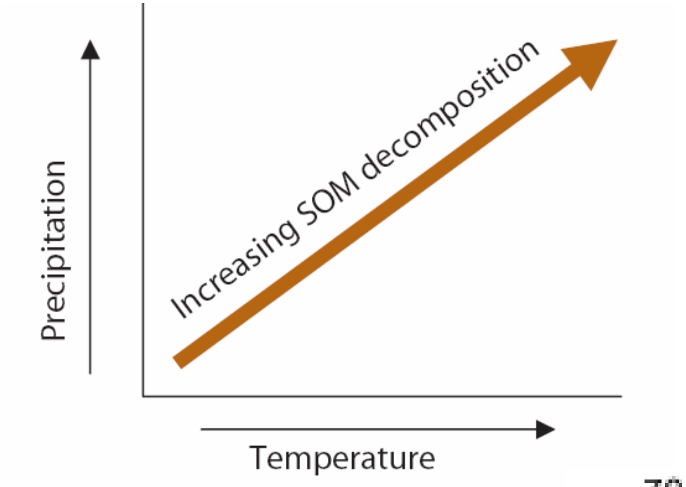
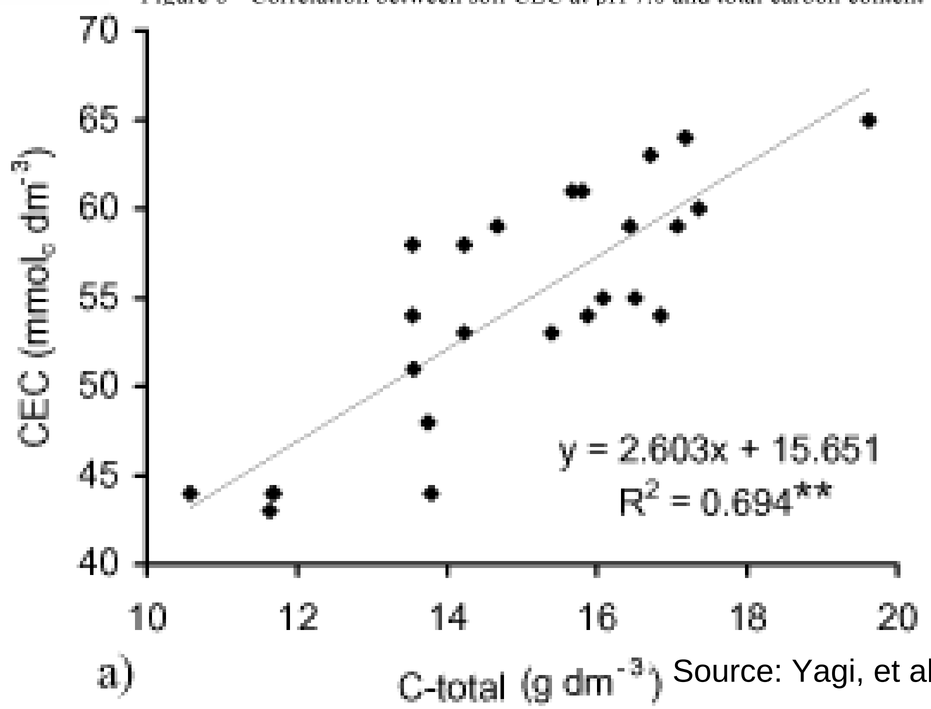
Management and Benefits of Organic Matter



