

Teórica 14:
Metabolismo ecosistémico 3:
Ciclo de nutrientes

Refrescando la memoria...

Teórica 12: Productividad primaria

- Las plantas capturan energía mediante fotosíntesis, sosteniendo a todos los niveles tróficos.
- La productividad primaria (PP) varía geográficamente
- Principales limitantes de PP:
 - Mar: N y Fe, y P en menor medida. Luz y temp. no suelen limitar.
 - Agua dulce: luz y temp., junto con P y N.
 - Tierra: luz (radiación), temp., humedad, N y P.
- La diversidad de especies y la productividad primarias están íntimamente relacionadas.

Refrescando la memoria...

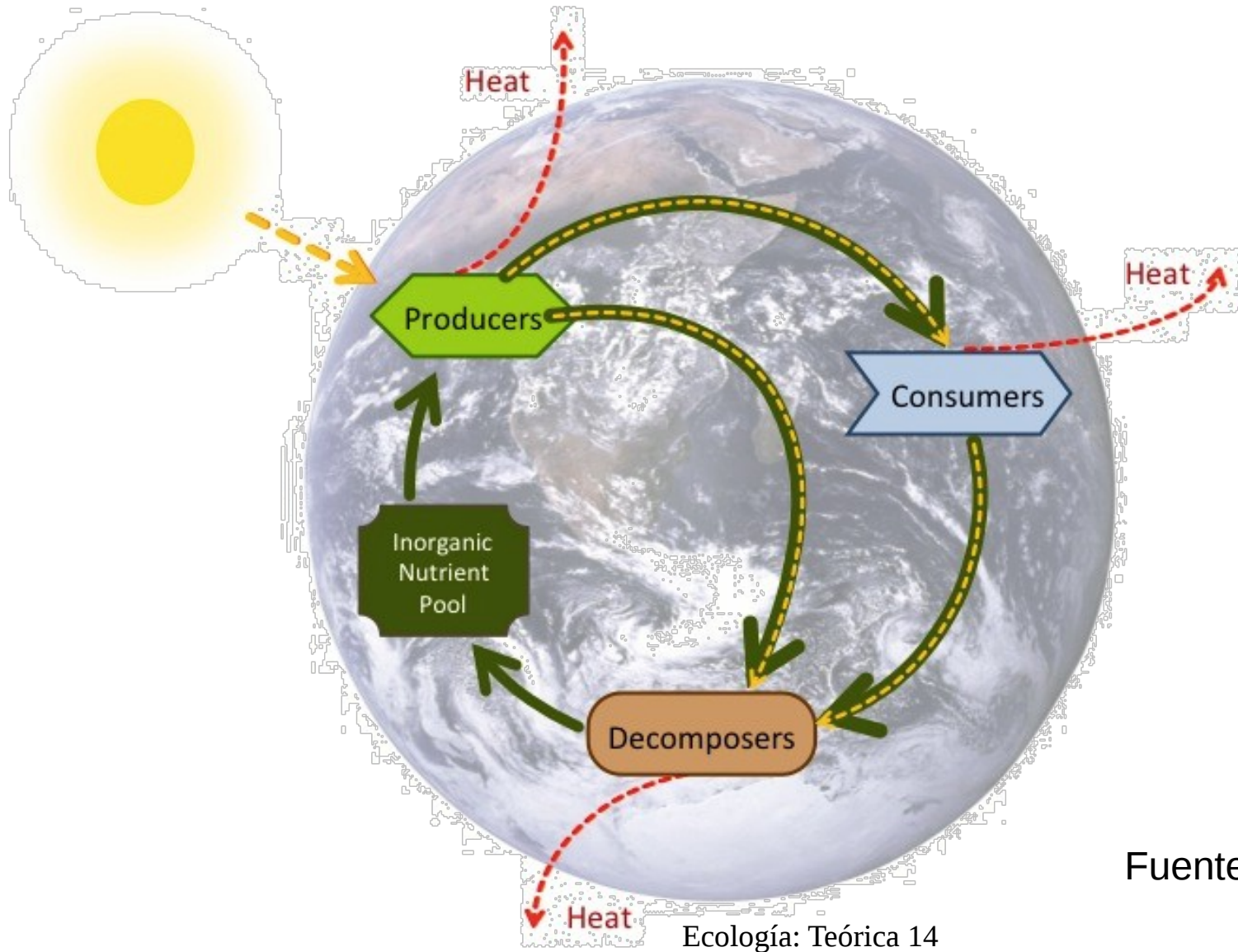
Teórica 13: Productividad secundaria

- La energía fijada por las plantas fluye a los herbívoros o al detrito, o se pierde en la respiración
- La proporción de PP consumida varía entre tipos de ecosistema; en general es mayor en ambientes acuáticos que en terrestres
- En general hay baja eficiencia en la transferencia de energía entre niveles tróficos
- La PS está limitada por la PP
- La teoría metabólica de la ecología es un intento de relacionar procesos fisiológicos de los individuos con procesos poblacionales y ecosistémicos

Teórica 14: Esquema conceptual

- Generalidades
- Ciclo de nutrientes en ambientes dulceacuícolas
- Ciclo de nutrientes en bosques
- Eficiencia en el uso de nutrientes
- Lluvia ácida y el ciclo del azufre
- El ciclo del nitrógeno

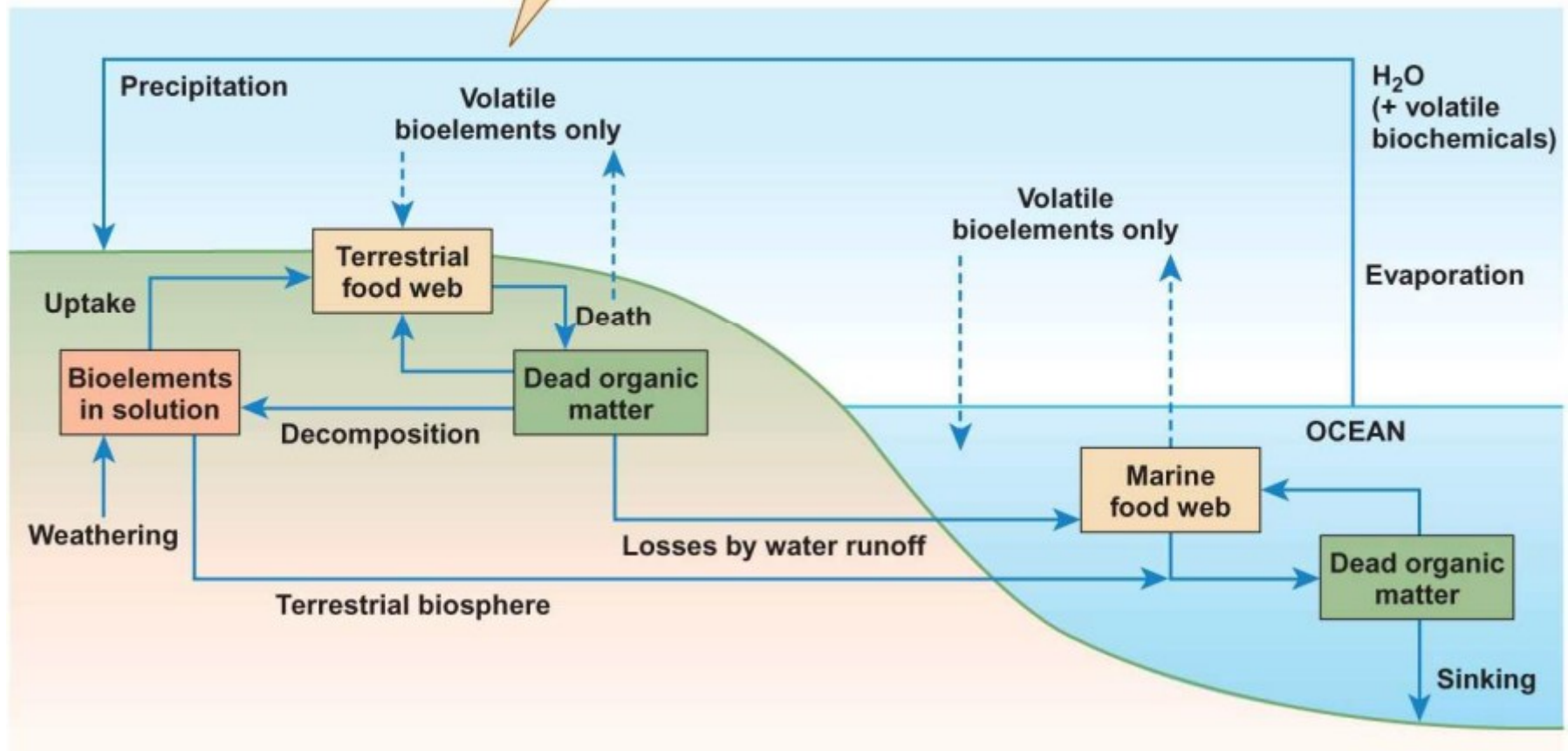
Ciclo de nutrientes general a nivel global



Fuente: [khanacademy.org](https://www.khanacademy.org)

Ciclo de nutrientes general a nivel global

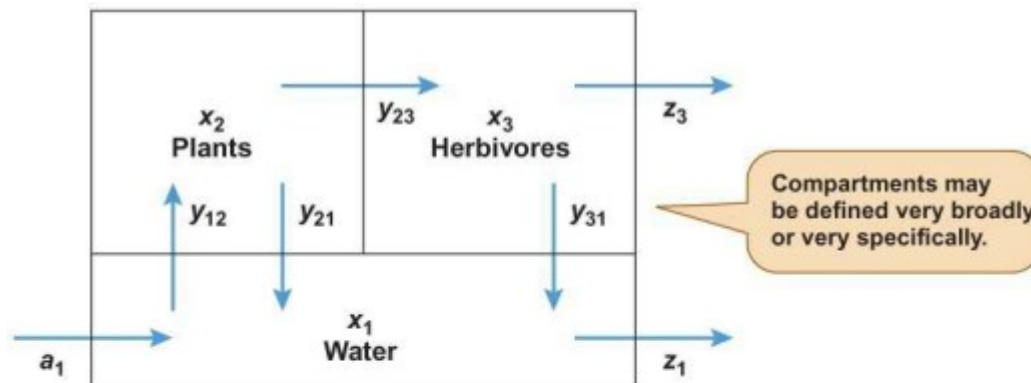
The volatile bioelements are nitrogen, carbon, oxygen, and hydrogen in water.



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Ciclo de nutrientes en ambientes de agua dulce:

Ejemplo hipotético para un lago

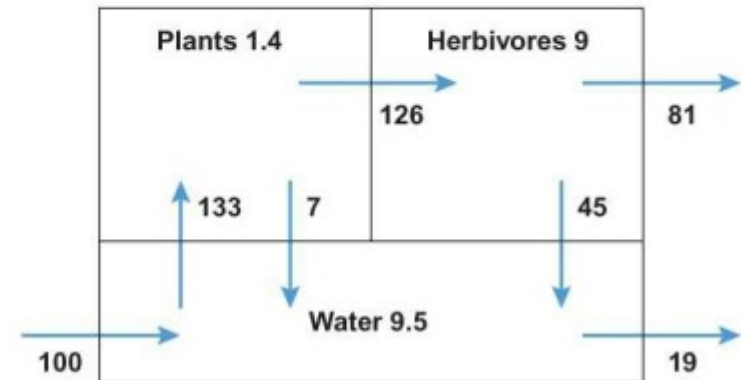


Compartments may be defined very broadly or very specifically.

- x_1 = amount of P in water
- x_2 = amount of P in plants
- x_3 = amount of P in herbivores
- a_1 = rate of inflow of P in water
- z_1 = rate of outflow of P in water
- z_3 = rate of outflow of P in herbivores
- y_{12} = rate of uptake of P from water by plants
- y_{21} = rate of loss of P from plants to water
- y_{23} = rate of uptake of P from plants by herbivores
- y_{31} = rate of loss of P from herbivores to water

(a)

