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Looking Back on Ten Years of Inter- and Transdisciplinary Research, Education, and Outreach

After ten years of operation, the Competence Center Environment and Sustainability (CCES) of the ETH Domain ceased its activities at the end of 2016. CCES covered a broad range of topics grouped into five overarching research themes: *Climate and Environmental Change*; *Sustainable Land Use*; *Food, Environment and Health*; *Natural Resources*; and *Natural Hazards and Risks*. In the 18 preceding ProClim Flashes we regularly reported on various specific results of CCES in research, education, and outreach. In this last issue, we take a brief look back on CCES as a whole by summarizing some of its achievements and by addressing some important experiences made during its operation. Some key data on CCES are given in the table on the right. A more comprehensive assessment of this quite unique collaborative effort involving more than 800 people including an overview of and links to the various projects will be published elsewhere (Kassab *et al.*, submitted for publication in GAIA).

RESEARCH

The call for proposals launched in early 2006 resulted in the approval of 17 projects and the technical platform Swiss Experiment aimed at environmental data collection and processing for a first period until 2011. Since many of the scientists participating in CCES projects had never collaborated or did not even know each other before working together in CCES, it was not surprising that it took two or even three years to form a coherent research community for most of the projects, while a few projects never really reached that goal. Nevertheless, towards the end of the first period, more than two-thirds of the projects had managed to successfully build scientific communities capable of conducting inter- and transdisciplinary research of high societal relevance. From those, eight projects selected by the Advisory Board as being the «CCES jewels» as well as the technology platform Swiss Experiment were supported during the second period 2012 to 2016.

SCIENTIFIC PUBLICATIONS	
Peer-reviewed ISI journal publications	1,085
Peer-reviewed non-ISI journal publications	191
PhD theses	185
Master and diploma theses	417
Abstracts/proceedings/presentations/posters at scientific conferences/congresses/workshops	2,599
SCIENTIFIC EVENTS ORGANIZED BY THE PROJECT/BY PROJECT PARTNERS	
Conferences/workshops open to an audience beyond project partners/participants	254
PhD courses/summer schools, etc.	92
Other events	104
OUTREACH	
Publications for stakeholders outside the scientific community (e.g. public administration)	227
Press articles (newspapers, radio/TV broadcasts, etc.)	504
Courses/seminars/workshops for stakeholders outside the scientific community	235
Public information events for local/regional authorities/residents	144
Events/activities at schools (courses)	168
Other events	142
Patents	8

TABLE : CCES 2006 to 2016 at a glance (absolute numbers).

CCES triggered and supported research that could not have been carried out by a single institution alone and that would have been difficult to support through traditional funding channels. A particular asset of these research activities was the construction of numerous field sites all over Switzerland that could never have been established without CCES. These field sites were not only pivotal for comprehensive experimental studies, but they also played an important role with respect to the interaction of the scientists with local people and authorities. Many of them will continue to be available for future experiments.

Another major achievement has been the mobilization of a large number of established scientists to devote a considerable amount of their time to inter- and transdisciplinary research projects of high societal relevance. CCES has undoubtedly influenced the research agendas of those scientists in that it has positively changed their attitude towards this kind of research. This is particularly remarkable in a time in which success in academic careers continues to be assessed primarily based on personal research achievements in scientific disciplines. Furthermore, through CCES, quite a large number of young academics got a chance to act as project leaders and thus were able to increase their national and international visibility. With respect to the scientific output, in general, CCES partners have been very productive (see summary table).

EDUCATION

The most important impact of CCES in the educational sector was the exposure to other disciplines of an impressive number of doctoral and master/diploma students (table). Within the CCES projects, graduate students and postdocs from different disciplines worked closely together and thus experienced collaboration across various fields of natural sciences, social sciences, and engineering. According to many of these young researchers, this exposure to other disciplines has had a great impact and will continue to strongly influence their further careers. Many of them are confident that the contacts established within the CCES projects will sustain after the end of their doctoral or postdoc work, and, apparently, have already proven beneficial for them in the short-term.