1. Soil Climate

– moisture and temperature

Figure 6 - Correlation between soil CEC at pH 7.0 and total carbon content



2. Nutrients

3. pH Stability

Source: Yagi, et al. Sci. agric. (Piracicaba, Braz.) vol.60 no.3 Piracicaba 2003

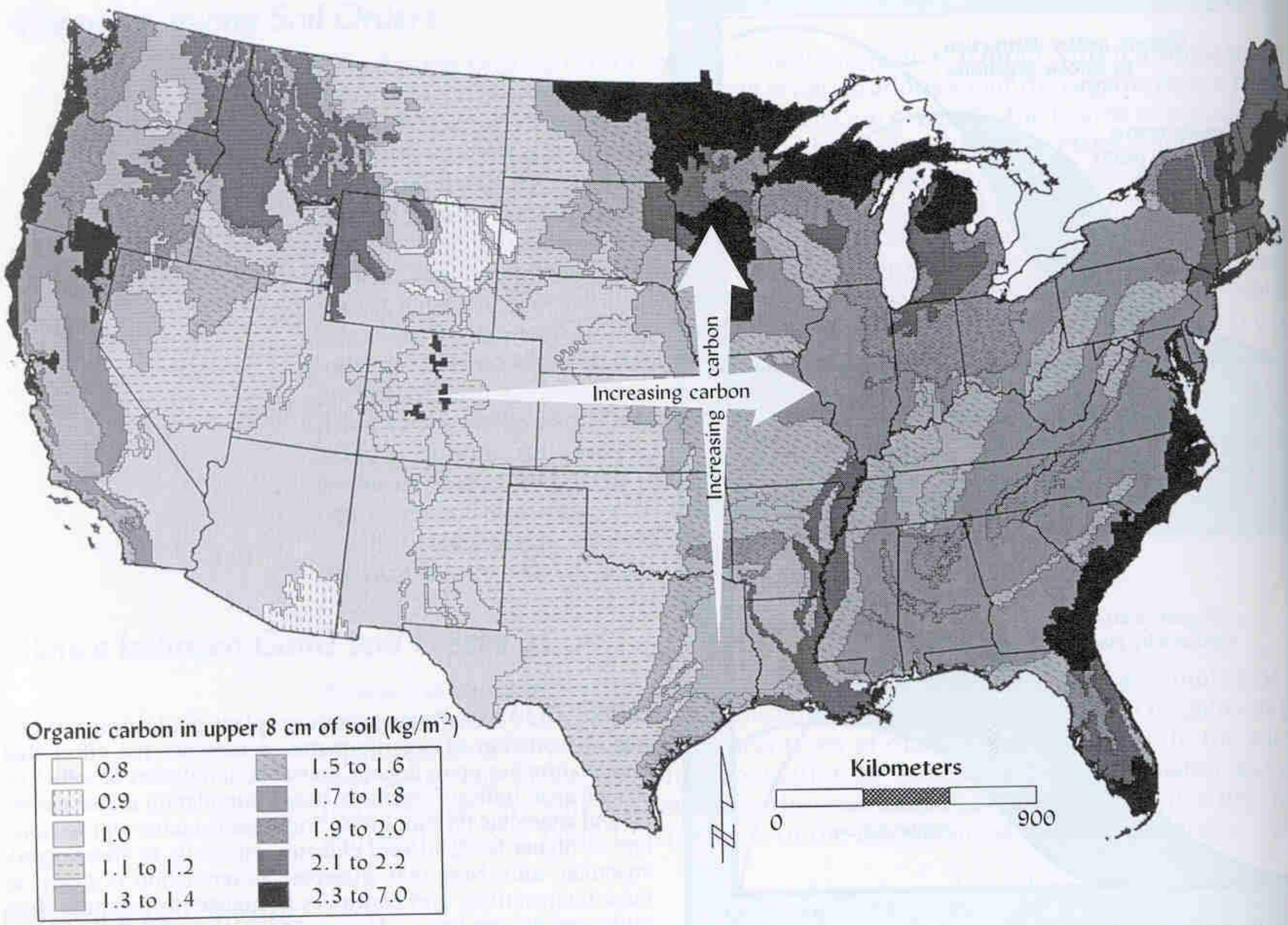
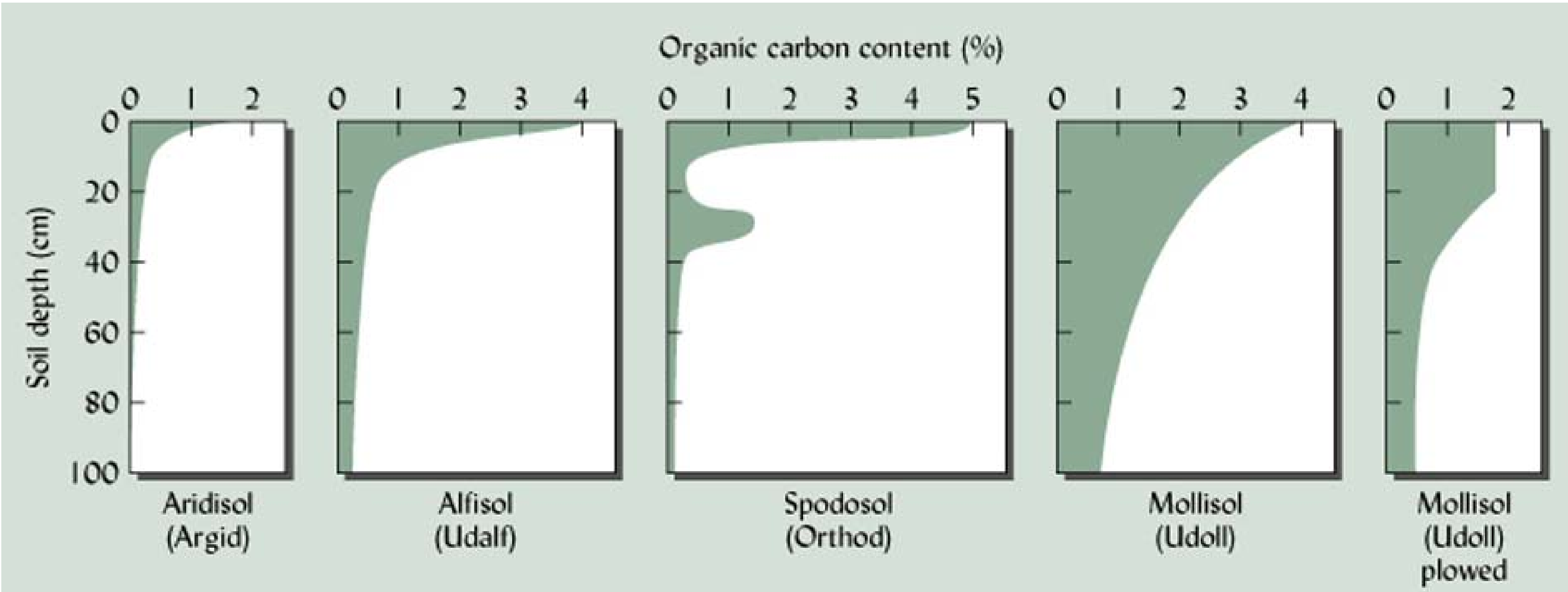
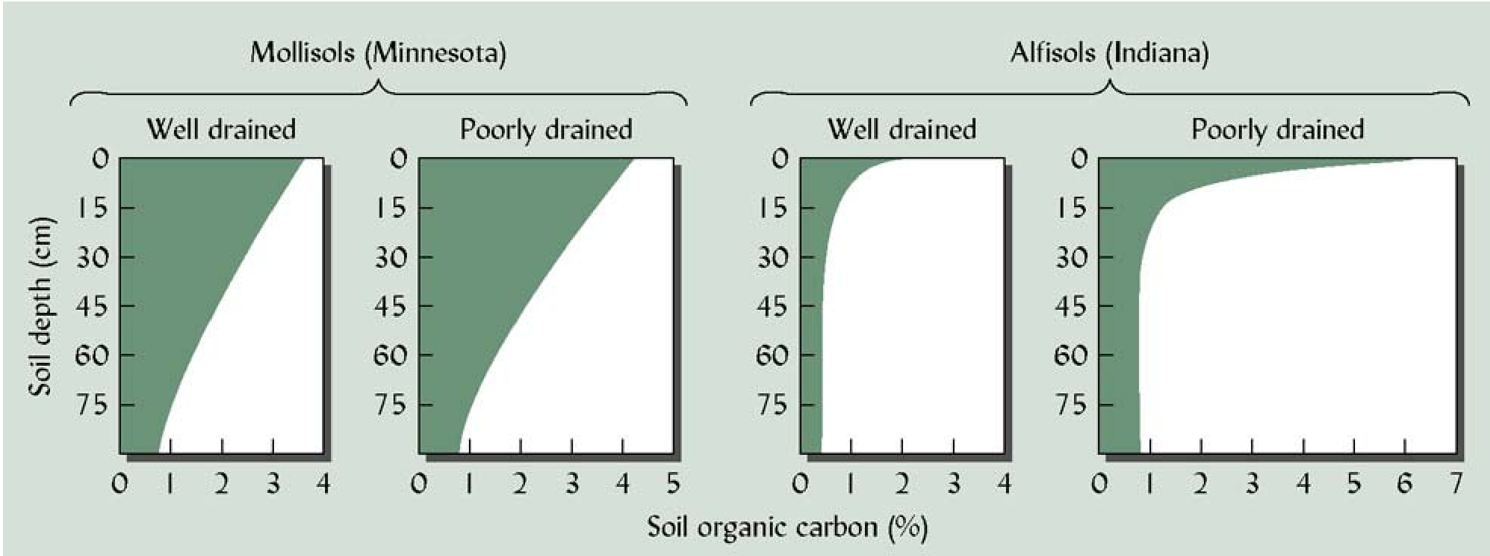
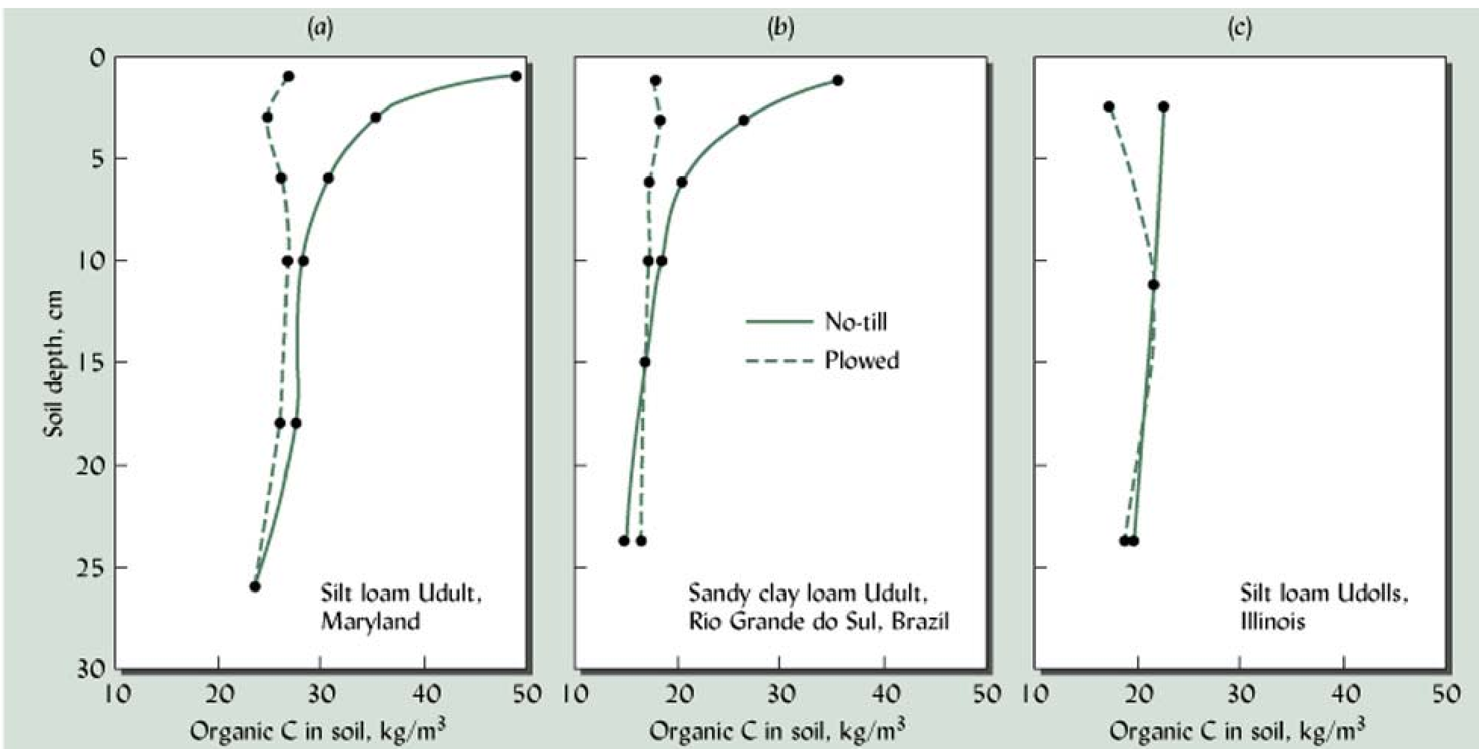


FIGURE 12.21 Influence of mean annual temperature and precipitation on organic matter levels in soils and on the difficulty of sustaining the soil resource base. The large white arrows on the map indicate that in the North American Great Plains region, soil organic matter increases with cooler temperatures going north, and with higher rainfall going east, provided that the soils compared are similar in texture, type of vegetation, drainage, and all other aspects except temperature and rainfall. These trends can be further generalized for global environments. [Kern (1994); Map courtesy of J. Kern, U.S. Environmental Protection Agency.]


