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EAWAG news

50e February 2001
Swiss Federal Institute for Environmental Science and Technology (EAWAG),
A Research Institute of the ETH-Domain • CH-8600 Duebendorf

Opening Science to the Public

EAWAG

EAWAG news 50e • Feb. 2001
Information Bulletin of the EAWAG

Opening Science to the Public

Publisher Distribution and © by:
EAWAG, P.O. Box 611, CH-8600 Duebendorf
Phone +41-1-823 55 11
Fax +41-1-823 53 75
http://www.eawag.ch

Editor Anja Pauling, EAWAG; Patricia J.S. Colberg (U.S.A.)

Translations Norbert Swoboda, EAWAG

Publication Three times yearly in English, German and French

Cover Photos ClickArt, EAWAG, Susi Lindig, ClickArt

Design inform, 8005 Zurich

Layout Peter Nadler, 8700 Kuesnacht

Printed on original recycled paper

Subscriptions and changes of address New subscribers are welcome! The order form is in the middle of this issue.

ISSN 1440-5289

Editorial

Alexander J.B. Zehnder
Director of the EAWAG

A long declared goal in the world of science is to bring about closer ties between the natural and engineering sciences on the one hand and the social sciences[1] on the other. Over the past ten years, many attempts have been started to bring these disciplines together, both in Switzerland and abroad – with varying degrees of success.

EAWAG has tried to better integrate the social sciences since the 1980's. Our first endeavors, however, were not very fruitful. The problem lay mostly in an imbalance between the various disciplines inasmuch as the social sciences were heavily underrepresented in a field of approximately 100 scientists from other disciplines. At the same time, the social sciences were expected both to conduct foremost research in their own track and to contribute to social science perspectives on a number of projects. Such discrepancies among obligations, available resources and expectations were a sure recipe for failure. An additional obstacle was the poorly developed mental understanding of the various disciplines for one another. There is a long learning curve before molecular sciences and social sciences, for example, can communicate meaningfully.

In 1993, EAWAG brought in a small group of social scientists under Professor Carlo Jaeger. The group had primarily two tasks: to conduct first-class research in the field of human ecology and to sensitize the traditional disciplines at EAWAG to their research questions in order to develop joint projects. Successful examples of these efforts are illustrated in the present issue. Interestingly, the engineering discipline acted as a catalyst in the integration of human ecology considerations. The engineers perceived at an early stage how to make use of the social sciences for their own benefit. Since the engineering sciences are used to working closely with the natural sciences, the engineers became mediators in many cooperation processes. Collaboration across the disciplines facilitated an extremely high level of integration, as demonstrated by the project "Ecoelectricity", which will be discussed in the next issue of EAWAG news.

Today, we at EAWAG are convinced that the social sciences form an integral part of our activities, yet the balance between the different disciplines must be improved. The loss of some of the leading individuals of our human ecology group (Prof. Carlo Jaeger, for example, has moved to the Potsdam Institute for Climatological Research) urges us to reconsider and reorganize the social sciences at EAWAG. Significant expansions in the areas of "Complex System Analysis", "Integrated Assessment" and "Socio-Economics of Water" are planned. I am looking forward to the challenge of contributing to EAWAG's development to a truly interdisciplinary institution.

[1] The term social sciences is used here to include sociology, economics, geography, psychology and other related sciences.

The CLEAR Project

Experiences based on the CLEAR project (Climate and Environment in Alpine Regions) have taught us that the scientific community should put more emphasis on analyzing and communicating uncertainties in interpreting environmental studies. Furthermore, climate change research must pay more attention to both short- and long-term approaches to reduce energy consumption. Focus groups appear to be a promising way to allow citizens input into the research process.[1]

In the early 1990s, a group of researchers became involved in a regional integrated assessment (IA) of Climate and Environment in Alpine Regions: the CLEAR project. Research teams at most Swiss universities and at several research institutions joined forces, spanning a broad disciplinary base that included atmospheric physics, climatology, biology, geography, economics and sociology.

The CLEAR project was part of the Swiss Priority Program Environment (SPPU) sponsored by the Swiss National Science Foundation and was aimed at fostering transdisciplinary research. In the CLEAR project, a number of disciplinary projects investigated various aspects of regional climate change, ranging from climate scenarios to impacts on ecosystems to options for adaptation and mitigation. A participatory integrated assessment (IA) involving focus groups was an essential part of the research effort. The project focused on the phenomenon of climate change in alpine regions and its impact and response options from a wide variety of perspectives.

Uncertainties and Limitations of Research

The CLEAR project proceeded on two fronts. The first phase led to a wide-ranging collection of data about climate and environment in alpine regions, together with a methodological proposal for regional integrated assessment [1]. The proposal acknowledged the heterogeneity of scientific knowledge and the inherent uncertainties associated with such information. Of course, any specific uncertainty in such an assessment may be reduced by additional research, but in so doing, new uncertainties arise – quite often at the boundaries between the disciplines (compare the macroscopic uncertainty principle advocated by Pahl-Wostl, 1995 [2]). A specific disciplinary barrier may be reduced so as to integrate knowledge developed on its two sides, which ultimately results in the evolution of human knowledge shaped by new barriers.

Finding a Common Language

In order to support effective problem solving in a field as complex as climate change, regional assessments must deal with heterogeneous ensembles of knowledge; they must also deal with mixtures of information and misinformation. According to the methodological approach employed in CLEAR, problem solving is only feasible if the vocabulary of science is embedded in a structured debate that takes place in ordinary language.

In the second phase of CLEAR, we developed and used IA focus groups in collaboration with the ULYSSES project [3]. Groups of citizens were convened using a stratified random selection procedure (ensuring representation of various segments of the population) and given access to integrated computer models on climate change in alpine regions. Producing these models with a nonscientific audience in mind was an important objective of CLEAR (developed by Claudia Pahl and her collaborators). During the course of the project, highly specialized researchers debated with one another and with ordinary citizens on climate change issues. It was soon obvious that meaningful discussions were indeed possible without getting lost in the technicalities of specific disciplines.

Lack of Prudence and Fairness

The discussions were initiated with the question of how to assess climate change in alpine regions. The answer we found, forced us to reframe the question. The citizens in the focus groups view climate change as part of the much larger issue: that there is something fundamentally wrong in the relationship between humans and the global environment. This viewpoint is perhaps more a matter of moral and aesthetic judgement than one of scientific and economic rationality, so what seems to be at stake is a perceived lack of prudence and fairness. At the same time, however, when deliberating about possible solutions to the problem, the citizens considered both scientific and economic issues.

How then are we to assess climate change in alpine regions? There is no doubt that there are some inherent environmental risks. Anthropogenic climate change may disrupt features of alpine landscapes, which people in Switzerland (and elsewhere) value aesthetically and for which they accept individual and collective moral responsibility. Glaciers may melt away; floods and mudslides may increase in frequency and intensity; forests may drastically change their

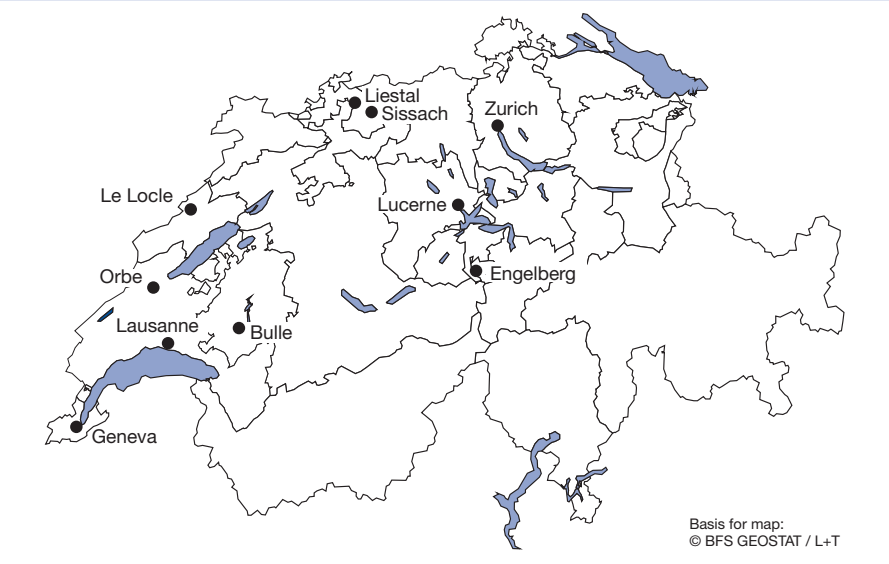
Integrated Assessment

is an interdisciplinary and participatory process of combining, interpreting and communicating knowledge from diverse scientific disciplines to allow a better understanding of complex phenomena. Integrated Assessment has two main characteristics:

a) it should contain added value compared to insights derived from disciplinary research and

b) it should provide decision-makers (and society) with useful information.

[1] This text is based on a contribution to a special issue on the CLEAR project which will be published in the journal "Integrated Assessment".



Institutions in the German- and the French-speaking regions of Switzerland where focus groups met.

composition; and some uniquely alpine species may disappear. In monetary terms, the vagaries of global financial markets are more relevant to the Swiss economy than the aesthetic aspects of climate change; but even in Switzerland, money is not all that matters in life.

Moreover, impacts of climate change are considered an important part of the problem in other parts of the world as well. The problem is not only one of monetary costs caused by specific alterations in the climate system. The problem is a situation in which humankind is perceived to have abused the planet in pursuit of shortsighted, and sometimes ruthless projects, rather than having inhabited it as our home.

A Society of Low Energy Consumption: Vision or Utopia?

No simple solution was proposed in these deliberations, which is testimony to their gravity. What did emerge, however, is a vision inviting new research and additional action. It is quite remarkable that the citizens involved in the IA focus groups generally view a low-energy society [4] as an attractive option (Fig. 1). This solution, however, may not accrue the intended benefits. Switzerland is a country that turned a lack of resources into a comparative advantage. Less than a century ago, the Alps were equated with a lack of agricultural land, extreme transportation difficulties, and danger in daily life. By accepting the challenge posed by these conditions, those living in alpine regions learned to develop a set of skills and institutions that enabled them to engage in a variety of businesses with remarkable success – including the "sale" of now world famous alpine experiences to tourists. Is it not somewhat naïve for citizens who enjoy the wealth created along such a path to now conclude that a low-energy society could bring about more, not less, well being?

Holistic Approaches in Science

As researchers investigating climate change in the alpine region, we should perhaps dismiss proposed lifestyle changes as irrelevant to our research, although we should certainly continue to engage in a dialogue with a citizenry who entertains such images. Most scientists studying climate change likely share many of the moral and aesthetic concerns voiced by our IA focus groups.

It is possible to develop scientific research so as to combine the sense of beauty conveyed by an elegant computer model of, for example, cloud formation with the sense of beauty conveyed by the observation of cloud formation on a Sunday afternoon. And it is quite likely that better research will result when these two sensitivities are not completely separate. It is possible to study technologies, lifestyles, institutions and the like, so as to combine the constraints they impose with an awareness of the opportunities they offer to those willing to explore new courses of action; again, the originality of the research may ultimately gain from such a fusion.

Carlo Jaeger, former head of the Human Ecology Department at EAWAG and Professor for Sociology at the Technical University Darmstadt, currently Head of the Department for Social Systems at the Potsdam Institute for Climate Research. Research interests: the human dimension of global climate change (modeling of socio-economic systems, integrated assessment of climate risks and water problems).

Co-authors:
PD Dr. Claudia Pahl-Wostl, Group leader for Integrated Assessment at EAWAG. Research interests: modeling of human-environment systems, participatory integrated assessment and water resource management.
Prof. Huw C. Davies, Director of the Institute for Atmospheric Science at ETH and Professor of Physics. Research interests: atmospheric fluid dynamics, weather prediction and climate change.

The CLEAR project (Climate and Environment in Alpine Regions) was conducted from January 1996 until April 2000. A total of 50 scientists participated in 15 sub-projects which were conducted at a number of Swiss universities and research institutions.
CLEAR was conceived as a coherent, transdisciplinary study of issues that pertain specifically to climate-related changes in alpine regions. CLEAR brought together scientists from disciplines as diverse as physics, biology, geography, economy, political sciences, and sociology.
The problem of climate change was investigated with respect to causes, processes, and effects, particularly as they apply to alpine regions. All of the relevant information gathered as a part of this project was entered into a computer data base and used in model development.
In several of the sub-projects, this information was presented to citizens and representatives from decision-making bodies. Response strategies and a mechanism for testing likely measures before policy implementation were discussed.

[1] Cebon P., Dahinden U., Davies H., Imboden D.M., Jaeger C.C. (Hrsg.) (1998): Views from the Alps. Towards Regional Assessments of Climate Change. The MIT Press, Cambridge/Mass.
[2] Pahl-Wostl C. (1995): The Dynamic Nature of Ecosystems: Chaos and Order Entwined. John Wiley & Sons, Chichester.
[3] Kasemir B., Schibli D., Stoll S., Jaeger C.C. (2000): Involving the Public in Climate and Energy Decisions. Environment, *42* (3), p. 32–42.
[4] Imboden D.M., Jaeger C.C. (1999): Towards a Sustainable Energy Future. In: OECD, Energy: The Next Fifty Years. OECD, Paris.

Public Participation in Environmental Decision Making

The previous article discussed the general approach used in the CLEAR project; namely, why citizens should be included in "Integrated Assessments" of complex environmental phenomena. In this article[1], we argue that public participation is not only desirable for theoretical reasons, but also necessary because of very practical problems during the decision finding process. Here we present in some detail, the design and results of pilot projects on citizen participation in the examples of the European project ULYSSES and the Swiss project CLEAR.

