Karl Bruckmeier

The significance of economic knowledge in the environmental sustainability discourse
The theme “significance of economic knowledge in the environmental sustainability discourse”

is discussed in interdisciplinary perspective: with knowledge from social ecology - in the following aspects

1. The situation: difficulties in the sustainability process - deteriorating state of the environment & little success of sustainability governance

2. Knowledge problems of sustainable development

3. Sustainable development - when scientific knowledge from different disciplines is contradicting

4. Discussion and conclusions - how to make sustainable development more successful?
1. The situation: difficulties in the sustainability process - deteriorating state of the environment & little success of sustainability governance

- Sustainable development is on national and international policy agendas since about thirty years
- but the success (in terms of environmental improvements and maintenance of the natural resource base on the earth) is limited

- The **Millennium Ecosystem Assessment** and further global assessments showed:
  - only few and small environmental improvements happened in the past decades (in some areas through reforestation)
  - the main trends of deterioration of the state of the environment continue, including the industrial and agricultural pollution of soils and waters and the CO2-pollution of the air (the main reason for global climate change)
### Direct drivers growing in intensity

Most direct drivers of degradation in ecosystem services remain constant or are growing in intensity in most ecosystems.

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<th>Ecosystem Type</th>
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#### Driver's impact on biodiversity over the last century
- Low
- Moderate
- High
- Very high

#### Driver's current trends
- Decreasing impact
- Continuing impact
- Increasing impact
- Very rapid increase of the impact

*Source: Millennium Ecosystem Assessment*
The lacking success of sustainability policies

... has many reasons and causes: prominent explanations include policy failures and vested interests of powerful actors and organisations that gain from the present practices of environmental pollution (e.g. industrial enterprises that do not have to bear the costs of pollution, or only to a limited degree through environmental policy and legislation).

Such explanations are not wrong but insufficient – more actors and interests count:

the consumers and their behaviour, for example: this evokes the question, who is more responsible – the producing firms or the consumers that buy the products?: not discussed further here, but:

a rather neglected issue in the sustainability process - the forms and practices of knowledge: which knowledge is used, should be used, how is it selected?
Sustainability and sustainable development

- Sustainable development includes environmental, social and economic sustainability - environmental sustainability is about the interaction of modern nature and society: how can the effects of human modification of nature (through science, technology, resource use) for nature and for humans be reduced/avoided?
- To answer this question requires a process of interdisciplinary learning
- It began with the debate about global environmental problems in the 1970s - with the “Limits to Growth”-Report of the Club of Rome from 1972: a system analysis of limits of the natural resources on the earth and potential consequences for humans, social- and ecosystems
- Environmental problems are caused by social actors and connected with other problems in modern societies (unequal access to resources, poverty, hunger etc. - therefore social and economic sustainability need to be dealt with simultaneously)
- The problems transgress political boundaries and boundaries of scientific disciplines (boundaries in academic science/universities): requiring interdisciplinary cooperation in search for solutions
Sustainable development: a main goal of governments and NGOs/ environmental movements - definition of European Union

“Sustainable development can be defined simply as a **better quality of life for everyone, now and for generations to come**. It is a vision of progress that **links economic development, protection of the environment and social justice**, and its values are recognised by democratic governments and political movements the world over. Sustainable Development is about:

- Balanced and equitable economic development
- High levels of employment, social cohesion and inclusiveness
- A high level of environmental protection and responsible use of natural resources
- Coherent policy making in an open, transparent and accountable political system
- Effective international co-operation to promote sustainable development globally” (http://ec.europa.eu/sustainable/pages/idea_en.htm)

* A simple list of wishes, but including the points important in the scientific and political discourse of sustainability
A graphical interpretation of the complexity inherent in sustainable development (seen as a multi-scale process of natural resource use/governance: Howitt 2001): interconnecting biophysical, economic, political and sociocultural processes that require a new world order.

**Figure 2.5** New world order, power and local restructuring
Environmental problems that require sustainable development for their solution

(1) Industrial pollution, a main cause for local, national and global environmental problems, has not stopped with all efforts of environmental policy in the past fifty years and some ecological modernisation of industry in Europe. Industrial production is now relocated from the old industrial countries in Europe to newly industrialising countries as the BRICS-countries, especially China that produces now much of the industrial goods consumed in European countries - with extreme forms of pollution of air, water and soil.

(2) Agricultural pollution is a newer phenomenon, connected with the modernisation and industrialisation of agriculture in most European countries since the 20th century - especially since the 1970s through the Common Agricultural Policy of the European Union.

