Loris Verron
June 21th, 2022

Availability of earth for light earth building: modelling using spatialized pedological data in Brittany

Authors: Loris VERRON, Erwan HAMARD, Andry RAZAKAMANANTSOA, Bogdan CAZACLIU, Myriam DUC

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Introduction

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Introduction

Raw earth

- Not fired
- No hydraulic binder (cement/lime)

  - **No combustion energy need**
  - **Infinitely reversible or "compostable"**
  - **On-site excavation : no transportation**
    → *Sustainable !*

  - **Free and abundant material**
  - **Labour intensive : local economy**
    → *Socially inclusive !*

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Introduction : raw earth building

Rammed earth (pisé)

Cob (bauge)

Chantier : Ghislain Maetz, Architecte : Amélie Le Paih, Vidéo : Sunmetron

A rammed earth building in Lyon.
Photo : Emmanuel Mille

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Introduction : light earth

Réalisation et vidéo : Eco Pertica

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Objectives

- Quantification & spatial distribution

- Excavated earth potentials

Full length article

Estimating and mapping the availability of earth resource for light earth building using a soil geodatabase in Brittany (France)

Loris Verron [a,*], Erwan Hamard [a], Bogdan Cazacliu [a], Andry Razakamanantsoa [b], Myriam Duc [c], Théo Vinceslas [d], Arthur Hellouin de Menibus [e], Blandine Lemercier [f], Rhoda Julia Ansaa-Asare [b], Thibaut Lecompte [g]

[a] MAST-GPEM, Université Gustave Eiffel, Bouguenais F-44344, France
[b] GERS-GIE, Université Gustave Eiffel, Bouguenais F-44344, France
[c] GERS-SRO, Université Gustave Eiffel, Marne-la-Vallée F-77454, France
[d] UniLaSalle, ULR7519 - Transformations & Agro-Ressources, Normandie University, Mont-Saint Aignan F-76130, France
[e] French association of hemp producer in short circuits, Mas de Saint Gelly Bouquet, 30580, France
[f] UMR SAS, Institut Agro, INRAE, Rennes F-35000, France
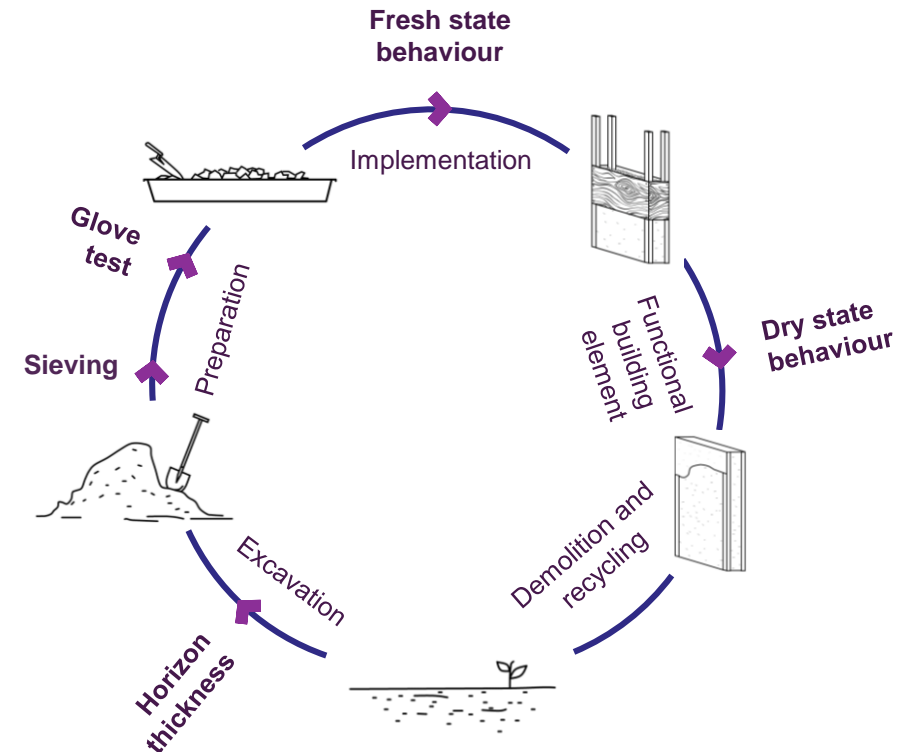[g] UMR CNRS 6027, IRDL, Université Bretagne-Sud, Lorient, F-56100, France

