Chapter 10

The Environment and Development

Economic Development

11th Edition

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Green mountains and clear waters are as valuable as gold and silver mountains.

Nanjing, Guangxi

10.1 Environment and Development: The Basic Issues

- Environmental issues affect, and are affected by, economic development
- Classic market failures lead to too much environmental degradation 恶化
- Poverty and lack of education may also lead to non-sustainable use of environmental resources
- Global warming and attendant 伴随的 climate change is a growing concern in developing countries

10.1 Environment and Development: The Basic Issues

- Sustainable development and environmental accounting
- Population, resources, and the environment
- Poverty and the environment
- Growth versus the environment?
- Rural development and the environment

10.1 Environment and Development: The Basic Issues

- Urban development and the environment
- The global environment and economy
- Nature and pace of Greenhouse Gas-Induced Climate change
- Natural Resource-Based Livelihoods as a pathway out of poverty: Promise and Limitations

10.1 Environment and Development: The Basic Issues

- Sustainable development has been defined as "meeting the needs of present generation without compromising the wellbeing of future generations"

- So, running down the capital stock is not consistent with the idea of sustainability

- Environmental and other forms of capital are substitutes only to a degree; eventually they likely act as complements

  - Manufactured capital: machines, factories, roads

  - Human capital: knowledge, experience, skills

  - Environmental capital: forests, soil quality, rangeland 牧场

10.1 Environment and Development: The Basic Issues

- In developing countries, environmental capital is generally a larger fraction of total capital
- To know whether environmental capital is increasing or decreasing, we need environmental accounting
  - Definition: the incorporation of environmental benefits and costs into the quantitative analysis of economic activities.

10.1 Environment and Development: The Basic Issues

Sustainable net national product is:

$$NNI^* = GNI - D_m - D_n$$

可持续国民收入

where   *NNI**   is sustainable national income

           GNI   is Gross national income

           D_m is the depreciation of manufactured capital assets   生产性资本折旧

           $D_{n.}$ is the depreciation of environmental capital   环境资本折旧

10.1 Environment and Development: The Basic Issues

More expansively, sustainable net national product is:

$$NNI^{**} = GNI - D_m - D_n - R - A$$

Where

NNI** is the revised NNI calculation

GNI, D_m, and D_n are defined as before

R   is expenditure needed to restore environmental capital   恢复环境支出

A   is expenditure required to avert destruction of environmental capital   防止环境支出

(Note: R and A are components of GNI but not NNI**)

The poor as both agents and victims of environmental degradation

- Victims: 穷人住在环境差的地区，土地污染
    - The poor live in environmentally degraded lands which are less expensive because the rich avoid them
    - People living in poverty have less political clout 影响力 to reduce pollution where they live
    - Living in less productive polluted lands gives the poor less opportunity to work their way out of poverty

- Agents: 贫困人口高生育率
    - The high fertility rate of people living in poverty
    - Short time horizon of the poor (by necessity) 人生短
    - Land tenure insecurity
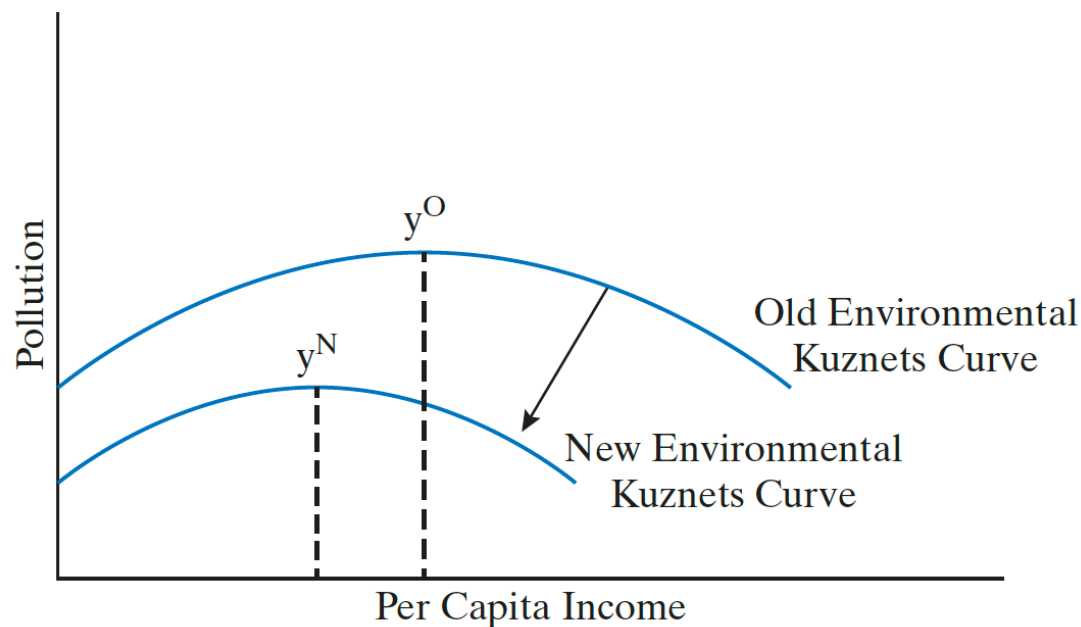   - Incentives for rainforest resettlement 雨林再生