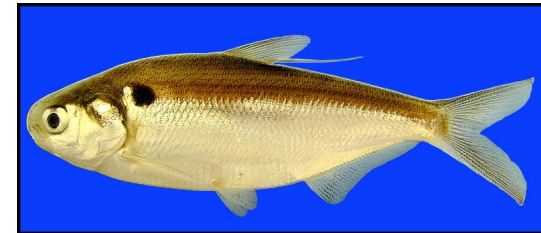
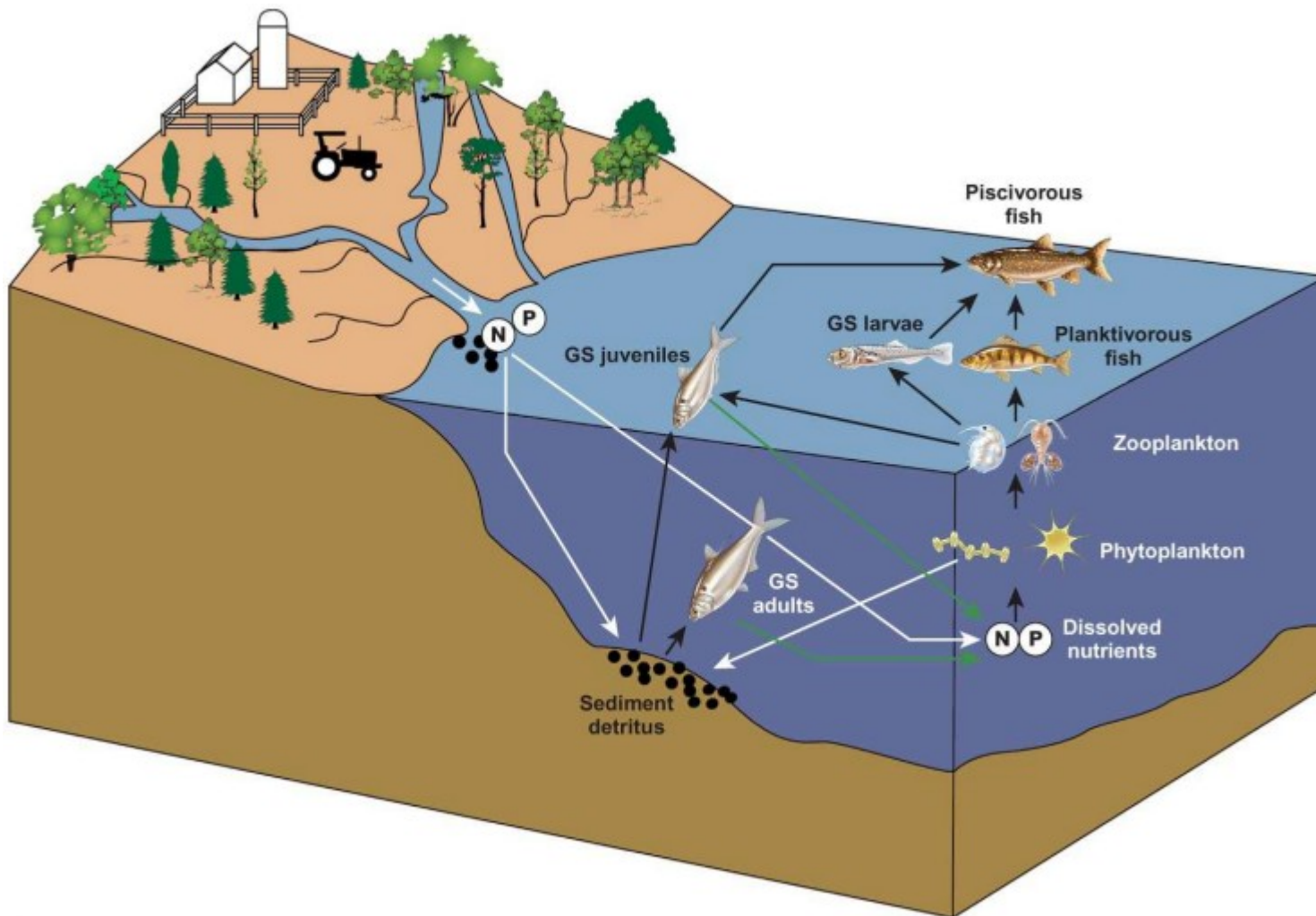
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(b)

Ciclo de nutrientes en ambientes de agua dulce:

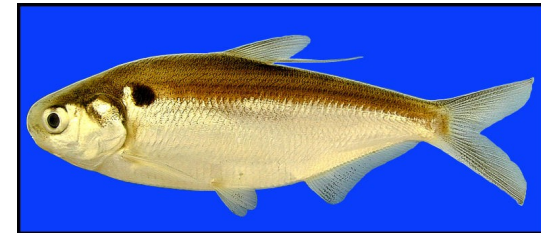
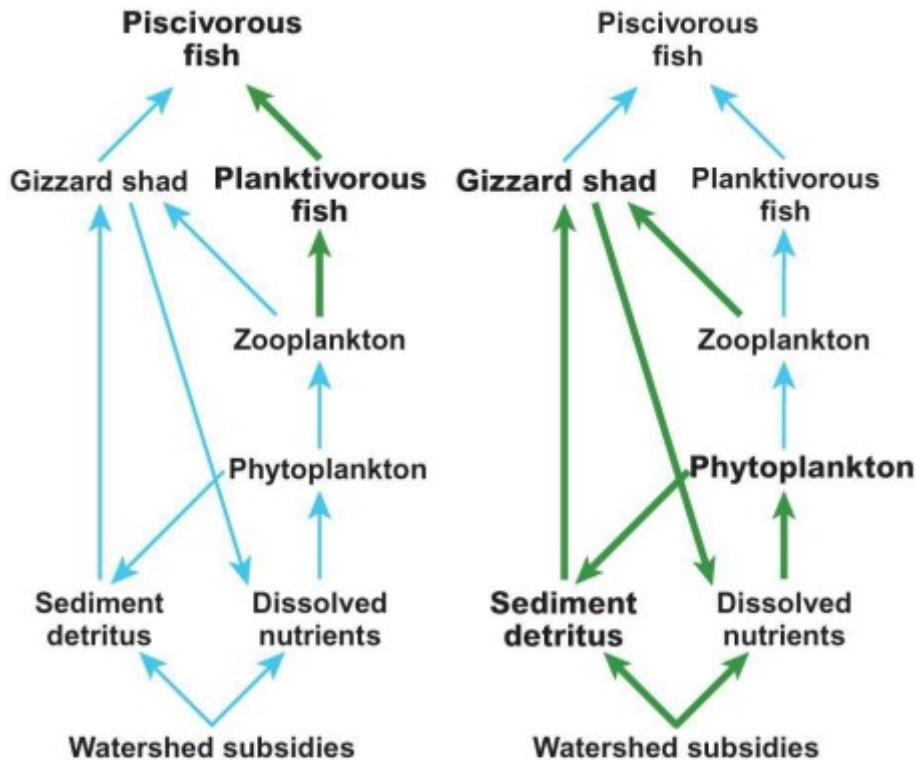
Peces piscívoros y ciclo de P



Dorosoma cepedianum

Ciclo de nutrientes en ambientes de agua dulce:

Peces piscívoros y ciclo de P



Dorosoma cepedianum

Reservoirs characterized by

- Low sediment input
- Low phytoplankton biomass
- High sport-fish abundance

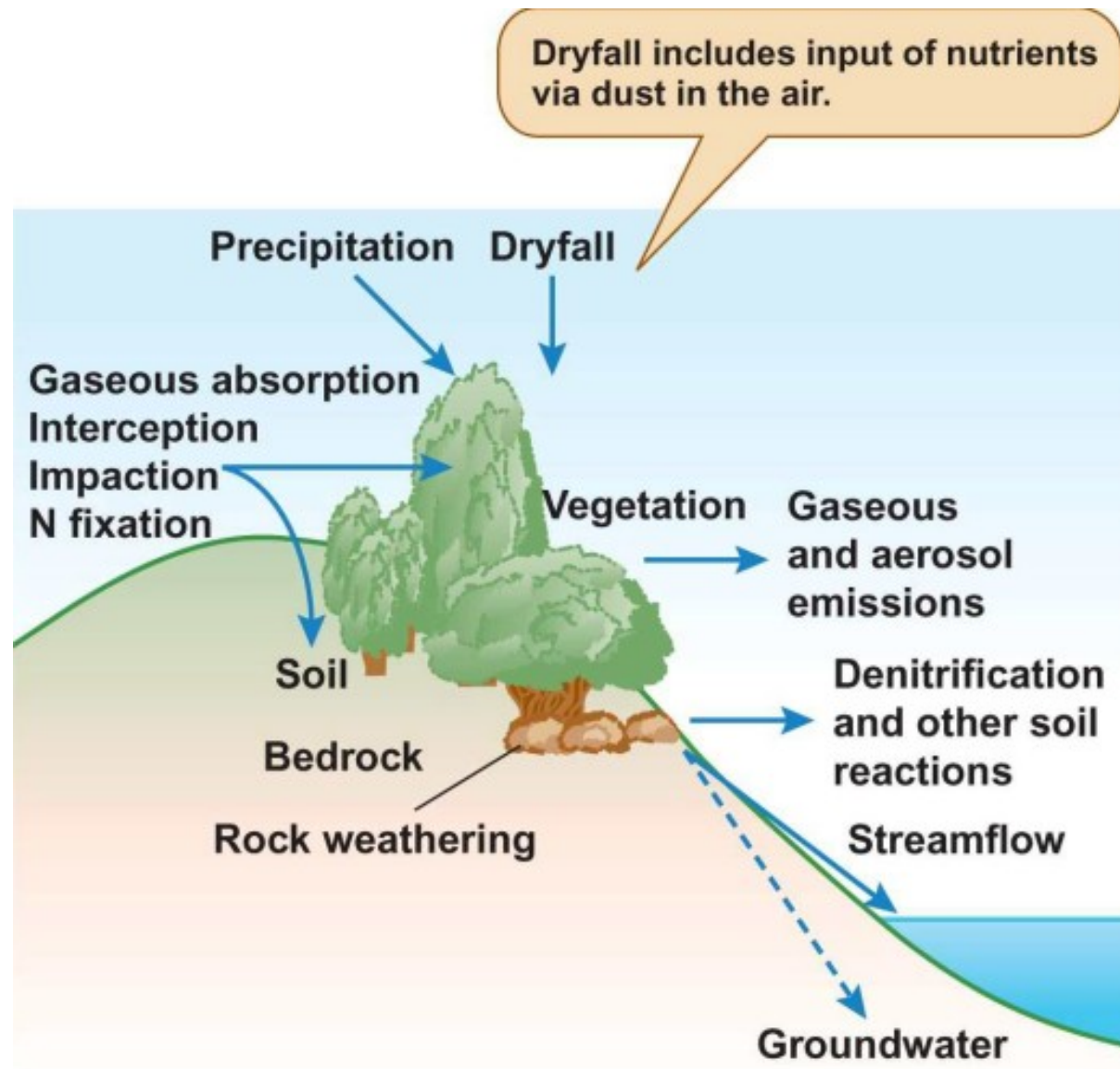
(a) Forested watersheds

Reservoirs characterized by

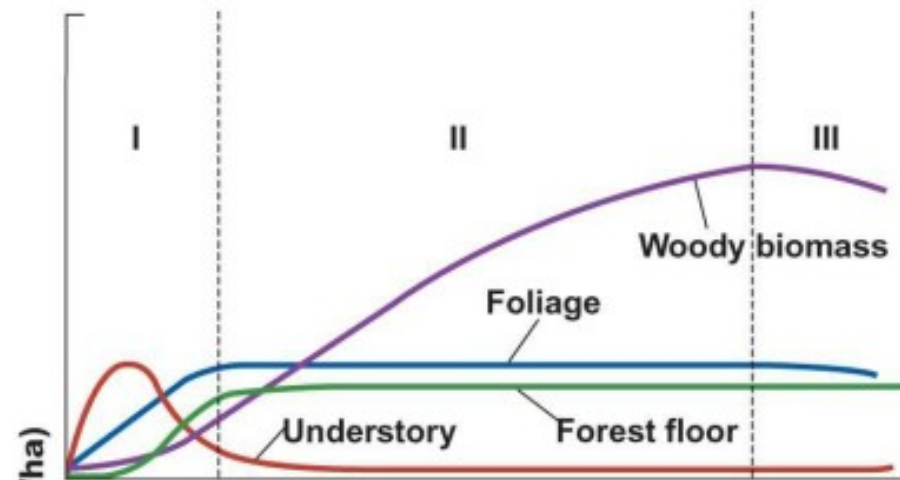
- High sediment input
- High phytoplankton biomass
- Low sport-fish abundance

(b) Agricultural watersheds

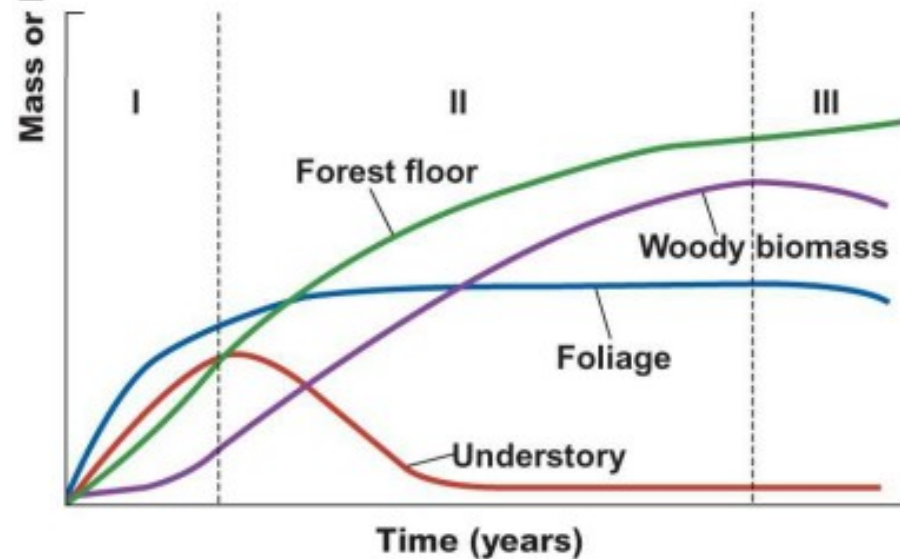
Ciclo de nutrientes en ambientes terrestres



