Alliance H@rvest

Agreen Tech Valley
LA VALLÉE NUMÉRIQUE DU VÉGÉTAL

AgroParisTech
Talents d'une planète soutenable

Groupe EXEL Industries

Fondation AgroParisTech
Sous égide de la Fondation ParisTech

SCP Partager l'eau, construire l'avenir

SOFIPROTEOL
L'engagement durable

TELECOM Paris
IP PARIS

Terres Inovia
l'agronomie en mouvement

UniLaSalle
Institut Polytechnique

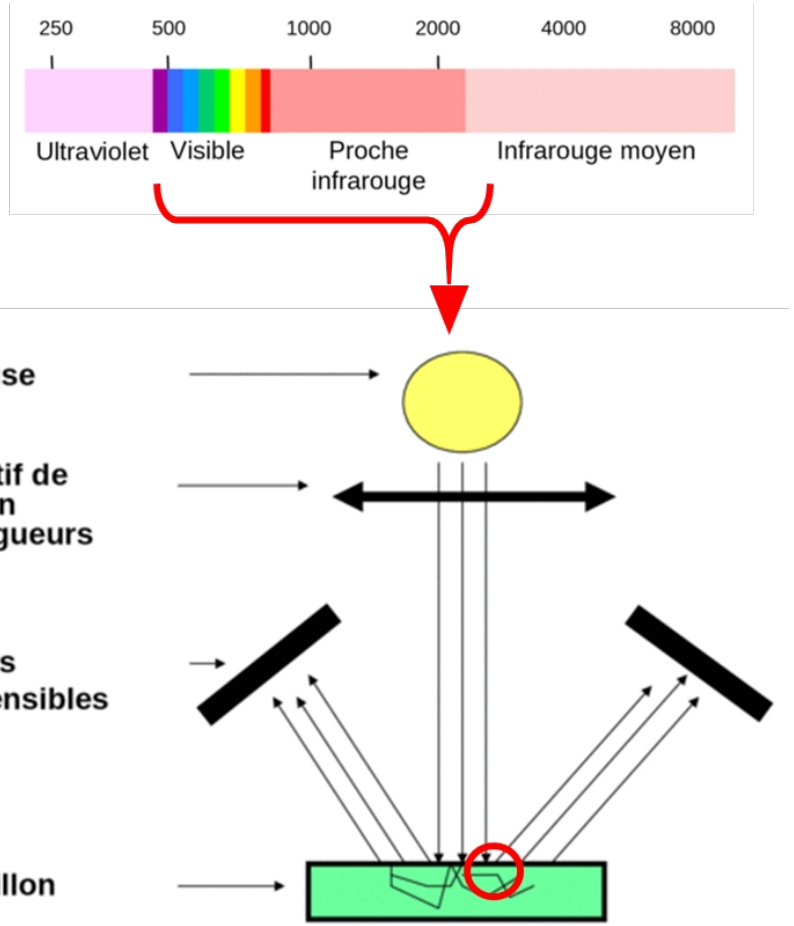
Alliance H@rvest

Projet SolNum

Spectroscopie IR des sols

Spectrométrie infrarouge (IR) une piste à développer

Spectrométrie IR: Principe et Utilisation



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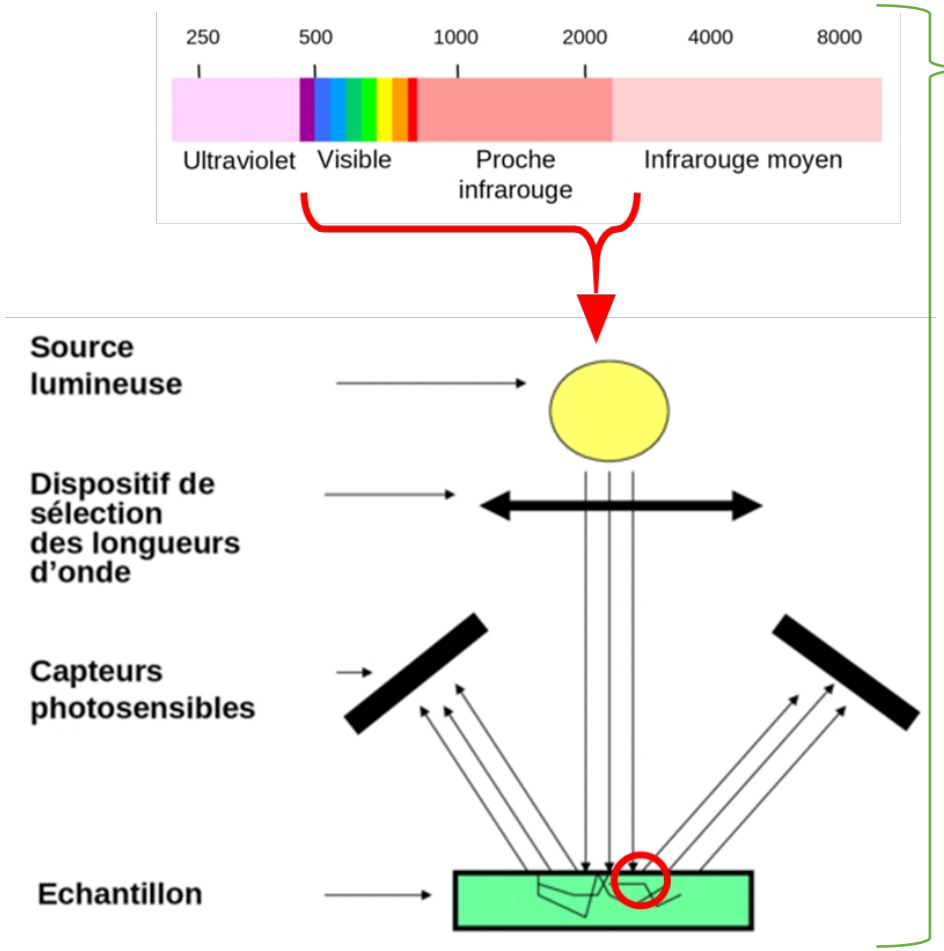