10.1 Environment and Development: The Basic Issues

- Natural resource based livelihoods are at risk
- The Scope of Domestic-Origin Environmental Degradation: An Overview
- Environmental problems have consequences both for health and productivity
  - Loss of agricultural productivity
  - Prevalence of unsanitary conditions created by lack of clean water and sanitation
  - Dependence on biomass fuels 有机燃料 and pollution
  - Airborne pollutants 空气污染物

Figure 10.1 Hypothetical Income-Pollution Relationship: Environmental Kuznets Curves

- Environmental Kuznets curve: pollution would first rise and then fall as incomes increased.
- More effective environmental policies can shift the pollution curve downward.

10.2 Global Warming and Climate Change: Scope, Migration, and Adaptation

- The benchmark 2007 IPCC report paints a dire 可怕的 picture for developing economies
- Recent reports amplify:
  - Summary in World Bank 2009 *World Development Report*
  - Using data not yet available to IPCC report, the 2010 U.S. NOAA study found evidence of global warming due to greenhouse gases on all 11 indicators examined
- Impact of global warming likely hardest on the poorest
- Agriculture harmed in tropical and subtropical areas
- Resultant conflicts over natural resources may grow
- Range of adverse health impacts

Some impacts of climate change in Developing Countries identified by IPCC

- prolonged droughts 干旱, expanded desertification 沙漠化
- increased severity 严重性 of storms with heavy flooding and erosion 侵蚀
- longer and more severe heat waves
- reduced summer river flow and water shortages
- decreased grain yields
- climate-induced spreading ranges of pests and disease
- lost and contaminated 受污染的 groundwater
- deteriorated 恶化的 freshwater lakes, coastal fisheries 渔业, mangroves 红树林, coral reefs 珊瑚礁
- coastal flooding
- loss of essential species such as pollinators 传粉者 and soil organisms 微生物
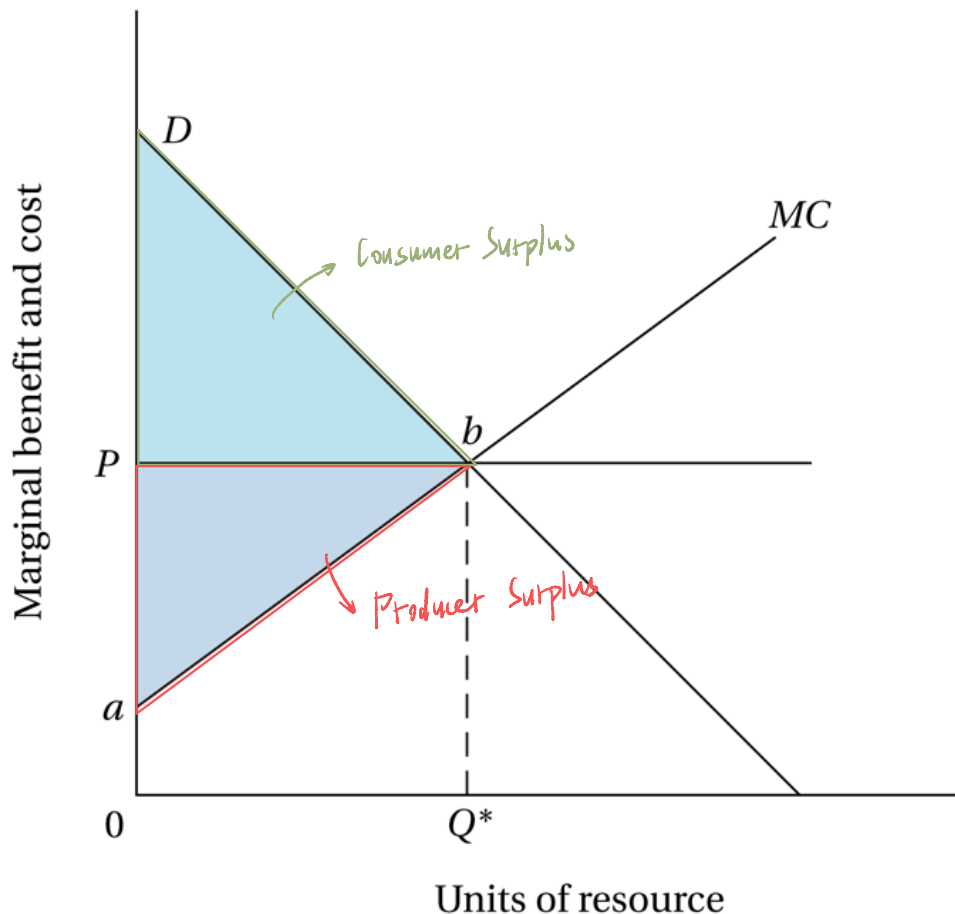- forest and crop fires