Ciclo de nutrientes en ambientes terrestres

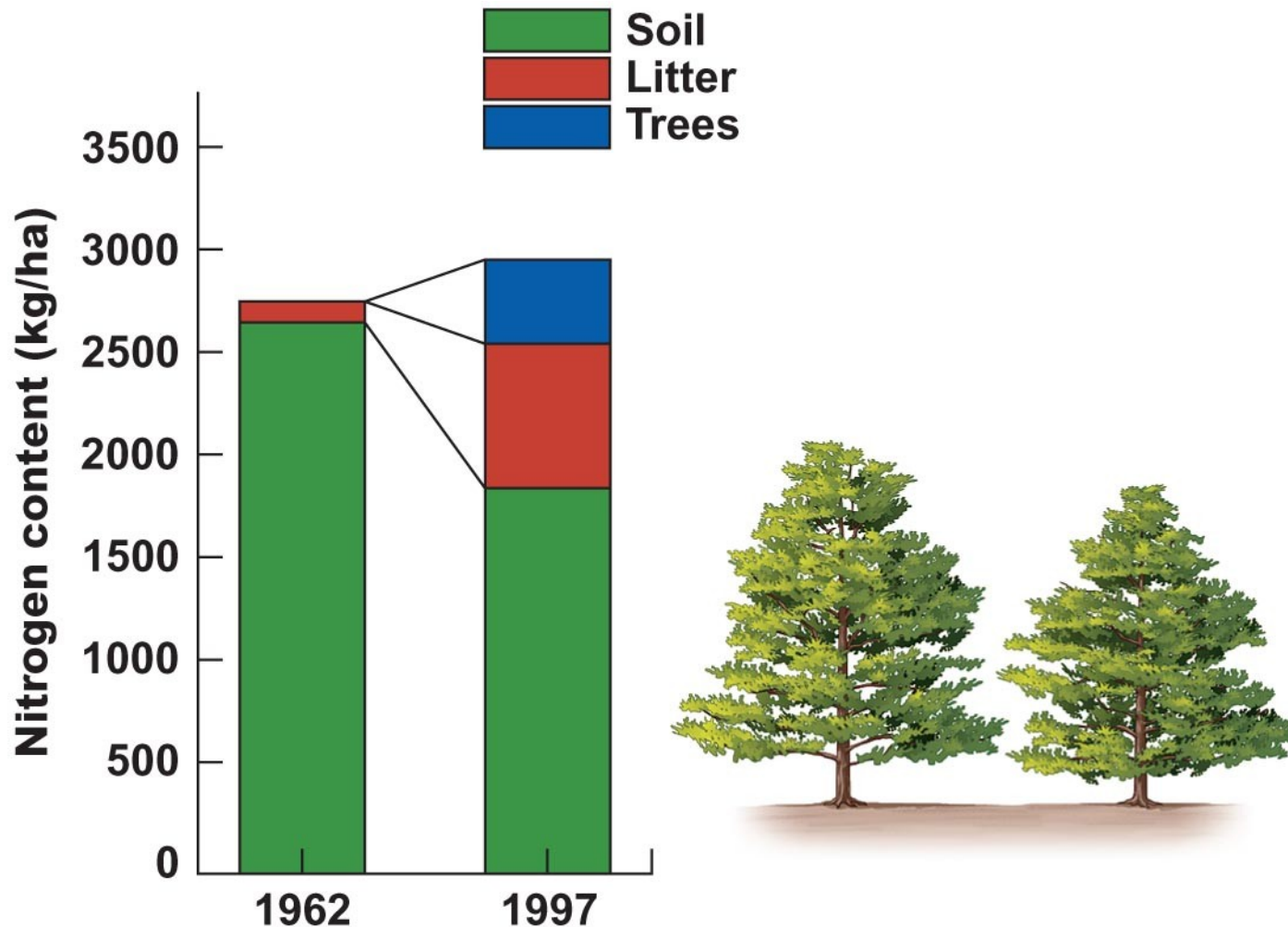


(a) Warm ecosystem

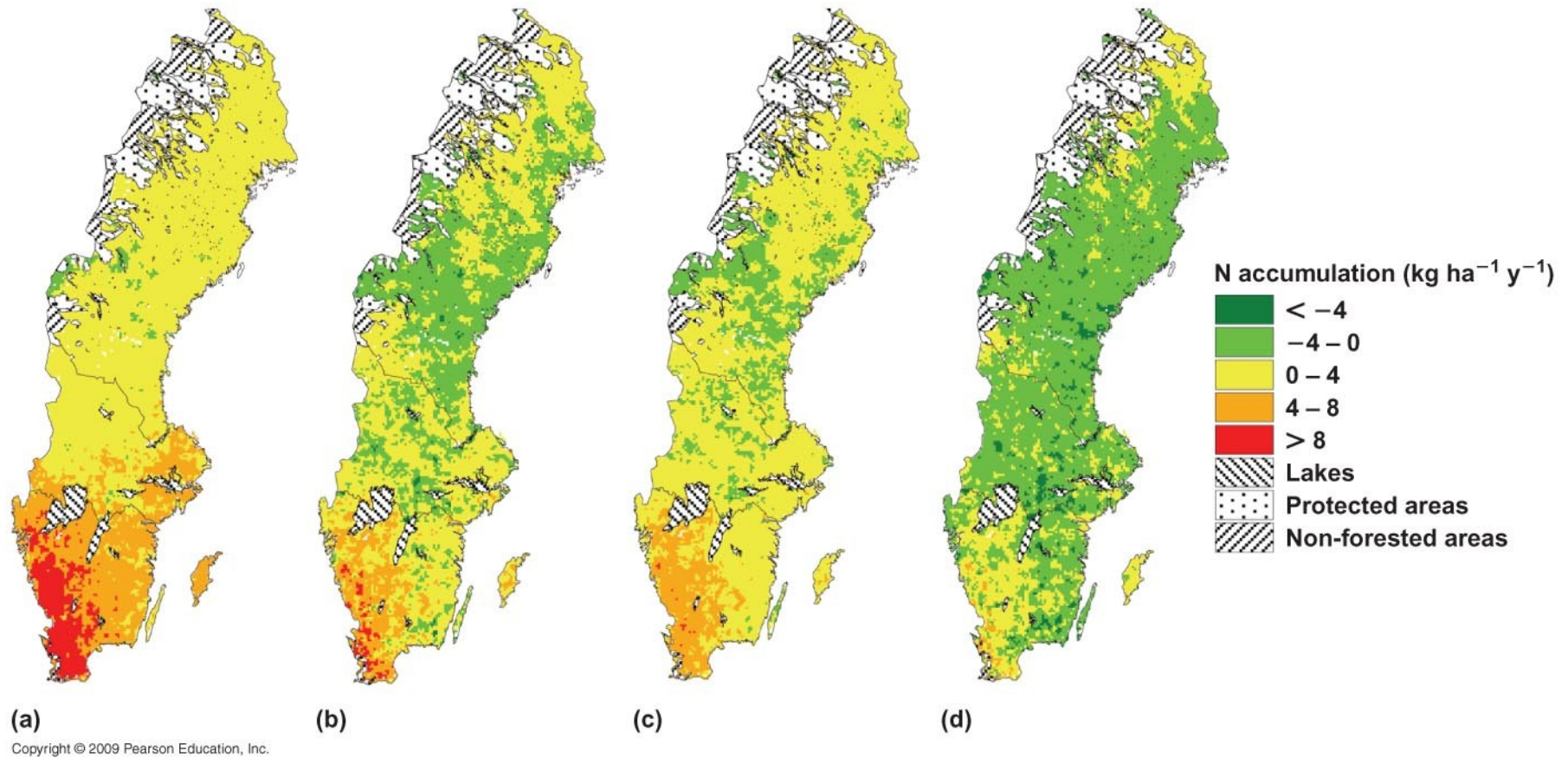


(b) Cool ecosystem

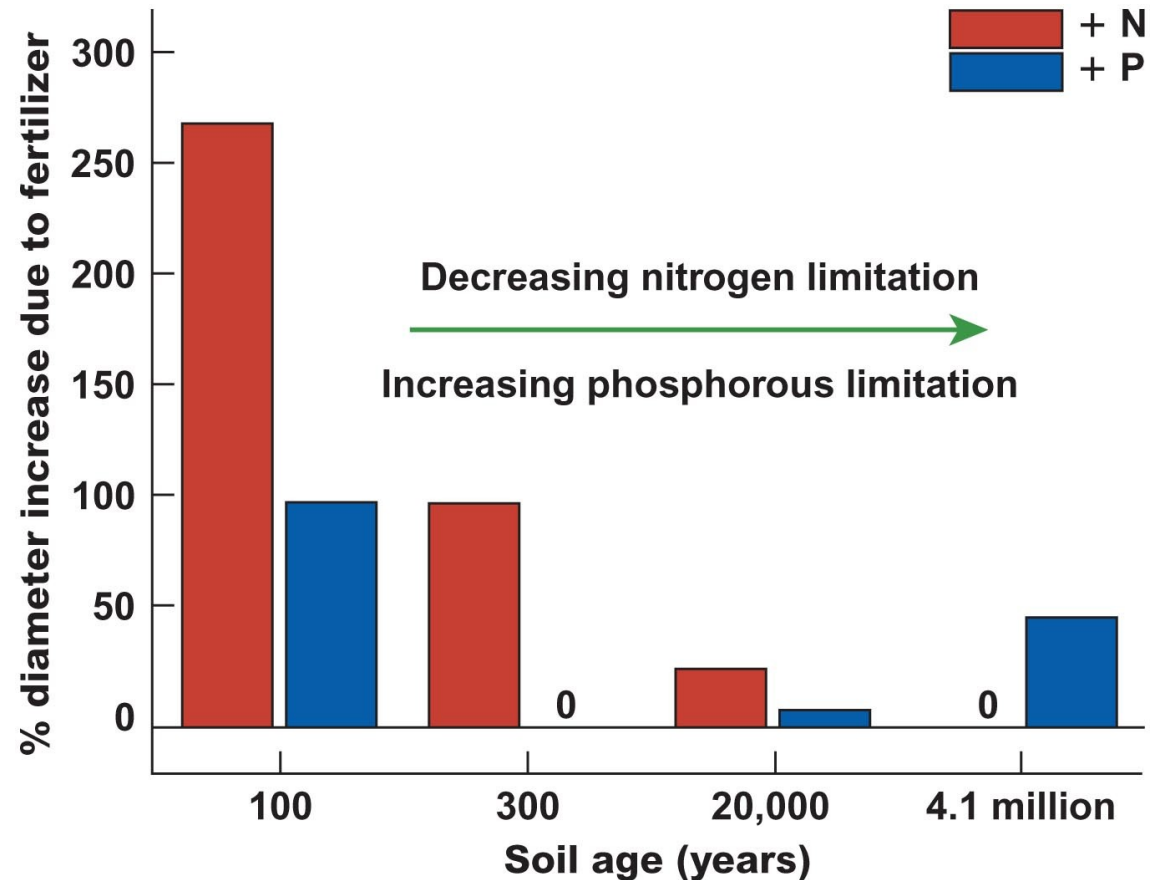
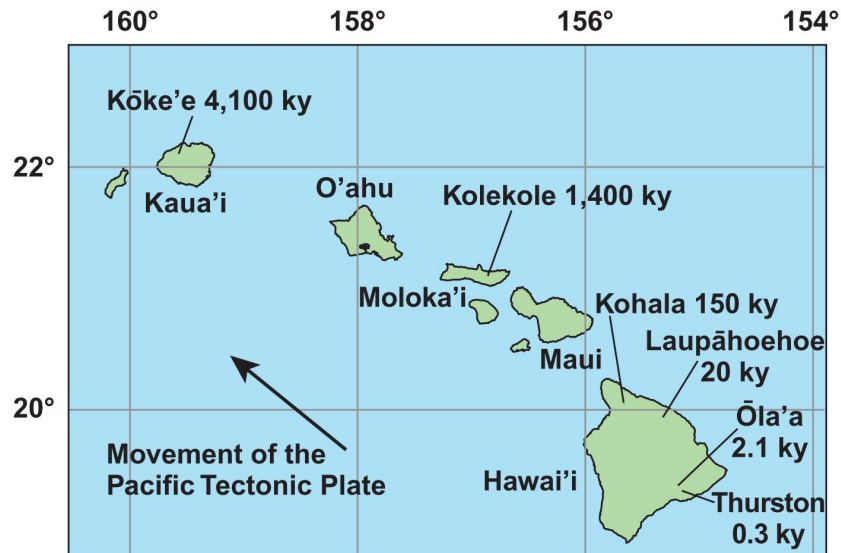
Ciclo de nutrientes en ambientes terrestres