(3) Global environmental change: climate change, biodiversity reduction and land use change (agricultural, industrial and urban land use) includes the new phenomena of environmental disruption at global levels that are intensively investigated and discussed in the environmental discourse in science and policy in the past decades.
Economic problems that affect environmental sustainability

... include the scarcity and the economic valorisation of natural resources, growth, distribution and redistribution of resources, property rights and access to resources (and solution ideas as that from bioeconomic approaches = interdisciplinary knowledge practices, or “green economy”)

A major **knowledge problem in the sustainability process**: these economic phenomena require further knowledge, not only economic research. Scarcity of natural resources can be quantified in ecological and economic terms, as naturally or as socially caused scarcity, or as combination of both

Economic knowledge, especially about scarcity and growth, is important for the solution of environmental problems, but not enough for sustainability governance:

**Economic knowledge needs to be connected systematically with ecological knowledge** about the functioning and development of ecosystems, consequences of environmental pollution for humans and nature including toxicity, environmental and social risks of overuse of natural resources, coupling and the interaction of ecological and social systems, causes and consequences of global climate change, biodiversity loss, land use change & urbanisation, planetary boundaries of resource use/limits to growth
2. Knowledge problems in a broader view: Sustainable development depends on knowledge from the natural and social sciences and interdisciplinary syntheses

- In economics, as in many other disciplines in academic science, interdisciplinary knowledge exchange and integration is not widespread.
- Sustainability policy/governance requires broader knowledge to deal with the multifaceted and complex processes that sustainability implies: systematic knowledge exchange between the social and natural sciences in research, theory production, integration or synthesis of knowledge.
- Improvements of the sustainability process require as first step: critical reviews/assessments of the practices of knowledge use (why did the process not work well so far?) and as second step: development of interdisciplinary knowledge practices in research and governance.
- In the past decades developed an intensive debate of inter- and transdisciplinarity (Thompson-Klein 1990, Gibbons et al 1994, Nowotny et al 2001) influencing also environmental research, but academic sciences are skeptical or hesitate to open their research practices for interdisciplinary cooperation.
With interdisciplinary knowledge integration come up questions of knowledge selection

- ... and the methodological difficulties in this process may be among the reasons for the lacking willingness for interdisciplinary cooperation (also the skeptical view: interdisciplinarity does not work practically, is too complicated) – but in future it cannot be avoided to learn it

- **Which knowledge, from which disciplines should be applied and combined in the sustainability discourse and the governance processes?** How to deal with incompatible or contradicting knowledge and information? Which social and cultural resources, beyond the natural and economic resources, are required for sustainable development in a given area or country and globally? These questions require an answer to the question, **why economics should participate in interdisciplinary discourses** when sustainable development is at stake. Four parts of an answer can be differentiated:

  - **(1) Scientifically seen** economics is only a limited part of the sustainability discourse where many disciplines are involved. To find out, which knowledge is important and should be used in sustainability governance requires interdisciplinary knowledge integration and syntheses in both processes that constitute sustainability - research and governance
(2) Practically seen economic processes are interwoven in manifold ways with political, social, and cultural processes.

Two overarching processes influence today all national economies: that of *globalisation* and deregulation of the markets, and as contrasting process that of *sustainable development* – for the further clarification of these processes, their consequences and the interaction between them economic knowledge is needed, combined with further knowledge:

- both processes are multi-faceted and multi-dimensional, interact with each other, creating a complex reality in which also “genuine” economic processes as production, exchange and trade can no longer to be understood with economic knowledge only; they include so many social, cultural, political, ecological influences and factors that they require interdisciplinary knowledge and multi-causal explanations.
(3) The "political rhetoric of sustainability" is a widespread problem and practice in the policy processes for sustainable development:

- **symbolic commitment** to the values of sustainability, but **lack of agency**, of implementation and regulation capacity, and of interdisciplinary knowledge use

The examples of the definitions and descriptions of sustainable development by the European Union (given above) and the United Nations (UN 2015), two important institutional actors in the global sustainability process, show such deficits in exemplary forms: lists of wishes and normative thinking, but not addressing the question: what forms of knowledge are required to develop implementation and regulation capacity or transformational agency (the International Social Science Council has developed ideas and supports research for creation such agency for sustainable development: ISSC 2010)

- **(4) Forms of knowledge exchange, integration and cooperation** to overcome the deficits of sustainability governance: interdisciplinary research projects, synthesis projects and workshops, global assessment projects, integrated and multi-scale governance programmes, participatory resource management
Contrasting and controversial discussions of **globalisation and sustainable development** happen within economics (regarding the environment and natural resource use, for example, in the heterogeneous approaches of neoclassical economics, institutional economics, and ecological economics) and between economics and other disciplines.

For the dissolution of controversies **new, pluralistic knowledge cultures** need to be developed (a process of joint learning):

- the ever increasing complexity of modern societies and their interactions with nature require the development of new knowledge cultures in science where **specialisation/differentiation and integration/synthesis of knowledge** need to be combined and balanced.