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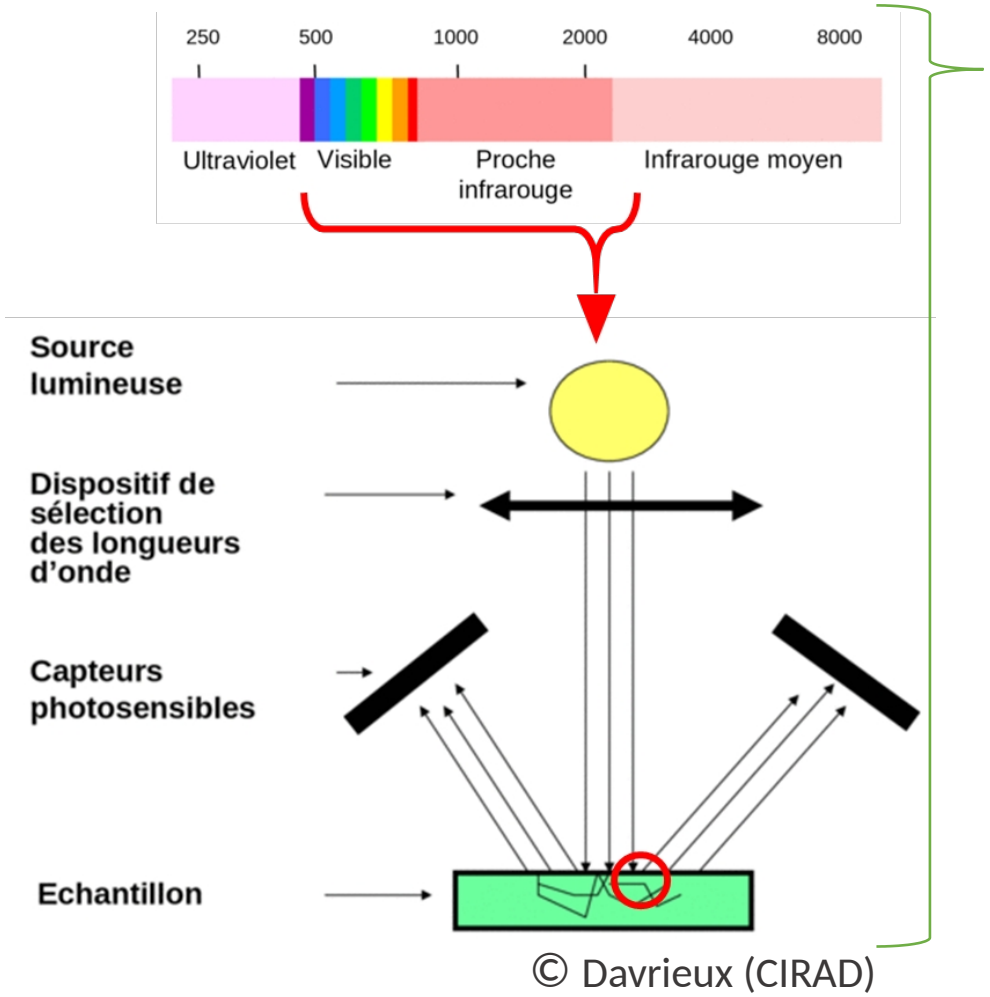
...	0.589	0.59	0.588	0.589	0.589	0.586	...	0.634	0.636	0.638	0.64	0.641	0.642	...
...	0.539	0.538	0.539	0.538	0.537	0.537	...	0.583	0.585	0.587	0.588	0.589	0.591	...
...	0.558	0.556	0.557	0.556	0.556	0.556	...	0.606	0.608	0.61	0.612	0.613	0.614	...
...	0.655	0.654	0.654	0.653	0.654	0.653	...	0.742	0.745	0.748	0.75	0.752	0.754	...
...	0.522	0.521	0.521	0.52	0.518	0.517	...	0.569	0.571	0.573	0.575	0.576	0.578	...
...	0.563	0.562	0.561	0.56	0.56	0.56	...	0.614	0.616	0.618	0.62	0.621	0.623	...
...	0.565	0.564	0.563	0.563	0.562	0.562	...	0.602	0.604	0.606	0.607	0.609	0.61	...
...	0.48	0.481	0.482	0.479	0.48	0.479	...	0.512	0.514	0.515	0.517	0.518	0.519	...
...	0.48	0.48	0.481	0.481	0.48	0.48	...	0.519	0.521	0.523	0.524	0.525	0.526	...
...	0.481	0.481	0.481	0.481	0.48	0.479	...	0.522	0.524	0.525	0.527	0.528	0.529	...
