CCICED-WWF

Report on Ecological Footprint In China

Interim Report 3.0

November 2007

Advisors
Sheng Guofang[1]
Arthur Hanson[1]
Claude Martin[2]
Chris Hails[3]
Dermot O'Gorman[3]

Authors
Justin Kitzes[5]
Susannah Buchan[5]
Steven Goldfinger[5]
Cheng Shengkui[4]
Xie Gaodi[4]
Cao Shuyan[4]

1 CCICED(China Council for International Cooperation on Environment and Development)

2 Former Director General of WWF International and CCICED member

3 WWF (World Wide Fund for Nature)

4 IGSNRR(Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences

5 Global Footprint Network

Notice

CCICED Secretariat and WWF China (both parties) feel very happy to share this Interim Report of Ecological Footprint in China, a CCICED-WWF Joint Project, with the 2007 Annual General Meeting of CCICED.

Aiming at a formal release tentatively scheduled for 05 June 2008, both parties would like to collect more comments from this meeting for continuous improving. A workshop on the report has already been planned to take place in mid-January 2008, during which more in-depth discussions are expected.

The team of authors consists of both international experts from US-based Global Footprint Network (GFN) and local researchers from the Institute of Geographic Sciences and Natural Resources Research (IGSNRR) with the Chinese Academy of Sciences. Both parties are deeply grateful to GFN experts for their roles in general framework and preparing of most of chapters; and to IGSNRR experts for their contribution to local data collection and drafting of chapter 5, 7 and 11.

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2 Introduction

The 20th century was characterized by rapid growth in human societies, and in those societies' impacts on the natural world. Over the last century, world population quadrupled, and energy consumption grew over ten-fold. The planet has seemed, for practical purposes, limitless. The only limitation was the ability to access resources, and to transport them over long distances.

Yet today, with a globalized economy and nearly unlimited transportation capacity, human demand for resources has grown beyond what planet Earth can supply. Humanity is now using at least 25 percent more than what the planet can regenerate (Figure 2.1). This global overshoot means that we are depleting and degrading the biological capital on which the human economy depends, and are allowing waste products to build up around us.

Already, increasing scarcity of resources has begun affecting us all. Fisheries all over the world are under stress, timber supplies come from more and more distant forests, and many analysts place the blame for ongoing international conflict on competition for fossil fuel and fresh water resources.

The reality of the coming century will be different than the past: the implications of global overshoot will become more and more evident throughout our daily lives.

In the coming world of limits, what will be a successful strategy for government policy? How will global trends shape the options available for decision makers and planners? How will each nation's own ecological deficit situation affect their competitiveness on a global scale? How can national and international businesses remain viable? How can individuals ensure their own quality of life and that of their families?

These questions are global in scope, but answers will be developed locally, by individual regions, nations, provinces, cities, and individuals.

The Asia-Pacific region will play an increasingly central role in the ecological context of the coming century. With more than 50 per cent of the world's population demanding nearly 40 per cent of global biological capacity, decisions made in this region will reverberate around the globe. Will Asia Pacific avoid local and large scale collapses and shield itself from collapses elsewhere? Can it catalyze a shift to global sustainability that will serve as a model for nations elsewhere in the world?

As the most powerful country of the region, China's decisions will be especially important. As a nation, China consumes 15% of the world's total biological capacity, the second most of any nation in the world. Although its biological capacity continues to grow through the expansion of productive lands and the introduction of new technologies, each year the residents of China demand

Fig. 2.1: **HUMANITY'S ECOLOGICAL FOOTPRINT**, 1961-2003

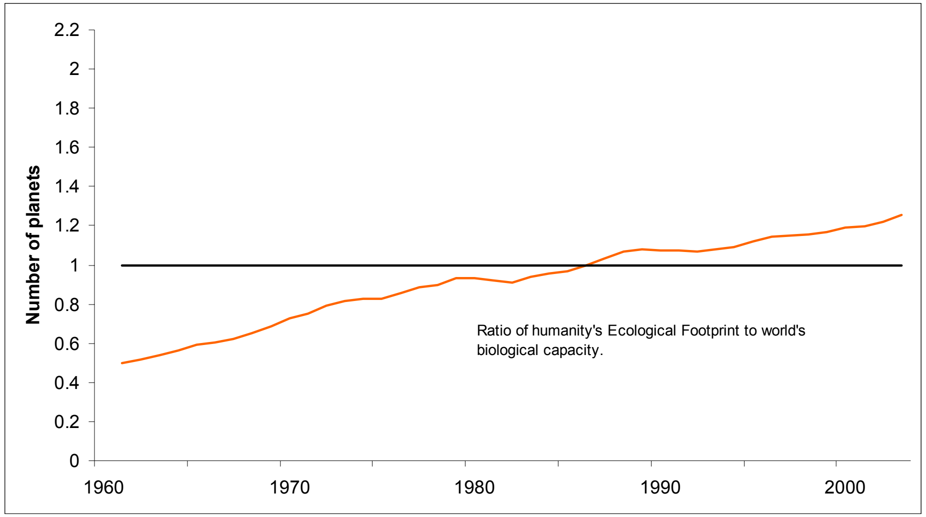
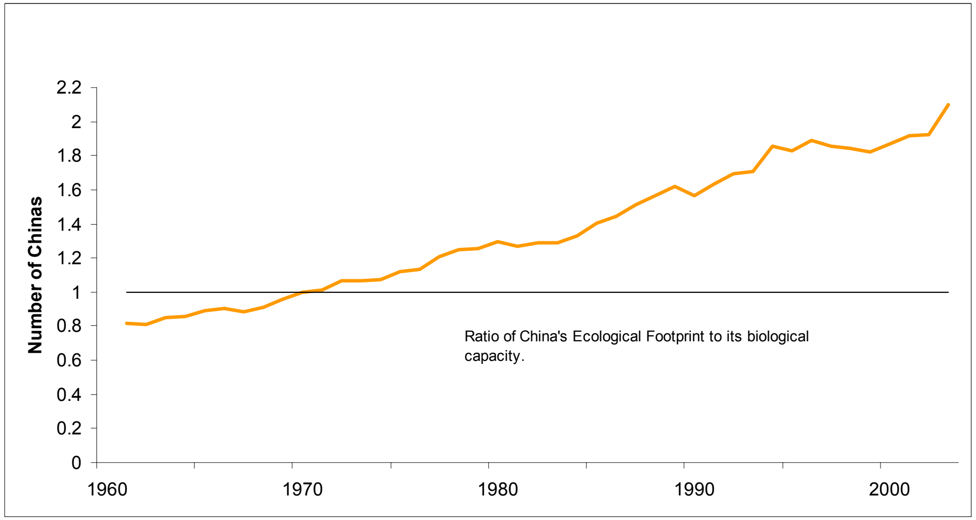


Fig. 2.2: **CHINA'S ECOLOGICAL FOOTPRINT**, 1961-2003



more than two times what its own ecosystems can sustainably supply (Figure 2.2).

If China were to follow the lead of the United States, where each person demands nearly 10 hectares of productive area, China would demand the available capacity of the entire planet. This is likely to be a physical impossibility for China, or for the other nations of the world. In contrast, if China can model a development path that leads to healthy lives, with much higher resource efficiency, it will lead the way for the world as a whole, North and South, East and West. Such development can be made possible through intelligent planning and management, founding on strong scientific principles and knowledge.

This report uses the Ecological Footprint to showcase the current state of demand for biological capacity in China, and set China's situation in the context of an increasingly full world. As a resource accounting tool that makes demand on biological capital visible, measurable, and manageable, the Ecological Footprint allows decision makers at all levels to identify strategies for sustainable development.

Figure 2.1: Humanity's Ecological Footprint. Human consumption has grown over the past forty years, with global demand for biological capacity exceeding what the planet can supply by 25% in 2003.

Figure 2.2: China's Ecological Footprint. The residents of China currently consume more than twice the capacity that China's own ecosystems can provide.

Fig. 2.3: **TOTAL FOOTPRINT, top countries,** 2003

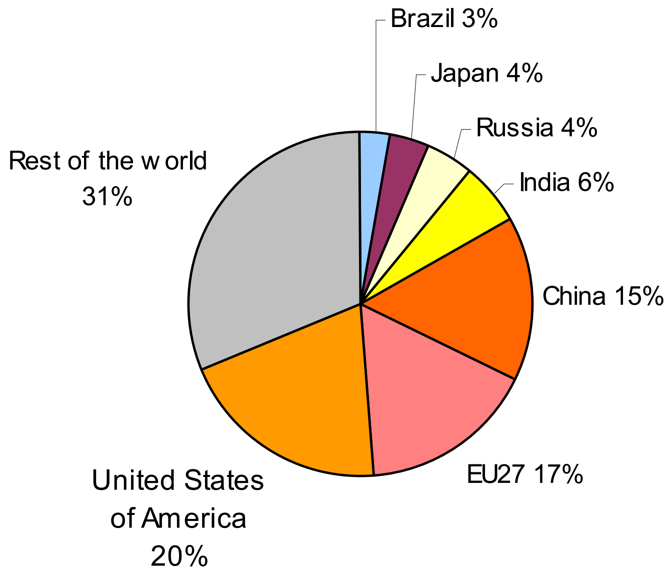
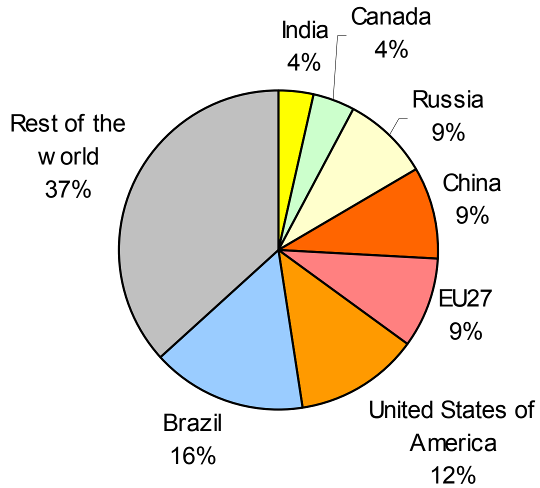


Figure 2.3: Total Ecological Footprint by nation. As a nation, China has a total Ecological Footprint comparable to the entire EU-27, and the second largest Ecological Footprint of any single nation after the USA.

Figure 2.4: Total biocapacity by nation. China is home to 9% of the total biological capacity of the planet.

Fig. 2.4: **TOTAL BIOCAPACITY, top countries**, 2003



3 The Global Context: Humanity's Ecological Footprint

The Ecological Footprint is a widely used tool for measures human demand on nature. The Ecological Footprint of a nation is the total area required to produce the food, fiber and timber that it consumes, absorb its waste, and provide space for its infrastructure. The residents of a nation consume resources and ecological services from all over the world, and its Ecological Footprint is the sum of these areas, wherever they are located on the planet.

In 2003, the global Ecological Footprint was 14 billion global hectares, or 2.2 global hectares per person (a global hectare is a hectare with world-average productivity).

This demand on nature can be compared to the planet's biocapacity, the amount of biologically productive area available to meet human demand. In 2003, the planet's total biocapacity was 11.2 billion global hectares, or 1.8 global hectares per person

This global average, however, varies significantly by region and nation. Many of the countries with largest per person Footprints are found in the high income regions of North America and Western Europe. China's Ecological Footprint in 2003 was 1.5 global hectares per person, giving China the 69th highest Footprint out of the 147 nations measured that year. For both high income nations, and for China, the carbon Footprint makes up about one half of the nation's total Ecological Footprint.

Figure 3.1: Ecological Footprint per person, by nation, by land type. 150 nations are shown with their Ecological Footprint divided into major land types. For most high income nations, the largest portion of the Footprint comes from carbon dioxide emission, as compared to cropland and pasture for low income nations.

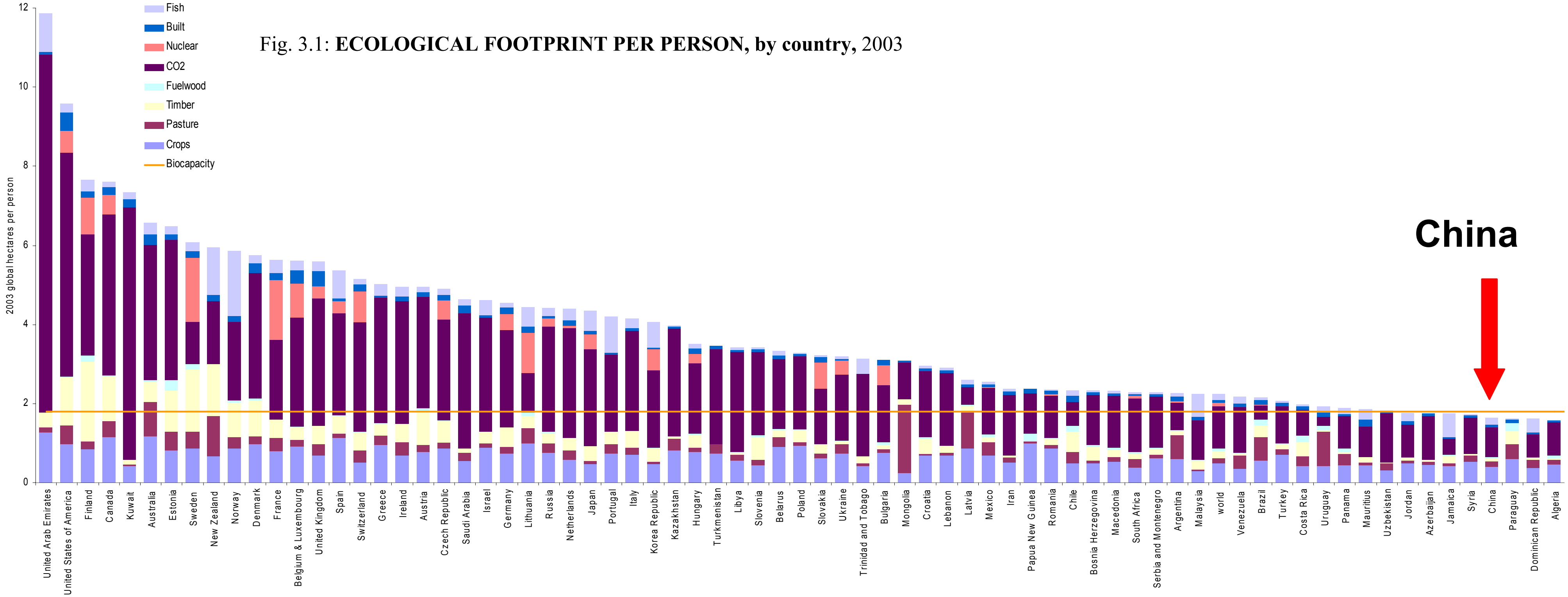
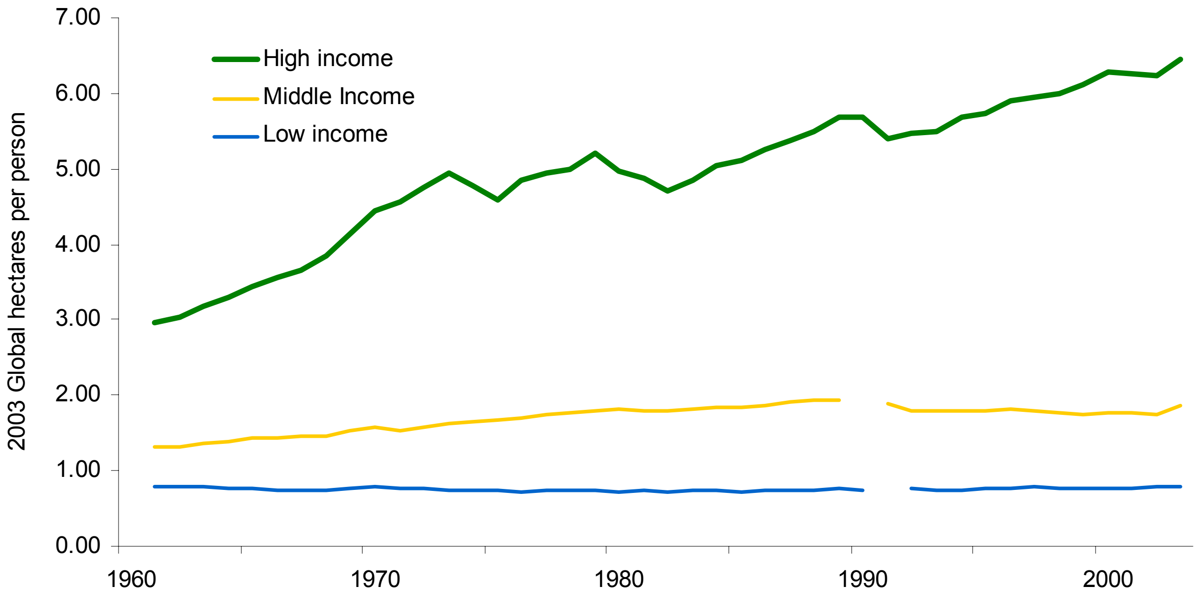
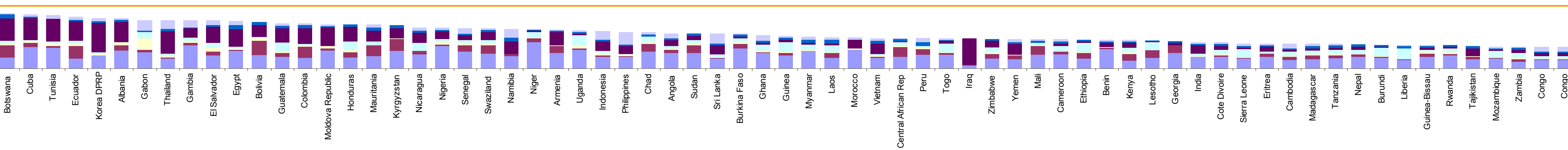


Figure 3.2: Ecological Footprint by income group, over time. The demand for biological capacity in high income countries began higher and rose faster than for middle and low income counties from 1961-2003. Dotted lines indicate gaps in data associated with the dissolution of the Soviet Union.

