

Soil Chemistry and Sustainability

Why do we spend so long caring for our own skin, only to neglect Earth's?

Your skin is filled with millions of microorganisms, important minerals and water and home to some of the most important functions of the human body: the protection against viral and bacterial infection, production of vitamin D and regulation of your body temperature (White, n.d.).

Philosophically, Earth's skin is the interface between the atmosphere and the Earth's crust, otherwise known as soil (Birkeland, 1999). There is a broad range of definitions for soil, such as: a plant growth medium in agriculture and unconsolidated material in civil engineering. Think of it like this; soil is filled with millions of microorganisms, important minerals and water and home to some of the most important functions on Earth: protection of underground ecosystem from anthropogenic and weathering events, the primary home of nutrient and mineral cycling and regulation of land and air temperature.

What skin is to us, soil is to Earth and the health and development of skin and soil is critical for wellbeing and sustainable environmental systems respectfully.

Understanding the importance aspects of soil chemistry and biology

Water

Water is the ultimate transport fluid and plays an important role in regulating plant growth, biodiversity and nutrient uptake. As most essential nutrients are water soluble, sufficient water in the soil allows for the transportation of nutrients.

Fungi, Bacteria and Enzymes

Soil is often considered alive. It is filled with millions of bacteria, detritivores and enzymes that breakdown organic matter to forms accessible by plants. For example, (Weaver, 2018):

- Cellulase hydrolyses cellulose, key in breaking down physical plant matter in carbon cycling;
- Protease mineralizes proteins into peptides and amino acids for nitrogen

cycling; and

- Phosphatase releases bioavailable phosphate from minerals for phosphorus cycling.

Fundamentally, these microorganisms are the foundation of life on Earth and a healthy soil provides the perfect home for this life to THRIVE.

Nutrient and Mineral Cycling

As a result of the presence of these microorganisms and water, the soil behaves as the bedrock for nutrient cycling on earth. Besides its role in the carbon and water cycles, the soil controls the movement of macro- and micro-nutrients.

Macronutrients (such as nitrogen, potassium, phosphorus, magnesium, calcium and sulphur) are introduced into the soil by complex deposition and leaching mechanisms, that become enzymatically bioavailable in the presence of water (Huang, 2015).

Micronutrients (primarily heavy metals such as iron or manganese) are often found mineralised in rocks and clay beneath the surface that leach in small quantities to aid plant growth (Huang, 2015).

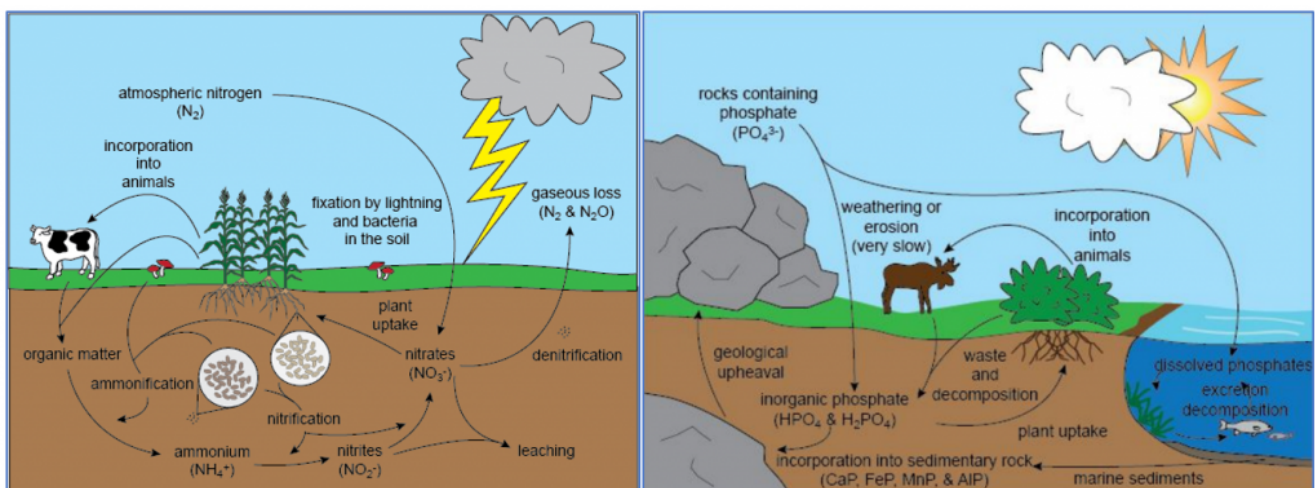


Figure 1: Nitrogen (left) and phosphorus (right) cycles.