...	0.55	0.549	0.55	0.548	0.549	0.548	...	0.614	0.616	0.618	0.62	0.622	0.623	...
...	0.665	0.666	0.666	0.665	0.664	0.665	...	0.738	0.741	0.743	0.745	0.747	0.749	...
...	0.644	0.647	0.643	0.643	0.643	0.642	...	0.71	0.712	0.715	0.717	0.718	0.72	...
...	0.49	0.489	0.489	0.487	0.488	0.487	...	0.544	0.547	0.549	0.551	0.552	0.554	...
...	0.515	0.513	0.515	0.514	0.514	0.512	...	0.554	0.556	0.558	0.559	0.56	0.561	...
...	0.488	0.486	0.486	0.486	0.484	0.485	...	0.522	0.524	0.526	0.527	0.528	0.529	...
...	0.502	0.503	0.503	0.501	0.501	0.503	...	0.525	0.527	0.528	0.529	0.53	0.531	...
...	0.479	0.478	0.478	0.478	0.478	0.478	...	0.504	0.506	0.507	0.508	0.509	0.51	...
...	0.483	0.484	0.481	0.482	0.482	0.481	...	0.504	0.505	0.506	0.508	0.509	0.509	...
...	0.606	0.604	0.603	0.605	0.604	0.604	...	0.653	0.655	0.657	0.658	0.66	0.661	...
...	0.524	0.523	0.523	0.523	0.523	0.522	...	0.564	0.566	0.568	0.569	0.571	0.572	...
...	0.484	0.486	0.484	0.482	0.483	0.483	...	0.523	0.525	0.527	0.528	0.529	0.53	...

