Theories and Practices of Sustainable Development (TPSD)

2nd lecture

28-February-2026

Summary:

What is sustainable development?

- second, What is sustainability?

1. Multiple (old and new) meanings for sustainability
2. Economy and environment: economic circuit and GDP; materials and energy flows
3. Scale and sustainability: Kenneth Boulding's spaceship earth
4. Is there a real sustainability problem (today)? Environmental Kuznets curves: growth, technology, institutions, policies and the environment
5. The illusion of preservation: markets and global environmental impact
6. Decoupling and sustainability

What is sustainability?

Multiple (old and new) meanings for sustainability

- Sustainable forest management (German foresters, 19th century);
- the concept of income (John Hicks, 1950s)
- overshoot and collapse (The Limits to Growth, 1972)
- market failure, public intervention and the resulting cost-benefit *trade offs* (Pigou, 1920)
- a new environment-competitiveness relationship (Porter et al 1994) – the *no-trade-off hypothesis*
- Poverty and environmental degradation (Brudtland report)

Multiple (old and new) meanings for sustainability

- environmental policy and sustainable development – integration of the environment and SD in sectoral policies (Rio 1992; Cardiff process, U.E. 1998);
- integration of the environment and SD in all other decision-making systems (local decision-makers, firms, consumers …)
- Sustainability, public access to information and public participation (governance, Aarhus Convention 1998)
- green economy / green growth … circular economy
- steady state economy (H.E.Daly)
- degrowth (from Georgescu-Roegen)

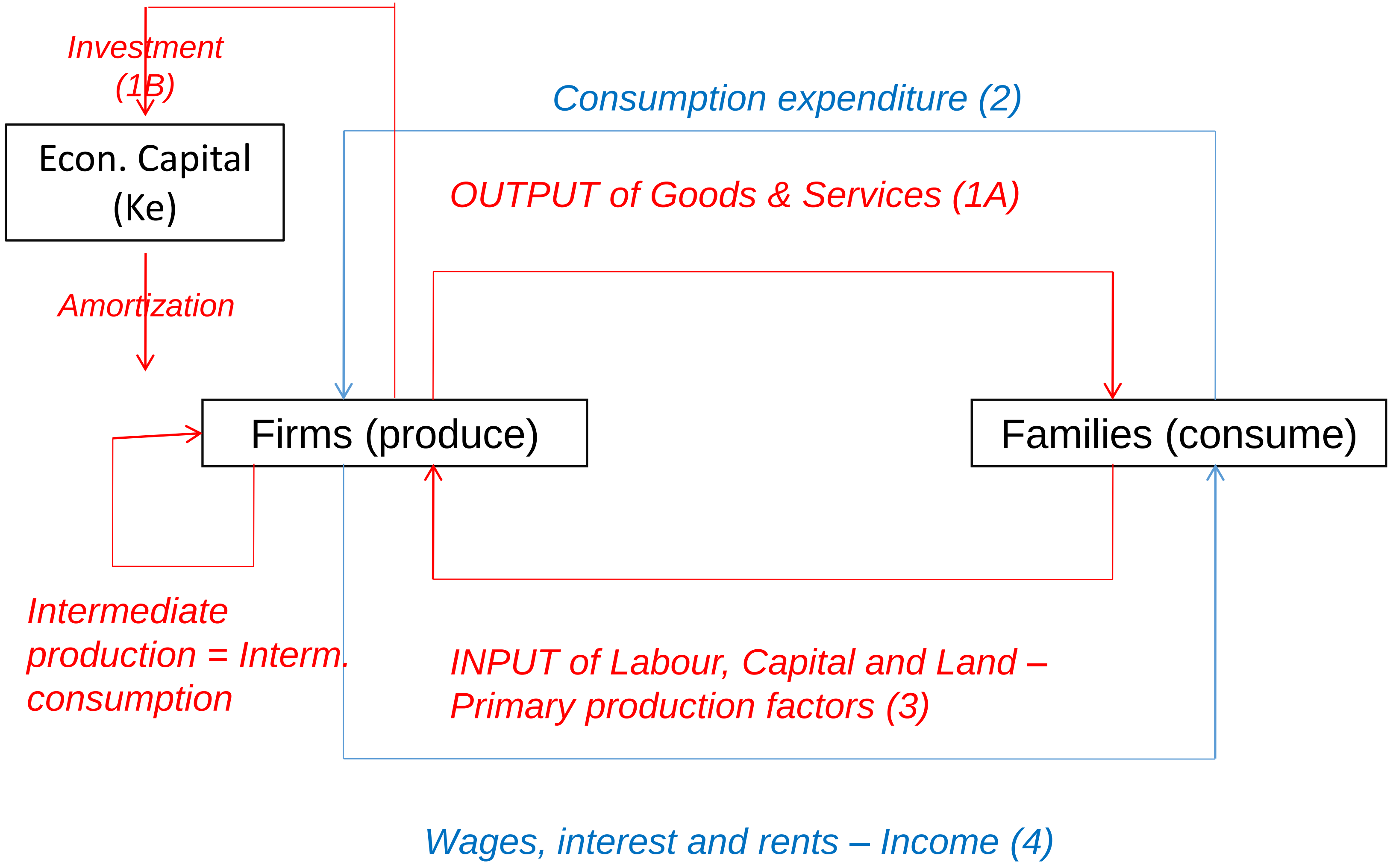
Trends in public policy styles in the EU environmental policy (1967-present)

- Substantive norms (e.g.: emission standards or water quality standards) -> process norms (ex.: EIA)
- Law (ex.: EU directives) -> soft law (ex.: action plans; thematic strategies, etc.)
- Clear definition of the policy tool (ex.: Nitrate directive) -> clear specification of the targets to be reached and flexibility as regards policy tools to be used by member states (ex.: Habitats directive)
- Command and control policy tools (ex.: emission standards) -> Economic incentives (water price; carbon markets; environmental liability, etc.).