Such new knowledge cultures develop since the last decade under the guiding terms of **transdisciplinarity** and **mode 2**, which brought a further component in the interdisciplinarity discourse: the possibilities to combine and **integrate scientific and non-scientific knowledge** (for example practical knowledge, local ecological knowledge) – these practices need to be continually developed in research and knowledge syntheses.
Something to learn from an example from classical political economy: knowledge controversies can create new knowledge and insights - opening the way to knowledge synthesis through theoretical discussion: the debate about the future of industrial society in “the dismal science”

- **Malthus, Ricardo and Mill** foresaw that industrialisation ends in a plundered earth (Mill: what will be when growth has come to an end?)

- Mill discussed and assessed the Malthusian and Ricardian views of resource scarcity, interpreted Malthus’ proposition: that, population grows geometrically (exponentially), subsistence arithmetically (in linear form), which results in diminishing returns, overuse and misery. Mill clarified Malthus’ assumptions through further interpretation (Barnett and Morse 1963: 64ff):

  - the power of population growth has in human history never gone to extreme forms, but was modified through other influences: the assumption of Malthus that there is an absolute limit of available land that will be reached in the foreseeable future Mill saw as doubtful - progress works against scarcity and diminishing returns (as in Ricardo’s view, where scarcity appears only as a threat in the distant future):

- **Long before Malthusian scarcity (absolute limits of natural resources) is achieved Ricardian scarcity becomes effective that is mitigated through the principle of progress** (new agricultural techniques, new knowledge, skills, inventions, innovation - all working against diminishing returns)
Mill (as Malthus and Ricardo) believed that there is a tendency to increasing scarcity of natural resources and diminishing returns; he expected that industrialisation and growth will come to an end, resulting in a “stationary state” as the consequence of a long time of economic growth,

although in his view there is space on the earth for a high number of human population - when the described improvements happen (ibid: 70)

Mills reasoning with the antagonistic principles of scarcity and progress brought the debate to the point where the sustainability discourse takes it up again today - in economics in the newly developing ecological economics:

- **Georgescu-Roegen** (thermodynamic laws as limits of economic growth),
- **Daly** (adopting the idea of the “stationary state” in a modified form as “steady state economy”: to minimise the use of material and energetic resources = the throughput; the “full earth”), and **Martinez-Alier** (connecting the debate of resource scarcity with the newly unfolding debate of degrowth or zero-growth; the economics of ecosystems and biodiversity)
Comment: the scarcity controversy in classical political economy anticipated potential limits and overuse of natural resources as the final stage of industrial society

- ... as a **hypothetical state of the world in a distant future** about which nothing could be concretely said with the economic and the ecological knowledge of the time (Malthus, Ricardo and Mill used economic and ecological knowledge, although they argued as economists - ecology was not yet existing under this name)

- **When could such a state of transgressing the global limits of the earth's resource base be achieved?**

- The classical political economists and Marx, who spoke a clarifying word after the debate, could not imagine when this will happen. Marx, who criticised Malthus sharply for his naturalistic reductionism in political economy, conceded that he is right in one hypothetical case:

  - when the global population growth is so high that all resources of the earth, (land, sea, physical and living resources) were not enough to feed all humans. But also he thought that this can only be in a very distant future, could not imagine that this, what ecological economists today call “the full earth”, is approaching already in the 21st century (but economic growth continues)
Continuing with the scarcity discourse: present debates of exponential growth, degrowth, “prosperity without growth (Jackson 2009)

- When the Club of Rome opened the new, ecologically motivated growth debate with the first report on the “Limits to growth” (Meadows and Meadows 1972) the reactions were: this is “doomsday prophecy”, a new philosophy of fear and catastrophe, but not a realistic picture of the near future.

- The principal question: Is decoupling of economic growth from resource use possible? No final answers are presently found, but the interdisciplinary discussion brought some progress: that several forms of growth, their connections, and forms of decoupling need to be differentiated (for absolute decoupling of economic growth from growing natural resource use would, for example, huge investments in new technologies, especially low carbon technologies, be required; Jackson 2009: 83)
More differentiated growth analyses

- **Economic growth** (in the 20th century: 2000 %, see Maddison 2001) and other forms of growth – **population growth** (400 %), **growth of global biomass extraction** (360%), and **growth of use of material resources** (800%; Krausmann et al 2009: 2696)

- Many resource-related processes develop towards exponential growth, but how they influence economic growth is more complicated – the conditions and the drivers of economic growth change with the development of new technologies and other innovative changes: a field of future interdisciplinary sustainability research – where the first question is:

- **What is growing when the economy grows?:** Daly (referring to Boulding) specifies the economic growth by differentiating between **growth of GDP** (the annual marketed flow of goods and services in monetary terms, which does not measure environmental effects of growth and conflates costs and benefits for the environment) and **throughput growth**

