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## SOLVING ENVIRONMENTAL PROBLEMS BY TRANSDISCIPLINARY RESEARCH

### ZGJIDHJA E PROBLEMEVE MJEDISORE ME NDIHMËN E PUNËS KËRKIMORE NDËRDISIPLINORE\*

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#### Abstrakt

Eksperienca e tetë viteve e një programi të gjerë Zviceran me përparësi në shkencat mjedisore (SPPE, 1992-2001) çon në përfundimin se problemet mjedisore të krijuara prej sjelljes së gabuar të njeriut dhe rritjes së shpejtë të tij në mbarë botën nuk mund të zgjidhen në strukturat tradicionale akademike kërkimore, por nëpërmjet bashkëveprimit të ndërsjellët ndërdisciplinor midis shkencës, shoqërisë, politikës dhe praktikës, ku zgjidhja e një problemi është një proces i vazhdueshëm i pandërprerë bashkëpunimi midis arritjeve të reja dhe zbatimeve të tyre. Dy projektet Shqiptaro-Zviceranë 2002-2004 dhe 2005-2008 janë diskutuar këtu në këndvështrimin ndërdisciplinor.

#### Abstract

The experiences of eight years of a large Swiss priority program on environmental sciences (SPPE, 1992-2001) led to the conclusion that environmental problems created by the misbehavior of men and its rapid growth worldwide cannot be solved in the traditionally structured academic research, but by true transdisciplinary interaction between science, society, politics and practice where problem solving is a continuous process with constant interaction between new results and application. The two Albanian-Swiss projects 2002-2004 and 2005-2008 are discussed in the context of transdisciplinarity.

#### Introduction

Environmental problems and disorders are often a consequence of the misbehavior of man; the rapid industrial and technical advancement which certainly brought a massive increase in wealth to a large part of the societies in the world resulted in a broad spectrum of interactions at different levels

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between nature and man. The increasingly visible problems lead to changes in the equilibrium in nature, and most are of high complexity:

Many processes occur simultaneous and are overlapping in time and space, the result in nature may

- be additive (the hundreds of volatile compounds in the water of the Buvilla reservoir may origin from Cyanobacteria, Streptomyces or from submersed decaying vegetation by heterotrophic bacteria, Fig. 13-1);
- be non linear with feedback effects (the relation between rainfall and total suspended solids in the Buvilla reservoir, Fig. 13-2);
- become visible only after a time lag (eutrophication delayed by years after pollution);
- appear great distances away from the point of pollution or in other ecological systems (soil pollution → change of water quality);
- become visible only in limited organismic groups (specific sensitivity, ideal as indicator organisms).

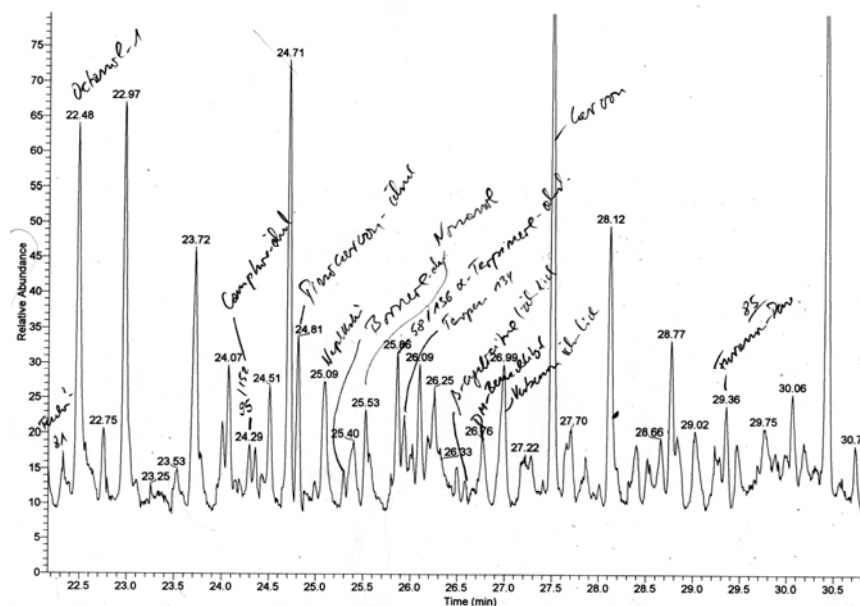
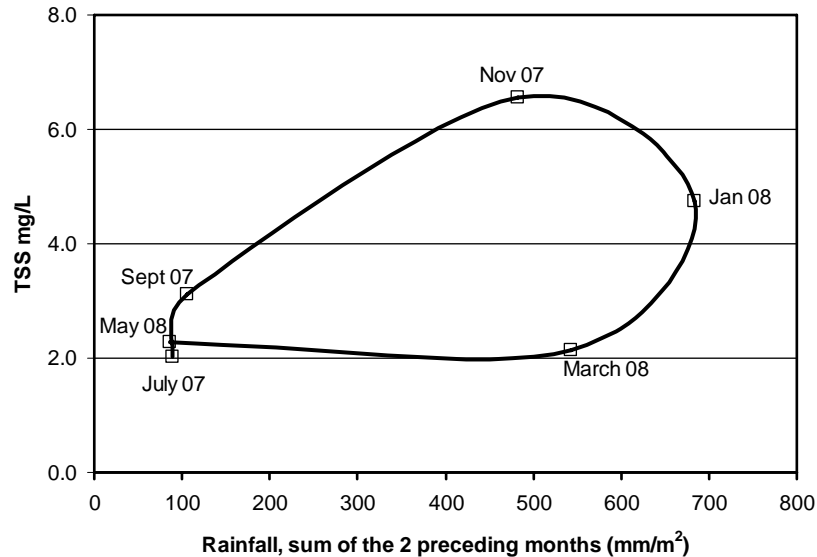