ARTICLE INFO

ABSTRACT

Light earth is a natural insulating material composed of earth and vegetal fibres. It can be used to insulate existing and new buildings to reduce energy and resources consumption, and excavated earth generation by the construction sector. A pedological database is crossed with suitability thresholds in order to evaluate spatially the availability of earth resources. Then, the soil suitability is mapped, and suitable soil amounts metrics are estimated for Brittany territory. A sensitivity analysis is performed to understand the potential variability of the results. Study estimates that 48% of Brittany's soil horizons are suitable for light earth building. Every year, 1.3 Mt of suitable soil are excavated in Brittany. Using only these excavated earths, all existing and new buildings in Brittany could be insulated with light-earth in less than 8 years. This study shows that suitable earth availability is not a limiting factor to develop light earth insulation in Brittany.
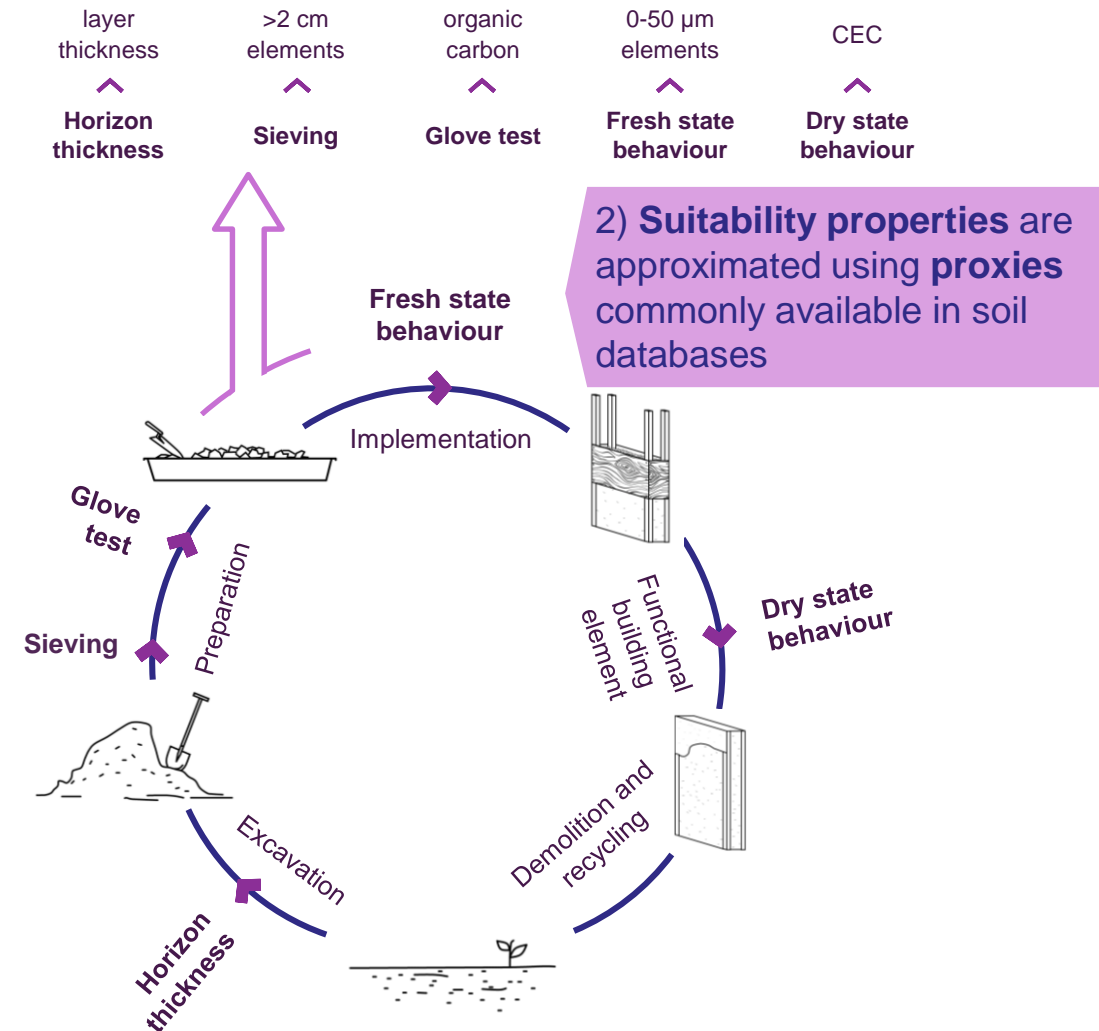
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Methods

