Labour implications of the oncoming socio-ecological transition

Willi Haas and Marina Fischer-Kowalski

ETUI Monthly Forum on 28 June
Overview

1 Socio-ecological transitions
   - Defining socio-ecological transitions
   - “Historical” transitions
   - “New” transition as the continuation of pathway is impossible

2 Labour implications in human history
   - “Historical” transitions and their consequences on human labour: qualitative, quantitative and institutional form

3 “New” transition and possible labour implications
   - Sketching the uncertain “new” transition and their possible consequences on human labour
What is a ‘socio-ecological’ transition?

- A structural transformation in the patterns of society-environment interaction
- A transformation of society’s energetic and material metabolism
- A transition between ‘socio-ecological regimes’

Source: Martens and Rotmans 2002
'Socio-ecological regimes' in human history

**hunter and gatherer society**
- 1t biomass (food, wood)
- <0.1t minerals (stones, metals)

**agrarian society**
- 4t biomass (food, fodder, wood)
- 0.2-2t minerals (stones, metals)

**industrial society**
- 5t biomass (food, fodder, wood)
- 5t fossil fuel energy carriers
- 8t construction minerals
- 2t metals

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Material metabolism in t/cap*yr

<table>
<thead>
<tr>
<th>Hunter and gatherer society</th>
<th>Agrarian society</th>
<th>Industrial society</th>
</tr>
</thead>
<tbody>
<tr>
<td>1t biomass (food, wood)</td>
<td>4t biomass (food, fodder, wood)</td>
<td>5t biomass (food, fodder, wood)</td>
</tr>
<tr>
<td>&lt;0.1t minerals (stones, metals)</td>
<td>0.2-2t minerals (stones, metals)</td>
<td>5t fossil fuel energy carriers</td>
</tr>
<tr>
<td>8t construction minerals</td>
<td>2t metals</td>
<td>8t construction minerals</td>
</tr>
<tr>
<td>20t total DMC/cap*yr</td>
<td></td>
<td>20t total DMC/cap*yr</td>
</tr>
</tbody>
</table>

Source: SEC database

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Energy consumption per capita depends on socio-ecological regime

Source: Sieferle et al. 2006, Schandl et al. 2008, SEC database
Mature industrial countries: stagnation of resource use since the early 1970s, despite economic growth

Source: SEC database
Emerging economies (eg BICs): take off and acceleration in the transition to high resource use

Source: SEC database

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Energy consumption per capita depends on socio-ecological regime

Source: Sieferle et al. 2006, Schandl et al. 2008, SEC database
Global resource use (DMC) 1970 – 2005

Source: SEC database

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Sink capacities: the planetary boundaries

<table>
<thead>
<tr>
<th>thresholds for atmospheric CO₂</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>widely accepted 2°C target</td>
<td>&lt;450</td>
</tr>
<tr>
<td>ensure stability of large polar ice sheets</td>
<td>350</td>
</tr>
<tr>
<td>current state</td>
<td>387</td>
</tr>
<tr>
<td>pre-industrial</td>
<td>280</td>
</tr>
</tbody>
</table>

Increases in atmospheric CO₂ are “locked in” over the coming decades irrespective of the assumed emission scenario.
Source limitations

McKinsey Global Institute commodity price index (average of 1999-2011 = 100) in real terms

“Cheap resources underpinned economic growth for much of the 20th century. The 21st will be different.”

What does this mean for our future

Human society is – willingly or not, slowly or fast - in a transition away from the use of fossil fuels.

