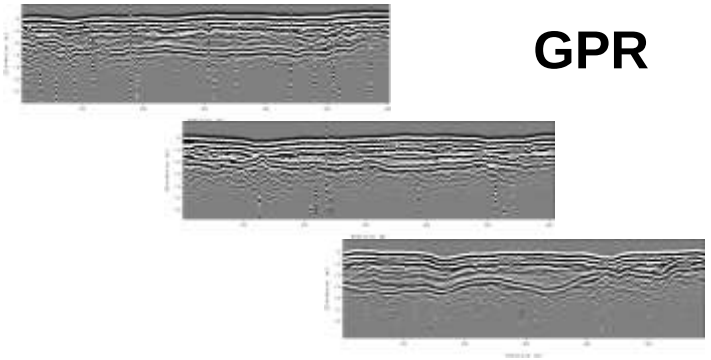
Resistivity & Induced Polarisation



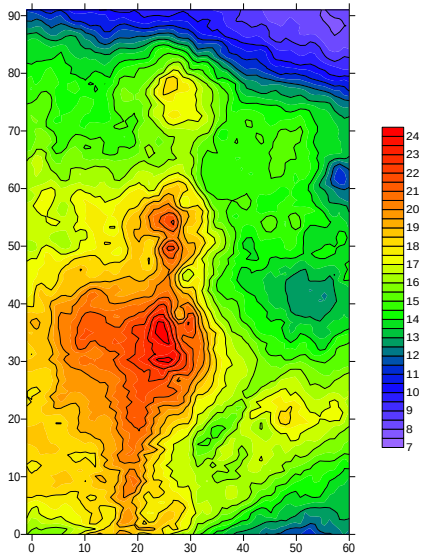
Push rod logs



GPR

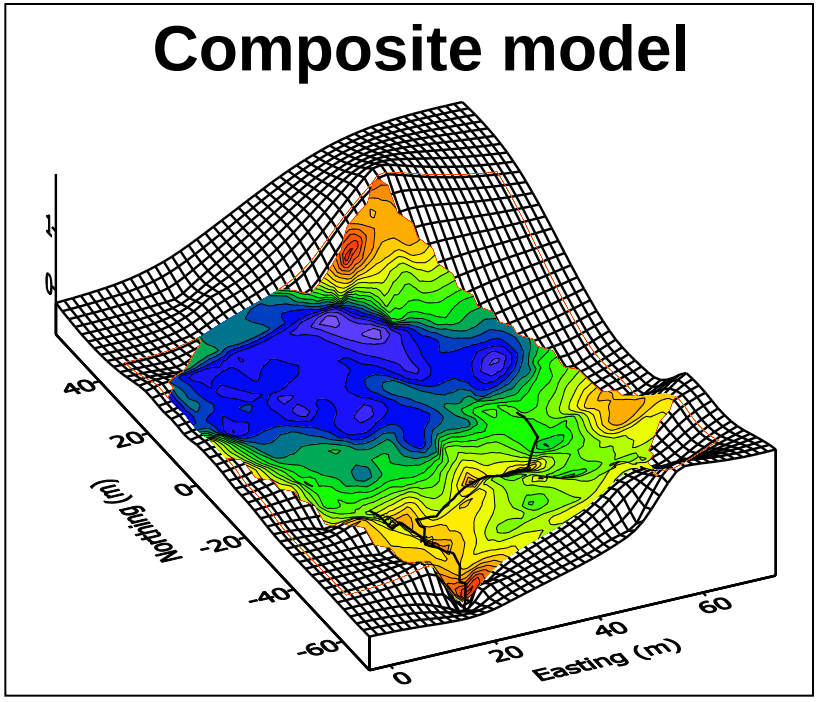


Ground Conductivity



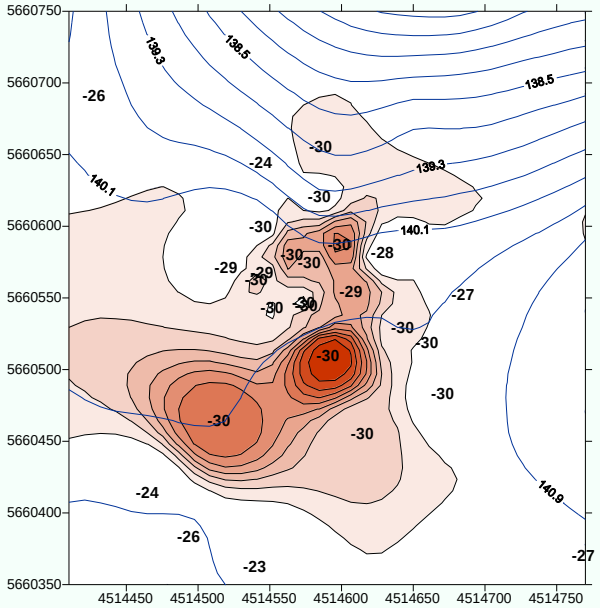
Local sampling

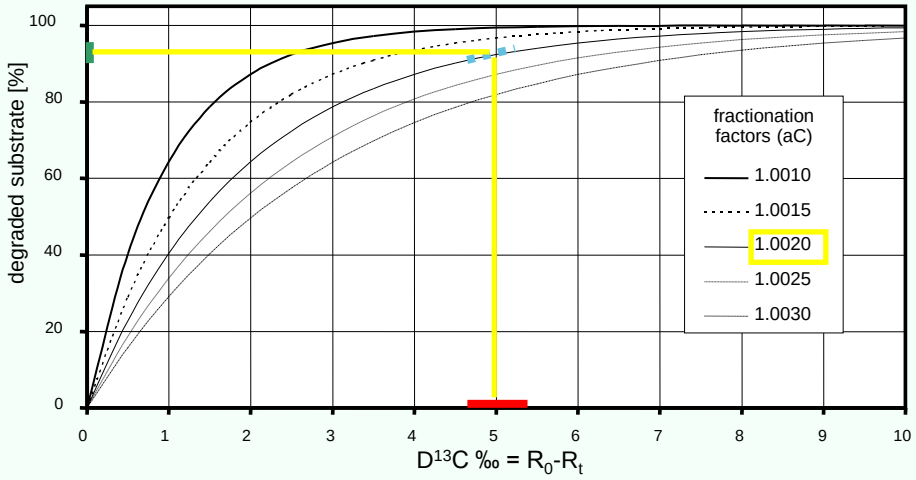
Composite model



