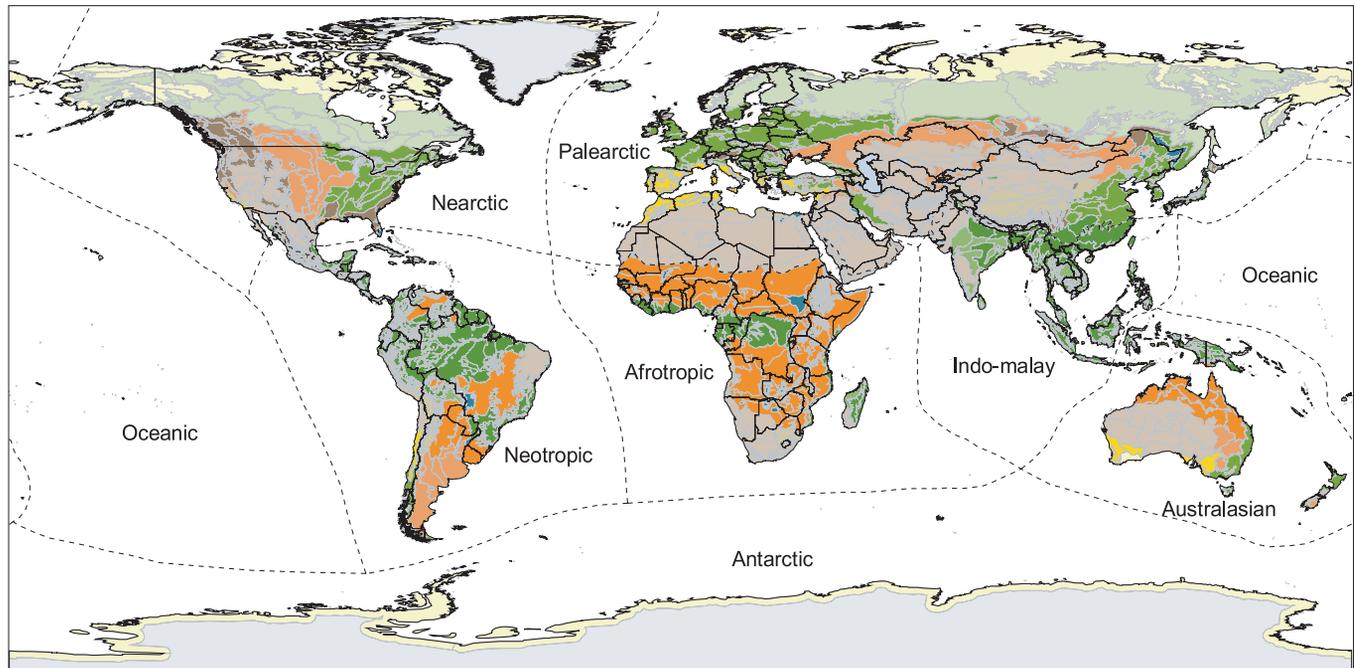


# Color Maps and Figures

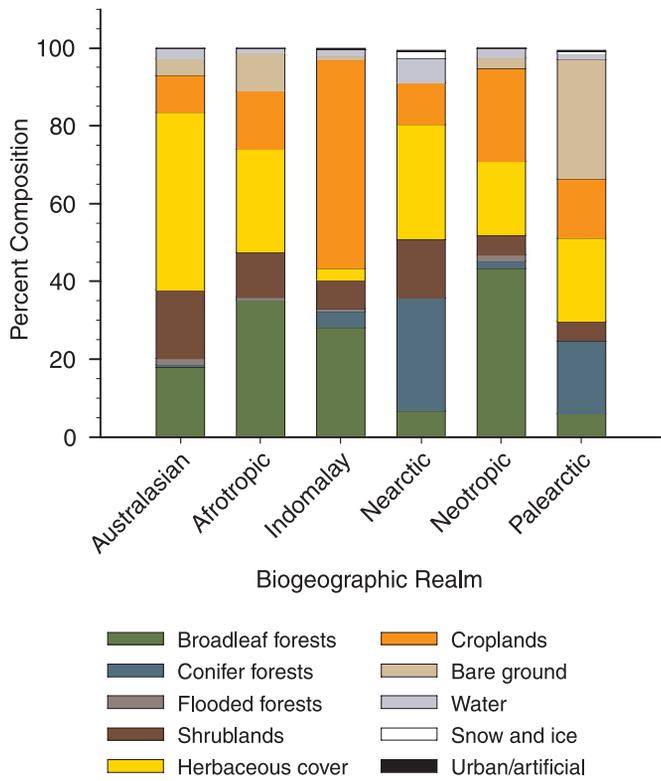


**Biome**

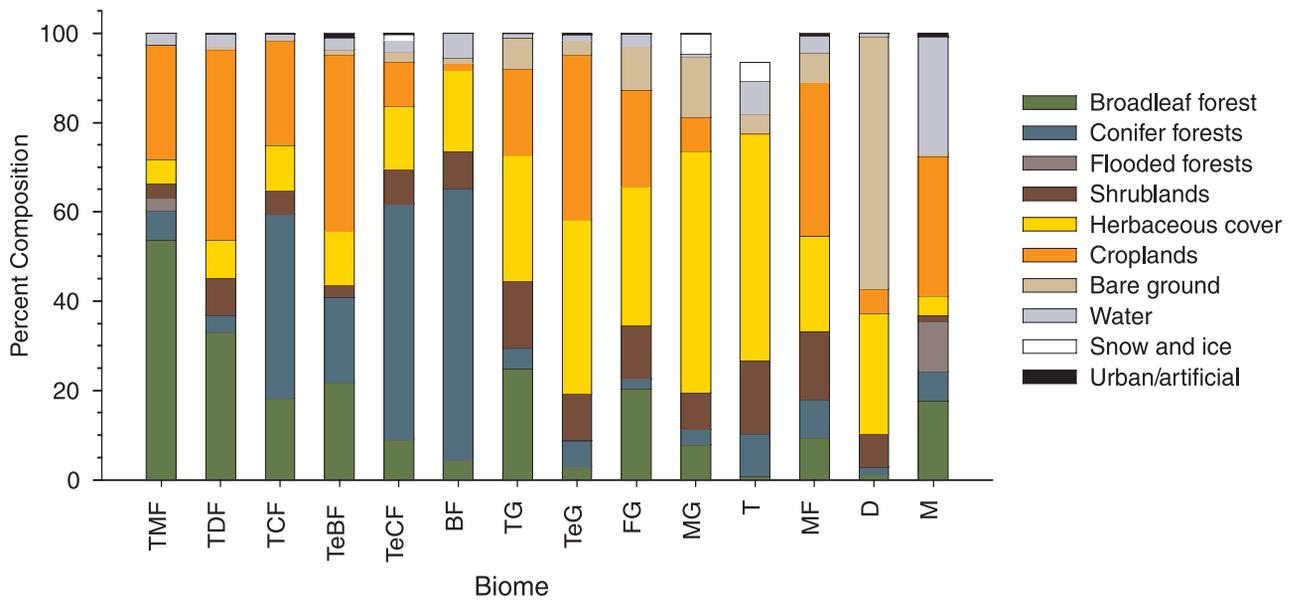
- TMF: Tropical and sub-tropical moist broadleaf forests
- TDF: Tropical and sub-tropical dry broadleaf forests
- TCF: Tropical and sub-tropical coniferous forests
- TeBF: Temperate broadleaf and mixed forests
- TeCF: Temperate coniferous forests
- BF: Boreal forests/taiga
- TG: Tropical and sub-tropical grasslands, savannas, and shrublands
- TeG: Temperate grasslands, savannas, and shrublands
- FG: Flooded grasslands and savannas

- MG: Montane grasslands and shrublands
- T: Tundra
- MF: Mediterranean forests, woodlands, and scrub
- D: Deserts and xeric shrublands
- M: Mangroves
- Lakes
- Rock and ice
- Biogeographic realm
- Country
- Ecoregions

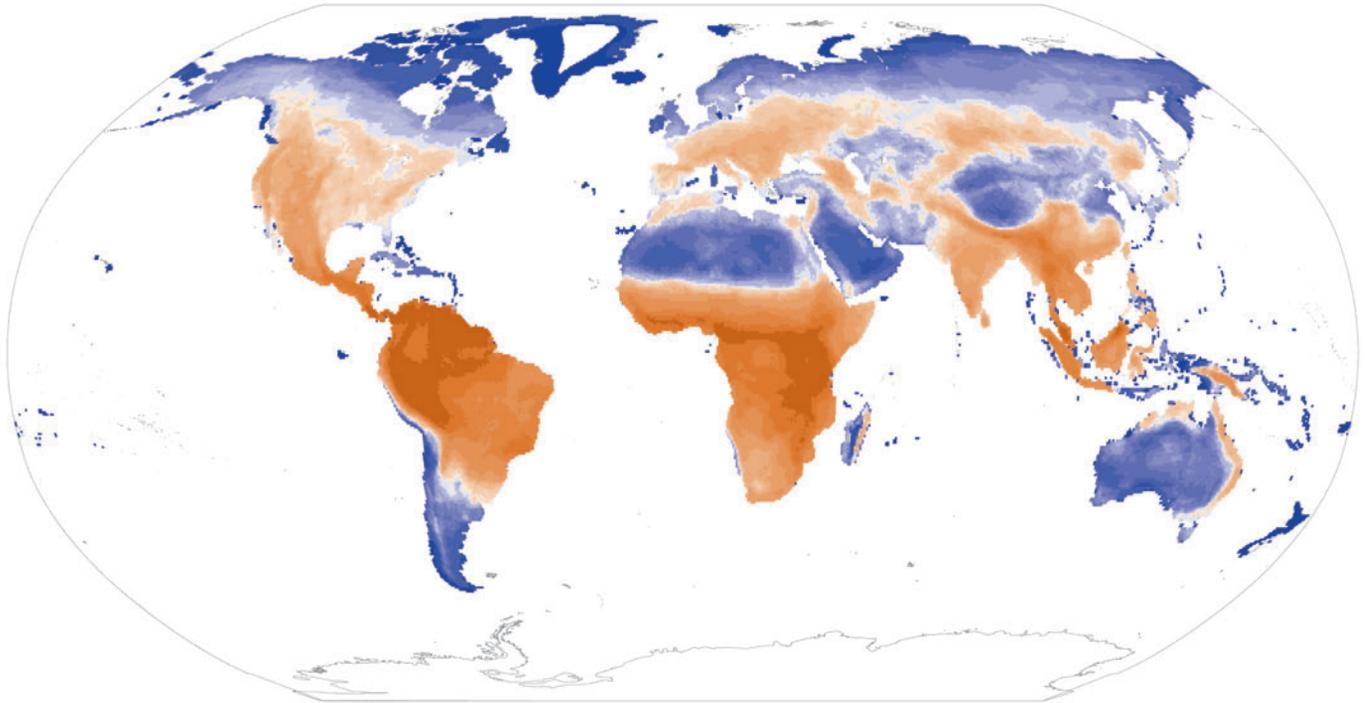
**Figure 4.3. The 14 WWF Biomes and Eight Biogeographic Realms of the World.** Biomes are coded in colors and listed with abbreviations that will be used in following figures and tables (e.g., TMF). Biogeographic realms are named in the figure. Ecoregions are nested within both biomes and realms.



**Figure 4.4. Land Cover Composition of Six of the Eight Terrestrial Biogeographic Realms.** Oceania and Antarctica are omitted because land cover data were not available.

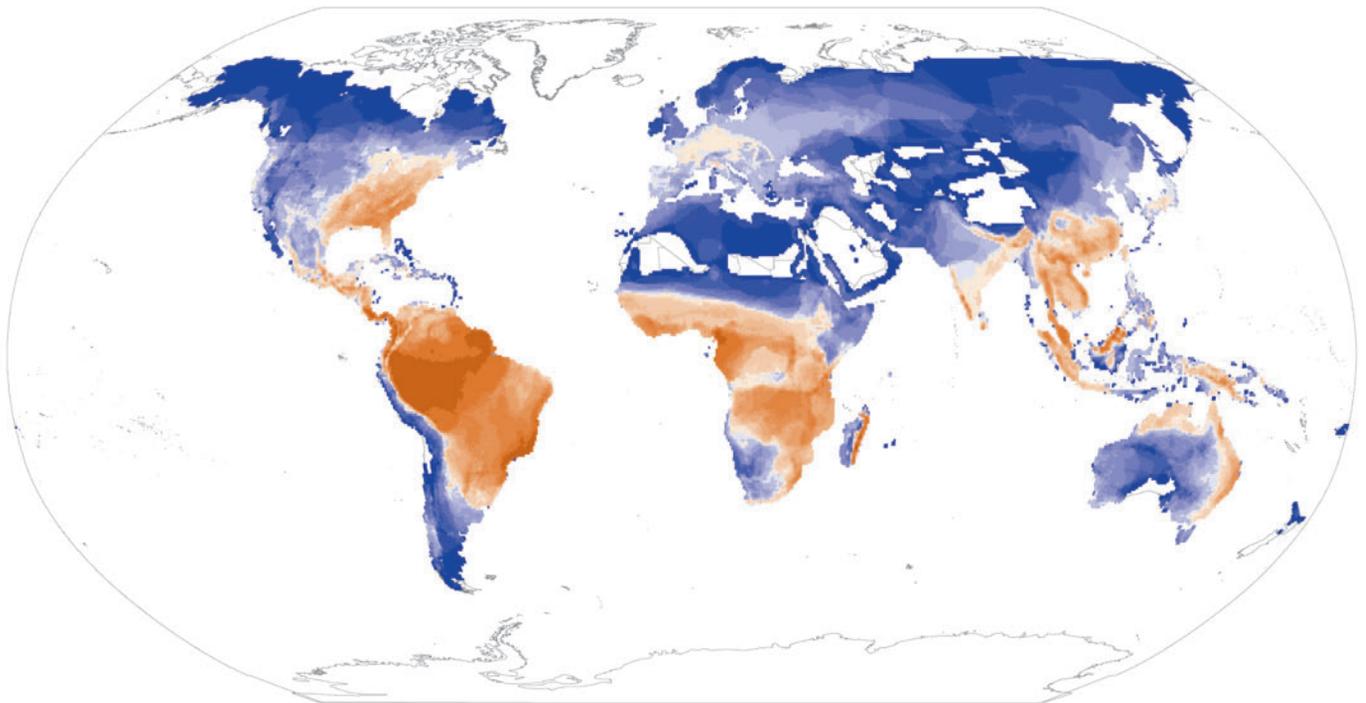


**Figure 4.6. Land Cover Composition of 14 Terrestrial Biomes.** Biome codes as in Figure 4.3. Tundra bar does not reach 100% because 7% of this biome was unclassified by the land cover dataset.



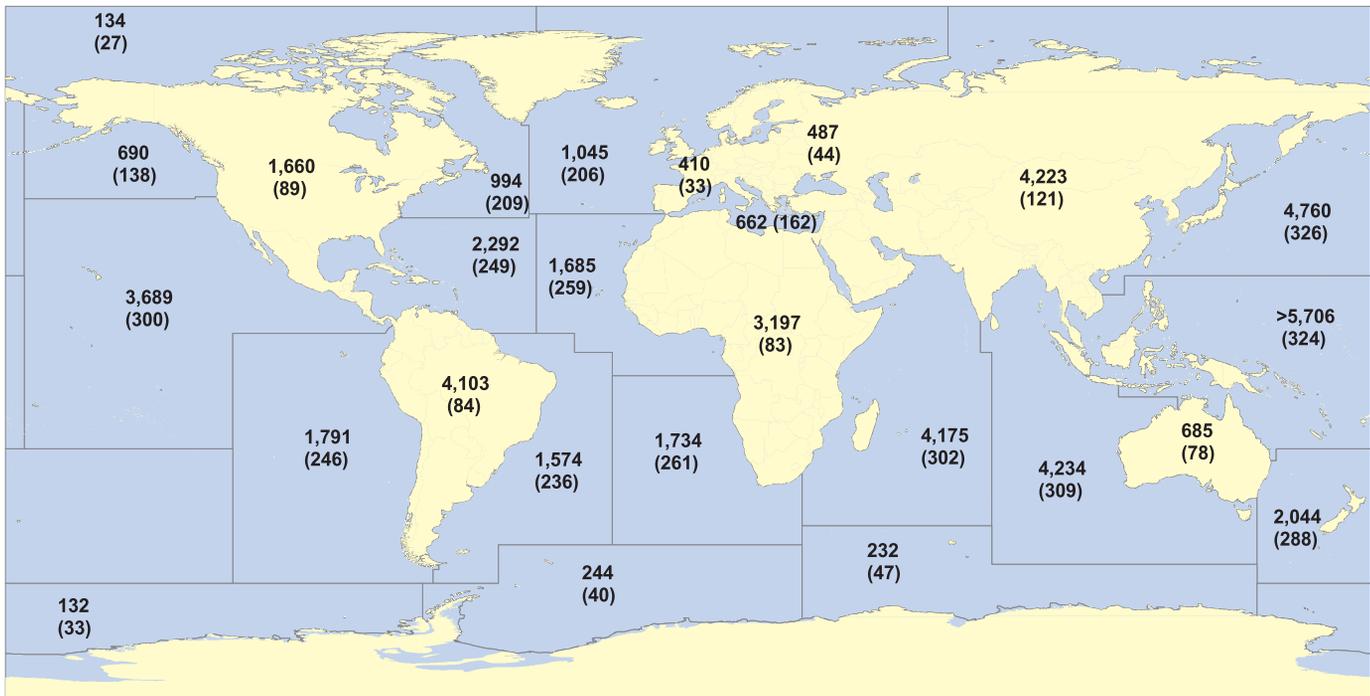
**Figure 4.10. Global Species Richness of Terrestrial Mammals per Half-degree Cell.**  $N = 4,734$ . Dark orange colors correspond to higher richness, dark blue colors correspond to lower richness. Maximum richness equals 258 for mammals. Color scale based on 20 equal-area classes. (Baillie et al. 2004)

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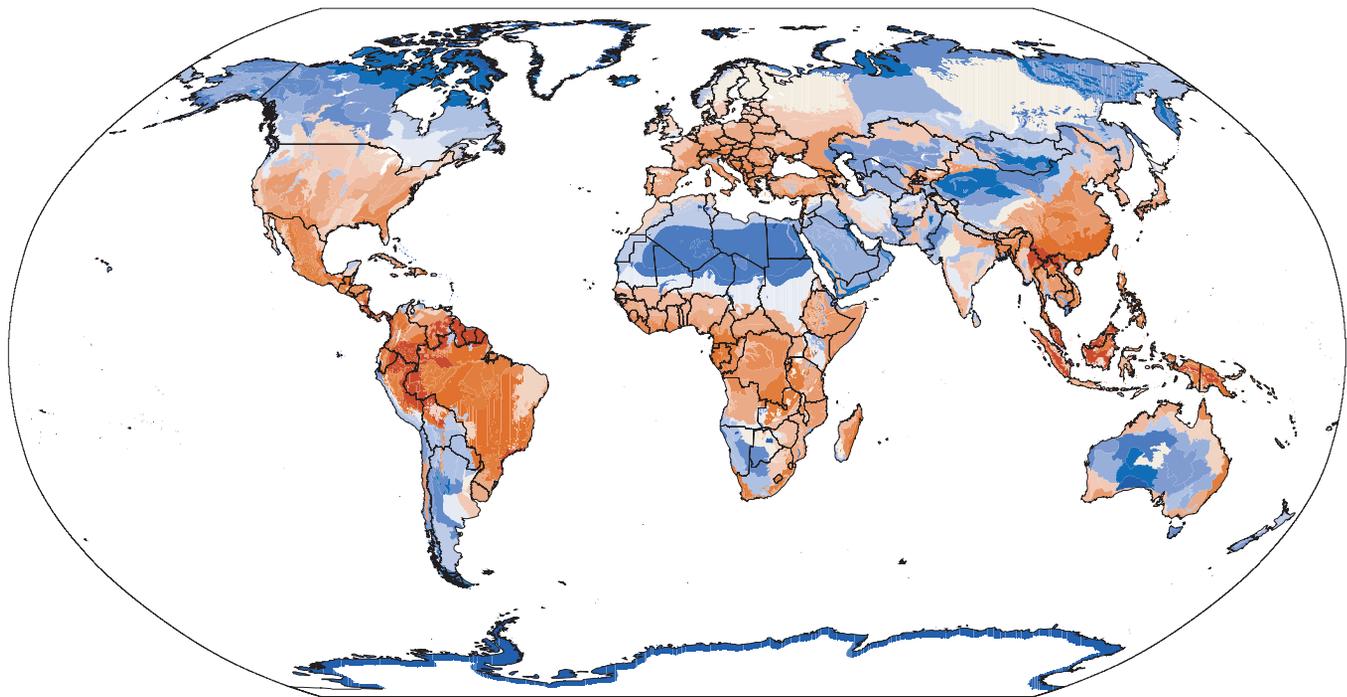


**Figure 4.11 Global Species Richness of Amphibians per Half-degree Cell.**  $N = 5,743$ . Dark orange colors correspond to higher richness, dark blue colors correspond to lower richness. Maximum richness equals 142 for amphibians. Color scale based on 20 equal-area classes. (Baillie et al. 2004).

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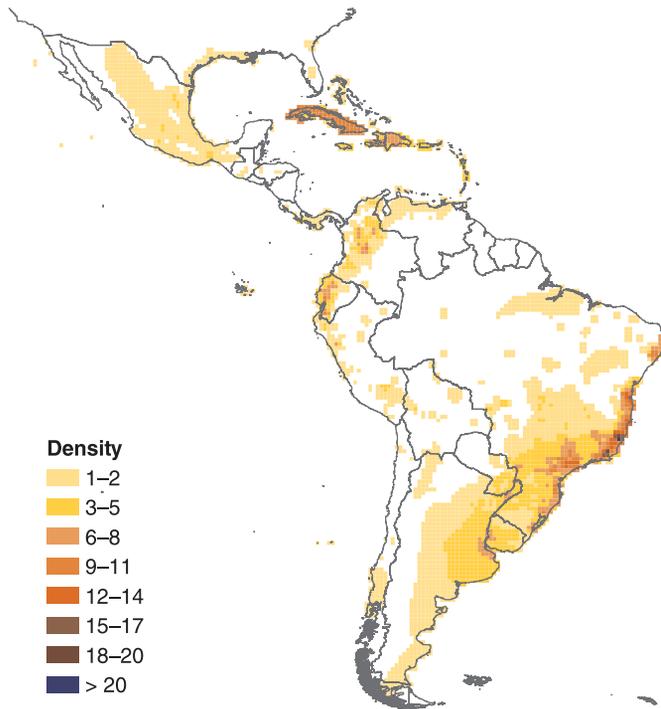
**Figure 4.12. Global Richness of Finfish Species (and Finfish Families in Parentheses) across FAO Areas** (data source Froese and Pauly 2003)



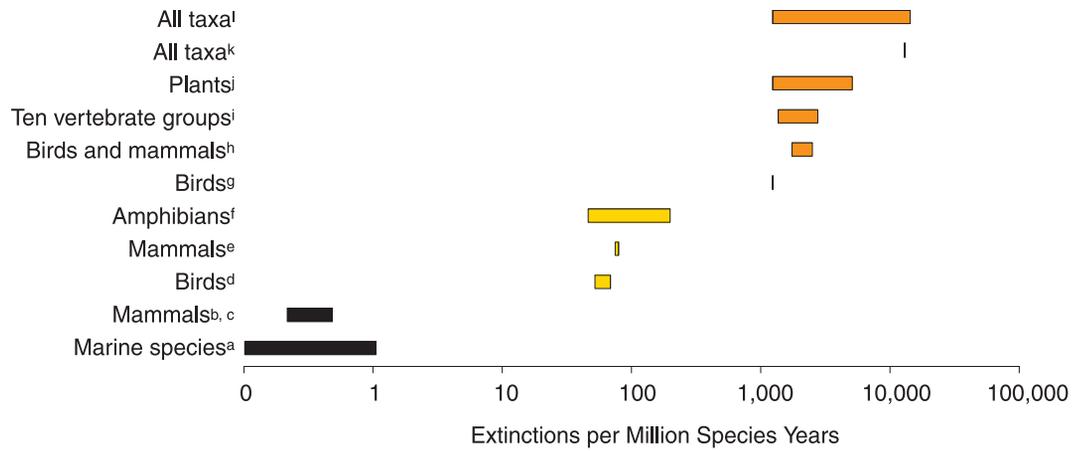
**Figure 4.13. Global Species Richness of Vascular Plants Modeled and Mapped across Ecoregions.** Dark orange colors correspond to higher richness, dark blue colors correspond to lower richness. Maximum richness equals 10,000 for plants. Color scale based on 20 equal-area classes. (Kier et al. 2002; Olson et al. 2001)

Anthropogenic Drivers	Scales of Ecological Organization		
	Genes	Populations/Species	Biomes
Habitat change	↑ 4	↑ 3	↑ 1
Fragmentation/Dam construction	↑ 2	↑ 2	? 2
Invasive alien species	? 4	↑ 4	↑ 4
Exploitation	? 4	↑ 2	↑ 2
Inputs (fertilizer, acid rain, pollution)	? 2	↑ 2	↑ 2
Disease	? 2	↑ 3	? 3
Climate change	? 5	↑ 5	↑ 5

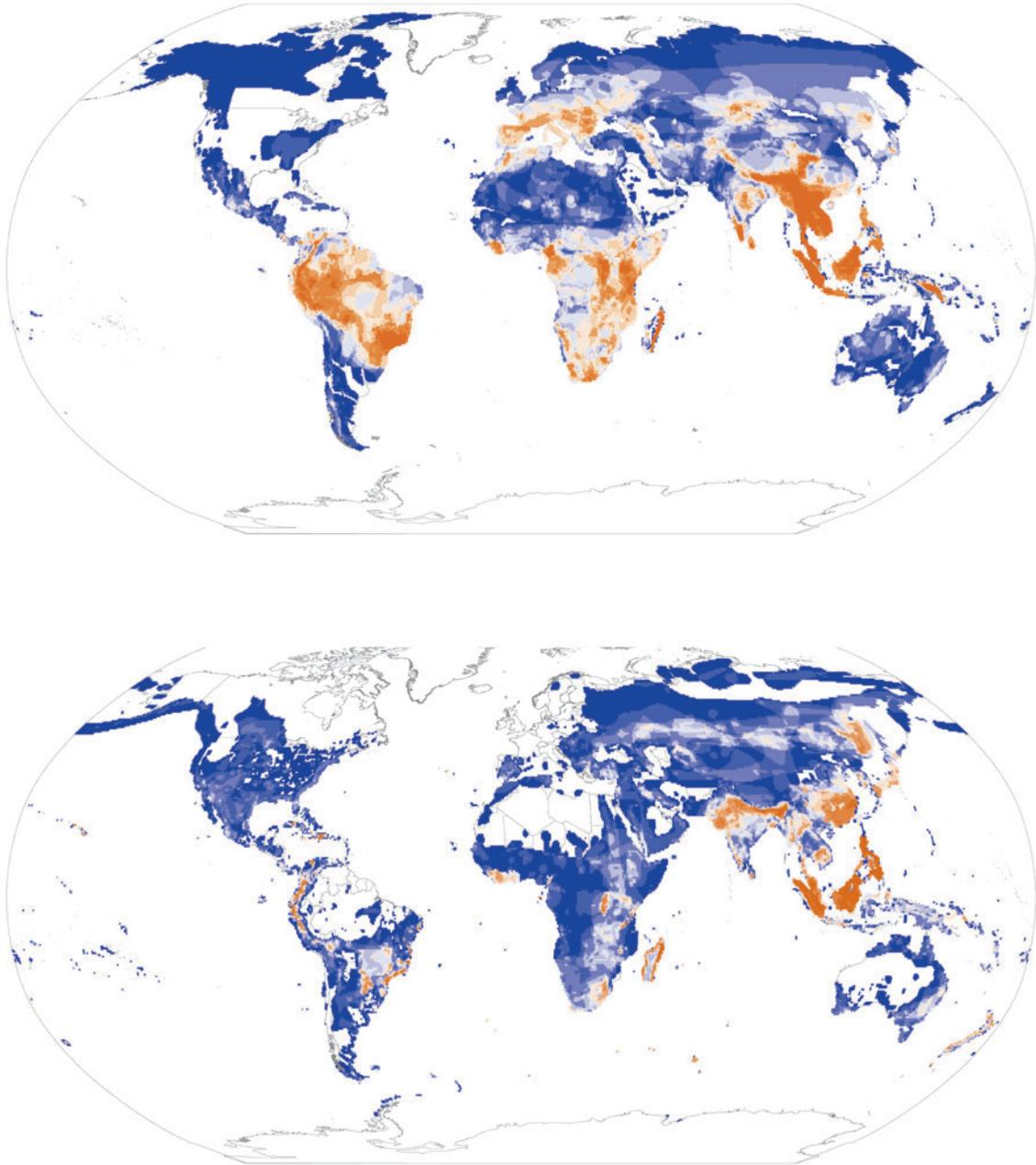
**Figure 4.16. Major Anthropogenic Variables Acting as Drivers of Change on Different Scales of Ecological Organization or Biodiversity Levels.** Color=degree of driver impact on ecological scale (red=maximum impact followed by orange, then yellow); ↑=upward trend of driver impact on ecological scale; 1 to 5=degree of impact reversibility (5=least reversible); Shading=degree of certainty based on expert knowledge (dark shading=least certain); ?=information on trends unknown. Impact indices were based on a year 2010 timeframe.