It might be because

• overstretching sink capacities and subsequent adverse impacts trigger new policies (before or after extreme impacts become visible)

• if this is not the case, finite stocks trigger fundamental changes in the economic system

• maybe an unpredictable mix of both will take place
Energy consumption per capita depends on socio-ecological regime

- Hunter & Gatherer: ~10 GJ/cap*yr
- Hunter & Gatherer: 40-70 GJ/cap*yr
- Agrarian societies: 40-140 GJ/cap*yr, avg 75
- Emerging economies: 40-140 GJ/cap*yr, avg 75
- Industrial society: 140-440 GJ/cap*yr, avg 280

Source: Sieferle et al. 2006, Schandl et al. 2008, SEC database

- Convergence and contraction
- Increasingly unequal access to resources (secured by force)
Labour implications
in human history

To better understand what the “oncoming” transition’s labour implications might be, we first delve more deeply into the previous historical transitions and describe their consequences for human labour on three levels:

1. Qualitative change: critical capacities of human labour
2. Quantitative change: how much of collectively existing human lifetime is spent on labour?
3. Change in the institutional form of labour: how is labour organized?
1. Qualitative features

• Human labour, by nature and socio-culturally, may be seen as equipped with three basic capacities:
   - **physical power**: capacity to alter physical objects through the use of force (> exergy, > EROI)
   - **knowledge**: capacity to anticipate the effect own actions have (> experience & learning, > information, > communication)
   - **empathy**: capacity to emotionally anticipate and mirror the feelings of other living beings (> caring, > communication)

• Depending on conditions, each capacity can be
  - **functionally** (economically, technologically) more or less relevant
  - **socially** (culturally) valued & enhanced (education) or suppressed
  - **technologically** supported, enhanced or substituted
2. Quantitative features

Anthropologically speaking, human labour is an element of human time use in a social (distributional) context. There needs to be time use for…

1. reproduction of the self (non-delegable activities such as sleeping, eating, resting, learning, having fun…). This requires at least 50% of human time (much more with children & elderly)

2. reproduction of the household / family (child rearing, food preparation, daily chores…)

3. reproduction of the community (infrastructure work, collective decision making, taking care of social relations…)

4. economic (re)production (functionally specialised labour: food procurement, income generation on the market …)

What share of a population’s time is devoted to each function, varies strongly between socio-ecological regimes.

How this is distributed among subgroups of the population (gender, age, status) is highly variable.
3. Institutional form of labour

• Labour can be organized …
  – within personally interdependent **household systems**: mutuality of obligations (subsistence agriculture, hunters & gatherers)
  – as **slavery** (master owns the labourer, has to care for his/her reproduction or, if cheaper, buy a new one)
  – within **manorial systems** (family gets land from lord of the manor, owes a share of its produce and compulsory labour in return)
  – as other kinds of **compulsory services** (military, prisoners camps, …)
  – as **self-employed** in own firm/enterprise, household based but selling produce on markets
  – as **wage labour** (personally free to sell a certain quantity of time on a labour market)

• these offer very different balances of self determination / dependency, security of self-reproduction, and chances for learning & innovation
'Socio-ecolgical regimes’ in human history

agrarian society

industrial society coal phase

industrial society oil phase

Transition away from fossil fuels

Qualitative: • physical power
• knowledge
• empathy

Quantitative: working hours

Institutional form
## Labour quality

<table>
<thead>
<tr>
<th>Physical Power</th>
<th>Agrarian</th>
<th>Industrial: coal phase</th>
<th>Industrial: oil phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans dominant source of mechanical traction. Partial substitution: animal power. water &amp; windmills 3-5%, plus sailing ships (see Smil 2009).</td>
<td>In the UK, coal at first only substituted for wood in heat production, but had a huge impact on labour by allowing urban centres and manufacturing to grow.</td>
<td>Liquid fossil fuels allow for substitution of human physical power by decentralized mechanical services (combustion engines, and electro motors): ↗energy input and ↘labour hours (less exercise)</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>Peasant work versatile: agriculture, animal breeding &amp; training, tool production, spinning &amp; weaving &amp; textile production... But barely societal efforts at systematic knowledge creation and education.</td>
<td>From 1750 onward, the steam engine substituted for human and animal traction in mines, provided rotary power in textile mills and locomotives and for a large variety of applications.</td>
<td>Growth in public education. Knowledge processing/communication become major tasks increase of white collar over blue collar and agricultural labour. Knowledge production no class privilege, no ideological bastion, becomes secular and rational, and functionally related to performance on the labour market. (Bell 1973)</td>
</tr>
<tr>
<td>Empathy</td>
<td>Rather suppressed by cultural emphasis on heroism and cruelty.</td>
<td></td>
<td>major requirement of growing communication based work (education, marketing, health care, arts, sales work ..)</td>
</tr>
</tbody>
</table>
## Labour quantitative

