

Ecosystem Appropriation by Cities

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# Ecosystem Appropriation by Cities

We estimated the ecological footprint of cities in Baltic Europe and globally. The 29 largest cities of Baltic Europe appropriate for their resource consumption and waste assimilation an area of forest, agricultural, marine, and wetland ecosystems that is at least 565–1130 times larger than the area of the cities themselves. Of the global human population, 20% (1.1 billion), living in 744 large cities worldwide, appropriate for their seafood consumption as much as 25% of the globally available area of productive marine ecosystems. The same cities' appropriation of forests for assimilation of CO<sub>2</sub> emissions exceeds the full sink capacity of the world's forests by more than 10%. If the goal as emphasized at the UN Habitat II Conference, 1996, is sustainable human settlements, the increasingly limited capacity of ecosystems to sustain urban areas has to be explicitly accounted for in city planning and development.

The populations of world's cities are growing by about 1 million people each week (1). In 1960, 34% of the human population of the world lived in urban areas, in 1990 this figure had grown to 44%, and it is projected that 60% of the world population will be city dwellers in 2025 (2).

City inhabitants require productive ecosystems, outside the borders of the city, to produce the food, the water, and the renewable resources that are consumed inside the city. They also depend on ecological systems to provide clean air and to process waste. However, current city planning tends to take the work of ecosystems for granted. Since the capacity of ecosystems to generate nonmarketed natural resources and ecological services (3–5) is increasingly becoming a limiting factor for social and economic development (6), underestimating the importance of ecosystems is not a wise strategy, particularly not if the goal, as in the recent UN Conference on cities, is to develop sustainable human settlements.

In this paper we provide i) an estimate of the ecosystem area, or the 'ecological footprint' (7–10) that is appropriated by the 29 largest cities within the Baltic Sea drainage basin in northern Europe (Fig. 1). This region consists of 14 nations in both western and eastern Europe (11). ii) We also estimate the appropriation of global marine ecosystems for seafood consumption; and iii) of global forest ecosystems for assimilation of carbon dioxide (CO<sub>2</sub>) released by 744 large cities worldwide, including 21 megacities (12). All cities in the study have more than 250 000 inhabitants.

## ESTIMATING APPROPRIATED ECOSYSTEM AREAS OF CITIES

### Renewable Resource Footprints of Baltic Cities

We estimated the consumption of wood, paper, fibers, and food, including seafood, by people in the largest cities of the Baltic Sea drainage basin (1.7 million km<sup>2</sup>), and related this consumption to the area required to produce these resources in agricultural, forest and marine ecosystems (13). We based our quanti-



Figure 1. The 29 cities in the Baltic Sea drainage basin with a population of 250 000 or more.

tative analyses on existing national data from this large-scale region with varying standards of living. Data on food and fiber consumption and land-use statistics, were obtained from the FAO computerized database Agrostat (14). Population data for the cities and land use in the region were obtained from Sweitzer et al. (15), and data on shelf sea areas and marine exclusive economic zones from the World Resources Institute on Diskette Database (16). The area of the cities was derived from an aerial photo-based GIS-data base combined with a GIS-data base of the Baltic Sea drainage basin (15). In addition, various statistical sources were used, as reported in Folke et al. (13).

Our calculations indicate that the 22 million inhabitants of the largest cities, corresponding to about 26% of the human population of the Baltic region, need an area from forest, agricultural and marine ecosystems for their consumption of wood, papers, fiber and food that is approximately 200 times the area of the cities themselves (17) (Table 1). The appropriated ecosystem area of forests was estimated to be 18 times larger, of agricultural land 50 times larger, and of marine systems 133 times larger than the area of the cities. If they were to receive their resources exclusively from the Baltic Sea drainage basin (which is not the

case due to trade), they would appropriate 70% of the Baltic Sea area, 15% of agricultural land, and 5% of the forested area. The western European cities appropriate, per capita, about twice as large an ecosystem area of forests and marine systems as the Eastern European cities. The opposite is the case for agricultural ecosystems (18) (Table 1).

### Waste Assimilation Footprints of Baltic Cities

Ideally, an ecological footprint analysis should include the ecosystem areas appropriated to absorb all waste a city discharges. Here, we concentrate our footprint analysis on the emissions of two key nutrients, nitrogen (N) and phosphorous (P), and of carbon dioxide (CO<sub>2</sub>) from the 29 largest cities in the Baltic Sea drainage basin. The ecological footprint is estimated by investigating the size of the areas of forests, wetlands and agricultural ecosystems that would be needed to absorb parts of the cities' emissions of these compounds.

