

Compressed soil



Explanation of the diagram
"The magic of soil" sheet

Compacted soil is soil that has been crushed and compressed, affecting either the surface/first few centimetres or deeper levels. This damaging phenomenon has become more prevalent over the last forty years as a result of the increasing mechanisation of agricultural and forestry operations, and the use of heavier machinery.

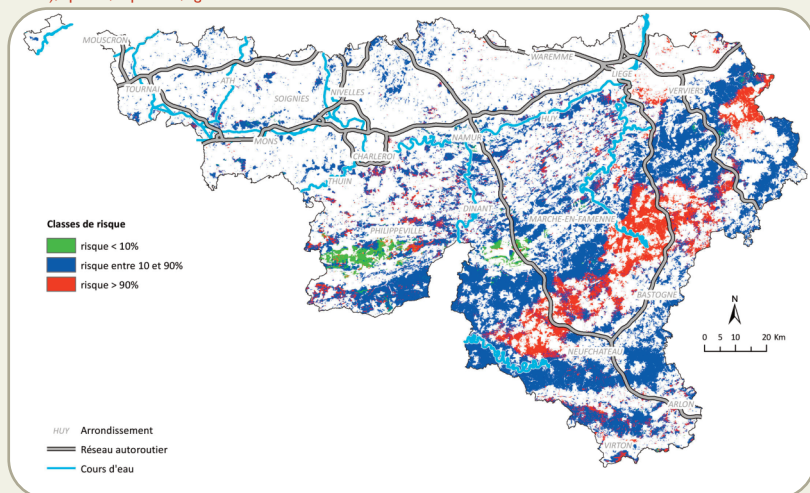
Compacted soil is no longer able to effectively fulfil its functions, in particular absorption of water and growth of plants.



In Wallonia

Walloon soil's vulnerability to compaction

Source: Final report by the Convention
"Evaluation des Risques de Compaction des Sols en Région Wallonne" (Assessment of compaction risk for Walloon soil), Ephesia, Sept 2013, fig. 34b



Compaction risk varies widely. Maps provide an overview. For example, this shows compaction risks at a depth of 40 cm for loads of 4.6 tonnes on wet soil.

What is soil compaction?

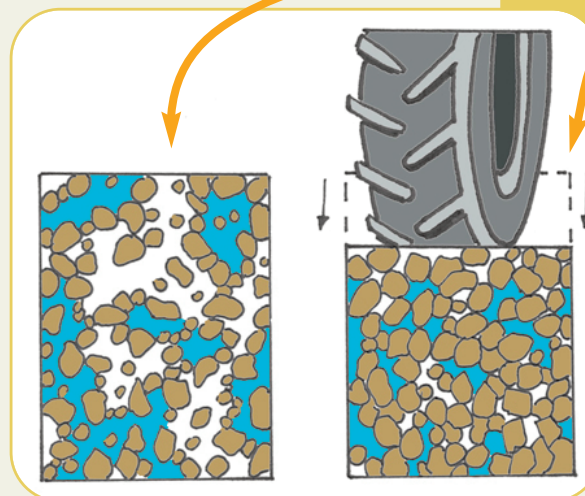
The solid proportion of soil is made up of mineral matter (source rock particles) and organic matter (residue of plants and dead organisms, droppings, humus, etc.). In healthy soil - with high levels of organic matter and **no compaction** - this solid part forms small aggregates*, between which water, air and organisms (such as earthworms) can circulate.

Excessive pressure compresses these aggregates and crushes the pores**. This reduces the space available for air and water. Soil becomes harder and its structure alters. This compaction of aggregates and pores continues for as long as pressure is applied to the soil...

* small clumps or clods

**spaces, gaps, micro-cracks.

Pores allow air and water to circulate in soil.



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Compacted soil...

...has a modified structure caused by resistance to pressure, usually applied in a downward direction.