Fig. 3.2: **TOTAL ECOLOGICAL FOOTPRINT OF NATIONS, by income**





4 Asia Pacific's Ecological Footprint

Compared to other regions of the world, the Asia-Pacific region has a relatively low Ecological Footprint per person (Figure 4.1). The large population of the region, however, gives Asia-Pacific the largest total Ecological Footprint of any region of the world. On a global scale, Asia-Pacific contains more than 50% of the world population, and demands more than 40% of the total biological capacity of the planet (Figure4.2).

All together, the Ecological Footprint of the Asia-Pacific region is now 1.7 times as large as its own biological capacity. For comparison, in 1961, the region's total Footprint was only 75% of its biocapacity. Although the region's productive capacity has grown over the past forty years, particularly through the green revolution and other technology, demand for resources and ecological services has been growing far more rapidly.

The Asia-Pacific region compensates for its ecological deficit in two ways: first, by importing resources and using the biological capacity of other countries and the global commons, and, secondly, by drawing down stocks of accumulated biological capital within the region (e.g., cutting down trees faster than they can regrow).

Great Footprint variation can also be found within the Asia-Pacific region. While the average Australian lives on 7.7 global hectares, the average Bangladeshi uses only 0.6. The average resident of China uses 1.5 global hectares (Figure 4.3).

China and India clearly stand out as influential in the region for their large populations, and large total Ecological Footprints. The per person Footprint of both nations, however, is well below the global average.

Figure 4.1: Ecological Footprint by region. Although North America has the highest Footprint per person, the large population of the Asia-Pacific region gives Asia-Pacific the largest total Ecological Footprint of all major regions. The green dashed lines indicate available biocapacity within the region.

Figure 4.2: Asia-Pacific's use of world biocapacity. The Asia-Pacific region's population and Ecological Footprint continue to grow rapidly. In 2003, the Asia-Pacific region demanded 40% of the total biological capacity of the planet.

Fig.4.1: **ECOLOGICAL FOOTPRINT AND BIOCAPACITY, by region,** 1961-2003

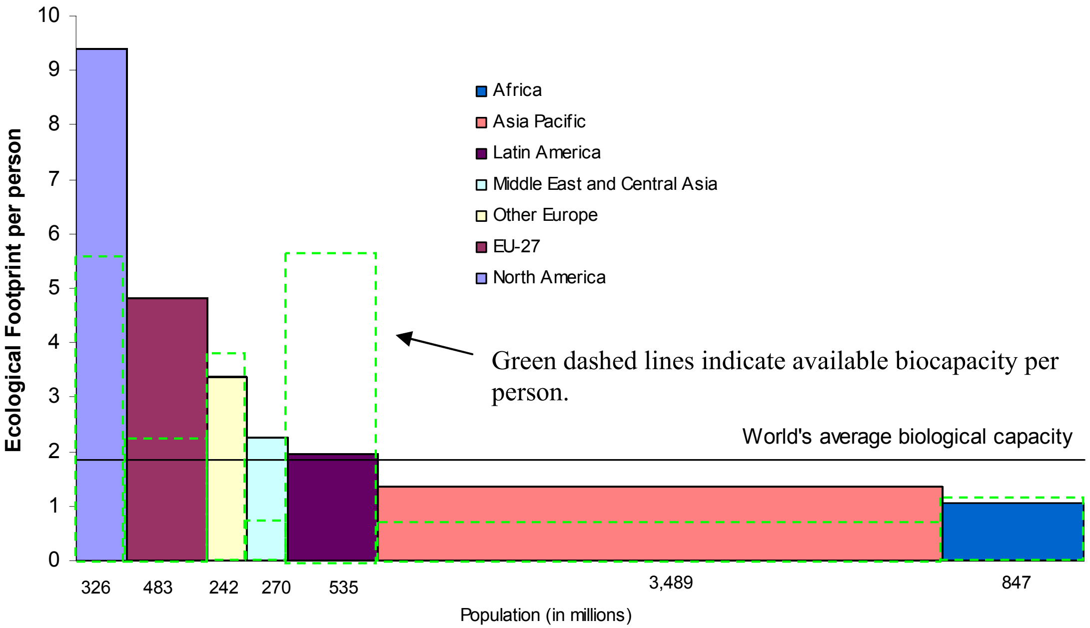
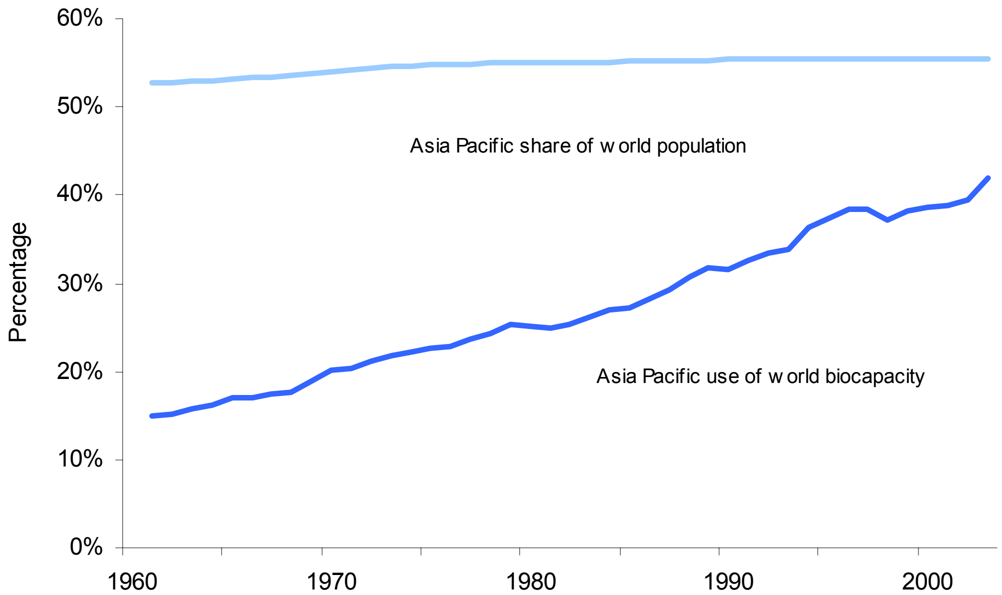


Fig.4.2 **ASIA PACIFIC'S USE OF WORLD BIOCAPACITY,** 1961-2003



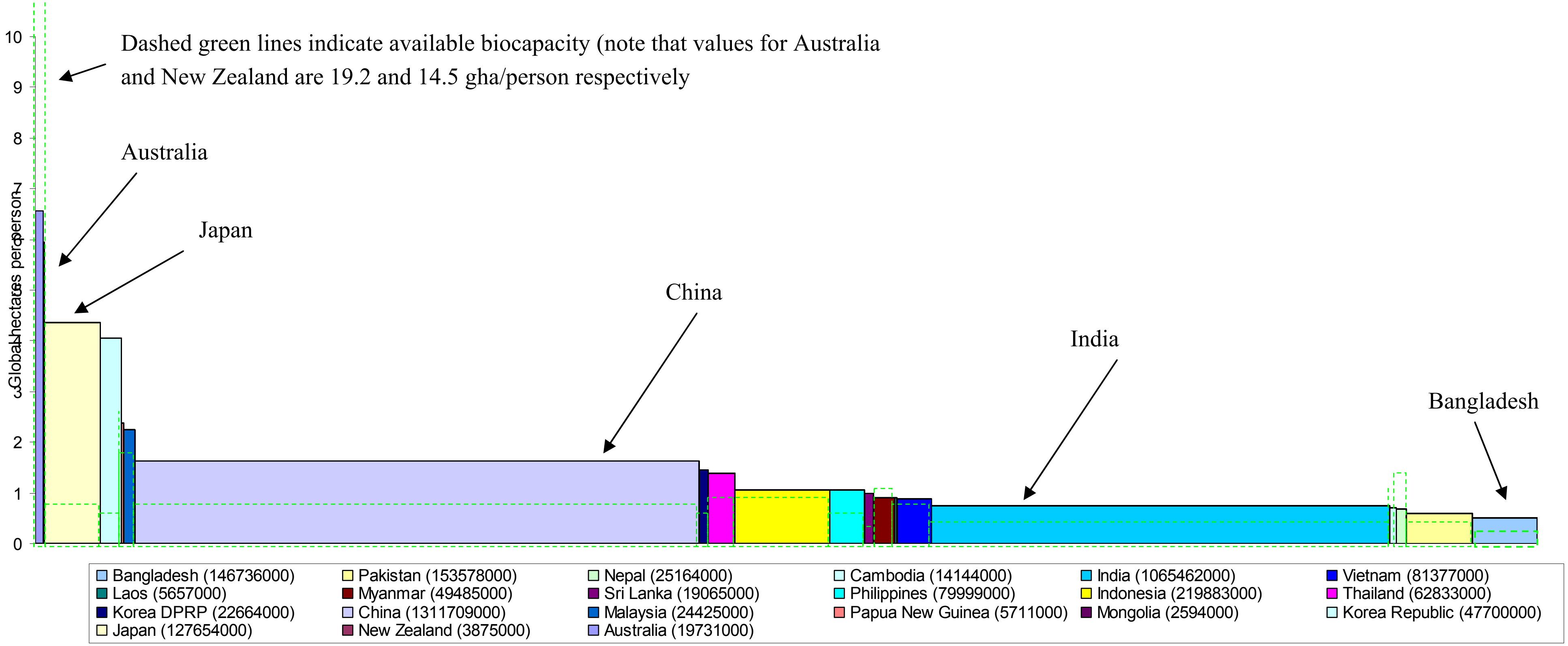


Fig. 4.3**: DEMAND ON AND SUPPLY OF BIOCAPACITY, per Asia-Pacific nation,** 2003**.** Solid bars show the Ecological Footprint of each nation, while dashed green lines represent each nation's biocapacity. While the highest per capita Footprints are found in Australia and New Zealand, the largest total Footprints are found in China and India. Countries with a green dotted area smaller than their solid bar are Ecological Debtors, who must either import biological capacity or draw down their own natural capital to meet their consumption needs

5 Ecological Footprint Concept in China

The end of 20th century presents China with unprecedented challenges in terms of resources and environmental security due to the limited land resources, ever growing population, accelerated urbanization and industrialization process, as well as an increasing demand from the consumers. Some ecologists, environmental scientists and sociologists have been trying to come up with an index for national and regional sustainable development. Chinese government has also been actively pushing the research and experiments in setting up an indicator system of sustainable development to guide the decision making. Against this backdrop, the concept of Eco-Footprint was introduced into China in 1999 and gained immediate popularity among the academics. It has shown the following characteristics: General Ecological Footprint Model (GEFM) is used to describe and identify the supply-demand relations of China's natural capital; Component Ecological Footprint Model (CEFM) is used to describe and identify the various productive and consumer behaviors as well as their impact on the ecosystem; Different from the developed countries, the dual ecological impact of fossil energy consumption is stressed.

(1) Demonstration and Identification of the Supply-Demand Relations on China's Natural Capital

At the initial stage of China's Ecological Footprint research, it mainly practices on Wackernagel and Rees' GEFM. In 2001, China evaluated the supply-demand relations of China's natural capital in 1995, and mapped the supply-demand relations in different provinces of China, providing a study on the change of China's Ecological Footprint in a chronical order. The research, which was done on a massive scale, covered all Chinese provinces, over 70 cities and 20 counties. It was concluded from the research that from the perspective of ecological balance, Chinese ecological system showed similar tendencies to the world's ecosystem. The late 1970s was a dividing line between ecological reserve and ecological deficit. Compared with the world's average, China's ecological capital supply-demand relations showed much faster changes, indicating an increasingly prominent impact on the evolution of the world's ecosystem. In the same year, the Administrative Center for China's Agenda21 (ACCA21) published the results of the Ecological Footprints in time series for all the provinces in China from 1980 to 2000. Main conclusions are:

- 1980-2000, the number of Chinese provinces that had ecological deficit grew from 19 to 26, indicating a much larger scale of ecological overshoot in China and the inevitable future appropriation of international biocapacity. (see table 5.1);
- The enlarging ecological deficit is caused by increasing consumption of fossil energy. Therefore, improving the energy efficiency and adjusting the energy structure remain the fundamental ways to lighten China's Ecological Footprints.
- The potential for developing biocapacity in China is not much. The key to improve biocapacity lies in improving the productivity of bioproductive area.

In general, GEFM has the following characteristics when describing and identifying China's natural capital supply-demand relations: research scale is for regions above the city level; the structural Ecological Footprint research based on input and output is just at an early stage; Some misapplications of yield factors exist, which affect the accuracy of analysis to certain extent; Due to the multiple data sources, the research findings have weak comparability and are limited in providing guidance to the users.

(2) Demonstration and Identification of Ecological Impact on Various Production and Consumption

CEFM uses product life cycle analysis to evaluate the ecological impact of various productive and consumer behaviors, starting from gathering raw materials to the final treatment of the finished product. The findings can help organizations and public in general to gain a better idea of their behaviors' ecological impact, and guide them to adopt productive behaviors or consumer behaviors of small ecological cost. In this respect, China's Ecological Footprint research covers urban tourism, water resources, transportation, education, agricultural products processing. (figure 5.1) The Ecological Footprint of tourism is composed of 6 sub-footprints including tourist transportation, lodging, catering, shopping, entertainment and sightseeing, providing an effective index for the ecological cost of tourism. Research shows that the average Ecological Footprint per tourist in Huangshan is 0.106gha, annual conversion value is 12.36 gha, 9 times of the value for local residents' average Ecological Footprint, revealing tourism's high demand and consumption of natural resources as a life style. The Ecological Footprint research for transportation shows that the total Ecological Footprint value of the private cars in Beijing is over 5 times of that value for public transportation. Therefore, developing public transportation should be an important way to cut down urban citizens' ecological impact. China's water resources research adopts the Water Footprint method, an extension of Ecological Footprint. According to the research, 60% of water resources consumed by China's national economy is green water (soil moisture), which exists in agricultural produce as virtual water. Such figures show the double challenges and demands China's agricultural development poses on biocapacity and water carry capacity.

In general, the CEFM is only at an initial stage. It covers smaller fields, focusing on the individual sector of a single regional social economic metabolism, such as direct energy consumption, raw material, waste, food, transportation, water resources, construction land, calling for further research in a comprehensive and systematic way.

Table 5.1: **NUMBER OF PROVINCES WITH ECOLOGICAL FOOTPRINT DEFICIT/RESERVE**

	1980	1990	2000
Deficit regions	**19**	**24**	**26**
Very severe deficit	0	2	3
Severe deficit	3	2	4
Moderate deficit	3	8	12
Minor deficit	13	12	7
Reserve or balanced regions	**12**	**7**	**5**
Balanced regions	4	4	2
Reserve regions	8	3	3

Table 5.1: The number of provinces with ecological deficit in China has been growing. In 1980, there were 19 provinces in ecological deficit, 12 with ecological reserve or balance; In 2000, the number grows to 26 for ecological deficit provinces, indicating a prevalent lasting ecological overshoot in China.