The importance of including the public in the evaluation of environmental problems is demonstrated in two recent cases. In both situations, the gap between the public's perception of the problem and how the responsible parties handled it led to a fiasco. In 1995, the oil producer Shell decided to sink the aging drilling platform Brent Spar in the North Atlantic. Despite convincing arguments that this solution was the most economical and environmental, the decision had to be reversed. The reason: overwhelming public opposition. The cost to Shell was enormous, both financially and even more so in terms of damage to their corporate image. Another example is the wave of consumer opposition to genetically engineered food, which has recently reached new heights, spreading from Europe to the United States. Europe's resistance to the use of biotechnology in food production was intensified by an ill-advised public relations campaign conducted by the American Monsanto Corporation. One of the reasons why Monsanto's effort to win over European consumers backfired was that the debate about genetically modified food coincided with the scandal over bovine spongiform encephalitis (BSE, or "mad cow" disease). In the BSE case, the European public was outraged that the authorities tolerated an agricultural system in which normally herbivorous animals were fed waste products from slaughterhouses without appropriate monitoring.

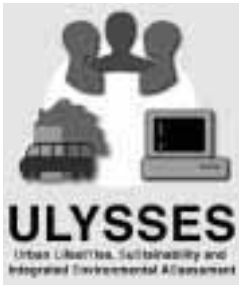
The two cases offer important lessons for decisions on complex environmental problems. It is dangerous to base strategic decisions solely on the judgement of experts. In the biotechnology case, scientists had been focusing on the probability of genetically modified organisms affecting human health or ecosystems. In the BSE case, the primary concern was over the regulatory oversight of agricultural production processes. For many ordinary citizens, however, the real issue was the legitimacy of these types of food production systems. Relying exclusively on scientific and expert advice in dealing with any problem carries the inherent danger of excluding aspects of the problem that lie close to the hearts of the citizens. Decisions made unilaterally are often met by a surprising level of public outrage.

On the other hand, it is equally treacherous to rely solely on public opinion. The choice appears to be between a technocratic or a populist approach to environmental policies, although neither one alone is adequate. In order to effectively deal with this dilemma, we need tools to connect scientific expertise with social discourse. Inclusion of the public in integrated environmental assessments, as developed in the ULYSSES and CLEAR projects, is a first step in this direction.

How to Involve Citizens?

ULYSSES and CLEAR used focus groups in order gauge the opinions of the "ordinary citizen" on the topic of climate change. Focus groups are often used in market research and public opinion polls [1]. The focus groups used in ULYSSES and CLEAR were specially adapted for their use in integrated assessment (IA, [3]). In contrast to their original purpose of collecting highly detailed, but not necessarily coherent, information, focus groups used in integrated assessment settings need to provide decision-making bodies with a composite picture of the structure of a complex prob-

1 This article is excerpted from a paper presented by B. Kasemir, D. Schibli, S. Stoll and C.C. Jaeger (2000), "Involving the Public in Climate and Energy Decisions." Environment April 2000, p. 32–42.



ULYSSES is the acronym for *Urban Lifestyles, Sustainability, and Integrated Environmental Assessment.* The main goal of the project was the development and testing of participatory tools for integrated assessments in the area of climate and energy.

ULYSSES was supported financially by the European Commission (Fourth RTD Framework Program, Environment and Climate, Human Dimensions of Climate Change).

Carlo Jaeger (coordinator); Silvio Funtowicz, Brian Wynne, Salvador Giner, Asa Gerger, Maria Giaoutzi, Ferenc Toth, Jill Jäger, Jerry Ravetz, Bernd Kasemir, Jeroen van der Sluijs and John Robinson led the teams participating in the project.

Ralf Schüle, Frankfurt, group 4

Fig. 1
Detail from a focus group collage illustrating unbridled growth in energy consumption.

lem [2]. After an initial round of spontaneous reactions to various environmental problems, the participants received information on the most current scientific results. The groups were then given an opportunity to discuss the information and to come to a set of conclusions reflecting the group as a whole.

In order to obtain a broad sampling of opinions within Europe, ULYSSES and CLEAR organized IA focus groups in seven cities: Athens, Barcelona, Frankfurt, Manchester, Stockholm, Venice and Zurich. Including the pilot projects, close to 600 people from all over Europe were involved in this project. Participants were screened carefully so that they represented a spectrum of age, gender, income, level of education, and attitudes towards environmental questions. Quotas were established, for example, for academics; craftspersons; for those who considered environmental problems important and for those who did not; for individuals who welcome environmental laws and for those who do not. Each IA focus group was composed of of six to eight individuals.

Each group met five times, for approximately two and a half hours each, for discussions led by a moderator. The discussions progressed through three distinct phases:

In the first phase, participants expressed their spontaneous feelings on the topic of climate change and energy use. Among other things, they created two collages of how they envision their region could look in 30 years, assuming current levels in energy consumption as well as a 50% reduction in the energy use. In the second phase, scientists and experts presented their views on key environmental issues. During the third phase, participants were asked to formulate their own opinions, typically in the form of a written report; the format was predetermined by a selected list of questions.

Citizens' Perspectives on Climate Change

How does the average European citizen view climate change and climate change mitigation? To address this question, we will consider how focus groups in Barcelona, Frankfurt, Stockholm and Zurich dealt with two key issues: the probable impacts of climate change and possible actions to meet these impacts.

Across Europe, the potential effects of climate change were perceived to be a serious problem. It was generally assumed that fundamental living conditions will deteriorate, and ecological destruction was expected. In the opinion of most, risks to future generations make a 'wait-and-see' policy unacceptable.

Gudrun[2]: *"What will happen to our beautiful Mother Earth? Gloomy outlook for the future – one gets scared. My only consolation is that I will not […] experience all the misery in my lifetime. But I do want my children and grandchildren to have a reasonable quality of life!"* (Stockholm, group 4, session 3, entry in journal).

Similar fears were expressed in collages in which members of the focus groups tried to depict the future they see if there are no restrictions on the growth of energy consumption (Figure 1). In general, participants advocated action towards climate protection, despite the scientific uncertainties. The discussions revolved around the risks in climate change. The tendency was to argue for caution and to adopt an ethical rather than an economic point of view. Evaluating climate change from an economic point of view was, in fact, often met with open hostility:

Heike: *"If I understand this correctly, then some economists […] are trying to calculate what is cheaper: to pay for the consequences of environmental catastrophes or … it may be cynical of me to interpret what they are saying in this way … or to do what would have to be done now to avoid these catastrophes."* (Frankfurt area, group 2, session 2).

In contrast, participants had no reservations about considering mitigation measures in economic terms.

Konrad: *"In my opinion, it is naïve to declare a favorite solution without discussing its economic consequences."* (Stockholm, group 3, session 2).

ClickArt

BSE is not only scaring cows...

[2] All names were changed in order to preserve the privacy of the participants.

Most participants advocated small increases in energy prices, but rejected raising the cost massively.

Fabian: *"It is a question of the appropriate level. One can see that in Germany. During the recent election campaign, the Green Party advocated increasing gasoline prices to 5 Marks in order to protect the environment. Now they have enormous problems retaining 5 percent of the vote, which is what they need to stay in the Bundestag. You can't come up with grossly exaggerated proposals and then expect to get elected."* (Lucerne, group 12, session 3).

Generally, focus groups considered a society reducing its energy consumption to be more desirable than one that continues with its current habits. The low-energy society was often associated with a simple lifestyle in an intact, natural environment (Figure 2). Many participants wanted to reach this goal without excessive increases in energy prices. They tended to feel that the development of innovative and energy-efficient products was a crucial requirement in reaching this goal. They also felt strongly that academic institutions and companies should assume primary responsibility for research in this field.

Margot: *"They fly to the moon and I don't know where else, but they are not able to produce a car – that fact is that it would be possible – that only uses three liters of gasoline [per 100 kilometers]. But they don't because the [car] lobby is too strong."* Frankfurt area, group 3, session 1).

In summary, it appears that most Europeans would accept climate policies, but only if they were aimed at finding cost-effective options for significantly reducing energy consumption.

ClickArt

...as well as genetically modified feed.

Conclusions: Citizens' Perspectives in Climate Issues

As the examples of the Brent Spar, genetically-engineered foods and BSE have demonstrated, it is important that government and corporate decision-makers be aware of what aspects of a certain problem are important to the public. Ignoring these aspects can cause important decisions to be overturned by unexpected opposition. What does the "European citizen" consider important in the case of climate change? To what extent are these "hot spots" taken into account when deciding on issues of climate change?

Our work shows that the European public as a whole looks at the effects of climate change much more from an ethical than from an economic perspective. Preferring to err on the side of caution, people usually advocate action to protect the climate despite the scientific uncertainties; however, when it comes to considering concrete action, economic criteria become very important. Participants of the IA focus groups were very much in favor of drastic reductions in energy consumption, but rejected massive price increases as a tool to induce these reductions. In order to adequately take into account the mindset of the "average European", any discussion about climate change issues must include a strong ethical component. The fundamental questions must be what effects are unacceptable, and what is the best way to avoid these unacceptable effects. The answer will often be to reduce energy consumption through technological innovations.

Ralf Schüle, Frankfurt, group 8

Fig. 2
Detail from a focus group collage on the theme of "drastic reductions in energy consumption".

Bernd Kasemir has worked at EAWAG since 1995. His research in the Human Ecology Department focuses on questions of citizen participation and ecological investments. He was responsible for management of the ULYSSES project. Bernd's educational background is in chemistry and theoretical physics.

[1] Morgan D.L., Krueger R.A. (1998): The Focus Group Kit (Volume 1–6). Sage, London.

[2] Weyant J., Davidson O., Dowlatabadi H., Edmonds J., Grubb M., Richels R., Rotmans J., Shukla P., Tol R., Cline W., Frankhauser S. (1996): Integrated Assessment of Climate Change: An Overview and Comparison of Approaches and Results. In: "Economic and Social Dimensions of Climate Change", Bruce J., Lee H., Haites E. (Eds.). IPCC, Cambridge University Press, Cambridge.

[3] Kasemir, B., van Asselt M.B.A., Dürrenberger G., Jaeger C.C. (1999): Integrated Assessment of Sustainable Development: Multiple Perspectives in Interaction. International Journal of Environment and Pollution *11* (4), p. 407–425.

[4] Skolnikoff E.B. (1999): The role of science in policy. Environment *41* (5) p. 16–20, 42–45.

Democracy Depends on the Procedure

Conditions for Political Participation

Discourse-oriented approaches to political participation at the community level are becoming more widely used, but are often undemocratic. Either directly or indirectly, however, they create situations of inequality by disallowing some participants to voice their opinion adequately. This, in turn, can lead to results where the recommendations of the group are not represented correctly. Methods of empirical sociology allow us to determine conditions of the group environment from the perspective of the various participants, thereby helping us to achieve a more democratic process.

One of the results of the United Nations Conference on Environment and Development 1992 in Rio de Janeiro is Agenda 21. It calls on the community of nations to promote "sustainable actions" and challenges communities to engage in a "consultation process" with its citizens. The goal is to receive input on how sustainable development should look on a local level and to draw citizens into the decision-making process. Since that conference, this exchange has begun to develop outside conventional political processes (i.e., elections or polls), particularly in the western democracies.

This development is not entirely new. In the 1970s, potentially affected parties at the community level were included in planning processes in order to draw on their experience and expertise, to improve the quality and acceptance of solutions and to fend off potential conflicts. This approach allows for material input into the political decision by including the ideas of all participants in the planning process. Particularly in the environmental and technological contexts, this participation was realized in a number of different ways. Mediation is probably the most widely known example of such a process. Mediation deals with actual conflicts where the affected parties try to find a mutually acceptable solution under the guidance of a neutral moderator.

In political science, such forms of political participation are called "unconventional" and "problem oriented". They are not anchored in the law but develop from a concrete problem; they are, therefore, usually only of short or medium duration.

Communication as Political Action

In this form of community participation, political action becomes a communication process with the goals of facilitating the exchange of rational arguments and of ultimately reaching a result that is satisfactory to all participants. A fundamental prerequisite for success is the recognition that each individual is free and equal [1]. Traditional hierarchical and economic controls exerted by political institutions are complemented by negotiations and argumentation which are based on a real situation and which are exchanged between the various affected parties. The composition of the group has to be determined according to the actual problem at hand.

New mechanisms for determining the path a society chooses to follow are emerging. Differentiation within society is an important parameter in these mechanisms, as it introduces a plurality in values and norms. Political processes that are able to deal with this differentiation are, therefore, gaining in importance.

Guarantee Authentic Representation of Opinions

The further development of these interactive processes should become a central research topic in the social sciences. An important condition for the participants in such a process includes acceptance of the decision itself as well as the *conditions* under which the decision has been reached.

In democracies, the political process should assure that opinions are represented correctly. Voting is one of the best tools to achieve equality. The voting process is general, equal, secret and represents one of the cornerstones of any democratic system. According to results from empirical research, however, certain segments of the population participate more than others. Structural exclusion mechanisms are often the source of these imbalances. Additionally, the degree of participation, and therefore political clout, increases with income, affluence, professional position, and education. What should be cause for concern is that the participants in the political communication process typically reflect the same "layering" of the population.

