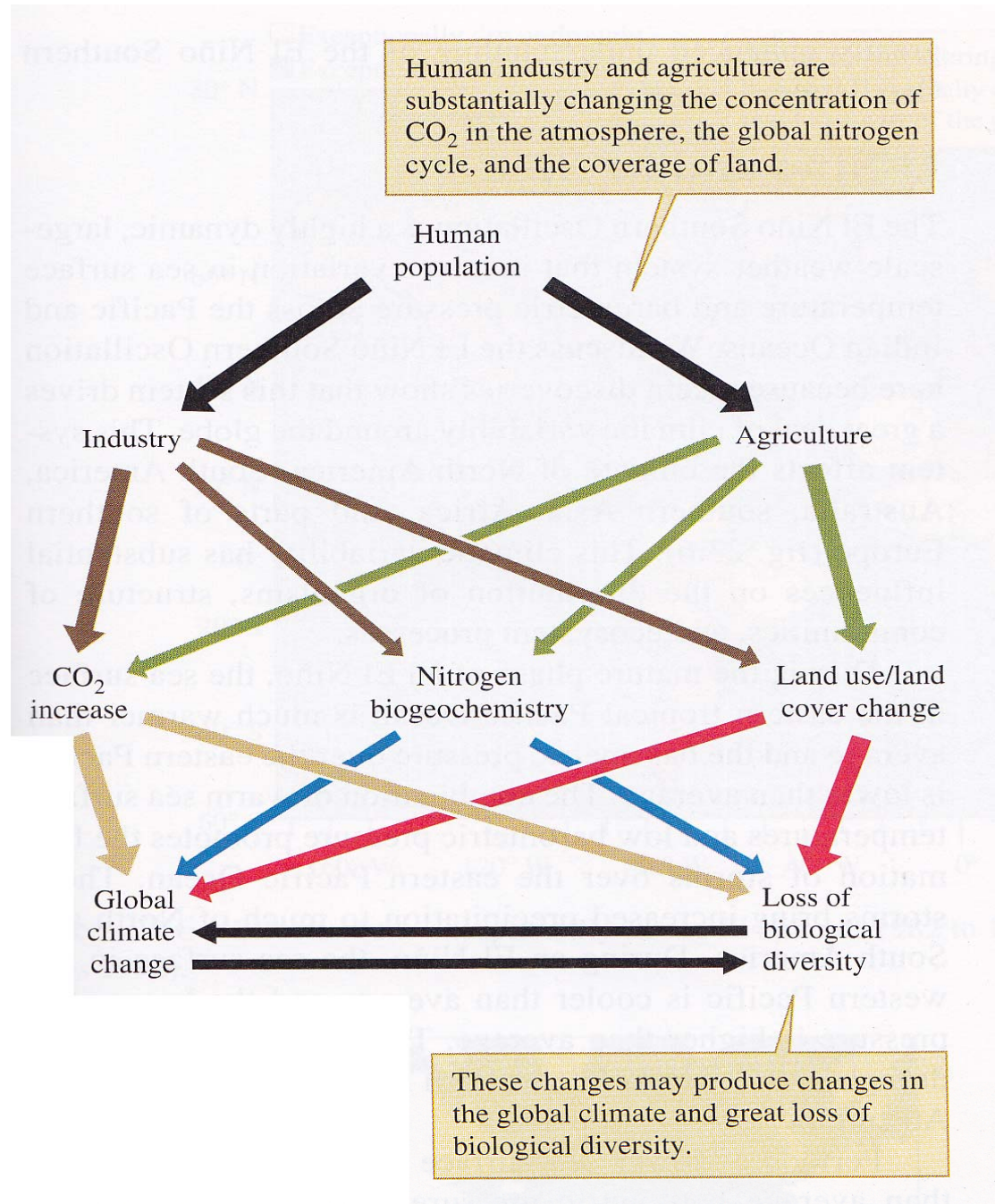


# Επίδραση του ανθρώπου



## Γεωργία και επίδραση στον κύκλο του N



▲ **Figure 54.20 Agricultural impact on soil nutrients.**

Removal of harvested plant biomass for market removes mineral nutrients that would otherwise be cycled back to the local soil. To replace the lost nutrients, farmers must apply fertilizers—either organic fertilizers, such as manure or mulch, or manufactured fertilizers.

Το N είναι το κύριο θρεπτικό που χάνεται κατά την καλλιέργεια και απελευθερώνεται ως οξείδια του N στην ατμόσφαιρα συνεισφέρει στο φαινόμενο του θερμοκηπίου, στην τρύπα του όζοντος και στην όξινη βροχή.

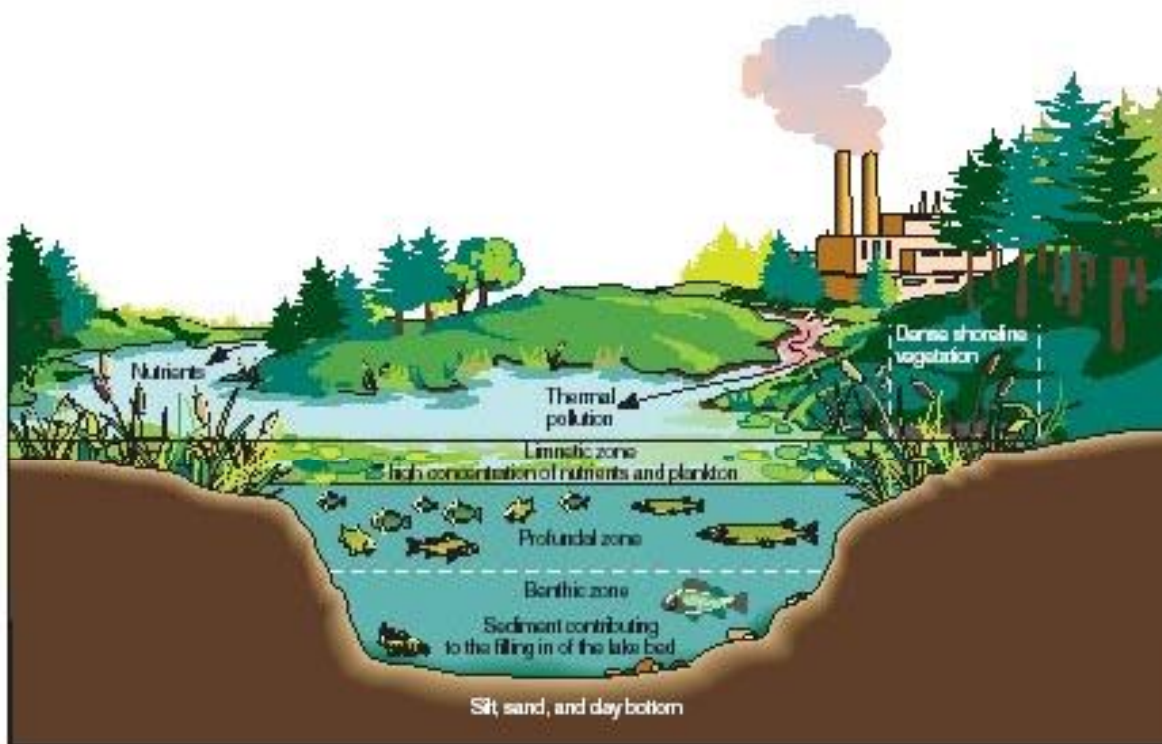


## Μόλυνση των υδάτινων οικοσυστημάτων

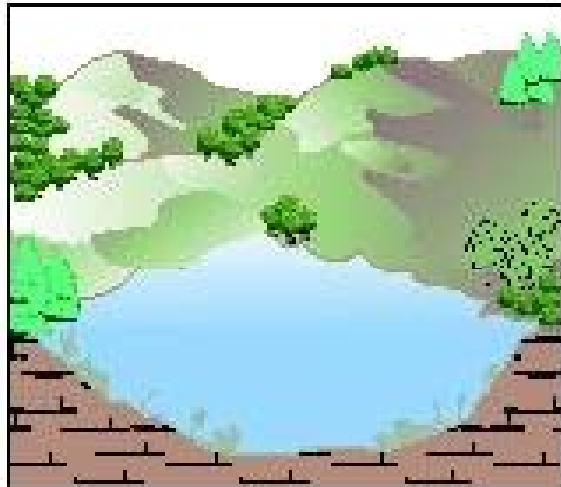
Η πρόσθεση Ν επιβαρύνει το οικοσύστημα.

Μέσω των υπόγειων υδάτων οδηγείται σε θάλασσες, λίμνες ή ποτάμια (ευτροφισμός και μόλυνση πόσιμου νερού).

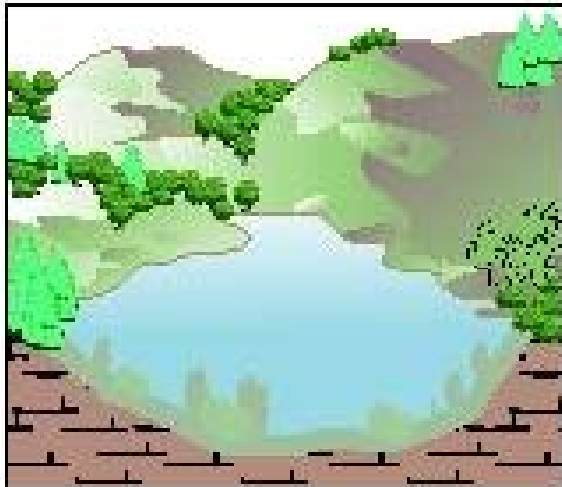
Τα νιτρικά δημιουργούν καρκινικές νιτροζαμίνες, και ελαττώνουν στα παιδιά την φέρουσα ικανότητα σε οξυγόνο του αίματος.



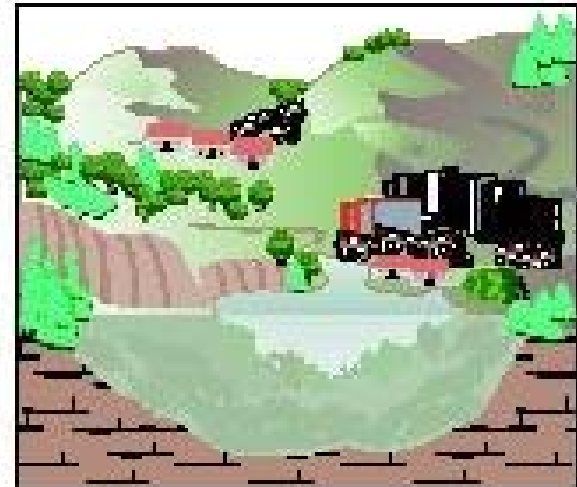
Oligotrophic



Mesotrophic



Eutrophic



NATURAL EUTROPHICATION AND LAKE AGING occurs over centuries, and results from natural sources of nutrients and sediments

N A T U R A L : C E N T U R I E S

CULTURAL EUTROPHICATION AND LAKE AGING occurs over decades, and results from human-induced urban runoff, sewage effluent, industrial waste, fertilizers, pesticides, and excess sediments

C U L T U R A L : D E C A D E S



Το 1852, ο Βρετανός Angus Smith χρησιμοποίησε για πρώτη φορά τον όρο "acid rain" για να περιγράψει μια επίδραση της Βιομηχανικής Επανάστασης στην αγγλική ύπαιθρο.

Σήμερα χρησιμοποιείται κυρίως ο όρος "acid precipitation".



Concentration of Hydrogen ions compared to distilled water

Concentration of Hydrogen ions compared to distilled water	pH	Examples of solutions at this pH
10,000,000	pH = 0	Battery acid, Strong Hydrofluoric Acid
1,000,000	pH = 1	Hydrochloric acid secreted by stomach lining
100,000	pH = 2	Lemon Juice, Gastric Acid Vineger
10,000	pH = 3	Grapefruit, Orange Juice, Soda
1,000	pH = 4	Tomato Juice Acid rain
100	pH = 5	Soft drinking water Black Coffee
10	pH = 6	Urine Saliva
1	pH = 7	"Pure" water
1/10	pH = 8	Sea water
1/100	pH = 9	Baking soda
1/1,000	pH = 10	Great Salt Lake Milk of Magnesia
1/10,000	pH = 11	Ammonia solution
1/100,000	pH = 12	Soapy water
1/1,000,000	pH = 13	Bleaches Oven cleaner
1/10,000,000	pH = 14	Liquid drain cleaner

**Ατμόσφαιρα**  
 $CO_2$  και  $H_2O \rightarrow$  λίγο  $HCO_3$  pH:5,6

+  $H_2O$

Οξειδία του S και του N  
 $SO_2, NO_2$

$H_2SO_4$  (Θειικό οξύ)  
 $HNO_3$  (Νιτρικό οξύ)

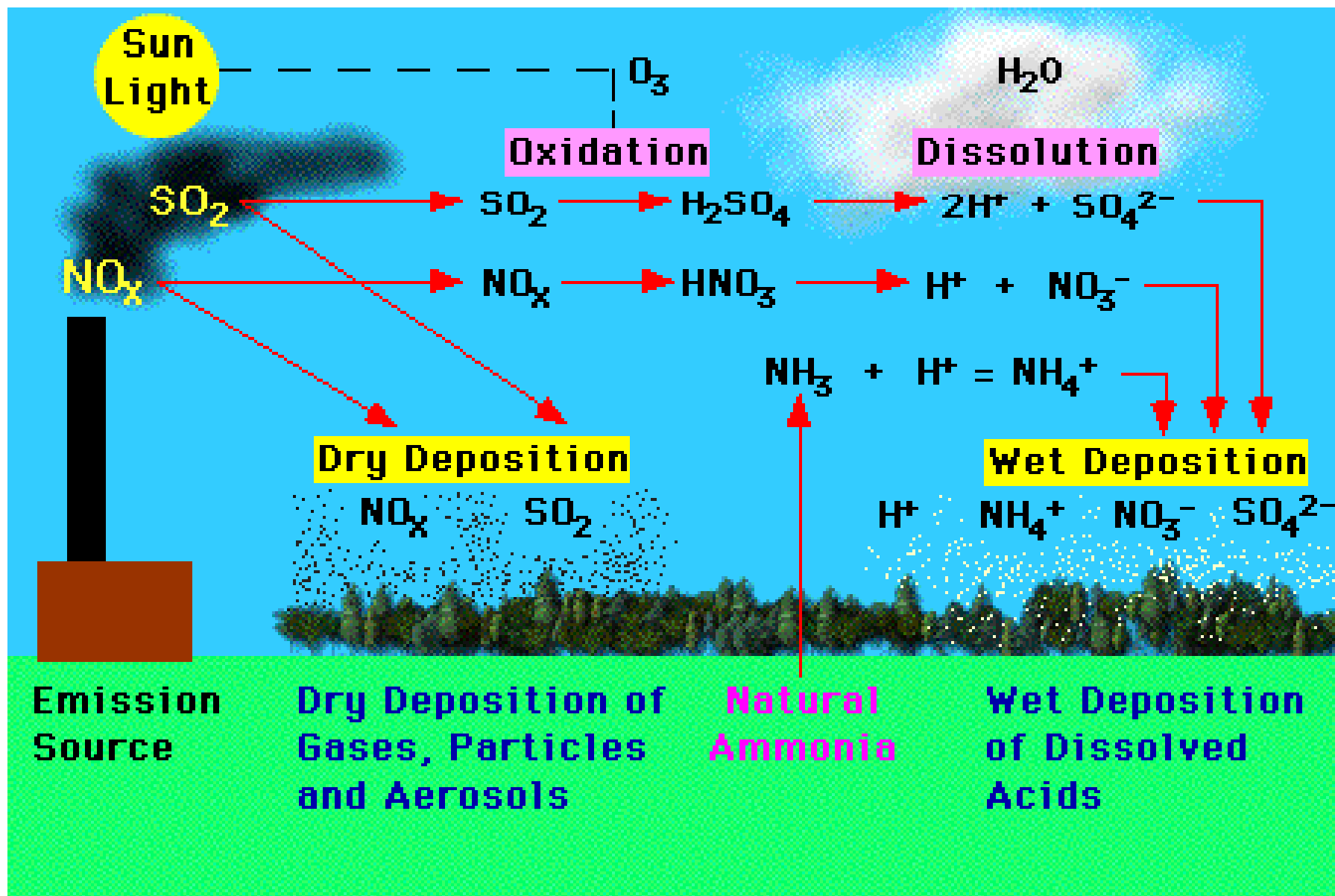


pH < 5,6



1. Χερσαία περιβάλλοντα: Η μείωση του pH  $\rightarrow$  μείωση της κατακράτησης  $Ca^{2+}$  και θρεπτικών







## 2. Δραματική επίδραση στις λίμνες:

Καταστρέφονται τα  
αυγά, ή οι απόγονοι  
είναι δύσμορφοι.