<https://edu.glogster.com/glog/nutrient-cycles/249cbeevv4m?=&glogpedia-source>

Many of these micro- and macro-nutrients are dissolved into solutions in the soil for nutrient uptake in roots by ion exchange. When minerals dissolve into water, they exhibit a partial positive charge, and when the roots of a plant need to absorb mineral and nutrient ions, they release hydrogen ions to displace mineral ions within the soil (Hammer, 2000). The success of this process heavily depends

on high concentrations of these nutrients being present, hence, healthy and nutrient-dense soil is the key to THRIVING ecosystems and sustainable agriculture.

How does it come together?

Soil is an ecosystem itself (Walsh, 2019). Similar to a rainforest or marsh, soil has biotic and abiotic components, access to primary producers (overground plants and organic layer organisms), consumers in the food chain (underground microbes and insects) and decomposers/nutrient cycling (fungi, bacteria and other enzymes).

In the same way rainforests or marsh ecosystems provide important ecosystems services to humans and the greater environment, healthy soil ecosystems provide the essential services such as: primary production, carbon sequestration and nutrient cycling. It is both figuratively and literally the foundation of life on earth.

Threats to soil health and sustainability

Despite the endless benefits of a healthy soil, unsustainable anthropogenic and mass agricultural practices have led to the degradation of this ecosystem.

Physical threats include compaction, compacting soil damages the natural aeration that is key for sustaining aerobic life underneath the surface and directly inhibits water flow, and dredging, the large-scale clearing of land leads to the unwanted disruption of soil structures, and after the dredged material is disposed of (often nearby), some components of soil are known to become toxic after aeration, for example cadmium sulfide produces sulfuric acid (toxic to plants and animals) when exposed to air (Zhuang, Allen, & Fu, 1994).

Biological threats to biodiversity and organic matter loss due to clearing or intensive agriculture restricting the diversity of macronutrients, water retention and overall health of the soil.

Chemical threats such as pollution, where landfill leaching, disposal of industrial waste and fertilizer or pesticide application leads to increased chemical toxicity. This has adverse and ongoing effects on environmental and soil health, including the contamination of groundwater aquifers, introduction of unwanted pathogens and excessive nutrient content.

Takeaway

Soil is the key to productive agricultural, a healthy environment and diverse ecosystems, yet in environmental talks the importance of soil health and sustainability often gets overlooked. With a skincare and cosmetic industry worth over \$AU1,387.8 million (Statista Consumer Market Outlook, 2019), it's a wonder why we do not transfer the same enthusiasm to soil health. Well, here is a few things to remember for yourself, your friends and your garden:

- Improving soil health is not an overnight exercise – the key to sustainable and adaptive soil systems are long-term and consistent efforts. It is like overcoming skin damage or breakouts, if you apply treatment once or twice a day, be mindful of the food and drink you consume, remember to remain hydrated and give your skin time, your chances for success improve drastically;
- Soil is alive and constantly working – cycling important minerals and nutrients and adapting to change. Applying unnecessary stress to these soil frameworks, like scratching bites and scabs, is detrimental to the soil's natural recovery and operation. Low disturbance is key;
- Protecting soil from weathering – just like wearing sunscreen or protective clothing, protecting your soil is critical for ensuring the long-term health and maintaining hydration. This can be as simple as piling fallen leaves as mulch around the base of your plants or as complex as using groundcover crops to protect bare ground; and
- Diversity is key – like the importance of a diverse diet and a range of skincare methods, a diversity of vegetation, ideally native, is key for promoting the resilience and diversity of the soil systems and nutrient cycles. Healthy native plants promote healthy soil, and healthy soil promotes healthy native plants, a truly sustainable and symbiotic relationship.

For further information about your environmental and ecosystem sustainability and how to improve your footprint, including enterprises, do visit [THRIVE Project](#), designed to guide you towards sustainable prosperity.

Written in collaboration with THRIVE Tribe member Thomas Jackson.

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