Spectrométrie infrarouge (IR) une piste à développer

Spectrométrie IR: Principe et Utilisation



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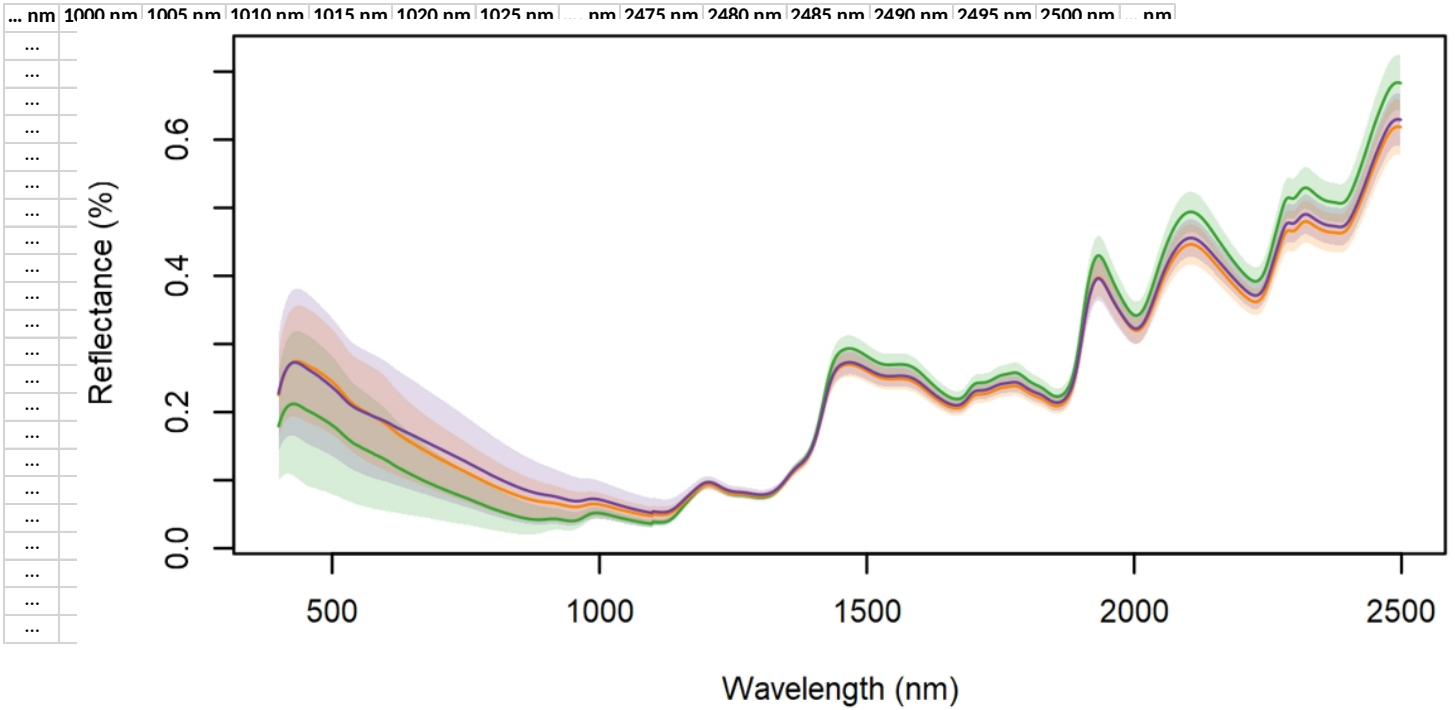

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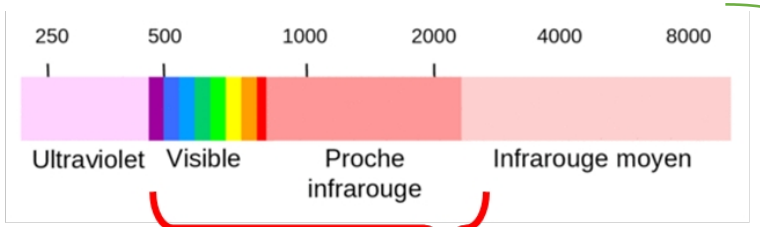