Eutrophication of the Baltic Sea is a serious problem. As a consequence of a growing human population and intensified socioeconomic activities, the N load to the Baltic Sea has increased four times and the P load eight times since the early 1900s (19), which has caused environmental problems (20). Sewage treatment plants have been built, but there are cities that still release their waste unprocessed into coastal areas and rivers that run into the Baltic Sea. Here, the footprint analysis of nutrient assimilation concerns only the excretory release of N and P by humans. Consequently, it is an underestimate of the situation, since the emissions of N and P from food processing, household waste, car emissions, and other sources are not included in the analysis.

In the region, wetlands are increasingly used as a N-abatement technology, since they serve as cost-effective filters for both point source and nonpoint source pollution (21–23). We assume that all N-releases from urban areas pass through sewage treatment plants, and that N remaining in the purified water is processed in wetlands. The data for our estimate of the appropriated wetland area for processing N generated by people in the Baltic cities is based on a recent analysis of the N-retention capacity of natural wetlands of the whole Baltic Sea drainage basin (24).

Sewage treatment plants generate P-rich sludge that cannot be stored indefinitely. It has to be processed in one way or another. Deposition of P-rich sludge on agricultural land is one measure employed in the region. Since the level of P in Baltic region soils varies substantially, and since there are agricultural soils that are

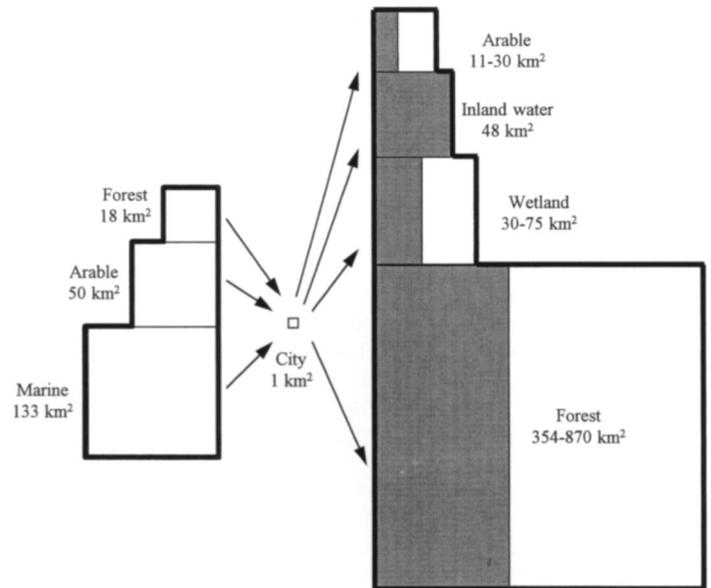


Figure 2. The ecological footprint of the 29 largest cities in Baltic Europe. Left: Ecosystem appropriation for natural resources production. Right: Ecosystem appropriation for waste assimilation (shaded area = low-range estimate).

saturated with P, due to excess use of fertilizers, we use the uptake of P in produce as a basis for our estimate of the agricultural waste assimilation footprint (25).

The Baltic Sea drainage basin is an industrial region which depends on substantial amounts of fossil energy. Per capita emission of CO<sub>2</sub> ranges from 2 to 4.6 tons C per year (26). Terrestrial ecosystems, especially forests, play an important role in the carbon cycle (27). European forests have served as carbon sinks during the last decades (28). Since almost 50% of the Baltic Sea drainage basin is covered with forests (15), at present these represent the major net sink of C in the region. Wetlands and lake sediments also contribute to carbon sequestering (29), while agricultural land and the Baltic Sea ecosystem are net exporters of carbon (30). Therefore, we concentrate on the area of forests, wetlands and inland water bodies that would be required to sequester C from the CO<sub>2</sub> emissions of the 29 largest cities in the Baltic Sea drainage basin.

Our estimates indicate that the region's forests, inland water

Table 1. Ecosystem appropriation by the 29 largest cities in the Baltic Sea drainage basin.

