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There are big issues for universities to deal with, including the state that they are in. Higher education is fast becoming a commodity rather than a value - yet another eclectic means of knowledge-seeking. Universities are part of a 'knowledge industry', full of parochialism and the personal rejection of shared academic dialogue or a sense of purpose. What has been seemingly lost as unsustainable is the sense of universal humanism, the possibility of transcendentalism and the power of reason. One day, universities might be forced to reconsider what they have to offer in a world of global poverty, environmental degradation and uncivilized behaviour.
This is the big issue of our time.[1]

What Kind of Science Do We Want? A few Observations on "Third Tasks" and New Challenges

Science in times of global change

We are witnessing a process of fascinating change in science and research. This process is still young. Scientists who are active in problem- and solution-oriented work are embarking on new territory. But they have to struggle with parameters which have not yet been adapted to match the peculiarities of "new"[2] fields of activities for science and research. Prevailing parameters in today's universities, for career making and in science funding often impede a focus on real world problems. There are many factors involved. The following hypotheses summarize a few observations from personal experience and literature reviews during the work on a habilitation[3] presently prepared by the author. If proven via more empirical research these hypotheses could be indications for major trends within science:

Hypothesis 1

We live in an age of worldwide upheaval in societies, occurring against the background of global change. This phase may be characterised by four predominant factors which are highly interdependent and which are themselves carriers of a powerful mix of ever changing, unexpected and reciprocal reinforcements:

- *the growing interdependency and fragility of the global economy (with the financial markets as especially fragile but volatile drivers of change)*
- *the globalisation of ecological threats*

1 Cullingford 2004, p. 22

2 Arguably all this is not necessarily very "new": There have been times in the history of science where a problem- and solution-orientation was very common, at least in the natural sciences. The notion of objectivity versus getting involved in socio-politically important topics is probably just about 150 years old and goes back to the activities of the first Academies of Sciences in England, France and the USA. It was the „purity" of the experiment and the wish of no interference from outward factors that led those scientists towards exclusion of the social and the political (see also Novick 1988).

3 This work is conducted with artec / Research Center for Sustainability Studies at the University of Bremen, Germany (Prof. Hellmuth Lange). The title of the habilitation is: Sustainability Science - Perspectives of integrative research on global change on the basis of comparative analyses of national research conceptions in the EU.

- *the overfill of available information ("info-glut") to any of the involved individual topics and the enormous growth of complexity that goes along with that and with ever more efficient means of knowledge generation and evaluation*
- *the growing inadequateness of solution capabilities, i. e. the human inability to deal with these problems in a meaningful way which has foremost historical-cultural and political-power structural reasons.*

Globalisation of commodity flows and recurring ecological hazards alone demand answers from science and research – and a pace in developing those answers - that goes far beyond our present capabilities. There is a need for another dynamic in developing such solutions which keeps pace with the dynamic of the global change presently experienced. Science plays a special role in this context. However, up to now science has only just about started to face let alone live up to expectations brought upon it from "outside groups", i. e. (civil) society, the business world, NGOs and the polity.

Hypothesis 2

This change is itself so volatile and all encompassing that the development of adequate responses and counter-measures are of high priority. It is in this situation that questions concerning the sustainability of human (and non-human) life are coming into the worlds of science. Such questions and problems are by definition "normative" as the continuation of life on earth itself is a normative vision. Science that deals with these topics needs not necessarily be classified "normative science". But it is operating in social and policy initiated and impacted contexts. And it is expected to deliver results towards some - however vaguely defined - notion of a common good (e.g. slow down and adaptation to climate change). Transdisciplinarity[4], i.e. the involvement of knowledge within scientific efforts from other sectors than science, is highly needed in such a situation as science alone is not capable of delivering the needed estimations and suggestions for action. However, in the long run this only operable under some commonly shared sense of working towards (in each case more clearly to be defined) aspects of a common good.[5]

A systems-based, holistic understanding of the underlying factors of globalisation and global change, be they social, economic, political and/or cultural factors, as well as their interdependencies, is becoming ever more important. Broad-based cooperation between actors in research and actors in implementation is becoming essential for coping with the involved challenges. And all involved groups seem to depend on each other in their efforts of working towards possible solutions.