Trends in EU Environmental policy ... (Cont.)

- Environmental policy -> Integration of environmental objectives in the relevant sectorial policies (ex.: CAP, energy policy /biofuels; etc.) and in corporate policies (EMS, audits, life-cycle analysis, eco-labels) and local/municipal policies (Local Agenda 21)
- Sustainable development: the end of environmental policy? (e.g. no need for environmental ministries?)
- Green economy and green growth.
- … but never steady state economy or degrowth!

REAL and MONETARY ECONOMIC CIRCUITS



GDP (flow) = **Final production** = **Consumption** (flow 1A) + **Investment** (flow 1B)
Thus: Investment = GDP – Consumption (Final production that is not consumed)

Hicksian Income (flow) = GDP – Amortization

GDP as an indicator of economic performance

- GDP as output: flow (1), sum the monetary value of all final outputs, or sum the gross value added (GVA) of all production units

  (GVA = Gross output – Intermediate consumption)

- GDP as expenditure: flow (2);
- GDP as income: flow (4); (Hicksian) income is GDP - depreciation of all types of capital.

Hicksian sustainability constraints

- Consumption ≤ Hicksian Income

  Hicksian income is the maximum sustainable consumption.

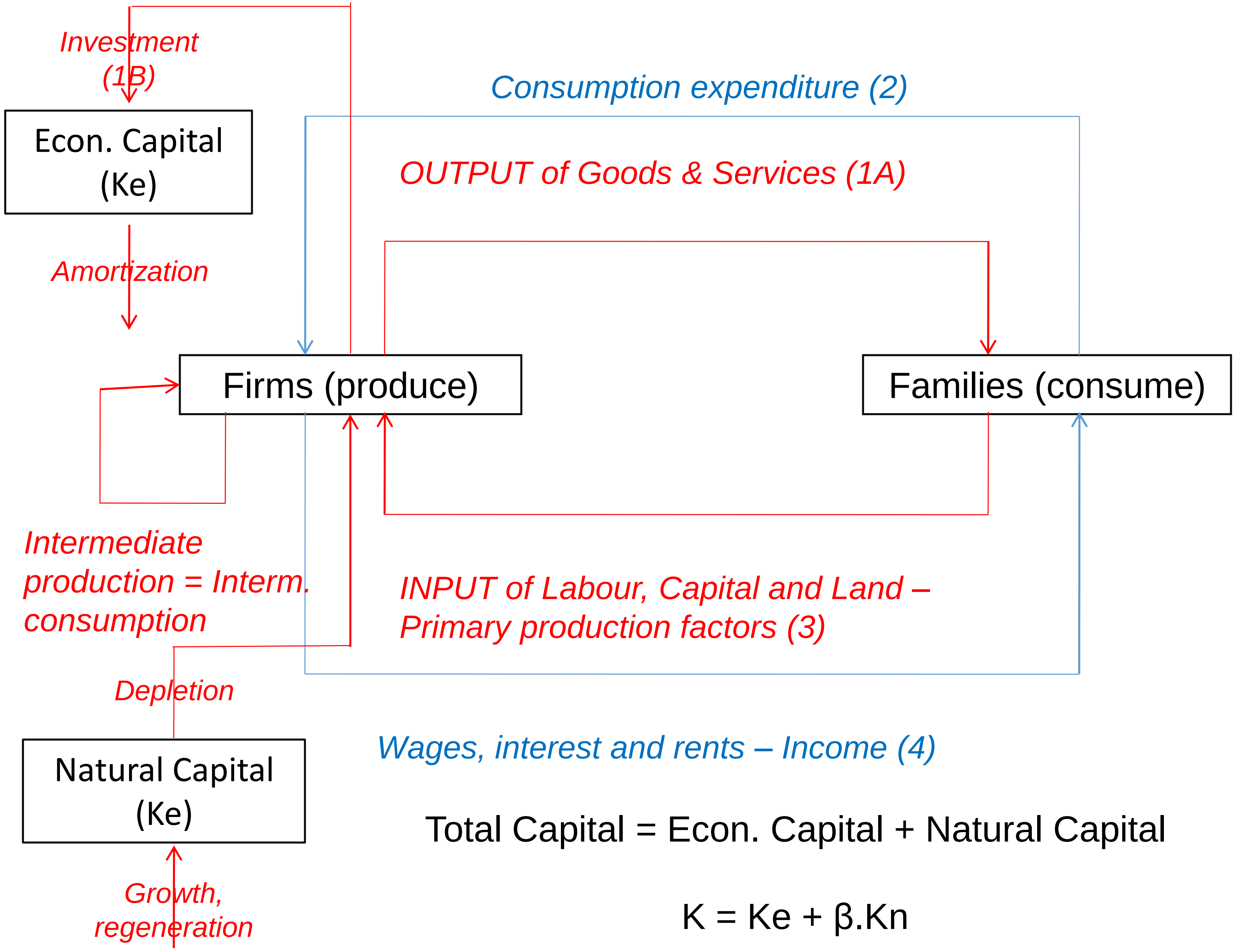
- Investment ≥ Amortization

  The creation of new capital offsets capital depreciation.