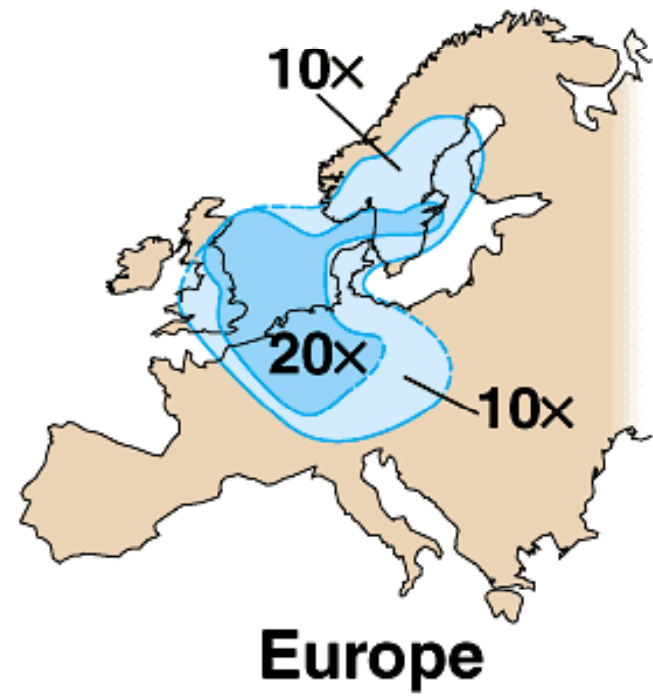
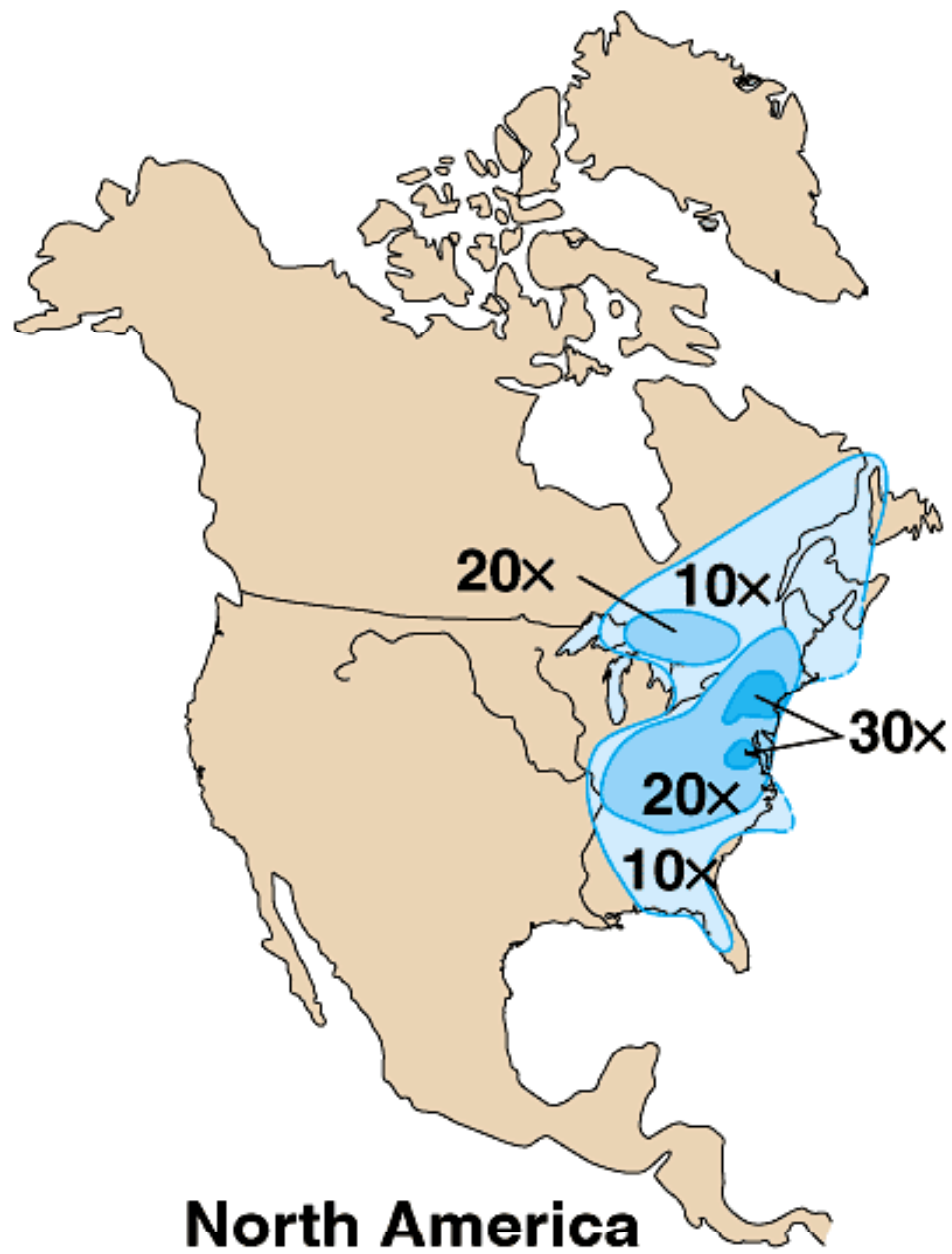
Οι εξωσκελετοί των  
μαλακίων δεν  
σκληραίνουν.

Ασπόνδυλα και  
πρώτιστα πεθαίνουν.

Μύκητες και φύκια  
αντικαθιστούν τα  
ανθοφόρα φυτά.

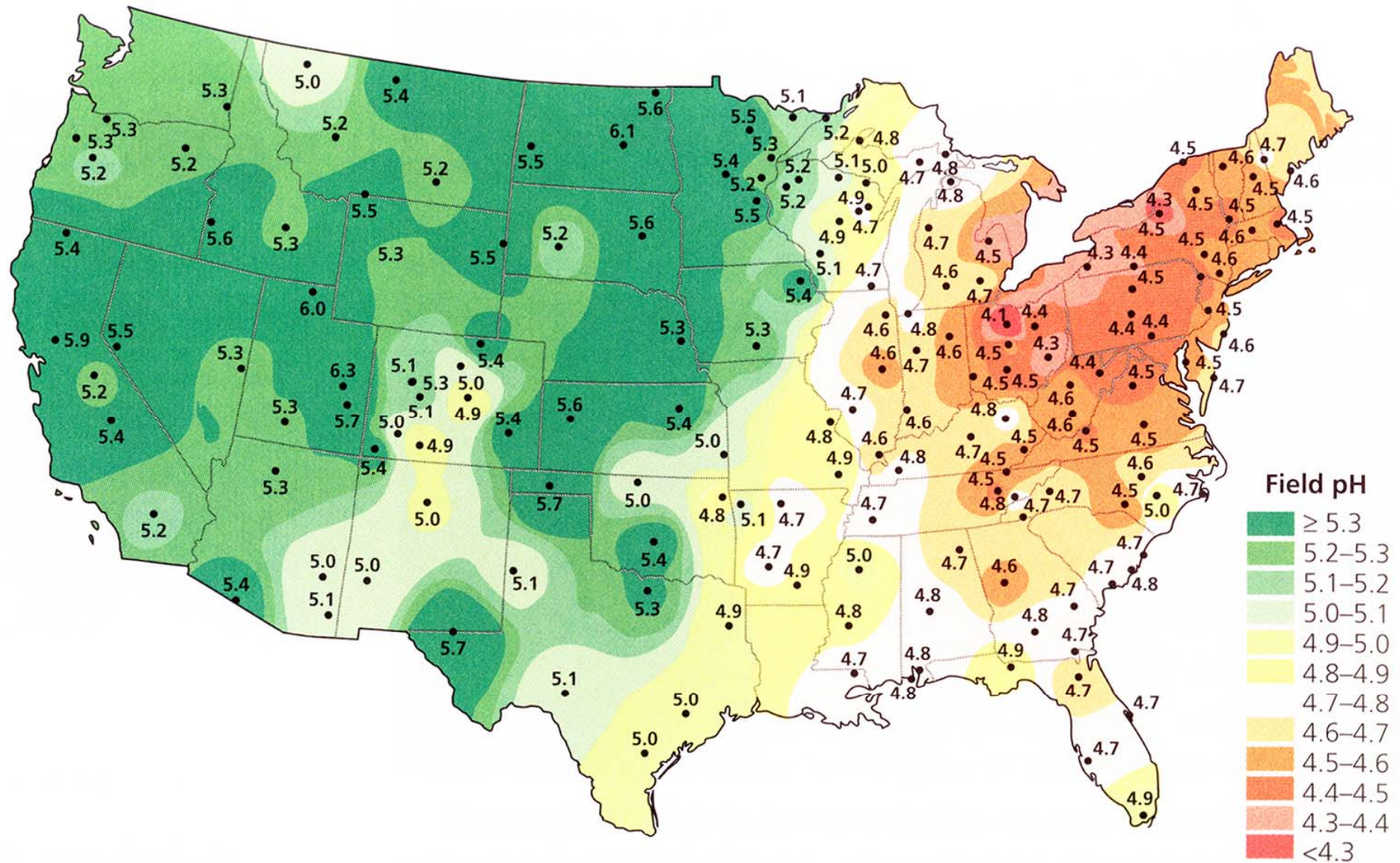
Πεθαίνουν οι πέστροφες  
και αυξάνουν τα ψάρια  
που είναι ανθεκτικά σε  
όξινα περιβάλλοντα.  
Διαταράσσεται η  
τροφική αλυσίδα.





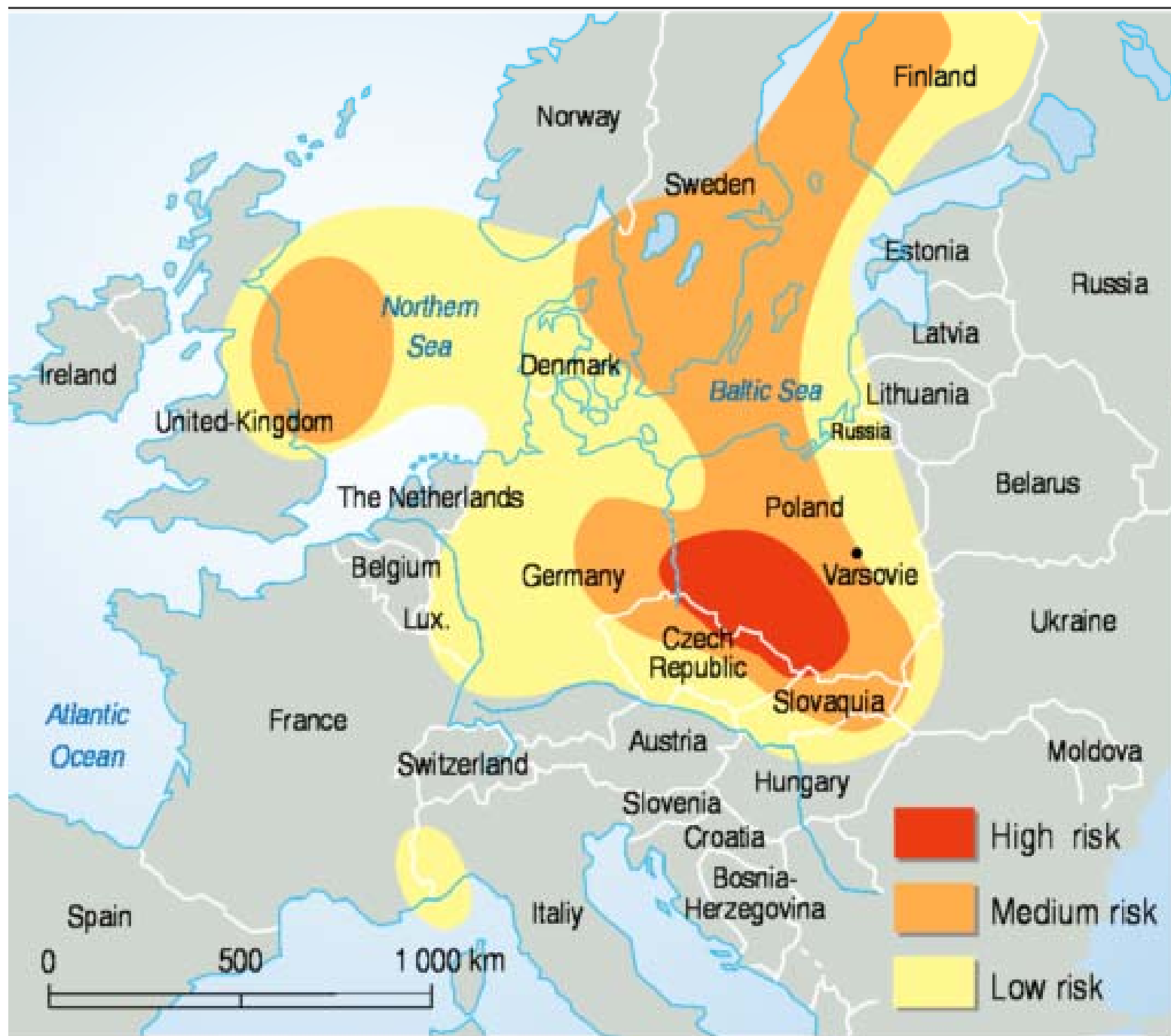
**(a)**

Στις ΗΠΑ από το 1993-2002 η εκπομπή  $SO_2$  μειώθηκε κατά 31%. Θα χρειαστούν ακόμη 20 χρόνια για να επανέλθει το οικοσύστημα



▲ **Figure 54.22** Average pH for precipitation in the contiguous United States in 2002.





Από το 1968, επιστήμονες προσθέτουν  $H_2SO_4$  στη λίμνη Manitoba (μια λίμνη 322 Km), μειώνοντας το pH από 6,8 στο 5.

Επηρεάστηκε η βιοποικιλότητα.

Η όξινη βροχή δεν φαίνεται να επηρεάζει την πρωτογενή παραγωγή και το ρυθμό αποικοδόμησης.



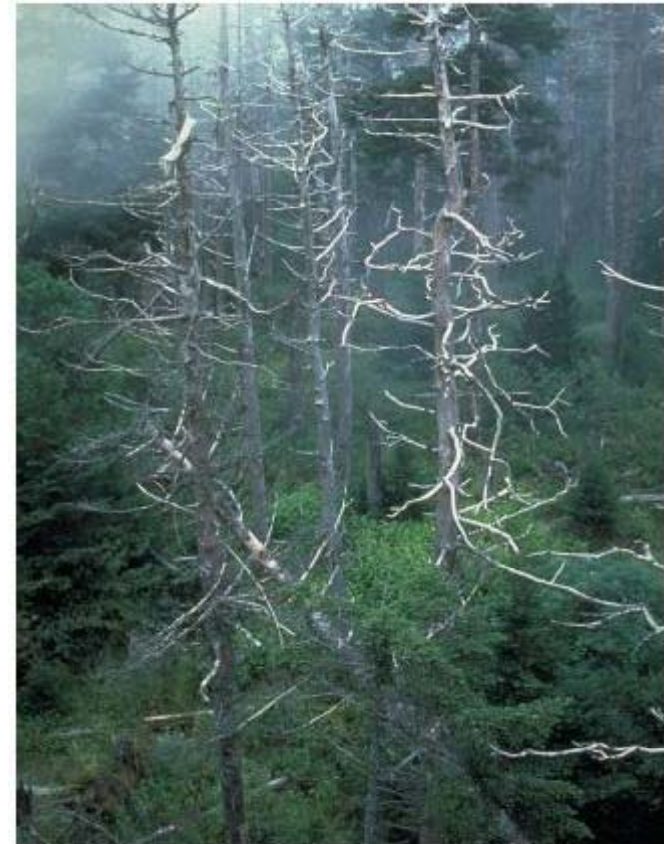
### Φυσικά γεγονότα μπορούν να αντισταθμίσουν την οξίνιση του περιβάλλοντος

- Προϊόντα του  $Ca^{2+}$  έχουν ρυθμιστικό αποτέλεσμα
- Βακτήρια σε πευκοβελόνες εξουδετερώνουν την όξινη βροχή
- Βρύα σε τυρφοειδή εδάφη γύρω από λίμνες απορροφούν και εξουδετερώνουν την όξινη βροχή
- Βαθιά στις λίμνες, βακτήρια καταβολίζουν τα προϊόντα N και S.

