1

It all comes down to

SOIL

2

Soil

Layer of chemically and biologically altered material that overlies rock

Photo: Soil Science Typic Hapludult (fine-loamy, mixed, semiactive, isohyperthermic) In Loreto, Peru. (CC BY 2.0)

3

Soil Chemistry

Macronutrients: Needed in large amounts.

Micronutrients: Needed in trace amounts

TABLE 21.2

Plant Nutrients and Their Principal Functions

Nutrients	Principal functions
Carbon, hydrogen, oxygen	Components of organic molecules
Nitrogen	Component of amino acids, proteins, chlorophyll, nucleic acids
Phosphorus	Component of ATP, NADP, nucleic acids, phospholipids
Potassium	Ionic/osmotic balance, pH regulation, regulation of guard cell turgor
Calcium	Cell wall strengthening and functioning, ionic balance, membrane permeability
Magnesium	Component of chlorophyll, enzyme activation
Sulfur	Component of amino acids, proteins
Iron	Component of proteins (e.g., heme groups), oxidation–reduction reactions
Copper	Component of enzymes
Manganese	Component of enzymes, activation of enzymes
Zinc	Component of enzymes, activation of enzymes, component of ribosomes, maintenance of membrane integrity
Nickel	Component of enzymes
Molybdenum	Component of enzymes
Boron	Cell wall synthesis, membrane function
Chlorine	Photosynthesis (water splitting), ionic and electrochemical balance

Sources: Salisbury and Ross 1992; Marschner 1995.

***ECOLOGY*, Table 21.2**

4

organisms at higher trophic levels get (most of) them from their food

Plants get nutrients from their environment

5

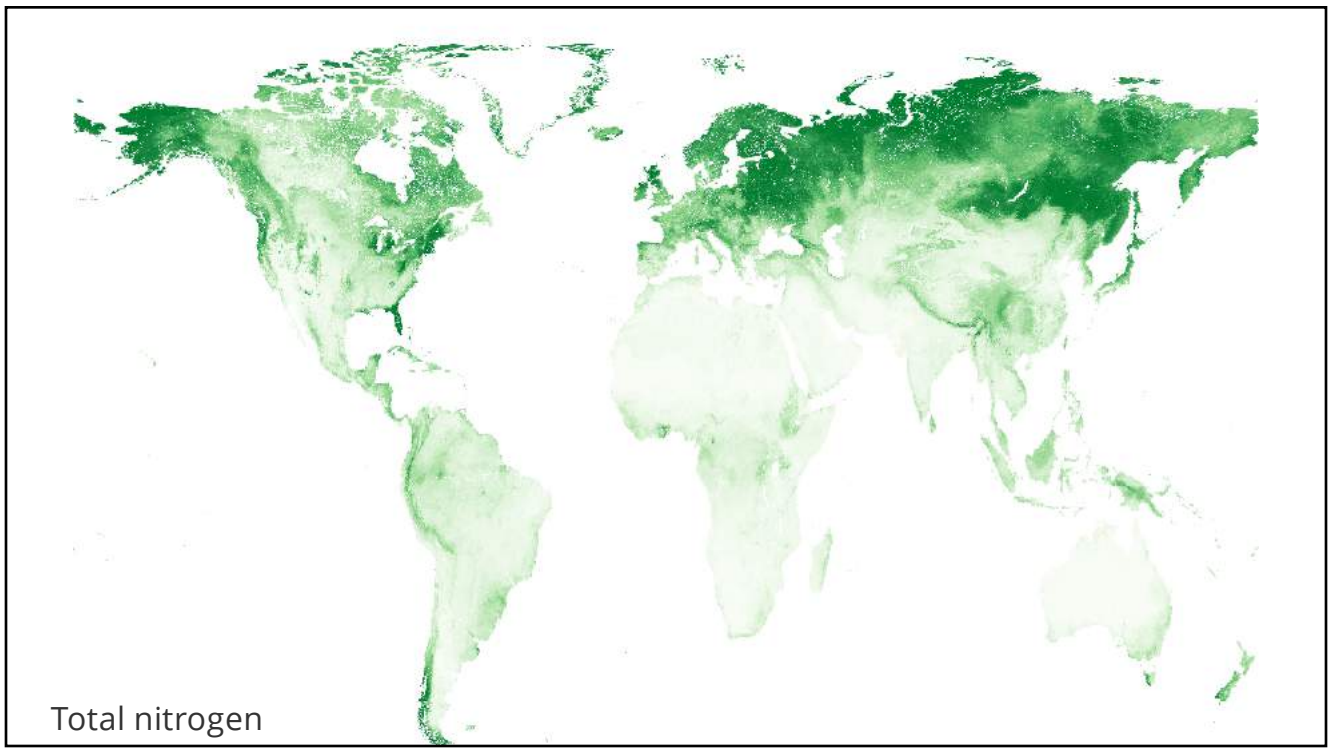
Nutrients must be present in simple, water soluble forms for plant roots to take them up