Country	No. of Cities	City area km <sup>2</sup>	Population in cities x1000	Appropriated ecosystem areas (km <sup>2</sup> x 1000)						
				Marine		Arable		Forest		Wetland
				Food consumption	Phosphorus retention	Food consumption	Phosphorus retention	Wood consumption	Carbon sequestering	Nitrogen retention
Czech Rep.	2	40	610	6.0	2.1	0.7–1.8	0.6	26.5–65.2	1.8–4.9	
Denmark	2	280	1620	33.5	5.1	1.8–4.9	2.2	70.3–173.1	3.6–9.8	
Estonia	1	60	490	6.4	2.1	0.6–1.5	0.9	21.5–52.9	1.4–4.0	
Finland	1	20	500	17.0	1.9	0.6–1.5	3.7	18.4–45.2	1.1–3.0	
Germany	2	90	575	5.7	1.6	0.7–1.7	0.7	24.7–60.9	1.3–3.5	
Latvia	1	110	895	11.6	6.3	1.0–2.7	1.5	39.2–96.4	2.6–7.2	
Lithuania	2	75	1005	13.0	7.1	1.1–3.0	1.7	43.9–108.0	2.9–8.1	
Poland	13	555	7925	72.9	34.8	8.9–23.8	7.6	226.5–557.5	23.1–63.7	
Russia	1	250	5035	65.1	35.6	5.7–15.1	8.6	219.8–540.9	14.7–40.4	
Sweden	3	685	2595	52.3	7.9	2.9–7.8	10.8	57.4–141.2	5.7–15.6	
Ukraine	1	55	805	10.4	5.7	0.9–2.4	1.4	35.2–86.7	2.4–6.5	
Total:	29	2216	22065	293.9	110.2	24.9–66.2	39.7	783.4–1928.0	60.6–166.7	

bodies, and wetlands can sequester all (105%) to less than half (45%) of the CO<sub>2</sub> emissions from the cities. Despite the fact that forests cover close to 50% of the Baltic Sea drainage basin, the 29 cities would require from 95% of the forests to 2.3 times more forests for CO<sub>2</sub> sequestering than available within the region. If the excretory release of N from city inhabitants were processed in wetlands, 45–120% of the presently available wetland area would be appropriated. There is enough agricultural land in the region to assimilate the excretory release of P by the city inhabitants. A footprint of 5–15% of available agricultural land would be required for absorption of P in sewage sludge.

The waste assimilation demand for forests is estimated to be 355–870 times larger than the area of the cities (31). For inland water bodies it is 50 times larger (32), for wetlands 30–75 times larger (33), and for agricultural land 10–30 times larger than the area of the cities (34). If the cities' emissions of CO<sub>2</sub>, and the excretory release of N and P from humans, were assimilated by these terrestrial and aquatic ecosystems the waste footprint would be 390–975 as large as the area of the cities (Table 1).

The Baltic cities' total appropriation of terrestrial and marine ecosystems is estimated to be at least 565–1130 times the area of the cities themselves (35) (Fig. 2), or 60 000 m<sup>2</sup>–115 000 m<sup>2</sup> for the average citizen. The actual area of the 29 cities corresponds to 0.1% of the area of the whole Baltic Sea drainage basin, but when their 'hidden demand' for ecosystem support is accounted for their appropriation of ecosystem-produced resources and services requires an area corresponding to as much as 75% to 1.5 times the whole Baltic Sea drainage basin (Fig. 3). The estimate is conservative, since we have only quantified the spatial capacity of some ecosystems to produce some renewable resources and ecosystem services used by cities.

## GLOBAL FOOTPRINT OF 20% OF THE HUMAN POPULATION LIVING IN 744 LARGE CITIES WORLDWIDE

The aggregate population of the 744 large cities worldwide is about 1.1 billion inhabitants or 20% of the present human population. Each city has more than 250 000 inhabitants, including suburbs and including 21 megacities (36). The analysis concerns cities in both materially developed and less materially developed countries.

### Cities' Appropriation of Marine Ecosystems for Food Production

The results for the Baltic cities were used as a starting point for an estimate of the global appropriation of marine ecosystems for seafood production (37) by 744 major cities worldwide. Western European cities in the Baltic region appropriate 21.2 km<sup>2</sup> per 1000 inhabitants, compared to 12 km<sup>2</sup> per 1000 persons in eastern European cities (13). We use the ecological footprint of Baltic cities in Western Europe for all countries with higher GNP capita<sup>-1</sup> than the Eastern European countries in the drainage basin, and the ecological footprint of Baltic cities in Eastern Europe for those with a lower GNP capita<sup>-1</sup> (18, 38).