**Figure 4.18. Density Map on Extent to Which the Ranges of Threatened Bird Species Have Contracted in Central and South America.** The color scale indicates the number of threatened bird species that used to occur in a pixel, but no longer do so. (BirdLife International 2004a; unpublished data from BirdLife's World Bird Database)

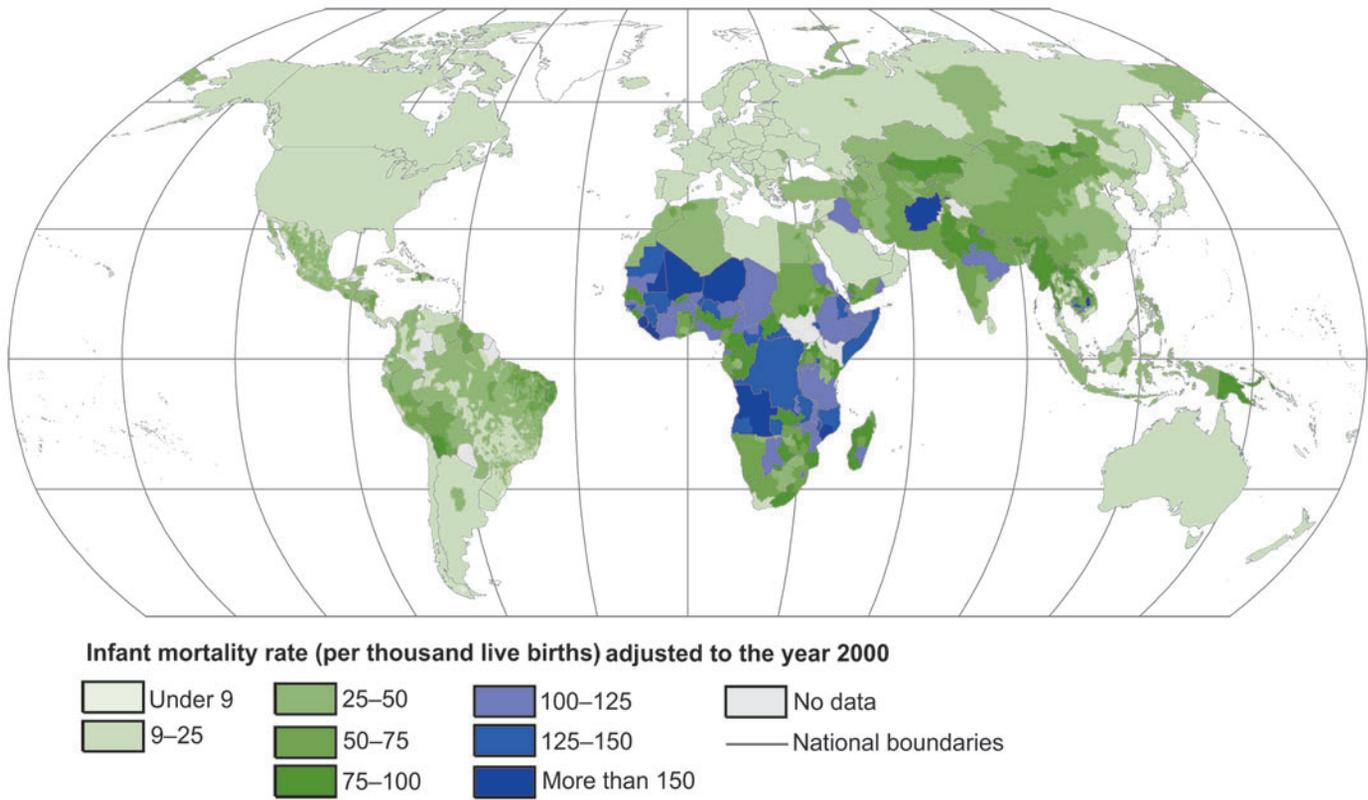


**Figure 4.22. Background and Contemporary Extinction Rates.** Background extinction rates are in black, extinction rates based on observed extinctions over the past 100 years are in yellow and estimated contemporary extinction rates using a number of different approaches are in orange. Based on background extinction rates from the fossil record: <sup>a</sup>May (1995), <sup>b</sup>Alroy (1998) (lower estimate of 0.21), <sup>c</sup>Foote (1997) (higher estimate of 0.46). Observed extinctions over the past 100 years: <sup>d</sup>, <sup>e</sup>, <sup>f</sup>Baillie et al. (2004). Projections based on threatened species: <sup>g</sup>Pimm and Brooks (1997), <sup>h</sup>Smith et al. (1993) (also uses recently extinct species), <sup>i</sup>Mace (1994). Plant extinctions using species-area curve with assumptions about habitat loss from agricultural/urban expansion and from climate change: <sup>j</sup>MA *Scenarios*, Chapter 10. Increased energy consumption: <sup>k</sup>Ehrlich (1994). Species-area relationship from deforestation rates: four studies in <sup>l</sup>Reid (1992).



**Figure 4.25. Density Distribution Map of Globally Threatened Mammal and Bird Species Mapped at a Resolution of 1/4 Degree Grid Cell.** N = 1,063 mammals and 1,213 birds. Dark orange colors correspond to higher richness, dark blue colors to lower richness. Maximum richness equals 25 for mammals and 25 for birds. Color scale based on 10 equal-area classes. (Baillie et al. 2004)

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**Figure 5.5. Global Distribution of Infant Mortality Rate** (Robinson Projection; UNICEF, DHS, NSOs, NHDRs)

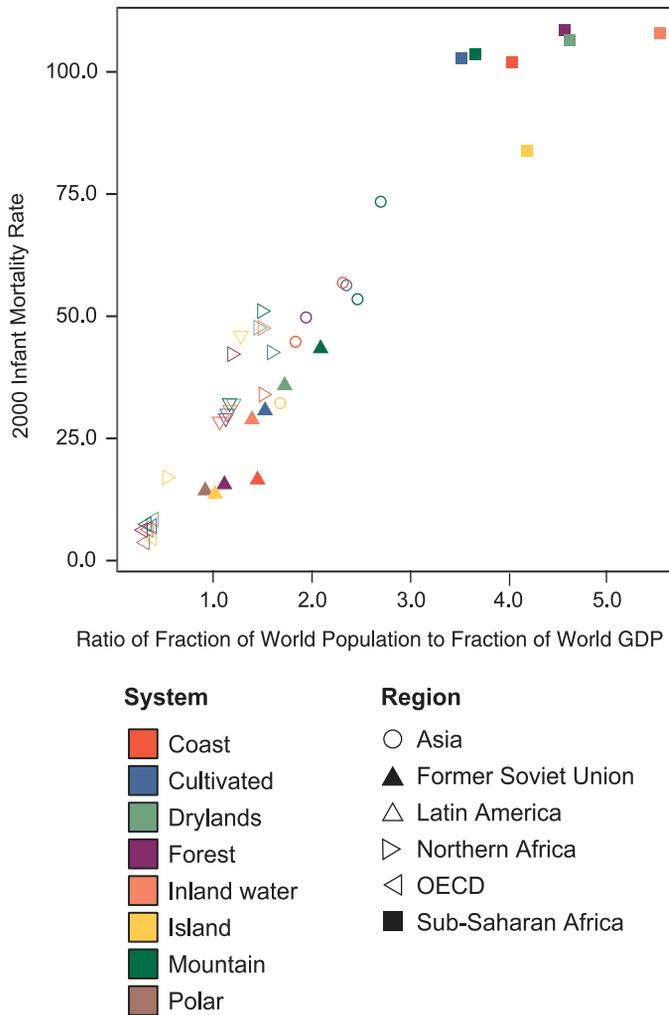


Figure 5.8. MA Regions and Systems and Relative Measures of Well-being

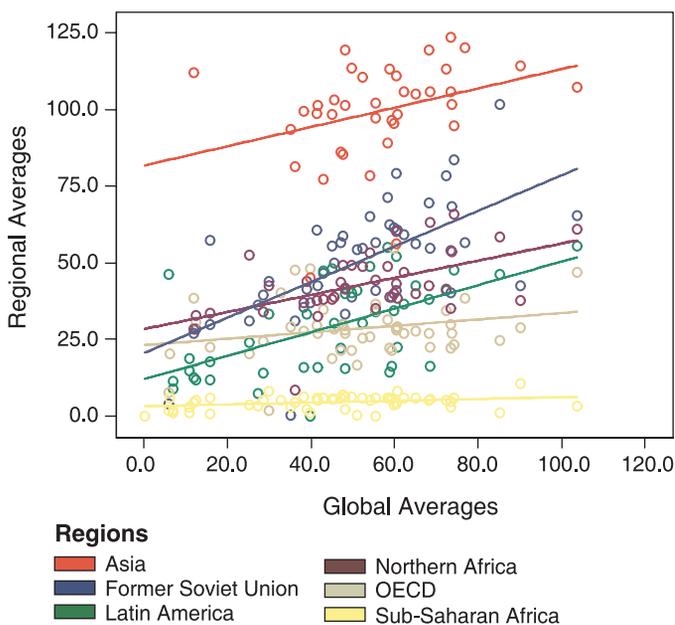
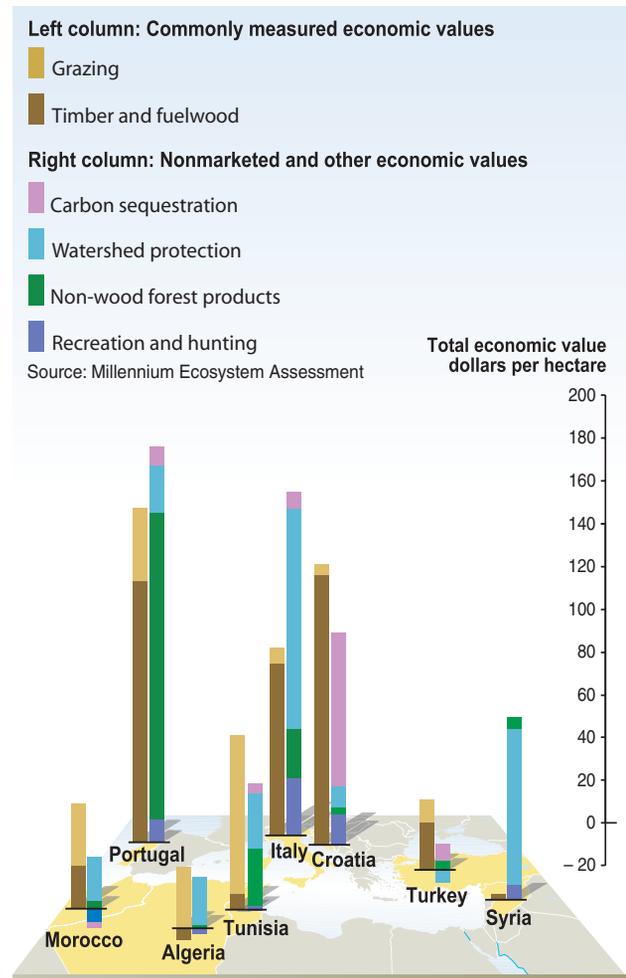
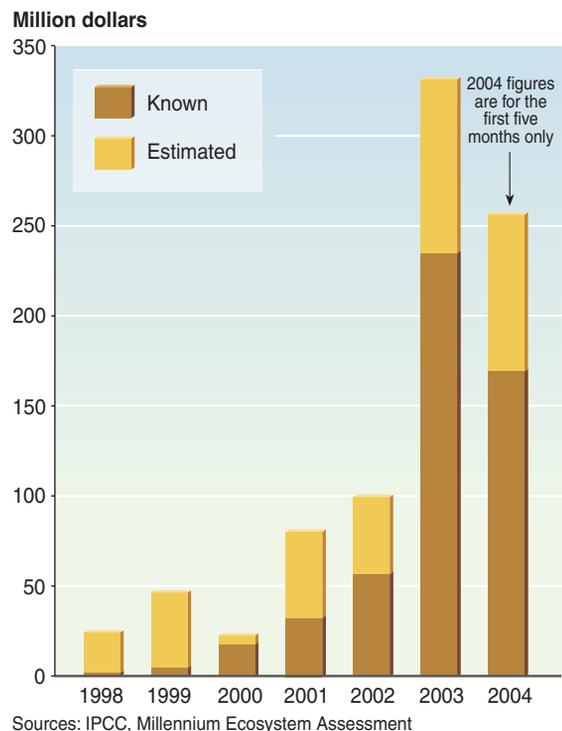


Figure 5.9. Infant Mortality Rate in MA Subsystems, Regional Averages Compared with Global Averages



Box 5.2 Figure A



Box 5.2 Figure B

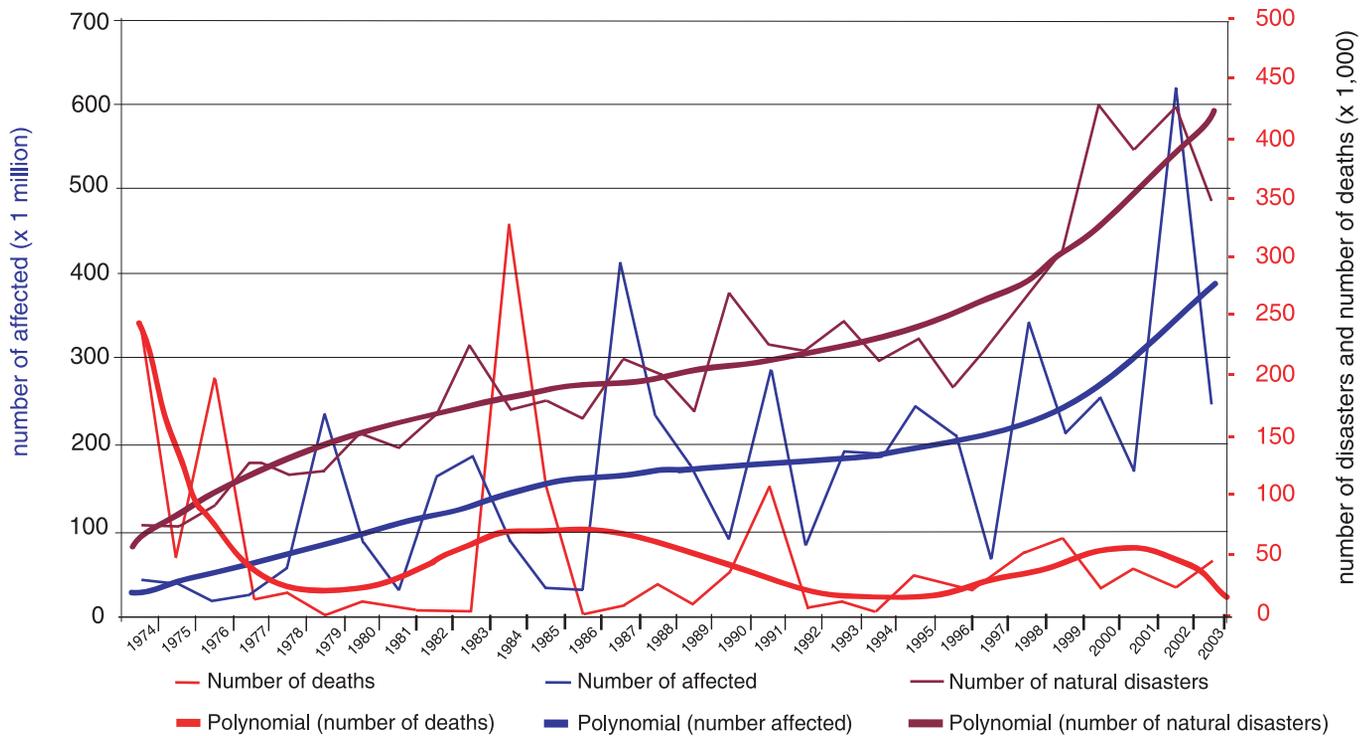
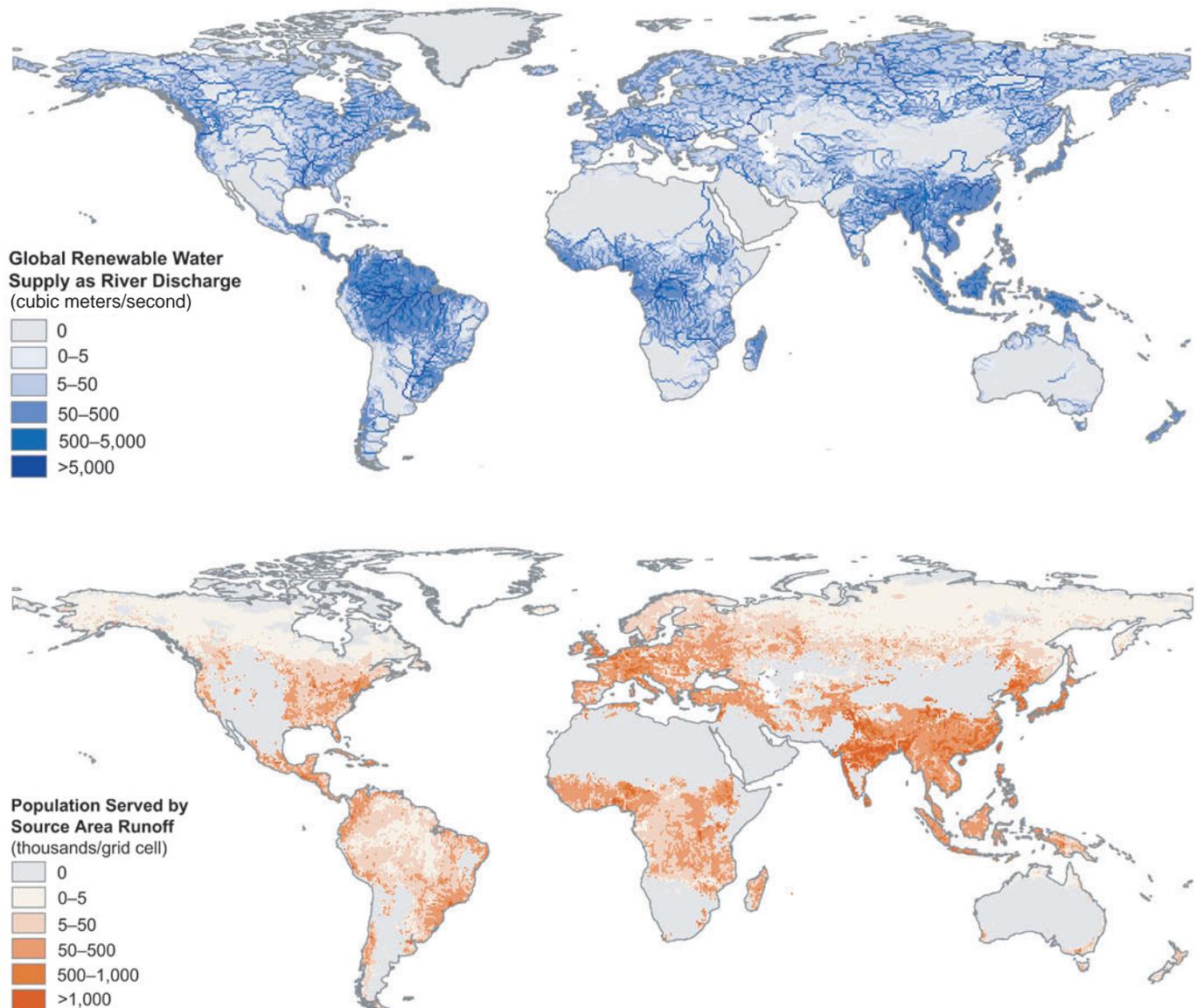


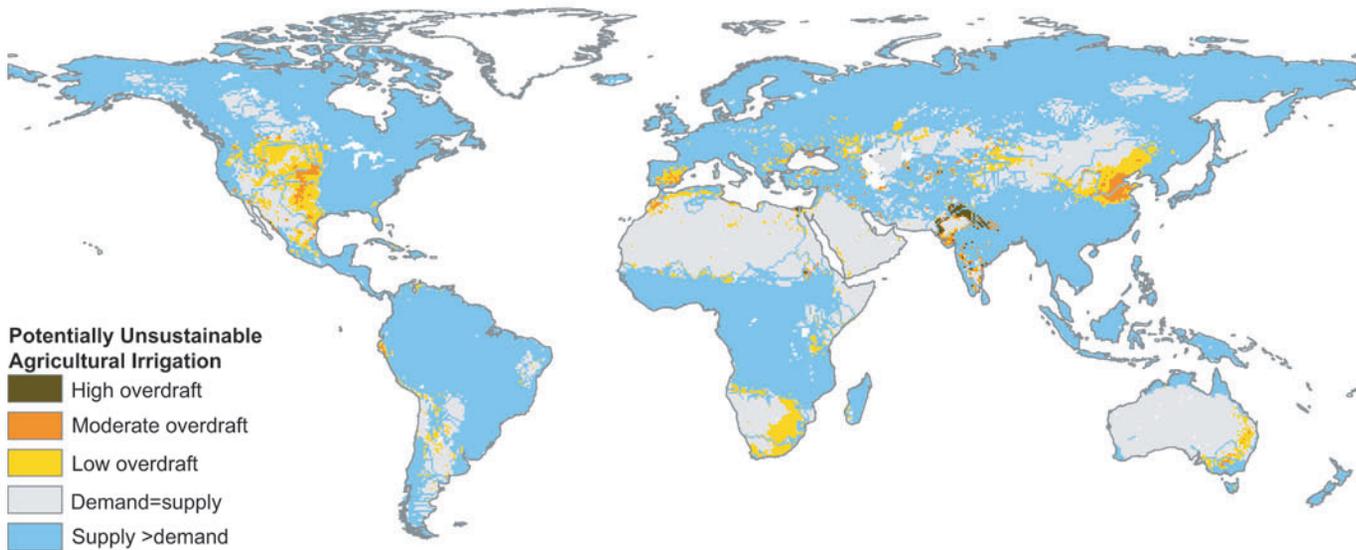
Figure 6.3. Polynomial Trends in the Numbers of Natural Disasters, Persons Killed, and Persons Affected, 1974–2003 (CRED 2003)

Reasons for Concern					
Global warming °C	I: Global food production	II: National agricultural economies and market trade	III: Effects on natural resource base	IV: Food security among vulnerable livelihoods	V: Impacts of large-scale droughts and floods
6	Increased potential for shortfalls	Large increases in trade and dependence on imports	Widespread increase in desertification	Increased variability and costs in some regions threaten food security	Potential for large-scale, prolonged events to trigger migration and economic collapse
5	Increased risks in periods of adverse weather	Risks to economies with existing stresses (water shortages, high temperatures)	Increased competition for water, depleted surface water	Regional risks are significant for many livelihoods	Prolonged events create serious economic and societal crises
4	Little threat to global food supply	Some risk to small economies, e.g., small island states	Locally significant water conflicts; widespread soil degradation	Some livelihoods already in crisis	Prolonged events have significant costs at present
3					
2					
1					
0 (present)		Underdevelopment prevalent in LDCs			

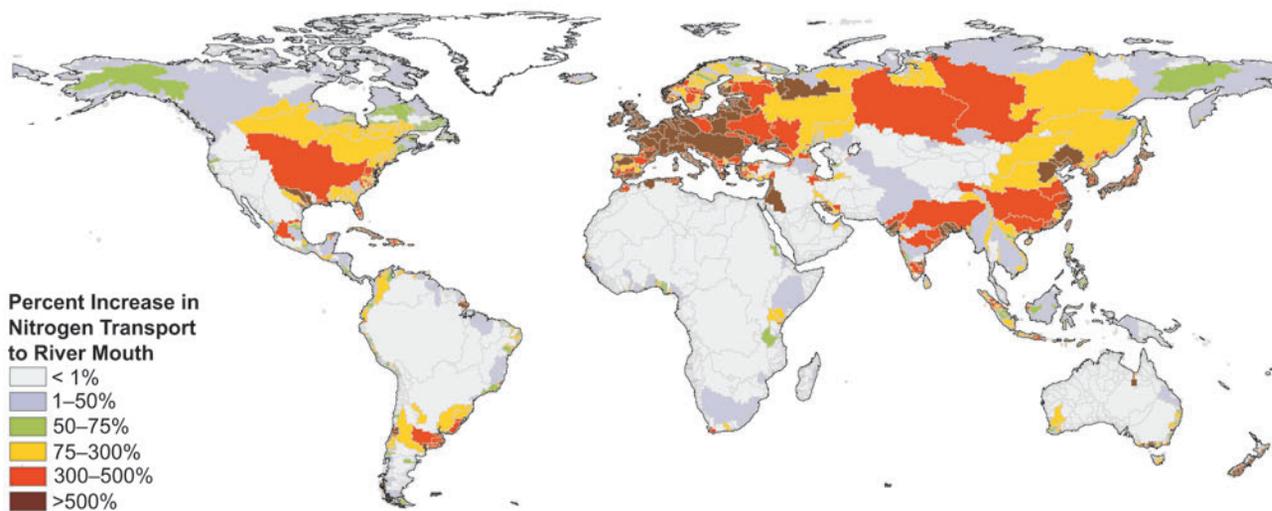
Figure 6.6. Climate Change Risks for Agricultural Systems. The five “Reasons for Concern” follow the IPCC’s template from the Third Assessment Report’s Summary for Policymakers (IPCC 2001). (Downing 2002)



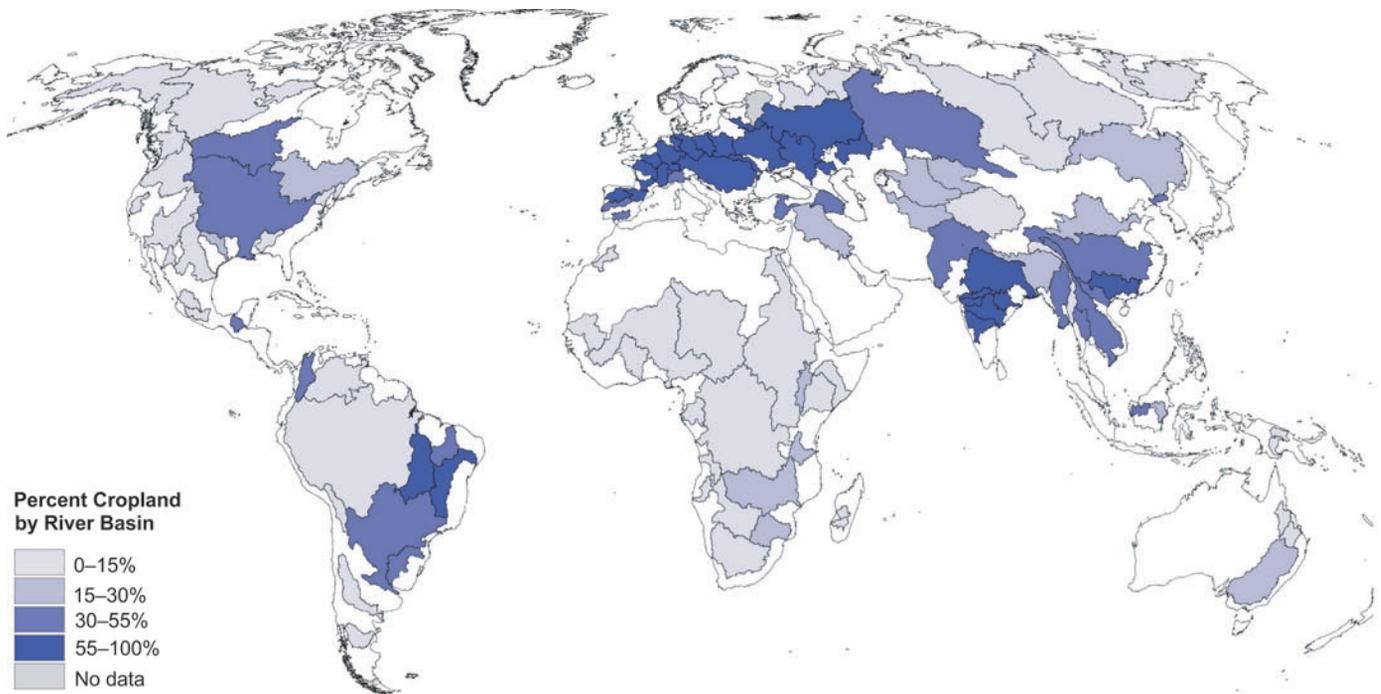
**Figure 7.1. Global Renewable Water Supply as River Discharge and Populations Dependent on Accessible Runoff at Point of Origin.** River flows, or total blue water ( $B_r$ ) is that water passing through 50 km x 50 km grid cells. The top map depicts the global renewable water supply. The bottom map depicts total renewable blue water that is accessible to humans ( $B_a$ ). Due to their remoteness, some high runoff-generating regions (e.g., Amazonia) fail to support significant populations and are effectively inaccessible. Populations served by nonrenewable groundwater or desalinization are not shown. Table 7.2 gives aggregated regional summaries of the geographic distributions shown here. (Dividing by 31.7 converts values in the top map into units of cubic kilometers per year.)



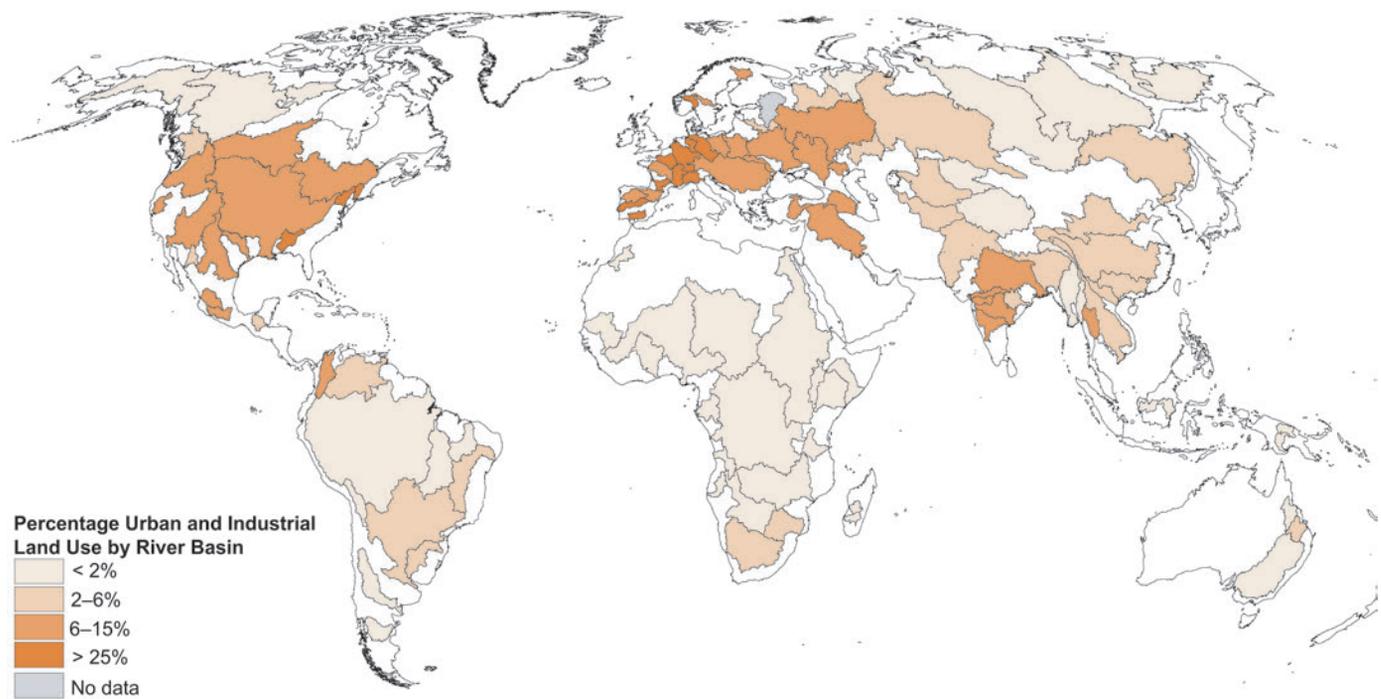
**Figure 7.3. Contemporary Geography of Non-sustainable Withdrawals for Irrigation.** The following divisions based on calculated consumptive use by crops were used: High overdraft:  $<1 \text{ km}^3/\text{yr}$ ; Moderate:  $0.1\text{--}1 \text{ km}^3/\text{yr}$ ; Low:  $0\text{--}0.1 \text{ km}^3/\text{yr}$ . All estimates made on ca.  $50 \text{ km} \times 50 \text{ km}$  resolution grids. The map indicates where there is insufficient fresh water to fully satisfy irrigated crop demands. The imbalance in long-term water budgets necessitates diversion of surface water or the tapping of groundwater resources. The areas shown with moderate-to-high levels of non-sustainable use occur over each continent and are known to be areas of aquifer mining and/or major water transfer schemes.