Figure 13-1: Part of chromatogram of volatile compounds in water of the Bovilla reservoir. / Pjesë nga kromatograma e lëndëve të avullueshme në ujin e ujëmbledhësit të Bovillës (Courtesy F. Jüttner, see also Çullaj & Bachofen, Nr. 2 this volume)



**Figure 13-2:** Relation between rainfall in the catchment area and TSS in water of the Bovilla reservoir. / Lidhja midis reshjeve në pellgun ujëmbledhës dhe lëndëve të ngurta pezull (TSS) në ujën e ujëmbledhësit të Bovillës.

Academic science and research has been and is concentrated in universities, these are traditionally structured in scientific disciplines. While the 18<sup>th</sup> century scientists were real natural scientists, all-rounders from geology to botany, zoology and medicine, most of today's scientists are highly specialized. Invisible boundaries separate the disciplines and it is clear that such fixed structures are inadequate for solving complex environmental problems. System oriented research needs approaches from many disciplines. Only recently some new disciplines, combining separate topics, were created at universities, such as biochemistry, geomicrobiology or neuroscience.

However, a few scientific fields are historically system oriented where its research covers several traditional disciplines. One is limnology which originally described aquatic systems in a broad view, mainly through hydrology, physics, biology and chemistry. A broad literature exists, analyzing with sophisticated methods the present state of our lakes and rivers. But also here specialization increased and resulted in finer resolution of specific single aspects of only academic interest. As examples, Egli *et al.* (2004) studied the active movement and orientation of a layer of phototrophic bacteria in a

meromictic alpine lake in Switzerland in the cm range and time resolution of minutes, or Matzinger *et al.* (2006) measured density differences in the sediment near water of Lake Ohrid from temperature measurements with 0.01 °C. Discussions on most academic research remain restricted within universities and are hardly linked neither to application, to society nor to practice.

With increasing local and global pressure on the environmental situation, research in limnology shifted in recent decades also towards restoration of environmental changes that had occurred in the past. This moves problem solving beyond basic natural sciences and implicates a broad discussion among many partners.

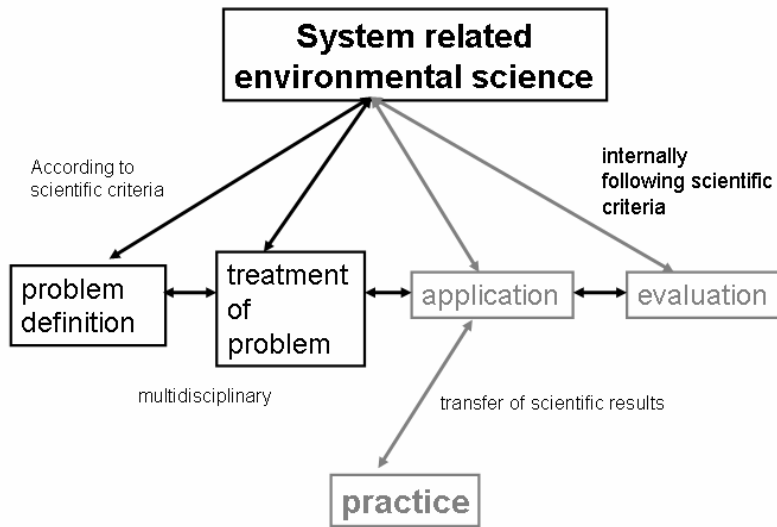
For solving successfully such environmental problems three types of knowledge concerning the system to be restored must be gained:

- **System knowledge** concerns the structures, the processes including the variability of these, the interactions at the level of natural sciences, but also the social and economic implications within the sum of interactions of man with the environment have to be included.
- **Knowledge concerning the goal** that could be achieved and the final state to be envisaged. What are the conditions which yield a sustainable state and how could a lifestyle be formulated leading to it. This is often more a question of politics and economy than of natural sciences.
- **Knowledge on how we can reach this state**, how we can **transform** the knowledge gained into practice.