10.2 Global Warming and Climate Change: Scope, Mitigation, and Adaptation

- Problem primarily but not exclusively caused by developed countries
  - Rapid industrial growth especially in Asia
  - Deforestation in developing countries
- Strategies for mitigation 缓解
  - Taxes on carbons
  - Caps on greenhouse gases (with "carbon markets")
  - Subsidies to encourage technological progress
- Types of adaptation 适应
  - Planned (or "policy") adaptation
  - Autonomous adaptation (some types are reviewed in Box 10.1)

10.3 Economic Models of Environment Issues

- Privately owned resources
- Common property resources
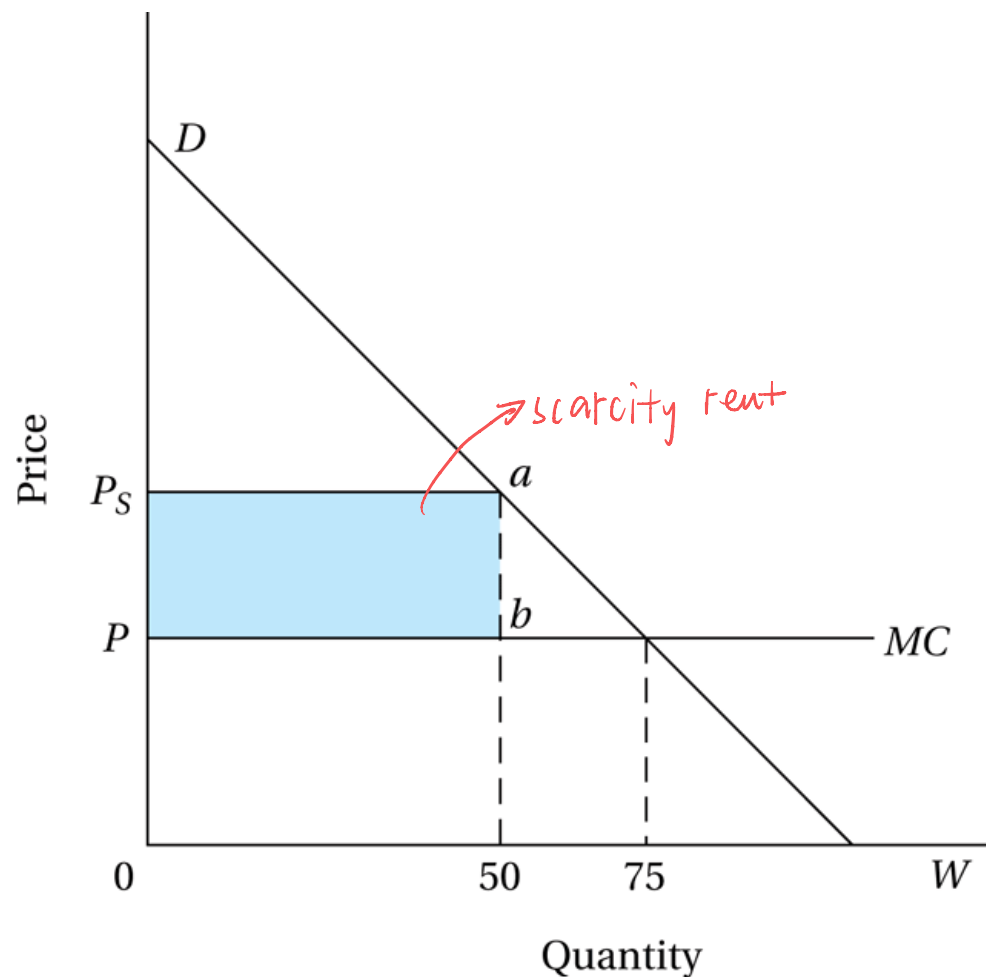- Public goods and bads

10.3.1 Privately Owned Resources

- Figure 10.2 Static Efficiency in Resource Allocation demonstrates how the market determines the optimal consumption of a natural resource.