Procedural Conditions from the Perspective of the Participants

We are faced with the challenge to design a procedure that both fulfills democratic requirements and is perceived by the participants as "fair" [2]. This is important for securing equal opportunity for all parties and to ensure that differing opinions are expressed and recorded even-handedly. Bringing sustainability into the picture adds additional requirements: the procedure should not only apply to acute and localized problems, but create a framework for solving problems that will be experienced to their full extent by future generations. Additionally, procedures should not only include organized interest groups, such as unions, but also individuals. The need for developing procedural rules is becoming more urgent as the term participation – just like the term sustainability – is becoming rather fashionable and tends to be increasingly misused. Not everything that is labeled "participation" actually contains participation, as for example in the development of "local agendas". In these cases, citizen input is often neglected; existing cooperation

Jeannette Behringer, EAWAG

Participatory processes place high demands on the expertise, motivation and social capabilities of all participants.

between administration and unions is continued under the new label of "local agenda 21 process". In order to truly democratize the decision-making process, input must be sought from *all* participants; that is, from all segments of the population as well as from experts and politicians.

Focus Groups and their Procedures

One such procedure for the dialogue-based formulation of opinions and intents was developed as a demonstration project on the topic of "Climate Change and Local Climate Protection" [3]. The procedure borrowed the concept of panel discussions in focus groups, which is an established tool in the social sciences. It is an extension of the original focus group, which is a theme-oriented discussion in small groups. In order to incorporate the notion of a panel discussion and focus on specific problems, the initial core group of 7–9 individuals was supplemented by a varying number of outside experts. One panel met five times for approximately two to three hours, with a week between meetings. Participants then personally communicated the results to the political addressees. In all, six panels were conducted. In order to evaluate the procedure, representatives of all the participating groups – citizens, local environmental agencies, experts, and the local legislative body – were surveyed. In all, 60 people were involved.

Split Opinion on Participatory Processes

Participatory processes were not viewed positively by all parties. Some considered it an academic exercise or as simply a tool for surveying opinions. The *acceptance* of such procedures can, therefore, vary considerably.

Another important result was the general opinion among participants that internal procedural rules (micro-level) are needed for acceptance of participatory procedures, but are not in themselves sufficient (see Fig. 1).

The general attitude towards the political system and the topic as a whole plays a major role. Finally, the efficiency of the procedures (meso-level) is also very important in determining the general level of acceptance.

Overall, it was not considered legitimate to discuss climate at a global level with the goal of developing recommendations at the local level. The call to "think global, act local" is, therefore, open to further discussion.

Different Degrees of Competence

With respect to the detailed design of such procedures, we can identify core criteria that are important to all participants; namely, composition of the group, competence of the participants, fairness and efficiency. Of these, one of the most important is ensuring the representation of different fields of expertise, not only in science, but also in practice-oriented applied fields. Participants should also have access to information about the conventional political system. Citizens appear to very much appreciate "social competence" in the participants. This includes a certain degree of openness and a basic readiness to reconsider one's own point of view in order to come to consensus and find a solution that will be acceptable to all parties. Interestingly, experts and representatives from the executive and legislative branches consider "social competence" somewhat less important.

The general results from this study will be used to increase acceptance and improve the quality of dialogue-based decision-making procedures. We are currently investigating the possibility of combining conventional and unconventional political processes.

Jeannette Behringer, Political Scientist M.A., Research Scientist and coordinator of the Project CLEAR (1996–2000); doctoral research at EAWAG. For general information on research and on Project CLEAR: behringer@eawag.ch

[1] Habermas J. (1996): Die Einbeziehung des Anderen. Studien zur politischen Theorie. Suhrkamp, Frankfurt a.M.

[2] Renn O. et. al (1995) (Eds.): Fairness and Competence in Citizen Participation. Evaluating Models for Environmental Discourse. Kluwer Academic Publishers, Dordrecht.

[3] Dürrenberger G., Behringer J. (1999): Die Fokusgruppe in Theorie und Anwendung. Akademie für Technikfolgenabschätzung, Stuttgart.

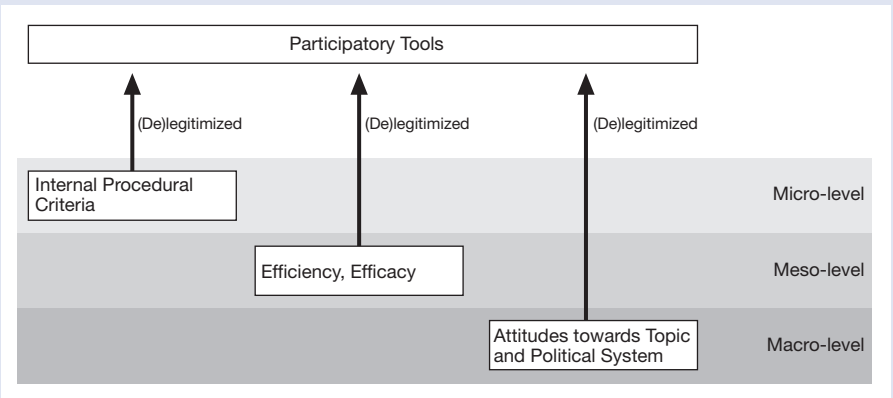


Fig. 1
Acceptance of instruments facilitating political participation depends on internal and external criteria. The graph is a simplified representation of the basic facts.

Citizens' Perspectives of Climate Change in Switzerland

Perceived Barriers to Action

How do groups of informed citizens view their personal responsibility for climate change mitigation? Through the lens of an Integrated Assessment (IA) focus group, this paper looks at a number of psychological devices that people employ to justify the emotional dissonance they experience when confronted with the prospect of changing consumption patterns and lifestyles in order to reduce the levels of greenhouse gases in the atmosphere.

This work was performed as part of the ICRA project (Integrated Climate Risk Assessment), one of 15 CLEAR sub-projects.

The Desire for a Low-Energy Society

Along with other environmental problems, Swiss Citizens in the focus groups generally perceived global climate change as a serious issue. Accordingly, they mostly considered a world characterized by high levels of energy use as rather unattractive, even nightmarish. In contrast, a world typified by low levels of energy use was most often perceived as attractive (see Figs. 1 and 2). This apparent consensus over the "goodness" of a low-energy future exposes a fundamental contradiction: almost no one in the focus groups was prepared to undertake the kinds of personal actions deemed necessary to achieve a future that would modulate global climate change.

Focus group 1, Zurich

Fig. 1
The images linked to the low-energy scenario were interpreted as being friendly to people, animals, biota in general, and vulnerable groups such as women and children. The evidence suggests that participants tended to regard a low-energy future as highly desirable for the planet and its human inhabitants.

Socio-Psychological Theories of Dissonance and Denial

It is well established in socio-psychological theory that attitudes help a person to mediate between the inner demands of the self and signals from the outside world [1]. Attitudes seek to establish a sense of consistency and, hence, inner calm [2]. A lack of consistency is the state of *dissonance.* In general, individuals experiencing dissonance seek to resolve it, deny it, or displace it. We will see from the IA focus group research reported here that, for the most part, denial or displacement maintained the gap between attitude and behavior with regard to climate change norms.

Attitudes differ from behavior for a number of well-known reasons. One explanation is offered from the evidence presented thus far; namely, that attitudes about climate change relate more to a general societal norm, while behavior is specifically based on individual responsibility. Another more common interpretation is that attitudes encompass a vast array of cognitive processes and compositions that, for the most part, remain chaotically in conflict, that is, until contradictions must be confronted. The following dimensions of attitude contribute to environmentally dependent behavior:

- the need for personal comfort,
- the belief in technological solutions,
- the belief in personal contribution to mitigation,
- the demand for a justifiable relationship between personal costs and social gains,
- the acceptance that there is indeed a crisis [3].

One area of consistency analyzed here lies in the possible disjunction among personal preferences for a particular lifestyle, consumption habit, or behavioral choice and the need to respond effectively to climate change mitigation strategies. In short, people may profess anxiety over climate change, but are faced with internal resentment (even denial) over what they cannot accept as a justifiable change in behavior (e.g., to use public transportation, ride a bike in the rain, invest in costly insulation materials for their home). Possible ways in which this denial may occur include the following:

- *"fabricated constraints"* (i.e., "there are too many impediments"),
- *"ignorance"* ("I simply don't know the consequences of my actions"),
- *"denial of responsibility in general"* (i.e., "I am not the main cause of this problem" [4].).

From an emotional viewpoint, such responses help to alleviate guilt, to reinforce

Focus group 4, Zurich

Fig. 2
A high-energy scenario is associated with images of catastrophes, monsters, war, the destruction of nature and general chaos. There was a remarkable consistency among all of the participants over a coherent set of perceptions of crises linked to a high-energy future.

victim status, to justify resentment or anger, and to emphasize the negative feelings towards the disliked behavior (e.g., the inconvenience of using public transportation and the a loss of social prestige).

A common theme throughout this denial processing is the well-known *tragedy-of-the-commons* [5]. In these kinds of situations, "behavior" that makes sense from an individual's point of view, when repeated by enough individuals, ultimately proves disastrous to society. […] Each individual gains, financially or otherwise, by consuming the natural resource. Furthermore, each sees little harm in doing so since the resource is so huge and their impact on it is so small [6]. Based on this theoretical perspective, and especially taking into account the "barriers of denial" listed above, we hypothesize that denial in the face of political and moral calls to change behavior in order to mitigate the effects of climate change is reinforced by the following:

- an unwillingness to give up customary habits and favored lifestyles which are closely associated with a sense of self-identity (the "comfort" interpretation),
- the construction of attitude and behavior connections that regard any costs to the self as greater than the benefits to others (the "tragedy-of-the-commons" interpretation),
- a lack of acceptance that the climate problem is as serious as purported, and a belief that it can be solved by simple technological and regulatory improvements (the "pat solution" interpretation).

These three "interpretations" are closely interlinked. The richness of the data set reveals this to a remarkable extent. The separation of these interpretations reported below is largely to clarify nuances of outlook.

Results: Perceived Barriers to Action

We will use excerpts from discussions held in the IA focus groups to illustrate the three "interpretations", grouped according to the literature. The statements were made spontaneously and coherently during the discussions and reflect the opinions of citizens responding to a palette of targeted, provocative statements. They reflect the individual's personal and authentic perspective.

The "Comfort" Interpretation

The most powerful area of denial was the perceived unwillingness to abandon what appears as personal comfort and lifestyle-related consumption in favor of mitigating the negative impacts of climate change. Participants regarded consumption as both a social and economic good and, therefore, found it difficult to accept that any personal sacrifices they might make would be worth the social gain.

"I find it so hard to think differently because it really interferes with your life. If, for instance, you have to rely on public transportation and depend on their schedules … I think that's the main problem: you have to give up quite a bit of your comfort." (Group 4, Zurich).

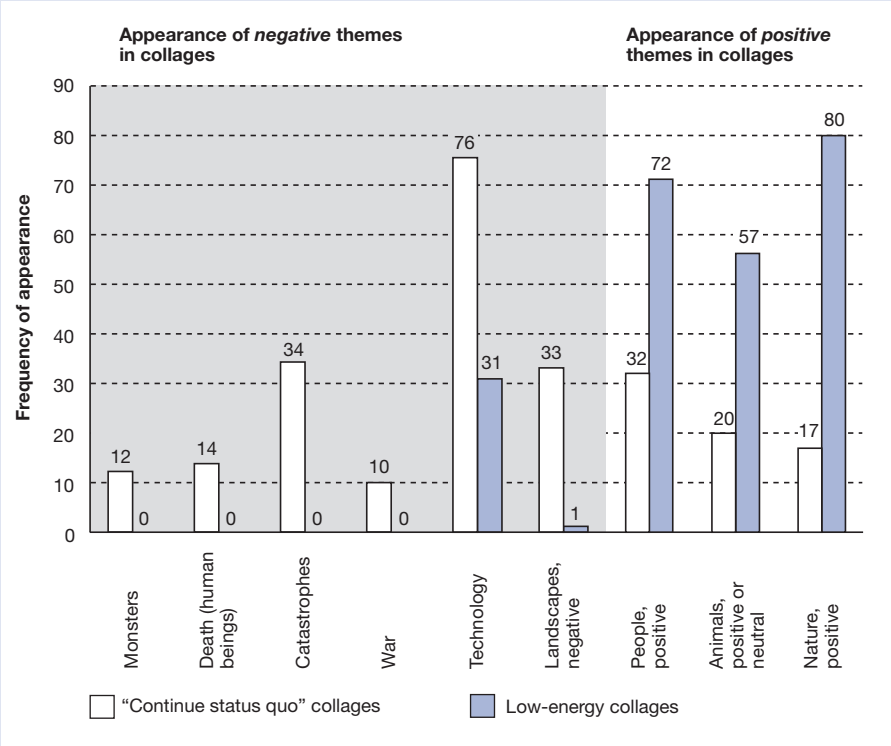
"Perhaps we are a bit too lazy. Perhaps society is too apathetic to engage in environmental issues, to orient individual lives to ecological criteria, (…) to save energy. And as long as the big collapse has not yet occurred, as long as the catastrophe is not yet imminent, people will just pursue their comfort, unless there are financial incentives." (Group 6, Sissach).

The "Tragedy of the Commons" Interpretation

The following quotations reflect the attitude that the cost to individual freedom of choice and restrictions on the pursuit of happiness in a strong economy are too great, especially considering the uncertainty associated with the exact effects of climate change. One way of coping with this interpretation is to believe in the insignificance of individual action to change the order of things; another is to look to others to adopt the same unwillingness to act. It is tempting to blame the collective tardiness in adopting behaviors to mitigate climate change as something through which all people reluctantly share. One noticeable feature of this response is to emphasize the relative insignificance of one's own behavior that would have to be changed.