Ciclo de nutrientes en ambientes terrestres



Ciclo de nutrientes en ambientes terrestres



Ciclo de nutrientes en ambientes terrestres

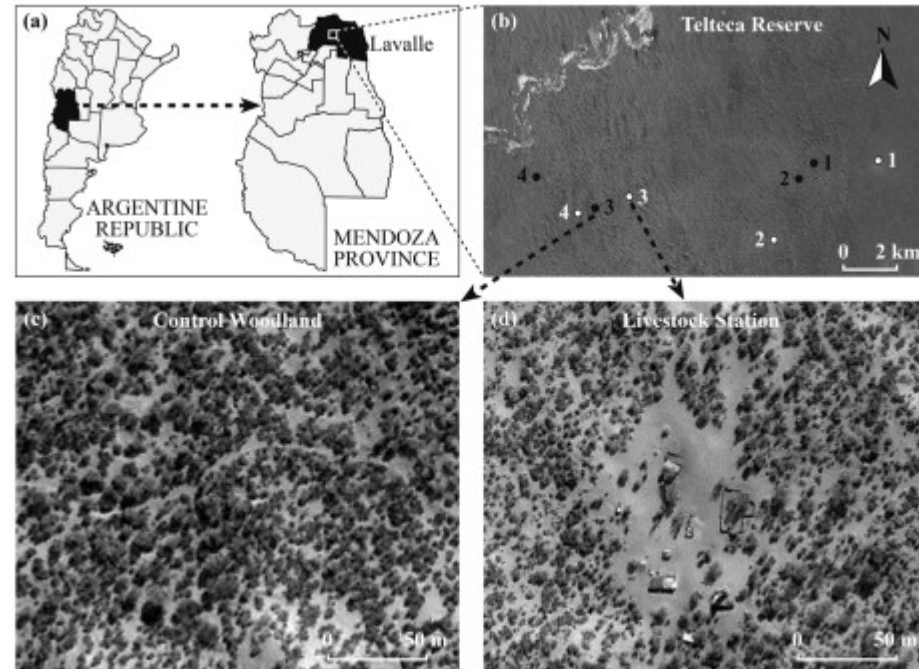
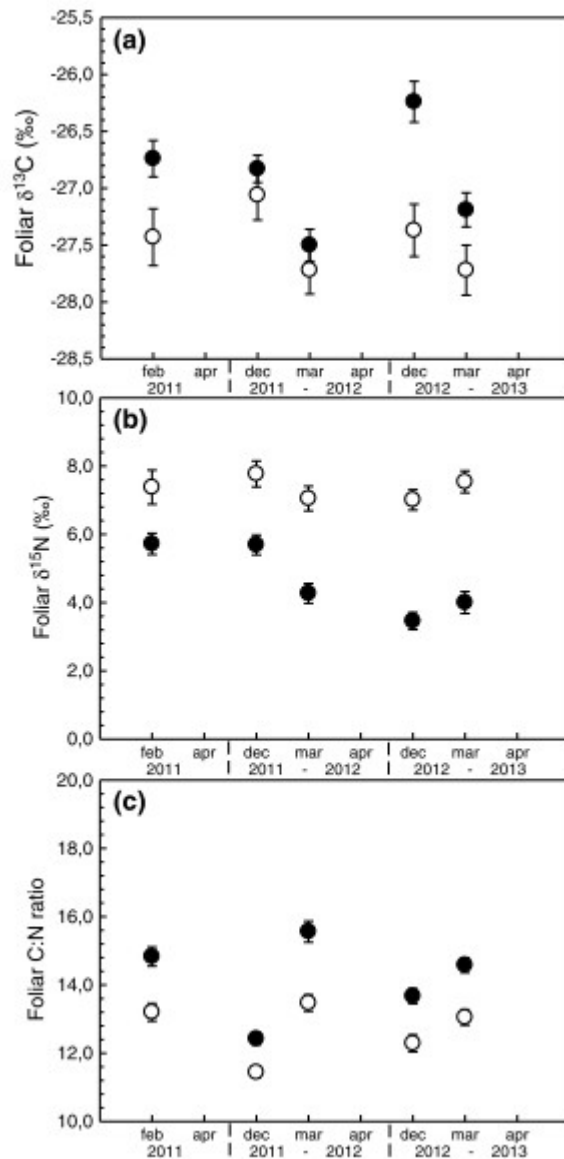
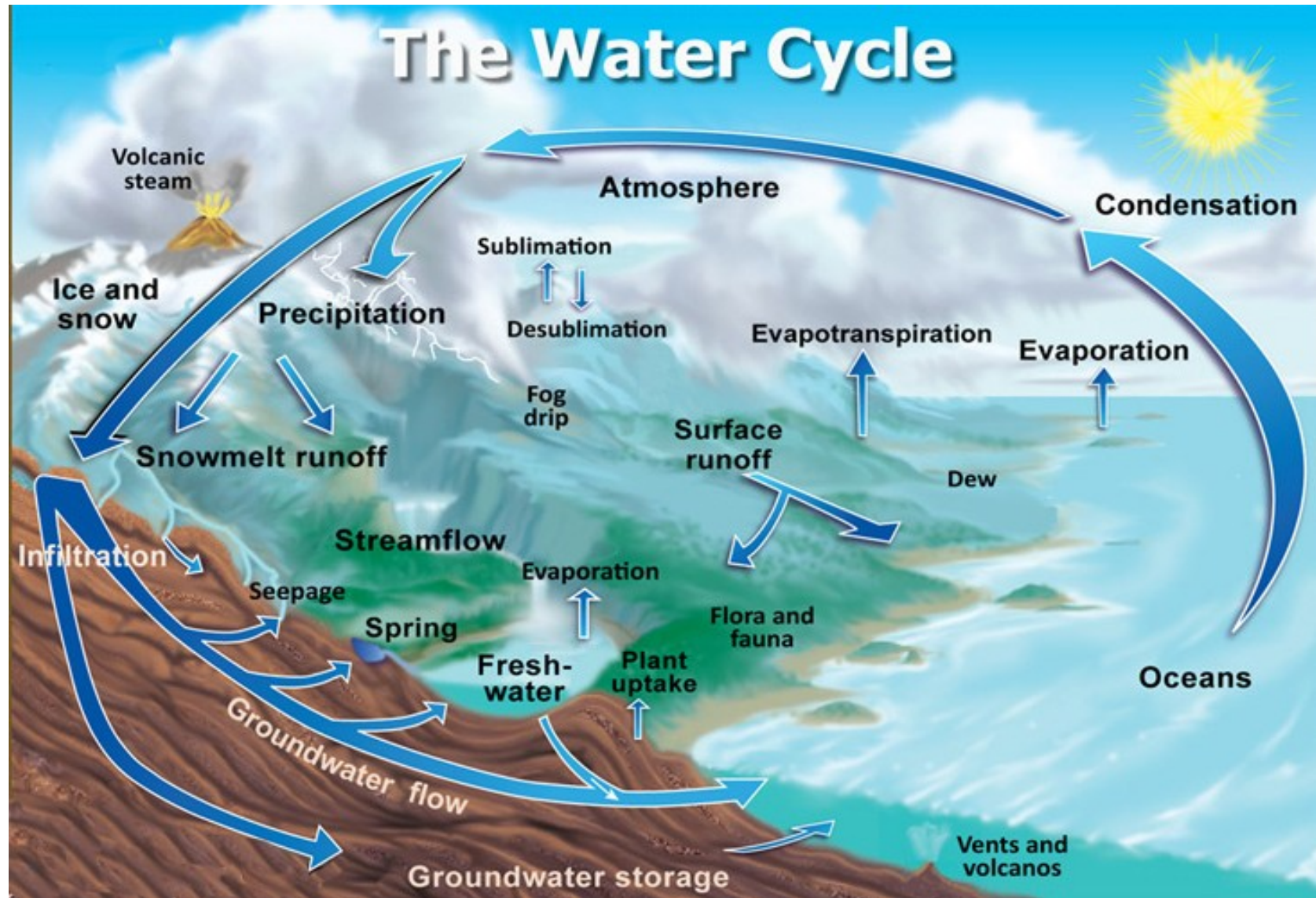


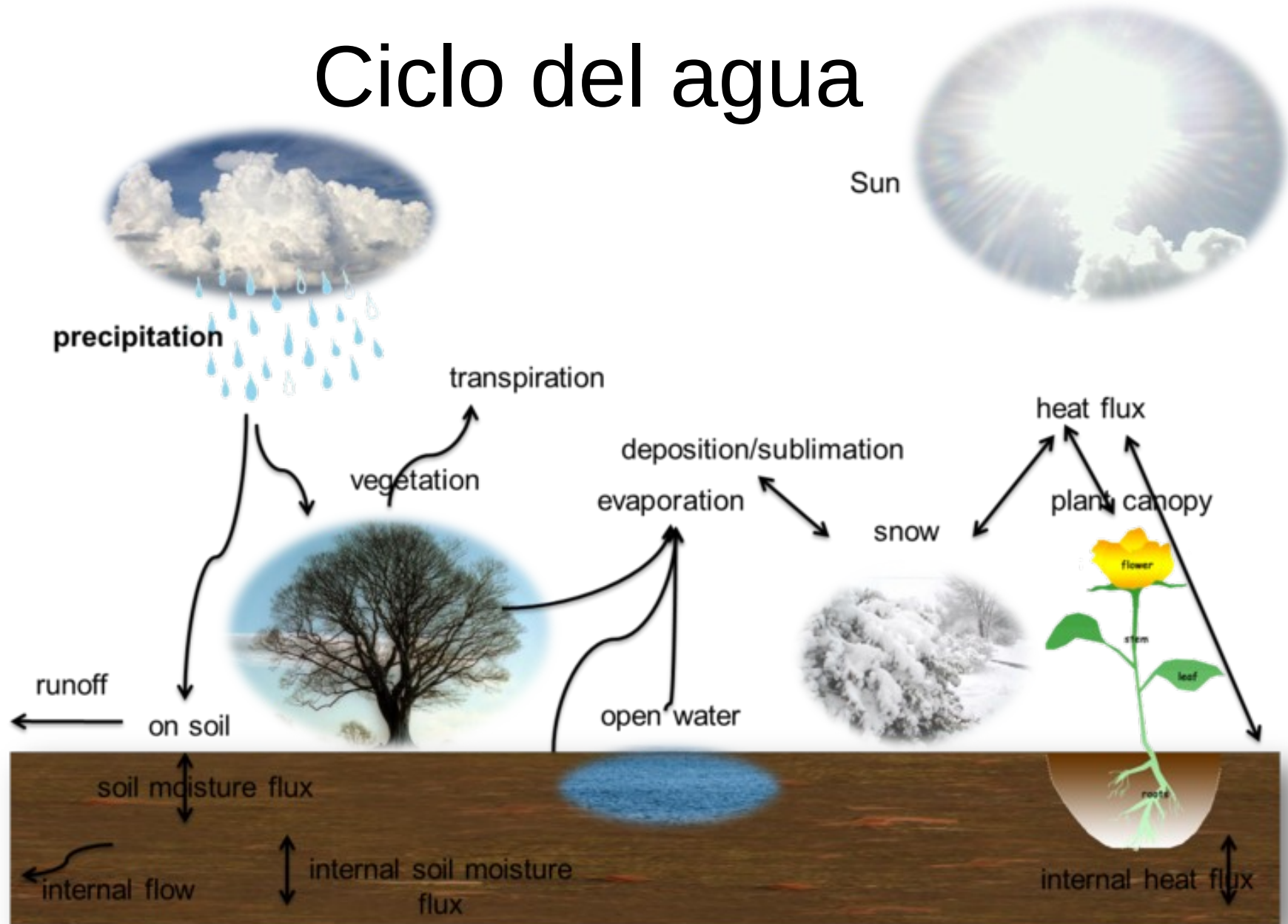
Figure 1. Maps of the Argentine Republic (a) and Mendoza Province (b). A satellite image marks the location of the control woodlands (black mark) and the livestock stations (white mark) in the Telteca Reserve (c). Satellite images with zoom of a control woodland (d) and of paired livestock station (e). Source for the satellite images was Google Earth <http://earth.google.es>.

Figure 6. Relative abundance of stable isotopes of carbon (a) and nitrogen (b), and their carbon to nitrogen ratio (c) in leaves of *P. flexuosa* for control woodlands (filled circles) and livestock stations (open circles) during the experimental period. Symbols are means \pm 1 s.e.m.

Ciclo del agua



Ciclo del agua



(Chen et. al., 1996, 1997; Chen and Dudhia, 2001; Ek et. al., 2003; Koren et. al., 1999)

Ciclo del agua

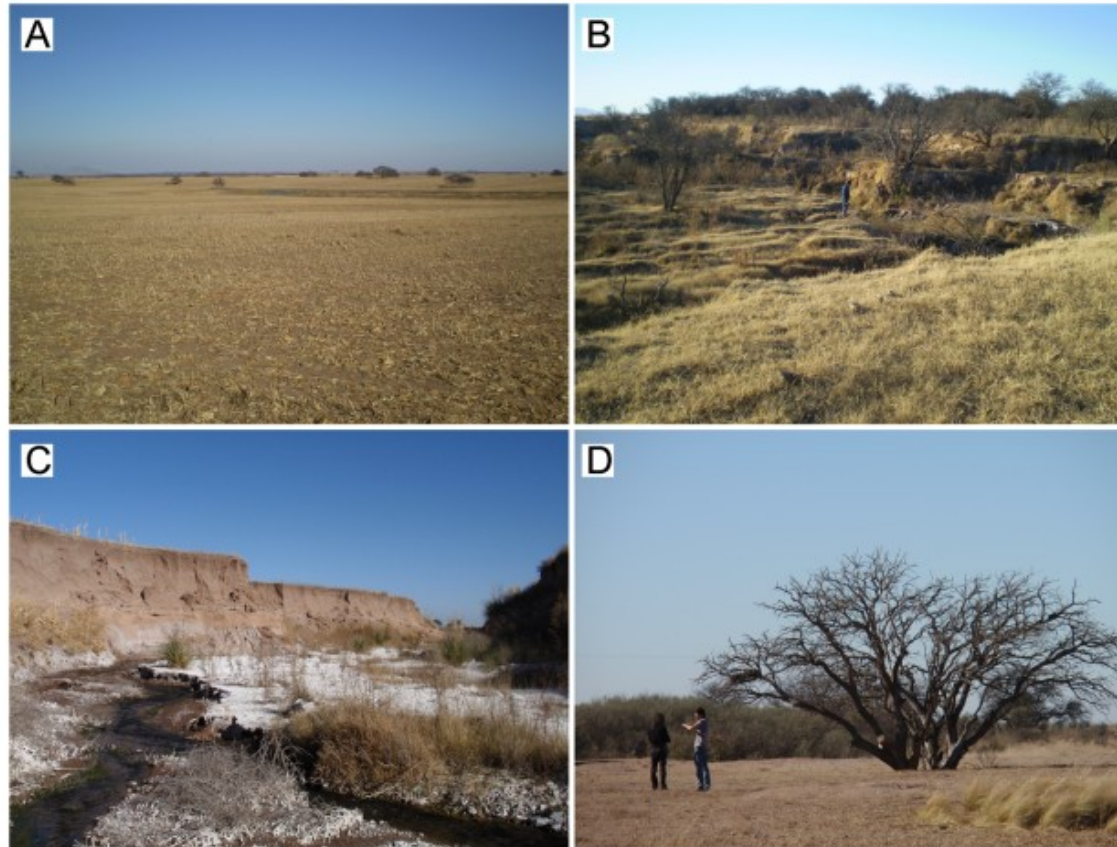


Figure 6. (A) Agriculture stands in the upper section of the catchment with a small surface water body resulting from the groundwater rise, (B) deep-seated mass failures driven by subsurface erosion processes along the new stream banks ('Río Nuevo' creek), (C) new stream channels at the upper section of the catchment ('Río Nuevo' creek) with 6 m vertical side walls and secondary salinity signals and (D) soil embankment in the middle section of the catchment (depth of the new sediments is estimated ~1.5 m).