- MC curve is upward-sloping because extraction costs increase as a resource becomes more scarce.

- Total net benefit 总净收益 is maximized when marginal cost = marginal benefit
  - The sum of net benefits to all consumers.
- In perfect competition, Q*
- Producer surplus is area aPb
  - Excess of what a producer of a good receives and the minimum amount the producer would be willing to accept because of a positive-sloping marginal cost curve.
- Consumer surplus is area DPb
  - Excess utility over price derived by consumers because of a negative-sloping demand curve.
- Total net benefit: the shaded area

Allocational efficiency 分配效率

- Equate present value of marginal net benefits of last unit consumed in each period
  - PV: the discounted value at the present time of a sum of money to be received in the future.
  - MNB: The benefit derived from the last unit of a good minus its cost.
- That is, for allocational efficiency, consumer must be indifferent between consuming last unit in this period or in another period.
- In the absence of scarcity, all of the resource will be sold at the extraction cost P=MC, 75 units will be consumed at one time, and no rent will be collected.

Figure 10.3 Optimal Resource Allocation over Time

- If resources are scarce and are rationed over time, scarcity rents may arise; these may obtain even when the marginal cost of production is constant.
  - Definition: the premium or additional rent charged for the use of a resource or good that is in fixed or limited supply.
- The owner of a scarce resource has a finite volume of a resource X to sell (75 units)
- If he or she is willing to offer only 50 units today, market price for scarce resource is P_s.
- The scarcity rent collected is $P_s$abP
- It is the owner's ability to collect this rent that creates the rationing effect to ensure the efficient allocation of resources over time.

- Inefficiencies result from imperfections in property rights 低效率在于产权不完善.
- Perfect property rights are characterized by
  - 普遍性 – Universality – all resources are privately owned
  - 排他性 – Exclusivity or Excludability - it must be possible to prevent others from benefiting from a privately owned resource
  - 可转移性 – Transferability – the owner of a resource may sell the resource when desired
  - 可执行性 – Enforceability – the intended market distribution of the benefits from resources must be enforceable
- If the foregoing conditions are not met simultaneously, inefficiencies are likely to arise.
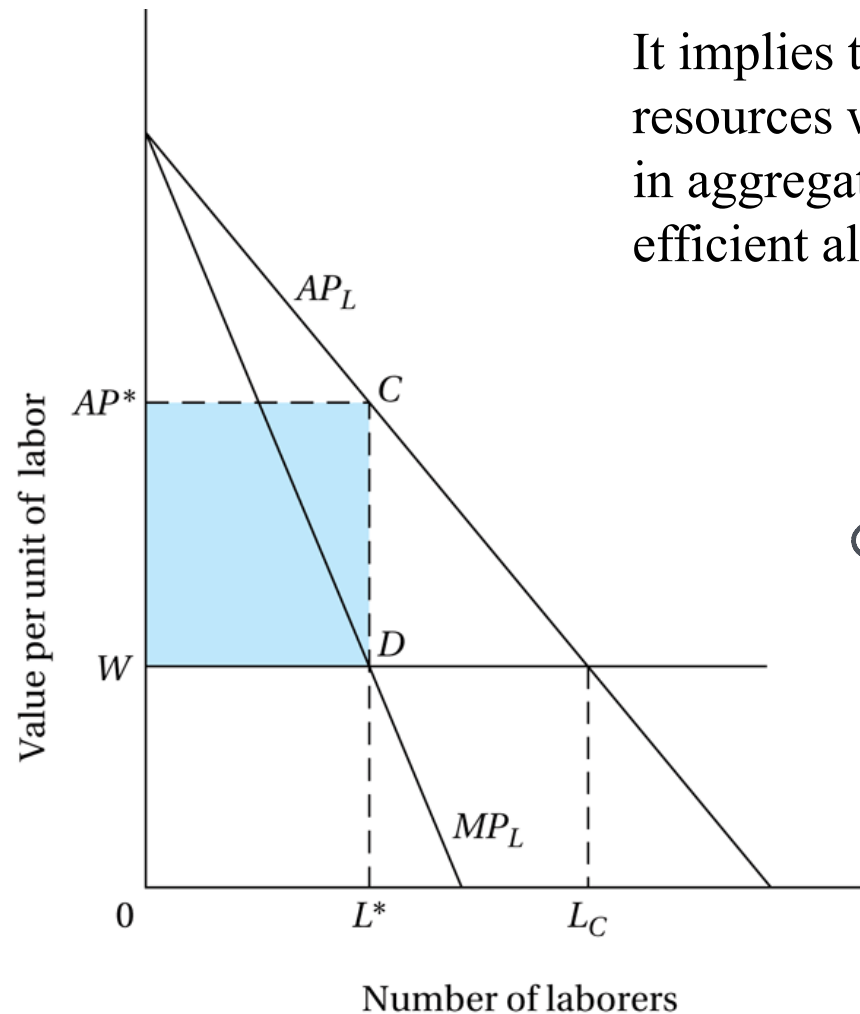
10.3.2 Common Property Resources