Organic carbon content (%)
Soil depth (cm)
0
20
40
60
80
100
0 1 2
0 1 2 3 4
0 1 2 3 4 5
0 1 2 3 4
0 1 2
Aridisol (Argid)
Alfisol (Udalf)
Spodosol (Orthod)
Mollisol (Udoll)
Mollisol (Udoll) plowed

Reduce loss by Soil Environment Modification

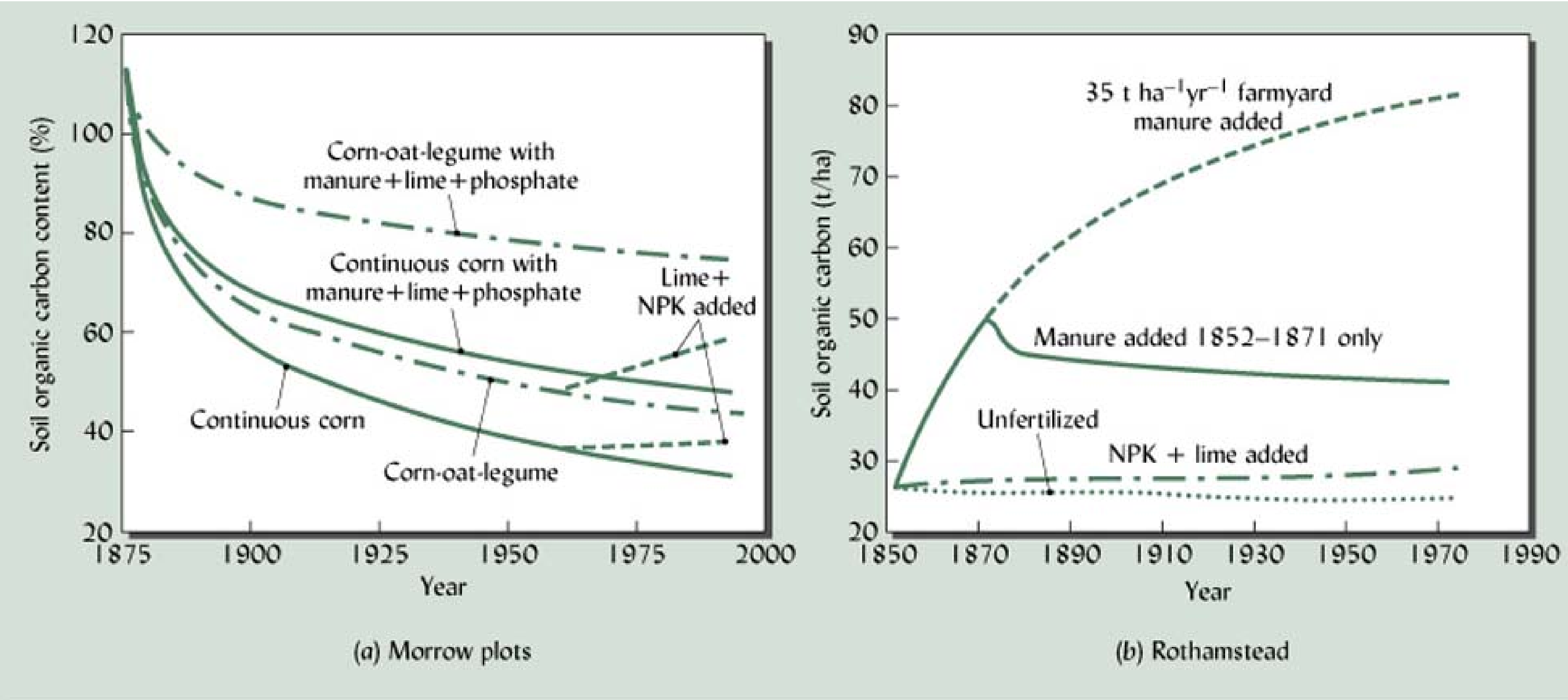




Increase input by OM Addition & Crop Modification

Cropping Rotation

Manure Addition



Soil Organic Matter

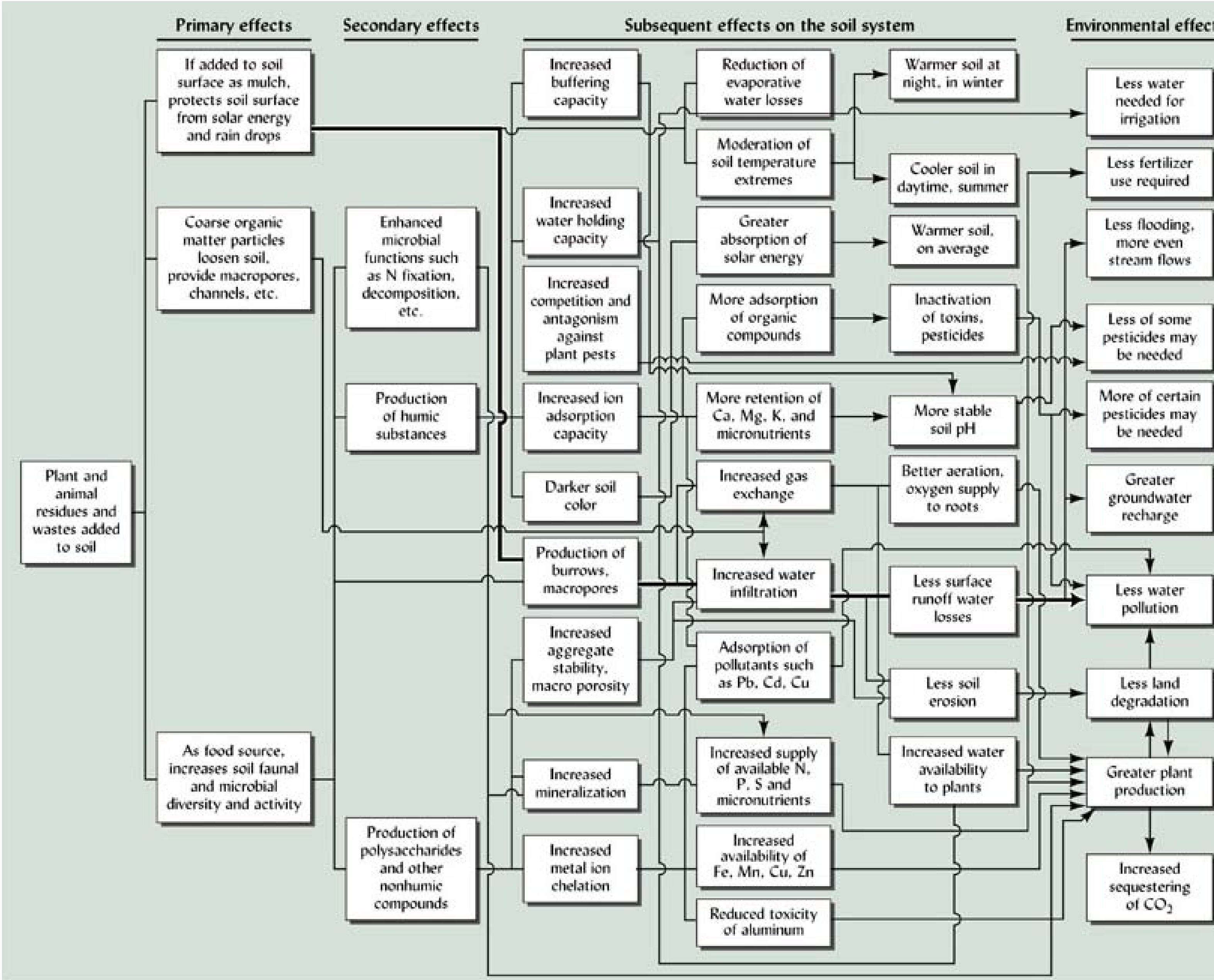


Figure 12.15

Effects of Organic Matter in Soil

1^{O} Effects

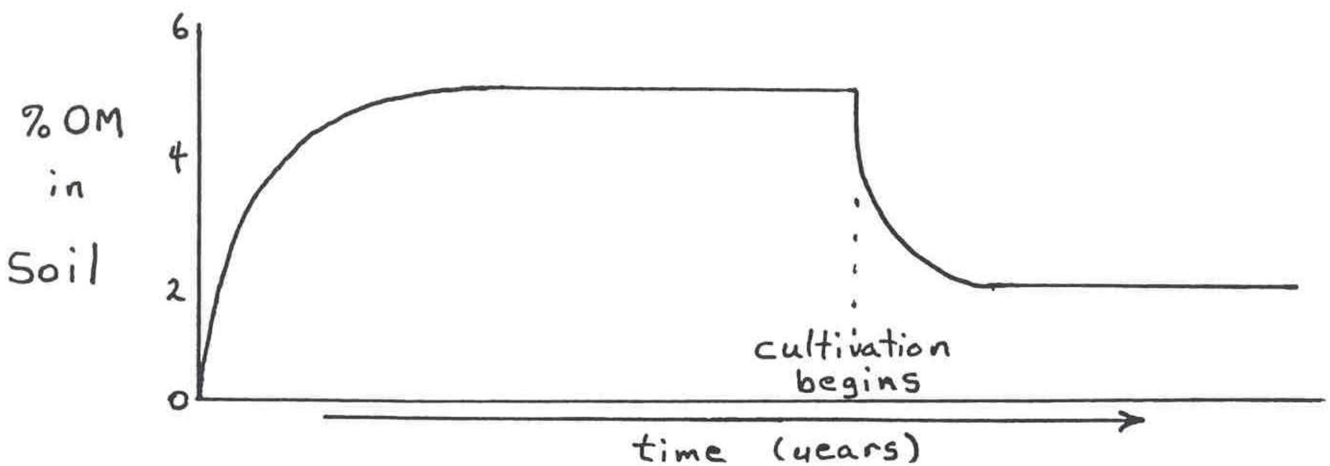
1. Protection from structural degradation and attenuates heat