Most present research in environmental sciences can be described as system oriented research, focused on systems like soil, water, special organismic groups, etc. It may be multidisciplinary or interdisciplinary. By multidisciplinary we obtain a special service of a second discipline to our home one, while in interdisciplinarity, methods are transferred from one discipline to another. This is only possible in team work. With present day complex questions, the time when individuals could work on their own is gone. There is a need to work with others who complement our skills.

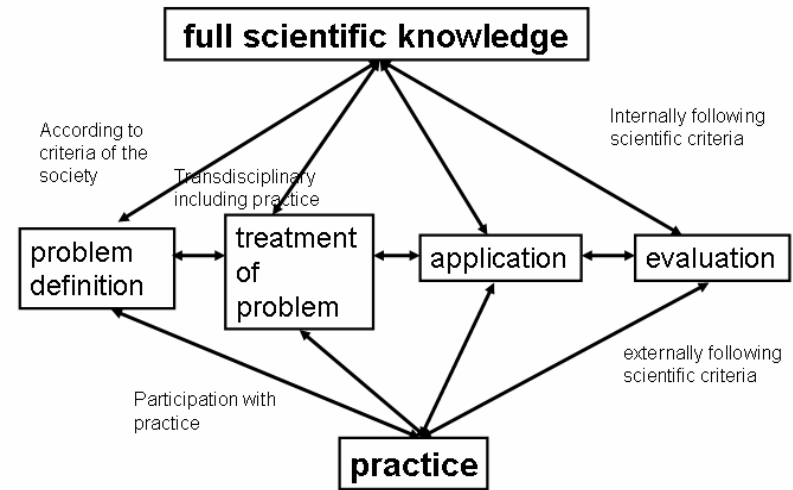
Although the knowledge obtained by this academic research is freely available in publications, it is usually not presented for general use. Results are hardly discussed in the public, and there is a large gap between scientific and practical knowledge. The presentation of the research and the discussion of possible consequences are often too abstract and the researchers do seldom reflect about a practical use of the data. Furthermore there is a time gap between urgently needed practical solutions and the full scientific exploration of the problem which has to be attempted in good academic research for publication (Fig. 13-3, *black*).

While all data can be used by control agencies or politicians, but they seldom have a direct effect on laws and regulations. A positive example may be the ban of phosphate in washing powder in Switzerland, which has greatly reduced phosphate- input into lakes and thus their eutrophication (Fig. 13-3, *black and grey*).



**Figure 13-3:** Academic research (*black*) is mostly a closed system, not related to application and practice (*grey*); if application takes place, it is decoupled from the academic part. / Kërkimi akademik (*me të zezë*) është kryesisht një sistem i mbyllur, jo i lidhur me zbatimet dhe me praktikën (*me gri*); në rast se zbatimi arrihet të bëhet, shkëputet nga pjesa akademike (*adapted* from Mogalle, 2001).

In contrast, transdisciplinary research includes goal oriented and transformation knowledge, it is application oriented research (Fig. 13-4). Transdisciplinary research develops a distinct but constantly evolving framework to guide problem solving efforts by continuous interaction between new results and application. Transdisciplinary knowledge develops independently of disciplinary knowledge and the results are communicated continuously to all participants of the project; the result means joint problem solving.



**Figure 13-4:** In transdisciplinary research the academic part is coupled to application and practice from the beginning in a continuous process part. / Në kërkimin ndërdisiplinor pjesa akademike çiftohet me zbatimin dhe praktikën në një proces të pandërprerë (*adapted* from Mogalle, 2001).

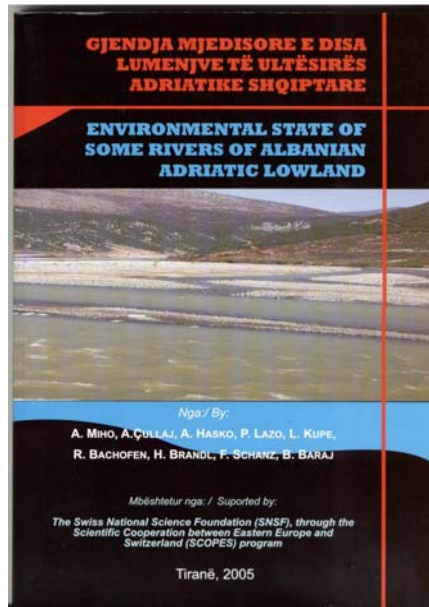
The term transdisciplinarity was originally created by the psychologist Jean Piaget, describing it as “superior to the stage of interdisciplinarity by linking disciplines inside a total system lacking boundaries between disciplines”. Transdisciplinarity is defined to concern what is between and across disciplines and beyond of these.