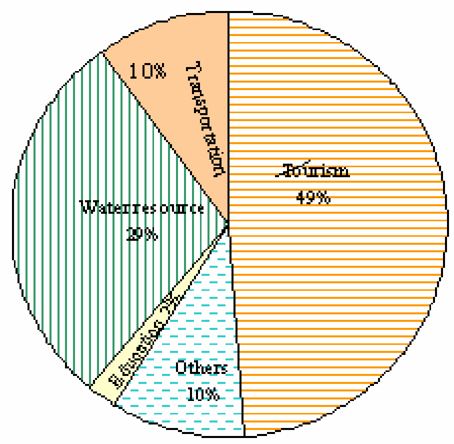


Figure 5.1: CEFM use to evaluate the ecological impact of productive and consumer behaviors. China's Ecological Footprint research covers tourism, water resources, transportation, education, agricultural products processing. Of them 49% of the research papers published in China since 1995 links to Tourism Ecological Footprint, 29% to Water Ecological Footprint and 10% to Transportation Ecological Footprint

Fig. 5.1: **DISAGGREGATING RESEARCHES USING COMPONENT FOOTPRINT MODEL**

(3) Emphasizing of the Dual Ecological Impact of Fossil Energy Consumption

Since 1980s, many countries around the world, China included, have seen worsening ecological deficit situations while keeping a rapid social economic growth showing no sign of declining. Chinese experts believe that the unaccounted non-renewable energy has made significant contribution of supporting ecosystem. The research shows that:

- With the current social economic development and technological innovations, fossil energy plays an indispensable role in supporting the ecosystem. By using the power generated of burning ITJ coal, petroleum and natural gas, even assuming biomass could be efficiently converted, it will take the net-biomass-output of 23.2 ha, 22.9 ha and 29.1 ha forests respectively annually, deducting the negative ecological space brought by the negative ecological impact due to the emission of CO_2, CH_4, N_2O, SO_2, NO_X, and land use, the unit fossil energy use still shows Ecological Footprint reserve (see figure 5.2)
- From 1985 to 2004, if China keeps the current demand for resources without using fossil energy, even if we consider the total area of Chinese territory as arable land with yield factor 3, the total ecological deficit would be enough to cover 6 entire China. Such high level ecological deficit would be unmanageable to any country or region in the world and could not be accommodated through regional relocations.
- The supporting role of fossil energy is achieved at the expense of cutting energy stock accumulated over centuries. Fossil energy can drive the economic development; however, it is a short term choice when technologies are not mature enough to tap into the renewable energy sources to energize the national economic system. Such a development model will result in the exhaustion of fossil energy, global warming and exorbitant ecological risks.

Has the use of fossil energy intensified Ecological Footprints or increased biocapacity? It remains a question. Chinese scholars believe that under the current socio-economic development level, fossil energy generates more bio-capacity than it consumes. The maximizing capacity of fossil energy on biocapacity cannot be overlooked.

(4) Expansion of Research Scope and Applied Fields in the Light of Shortage of Ecosystem Services

The fairness, validity and regional flow of ecological consumption are the most attended fields in recent Ecological Footprint studies. Gini coefficient, coefficient of variation, Hoover Center Index have been incorporated into the Ecological Footprint studies as the measuring indicators for the regional fairness of the supply and demand of natural capital. The balanced diet footprint (0.92-0.98 gha per head per year) based on healthy, balanced diet and demographic structure of rural and urban areas, is recommended as the benchmark indicator for the validity of biomass consumption for population. Some studies are paying attention to the regional or international transfer of Ecological Footprint carried by domestic or international trade on items such as forestry produce, water resources, and agricultural produce and have already initiated the analysis on the regional or global transfer of ecological responsibility.

In general, the Ecological Footprint studies have been widely practiced in China with its significance appreciated. The research results have important impact on shaping the government's policies on ecological construction, as well as promoting the public awareness on environmental protection. Looking into the future of China's Ecological Footprint studies, we should enhance our efforts on the following aspects:

- On the research subject: focus more on studies of smaller scale and of groups to meet the demands in public education and policy deliberation.
- In terms of duration, focus more on longer duration studies to reveal the changes of regional Ecological Footprint over the time and the driving mechanism as well as future trend for regional development
- In terms of research method, improve in areas such as productivity statistics, output factor, structure, complete accounting to improve the accuracy, comparability and structure of the final results.
- In other aspects, continue to focus on the study and validation of subjects like the overall effect of fossil energy on ecology, fairness of ecological consumption, validity of ecological consumption, regional and global flow as well as global impacts.

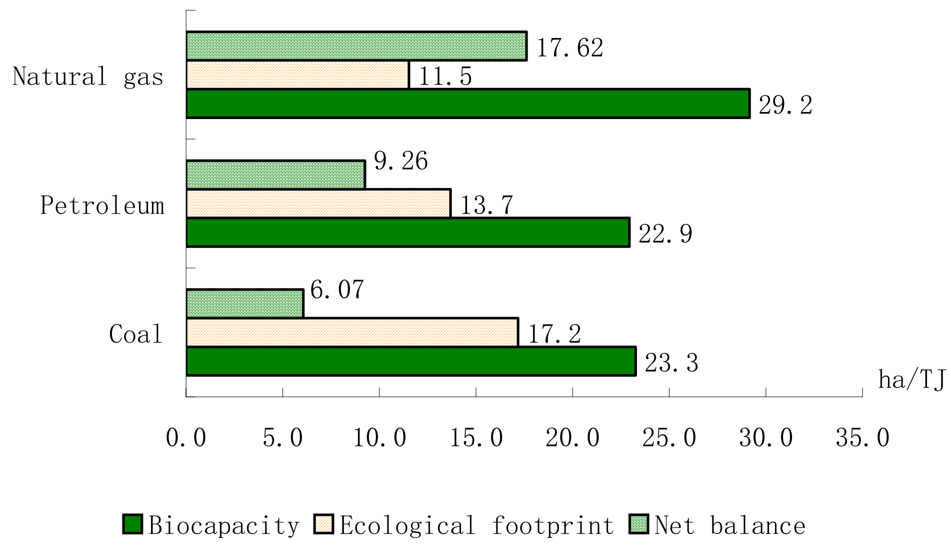


Fig. 5.2 **ECOLOGICAL FOOTPRINT, BIOCAPACITY AND NET BALANCE PER UNIT OF FOSSIL FUEL USED**

6 China's Ecological Footprint and Biocapacity

The story of China over the past forty years is the story of growth. Since 1961, China's population has doubled, its per person Ecological Footprint has doubled, and it's total demand on the planet has increased by a factor of four. Only the 114th highest user of biological capacity in 1961, China now demands more from the planet than any nation except the United States.

In addition to a high demand, however, China is also fortunate to have a great amount of available capacity within its own borders. The ability of its croplands to produce useful products is the second highest of any nation in the world. Its forests produced 1.6 times the timber of all of Western Europe in 2001, and its available grazing land capacity is greater all of the OECD nations combined.

Sustainability requires demand remaining within the regenerative capacity of nature, however. If any nation consumes more than its own ecosystems can provide, it runs an ecological deficit. This deficit can only be met in two ways – by relying on biological capacity from other nations or the global commons, or by depleting the biological capacity available within its borders.

Since the early 1970's, China has run an aggregate ecological deficit. Its deficit in cropland has narrowed, but China still must import an equivalent of 83,000,000 global hectares of cropland capacity each year. China still has an ecological reserve in grazing land and forest, with demand for these types of capacity within the ability of the nation to provide, but these reserves are shrinking over time. A small reserve in fishing grounds has become a deficit.

The most significant change over this time has been the dramatic increase in the carbon Footprint. This has resulted from an equally dramatic increase in energy consumption per person in China, which has more than tripled since 1961. Given that China's coal-powered electricity is relatively carbon intensive, the power sector will have a major role to play in reducing China's carbon Footprint in the future.

Figure 6.1: China's use of world biocapacity, 1961-2003. China's share of world population has slightly decreased since the 1970's when population growth rate was slowed.
Define ecological remainder

Figure 6.2: China's ecological reserve or deficit, per land type. China has entered ecological deficit for all but one of its land types, i.e. forest land. However even forest land is not far off from dropping into deficit and has been decreasing steadily over the past 40 years. CO_2 land is the most severely in deficit and is the major contributor to pushing China into total ecological deficit. Thus a significant reduction in CO_2 emissions could greatly reduce China's total ecological deficit.

Fig. 6.1: **CHINA'S USE OF WORLD BIOCAPACITY,** 1961-2003

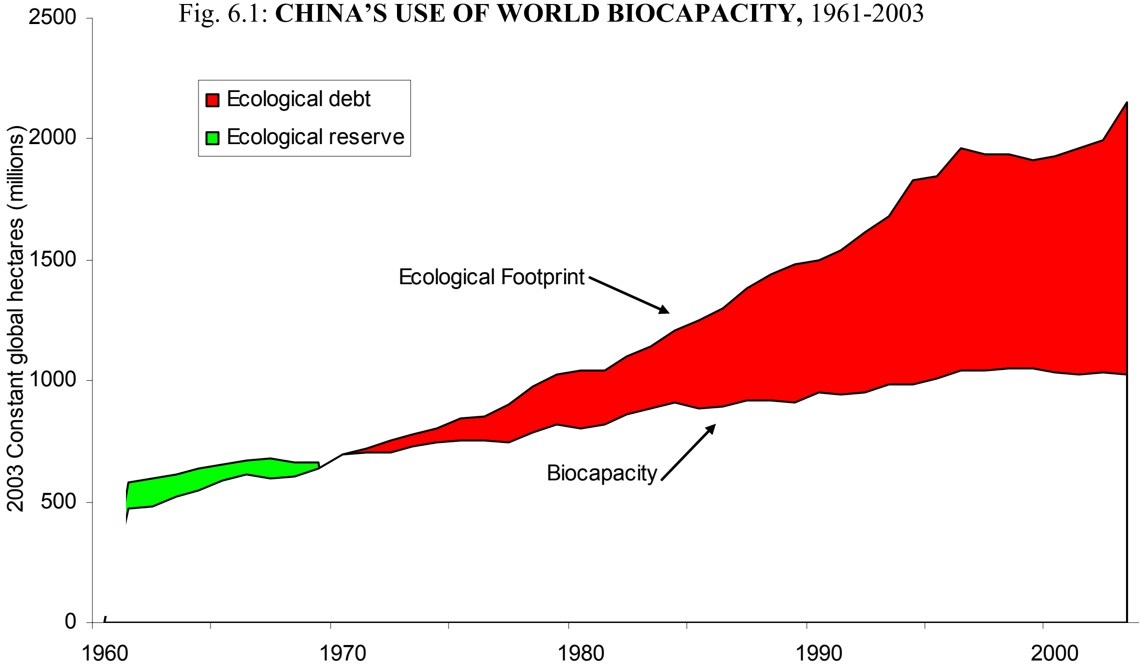
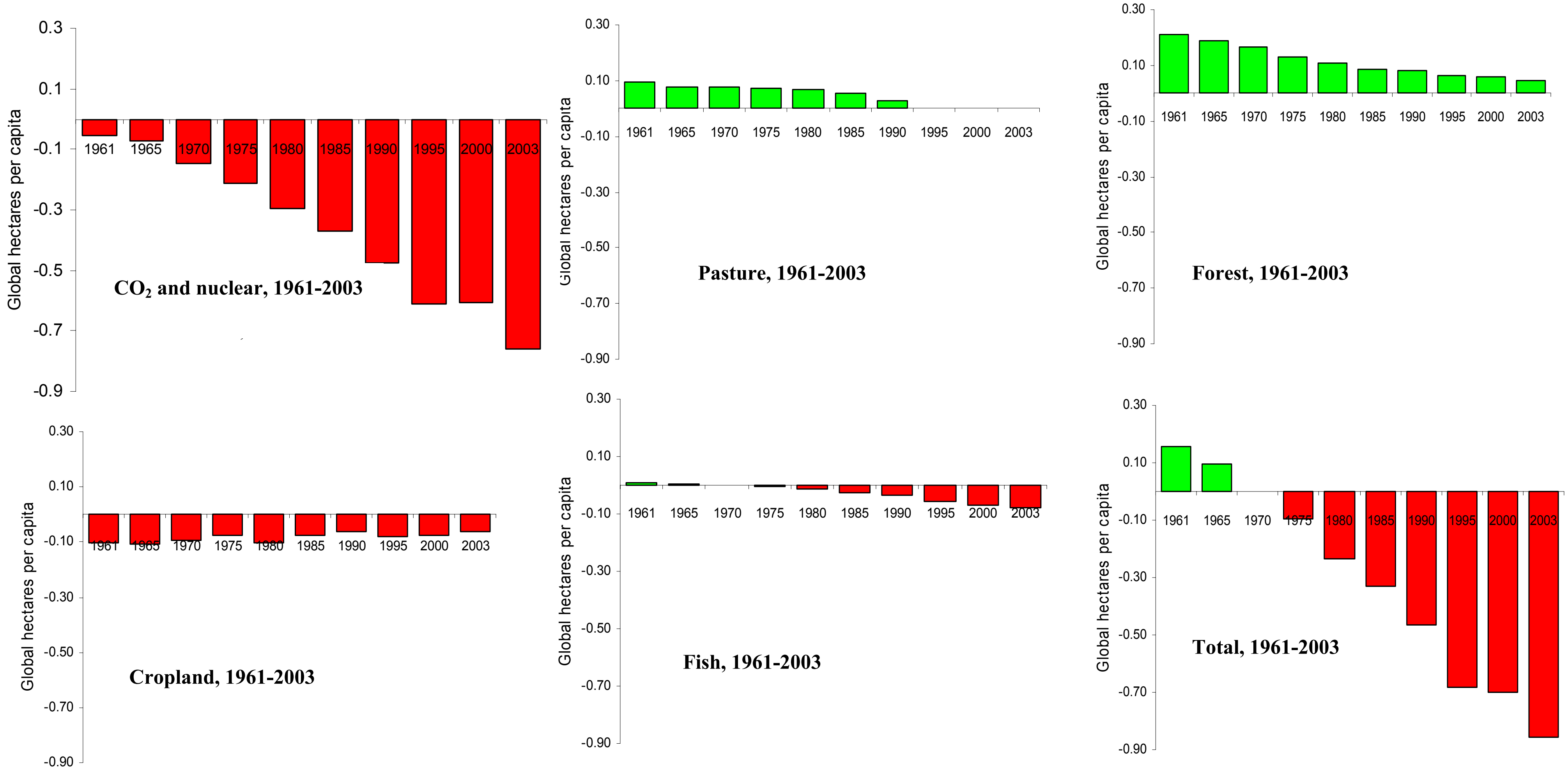


Table 6.1: **CHINA'S TOTAL ECOLOGICAL FOOTPRINT AND BIOCAPACITY BY LAND TYPE,** 2003.

Land types	Total Ecological Footprint (Mgha)	Total Biocapacity (Mgha)
Crops	530	450
Pasture	160	160
Forest	150	210
CO_2	990	-
Nuclear	10	-
Built	90	90
Fish	220	120
Total	2,150	1,030



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7 China's Global Reach

China's international trade has the characteristic of importing primary produce and exporting finished products. When calculating China's embodied biocapacity flows in international trade, the focus needs to be put on large volume goods, such as grains, soybeans, cotton, wool, vegetable, fruit, aquatic produce, animal and poultry meat, timber and timber products.

One of China's strategies to cover her ecological deficit is to obtain bio-capacity beyond its border. In 2004, as a net bio-capacity importer China gained net bio-capacity 65.6 x 10^6 gha through international trade, among which, exports of embodied biocapacity standing at 95.4 x 10^6 gha, and imports of embodied bio-capacity 161.1 x 10^6 gha.

Forestry is a decisive type of bio-productive space to China's scale of net import of bio-capacity, accounting for 82% of total volume of net import of biocapacity in 2004, amounting to 54.0 x 10^6 gha. This is a result caused by the comparative scarcity of Chinese forestry resources, insufficiency in meeting the domestic demands and heavy reliance on import of log, pulp, and paper products.

Driven by demands in both consumption and production, China will inevitably continue its imports of biocapacity for the foreseeable future. For a country in drastic urbanization and economic development, the consumption of meat and diary products will take a bigger share in the diet of Chinese people. Thus, China is expected to gain more grassland biocapacity through international trade.

Figure 7. 2 exhibits major trading partners of China in 2004. In its trading with these countries, China exports net biocapacity of 2.5 x 10^6 gha, among which, 79.6 x 10^6 gha of embodied biocapacity in exports and 77.1 x 10^6 gha of embodied biocapacity in imports.