Η όξινη βροχή επηρεάζει και τα δάση (δάσος κωνοφόρων στο Fichtelgebirge στη Γερμανία):

- Το  $H_2SO_4$  και το  $HNO_3 \rightarrow pH < 5 \rightarrow$  τα ιόντα αλουμινίου ( $Al^{3+}$ ) και σιδήρου ( $Fe^{3+}$ ) διεισδύουν στις ρίζες και αντικαθιστούν θρεπτικά, όπως τα **ιόντα  $Ca^{2+}$**  (απαραίτητων για την αύξηση φύλλων, κλαδιών και κορμών) και τα **ιόντα  $Mg^{2+}$**  (συστατικό της χλωροφύλλης)  $\rightarrow$  παρεμποδίζεται η ανάπτυξη των δέντρων.

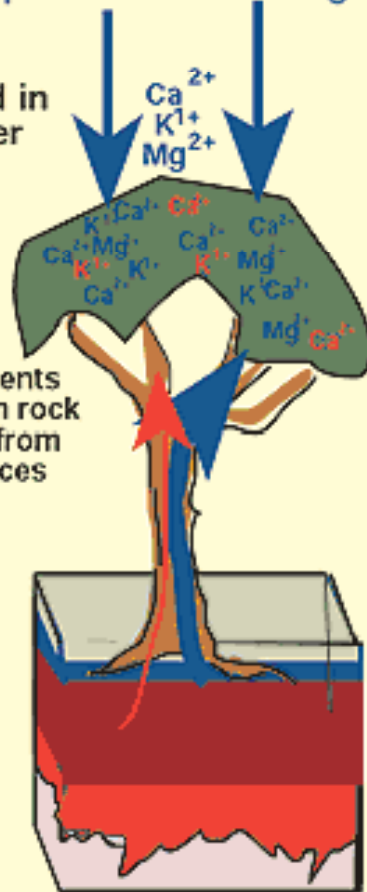
- Επιπλέον η συσσώρευση N από το  $HNO_3$  διεγείρει την αύξηση του δέντρου.  
 $\rightarrow$  Τα δύο αυτά αντικρουόμενα σήματα στρεσάρουν το φυτό και το καθιστούν ευάλωτο σε μολύνσεις ή στο να ανταποκριθεί σε ένα δριμύ χειμώνα.





**Chilean Forest:**  
The amount of precipitation derived elements leaving is equal to those arriving

Nutrients dissolved in precipitation enter



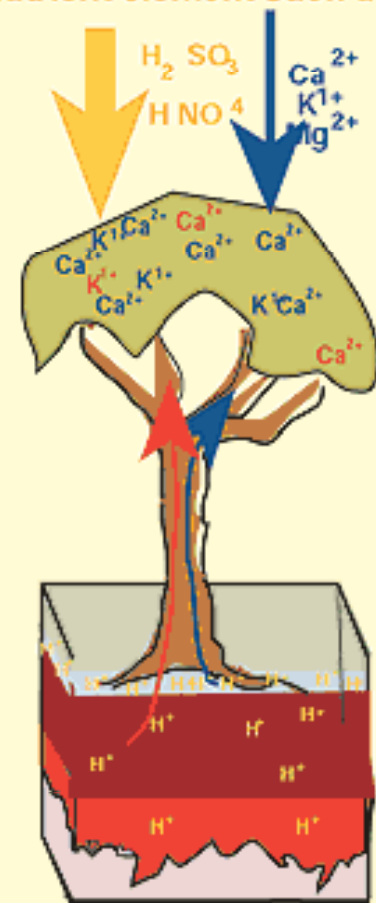
Tree takes up nutrients from soil, some from rock weathering, some from atmospheric sources

Blue=precipitation derived nutrients

Red=Rock derived nutrients

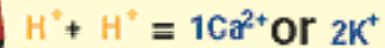
Nutrients exit to groundwater and streams

**Acid impacted forest:**  
Every  $H^+$  added to the soil by acid rain replaces an equivalent amount of a nutrient element such as K



Tree leaves become yellow as nutrients become scarce in the soil

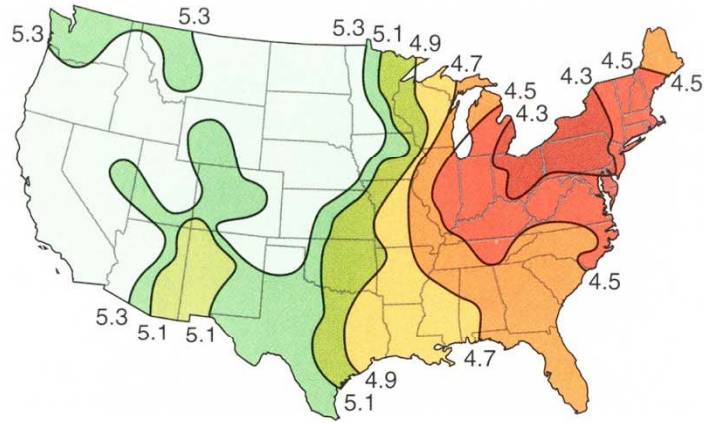
$H^+$  ions from acid replace the nutrient elements in the soil: for every unit of acid added to the soil, an equivalent amount of nutrient elements are removed



More nutrient elements are leached from the soil than arrive from weathering of rocks or precipitation; the forest goes into decline







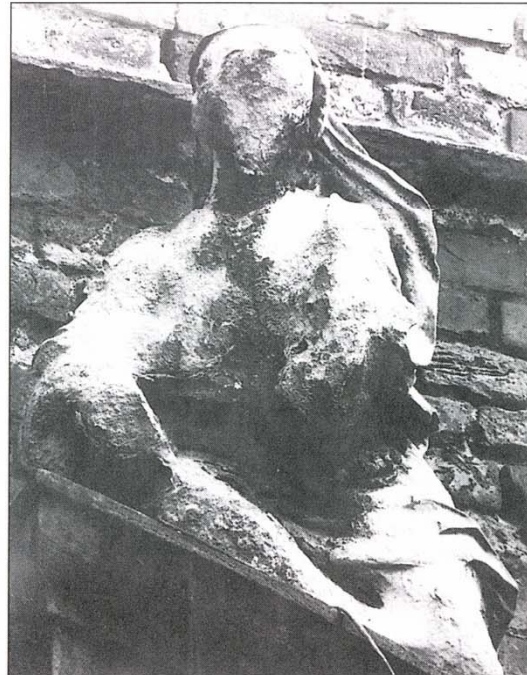
A



B



C 1908



1969

Westfälisches Amt für Denkmalpflege



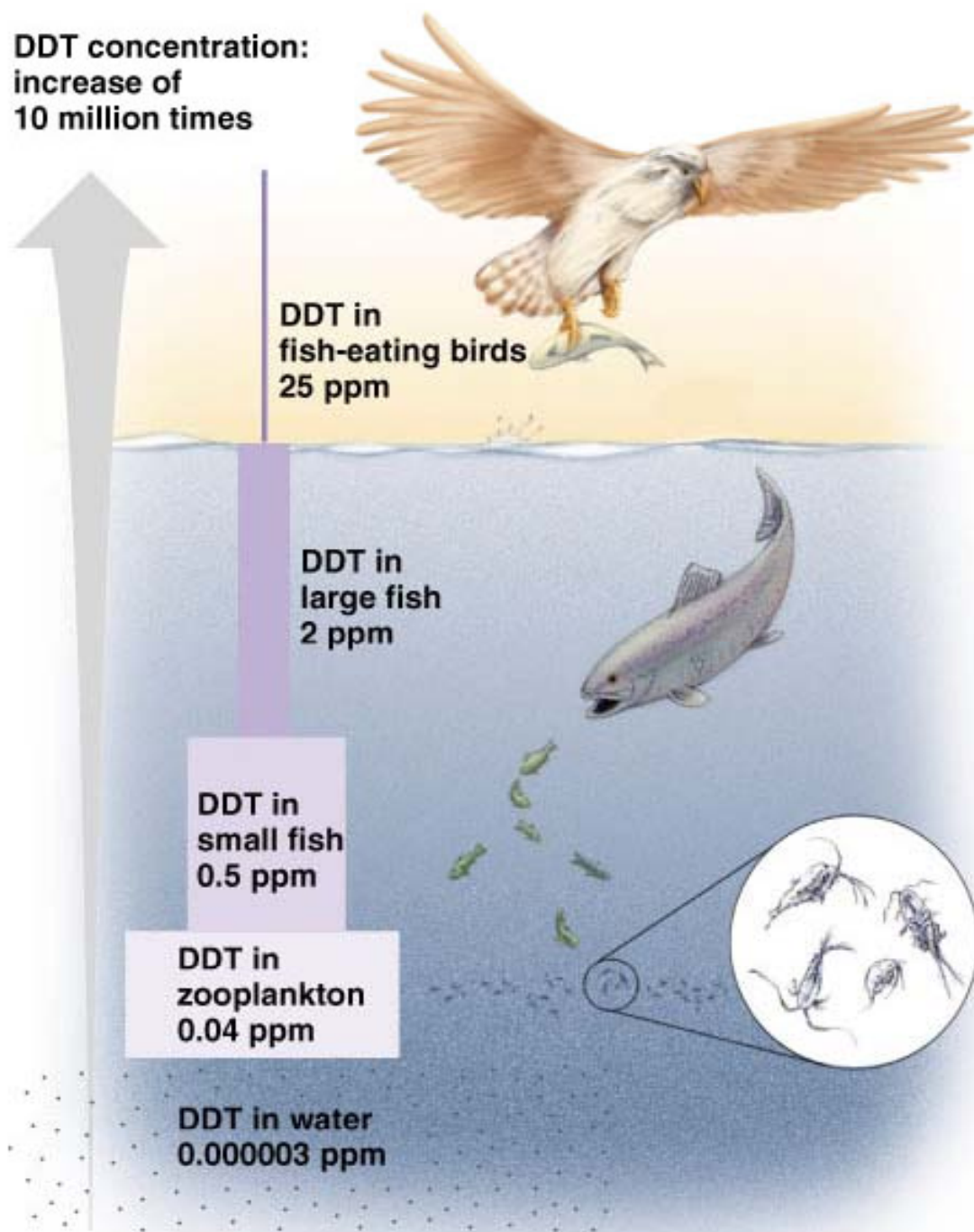
**FIGURE 45.3 Acid Deposition.** (A) In the United States, the average pH of precipitation drops in an eastward direction. Sulfur and nitrogen oxides from industry in the U.S. midwest cause the acid deposition in the East. (B) Brown conifer needles are an early sign of acidified soil. (C) Years of acid deposition have defaced this statue in Hertzen, Germany.

Source: Data from Thomas Graedel and Paul Crutzen, "Atmosphere, Climate and Change" in *Scientific American Library*, 1995.

## Τοξίνες στο περιβάλλον

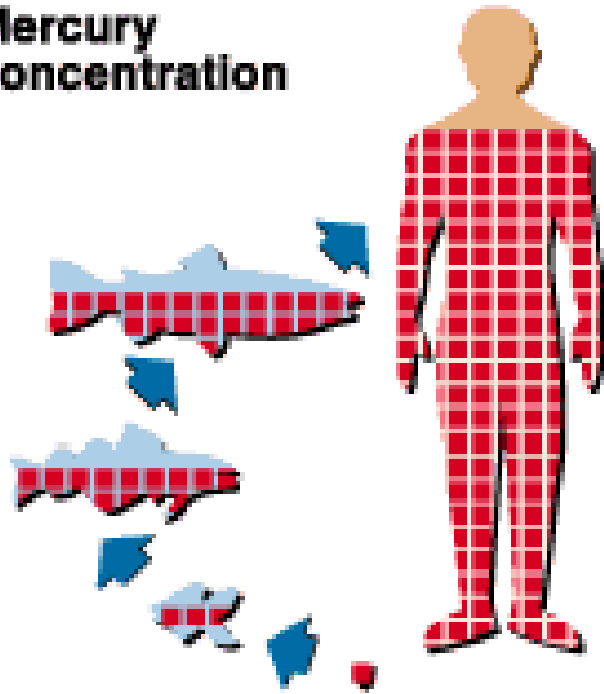
Οι τοξίνες αποθηκεύονται σε ειδικούς ιστούς, όπως ο λιπώδης.

Είναι επικίνδυνες γιατί αυξάνεται η συγκέντρωσή τους όσο ανεβαίνουμε σε τροφικό επίπεδο: βιολογική μεγέθυνση (biological magnification).





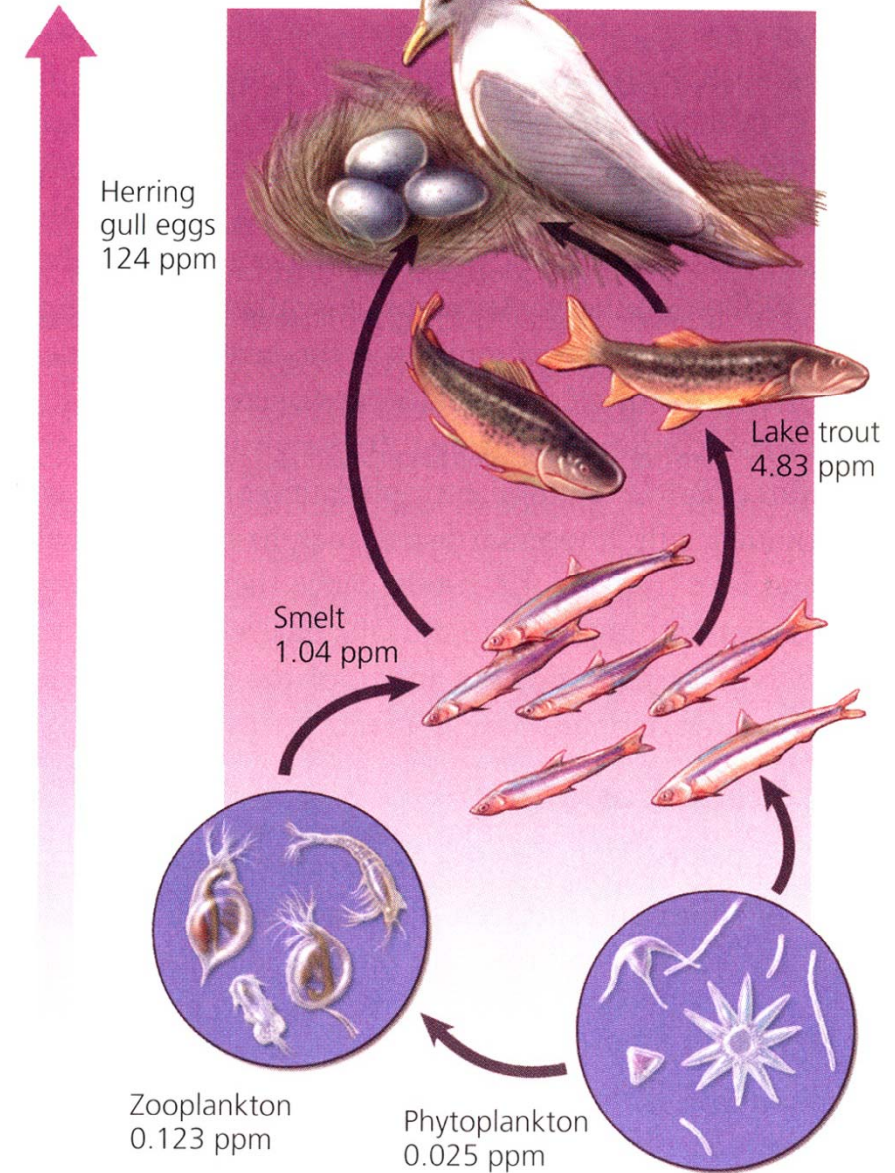
## Mercury concentration



Ο υδράργυρος προέρχεται από την παραγωγή πλαστικών και χύνεται στα ποτάμια σε αδιάλυτη μορφή. Εκεί τα βακτήρια τον μετατρέπουν σε μεθυλιωμένο παράγωγο, εξαιρετικά τοξικό και διαλυτό που συσσωρεύεται στους ιστούς.