Transdisciplinarity is addressing to complex problems, to understand the present world and not only focusing on part of it. Stakeholder participants are not only academics, but people with all possible backgrounds. Promoting transdisciplinary research demands openness on the side of academia as well as on the side of practice and is a new form of learning between different parts of the society. Published guidelines and checklists may help the group in all stages during the whole process.

Looking back at the 6 years of collaboration of SCOPES with Tirana University, the 1<sup>st</sup> on heavy metals in Albanian rivers, started basically as a multidisciplinary project with mainly 2 cooperating groups. The booklet published after 3 years (Miho *et al.*, 2005) in Albanian language (Fig. 13-5) with the purpose of disseminating the results lifted the project towards

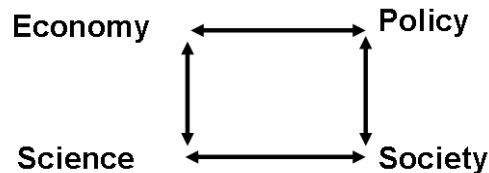
transdisciplinarity, however, the public or the society were hardly involved neither in the project formulation nor in the research itself (no joint efforts).

**Figure 13-5:** Cover of publication to convert multidisciplinary research towards a transdisciplinary process. / Kopertina e publikimit që kthen një kërkim shumëdisiplinor drejt një procesi ndërdisiplinor.



The 2<sup>nd</sup> project evolved from the start to a transdisciplinary project, as the number of disciplines increased and with the Tirana water supply, an important stakeholder participated directly in the formulation of the goal and in the research. The involvement of many young scientists, mandatory in transdisciplinarity, in this joint learning process was well fulfilled in both projects.

### Dialogue and knowledge



**Team work =**

**Together every-one achieves more**

**Figure 13-6:** Intersections between the different fields involved in a transdisciplinary process. Prerjet e ndërsjellëta midis fushave të ndryshme që mërrin pjesë në një proces ndërdisiplinor (Bill *et al.*, in Thompson Klein *et al.*, 2001).

### Summary

Transdisciplinarity:

- develops a distinct but evolving framework to guide problem solving efforts;
- as the solution comprises both empirical and theoretical components, it is a contribution to knowledge, not necessarily disciplinary knowledge;
- the results are communicated to those who have participated, their diffusion is accomplished during the process;
- transdisciplinarity is dynamic and marked by the close interaction of knowledge produced which may not fit into any one discipline which contributed to the solution (cited from Gibbons, in Mogalle, 2001).

	academic research	system related environmental science	Transdisciplinary sustainable research	industrial research
<b>definition of problem</b>	disciplinary theory and methods	ecological problems	problem of the society	problem of the society
<b>handling of problem</b>	disciplinary success, system knowledge, general scientific laws, explains the present state	disciplinary, multidisciplinary, interdisciplinary, system knowledge on ecological problem, explains the present state	transdisciplinary participatory, explains a future state to be achieved	transdisciplinary participatory, looking for future economic solutions
<b>evaluation</b>	internally within the scientific field	internally within the scientific field	internally and externally	externally
<b>transfer to application</b>	= task of practice and applied science	= task of practice and applied science	science is a constructive partner of the society, paving ways to new solutions	science is a slave partner of the economy

**Figure 13-7:** Condensed summary of different types of research. / Përmbledhje e tipave të ndryshme të kërkimit (Mogalle, 2001).

## Përmbledhje

Ndërdisciplinariteti:

- zhvillon një rrjet të dallueshëm dhe të evolueshëm që udhëheq përpjekjet drejt zgjidhjes së problemit;
- meqë zgjidhja përfshin si pjesën teorike dhe atë empirike, kjo përbën një ndihmë për dijen, jo vetëm për dijen brenda një disipline;
- rezultatet u shpërndahen gjithë pjesëmarrësve, përhapja e tyre arrihet gjatë procesit;
- Ndërdisciplinariteti është në lëvizje dhe i dalluar nga bashkëveprimi i ngushtë i dijes së përftuar e cila nuk mund të bëjë pjesë në asnjërën disiplinë që ka ndihmuar në zgjidhje (*cituar nga* Gibbons, in Mogalle, 2001).

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