Fuente: Contreras et al. (2013)
Ecohydrology

Ciclo del agua

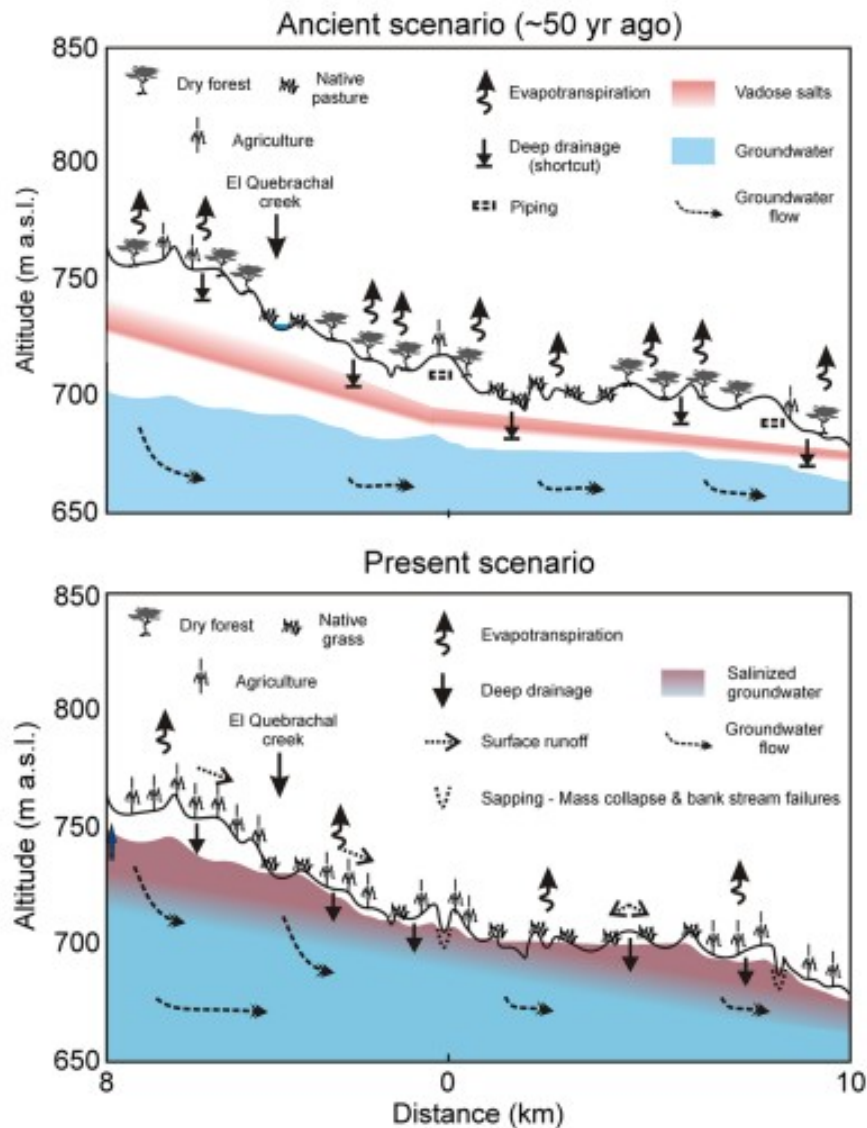
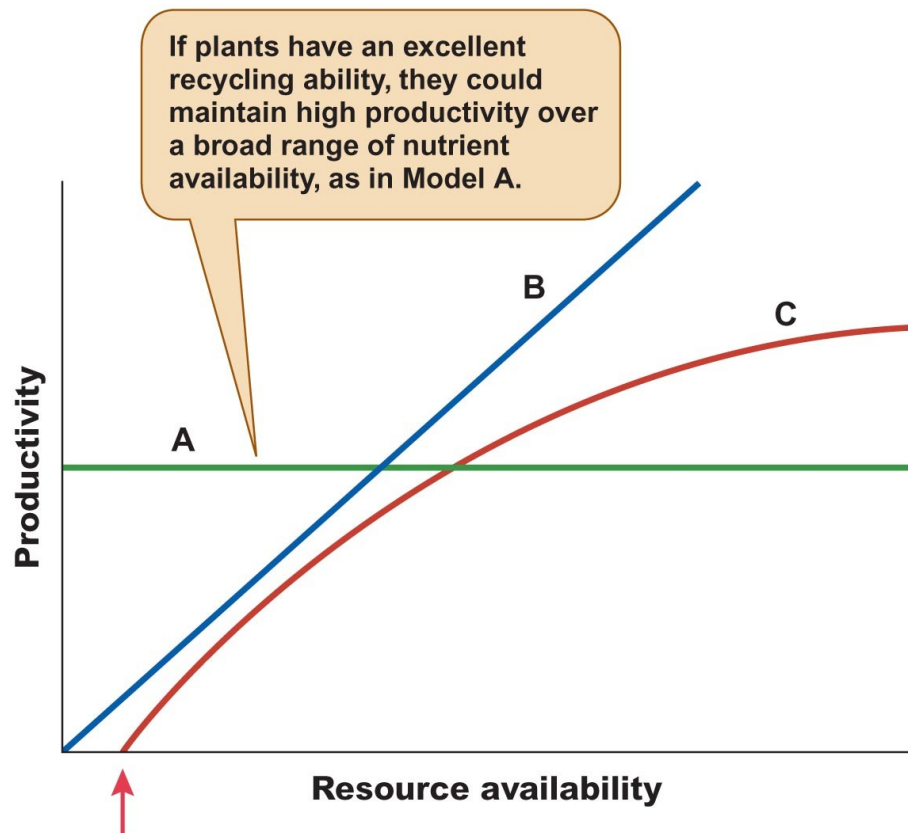


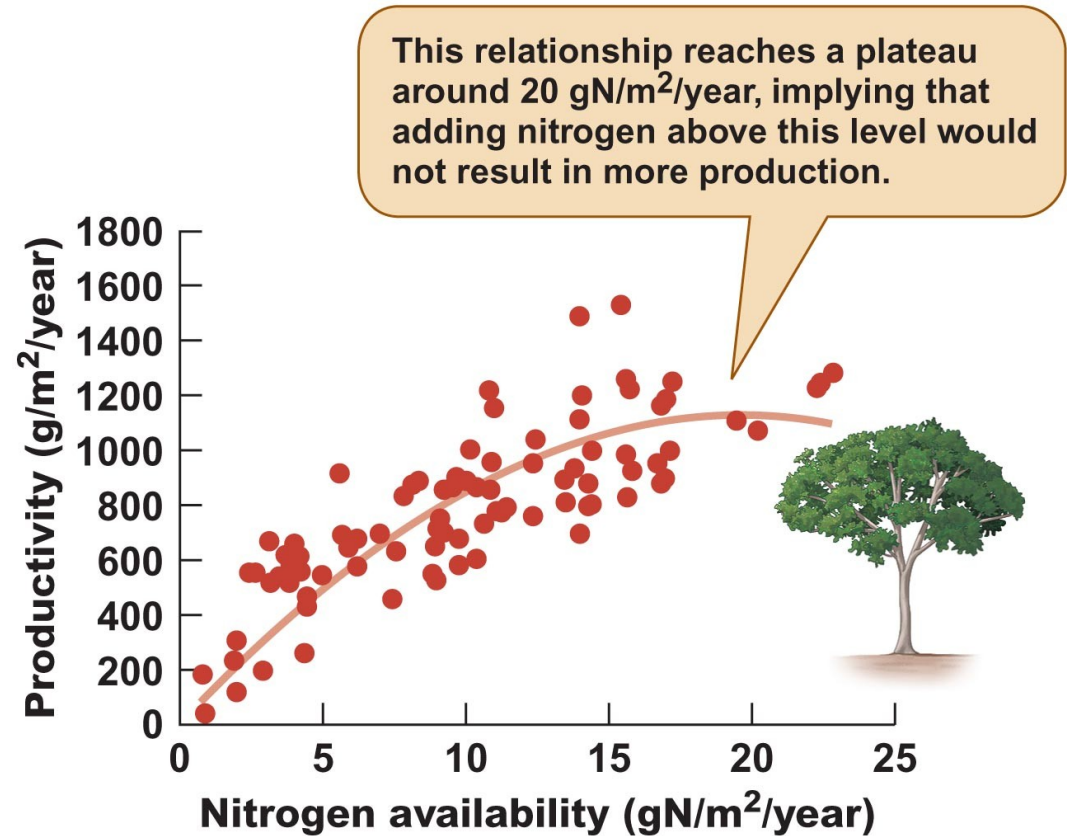
Figure 7. Conceptual model showing the processes and mechanisms involved in the hydro-geomorphologic evolution of the catchment. The profile section, located at the transition between the loessic-sandy and sandy plains, is at scale and shows the local tectonic depression where most of the new canyons and watercourses originate (transect A–A' in Figure 1). An ancient scenario with a dense dry forest coverage was characterized by the non-flow condition with dry and salty vadose profiles, and deep groundwater levels. After the conversion of native vegetation into agriculture (present scenario), recharge was enhanced resulting in water table level rises, activation of subsurface erosion processes (piping and sapping) and abrupt appearance of lagoons and new watercourses. Once these canyons and watercourses were formed, their expansion was controlled firstly by streambank erosion and lateral mass failures led by sustain groundwater seepage inflows and secondly, by surface runoff following intense rainfall events.