WP 6: Microbial in situ activity + environmental forensics: compound specific stable isotope analysis

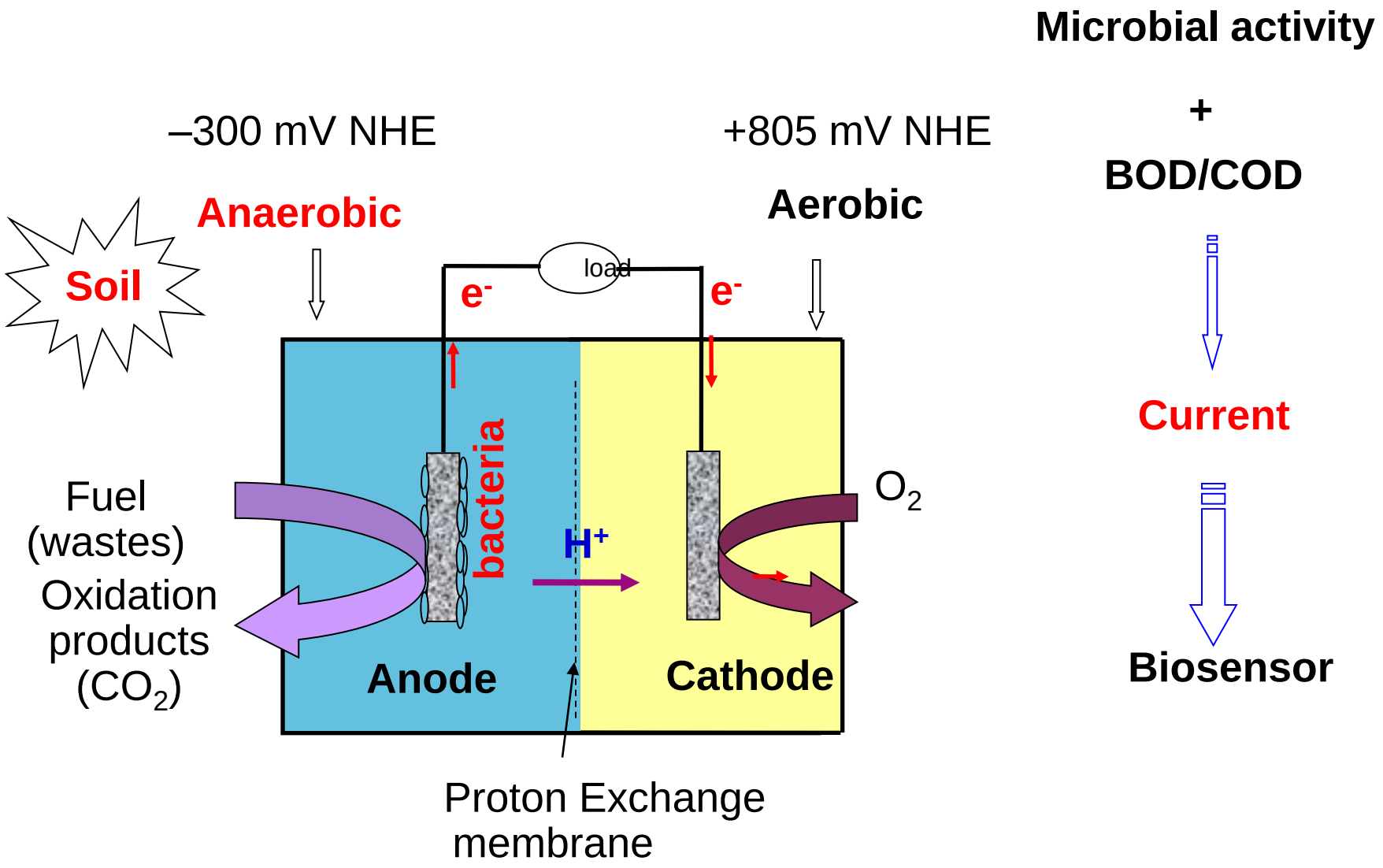
Isotope fractionation by microbial activity → **Determination of the fractionation factor α C** → **Field analysis of isotope signature** → **Calculation of biodegradation** → **Quantification of the *in situ*-biodegradation**