This pressure may have been caused by:

- very heavy agricultural or forestry tools (beet harvesters, hauling machines used in forests, for example) and/or machinery with over-inflated tyre;
- agricultural or forestry operations carried out on damp soil, which is more vulnerable to compaction;
- high traffic over a surface (pedestrians, walkers, etc.) and repeated movements of motorised vehicles (in forests, motorcycles, quad bikes, etc.);
- trampling of earth by cattle in watering areas;
- construction machinery, etc.

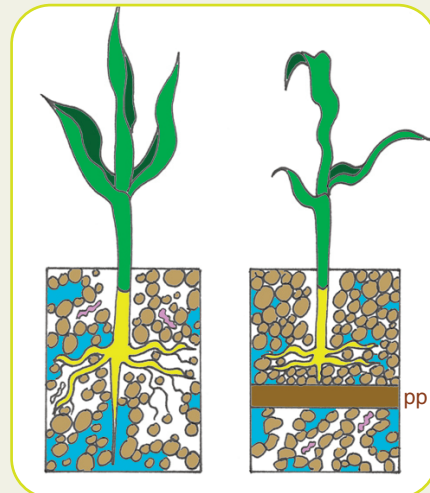
Permanent puddles and ruts are immediately visible surface indications of soil compaction.



When soil is compacted

1 Rain water can no longer penetrate.

There is a risk of water stagnating in puddles, damaging the profitability of crops. In the case of land located on a slope, water flows over its surface and sweeps away particles of earth (erosion): resulting in the formation of furrows and mudslides. The earth swept away by erosion is lost for crop-growing. It could also potentially flow into watercourses: with harmful consequences for aquatic environments as a result of influxes of earth (cloudy water and silting), organic matter and, in some cases, pesticides or fertilisers.



Effect of compressed soil (on the right) with plough pan (pp*) on the development of a plant's roots

*see box on page 53 (note)

3 Roots no longer develop normally.

As well as a reduction in oxygen supplies, roots can no longer pierce this hard soil. This often results in stunted growth and a decline in agricultural yields.

4 Water trapped in soil is no longer able to escape.

Soil is colder and takes longer to warm up in spring (dry soil warms up faster than wet soil).

2 Soil's pores* are crushed.

Compaction therefore reduces oxygen supplies and available habitat for soil micro-organisms. Biological activity slows down.

*spaces, gaps, micro-cracks.

Pores allow air and water to circulate in soil.

5 In forests, trees' natural regeneration is compromised.

Compaction of land prevents seeds from germinating and new growth does not survive.



Earthworms, **allies** in the battle against soil compaction



Earthworms play an important role in soil's **good health**. Soil with high populations of different species of earthworms will repair itself faster after compaction.



The tunnels created by worms, especially those formed by species which tunnel vertically, allow rain **water to circulate** in soil. Water seeps into soil and is absorbed. It can also be more easily absorbed by plants' roots and is able to percolate more efficiently to groundwater bodies.



Tunnels provide **good ventilation** for soil, due to the formation of larger interconnected pores.



Tunnels promote the development and colonisation of soil by plants' roots. In forests, this network of roots **reduces risks** of compaction by very heavy machinery.



Worms are "**mixers**": they continuously transport organic matter, mixed with mineral particles and micro-organisms, between different layers of soil. This helps to homogenise and stir the soil. Their excrement is impregnated with a sticky mucus which helps to form aggregates. This promotes soil's stability and makes it easier to cultivate.



Sheet number 4 "Biodiversity"



Excessive compaction prevents earthworms from carrying out these activities. Either because they are no longer able to pierce the soil or due to a lack of oxygen.



A phenomenon with **lasting effects**

Compaction of soil can have **long-term effects**.

On the surface (up to 20 or 30 cm in some cases), it can take compacted soil months or even years to completely recover.

Deeper down, (up to 60 or 70 cm), recovery can take decades: some soil in Wallonia still bears the traces of deep ploughing carried out over 40 years ago!*

The effects are aggravated if the subsoil is affected by compaction. In this case, the phenomenon is almost irreversible.

* A "plough pan" is a layer of compacted and impermeable earth which forms below the topsoil, caused by repeated crushing of soil over a period of years by the blade of a plough. It is also caused by tractor tyres travelling along the plough furrow.