公共物品

公共财产资源:

- Common property resources: a resource that is collectively or publicly owned and allocated under a system of unrestricted access, or as self-regulated by users.

- Inefficiencies may arise because resource is not privately owned

- Traditional models do not concern themselves with equity and income distribution

- Family farmers can benefit from extended tenancy or ownership

- Who should buy publicly owned land

Figure 10.4 Common Property Resources and Misallocation

It implies that privatization of resources will lead to an increase in aggregate welfare and an efficient allocation of resources.

① private: $MP_L = MC = W.$

$$L = L^*$$

scarcity rent : $AP^* - WDC$

② common: $AP_L = MC = W.$

$$L = L_C$$

$L\uparrow, MP_L\downarrow, MP_L < W.$

- Figure 10.4 describes the relationship between the value per unit of labor on a given piece of land and the number of laborers cultivating it.
- Suppose that this piece of land is privately held.
- The landowner will hire additional labor to work the land until MP of the last worker is equal to the market wage, W, at point L*.
- The workload is shared equally among employees, each of whom produces the *average* product.
- By decreasing returns to labor, each new worker hired reduces the *average* product of all workers.
- MP of each additional worker is thus equal to his *average* product minus the decrease in the average product across all other workers.

- If an additional employee is hired beyond L*, his cost to the producer, W, will be greater than his marginal product, and the difference will represent a net loss to the landowner.
- A profit maximizer will thus hire L* workers, with a total output equal to average product AP* multiplied by the number of workers, L*.
- Scarcity rents collected by the landowner: AP*CDW

- If land is commonly owned, each worker is able to appropriate（侵吞）the entire product of his work, which is equal to the average product of all workers
- Worker income will continue to exceed the wage until enough workers are attracted so that the average product falls to W, and the labor force equals L_C
- Though total output may either rise or fall (depend on positive or negative MP_L), $MP_L < W$
- Since all workers could be employed elsewhere with productivity equal to or greater than W, it follows that social welfare must fall when $MP_L < W$
- This situation is referred to as the "tragedy of the commons." 公有地悲剧
- No scarcity rent is collected at L_C

Understanding the tragedy of the Commons

- Users fail to take account of an externality: that as each uses more of the common resource the average return is lowered for other users

- Traditional societies have sometimes responded effectively with social enforcement mechanisms
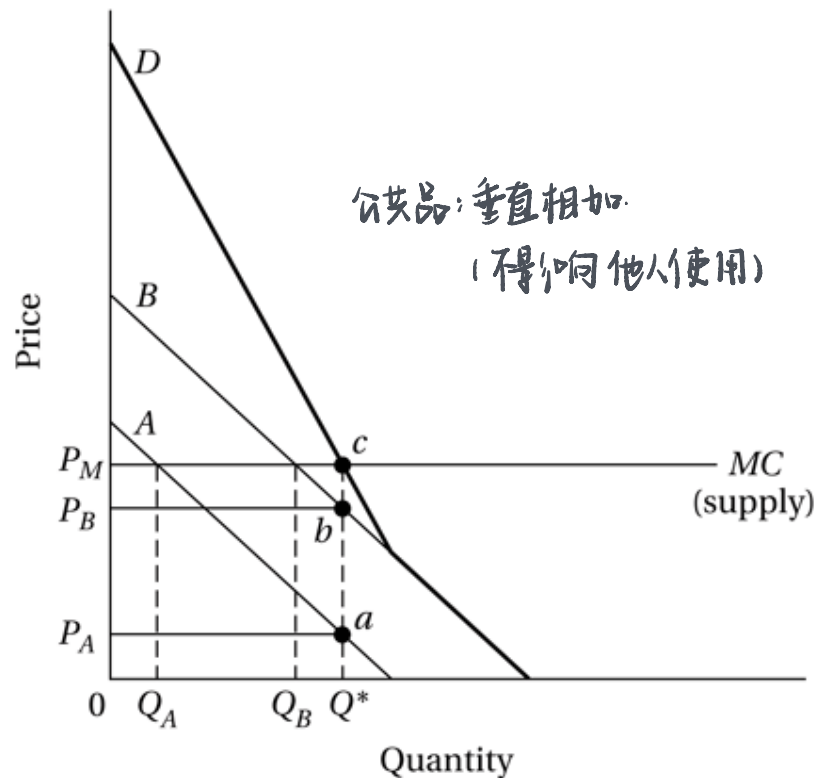
- Reviewed in Box 10.2