Hypothesis 3

It needs careful thinking what that means for the perception of science. This holds true for scientists themselves just as much as for other societal groups. Science was seen as a so far (relatively) independent and (more or less) "objective" knowledge generation system. Can this hold? It needs careful thought what these developments mean for the (self-)perception and -understanding of scientists. There is a complex process of re-thinking and re-establishing science under way right now.[6] *The process of finding answers to questions connected with the change involved has begun some ten to fifteen years ago. But the meaning of it and its possible consequences are rarely openly discussed in academia.*

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4 on the development of the concept of transdisciplinarity see the volume edited by Thompson Klein et al 2001. This book summarizes the results of a conference held in February 2000 in Zurich with participation of some 800 participants from 50 countries.

5 see also the notion of a "civic science" from O'Riordan 1998

6 see among many others: Gibbons et al 1994; Funtowicz / Ravetz 1993

This has far-reaching consequences for the way in which science dealing with such topics is operated. However, in no way does that imply that science and research can act only in implementation- and target-oriented manner. There will continue to be a need for basic research and science organised along the lines of the classical disciplines.

These "traditional" forms of science will continue to be needed – probably even more so in future than at present. But whenever we deal with topics centring on global change, globalisation, sustainable development and other policy relevant topics of such complexity and possible impact, scientists will have to deal with different parameters. They are imposed by the necessity to see problems within their contexts and by aims for wider society. Expedience and serviceability of results – all in reference to predefined objectives - suddenly play a decisive role. Beyond this there is the further challenge of readying results for translation into concrete action and the corresponding process of change. Only this way science and research can become active partners for implementation, and themselves actors taking part in the formulation of the local to global solutions required. But themselves actors and/or stakeholders? For many scientists educated in the classical disciplines this is difficult to take. Many fear in this connection a loss of independence. And of course independence of science remains a good to be strongly defended. But independence has been a challenge all along and arguably there never was a totally independent science. It always was highly dependent on funding from outer sources and will probably remain to be.[7]

Various forms of knowledge

To be able to deal with the above described change science has to form alliances with other groups of society and other holders of knowledge. Among them are people from the polity, the private sector (e. g. industrial engineers, bio-scientists in private industry, telecommunication specialists...), administration and local / regional governance (e. g. water authorities, land use planners...) and the wide-ranging scene of NGOs and pressure groups (e. g. NGOs active in the Kyoto Process or in international health campaigns...). Each of these groups possesses particular forms of knowledge. The first step is to realise this fact. Secondly, these forms of knowledge need to be respected and taken seriously. On this ground cooperation then may become more sensible and meaningful.

The literature of science theory lists, among others, the following forms of knowledge:

- Factual knowledge (data, empirical and historical facts...)
- System knowledge (knowledge of the function of systems and interrelations)
- Knowledge (and particularly learning) from experience, i.e. knowledge possessed mainly by people doing practical work on the problems addressed
- Orientational knowledge (surveys, knowledge from scanning broad areas of experience and facts)
- Transformational knowledge (strategic understanding of how to change present conditions, knowledge about change management or knowledge on how to start and run reforms...).[8]

Without going into this much further I would like to drive home two points:

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7 Just a short note on this: State funded science is not necessarily more independent than science funded by the private sector. There are all sorts of interests involved and at many levels, surely also on the side of scientists themselves (see for a detailed discussion Weingart 2005).

8 See for example Ulrike Felt et al 1995

In implementation- and target-(policy-)oriented research fields there is usually a mix of different forms of knowledge to be taken into account. These forms of knowledge need to be distinguished and each of them taken seriously for a possible contribution to solutions.