Fuente: Contreras et al. (2013)
Ecohydrology

Eficiencia en el uso de recursos

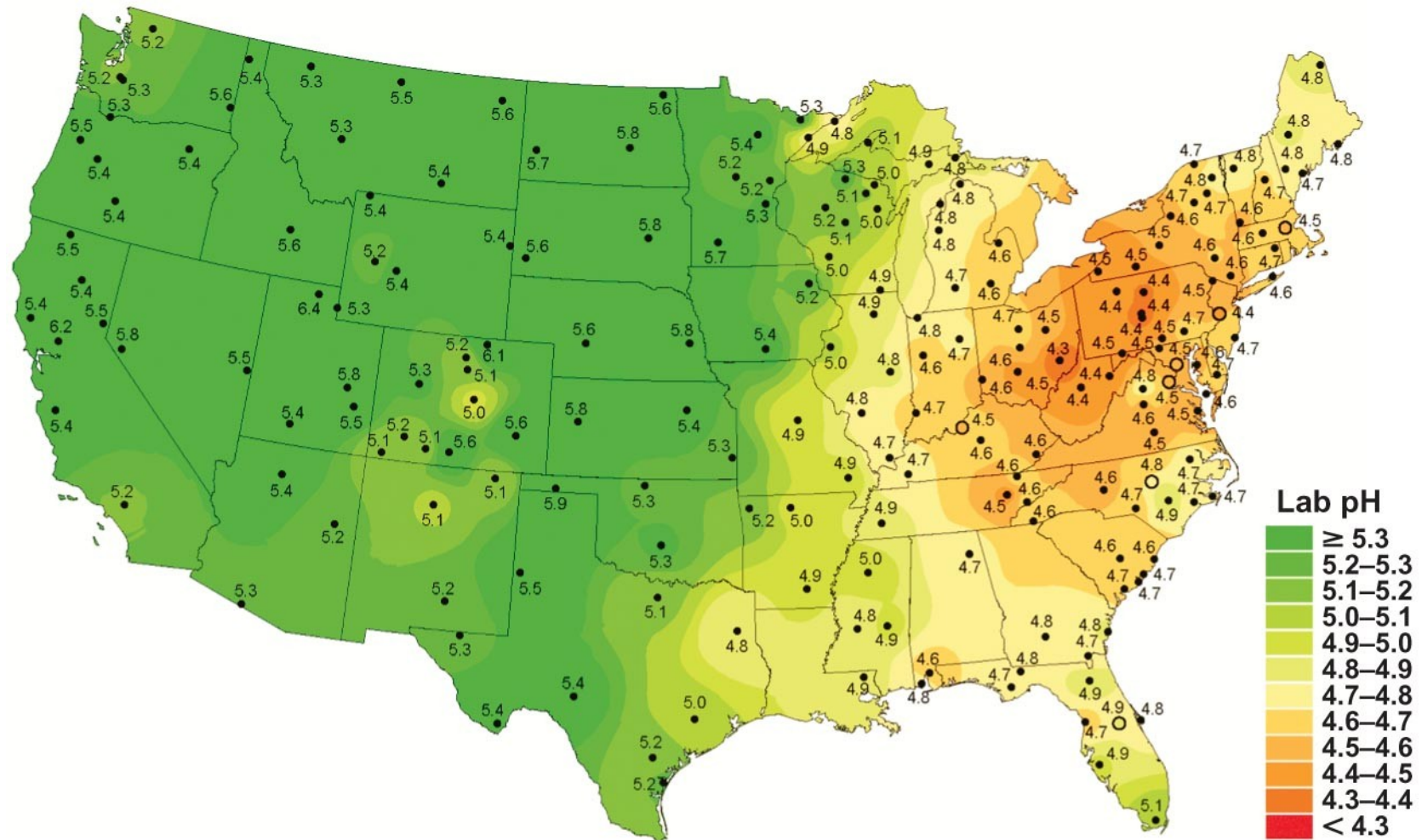


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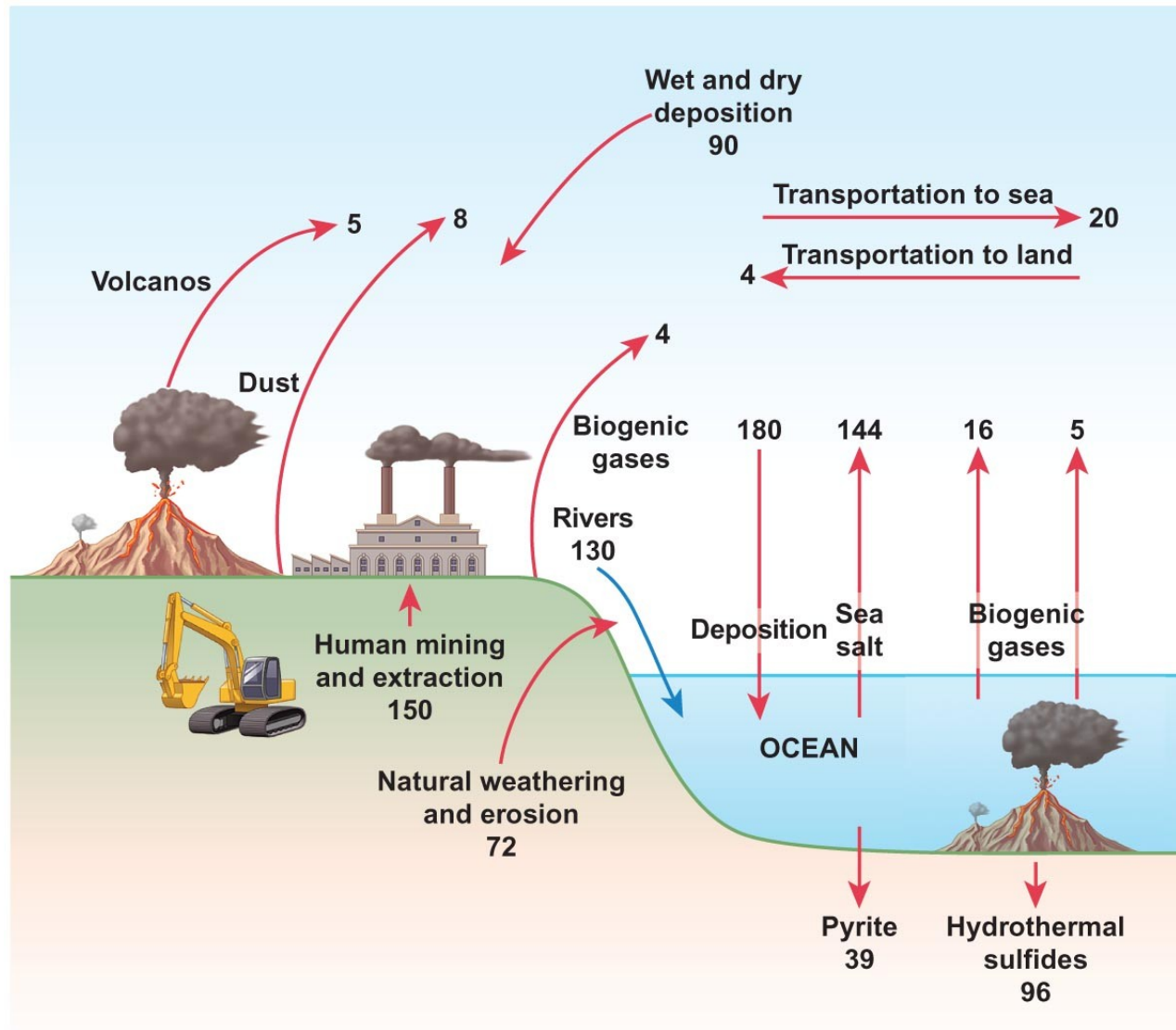
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Lluvia ácida y el ciclo de azufre



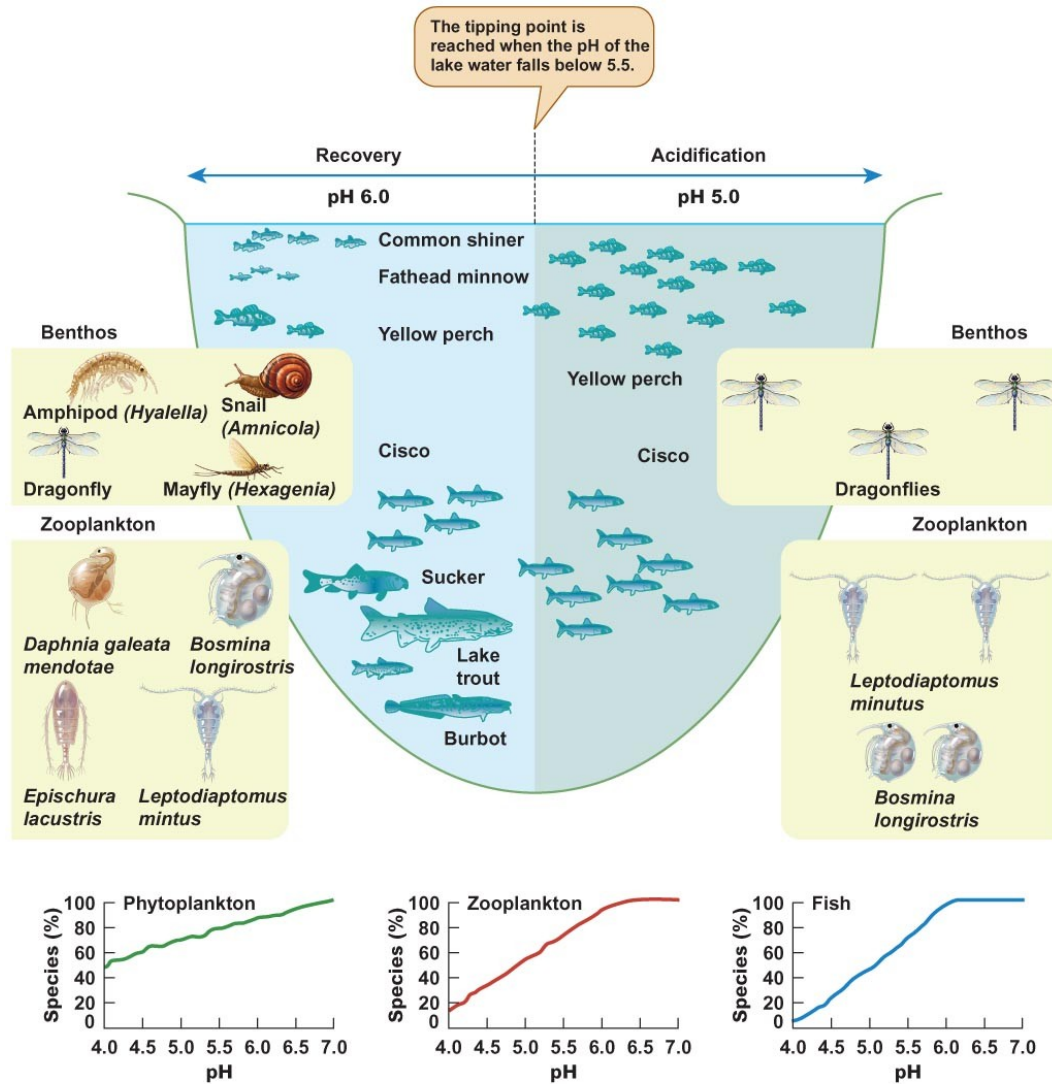
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Lluvia ácida y el ciclo de azufre



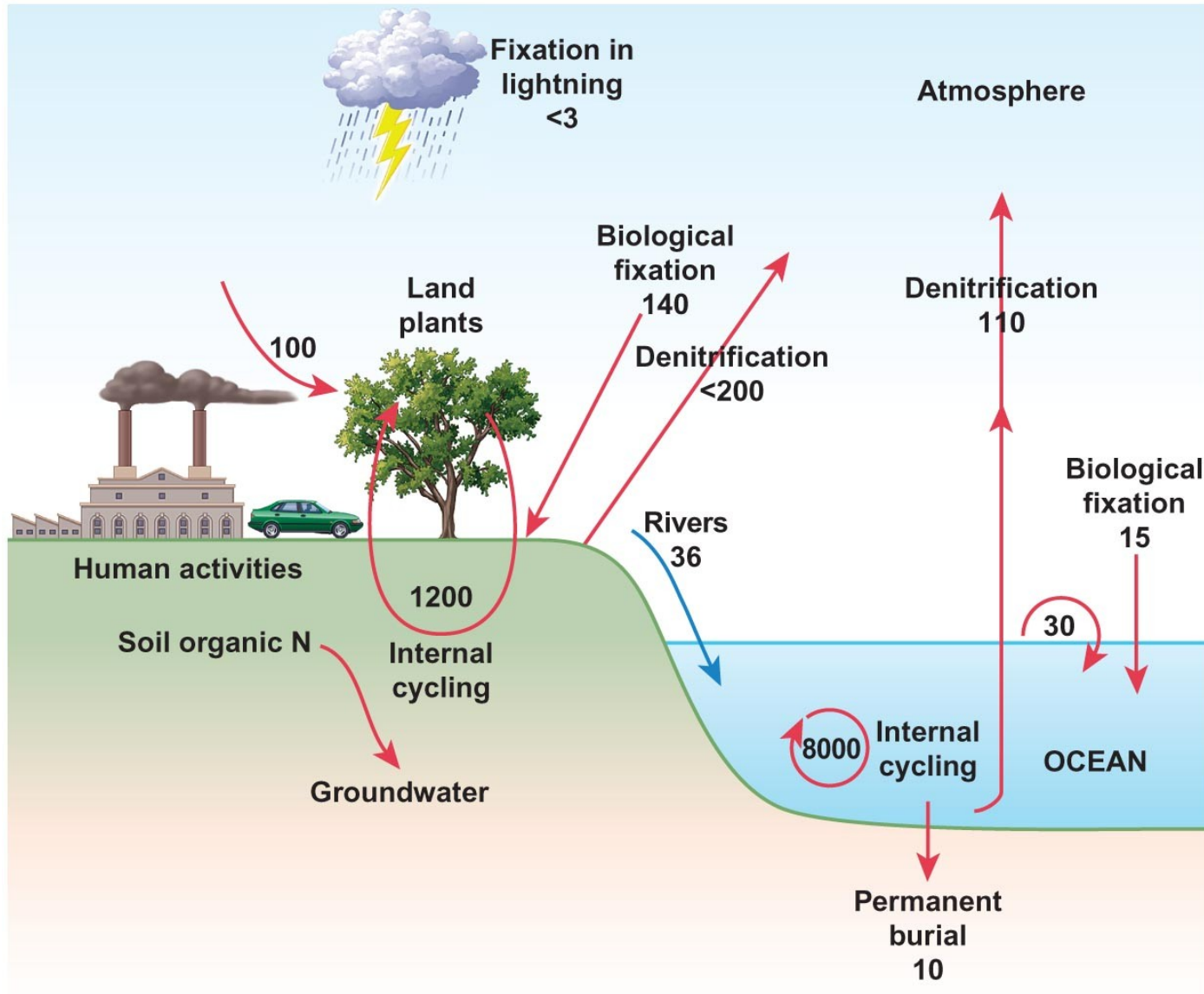
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Lluvia ácida y el ciclo de azufre