(Meckenstock et al. 1999, EM, 1; 409-414;
Richnow et al. 2003, JCH, 65; 101-120;
Meckenstock et al. 2004, JCH, 75; 215-255)

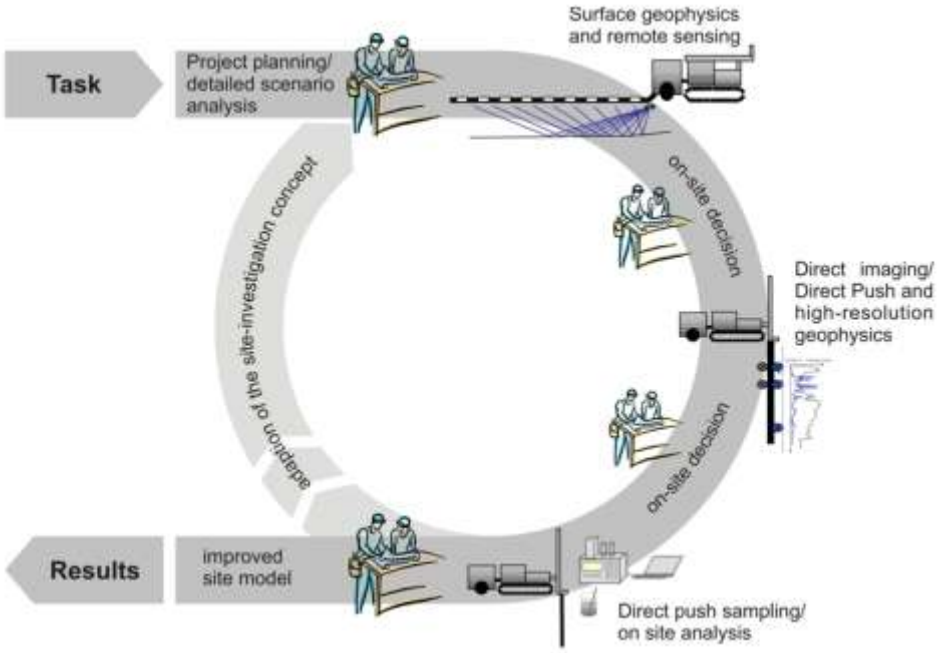
Microbial fuel cells (MFC)



Chang et al. 2005; Kumlanghan et al. 2007; Lorenzo et al. 2009

Handbook (A: Guideline)