10.3.3 Public Goods and Bads

- Public goods and bads: regional environmental degradation and the free-rider problem
  - Public good: anything that provides a benefit to everyone and the availability of which is in no way diminished by its simultaneous enjoyment by others
  - Public bad: any product or condition that decrease the well-being of others in a nonexhaustive manner
  - Internalization 内部化 of externalities is not easy
  - Free rider problems
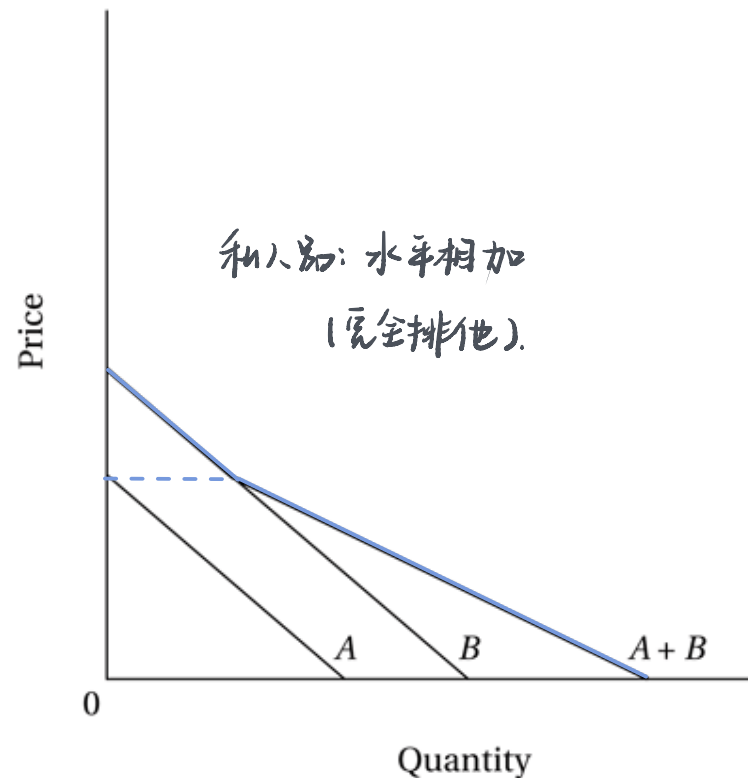- Limitations of the public goods framework
  - Pricing mechanism

- Consider the case of regional environmental degradation caused by deforestation 森林砍伐

- Aggregate demand for the public resource is determined by summing individual demand curves vertically, to capture all benefits accruing to all individuals from each unit of a public good

- The marginal cost associated with the preservation of an additional tree is equal to the forestry maintenance cost plus the opportunity cost of the tree

- The socially optimal number of trees is Q*
- Total net benefits to society from the public good $P_M Dc$ are maximized
- Internalization of externalities is not easy
- Free rider problems: individuals enjoy the benefits of trees provided by others
- At a price of P_M, the free market will satisfy person B's demand Q_B, while not denying person A's requirement of Q_A; A can free ride on B
- The market provide a suboptimal level Q_B
- The most effective solution is to charge each consumer just enough per unit, P_A and P_B
- The joint payments $P_A * Q* + P_B * Q* = P_M * Q*$, exactly the sum required to purchase the socially optimal level of preservation

Figure 10.5 Public Goods, Private Goods, and the Free-Rider Problem

公共品: 垂直相加.
　　　(不影响他人使用)

私人品: 水平相加
　　　(完全排他).

(a) Public good (vertical summation)

(b) Private good (horizontal summation)

10.4 Urban Development and the Environment

- Environmental Problems of Urban Slums
  - Health threatening pollutants
  - Unsanitary environmental conditions
  - Serious impact on poor
- Industrialization and urban air pollution
  - Environmental Kuznets curve (see Figure 10.1)
  - Pollution tax: a tax levied on the quantity of pollutants released into the physical environment.
  - Absorptive capacity of the environment
  - Severity of industrial pollution- impact on health

- S=MC_P represents the marginal private costs, making free-market equilibrium Q_M and P_M
- Legislate a $2-per-unit pollution tax to shift up to the marginal social cost curve MC_S
- The actual output of the pollution product is reduced to the socially optimal level while the price charged to the consumer rises to P* and the price received by the producer falls to P_C
- The consumer pays *ab* and the producer pays *bc*

Figure 10.6 Pollution Externalities: Private versus Social Costs and the Role of Taxation

- Human have some tolerance for most toxins, although the ability to tolerate exposure may rapidly decline as concentrations in drinking water and air increase.