- Δ Ke = α. (Investment – Amortization) ≥ 0

  The stock of economic capital doesn't decline in time, which means that the productive capacity of the economy does not decline in time.

REAL and MONETARY ECONOMIC CIRCUITS



Total Capital = Econ. Capital + Natural Capital

$$K = Ke + \beta.Kn$$

Extending Hicksian sustainability constraints
→ Weak sustainability rules

- $\Delta K \geq 0$

  The stock of total capital doesn't decline in time, so:

- $\Delta K = \Delta Ke + \beta . \Delta Kn \geq 0$
- Meaning that a decline in natural capital can be offset by an increase (net investment = investment – amortization) in economic capital, and *vice versa*.
- Basic assumption: perfect substitution between natural capital and economic capital, which means:
- if natural capital declines there is always an amount of net investment (possibly very large) that will ensure that the productive capacity of the economy doesn´t decline.

Strong sustainability rules

- Doesn't assume substitutability of natural capital by economic capital. Under this circumstances, sustainability (that is non declining productive capacity) may require:

$$\Delta\ Kn \geq 0$$

(non declining natural capital)

That is: sustainable growth requires both the growth of Hicksian income (Δ (GDP – Amortization) > 0), and non declining natural capital (Δ Kn $\geq$ 0).

Including the environment into our model of the economy: the economic functions of the environment

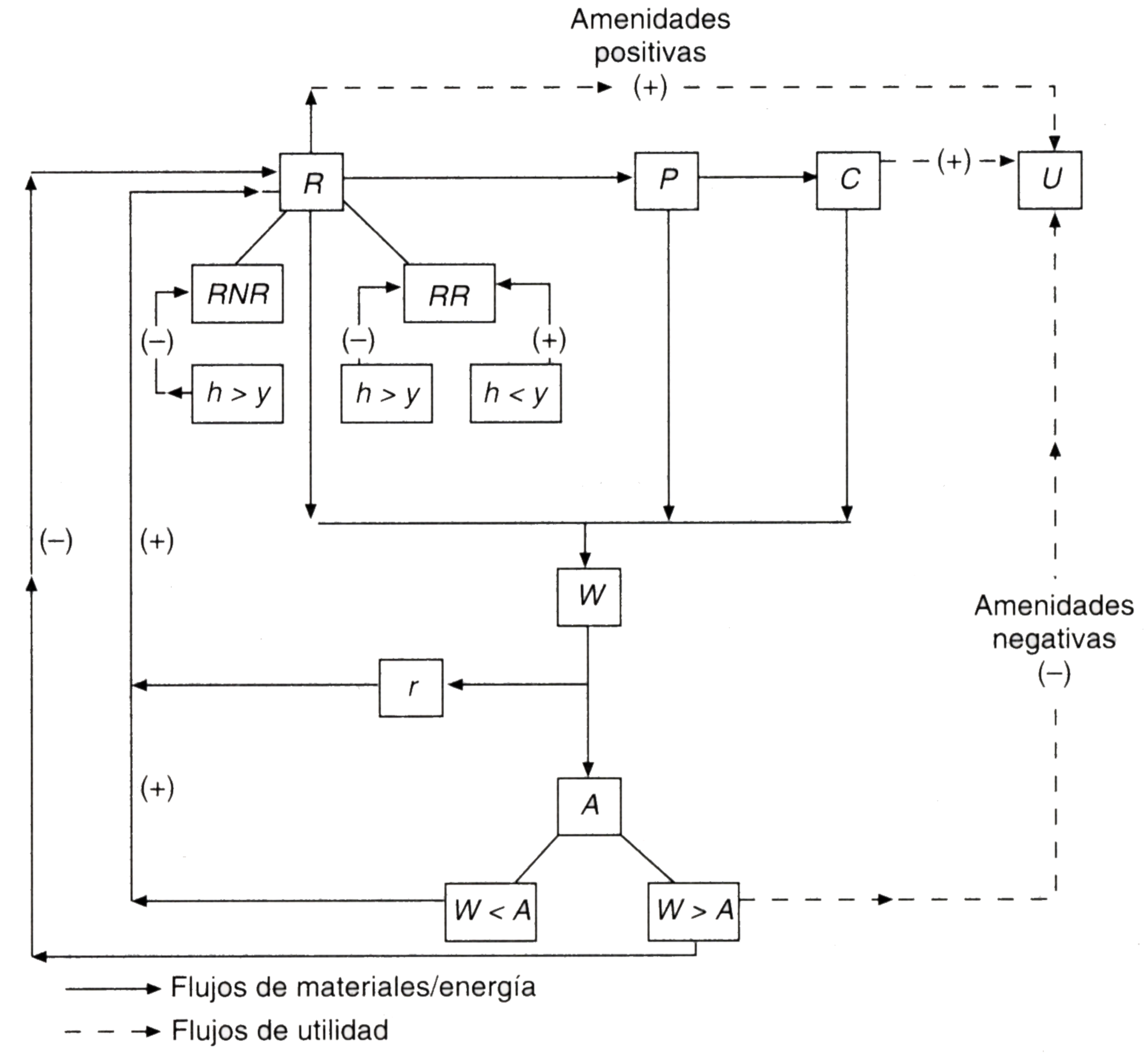
1. Providing **raw materials** and **other inputs** (energy) to productive activities (second law of thermodynamics; global resource scarcity versus unlimited economic growth)