- The relevant magnitude (to answer the question, how big the economy is or can become): **the throughput** - **the flow of material and energy from environmental sources through the economy** (in social ecology called: “societal metabolism”)
Progress in ecological research relevant for the study of future possibilities of economic growth: “planetary boundaries” (Rockström et al 2009)

- …some ecological indicators and data that measure different aspects related to economic growth: ecological footprint, MEFA – material and energy flow accounting, HANPP – human appropriation of net primary production, EROI – energy return on investment (they are not yet well connected with economic data of monetary growth)

- The growth of resource flows in the global economy is measured in physical terms in social ecology, for example in MEFA, which needs finally be integrated with the monetary growth (for that purpose the GDP growth needs to decomposed and recalculated)

- Daly: throughput growth should be stopped before it creates environmental and social costs that exceed the extra production benefits (in: Jackson 2009: xii). Logically or theoretically the argument is clear, practically it is more complicated to calculate the levels of economic growth that are finally possible - and still more complicated: how can the institutionalised exponential process of economic growth be reduced to sustainable levels or stopped
The work in the future interdisciplinary economic and ecological sustainability discourse/research: to clarify the connections between different forms of growth.

Jackson (2009) gives a detailed description of the problems and consequences connected with economic growth, but the question of limits to growth is only answered in physical and ecological terms, for example: 60% of the global ecosystem services are degraded and over-used, mostly during the 20th century, or: CO2-emissions happen 3 times faster than the land and the oceans can absorb the carbon dioxide.

The final argument of Jackson, as that of the ecologists and ecological economists is: no subsystem (as the economy) of the finite earth system can grow indefinitely in physical terms, therefore there is no alternative to question and limit economic growth.

But how a transformation of the modern economy to a sustainable economy of the future (with limited growth) can be practically achieved, is not yet known, requires further cooperation of economists and ecologists.
The answer of Jackson and ecologists is theoretically clear – to halt economic growth and introduce more forms of sharing and (equitable) redistribution of the available natural resources on the earth, as also the idea of sustainable development requires, but how this can be achieved concretely and at global level, is unclear.

It requires more than presently available mechanisms in policy and governance to transform the economy.

At this point the dilemma of sustainable development is obvious: the next “Promethean revolution” (as Georgescu-Roegen called the great transformations in human history: that from hunting to agriculture and then to industry)

is the building of a new economy where the natural resource use does not grow (the stock of natural capital is maintained) – it is a transformation that begins with insufficient knowledge: it needs to be learned on the way how to approach, a sustainable economy (probably in “trial and error”-procedures, through adaptive management = policy as experiments, and with new knowledge and knowledge syntheses)
3. Sustainable development - when scientific knowledge from different disciplines is clashing

- The greatest difficulty - and the test for economics as other disciplines to develop cooperation and interdisciplinary knowledge cultures - is, when for the multi-faceted sustainability process contrasting or contradicting knowledge is provided:

- What to do when ecological research and local knowledge about availability of natural resources or their depletion contradicts economic calculations (for example, in the bio-economic modelling in fisheries management),DBP:

- What to do, when sociological or cultural-anthropological research about resource use and consumer behaviour contradicts economic research?

- What to do, when policy research shows that economic policy instruments (such as tradeable pollution certificates) are not efficient or counter-productive in combatting environmental damages or overuse of natural resources?

- What to do when core institutions and processes of modern economy (markets, private property rights, forms of profit economy and economic growth, valorisation and pricing of natural resources) are more and more criticised in the sustainability discourse?
The answers to these questions, in a nutshell

- In a situation where complex social and ecological systems interact no discipline has sufficient and adequate knowledge, only partial knowledge that needs to be woven together in a patchwork of explanations (also formal sciences as cybernetics, logic, mathematics, or general systems theory do not have privileged knowledge to understand complex processes – there is no single and simple science of complexity)

- All of the questions above articulate directly or indirectly situations of problems, conflicts, crises, in which specialised knowledge and traditional form of resource management show their deficits and produce failures, need to be corrected or innovated in institutionalised processes of collective learning of interdisciplinary knowledge practices:

- sustainable development is a combined form of such necessary innovations: a mega-innovation that covers different social, scientific, political, economic, environmental aspects which require interdisciplinary knowledge integration and transdisciplinary knowledge use and - sharing
Knowledge sharing and knowledge negotiation

- ... is the pluralist rationality of interdisciplinary research and knowledge use and of participatory resource management (where not only scientists are involved in decision making as experts, but also the producers and resource users as experts of other kind). Bi-directional knowledge flows, knowledge sharing and participatory resource management develop today, not the least with the increasing environmental problems and environmental research, but they need to be continually improved and institutionalised in the global environmental governance process.