Of world fisheries catches, 90% or 94.3 million tons derive from marine systems. The dominant part of the fish catch in the

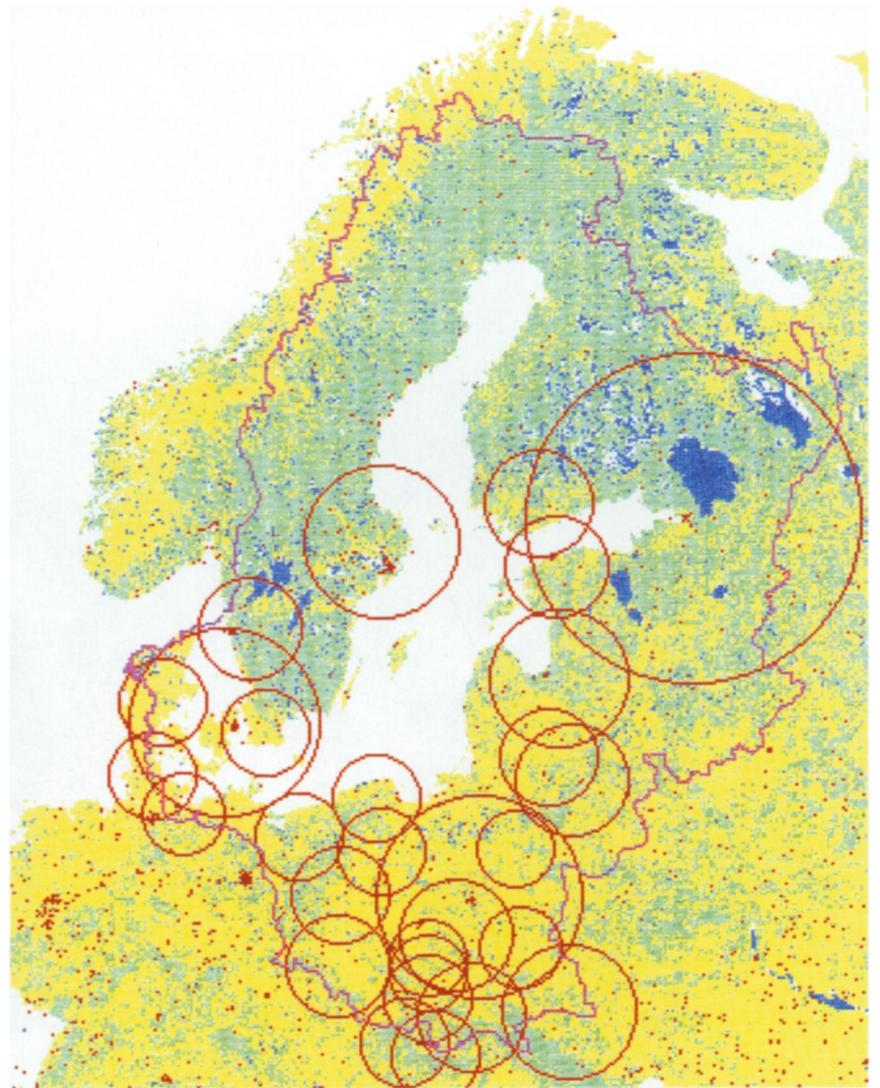


Figure 3. The location of the 29 largest cities in the Baltic Sea drainage basin and their 'hidden demand' for ecosystem support. The area of hidden demand is illustrated by the circles around each city. The circles represent the average footprints of Table 1. The figure does not imply that the cities appropriate the actual area of the circles, only that they demand this area. Due to trade appropriation may take place elsewhere on Earth.

sea is harvested in shelf, coastal and upwelling areas (96%), corresponding to 87% of world fisheries catches. Annual world fisheries catch is about 28 kg ha<sup>-1</sup> shelf, coastal, and upwelling areas (39). Our Baltic data gives 14.2 kg ha<sup>-1</sup>, due to lower productivity in shelves areas such as the North Sea. This implies that the global productivity of shelf, coastal and upwelling areas is about twice as high, which has been taken into account in the estimate. To avoid double-counting, modern aquaculture production is excluded from the analysis, since modern aquaculture to a large extent depends on wild fish catches to provide feed for the cultured species (40).