ModelPROBE approach



(1) Site history, planning phase
(2) Non-invasive geophysics
(3) Tree core sampling
(4) Data evaluation
(5) Direct Push + geophysics
(6) Data evaluation (field)
(7) DP + bio-geo-chemical sampling
(8) Data evaluation + modelling
(9) Feedback ➔ additional sampling
(10) Adaptive site description
(11) Site assessment

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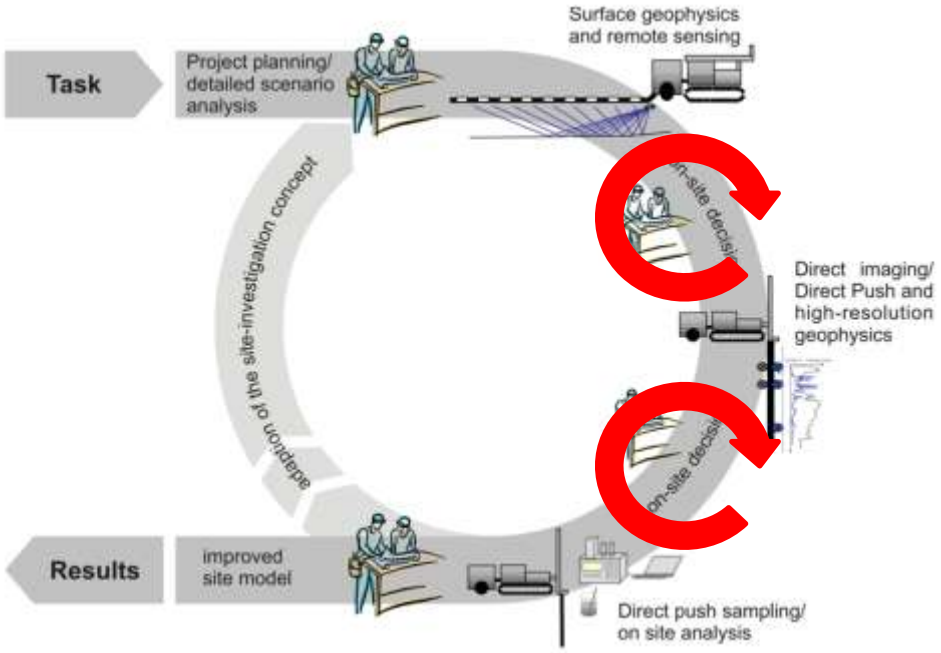
Handbook (A: Guideline)

ModelPROBE approach revised



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ModelPROBE Dissemination System
development status

ModelPROBE Dissemination System currently includes 2 types of artifacts:

- ✓ A Central Dissemination Platform, available online at www.modelprobedisseminationsystem.com
- ✓ A number (currently 2) of distributable, lightweight e-learning packages, developed ad-hoc for each ModelPROBE training course