China's international flows of biocapacity have shown their variety either in geography and causes. China's major source countries of embodied biocapacity are the U.S., Canada and Indonesia (see figure 7. 4) , among which, the embodied bio-capacity imported from the U.S. is in the form of imports of grains, logs, and pulp; the bio-capacity imported from Indonesia is in the form of pulp imports. Major destination countries of China's embodied bio-capacity are South Korea, Japan, Australia, and the U.S. (see figure 7.5), among which, the embodied exports of bio-capacity to Japan, South Korea are in the form of exports of woolen products, aquatic produce and aquatic products; the exports of bio-capacity to Australia is in the form of China's export of paper products and the export of bio-capacity to the U.S. is in the form of export of aquatic produce.

In general, three routes exist for any biocapacity inflow to China: direct consumption, indirect consumption and re-distribution through international trade.

- Direct Consumption: the imported products are directly consumed by Chinese inhabitants, for a typical example-rice.
- Indirect consumption (domestic re-distribution): the imported products are used as intermediary inputs in production and then transformed into other products, which will further be consumed domestically. For example, the chain from imported corn, raising pigs and to pork;
- Re-distribution through international trade: the imported products are used as intermediary inputs in production and then transformed to other products, which will further be consumed internationally. For example, China's exports of woolen products to the U.S. and Japan is a typical example of international re-distribution of bio-capacity, with its initial providers of bio-capacity being Australia and New Zealand. China's international trade mode is patterned in this way, mainly importing primary produce and exporting finished products, which means most of the biocapacity inflows to China through international trade will be redistributed through international trade again.

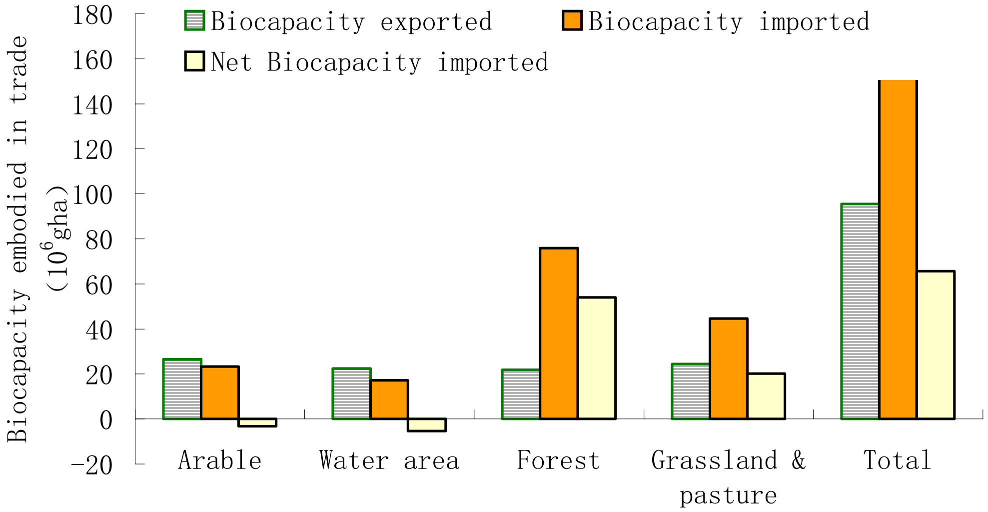


Fig. 7.1 **THE FLOW OF CHINA'S BIOCAPACITY CARRIED BY INTERNATIONAL TRADE** (2004)

Shortage of timber resource has made forest a decisive type of bio-productive space to China's scale of net import of biocapacity

Table 7.1 **INFLOWS AND OUTFLOWS OF CHINA'S BIOCAPACITY** (2004) (10^6 gha)

Country	Inflow	Outflow	Net outflow
India	1.5	3.3	1.9
Indonesia	11.3	2.3	-9.0
Malaysia	1.0	1.7	0.7
Japan	1.5	17.2	15.8
Saudi Arabia	0.0	0.6	0.6
Singapore	0.0	1.2	1.2
South Korea	1.0	14.2	13.3
Thailand	3.4	0.6	-2.8
Germany	1.1	3.0	2.0
France	1.2	0.5	-0.7
Britain	0.4	2.0	1.6
Italy	0.4	1.2	0.8
Netherlands	1.3	2.0	0.7
Russia	6.6	2.3	-4.3
Spain	0.3	0.7	0.4
Canada	17.6	1.2	-16.4
United States	13.7	11.4	-2.3
South Africa	0.4	0.5	0.1
Egypt	0.2	0.2	0.0
Brazil	6.3	0.1	-6.2
Mexico	0.1	0.6	0.6
Australia	4.1	12.3	8.2
New Zealand	3.8	0.2	-3.6
Total	77.1	79.6	2.5

Fig. 7.2 **NET EMBODIED BIOCAPACITY FLOWS IN CHINA'S INTERNATIONAL TRADE WITH ITS MAJOR TRADING PARTNERS** (BY COUNTRY)

Notes: (1) Positive biocapacity represents net inflow; otherwise net outflow;(2)A certain part of net capacity inflows to China comes from countries not displayed in the chart.

Figure 7.2: By individual countries, in terms of its trade with some countries , China exports biocapacity to neighboring countries such as South Korea and Japan, while mainly imports from countries with rich forestry resources such as Canada, Indonesia and Brazil.

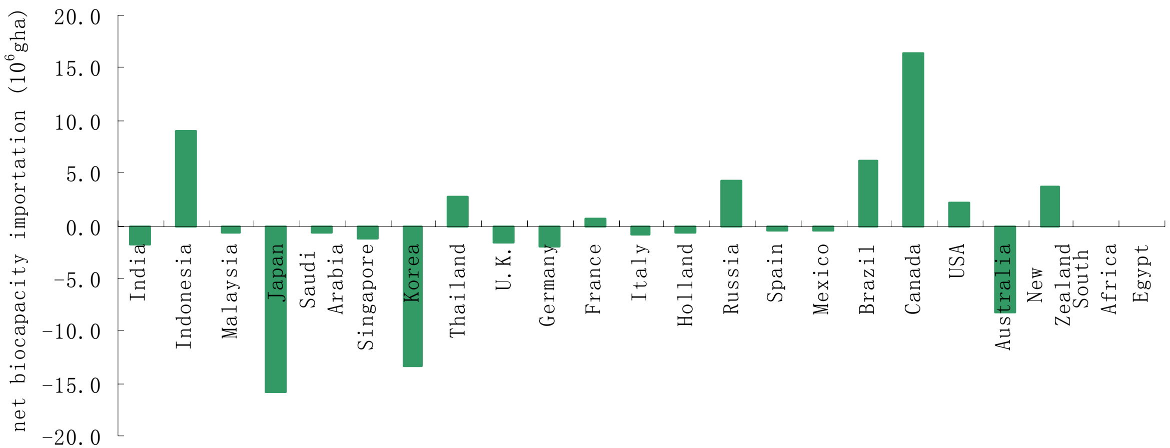
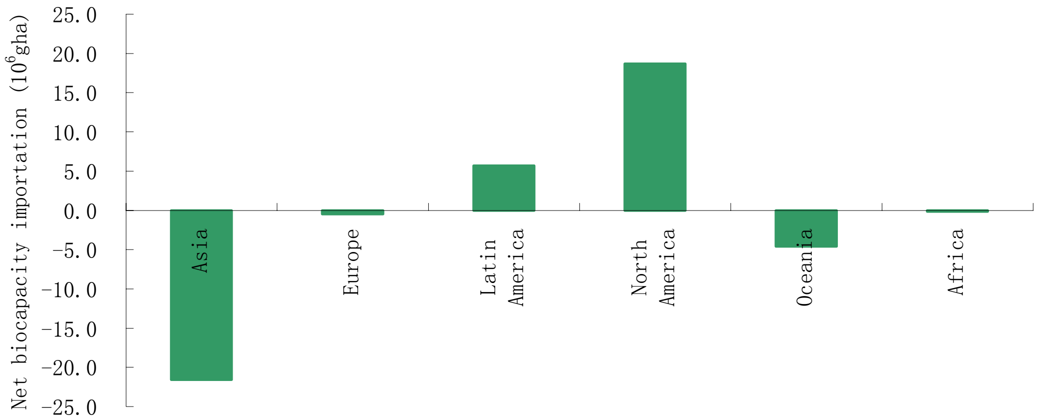


Fig. 7.3 **NET EMBODIED BIOCAPACITY FLOWS IN CHINA'S INTERNATIONAL TRADE WITH ITS MAJOR TRADING PARTNERS** (BY CONTINENTS WITH SELECTED COUNTRIES)

Note: Positive biocapacity represents net inflow; otherwise net outflow

Figure 7.3: By continent, in terms of its trade with some countries, China mainly exports biocapacity to Asia and Oceania and imports bio-capacity from North America.



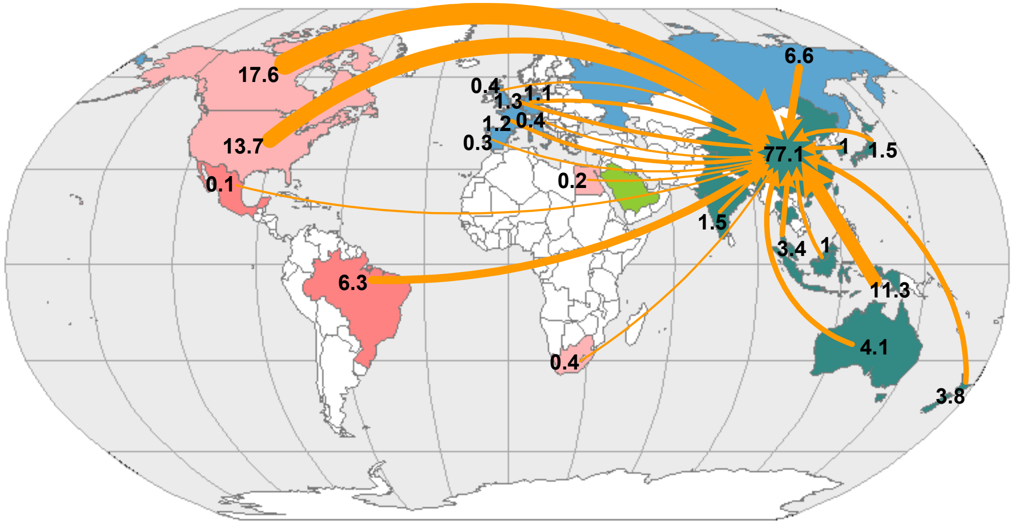


Fig. 7.4 **CHINA'S INFLOWS OF BIOCAPACITY WITH MAJOR COUNTRIES**(2004)

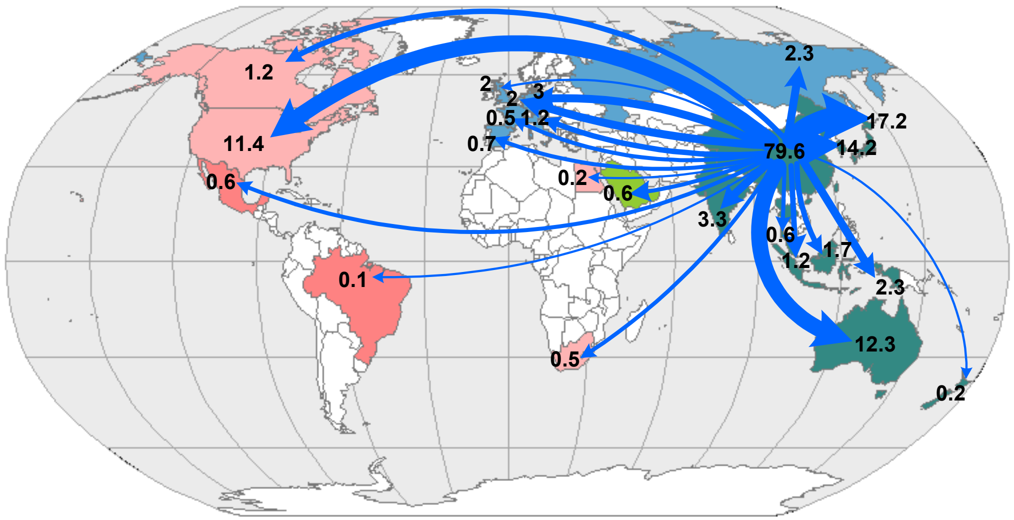


Fig. 7.5 **CHINA'S OUTFLOWS OF BIO-CAPACITY WITH MAJOR COUNTRIES**(2004)

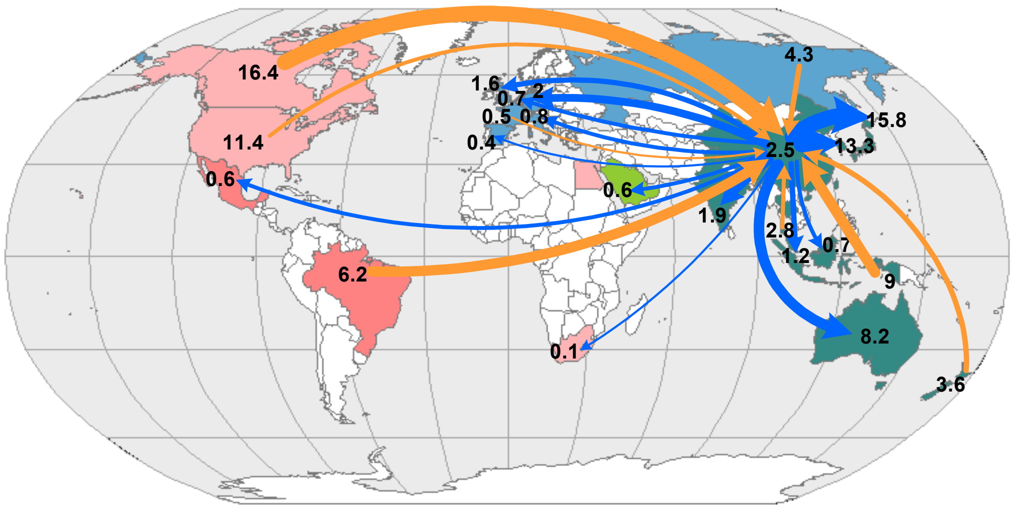


Fig. 7.6 **CHINA'S NET FLOWS OF BIOCAPACITY WITH MAJOR COUNTRIES**(2004)

8 The Global Development Challenge

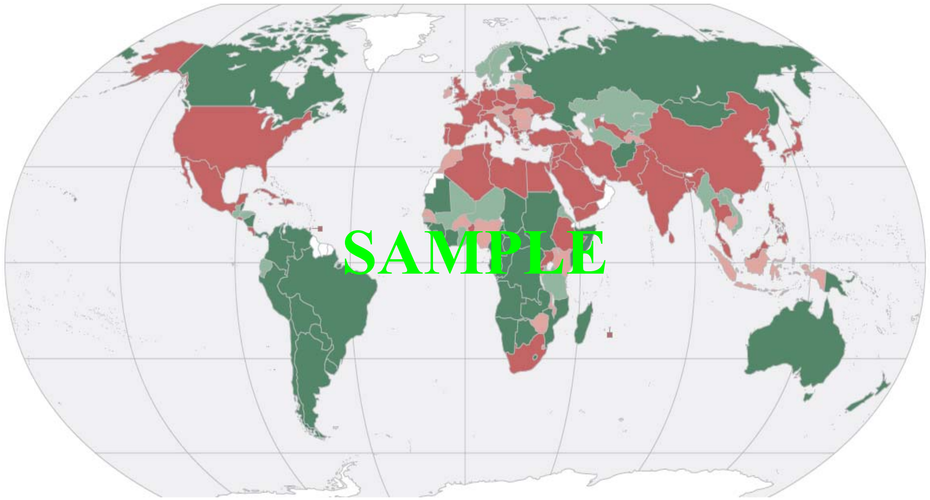


Fig.8.1(a): **1961**

Ecological debtor nations are countries that, in aggregate, consume more than the ecosystems within their own borders provide. Ecological creditor nations have ecological reserves, and their residents have Ecological Footprints lower than their own domestic biocapacity per person.

The biocapacity reserve of creditor nations may be used by wild species, or may be occupied by exports to other nations. In spite of the reserve, if ecosystems of creditor nations are not carefully managed, it is still possible that some of them get overused.