**Figure 7.5. Contrast between Mid-1990s and Pre-disturbance Transports of Total Nitrogen through Inland Aquatic Systems Resulting from Anthropogenic Acceleration of This Nutrient Cycle.** While peculiarities of individual pollutants, rivers, and governance define the specific character of water pollution, the general patterns observed for nitrogen are representative of anthropogenic changes to the transport of waterborne constituents through inland waterways. Elevated contemporary loading to one part of the system (e.g., to croplands) often reverberate through other parts of the system (e.g., coastal zones), exceeding the capacity of natural systems to assimilate additional constituents. (Green et al. 2004)



**Figure 7.10. Percentage of Cropland Area by River Basin.** Cropland areas exclude those with more balanced mosaics of cropland and natural vegetation. (Revenga et al. 2000)



**Figure 7.11. Percentage Urban and Industrial Land Use by River Basin** (Revenga et al. 2000)

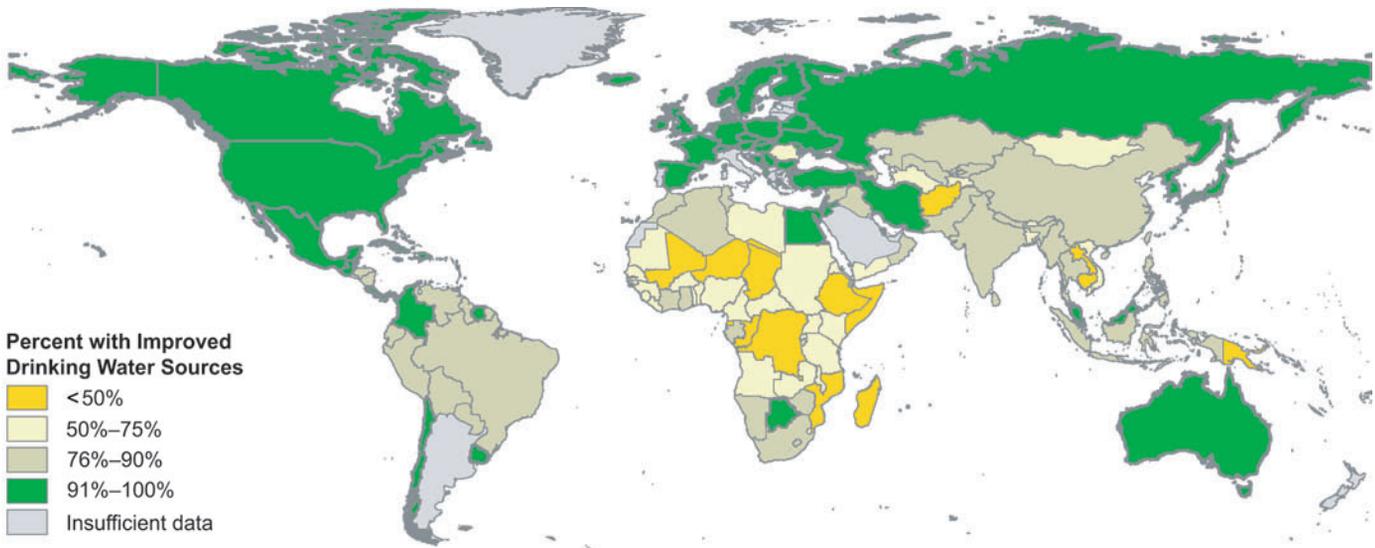


Figure 7.13. Proportion of Population with Improved Drinking Water Supply, 2002 (WHO/UNICEF 2004)

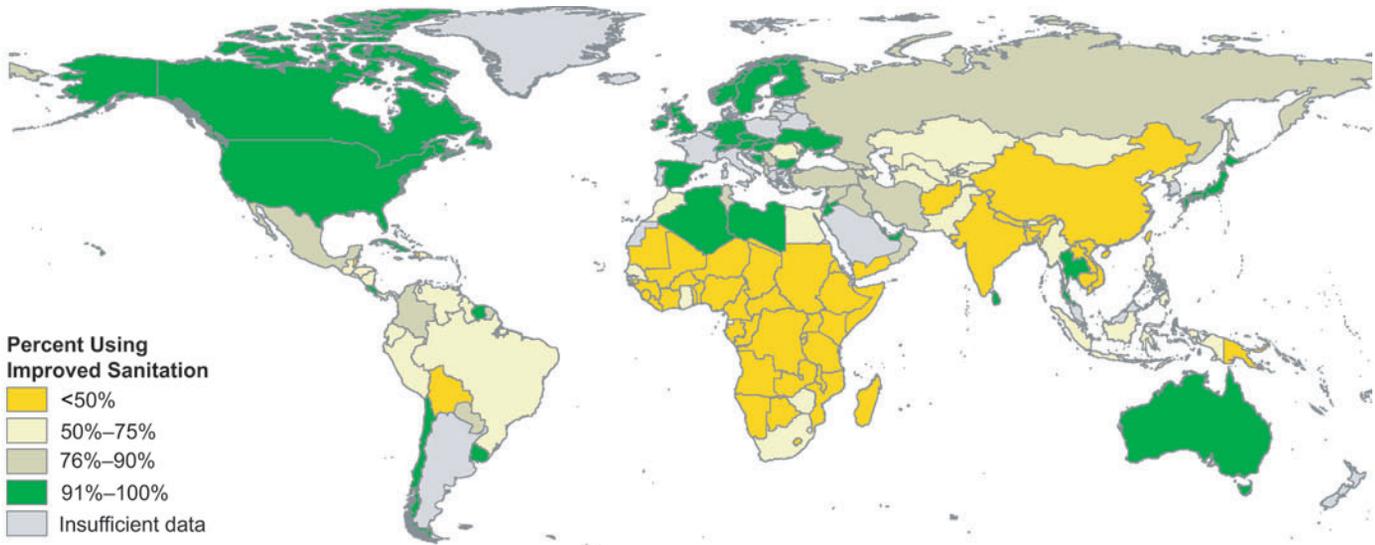
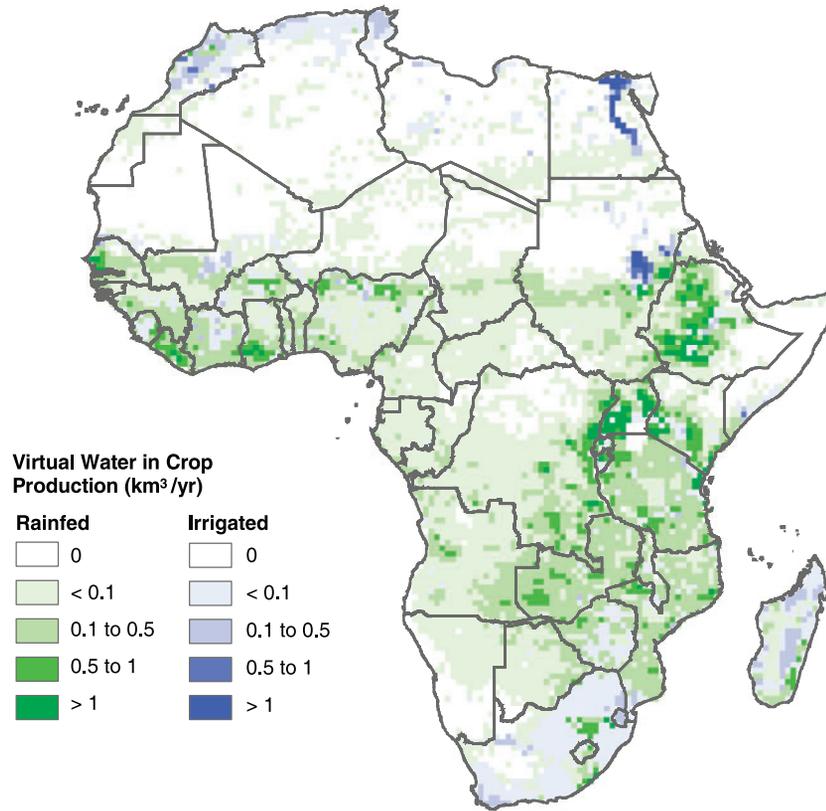


Figure 7.14. Proportion of Population with Improved Sanitation Coverage, 2002 (WHO/UNICEF 2004)



Virtual Water for Africa (km<sup>3</sup>/yr)

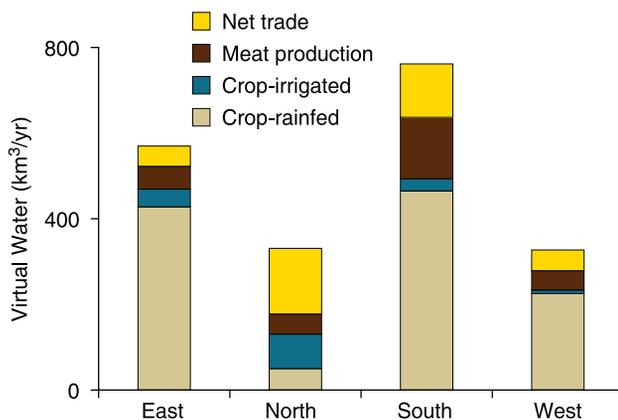
	Crops <sup>1</sup>	Meat <sup>2</sup>	Total
Production	1326	289	1615
Percent of AET <sup>3</sup>	9%	2%	11%
Imports	404	21	425
Exports	50.5	0.3	50.8
VW Balance	1680	309	1989

<sup>1</sup> VW in crops = AET over rainfed cropland + PET over irrigated cropland.

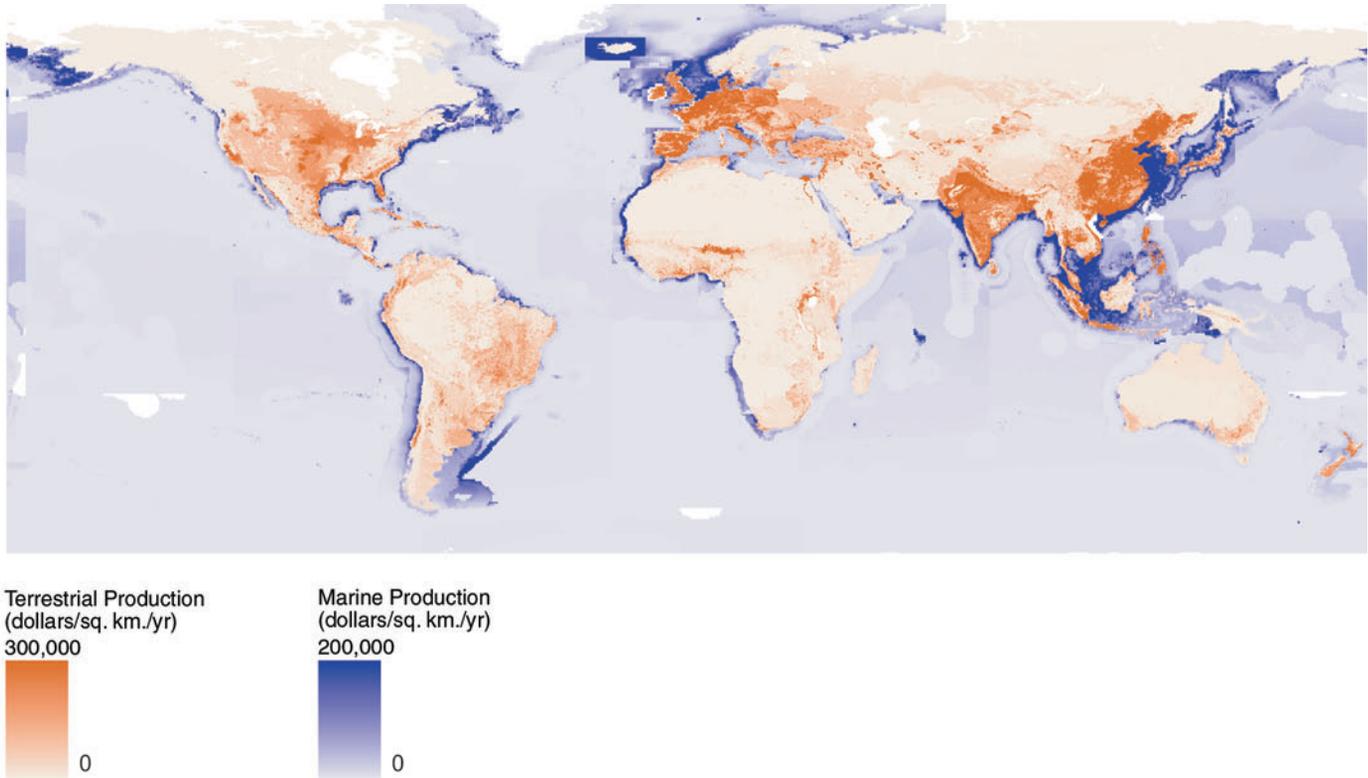
<sup>2</sup> VW in meat = VW in feed/fodder + 30% AET over grazing land.

<sup>3</sup> AET = actual evapotranspiration; percent relative to continental total.

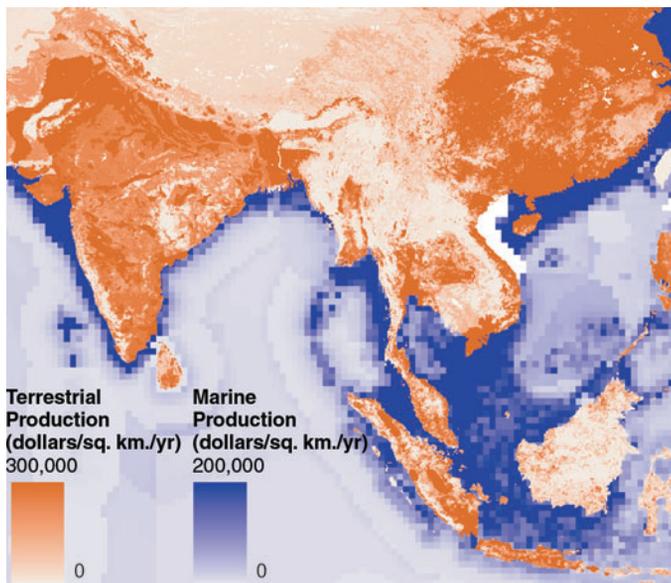
Box 7.4 Figure A



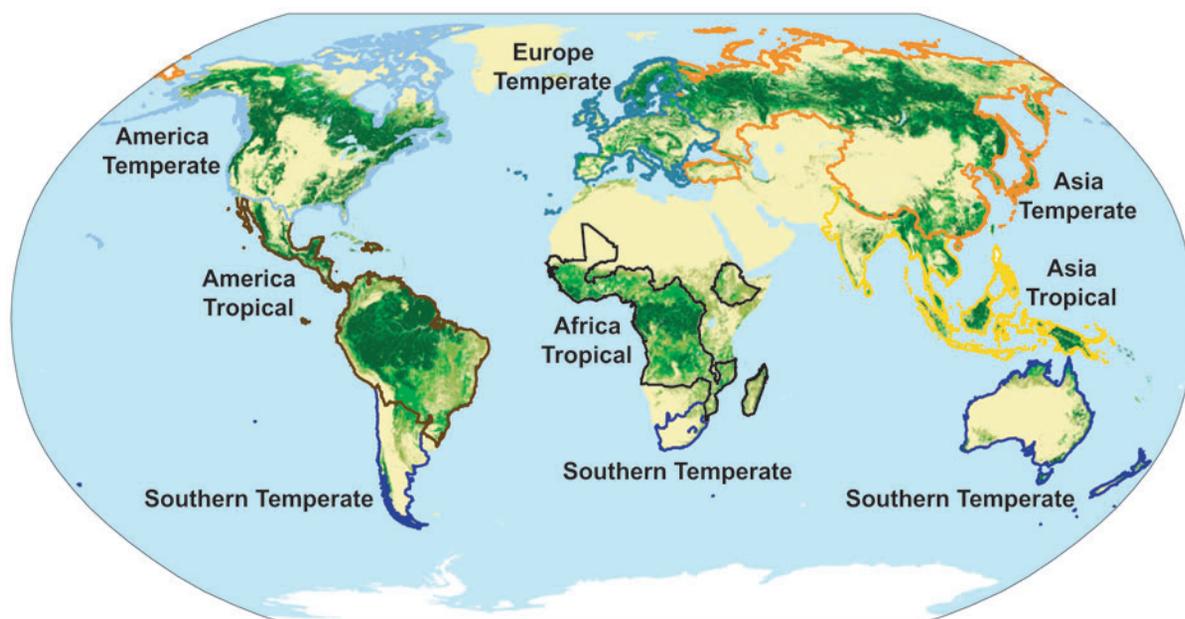
Box 7.4 Figure B



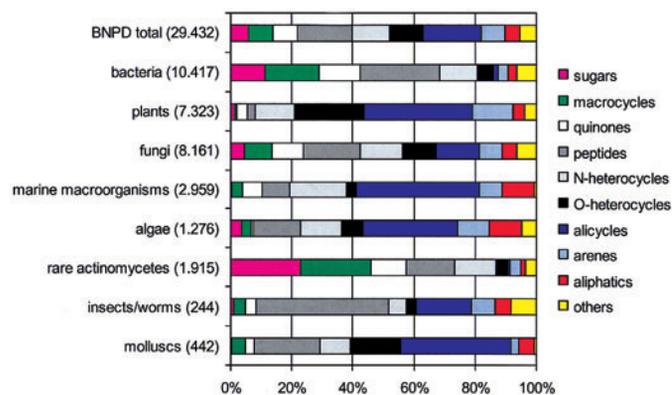
**Figure 8.2 Spatial Distribution of Value of Food Production for Crops, Livestock, and Fisheries, 2000.** The map shows the approximate value of production in year 2000 using FAOSTAT (2003) production data for all food crops and livestock products weighted by a set of 1989–91 global average commodity prices denominated in International US dollars. These prices are used by FAO to compute its Production Indices. The image was constructed from a composite rainfed-irrigated cropland surface using the global 1992–3 cropland map of Ramankutty and Foley (1998) intersected by the global irrigation map of Doell and Siebert (1999). Crop production was allocated by country in proportion to the share of each 100 km<sup>2</sup> occupied by rainfed and irrigated agriculture assuming irrigated agriculture is, on average, twice as productive as rainfed agriculture. Livestock production was allocated across a global pasture dataset (Foley et al. 2003) by country, assuming production was distributed into each pixel in proportion to its area of pasture/rangeland.



**Figure 8.3 Spatial Distribution of Food Production in Parts of Asia for Crops, Livestock, and Fisheries, 2000.** This map shows a detail of Figure 8.1. Notice the high value of food production—both marine and terrestrial—in coastal areas.



**Figure 9.1 Forest Regions Used in Wood Products Analyses.** Regions are based on closed forest cover, continents, climate, and national boundaries. (FAO 2001a; cartography, P. Gonzalez)

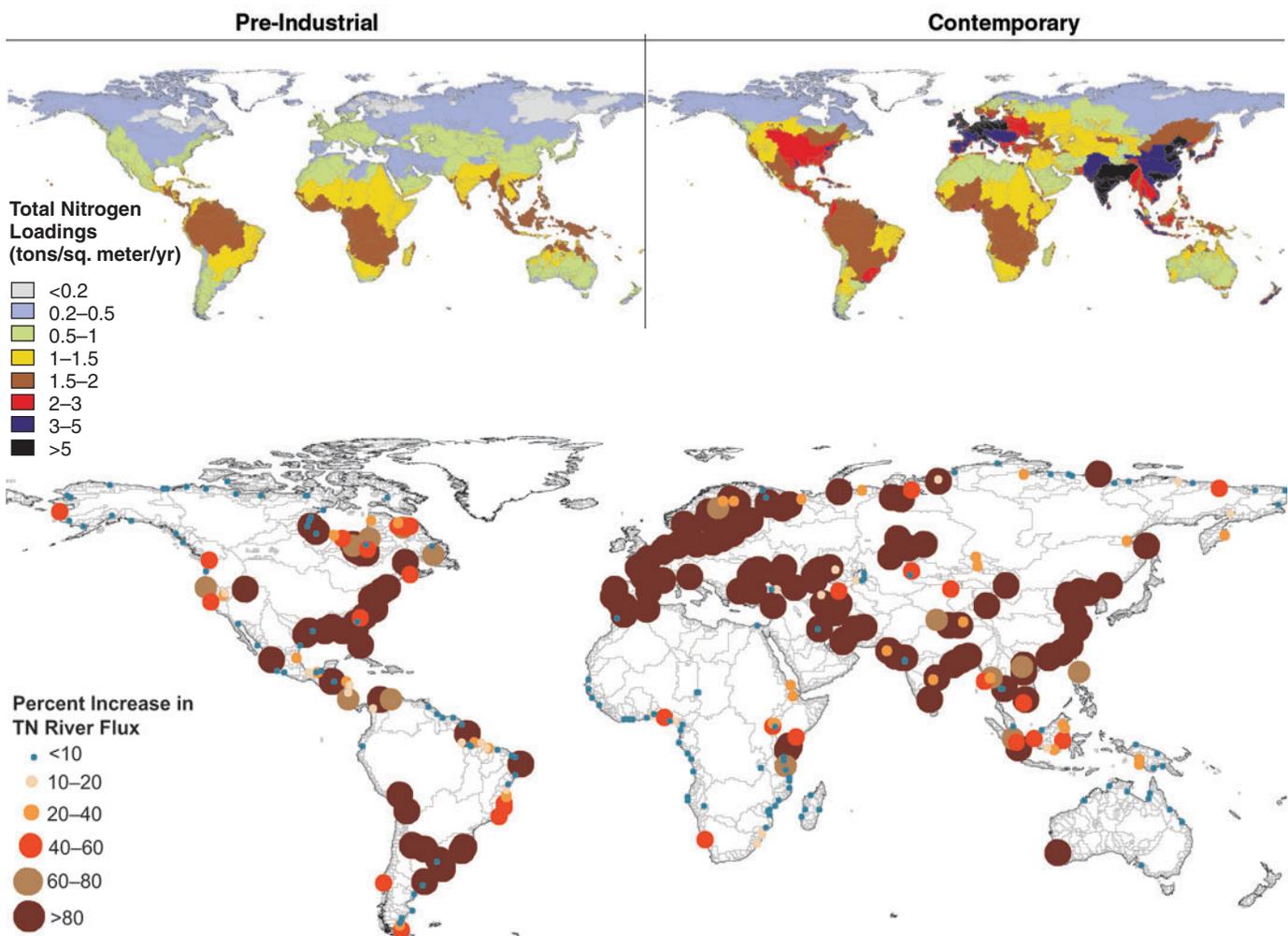


**Figure 10.1 Summary of Different Kinds of Natural Product Structures Produced by Different Organisms** (Bioactive Natural Product Database, Szenzor Management Consulting Company, Budapest, cited in Henkel et al. 1999)

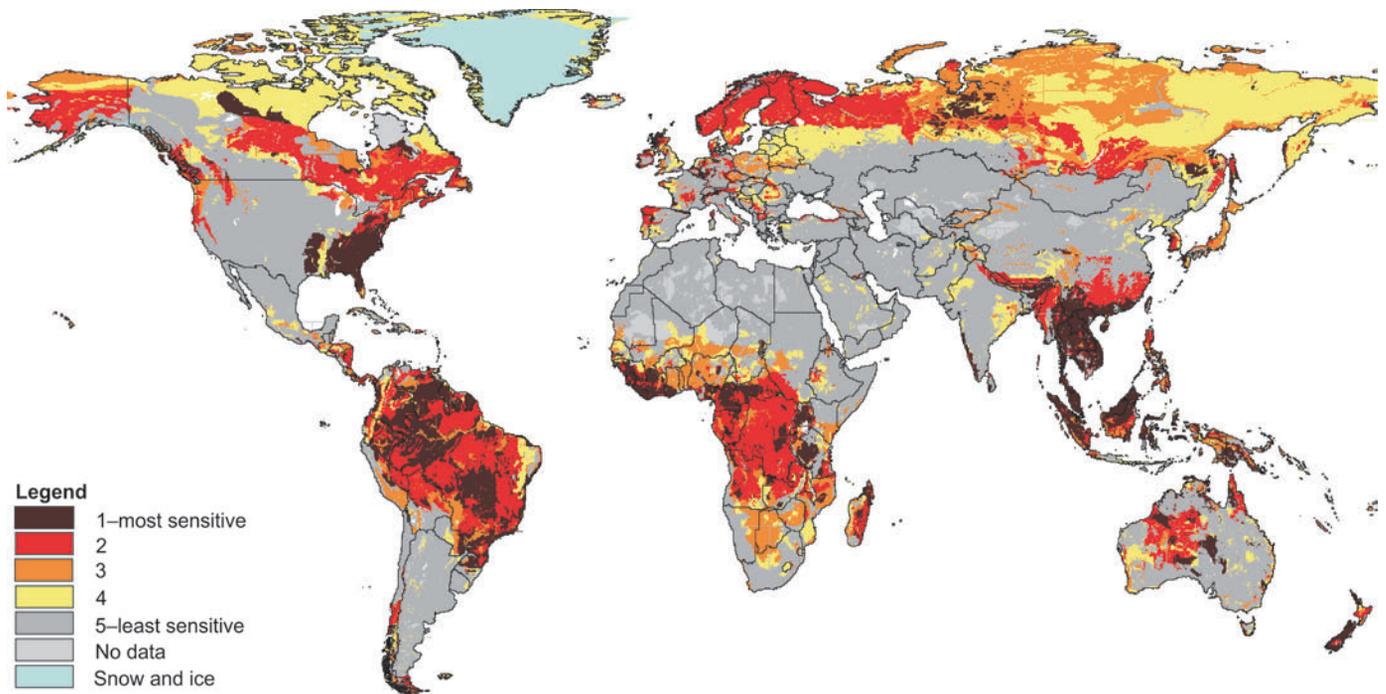


**Box 10.3 Figure Lake in Australia Covered by the Weed Salvinia**  
(Photos from CSIRO, Australia)

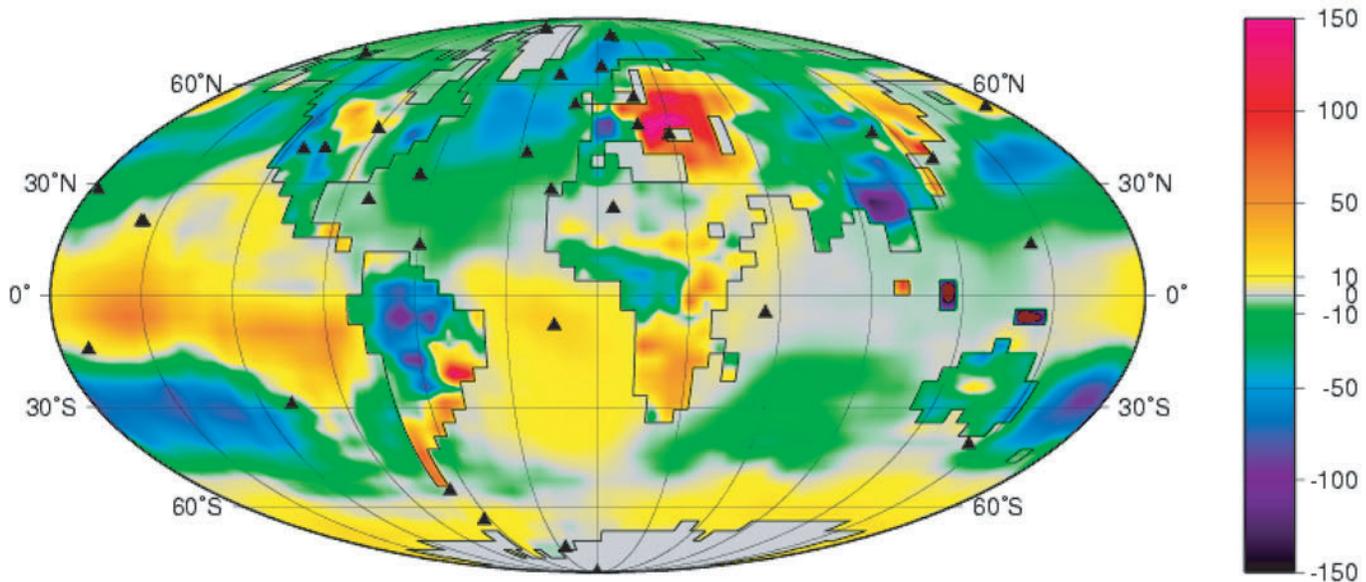
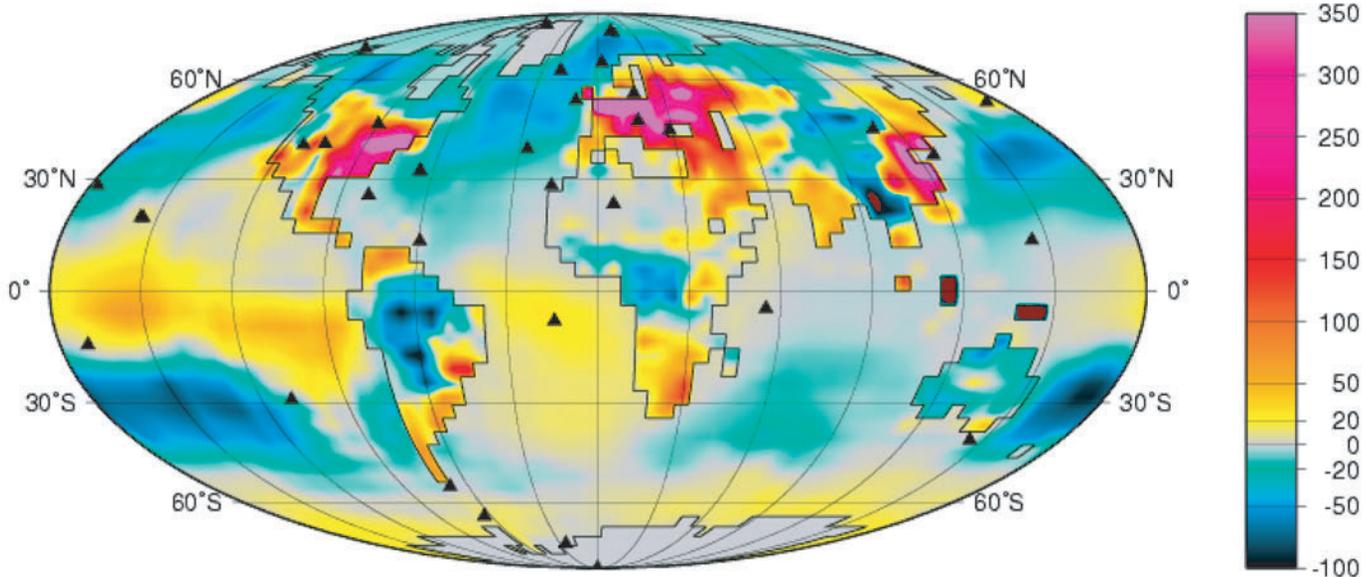
**The Same Lake Six Months Later Following the Release of a Weevil Biological Control Agent**