2. Creation of structure and increase in macroporosity
3. Increases the soil faunal diversity and activity

Subsequent Environmental Effects

1. Increased water storage and availability
2. Less need for fertilizer, more and less need for pesticides
3. Storm water mitigation and increase groundwater recharge
4. Less water pollution
5. Increased CO2 Sequestration
6. Less land degradation
7. Greater Plant Production

Land Use/Cover Conversion

Soil Organic Carbon (SOC)



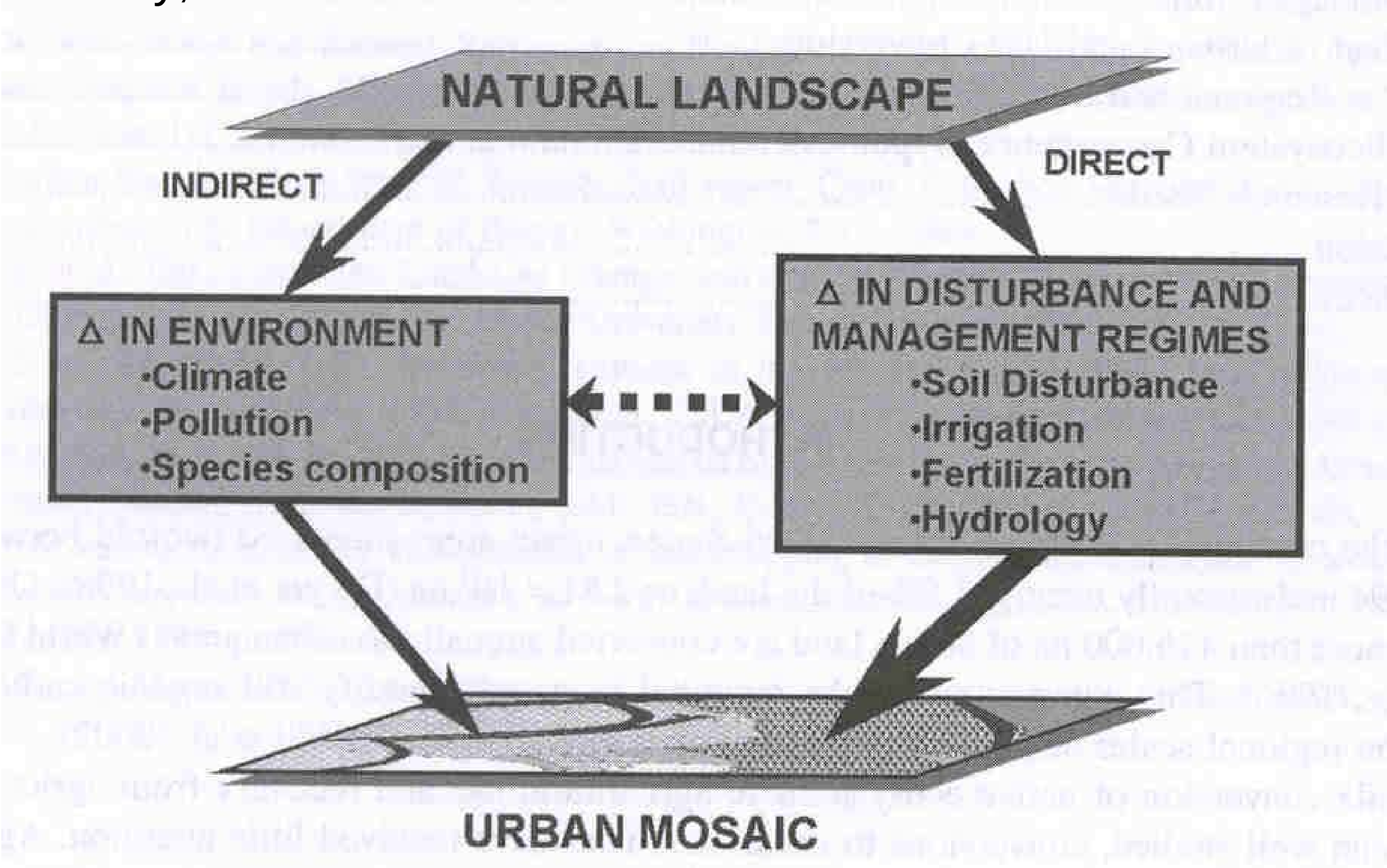
Effects of Urbanization on Soil

Currently 3.5% of land in US is under urban land cover (1% world wide)