With continuing and growing global overshoot, debtor and creditor countries alike will continue to experience the increasing importance of access to ecological assets. Reducing a nation's Ecological Footprint thus becomes a way for a nation to improve its resilience, national security, and competitive advantage in a world with ever larger overshoot.

In fact, as national ecological deficits continue to increase, the European Environment Agency has noted that the predominant geopolitical line may gradually shift from the current economic division between "developed and developing countries", to a resource division between ecological debtors and ecological creditors.

Figure 8.1: Ecological debtor and creditor countries, 1961, 1982, 2003. Ecological debtors are shown in red, and ecological creditors in green. In 1961, only 26 out of 147 countries were ecological debtors, but by 2003, 90 countries were running ecological deficits.

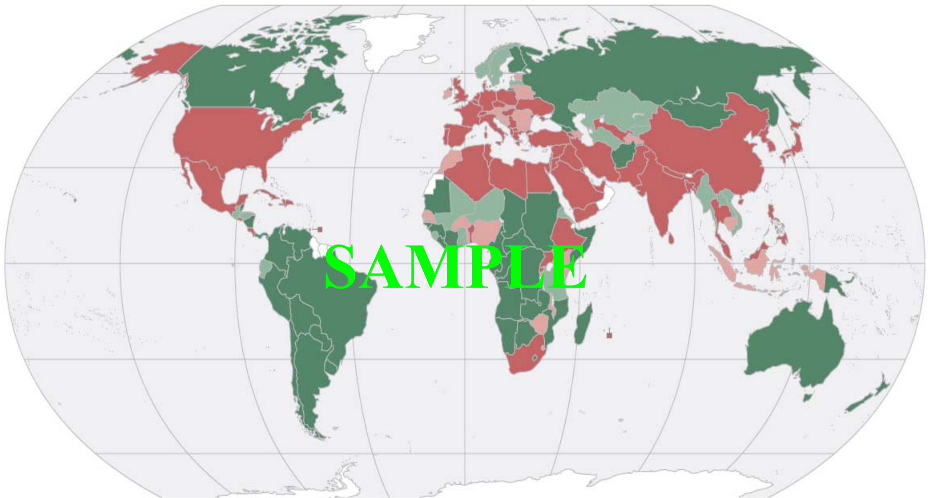


Fig.8.1(b):**1982**

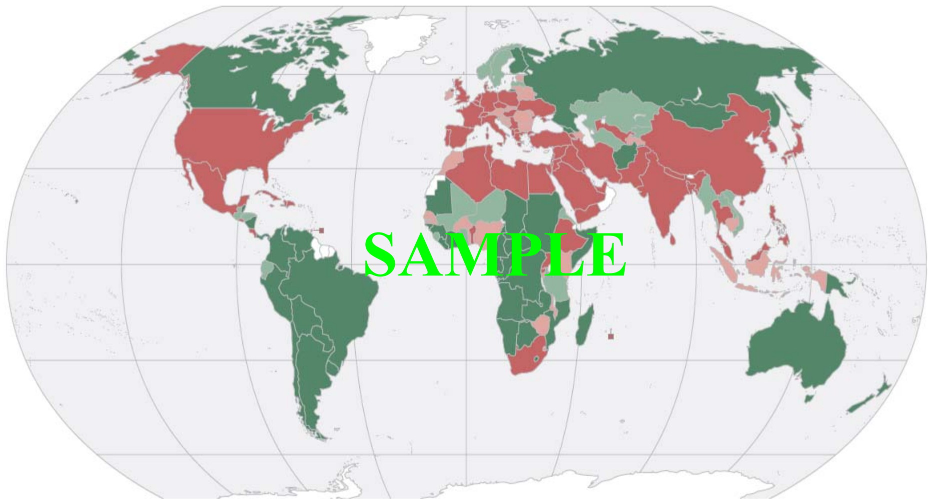


Fig.8.1(c): **2003**

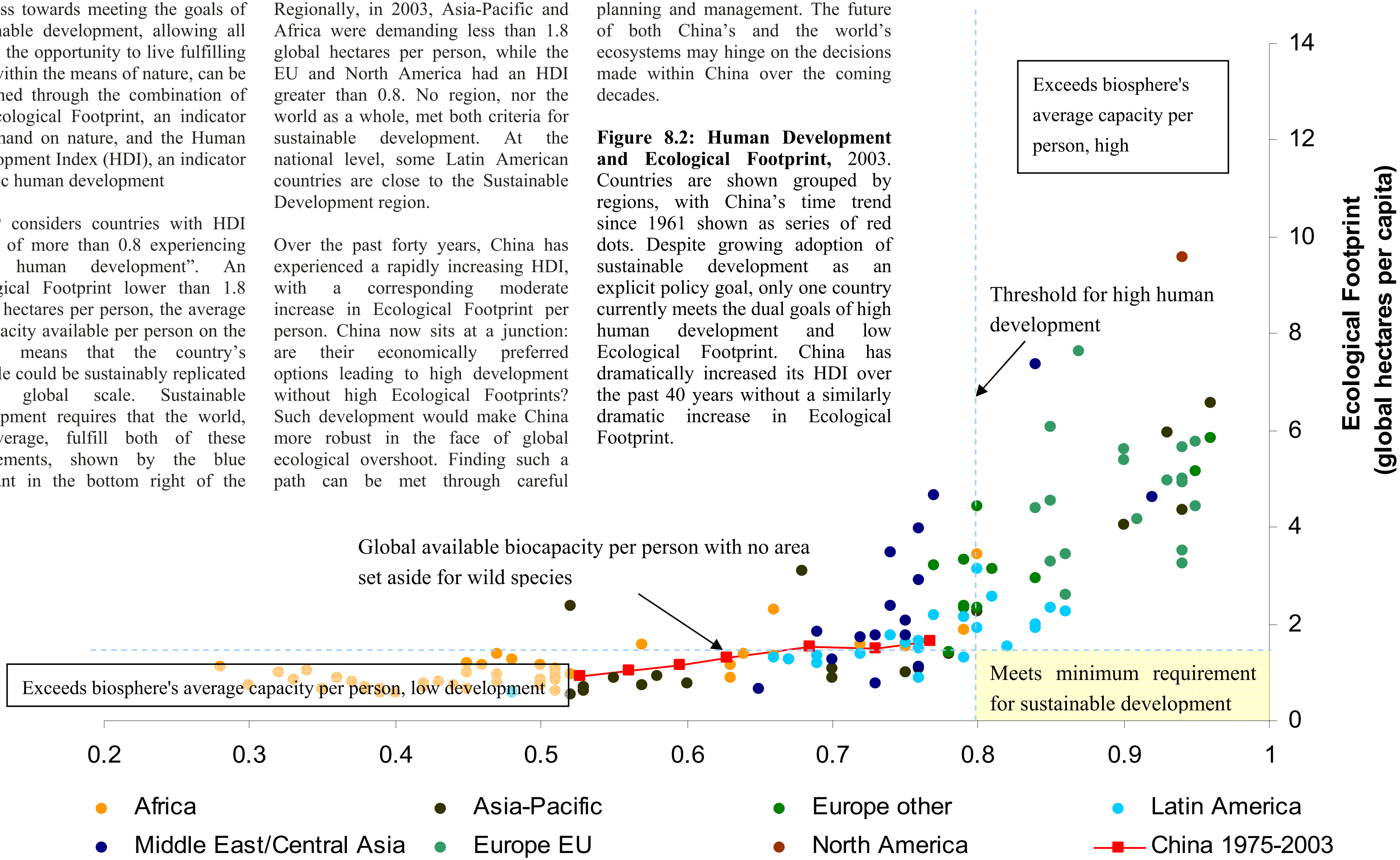
Progress towards meeting the goals of sustainable development, allowing all people the opportunity to live fulfilling lives within the means of nature, can be examined through the combination of the Ecological Footprint, an indicator of demand on nature, and the Human Development Index (HDI), an indicator of basic human development

UNDP considers countries with HDI values of more than 0.8 experiencing “high human development”. An Ecological Footprint lower than 1.8 global hectares per person, the average biocapacity available per person on the planet, means that the country’s lifestyle could be sustainably replicated at a global scale. Sustainable development requires that the world, on average, fulfill both of these requirements, shown by the blue quadrant in the bottom right of the graph.

Regionally, in 2003, Asia-Pacific and Africa were demanding less than 1.8 global hectares per person, while the EU and North America had an HDI greater than 0.8. No region, nor the world as a whole, met both criteria for sustainable development. At the national level, some Latin American countries are close to the Sustainable Development region.

Over the past forty years, China has experienced a rapidly increasing HDI, with a corresponding moderate increase in Ecological Footprint per person. China now sits at a junction: are their economically preferred options leading to high development without high Ecological Footprints? Such development would make China more robust in the face of global ecological overshoot. Finding such a path can be met through careful planning and management. The future of both China’s and the world’s ecosystems may hinge on the decisions made within China over the coming decades.

Figure 8.2: Human Development and Ecological Footprint, 2003. Countries are shown grouped by regions, with China’s time trend since 1961 shown as series of red dots. Despite growing adoption of sustainable development as an explicit policy goal, only one country currently meets the dual goals of high human development and low Ecological Footprint. China has dramatically increased its HDI over the past 40 years without a similarly dramatic increase in Ecological Footprint.



9 Country Profiles

The world has changed dramatically in many ways over the past forty years. Many nations, including those in the Asia-Pacific region, have experienced economic growth, a reduction of poverty, and the improvement of quality of life. These positive aspects, however, have often been accompanied by a corresponding rise in Ecological Footprint.

Each person alive today consumes more on average than a person alive forty years ago. But at the same time, the amount of biological capacity available per person has fallen, as population growth outpaces increases in the productive area and yield of ecosystems throughout the world. These two pressures have led to growing ecological deficits for nations around the world.

This pattern is also evident in the forty year history of China's Ecological Footprint, biocapacity, and GDP per person. Perhaps surprisingly, the largest absolute increases in GDP per person occurred without an equally dramatic increase in Ecological Footprint. This could be caused by an increase in less resource intensive economic activities, or by inequality in the distribution of Footprint and income within different populations in China.

India shows a different trend, with a declining Ecological Footprint per person, as population increases have offset any total growth in consumption within the country. This contrasts with China where slower population growth leads to a less dramatic decrease in the available biocapacity per person. The time trends for India also demonstrate how Ecological Footprint can be constrained by biocapacity – in years where biocapacity fell sharply or spiked upward, a corresponding pattern is seen in the graph for Ecological Footprint.

In Japan and the United States, high income countries with the ability to import resources from abroad, increases in Ecological Footprint have been dramatic. The decreases in consumption associated with various recessions during the past forty years are clearly evident in these charts. Interestingly, through changes in technology and economic structure, Japan's per person Ecological Footprint in 2003 is nearly identical to that in the early 1970's, despite a near doubling in per person GDP over this period.

The United States and the European Union are both notable for their relatively stable Ecological Footprint and biocapacity per person over the past thirty years, especially as compared to the rapidly growing Asia-Pacific nations. The rapid growth in the consumption of the residents of these high income nations occurred before 1961, and is thus not evident from these figures.

The trend in Africa is strikingly different. Per person consumption has increased very little on the continent as a whole, while rapid population growth has led to a dramatic decline in the available biocapacity per person. While in the aggregate, Africa remains an ecological creditor, some of the continent's reserve is harvested for exports.

Figure 9.1-9.6: Ecological Footprint, Biocapacity and GDP per person for China, India, Japan, the United States, the European Union, and Africa, 1961-2003.