"I find it an interesting observation that we rather quickly conclude: I alone can do nothing; I can achieve something only if the others join." (Group 8, Liestal).

"As long as the U.S.A doesn't do anything (…), I am simply a bit disappointed that countries of such relevance lag so far be-



The diagram shows the frequency with which the IA focus groups have used certain pictures in the context of two given energy scenarios. Images relating to the low-energy scenario were generally considered to be favorable towards humans, animals and the environment in general. This observation supports our assumption that the participants consider this scenario as desirable for the wellbeing of both humankind and nature.
The «continue-as-is» scenario, on the other hand, evokes associations with catastrophes, monsters, war, destruction of the environment, and chaotic conditions in general. The general agreement between the perceptions of all participants was striking.

hind and don't even understand it. If only those countries with their enormous populations concerned could make this clear…" (Group 11, Lucerne).
A Dialogue – Fabian: *"Standing in the way of ecological regulations is lacking in insight, individualism and egoism."* Renaldo: *"Yes. Individualism, personal freedom, which in our society is one of the highest goods, or is seen as one of the highest goods. Clear the way for free citizens."* (Group 12, Lucerne).
"The mobility mania is just a symptom. The cause is our society. Our society is oriented to a certain rationale, e.g., by certain ideals of beauty, by ideals about how to spend vacations, what to do to be 'in', what mountain bike to ride. I think, the cause could perhaps be found at school, in education." (Group 12, Lucerne).

The "Pat Solution" Interpretation

A faith in some form of easy fix is always a comfortable zone for denial. This is usually found in the more technocentrically-oriented citizens. But from the evidence from these IA focus groups, this perspective is widespread, both as a hope and as an expectation.
"I am content with the possibility of buying one detergent. I don't need 50 different products to choose from. But I expect this one detergent to be produced by intelligent people, chemists and so on, in a way that I'm not additionally forced to dose it as minimally as possible in order not to stress the environment. This should be the task of them up there, and I should be able to rely on them." (Group 8, Liestal).

Conclusions

The results of this study suggest both a coherence and a tendency to dissonance and denial that will not make it easy for democracies to gain early consent on strong climate change mitigation measures. Indeed, this analysis suggests a level of sophistication and cohesion in emotional reactions that will prove difficult to alter, unless wide-ranging policy responses are integrated over a prolonged period of time. The application of socio-psychological theories provides a rich interpretation of why attitudes do not readily fit with behaviors. Further research extending these theories by building on the procedures reported in this paper, perhaps by using a wider array of participants from other political cultures, should reveal the more fundamental nature of barriers to citizen action. The results of these studies need to be carefully translated into appropriate policy action through dialogue with policy-makers and decision-takers. In this way, a blending of socio-psychological and political perspectives may provide the most relevant theoretical and political framework on which to base policy.

Susanne Stoll-Kleemann, Environmental Social Scientist, working in the Human Ecology Group of EAWAG up to summer 2000, is currently with the Potsdam Institute for Climate Research. Research interests: human dimensions of global change (implementation of biodiversity strategies in Europe and developing countries, psychological aspects of climate change).

[1] Katz D. (1960): The functional approach to the measurement of attitudes. Public Opinion Quarterly *24,* p. 163–204;
McGuire W.J. (1969): The nature of attitudes and attitude change. In: Lindzey G., Aronson E. (Hrsg.): Handbook of social psychology, 3rd edition. New York, Random House; Pennigton, D.C.;
Gillen K., Hill,P. (1999): Social Psychology. London, Oxford University Press.
[2] Heider F. (1946): Attitudes and cognitive organisation. Journal of Psychology *21,* p. 107–112;
Festinger L. (1957): A theory of cognitive dissonance. Stanford, CA, Stanford University Press.
[3] Wortmann K., Stahlberg D., Frey D. (1993): Energiesparen. In: Schahn J., Giesinger T. (Hrsg.): Psychologie für den Umweltschutz. Weinheim, Beltz, p. 77–101, 81.
[4] Schahn J. (1993): Die Rolle von Entschuldigungen und Rechtfertigungen für umweltschädigendes Verhalten. In: Schahn J., Giesinger T. (Hrsg.): Psychologie für den Umweltschutz. Weinheim, Beltz, p. 51–61.
[5] Hardin G. (1968): The tragedy of the commons. Science *162,* p. 1243–1248.
[6] Gardener G.T., Stern P.C. (1996): Environmental problems and human behavior. Allyn and Bacon, Needham Heights, *23.*

Images of Science

Science from the Citizen's Perspective

Which images of science circulate in the heads of the average citizen? What does he or she expect from science, and how is science judged? These questions play a central role in the discussion of political, social and ecological themes that are closely related to science and technology [1]. It is important to know how the public views science in order to understand the relationship between science and the layperson and to actively shape communication.

Topics such as climate change and gene technology can no longer be discussed without input from ordinary citizens. This is illustrated by the arguments Kasemir et al. [2] (p. 5 in this issue) and Jaeger et al. (p. 3 of this issue) make in their articles. The necessity of including citizens in the decision-making process goes hand in hand with the need to develop new forms of communication between scientists and the public. An example is the EAWAG project "Science et Cité", which was recently initiated [3]. How do certain notions about science influence the thought process? What expectations does the public have of science? How is science judged by the average citizen? All these questions are extremely important in the discussion and in the participatory process.

Two Different Perceptions of Science

Two projects on the topic of climate change, CLEAR and ULYSSES, were conducted in the form of focus groups in the German-speaking part of Switzerland and yielded a wealth of information about the various perceptions of science held by the participants. In each project and before any scientific presentations were made, participants were asked what they expected from the "experts". At the end of the discussions and presentations, the participants were invited to judge the level of expertise that was presented to them. *Two distinct perceptions of science* emerged from these discussions: the classic-modern perception and a perception that is more reflective and only just emerging.

EAWAG

We are only at the beginning of a transition phase to a reflective approach to science; the classic-modern perception still clearly prevails.

The Classic-Modern Perception of Science

The classic-modern perception expects science to describe our environment in its current state as accurately and realistically as possible. For example, the focus groups were interested in concrete signs of climate change or in what connections exist between global and local trends. Beyond that, experts were asked to predict the development of our climate, to lay out the consequences of these changes, and to present concrete solutions to any problems caused by climate change. Some members of the discussion group, like Magda from Zurich, wanted to know what they personally could do to counter the warming trend of our climate.

Magda: *"What is of burning interest to me, and what is the topic of many discussions: what can I do in reality, how much of an effect can I have, how much of a part can I play to keep it from getting too bad? Everybody knows about the protection of the environment, of course, and the separate recycling of waste. But what can I do against the warming of Earth, the rising of the water*

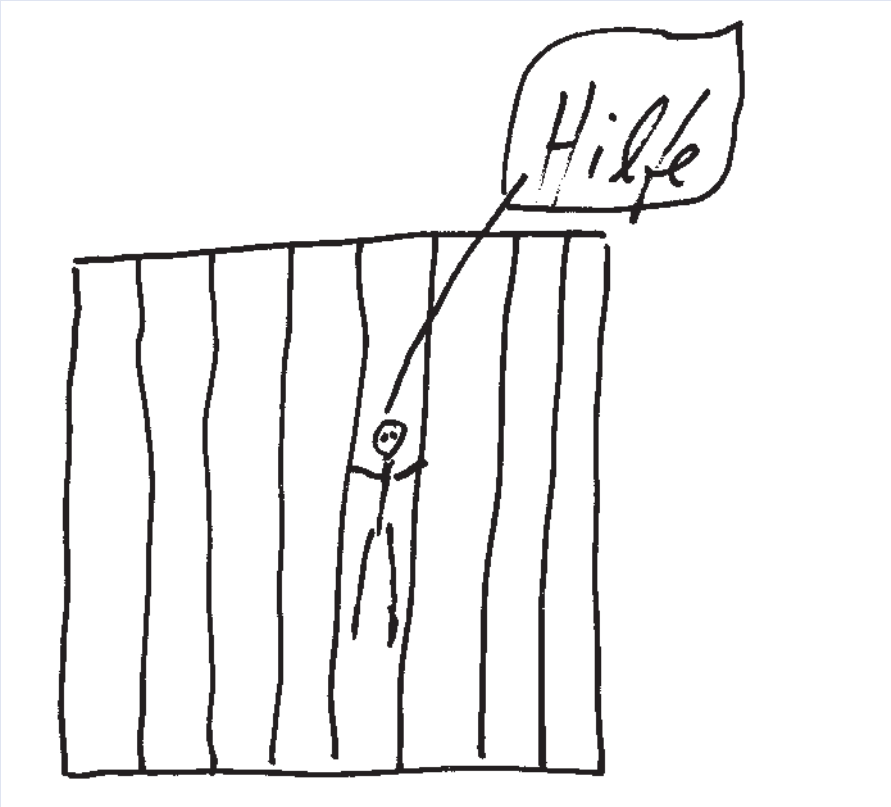


Fig. 1
Magda, as a representative of the "classic-modern science" group, felt that uncertainty conveyed by scientists causes her uncertainty. She wondered how the whole project could be considered scientific if it is associated with such uncertainty. She chided scientists for not having only one answer to any given problem. Commenting on her collage and her impression of the presentations made she said: *"I felt like I was in a huge prison and was completely helpless. I cannot say any more about the topic." («Hilfe» = Help),* (Focus group 1, Zurich).

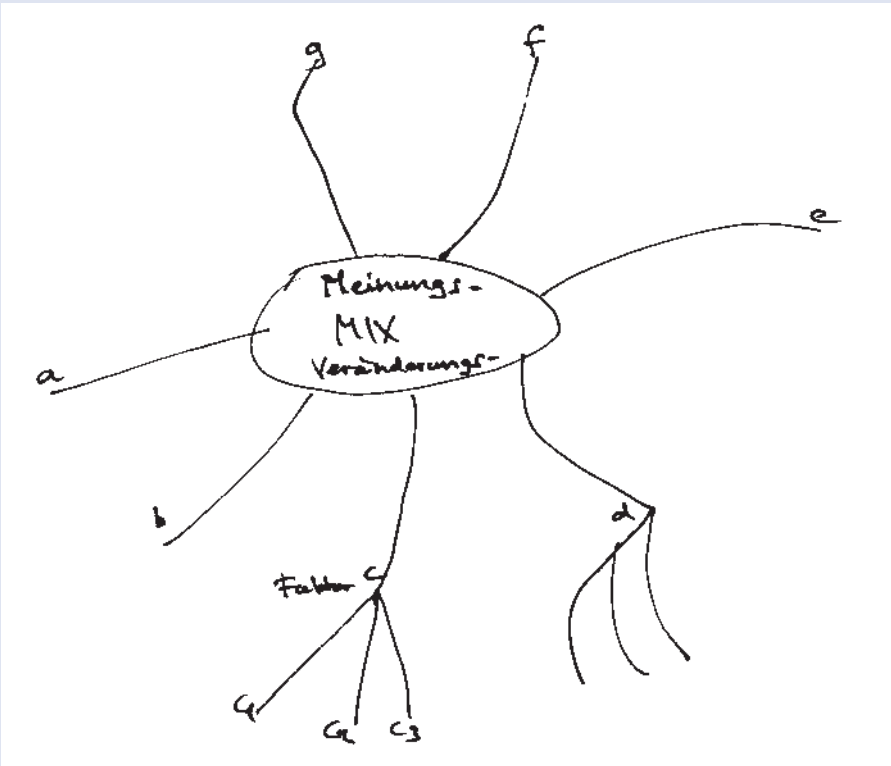


Fig. 2
Ernst, as an advocate for the emerging reflective approach to science, considers it difficult and even dangerous if only one hypothesis is being presented, since problems typically are complex and multi-faceted. Dangerous particularly because one hypothesis usually tries to identify one culprit, which leads to the misleading assumption that eliminating that one culprit would cure the problem. Ernst's comment on his collage was *"All the different factors involved result in a mix – […] a mix of opinions and a mix of changes. The mix takes a different shape depending on what factors are included, how they are weighted, and how their importance is assessed from the outside. We have clearly seen this in the model calculations"* (Focus group 1, Zurich).

levels? What are the possibilities for the individual. That is what I would like to know." (Focus group 1, Zurich).

Apart from questions and expectations regarding the content, many participants also had high demands with respect to the quality of the scientific information. They expected the information to be concrete, objective, exact, neutral, true and easily presented "black on white".

Edgar (Moderator): *"First off, what would he [the scientist] have to tell you, and how would he have to tell it for you to have confidence in his statements?"* Raoul: *"I think it would be important that the same statements were also being made black on white, and not just orally. I think that is rather important. [Then I know] something is known, something is there."* (Focus group 7, Liestal).

The image of science as a realm where reality can be objectively measured and represented, where results are certain and true, is in drastic contradiction with the real world of science where uncertainties and differing scientific opinions are the rule. It is, therefore, not surprising that the presentation of scientific uncertainty or disagreements caused negative reactions in the classic-modern perception of science. The reactions ranged from disbelief, to feelings of helplessness, and to the fundamental questioning of the scientific method (see Fig. 1). Repeatedly, scientific presentations discussing different scenarios resulted in the demand for more accurate work. In face of these uncertainties, some members of the focus groups were questioning the purpose of the meetings. They felt they could no longer discern what was true and what was not true; they were concerned that this uncertainty might ultimately lead to scientific results losing their credibility.