2. Direct provisioning of **amenities** and **high-quality environment** for human beings (direct, as not through extractive and productive activities as in 1)

3. Assimilation of waste produced by human activities of extraction, production and consumption

- First law of thermodynamics (used resources = waste flow + stock accumulation);
- Dangerousness of wastes (organic matter versus mercury or radioactive waste) and their reduction by naturally occurring processes in biosphere, hydrosphere, geosphere or atmosphere;
- The assimilation capacity of the environment (as a resource) is apparently scarcer than natural resources themselves (ex.: GGE assimilation versus oil availabilty).

GRAFICO 2.4
LA ECONOMIA CIRCULAR



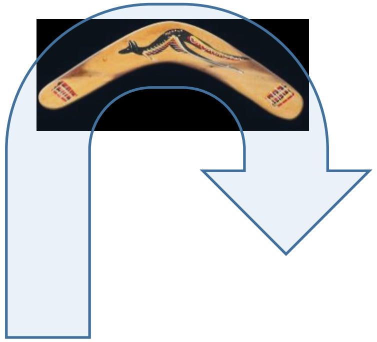
economic functions of the environment (Cont.)

4. **Regulation of the conditions for life on earth**, thus also human life (previous condition and ultimate goal of any economic activity) and economic activities involving biological processes (e.g. agriculture).

Examples:

- hydrological cycle regulation (infiltration, evaporation, transpiration soil protection, water retention in wetlands and aquifers);
- regulation of bio-geo-cycles of chemical elements such as nitrogen, sulphur and carbon, and thus the composition of water and atmosphere (thus climate regulation and water ecosystem regulation)
- regulation of water quality parameters (including eutrophication and water temperature/oxygenation);
- ecosystem resilience, very dependent on the respective species and functional diversity and multiple biotic interactions.

Interdependency between functions, and feed-back on human wellbeing – or <u>the boomerang effect</u>



- Excessive use of the nitrogen assimilative capacity, leads to:

    - Decline in renewable natural resources:

    Ex 1. Nitrate pollution, eutrophication and losses in fisheries (e.g. North Sea;

    Ex. 2. Nitrate pollution, degraded groundwater for providing drinking water;

    - Decline in amenities, recreation services and existence values of endangered species:

    Ex.3: Nitrate pollution, eutrophication, decline in fish populations, decline in populations of cherished seabirds (e.g. puffin) and seals;

- Direct feedback on production of overuse of renewable resources:

    Ex. 4. Overuse of fisheries, stock depletion, fishing cost rises, higher prices, aquaculture development;

- Feedback effects of urban congestion on everyday amenities, quality of life and time spent in transportation;

  Ex 6 quality of life and mobility in metropolitan areas,

  Ex 7. congestion in recreation resources as beaches or close-to-city national parks.

Economic growth and generalized environmental scarcity– through demand expansion (demography and per capita consumption levels) and supply contraction (environmental degradation)

- From the (open) cowboy economy to the (closed) spaceship economy (*Kenneth Boulding*)

Conclusion: The environment needs to be included in our analysis (model) of the economy, because environmental scarcity is induced by our economic choices. If we leave the environment outside, we cannot even explain how the economy works! e.g. why some prices are rising.

Open (cowboy) economy

... the cowboy is the symbol of unlimited flatlands and boundless, exploitative, romantic and violent behaviour, which is characteristic of open societies.

Consumption and production are seen as good things.

The performance of the economy is measured as a flow (*throughput*) of materials extracted from immense resource stocks and wastes given back to immense waste stocks.

If stocks are infinitely large, then this *throughput* (e.g. GDP or energy consumption) is in fact a possible metric for economic performance.

GDP is na approximate measurement of this total *throughput*.

Human wellbeing is a *flow*, not a *stock* – it refers, e.g., to the act of eating and not being in a good nutrition state.

Closed (spaceman) economy

... in which land became a small spaceship without unlimited resource stocks or unlimited containers for waste deposition,

... which requires circular (closed) physical/economic circuit.

Here, flows (*throughput*) are something to minimize, not maximize.

Economic performance cannot be measured as production/output or consumption, but the nature, quality and complexity of the total capital stock, including the state of human minds and bodies.

Maintaining this stock *from* the smallest possible flow (*throughput*) is now the goal.

Human wellbeing is described as a state (i.e., a *stock*) not a flow – what is now good is being well fed, not feeding in itself.