Fig. 9.1: **CHINA'S ECOLOGICAL FOOTPRINT, BIOCAPACITY AND GDP,** 1961-2003

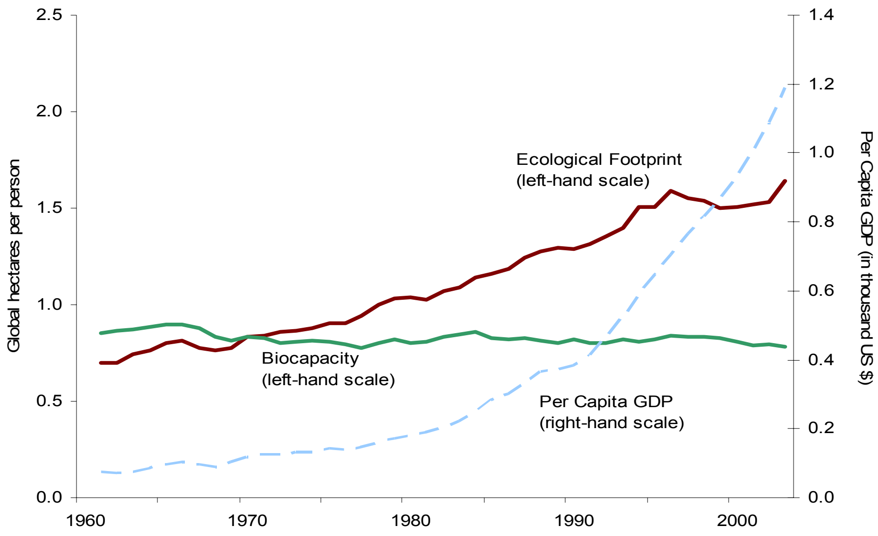


Fig. 9.2: **INDIA'S ECOLOGICAL FOOTPRINT, BIOCAPACITY AND GDP,** 1961-2003

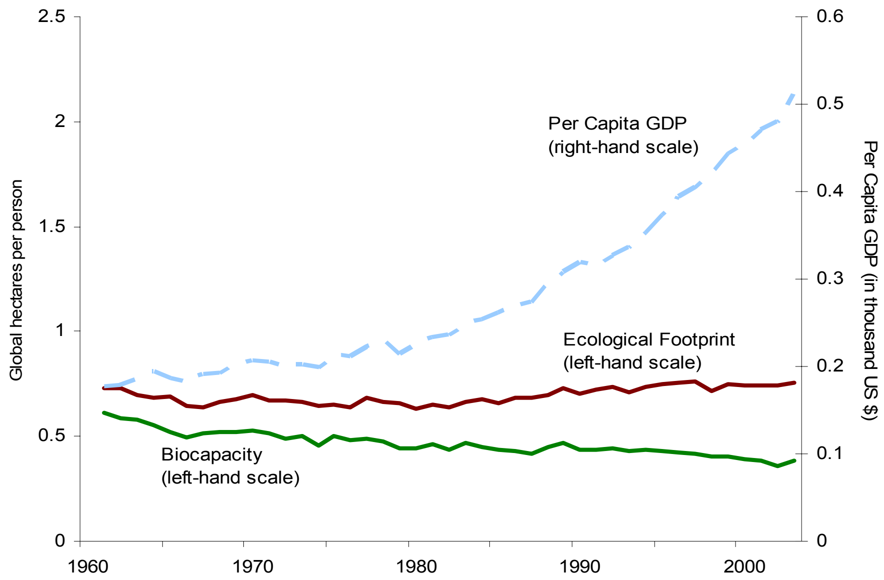


Fig. 9.3: **JAPAN'S ECOLOGICAL FOOTPRINT, BIOCAPACITY AND GDP,** 1961-2003

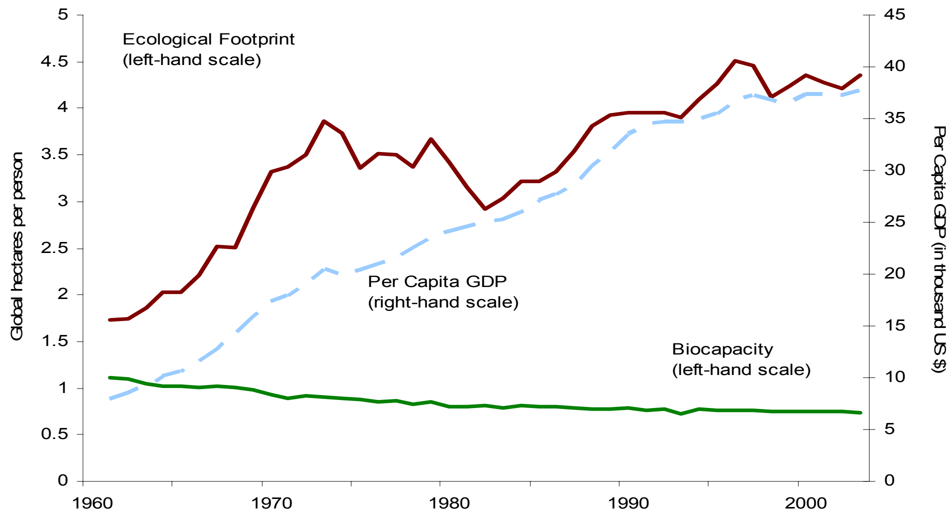


Fig. 9.4: **EU-27'S ECOLOGICAL FOOTPRINT, BIOCAPACITY AND GDP,** 1961-2003

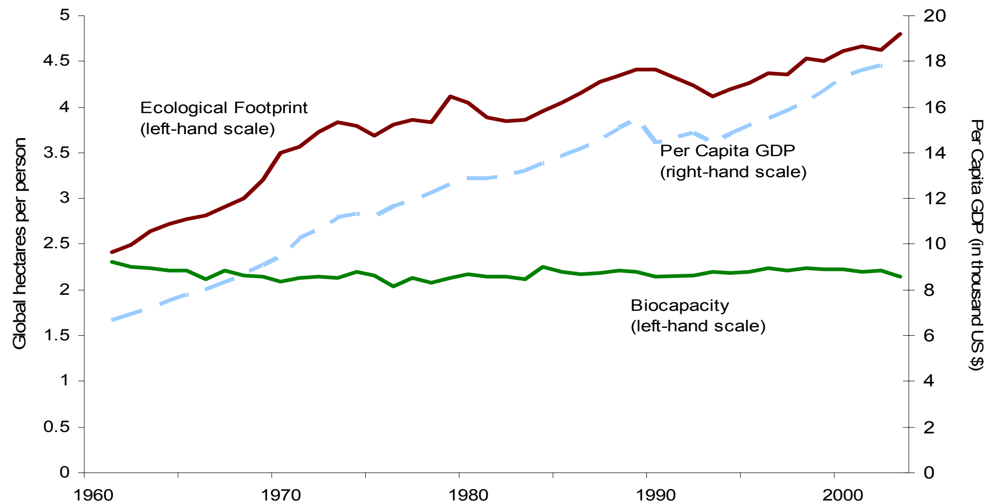


Fig. 9.5: **USA'S ECOLOGICAL FOOTPRINT, BIOCAPACITY AND GDP,** 1961-2003

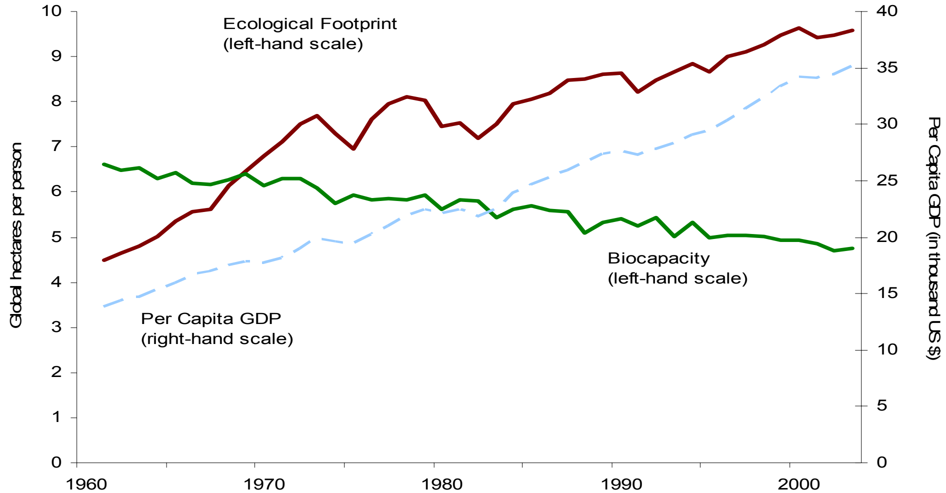
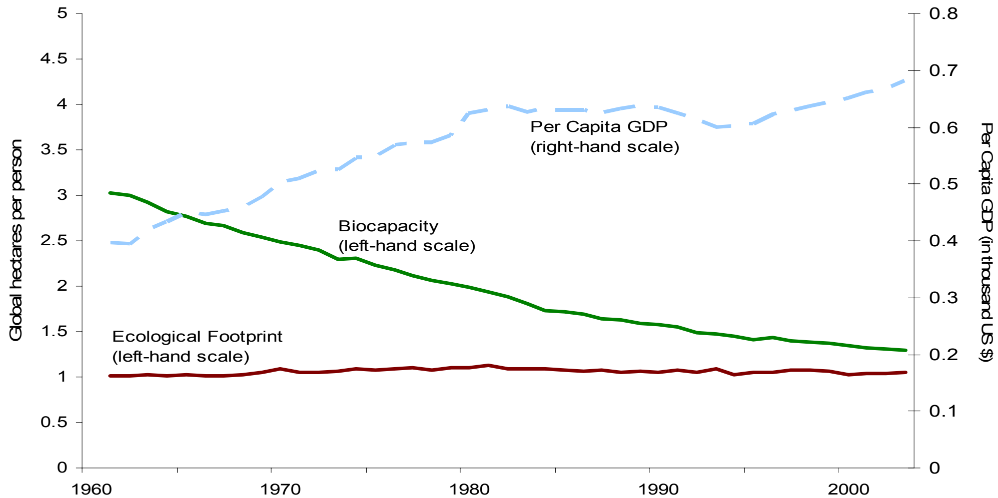


Fig. 9.6: **AFRICA'S ECOLOGICAL FOOTPRINT, BIOCAPACITY AND GDP,** 1961-2003



10 Paths for China's Future

China's options in the coming century will be closely related to the fate of the world as a whole. If global society continues on its current trajectory, even optimistic United Nations projections with moderate increases in population, food and fibre consumption, and carbon emissions suggest that, by 2050, humanity will demand resources and ecological services at double the rate at which the Earth can generate them. In other words, by 2050, we will be consuming two planets.

Within this global context, China's ecological deficit continues to rise, making China more dependent on the use of biological capacity outside its borders and putting its own ecosystems at risk of degradation or collapse. As limits become increasingly evident, this deficit presents an increasing risk to China's economy and society.

How will China make successful decisions within this new ecological reality? What steps might China take to continue to improve its residents' quality of life while reducing its ecological deficit?

Five factors determine the size of China's ecological deficit. Three of these factors influence China's total demand on the planet: population size, average consumption per person, and the footprint intensity per unit of consumption. Two additional factors control biocapacity, or what China's ecosystems are able to supply: the amount of biologically productive area available, and the productivity or yield of that area.

1. The Population Factor.
Increase in population can be slowed and eventually reversed by supporting families in choosing to have fewer children. Offering women access to safe and affordable family planning, better education, economic opportunities, and health care are proven approaches to achieving this. Changes in population size are slow moving, and decisions today will reverberate for several generations into the future.

2. The Consumption Factor.
The potential for reducing the amount of resource consumption per person depends on an individual's economic situation and the social and cultural context in which they live. While people living at or below subsistence levels may need to increase their consumption to move out of poverty, there are ways for the affluent to reduce their consumption without, arguably, reducing their quality of life. The average resident of Italy, for example, lives on less than one half the average Footprint of a resident of the United States.

3. The Technology Factor.
With any number of people and any given level of consumption, the Ecological Footprint used to provide goods and services can often be significantly reduced. Lowering the Footprint intensity of consumption can be achieved in many ways, from increasing energy efficiency in manufacturing and in the home, through minimizing waste and increasing recycling and reuse, to building fuel-efficient cars and reducing the distance many goods are transported. Business and industry do adjust to government policies and incentives to promote resource efficiency and technical innovation, where such policies are clear

Fig. 10.1: **FIVE ECOLOGICAL FOOTPRINT AND BIOCAPACITY FACTORS THAT DETERMINE OVERSHOOT**

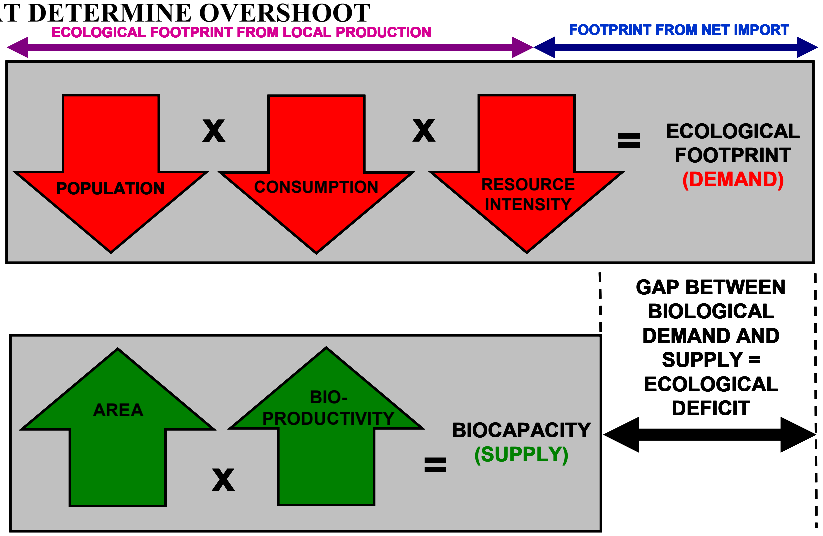
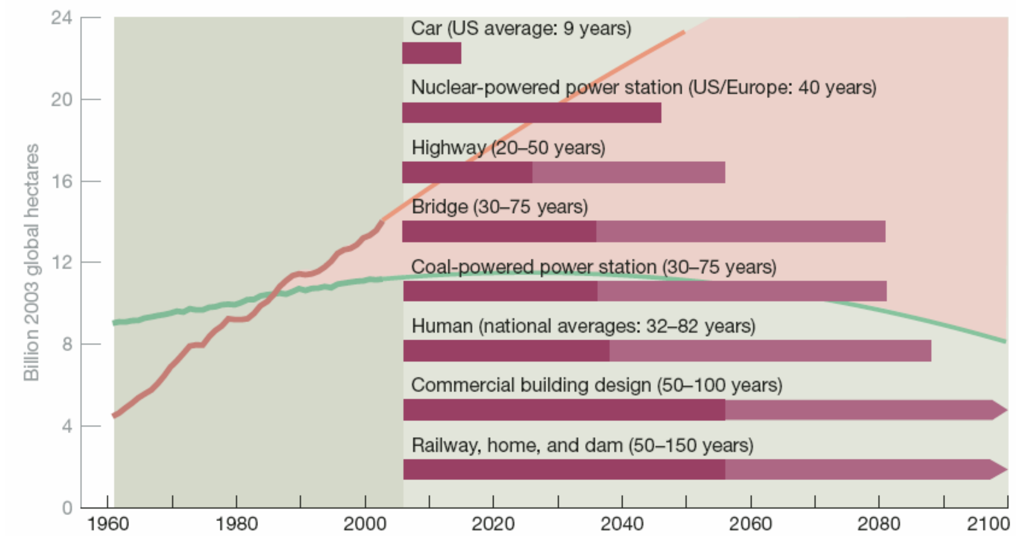


Fig. 10.2: **LIFESPAN OF PEOPLE, ASSETS AND INFRASTRUCTURE**



and long term, as well as to consumer pressure.

4. The Area Factor.
In some cases, the total amount of bioproductive area available for human use can be increased. Degraded lands can be reclaimed through careful management, terracing has had historical success in mountainous regions, and irrigation can make previously unusable land productive. Decisions and policies to increase productive area must be made carefully, however, to avoid negative impacts on biodiversity and the health of wild species. Care must be taken to ensure that new lands will remain productive beyond the initial years, and good land management must ensure that currently bioproductive area is not lost to urbanization, salinization, or desertification.

5. The Productivity Factor.
The total amount of useful production per hectare depends both on the type of ecosystem being considered and the way that it is managed. Agricultural technologies can boost productivity, but can also diminish biodiversity, and gains can be reversed if the land is degraded. Energy intensive agriculture and heavy reliance on fertilizer may increase yields, but at the cost of a larger Ecological Footprint associated with increased inputs.

Out of all of the possible decisions and investments China could make, which are the most important to consider today? Two general strategies for reducing ecological deficit stand out as important:

1. Low Hanging Fruit.
This strategy involves solving the simplest, cheapest, and most publicly acceptable challenges first. Investments in clean technology, such as energy efficient light bulbs, often are able to quickly reduce Footprint intensity without reducing the quality of life of end consumers or the profits of businesses. This strategy can result in very rapid, short-term gains that build momentum and help to set society on a low-Footprint path.

2. Slow Things First
Reducing China's ecological deficit in the long run will require considering which decisions today are likely to have long term impacts. Often, the most important decisions made today are not those that place the greatest demand on the planet today, but rather those that have a moderate to high current demand but last for a long time. Although highways may be cheaper to maintain as compared to the construction of a new light rail system this year, over the long term, the highways will result in a much higher future demand than the light rail system. Decisions and actions related to human populations and buildings are two examples of slowly changing factors with long lifespans that will influence the ecological deficit of China well into the coming century.

Figure 10.1: Five Ecological Footprint and biocapacity factors that determine overshoot.

Figure 10.2: Lifespan of people, assets and infrastructure. The most important decisions for the long-term are those that will be with us for the longest time. Decisions about buildings, infrastructure, and family planning made today will reverberate well into the coming century.

11 China: Transformation to Sustainability

It is estimated that for the next 10 to 20 years, Chinese population will continue to grow, posing threats to the overaloverall ecological system. Meanwhile, with the acceleration of urbanization, industralization and globalization, human beings' demand on natural resources will grow accordingly and the per capita demand intensity for resources will also intensify. If no measures are taken, the growing population and a growing Ecological Footprint per capita will naturally lead to greater ecological deficit and much more ecological capital to be borrowed from our descendents. Now that natural capital has set the limits for the development of all the countries around the world, this development model of " borrow-from-next generations" is neither sustainable nor responsible. Chinese government has realized the significance of this issue and integrated sustainable development as one objective for building a well-off society. It is mentioned explicitly that (the government needs) to enhance the capacity of Sustainable Development, to improve the ecological environment, to enhance the energy efficiency and to foster the harmony between human beings and the nature, so that the whole society could embark on the development road characterized with productive development, human wellbeing and ecological soundness. An integrated strategy including Compact, Feedback, Reduce, Increase, Conservation, and Diversity approach, shortened as CFRICD will be conducive to China's sustainable development.

1. Compact: an strategy to control over urban expansion for the Preservation and Maintenance of Biocapacity

It is estimated that by 2020, total Chinese population would reach 1.45 billion with the rate of urbanization at 55%, which means that in the next 12 years, urban population will increase by 220 million. A compact urban development strategy is the fundamental way to protect limited land resources from abuse by rapid urbanization in China.

There exists a significant difference of per capita Ecological Footprint between the urban and rural population, i.e. a resident who lives in urban area takes much more Ecological Footprint than one who lives in rural area (see figure 11.1), which means the increase of built-up land and per capita Ecological Footprint. Considering ecosystem service security and food security, China expects to increase the forest areas, improve grassland quality, and maintain the existed area of arable land. Though from 1980 to 2000, China maintained a relative stable land use structure against an accelerating urbanization process (see figure 11.1): national arable land area is maintained at 127 x 10^6 ha, grassland 264 x 10^6 ha, forest land area shows 15.3% increase, successfully balancing the expanding urbanization and stabilizing of the quantity of land resources, the annual 1.5% expansion of built-up areas and the ever-decreasing green areas per capita delivers a warning signal to land security for an urbanizing China.

Compact urban development strategy includes no less than two folds of meanings:

Spatially compact city. Though a spatially compact urban development may not be the most appropriate one for all countries committed to sustainable development, it is an ideal solution for China, especially true for the densely populated middle and eastern part of China where excessive rural land is hard to find to stage urbanization. A spatially compact city can shorten the per capital annual transportation distance and therefore, lower the consumption of energy and the emission of GHG. Chinese government is prioritizing and subsidizing public transportation, which essentially aims to compact the urban layout and check the uncontrolled expansion of urban areas. However, due to the lack of scientific planning, many Chinese cities still expand like a big pan-cake. It is difficult to find a Chinese city with multi-center layout to intensify the land use and shorten the distance between different functional centers. Meanwhile, the appreciation of asset prices leads to the surge in demand for bigger, more spacious apartments, ending up in excessive empty apartments on the market. As a result, the urban areas take up more space and quality land, whose biocapacity is lost during this process.

Eco-functionally compact city: In China's highly urbanized areas, the biocapacity per unit of land is quite high. Take Tian Jin, Beijing and Shanghai for example, the biocapacity per unit of land in these cities is 2 to 6 times of the national average, thanks to a more efficient use of land and more intensified cultivation. From the perspective of supply and consumption of ecosystem services, it is advisable to control the size of the urban areas and reserve some bio-productive areas among built-up areas, beneficial not only to better public living conditions but also to saving costs incurred from importing and transporting ecosystem services from far away regions.