Fresh state behaviour · Implementation · Glove test · Sieving · Preparation · Dry state behaviour · Functional building element · Demolition and recycling · Excavation · Horizon thickness

1) Soil suitability for earth building depends on **suitability properties** that are located all along the building life cycle

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Methods

layer thickness — **Horizon thickness**

>2 cm elements — **Sieving**

organic carbon — **Glove test**

0-50 μm elements — **Fresh state behaviour**

CEC — **Dry state behaviour**

2) **Suitability properties** are approximated using **proxies** commonly available in soil databases

1) Soil suitability for earth building depends on **suitability properties** that are located all along the building life cycle

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Methods

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3) **Proxies thresholds** are applied to a pedological database

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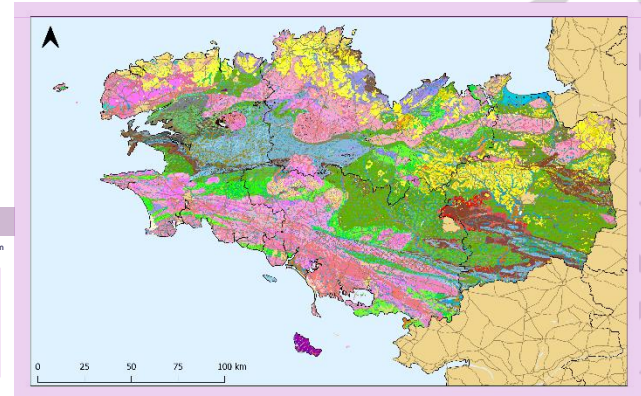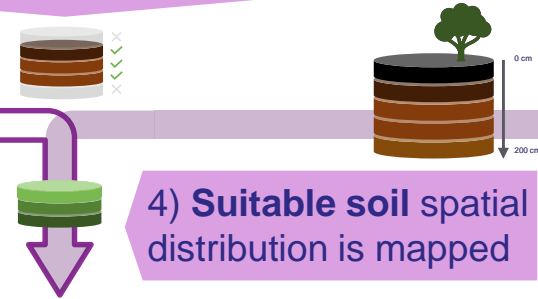
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Fresh state behaviour

Implementation

Glove test

Preparation

Sieving

Excavation

Horizon thickness

Demolition and recycling

Functional building element

Dry state behaviour

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Methods

3) Proxies thresholds are applied to a pedological database

layer thickness	>2 cm elements	organic carbon	0-50 μm elements	CEC
Horizon thickness	**Sieving**	**Glove test**	**Fresh state behaviour**	**Dry state behaviour**

2) Suitability properties are approximated using **proxies** commonly available in soil databases