What can we do ?



Prevention

Although the problem is particularly acute in major arable regions, soil compaction also affects forest soil. Various techniques can be used to decompact compressed agricultural soil. These tend to be very expensive and do not guarantee the complete recovery of soil's properties. The best means of prevention is, of course, avoiding compaction by reducing movements of machinery, choosing ideal humidity conditions for certain operations, reducing tyre pressures on very heavy vehicles and other measures. In forests, tests using horses for hauling have had some success.



A forest walk

Comply with rules governing access to forest land. These are also intended to reduce excessive compaction of soil by high numbers of users, walkers or motorised vehicles.



In the garden

Earthworms are natural allies in efforts to combat compaction. In general, they play an essential role in maintaining soil's quality. Leaving organic matter on soil (crop residue, dead leaves, etc.) and/or adding organic matter (manure, plant debris, compost, etc.) will help to provide them with nourishment. It is very important to avoid chemical pesticides as these are toxic to soil fauna.



Sheet numbers 3 and 4
"Organic matter" and "Biodiversity"

General publications by the SPW – online information

Les Indicateurs Clés de l'Environnement Wallon 2012 (ICEW 2012), Direction de l'Etat Environnemental, SPW Éditions - DGRNE - DEMNA- DEE, 2013 (available for download in French, English and German) <http://etat.environnement.wallonie.be>

Tableau de bord de l'environnement wallon 2010, SPW Éditions - DGRNE – DEMNA - DEE, 2010 (available for download in French, English and German) <http://etat.environnement.wallonie.be>

Rapport analytique sur l'état de l'environnement wallon 2006-2007, MRW – DGRNE, Namur, 2007 (available for download in French, English and German) - "L'imperméabilisation et la compaction des sols" pp.520 ssq. – scientific report (available for download) <http://etat.environnement.wallonie.be>

La compaction des sols forestiers en Wallonie, Guide de bonnes pratiques pour éviter la compaction des sols forestiers Wallons, SPW Editions, DGO3, 2014

La compaction des sols agricoles en Wallonie, Guide de bonnes pratiques pour éviter la compaction des sols agricoles forestiers Wallons, SPW Editions, DGO 3, 2014 www.environnement.wallonie.be

Forest soil / Agricultural soil

La compaction des sols forestiers. Définitions et principes du phénomène, PAUL de, M-A., BAILLY, M., Forêt Wallonne n° 76, May-June 2005, pp. 39 ssq. (available for download)

Effets de la compaction des sols forestiers, PAUL de, M-A., BAILLY, M., Forêt Wallonne n° 76, May-June 2005, pp. 49 ssq. (available for download)

Exploitation forestière mécanisée en zone humide. Quelques pistes, PAUL de, M-A., Forêt Wallonne n° 76, May-June 2005, pp. 32 ssq. (available for download)

Le cloisonnement d'exploitation pour préserver les sols forestiers, Document, informatif, PAUL de, M-A., BAILLY, M., HEYNINCK, C., Service public de Wallonie, DGO3, 2009 (available for download) www.foretwallonne.be

Le tassement des sols agricoles. Prévenir et remédier, Partenariat Prosensols, 2011 www.prosensols.eu (available for download)

Teachers

Le sol - Qu'est-ce que le sol? Comment se forme un sol? Quelles fonctions remplit le sol? Quelles sont les menaces qui pèsent sur les sols?, educational report, Prosensols, s.d. (available for download)
Les menaces qui pèsent sur les sols, educational presentation, partenariat Prosensols, s.d. (available for download)

Educational folder and sheets on soil (from age 12) www.prosensols.eu

Creusons le sol, Symbioses, le magazine de l'Education relative à l'Environnement, N°98, second half of the year 2013 www.reseau-idee.be (available for download)

Europe

Soil Atlas of Europe, European Soil Bureau Network, European Commission, 2005 – "Compaction" pp.115 ssq. <http://eussoils.jrc.ec.europa.eu/>

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