Figure 1
The Kuznets Curve

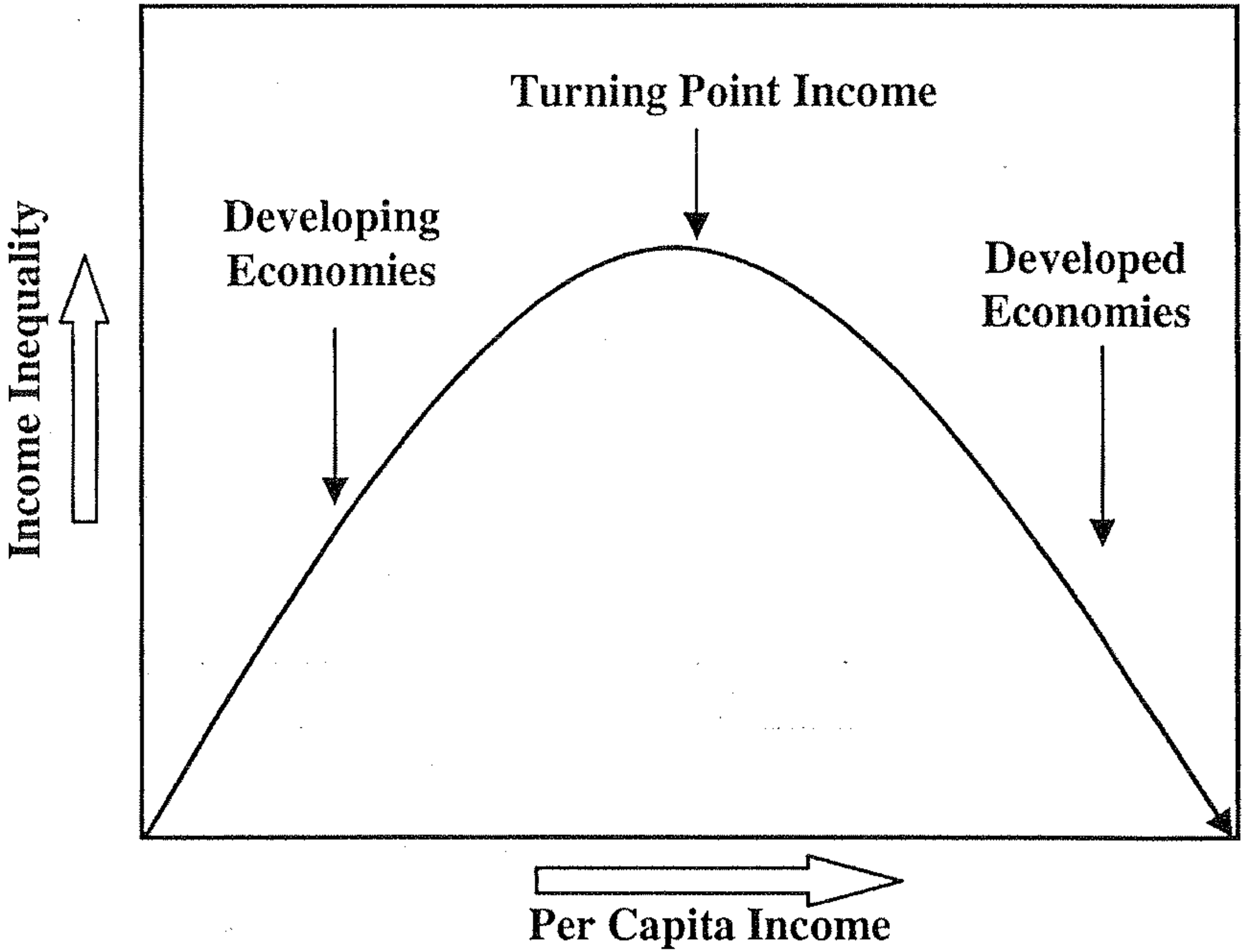


Figure 2
Environmental Kuznets Curve