As much as 25% of globally available shelf, coastal and upwelling areas are appropriated to supply 20% of the global human population living in 744 cities with seafood. The result indicates that the remaining 80% (4.7 billion people) cannot consume similar amounts of marine resources, since it would mean that the world's productive marine ecosystems would be exploited beyond their full capacity. Bycatch or discards, which has been estimated to at least 25% of annually reported world fisheries catch (39), is not included in the analysis.

### Cities' Appropriation of Forest Ecosystems for Assimilation of Carbon

Forests cover about 20% of the world's total land area (excluding Antarctica). It has been proposed that they play a signifi-



The inhabitants of a city like Tokyo require huge ecosystem areas for life support. Photo: C. Folke.

cant role in the “missing carbon” or imbalance in the carbon budget (41, 42). Mid- and high-latitude forests, which represent 58% of the natural forests, serve as carbon sinks (43). As a consequence of widespread deforestation low-latitude forests are at present sources of carbon to the atmosphere. Oceans are major sinks of carbon emissions. Their sequestering capacity is included in the analysis. The CO<sub>2</sub> estimate for the cities is based on per capita emissions by nation (26).

The 744 cities are responsible for 32% of global emissions of CO<sub>2</sub> (Table 2). Oceans absorb between 20–57% of the carbon

from annual emissions of global CO<sub>2</sub> by fossil fuel combustion (43, 44). We assume that this is also the case for the CO<sub>2</sub> emissions by cities.

Mid- and high-latitude forests have the capacity to sequester 30–50 tons C per km<sup>2</sup> yr<sup>-1</sup>. If the remaining carbon were sequestered by mid- and high-latitude forests the lower end estimate indicates that almost all of the present C sink capacity of forests (95%) would be appropriated. In the upper end estimate, the cities would need almost 3 times more forests serving as C sinks than what is presently available on Earth, with 12% more for-

Table 2. CO<sub>2</sub> emission from 744 cities in the world (pop > 250 000 per city).

Region <sup>1</sup>	No of cities <sup>1</sup>	Population <sup>1</sup> 10 <sup>6</sup>	CO <sub>2</sub> emission per capita, (ton C person <sup>-1</sup> y <sup>-1</sup> )	CO <sub>2</sub> emission from cities <sup>2</sup> (metric tons x 10 <sup>6</sup> )	Forest area needed to sequester CO <sub>2</sub> emission from cities <sup>3</sup> (km <sup>2</sup> x 10 <sup>6</sup> )	Forest area available at present <sup>4</sup> (km <sup>2</sup> x 10 <sup>6</sup> )
Europe <sup>5</sup>	227	222.8	2.68	597.2	13.27	11.67
Africa	69	84.7	0.39	32.8	0.73	5.27
North America <sup>5</sup>	86	191.5	4.26	815.1	18.11	7.29
South America	61	113.4	0.55	62.7	1.39	9.18
Asia	292	514.1	1.05	541.6	12.04	4.28
Oceania	9	12.9	3.85	49.7	1.10	3.96
Total or average:	744	1139.4	1.84	2099.1	46.65	41.65

<sup>1</sup> Statistical Yearbook (36).

<sup>2</sup> World Resources (26).

<sup>3</sup> Assuming newly growing forest and an average C retention potential of 45 ton C km<sup>-2</sup> derived from temperate forests (31).

<sup>4</sup> Dixon et al. (43).

<sup>5</sup> Regions with forests at present acting as sinks (43).

ests as an average (Table 2).

Dixon et al. (43) estimate unrealized global forest sequestering potential through sustainable forest management (slowing deforestation and forest degradation, maintaining and expanding existing C sinks and creating new sinks, substituting renewable wood-based fuels for fossil fuels). If such measures were implemented the sequestering capacity of worldwide forests would be about 55–120 tons C per km<sup>2</sup> yr<sup>-1</sup>. With this increased sequestering capacity the 744 cities would appropriate 20–75% of all forests worldwide.

## DISCUSSION: WHY CARE ABOUT ECOSYSTEM APPROPRIATION?

We have illustrated that every city draws on the productivity of vast and scattered ecosystems (44–45). The appropriation of ecosystems for food and timber production and waste assimilation by the cities in the Baltic Sea drainage basin was estimated to be at least 565–1130 times the area of the cities themselves. This is a partial ecological footprint since it does not account for the production of other essential ecosystem services such as providing water and maintaining biological diversity (46). Of the human population in the 744 large cities on the Earth, 20% were estimated to appropriate 25% of productive global marine ecosystems, leaving less room for the remaining 4.7 billion (80%) of the people to consume marine resources. In the light of this result it is not surprising that there is a global fisheries crisis (47).