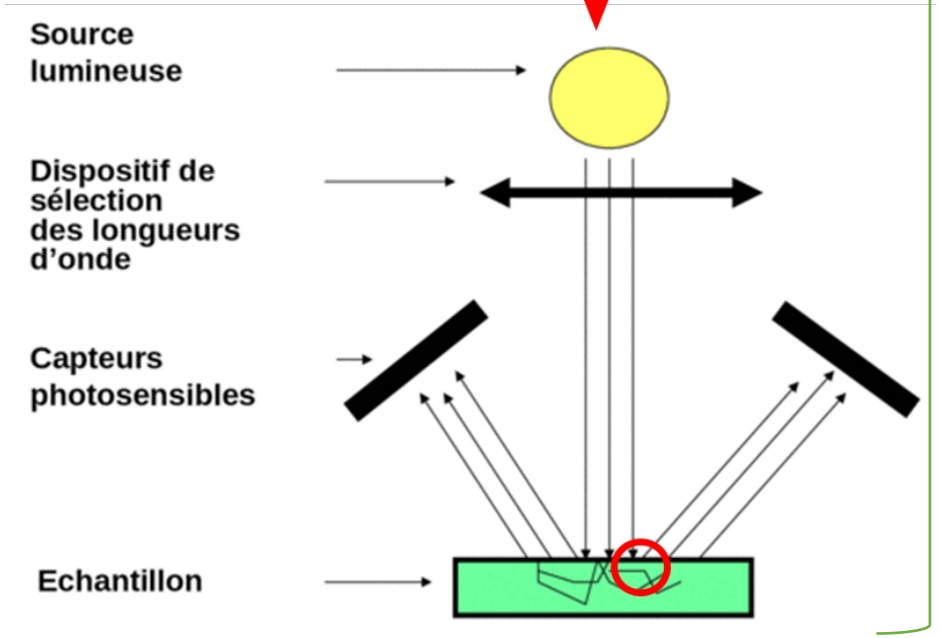

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...	0.565	0.564	0.563	0.563	0.562	0.562	...	0.602	0.604	0.606	0.607	0.609	0.61	...
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...	0.48	0.48	0.481	0.481	0.48	0.48	...	0.519	0.521	0.523	0.524	0.525	0.526	...
...	0.481	0.481	0.481	0.481	0.48	0.479	...	0.522	0.524	0.525	0.527	0.528	0.529	...
...	0.55	0.549	0.55	0.548	0.549	0.548	...	0.614	0.616	0.618	0.62	0.622	0.623	...
...	0.665	0.666	0.666	0.665	0.664	0.665	...	0.738	0.741	0.743	0.745	0.747	0.749	...
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...	0.49	0.489	0.489	0.487	0.488	0.487	...	0.544	0.547	0.549	0.551	0.552	0.554	...
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...	0.488	0.486	0.486	0.486	0.484	0.485	...	0.522	0.524	0.526	0.527	0.528	0.529	...
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...	0.483	0.484	0.481	0.482	0.482	0.481	...	0.504	0.505	0.506	0.508	0.509	0.509	...
...	0.606	0.604	0.603	0.605	0.604	0.604	...	0.653	0.655	0.657	0.658	0.66	0.661	...
...	0.524	0.523	0.523	0.523	0.523	0.522	...	0.564	0.566	0.568	0.569	0.571	0.572	...
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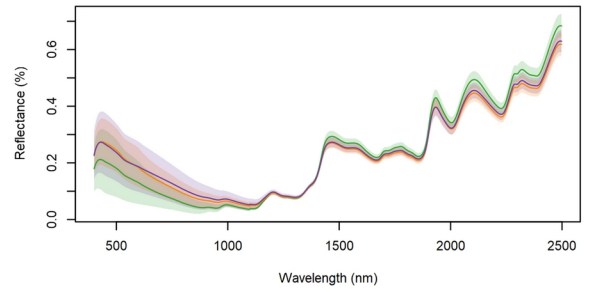

Les spectres (X) issus du sol

Calibration

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...	0.589	0.59	0.588	0.589	0.589	0.586	...	0.634	0.636	0.638	0.64	0.641	0.642	...
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...	0.655	0.654	0.654	0.653	0.654	0.653	...	0.742	0.745	0.748	0.75	0.752	0.754	...
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...	0.48	0.481	0.482	0.479	0.48	0.479	...	0.512	0.514	0.515	0.517	0.518	0.519	...
...	0.48	0.48	0.481	0.481	0.48	0.48	...	0.519	0.521	0.523	0.524	0.525	0.526	...
...	0.481	0.481	0.481	0.481	0.48	0.479	...	0.522	0.524	0.525	0.527	0.528	0.529	...
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...	0.49	0.489	0.489	0.487	0.488	0.487	...	0.544	0.547	0.549	0.551	0.552	0.554	...
...	0.515	0.513	0.515	0.514	0.514	0.512	...	0.554	0.556	0.558	0.559	0.56	0.561	...

Validation

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Modèle prédictif

Indicateur (Y)

multifunctionality_index
0.277
0.313
0.204
0.362
0.214
0.326
0.219
0.161
0.164
0.213
0.212
0.266
0.181
0.222
0.317
0.258
0.199
0.125
0.184
0.243
0.195
0.187

Données de spectrométrie infrarouge : l'existant

Spectrométrie IR: Quelques résultats

Soil properties	R^2
TN	0.12
	0.03
SOC	0.14
	0.05
pH (−)	0.35
	−0.67
Clay content (%)	0.14
	−0.18
Exchangeable Ca^{2+} ($cmol_{(+)}$ kg^{-1})	0.56
	0.14
Exchangeable Mg^{2+} ($cmol_{(+)}$ kg^{-1})	0.39
	0.35
Exchangeable Na^{+} ($cmol_{(+)}$ kg^{-1})	0.13
	−1.57
Exchangeable K^{+} ($cmol_{(+)}$ kg^{-1})	0.41
	0.24

