Materia orgánica del suelo

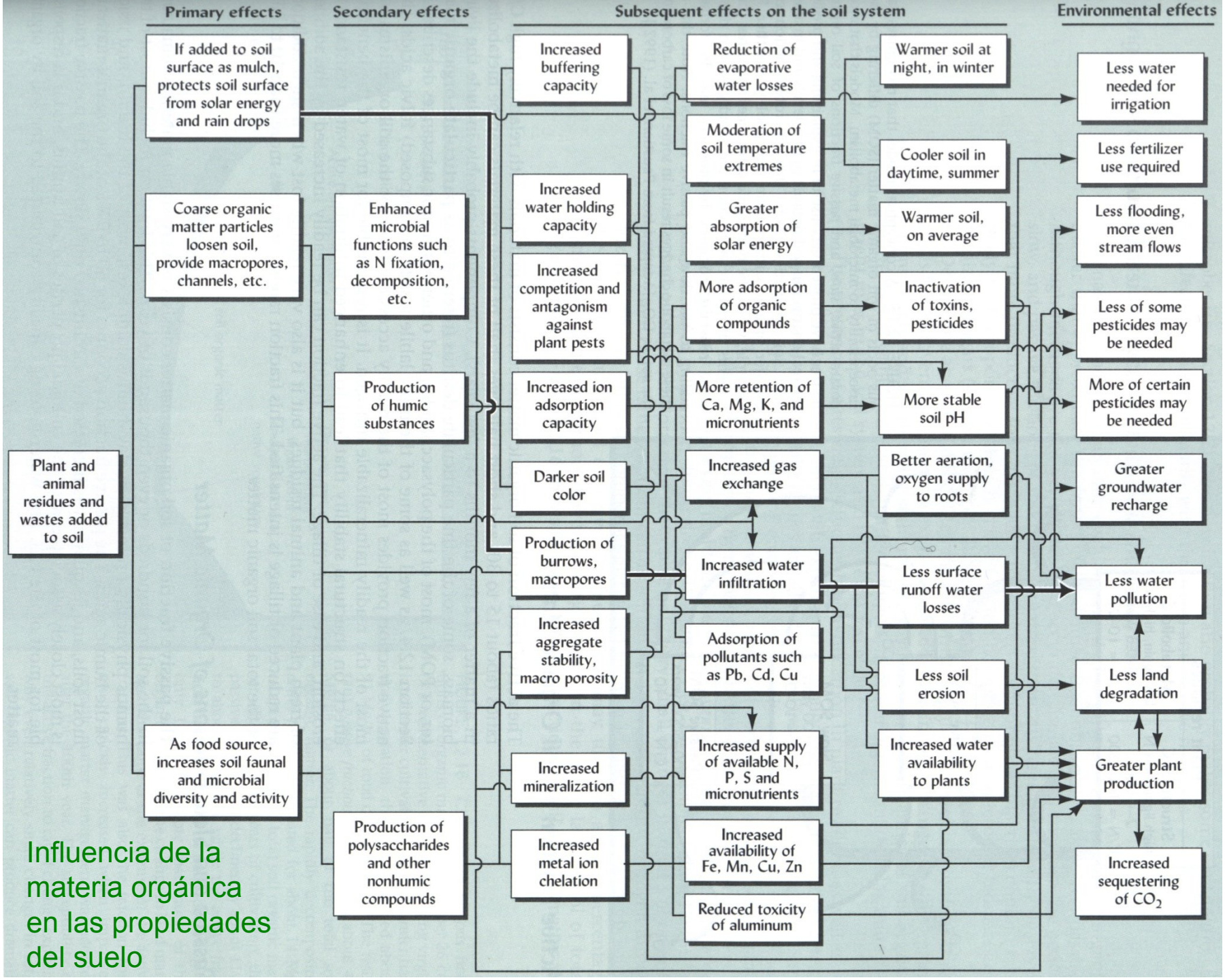
Definición:

Mezcla compleja y variada de sustancias orgánicas que se encuentran en diversos estados de descomposición. Contiene residuos (vegetales y animales) frescos, parcialmente descompuestos y descompuestos (humus) .

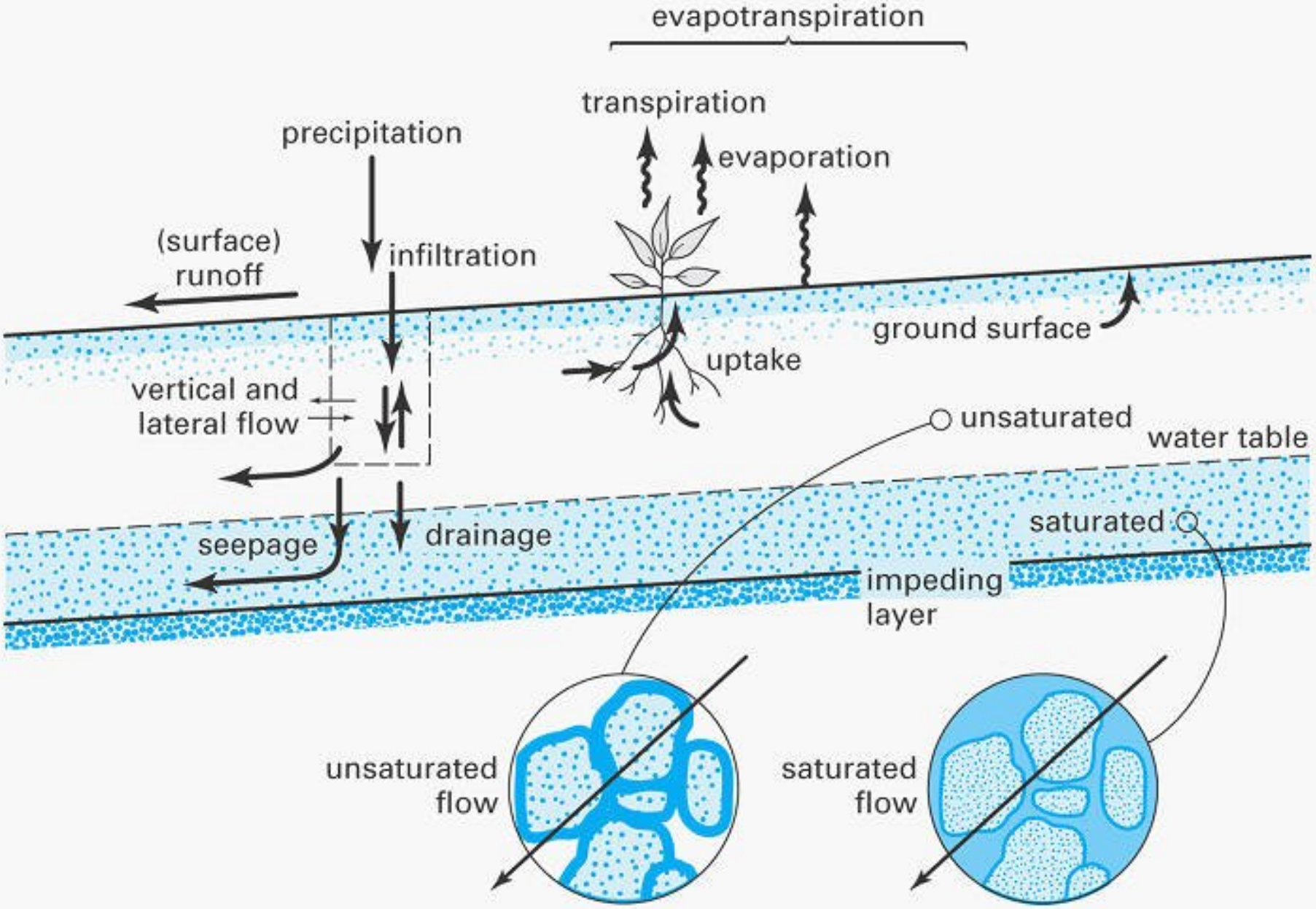
Dark colored topsoil showing high levels of SOC due to abundant plant roots and their associated soil fauna and microbes in a cultivated soil in central Iowa.