Even though the oceans sequestering capacity of C is taken into account, the same cities appropriate the full C sink capacity of forests and may already need close to 3 times more forests serving as C sinks than are presently available on Earth. This occurs even though the majority of the 1.1 billion city inhabitants release relatively low amounts of CO<sub>2</sub> per capita (Table 2). Hence, it is not surprising that the *Intergovernmental Panel on Climate Change* has suggested that the goal for year 2050 should be a reduction of emissions to 0.9 ton C per capita (48). The current average emission for the cities of this study is 1.84 ton C per capita. Clearly, the whole planet cannot consist of cities. Cities need productive ecosystems to exist. Ecosystems provide the biophysical foundation for people living in cities.

The capacity of ecosystems to sustain city development is becoming increasingly scarce as a consequence of rapid human population growth, intensified globalization of human activities, and human overexploitation and simplification of the natural resource base (6, 49, 50). The web of connections linking one ecosystem and one country with the next is escalating across all scales in both space and time (51). Everyone is now in everyone else's backyard.

Cities are embedded in this web of connections. Cities free themselves from local ecological boundaries by importing resources and ecological services from elsewhere. But this implies that cities become dependent on their access to resources and ecosystem functions outside the boundaries of their own jurisdiction (52, 53). As a consequence their inhabitants will have limited ability to influence the use of foreign ecosystems on which their city life depends. This may become a serious problem for the well-being of cities since they are not the only appropriators of the ecological footprint. Other human activities use and abuse it as well, and cause changes in the capacity of ecosystems and biological diversity to produce essential goods and services (54, 55). It is therefore no longer wise to take the ecological resource base for any city for granted, since the productive potential of this resource base is becoming increasingly limited and stressed.

It is in this context that estimates of appropriated ecosystem area—the ecological footprint—become interesting. Although appropriated ecosystem area, a static measure, does not provide



Centers of business and financial markets depend on ecosystem services. Central Boston. Photo: C. Folke.

an estimate of ecological carrying capacity (due to the dynamics of complex systems, and associated uncertainty about where ecological thresholds are)(56) it illuminates the 'hidden' human requirements for ecosystem functions, and puts the scale of city growth in the context of ecological sustainability. It is hidden because it has no price in the economy and people and policy seldom perceive it, but nevertheless it is real.

The follow up process of the UN Habitat II conference would do well to explicitly apply an integrated view of ecosystems and human settlements, asking questions such as how large can the city grow without challenging the capacity of ecosystems to support it; how sensitive is the city to changes in the productive capacity of ecosystems; and how can the city be developed to become more in tune with the processes and functions of the ecosystems that sustain it? And what are the appropriate levels of institutions to deal with these matters, locally, regionally, and globally? (7).

In many cities, problems of poverty, unemployment, and inadequate living conditions are becoming overwhelming (57). Clearly, there is a pressing need for improved governance to cope with such acute problems in order to maintain cities as centers for knowledge, culture, creativity and innovation. But, as we illustrate there is also a pressing need to explicitly take into account the increasingly scarce capacity of ecosystems to sustain cities with resources and ecological services. One cannot talk about sustainable cities if the ecological resource base on which they depend is excluded from analysis and policy. It is in the self-interest of city inhabitants to make sure that ecosystems continue to produce the biophysical preconditions on which they live. We challenge the follow up process of the UN Habitat II conference to explicitly add to the agenda the necessity of functional ecosystems for prosperous city development.