4) Suitable soil spatial distribution is mapped

Fresh state behaviour

Implementation

Glove test

Sieving

Preparation

Excavation

Horizon thickness

Functional building element

Dry state behaviour

Demolition and recycling

Cumulated suitable thickness (cm)
- 100+
- 60-100
- 30-60
- Not suitable
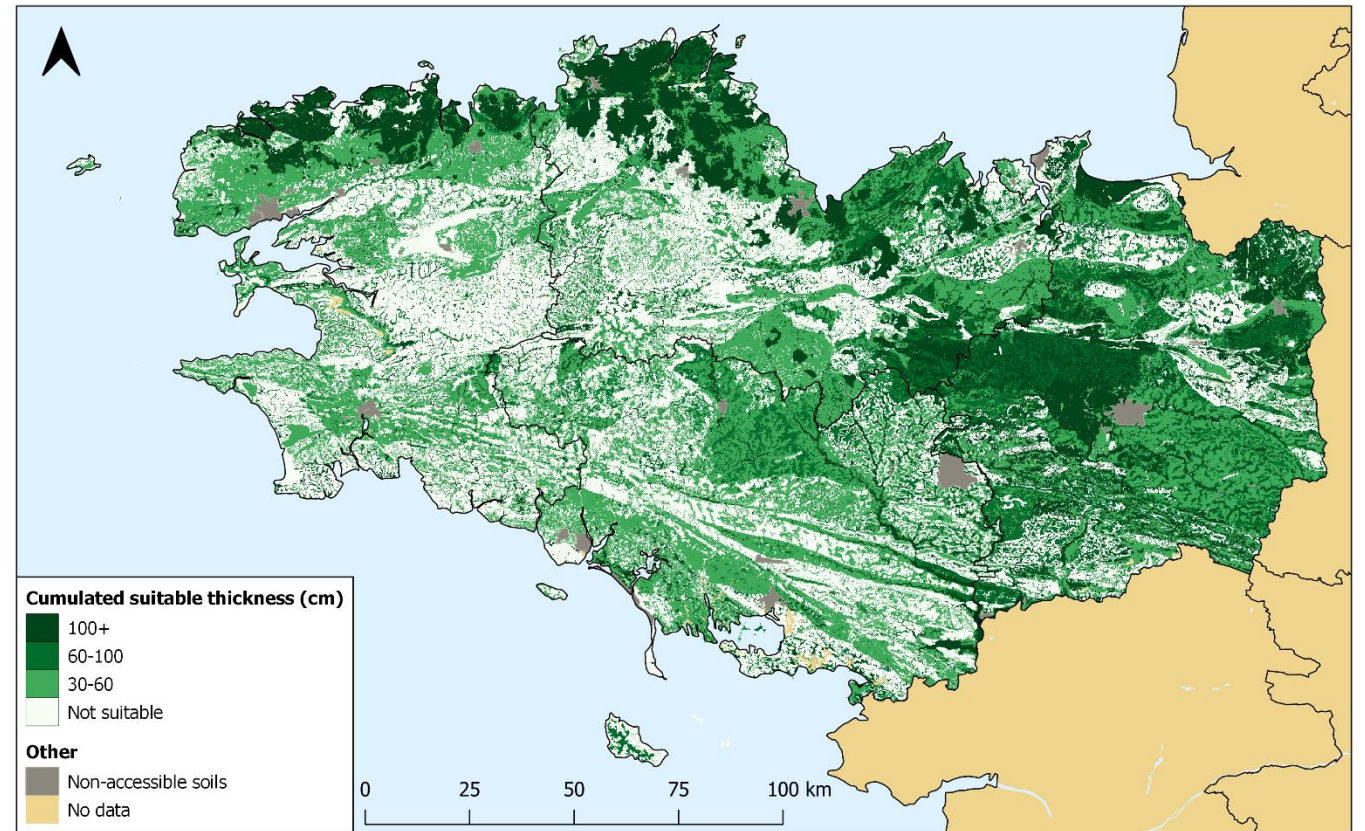
Other
- Non-accessible soils
- No data