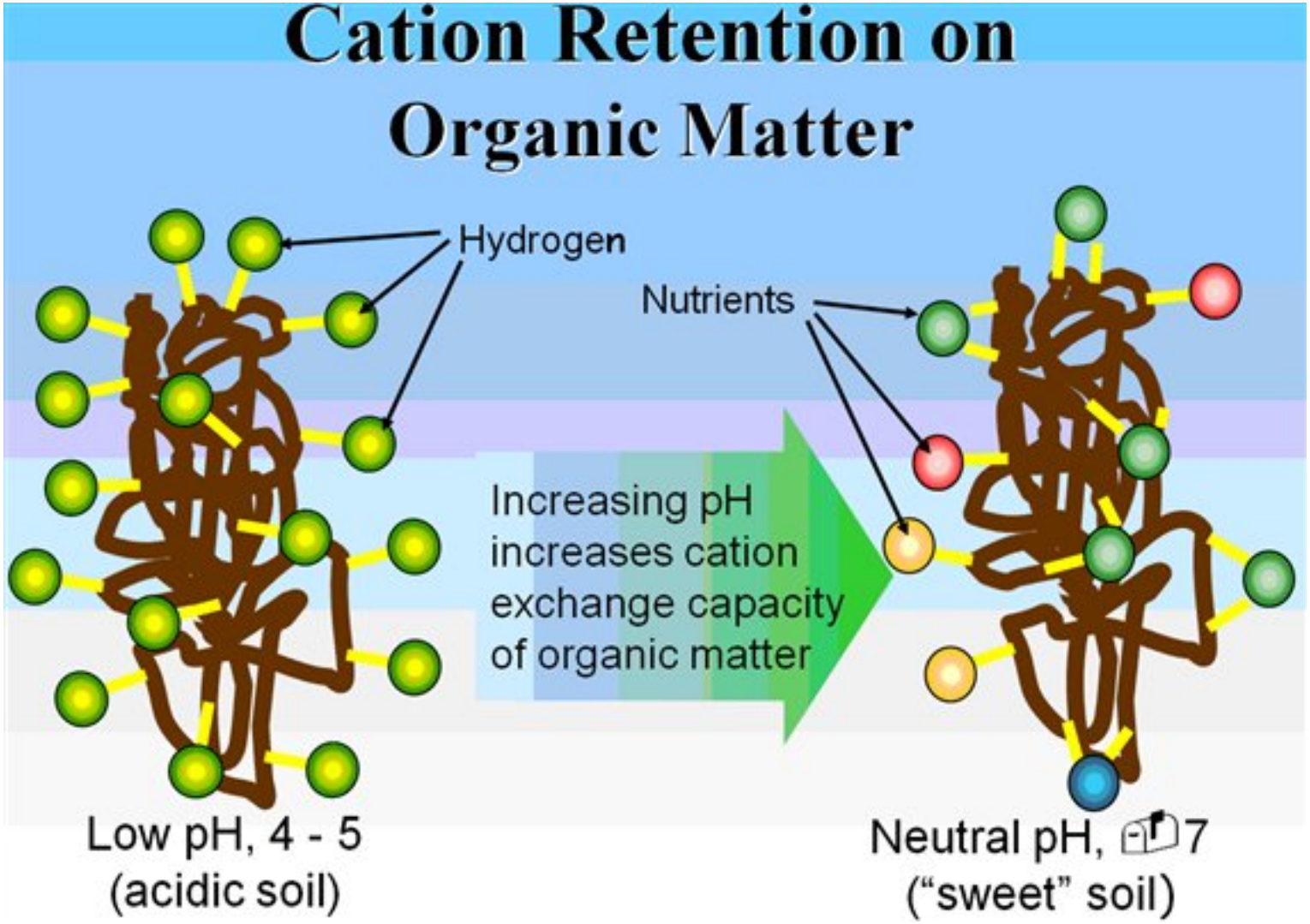
Importancia de la materia orgánica en los ecosistemas terrestres:

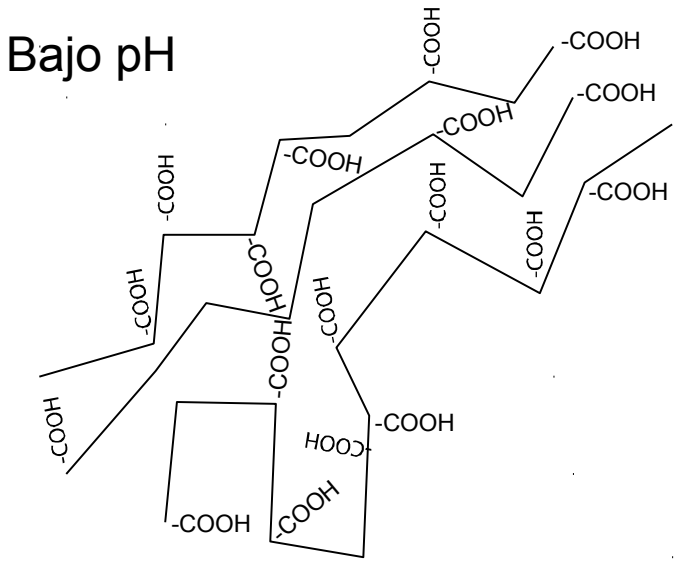
- Regeneración
- Protección contra la erosión
- Regulación del régimen hídrico (capacidad de retención de agua)
- Regulación del ciclo de nutrientes
- Génesis del suelo
- Fuente nutritiva para los organismos del suelo
- Filtraje y almacenaje de contaminantes

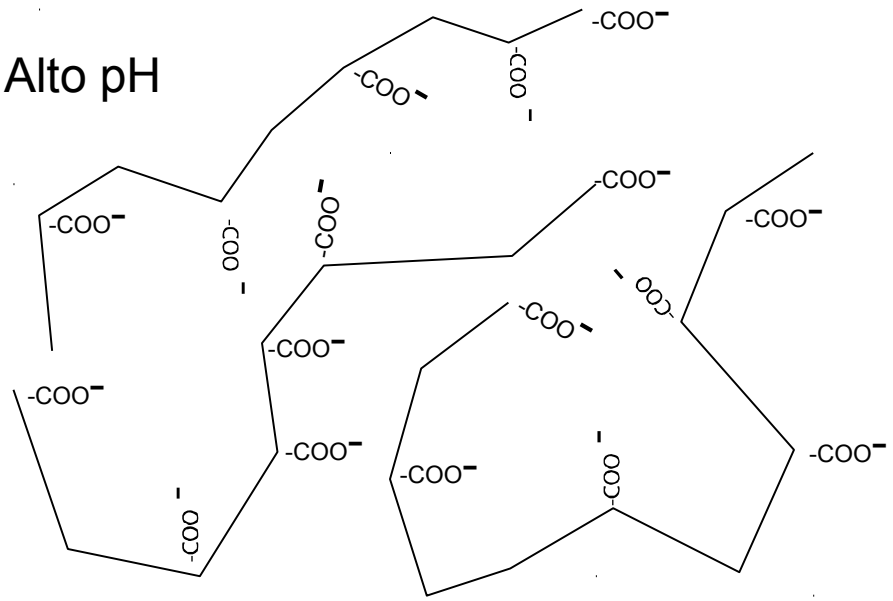


Influencia de la materia orgánica en las propiedades del suelo

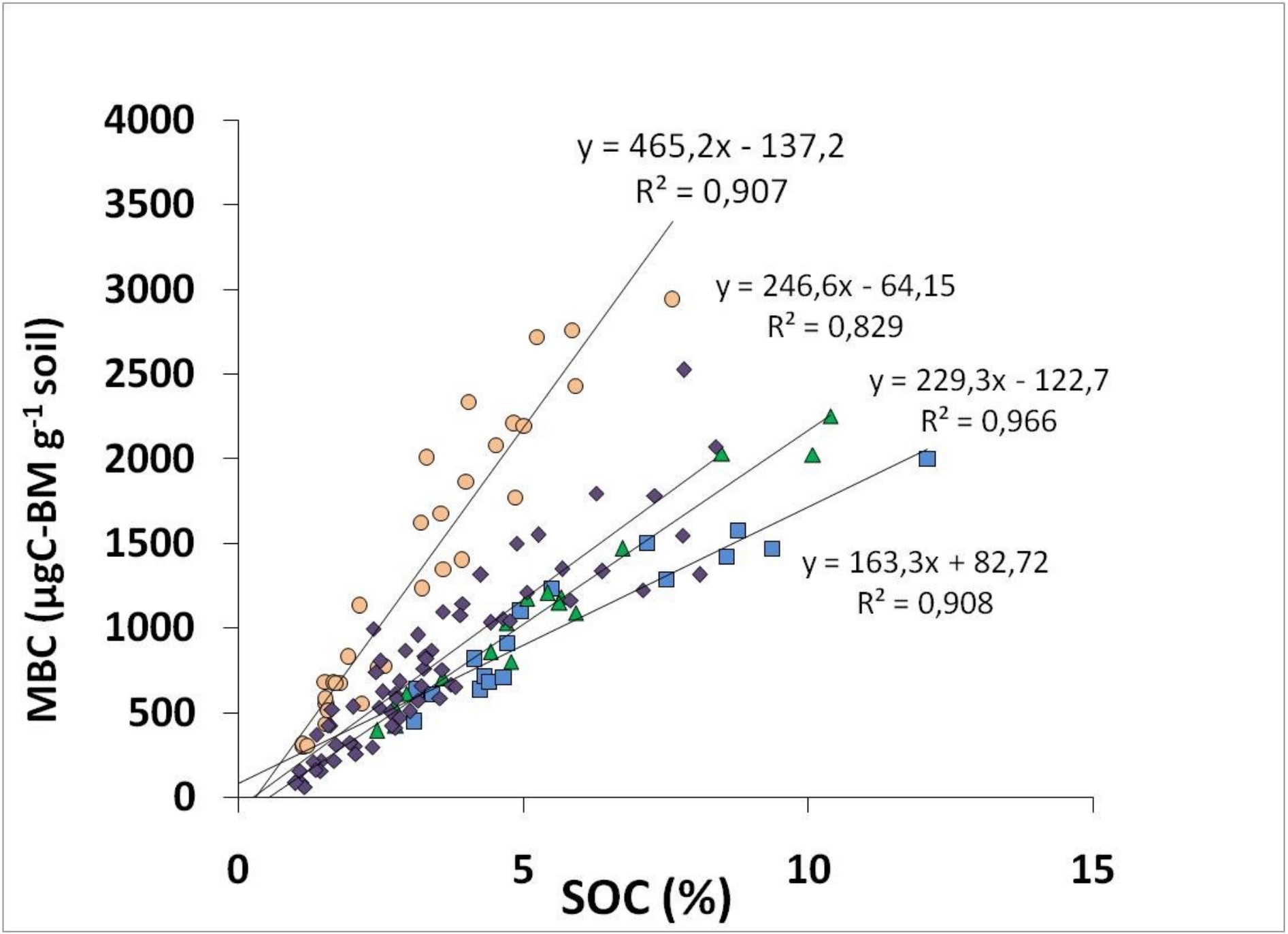

evapotranspiration
transpiration
evaporation
precipitation
(surface)
runoff
infiltration
ground surface
uptake
vertical and
lateral flow
unsaturated
water table
saturated
seepage
drainage
impeding
layer
unsaturated
flow
saturated
flow