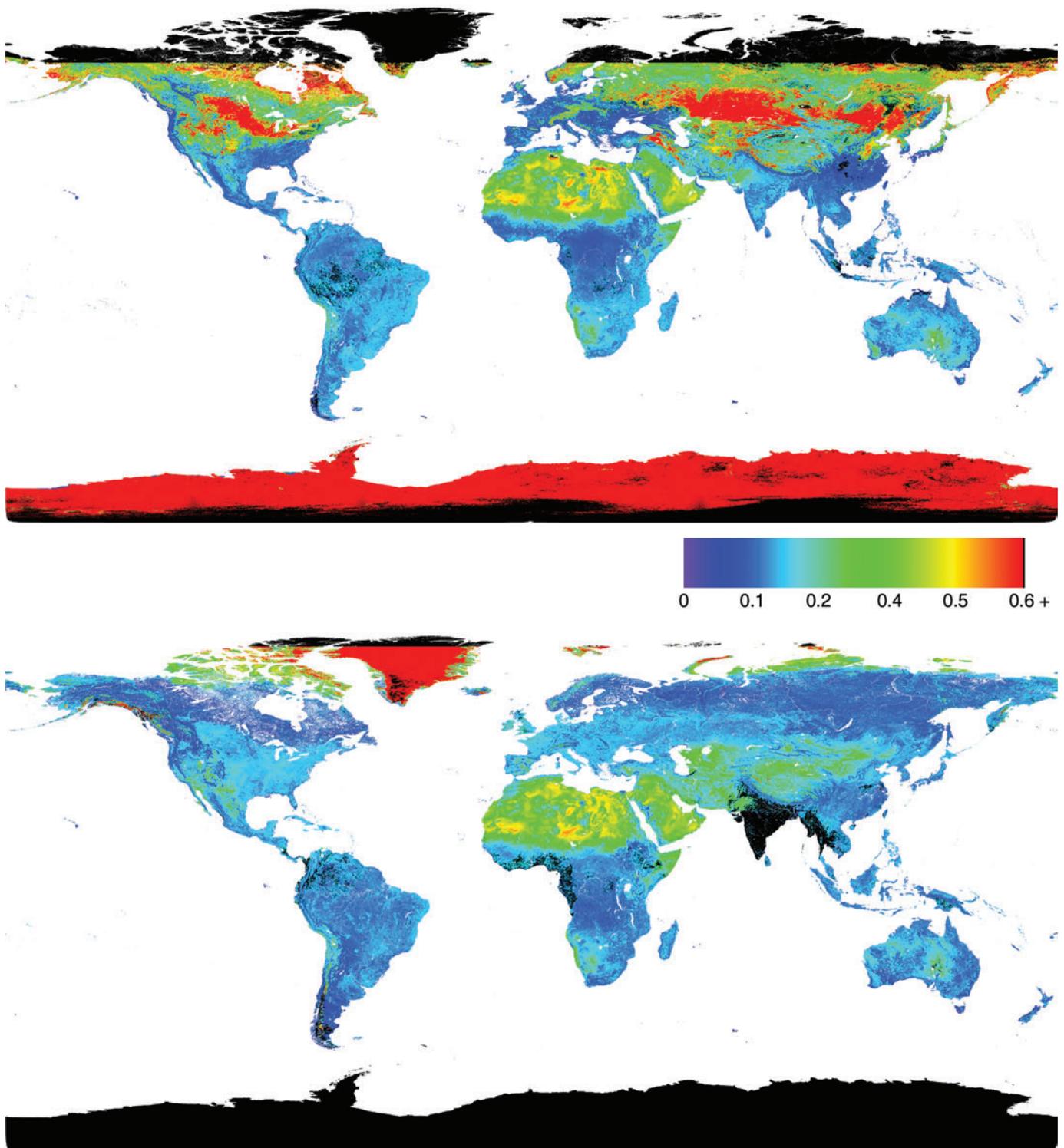
**Figure 12.3 Contrast between Contemporary and Preindustrial Loadings of Easily Transported Nitrogen onto Land Mass of Earth and Geography of Relative Increases in Riverborne Nitrogen Fluxes Resulting from Anthropogenic Acceleration of Cycle.** Contemporary time is from the mid-1990s. While the peculiarities of individual pollutants, rivers, and governance define the specific character of water pollution, the general patterns observed for nitrogen are representative of anthropogenic changes to the transport of waterborne constituents. Elevated contemporary loadings to one part of the system (e.g., to croplands) often reverberate to other parts of the system (e.g., coastal zones), exceeding the capacity of natural systems to assimilate additional constituents. (Green et al. 2004)



**Figure 12.6 Global Map of Soil Sensitivity to Acidic Inputs from Atmospheric Sulfur and Nitrogen Deposition.** This map shows the ability of the soil to buffer acid deposition. Problems of acidification are most likely to arise where high projected rates of deposition coincide with high sensitivity—for instance, in Southeast Asia. (Kuylenstierna et al. 2001)

**Modeled Map of Carbon Dioxide Sources and Sinks, Excluding Fossil Fuels****Modeled Map of Carbon Dioxide Sources and Sinks, Including Fossil Fuels**

**Figure 13.5 Maps of Carbon Dioxide Fluxes Estimated from Atmospheric Measurements, July 1995 to June 2000 (in  $\text{gC}/\text{m}^2/\text{year}$ )** (Rödenbeck et al. 2001). The spatial allocation of sources and sinks of  $\text{CO}_2$  is derived from measurements of atmospheric concentrations from a network of sites over the globe using a technique known as inverse modeling. This technique gives the sum of all fluxes. Positive numbers denote a source into the atmosphere; negative numbers denote a sink from the atmosphere. The magnitude and spatial allocation of fluxes is very sensitive to the number of measuring sites and the time period of the analysis. The top figure is the total flux excluding fossil fuel emissions to highlight the terrestrial vegetation fluxes. The bottom figure includes fossil fuel emissions; therefore land areas appear to be sources or smaller sinks.



**Figure 13.8 Map of Land Surface Albedo Captured by the MODIS Satellite Instrument** (Schaaf et al. 2002; Lucht et al. 2000). Albedo is the fraction of solar radiation reflected back into the atmosphere from Earth's surface. Higher albedo means that more energy leaves the planetary boundary layer (net cooling of the atmosphere). Regions where there were no data available, e.g., due to clouds, are indicated by black. The top figure is of data sampled in January 2001. In the northern areas during the winter season, snow albedo is very high (up to 0.8, red). The boreal forest belt can be clearly seen in blue and green since trees mask snow, reduce albedo, and warm the surface air during the snow season. The bottom figure is of data sampled in June 2001. In comparison with January 2001, the northern land areas have a much lower albedo due to the absence of snow. In this map, the area with the highest albedo (up to 0.5, green and yellow) is the Sahara desert. High albedo in this region suppresses rainfall during the summer rain season.

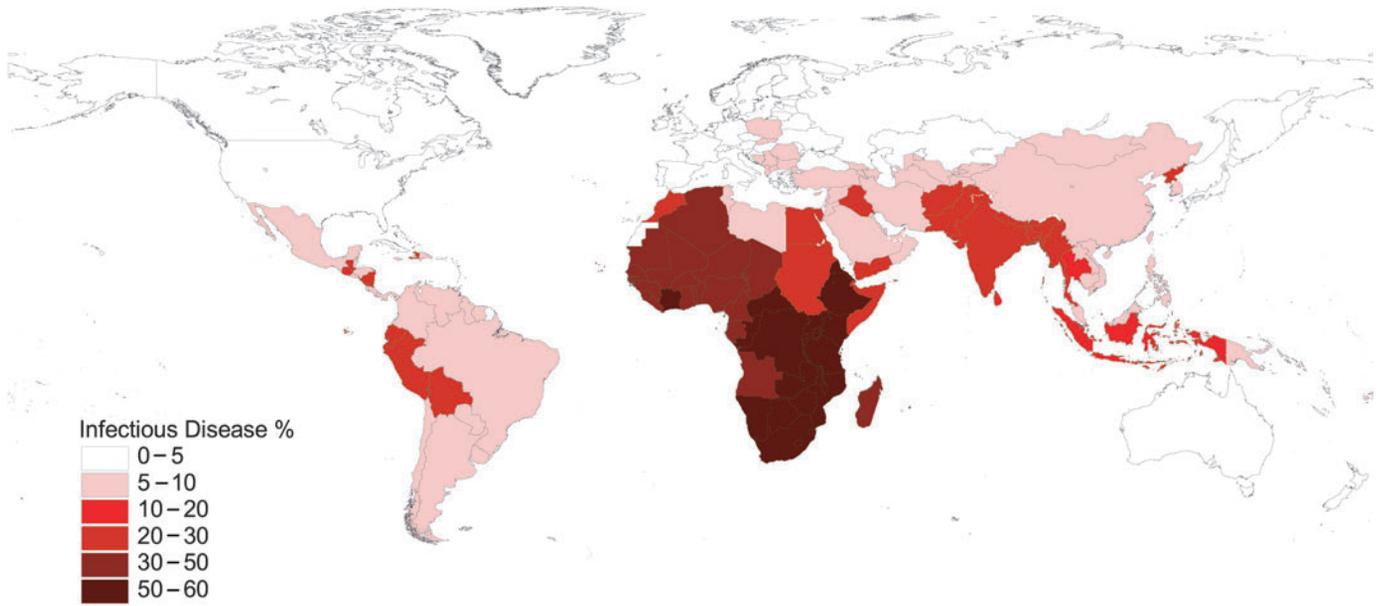


Figure 14.1 Current Map of Infectious and Parasitic Diseases

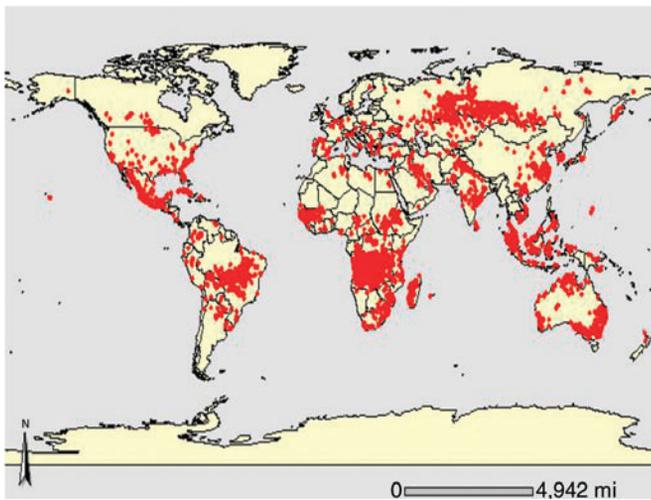


Figure 16.2 MODIS Fire Pixels Detected May 20–22, 2004 (Image courtesy of MODIS Rapid Response Project at NASA/GSFC)

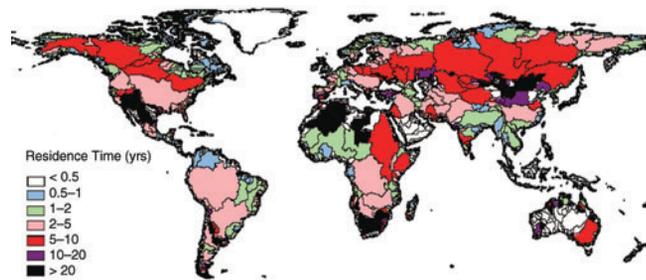


Figure 16.3 Residence Time in Lakes, Reservoirs, and Soils, by Basin (Green et al. 2004)

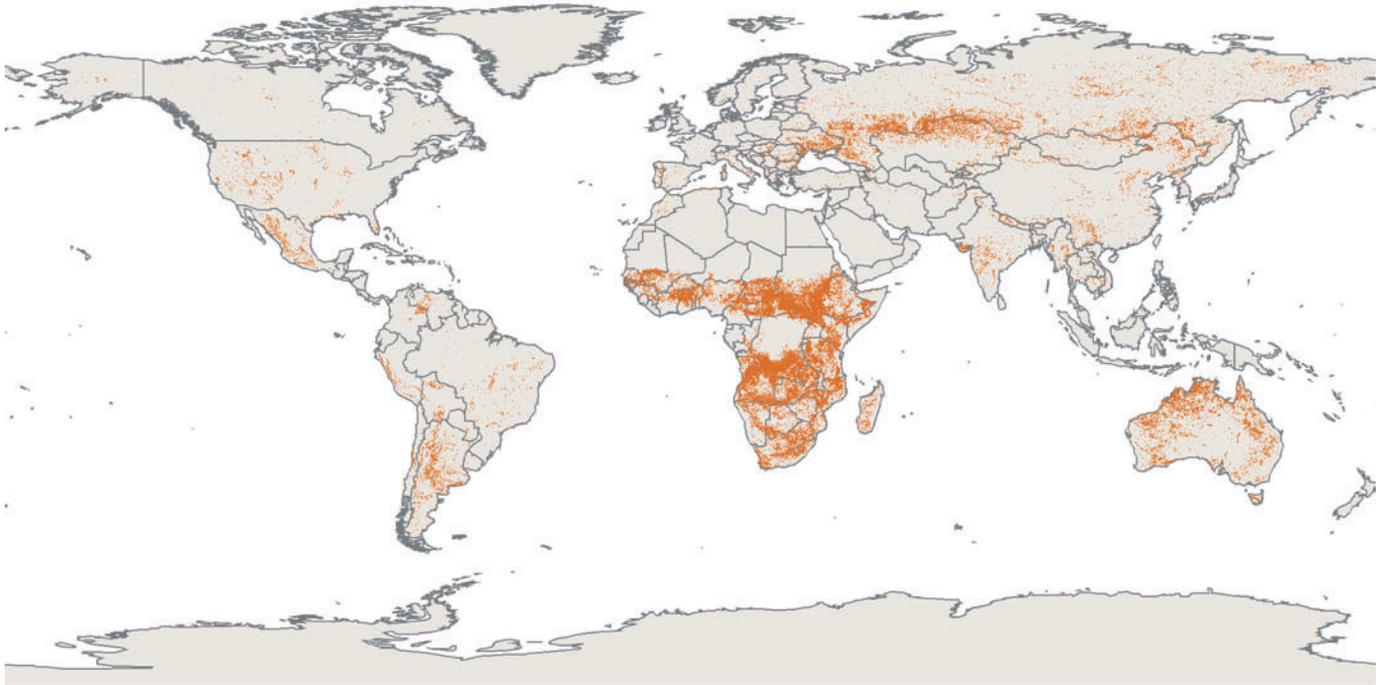


Figure 16.6 Global Patterns of Burned Area in 2000, Based on the GBA2000 Product (Grégoire et al. 2003)

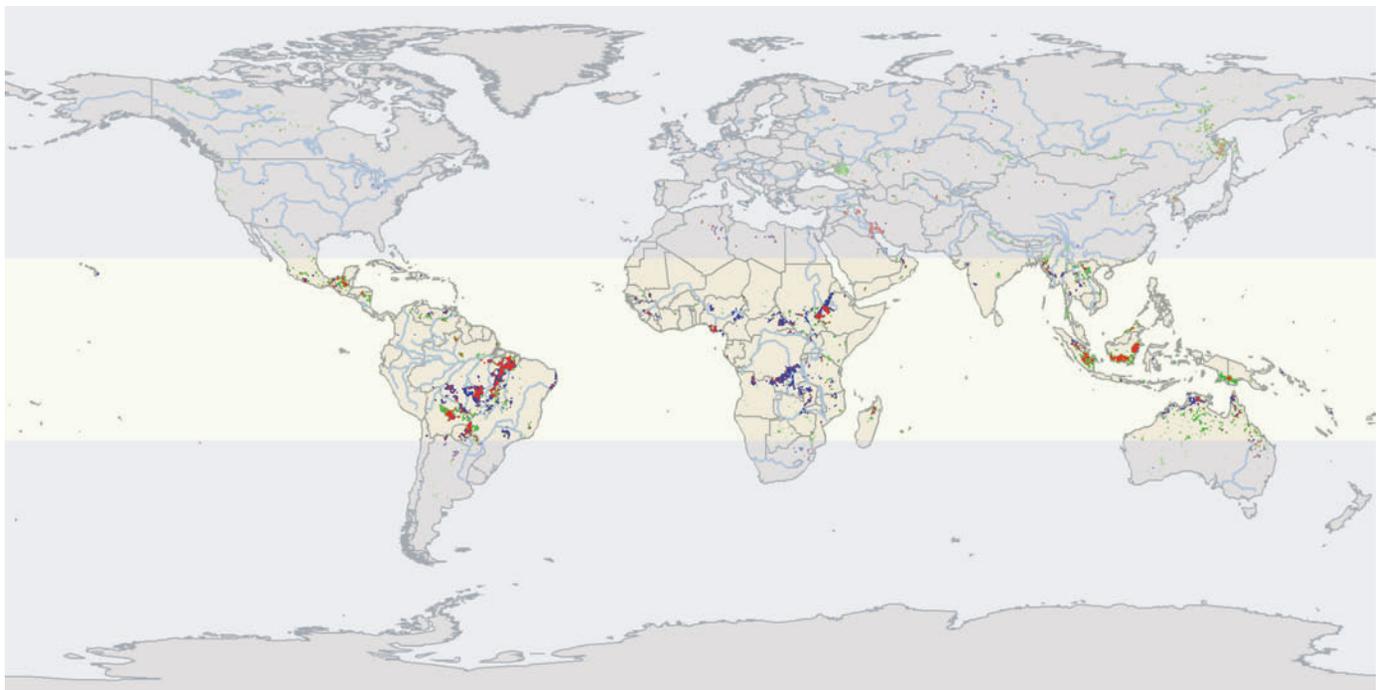
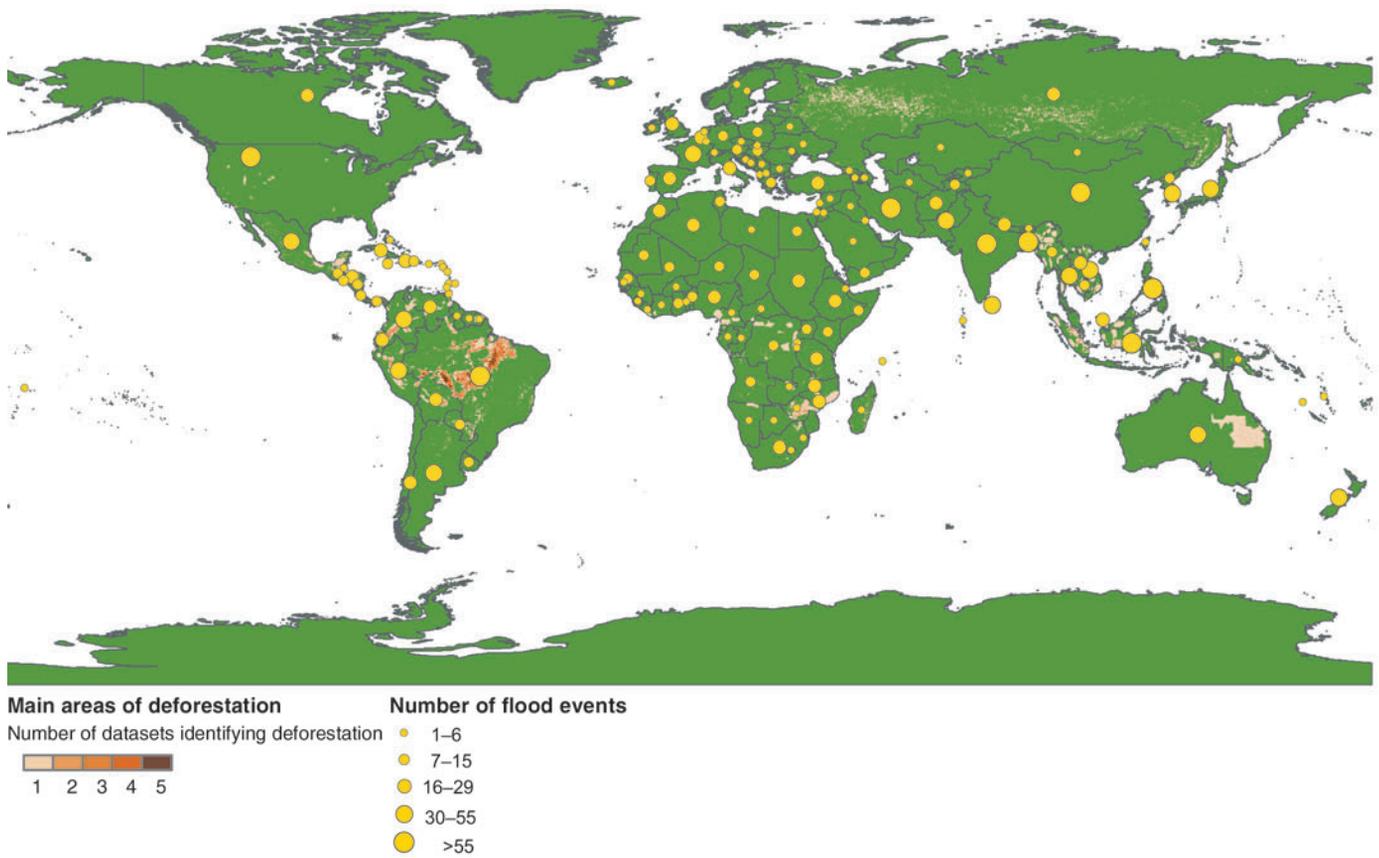
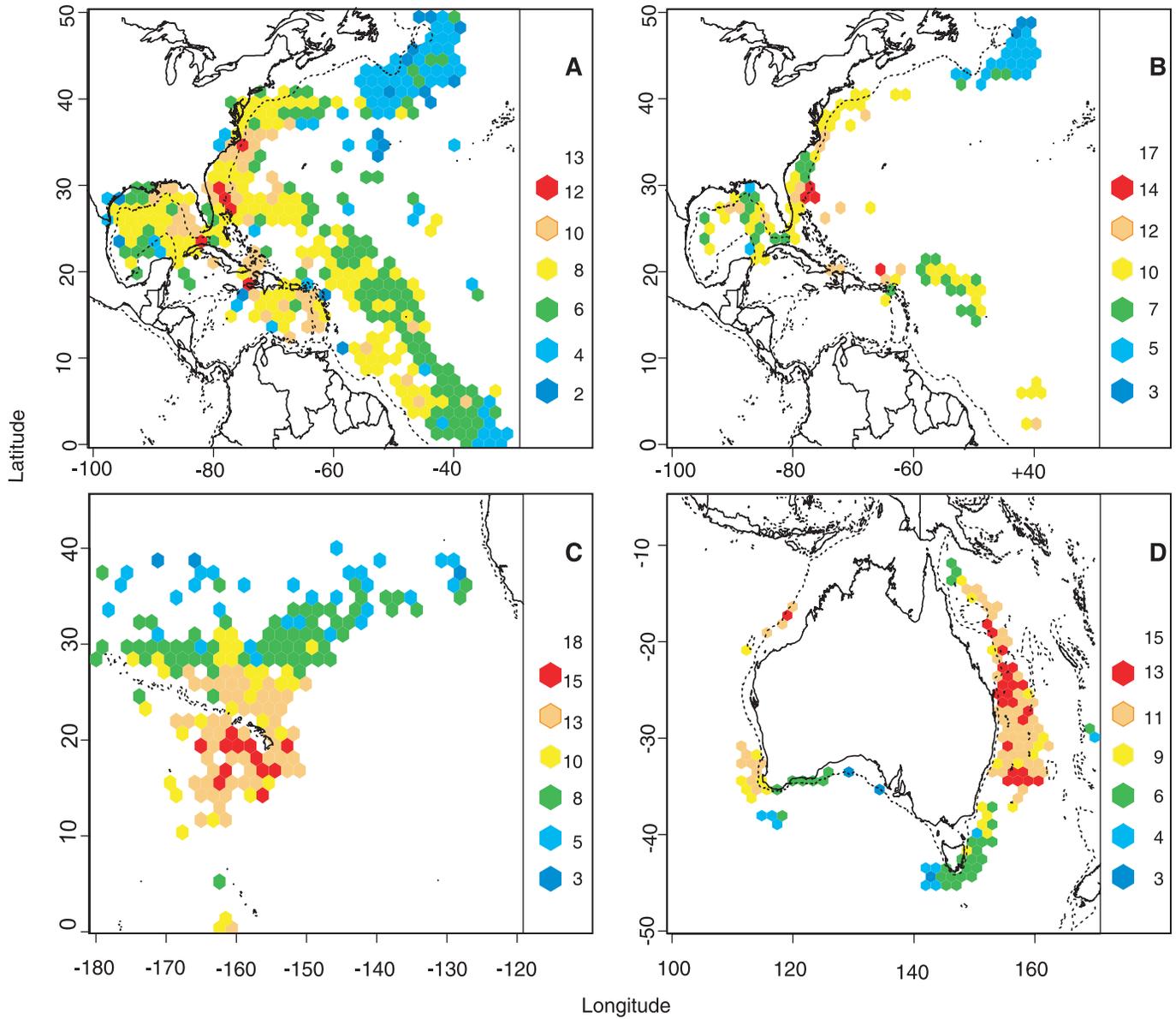


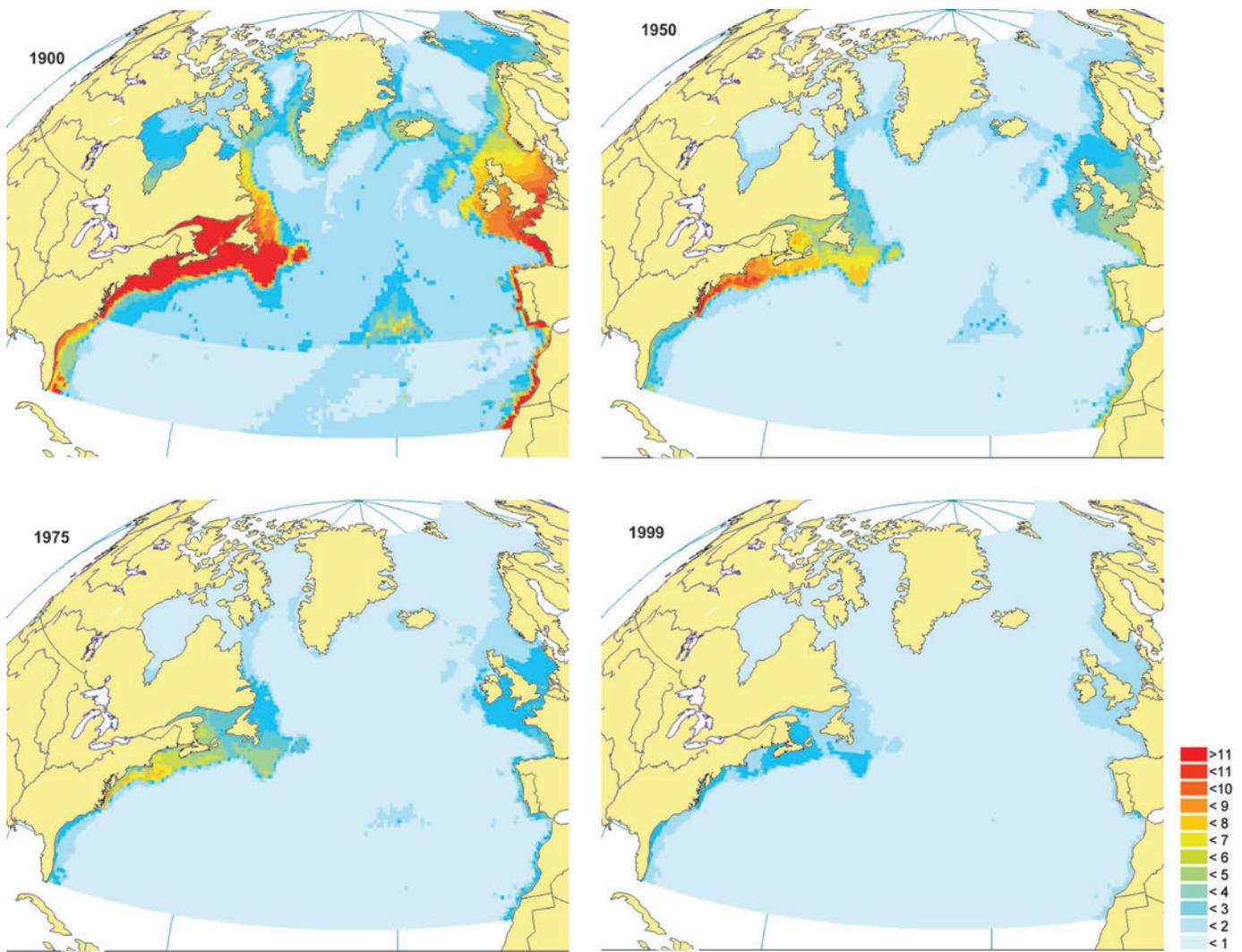
Figure 16.7 Map of Most Frequent and Exceptional Fire Events in the Tropics, 1997–2000 (Lepers 2003)



**Figure 16.10** Main Areas of Deforestation and Forest Degradation and Number of Floods, by Country, 1980–2000 (Lepers 2003; OFDA/CRED)



**Figure 18.7 Predator Diversity in the Ocean.** Predicted from the Northwest Atlantic Longline Logbook (A), Observer Data (B), Hawaiian Observer Data (C), and Australian Observer Data (D). Codes indicate level of species diversity. Dotted line represents 1,000-m isobaths, identifying the outer margins of continental slopes. (Worm et al. 2003)



**Figure 18.8** Changes in Marine Biomass in North Atlantic in 1900, 1950, 1975, and 1999 (in tons per square kilometer) (Christensen et al. 2003)

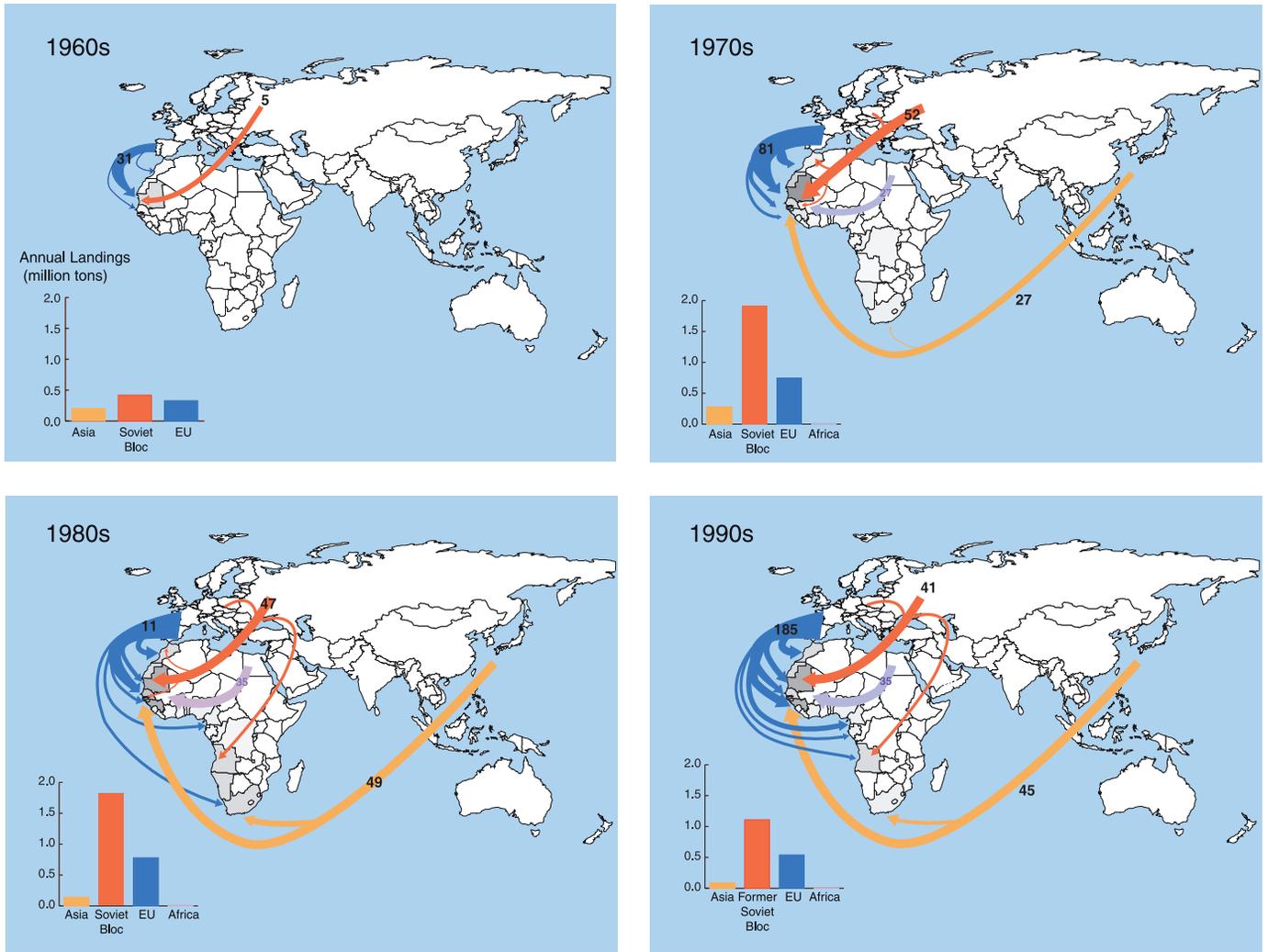


Figure 18.17 Changes in Distant Water Fleet Access as Number of Agreement Years for 1960s, 1970s, 1980s, and 1990s (Alder and Sumaila 2004)