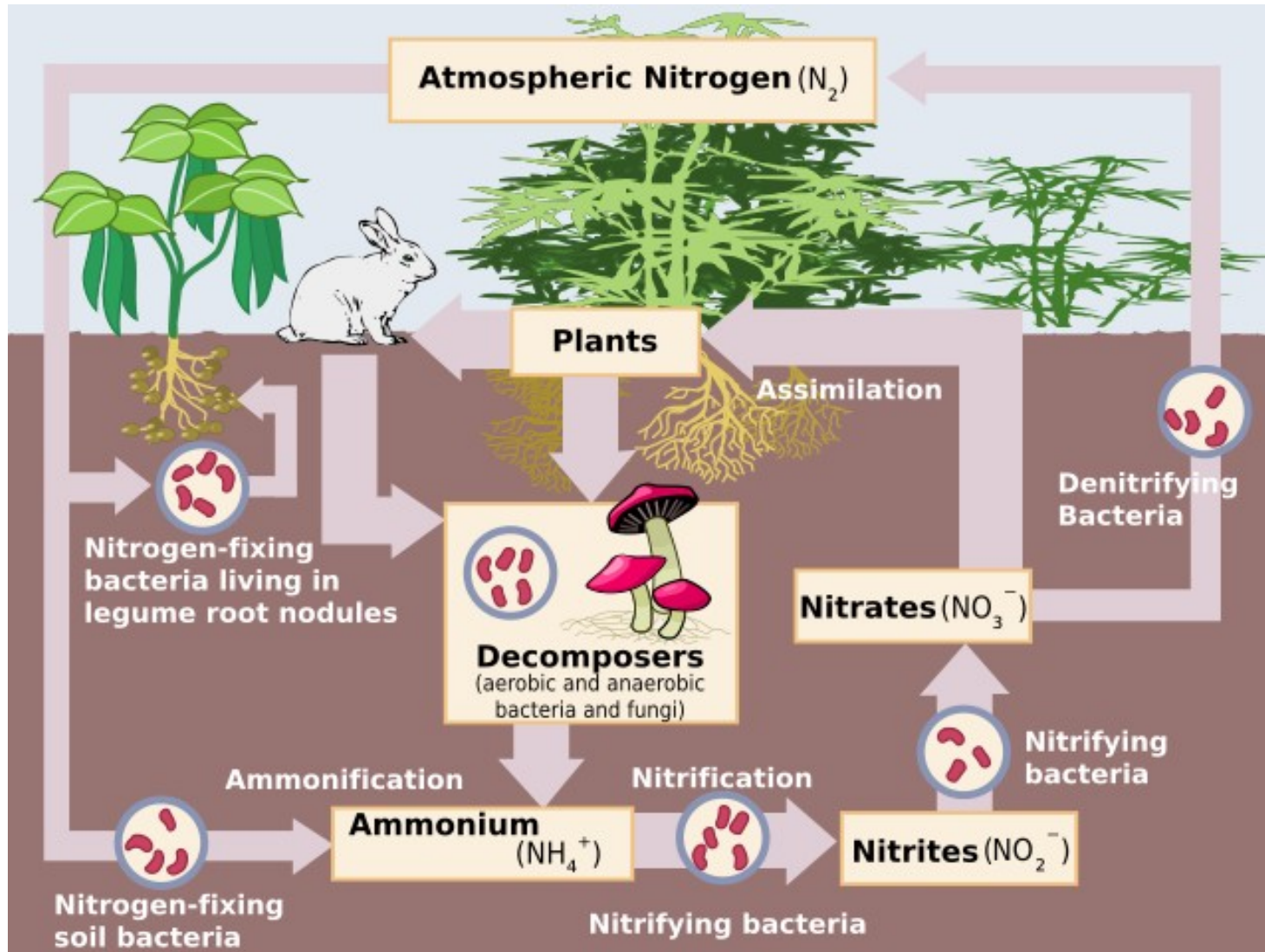


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El ciclo del nitrógeno



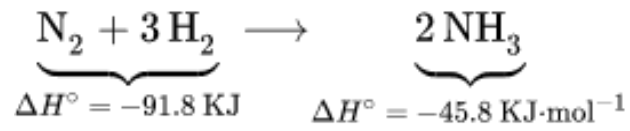
El ciclo del nitrógeno



Fuente: Wikipedia

El ciclo del nitrógeno

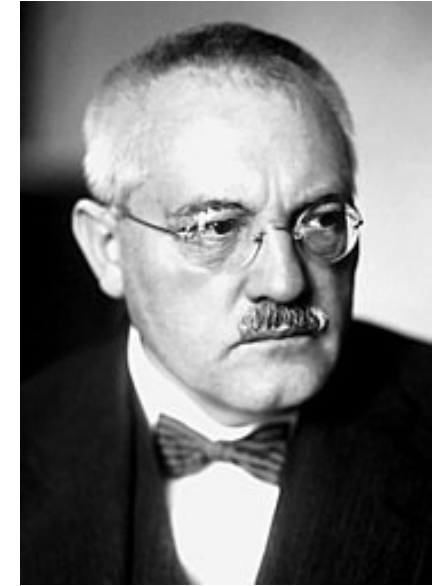
El proceso Haber-Bosch



Fábrica de fertilizante industrial



Fritz Haber



Carl Bosch

Fuente: Wikipedia

El ciclo del nitrógeno

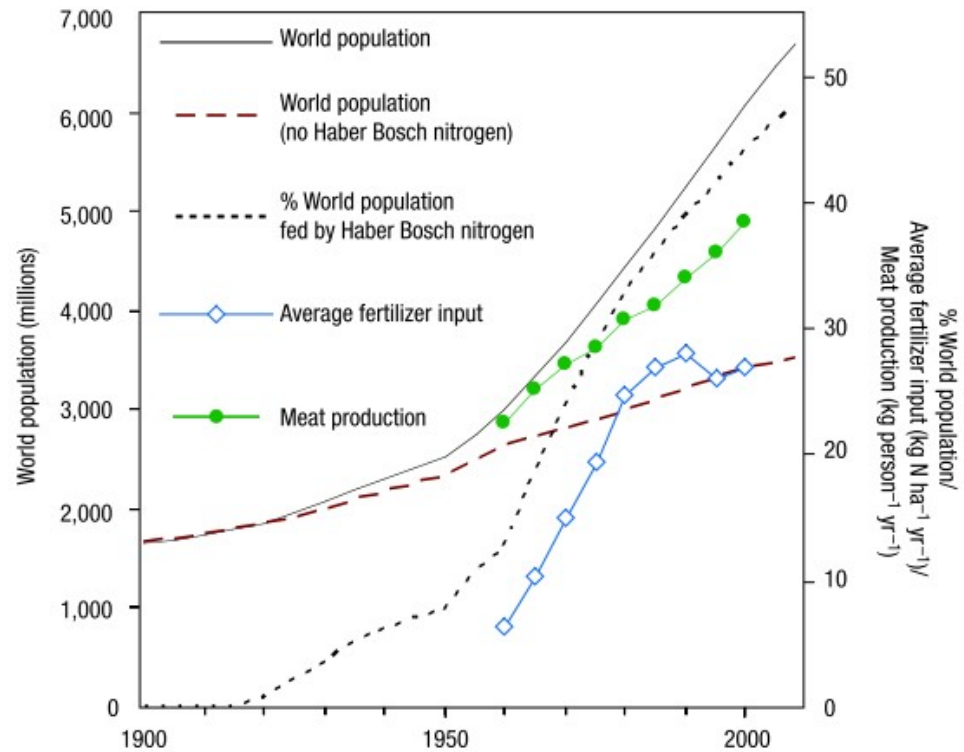


Figure 1 Trends in human population and nitrogen use throughout the twentieth century. Of the total world population (solid line), an estimate is made of the number of people that could be sustained without reactive nitrogen from the Haber–Bosch process (long dashed line), also expressed as a percentage of the global population (short dashed line). The recorded increase in average fertilizer use per hectare of agricultural land (blue symbols) and the increase in per capita meat production (green symbols) is also shown.

Fuente: Erisman et al. (2008)
Nature Geosc 1: 636-639

El ciclo del nitrógeno

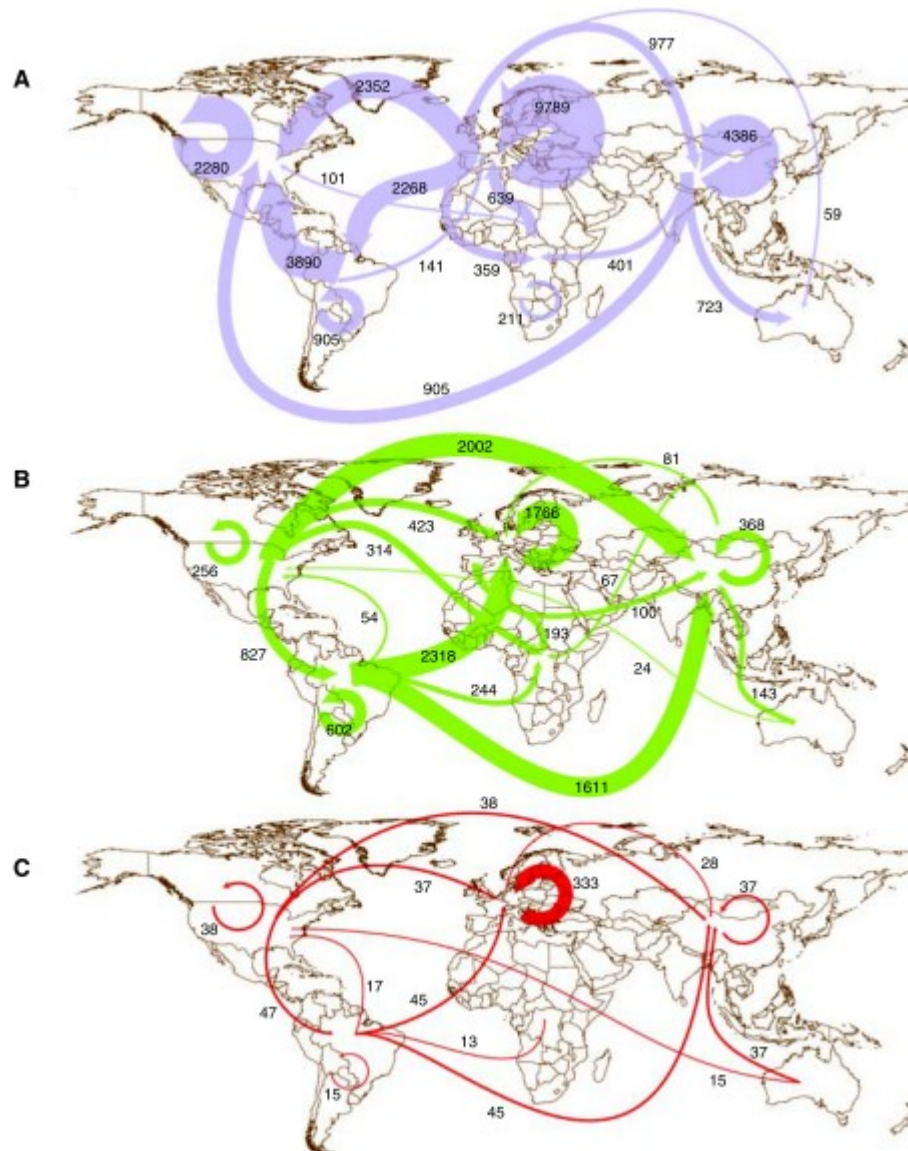


Fig. 1. N contained in internationally traded (A) fertilizer (31 Tg N), (B) grain (12 Tg N), and (C) meat (0.8 Tg N). Data are for 2004 and are in units of thousand of tons. Minimum requirements for drawing a line are 50,000 tons N, 20,000 tons N, and 10,000 tons N for fertilizer, grain, and meat, respectively (42).

Fuente: Galloway et al. (2008)
Science 320: 889-892

El ciclo del nitrógeno

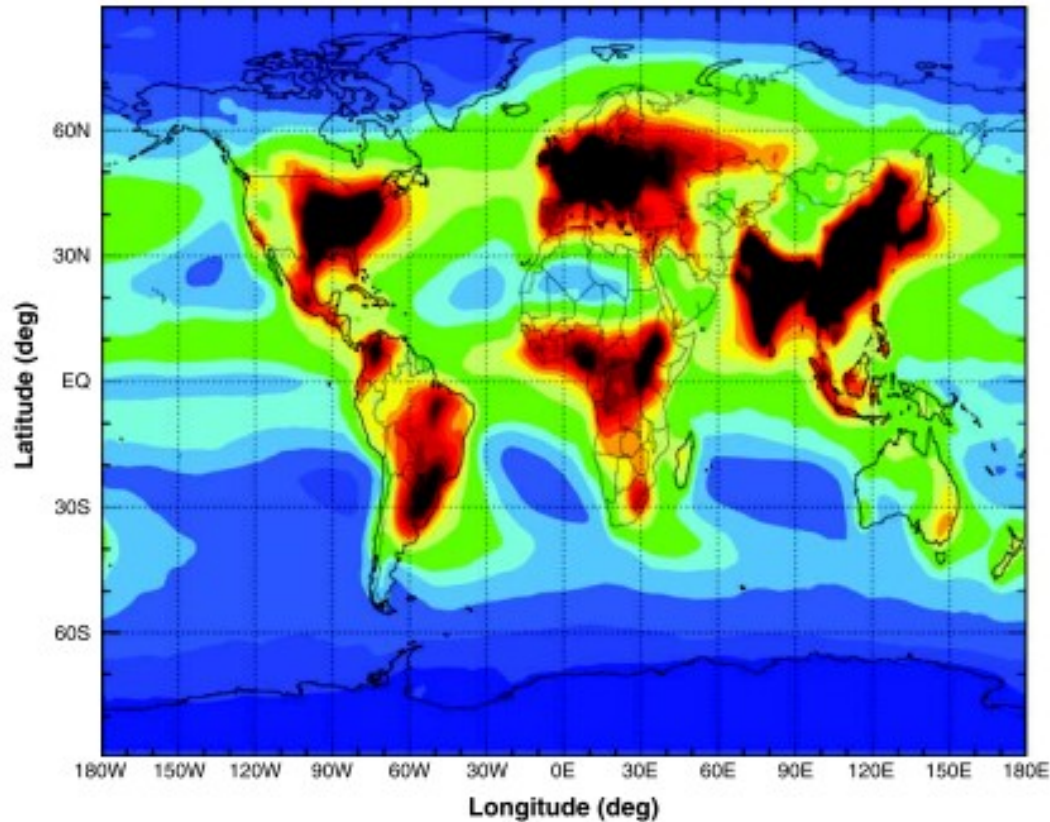


Fig. 2. Estimated N deposition from global total N (NO_y and NH_x) emissions, totaling 105 Tg N y⁻¹. The unit scale is kg N ha⁻¹ y⁻¹, modified from the original units (mg m⁻² y⁻¹) (16).

Fuente: Galloway et al. (2008)
Science 320: 889-892

El ciclo del nitrógeno

Table 24.4 Adverse effects of nutrient additions of nitrogen and phosphorus on freshwater and coastal marine ecosystems.