Lena (in the context of evaluating "Impacts" [5]): *"Sometimes we hear there will be a lot of rain; sometime we hear it will be dryer. Which one is it now? The evening was very informative, although somewhat divisive. What is true now? I really have a problem with that. It leads to the problem not being*

Uncertainties Made Transparent

Revealing and explaining scientific uncertainties and differences in scientific interpretations in climate research was a central task for the CLEAR and ULYSSES projects. In both projects, detailed computer models were developed and presented to the focus groups. Each of the projects used different approaches in dealing with uncertainty.

***"Impacts" – Climate Change in the Alpine Region* [5]**
is a model for the risk assessment of climatological changes in the alpine region. The model uses the best-case/worst-case approach and bases all its predictions on either a scenario of very little climate change or very dramatic climate change. Projections therefore demonstrate the full width of possible developments and their effects for the next 30 to 100 years.

***"Options" – Paths to a Low-Energy Society* [6]**
is a model allowing us to explore a number of avenues the energy sector in Switzerland could pursue. "Options", an interactive model, lets the user define scenarios, change parameters at will, and explore different outcomes.

"Targets"
(Tool to Assess Regional and Global Environmental and Health Targets for Sustainability) [7]
is another model allowing the user to compare different scenarios. The user chooses between three different perspectives, mainly defined by their attitudes towards the environment and towards society. For each perspective, the user can review key aspects of climate change and future developments under that scenario.

taken seriously, and that is a disservice to the cause." (Focus group 13, Engelberg).

The Reflective Perception of Science is Growing

The difference between the reflective and the classic-modern perception of science lies mainly in how uncertainties and opposing opinions are dealt with. Different opinions and points of view are actually being sought in order to help form one's own opinion. Revealing the uncertainties and limitations of scientific research was considered to make science more credible and to strengthen its acceptance (Fig. 2).

Cornelia: *"I prefer being told what the current results are, but also what the limitations of the results are; I like to see everything being put in perspective, not just presented as "absolute truth". I find that the most credible. As soon as someone makes absolute statements on this topic, I start having doubts, and I become very critical."* (Focus group 6, Sissach).

The demonstration of uncertainty and latitude in an interpretation was perceived as positive. For this group of people, it appeared plausible that there could be differing scientific opinions on any given topic and that models and scenarios are neither necessarily desirable nor able to predict the future with certainty.

Apart from a different way of dealing with uncertainties and opposing scientific opinions, there were other indications of a perception that science is evolving. A number of group members explicitly placed data and facts in the background, focusing their attention instead on the larger context within which scientists must operate.

Hanna: *"… and when it comes right down to it, one doesn't necessarily want to get information only from the scientists; one needs to know the arena, the context, in which the scientists are working. What is their mission, and where is it leading? Who is funding the work? What are the goals? This really is of great concern to me."* (Focus Group 16, Engelberg).

Experts were also of interest as human beings. In order for the citizen to form an opinion, he or she would like to know more about the values of these people, about their attitudes towards nonscientific issues. Some focus group members explicitly voiced their rejection of "neutral" experts and said they would rather deal with scientists who admit their partiality on environmental issues. One discussion member stated that she would not trust an expert unless she also sensed some level of social engagement.

Weight of the Two Perceptions of Science

The classic-modern perception of science clearly dominated the discussions. Because this approach is more clearly defined than its counterpart, it is expected that the shift from one to the other will happen very slowly. Nonetheless, such a shift will occur, as other developments seem to confirm. Science itself is in transition [4], and the relationship between science and the public is changing. Scientific findings are no longer being accepted without question; participation is being increasingly promoted, and communication between scientists and the public is taking on new forms.

Communication of Uncertainties

Whether environmental problems like climate change, which are closely tied to the natural sciences, will be discussed in a constructive and publicly acceptable way largely depends on whether or not the general public's perception of science are taken into consideration. For example, it is extremely important for questions relating to climate change to present the uncertainties in such a way that the scientific information is not rejected, but helps individuals to draw their own conclusions. This challenge should not be underestimated, particularly because the classic-modern perception of science still prevails; citizens have only begun to shift towards a more reflective impression. For the time being, communication between scientists and the public must satisfy both camps.

Daniela Schibli is a sociologist working in the Human Ecology group at EAWAG. Her work concentrates on different areas in the sociology of science and on the topics of "uncertainty" and "regional differences".

[1] Felt U., Nowotny H. , Taschwer K. (1995): Wissenschaftsforschung. Frankfurt, Campus.
[2] Kasemir B., Schibli D., Stoll S., Jäger C. (2000): Involving the public in climate and energy decisions. Environment, *42,* 3, p. 32–42.
[3] Information on Science et Cité: http://www.science-et-cite.ch
[4] Gibbons M., Limoges C., Nowotny H., Schwartzman S., Scott P., Trow M. (1994): The new production of knowledge. London, Sage Publications.
[5] "Impacts" was developed by Claudia Pahl-Wostl and her group at EAWAG. The module can be examined under: http://clear.eawag.ch/impacts
[6] "Options" was developed by Claudia Pahl-Wostl and her group at EAWAG. The module can be examined under: http://clear.eawag.ch/optionen
[7] For more information see: Rotmans J., de Vries B. (1997): Perspectives on global change: the TARGETS approach. Cambridge, Cambridge University Press.

CLEAR Goes to School

Teachers face a difficult task when discussing topics that include environmental issues. They must stay up-to-date and keep an eye on new research in order to incorporate the most recent information in their classrooms. Research results, however, are often not easily taken in at a glance; they are typically in the form of individual reports on very specific aspects of a larger problem. It is even difficult for the scientifically educated individual to digest and simplify the plethora of information into the "big picture".

What would be needed is a monitoring tool for environmental research that

- integrates results from different projects,
- presents the information in a form easily understood by the nonscientist,
- is easily accessible and
- is kept current.

Application of an Information Platform in Environmental Education

An example for such a "research monitor" is the information platform that was established as part of the CLEAR project (see Jaeger et al., p. 3). The initial target audience were participants of the focus groups discussing various energy scenarios for Switzerland (see Schibli, p. 14). Beyond that, however, the CLEAR information platform has contributed to the public relations work with respect to the UN Climate Convention. Per invitation by BUWAL (Swiss Agency for the Environment, Forests and Landscape), it was presented at the world climate summit COP5 in Bonn in the fall of 1999.

The CLEAR Information Platform in Schools

The modules in the CLEAR information platform are well suited for use in the classroom because they are easy to understand and well integrated in their presentation. Students can use a computer to explore concrete questions on their own or, preferably, in groups of two or three.

From a large body of information, they select facts that are relevant from their point of view, interpret them, and arrange them into a new structure. They will usually summarize their results in the form of a presentation or in a paper. If there were a number of groups working on different topics, the results could be presented in a hallway poster session.

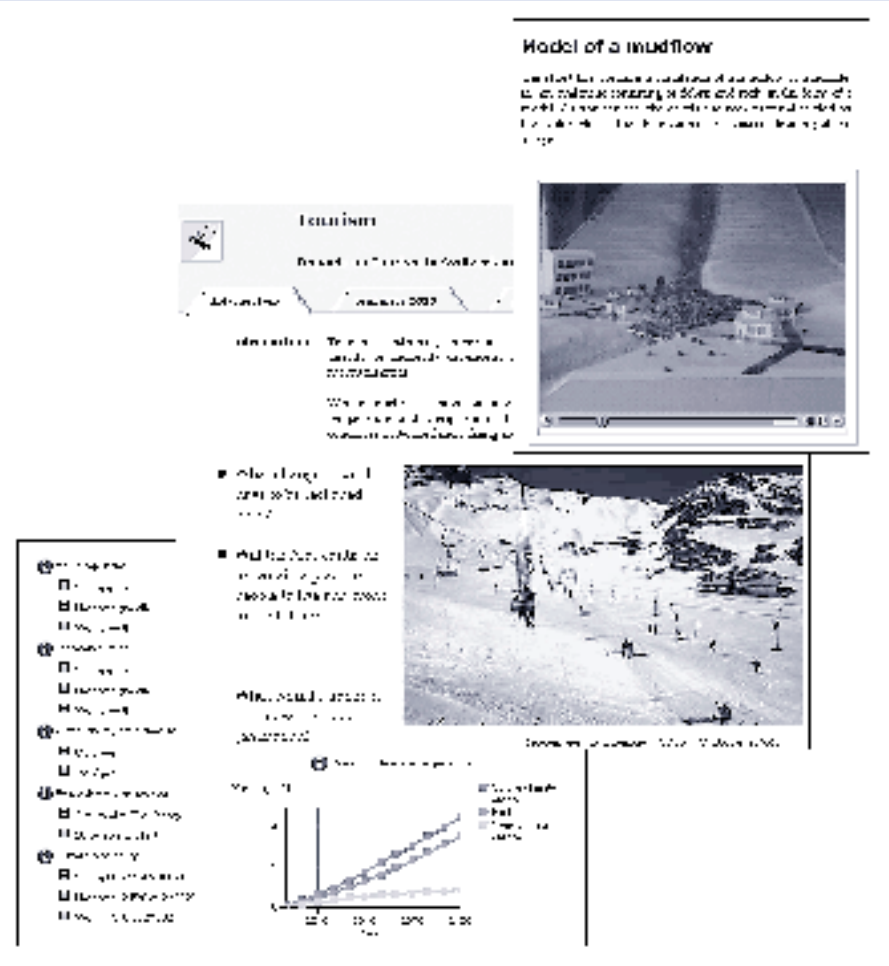
A particularly instructive situation was chosen for a special project day in the Alpine Middle School in Davos, Switzerland. Nine students from the class 5C had the task of pretending to represent local interest groups in a discussion about long-term planning in their community. The goal was to create a set of recommendations to the city council, detailing how to respond to expected consequences of climate change. In addition to what they had already learned in their class, tools at their disposal included the "Impacts" module and other sources on the internet.

Giant Developers and Environmental Activists

The day started out with a short introduction of the students' roles as representatives of various interest groups:

Personal CO_2-Calculator http://clear.eawag.ch/co2	Calculates an energy and carbon dioxide budget for the user based on his or her individual lifestyle.	■ Why is the CO_2 budget affected by what I eat? ■ How much energy did I use on my last airplane trip?
"Impacts" – Climate Change in the Alpine Region http://clear.eawag.ch/impacts	Interactive data base on the consequences of the greenhouse effect for Switzerland. Topics include the frequency of natural disasters, effects on winter tourism and the construction sector.	■ What are the causes for climate change? How good are the predictions? ■ Over the next 30 years, what effects will a changing climate have on daily life in my community, and what should be done about it?
"Optionen" – Paths to the Low-Energy Society http://clear.eawag.ch/optionen	Discusses options for political action at the national level. Scientific information is supplemented by model calculators.	■ What would have to be done on a global scale in order to reduce CO_2 emissions? ■ What options for political action does Switzerland have?
"Sure"? – Decision Making and Acting under Uncertainty (under construction) http://clear.eawag.ch/sure	Describes the different types of uncertainty in scientific research and confronts the user with actual decisions that need to be made.	■ What is the source of uncertainties in scientific results? ■ How can one make decisions in situations where there is uncertainty associated with the different options?

The modules of the CLEAR information platform. The modules are accessible on the WWW with any of the current browsers. Some features require Java and multimedia plug-ins.



"Impacts" demonstrates the effects of climate change on Switzerland. Basic factual information is supplemented by video clips and scenario calculators.

- Tourism
- Construction Company
- Energy Supply
- Automobile Club
- Local Environmental Organization

During the morning, questions for their small group discussion were the following:

- What are the likely consequences of climate change that Davos will have to deal with between now and the year 2030?
- In your opinion, how serious are these consequences?
- What practical action is required on the community level in order to adapt to the changes?
- What political action is needed?

After lunch, the "experts" discussed the various aspects of the problem under the guidance of a moderator. The dominating theme during the discussion was the importance of tourism to the economic well being of Davos. According to what is known currently, climate change will most dramatically impact winter sports; while the probability for snow decreases in lower altitude ski areas, regions like Davos would be able to attract more ski tourism. The construction lobby vehemently argued for increasing capacity, while the environmental groups offered only limited support for the idea. The automobile club argued for upgrading roads leading up to Davos, which would facilitate access but would also destroy the picture of "intact mountain scenery" which is one of the reasons why tourists come in the first place. No consensus was reached on this point, although all "groups" advocated a moderate expansion of capacities for winter sports.

Frighteningly Realistic

During the subsequent evaluation of the day, students as well as teachers were shocked about the direction of the discussions. There was consensus, however, that the "game" was very realistic and that similar developments can be expected to take place. *"We realized that the discussions tended to go off into extremes, and we can only hope that this will not be the case in the real world."*

In general, the students were somewhat uncomfortable in their roles; it was important to them to communicate their true attitudes at the end of the exercise: no new roads, reforestation instead of tree clearing for new ski areas, and the utilization of alternative energy sources. Results and experiences from this special project day and the students' thoughts on the potential impacts of climate change on Davos can be found on the internet under http://www1.gr-net.ch/samd/Galerie/klima/start.htm.

"Impacts" is User Friendly and Fun to Use

Questionnaires and interviews evaluating the experiences users had when working with "Impacts" consistently yielded a very positive response:

- "Impacts" makes it very easy to find and understand information on any topic of interest. Illustrations and animations are used very effectively to enhance the text-based information.
- Students feel very comfortable working independently.
- Working with "Impacts" is Fun!

The modules of the CLEAR information platform present teachers in the environmental field with an easy tool for keeping up with the latest results in global climate research. Since the database is now under the auspices of ProClim, the Forum for Climate and Global Change, its future existence, accessibility on the internet, and incorporation of updated information are ensured for the next several years.

Martin Büssenschütt, mathematician and environmental scientist, works in the area of environmental communication.