Ca^{2+}
K^{+}
Mg^{2+}

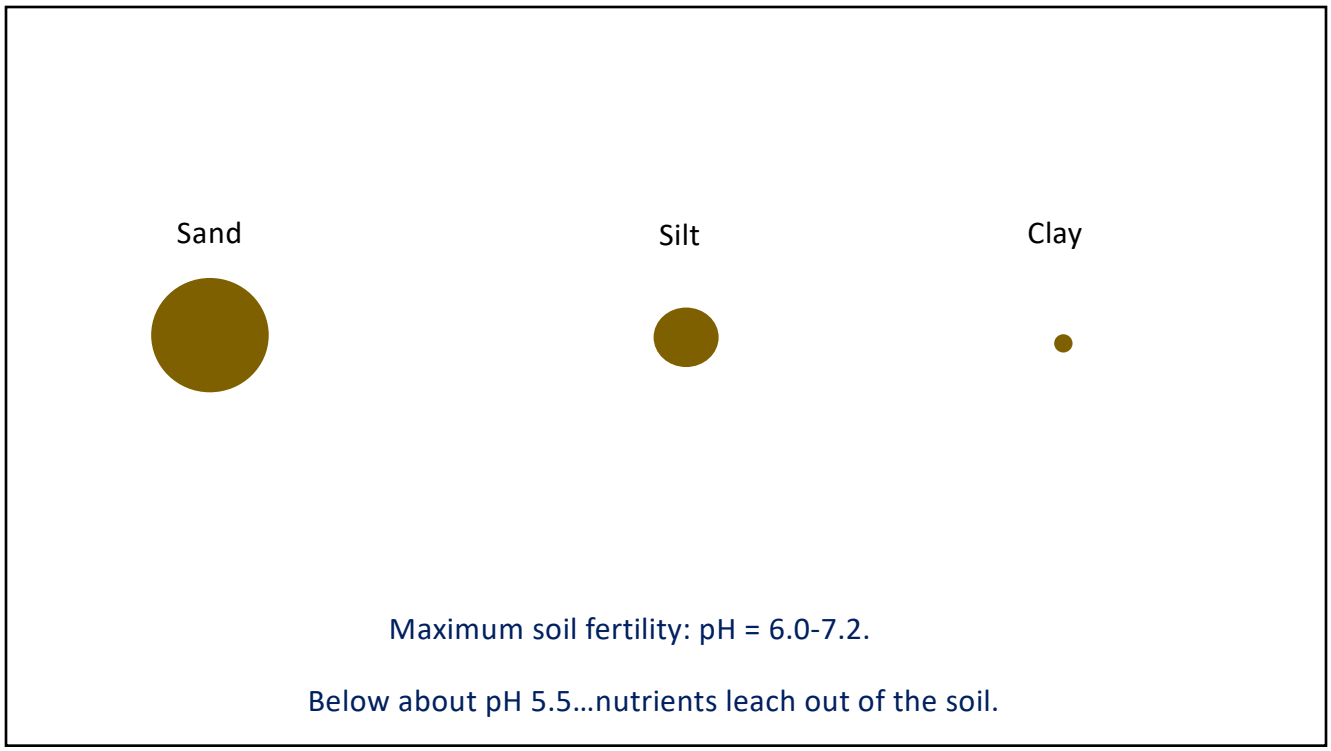
Many of these are positively charged ions…this will be important later!

Nitrogen is the limiting nutrient in most tropical forests

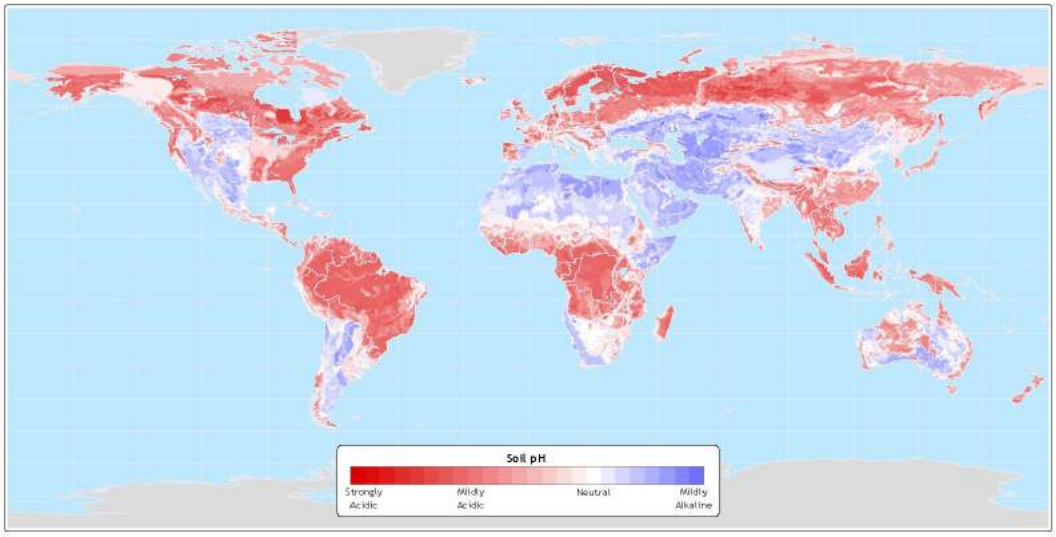
6


Total nitrogen

7


Sand
Silt
Clay
Maximum soil fertility: pH = 6.0-7.2.
Below about pH 5.5…nutrients leach out of the soil.