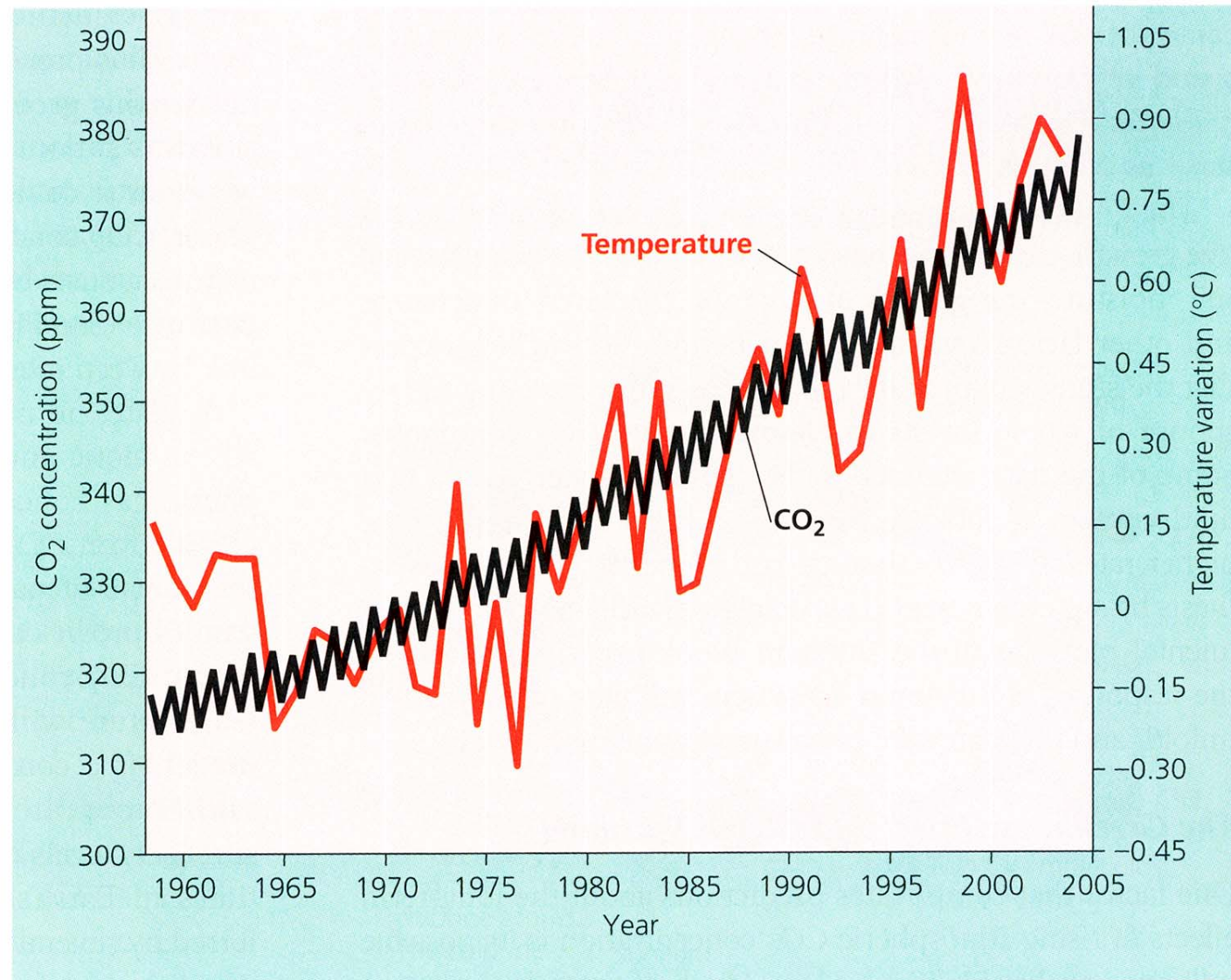
Εμποδίζει την απόθεση  $\text{Ca}^{2+}$  στα αυγά

Πολυχλωριωμένα διφαινύλια (PCBs)



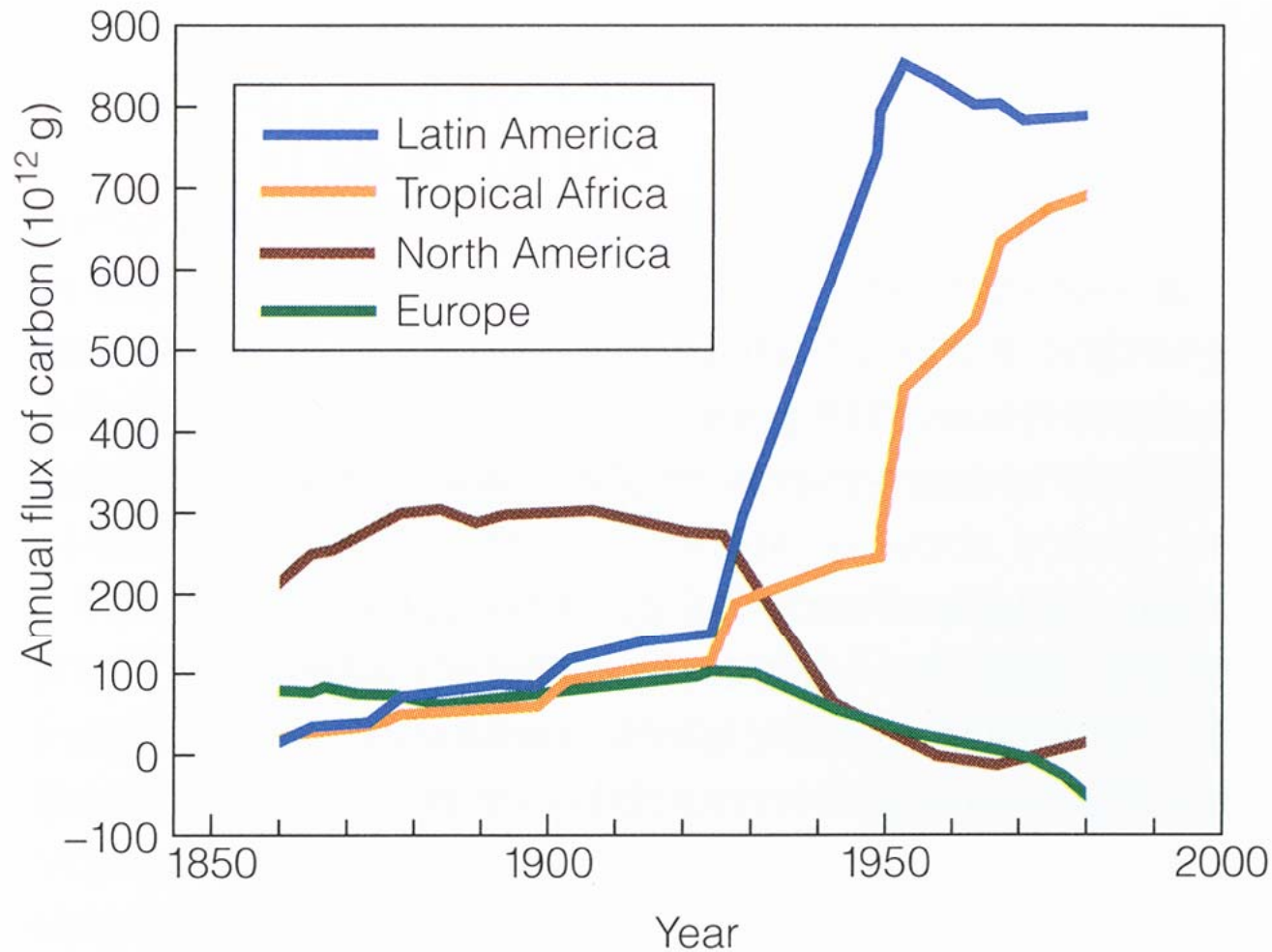
▲ **Figure 54.23** Biological magnification of PCBs in a Great Lakes food web.

Ατμοσφαιρικό CO<sub>2</sub>  
και αύξηση της  
Θερμοκρασίας του  
περιβάλλοντος



▲ **Figure 54.24** The increase in atmospheric carbon dioxide at Mauna Loa, Hawaii, and average global temperatures over land from 1958 to 2004. Aside from normal seasonal fluctuations, the total amount of CO<sub>2</sub> has increased steadily (black). Though average global land temperatures over the same period fluctuate a great deal (red), there is a warming trend.





(b)

**Figure 29.4** | Historical record of annual input of  $\text{CO}_2$  to the atmosphere from the clearing and burning of forest (a) globally and (b) in selected geographic regions: Latin America, Tropical Africa, North America, and Europe. (Adapted from Houghton 1997.)



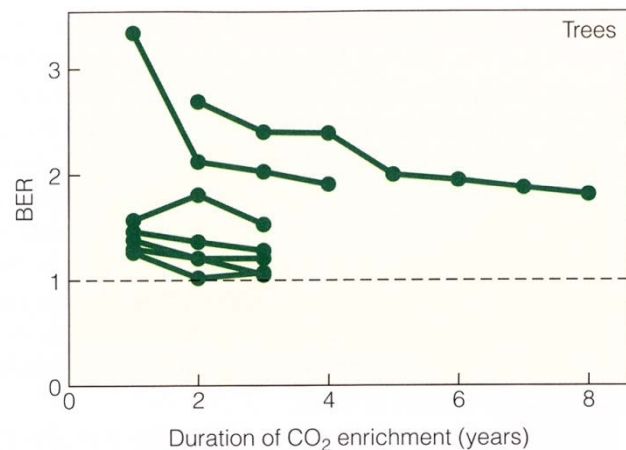
## Ατμοσφαιρικό CO<sub>2</sub>

↑ CO<sub>2</sub>

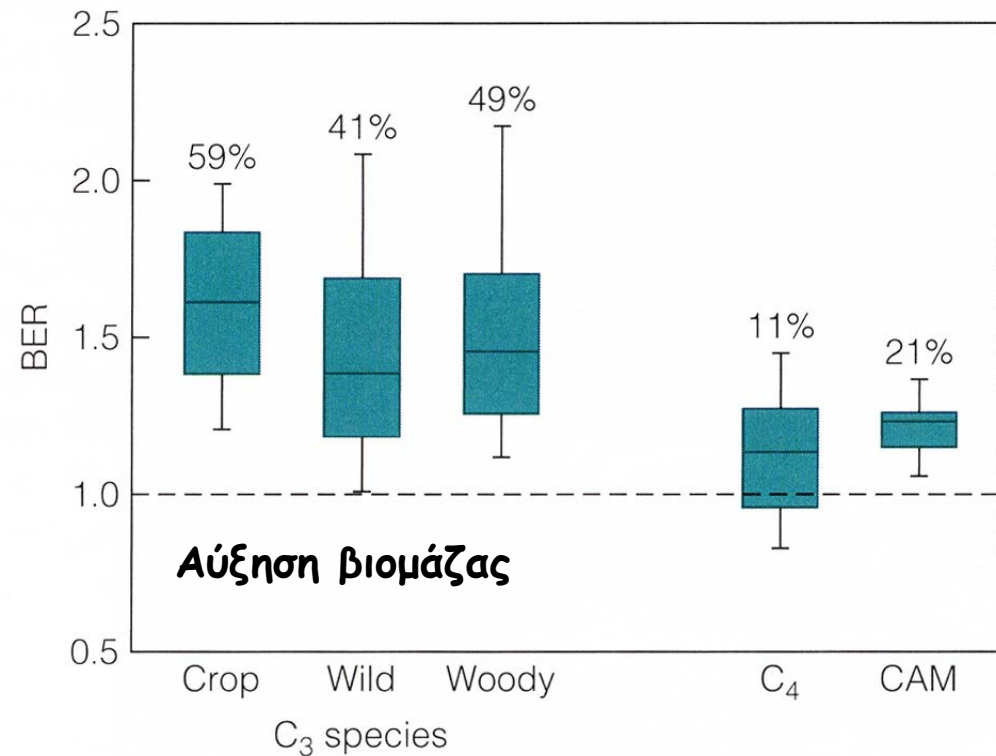
↑ βλάστησης

↑ C<sub>3</sub> φυτών (σιτάρι, σόγια) εις βάρος των C<sub>4</sub> (καλαμπόκι)

Η αύξηση αυτή αντισταθμίζεται με το χρόνο



**Figure 29.8** | Time course of biomass enhancement ratio (BER) due to elevated CO<sub>2</sub>. BER is the ratio of biomass growth at elevated and ambient levels of CO<sub>2</sub>. Each line represents the results of an experiment with a different tree species. (Adapted from Poorter and Pérez-Soba 2002.)



**Figure 29.7** | Distribution of biomass enhancement ratio (BER) for several functional types of species. BER is the ratio of biomass growth at elevated and ambient levels of CO<sub>2</sub>. Distributions are based on 280 C<sub>3</sub>, 30 C<sub>4</sub>, and 6 CAM species. C<sub>3</sub> species were separated into three groups: crop, wild herbaceous, and woody species. Boxes indicate the distribution of the range of observation. Line represents median value, lower box 25th percentile, and upper box 75th percentile. Error bars give 10th and 90th percentile. (Adapted from Poorter and Pérez-Soba 2002.)



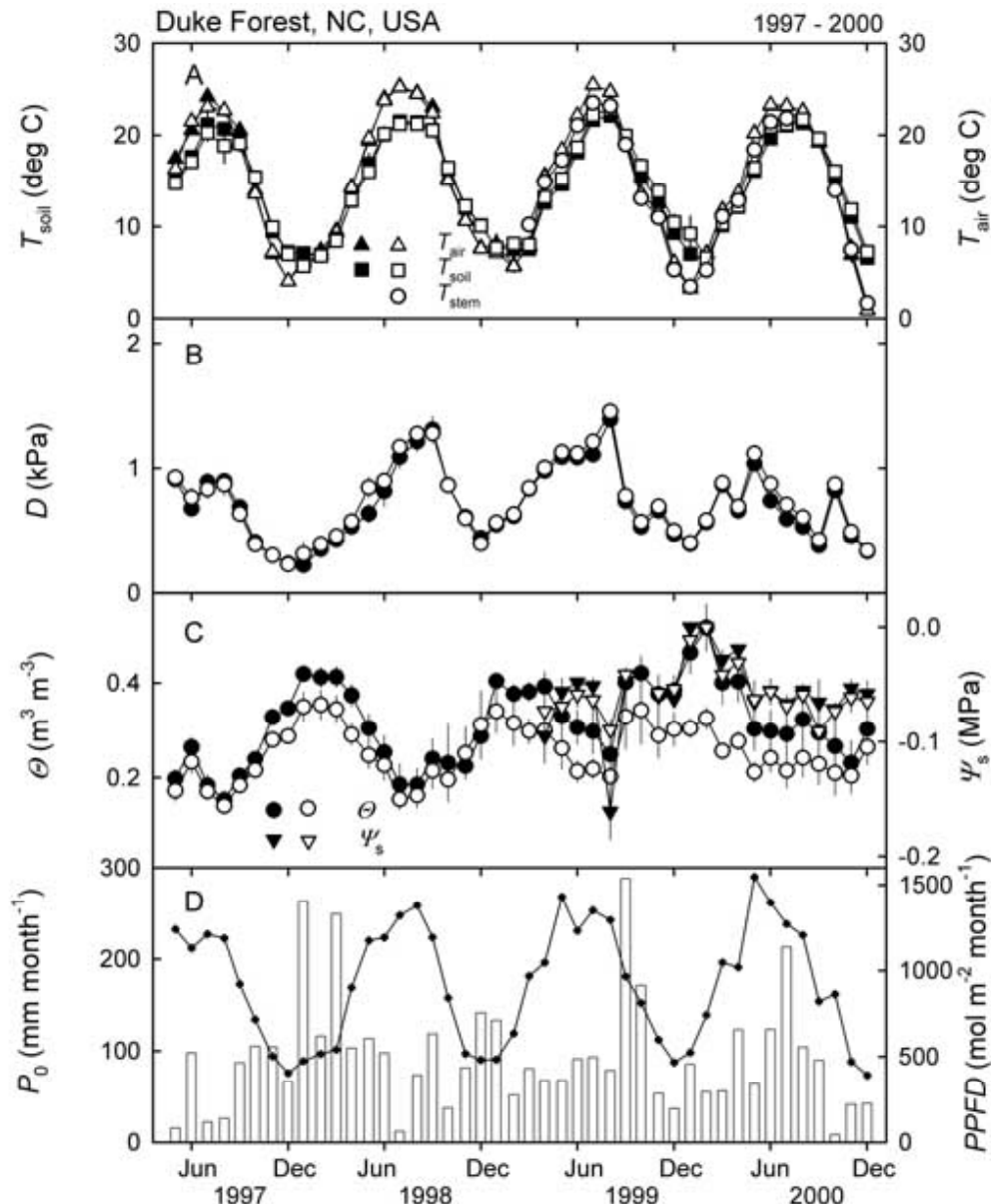
Πώς η αύξηση του  $CO_2$   
επηρεάζει την οικολογία των  
δασών.