0   25   50   75   100 km

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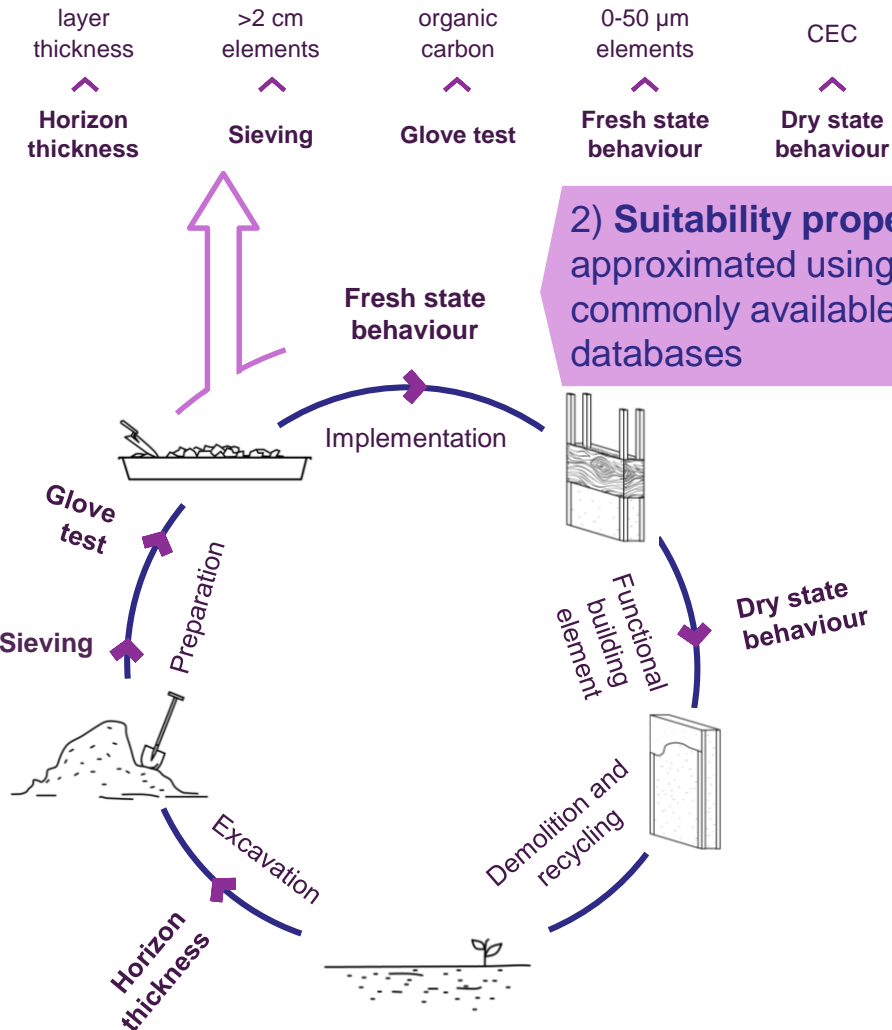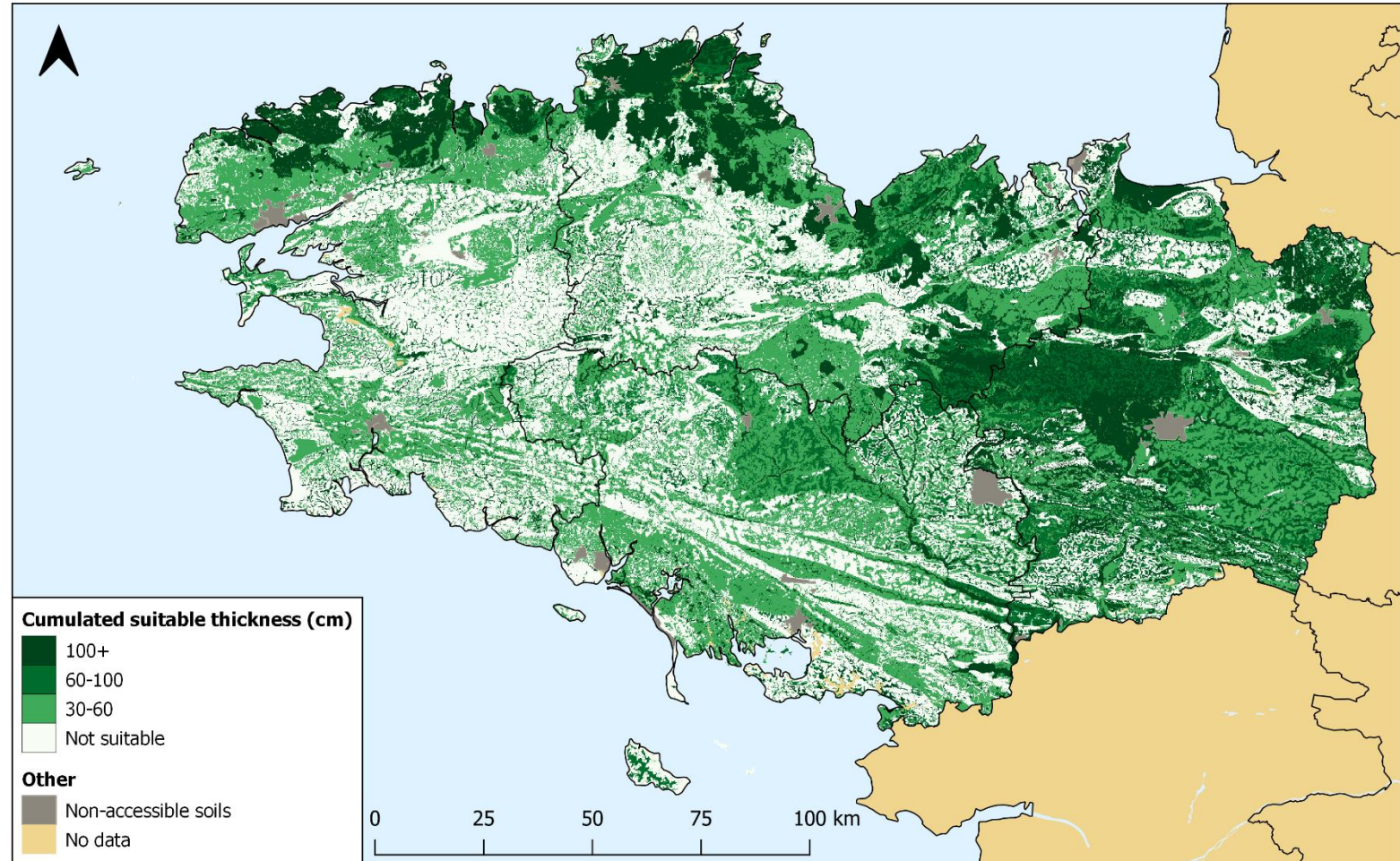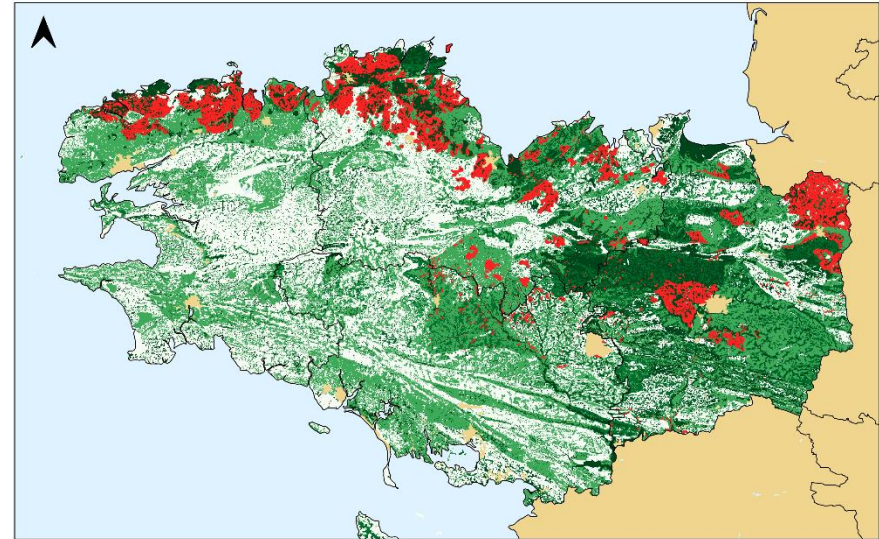
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Results : suitable soils distribution