<table>
<thead>
<tr>
<th>Agrarian</th>
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<th>Industrial: oil phase</th>
</tr>
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<tbody>
<tr>
<td>Majority of population (incl. children and elderly) is occupied with food production, most of their available lifetime; very high workload</td>
<td>Lots of additional physical power is brought into the economy</td>
<td>In response to two world wars, a world economic crisis enhancing fascism, and the rise of state socialism, social welfare states are being built up, based mainly upon taxing wage labour and consumption.</td>
</tr>
<tr>
<td>Relatively low EROI (~ 10:1)</td>
<td>Creates labour demand that can absorb the rapidly increasing population (demographic transition), males, females and children.</td>
<td>Large fractions of the population are formally relieved from work and receive retirement pensions.</td>
</tr>
<tr>
<td>Low surplus (→ urban population ~ 2-10%)</td>
<td>More energy does not substitute, but facilitate the use of additional human labour.</td>
<td>Low qualified <strong>physical work</strong> is gradually externalized to the global periphery, and structural unemployment of low qualified people in the centres becomes a problem.</td>
</tr>
<tr>
<td>Boserup hypothesis: the more mature</td>
<td></td>
<td>Since the 1970s, information and communication technologies enhance, but also substitute for <strong>knowledge based work</strong>. Knowledge based work is not a human prerogative any more.</td>
</tr>
<tr>
<td>• the more rural population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the higher the land productivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the lower the labour productivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>progress = decrease of labour productivity, increase of population!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Labour hours in the economy

Number of hours for average inhabitant and average day of the year

Household and family work: 2,1 hrs/day

Sources: Fischer-Kowalski et al. 2011 (for Trinket, Campo Bello and Nalang), Maddison 2001 (for Japan), Clearingstelle Verkehr 2012 (for Germany 2001/02)
### Institutional form

<table>
<thead>
<tr>
<th>Agrarian</th>
<th>Industrial: coal phase</th>
<th>Industrial: oil phase</th>
</tr>
</thead>
</table>
| Labour in agriculture (> 90%):  
  • In peripheral or unproductive regions: **household based self-employment**, largely subsistence  
  • elsewhere: **manorial systems** with bonded serfs or slaves  
  Labour outside agriculture (< 10%)  
  • **slave and compulsory labour** (mining, construction)  
  • Household based **self-employment** (crafts & trades, transportation)  
  „atomization of production was the rule...“ (Christ 1984)  
  **Freedom of labour** is considered a key social privilege. Physical labour is looked down upon and made culturally invisible. | Free **wage labour**, minoritarian at first, gradually grows to become most dominant form. Gradually, often by revolutions, serfdom and slavery are abolished.  
In contrast to the landed aristocracy, **industrialists** see themselves as hard-working, responsible for the labour process, and drivers of technical innovation. They are not a leisure class, but obliged to protestant ethics (Max Weber). | • Increasing differentiation in functional systems with increasing division of labour at a global scale  
• **Wage labour** and increasingly self-employment are the dominant forms  
• Automation of household system (reduction of physical work) |
### Labour in the transition phase away from fossil fuels: quality