Το πείραμα FACTS-I.  
(Forest-Atmosphere Carbon  
Transfer and Storage)



▲ **Figure 54.25** Large-scale experiment on the effects of elevated  $CO_2$ . Rings of towers in the Duke University Experimental Forest emit enough carbon dioxide to raise and maintain  $CO_2$  levels 200 ppm above present-day concentrations.





A) Monthly average soil temperature ( $T_{soil}$ , squares), air temperature ( $T_{air}$ , triangles) and stem temperature ( $T_{stem}$ , circles) for ambient and elevated  $CO_2$  plots, B) monthly daytime averaged vapor pressure deficit ( $D$ ), C) monthly averaged volumetric soil moisture content ( $\theta$ , circles) and soil water potential ( $\psi_s$ , triangles), D) monthly summed precipitation ( $P_0$ , open bars) and monthly sum of photosynthetic photon flux density  $PPFD$  (dots). Open symbols denote ambient and solid symbols elevated atmospheric  $CO_2$  conditions (when solid symbols are not seen they are hidden behind open symbols). Vertical bars represent one s.e. ( $n=3$ ).



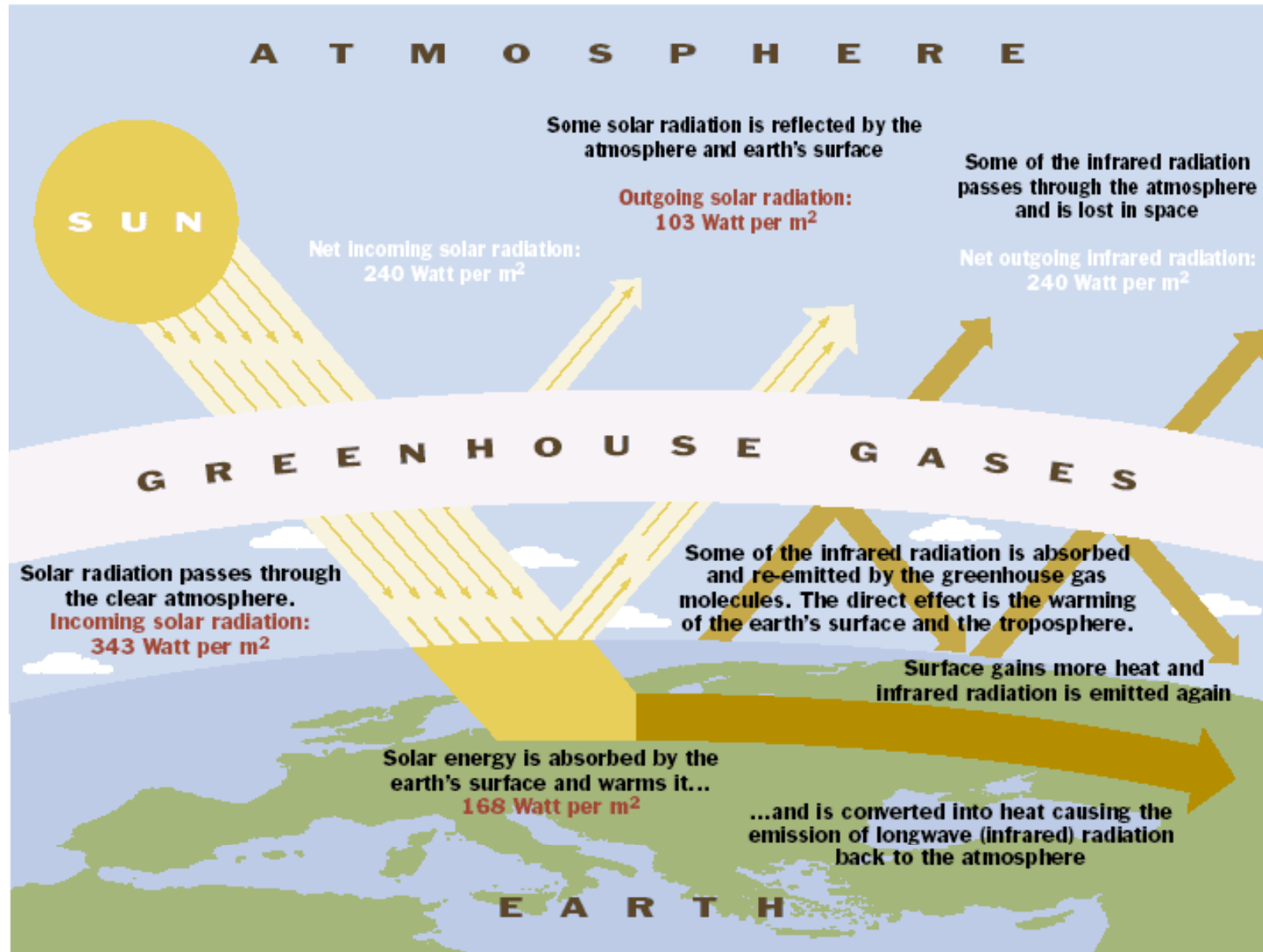
## Duke experimental forest

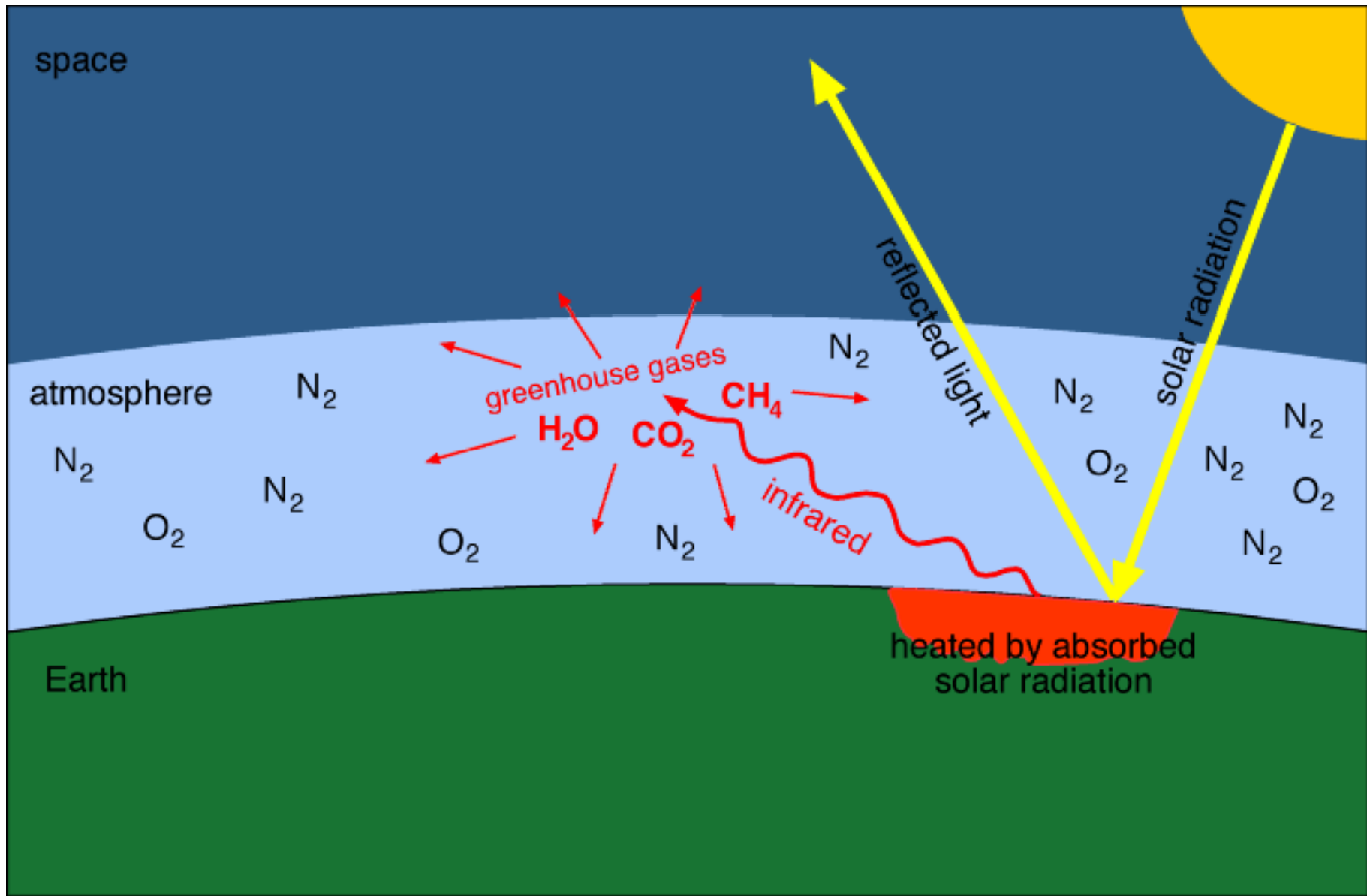
1. 14% αύξηση της βιομάζας
2. Μεγαλύτερο βάρος και περιεκτικότητα λιπιδίων στους σπόρους των πεύκων
3. Υψηλότεροι ρυθμοί φωτοσύνθεσης
4. Υψηλότερος ρυθμός διάβρωσης του εδάφους



The

# Greenhouse Effect





## The main greenhouse gases

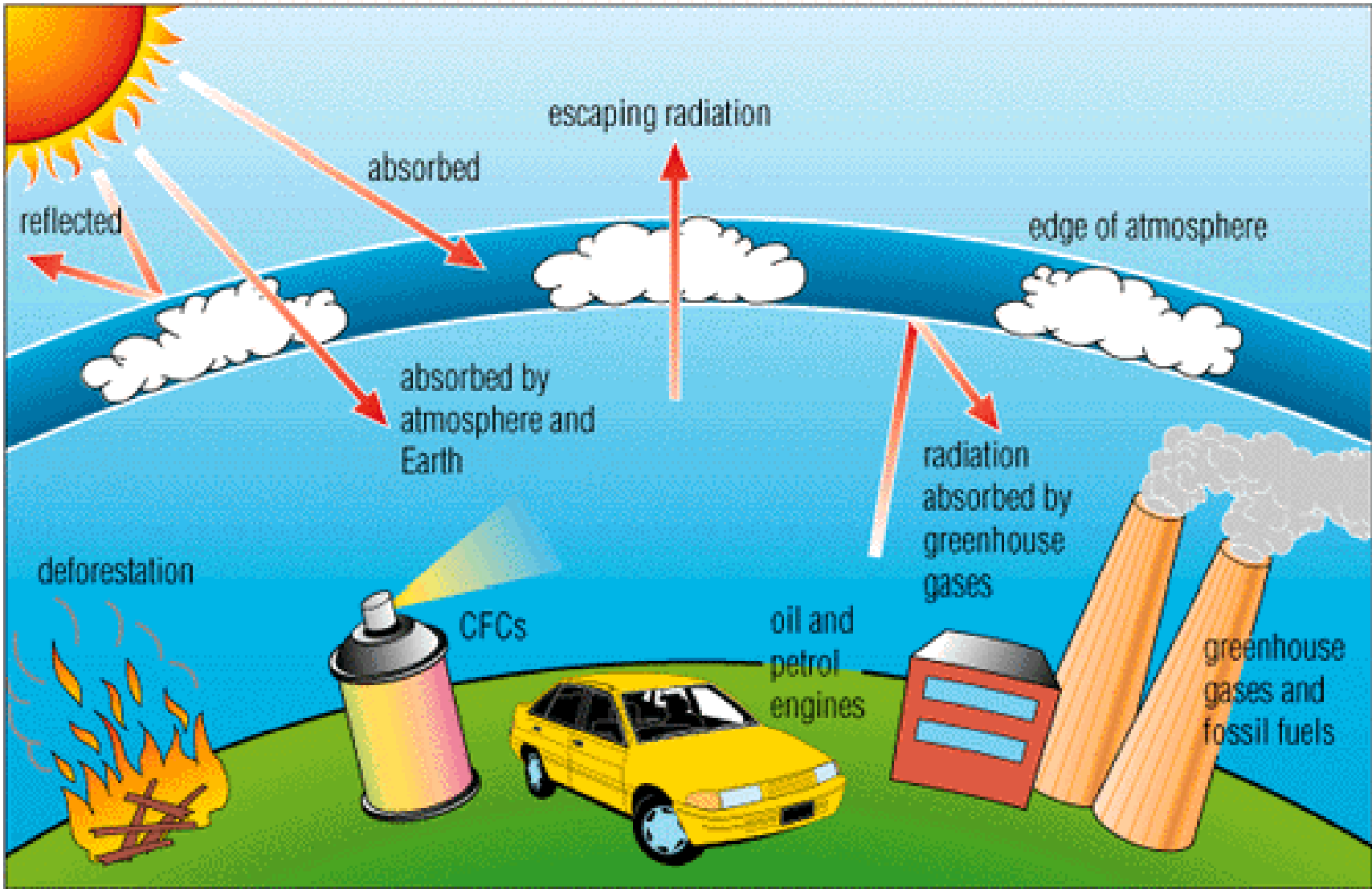
Greenhouse gases	Chemical formula	Pre-Industrial concentration	Concentration in 1994	Atmospheric lifetime (years) <sup>***</sup>	Anthropogenic sources	Global warming potential (GWP) <sup>*</sup>
Carbon-dioxide	CO <sub>2</sub>	278 000 ppbv	358 000 ppbv	Variable	Fossil fuel combustion Land use conversion Cement production	1
Methane	CH <sub>4</sub>	700 ppbv	1721 ppbv	12,2 +/- 3	Fossil fuels Rice paddies Waste dumps Livestock	21 <sup>**</sup>
Nitrous oxide	N <sub>2</sub> O	275 ppbv	311 ppbv	120	Fertilizer industrial processes combustion	310
CFC-12	CCl <sub>2</sub> F <sub>2</sub>	0	0,503 ppbv	102	Liquid coolants. Foams	6200-7100 <sup>****</sup>
HCFC-22	CHClF <sub>2</sub>	0	0,105 ppbv	12,1	Liquid coolants	1300-1400 <sup>****</sup>
Perfluoromethane	CF <sub>4</sub>	0	0,070 ppbv	50 000	Production of aluminium	6 500
Sulphur hexa-fluoride	SF <sub>6</sub>	0	0,032 ppbv	3 200	Dielectric fluid	23 900

Note : pptv= 1 part per trillion by volume; ppbv= 1 part per billion by volume, ppm v= 1 part per million by volume

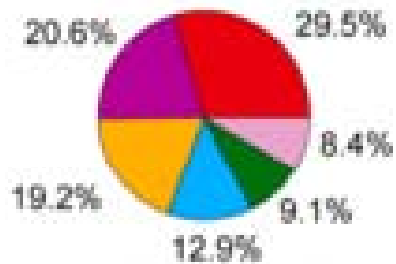
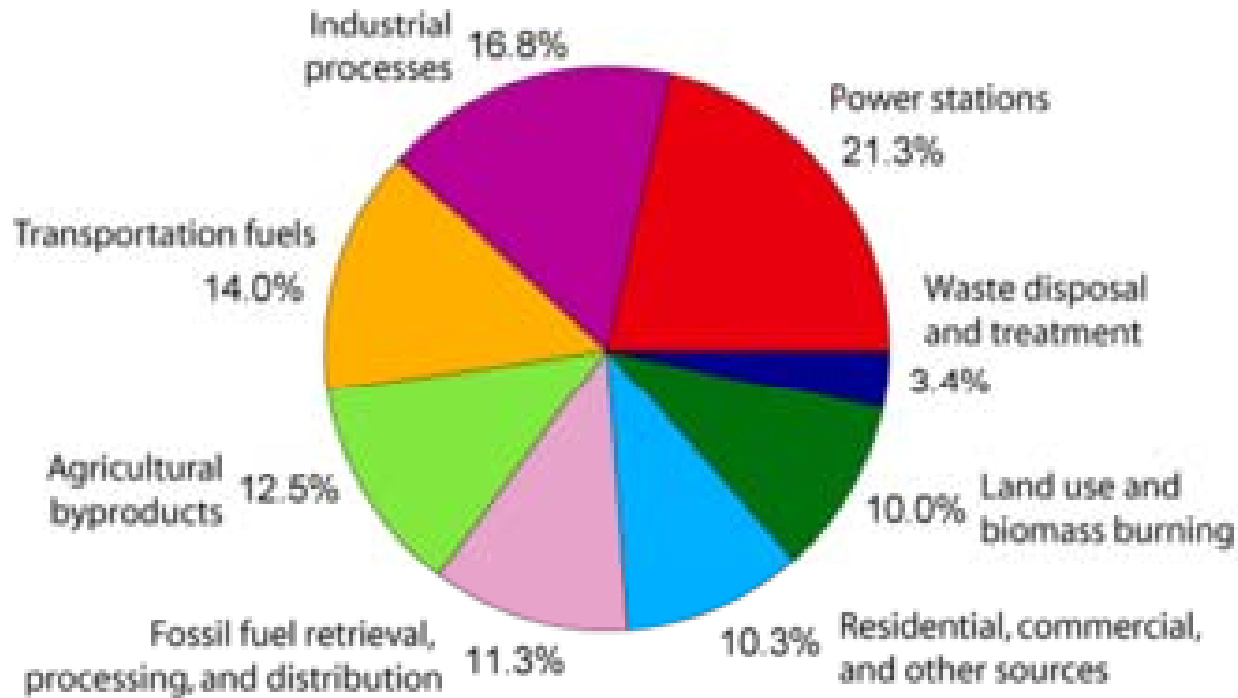
\* GWP for 100 year time horizon. \*\* Includes indirect effects of tropospheric ozone production and stratospheric water vapour production. \*\*\* On page 15 of the IPCC SAR. No single lifetime for CO<sub>2</sub> can be defined because of the different rates of uptake by different sink processes. \*\*\*\* Net global warming potential (i.e., including the indirect effect due to ozone depletion).