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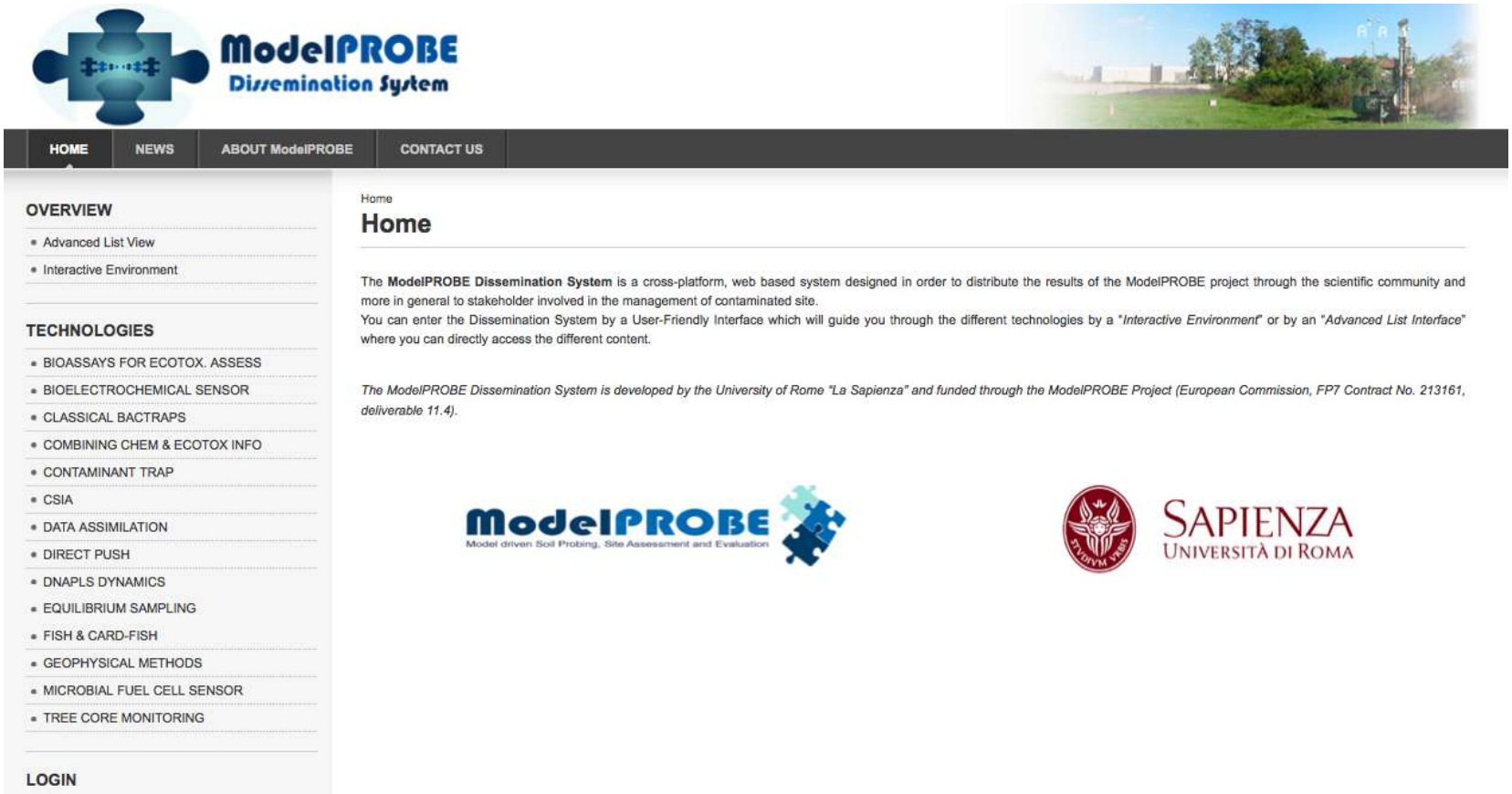
ModelPROBE Dissemination System
Central Dissemination Platform



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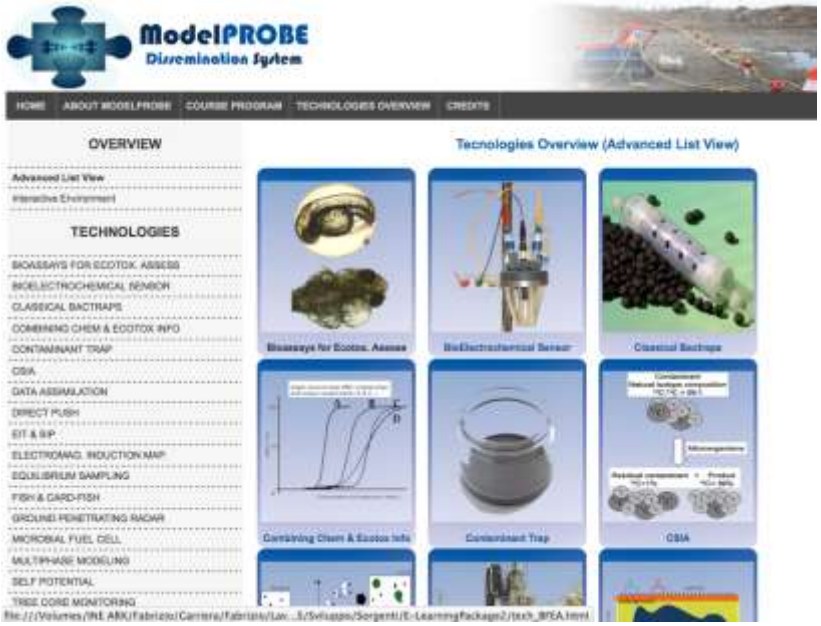
ModelPROBE Dissemination System
E-Learning Packages

E-learning packages typically provide:

- ✓ A tiny overview of the Central Dissemination Platform, typically limited to technologies' factsheets