In addition to exposing young (as well as senior) people to inter- and transdisciplinary research, numerous other educational activities have taken place within the CCES projects and within CCES as a whole. As summarized in the table, numerous scientific events have been organized by CCES partners. In addition, with the six editions of the CCES Winter School «Science Meets Practice» more than 150 doctoral students and postdocs were trained in conducting a dialogue with practitioners and the wider public. These types of event formats were judged by the participants as extremely valuable for the development of soft skills required for the next generation of leaders and decision makers.

Finally, a unique asset of the CCES educational program has been the translation of scientific results of several CCES topics into teaching materials that can be used by high school teachers in traditional courses in chemistry, physics, mathematics, biology, geography, and as topics of special courses («Vertiefungsblöcke») focusing on broader issues also including societal aspects. These teaching materials

«With CCES, the ETH Domain has created something of which it can be proud of – not only from the point of view of measurable scientific output but also with respect to integration and the building of very substantial multidisciplinary programs across institutions as well as triggering inter- and transdisciplinary approaches.»

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have been developed in close collaboration with the MINT-Learning Center at ETH Zurich. Already accomplished or close to finished materials cover «River Restoration», «Landscape Genetics», «Geothermal Energy and Thermodynamics», and «The Chemistry of Climate Change» (see figure overleaf). As has already been shown in various courses taught by the MINT-Learning Center, these teaching materials are highly appreciated, particularly by future high school teachers. In addition, another three projects dealing with (i) natural hazards and risks, (ii) with the ozone problem both in the troposphere and the stratosphere and (iii) with carbon sequestration just started and will end in 2018.



Inauguration of the MOUNTLAND project rain-shelter experiment field site in Leuk, Canton of Valais. In 2013 the project received the Swiss Academies award for transdisciplinary research acknowledging its exemplary research across disciplines on societally relevant topics.

KNOWLEDGE TRANSFER BETWEEN SCIENCE AND SOCIETY

With its many outreach activities (table), CCES has managed to significantly increase the visibility of environmental and sustainability science not only within the academic community but also in society including politics, governmental agencies, consulting firms, as well as the general public in Switzerland. CCES participants as well as CCES as a whole have managed to become a highly regarded partner for knowledge transfer between science and society.

Finally, in 2014/2015, together with the Platform Science and Policy (SAP) of the Swiss Academy of Natural Sciences (SCNAT), the CCES Management organized two workshops on the improvement of the policy-science dialog with high-level participants from politics, administration, the private sector, and science. The results and recommendations from the workshops formed the base for a follow-up project that is presently carried out by SAP itself with the goal to initiate new pathways for interactions between researchers and politicians.

FINAL REMARK

In conclusion, after ten years of operation, it is probably fair to state that CCES has had a significant, positive and lasting impact on the involved academic community in that it enabled research which would otherwise have been very difficult to promote, and in that educational and outreach activities took place which were strongly facilitated by having an «umbrella» or «family» organization and not just a collection of independent scientific consortia.

«Over the course of the years since its establishment in 2006, CCES has created a clear, visible and measurable added value with regards to science, capacity building and interdisciplinary work that should and also could absolutely be maintained through other funding avenues.»



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REFERENCES

Kassab O, Schwarzenbach RP, Gotsch N **Assessing Ten Years of Inter- and Transdisciplinary Research, Education, and Outreach – The Competence Center Environment and Sustainability (CCES) of the ETH Domain**. GAIA (submitted for publication).