- As concentrations of pollutants increase, the gap between the social and private cost curves increases.

- The demand curve shifts outward with rapid urbanization and rising incomes, the importance of externalities rises at an increasing rate.

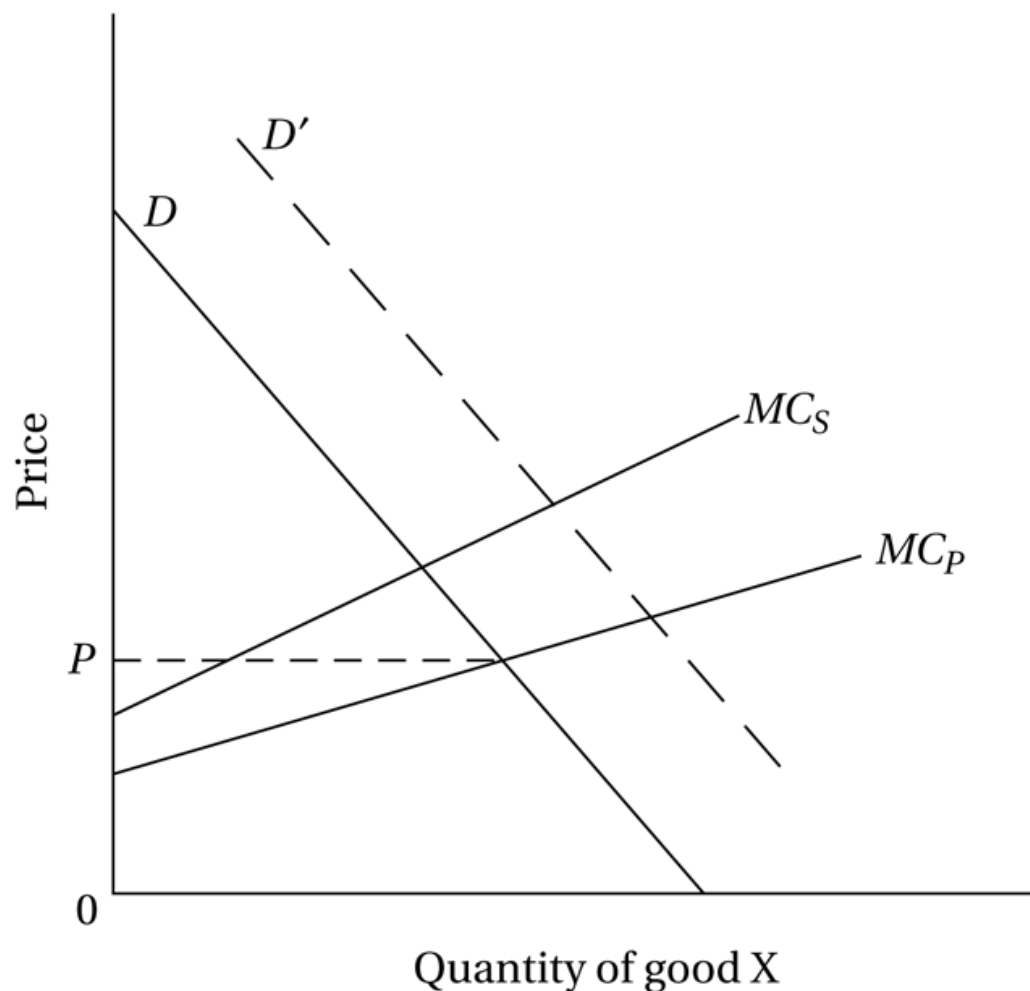# **Figure 10.7** Increasing Pollution Externalities with Economic Growth

Figure 10.8 The Earth at Night, Reflecting Inequality of Energy Use across High-, Middle-, and Low-Income Countries; and Concentration of Economic Activity along Seacoasts

Craig Mayhew and Robert Simmon, NASA GSFC

10.4 Urban Development and the Environment (cont'd)

- Problems of congestion, clean water, and sanitation
  - High health and economic costs associated with environmental degradation
  - Drag on development
  - Impact on poor
  - Private wells have led to land subsidence and flooding
  - Impact on export earnings