Figure 19.5 Global Distribution of Mangrove Forests, and Levels of Sediment Loading on Mangroves in the Asia-Pacific Region (UNEP-WCMC 2003a; Syvitski et al. 2005)

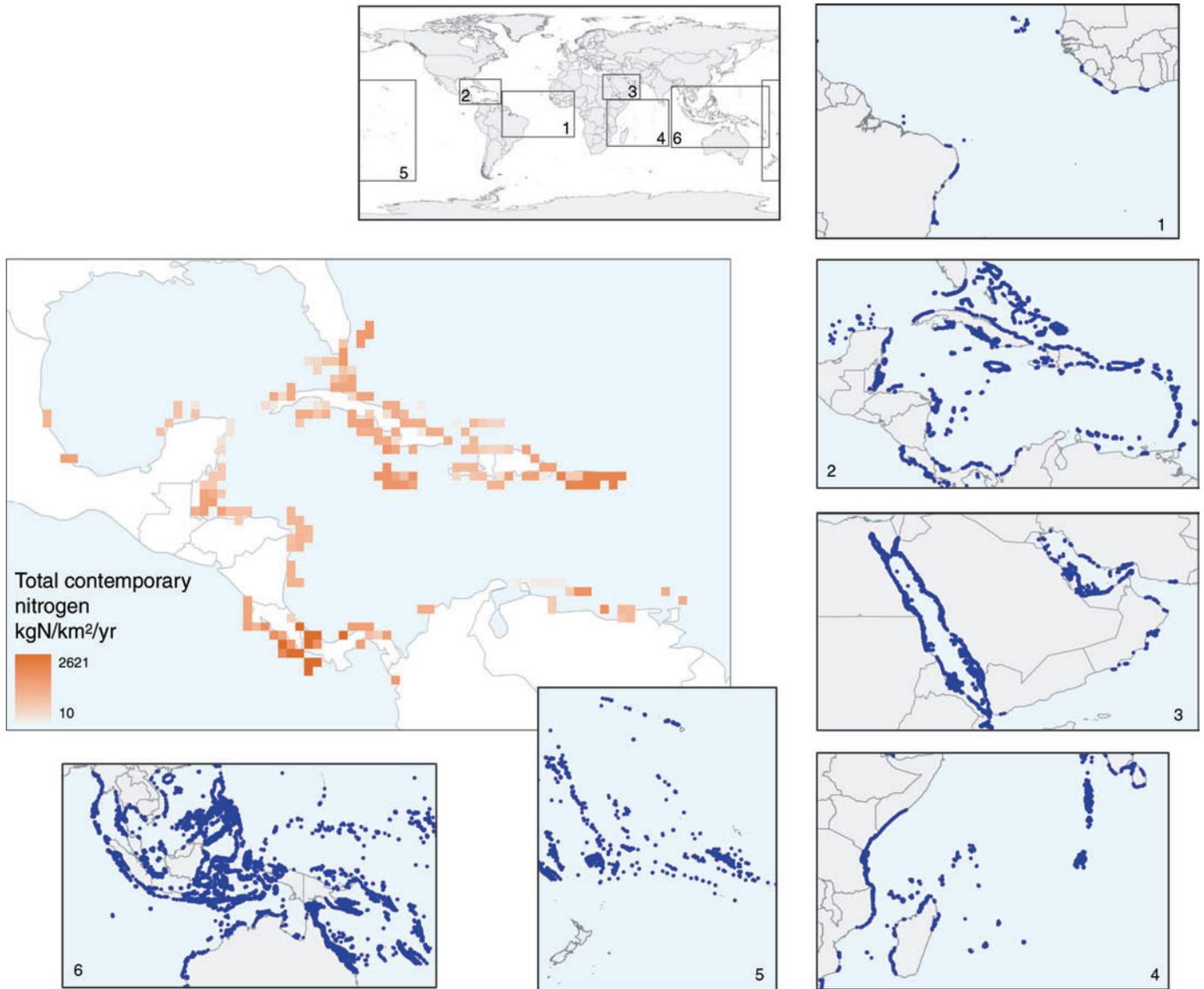


Figure 19.6 Global Distribution of Major Coral Reefs and Levels of Nitrogen on Caribbean Coral Reefs (UNEP-WCMC 2003d; Syvitski et al. 2005)

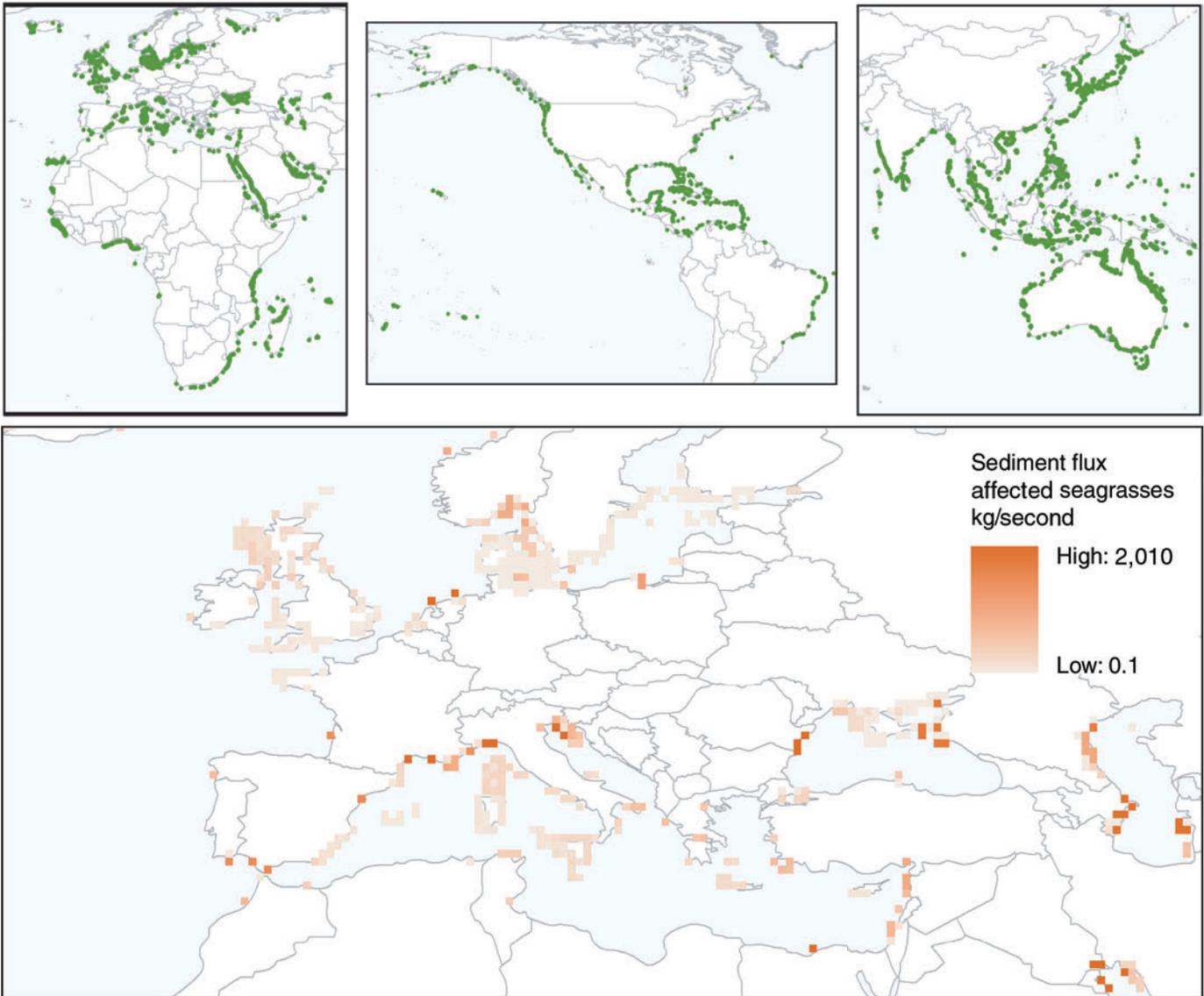
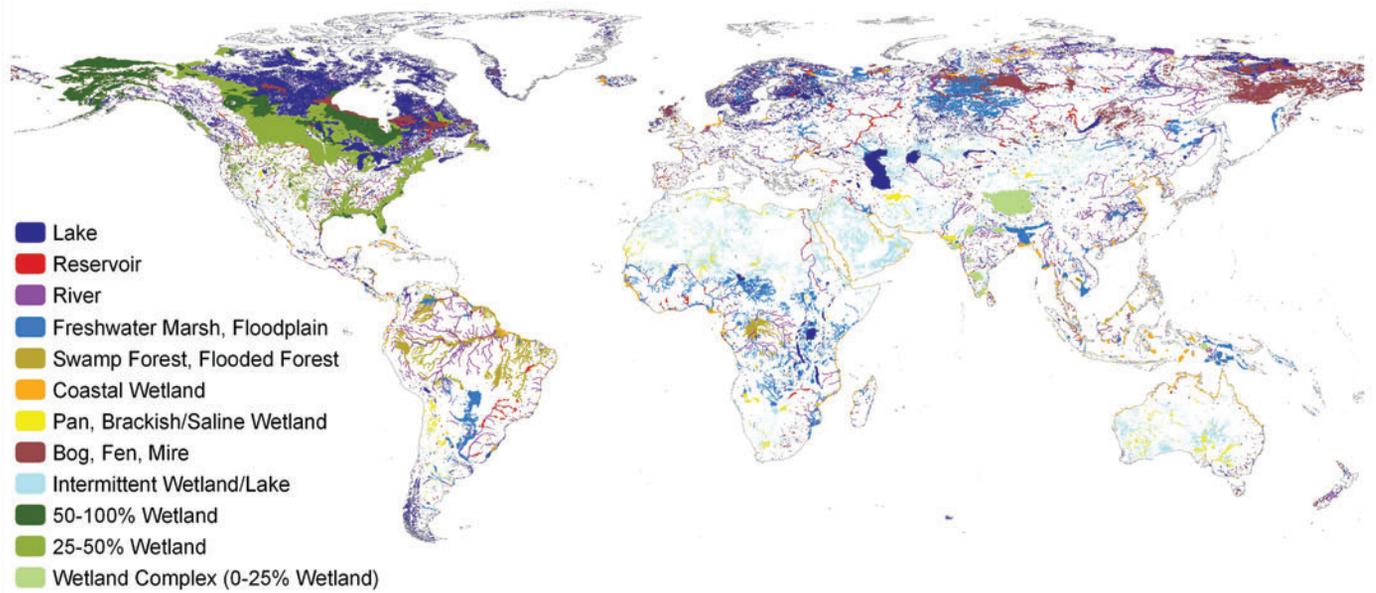
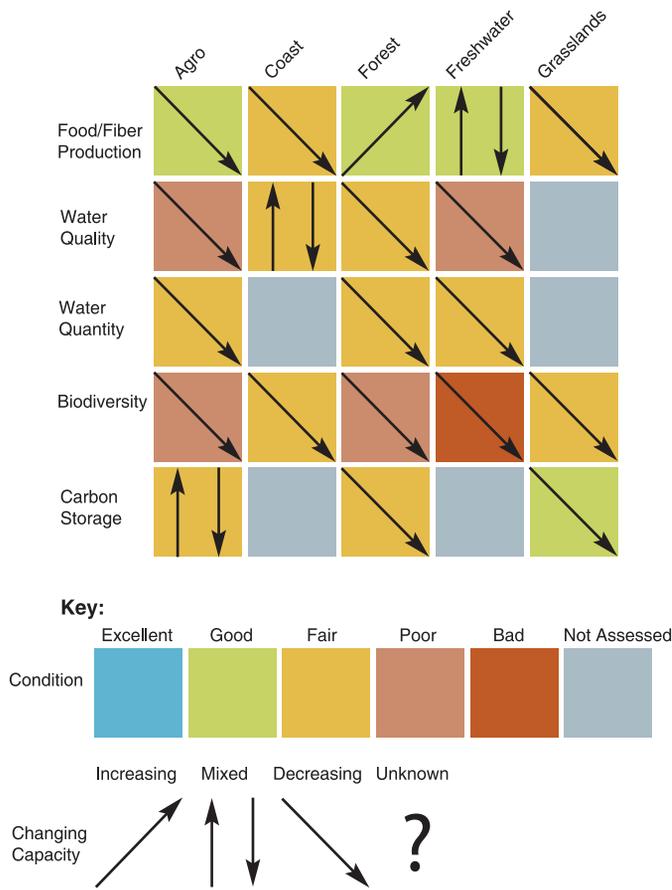


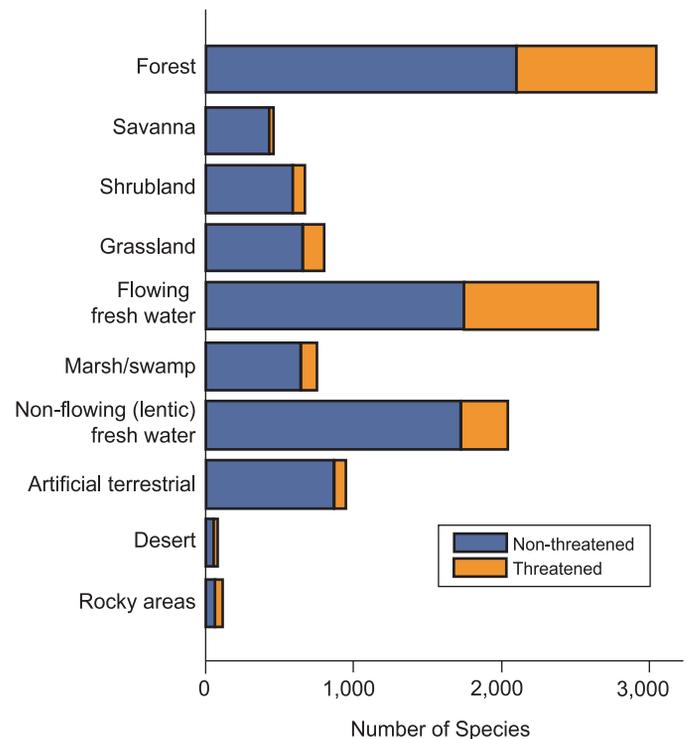
Figure 19.7 Global Distribution of Seagrasses, and Levels of Sediment Loading on European Seagrass Areas (UNEP-WCMC 2003c; Syvitski et al. 2005)



**Figure 20.1** Distribution of Inland Water Systems Described as Large Lakes, Reservoirs, and Wetlands (Adapted from Lehner and Döll 2004 and LakeNet)



**Figure 20.2** Summary Analysis of Capacity of a Range of Ecosystems to Produce Services (WRI et al. 2000)



**Figure 20.4** Number of Threatened versus Non-threatened Wetland-dependent Amphibian Species by Major Habitat Type I (Data compiled under the Global Amphibian Assessment; IUCN et al. 2004)

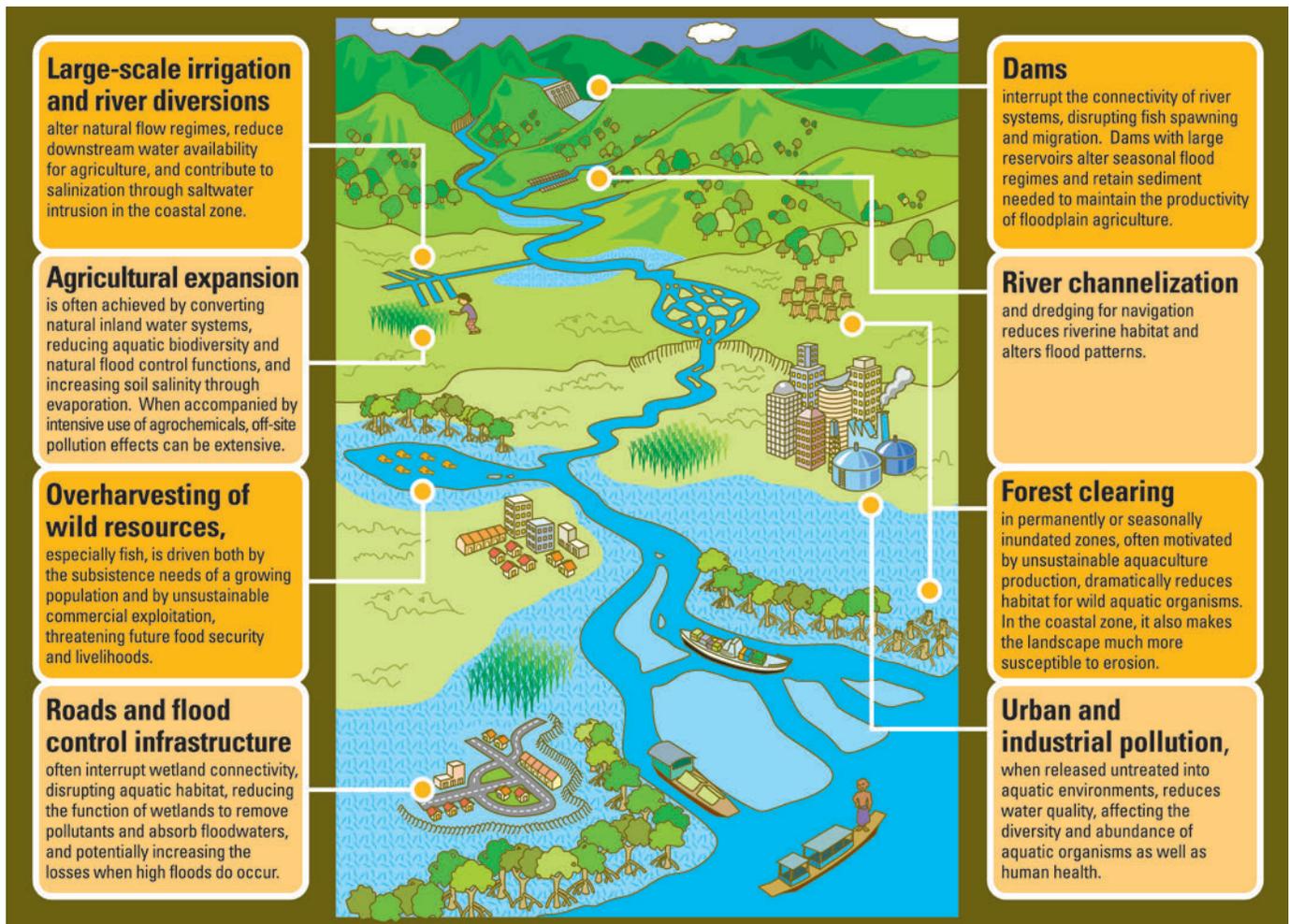


Figure 20.7 Pictorial Presentation of the Direct Drivers of Change in Inland Waters (Ratner et al. 2004)

1973



1986



1999



2001



Figure 20.8 Changes in the Aral Sea, 1960–2001 (UNEP 2002)

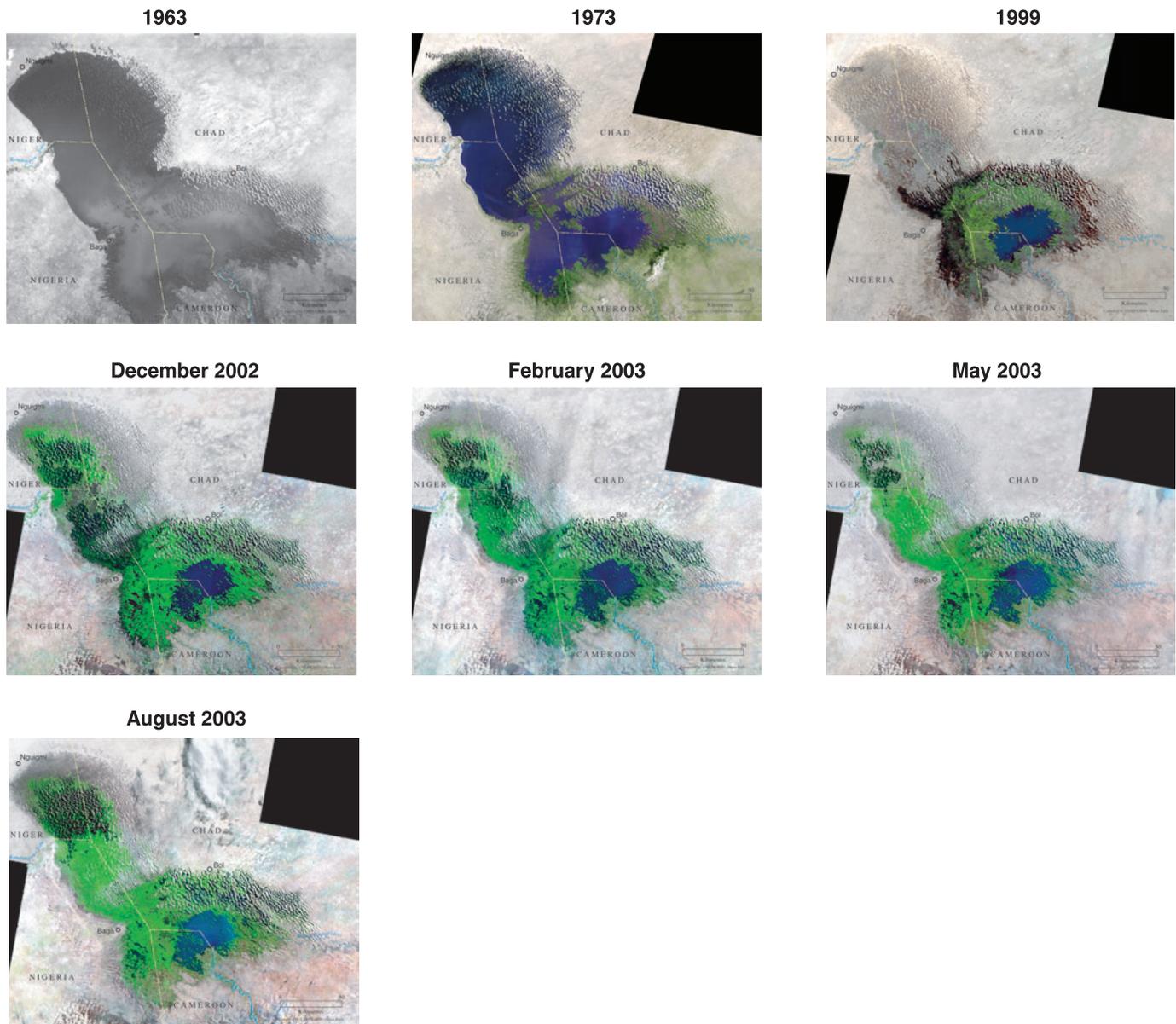


Figure 20.9 Changes in Area of Water in Lake Chad, 1963–2001 (UNEP 2002)

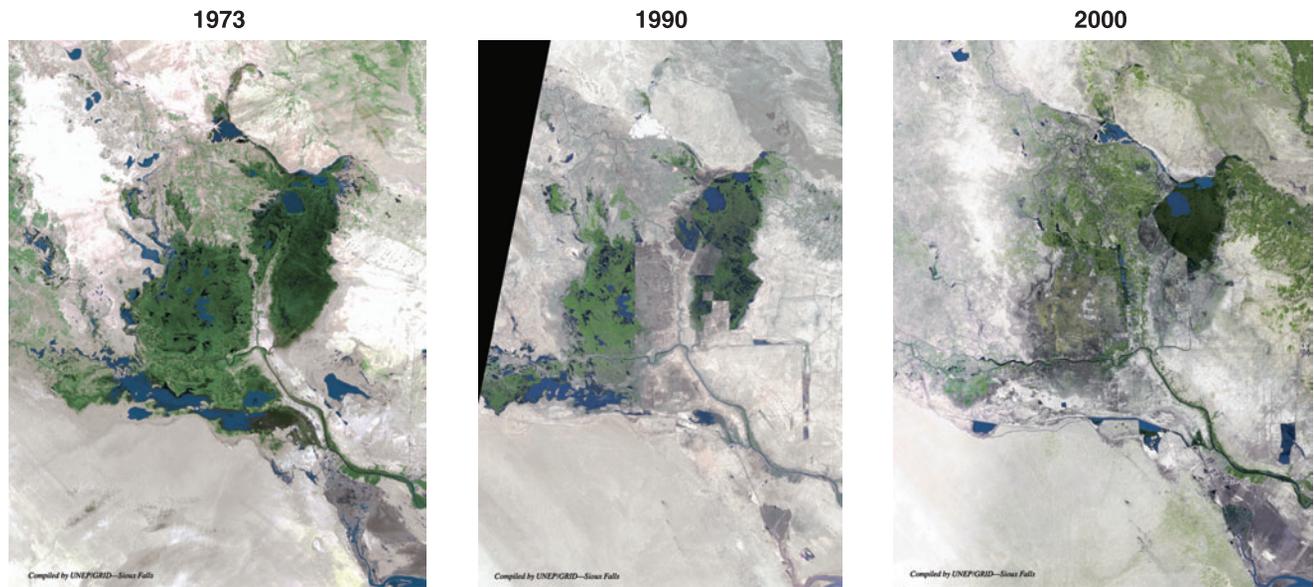


Figure 20.10 Changes in the Mesopotamian Marshes, 1973–2000 (Partow 2001)

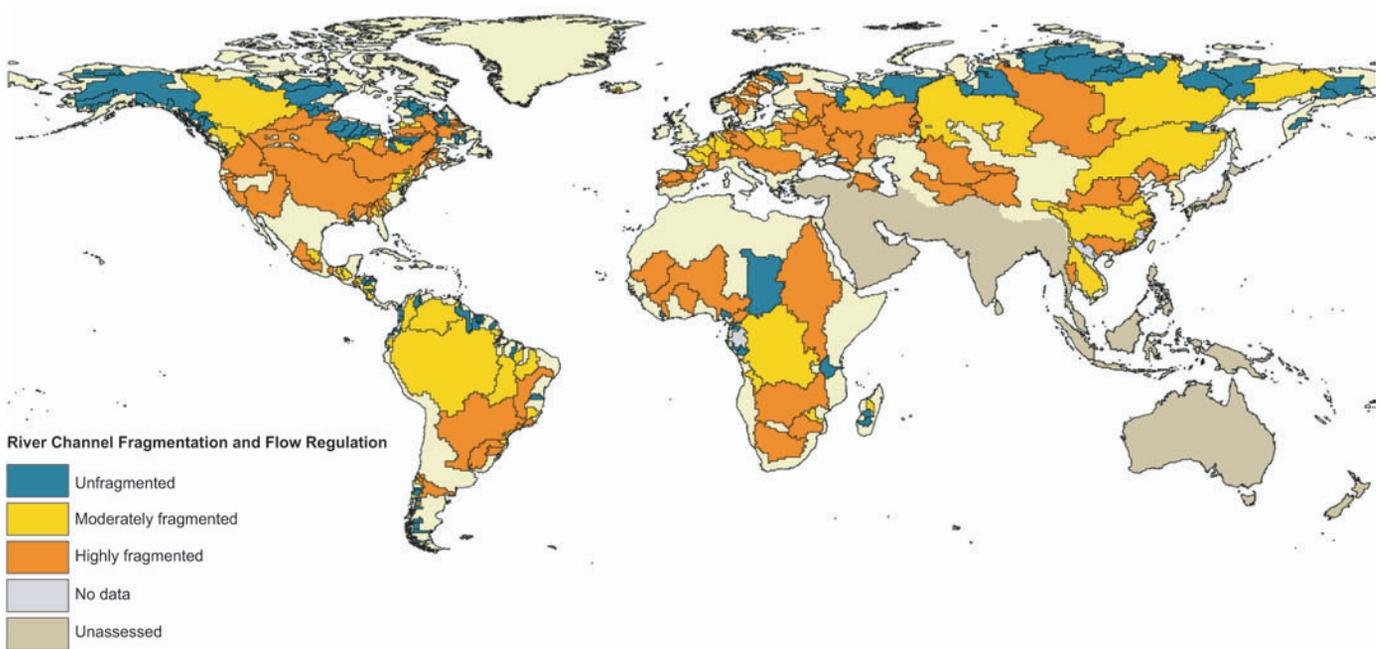
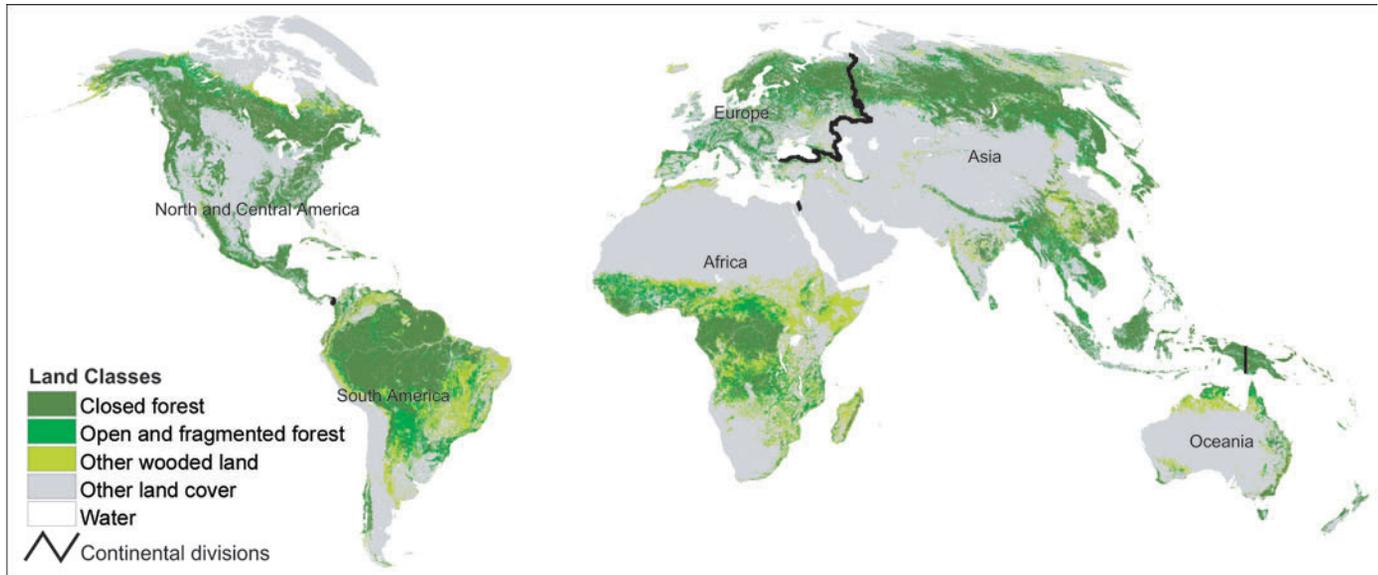
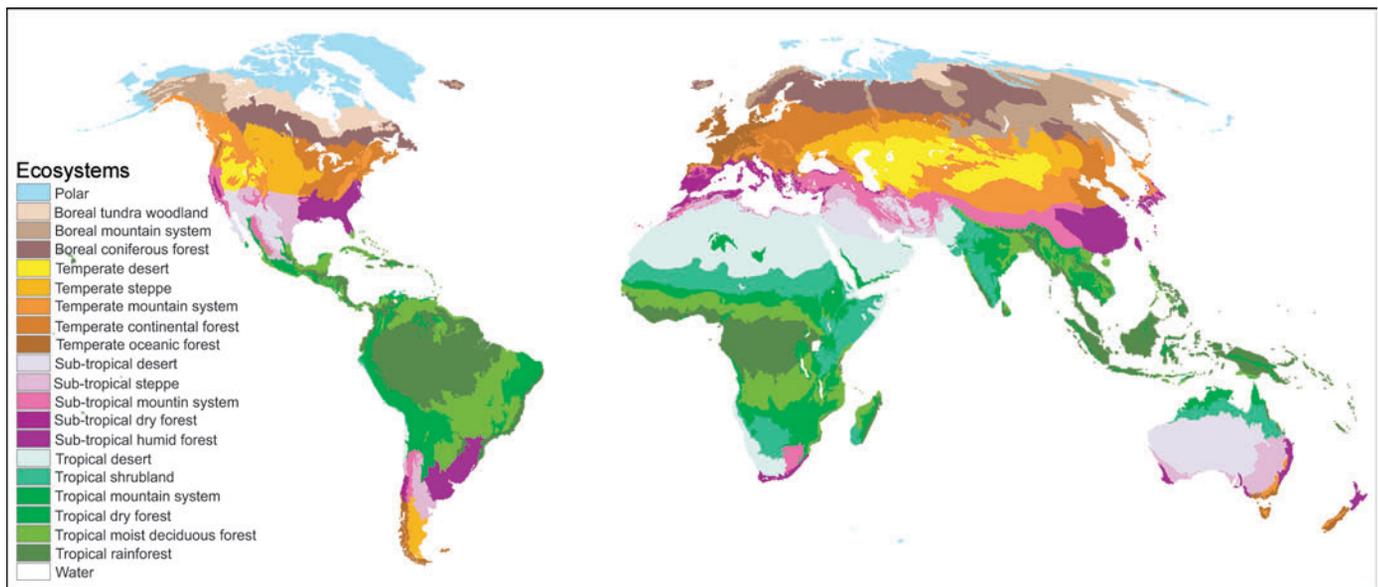