Evaluation of a miniaturized portable NIR spectrometer for the prediction of soil properties in Mediterranean central Chile (Salazar et al., 2023)

Parameter	R^2 CV
Dehydrogenase	0.23*
β-Glucosidase	0.60***
Arylsulphatase	0.46**
Alkaline phosphatase	0.63***
Acid phosphatase	0.33**
Potential nitrification	0.36**
GMea	0.70***

Infrared spectroscopy as a tool for the assessment of soil biological quality in agricultural soils under contrasting management practices (Gomino et al., 2018)

Property	Q^2
Potential denitrification	0.38
	0.87
	0.91
Potential nitrification	0.43
	0.70
	0.89
Microbial carbon (C_{mic})	0.55
	0.83
	0.90
C_{mic}:C_{org} ratio	0.14
	0.73
	0.84
Cellulase	0.18
	0.72
	0.81
FDA hydrolase (Fdase)	0.03
	0.78
	0.84

Variable selection in near infrared spectra for the biological characterization of soil and earthworm casts (Cécillon et al., 2008)

Données de spectrométrie infrarouge : l'existant

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	0.84
Cellulase	0.18
	0.72
	0.81
FDA hydrolase (Fdase)	0.03
	0.78
	0.84

Variable selection in near infrared spectra for the biological characterization of soil and earthworm casts (Cécillon et al., 2008)

Paramètre	Préparation sol	Prétraitement	r^2
Xylanase (XYLAN)	frais 2 mm	D	0,94
	sec 2 mm	**D**	**0,96**
	sec 0,2 mm	SNV-D	0,23
Cellulase (CEL)	frais 2 mm	D	0,91
	sec 2 mm	**/**	**0,96**
	sec 0,2 mm	D	0,96
Acétylglucosaminidase (NAG)	**frais 2 mm**	**SNV-D**	**0,91**
	sec 2 mm	SNV	0,91
	sec 0,2 mm	/	0,92
β-glucosidase (β-GLU)	frais 2 mm	SNV-D	0,83
	sec 2 mm	**/**	**0,85**
	sec 0,2 mm	SNV-D	0,95
ADN total	frais 2 mm	MSC	0,82
	sec 2 mm	**MSC**	**0,92**
	sec 0,2 mm	/	0,83
AWCD	frais 2 mm	/	0,21
	sec 2 mm	**/**	**0,27**
	sec 0,2 mm	/	0,11
Respiration	frais 2 mm	SNV	0,45
	sec 2 mm	**SNV-D**	**0,43**
	sec 0,2 mm	MSC	0,47

Télédétection une piste à développer

Mesures conventionnelles

Evaluation de la biodiversité des sols

Mesures d'abondances

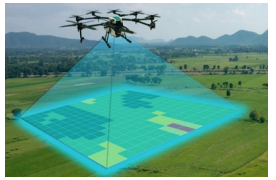
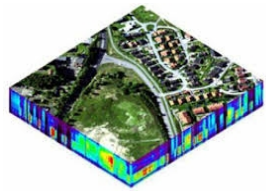
- Abondance des microorganismes totaux
- Abondance des bactéries
- Abondance des champignons
- Diversité des communautés microbiennes bactériennes et fongiques
- Microorganismes spécifiques

Mesures d'activités

- Diversité fonctionnelle potentielle
- Activités enzymatiques *in situ*
- Minéralisations potentielles C, N, P, S
- Nitrification, dénitrification potentielle
- Respirométrie

Mesures avec des outils et technologies du numérique




Télédétection une piste à développer

- **Création des d'OAD**: Combinaison des indicateurs physico-chimiques et biologiques
  ⇒ en fonction du type de sol, des conditions environnementales, des pratiques de gestion et du type de culture.
- **Images satellitaires pour l'estimation des propriétés du sol**
  ⇒ prise en compte informations topographiques, informations climatiques, images multispectrales/hyperspectrales.
- **Effet de la différence entre les dates des mesures conventionnelles et celles des images satellitaires/drones**
- **Etapes d'évaluation de la qualité des sols via la végétation**
  - Capture de la réflectance de la chlorophylle
  - Estimation de la concentration de la chlorophylle
  - Estimation de la santé des plantes à partir de la concentration de la chlorophylle
  - Estimation de la santé des sols à partie de la santé des plantes