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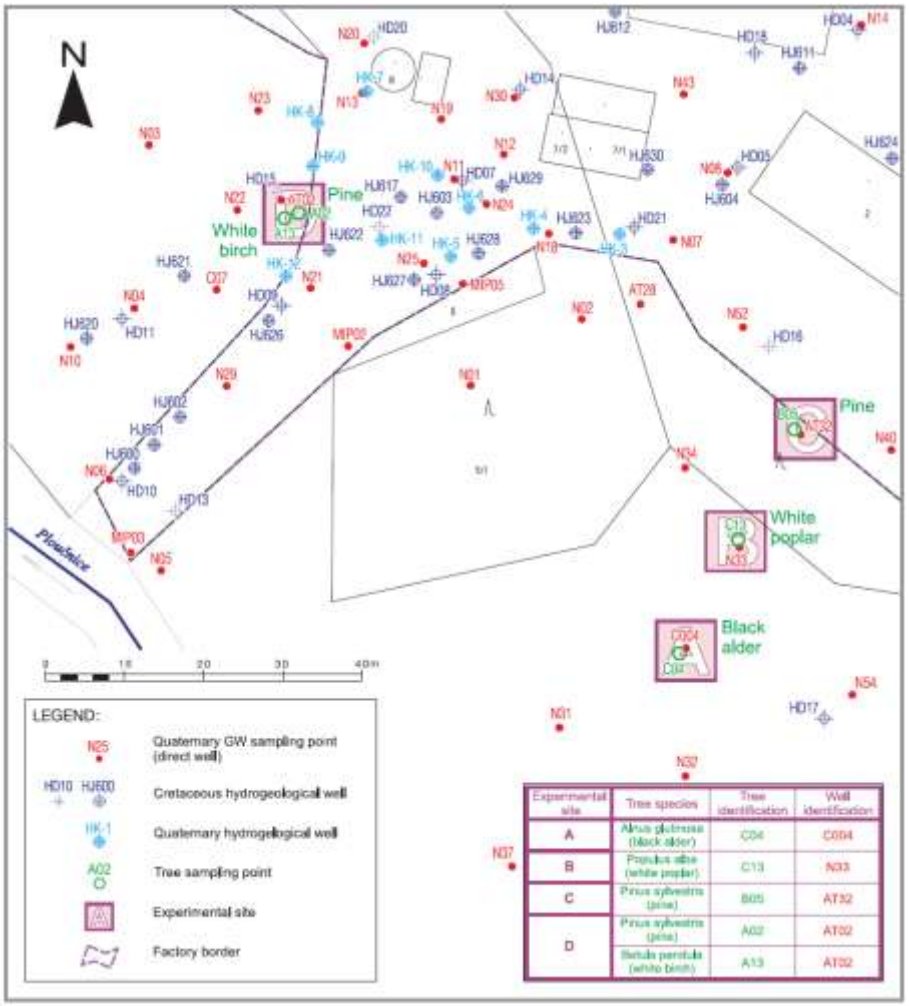