Figure 20.11 Fragmentation and Flow Regulation of Global Rivers (Revena et al. 2000)



**Figure 21.1 Global Forest and Woodland Cover by Aggregated Category and Continent.** Open forests and fragmented forests have a canopy closure from 10–40%, and closed forests have a canopy closure of less than 40%. (FRA 2000 datasets)



**Figure 21.2 Distribution of Global Forests by Ecological Zone** (FRA 2000 datasets)

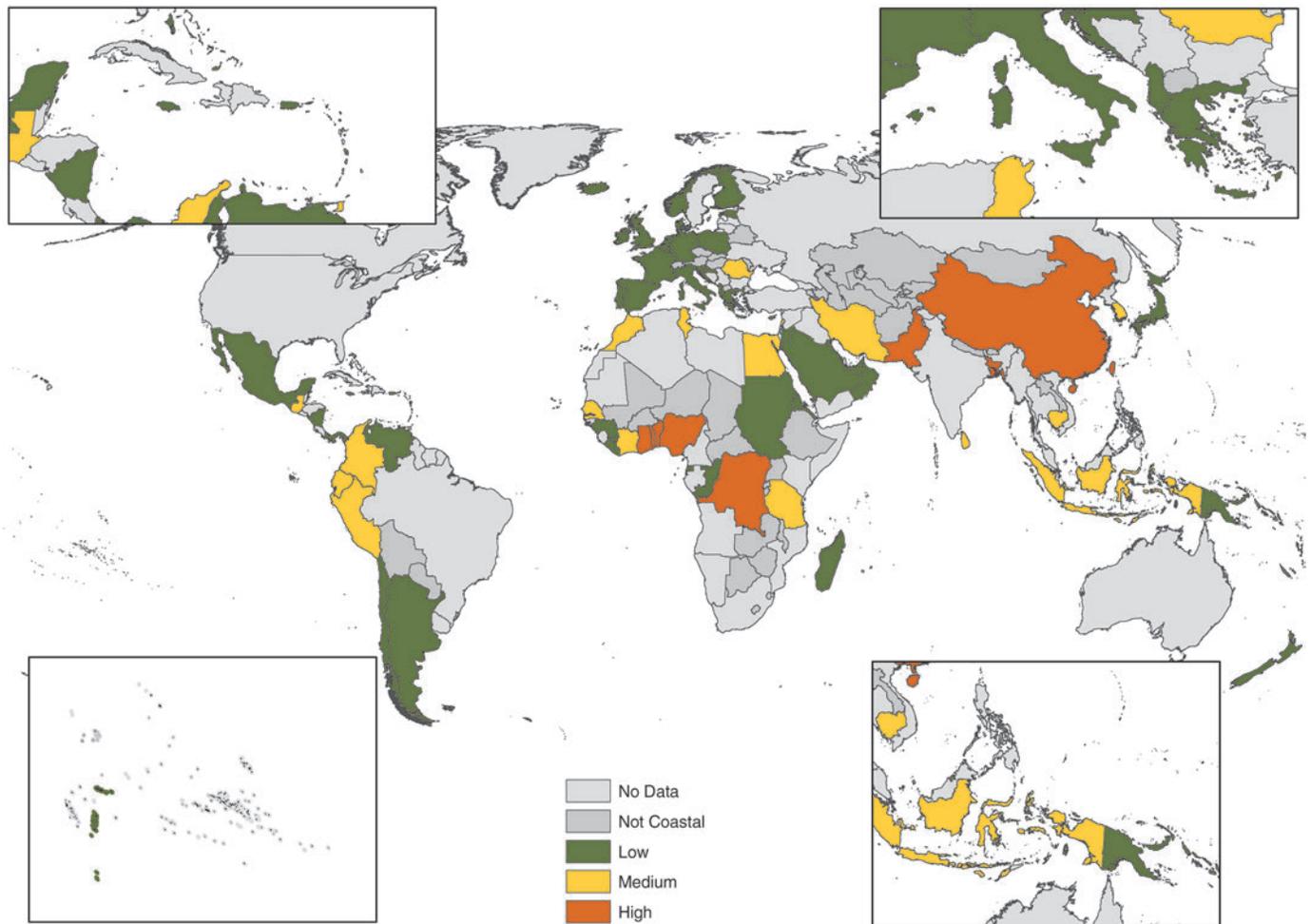


Figure 23.1 Fishing Pressure in Coastal Areas Based on the Number of People Actively Fishing per Kilometer of Coastline

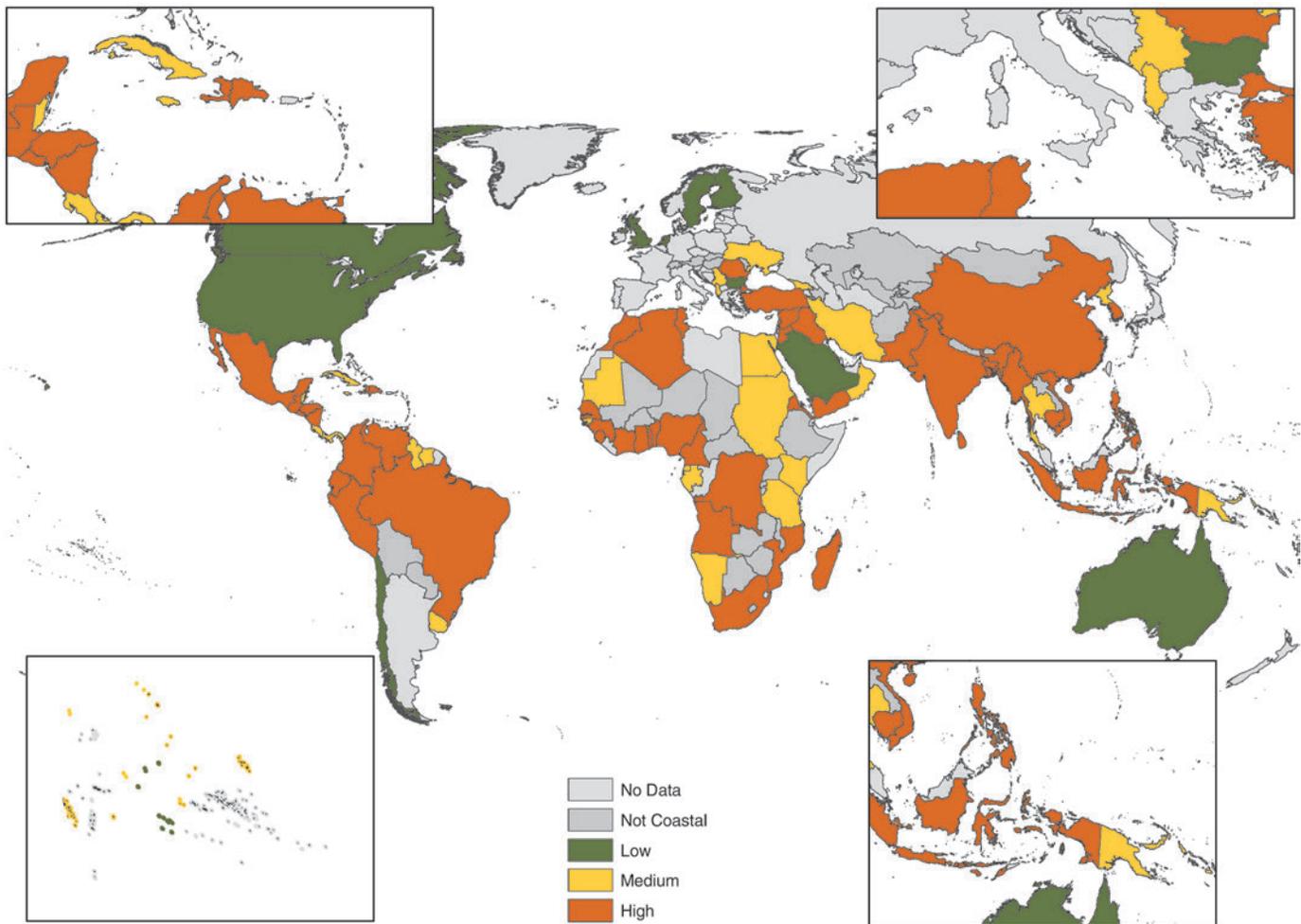


Figure 23.2 Sewage Pollution Index for Coastal Areas

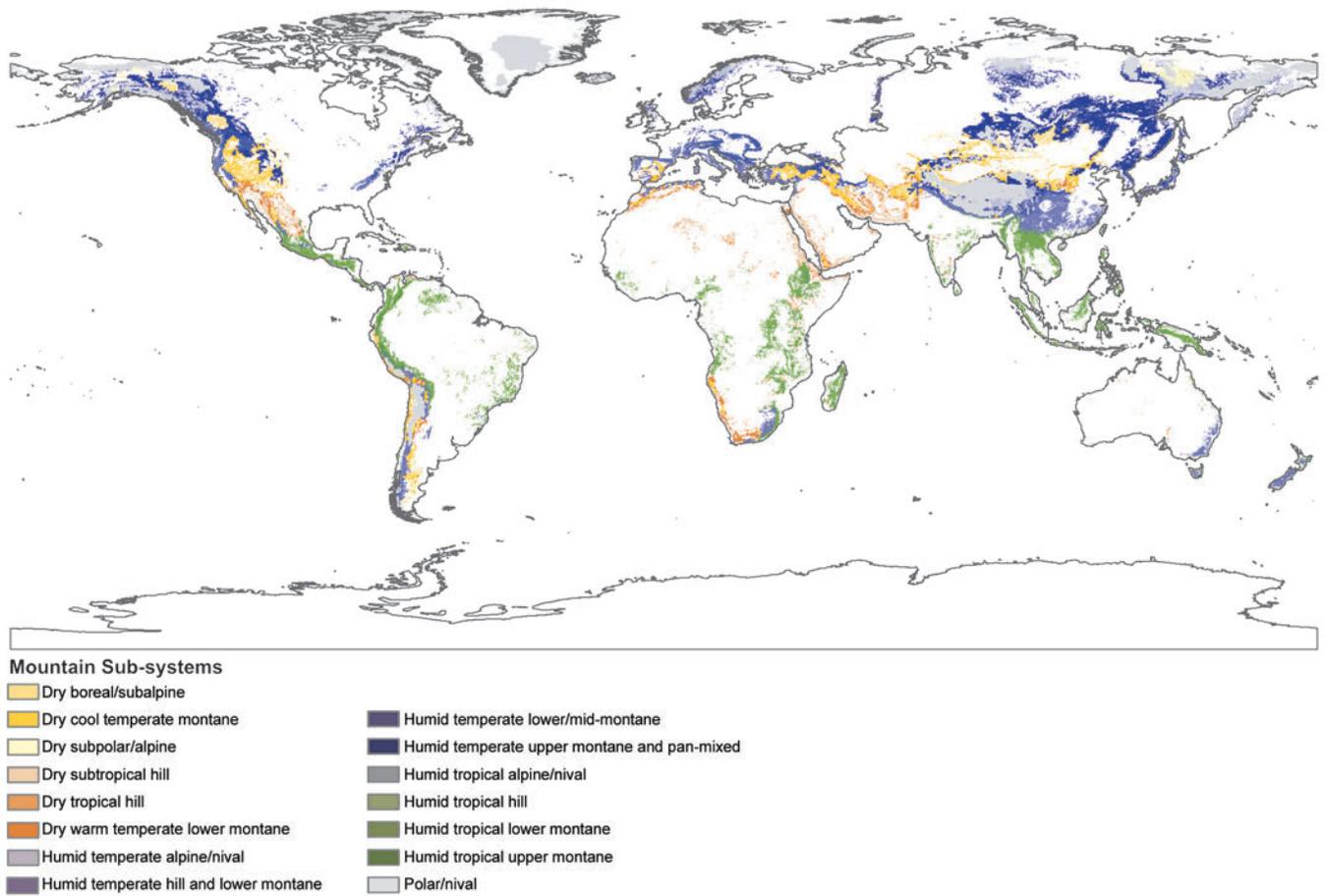


Figure 24.5 Mountains of the World Based on Topography Alone (Kapos et al. 2000) Copyright UNEP-WCMC, Cambridge, UK

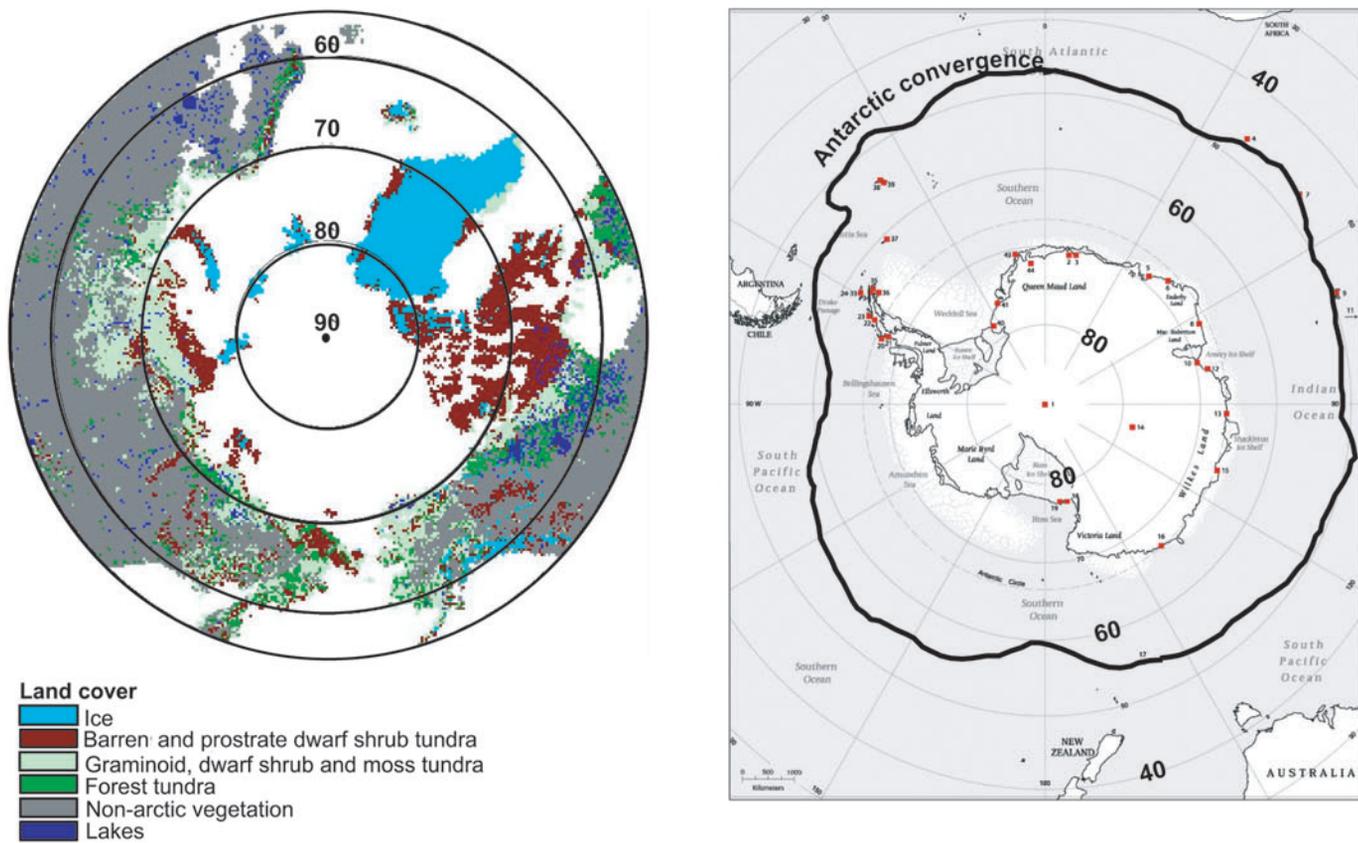


Figure 25.1 Major Subtypes of Arctic and Antarctic Terrestrial Ecosystems (Arctic modified from McGuire et al. 2002; Antarctic modified from Holdgate 1970)

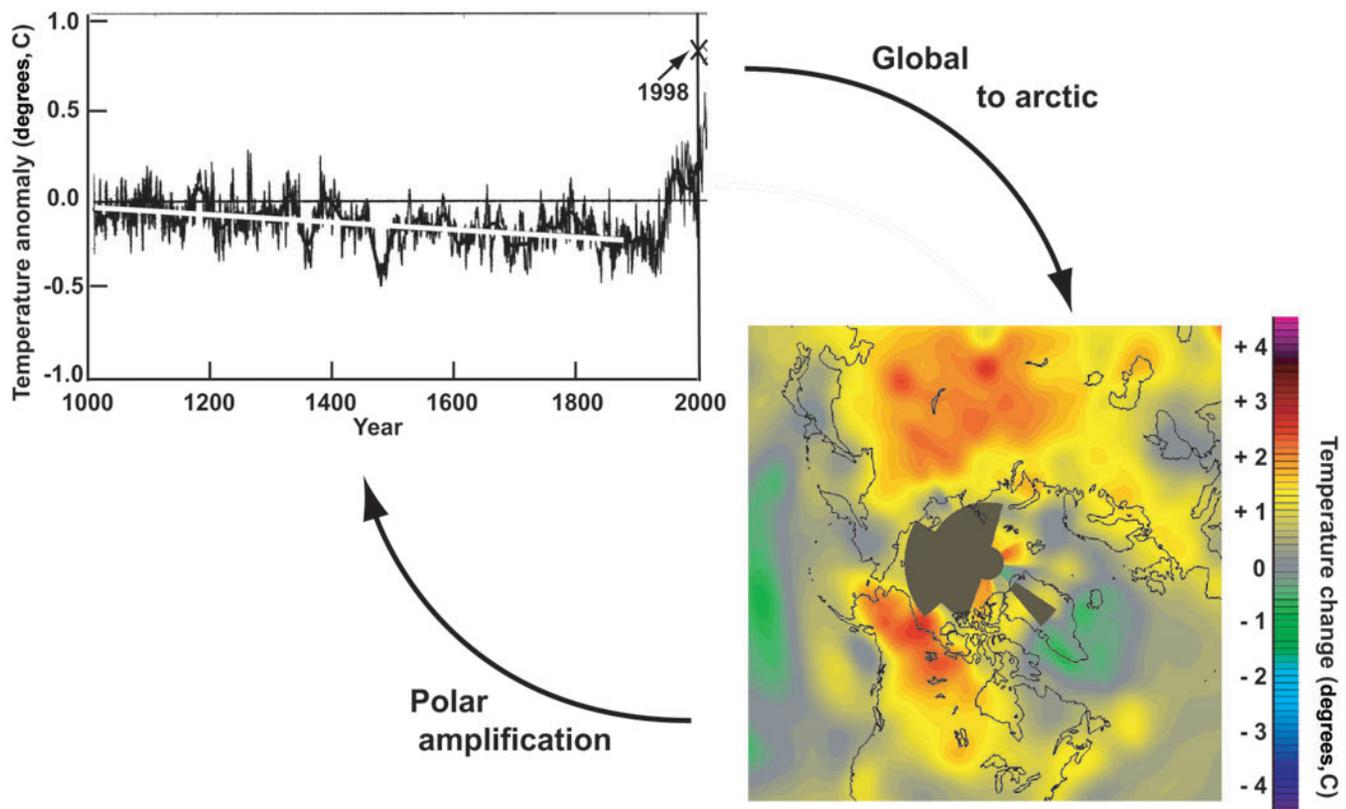


Figure 25.8 Interaction of Global and Northern Hemisphere Temperature Trends (Hinzman et al. in press; Mann et al. 1999)

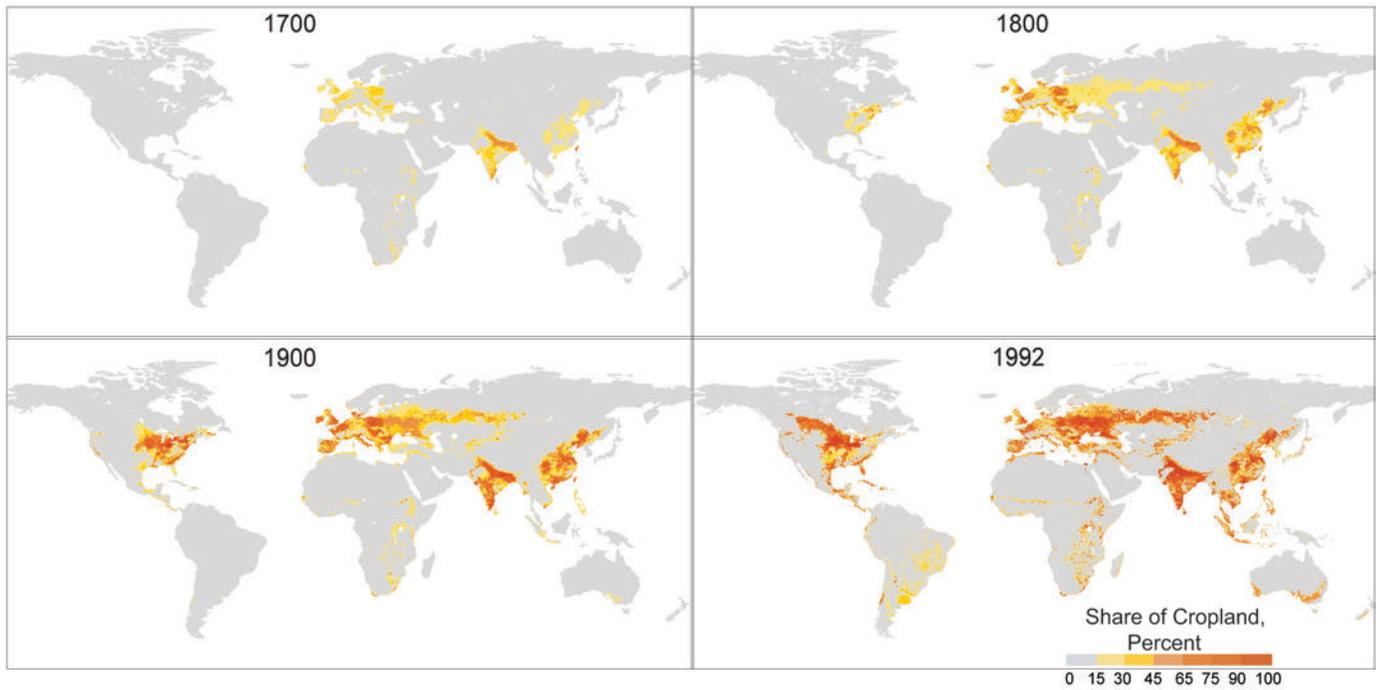


Figure 26.1 Evolution of Cultivated Systems from Pre-Industrial to Contemporary Times (Ramankutty et al. 2002)

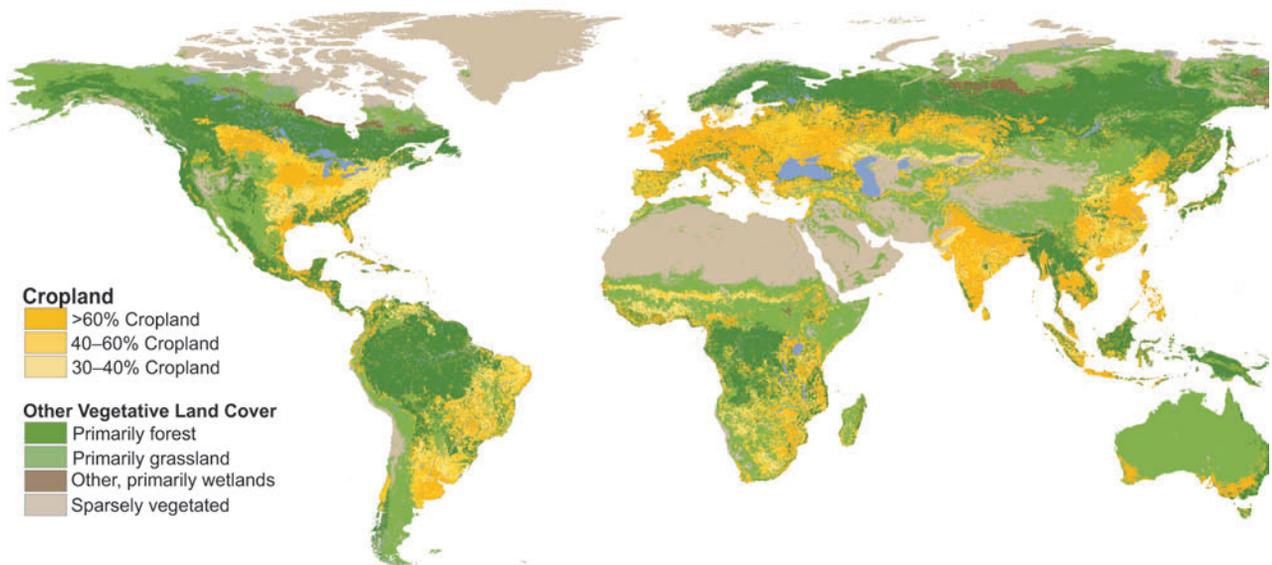
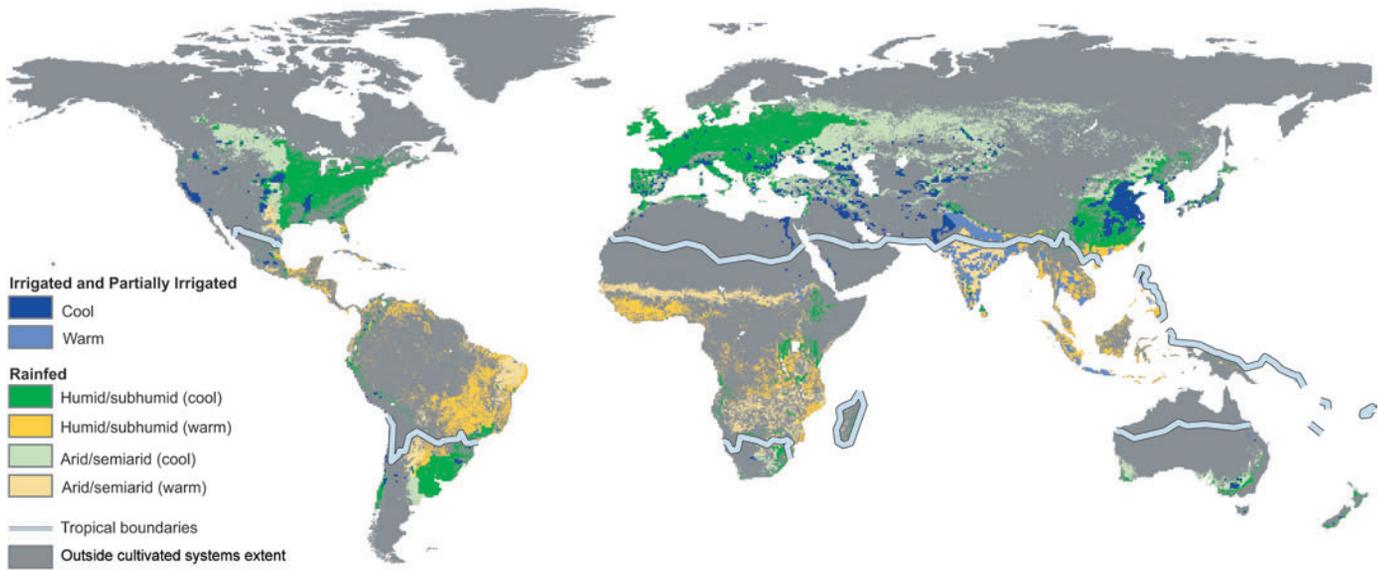
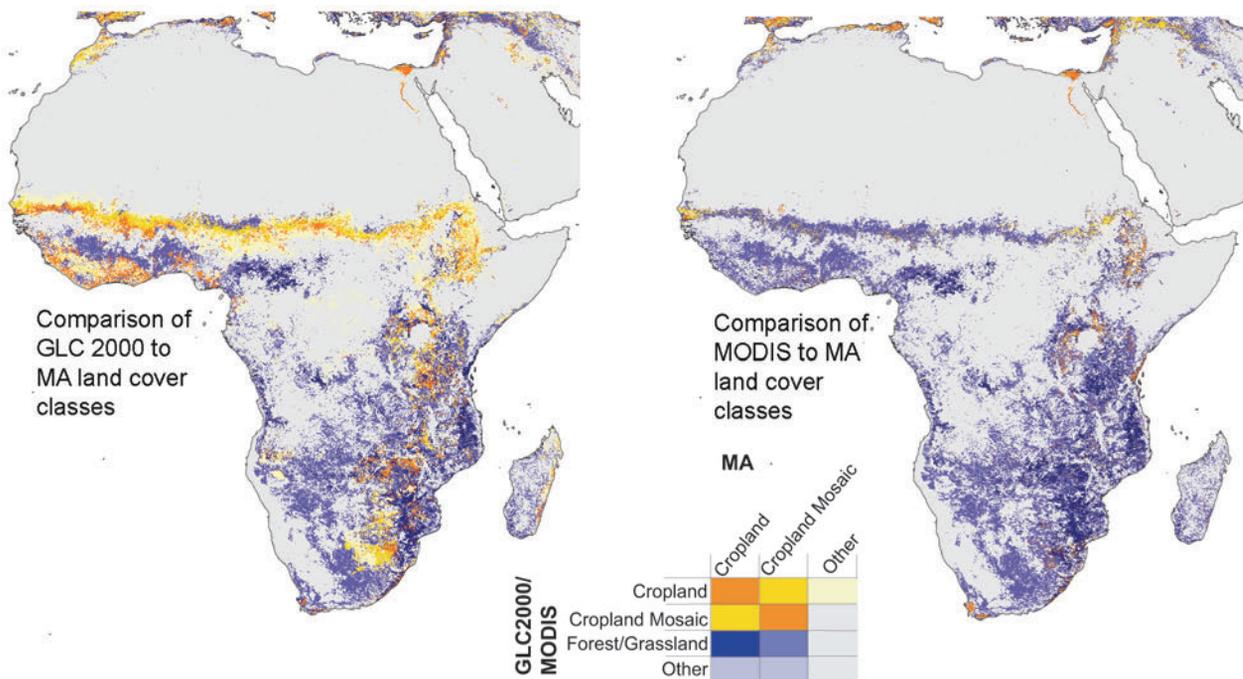