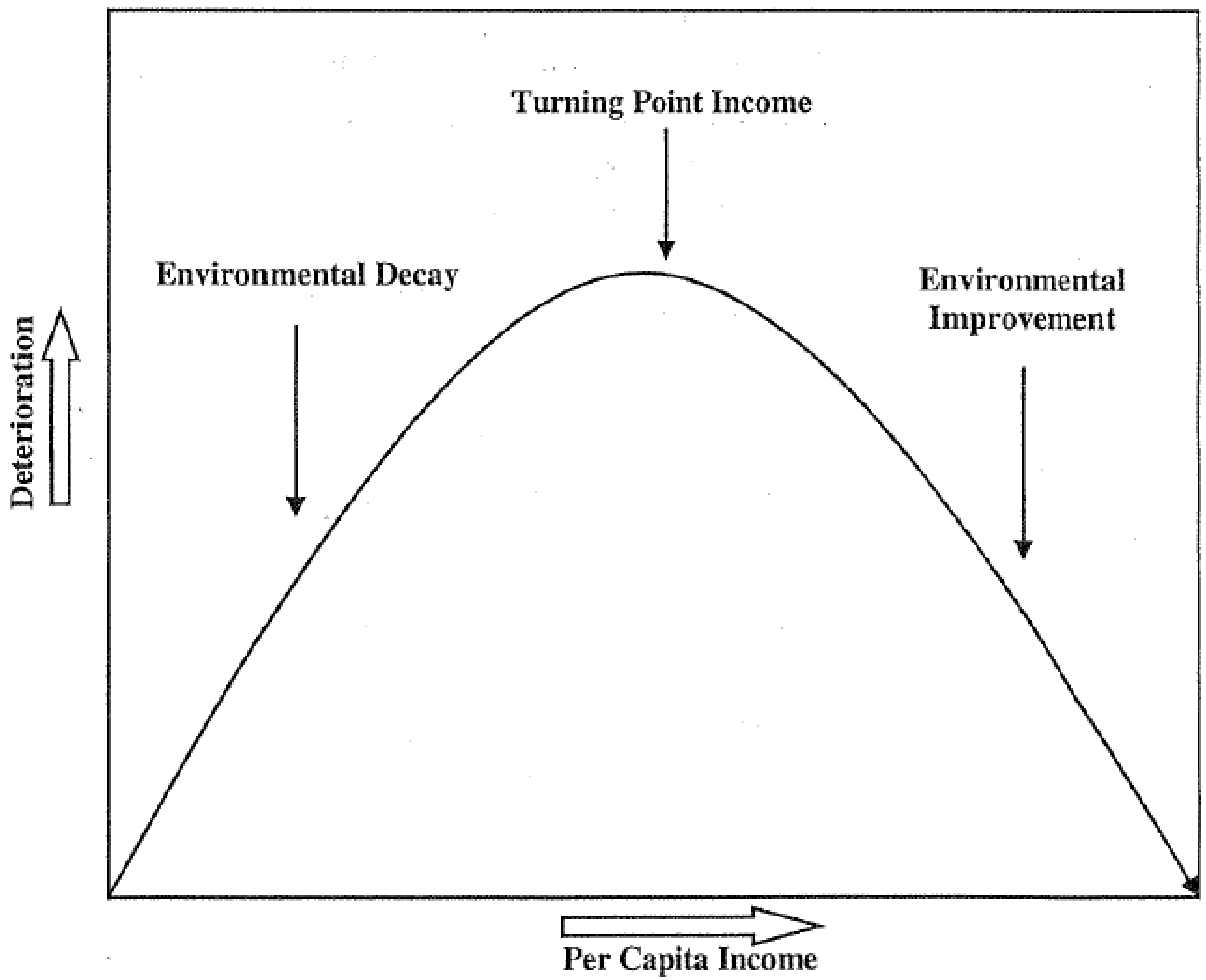
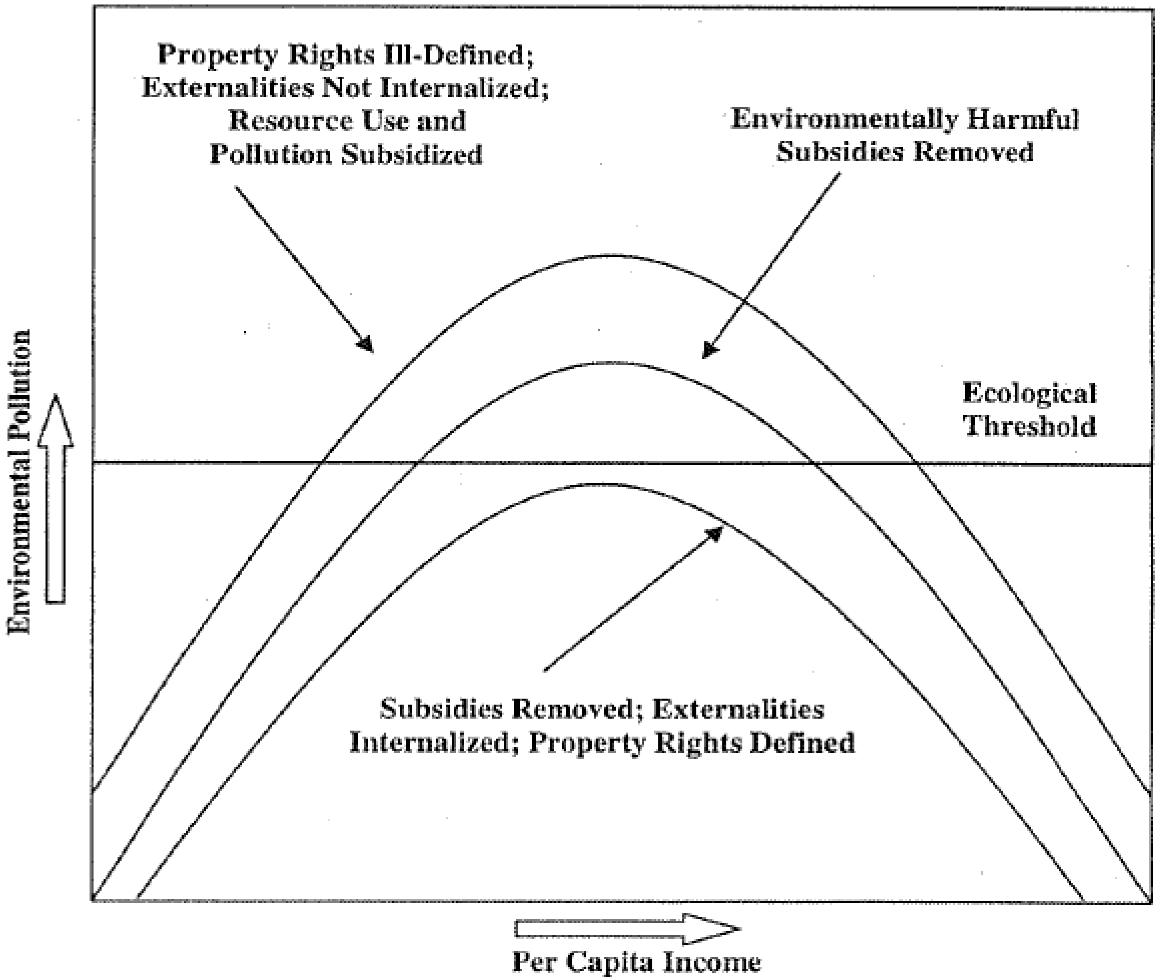