8



Data taken from: IGBP-DIS Global Soils Dataset (1998)

Atlas of the Biosphere
Center for Sustainability and the Global Environment
University of Wisconsin - Madison

9

So if tropical soils are so terrible, where did all this productivity come from?

10

Most of the nutrients in Trop. Rain Forests are in the living (tree) biomass.

11

When tropical forests are cleared and burned, most nutrients are lost in smoke and ash and soil erosion.

If severe enough, these ecosystems can take centuries to return to their previous state.

12

13

John Terborgh called this

"The Paradox of Luxuriance"

14

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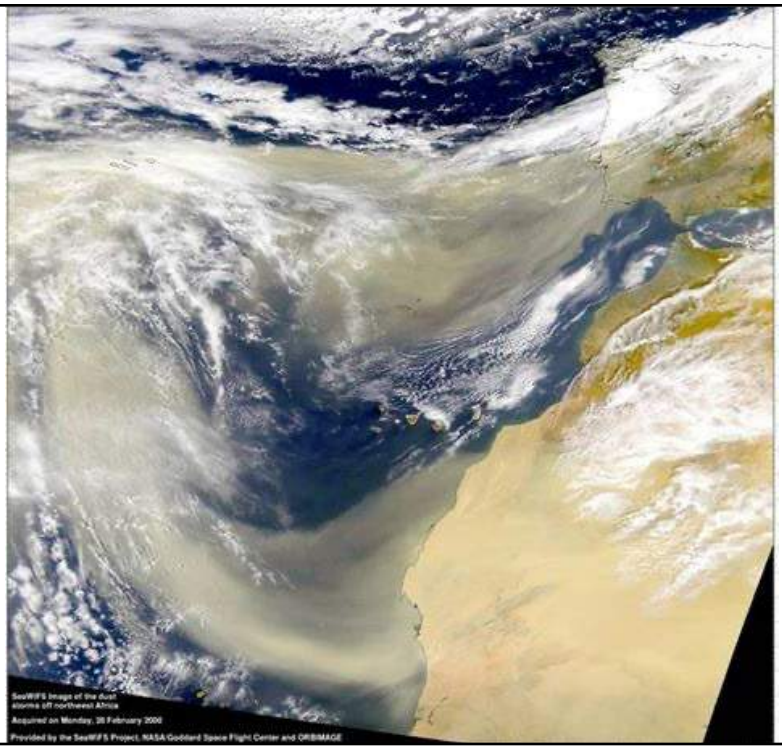
How do nutrients get back into the soils?

- Rain
- Exposure of new parent material
- River deposits
- Volcanoes
- Outer space
- Nutrient Cycling / Decomposition

16



17

Variability in soil quality has major ecological impacts

Plant fertility

Animal abundance,
Home range sizes,

Human settlement and
agriculture

Forest biomass

18

19

Three key properties of soil:

(1) TEXTURE

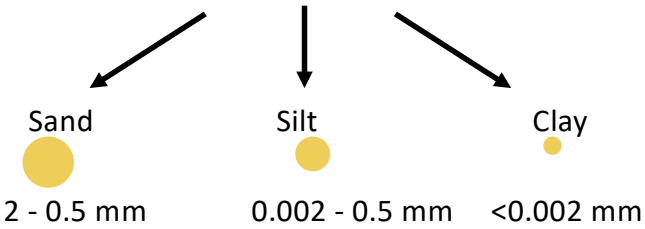
(2) WATER RETENTION CAPACITY

(3) CHEMISTRY

1) Texture: size distribution of mineral particles

20

1) Texture: size distribution of mineral particles



1. Largest Ratio of SA:V
2. Weak negative charge attracts positively charged Ions*
3. Absorb water

21

2) Water Retention Capacity

Determined by type of particles in soil & their distribution throughout the soil

Clay Soils:

Hold large volumes of water

Sandy Soils:

Drain Well

What does this mean for nutrient availability?

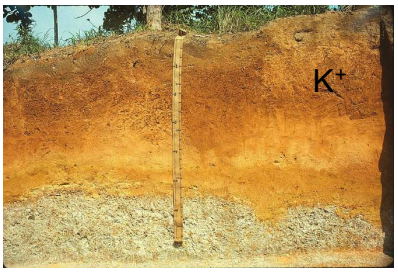
22

3) Soil Chemistry: soil pH strongly influences nutrient availability

↓ pH: large concentration of H^+ (acidic)

↑ pH: low concentration of H^+ (Basic or alkaline)

A little acidity promotes nutrient availability. How?



Clay
H^+

Below about pH 5.5…nutrients leach out of the soil. Maximum soil fertility: pH = 6.0-7.2

23