- **Well distributed** : 99.5% of the territory is at less than 1 km of a suitable soil resource.

- **High suitability :** 48% of the total soil volume in Brittany could technically be used for light earth building.
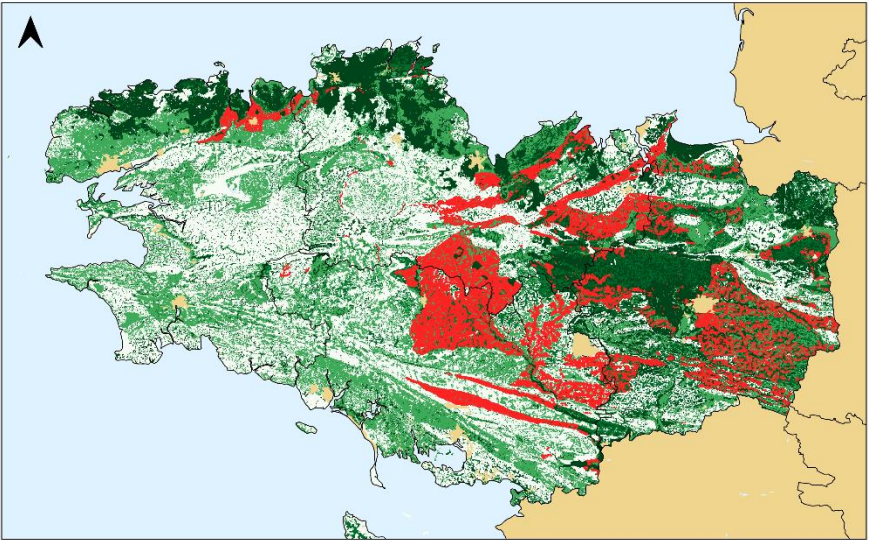