Fig. 11.1: **DIFFERENCE OF PER CAPITA ECOLOGICAL FOOTPRINT BETWEEN URBAN AND RURAL AT PROVINCIAL LEVEL IN 2004**

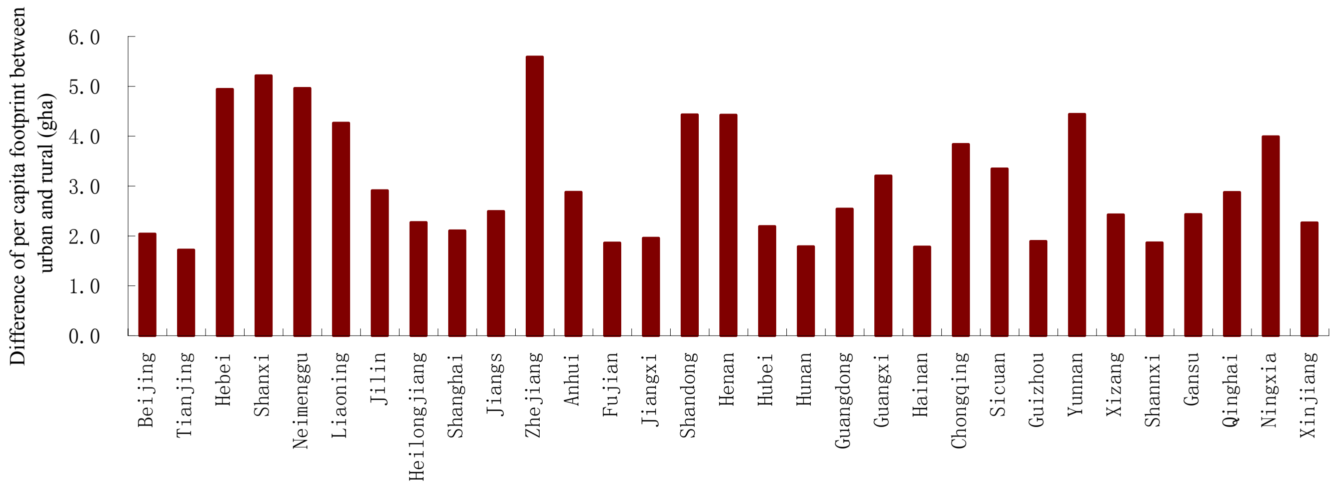


Table 11.1: **THE AREA CHANGE OF DIFERENT LAND TYPES (1982-2000)**

	Forest	Pasture	Arable land	Garden	River or lake	Built-up	Unused land
			Total area（10^6ha，%）				
1982	198.7	264.0	126.7	5.8	36.5	27.8	300.5
2000	229.2	263.8	127.6	10.6	22.0	36.4	270.3
Rate of change	15.3	-0.1	0.7	82.8	-39.7	30.8	-10.0
			Per capita area（ha，%）				
1982	0.20	0.27	0.13	0.01	0.04	0.03	0.30
2000	0.18	0.20	0.10	0.01	0.02	0.03	0.21
Rate of change	-11.74	-23.55	-22.94	39.83	-53.88	0.18	-31.18

2. Feedback: a strategy to improve the feedback loop for ensuring expedite operation of eco-economic system

In the socioeconomic metabolic process, socioeconomic system extracts natural capital from nature and discharge wastes to the nature, which forms Ecological Footprint of socioeconomic development. Improvement of “feedback loop” system means less natural capital extracted from nature and less wastes discharged to the nature. This model of economic operation will increase the frequency and prolong the life of pathway of natural resources use and, reduce the intensity of natural capital consumption and quantity of discharged wastes, which inevitably will reduce the Ecological Footprint and increase the sustainability of socioeconomic development.

In China, the measures for improvement of feedback loop should be considered as follows:

(1) Develop circular agriculture at household level, within the agriculture sector. Organize the rural economic system into a feedback flow from Natural Resources to Products and Consumables to Renewable Resources.

(2) Develop circular industry and service industry on the business level and knit them into a web of industrial systems. Developing core eco-industry chain and core eco-industry park serves as the foundation for circular industry.

(3) At household, enterprise and city levels, wastes treatment and reuse industry should be upgraded. The integrated management system of wastes from disposal, collection, transportation, stockpile, reuse, and treatment steps should be formed.

(4) On the national level, incentive policies for circular economy should be encouraged. Such measures as improved pricing system, green account system, rational industrial pattern, and governmental approval and public supervision for clear production should be adopted.

3. Reduce: a strategy to reduce over consumption of resource for mitigating ecological backpack

The resource-reduced development strategy is to solve the rampant invisible loss and over-consumption of resources China is currently suffering from. Till today, the fossil resources are wasted on a large scale, for example, 2 tons of waste for 1 ton exacted resources. The average extraction rate for coal mines is only 30%, while for crude oil and natural gas, the extraction rates are 27% and 35% respectively. The unaccounted eco-burden is very high. For coal resources, lots of them are unselected or unwashed, wasting over 20% of transportation energy. China consumes over 4.5 million cubic meter of timber and 1.4 billion tons of water resources for wood packaging each year and consumes almost 2 million tons of metallic resources such as iron, aluminum, tin for metal packaging. The plastic packaging consumes 1.5% of the crude oil resources annually. The total losses incurred during crops harvesting, storage, transportation, processing, distribution and consumption amount to 18.7%. Over-consumption can also be found in inefficient conversion and use of energy during production.

The resource-reduced strategy mainly includes:

(1) Lower the volume of resources extracted and improve the extraction efficiency. The enrichment or the separation of the waste should happen close to the extraction site to reduce the consumption of energy during transportation, facilities running and human resources.

(2) During the resource processing and utilization, try to increase the circular feedback loop to improve the utilization efficiency of the raw materials.

(3) Reduce unnecessary packaging.

(4) Reduce the losses incurred during storage and transportation.

4. Increase: a strategy to increase land productivity for meeting the growing demands

With limited land resources, one fundamental way for China to balance the eco-deficit is to improve the eco-productivity per unit of land while stabilizing the stock of land resources.

From 1978-2004, for every 1 GJ final plantation products China consumes, the indirectly consumed fossil energy grows from 0.294 GJ to 0.469 GJ. For each 1 GJ animal and poultry products consumed, the indirectly consumed fossil energy grows from 1.045 GJ to 0.759 GJ. Unarguably, agriculture shows strong reliance on fossil energy. (see figure 11.2, 11.3), caused by the heavy use of fertilizer in plantation, which leads to unnecessary waste and brings negative impact to land, water resources and food safety. The future of Chinese agriculture lies in developing circular agriculture. Concrete measures to promote the agricultural productivity include:

(1) Maintain and raise the capacity of ecological service of forestland and pastureland to provide natural protection and increase capacity of risks prevention for water resources and agricultural system;

(2) Make use of high yield varieties (HYV) and increase irrigated land area and improve irrigation efficiency;

(3) Optimize the structure and amount of chemical fertilizer used and mitigate or eliminate unnecessary inputs of chemical fertilizers, and increase mechanic inputs in land management, crop management and crop harvest; and

(4) Rational agricultural structure and scientific field management.

5. Conservation: a strategy to promote resource-saving consumption as responsible global citizen

The resource saving should be a code of conduct for every global citizen to practice in the role as a producer and a consumer. Under the constraints of energy bottleneck, the primitive economic growth model is facing serious challenges. With urbanization process and the growing demand of consumption, conservation is one of the vital strategies for China to promote sustainable development. The most urgent needs are in the following categories:

(1)The use of land, especially arable land resources needs to be intensified

(2)Improve the utilization efficiency of water resources, especially water used for agriculture purposes and improve the reusability of industrial water as well as household water.

(3)Optimize the energy structure. Adopt energy efficient techniques and improve the overall efficiency of energy system; promote buildings of high energy efficiency to save energy and raw material consumption

(4)Cultivate a balanced diet. Promote the diet and life style that is not only healthy, but suitable for the sustainable development of ecology. It is recommendable to continue traditional Chinese diet structure centering on vegetable food

(5)Try to select the most environmentally friendly transportation means to lower the impact on environment

6. Diversity: a strategy to diversify Ecological Footprint for alleviating ecological deficit

Consumption of fossil energy is an important reason for the ever enlarging ecological deficit China and countries around the world are facing. Lower the fossil energy footprint, and improve biodiversity is an indispensable strategy for sustainable development. Diversifying the Ecological Footprint is closely related to other strategies such as improving the land productivity. Specific measures are:

(1) Improve energy utilization efficiency in each stage of energy life cycle;

(2) Adopt biomass energy technology to substitute fossil fuel energy;

(3) Adopt carbon capture technology.

In general, to launch the whole package of C-FRIED strategies, which in itself is mutually promoting, and mutually binding, will lower and balance China's demand for biocapacity for the next 10 years' rapid development; improve Nature's ability to provide biocapacity , and relieve the pressure posed by ecological deficit. The implementation of CFRICD approach will prompt China onto the sustainable development road with production growth, well being livelihood for her people and a sound ecological system.

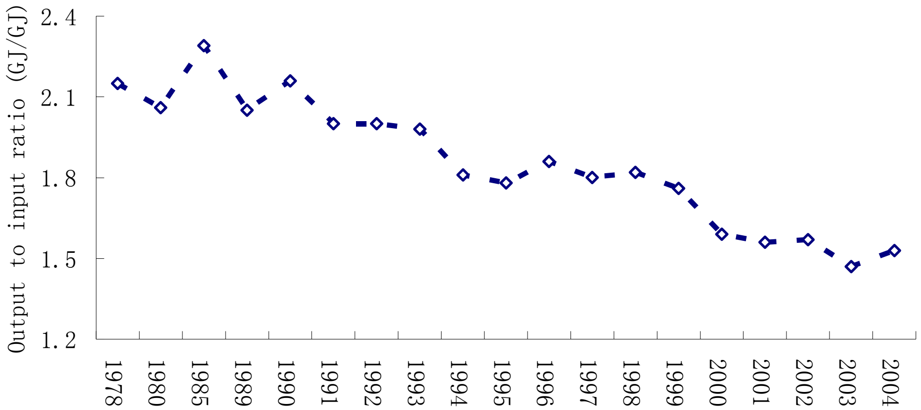


Fig. 11.2 **CHANGE OF ENERGY EFFICIENCY OF CHINA'S CROPPING INDUSTRY FROM 1978 TO 2004**

Energy efficiency drops down but the returns to the supplementary energy input is still positive. It is possible for the cropping industry to increase the input of supplementary energy, especially the direct or indirect fossil energy inputs to improve the productivity.

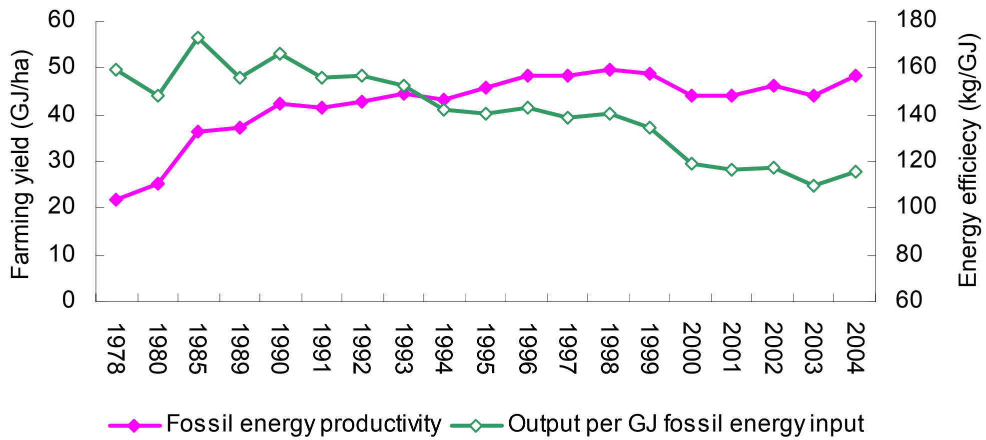


Fig. 11.3 **EFFECTS OF FOSSIL FUEL ENERGY ON LAND PRODUCTIVITY FROM 1978 TO 2004**

Though increase of fossil energy input still can boost agriculture productivity, the returns has dropped.

12 Technical Notes

What is included in the Ecological Footprint? What is excluded?

To avoid exaggerating human demand on nature, the Ecological Footprint includes only those aspects of resource consumption and waste production that are potentially sustainable, and for which there are data that allow this demand to be expressed in terms of the area required.

Since nature has no significant absorptive capacity for heavy metals, radioactive materials such as plutonium, or persistent synthetic compounds (e.g. chlordane, PCBs, CFCs, PVCs, dioxins), sustainability requires eliminating the release of such substances into the biosphere. Also, the impacts of many other waste flows are poorly captured by the present Ecological Footprint accounts. For example, accurate data on the reduction of biocapacity due to acid rain are not yet available, and so are not included in the accounts.

Water is addressed only indirectly in Ecological Footprint accounts. Overuse of freshwater affects present and future plant growth, reflected as changes in biocapacity. Further, the Ecological Footprint includes the energy needed to supply and treat water, and the area occupied by reservoirs.

Ecological Footprint accounts provide snapshots of past resource demand and availability. They do not predict the future. Thus, the Ecological Footprint does not estimate future losses caused by present degradation of ecosystems, be it soil salination or loss, deforestation, or destruction of fisheries through bottom trawling. These impacts will, however, be reflected in future Ecological Footprint accounts as a loss of biocapacity. Footprint accounts also do not indicate the intensity with which a biologically productive area is being used. Intensity can lead to degradation, but not always. For example, in China, yields of cultivated rice have remained stable for more than a thousand years. While the Ecological Footprint captures overall demand on the biosphere, it does not pinpoint specific biodiversity pressures. It only summarizes the overall risk biodiversity is facing. Lastly, the Ecological Footprint does not evaluate the social and economic implications of sustainability.

How is international trade taken into account?

The Ecological Footprint accounts calculate each country's net consumption by adding its imports to its production and subtracting its exports. This means that the resources used for producing a car that is manufactured in Japan, but sold and used in India, will contribute to the Indian, not the Japanese, footprint.

The resulting footprint of apparent consumption can be distorted, since the waste generated in making products for export is not fully documented. This can exaggerate the footprint of countries whose economies produce largely for export, and understate that of importing countries. While these misallocations may distort some national averages, they do not bias the overall global Ecological Footprint.

What is Overshoot?

Today, humanity uses about 30% more in one year than nature can regenerate in that same year. This is called "overshoot". An ecological overshoot of 30% means that it takes over one year and three months for the Earth to regenerate what is being used by people in one year. This overshoot accumulates over time to create a global ecological debt.

We currently maintain this overshoot by liquidating the planet's natural resources. For example we can cut trees faster than they re-grow, and catch fish at a rate faster than they repopulate. While this can be done for a short while, overshoot ultimately leads to the depletion of resources on which our economy depends.

Overshoot is like ecological overspending. Just as any business that does not keep financial books will go bankrupt over time, we must document whether we're living within our ecological budget or running an ecological debt that will eventually deplete our renewable assets.

Overshoot could be the biggest issue you've never heard of, yet its causes and effects are as simple as they are significant. For example, in any given year if we cut down trees faster than the forests can grow them back or catch more fish than the oceans can replenish, we begin liquidating the planet's assets. The consequences of our annual overshoot is an accumulating ecological debt, with consequences including global climate change, species extinction, insecure energy supplies, water shortages, and crop failure.

How does the Ecological Footprint account for fossil fuels?

The Ecological Footprint measures humanity's past and present demand on nature. Although fossil fuels such as coal, oil and natural gas are extracted from the Earth's crust and not regenerated in human timescales, their use still requires ecological services. Burning these fuels puts pressure on the biosphere through the release of greenhouse gases such as CO_2. The Ecological Footprint includes the biocapacity needed to sequester this CO_2, less the amount absorbed by the ocean. One global hectare can absorb the CO_2 released from consuming approximately 1,450 litres of gasoline in a year.

The fossil fuel footprint does not suggest that carbon sequestration is the key to resolving global warming. Rather, it points out the lack of ecological capacity for coping with excess CO_2 and underlines the importance of reducing CO_2 emissions. The sequestration rate used in Ecological Footprint calculations is based on an estimate of how much human-induced carbon emissions the world's forests can currently remove from the atmosphere and retain.

Energy efficiency or new renewable energy technologies, such as wind or solar, may be the most cost-effective way to reduce the energy footprint. As the Ecological Footprint measures the current state of resource demand and availability, however, these technologies are only included in the accounts according to their usage today, not their possible growth in the future.