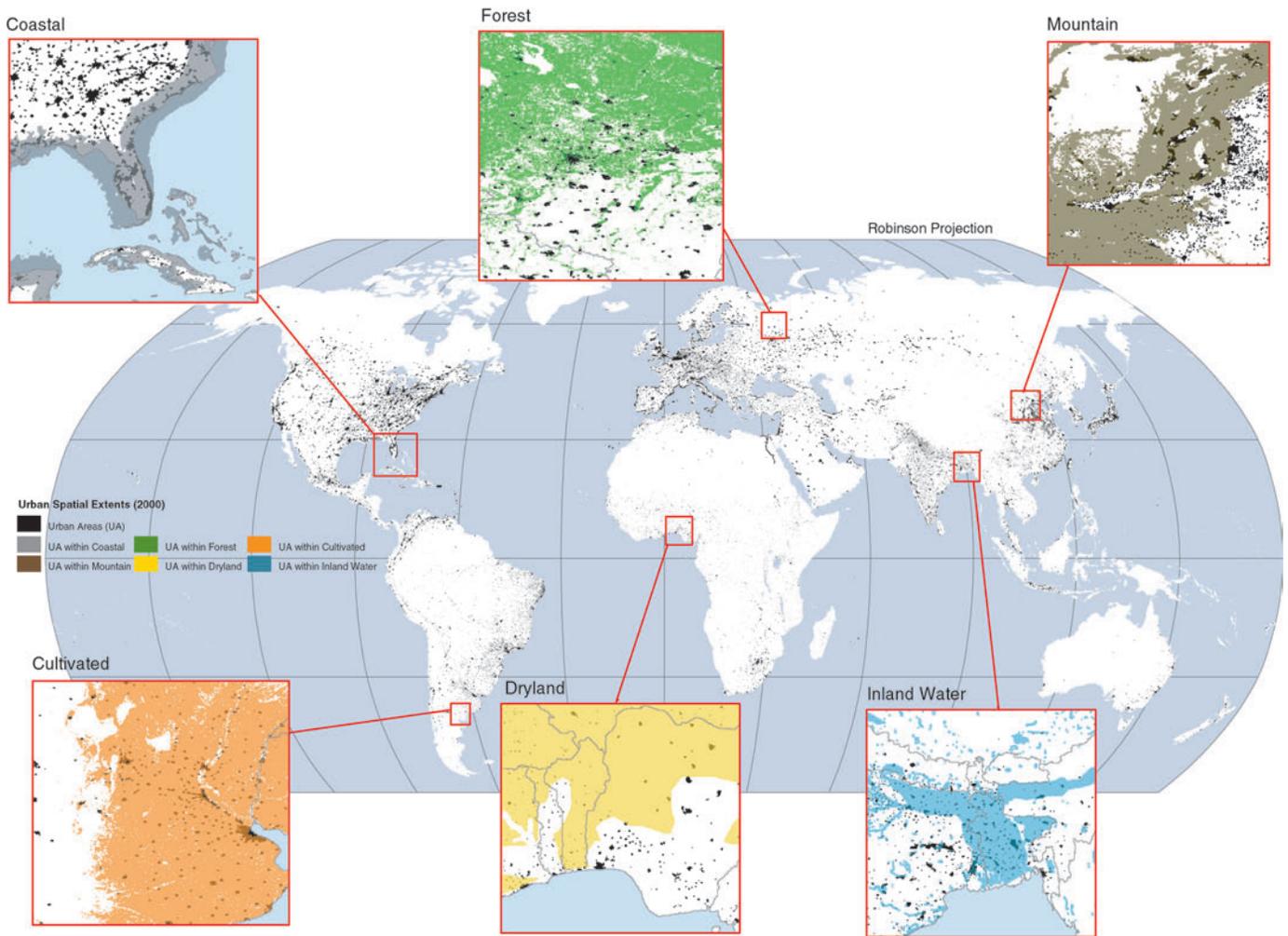
Figure 26.2 Contemporary Global Extent of Cultivated Systems (Wood et al. 2000)



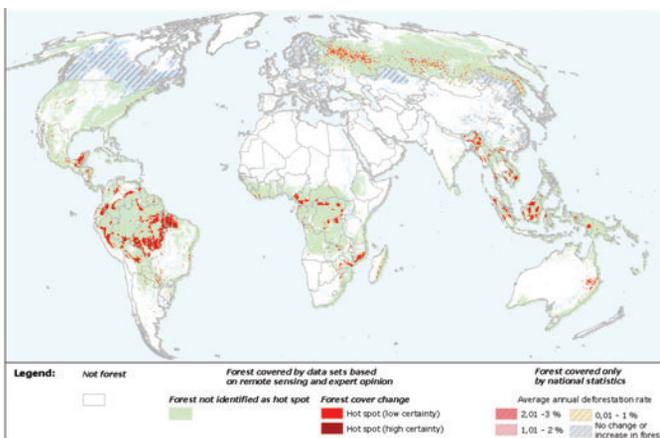
**Figure 26.3 Agroecological Characterization of Cultivated Systems.** This map classifies cultivated systems according to their major agroecological characteristics. Farm management practices have not been mapped consistently at a global scale, but important agroecological sub-divisions determined by climate, rainfall, irrigation, and slope are broadly indicative of the type of cultivation opportunities and constraints. This typology also gives some indication of potential productivity and of cultivation externalities—e.g., irrigation suggests higher productivity and a more intensive use of freshwater resources; cultivation in semi-arid and sloping areas may have lower productivity and higher potential for soil erosion (Wood et al. 2000). The map is a composite of the 1 km. resolution global irrigation map produced by Kassel University and FAO (Doell and Siebert 2002), climate data from the Global Agroecological Zones project (FAO/IIASA 2001) and the PAGE agricultural extent (Wood et al. 2000).



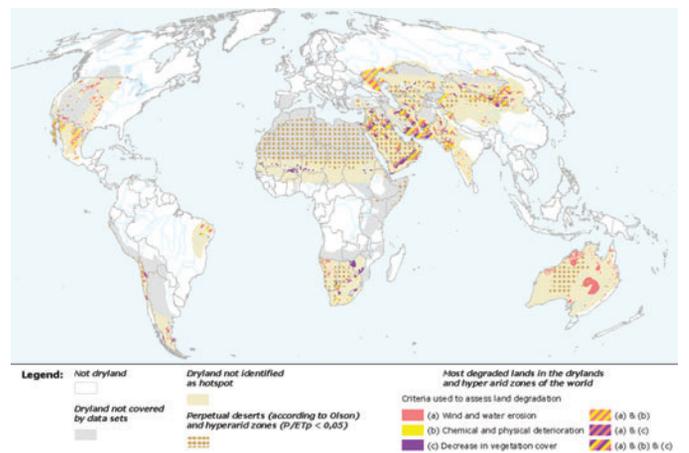
**Box 26.1 Figure B. Comparison of Cropland and Cropland Mosaic Areas by Data Source**



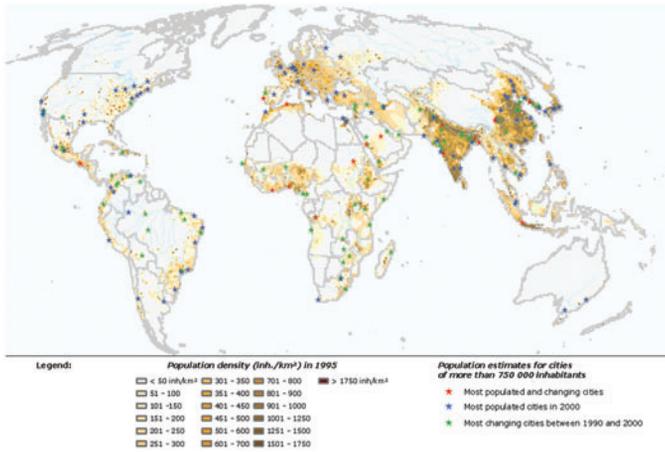
**Figure 27.1 Urban Areas across the Globe** (Copyright 2004: The Trustees of Columbia University in the City of New York. Center for International Earth Science Information Network, Columbia University; International Food Policy Research Institute, World Bank; and Centro Internacional de Agricultura Tropical, 2004. Global Rural-Urban Mapping Project: Urban Mask version 1. Palisades, NY: CIESIN, Columbia University. Available at <http://sedac.ciesin.columbia.edu/gpw/>)



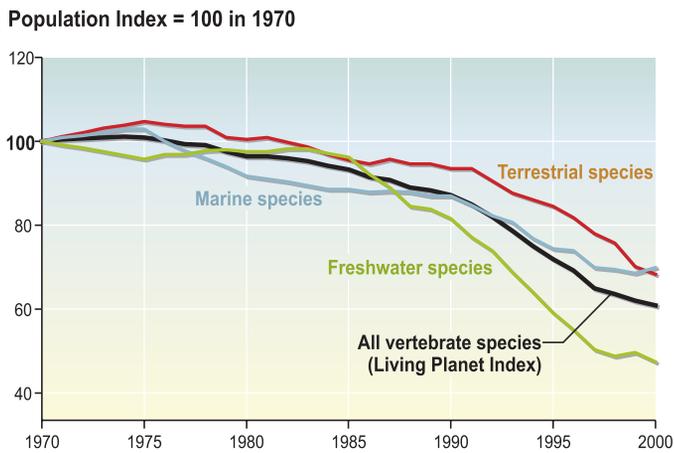
**Figure 28.1 Areas of Rapid Land Cover Change Involving Deforestation and Forest Degradation** (Lepers et al. 2005)



**Figure 28.2 Areas of Rapid Land Cover Change Involving Desertification and Land Degradation** (Lepers et al. 2005)



**Figure 28.3** Areas of Rapid Land Cover Change Involving Changes in Urban Extent (Lepers et al. 2005)



**Figure 28.4** The Living Planet Index, 1970–2000. The Living Planet Index is an indicator of the state of the world’s biodiversity: it measures trends in populations of vertebrate species living in terrestrial, freshwater, and marine ecosystems.

## Appendix B

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## Appendix C

# Abbreviations and Acronyms

<b>AI</b>	aridity index	<b>CIFOR</b>	Center for International Forestry Research
<b>AKRSP</b>	Aga Khan Rural Support Programme	<b>CITES</b>	Convention on International Trade in Endangered Species of Wild Fauna and Flora
<b>AMF</b>	arbuscular mycorrhizal fungi	<b>CMS</b>	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
<b>ASB</b>	alternatives to slash-and-burn	<b>CONICET</b>	Consejo de Investigaciones Científicas y Técnicas (Argentina)
<b>ASOMPH</b>	Asian Symposium on Medicinal Plants, Spices and Other Natural Products	<b>COP</b>	Conference of the Parties (of treaties)
<b>AVHRR</b>	advanced very high resolution radiometer	<b>CPF</b>	Collaborative Partnership on Forests
<b>BCA</b>	benefit-cost analysis	<b>CSIR</b>	Council for Scientific and Industrial Research (South Africa)
<b>BGP</b>	Biogeochemical Province	<b>CV</b>	contingent valuation
<b>BII</b>	Biodiversity Intactness Index	<b>CVM</b>	contingent valuation method
<b>BMI</b>	body mass index	<b>DAF</b>	decision analytical framework
<b>BNF</b>	biological nitrogen fixation	<b>DALY</b>	disability-adjusted life year
<b>BOOT</b>	build-own-operate-transfer	<b>DDT</b>	dichloro diphenyl trichloroethane
<b>BRT</b>	Bus Rapid Transit (Brazil)	<b>DES</b>	dietary energy supply
<b>BSE</b>	bovine spongiform encephalopathy	<b>DHF</b>	dengue hemorrhagic fever
<b>Bt</b>	<i>Bacillus thuringiensis</i>	<b>DHS</b>	demographic and health surveys
<b>C&amp;I</b>	criteria and indicators	<b>DMS</b>	dimethyl sulfide
<b>CAFO</b>	concentrated animal feeding operations	<b>DPSEEA</b>	driving forces-pressure-state-exposure-effect-action
<b>CAP</b>	Common Agricultural Policy (of the European Union)	<b>DPSIR</b>	driver-pressure-state-impact-response
<b>CAREC</b>	Central Asia Regional Environment Centre	<b>DSF</b>	dust storm frequency
<b>CBA</b>	cost-benefit analysis	<b>DU</b>	Dobson Units
<b>CBD</b>	Convention on Biological Diversity	<b>EEA</b>	European Environment Agency
<b>CBO</b>	community-based organization	<b>EEZ</b>	exclusive economic zone
<b>CCAMLR</b>	Commission for the Conservation of Antarctic Marine Living Resources	<b>EGS</b>	ecosystem global scenario
<b>CCN</b>	cloud condensation nuclei	<b>EHI</b>	environmental health indicator
<b>CCS</b>	CO <sub>2</sub> capture and storage	<b>EIA</b>	environmental impact assessment
<b>CDM</b>	Clean Development Mechanism	<b>EID</b>	emerging infectious disease
<b>CEA</b>	cost-effectiveness analysis	<b>EKC</b>	Environmental Kuznets Curve
<b>CENICAFAE</b>	Centro Nacional de Investigaciones de Café (Colombia)	<b>EMF</b>	ectomycorrhizal fungi
<b>CFCs</b>	chlorofluorocarbons		
<b>CGIAR</b>	Consultative Group on International Agricultural Research		

<b>E/MSY</b>	extinctions per million species per year	<b>HWB</b>	human well-being
<b>ENSO</b>	El Niño/Southern Oscillation	<b>IAA</b>	integrated agriculture-aquaculture
<b>EPA</b>	Environmental Protection Agency (United States)	<b>IAM</b>	integrated assessment model
<b>EPI</b>	environmental policy integration	<b>IBI</b>	Index of Biotic Integrity
<b>EU</b>	European Union	<b>ICBG</b>	International Cooperative Biodiversity Groups
<b>EU ETS</b>	European Union Emissions Trading System	<b>ICDP</b>	integrated conservation and development project
<b>FAO</b>	Food and Agriculture Organization (United Nations)	<b>ICJ</b>	International Court of Justice
<b>FAPRI</b>	Food and Agriculture Policy Research Institute	<b>ICRAF</b>	International Center for Research in Agroforestry
<b>FLEGT</b>	Forest Law Enforcement, Governance, and Trade	<b>ICRW</b>	International Convention for the Regulation of Whaling
<b>FRA</b>	Forest Resources Assessment	<b>ICSU</b>	International Council for Science
<b>FSC</b>	Forest Stewardship Council	<b>ICZM</b>	integrated coastal zone management
<b>GATS</b>	General Agreement on Trade and Services	<b>IDRC</b>	International Development Research Centre (Canada)
<b>GATT</b>	General Agreement on Tariffs and Trade	<b>IEA</b>	International Energy Agency
<b>GCM</b>	general circulation model	<b>IEG</b>	international environmental governance
<b>GDI</b>	Gender-related Development Index	<b>IEK</b>	indigenous ecological knowledge
<b>GDP</b>	gross domestic product	<b>IFPRI</b>	International Food Policy Research Institute
<b>GEF</b>	Global Environment Facility	<b>IGBP</b>	International Geosphere-Biosphere Program
<b>GEO</b>	<i>Global Environment Outlook</i>	<b>IIASA</b>	International Institute for Applied Systems Analysis
<b>GHG</b>	greenhouse gases	<b>IK</b>	indigenous knowledge
<b>GIS</b>	geographic information system	<b>ILO</b>	International Labour Organization
<b>GIWA</b>	Global International Waters Assessment	<b>IMF</b>	International Monetary Fund
<b>GLASOD</b>	Global Assessment of Soil Degradation	<b>IMPACT</b>	International Model for Policy Analysis of Agricultural Commodities and Trade
<b>GLC</b>	Global Land Cover	<b>IMR</b>	infant mortality rate
<b>GLOF</b>	Glacier Lake Outburst Flood	<b>INESI</b>	International Network of Sustainability Initiatives (hypothetical, in <i>Scenarios</i> )
<b>GM</b>	genetic modification	<b>INTA</b>	Instituto Nacional de Tecnología Agropecuaria (Argentina)
<b>GMO</b>	genetically modified organism	<b>IPAT</b>	impact of population, affluence, technology
<b>GNI</b>	gross national income	<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>GNP</b>	gross national product	<b>IPM</b>	integrated pest management
<b>GPS</b>	Global Positioning System	<b>IPR</b>	intellectual property rights
<b>GRoWI</b>	<i>Global Review of Wetland Resources and Priorities for Wetland Inventory</i>	<b>IRBM</b>	integrated river basin management
<b>GSG</b>	Global Scenarios Group	<b>ISEH</b>	International Society for Ecosystem Health
<b>GSPC</b>	Global Strategy for Plant Conservation	<b>ISO</b>	International Organization for Standardization
<b>GtC-eq</b>	gigatons of carbon equivalent	<b>ITPGR</b>	International Treaty on Plant Genetic Resources for Food and Agriculture
<b>GWP</b>	global warming potential	<b>ITQs</b>	individual transferable quotas
<b>HDI</b>	Human Development Index	<b>ITTO</b>	International Tropical Timber Organization
<b>HIA</b>	health impact assessment	<b>IUCN</b>	World Conservation Union
<b>HIPC</b>	heavily indebted poor countries	<b>IUU</b>	illegal, unregulated, and unreported (fishing)
<b>HPI</b>	Human Poverty Index	<b>IVM</b>	integrated vector management
<b>HPS</b>	hantavirus pulmonary syndrome		

<b>IWMI</b>	International Water Management Institute	<b>NFP</b>	national forest programs
<b>IWRM</b>	integrated water resources management	<b>NGO</b>	nongovernmental organization
<b>JDSD</b>	Johannesburg Declaration on Sustainable Development	<b>NIH</b>	National Institutes of Health (United States)
<b>JI</b>	joint implementation	<b>NMHC</b>	non-methane hydrocarbons
<b>JMP</b>	Joint Monitoring Program	<b>NOAA</b>	National Oceanographic and Atmospheric Administration (United States)
<b>LAC</b>	Latin America and the Caribbean	<b>NPP</b>	net primary productivity
<b>LAI</b>	leaf area index	<b>NSSD</b>	national strategies for sustainable development
<b>LARD</b>	livelihood approaches to rural development	<b>NUE</b>	nitrogen use efficiency
<b>LDC</b>	least developed country	<b>NWFP</b>	non-wood forest product
<b>LEK</b>	local ecological knowledge	<b>ODA</b>	official development assistance
<b>LME</b>	large marine ecosystems	<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>LPI</b>	Living Planet Index	<b>OSB</b>	oriented strand board
<b>LSMS</b>	Living Standards Measurement Study	<b>OWL</b>	other wooded land
<b>LULUCF</b>	land use, land use change, and forestry	<b>PA</b>	protected area
<b>MA</b>	Millennium Ecosystem Assessment	<b>PAH</b>	polycyclic aromatic hydrocarbons
<b>MAI</b>	mean annual increments	<b>PCBs</b>	polychlorinated biphenyls
<b>MBI</b>	market-based instruments	<b>PEM</b>	protein energy malnutrition
<b>MCA</b>	multicriteria analysis	<b>PES</b>	payment for environmental (or ecosystem) services
<b>MDG</b>	Millennium Development Goal	<b>PFT</b>	plant functional type
<b>MEA</b>	multilateral environmental agreement	<b>PNG</b>	Papua New Guinea
<b>MENA</b>	Middle East and North Africa	<b>POPs</b>	persistent organic pollutants
<b>MER</b>	market exchange rate	<b>PPA</b>	participatory poverty assessment
<b>MHC</b>	major histocompatibility complex	<b>ppb</b>	parts per billion
<b>MICS</b>	multiple indicator cluster surveys	<b>PPI</b>	potential Pareto improvement
<b>MIT</b>	Massachusetts Institute of Technology	<b>ppm</b>	parts per million
<b>MPA</b>	marine protected area	<b>ppmv</b>	parts per million by volume
<b>MSVPA</b>	multispecies virtual population analysis	<b>PPP</b>	purchasing power parity; also public-private partnership
<b>NAP</b>	National Action Program (of desertification convention)	<b>ppt</b>	parts per thousand
<b>NBP</b>	net biome productivity	<b>PQLI</b>	Physical Quality of Life Index
<b>NCD</b>	noncommunicable disease	<b>PRA</b>	participatory rural appraisal
<b>NCS</b>	National Conservation Strategy	<b>PRSP</b>	Poverty Reduction Strategy Paper
<b>NCSD</b>	national council for sustainable development	<b>PSE</b>	producer support estimate
<b>NDVI</b>	normalized difference vegetation index	<b>PVA</b>	population viability analysis
<b>NE</b>	effective size of a population	<b>RANWA</b>	Research and Action in Natural Wealth Administration
<b>NEAP</b>	national environmental action plan	<b>RBO</b>	river basin organization
<b>NEP</b>	new ecological paradigm; also net ecosystem productivity	<b>RIDES</b>	Recursos e Investigación para el Desarrollo Sustentable (Chile)
<b>NEPAD</b>	New Partnership for Africa's Development	<b>RIL</b>	reduced impact logging
<b>NFAP</b>	National Forestry Action Plan	<b>RLI</b>	Red List Index
		<b>RO</b>	reverse osmosis

<b>RRA</b>	rapid rural appraisal	<b>TSU</b>	Technical Support Unit
<b>RUE</b>	rain use efficiency	<b>TW</b>	terawatt
<b>SADC</b>	Southern African Development Community	<b>UMD</b>	University of Maryland
<b>SADCC</b>	Southern African Development Coordination Conference	<b>UNCCD</b>	United Nations Convention to Combat Desertification
<b>SAfMA</b>	Southern African Millennium Ecosystem Assessment	<b>UNCED</b>	United Nations Conference on Environment and Development
<b>SAP</b>	structural adjustment program	<b>UNCLOS</b>	United Nations Convention on the Law of the Sea
<b>SAR</b>	species-area relationship	<b>UNDP</b>	United Nations Development Programme
<b>SARS</b>	severe acute respiratory syndrome	<b>UNECE</b>	United Nations Economic Commission for Europe
<b>SBSTTA</b>	Subsidiary Body on Scientific, Technical and Technological Advice (of CBD)	<b>UNEP</b>	United Nations Environment Programme
<b>SEA</b>	strategic environmental assessment	<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>SEME</b>	simple empirical models for eutrophication	<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>SES</b>	social-ecological system	<b>UNIDO</b>	United Nations Industrial Development Organization
<b>SFM</b>	sustainable forest management	<b>UNRO</b>	United Nations Regional Organization (hypothetical body, in <i>Scenarios</i> )
<b>SIDS</b>	small island developing states	<b>UNSO</b>	UNDP's Office to Combat Desertification and Drought
<b>SMS</b>	safe minimum standard	<b>USAID</b>	U.S. Agency for International Development
<b>SOM</b>	soil organic matter	<b>USDA</b>	U.S. Department of Agriculture
<b>SRES</b>	Special Report on Emissions Scenarios (of the IPCC)	<b>VOC</b>	volatile organic compound
<b>SSC</b>	Species Survival Commission (of IUCN)	<b>VW</b>	virtual water
<b>SWAP</b>	sector-wide approach	<b>WBCSD</b>	World Business Council for Sustainable Development
<b>TAC</b>	total allowable catch	<b>WCD</b>	World Commission on Dams
<b>TBT</b>	tributyltin	<b>WCED</b>	World Commission on Environment and Development
<b>TC</b>	travel cost	<b>WCMC</b>	World Conservation Monitoring Centre (of UNEP)
<b>TCM</b>	travel cost method	<b>WFP</b>	World Food Programme
<b>TDR</b>	tradable development rights	<b>WHO</b>	World Health Organization
<b>TDS</b>	total dissolved solids	<b>WIPO</b>	World Intellectual Property Organization
<b>TEIA</b>	transboundary environmental impact assessment	<b>WISP</b>	weighted index of social progress
<b>TEK</b>	traditional ecological knowledge	<b>WMO</b>	World Meteorological Organization
<b>TEM</b>	terrestrial ecosystem model	<b>WPI</b>	Water Poverty Index
<b>TESEO</b>	Treaty Enforcement Services Using Earth Observation	<b>WRF</b>	white rot fungi
<b>TEV</b>	total economic value	<b>WSSD</b>	World Summit on Sustainable Development
<b>TFAP</b>	Tropical Forests Action Plan	<b>wta</b>	withdrawals-to-availability ratio (of water)
<b>TFP</b>	total factor productivity	<b>WTA</b>	willingness to accept compensation
<b>TFR</b>	total fertility rate	<b>WTO</b>	World Trade Organization
<b>Tg</b>	teragram (10 <sup>12</sup> grams)	<b>WTP</b>	willingness to pay
<b>TK</b>	traditional knowledge	<b>WWAP</b>	World Water Assessment Programme
<b>TMDL</b>	total maximum daily load	<b>WWF</b>	World Wide Fund for Nature
<b>TOF</b>	trees outside of forests	<b>WWV</b>	World Water Vision
<b>TRIPS</b>	Trade-Related Aspects of Intellectual Property Rights		

# Glossary

**Abatement cost:** See *Marginal abatement cost*.

**Abundance:** The total number of individuals of a taxon or taxa in an area, population, or community. Relative abundance refers to the total number of individuals of one taxon compared with the total number of individuals of all other taxa in an area, volume, or community.

**Active adaptive management:** See *Adaptive management*.

**Adaptation:** Adjustment in natural or human systems to a new or changing environment. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

**Adaptive capacity:** The general ability of institutions, systems, and individuals to adjust to potential damage, to take advantage of opportunities, or to cope with the consequences.

**Adaptive management:** A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, management is treated as a deliberate experiment for purposes of learning.

**Afforestation:** Planting of forests on land that has historically not contained forests. (Compare *Reforestation*.)

**Agrobiodiversity:** The diversity of plants, insects, and soil biota found in cultivated systems.

**Agroforestry systems:** Mixed systems of crops and trees providing wood, non-wood forest products, food, fuel, fodder, and shelter.

**Albedo:** A measure of the degree to which a surface or object reflects solar radiation.

**Alien species:** Species introduced outside its normal distribution.

**Alien invasive species:** See *Invasive alien species*.

**Aquaculture:** Breeding and rearing of fish, shellfish, or plants in ponds, enclosures, or other forms of confinement in fresh or marine waters for the direct harvest of the product.

**Benefits transfer approach:** Economic valuation approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context.

**Binding constraints:** Political, social, economic, institutional, or ecological factors that rule out a particular response.

**Biodiversity** (a contraction of biological diversity): The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species, and between ecosystems.

**Biodiversity regulation:** The regulation of ecosystem processes and services by the different components of biodiversity.

**Biogeographic realm:** A large spatial region, within which ecosystems share a broadly similar biota. Eight terrestrial biogeographic realms are typically recognized, corresponding roughly to continents (e.g., Afrotropical realm).

**Biological diversity:** See *Biodiversity*.

**Biomass:** The mass of tissues in living organisms in a population, ecosystem, or spatial unit.

**Biome:** The largest unit of ecological classification that is convenient to recognize below the entire globe. Terrestrial biomes are typically based on dominant vegetation structure (e.g., forest, grassland). Ecosystems within a biome function in a broadly similar way, although

they may have very different species composition. For example, all forests share certain properties regarding nutrient cycling, disturbance, and biomass that are different from the properties of grasslands. Marine biomes are typically based on biogeochemical properties. The WWF biome classification is used in the MA.

**Bioprospecting:** The exploration of biodiversity for genetic and biochemical resources of social or commercial value.

**Biotechnology:** Any technological application that uses biological systems, living organisms, or derivatives thereof to make or modify products or processes for specific use.

**Biotic homogenization:** Process by which the differences between biotic communities in different areas are on average reduced.

**Blueprint approaches:** Approaches that are designed to be applicable in a wider set of circumstances and that are not context-specific or sensitive to local conditions.

**Boundary organizations:** Public or private organizations that synthesize and translate scientific research and explore its policy implications to help bridge the gap between science and decision-making.

**Bridging organizations:** Organizations that facilitate, and offer an arena for, stakeholder collaboration, trust-building, and conflict resolution.

**Capability:** The combinations of doings and beings from which people can choose to lead the kind of life they value. Basic capability is the capability to meet a basic need.

**Capacity building:** A process of strengthening or developing human resources, institutions, organizations, or networks. Also referred to as capacity development or capacity enhancement.

**Capital value** (of an ecosystem): The present value of the stream of ecosystem services that an ecosystem will generate under a particular management or institutional regime.