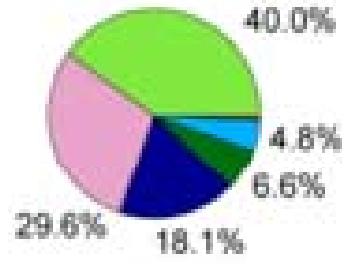




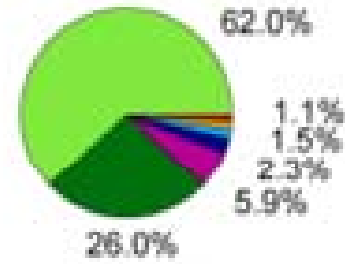
# Annual Greenhouse Gas Emissions by Sector



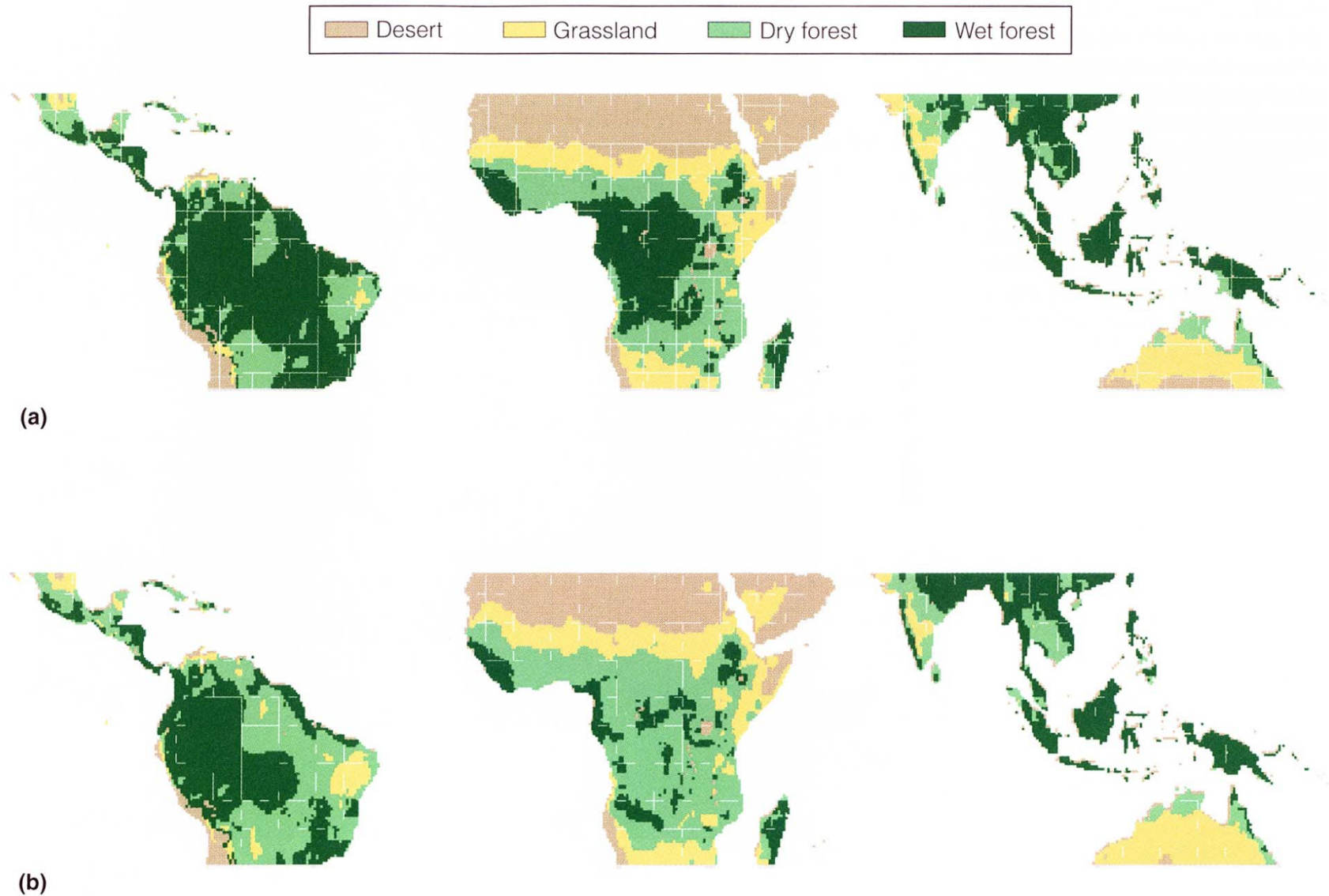
**Carbon Dioxide**  
(72% of total)



**Methane**  
(18% of total)



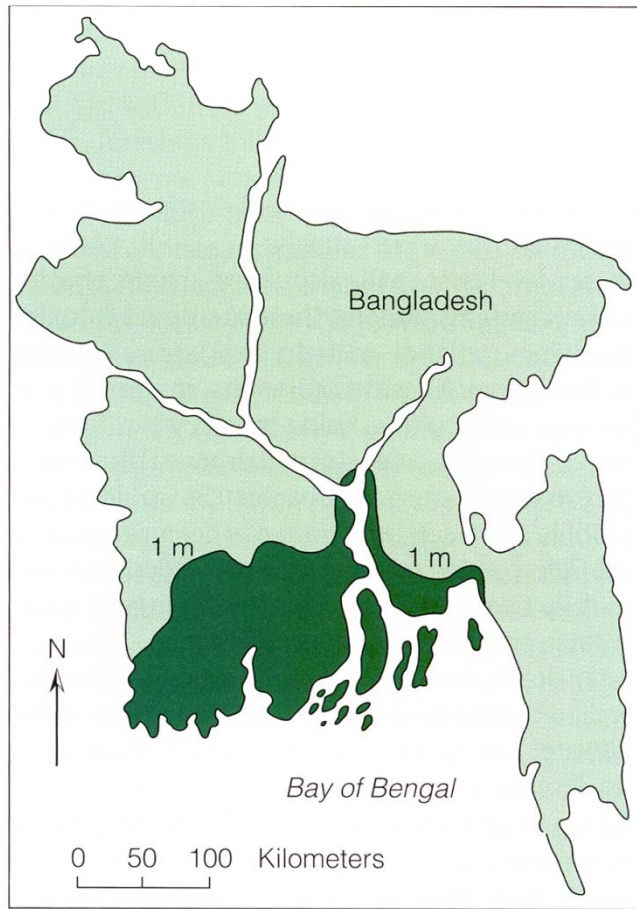
**Nitrous Oxide**  
(9% of total)



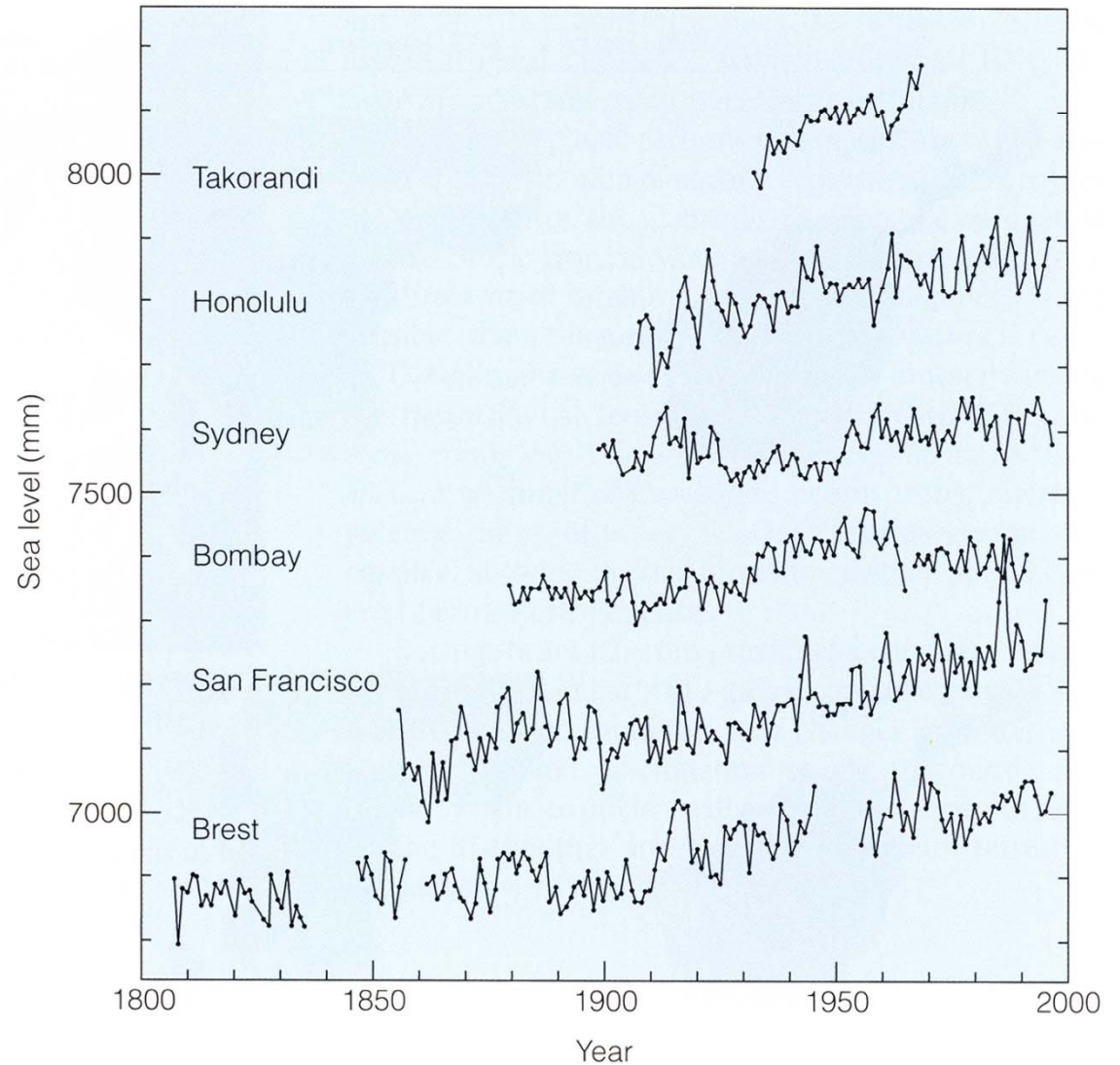
**Figure 29.20** | Maps of the areas in the tropical zone that could possibly support rain forest ecosystems as predicted by the Holdridge biogeographical model of ecosystem distribution. Map **(a)** is the area of tropical rain forest under current climate conditions, and **(b)** is the predicted area under changed climate conditions predicted by the United Kingdom Meteorological Office general circulation model for a doubled atmospheric  $\text{CO}_2$  concentration. (Adapted from Smith et al. 1992.)



**Figure 29.21** | Long-term sea level records from six coastal regions of the world: Takorandi (Africa), Honolulu (Hawaii), Sydney (Australia), Bombay (Asia), San Francisco (North America), and Brest (Europe). (Adapted from Houghton et al. 1996.)

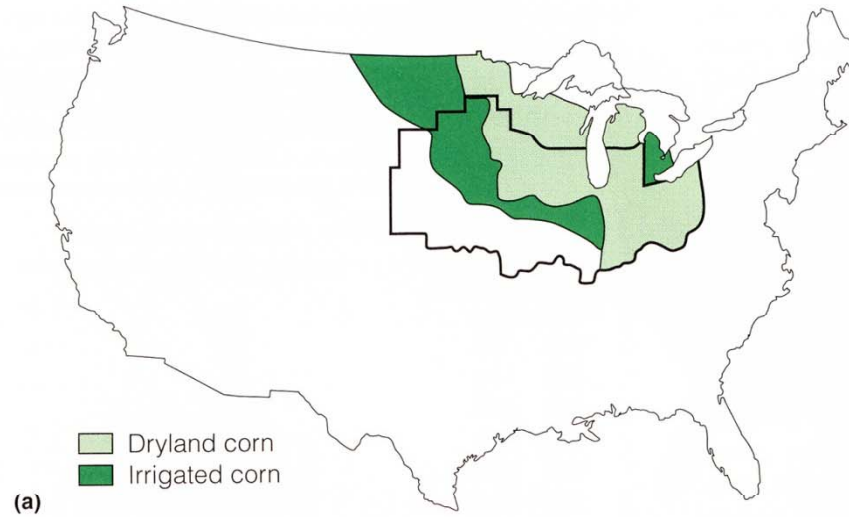


**Figure 29.22** | Land area in Bangladesh that would be submerged (dark green area of map) if sea level rose by 1 m. (Adapted from Nicholls and Leatherman 1995.)