Table 2
Selected Pollutants and Income

Pollutant	EKC Turning Point	
	1985 US$	2001 US$
Carbon Dioxide	$ 22,500 – $ 34,700	$ 37,000 – 57,000
Carbon Monoxide	9,900 – 10,100	16,300 – 16,600
Nitrates	15,600 – 25,000	25,600 – 41,000
Nitrogen Oxide (industrial)	14,700 – 15,100	24,100 – 24,800
Nitrogen Oxide (transport)	15,100 – 17,600	24,800 – 28,900
Sulfur dioxide	5,700 – 6,900	9,400 – 11,300
Sulfur dioxide (transport)	9,400 – 9,800	15,400 – 16,100
Suspended particulates (non-transport)	7,300 – 8,100	12,000 – 13,000
Suspended particulates (transport)	15,000 – 18,000	24,600 – 29,600

Note: The values in 2001 U.S. dollars are approximate.
Source: Cole, Rayner, and Bates (1997).

Figure 3
Income-Environment Relationship under Different Policy and Institutional Scenarios



Source: Panayotou (1997).

Journal of Biogeography, **29**, 1557–1568

The illusion of preservation: a global environmental argument for the local production of natural resources

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Abstract

Aim The United States (US) and other affluent countries consume vast quantities of global natural resources, but contribute proportionately less to the extraction of many raw materials. This imbalance is due, in part, to domestic policies intended to protect the environment. Ironically, developed nations are often better equipped to extract resources in an environmentally prudent manner than the major suppliers. Thus, although citizens of affluent countries may imagine that preservationist domestic policies are conserving resources and protecting nature, heavy consumption rates necessitate resource extraction elsewhere and oftentimes under weak environmental oversight. A major consequence of

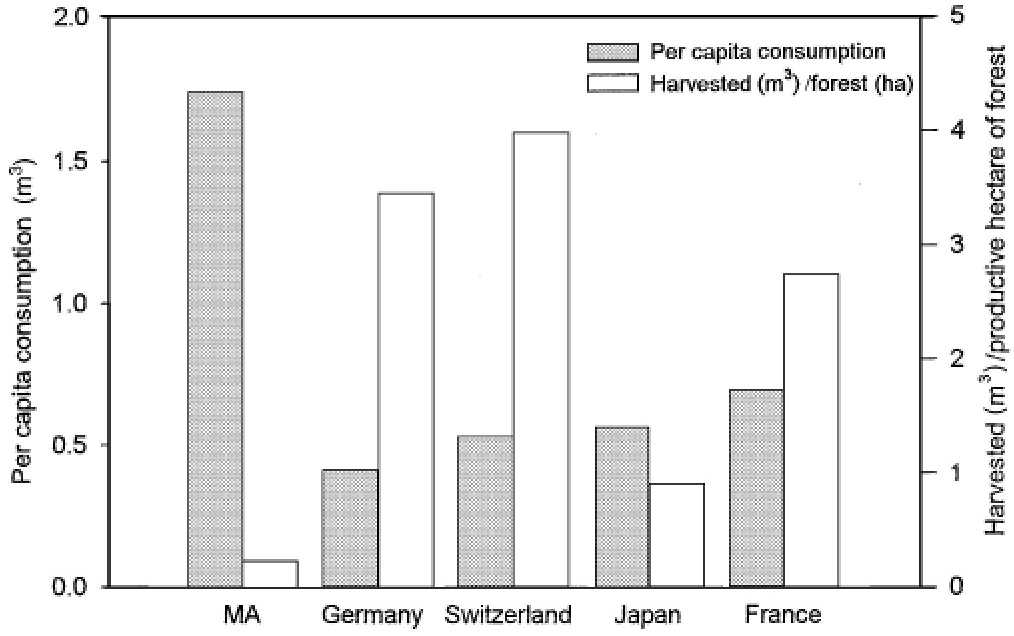

Figure 6 Per capita wood consumption and harvest per forested area: Massachusetts, Germany, Switzerland, Japan and France. Although relatively heavily forested, harvesting per unit area from Massachusetts forests is low compared with other countries. In contrast, per capita consumption of wood is several times greater in Massachusetts. [Source: Massachusetts, DEM; Howard (1997); Alerich (2000); MISER; Other nations, FAO (2000), http://apps.fao.org].