10.5 The Local and Global Costs of Rain Forest Destruction

- Rainforest loss contributes to global warming
- Loss of biodiversity
- Loss of livelihoods for people living in poverty who depend upon them
- Much waste in the process of forest clearing
- Thus, rainforest preservation (and restoration) is a global public good - a restorative mechanism for the environment
- Sustainable management of rain forests is a priority
- Provide funds, debt relief to help enhance biodiversity
- In addition, support for forest preservation as climate change mitigation

10.6 Policy Options in Developing and Developed Countries

- ## What Developing Countries can do
  - Proper resource pricing
  - Community involvement
  - Clearer property rights and resource ownership
  - Improved economic alternatives for the poor
  - Improved economic status of women
  - Investments that yield returns regardless of the shape of climate change, such as a better road network
  - Industrial emissions abatement policies
  - Proactive stance toward adapting to climate change

10.6 Policy Options in Developing and Developed Countries (cont'd)

- How developed countries can help developing countries
  - Lower developing country costs for environmental preservation
  - Trade policies: reduce barriers, subsidies
  - Debt relief and debt for nature swaps
  - Development assistance

10.6 Policy Options in Developing and Developed Countries (cont'd)

- What developed countries can do for the global environment
  - Emissions controls, including greenhouse gases
  - Research and Development on green technology and pollution control
  - Transfer of technology to developing countries
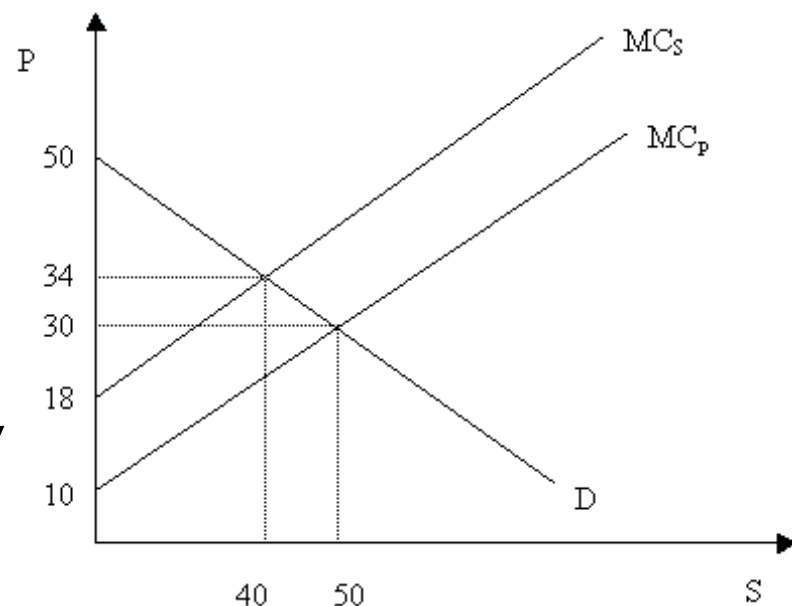 - Restrictions on unsustainable production

- *Exercise:* Graph the following supply and demand curve:
  Supply: $P = 10 + 0.4Q$
  Demand: $P = 50 - 0.4Q$

  - What is the equilibrium price and quantity?

  - Suppose production of the good in question creates a negative externality equal to $8 per unit. Draw a new supply curve that represents the marginal cost to society. What is the socially optimal price and quantity?

  - From your graph in question 3, calculate the net benefit to society if the government imposes a pollution tax of $8 per unit. Is this figure (net benefit to society) higher or lower than what would result if the government took no action?

Answer:

a) $P* = 10 + 0.4Q* = 50 - 0.4Q*$,
   so $P* = 30$, $Q* = 50$

b) $P*_S = 10 + 0.4Q*_S + 8 = 50 - 0.4Q*_S$,
   so $P*_S = 34$, $Q*_S = 40$

c) $NB = .5 * (50 - 18) * 40 = 640$.
   If no pollution tax were to be imposed, net benefit would
   be lower since for each unit above 40 social marginal
   cost exceeds marginal benefit (demand).

Note: Net benefit is the difference between marginal
benefit (demand curve) and marginal cost curve.

1. A pollution tax
A. leads to lower production levels
B. has no effect on the polluter's private cost curve.
C. ignores the social costs of pollution.
D. shifts down the polluter's private cost curve.

2. A good that provides a benefit to everyone and the availability of which isn't diminished by its simultaneous enjoyment by others is called a
A. public bad.
B. positive externality.
C. free-market good.
D. public good.