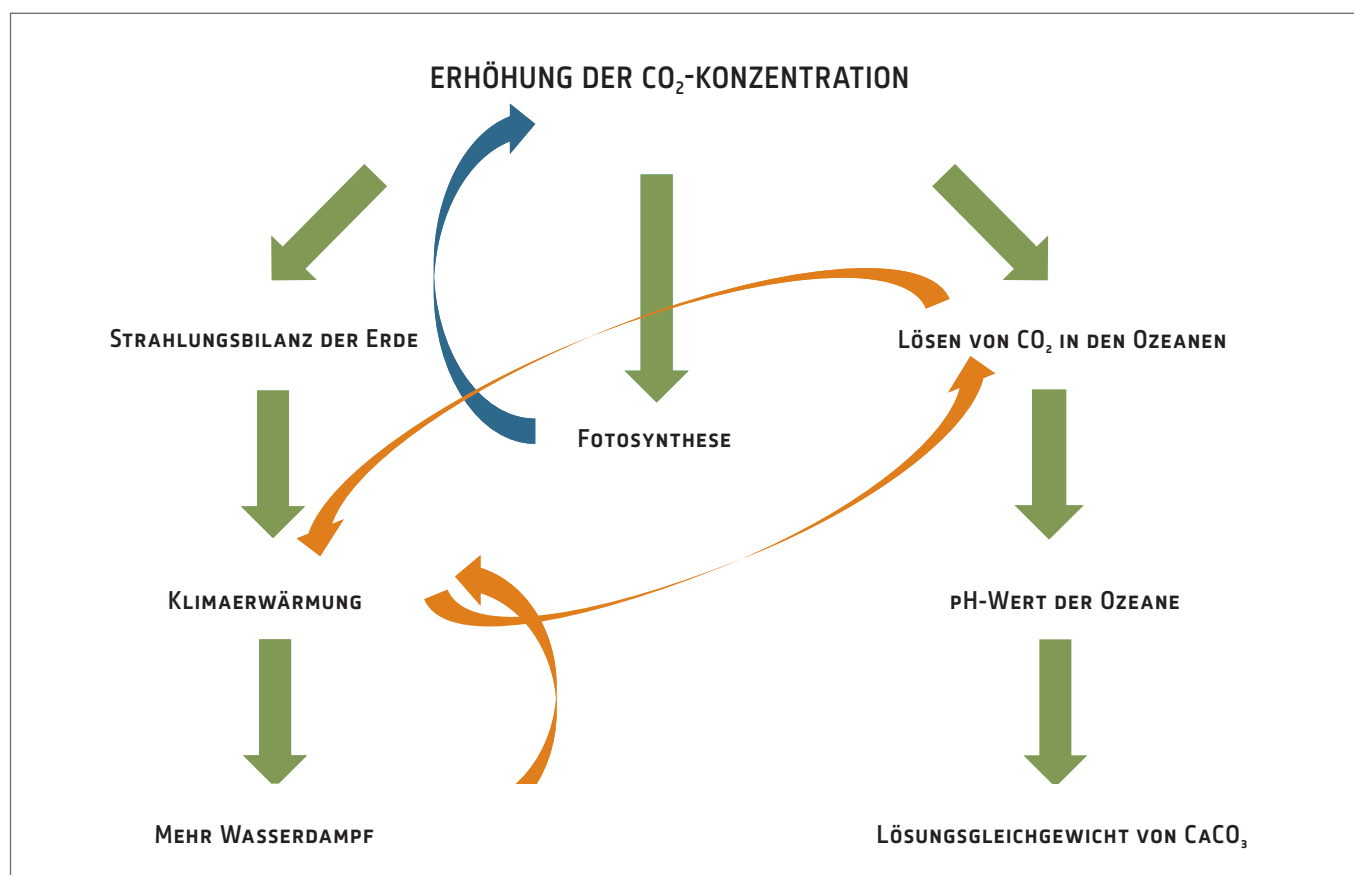


FIGURE : The influence of an increase in carbon dioxide on various sub-systems. Illustration from the teaching unit «Der Klimawandel im gymnasialen Chemieunterricht». © MINT-Learning Center at ETH Zurich, J. Lipscher.