If in fact different forms of knowledge are needed for finding answers to questions involving (societal) change, then there is a growing need to bring together and evaluate these kinds of knowledge. This effort may be coined "knowledge management" – but realising, in a non-technical sense, that a key part of such knowledge management has to do with facilitating communication and interaction among people.[9] It is easy to see that science so far is not very well equipped to deal with this situation, i.e. having to manage not only different but in many cases equally important and useful forms of knowledge ("inward communications").

Arguably, in some ways this has been a challenge for science for a very long time (and probably since the origins of science itself). But the necessity to work in this way becomes ever more urgent when we address topics concerning global change, globalization and sustainability.

Different challenges for communication and involvement

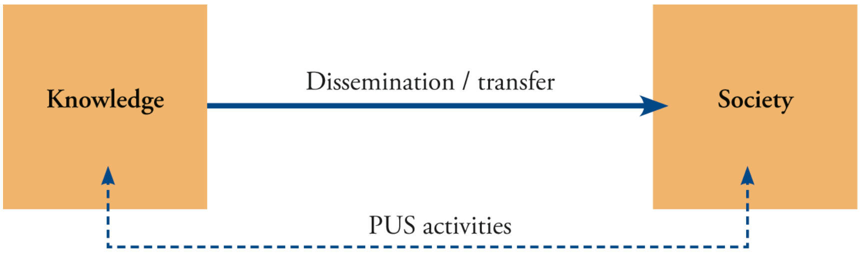
This situation is seen once again when looking at outward communications. When science "opens up" and starts to communicate with the rest of society an important interface appears between those involved in academic knowledge generation and those addressed by the results of their efforts. This interface is highly diverse itself. Different types of science predominantly make use of different types of communication and involvement of non-science actors. But in the context of implementation– and target-orientation this interface needs to be carefully dealt with when considering potential moves from knowledge to action. In fact it is crucial for all implementation work (see for a detailed discussion Moll / Zander 2006).

Unfortunately many existing metaphors concerning the famous "gap" between knowledge and action fall astonishingly short of the real challenge. The mental images as in the often-cited "bridging the gap" metaphor are inadequate in the context of globalisation and global change. The challenge lies not in building (one-way) bridges, or in transfer alone or just in dissemination, even though these all are important elements of the overall challenge. What is needed in implementation– and target-oriented science is strategy development, modification, integration, feedbacks, supplementation (with different forms of knowledge), analysis of systems and environments fit or unfit for innovation and reform, analysis of target groups and much more. Thus there is not one "bridge" over one river but often a whole ocean to cross – and that with many different modes of transport.

However, it is possible to distinguish at least roughly between **three types of interfaces** that play a role when communication between science and society takes place:

[9] Thus we refer here not to the technical management of data as in computer science literature. The latter seems to us better termed as "information management". For a discussion of „knowledge management" of different forms of knowledge see: Paul Hildreth / C. Kimble 2002