Cation Retention on Organic Matter
Hydrogen
Nutrients
Increasing pH increases cation exchange capacity of organic matter
Low pH, 4 - 5
(acidic soil)
Neutral pH, 7
("sweet" soil)

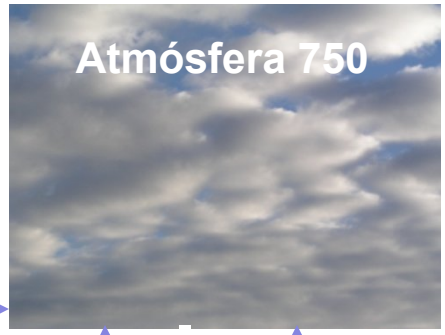




El humus presenta un gran número de ácidos carboxílicos y fenólicos, los cuales presentan fenómenos de protonación y deprotonación (entrada y salida de iones H). Esto genera que la molécula orgánica pueda cambiar su forma. Con bajo pH, los iones hidrógeno tienden a formar puentes de hidrógeno, los cuales hacen que la molécula tenga una forma más enroscada. Con un pH más básico, se genera incluso repulsión entre los grupos COO^-, por lo que la estructura molecular del humus se estira y presenta aún más sitios de intercambio catiónico.


y = 465,2x - 137,2
R² = 0,907
y = 246,6x - 64,15
R² = 0,829
y = 229,3x - 122,7
R² = 0,966
y = 163,3x + 82,72
R² = 0,908
MBC (µgC-BM g-1 soil)
SOC (%)
4000
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15

Rol de la materia orgánica del suelo en el ciclo global del carbono:



Números expresados en Pg.