- **A scientific example for successful development of interdisciplinary knowledge cultures:** Economists and ecologists can learn from the interdisciplinary, social-ecological research that Elinor Ostrom and her colleagues practiced: on the basis of empirical research and case studies they identified the weaknesses, deficits and failures of resource management and environmental governance (an exemplary comparison and discussion: Acheson 2006)
A practical example of (partially) successful development of interdisciplinary knowledge practices: the European Union has supported and introduced new ecologically oriented forms of resource management - fisheries policy is a paradigmatic example.

The trends towards non-hierarchical, network-based, more democratic and participation-based forms of policy and governance were long time discussed in a simplified form - as power-sharing and empowerment of powerless groups, in short: as problems of legitimation and democratisation of policy and governance processes.

Only in the course of practical implementation of such governance practices (and with the difficulties experienced in this process) developed gradually the insight and awareness that subtle forms of interconnection between power and knowledge are at the core of the problems to deal with. Power sharing and democratisation of resource governance is also sharing of different forms of knowledge, experience, and expertise (from different professional roles and knowledge bearers).
The example of fossil energy sources - what happens, when important resources approach their final limits?

- ... either search for new sources, for example, of oil and use of risky extraction technologies (such as deep sea thrilling or the fracking technology)
- or to phase out fossil resources and develop new energy systems with renewable sources. The “peak oil”- debate supported the search and development of energy from regenerative sources and more sustainable energy regimes as the use of wind and solar energy
- These have been initiated with environmental and ecological knowledge and from environmental actors, through critique of economic doctrines or economic practices. Economic corporations in the oligopolistic energy sector have only gradually adopted innovations, when a new technology was developed (mainly through public financing) and supported by governments
- Windpower is meanwhile established in many European countries - the utopian moment, that a big country had for a short time so much energy from windpower, that it was enough for the whole electricity use in the country, happened already some years ago (in Germany)
- Windpower is also a positive example through the development of different organisation forms, large and small scale, commercial and non-commercial, cooperative forms or citizen energy cooperatives
4. Discussion and conclusions

- The knowledge problems and examples discussed provide some ideas, how to deal with knowledge in science and in governance of sustainable development:

- In a continuous process of search and joint learning: finding better “knowledge mixes” and compromises, integrating and synthesising knowledge from different disciplines, combining knowledge about ecosystems, social systems, technologies and technical systems, organising the process as one of continuous collective learning of different actors, seeking solutions in form of adaptive management/governance:

- “policy as experiments”), participation and cooperation of different actors and their knowledge, giving room for different forms of knowledge (scientific, managerial, practical, local, normative etc.)
... how to make sustainable development successful

... through learning from three decades of limited success:

- sustainable development is a process of seeking ways towards a future unknown economy and society; it cannot be achieved through economic and technical changes only

- To build a sustainable society is a long process of several generations, beyond the time horizons of planning and management. It requires joint learning on the way, from failures and experiences, how to build a new global system that can replace the industrial society and economy

- The post-industrial society which is discussed since half a century, first (by Bell) as a social and structural change from a first sector (agriculture) to a second sector (industry) to a third sector (services) is not yet achieved; in the ecological discourse it was called a “premature utopia” (Bühl)

- The main problem that comes with the sustainability discourse: we do not yet know how a future sustainable society looks like; we know only how to begin a new “great transformation” (Polanyi) – through the transition to less polluting, less material and energy intensive forms of economic production and consumption which requires multi-scale governance (integration of local, regional, national, global transformation processes)
In the past three decades since the beginning of the global sustainability discourse

- ... much research has happened, and we know much more today, not to the least through failures and bad experience. Only during this decade came the breakthrough in ecological research that brought a new and more realistic view of the sustainability:

- a long-term perspective ("longue durée", see Braudel and world system theory); a complex process of social-ecological transformation of the global economic and societal systems; an inter- and transdisciplinary process of knowledge integration and knowledge use; a pluralistic knowledge practice, where different disciplines, approaches, theories and methods, scientific as well as non-scientific knowledge can be applied and need to be combined;

- The process ends in the distant future about which we know nothing, and for which new knowledge practices are required: in the metaphorical formulation “navigating social-ecological systems” something is said about this approaching of a distant future about which we know nothing.
At present we have rather simple and undeveloped concepts, tools and methodologies to study and discuss potential futures and long-term development perspectives

- ... the most prominent one is the global scenario construction and movement that has already significantly enhanced the debate of sustainability transformation. The possible, wanted and unwanted future paths of development, when compared in the scenario construction, show already much of the problems and dilemmas on the ways towards a sustainable future.