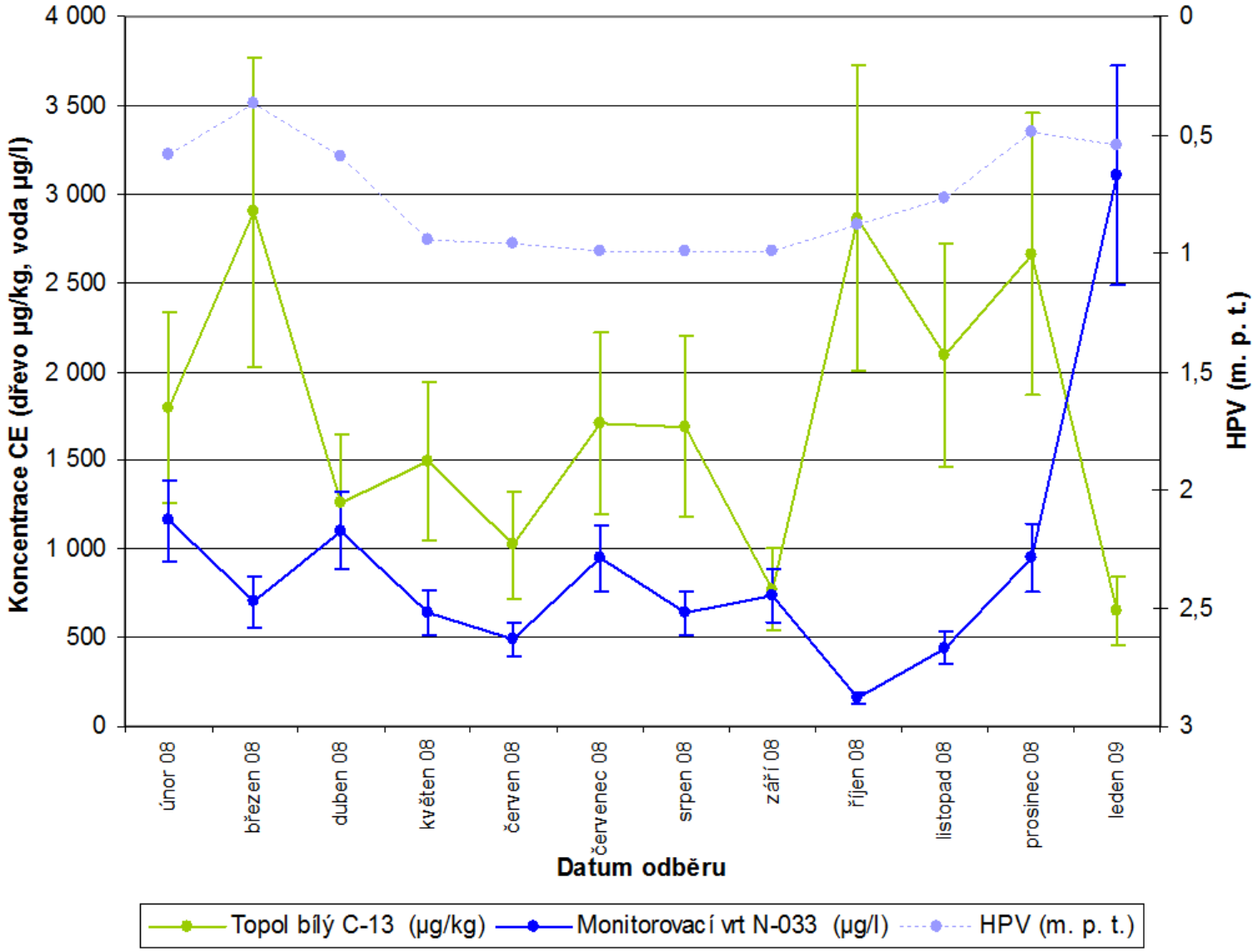
Výzkum AECOM/ČZU – závislost koncentrací CE v podzemní vodě a dřevní hmotě