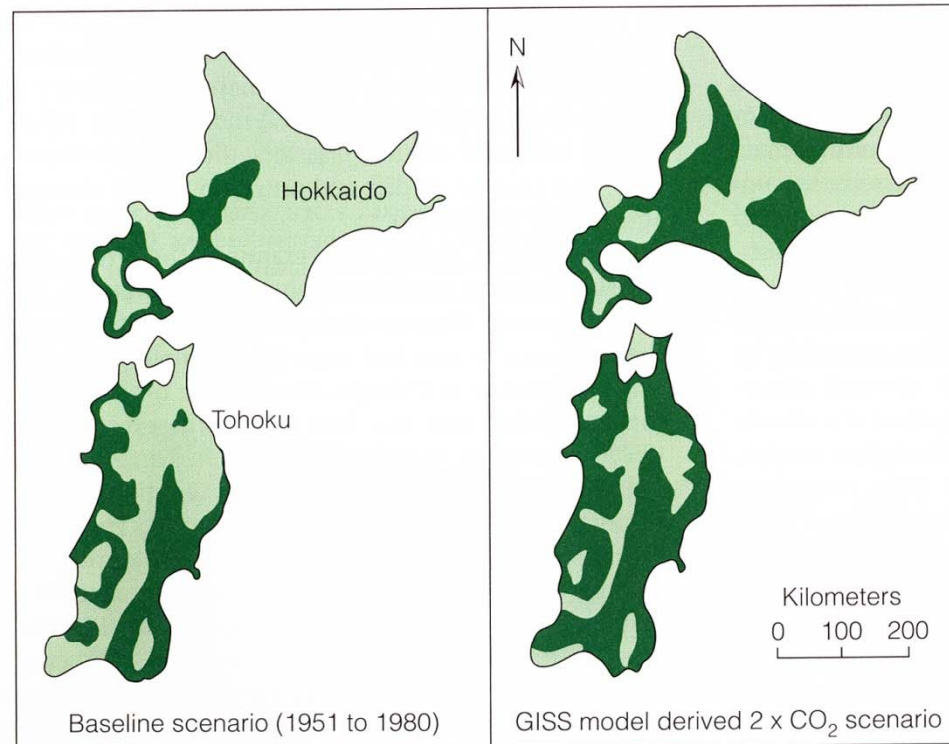


Η αύξηση της θερμοκρασίας θα επηρεάσει τη στάθμη της θάλασσας

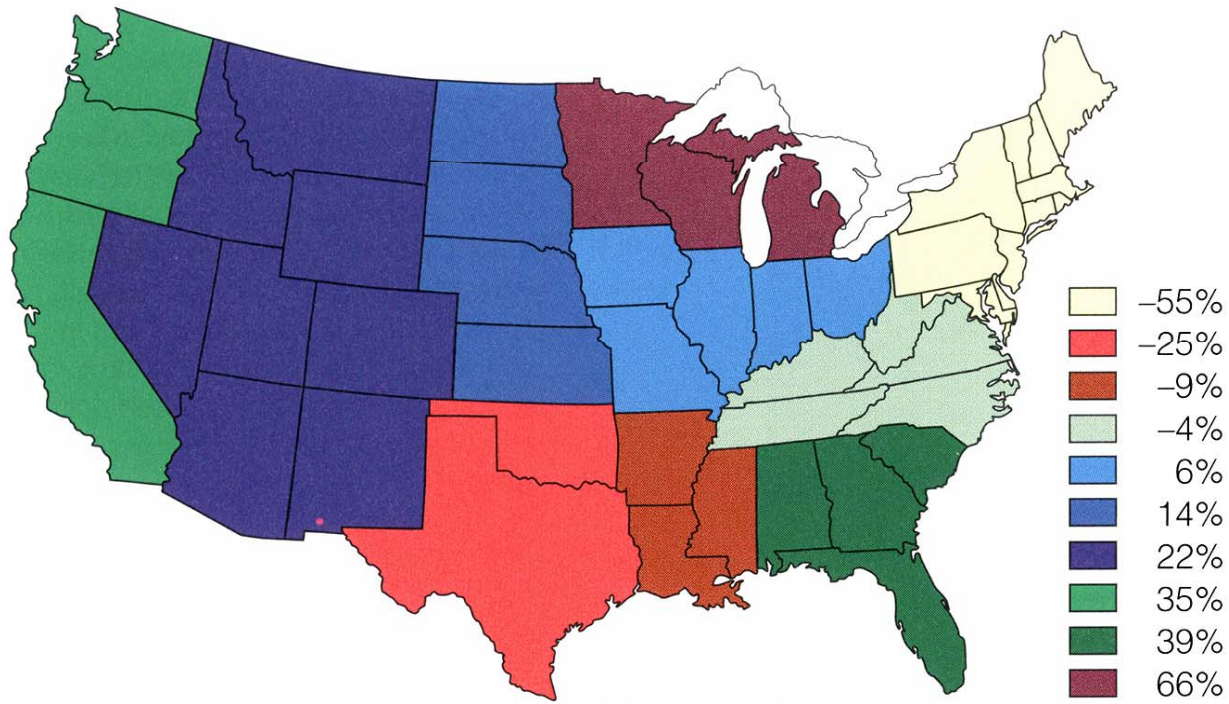
# Η αλλαγή κλίματος μπορεί να επηρεάσει και τις καλλιέργειες



**Figure 29.23** | Regional shifts in areas suitable for crop production under a changed climate as predicted by the Goddard Institute for Space Studies GCM: **(a)** shift in the region suitable for corn production in the United States (Adapted from Blasing and Solomon 1983.); **(b)** shift in areas suitable for irrigated rice production in northern Japan. The areas in dark green are suitable for irrigated rice production. (Adapted from Yoshino et al. 1988.)



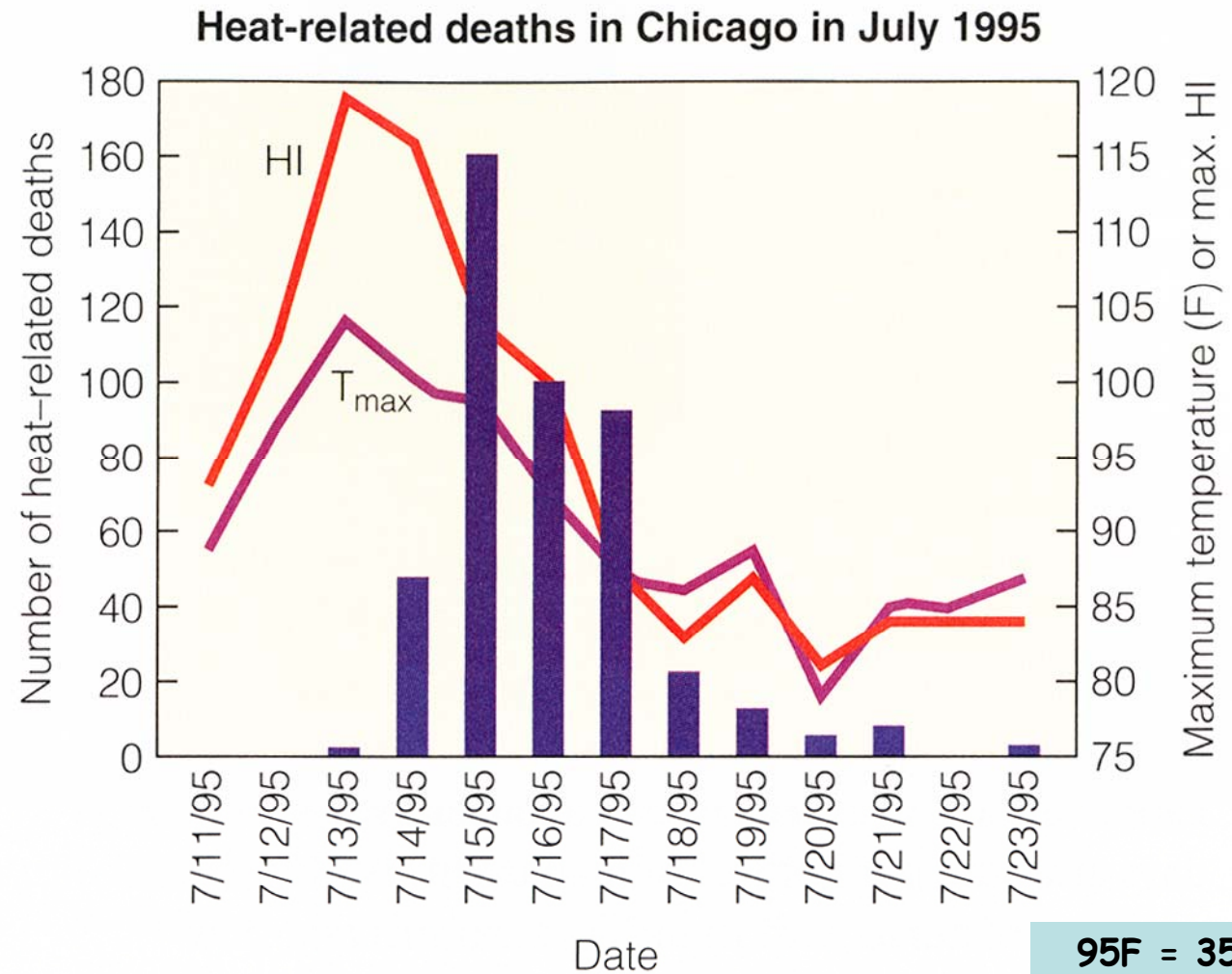
**(b)**



**Figure 29.24** | Changes in regional crop production by year 2060 for the United States under a climate change as predicted by the Goddard Institute for Space Studies GCM (assuming an average 3°C increase in temperature, 7 percent increase in precipitation, and 530 ppm CO<sub>2</sub>). (Adapted from Adams et al. 1995.)

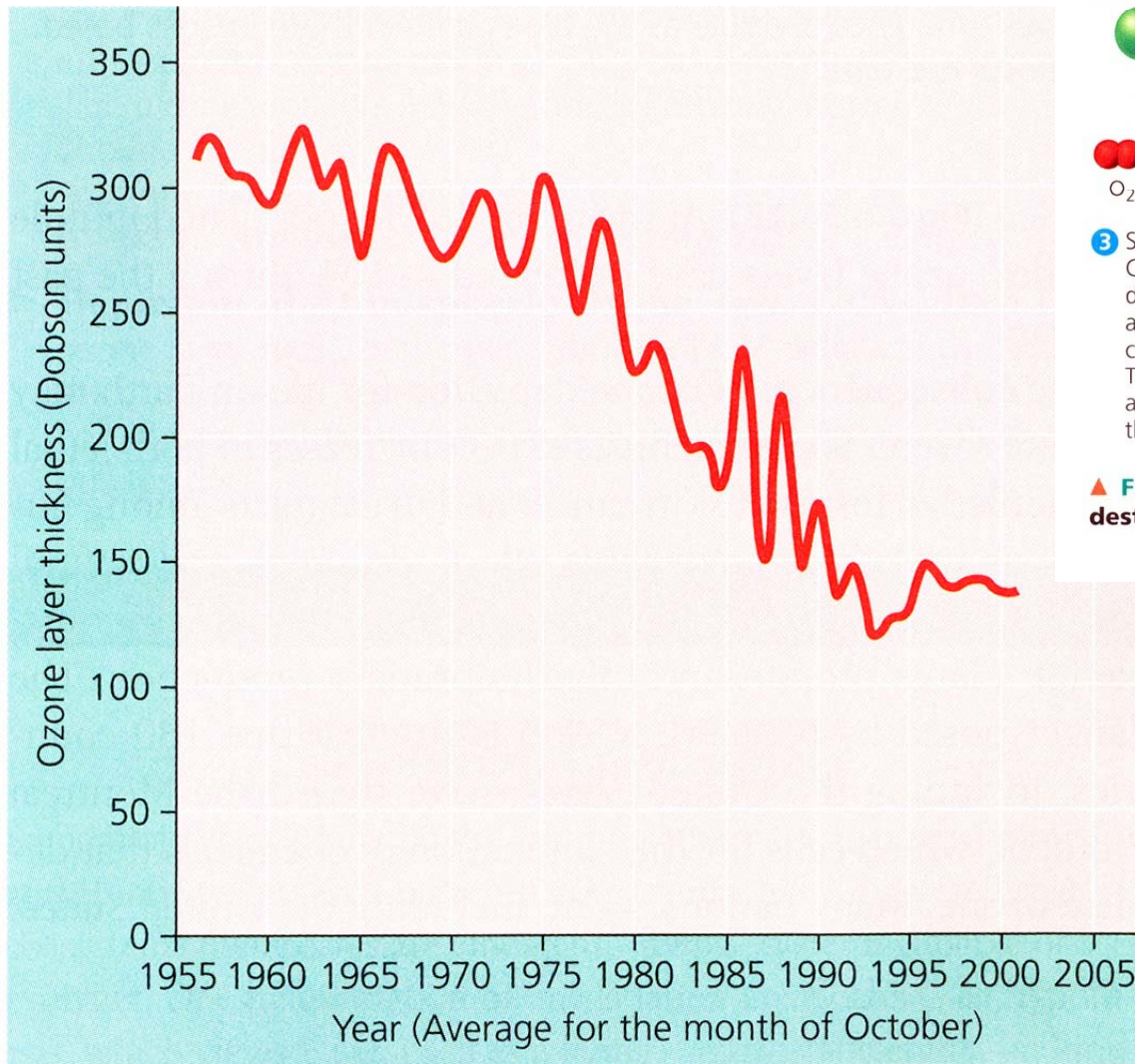


Η αύξηση της θερμοκρασίας μπορεί να επηρεάσει και την ανθρώπινη υγεία

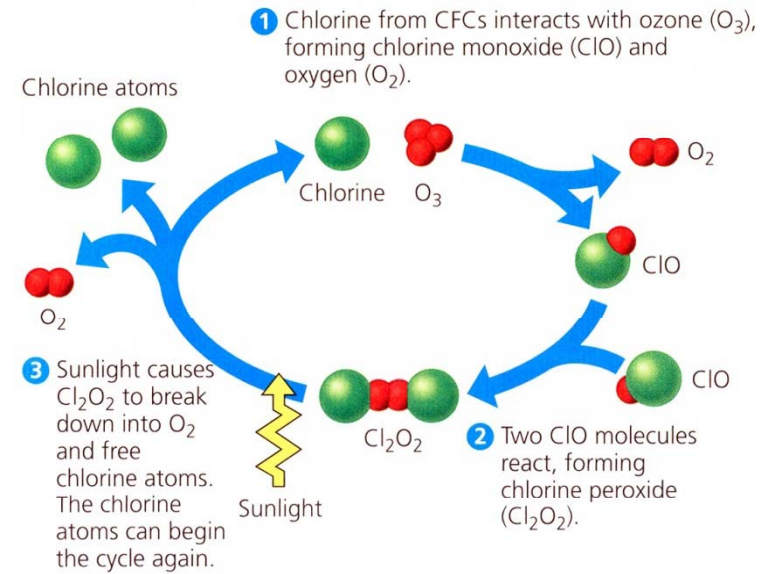


**Figure 29.25** This graph tracks maximum temperature ( $T_{\max}$ ), heat index (HI), and heat-related deaths in Chicago each day from July 11 to 23, 1995. The maroon line shows maximum daily temperature, the red line shows the heat index, and the bars indicate number of deaths for the day. (Adapted from NOAA/NCDC.)

# Ελάττωση του ατμοσφαιρικού όζοντος

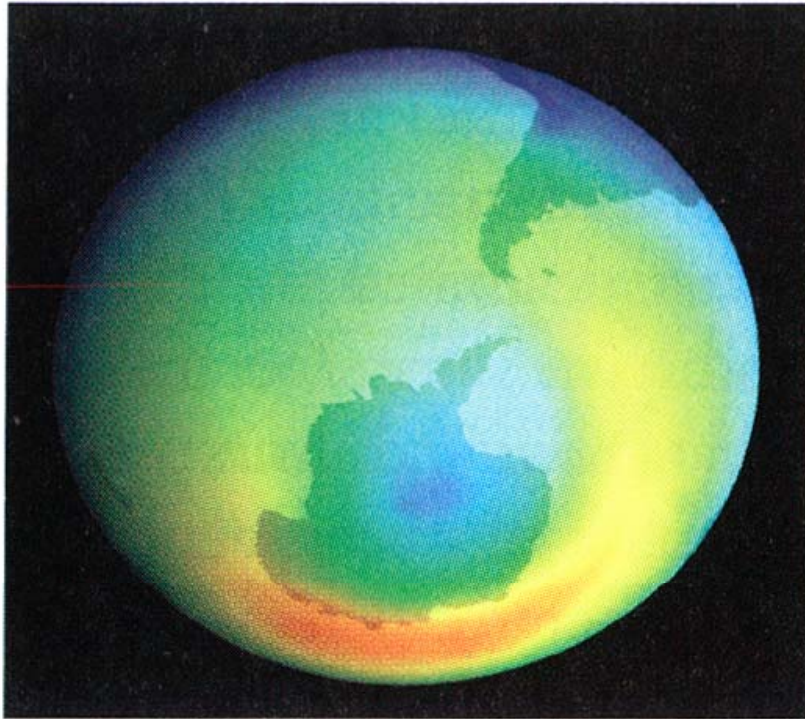


▲ **Figure 54.26** Thickness of the ozone layer over Antarctica in units called Dobsons.

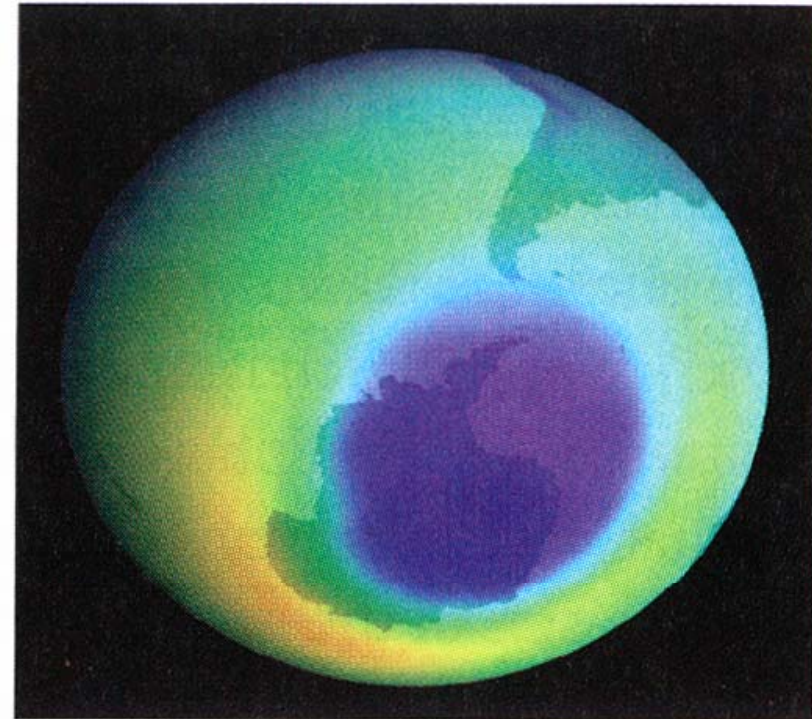


▲ **Figure 54.27** How free chlorine in the atmosphere destroys ozone.