- This is only the beginning of a new future science of transformation that needs to be developed and complemented with other methods, and theories, and further knowledge. The methodological challenge of such a science of the future which is to a large degree a science of sustainability is: to develop and continuously improve epistemological and methodological tools - this method development happens slowly, but in the scientific journals about future studies/research, one can observe the discussion of new methods; for knowledge synthesis methods see the discussion in: Bruckmeier 2019.

- Social ecology, the pioneering interdisciplinary science that helped since the 1990s to improve the knowledge about sustainability and to qualify the sustainability debates in science and policy, can provide some orientation in the further search on our way to the “common future”, the lead metaphor of the political sustainability discourse.
Appendices

- Additional information
Interdisciplinarity developed rapidly as a new and alternative scientific knowledge culture in the second half of the 20th century

- ... and has become a dominant form of research and cooperation (for example in the environmental and the technical sciences)
- Interdisciplinarity is not a new phenomenon; the recent trend is only a renewal of older forms that were not discussed under this name. In the history of economics exists a long tradition of interdisciplinary thinking since the early political economy that should not be forgotten. What needs to be learned in the present new wave of interdisciplinarity in economics is especially the integration of natural scientific and ecological knowledge from environmental research with economic knowledge. Throughout the development of modern political economy since the sixteenth century interdisciplinary thinking was practiced, concepts and knowledge transfer in economics
- What needs to be learned in the present new wave of interdisciplinarity in economics is especially the integration of natural scientific and ecological knowledge from environmental research with economic knowledge
Knowledge problems in the discourse of environmental sustainability

- The first knowledge problem: to clarify the notion of sustainable development; This “essentially contested concept” (Collier et al 2006) is insufficiently defined (in the Brundtland-report from 1987) as **intra- and inter-generational solidarity of resource use**

- The term is continually discussed and interpreted without achieving consensus in science and politics; it exists as a **bridging concept** with a plurality of interpretations (including contrasting and competing ones) and requires a complex, multidimensional analysis of human use of natural resources (Howitt 2001)

- Nevertheless it became an influential bridging concept in environmental science and policy that was adopted by most countries as overarching policy goal, although often more rhetorically used than implemented

- That sustainable development has little success so far is not the only a lack of policies and political interest, but to a knowledge problem: less one of too little knowledge, more one of insufficiently and inadequately applied knowledge. There is much knowledge available from many disciplines, which would require interdisciplinary knowledge integration
• **Critique of the sustainability concept:** more recently came up concerned voices whether it is too late for realising sustainable development (Worldwatch Institute 2013)

• and more critical ideas against sustainability in the ecological discourse which can be understood as reaction to the lacking success in sustainability governance in the past decades:

• sustainability or sustainable development are too complex concepts that cannot be realised practically because of insufficient knowledge and understanding of the social and ecological complexity

• therefore they need to be replaced by simpler concepts, for example that of resilience, which can be achieved more easily (Benson and Craig 2014). The problem is, that resilience is an as diffuse and unclear concept as sustainability can be specified in different forms
Against the reduction of sustainability to resilience raised new critical voices, arguing for a renewal and improvement of the sustainability that has gained momentum in politics (Allen 2008, Markard et al 2012; Rees 2010; Asara et al 2015; for further discussion see: Bruckmeier 2016)

In the policy and governance practice, sustainability has been dealt with in reductionist forms – either reduced to a normative goal of the governance process, or dissolved in a pluri-dimensional concept which is the mainstream variant: of economic, social and ecological sustainability. Such interpretations, although not sufficient for the scientific discourse, can be dealt with in the broader sustainability debate - as forms of a deficient practice that includes the political rhetoric of sustainability
The nature of the modern energy system

- … is that of a global system that is based on the modern economic and industrial system - according to its main components of fossil energy sources that developed through industrialisation: coal, oil, gas, the energy from the “subterranean forests” as it is formulated in environmental history.

- The further energy forms are developments that came one after the other, as forms of modernisation, such as nuclear energy, or the renewable energy sources. It does not matter so much, whether and how the composition varies at national levels - some countries may use more water based energy, other more coal based, other more nuclear based etc., but the global system has as main components that connected with the industrial economy; the big development processes happen at supra-national levels (for example during the history of industrialisation the transition from a coal-based to an oil-based energy regime, and in future to systems based on renewable energy sources).

- The main problem with new energy sources and conversion technologies: the long time of development and high development costs - who bears these costs?
The development of solar energy did not run so smooth. Some years ago the collapse of the “desertec”- project (to provide energy for whole Europe by building a huge solar park in the Sahara desert) showed that the economic system and corporations alone cannot create more sustainable systems of resource use alone and only relying on the market forces.

What went better in the case of windpower – a long development period in which compromises could be found and coexistence of different solutions, large and small-scale systems, cooperative and commercial forms: large, company owned on- and offshore wind parks, and small, cooperatively owned, decentral and locally adapted forms, even individual use of wind turbines on farms.