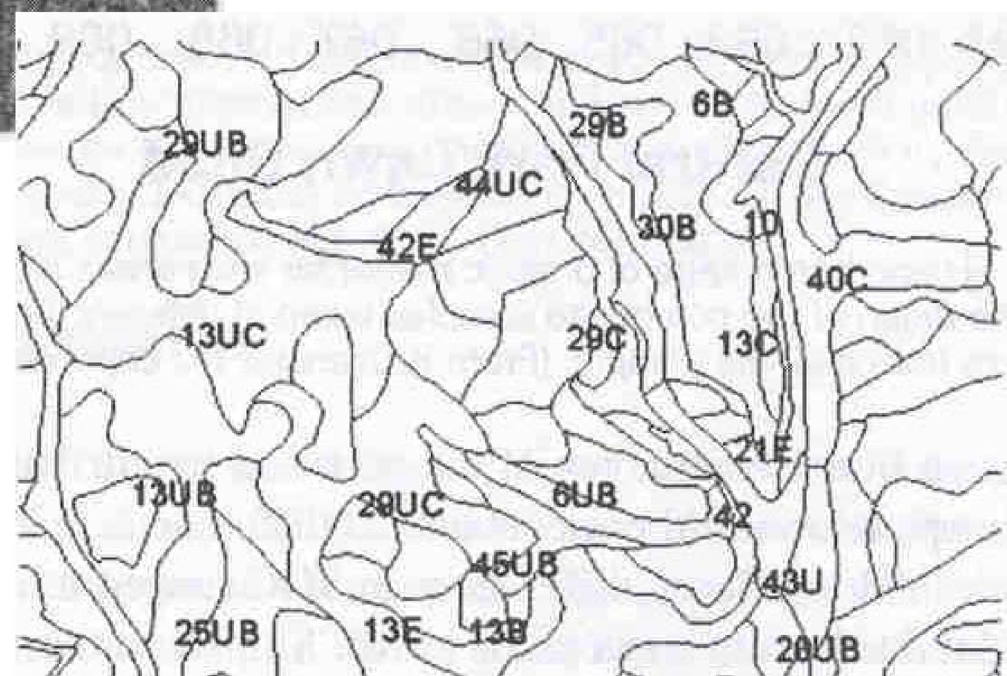
Twofold increase from 1969 to 1994 (currently 2.81 x 10^7 ha)

World wide 476 000 ha of arable land converted to urban use / year

Unfortunately, there is not a lot know about SOC in urban environments!



Urban Landscape Variability

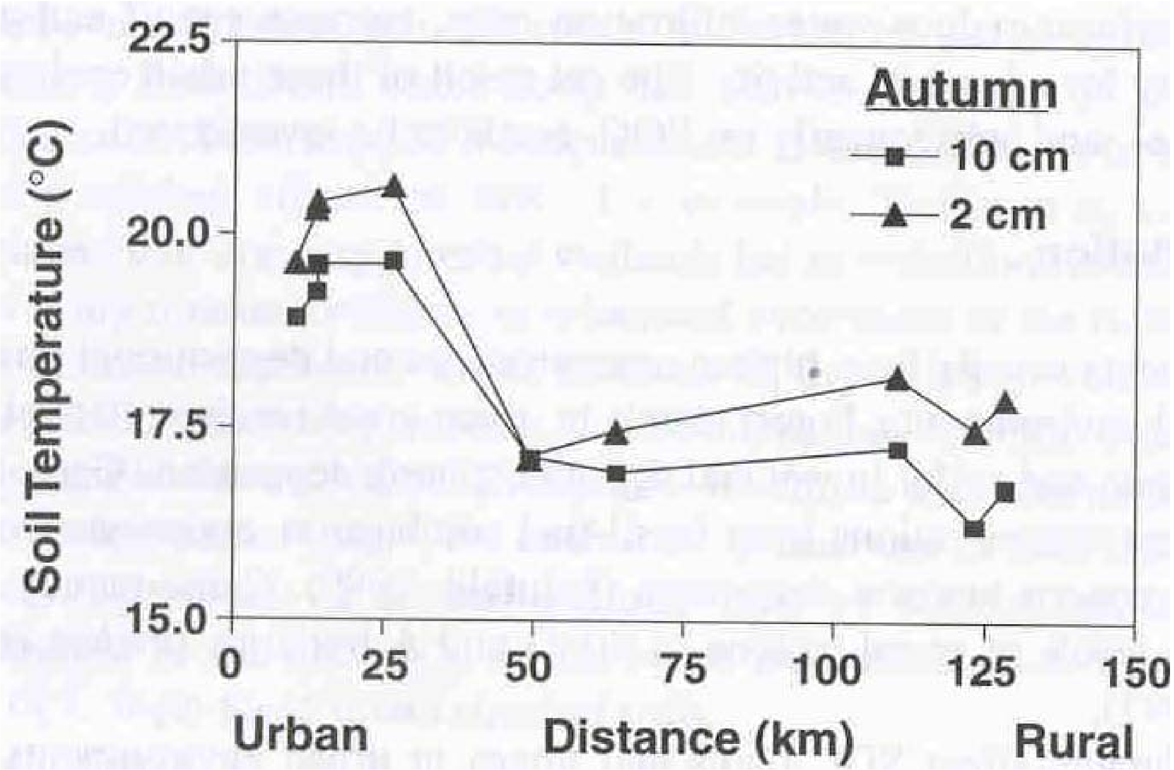


OM Decay/Accumulation Rates

- Properties of OM
- Water
- Temperature
- Stage of Decay
- Chemical Factors

Regional Variability

1. Soil Temperature and Moisture
2. Atmospheric Pollution
3. Species Composition
4. Hydrologic Changes



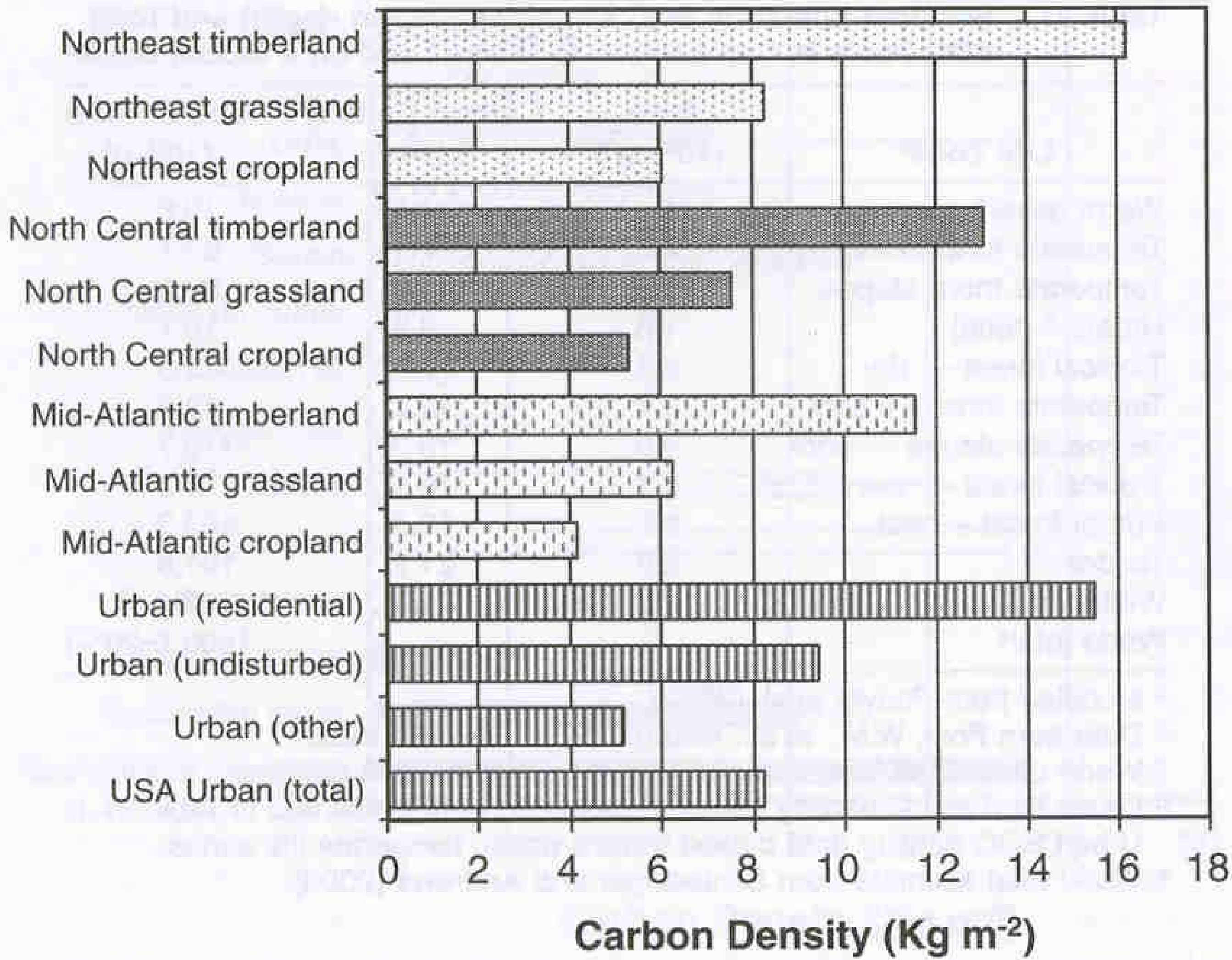


Figure 21.7 Comparison of SOC densities (kg/m² at 1-m depth) for disturbed, managed, and undisturbed soils found in urban ecosystems with forest and cropland soil estimates for the Northeast, North Central, and Mid-Atlantic states. Urban soil types were compiled from soil pedon data presented in Table 21.1. Carbon densities of forest and cropland soils from Birdsey (1992). Aerial coverages of forest and cropland soils calculated from Table 21.1 (Modified from the USDA Forest Service, 1997).