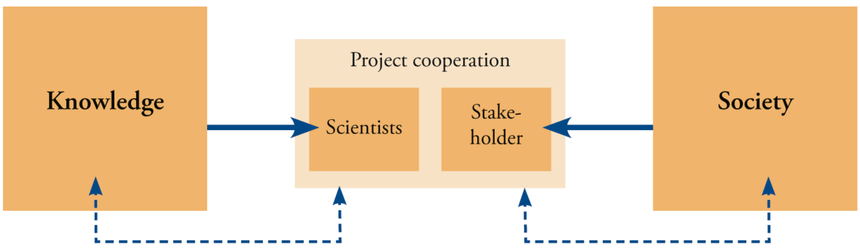
Figure 1: dissemination / transfer



graphic: Moll/Zander 2006

Dissemination and transfer – This is the classical approach in disciplinary science and for results from basic research. Knowledge is generated in classical manner and when the job of the scientists basically is finished results are communicated to the "outer world". The interface thus is with members of the wider public. They are to be informed about knowledge generated in science projects which might affect them. "Public understanding of science" (PUS) has become a major factor in science communication, with many activities worldwide. They are addressing, for instance, school classes and interested laypeople at "science weeks", technical museums or via imaginative projects like, to mention just one example, the Eden Project (www.edenproject.com) in the UK. In times of limited resources public acceptance becomes of growing importance. However, the learning is thought to be mostly in one direction, from the informed scientists to the less informed public. Feedbacks do take place in direct contacts. But it is doubtful whether they very often change the way further research is being conducted. In other words: the factual and system knowledge dominates clearly over other forms of knowledge possessed by practitioners or "lay-people".

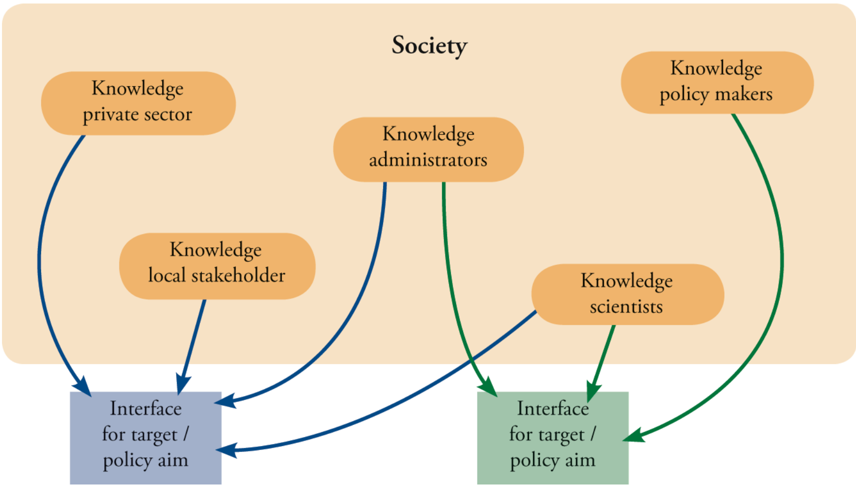
Figure 2: interaction / cooperation



graphic: Moll/Zander 2006

Interaction and cooperation – This interface is most apparent in applied science for the development of new technology. Science and non-science actors, in this case often from the private sector, form a team to work on a (most of the time) technological innovation or adaptation. The cooperation is very close and personal. Academics and technicians / practitioners from a private enterprise or private research institute work together for months, sometimes years, and often on equal terms. The cooperation usually survives for as long as project funding is available. There is not necessarily much public dissemination of findings. The main target is to develop a prototype stakeholders from industry or other sectors can adopt and – often after several more years of product development – may be able to turn into a marketable product. Communication is direct, often dominated by technical terminology and often not well suited for public dissemination. However, involvement certainly is one of the most successful ways of communication and often much could be learned from the experiences of such working teams for dissemination activities of the above described form.

Figure 3: transdisciplinary / joined work on problems & solutions



graphic: Moll/Zander 2006

Transdisciplinary / joined work on problems and solutions - This figure characterizes the particular form of knowledge generation in transdisciplinary projects. When the aim of a research project is to work on possible solutions for problems in the realm of global change and/or globalisation scientists have to bring together different stakeholders who posses knowledge and practical experience that may be needed to work on solutions. For example: In the area of water and river management the knowledge of "administrators" in this case the water authorities of a region is needed just as much as that of the "private sector" (water engineers / consultants / suppliers of new technology). And also local stakeholders such as owners of land or industry in need of large water supplies have information (not just interests!) that is needed to form a full picture of the overall water cycles needed in and for the region. A good part of the work of the project is to really bring together all this knowledge and manage the respective stakeholders. Without that no meaningful work on possible solutions could take place.