1 Pg =10 ^{15} g

110

50

5.5

60

62

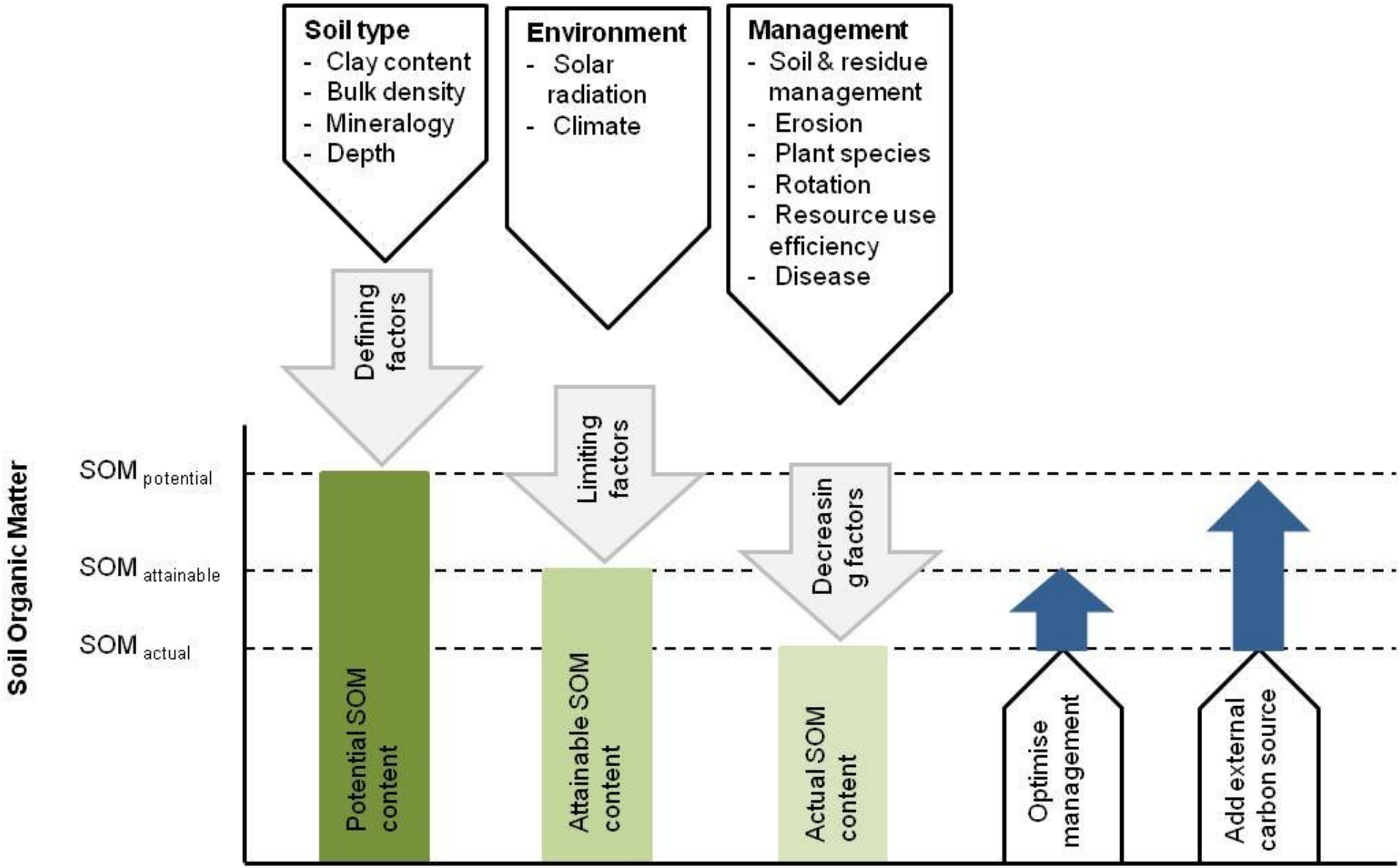
105

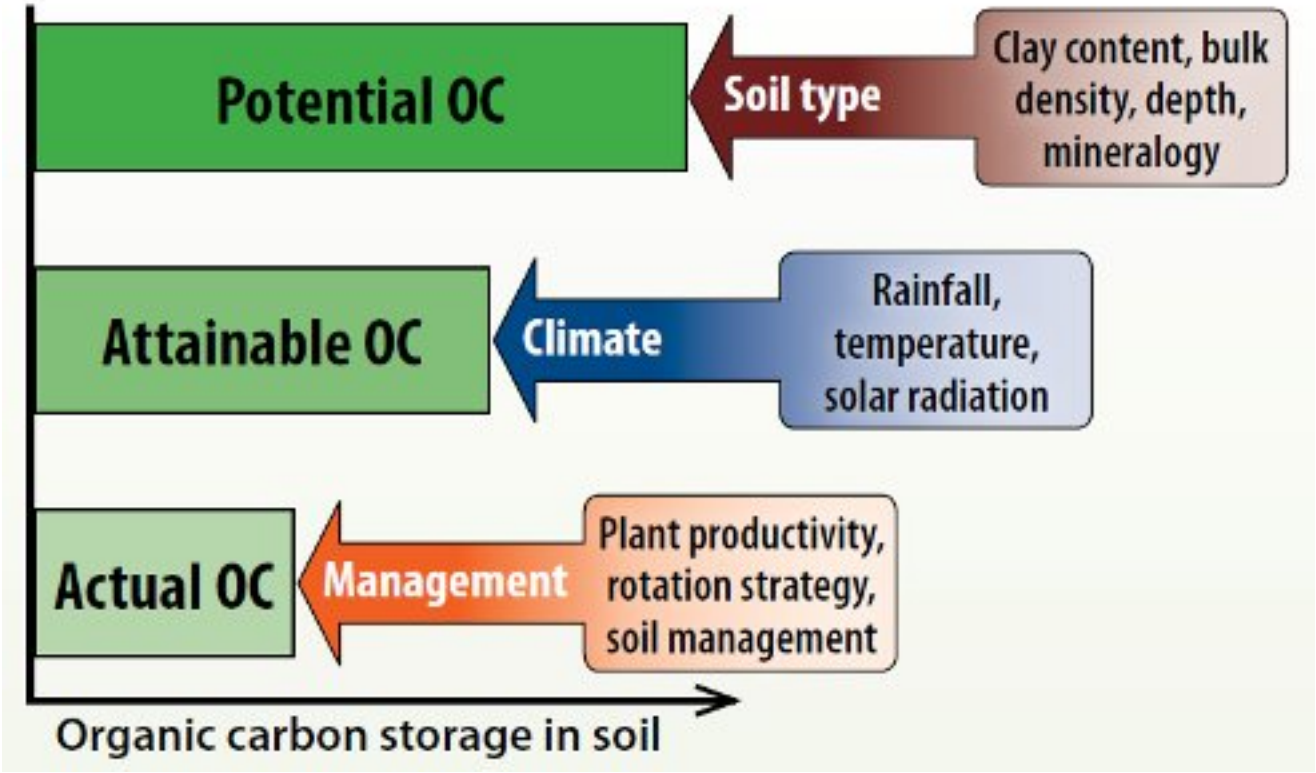
102

Bicarbonatos en drenaje 0.5

Sedimentos 0.5

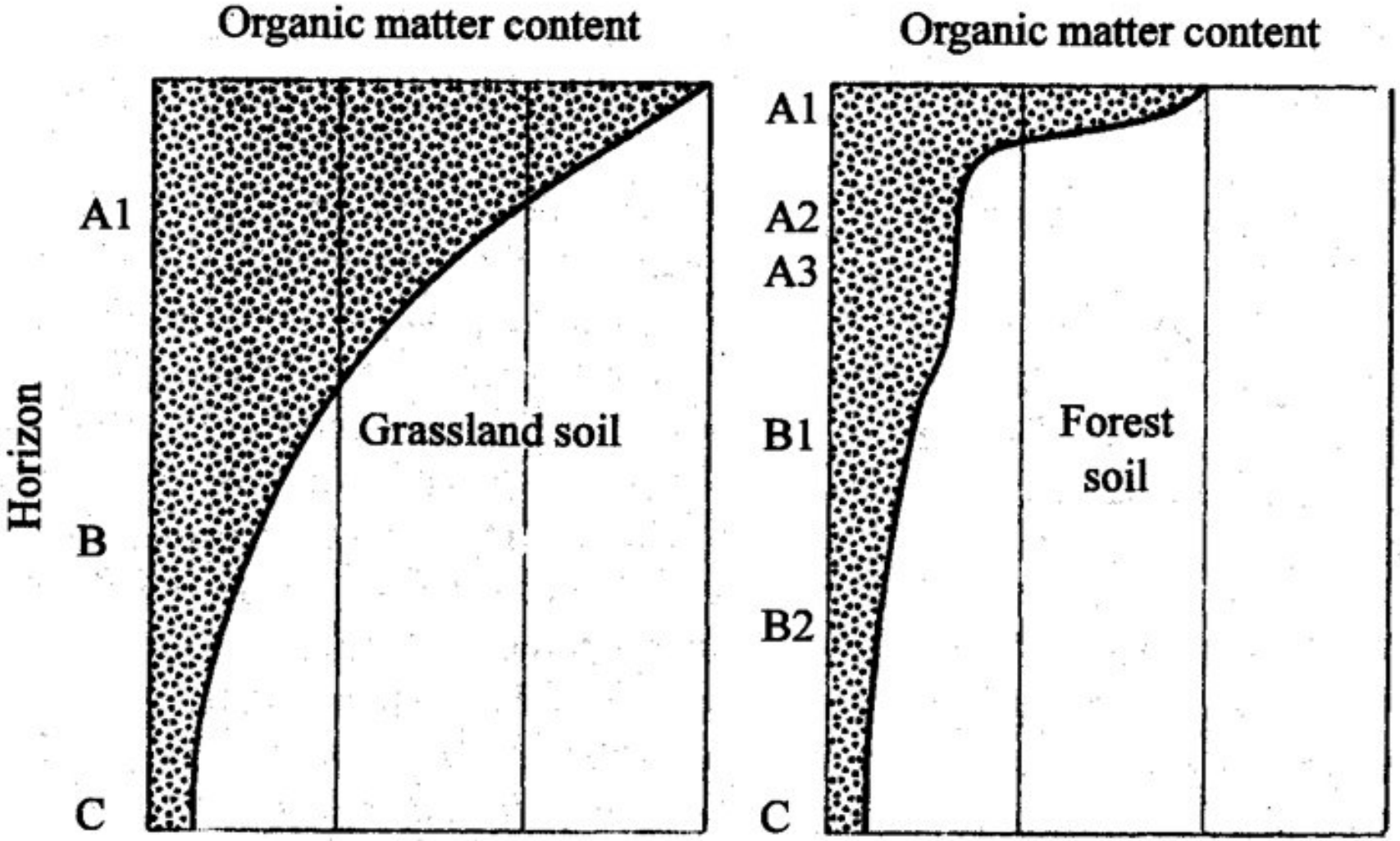
Rocas sedimentarias calcáreas 75.000.000


Soil type
- Clay content
- Bulk density
- Mineralogy
- Depth
Environment
- Solar radiation
- Climate
Management
- Soil & residue management
- Erosion
- Plant species
- Rotation
- Resource use efficiency
- Disease
Defining factors
Limiting factors
Decreasing factors
Soil Organic Matter
SOM potential
SOM attainable
SOM actual
Potential SOM content
Attainable SOM content
Actual SOM content
Optimise management
Add external carbon source

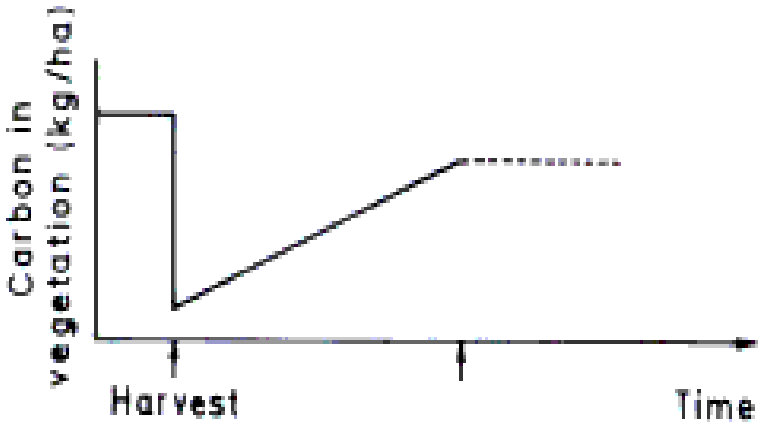

Potential OC
Soil type
Clay content, bulk density, depth, mineralogy
Attainable OC
Climate
Rainfall, temperature, solar radiation
Actual OC
Management
Plant productivity, rotation strategy, soil management
Organic carbon storage in soil

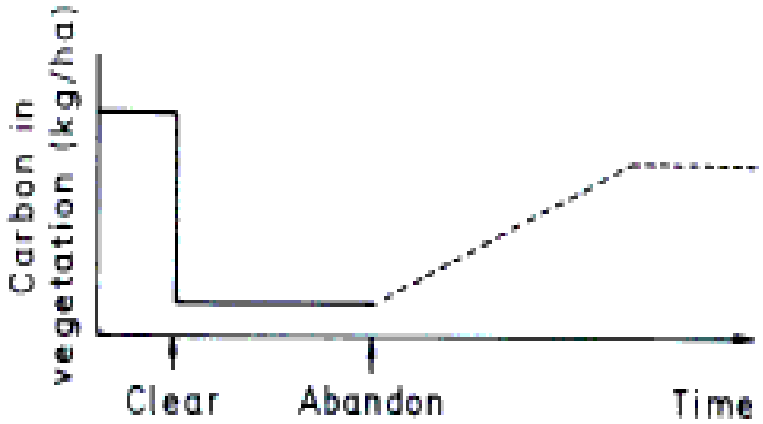
En el caso de los ecosistemas boscosos, la hojarasca es una de las principales fuentes de adición de materia orgánica al suelo.

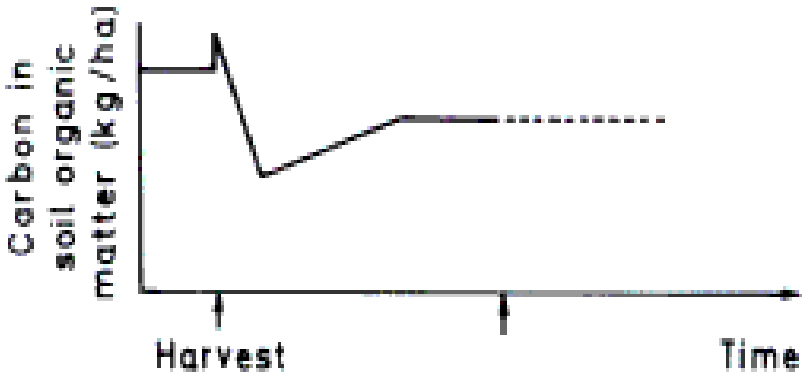
Distribución de la materia orgánica en los suelos

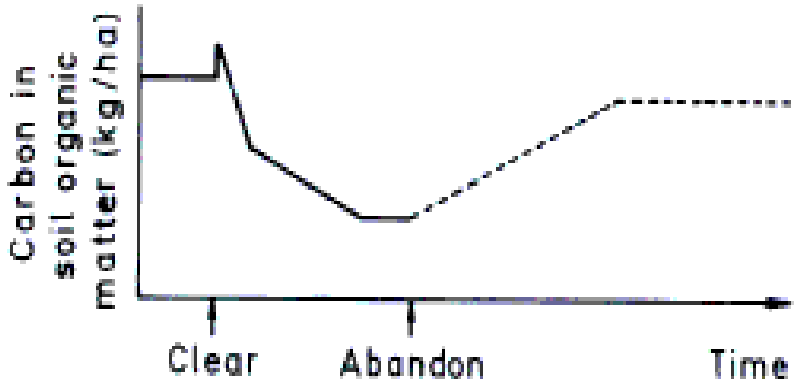


Schematic diagrams of carbon content of living vegetation (upper graphs) and soils following harvest (a) in forests, (b) in forests transferred into farm land which later is abandoned (Moore et al., 1981)