Local Physical and Chemical Variability

1. Soil Temperature and Moisture
2. Atmospheric Pollution
3. Species Composition
4. Hydrologic Changes

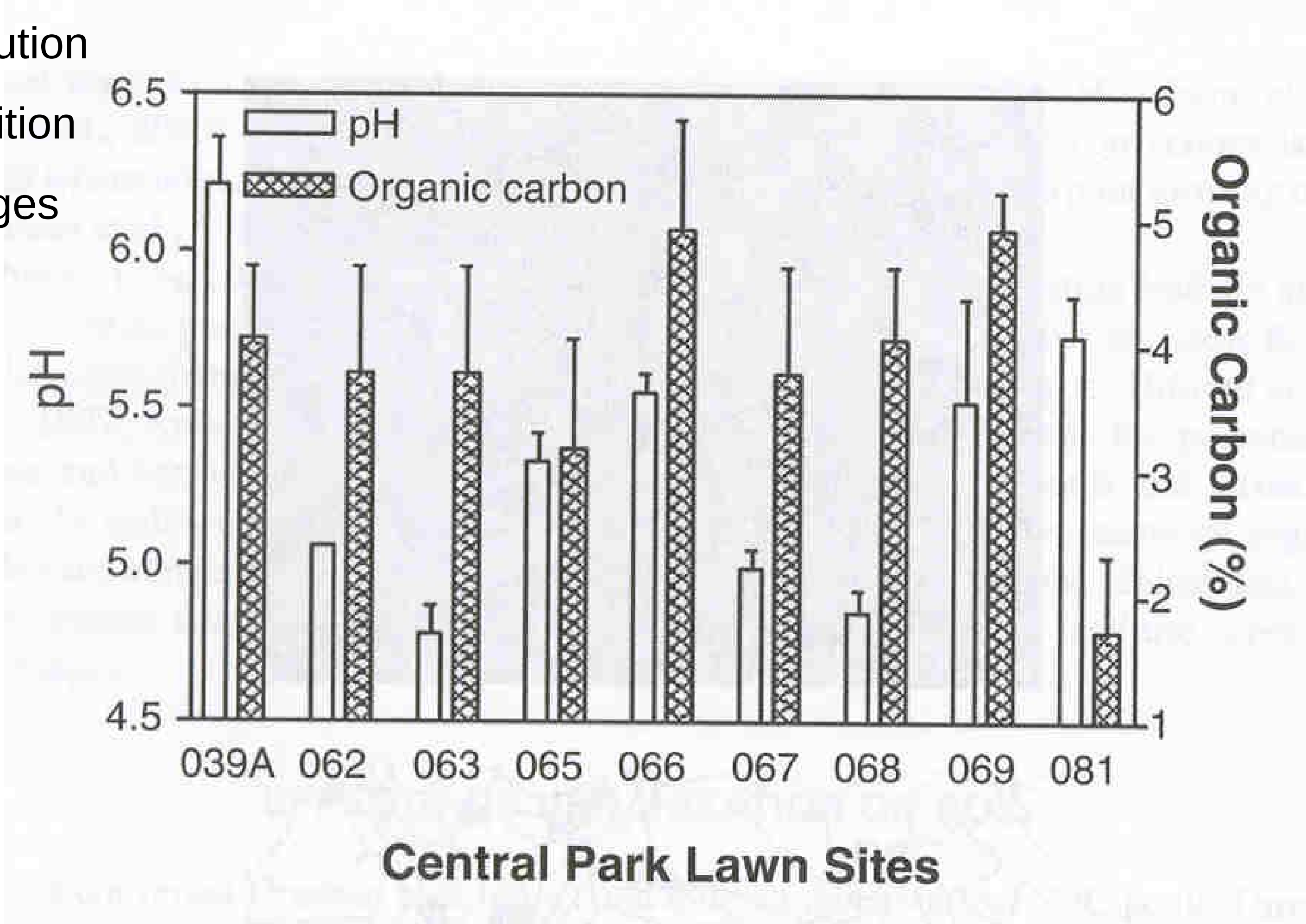
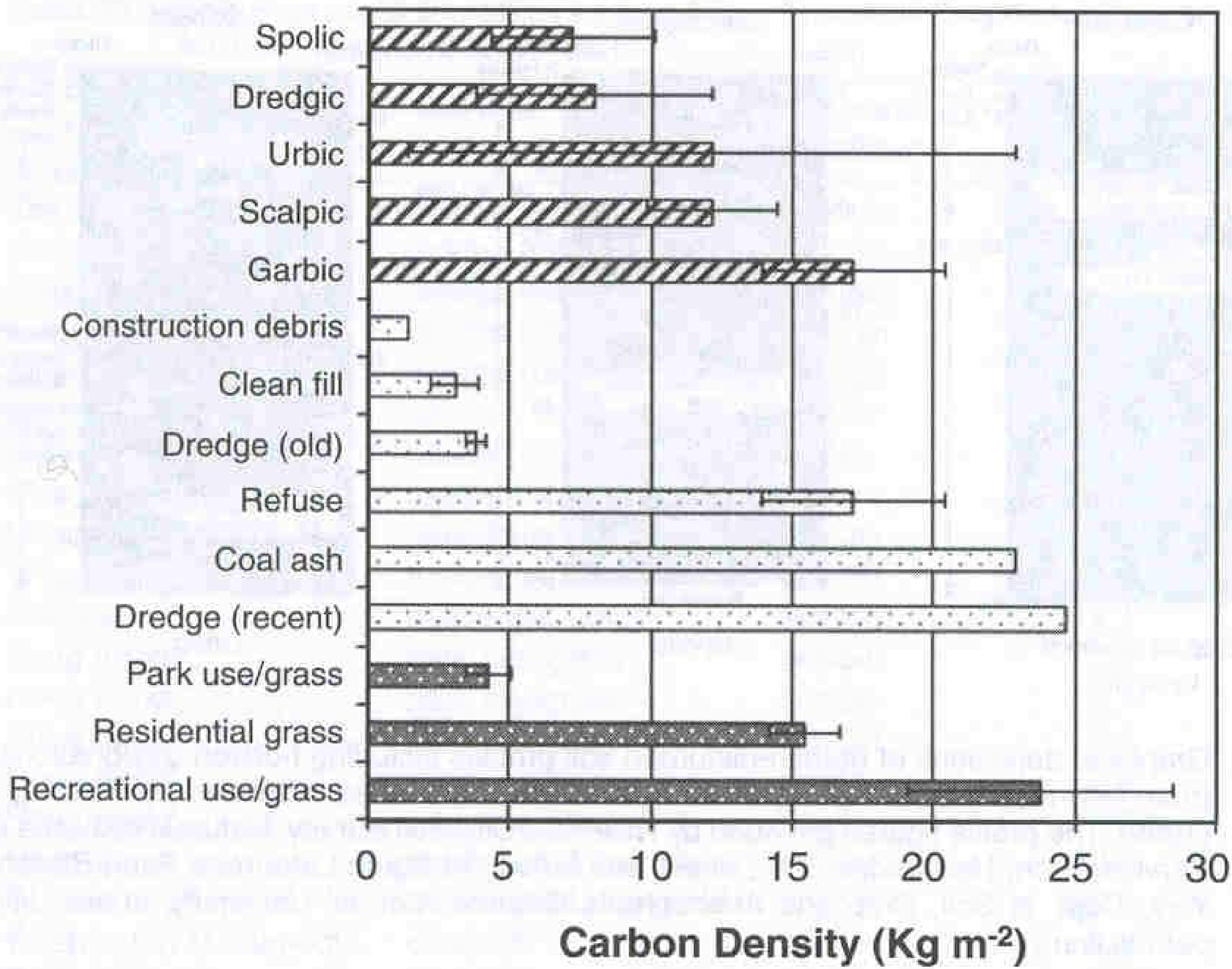