Increased biomass of phytoplankton

Shifts in phytoplankton communities to bloom-forming species that may be toxic

Increase in blooms of gelatinous zooplankton in marine ecosystems

Increased biomass of benthic algae

Changes in macrophytic species composition and biomass

Death of coral reefs

Decreases in water transparency

Taste, odor, and water treatment problems for domestic water supplies

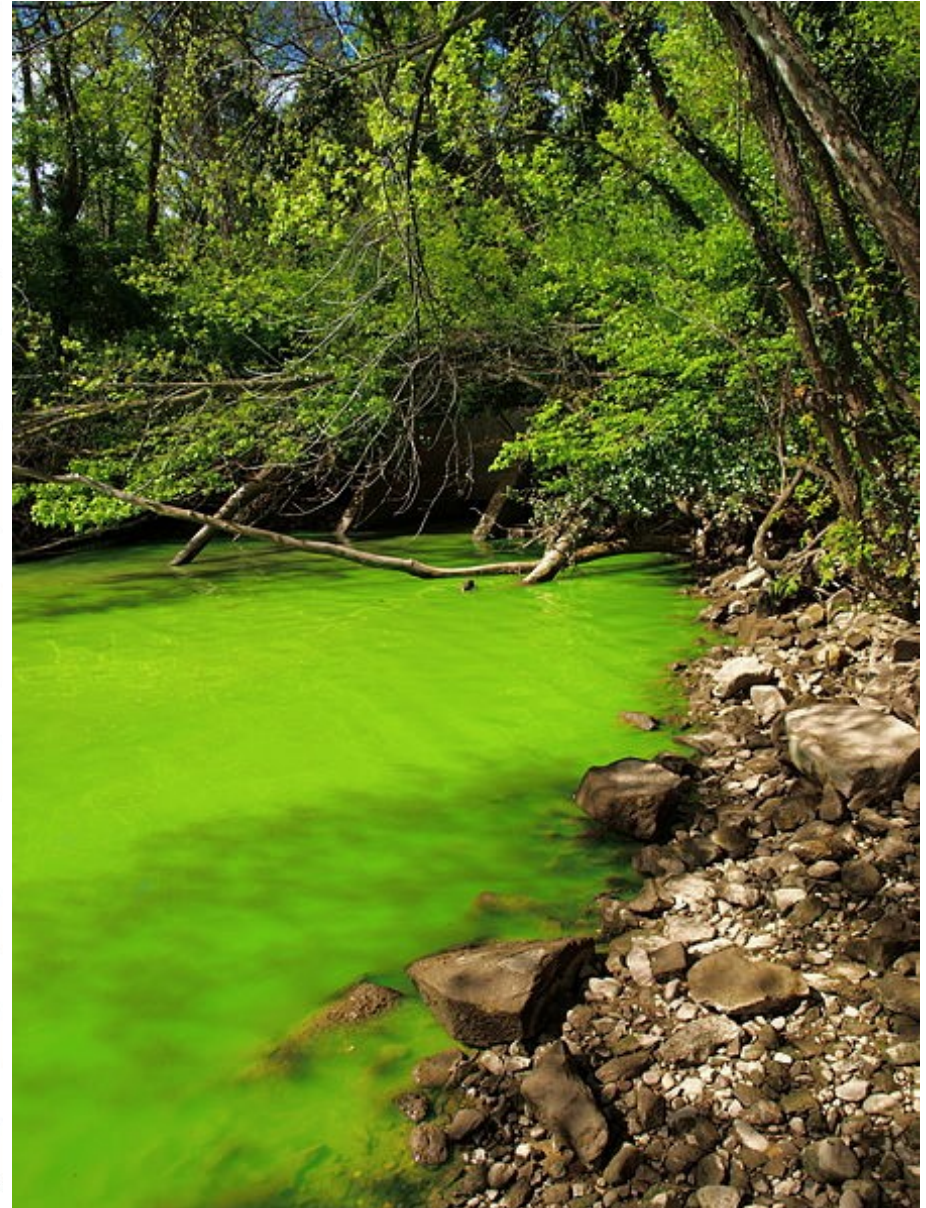
Oxygen depletion

Increased frequency of fish kills

Loss of desirable fish species

Reductions in harvestable fish and shellfish

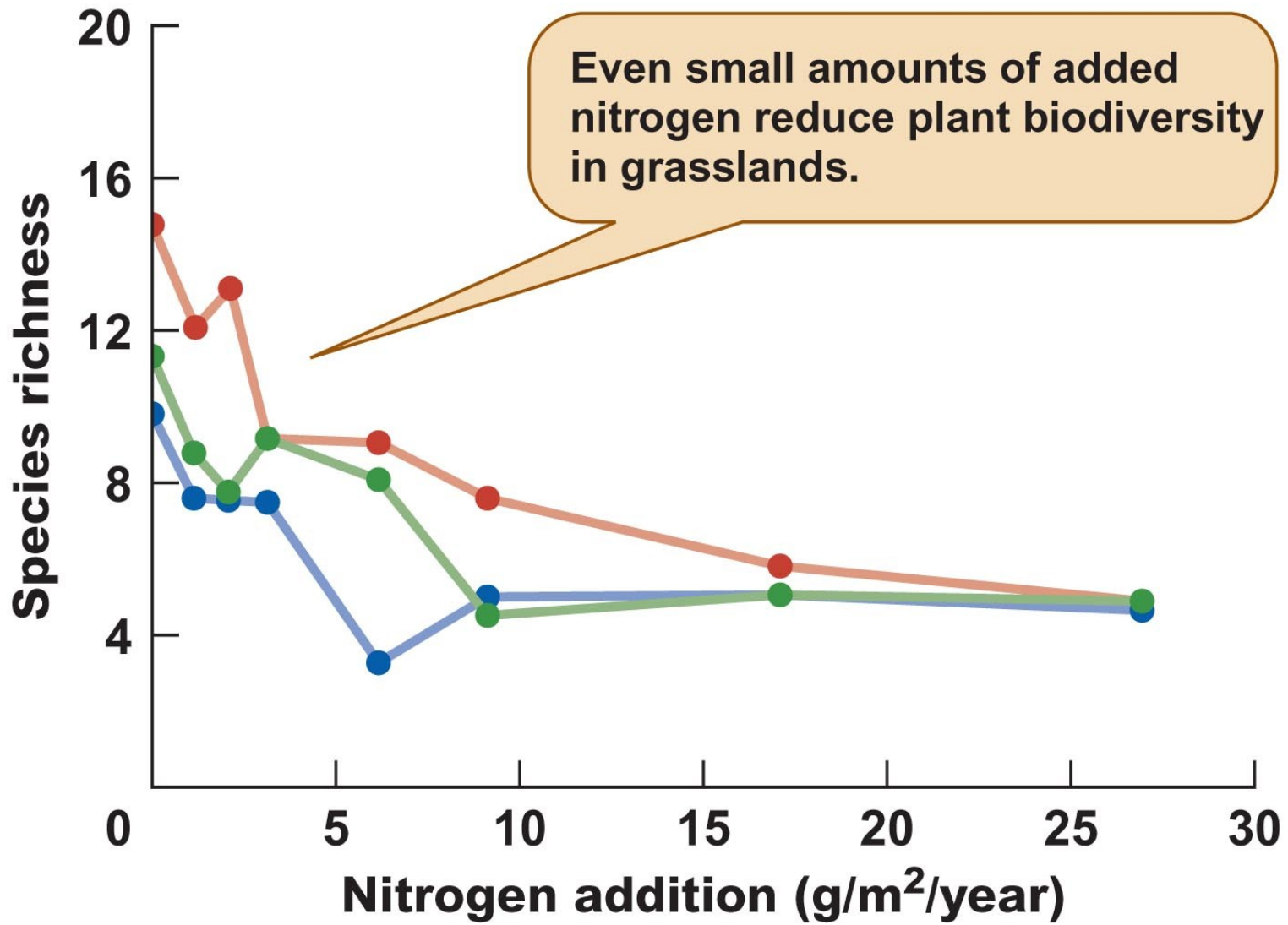
Decrease in aesthetic value of bodies of water



SOURCE: From Carpenter et al. (1998).

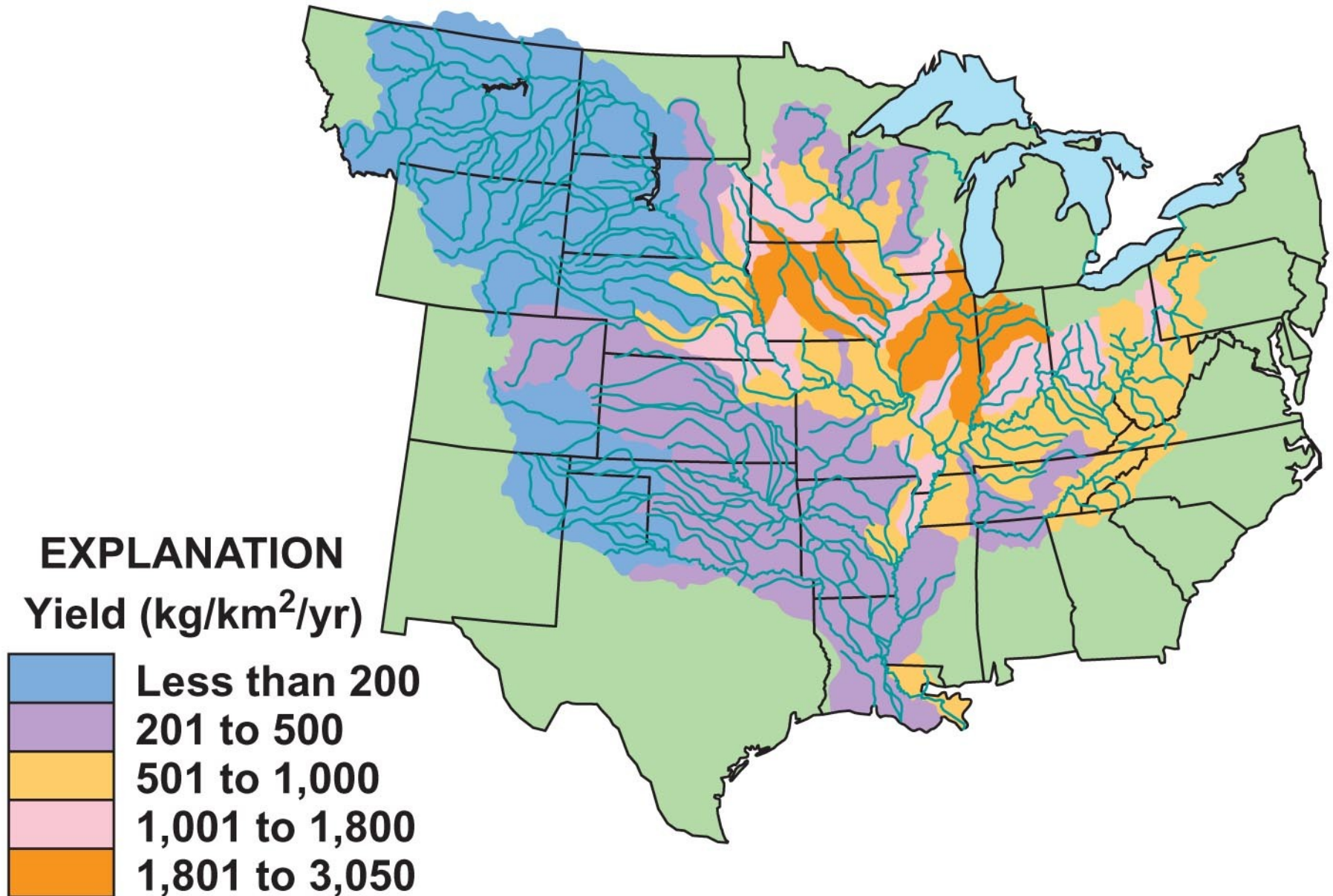
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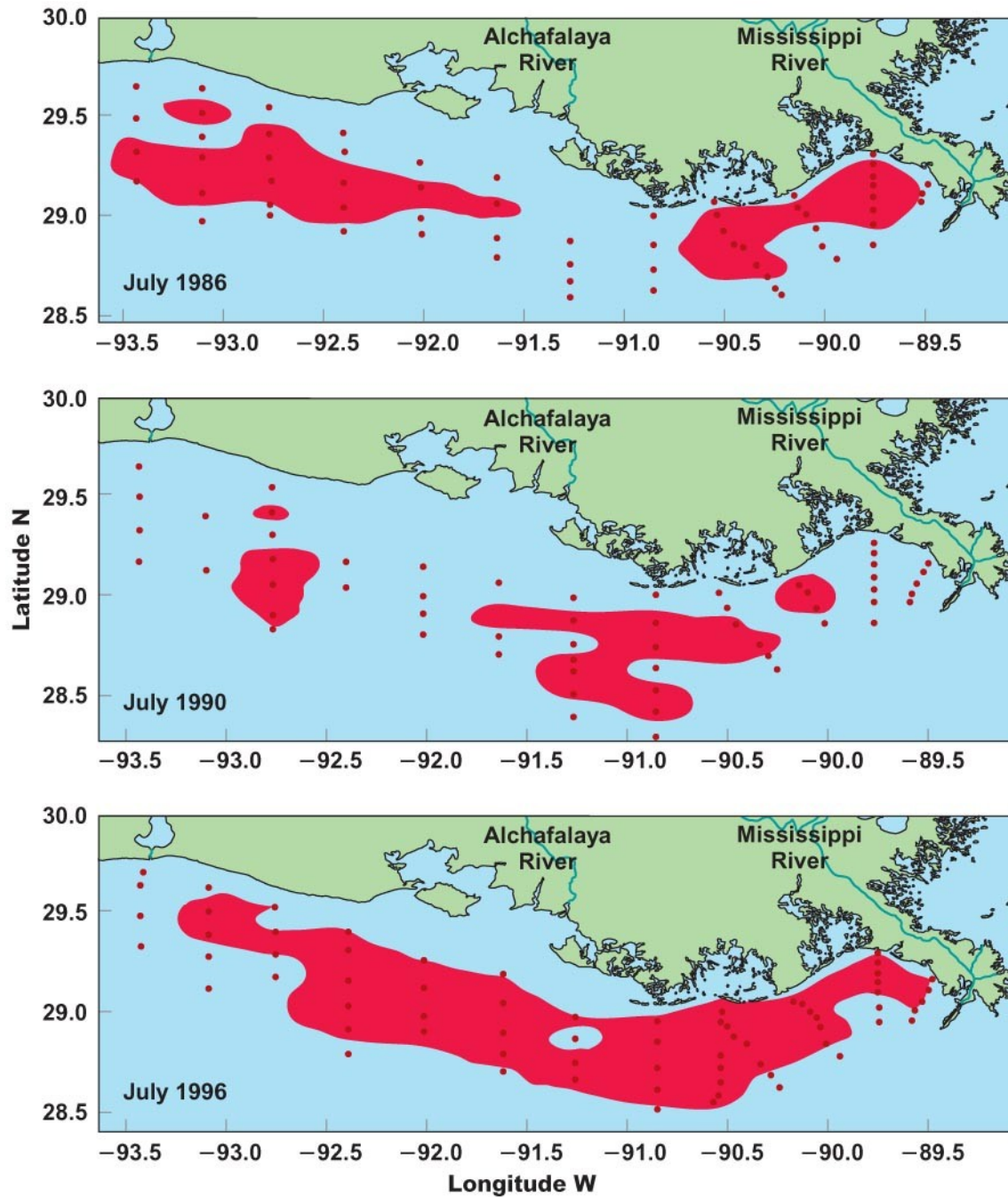
El ciclo del nitrógeno



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El ciclo del nitrógeno





Teórica 14: Conclusiones

- El ciclo de nutrientes es un proceso fundamental en los ecosistemas.
- El ciclo de nutrientes depende de los distintos componentes de los ecosistemas y del aporte externo.
- Las actividades humanas pueden afectar fuertemente los ciclos de nutrientes a nivel regional y global.