**Capture fisheries:** See *Fishery*.

**Carbon sequestration:** The process of increasing the carbon content of a reservoir other than the atmosphere.

**Cascading interaction:** See *Trophic cascade*.

**Catch:** The number or weight of all fish caught by fishing operations, whether the fish are landed or not.

**Coastal system:** Systems containing terrestrial areas dominated by ocean influences of tides and marine aerosols, plus nearshore marine areas. The inland extent of coastal ecosystems is the line where land-based influences dominate, up to a maximum of 100 kilometers from the coastline or 100-meter elevation (whichever is closer to the sea), and the outward extent is the 50-meter-depth contour. See also *System*.

**Collaborative (or joint) forest management:** Community-based management of forests, where resource tenure by local communities is secured.

**Common pool resource:** A valued natural or human-made resource or facility in which one person's use subtracts from another's use and where it is often necessary but difficult to exclude potential users from the resource. (Compare *Common property resource*.)

**Common property management system:** The institutions (i.e., sets of rules) that define and regulate the use rights for common pool resources. Not the same as an open access system.

**Common property resource:** A good or service shared by a well-defined community. (Compare *Common pool resource*.)

- Community (ecological):** An assemblage of species occurring in the same space or time, often linked by biotic interactions such as competition or predation.
- Community (human, local):** A collection of human beings who have something in common. A local community is a fairly small group of people who share a common place of residence and a set of institutions based on this fact, but the word 'community' is also used to refer to larger collections of people who have something else in common (e.g., national community, donor community).
- Condition of an ecosystem:** The capacity of an ecosystem to yield services, relative to its potential capacity.
- Condition of an ecosystem service:** The capacity of an ecosystem service to yield benefits to people, relative to its potential capacity.
- Constituents of well-being:** The experiential aspects of well-being, such as health, happiness, and freedom to be and do, and, more broadly, basic liberties.
- Consumptive use:** The reduction in the quantity or quality of a good available for other users due to consumption.
- Contingent valuation:** Economic valuation technique based on a survey of how much respondents would be willing to pay for specified benefits.
- Core dataset:** Data sets designated to have wide potential application throughout the Millennium Ecosystem Assessment process. They include land use, land cover, climate, and population data sets.
- Cost-benefit analysis:** A technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits.
- Cost-effectiveness analysis:** Analysis to identify the least cost option that meets a particular goal.
- Critically endangered species:** Species that face an extremely high risk of extinction in the wild. See also *Threatened species*.
- Cross-scale feedback:** A process in which effects of some action are transmitted from a smaller spatial extent to a larger one, or vice versa. For example, a global policy may constrain the flexibility of a local region to use certain response options to environmental change, or a local agricultural pest outbreak may affect regional food supply.
- Cultivar** (a contraction of cultivated variety): A variety of a plant developed from a natural species and maintained under cultivation.
- Cultivated system:** Areas of landscape or seascape actively managed for the production of food, feed, fiber, or biofuels.
- Cultural landscape:** See *Landscape*.
- Cultural services:** The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.
- Decision analytical framework:** A coherent set of concepts and procedures aimed at synthesizing available information to help policy-makers assess consequences of various decision options. DAFs organize the relevant information in a suitable framework, apply decision criteria (both based on some paradigms or theories), and thus identify options that are better than others under the assumptions characterizing the analytical framework and the application at hand.
- Decision-maker:** A person whose decisions, and the actions that follow from them, can influence a condition, process, or issue under consideration.
- Decomposition:** The ecological process carried out primarily by microbes that leads to a transformation of dead organic matter into inorganic matter.
- Deforestation:** Conversion of forest to non-forest.
- Degradation of an ecosystem service:** For *provisioning services*, decreased production of the service through changes in area over which the services is provided, or decreased production per unit area. For *regulating and supporting services*, a reduction in the benefits obtained from the service, either through a change in the service or through human pressures on the service exceeding its limits. For *cultural services*, a change in the ecosystem features that decreases the cultural benefits provided by the ecosystem.
- Degradation of ecosystems:** A persistent reduction in the capacity to provide ecosystem services.
- Desertification:** land degradation in drylands resulting from various factors, including climatic variations and human activities.
- Determinants of well-being:** Inputs into the production of well-being, such as food, clothing, potable water, and access to knowledge and information.
- Direct use value** (of ecosystems): The benefits derived from the services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting goods) and nonconsumptive uses (e.g., enjoyment of scenic beauty). Agents are often physically present in an ecosystem to receive direct use value. (Compare *Indirect use value*.)
- Disability-adjusted life years:** The sum of years of life lost due to premature death and illness, taking into account the age of death compared with natural life expectancy and the number of years of life lived with a disability. The measure of number of years lived with the disability considers the duration of the disease, weighted by a measure of the severity of the disease.
- Diversity:** The variety and relative abundance of different entities in a sample.
- Driver:** Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.
- Driver, direct:** A driver that unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. (Compare *Driver, indirect*.)
- Driver, endogenous:** A driver whose magnitude can be influenced by the decision-maker. Whether a driver is exogenous or endogenous depends on the organizational scale. Some drivers (e.g., prices) are exogenous to a decision-maker at one level (a farmer) but endogenous at other levels (the nation-state). (Compare *Driver, exogenous*.)
- Driver, exogenous:** A driver that cannot be altered by the decision-maker. (Compare *Driver, endogenous*.)
- Driver, indirect:** A driver that operates by altering the level or rate of change of one or more direct drivers. (Compare *Driver, direct*.)
- Drylands:** See *Dryland system*.
- Dryland system:** Areas characterized by lack of water, which constrains the two major interlinked services of the system: primary production and nutrient cycling. Four dryland subtypes are widely recognized: dry sub-humid, semiarid, arid, and hyperarid, showing an increasing level of aridity or moisture deficit. See also *System*.
- Ecological character:** See *Ecosystem properties*.
- Ecological degradation:** See *Degradation of ecosystems*.
- Ecological footprint:** An index of the area of productive land and aquatic ecosystems required to produce the resources used and to assimilate the wastes produced by a defined population at a specified material standard of living, wherever on Earth that land may be located.
- Ecological security:** A condition of ecological safety that ensures access to a sustainable flow of provisioning, regulating, and cultural services needed by local communities to meet their basic capabilities.
- Ecological surprises:** unexpected—and often disproportionately large—consequence of changes in the abiotic (e.g., climate, disturbance) or biotic (e.g., invasions, pathogens) environment.
- Ecosystem:** A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit.
- Ecosystem approach:** A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use. An ecosystem approach is based on the application of appropriate scientific methods focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.
- Ecosystem assessment:** A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers.
- Ecosystem boundary:** The spatial delimitation of an ecosystem, typically based on discontinuities in the distribution of organisms, the biophysical environment (soil types, drainage basins, depth in a

water body), and spatial interactions (home ranges, migration patterns, fluxes of matter).

**Ecosystem change:** Any variation in the state, outputs, or structure of an ecosystem.

**Ecosystem function:** See *Ecosystem process*.

**Ecosystem interactions:** Exchanges of materials, energy, and information within and among ecosystems.

**Ecosystem management:** An approach to maintaining or restoring the composition, structure, function, and delivery of services of natural and modified ecosystems for the goal of achieving sustainability. It is based on an adaptive, collaboratively developed vision of desired future conditions that integrates ecological, socioeconomic, and institutional perspectives, applied within a geographic framework, and defined primarily by natural ecological boundaries.

**Ecosystem process:** An intrinsic ecosystem characteristic whereby an ecosystem maintains its integrity. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

**Ecosystem properties:** The size, biodiversity, stability, degree of organization, internal exchanges of materials, energy, and information among different pools, and other properties that characterize an ecosystem. Includes ecosystem functions and processes.

**Ecosystem resilience:** See *Resilience*.

**Ecosystem resistance:** See *Resistance*.

**Ecosystem robustness:** See *Ecosystem stability*.

**Ecosystem services:** The benefits people obtain from ecosystems.

These include *provisioning services* such as food and water; *regulating services* such as flood and disease control; *cultural services* such as spiritual, recreational, and cultural benefits; and *supporting services* such as nutrient cycling that maintain the conditions for life on Earth. The concept “ecosystem goods and services” is synonymous with ecosystem services.

**Ecosystem stability** (or ecosystem robustness): A description of the dynamic properties of an ecosystem. An ecosystem is considered stable or robust if it returns to its original state after a perturbation, exhibits low temporal variability, or does not change dramatically in the face of a perturbation.

**Elasticity:** A measure of responsiveness of one variable to a change in another, usually defined in terms of percentage change. For example, own-price elasticity of demand is the percentage change in the quantity demanded of a good for a 1% change in the price of that good. Other common elasticity measures include supply and income elasticity.

**Emergent disease:** Diseases that have recently increased in incidence, impact, or geographic range; that are caused by pathogens that have recently evolved; that are newly discovered; or that have recently changed their clinical presentation.

**Emergent property:** A phenomenon that is not evident in the constituent parts of a system but that appears when they interact in the system as a whole.

**Enabling conditions:** Critical preconditions for success of responses, including political, institutional, social, economic, and ecological factors.

**Endangered species:** Species that face a very high risk of extinction in the wild. See also *Threatened species*.

**Endemic (in ecology):** A species or higher taxonomic unit found only within a specific area.

**Endemic (in health):** The constant presence of a disease or infectious agent within a given geographic area or population group; may also refer to the usual prevalence of a given disease within such area or group.

**Endemism:** The fraction of species that is endemic relative to the total number of species found in a specific area.

**Epistemology:** The theory of knowledge, or a “way of knowing.”

**Equity:** Fairness of rights, distribution, and access. Depending on context, this can refer to resources, services, or power.

**Eutrophication:** The increase in additions of nutrients to freshwater or marine systems, which leads to increases in plant growth and often to undesirable changes in ecosystem structure and function.

**Evapotranspiration:** See *Transpiration*.

**Existence value:** The value that individuals place on knowing that a resource exists, even if they never use that resource (also sometimes known as conservation value or passive use value).

**Exotic species:** See *Alien species*.

**Externality:** A consequence of an action that affects someone other than the agent undertaking that action and for which the agent is neither compensated nor penalized through the markets. Externalities can be positive or negative.

**Feedback:** See *Negative feedback*, *Positive feedback*, and *Cross-scale feedback*.

**Fishery:** A particular kind of fishing activity, e.g., a trawl fishery, or a particular species targeted, e.g., a cod fishery or salmon fishery.

**Fish stock:** See *Stock*.

**Fixed nitrogen:** See *Reactive nitrogen*.

**Flyway:** Areas of the world used by migratory birds in moving between breeding and wintering grounds.

**Forest systems:** Systems in which trees are the predominant life forms. Statistics reported in this assessment are based on areas that are dominated by trees (perennial woody plants taller than five meters at maturity), where the tree crown cover exceeds 10%, and where the area is more than 0.5 hectares. “Open forests” have a canopy cover between 10% and 40%, and “closed forests” a canopy cover of more than 40%. “Fragmented forests” refer to mosaics of forest patches and non-forest land. See also *System*.

**Freedom:** The range of options a person has in deciding the kind of life to lead.

**Functional diversity:** The value, range, and relative abundance of traits present in the organisms in an ecological community.

**Functional redundancy** (= functional compensation): A characteristic of ecosystems in which more than one species in the system can carry out a particular process. Redundancy may be total or partial—that is, a species may not be able to completely replace the other species or it may compensate only some of the processes in which the other species are involved.

**Functional types** (= functional groups = guilds): Groups of organisms that respond to the environment or affect ecosystem processes in a similar way. Examples of plant functional types include nitrogen-fixer versus non-fixer, stress-tolerant versus ruderal versus competitor, resprouter versus seeder, deciduous versus evergreen. Examples of animal functional types include granivorous versus fleshy-fruit eater, nocturnal versus diurnal predator, browser versus grazer.

**Geographic information system:** A computerized system organizing data sets through a geographical referencing of all data included in its collections.

**Globalization:** The increasing integration of economies and societies around the world, particularly through trade and financial flows, and the transfer of culture and technology.

**Global scale:** The geographical realm encompassing all of Earth.

**Governance:** The process of regulating human behavior in accordance with shared objectives. The term includes both governmental and nongovernmental mechanisms.

**Health, human:** A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The health of a whole community or population is reflected in measurements of disease incidence and prevalence, age-specific death rates, and life expectancy.

**High seas:** The area outside of national jurisdiction, i.e., beyond each nation’s Exclusive Economic Zone or other territorial waters.

**Human well-being:** See *Well-being*.

**Income poverty:** See *Poverty*.

**Indicator:** Information based on measured data used to represent a particular attribute, characteristic, or property of a system.

**Indigenous knowledge** (or local knowledge): The knowledge that is unique to a given culture or society.

**Indirect interaction:** Those interactions among species in which a species, through direct interaction with another species or modification of resources, alters the abundance of a third species with which it is not directly interacting. Indirect interactions can be trophic or nontrophic in nature.

- Indirect use value:** The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. (Compare *Direct use value*.)
- Infant mortality rate:** Number of deaths of infants aged 0–12 months divided by the number of live births.
- Inland water systems:** Permanent water bodies other than salt-water systems on the coast, seas and oceans. Includes rivers, lakes, reservoirs wetlands and inland saline lakes and marshes. See also *System*.
- Institutions:** The rules that guide how people within societies live, work, and interact with each other. Formal institutions are written or codified rules. Examples of formal institutions would be the constitution, the judiciary laws, the organized market, and property rights. Informal institutions are rules governed by social and behavioral norms of the society, family, or community. Also referred to as organizations.
- Integrated coastal zone management:** Approaches that integrate economic, social, and ecological perspectives for the management of coastal resources and areas.
- Integrated conservation and development projects:** Initiatives that aim to link biodiversity conservation and development.
- Integrated pest management:** Any practices that attempt to capitalize on natural processes that reduce pest abundance. Sometimes used to refer to monitoring programs where farmers apply pesticides to improve economic efficiency (reducing application rates and improving profitability).
- Integrated responses:** Responses that address degradation of ecosystem services across a number of systems simultaneously or that also explicitly include objectives to enhance human well-being.
- Integrated river basin management:** Integration of water planning and management with environmental, social, and economic development concerns, with an explicit objective of improving human welfare.
- Interventions:** See *Responses*.
- Intrinsic value:** The value of someone or something in and for itself, irrespective of its utility for people.
- Invasibility:** Intrinsic susceptibility of an ecosystem to be invaded by an alien species.
- Invasive alien species:** An alien species whose establishment and spread modifies ecosystems, habitats, or species.
- Irreversibility:** The quality of being impossible or difficult to return to, or to restore to, a former condition. See also *Option value*, *Precautionary principle*, *Resilience*, and *Threshold*.
- Island systems:** Lands isolated by surrounding water, with a high proportion of coast to hinterland. The degree of isolation from the mainland in both natural and social aspects is accounted by the *isola effect*. See also *System*.
- Isola effect:** Environmental issues that are unique to island systems. This uniqueness takes into account the physical seclusion of islands as isolated pieces of land exposed to marine or climatic disturbances with a more limited access to space, products, and services when compared with most continental areas, but also includes subjective issues such as the perceptions and attitudes of islanders themselves.
- Keystone species:** A species whose impact on the community is disproportionately large relative to its abundance. Effects can be produced by consumption (trophic interactions), competition, mutualism, dispersal, pollination, disease, or habitat modification (nontrophic interactions).
- Land cover:** The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Related to, but not synonymous with, *land use*.
- Landscape:** An area of land that contains a mosaic of ecosystems, including human-dominated ecosystems. The term cultural landscape is often used when referring to landscapes containing significant human populations or in which there has been significant human influence on the land.
- Landscape unit:** A portion of relatively homogenous land cover within the local-to-regional landscape.
- Land use:** The human use of a piece of land for a certain purpose (such as irrigated agriculture or recreation). Influenced by, but not synonymous with, *land cover*.
- Length of growing period:** The total number of days in a year during which rainfall exceeds one half of potential evapotranspiration. For boreal and temperate zone, growing season is usually defined as a number of days with the average daily temperature that exceeds a definite threshold, such as 10° Celsius.
- Local knowledge:** See *Indigenous knowledge*.
- Mainstreaming:** Incorporating a specific concern, e.g. sustainable use of ecosystems, into policies and actions.
- Malnutrition:** A state of bad nourishment. Malnutrition refers both to undernutrition and overnutrition, as well as to conditions arising from dietary imbalances leading to diet-related noncommunicable diseases.
- Marginal abatement cost:** The cost of abating an incremental unit of, for instance, a pollutant.
- Marine system:** Marine waters from the low-water mark to the high seas that support marine capture fisheries, as well as deepwater (>50 meters) habitats. Four sub-divisions (marine biomes) are recognized: the coastal boundary zone; trade-winds; westerlies; and polar.
- Market-based instruments:** Mechanisms that create a market for ecosystem services in order to improving the efficiency in the way the service is used. The term is used for mechanisms that create new markets, but also for responses such as taxes, subsidies, or regulations that affect existing markets.
- Market failure:** The inability of a market to capture the correct values of ecosystem services.
- Mitigation:** An anthropogenic intervention to reduce negative or unsustainable uses of ecosystems or to enhance sustainable practices.
- Mountain system:** High-altitude (greater than 2,500 meters) areas and steep mid-altitude (1,000 meters at the equator, decreasing to sea level where alpine life zones meet polar life zones at high latitudes) areas, excluding large plateaus.
- Negative feedback:** Feedback that has a net effect of dampening perturbation.
- Net primary productivity:** See *Production, biological*.
- Non-linearity:** A relationship or process in which a small change in the value of a driver (i.e., an independent variable) produces an disproportionate change in the outcome (i.e., the dependent variable). Relationships where there is a sudden discontinuity or change in rate are sometimes referred to as abrupt and often form the basis of thresholds. In loose terms, they may lead to unexpected outcomes or “surprises.”
- Nutrient cycling:** The processes by which elements are extracted from their mineral, aquatic, or atmospheric sources or recycled from their organic forms, converting them to the ionic form in which biotic uptake occurs and ultimately returning them to the atmosphere, water, or soil.
- Nutrients:** The approximately 20 chemical elements known to be essential for the growth of living organisms, including nitrogen, sulfur, phosphorus, and carbon.
- Open access resource:** A good or service over which no property rights are recognized.
- Opportunity cost:** The benefits forgone by undertaking one activity instead of another.
- Option value:** The value of preserving the option to use services in the future either by oneself (option value) or by others or heirs (bequest value). Quasi-option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values society is not currently aware of.
- Organic farming:** Crop and livestock production systems that do not make use of synthetic fertilizers, pesticides, or herbicides. May also include restrictions on the use of transgenic crops (genetically modified organisms).
- Pastoralism, pastoral system:** The use of domestic animals as a primary means for obtaining resources from habitats.
- Perturbation:** An imposed movement of a system away from its current state.

- Polar system:** Treeless lands at high latitudes. Includes Arctic and Antarctic areas, where the polar system merges with the northern boreal forest and the Southern Ocean respectively. See also *System*.
- Policy failure:** A situation in which government policies create inefficiencies in the use of goods and services.
- Policy-maker:** A person with power to influence or determine policies and practices at an international, national, regional, or local level.
- Pollination:** A process in the sexual phase of reproduction in some plants caused by the transportation of pollen. In the context of ecosystem services, pollination generally refers to animal-assisted pollination, such as that done by bees, rather than wind pollination.
- Population, biological:** A group of individuals of the same species, occupying a defined area, and usually isolated to some degree from other similar groups. Populations can be relatively reproductively isolated and adapted to local environments.
- Population, human:** A collection of living people in a given area. (Compare *Community (human, local)*.)
- Positive feedback:** Feedback that has a net effect of amplifying perturbation.
- Poverty:** The pronounced deprivation of well-being. Income poverty refers to a particular formulation expressed solely in terms of per capita or household income.
- Precautionary principle:** The management concept stating that in cases “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation,” as defined in the Rio Declaration.
- Prediction** (or forecast): The result of an attempt to produce a most likely description or estimate of the actual evolution of a variable or system in the future. See also *Projection* and *Scenario*.
- Primary production:** See *Production, biological*.
- Private costs and benefits:** Costs and benefits directly felt by individual economic agents or groups as seen from their perspective. (Externalities imposed on others are ignored.) Costs and benefits are valued at the prices actually paid or received by the group, even if these prices are highly distorted. Sometimes termed “financial” costs and benefits. (Compare *Social costs and benefits*.)
- Probability distribution:** A distribution that shows all the values that a random variable can take and the likelihood that each will occur.
- Production, biological:** Rate of biomass produced by an ecosystem, generally expressed as biomass produced per unit of time per unit of surface or volume. Net primary productivity is defined as the energy fixed by plants minus their respiration.
- Production, economic:** Output of a system.
- Productivity, biological:** See *Production, biological*.
- Productivity, economic:** Capacity of a system to produce high levels of output or responsiveness of the output of a system to inputs.
- Projection:** A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from “predictions” in order to emphasize that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized; they are therefore subject to substantial uncertainty.
- Property rights:** The right to specific uses, perhaps including exchange in a market, of ecosystems and their services.
- Provisioning services:** The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.
- Public good:** A good or service in which the benefit received by any one party does not diminish the availability of the benefits to others, and where access to the good cannot be restricted.
- Reactive nitrogen** (or fixed nitrogen): The forms of nitrogen that are generally available to organisms, such as ammonia, nitrate, and organic nitrogen. Nitrogen gas (or dinitrogen), which is the major component of the atmosphere, is inert to most organisms.
- Realm:** Used to describe the three major types of ecosystems on earth: terrestrial, freshwater, and marine. Differs fundamentally from *biogeographic realm*.
- Reforestation:** Planting of forests on lands that have previously contained forest but have since been converted to some other use. (Compare *Afforestation*.)
- Regime shift:** A rapid reorganization of an ecosystem from one relatively stable state to another.
- Regulating services:** The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.
- Relative abundance:** See *Abundance*.
- Reporting unit:** The spatial or temporal unit at which assessment or analysis findings are reported. In an assessment, these units are chosen to maximize policy relevance or relevance to the public and thus may differ from those upon which the analyses were conducted (e.g., analyses conducted on mapped ecosystems can be reported on administrative units). See also *System*.
- Resilience:** The level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.
- Resistance:** The capacity of an ecosystem to withstand the impacts of drivers without displacement from its present state.
- Responses:** Human actions, including policies, strategies, and interventions, to address specific issues, needs, opportunities, or problems. In the context of ecosystem management, responses may be of legal, technical, institutional, economic, and behavioral nature and may operate at various spatial and time scales.
- Riparian:** Something related to, living on, or located at the banks of a watercourse, usually a river or stream.
- Safe minimum standard:** A decision analytical framework in which the benefits of ecosystem services are assumed to be incalculable and should be preserved unless the costs of doing so rise to an intolerable level, thus shifting the burden of proof to those who would convert them.
- Salinization:** The buildup of salts in soils.
- Scale:** The measurable dimensions of phenomena or observations. Expressed in physical units, such as meters, years, population size, or quantities moved or exchanged. In observation, scale determines the relative fineness and coarseness of different detail and the selectivity among patterns these data may form.
- Scenario:** A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technology change, prices) and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a “narrative storyline.” Scenarios may include projections but are often based on additional information from other sources.
- Security:** Access to resources, safety, and the ability to live in a predictable and controllable environment.
- Service:** See *Ecosystem services*.
- Social costs and benefits:** Costs and benefits as seen from the perspective of society as a whole. These differ from private costs and benefits in being more inclusive (all costs and benefits borne by some member of society are taken into account) and in being valued at social opportunity cost rather than market prices, where these differ. Sometimes termed “economic” costs and benefits. (Compare *Private costs and benefits*.)
- Social incentives:** Measures that lower transaction costs by facilitating trust-building and learning as well as rewarding collaboration and conflict resolution. Social incentives are often provided by bridging organizations.
- Socioecological system:** An ecosystem, the management of this ecosystem by actors and organizations, and the rules, social norms, and conventions underlying this management. (Compare *System*.)
- Soft law:** Non-legally binding instruments, such as guidelines, standards, criteria, codes of practice, resolutions, and principles or declarations, that states establish to implement national laws.
- Soil fertility:** The potential of the soil to supply nutrient elements in the quantity, form, and proportion required to support optimum plant growth. See also *Nutrients*.

**Speciation:** The formation of new species.

**Species:** An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term *species* is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity, that once described and accepted is associated with a unique scientific name.

**Species diversity:** Biodiversity at the species level, often combining aspects of species richness, their relative abundance, and their dissimilarity.

**Species richness:** The number of species within a given sample, community, or area.

**Statistical variation:** Variability in data due to error in measurement, error in sampling, or variation in the measured quantity itself.

**Stock** (in fisheries): The population or biomass of a fishery resource. Such stocks are usually identified by their location. They can be, but are not always, genetically discrete from other stocks.

**Stoichiometry, ecological:** The relatively constant proportions of the different nutrients in plant or animal biomass that set constraints on production. Nutrients only available in lower proportions are likely to limit growth.

**Storyline:** A narrative description of a scenario, which highlights its main features and the relationships between the scenario's driving forces and its main features.

**Strategies:** See *Responses*.

**Streamflow:** The quantity of water flowing in a watercourse.

**Subsidiarity, principle of:** The notion of devolving decision-making authority to the lowest appropriate level.

**Subsidy:** Transfer of resources to an entity, which either reduces the operating costs or increases the revenues of such entity for the purpose of achieving some objective.

**Subsistence:** An activity in which the output is mostly for the use of the individual person doing it, or their family, and which is a significant component of their livelihood.

**Subspecies:** A population that is distinct from, and partially reproductively isolated from, other populations of a species but that has not yet diverged sufficiently that interbreeding is impossible.

**Supporting services:** Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

**Sustainability:** A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

**Sustainable use** (of an ecosystem): Human use of an ecosystem so that it may yield a continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.

**Symbiosis:** Close and usually obligatory relationship between two organisms of different species, not necessarily to their mutual benefit.

**Synergy:** When the combined effect of several forces operating is greater than the sum of the separate effects of the forces.

**System:** In the Millennium Ecosystem Assessment, reporting units that are ecosystem-based but at a level of aggregation far higher than that usually applied to ecosystems. Thus the system includes many component ecosystems, some of which may not strongly interact with each other, that may be spatially separate, or that may be of a different type to the ecosystems that constitute the majority, or matrix, of the system overall. The system includes the social and economic systems that have an impact on and are affected by the ecosystems included within it. For example, the Condition and Trend Working Group refers to "forest systems," "cultivated systems," "mountain systems," and so on. Systems thus defined are not mutually exclusive, and are permitted to overlap spatially or conceptually. For instance, the "cultivated system" may include areas of "dryland system" and vice versa.

**Taxon** (pl. taxa): The named classification unit to which individuals or sets of species are assigned. Higher taxa are those above the species

level. For example, the common mouse, *Mus musculus*, belongs to the Genus *Mus*, the Family Muridae, and the Class Mammalia.

**Taxonomy:** A system of nested categories (*taxa*) reflecting evolutionary relationships or morphological similarity.

**Tenure:** See *Property rights*, although also sometimes used more specifically in reference to the temporal dimensions and security of property rights.

**Threatened species:** Species that face a high (*vulnerable species*), very high (*endangered species*), or extremely high (*critically endangered species*) risk of extinction in the wild.

**Threshold:** A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behavior, especially at group levels, sometimes exhibits threshold effects.

Thresholds at which irreversible changes occur are especially of concern to decision-makers. (Compare *Non-linearity*.)

**Time series data:** A set of data that expresses a particular variable measured over time.

**Total economic value framework:** A widely used framework to disaggregate the components of utilitarian value, including *direct use value*, *indirect use value*, *option value*, *quasi-option value*, and *existence value*.

**Total factor productivity:** A measure of the aggregate increase in efficiency of use of inputs. TFP is the ratio of the quantity of output divided by an index of the amount of inputs used. A common input index uses as weights the share of the input in the total cost of production.

**Total fertility rate:** The number of children a woman would give birth to if through her lifetime she experienced the set of age-specific fertility rates currently observed. Since age-specific rates generally change over time, TFR does not in general give the actual number of births a woman alive today can be expected to have. Rather, it is a synthetic index meant to measure age-specific birth rates in a given year.

**Trade-off:** Management choices that intentionally or otherwise change the type, magnitude, and relative mix of services provided by ecosystems.

**Traditional ecological knowledge:** The cumulative body of knowledge, practices, and beliefs evolved by adaptive processes and handed down through generations. TEK may or may not be indigenous or local, but it is distinguished by the way in which it is acquired and used, through the social process of learning and sharing knowledge. (Compare *Indigenous knowledge*.)

**Traditional knowledge:** See *Traditional ecological knowledge*.

**Traditional use:** Exploitation of natural resources by indigenous users or by nonindigenous residents using traditional methods. Local use refers to exploitation by local residents.

**Transpiration:** The process by which water is drawn through plants and returned to the air as water vapor. Evapotranspiration is combined loss of water to the atmosphere via the processes of evaporation and transpiration.

**Travel cost methods:** Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination.

**Trend:** A pattern of change over time, over and above short-term fluctuations.

**Trophic cascade:** A chain reaction of top-down interactions across multiple trophic levels. These occur when changes in the presence or absence (or shifts in abundance) of a top predator alter the production at several lower trophic levels. Such positive indirect effects of top predators on lower trophic levels are mediated by the consumption of mid-level consumers (generally herbivores).

**Trophic level:** The average level of an organism within a food web, with plants having a trophic level of 1, herbivores 2, first-order carnivores 3, and so on.

**Umbrella species:** Species that have either large habitat needs or other requirements whose conservation results in many other species being conserved at the ecosystem or landscape level.

- Uncertainty:** An expression of the degree to which a future condition (e.g., of an ecosystem) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined terminology or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).
- Urbanization:** An increase in the proportion of the population living in urban areas.
- Urban systems:** Built environments with a high human population density. Operationally defined as human settlements with a minimum population density commonly in the range of 400 to 1,000 persons per square kilometer, minimum size of typically between 1,000 and 5,000 people, and maximum agricultural employment usually in the vicinity of 50–75%. See also *System*.
- Utility:** In economics, the measure of the degree of satisfaction or happiness of a person.
- Valuation:** The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on). See also *Value*.
- Value:** The contribution of an action or object to user-specified goals, objectives, or conditions. (Compare *Valuation*.)
- Value systems:** Norms and precepts that guide human judgment and action.
- Voluntary measures:** Measures that are adopted by firms or other actors in the absence of government mandates.
- Vulnerability:** Exposure to contingencies and stress, and the difficulty in coping with them. Three major dimensions of vulnerability are involved: exposure to stresses, perturbations, and shocks; the sensitivity of people, places, ecosystems, and species to the stress or perturbation, including their capacity to anticipate and cope with the stress; and the resilience of the exposed people, places, ecosystems, and species in terms of their capacity to absorb shocks and perturbations while maintaining function.
- Vulnerable species:** Species that face a high risk of extinction in the wild. See also *Threatened species*.
- Water scarcity:** A water supply that limits food production, human health, and economic development. Severe scarcity is taken to be equivalent to 1,000 cubic meters per year per person or greater than 40% use relative to supply.
- Watershed** (also catchment basin): The land area that drains into a particular watercourse or body of water. Sometimes used to describe the dividing line of high ground between two catchment basins.
- Water stress:** See *Water scarcity*.
- Well-being:** A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience.
- Wetlands:** Areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters. May incorporate riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six meters at low tide laying within the wetlands.
- Wise use** (of an ecosystem): Sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem



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