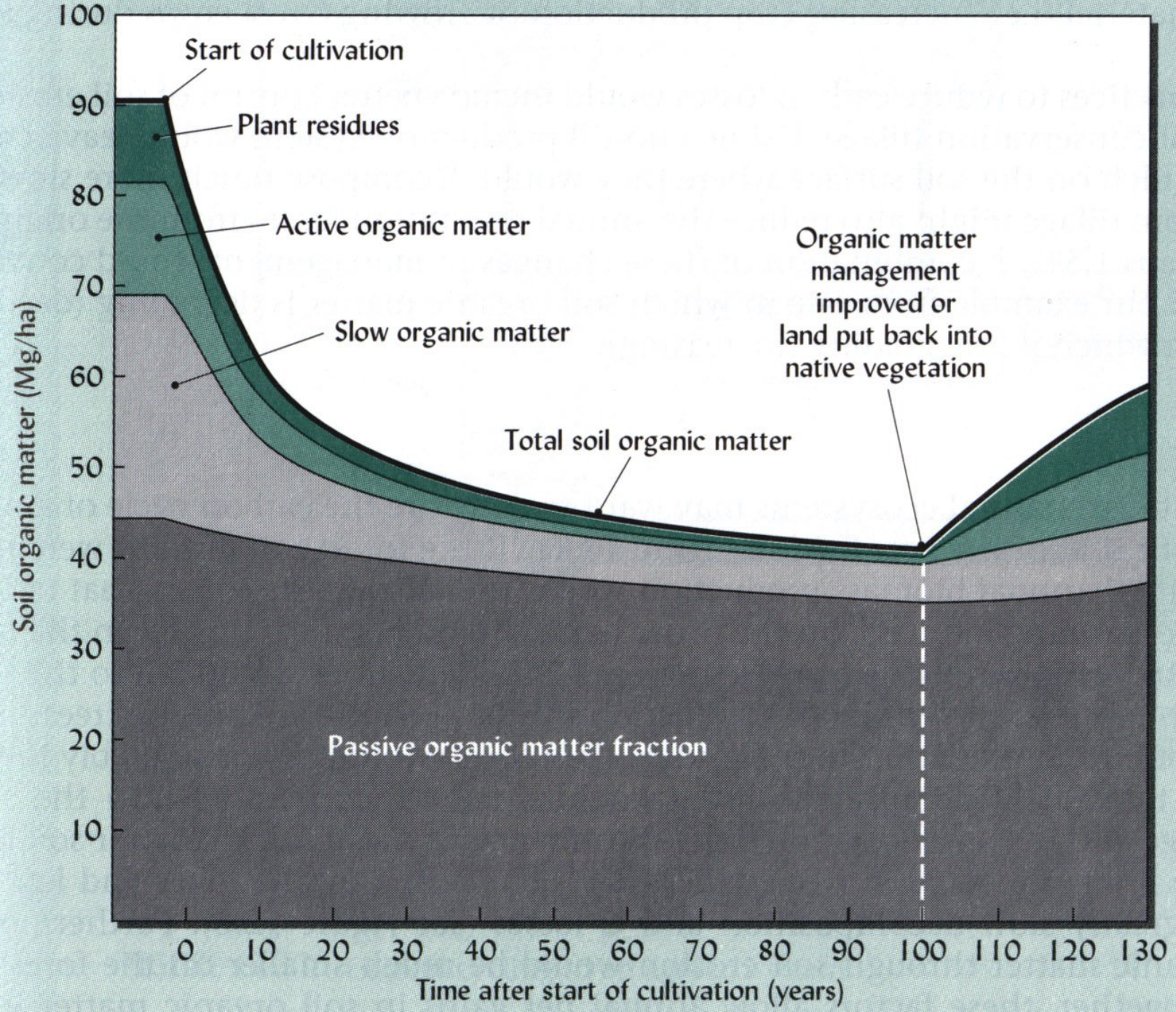


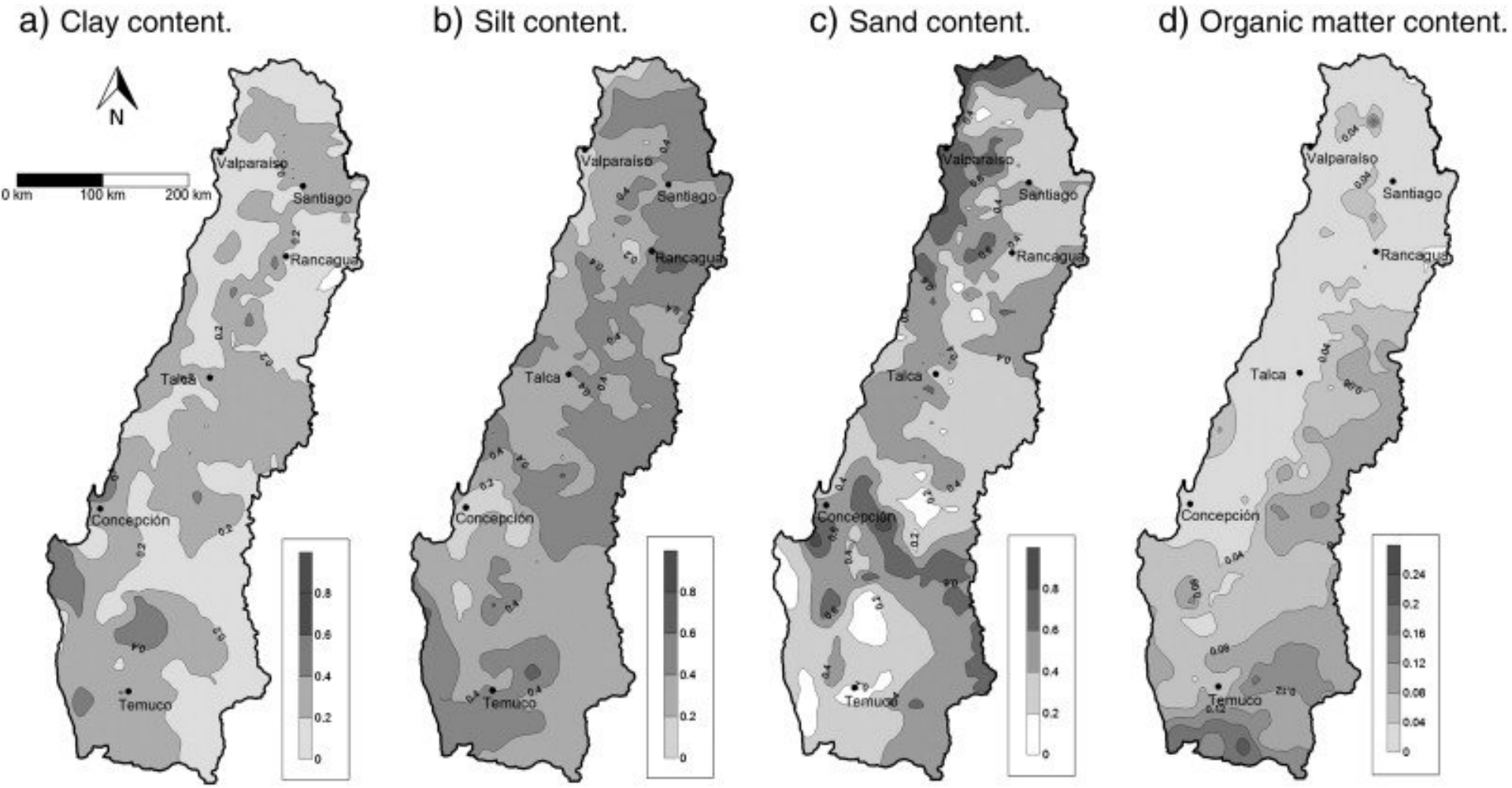




El declive en el contenido de C obedece a que hay más descomposición que productividad primaria neta