Communication in this case means stakeholder management and participation of often highly diverse groups of people. This is a totally different undertaking than doing research from the desk or in a university laboratory. It is the "common good" targets that determine who to involve and how to run a project. Those targets also determine what kind of knowledge is useful and should be generated and further researched. The process of doing so often carries the involved scientists far away from solely disciplinary academic interests and backgrounds.

It is important to stress that these three types often co-exist. They are non-exclusive. The third type, in various ways, combines elements of types 1 and 2. However, the illustrations show basic differences. And they are a visual indication for the enormous growth of complexity in transdisciplinary research and when dealing with (developing, communicating, transferring, implementing...) possible real world solutions.

Third tasks

In this context the experience of science policy making in Sweden is interesting. In 1992 the Swedish Government has issued a directive on the future of science and research in the country. All institutions of higher education were asked to invest more effort in implementation-oriented activities and research and in particular to strengthen cooperation with the surrounding communities (regional as well as city authorities, institutions, civil society). The idea was to build up and further develop Swedish capacities for "third tasks" within science: Besides the classical targets of research and career development of young academics via publications (first task) and teaching / education (second task) a third area of activities was regarded as of equal importance. A "transfer sector" should be built up where in particular cooperation with non-academic stakeholders of the region (cities and towns / local areas) and with NGOs and the business world was enforced. Activities like stakeholder integration and communication with non-scientists should be systematically developed. The idea was to regard such activities in the medium and long run as of equal importance as the other two tasks (National Agency of Higher Education 2005).

This fastidious effort was evaluated over the last fourteen years. Overall there are a number of success stories where universities seem to have got into closer cooperation with the "surrounding community". It is difficult to see though how much this has influenced the work of the scientists and in what way. And "cooperation" of course is not the same thing as "implementation" and "target-orientation". The question appears to be: Where – in concrete terms – have these "new types of cooperation" led? And how – in most systematic fashion possible – can cooperative efforts be employed to achieve scientific project goals?

To answer these questions evaluation mechanisms and criteria used also in Sweden seem not to be advanced enough. However, the initiative is of great interest for the development and support of "third task" activities and transdisciplinarity in science. When evaluations are carried out by the National Agency for Higher Education, top academics in Sweden tend to rate collaboration with non-academic institutions highly and, accordingly, give greater recognition to the work of universities who open up doors and emphasize active cooperation with their communities. This is a start. The long-term goal in our sense would be reached if third-task achievements on scientists' CVs were put on equal footing with lists of publications and lectures. In Sweden, too, there is still some way to go before this situation is reached. Also in Sweden "publish or perish" is the rule of the time, and not "apply or die".

What kind of science?

At present scientists are not rewarded when entering inter- or transdisciplinary discourses or for taking on "third task" efforts. On the contrary. Third tasks are still mainly counter-productive when individual career making and earning a good salary is the major aim. Only with changing emphases of funding programmes and policies directed towards a reform of university infrastructures this could very slowly be turned. Universities after all are highly conservative and deeply parochial institutions which take long time to change. With new BA/BSc and MA/MSc curricula which tend to be more inter- and transdisciplinary and with the changing role for science and research altogether quite a lot of this change is already taking place. In times of ever scarcer resources from the state the effect of all these developments need to be carefully observed and indeed seem not only to have positive effects.

What is much needed in such times is more clarity about the overall aims of the "science system" altogether. Where do we want to go? What kind of science do we want? How do we want the science system to be some twenty, fifty or hundred years from now? How much attention do scientists want (need?) to pay to real world problems? Do we want a science system that exists as far as possible away from real world interferences or is that kind of science our vision which already existed at the times of the Renaissance when real world problems were actively searched for and working on real world solutions was the commonly shared paradigm?

My personal impression is that the science system is both enlarging and diversifying. There might even be room for more than just one or two general perceptions and visions. But even more so it would be highly desirable if we better knew in what (part of the) system we are operating and how the parameters need to be adjusted to fit the respective aims and visions. This indeed would be a step forward.

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