[1] For further information see: Rotmans J., de Vries B. (1997): Perspectives on global change: the TARGETS approach. Cambridge, Cambridge University Press.

Innovations in the Private Transportation Sector: When Are They Acceptable?

The most common mode of transportation in Western industrial nations is by automobile. People own cars and basically have them available permanently. Such collective behavior has dramatic ecological consequences. Considering that the number of car owners is still on the increase, innovative solutions are needed to reverse this trend.

In transportation politics, the problem is being approached from different directions:

- Elimination or reduction of traffic by removing or reducing the need for travel;
- Shifting modes of transportation by influencing the choices individuals make in selecting their means of transportation (change in personal modal split[1];
- Optimization of vehicle performance: not altering traffic volume but optimizing the environmental performance of the vehicle [1].

From an ecological perspective, any action taken to reduce or eliminate traffic is by far the most efficient direction and, therefore, has priority in transportation politics. In the real world, however, such action often has to be implemented in the form of restrictions ("push-measures") and requires delicate political maneuvering. Measures based on alternative choices ("pull-measures") are usually more readily accepted [2].

In recent years, a number of innovative "green" transportation technologies have been developed (e.g., vehicles with alternative fuel systems, lightweight vehicles). Based on their technical potential alone, they are clearly less taxing on the environment than conventional gasoline-burning vehicles. In addition, a series of new services has been created which, along with technical innovations, help to blur the distinction between transportation systems; that is, they soften the traditional "either/or" decision regarding the selection of transportation carriers and allow a smoother transition to new modal splits (e.g., mobility centers, CarSharing, combined mobility options, PubliCars).

Innovations as Agents of Behavioral Change

From an ecological perspective, the most interesting innovative carrier system is the one where the technical potential is not eliminated by mass effects; that is to say, those systems whose positive environmental impact is not turned into a negative gain by encouraging significantly higher use of or decreased efficiency in the previous carrier system due to the reduced number of remaining users. The more an innovative technology is linked to behavioral changes, the better the chances that mass effects can be avoided – in the worst case, by changing the personal modal split or, in the best case, by shortening or eliminating travel altogether.

Experience with innovations in the area of personal transportation suggest that the user, who previously owned an automobile, must indeed change his or her behavior. In CarSharing, for example, several individuals (professionally organized) share one vehicle. They may use the vehicle individually, but must observe the times for which they have reserved it. The user does not have immediate access to the vehicle, and the cost structure makes the system more appealing to the occasional user. An individual switching from owning their own car to using CarSharing would, therefore, profit from relying on public transportation for regular commuting, using the car only in situations where public transportation is not available. Some daily travel could be shortened or eliminated altogether by combining several trips into a single trip, by reaching a number of destinations (driven by lower cost), and/or by shortening travel distances (e.g., choosing a nearby shopping center or recreation facility).

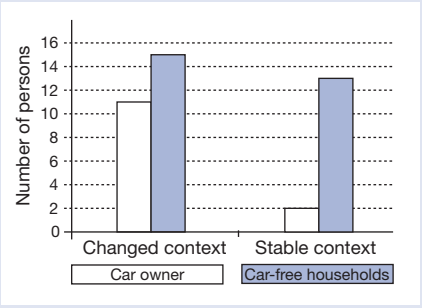


Fig. 1
Compared with individuals who do not own automobiles, car owners experience more difficulty in making the transition to CarSharing since their behavior has to be changed much more dramatically. Persons who have never owned a car already exhibit a behavioral pattern very similar to what is required for CarSharing and often accept this solution without experiencing a prerequisite trigger event in their personal life.

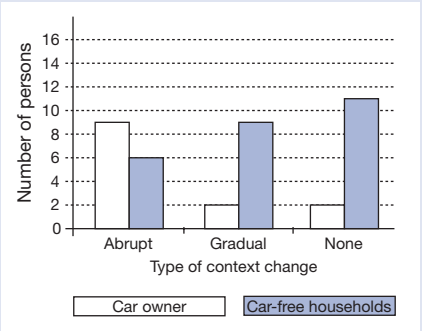
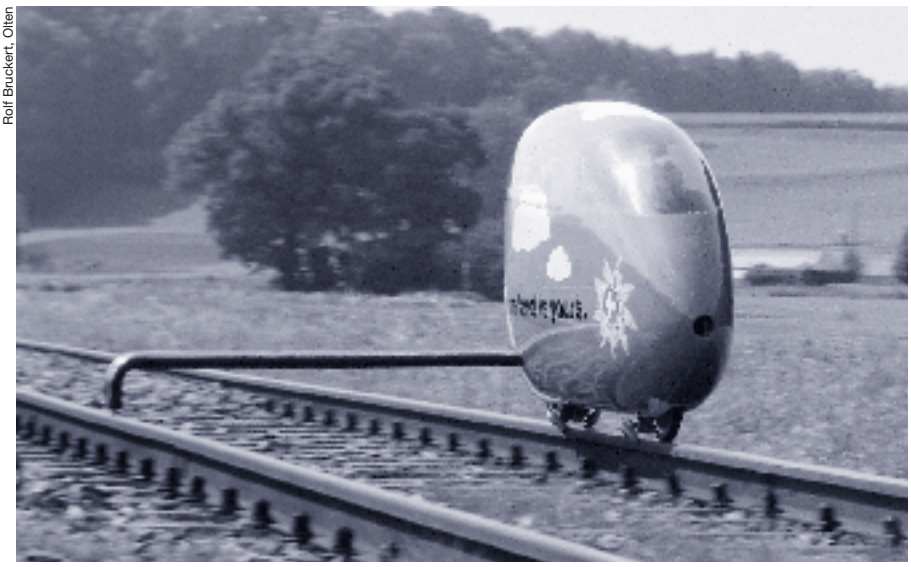


Fig. 2
Importance of changes in the need for mobility in the decision to join CarSharing based on qualitative interviews and group discussions with 39 CarSharing participants.

[1] the relative distribution between the use of a private car and environmental transportation (public transportation and bicycle; based on number of trips or distance traveled, whichever is more appropriate).



Rolf Bruckert, Olten

Alternative propulsion techniques for vehicles: muscle-powered vehicles on rails.

Wishful Thinking and Reality

What looks like an ecological advantage can easily be considered a disadvantage by the consumer: who wants to buy into a scheme that asks the consumer to relinquish old habits? In addition to the effort required to understand the details and conditions of the new product or service, there is the uncertainty as to whether or not the new service will allow the user to reach all of the accustomed destinations, and if so, how much extra effort it involves. The extent of behavioral change depends on what the individual used as his or her previous mode of transportation; that is, what modal split had been practiced? Car owners will have a harder time in CarSharing than people who have mainly been using public transportation. The modal split for CarSharing and the use of public transportation is very similar, while the former car owner must shift a significant portion of his or her travelling to a very different mode of transportation – public transportation.

If the consumer anticipates a major change in behavior associated with a certain innovation, the threshold for acceptance increases dramatically. Such an innovation runs the risk of remaining a fringe product or of attracting consumer groups who are undesirable because they already practice environmentally healthy behaviors (i.e., they already use public transportation or bicycles). In this case, the overall effect of the innovation would be negligible, possibly negative. The question then is how a technically significant innovation (or an entirely new service) can be sold to a target audience, despite the fact that it will force the consumer to assume new, environmentally friendly behaviors.

Closing the Gap

Much can be learned from users who begin to use a new service while it is still on the fringe. There always seem to be a sufficient number of consumers who are willing to give something new a try, even if it demands adaptation on their part. In the case of CarSharing, for example, between one fourth and one third of users, who previously owned cars, joined a CarSharing group on a trial basis; they gave up their car and completely changed their modal split.

This is really the starting point for my dissertation. I am most interested in the characteristics of such “fringe user groups”. How important is the new service? How do personal circumstances influence the adoption of innovations once they have grown from a marginal existence to wider acceptance. It appears that, as a general rule, new services will not be seriously considered unless there is an additional personal trigger event, causing the individual to completely rethink his or her life and behavior patterns. On a day-to-day basis, a person no longer consciously chooses his or her mode of transportation. Once an individual owns a car, he or she will use that car increasingly and habitually, without thinking much about it [3]. A rational evaluation of the different transportation alternatives for an individual trip rarely occurs. The choices are only considered and rethought if there is a trigger event, such as moving to a new location with very different options for public transportation, the car needing major repairs, or some other dramatic change in one’s personal life which affects the need for mobility. These are the types of situations in which innovative transportation solutions have the best chance of being considered.

A related observation can be made with people who have already changed their transportation habits and eventually must accept other behavioral changes. If they have already become well adjusted to some alternate solution, they will accept additional innovations far more readily, often without any trigger events. They have developed behavioral patterns that can accept additional changes much more easily [4] (see Fig. 1 and 2).

Sylvia Harms is a diploma psychologist and has been a Ph.D. student at EAWAG since 1996. She has participated in two EU projects in the area of individual mobility (electromobiles and CarSharing). Her doctoral dissertation work focuses on the influence of changes in personal situations on acceptance of innovative solutions.

[1] Gorr H. (1997): Die Logik der individuellen Verkehrsmittelwahl – Theorie und Realität des Entscheidungsverhaltens im Personenverkehr. Giessen, Focus Verlag.

[2] Steg E.M. (1996): Gedragsverandering ter vermindering van het autogebruik. Theoretische analyse en empirische studie over probleembesef, verminderingsbereidheid en beoordeling van beleidsmaatregelen. Dissertation, Rijksuniversiteit Groningen.

[3] Aarts H. (1996): Habit and Decision Making. The case of Travel Mode Choice. Dissertation, Katholieke Universiteit Nijmegen.

[4] Harms S., Truffer B. (submitted): The long way from interest to participation: When does the car owner change to car sharing? Eingereicht für: Transportation Research, Part F: Traffic Psychology and Behaviour.

Water Resource Management in the Heart of Europe

Pioneering Work and New Challenges

Pollution of water resources and resulting environmental degradation are the consequences of a wide range of human activities – including housing, laundry, agriculture, industry, energy extraction and use, and tourism. These types of activities are currently expanding at an enormous rate. What remains to be done? And is Switzerland prepared to face the demands of the future?

The introduction of the toilet and sewage treatment made a significant contribution to improving domestic hygiene in the cities of Europe and North America. But it also generated large volumes of wastewater that were initially discharged untreated into the environment. The 19th century marked the beginning of the development of large-scale water pollution. The hectic pace of urbanization and industrialization that followed simply aggravated the problem. Because feces and wastewater were not effectively removed from residential areas, despite the innovations mentioned above, the hygienic situation became untenable resulting first in an outbreak of cholera and later in typhoid epidemics. Preventing additional outbreaks of these infectious diseases in Switzerland and other industrialized countries was one of the first major successes of modern urban water management. In addition to a general improvement in hygienic standards, the key to the problem was in the strict separation of drinking water from contaminated wastewater.

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In 1825, a phenomenon occurred in Lake Murten, which could not be explained at the time. A massive growth of burgundy-red pigmented algae colored the water of the lake. More such algal blooms followed: in Lake Baldegg in 1884, in Lakes Hallwil and Zurich in 1898, in Rotsee in 1910, and in many others since. The murky waters and blooming algae were followed by a change in the lakes' fish populations: the native fishes were displaced by whitefish. This development, and that of serious pollution of other water courses, clearly suggested that natural processes were no longer able to purify human wastewater on their own.

The Development of Legislation

The first sewage treatment plant in Switzerland came on-line in St. Gallen in 1916, followed by the city of Zurich in 1924. Today, Switzerland is one of Europe's most advanced nations in terms of preventing pollution of water resources and water supplies. Almost all Swiss households are now connected to sewage lines, and much of the organic material and phosphorus in the wastewater is eliminated in effluent treatment plants. In addition, reduction of some substances at their source is governed by statutory provisions (e.g., the ban on phosphates in detergents since 1986). As a result of all of these measures, the quality of water in our larger lakes is steadily improving, and the populations of native fishes are recovering.

The main factors involved in the degradation of water resources are both pollution and the mostly irreversible changes in the water systems themselves: modifications to lake and river beds resulting from the construction of hydraulic systems, various soil improvement measures, and hard-surfacing of the landscape. The goals emerging from these situations for the protection of water resources have been largely achieved in terms of combating symptoms; but in the preventive field of dealing with causes and achieving sustainable use, we still have a long way to go.

New Challenges

The Alps are the mainstay of water supplies to large parts of Europe. Tourism and hydroelectric power generation in Switzerland are also concentrated principally in the mountains. The Alps are, therefore, an area where economic, ecological and social interests must be harmoniously resolved – in line with the modern view of sustainability. Water management in the future will no longer be able to concentrate principally on eliminating pollution once it has occurred. The emphasis will be on detecting risks at an early stage and then avoiding or reducing them altogether.