13 Glossary

acre: One U.S. acre is equal to 0.405 hectares. For U.S. audiences, Footprint results are often presented in global acres (ga) , rather than global hectares. See global hectare, hectare, local hectare.

area type: see land type

biodiversity buffer : The amount of biocapacity set aside to maintain representative ecosystem types and viable populations of species. How much needs to be set aside depends on biodiversity management practices and the desired outcome.

biological capacity or biocapacity : The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. “Useful biological materials” are defined as those used by the human economy Hence what is considered “useful” can change from year to year (e.g. use of corn (maize) stover for cellulosic ethanol production would result in corn stover becoming a useful material, and so increase the biocapacity of maize cropland). The biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor. Biocapacity is usually expressed in units of global hectares.

biological capacity available per person (*or* per capita) : There were 11.2 billion hectares of biologically productive land and water on this planet in 2003. Dividing by the number of people alive in that year, 6.3 billion, gives 1.8 global hectares per person . This assumes that no land is set aside for other species that consume the same biological material as humans.

biologically productive land and water : The land and water (both marine and inland waters) area that supports significant photosynthetic activity and biomass accumulation used by humans. Non-productive areas as well as marginal areas with patchy vegetation are not included. Biomass that is not of use to humans is also not included. The total biologically productive area on land and water was approximately 11.2 billion hectares in 2003.

carbon Footprint : When used in Ecological Footprint studies, this term is synonymous with demand on CO_2 area. NOTE: The phrase “Carbon Footprint” or “carbon footprint” has been picked up in the climate change debate. There are several calculators that use the phrase “Carbon Footprint”, but many just calculate tonnes of carbon, or tonnes of carbon per euro, rather than demand on bioproductive area.

CO_2 area (also CO2 land) : The demand on biocapacity required to sequester (through photosynthesis) the carbon dioxide (CO_2) emissions from fossil fuel combustion. Although fossil fuels are extracted from the Earth's crust and are not regenerated in human time scales, their use demands ecological services if the resultant CO_2 is not to accumulate in the atmosphere. The Ecological Footprint therefore includes the biocapacity, typically that of unharvested forests, needed to absorb that fraction of fossil CO_2 that is not absorbed by the ocean.

consumption : Use of goods or of services. The term consumption has two different meanings, depending on context. As commonly used in regard to the Footprint, it refers to the use of goods or services. A consumed good or service embodies all the resources, including energy, necessary to provide it to the consumer. In full life-cycle accounting, everything used along the production chain is taken into account, including any losses along the way. For example, consumed food includes not only the plant or animal matter people eat or waste in the household, but also that lost during processing or harvest, as well as all the energy used to grow, harvest, process and transport the food.

As used in Input Output analysis, consumption has a strict technical meaning. Two types of consumption are distinguished: intermediate and final. According to (economic) System of National Accounts terminology, intermediate consumption refers to the use of goods and services by a business in providing goods and services to other businesses. Final consumption refers to non-productive use of goods and services by households, the government, the capital sector, and foreign entities.

consumption components (also consumption categories) : Ecological Footprint analyses can allocate total Footprint among consumption components, typically Food, Shelter, Mobility, Goods, and Services, often with further resolution into sub-components. Consistent categorization across studies allows for comparison of the Footprint of individual consumption components across regions, and the relative contribution of each category to the region's overall Footprint. To avoid double counting, it is important to make sure that consumables are allocated to only one component or sub-component. For example, a refrigerator might be included in the food, goods, or shelter component, but only in one.

consumption Footprint : The most commonly reported type of Ecological Footprint. It is the area used to support a defined population's consumption. The consumption Footprint (in gha) includes the area needed to produce the materials consumed and the area needed to absorb the waste. The consumption Footprint of a nation is calculated in the National Footprint Accounts as a nation's primary production Footprint plus the Footprint of imports minus the Footprint of exports, and is thus, strictly speaking, a Footprint of apparent consumption. The national average or per capita Consumption Footprint is equal to a country's Consumption Footprint divided by its population.

Consumption Land Use Matrix : Starting with data from the National Footprint Accounts, a Consumption Land Use Matrix allocates the six major Footprint land uses (shown in column headings, representing the five land types and CO_2 area) to the five Footprint consumption components (row headings). Each consumption component can be disaggregated further to display additional information. These matrices are often used as a tool to develop sub-national (e.g. state, county, city) Footprint assessments. In this case, national data for each cell is scaled up or down depending on the unique consumption patterns in the state, county or city.

conversion factor : A generic term for factors which are used to translate a material flow expressed within one measurement system into another one. For example, a combination of two conversion factors—"yield factors" and "equivalence factors"— translates hectares into global hectares. The extraction rate conversion factor translates a secondary product into primary product equivalents.

Conversion Factor Library : See Footprint Intensity Table.

daughter product : The product resulting from the processing of a parent product. For example wood pulp, a secondary product, is a daughter product of roundwood. Similarly, paper is a daughter product of wood pulp.

double counting : In order not to exaggerate human demand on nature, Footprint Accounting avoids double counting, or counting the same Footprint area more than once. Double counting errors may arise in several ways. For example, when adding the Ecological Footprints in a production chain (e.g., wheat farm, flour mill, and bakery), the study must count the cropland for growing wheat only once to avoid double counting. Similar, but smaller, errors can arise in analyzing a production chain because the end product is used in produce the raw materials used to make the end product (e.g. steel is used in trucks and earthmoving equipment used to mine the iron or that is made into the steel). Finally, when land serves two purposes (e.g. a farmer harvests a crop of winter wheat and then plants corn to harvest in the fall), it is important not to count the land area twice. Instead, the yield factor is adjusted to reflect the higher bioproductivity of the double-cropped land.

Ecological debt : Since the mid-1980s, when human demand on biocapacity first exceeded the available biocapacity, mankind has been in condition of overshoot, with its Footprint each year exceeding the planet's biocapacity. By demanding more than the biocapacity can supply, humanity is accruing an ecological debt. This debt is the sum of all the annual deficits.

ecological deficit / reserve : The difference between the biocapacity and Ecological Footprint of a region or country. An ecological deficit occurs when the Footprint of a population exceeds the biocapacity of the area available to that population. Conversely, an ecological reserve exists when the biocapacity of a region exceeds its population's Footprint. If there is a regional or national ecological deficit, it means that the region is either importing biocapacity through trade or liquidating regional ecological assets. In contrast, the global ecological deficit cannot be compensated through trade, and is therefore equal to overshoot.

Ecological Footprint : A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country's Footprint includes land or sea from all over in the world. Ecological Footprint is often referred to in short form as Footprint (not footprint).

ecological reserve : See ecological deficit / reserve.

embodied energy : Embodied energy is the energy used during a product's entire life cycle in order to manufacture, transport, use and dispose of the product. Footprint studies often use embodied energy when tracking trade of goods.

energy Footprint : The sum of all areas used to provide non-food and non-feed energy . It is the sum of CO2 area, hydropower land, forest for fuelwood, crop land for fuel crops, and area for nuclear energy.

equivalence factor : A productivity based scaling factor that converts a specific land type (such as cropland or forest) into a universal unit of biologically productive area, a global hectare. For land types (e.g., cropland) with productivity higher than the average productivity of all biologically productive land and water area on Earth, the equivalence factor is greater than 1. Thus, to convert an average hectare of cropland to global hectares, it is multiplied by the cropland equivalence factor of 2.21. Pasture lands, which have lower productivity than cropland, have an equivalence factor of 0.48. See also yield factor.

extraction rate : A processing factor comparing the quantity of a parent product to the quantity of the resulting daughter product. When a parent product is processed its mass changes. For example, when wheat is processed into white flour, the bran and germ are stripped lessening its mass. Therefore, in order to

calculate the number of hectares needed to produce a given mass of flour, an extraction rate is needed. This extraction rate in this example is the ratio of tonnes of flour divided by the tonnes of wheat processed to produce the flour.

Footprint Intensity : The number of global hectares required to produce a given quantity of resource or absorb a given quantity of waste, usually expressed as global hectares per tonne. The National Footprint Accounts calculate a primary Footprint Intensity Table for each country, which includes the global hectares of primary land use type needed to produce or absorb a tonne of product (i.e., global hectares of cropland per tonne of wheat, global hectares of forest per tonne carbon dioxide)."

Footprint Intensity Table : A collection ofthe primaryand secondary product Footprint intensities from the National Footprint Accounts. Footprint intensity is usually measured in gha per tonne of product or waste (CO_2). The Footprint Intensity Table is maintained by Global Footprint Network, supported by the Network's National Accounts Committee.

Footprint neutral or negative : Human activities or services that result in no increase or a net reduction in humanity's Ecological Footprint . For example, the activity of insulating an existing house has a Footprint for production and installation of the insulation materials. This insulation in turn reduces the energy needed for cooling and heating this existing house. If the Footprint reduction from this energy cutback is equal to or greater than the original Footprint of insulating the house, the latter becomes a Footprint neutral or negative activity. On the other hand, making a new house highly energy efficient does not by itself make the house Footprint neutral, unless at the same time it causes reduction in other existing Footprints. This Footprint reduction has to be larger than the Footprint of building and occupying the new house.

global hectare (gha) : A productivity weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of biologically productive land and water in a given year. Because different land types have different productivity, a global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world bioproductivity varies slightly from year to year, the value of a gha may change slightly from year to year.

Guidelines (for Footprint studies) : Suggested criteria governing methods, data sources and reporting for use when Footprint Standards are not appropriate or not yet developed.

hectare : 1/100th of a square kilometre, 10,000 square meters, or 2.471 acres. A hectare is approximately the size of a soccer field. See also global hectare and local hectare

IO (Input-Output) analysis : Input-Output (IO, also I-O) analysis is a mathematical tool widely used in economics to analyze the flows of goods and services between sectors in an economy, using data from IO tables**.** IO analysis assumes that everything produced by one industry is consumed either by other industries or by final consumers, and that these consumption flows can be tracked. If the relevant data are available, IO analyses can be used to track both physical and financial flows. Combined economic-environment models use IO analysis to trace the direct and indirect environmental impacts of industrial activities along production chains, or to assign these impacts to final demand categories. In Footprint studies, IO analysis can be used to apportion Footprints among production activities, or among categories of final demand, as well as in developing Consumption Land Use Matrices .

IO (Input-Output) tables : IO tables contain the data that are used in IO analysis. They provide a comprehensive picture of the flows of goods and services in an economy for a given year. In its general form an economic IO table shows *uses*--the purchases made by each sector of the economy in order to produce their own output, including purchases of imported commodities; and *supplies*--goods and services produced for intermediate and final domestic consumption, and exports. IO tables often serve as the basis for the economic National Accounts produced by national statistical offices. They are also used to generate annual accounts of the Gross Domestic Product (GDP).

land type : The Earth's approximately 11.2 billion hectares of biologically productive land and water are categorized into five types of surface area: cropland, grazing land, forest, fishing ground, and built-up land. Also called "area type."

life cycle analysis (LCA) : A quantitative approach that assess a product's impact on the environment throughout its life. LCA attempts to quantify what comes in and what goes out of a product from "cradle to grave," including the energy and material associated with materials extraction, product manufacture and assembly, distribution, use and disposal and the environmental emissions that result. LCA applications are governed by the ISO 14040 series of standards (http://www.iso.org).

local hectare : A productivity weighted area used to report both the biocapacity of a local region, and the demand on biocapacity (the Ecological Footprint). The local hectare is normalized to the area-weighted average productivity of the specified region's biologically productive land and water. Hence, similar to currency conversions, Ecological Footprint calculations expressed in global hectares can be converted into local hectares in any given year (e.g., Danish hectares, Indonesian hectares) and vice versa. The amount of Danish hectares equals the amount of bioproductive hectares in Denmark – each Danish hectare would represent an equal share of Denmark's total biocapacity.

National Footprint Accounts : The central data set that calculates the Footprints and biocapacities of the world and roughly 150 nations from 1961 to the present (generally with a three year lag due to data availability). The ongoing development, maintenance and upgrades of the National Footprint Accounts are coordinated by Global Footprint Network and its 70 plus partners.

natural capital : Natural capital can be defined as all of the raw materials and natural cycles on Earth. Footprint analysis considers one key component, *life supporting* natural capital, or ecological capital for short. This capital is defined as the stock of living ecological assets that yield goods and services on a continuous basis. Main functions include resource production (such as fish, timber or cereals), waste assimilation (such as CO_2 absorption or sewage decomposition) and life support services (such as UV protection, biodiversity, water cleansing or climate stability).

nuclear Footprint : The Footprint of electricity generated by nuclear power is treated as equivalent, per kilowatt, to the world average Footprint of fossil-fuel derived electricity. As of 2003, the nuclear Footprint is approximately 8% of the total carbon Footprint. This assumption is a placeholder, which is currently under review, and may be subject to change in a future Edition of the National Footprint Accounts.

overshoot : Global overshoot occurs when humanity's demand on nature exceeds the biosphere's supply, or regenerative capacity. Such overshoot leads to a depletion of Earth's life supporting natural capital and a build up of waste. At the global level, ecological deficit and overshoot are the same, since there is no net-import of resources to the planet. Local overshoot occurs when a local ecosystem is exploited more rapidly than it can renew itself.

parent product : The product processed to create a daughter product. For example wheat, a primary product, is a parent product of flour, a secondary product. Flour, in turn, is a parent product of bread.

Planet Equivalent(s) : Every individual and country's Ecological Footprint has a corresponding Planet Equivalent, or the number of Earths it would take to support humanity's Footprint if everyone lived like that individual or average citizen of a given country. It is the ratio of an individual's (or country's per capita) Footprint to the per capita biological capacity available on Earth (1.8 gha in 2003). In 2003, the world average Ecological Footprint of 2.23 gha equals 1.26 Planet Equivalents.

primary product : In Footprint Studies a primary product is the least processed form of a biological material that humans harvest for use. There is a difference between the raw product, which is all the biomass produced in a given area, and the primary product, which is the biological material humans will harvest and use. For example, a fallen tree is a raw product that, when stripped of its leaves and bark, results in the primary product of roundwood. Primary products are then processed to produce secondary products like wood pulp, paper, and so on. Other examples of primary products are potatoes, cereals, cotton, or forage. Examples of secondary products are kWh of electricity, bread, clothes, beef, or appliances.

primary production Footprint (also primary demand) : In contrast to the consumption Footprint, a nation's primary production Footprint is the sum of the Footprints for all of the resources harvested and all of the waste generated within the defined geographical region. This includes all the area within a country necessary for supporting the actual harvest of primary products (cropland, pasture land, forestland and fishing grounds), the country's built-up area (roads, factories, cities), and the area needed to absorb all fossil fuel carbon emissions generated within the country. In other words, the forest Footprint represents the area necessary to regenerate all the timber harvested (hence, depending on harvest rates, this area can be bigger or smaller than the forest area that exists within the country). Or, for example, if a country grows cotton for export, the ecological resources required are not included in that country's consumption Footprint; rather, they are included in the consumption Footprint of the country that imports the t-shirts. However, these ecological resources *are* included in the exporting country's primary production Footprint.

productivity : The amount of biological material useful to humans that is generated in a given area. In agriculture, productivity is called yield.

secondary product : All products derived from primary products or other secondary products through a processing sequence applied to a primary product.

Ecological Footprint Standards : Specified criteria governing methods, data sources and reporting to be used in Footprint studies. Standards are established by the Global Footprint Net work Standards Committees composed of scientists and Footprint practitioners from around the world. Standards serve to produce transparent, reliable and mutually comparable results in studies done throughout the Footprint Community. Where Standards are not appropriate, Footprint Guidelines should be consulted. For more information, consult www.footprintstandards.org.

tonnes : All figures in the National Footprint Accounts are reported in metric tonnes. One metric tonne equals 1000 kg, or 2205 lbs.

yield : The amount of primary product, usually reported in tonnes per year, that humans are able to extract per area unit of biologically productive land or water.

yield factor : A factor that accounts for differences between countries in productivity of a given land type. Each country and each year has yield factors for cropland, grazing land, forest, and fisheries. For example, in 2002, German cropland was 2.5 times more productive than world average cropland. The German cropland yield factor of 2.5, multiplied by the cropland equivalence factor of 2.2 converts German cropland hectares into global hectares: one hectare of cropland is equal to 5.5 gha.

Note that primary product and primary production Footprint are Footprint specific terms. They are not related to, and should not be confused with. the ecological concepts of primary production, gross primary productivity (GPP) and net primary productivity (NPP).