What went wrong in the first big plan of conversion to solar energy is not the conversion technology or its efficiency, but the inflexible organisation and planning in form of one gigantic commercial solution idea, to deliver electricity for whole Europe from one technical system. Solar energy will not vanish in future, but develop in various institutional, technical and economic forms.
Limits to growth - two hypotheses:

social and physical limits/ scarcity

- Meadows & Meadows 1972 (”Club of Rome”-report) - **physical limits to growth** (today: ”planetary boundaries”):
  - production and consumption forms in industrial societies cannot continue forever because of limited availability of natural resources and limited production/reduction capacities of ecosystems

- Hirsch 1976 - **social limits to growth**: summarized in the hypothesis of ”industrialisation as positional good”:
  - positional goods are luxury goods that can be bought/consumed only by a limited number of people - there are not enough of these goods for all inhabitants of a country (or the earth) - industrialisation as privilege of the Western countries industrialising first, latecomers are denied that privilege
Both variants of the limits to growth debate sum up to the message:

- **Industrialisation in all countries, with the same levels and intensity of resource consumption as in Western countries, is impossible - not enough natural resources on the earth:**

- **Industrialisation does not solve global social or environmental problems - another society needs to be built: a ”postindustrial society”, with other forms of distributing and sharing resources**

- **Necessary in the ”limits to growth”-debate?:** specifying the environmental consequences of different forms of growth: population growth - economic growth - growth of resource use or consumption - growth of environmental damages
Global exponential growth
drivers of social-ecological processes

Steffen et al. 2004
James Rice (2007): unequal ecological exchange in the modern world system

• "the rich-country-illusion effect":
  "By importing natural resources and exporting sink capacity demand and environmental costs inhabitants of core countries can mistakenly perceive their lifestyles as sustainable, as their consumption rates are not highly linked to domestic environmental conditions … Conversely the rich-country-illusion effect implies that LDCs are to blame for failure to sustain their domestic natural capital" (l.c.p. 63)
The anthropocene

“Over the last two hundred years, humankind has evolved into a planetary force that influences global biogeochemical systems. No longer is the human species a spectator that merely needs to adapt to the natural environment. Humanity itself has become a powerful agent of earth system evolution. In particular global warming is proceeding rapidly. The snowfields on the Kilimanjaro might melt within a few decades, and the ice cover on the Arctic Ocean has shrunk by over 30 percent since satellite observations begun in 1979. Some scientists warn that major disruptions in the earth system could occur within this century (Steffen and others 2004). The evidence of human influence on all planetary systems is such that stratigraphy experts are prepared today to formally classify the present time as a distinct epoch in planetary history, the “Anthropocene” ....” (Biermann 2011, p. 4)
Historically 2 important "Promethean revolutions" (not counting the 1. one = use of fire):

1. **Neolithic revolution** – creating agricultural and urban societies of local/regional scope, based on renewable energy sources (solar energy, human and animal work, wind, wood)

2. **Industrial revolution** – creating a global, resource intensive economy based on fossil energy sources (coal, oil, gas) and nuclear energy

**(Future) post-industrial society** – based on renewable energy sources: solar energy gains importance
Barriers to global sustainable development
(from: Millennium Ecosystem Assessment)

• Inappropriate institutional and governance arrangements, including the presence of corruption and weak systems of regulation and accountability.
• Market failures and the misalignment of economic incentives.
• Social and behavioral factors, including the lack of political and economic power of some groups that are particularly dependent on ecosystem services or harmed by their degradation.
• Underinvestment in the development and diffusion of technologies.
• Insufficient knowledge (as well as the poor use of existing knowledge) concerning ecosystem services and responses that could enhance benefits from these services while conserving resources.
• Weak human and institutional capacity related to the assessment and management of ecosystem services.
Globalisation and sustainable development

In environmental sociology the linkages between economic and ecological globalisation have been studied e.g. by A. Mol, "Globalization and Environmental Reform", Boston 2001.


“Globalisation interacts with sustainable development at levels that make measurement difficult, e.g., trans-border environmental issues, cultural transformations and a so-called `global consciousness´. For example, the data do not show us that the most **globalised countries might have a higher HDI or EPI because they have exported their pollution or that the costs of the goods and services they enjoy and contribute to their lifestyles are borne by people and environments in other parts of the world.”
“What is clear is that the increasing complexity of our global society means that sustainable development cannot be addressed from a single perspective, country or scientific discipline. Planning for sustainable development in the context of globalisation is far more complex than most problems that had to be tackled in the past. Planning for sustainable development requires new paradigms and innovative methods, balancing the short term and long term, the objective and value-laden, the quantitative and qualitative, the certain and uncertain. As addressed by others (e.g., [38]), it is our hope that a further analysis of sustainable globalisation may help in adjusting and optimising the process of globalisation on every level in the direction of a sustainable development. To this end, extensive empirical work is needed to identify the relevant causal mechanisms underlying the influence of globalisation on sustainable development.” (p. 290f)
Four parts of the knowledge process