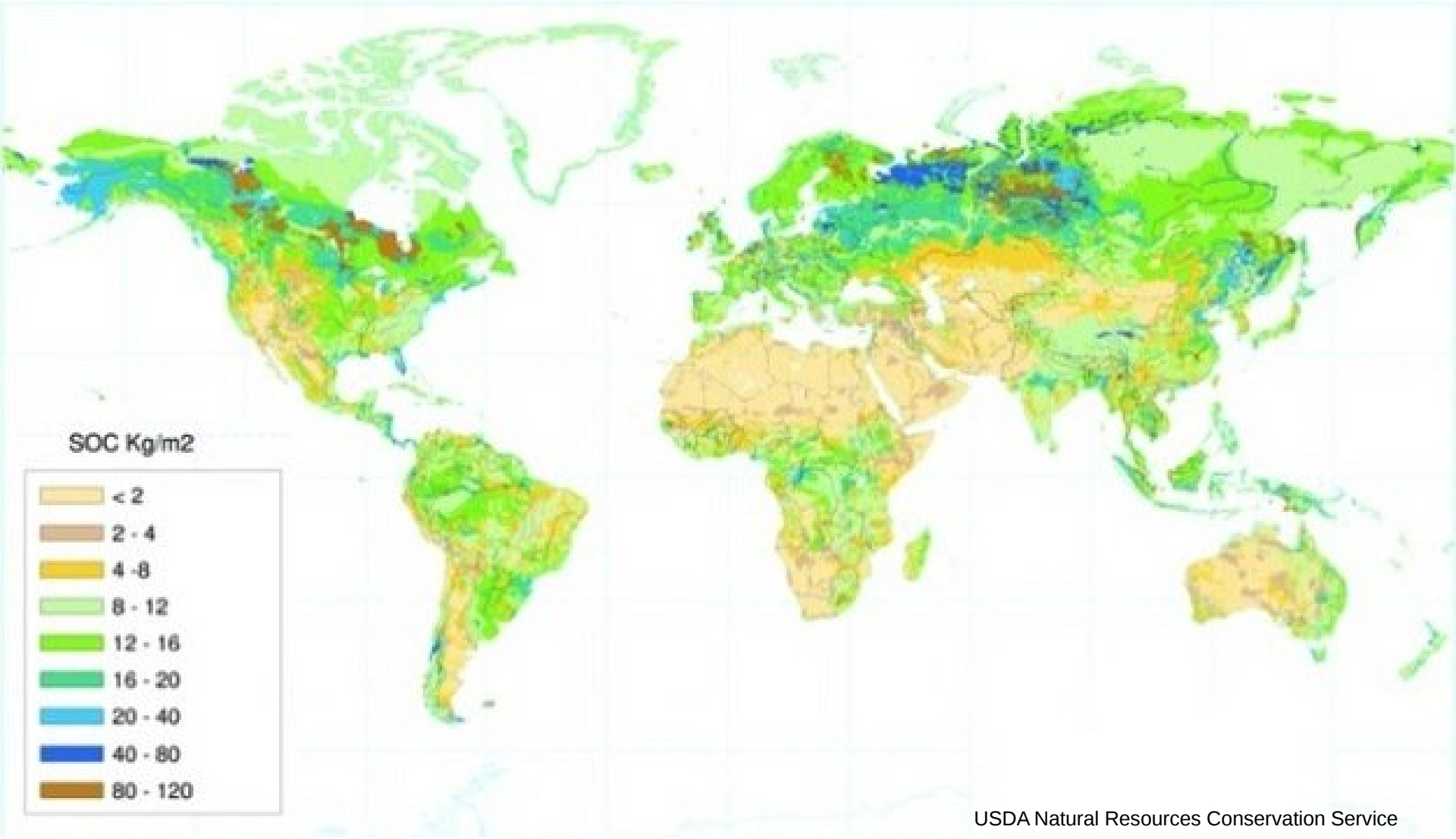
Moore, B., Boone, R. D., Hobbie, J. E., Houghton. R. A., Melillo, J. M., Peterson, G. R., Shaver, G. R., Vörösmarty, C. J., and Woodwell, G. M. (1981) A simple model for analysis of the role of terrestrial ecosystems in the global carbon budget, in Bolin B. (ed.) Carbon Cycle Modelling, SCOPE 16, Chichester, Wiley, 365-385.


Start of cultivation
Plant residues
Active organic matter
Slow organic matter
Organic matter management improved or land put back into native vegetation
Total soil organic matter
Passive organic matter fraction
Soil organic matter (Mg/ha)
Time after start of cultivation (years)
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
110
120
130



Distribución estimada de la materia orgánica del suelo (primeros 20 cm) en la zona Centro Sur de Chile. Los valores son expresados como fracción (i.e. 0.12 = 12% de materia orgánica [12 g materia orgánica por cada 100 g de suelo].

La descomposición acelerada de la materia orgánica producto del drenaje de tierras antes inundadas provoca la pérdida de suelo.



World map showing the quantity of SOC to 1 m depth

Persistence of soil organic matter as an ecosystem property

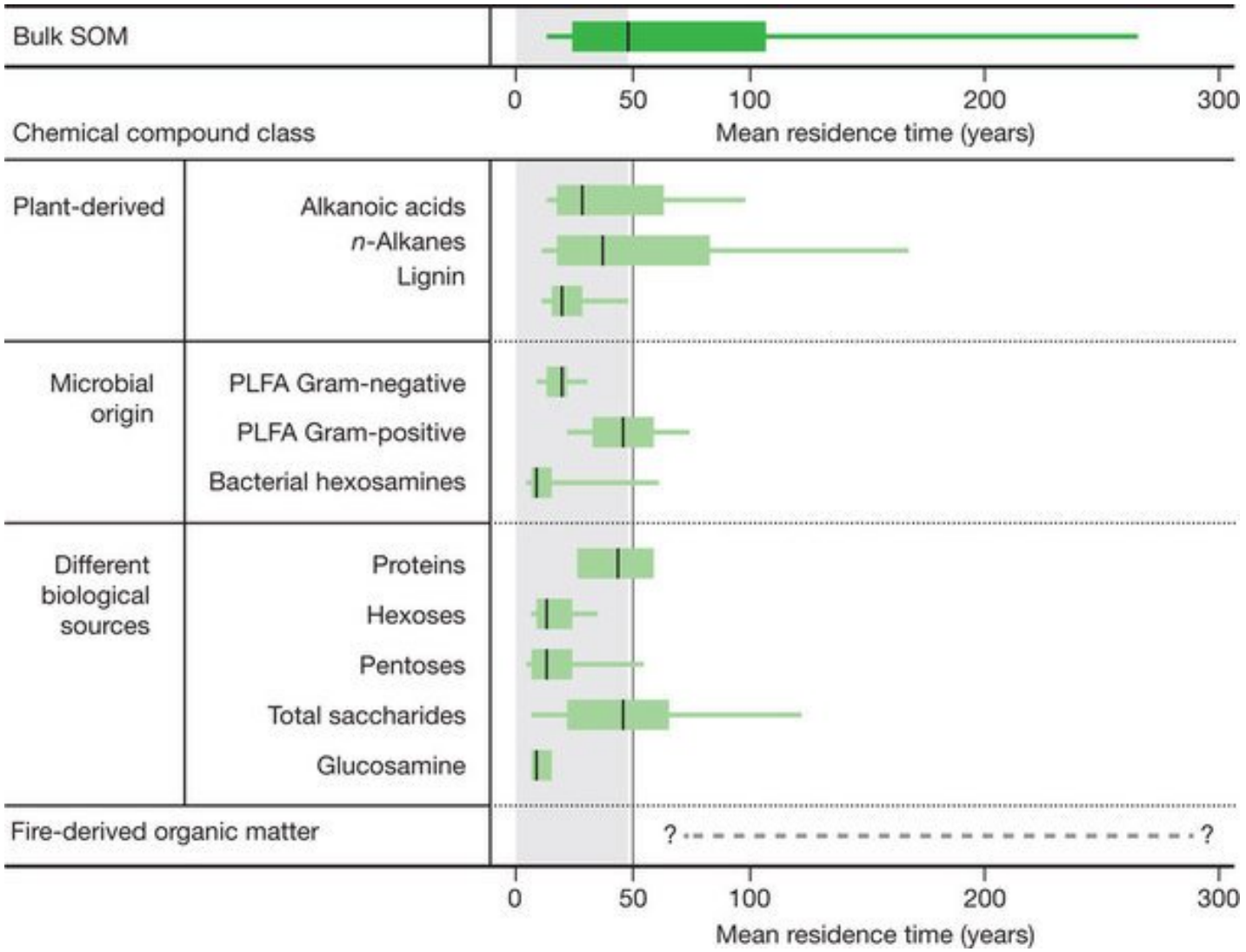
Nature 478, 49–56 (06 October 2011) doi:10.1038/nature10386

Globally, soil organic matter (SOM) contains more than three times as much carbon as either the atmosphere or terrestrial vegetation. Yet it remains largely unknown why some SOM persists for millennia whereas other SOM decomposes readily—and this limits our ability to predict how soils will respond to climate change. Recent analytical and experimental advances have demonstrated that molecular structure alone does not control SOM stability: in fact, environmental and biological controls predominate. Here we propose ways to include this understanding in a new generation of experiments and soil carbon models, thereby improving predictions of the SOM response to global warming.