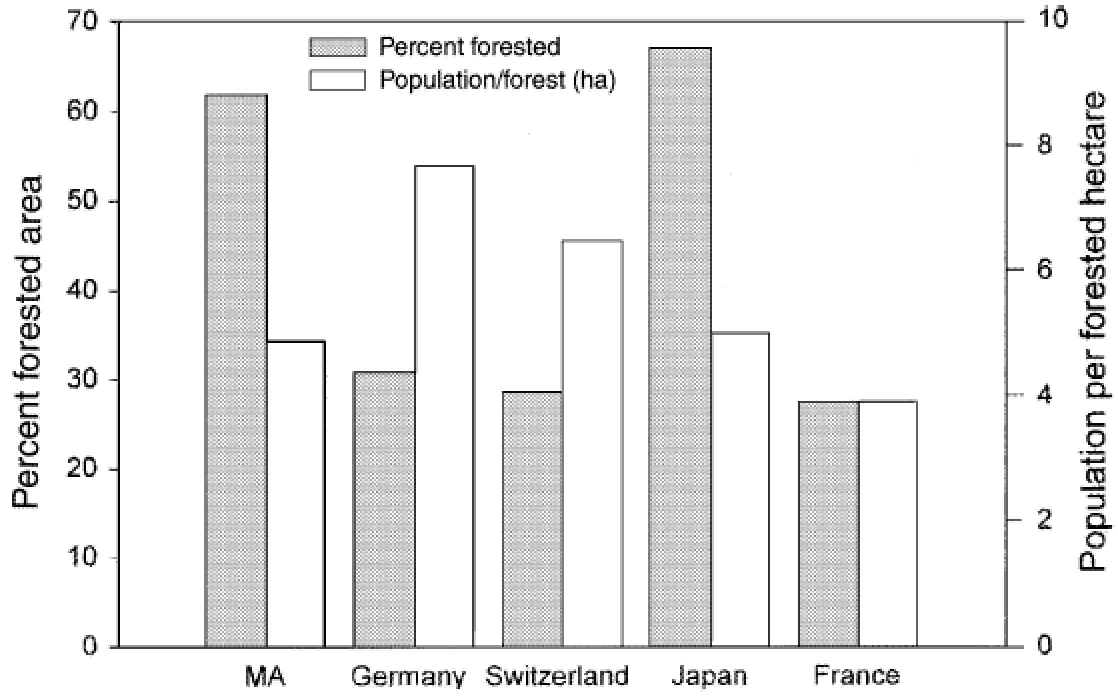

Figure 5 Comparison of percentage forested area and population density per forested area: Massachusetts, Germany, Switzerland, Japan and France. Massachusetts is more than 60% forested by area and experiences a population density per forest area comparable with Japan and France [Source: Massachusetts, Alerich, 2000; other nations, World Resources Inst. (1998), World Resources Institute, http://www.wri.org/wr-98–99/index.html].

Box 3: Unravelling the Arithmetic of Growth

The Ehrlich equation states that environmental (I) is a product of population (P) times affluence or income level (A) times the technological intensity (T) of economic output.

$$I = P \times A \times T$$

For carbon dioxide emissions from fuel combustion, for example, the total emissions are given by the product of population (P) times income (measured as dollars of GDP/person) times the carbon intensity of economic activity (measured as $gCO_2/\$$):

$$C = P \times \$/\text{person} \times gCO_2/\$$$

Using this arithmetic for the year 2007, when the global population was about 6.6 billion, the average income level in constant 2000 dollars (at market prices) was $5,900, and the carbon intensity was 760 gCO_2/$, we find that the total carbon dioxide emissions C were:

6.6 x 5.9 x 0.77 = 30 billion tonnes of CO_2.

In 1990, when the population was only 5.3 billion and the average income was $4,700 but carbon intensity was 860 gCO_2/$, total carbon dioxide emissions C were given by:

5.3 x 4.7 x 0.87 = 21.7 billion tonnes of CO_2.

These numbers are confirmed against those reported in the Energy Information Administration's *International Energy Annual*. The cumulative growth in emissions between 1990 (the Kyoto base year) and 2007 was 39% (30/21.7 = 1.39) with an average growth rate in emissions (r_i) of almost 2% ($r_i = (1.39)^{1/17} - 1 = 1.96\%$).

to an almost 40% increase in emissions (Box 3).[21] The same rule of thumb allows us a quick check on the feasibility of decoupling carbon emissions from growth in the future. The IPCC's Fourth Assessment report suggests that achieving a 450

emissions are 80% *higher* than they are today. Not quite what the IPCC had in mind.

To achieve an average year-on-year reduction in emissions of 4.9% with 0.7% population growth

Decoupling economic growth from environmental pressure (more efficiency in converting natural resources into GDP)

- relative decoupling

Raising GDP per unit of impact/footprint, (i.e.: resource use or waste emission). Higher efficiency in converting ecological footprint into GDP. As a result GDP grows at a faster pace than ecological footprint.

- absolute decoupling

Growing GDP with a constant or declining footprint, because the efficiency in converting impact into GDP grows faster than GDP itself.

Sustainability

Sustainable resource extraction flows (strong sustainability):

Rule 1: extraction <= growth (renewable resources) => constant or increasing resource stock;

Rule 2: extraction of non-renewable resources <= growth of substitute renewable resources

In both cases, the stock of natural capital is non-declining.

Natural capital decline <= growth of substitute economic capital (weak sustainability);

Sustainability is a condition of non-declining total capital (economic, natural, human and social), in which there is not a long term decline of the productive capacity of the economy.