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11. Eleven of those have cities within the drainage basin with > 250 000 inhabitants, namely Czech Republic 2, Denmark 2, Estonia 1, Finland 1, Germany 2, Latvia 1, Lithuania 2, Poland 13, Russia 1, Sweden 3 and Ukraine 1 city.
12. Among the megacities are Buenos Aires, Dacca, Rio de Janeiro, Sao Paulo, Beijing, Shanghai, Tianjin, Cairo, Bombay, Calcutta, Delhi, Jakarta, Osaka, Tokyo, Seoul, Mexico City, Lagos, Karachi, Manila, Los Angeles, New York.
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16. WRI. 1992. *The World Resources Data Base on Diskette*. The World Resources Institute, Oxford University Press, Oxford, UK. We used fish yields for shelf areas from the North Sea. The estimate is conservative since discards or by catch are not included.
17. The total area of the cities was derived from an aerial photo-based GIS-data base [S. Langaas, Completeness of the Digital Chart of the World (DCW) data base, DCW and Data Quality Series, Project Report 2, (UNEP/GRID Arendal, Norway 1995)] combined with the Baltic GIS-data base (15). The area was estimated to 2217 km<sup>2</sup> (13), which gives an average population density of the cities of 9925 persons/km<sup>2</sup>. For the urban population as a whole the population density is estimated to about 600 persons per km<sup>2</sup>.
18. Average per 1000 capita appropriation of ecosystems by Baltic cities' inhabitants: Eastern European cities: grazing land = 1.2 km<sup>2</sup>, crop land = 4.6 km<sup>2</sup>, forests = 1.5 km<sup>2</sup>, marine shelves = 12 km<sup>2</sup>. Western European cities: grazing land = 0.6 km<sup>2</sup>, crop land = 2.6 km<sup>2</sup>, forests = 3.5 km<sup>2</sup>, marine shelves = 21.2 km<sup>2</sup>.
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24. N-purification in the sewage treatment plants are 20–40% in the region. N-retention levels of wetlands range from 0.4–1.1 ton N km<sup>-2</sup>, based on Å. Jansson, C. Folke, and S. Langaas. Quantifying the nitrogen retention capacity of natural wetlands in the large-scale drainage basin of the Baltic Sea. (in review).
25. In Swedish agriculture, largely depending on the amount of livestock at the farm, the average input of P is 2–6 kg ha<sup>-1</sup> higher than P in produce, which varies from 2–10 kg ha<sup>-1</sup>. Excess use of P has created environmental problems. In a balanced ecological farming P embedded in agricultural output is about 3 kg P ha<sup>-1</sup>, which corresponds to 25% of the total circulation of P at the farm (Granstedt, A. and Westberg, L. 1993. *Flöden av växtnäring i jordbruk och samhäll. Aktuellt från Lantbruksuniversitetet* 416, 32 pp. (Swedish University of Agricultural Sciences, Uppsala). We assume that 3–4 kg P ha<sup>-1</sup>yr<sup>-1</sup> need to be added in the long run to maintain the agricultural system in balance (Günther, F. 1997. *Hampered effluent accumulation processes: Phosphorus management and societal structure. Ecol. Econ.*). (In press).
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33. Total nitrogen retention by natural wetlands in the Baltic Sea drainage basin is estimated to 57 000–145 000 ton N yr<sup>-1</sup> (24). Area of natural wetlands 137.725 km<sup>2</sup> (15). Excretory release from city inhabitants 4 kg N per person and (SCB. 1987. *The Natural Environment in Figures*. Official Statistics of Sweden. Statistics Sweden, Stockholm). Carbon sequestering by net peat growth is 8–55 ton C km<sup>-2</sup> and year (based on Eriksson, H. (29)).
34. There are approximately 353 000 km<sup>2</sup> of agricultural land in the Baltic Sea drainage basin (15). We assume that P-emissions from city inhabitants are processed in sewage treatment plants with 90% ± 4% (95% conf.interval) purification (data derived from Gren, I.-M., Elofsson, K., and Janke, P. In revision. Costs of nutrient reduction to the Baltic Sea. *Environ. Resource Econ.*), with no losses of P from purification to sludge (Stockholm Water, pers.comm.), and low enough concentration of heavy metals and organic pollutants for the sludge to be acceptable as manure on agricultural land. Excretory release from city inhabitants 0.5–1 kg P per person and year (Guterstam, B. 1991. Ecological engineering for wastewater treatment: Theoretical foundations and practical realities. In: *Ecological Engineering for Wastewater Treatment*. Etnier, C. and Guterstam, B. (eds). Bokskogen, Gothenburg, Sweden, pp. 38–54; SCB. 1987. *The Natural Environment in Figures*, Official Statistics of Sweden, Statistics Sweden, Stockholm).
35. Ecosystems are multifunctional in the sense that one system generates several resources and ecological services. To avoid double-counting we do not add footprints of different ecosystem services performed by the same ecosystem.
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