<table>
<thead>
<tr>
<th>“New” transition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>physical power</strong></td>
</tr>
<tr>
<td>• Physical power plays a minor role, physical exercise in leisure time</td>
</tr>
<tr>
<td>• The reduction of physical work in Europe was of course also greatly enhanced by the <strong>externalization</strong> of industrial production to the world’s periphery, where emerging economies with very low labour costs were prepared to produce the steadily increasing amount of industrial products that Europe and other rich regions of the world wished to consume. Studies of carbon emissions embodied in trade (Hertwich and Peters 2009) have shown, for example, that the apparent domestic growth reduction in fossil fuel based energy was – at least to a certain degree - compensated for by rising fossil fuel combustion elsewhere.</td>
</tr>
<tr>
<td><strong>knowledge</strong></td>
</tr>
<tr>
<td>• As increasing fossil fuel use substituted internal combustion and electric motors for much of human physical work, now <strong>information and communication technology</strong> is substituting for and adding to knowledge work. Substituting for knowledge work is inherently less energy intensive than substituting for physical work, even if not optimized.</td>
</tr>
<tr>
<td>• Intellectual educational standards in the labour force keep rising, as does school and university enrolment, and qualified <strong>white collar</strong> work increases while industrial <strong>blue collar</strong> work continues to decline.</td>
</tr>
<tr>
<td><strong>Empathy</strong></td>
</tr>
<tr>
<td>There are indications that – connected to the rising importance of marketing, services and communication processes – the capacity for empathy is gradually losing its exclusive female label and becoming a more important qualification for work generally.</td>
</tr>
</tbody>
</table>
Primary energy consumption per working hour 1870-1998

**Germany**

- PEC (PJ)
- Hours (10 mio h)
- PEC/working hour (MJ/h)

**Italy**

**UK**

Primary energy consumption per working hour 1870-1998

Labour in the transition phase away from fossil fuels: quantitativ

“New” transition

• Coinciding with the first world oil crisis, structural change in the relation between energy and labour becomes apparent: the trend of steeply increasing primary energy input is over, and gives way, after some sharp fluctuations, to a more stationary energy consumption, both overall and per working hour. There is no discernible correlation between energy use and working time any more.

• For the same period, Ayres observed a loosening of the so far very tight ties between exergy and economic output (Ayres and Warr 2005). He interprets this as an effect of the technology turn towards ICT.
How to link social metabolism, time use and labour time – implications for a sustainability transition

First link: Production

Social metabolism is driven by human production (human labour, working time, reinforced by technology and energy use)

Second link: Consumption

Social metabolism is driven by human consumption (demographic growth, life styles, purchasing power)

Feedback: Rebound effect

Investment of labour time produces income, and income produces consumption

Third link: High quality life time at minimized resource use

Sustainability, in its core, has to do with securing (high quality) human life time in the future. This needs to be achieved with as little resource use and environmental impact as possible.
Energy consumption per capita depends on socio-ecological regime

![Graph showing energy consumption per capita across different regimes:
- Hunter & Gatherer: ~10 GJ/cap*yr
- Agrarian societies: 40-70 GJ/cap*yr
- Industrial society: 140-440 GJ/cap*yr, avg 280
- Post-industrial society: avg 100 GJ/cap*yr (? <2°C)


Most of our economic and social theories were derived here.

What economic and social theories are appropriate here?

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“New” transition and possible labour implications

- Sketching the uncertain “new” transition and their possible consequences on human labour
Socio-ecological transition: tipping of some long-term trends?

*Rising cost of energy:* Could we possibly encounter a return of more physical labour, possibly with very intelligent but mechanical tools and devices with optimized energy use?

*Declining energy return upon investment (EROI):* In Europe, could we have to face an increasing amount of labour, at relatively low salaries?

*Resource scarcity, increase in caretaking activities:* Could we need to optimize resource productivity at the expense of labour productivity, and take into account declining labour productivity?

*Increasing communication:* Could empathy play a much more prominent role in our activities?

*Decreasing energy intensity:* Could our societies slow down again?