(a) October 1979



(b) October 2000

▲ **Figure 54.28 Erosion of Earth's ozone shield.** The ozone hole over Antarctica is visible as the blue patch in these images based on atmospheric data.



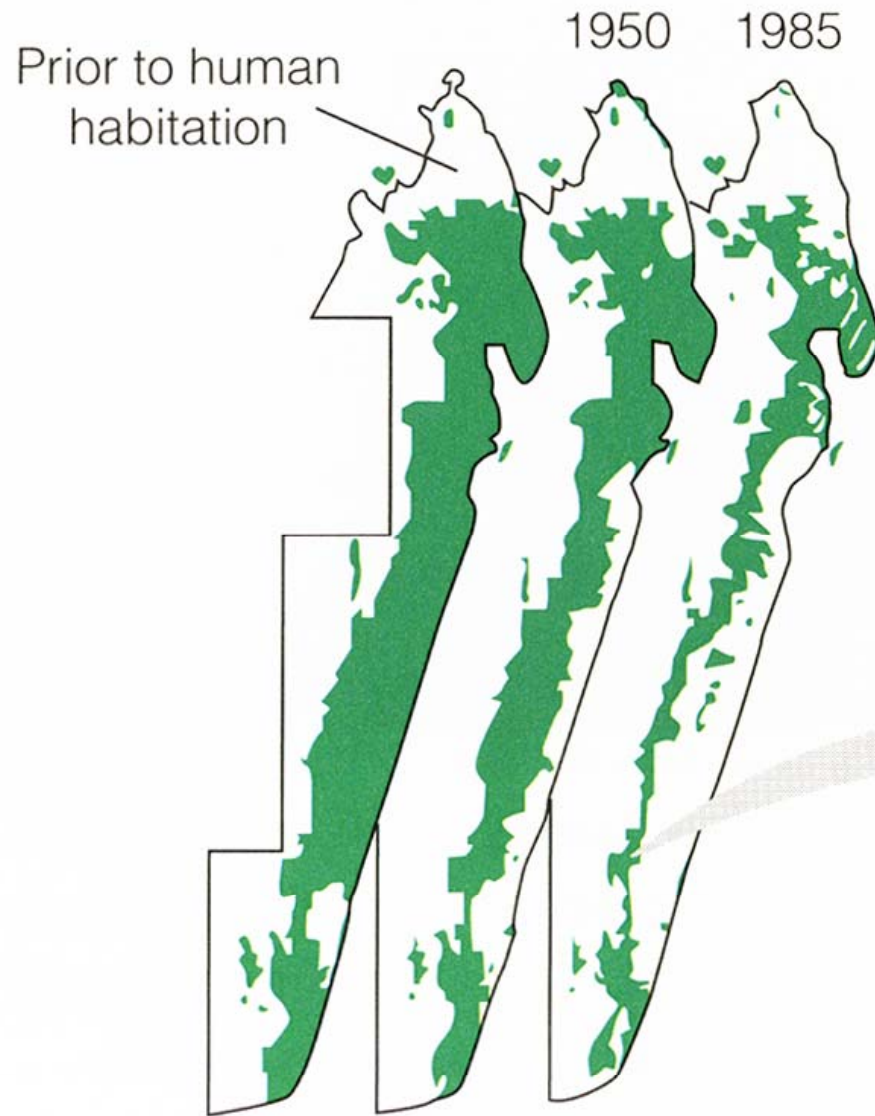
Άμεση ανθρώπινη επίδραση στα οικοσυστήματα: Εξαφάνιση ειδών



**Figure 28.1** | The Carolina parakeet, the only native U.S. parakeet, went extinct in 1914 as a result of hunting/extermination.



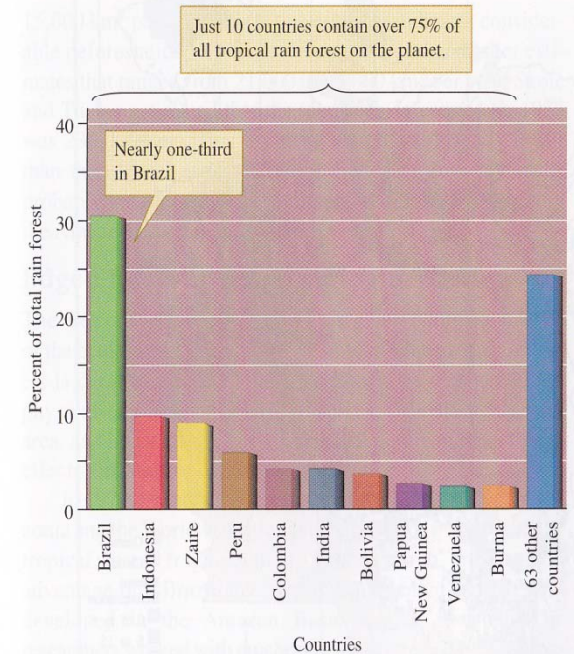
# Άμεση ανθρώπινη επίδραση στα οικοσυστήματα: Καταστροφή δασών στη Μαδαγασκάρη





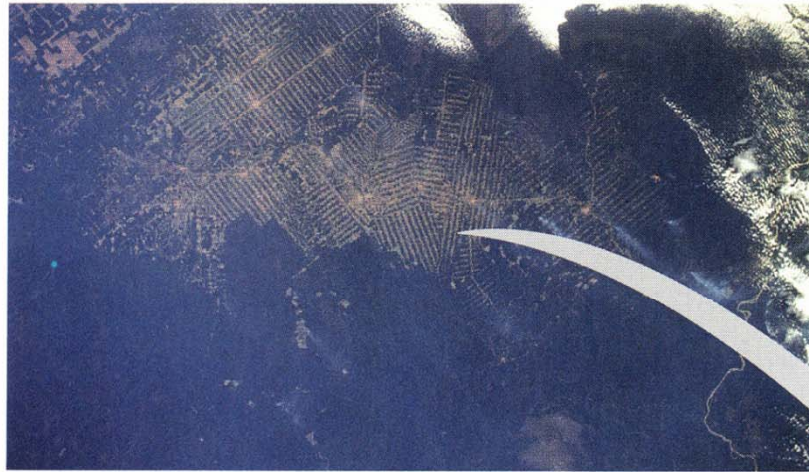
**Table 28.1** | Changes in Forest Cover During the Period 1990–2000. Countries Listed Represent the Top 10 in Terms of Total Area of Forest Cleared During That Period.

Country	Total Forest	Total Forest	Forest Cover Change (1990–2000)	
	1990 ha × 10 <sup>6</sup>	2000 ha × 10 <sup>6</sup>	Annual Change ha × 10 <sup>6</sup>	Annual Rate of Change (%)
Brazil	566,998	543,905	-2309	
Indonesia	118,110	104,986	-1312	
Sudan	71,216	61,627	-959	
Zambia	39,755	31,246	-851	
Mexico	61,511	55,205	-631	
Dem. Rep. of the Congo	140,531	135,207	-532	
Myanmar	39,588	34,419	-517	
Nigeria	17,501	13,517	-398	
Zimbabwe	22,239	19,040	-320	
Argentina	37,499	34,648	-285	

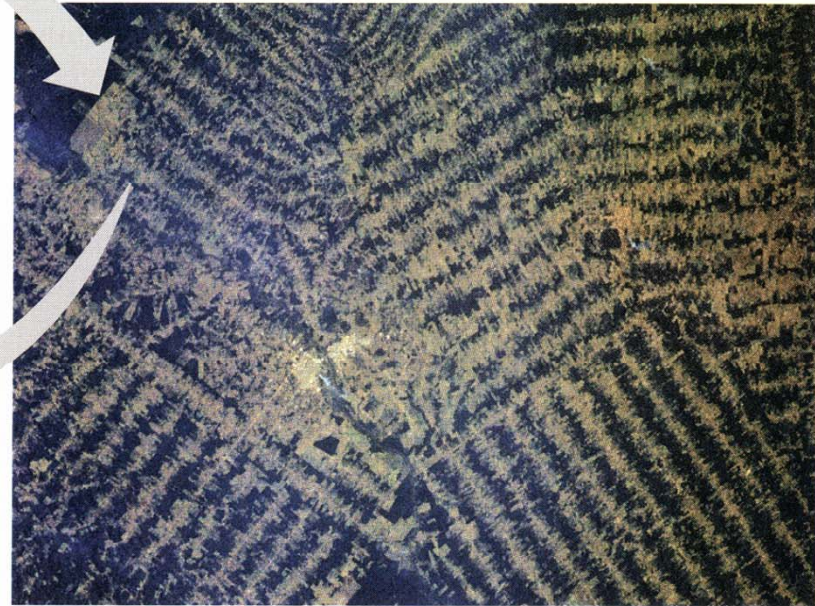


**Figure 23.15** Distribution of rain forest area by country (data from Skole and Tucker 1993).





(a)



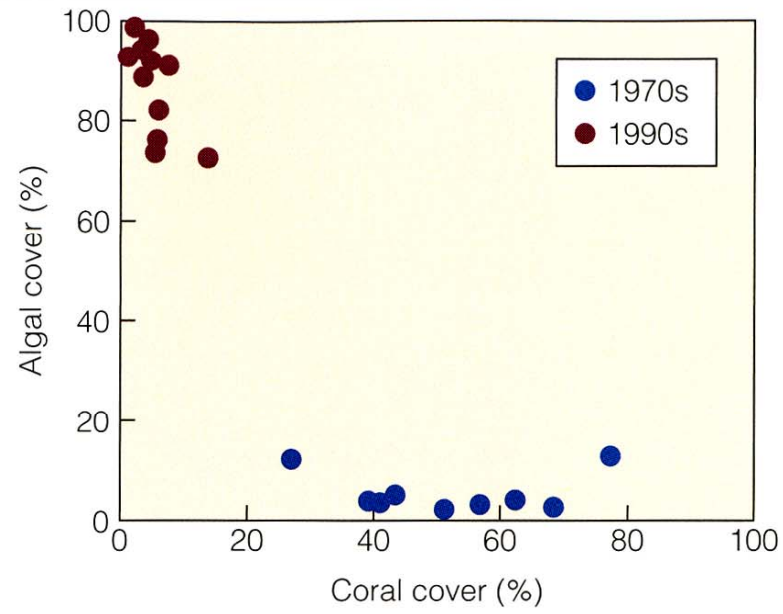
(b)



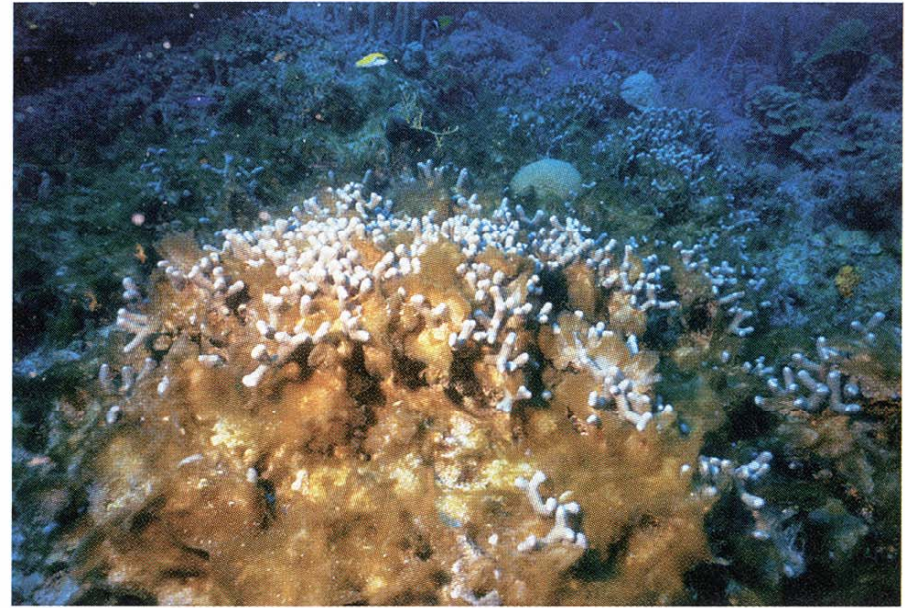
(c)

**Figure 28.4** | Forest clearing in the Rondonia region of Brazil in the Amazon basin as viewed at several spatial scales. The broad-scale view of the region **(a)** shows a pattern of linear clearings (light-colored areas) within the background of forest cover (dark green). **(b)** The linear pattern of clearing is associated with the development of roads for access to the area. **(c)** The forest is then cleared for the development of agricultural lands (primarily pasture).





(a)



(b)

**Figure 28.5** | (a) In the 1970s, coral dominated Jamaica's reef ecosystems; 20 years later, algae has taken over these same areas. The shift is due to water pollution and the overharvesting of algae-eating fish. Part (b) shows algae growing on soft corals. (Adapted from Hughes 1994; as in Primack 1998.)



## Άμεση ανθρώπινη επίδραση στα οικοσυστήματα: Εισαγωγή ξένων ειδών

Από την Ευρώπη στην Β. Αμερική



(a)

Από την Αυστραλία στην Φλόριδα

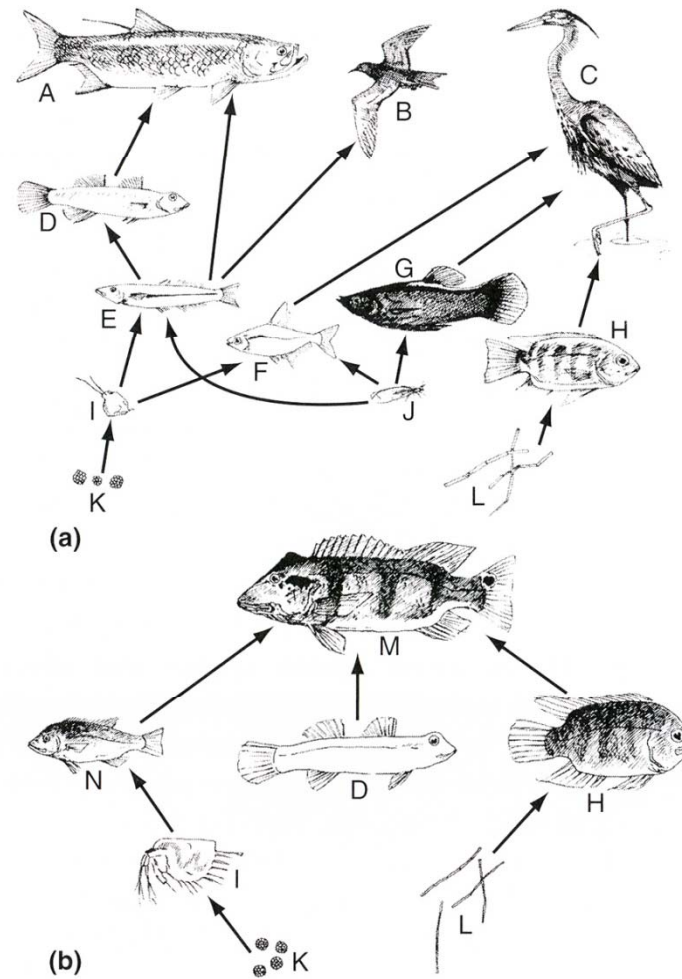


(b)

**Figure 28.6** | Two invasive plant species that have significant negative impacts on native communities in North America: **(a)** the perennial herb purple loosestrife and **(b)** Australian paperbark tree.



*Cichla ocellatus* από τον  
Αμαζόνιο σε λίμνη του  
Παναμά



**Figure 28.7** | Generalized food webs of common Gatun Lake populations contrasting (a) regions without or before introduction of *Cichla* (peacock bass) and (b) regions with *Cichla*. Key to species: A, *Tarpon atlanticus* (tarpon); B, *Childonias niger* (black tern); C, several species of herons and kingfishers; D, *Gobiomorus dormitory*; E, *Melaniris chagresi*; F, Characinidae, including four common species; G, Poecillidae, including two common species—the exclusively herbivorous *Poecilia mexicana* and the exclusively insectivorous *Gambusia nicaraguagensis*; H, *Chichlasoma maculicauda*; I, zooplankton; J, terrestrial insects; K, nannophytoplankton; L, filamentous green algae; M, adult *Cichla ocellaris*; N, young *Cichla*. (After Zaret and Paine 1973).