(1) Knowledge production through **empirical research**: data collection (primary and secondary data) – these are the methods mainly discussed in sociology as quantitative and qualitative methods (in textbooks)

(2) Knowledge production through **interpretation and theoretical research**: analysis and synthesis of knowledge (connecting data and concepts, e.g. in modeling)

(3) Knowledge use - **dissemination** – in education/training, application of knowledge (transfer and sharing of knowledge between scientists from different disciplines or/and non-scientists)

(4) Knowledge use - **communication of normative knowledge** (of worldviews and values) – the ”invisible methods”, usually not discussed as methods, not seen as part of the research process: premises/norms/assumptions that guide the formulation of theories, frameworks, hypotheses
Global ecological footprint

Demand = what humankind consumes, measured as global EF

Biocapacity = ecological supply/what the global ecosystem can produce in 1 year

Since the 1980s human resource use exceeds the global biocapacity
Metabolic profiles of socio-ecological regimes in world history (M. Fischer-Kowalski)

Per capita annual use of energy (GJ) and material (t):

**Basic human metabolism** 3.5 GJ/1 t
(biomass intake by nutrition)

**Hunter-gatherers** 10-20 GJ/2-3 t
(uncontrolled solar energy use)

**Agrarian societies** 40-70 GJ/4-5 t
(controlled solar energy use)

**Industrial societies** 150-400 GJ/15-25 t
"Post normal science/ PNS"

- The PNS-hypothesis formulated by Silvio Funtowicz and Jerome Ravetz describes knowledge situations like these of environmental problems or global environmental change - where risks are high, values disputed, decisions urgently required, but knowledge insufficient.

- The problems resulting from PNS:
  - No single discipline or specialised research can provide the knowledge required (interdisciplinarity, transdisciplinarity).
  - Scientific knowledge/expertise (with abstract, general and universal knowledge) come under pressure and critique (other knowledge forms upgraded).
Mode 1 and 2 (M. Gibbons et al., 1994, The New Production of Knowledge)

**Mode-1 Science:**
- Academic (universities)
- Mono-disciplinary
- Technocratic (specialists)
- Producing valid knowledge
- Predictive

**Mode-2 Science:**
- Primarily non-academic research
- Trans- and interdisciplinary
- Participative
- Uncertainty accepted
- Explorative
Transdisciplinarity

- "First, transdisciplinarity tackles complexity in science and it challenges knowledge fragmentation …

- Second transdisciplinary research accepts local contexts and uncertainty; it is a context-specific negotiation of knowledge…

- Third, transdisciplinarity implies intercommunicative action… includes the practical reasoning of individuals with the constraining and affording nature of social, organisational and material contexts …

- Fourth, transdisciplinary research is often action-oriented … deal with real world-topics and generate knowledge that not only address societal problems but also contribute to their solution”

(Roderick Lawrence & Carole Després, ”Futures” XX, 2003)
A. Jamison: Changing Regimes of Knowledge and Power

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Theoretical concept: "metabolism"

- Originally used for the description of chemical processes in organisms (e.g. in the human body) to provide energy (calorific throughput), generally: all energy and matter exchanges in living cells and organisms that support life.

- "Societal metabolism" - the change of ecosystems and nature through socially organized processes of production (materials and energy use, e.g. in agricultural or industrial production): material and energy resources that flow from nature to society, are modified in production and consumption processes (degraded, dissipated), to enter again in ecosystems/sinks (as waste).
“We have identified nine planetary boundaries and, drawing upon current scientific understanding, we propose quantifications for seven of them. These seven are climate change (CO2 concentration in the atmosphere <350 ppm and/or a maximum change of +1 W m-2 in radiative forcing); ocean acidification (mean surface seawater saturation state with respect to aragonite > 80% of pre-industrial levels); stratospheric ozone (<5% reduction in O3 concentration from pre-industrial level of 290 Dobson Units); biogeochemical nitrogen (N) cycle (limit industrial and agricultural fixation of N2 to 35 Tg N yr-1) and phosphorus (P) cycle (annual P inflow to oceans not to exceed 10 times the natural background weathering of P); global freshwater use (<4000 km3 yr-1 of consumptive use of runoff resources); land system change (<15% of the ice-free land surface under cropland); and the rate at which biological diversity is lost (annual rate of <10 extinctions per million species). The two additional planetary boundaries for which we have not yet been able to determine a boundary level are chemical pollution and atmospheric aerosol loading. We estimate that humanity has already transgressed three planetary boundaries: for climate change, rate of biodiversity loss, and changes to the global nitrogen cycle.”