Table 21.1 Soil Organic C Densities by Land-Use Type and Proposed Classes for Disturbed and Made Soils

City/County	Type/Land Use	Proposed Classes[a]	Carbon Density (kg/m^2)
Kings, NY[b]	dredge (old)	dredgic	3.9
Kings, NY[b]	dredge (old)	dredgic	4.0
Kings, NY[b]	dredge (old)	dredgic	4.5
Kings, NY[b]	dredge (old)	dredgic	2.9
Baltimore, MD[c]	dredge (recent)	dredgic	24.7
Queens, NY[b]	refuse	garbic	13.9
Richmond, NY[b]	refuse	garbic	20.4
Moscow, Russia[d]	residential grass	scalpic	12.9
Moscow, Russia[d]	residential grass	scalpic	16.3
Chicago, IL[e]	residential grass	scalpic	18.5
Chicago, IL[e]	residential grass	scalpic	14.1
Hong Kong[f]	park use/grass	scalpic	7.2
Hong Kong[f]	park use/grass	scalpic	4.7
Hong Kong[f]	park use/grass	scalpic	3.2
Hong Kong[f]	park use/grass	spolic	3.9
Hong Kong[f]	park use/grass	spolic	2.3
Hong Kong[f]	recreational use/grass	spolic	19.1
Queens, NY[b]	recreational use/grass	spolic	28.5
Washington Monument[g]	clean fill	spolic	1.6
Richmond, NY[b]	clean fill	spolic	3.6
Richmond, NY[b]	clean fill	spolic	3.4
Richmond, NY[b]	clean fill	spolic	6.9
Washington, DC[g]	clean fill	spolic	1.4
Washington, DC[g]	clean fill	spolic	1.6
Richmond County, NY[b]	coal ash	urbic	22.9
Washington Monument[g]	construction debris	urbic	1.4

Note: Except where indicated, carbon densities were calculated with data collected from soil pit characterizations to a depth of 1 m.

[a] Class determinations based on site descriptions in Fanning and Fanning, 1989.
[b] Data from New York City Soil Survey, Natural Resource Conservation Service.
[c] Calculated from data reported in Evans et al. (2000) and data provided by Fanning.
[d] Calculated from data reported in Stroganova et al. (1998).
[e] Calculated to a depth of 60 cm from data reported in Jo and McPherson (1995).
[f] Calculated from data reported in Jim (1998).
[g] Calculated from data reported in Short et al. (1986).


Spolic
Dredgic
Urbic
Scalpic
Garbic
Construction debris
Clean fill
Dredge (old)
Refuse
Coal ash
Dredge (recent)
Park use/grass
Residential grass
Recreational use/grass
0
5
10
15
20
25
30
Carbon Density (Kg m-2)

Estimates of Carbon Stock

- with assumption of 60% urban soil type in urban areas

2.63×10^{15} g –Nationally (USA)

10.7×10^{15} g – World Wide

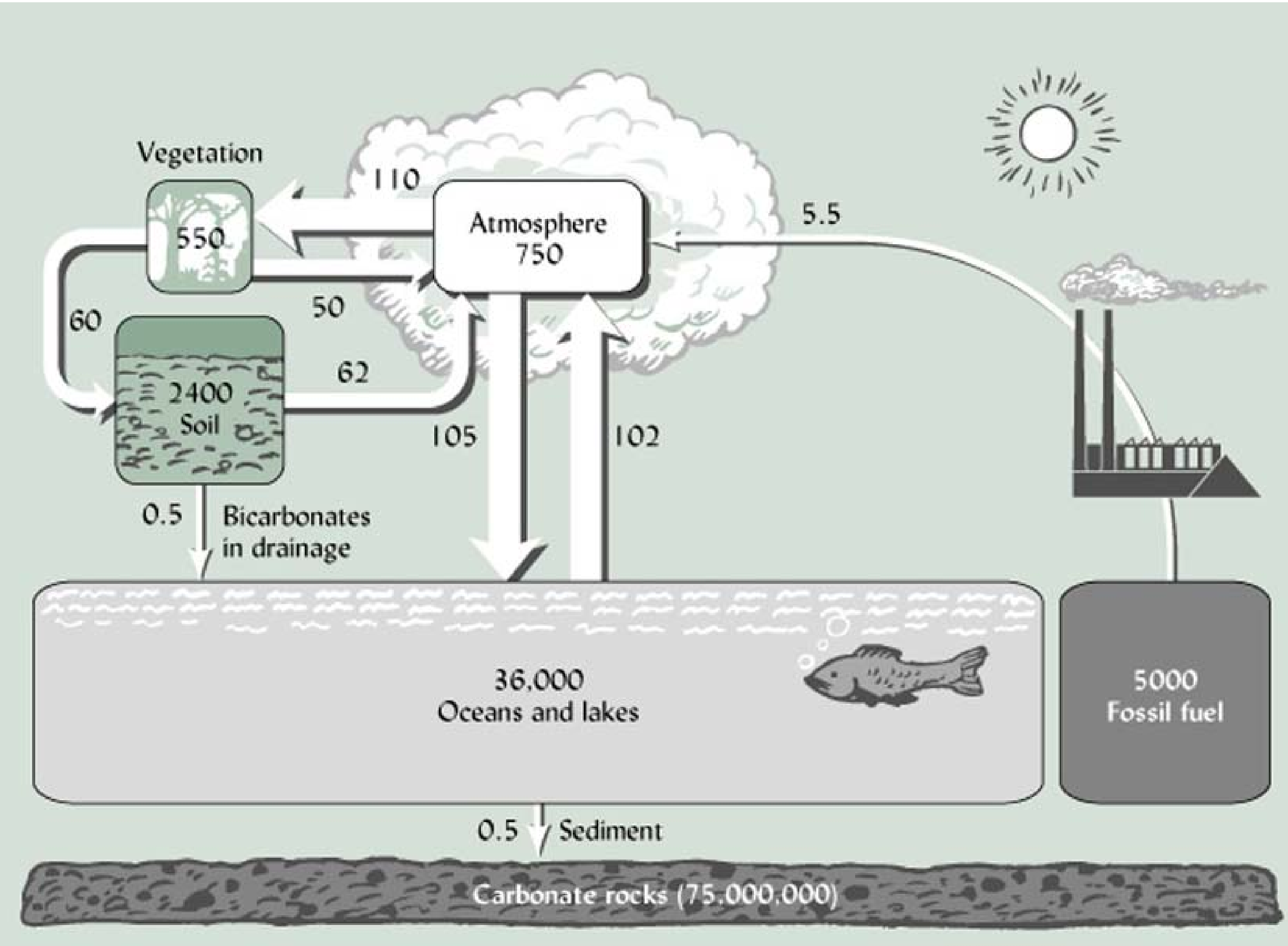
World wide this represent only 0.7 % of carbon stock
of a land cover that represents 1%

BUT this doesn't account for regional and local variability

ie where is the urban area growing

NOR does it account for Global Carbon pools

ie what is the relative % of total available carbon



0.7 % of SOC
is 16.8 Pg

But by comparison

this represents 2%
of the atmosphere

Or

3% of vegetation

Or

10% of the fluxes
between these
pools

Petagrams = Pg = 10^{15} g

Table 1.2 Population in Cities with More Than 1 Million Residents, by Region, 1950–2015

Region	**1950**	**1970**	**1990**	**2015**
	Total Population in All Cities with More Than 1 Million Residents (population in millions)			
Africa	3	16	59	225
Latin America	17	57	118	225
Asia	58	168	359	903
Europe	73	116	141	156
North America	40	78	105	148

Source: United Nations (U.N.) Population Division, *World Population Prospects: 1994 Revision* (U.N., New York, 1995), pp. 12, 14–17.