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0   25   50   75   100 km

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Results : suitable soils

NEOLUVISOL profond issu de limon éolien   N°256

	$F_{50/2000}$	CEC	OC	$F_{2000/D}$	T	Suitable
1 LA	22	8.7	17.1	1	50	Yes
2 E	21	4.2	5.5	1	-	No
3 BT	18	6.11	1.8	1	180	Yes

Depth markers: 0, 50, 80, 260

Total surface
876 km²
(3.24%)

Suit. volume
2.0 km³
(15.8%)

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Results : suitable soils

BRUNISOL moyennement profond issu de schiste tendre souvent altéré					

	$F_{50/2000}$	CEC	OC	$F_{2000/D}$	T	Suitable
1 LA	18	8.5	16.5	10	50	Yes
2 S	27	5.3	10.2	15	50	Yes
3 C	30	5.2	3.1	25	-	No

Total surface	Suit. volume
1453 km² (5.4%)	0.64 km³ (5.1%)

Depths: 0, 31, 50, 60
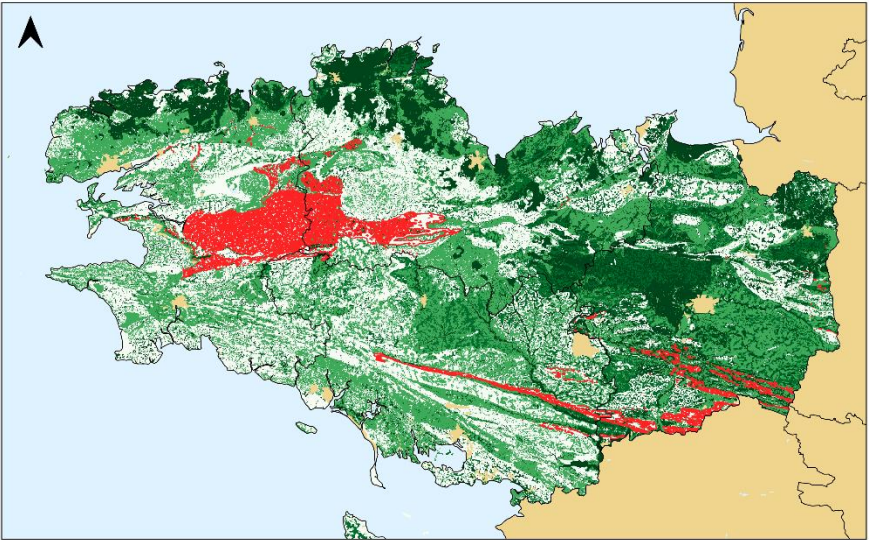
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Results : suitable soils

| RANKOSOL à horizon A humifère issu de schiste gréseux ou cornéenne parfois altéré | | N°67 |

		$F_{50/2000}$	CEC	OC	$F_{2000/D}$	T	**Suitable**
1	A	32	13.2	30.4	17	28	No
2	CR	46	7.03	1.8	40	-	No

Total surface	Suit. volume
162 km² (0.6%)	0 km³ (0%)

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Results : horizon type suitability

Horizon type	% volume in database	% volume suitable
A	33	67
E	5	7
B	15	93
O	1	2
S	44	27
X	3	0

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Results : excavated earth

Legend:
- **Total suitable excavated earth** (thick dashed line)
- Total earth used in new AND existing buildings (solid line)
- Total earth used to insulate existing buildings in 2020 (dashed line)
- Total earth used to insulate new buildings (dotted line)

Chart axes: Earth mass (Mt) on y-axis (0 to 12), Year on x-axis (1 to 10).

Annotations: 1.3 Mt/year; 0.3 Mt/year; tot = 7.4 Mt

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Conclusion

Suitable soil is abundant and well distributed

- **No need for long-distance transportation**

Soil is a fossil resource, but local excavated soil flows are more than sufficient for (light-)earth building needs

- **No need to excavate soil**

Provided **soil reversibility** is not impaired and **excavated soils** are privileged, earth building **does not enter in competition with other soil uses.**

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Loris Verron

loris.verron@univ-eiffel.fr

0602665039