The Urgent Need for Renewal

The significance of risk management is also evident with regard to domestic water supplies. Adequate quality control is made more difficult in Switzerland by the division of the water supply industry into 3,000 separate units. This problem will become more serious in the future in two ways: (1) Switzerland will have to renovate its entire water/wastewater infrastructure within the next few decades, including the drainage system, drinking water supplies and distribution networks, and water and wastewater treatment plants. (2) Switzerland is also facing the debate on privatization of some parts of the domestic water supply system. Experience abroad has suggested that there are both positive and negative impacts to privatization. The positive effects include increased efficiency and flexibility for the water companies, but investment shortfalls, especially

to replace aging or inadequate facilities can have fatal consequences. Bacterial, viral and parasitic infections spread very rapidly in an incompetent drinking water distribution network. A suitable form of organization for minimizing risks, while simultaneously optimizing efficiency and customer satisfaction, has yet to be developed here.
In all of these questions, scientific and technical know-how is no longer enough. It is becoming ever more important to involve the social sciences, especially the economic aspects of a problem. Political decisions are also required to be made with regard to acceptable risks and permissible costs. Such decisions must take into account the large number of parties interested in using water. This is not an easy task. It can be solved, however, if the combination of technical expertise and political responsibility, that have traditionally characterized water pollution prevention in Switzerland, is pursued with resolve in the coming years. This will also permit Switzerland to make a prominent international contribution to solving urgent global water supply problems based on our experience, ongoing efforts and scientific ingenuity.
(This is an abbreviated version of an article by Alexander J.B. Zehner, Director of EAWAG which appeared in the NZZ on May 18, 2000. The full version can be found at www.eawag.ch/news).

Personnel

Walter Munz Turns 80

On October 20 of this past year, *Walter Munz* celebrated his 80th birthday. Most wastewater engineers in Switzerland do not need an introduction to Walter Munz. Many know him as a competent consultant, engaged teacher and/or as an author of a number of theoretical works and practical tools in the area of urban drainage. Walter Munz played a particularly important role in shaping the development of urban drainage systems in Switzerland during his years in the Engineering Department at EAWAG (1961–1985). Among his most important achievements, most of which are still in use today, are the model "SASUM", the "rain catalogue" and the conceptual developments on the treatment of mixed wastewater. In the last example, for instance, Walter Munz was one of the first worldwide to use long-term simulation as an evaluation tool. As early as the 1960s, he was working in this area and led the field with several key publications. Shortly after the introduction of electronic data processing tools in the early 1970s, he developed a model for the simulation of rainwater run-off (for water and chemical components), in which he wrote the first versions of the code himself. The best known result of this effort is *SASUM* (simulation of rainwater run-off, including mass fluxes of water constituents, which allow the consideration of over-flow conditions and basin throughput for several drainage areas in series). An endless number of calculations have resulted in important diagrams and other engineering tools which are, in part, still used today.
Other important professional activities included his teaching ("sewer systems and wastewater treatment" at the Abendtechnikum Zurich, which is now Hochschule Zurich, Studienbereich Technik) and his work on the well known manual and text book "Waste Water". The book covers a wide range of topics and uses innumerable diagrams, recipes and examples. It was a hard nut to crack for many a student but, once cracked, became a reliable and highly valued resource, particularly in the area of designing sewer systems.

Wolfgang Geiger (1921–2000)

On July 3, 2000 *Wolfgang Geiger* died, just short of his 79th birthday. Between 1969 and 1986, Wolfgang Geiger built up and headed the area of Fisheries Science at EAWAG. He significantly influenced the development of modern fisheries management in our waters and deserves recognition for his engagement in research, teaching and consulting. An extensive obituary can be found in the EAWAG Annual Report 2000.

Award for Jürg Hoigné

The international selection committee of the "Association for Advanced Oxidation Technologies" has chosen *Jürg Hoigné* as the first recipient of the award for "Advanced Oxidation Technologies for Water Treatment", honoring him for these outstanding contributions over the last 20 years.
Much of the work that was recognized with this award was supported by the creative laboratory work of Heinz Bader, dissertations by Johannes Staehelin, Susan Masten and Urs Jans, and by contributions from postdoctoral fellows like Werner Haag and Lisa Nowell. Jürg Hoigné's work also benefited from his collaboration with Rolf Bühler (Radiation Chemistry at ETHZ) and the new direction set by Urs von Gunten and his collaborators. Jürg Hoigné expresses his gratitude to the former and the present directors of EAWAG, Prof. Werner Stumm and Prof. Alexander Zehnder, and appreciates Switzerland's academic policies. He particularly appreciates the long-term support of research, teaching and consulting, which ultimately made his work on the development of "Advanced Oxidation Technology" for water and wastewater treatment possible and helped him receive international recognition.

From left to right: Elliot Berman (Boston University), Gary Peyton (Illinois State Water Survey), Jürg Hoigné, Dave Hand (MTU), Roy Taylor (Amway), John Crittenden (MTU and Editorial Board ES&T).

Award for Rainer Zah

Rainer Zah received the "Outstanding Student Poster Award" at the annual meeting of the American Society of Limnology and Oceanography (ASLO) in Copenhagen. The award is based on scientific merit, quality of the work, and effectiveness of the presentation. Rainer Zah's work represents the first study combining remote sensing technology and classical limnological field studies in order to model the input of terrestrial organic material (i.e., grass, pine needles, soil) to a high alpine flood plain (Val Roseg, Upper Engadin). His results suggest that erosion by glacial streams within the flood plain contributes orders of magnitude more organic material to the river system than direct input in the form of grass or pine needles.

Publications and Books

Please use the order form in the center fold of EAWAG news to request individual back issues of EAWAG news.

2733 **Hilger S., Sigg L., Barbieri A.** (1999): Size fractionation of phosphorus (dissolved, colloidal and particulate) in two tributaries to Lake Lugano. Aquatic Sci. *61,* 337–353.

2734 **Beer J.** (1997): Cosmogenic isotopes as a tool to study solar and terrestrial variability. Proc. Internat. School of Physics "Enrico Fermi", Course CXXXIII, G. Cini Castagnoli, A. Provenzale (Eds.). IOS Press, Amsterdam, 25–36.

2735 **Kaenel B.R., Uehlinger U.** (1999): Aquatic plant management: ecological effects in two streams of the Swiss Plateau. Hydrobiol. *415,* 257–263.

2736 **Büssenschütt M., Pahl-Wostl C.** (2000): A discrete, allometric approach to the modeling of ecosystem dynamics. Ecol. Model. *126,* 33–48.

2737 **Büssenschütt M., Pahl-Wostl C.** (1999): Diversity patterns in climax communities. Oikos *87,* 521–540.

2738 **Baumgartner S., Beer J., Masarik J., Wagner G., Meynadier L., Synal H.-A.** (1998): Geomagnetic modulation of the ^{36}Cl flux. Science *279,* 1330–1332.

2739 **Beer J., Mende W., Stellmacher R.** (2000): The role of the sun in climate forcing. Quaternary Sci. Rev. *19,* 403–415.

2740 **Jaspers M.C.M., Suske W.A., Schmid A., Goslings D.A.M., Kohler H.-P.E., van der Meer J.R.** (2000): HbpR, a new member of the Xylr/DmpR subclass within the NtrC family of bacterial transcriptional activators, regulates expression of 2-hydroxybiphenyl metabolism in *Pseudomonas azalaica* HBP1. J. Bacteriol. *182* (2), 405–417.

2741 **Zeltner C., Bader H.-P., Scheidegger R., Baccini P.** (1999): Sustainable metal management exemplified by copper in the USA. Regional Environ. Change *1* (1), 31–46.

2742 **Livingstone D.M., Lotter A.F., Walker I.R.** (1999): The decrease in summer surface water temperature with altitude in Swiss Alpine lakes: a comparison with air temperature lapse rates. Arctic, Antarctic, Alpine Res. *31* (4), 341–352.

2743 **Ravens T.M., Kocis O., Wüest A.** (2000): Small-scale turbulence and vertical mixing in Lake Baikal. Limnol. Oceanogr. *45* (1), 159–173.

2744 **Acero J.L., Stemmler K., von Gunten U.** (2000): Degradation kinetics of atrazine and its degradation products with ozone and OH radicals: a predictive tool for drinking water treatment. Environ. Sci. Technol. *34* (4), 591–597.

2745 **Canonica S., Hellrung B., Wirz J.** (2000): Oxidation of phenols by triplet aromatic ketones in aqueous solution. J. Phys. Chem. A *104* (6) 1226–1232.

2746 **von Gunten U., Elovitz M., Kaiser H.-P.** (1999): Calibration of full-scale ozonation systems with conservative and reactive tracers. J. Water SRT–Aqua *48* (6), 250–256.

2747 **Heberle S.A., Aga D.S., Hany R., Müller S.R.** (2000): Simultaneous quantification of acetanilide herbicides and their oxanilic and sulfonic acid metabolites in natural waters. Anal. Chem. *72* (4), 840–845 (2000).

2748 **Leisinger U., Rüfenacht K., Zehnder A.J.B., Egge R.I.L.** (1999): Structure of a glutathione peroxidase homologous gene involved in the oxidative stress response in *Chlamydomonas reinhardtii.* Plant Sci. *149,* 139–149.

2749 **Robinson C.T., Gessner M.O.** (2000): Nutrient addition accelerates leaf breakdown in an alpine springbrook. Oecologia *122,* 258–263.

2750 **Jaspers M.C.M., Harms H., Werlen C., Meier C., van der Meer J.R.** (1999): Mikrobielle Monitoringsysteme zur Bestimmung der Bioverfügbarkeit von Schadstoffen. TerraTech No. 6.

2751 **Jans U., Hoigné J.** (2000): Atmospheric water: transformation of ozone into OH-radicals by sensitized photoreactions or black carbon. Atmos. Environ. *34,*1069–1085.

2752 **Fent K.** (2000): Stoffe mit hormonartiger Wirkung. In: "Handbuch der Umweltveränderungen und Ökotoxikologie", Band 3B "Limnische Systeme", R. Guderian et al. (Hrsg.), Springer-Verlag, S. 351–371.

2753 **Frutiger A.** (1999): Biologische Anpassungen an die harschen Lebensbedingungen alpiner Fliessgewässer. Laufener Seminarbeitrag 4/99, Bayer. Akad. Natursch. Landschaftspfl., Laufen/Salzach, S. 39–52.

2754 **Balmer M.E., Goss K.-U., Schwarzenbach R.P.** (2000): Photolytic transformation of organic pollutants on soil surfaces – an experimental approach. Environ. Sci. Technol. *34* (7), 1240–1245.

2755 **Reichenbecher W., Philipp B., Suter M.J.-F., Schink B.** (2000): Hydroxyhydroquinone reductase, the initial enzyme involved in the degradation of hydroxyhydroquinone (1,2,4-trihydroxybenzene) by *Desulfovibrio inopinatus.* Arch. Microbiol. *173,* 206–212.

2756 **Marcomini A., Zanette M., Pojana G., Suter M.J.-F.** (2000): Behavior of aliphatic alcohol polyethoxylates and their metabolites under standardized aerobic biodegradation conditions. Environ. Toxicol. and Chem. *19* (3), 549–554.

2757 **Biselli S., Bester K., Hühnerfuss H., Fent K.** (2000): Concentrations of the antifouling compound irgarol 1051 and of organotins in water and sediments of German North and Baltic Sea marinas. Marine Poll. Bull. *40* (3), 233–243.

2758 **Boersma M., De Meester L., Spaak P.** (1999): Environmental stress and local adaptation in *Daphnia magna.* Limnol. Oceanogr. *44* (2), 393–402 .

2759 **Schwenk K., Sand A., Boersma M., Brehm M., Mader E., Offerhaus D., Spaak P.** (1998): Genetic markers, genealogies and biogeographic pattern in the Cladocera. Aquat. Ecol. *32,* 37–51.

2760 **Schweigert N.A.** (1999): Modes of action and toxicity of (chloro-)catechol/copper combinations. Diss. ETHZ No. 13 353, Zurich.

2761 **Frank S.** (1999): Growth characteristics of *Acinetobacter Johnsonii* 210A under single and dual nutrient limitation with special reference to carbon, nitrogen and phosphorus. Diss. ETHZ No. 13 407, Zurich.

2762 **Ziegler F.** (2000): Heavy metal binding in cement-based waste materials: an investigation of the mechanism of zinc sorption to calcium silicate hydrate. Diss. ETHZ No. 13 569, Zurich.

2763 **Fent K.** (2000): Hormonaktive Stoffe in Gewässern: Auch eine Gefahr fürs Trinkwasser? Mitt. Lebensmittel Hygiene *91,* 11–25.

2764 **Snozzi M.** (2000): Neue Konzepte und Methoden für die mikrobiologische Qualitätssicherung des Trinkwassers. Mitt. Lebensmittel Hygiene *91,* 44–52.

2765 **Bührer H.** (2000): Light within algal cultures; implications from light intensities within a lens. Aquat. Sci. *62,* 91–103.

2766 **Winder M., Pehofer H.E., Füreder L.** (2000): Distribution patterns of benthic crustaceans in a formerly meromictic lake with changing trophic conditions (Lake Piburg, Tyrol, Austria). Arch. Hydrobiol. *147* (4), 519–533.

2767 **Robinson C.T., Rushforth S.R., Burgherr P.** (2000): Seasonal effects of disturbance on a lake outlet algal assemblage. Arch. Hydrobiol *148* (2), 283–300.

2768 **Gujer W.** (2000): Environmental engineering education at the Swiss Federal Institute of Technology in Zurich. Water Sci. Technol. *41* (2), 37–45.

2769 **Rauch W., Schilling W., Vanrolleghem P., Krebs P.** (2000): Integrated urban water systems

(IUWS) – an international postgraduate course. Water Sci. Technol. *41* (2), 67–74.

2770 **Laj C., Kissel C., Mazauc A., Channell J.E.T., Beer J.** (2000): North Atlantic palaeointensity stack since 75 ka (NAPIS–75) and the duration of the Laschamp event. Philosoph. Transact. Royal Soc. London A *358,* 1009–1025.

2771 **Robinson C.T., Minshall G.W., Royer T.V.** (2000): Inter-annual patterns in macroinvertebrate communities of wilderness streams in Idaho, U.S.A. Hydrobiologia *421,* 187–198.