Figure 1.2 Regional Trends in Urbanization, 1970–2025

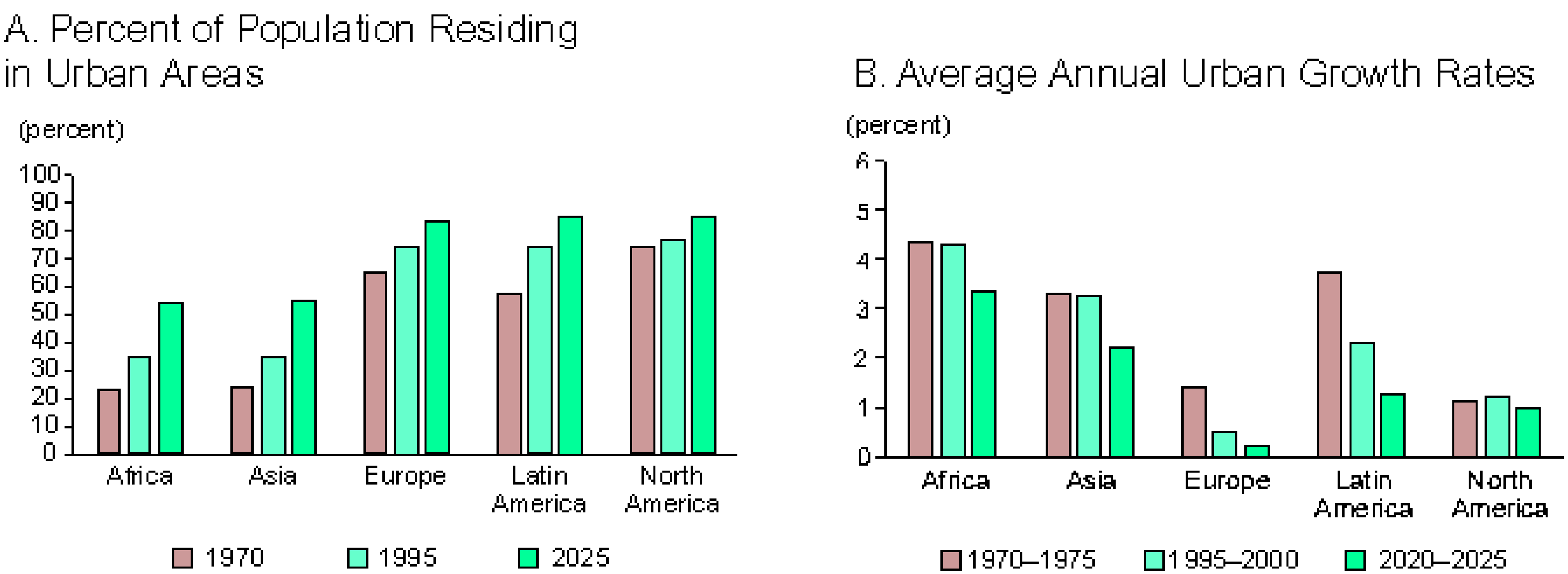


Table 21.2 Selected Life-Zone SOC Densities (at 1-m depth) and Total SOC Pools in Comparison to Urban Land on a Global Basis[a]

Life Zone[b]	Area (10^{12} m^2)	Carbon Density (kg/m^2)	Soil Carbon (10^{15} g)
Warm desert	14.0	1.4	19.6
Temperate forest — warm	8.6	7.1	61.1
Temperate thorn steppe	3.9	7.6	29.6
Urban[c, d] (total)	1.3	8.2	10.7
Tropical forest — dry	2.4	9.9	23.8
Temperate forest — cool	3.4	12.7	43.2
Temperate steppe — cool	9.0	13.3	119.7
Tropical forest — wet	4.1	19.1	78.3
Boreal forest — wet	6.9	19.3	133.2
Tundra	8.8	21.8	191.8
Wetlands	2.8	72.3	202.4
World total[e]			1500 (±20%)

[a] Modified from Pouyat et al. (2002).
[b] Data from Post, W.M. et al., Nature, 298, 156–159, 1982.
[c] World urban land total from World Resources Institute (1996).
[d] Urban land soil C density estimate based on data presented in Table 21.1. Urban SOC density data biased toward warm, temperate life zones.
[e] World total estimate from Schlesinger and Andrews (2000).

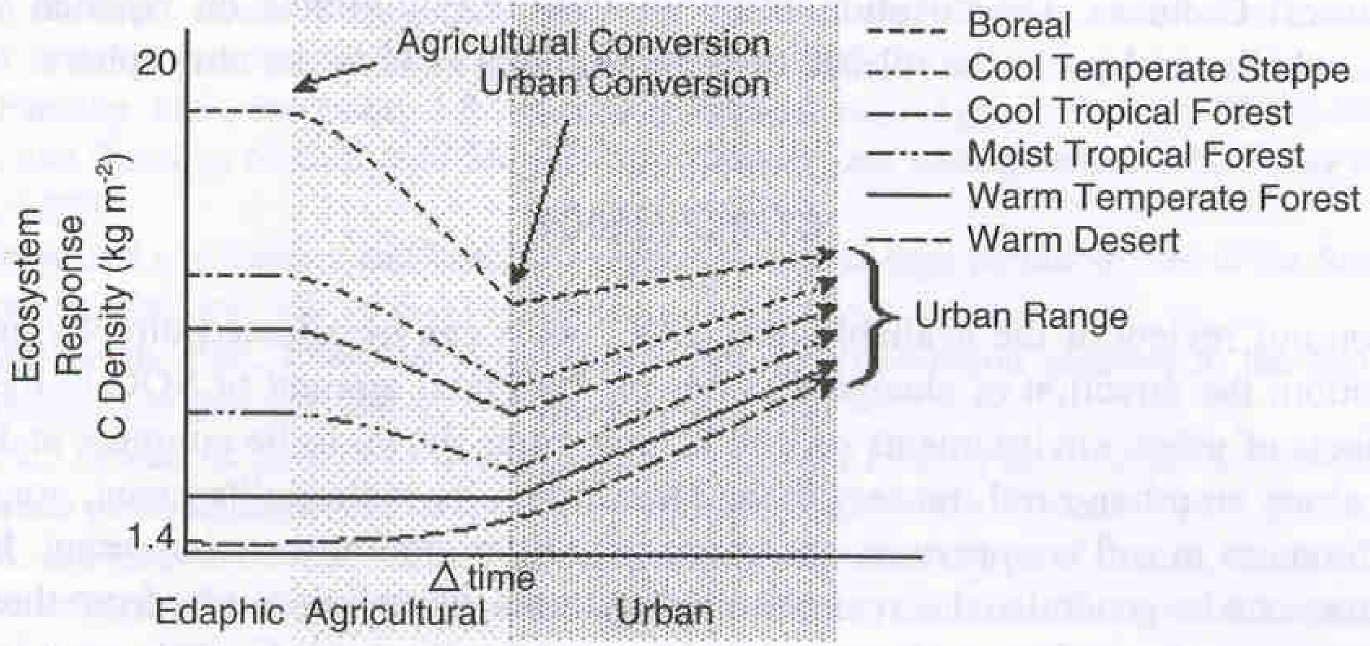


Figure 21.8 Plot of hypothesized ecosystem response to agricultural and urban land-use conversions over time. In this example, soil carbon density (kg/m^2) for boreal, cool temperate steppe, cool tropical forest, moist tropical forest, warm temperate forest, and warm desert life zones (Table 21.1) converge on a range of soil carbon densities following urbanization.