*Return of the spatial dimension:* How can Europe deal with this challenge?
From a socio-ecological perspective the “new” transition would encompass

<table>
<thead>
<tr>
<th>Area</th>
<th>Mechanism</th>
<th>Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>food</td>
<td>Reduction of energy intensity, less fertilizer, less meat consumption, urban gardening</td>
<td>Probably more labour intensive</td>
</tr>
<tr>
<td>health</td>
<td>Less material intensive repair medicine, more primary health care (more exercise, healthier food, less pollution)</td>
<td>Probably more labour intensive</td>
</tr>
<tr>
<td>transport</td>
<td>Reduced road infrastructure to infrastructure with less material, energy intensity and maintenance, more compact settlement structures, from construction to reconstruction, reduced working/living distance, low vulnerability</td>
<td>More physical exercise in day-to-day trips, constr. less, reconstr. more</td>
</tr>
<tr>
<td>building</td>
<td>Compact settlements, reconstruction/insulation, more recreational options close by, low vulnerability</td>
<td>More labour</td>
</tr>
</tbody>
</table>
From a socio-ecological perspective the “new” transition would encompass

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<tr>
<th>Area</th>
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<th>Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy production</td>
<td>Convert generation technology, lower EROI – less conversion losses, more decentralised solutions</td>
<td>Demands more labour</td>
</tr>
<tr>
<td>Circular economy</td>
<td>No growth in material consumption, focus on avoiding rebound effects (product to system innovation), eco-design, more repair and recycling, tracking of critical raw materials</td>
<td>Less and more labour, more knowledge based</td>
</tr>
</tbody>
</table>
From a socio-ecological perspective the “new” transition is a challenge

Most everything we do is based on cheap oil

- Where we live relative to where we work
- How much leisure time we have and how we spend it
- Price of our food and other purchases
- How much education
- What our jobs depend on
- How distributional conflicts were solved

Re-arranging the deck chairs (on the Titanic) will not do it – eco-efficiency is not sufficient - it’s about paradigm shifts in many areas

- Consumers don’t want to miss anything
- Business functions under present (economic) framework conditions and has vested interests
- Policy makers don’t want to loose support

However, its very likely that sooner or later we need to face the challenges ahead
Socio-ecological transition: structural change and biophysical degrowth

Institutional form

Quality of work

It’s not about too little work, it’s about getting the framework conditions right for securing (high quality) human life time in future
Thank you for your attention
References


Bell, D. (1973): The coming of post-industrial society


Hall and Klitgaard 2012: Energy and the wealth of nations

Krausmann, F. et al. (2009), Growth in Global Materials Use, GDP and Population during the 20th Century. Ecol.Econ.68(10), 2696-2705


Mosus global database on resource extraction: http://www.materialflows.net/index.php?option=com_content&task=view&id=16&Itemid=28


SEC database: http://www.uni-klu.ac.at/socsec/inhalt/1088.htm


Domestic energy consumption per capita (DEC)

- EU15
- EU12
- EU27
- Emerging econ. (average, n=14)
  - Turkey
  - Philippines
  - Nigeria
  - Indonesia
  - India
  - China
  - Brazil
- Mature industrial (average, n=31)
  - Ireland
  - USA
  - UK
  - Spain
  - Portugal
  - Norway
  - Japan
  - Netherlands
  - Italy
  - Greece
  - Germany
  - France
  - Denmark
  - Austria

Share of global population: 60%

Domestic material consumption per capita (DMC)

- EU15
- EU12
- EU27
- Emerging econ. (average, n=14)
  - Turkey
  - Philippines
  - Nigeria
  - Indonesia
  - India
  - China
  - Brazil
- Mature industrial (average, n=31)
  - Ireland
  - USA
  - UK
  - Spain
  - Portugal
  - Norway
  - Japan
  - Netherlands
  - Italy
  - Greece
  - Germany
  - France
  - Denmark
  - Austria

Tons per capita
Energy Return on Investment (EROI) is decreasing

For the USA

Hall and Day
(2009)
Global energy crunch

**Hypothesis 1.** The greater a country’s military potential and the stronger the perception that force will be more effective than the free market to protect access to vital resources, the more likely there will be a strategy of predatory militarism.

**Hypothesis 2.** The shorter and the less a country or society has practiced humanism, pluralism and liberal democracy, the more likely its elites will be willing and able to impose a policy of totalitarian retrenchment on their population.

**Hypothesis 3.** The shorter and the less a country or society has been exposed to individualism, industrialism and mass consumerism, the more likely there will be an adaptive regression to community-based values and a subsistence lifestyle.