Editor's summary

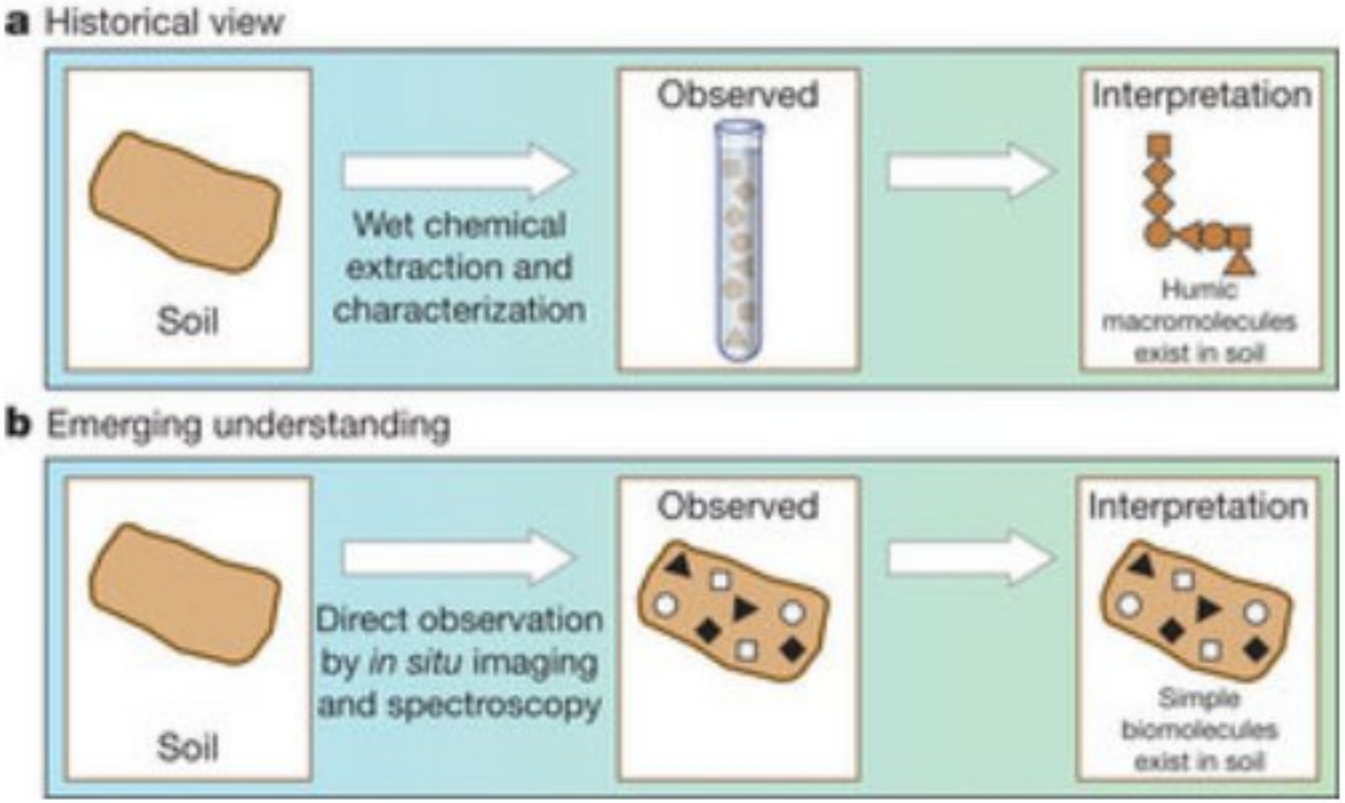
The mechanisms underpinning soil carbon stability are complicated. The future response of soil carbon to climate change is uncertain but crucial, given that the carbon pool in soils is three times greater than that of the atmosphere. In a Perspective, Michael Schmidt and an international team of collaborators discuss how our understanding of soil carbon cycling has been changing. Rather than being mostly a function of molecular structure, as has been assumed, soil organic carbon stability is an ecosystem property. This means that it arises from complex interactions among many biotic and abiotic factors that are not fully understood. This fact must be more rigorously addressed in a new generation of experiments and soil carbon models, say Schmidt et al., if we are to improve our attempts to understand this vital component of the Earth system.

Figure 1: Molecular structure does not control long-term decomposition of soil organic matter (SOM).



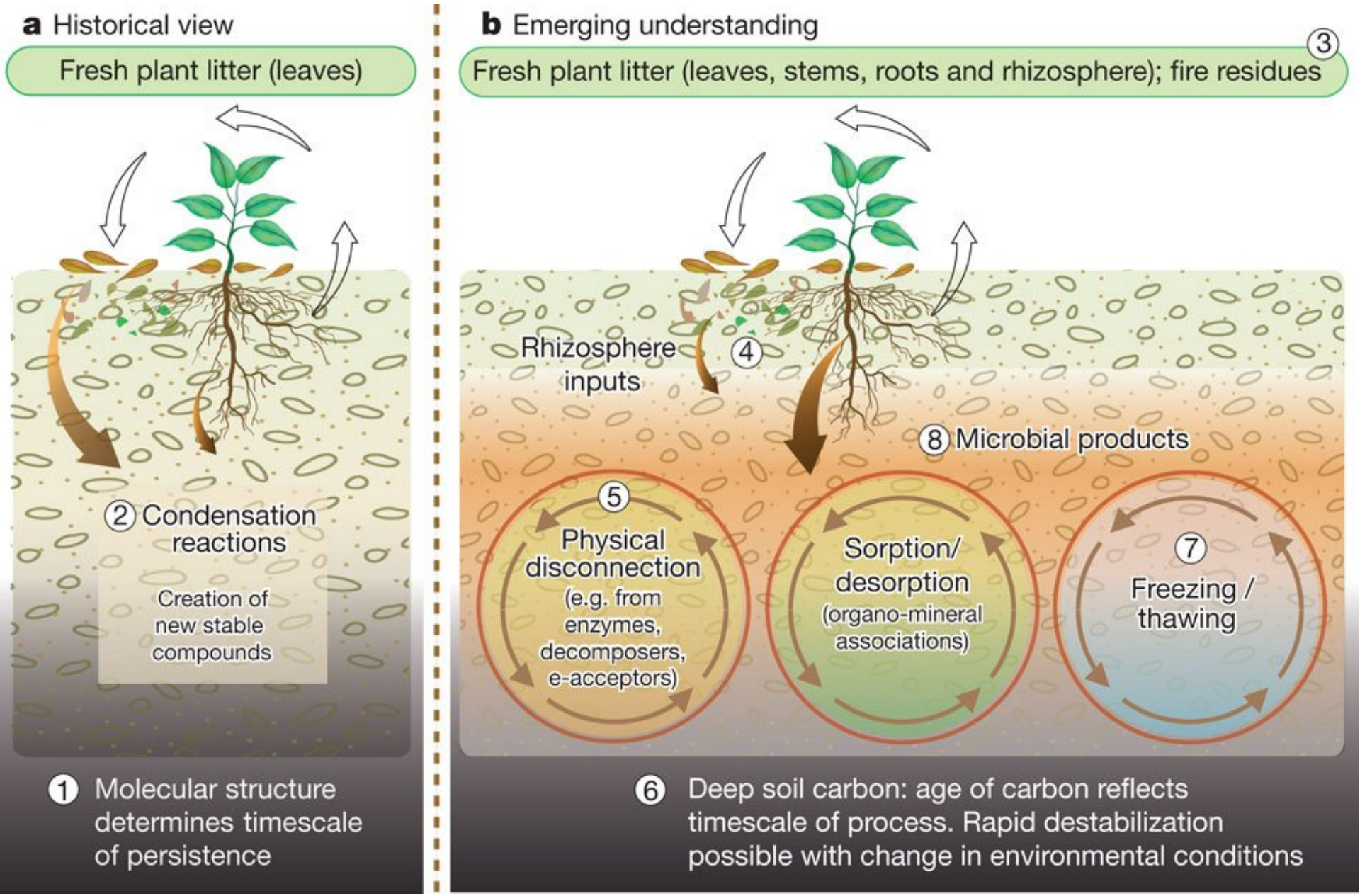
Certain plant-derived molecules (classically, long-chain alkanoic acids, n-alkanes, lignin and other structural tissues) often persist longer than others while plant biomass is decaying. In mineral soil, however, these relatively persis…

Figure 2: In soil, the existence of humic substances has not been verified by direct measurements.