2772 **Spaak P., Vanoverbeke J., Boersma M.** (2000): Predator-induced life-history changes and the coexistence of five taxa in a *Daphnia species* complex. Oikos *89,* 164–174.

2773 **Zobrist J., Müller S.R., Ammann A., Bucheli T.D., Mottier V., Ochs M., Schönenberger R., Eugster J., Boller M.** (2000): Quality of roof runoff for groundwater infiltration. Water Res. *34* (5), 1455–1462.

2774 **Heller F., Shen C.D., Beer J., Liu X.M., Liu T.S., Bronger A., Suter M., Bonani G.** (1993): Quantitative estimates of pedogenic ferromagnetic mineral Formation in Chinese loess and palaeoclimatic implications. Earth Planetary Sci. Lett. *114,* 385–309.

2775 **Satroutdinov A.D., Dedyukhina E.G., Chistyakova T.I., Witschel M., Minkevich I.G., Eroshin V.K., Egli T.** (2000): Degradation of metal-EDTA complexes by resting cells of the bacterial strain DSM 9103. Environ. Sci. Technol. *34* (9), 1715–1720.

2776 **Gloor M., Wüest A., Imboden D.M.** (2000): Dynamics of mixed bottom boundary layers and its implications for diapycnal transport in a stratified, natural water basin. J. Geophys. Res. *105* (C4), 8629–8646.

2777 **Lendenmann U., Snozzi M., Egli T.** (2000): Growth kinetics of *Escherichia coli* with galactose and several other sugars in carbon-limited chemostat culture. Canad. J. Microbiol *46,* 72–80.

2778 **Riediker S., Suter M.J.-F., Giger W.** (2000): Benzene- and naphthalenesulfonates in leachates and plumes of landfills. Water Res. *34* (7), 2069–2079.

2779 **Boersma M., Spaak P., De Meester L.** (1998): Predator-mediated plasticity in morphology, life history, and behavior of *Daphnia:* the uncoupling of responses. Amer. Nat. *152* (2), 237–248.

2780 **Kasemir B., Schibli D., Stoll S., Jaeger C.C.** (2000): Involving the public in climate and energy decisions. Environment *42* (3), 32–42.

2781 **Lead J.R., Wilkinson K.J., Starchev K., Canonica S., Buffle J.** (2000): Determination of diffusion coefficients of humic substances by fluorescence correlation spectroscopy: role of solution conditions. Envrion. Sci. Technol. *34* (7), 1365–1369.

2782 **Baumgartner S., Beer J., Suter M., Dittrich-Hannen B., Synal H.-A., Kubik P. W., Hammer C., Johnsen S.** (1997): Chlorine 36 fallout in the summit Greenland ice core project ice core. J. Geophys. Res. *102* (C12), 26659–26662.

2783 **Thompson L.G., Yao T., Davis M.E., Henderson K.A., Mosley-Thompson E., Lin P.-N., Beer J., Synal H.-A., Cole-Dai J., Bolzan J.F.** (1997): Tropical climate instability: the last glacial cycle from a Qinghai-Tibetan ice core. Science *276,* 1821–1825.

2784 **Hong Y.T., Jiang H.B., Liu T.S., Zhou L.P., Beer J., Li H.D., Leng X.T., Hong B., Qin X.G.** (2000): Response of climate to solar forcing recorded in a 6000-year $\delta^{18}O$ time-series of Chinese peat cellulose. The Holocene *10,* 1–7.

2785 **Sander J., Simon A., Jonas T., Wüest A.** (2000): Surface turbulence in natural waters: a comparison of large eddy simulations with microstructure observations. J. Geophys. Res. *105* (C1), 1195–1207.

2786 **Beer J., Baumgartner St., Dittrich-Hannen B., Hauenstein J., Kubik P., Lukasczyk Ch., Mende W., Stellmacher R., Suter M.** (1994): Solar variability traced by cosmogenic isotopes. In: "The sun as a variable star: solar and stellar irradiance variations" (J.M. Pap et al., Eds.), Cambridge University Press, pp. 291–300.

2787 **Fligge M., Solanki S.K., Beer J.** (1999): Determination of solar cycle length variations using the continuous wavelet transform. Astron. Astrophys. *346,* 313–321.

2788 **Lean J., Beer J., Bradley R.** (1995): Reconstruction of solar irradiance since 1610: implications for climate change. Geophys. Res. Lett. *22* (23), 3195–3198.

2789 **Zerle L., Faestermann T., Knie K., Korschinek Nolte E., Beer J., Schotterer U.** (1997): The ^{41}Ca bomb pulse and atmospheric transport of radionuclides. J. Geophys. Res. *102* (D16), 19517–19527.

2790 **Yiou F., Raisbeck G.M., Baumgartner S., Beer J., Hammer C., Johnsen S., Jouzel J., Kubik P.W., Lestringuez J., Stiévenard M., Suter M., Yiou P.** (1997): Beryllium 10 in the Greenland ice core project ice core at Summit, Greenland. J. Geophys. Res. *102* (C12), 26783–26794.

2791 **Looser P.W.** (2000): Bioaccumulation of triorganotin compounds by a sediment-dwelling organism *(Chironomus riparius):* assessment of bioavailability, uptake and elimination processes. Diss. ETHZ Nr. 13 661.

2792 **Enz C.A.** (2000): Population dynamics of whitefish *(Coregonus duidteri* Fatio) in artificially oxygenated Lake Hallwil, with special emphasis on larval mortality and sustainable management. Diss. ETHZ Nr. 13 706.

2793 **Frutiger A., Jolidon C.** (2000): Bestimmungsschlüssel für die Larven und Puppen der in der Schweiz, in Österreich und in Deutschland vorkommenden Netzflügelmücken (Diptera: Blephariceridae), mit Hinweisen zu ihrer Verbreitung und Phänologie. Mitt. Schweiz. Entomolog. Ges. *73,* 93–108.

2794 **Kohler H.-P.E., Nickel K., Zipper C.** (2000): Effect of chirality on the microbial degradation and the environmental fate of chiral Pollutants. Advances in Microbial. Ecology *16,* 201–231.

2795 **Acero J.L., von Gunten U.** (2000): Influence of carbonate on the ozone/hydrogen peroxide based advanced oxidation process for drinking water treatment. Ozone Sci. & Engng. *22,* 305–328.

2796 **Lass S., Boersma M., Spaak P.** (2000): How do migrating daphnids cope with fish predation risk in the epilimnion under anoxic conditions in the hypolimnion? J. Plankton Res. *22* (7), 1411–1418.

2797 **Gessner M.O.** (2000): Breakdown and nutrient dynamics of submerged *Phragmites* shoots in the littoral zone of a temperate hardwater lake. Aquatic Botany *66,* 9–20.

2798 **Meier G.M., Meyer E I. Meyns S.** (2000): Lipid content of stream macroinvertebrates. Arch. Hydrobiol. *147* (4), 447–463.

2799 **von Gunten U., Pinkernell U.** (2000): Ozonation of bromide-containing drinking waters: a delicate balance between disinfection and bromate formation. Water Sci. Technol. *41* (7), 53–59.

2800 **Lamche G., Burkhardt-Holm P.** (2000): Changes in apoptotic rate and cell viability in three fish epidermis cultures after exposure to nonylphenol and to a wastewater sample containing low concentrations of nonylphenol. Biomarkers *5* (3), 205–218.

2801 **Agusti-Panareda A., Thompson R., Livingstone D.M.** (2000): Reconstructing temperature variations at high elevation lake sites in Europe during the instrumental period. Verh. Internat. Verein. Limnol. *27,* 479–483.

2802 **Bürgi H.R., Stadelmann P.** (2000): Change of phytoplankton diversity during long-term restoration of Lake Baldegg (Switzerland). Verh. Internat. Verein. Limnol. *27,* 574–581 .

2803 **Robinson C.T., Gessner M.O., Callies K.A., Jolidon C., Ward J.V.** (2000): Larch needle breakdown in contrasting streams of an Alpine glacial floodplain. J. North Amer. Benthol. Soc. *19* (2), 250–262.

2804 **von Gunten U., Furrer G.** (2000): Steady-state modelling of biogeochemical processes in columns with aquifer material: 2. dynamics of iron-sulfur interactions. Chem. Geology *167,* 271–284.

2805 **Xue H., Sigg L., Gächter R.** (2000): Transport of Cu, Zn and Cd in a small agricultural catchment. Water Res. *34* (9), 2558–2568.

Books, Book Chapters and Conference Proceedings

Bührer H., Kirner P.K., Wagner G. (2000): Dem Bodensee in den Abflussjahren 1996 und 1997 zugeführte Stofffrachten. Ber. Internat. Gewässerschutzkommission für den Bodensee Nr. 53, 42 S.

Bührer H., Kirner P., Wagner G. (2000): Dem Bodensee in den Abflussjahren 1996 und 1997 zugeführte Stofffrachten (Sonderband der Daten). Anhang zu Ber. Internat. Gewässerschutzkommission für den Bodensee Nr. 53, 74 S.

Henze M., Gujer W., Mino T., van Loosdrecht M. (Eds.) (2000): Activated sludge models ASM1, ASM2, ASM2d and ASM3. Scientific and technical report ser. No. 9. Internat. Assoc. on water quality, IWA Publ., London, vi + 122 pp. ISBN 1-900222-24-8.

Koblet R. (2000): Spiel mit dem Wasser – Spiel mit dem Feuer? Gedanken zur Geschichte und Gegenwart der Wasser in der Schweiz. Im Selbstverlag, Dübendorf, 70 Seiten.

Hands-On Experience on Baldeggersee

For two weeks this past September, EAWAG-Kastanienbaum assisted in providing a hands-on experience in limnology at the request of the town of Reschwil, LU. Schools from the surrounding area went out on a float on Baldeggersee to collect water samples, titrate oxygen and alkalinity, examine plankton populations under binocular microscopes, measure temperature profiles, and check turbidity with a Secchi disc. In a flurry of adventure and new experiences, the students were confronted with questions and ideas, learned about the yearly life cycle of a lake, what is living in it, what it needs, what it doesn't take so well, and why it is on "life support". EAWAG's crew had its hands full to maintain a minimum of oversight but to satisfy all the various needs.

Ökomobil, Lucerne

The highlight of the event was a day especially organized for the general public. On a brilliant fall day towards the end of September, everybody met for an outdoor apéro in Retschwil. There were a number of booths and demonstrations. "Pro Natura" offered guided walks on a nature trail, and representatives from the environmental protection agency of the canton of Lucerne told an interested audience about the history of the lake.

EAWAG put the world within the water under binocular microscopes and illustrated the life cycle of the lake. Taking water samples and sediment cores from the float were the favorite attractions. Of course, the children were most taken with the snow they were able to scrape from the evaporators of the aeration equipment.

Contact: Beat Müller (beat.mueller@eawag.ch)

Triclosan in Lakes and Streams

EAWAG investigates the fluxes and behaviors of a number of chemicals in natural waters (e.g., pesticides, biocides, drugs such as pain killers, high blood pressure medications, antibiotics and hormones, detergents, fire retardants, gasoline additives, chemicals used in construction, corrosion inhibitors, nutrients, heavy metals). Among the pesticides and biocides, Triclosan is being examined in some detail. Triclosan is an antimicrobial compound that is used in soap, cosmetics, toothpaste, textiles and cleaning products.

The study will quantify the degradation of Triclosan in the Greifensee and develop a model allowing us to predict Triclosan degradation in other lakes or streams, yielding important information about the possible toxic effects of Triclosan. Data from a three-month long field study in the Greifensee watershed (in effluents from wastewater treatment plants, streams and the lake) is currently being evaluated. The field study is supplemented by experiments focusing on the photochemical decomposition of Triclosan.

In addition to EAWAG, the following organizations are participating in this study: Swiss Federal Office of Environment, Forests and Landscape (BUWAL), Bern; Ciba SC, Basel; Procter&Gamble, Egham, Surrey, England; Unilever, London, England.

Contact: Stephan Müller (stephan.mueller@eawag.ch)

The NoMix-Toilet

How can we accomplish sustainability in the public water supply? This is the main question the participants (both at EAWAG and from the outside) involved the cross-disciplinary project NOVAQUATIS are trying to answer. The current research foci are the separation of different wastewater components and their treatment or recycling, particularly the separate collection of urine in modern NoMix toilets with a two-chamber design. The Urban Water Management and Environmental Engineering specialists are working out the details of urine collection, storage and transport to a central processing facility. Of particular concern are the ecotoxicological and chemical characteristics of urine, which involves analytical chemistry, environmental microbiology, and molecular ecotoxicology of problematic chemical compounds. After collection and removal of medication or hormone residues, the urine will be processed into fertilizer. Whether such a recycled fertilizer will be accepted by agriculture is being investigated by FIBL (Research Institute for Biological Agriculture, Frick). Acceptance of the NoMix toilet is being studied in focus groups and field studies in collaboration with the University of Bern.

EAWAG

NoMix Toilet: urine collection basin in front, regular toilet in the back.

The motivation for this project is multifaceted. From the point of view of urban water management, simple and cost-effective improvements in wastewater treatment are highly desirable. Urine is extremely rich in nutrients, but its use currently requires elaborate measures to prevent the contamination of natural waters with nutrients. In addition, urine can contain drug and hormone residues that are only partially removed during wastewater treatment. These residues can reach natural waters and cause ecotoxicological problems. The separate collection of urine could reduce the quantities of these problem compounds that reach natural waters.

For more information about NOVAQUATIS, visit the home page at http://www.novaquatis.eawag.ch.