**Hypothesis 4.** In the event of peak oil, there will be winners and losers. It seems reasonable to expect a redistribution of power and wealth from oil importers to oil exporters, and from private to state-controlled companies.

**Hypothesis 5.** In the event of peak oil, we should not expect either immediate collapse or a smooth transition. People do not give up their lifestyle easily. We should expect painful adaptation processes that may last for a century or more.

UK lifetime timebudgets 1856-1980

Source: Gruebler 1998. pers.comm.
**Indications for proportion of population not engaged in agriculture: % urban**

**Urbanization ratios 1000 - 1890**

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan</th>
<th>China</th>
<th>W.Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>n.a.</td>
<td>3,0</td>
<td>0,0</td>
</tr>
<tr>
<td>1500</td>
<td>2,9</td>
<td>3,8</td>
<td>6,1</td>
</tr>
<tr>
<td>1820</td>
<td>12,3</td>
<td>3,8</td>
<td>12,3</td>
</tr>
<tr>
<td>1890</td>
<td>16,0</td>
<td>4,4</td>
<td>31,0</td>
</tr>
</tbody>
</table>

**Urbanization Europe 1800/1850**

<table>
<thead>
<tr>
<th>Year</th>
<th>ENGLAND</th>
<th>FRANCE</th>
<th>ITALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>~1800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>capital city</td>
<td>12%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>next big city</td>
<td>1%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>~1850</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>capital city</td>
<td>14%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>next big city</td>
<td>2%</td>
<td>1%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: Maddison 2001, p.40

Computed from www.populstat.info
working hours and primary energy consumption (UK 1870-2000)

after Schandl & Schulz 2002, 2003

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Phases of resource use dynamics

Source: after Krausmann et al. 2009
Socio-ecological transition: structural change and biophysical degrowth

Structural change such as:
- energy shift away from fossil fuel use towards solar and wind energy
- production shift towards human resources & capacities
- institutional shift towards low-vulnerability, low-maintenance infrastructures...

Biophysical degrowth such as:
- lowering energy consumption (efficiency increases, saving...)
- lowering use of (virgin) raw materials (efficiency increases, recycling, avoiding waste, waste mining...)
- European self sufficiency in biomass and water

New framework conditions:
- after decades of decline, sharp rise of prices of all raw materials
- Increasing commodity prices demand a challenging tax reform to escape the poverty trap
From a socio-ecological perspective the “new” transition would encompass

- a production/consumption shift away from energy- and materials-intensive products towards more labour intensive services (circular economy with more recycling and manual repair work, repair medicine to primary health care)
- an institutional shift towards low-vulnerability, low-maintenance infrastructures (decentralised grids, reduced road infrastructure, more compact settlement structures, construction to reconstruction)
- lowering energy consumption (efficiency increases, saving…)
- lowering use of (virgin) raw materials (efficiency increases, recycling, reduced consumption, avoiding waste, waste mining…)
- probably: European self-sufficiency in biomass and water.
Human development vs. Carbon emissions

Source: Steinberger & Roberts 2009

R² = 0.75 – 0.85
100% recycling would save 1 billion tonnes of energy carriers

Global socio-economic system

Environment

Material throughput

Energy use

Net addition to stocks

Recycling

Global material consumption

Input

Output

60 billion tonnes

100% recycling would save 1 billion tonnes of energy carriers

Source: own database, Krausmann et al. (2009), European RR: EC DG Env (2011), own calculations
Interrelation between resource use & income

Data for the year 2000; Source: UNEP Decoupling Report 2011
Decoupling of cereal production from land area – but at the expense of more fertilizer use

Figure 2.9. Global growth of cereals production and fertilizer consumption

Indexed
1961-100

Note: Global growth in the production of cereals since 1961 almost exclusively depended on intensification (nitrogen input, tractors, yields and many other factors not shown on this graph), whereas the expansion of harvested area played an insignificant role.
Source: UNEP GEO Portal, as compiled from FAOSTAT database, Food and Agriculture Organization of the United Nations (FAO), http://geodata.geonetwork.unep.ch