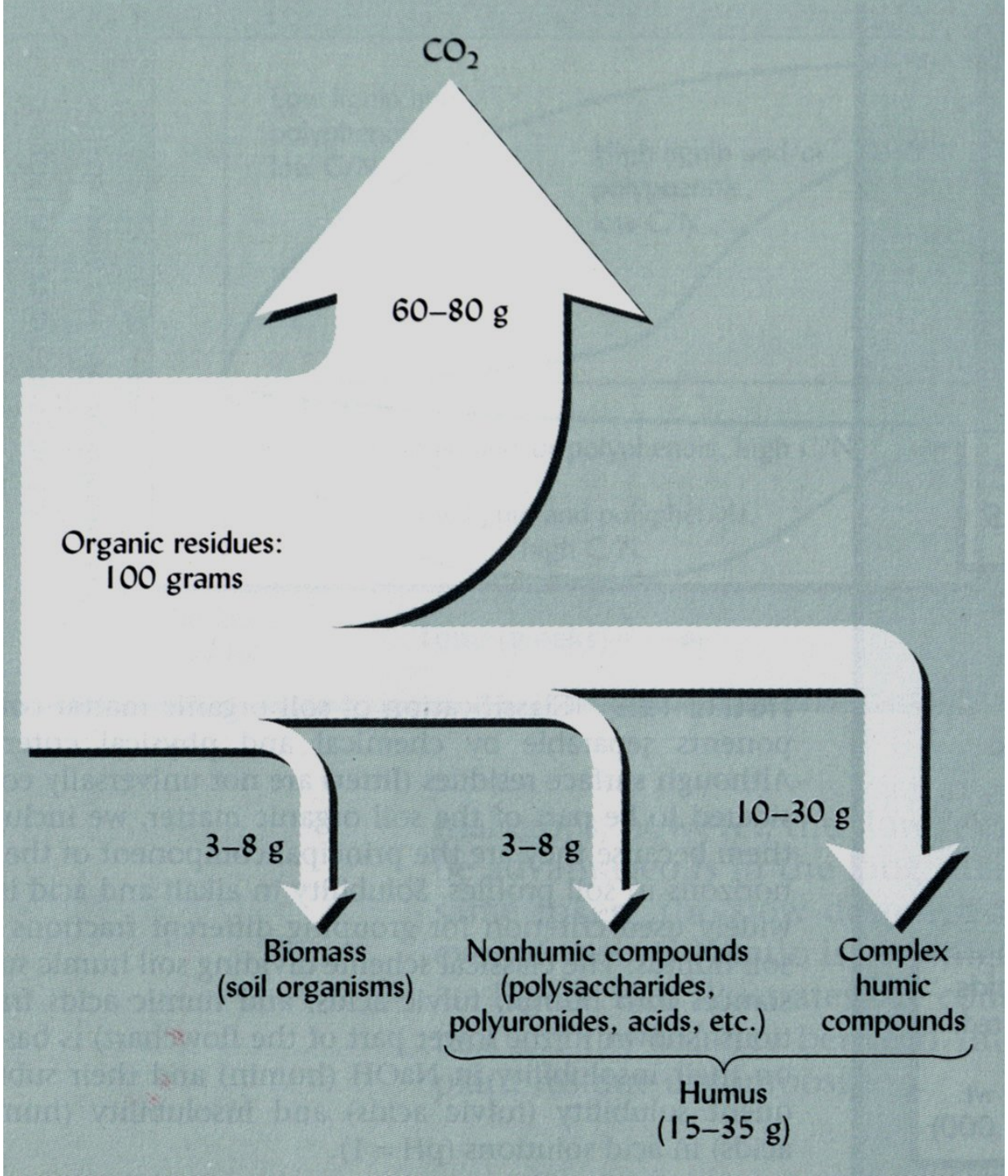


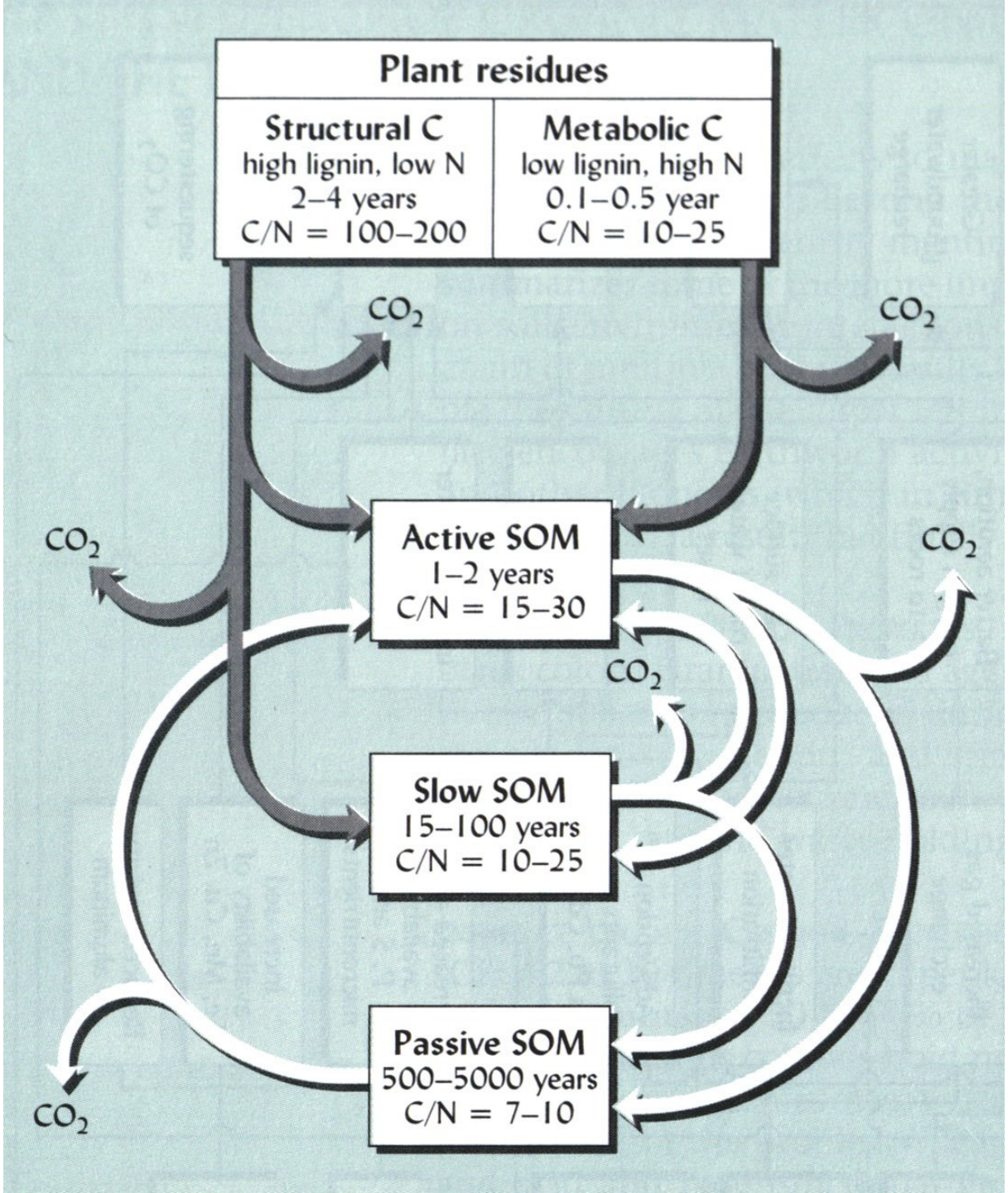
a, Based on chemical analysis of the extracted materials (Observed), the de novo formation of humic polymers (Interpretation) was postulated to be an important source of recalcitrant SOM. b, Direct high-resolution in situ observations w…

Figure 3: A synopsis of all eight insights, contrasting historical and



The historical view (a) has emphasized above-ground plant carbon inputs and organic matter in the top 30 cm of soil. Stable organic matter is seen to comprise mainly selectively preserved plant inputs and de novo synthesis products like…


CO_2
60–80 g
Organic residues:
100 grams
3–8 g
3–8 g
10–30 g
Biomass
(soil organisms)
Nonhumic compounds
(polysaccharides,
polyuronides, acids, etc.)
Complex
humic
compounds
Humus
(15–35 g)



El concepto de materia orgánica del suelo pasiva, activa y de lenta descomposición

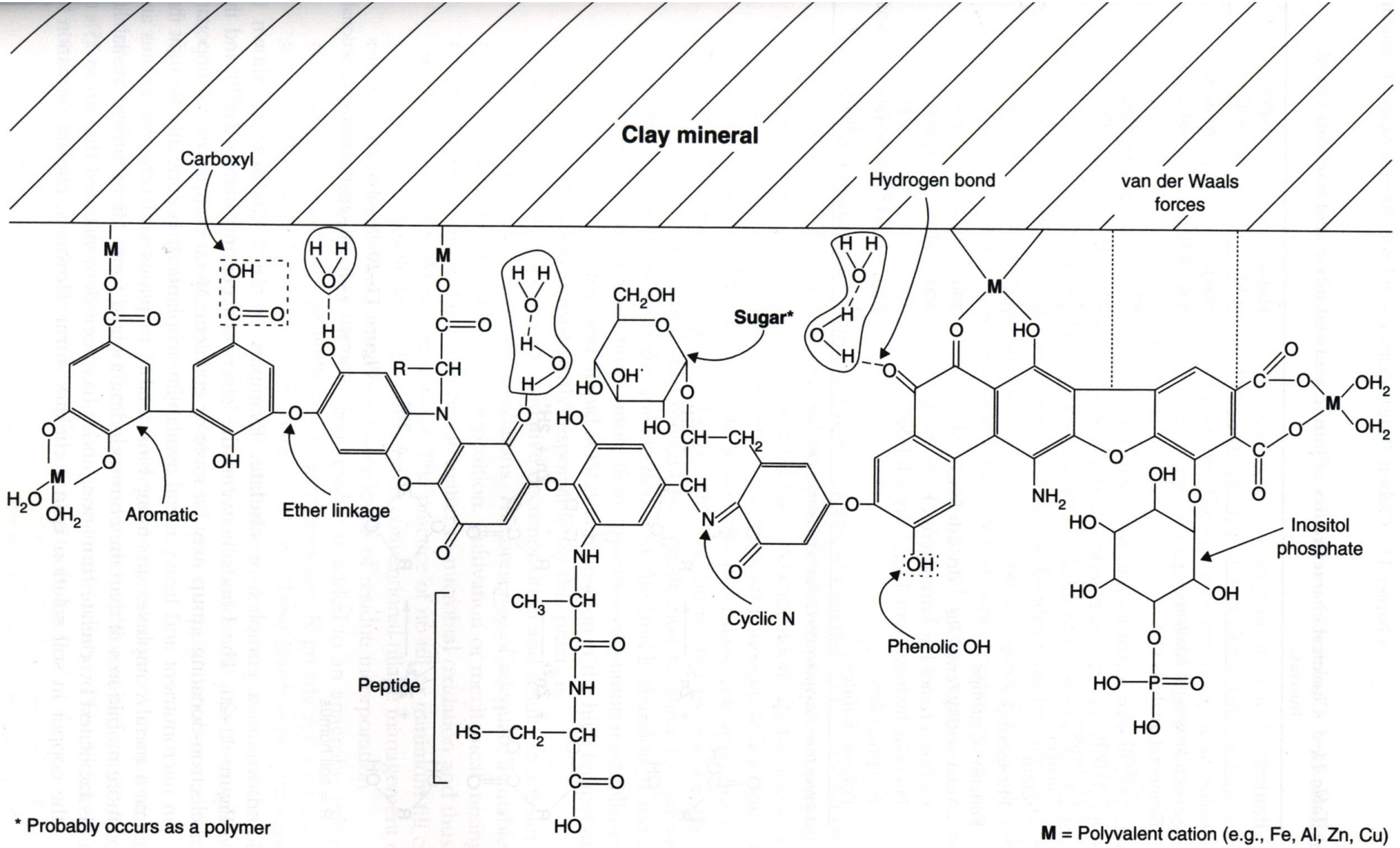


Figure 11–19 Hypothetical model of a soil humus-clay complex. The mass of the structure shown represents about 2% of the total humus unit that would have a molecular weight of $>10^5$. *Adapted with modifications from Stevenson and Ardakani (1972). Used with permission.*