- 1 rok sledování koncentrací na čtyřech dílčích lokalitách na lokalitě SAP Mimoň (měsíční interval)



Hladina podzemní vody, koncentrace CE ve vzorcích podzemní vody a dřevní hmoty během jednotlivých odběrů – lokalita B



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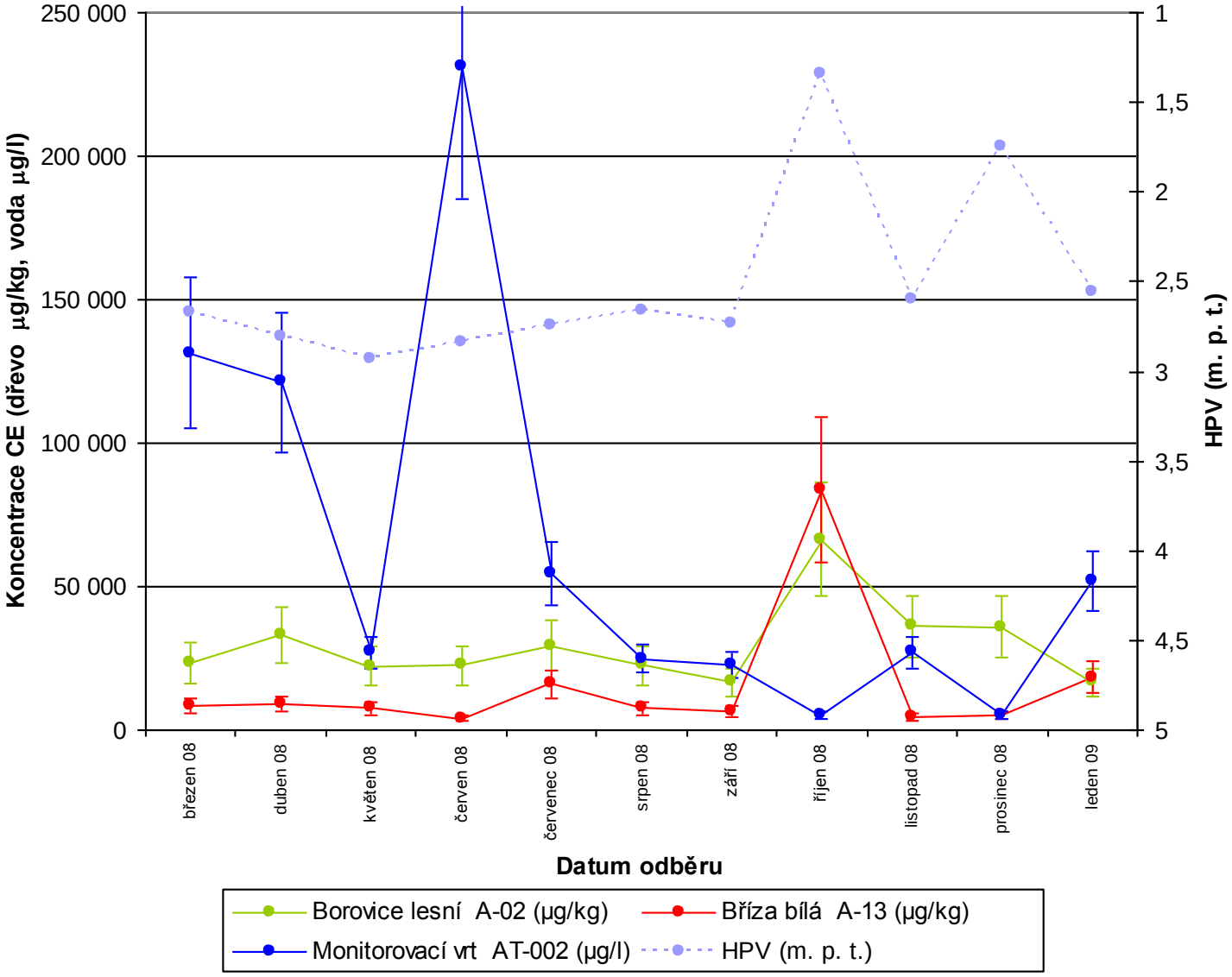
Hladina podzemní vody, koncentrace CE ve vzorcích podzemní vody a dřevní hmoty během jednotlivých odběrů – lokalita D



Lokalita	Druh stromu / věk	Kód dřeviny	Kód vrtu		
		průměrná koncentrace CE v dřevní hmotě (µg/kg)	průměrná koncentrace CE v podzemní vodě (µg/l)	koeficient determinace (%)	Bio koncentrační
		stupeň degradace - dřevo (% nižších CE v sumě)	stupeň degradace - voda (% nižších CE v sumě)	koeficient korelace	faktor
A	Olše lepkavá/ 15 let	C-04	C-004	5%	
		3 387	8 000	0,22	42%
		8%	30%		
B	Topol bílý /20 - 25 let	C-13	N-033	25%	
		1 741	923	-0,5	189%
		29%	16%		
C	Borovice lesní / 74 let	B-05	AT-032		
		632	2 904	13%	22%
		68%	55%	-0,36	
D	Borovice lesní / 26 let	A-02	AT-002	6%	
		28 925	58 738	-0,25	49%
		5%	1%		
	Bříza bradavičnatá / 20 let	A-13	AT-002	15%	
		22 687	58 738	-0,38	39%
		1%	1%		

Závěr

- kontaminace vzorků dřevní hmoty, získaných ze dřevin rostoucích v oblastech s kontaminací podzemní vody CE korespondovaly s obsahy kontaminatů v podzemní vodě
- při hodnocení výsledků je však nutno zohlednit celou řadu faktorů, které mohou ovlivnit koncentraci CE ve vzorcích dřevní hmoty.
- v rámci experimentu pozorované hlavní vlivy byly úroveň HPV, druh stromu a intenzita transpirace
- byla pozorována velmi rychlá odezva na zapojení sanační technologie, u borovice a topolu byl pozorován i možný fytoremediační vliv transpirace
- při využití vzorkování dřevního jádra pro hodnocení podpovrchové kontaminace je proto vhodné vyhodnotit i dendrologické charakteristiky vzorkovaných stromů a transpirační aktivitu a pokud je to možno, zopakovat vzorkování v různých obdobích vegetační sezóny

www.isosoil.eu

www.modelprobe.ufz.de

www.modelprobedisseminationsystem.com

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