CCES News 7

CCES goes into its second phase. Large multi- and transdisciplinary research projects on complex environmental systems and sustainability issues continue to form the backbone of the competence center. Many participants of the first round projects expressed their enthusiasm about this format offering a unique opportunity for scientific collaboration with partners from other ETH Domain institutions which otherwise would not have taken place, and at the same time, resulting in valuable scientific findings of high societal relevance. It is this particular setting of CCES that motivated researchers to submit research proposals for the second phase in spite of the sometimes cumbersome task to run such multi- and transdisciplinary projects.

News from the CCES office

Six new research projects approved

In its meeting of April 2, 2012 the CCES Steering Board approved the work plans of the following six new research projects for the period 2012 to 2016:
The OPTIWARES project ('OPTImization of the use of Wood As a Renewable Energy Source') aims at improving the quantitative understanding of the impact of aerosols from wood combustion on air quality and climate and develop improved strategies for encouraging the use of more appropriate wood combustion facilities.
The goal of the MAIOLICA-II project ('Modeling And experIments On Land-surface Interactions with atmospheric Chemistry and climAte') is to increase our understanding of fundamental processes that contribute to the observed variability of atmospheric CH_4 concentrations in the recent past, focusing on natural CH_4 emissions from wetlands and wildfires. Furthermore, atmospheric CH_4 in a changing climate including feedbacks among the terrestrial biosphere, atmospheric composition, and climate will be investigated.
The TRAMM-II initiative ('Triggering of Rapid Mass Movements in Steep Terrain') is connecting seven teams from the ETH Domain with complementary expertise towards developing models and observational strategies for linking measurable variables such as precipitation and hydro-mechanical material properties with dynamic mechanical events leading to hazardous failures in snow and soil.
The RECORD Catchment project ('Coupled Ecological, Hydrological and Social Dynamics in Restored and Channelized Corridors of a River at the Catchment Scale') investigates what measures are most effective to influence the river corridor so that river restoration and groundwater flow systems can help to mitigate the effects of floods and droughts, in particular in the context of climate and global change.

Collaborative research forms the backbone also in the 2012 to 2016 period. Photo: RECORD project

GeneMig ('Genetic variation and species Migration under environmental change: views of science, environmental management, and the general public') is an inter- and transdisciplinary research project assessing the challenges of migration (i.e. species and their genes) in a changing environment for society and environmental management.
Finally, the MOUNTLAND-II project ('Prioritization for adaption to climate and socio-economic changes – Backcasting tolerable future states to match supply and demand for ecosystem services in mountainous areas') will provide management and policy options that support society, including policymakers and ecosystem managers, to make choices in order to promote and improve sustainable development.

Scientific Events

CCES projects organized session at the 'Planet under Pressure' Conference

At the end of March 2012, the 'Planet Under Pressure' Conference united scientists and stakeholders in London. Plenary and parallel scientific sessions explored solutions to the global sustainability challenge. The first 'State of the Planet Declaration' is a major outcome of this event and can be downloaded at www.planetunderpressure2012.net.

The CCES projects RECORD and ENHANCE organized a session on 'Managing River Corridors under the Prospect of Climate Change' (www.planetunderpressure2012.net/pup_session.asp?19087). The take-home message from three keynote lectures and a lively panel discussion was that the ongoing climate change and increasing demands on river corridors in terms of ecosystem services require a constant adaptation of strategies and visions for their management. In particular, the sole restoration of a historic natural situation is not a successful recipe.

Jörg Luster and Irmi Seidl, Swiss Federal Research Institute WSL; Marco Baumann, Office for the Environment, Canton of Thurgau; Klement Tockner, Leibniz-Institute of Freshwater Ecology and Inland Fisheries IGB, Germany; Mario Schirmer, Eawag aquatic research
Contact: joerg.luster@wsl.ch

Education

Apply now for the CCES Winter School 2013 'Science Meets Practice'

"I got to know interesting and knowledgeable people, had some personal experience of the work "between" the spheres of science and practice, and can profit from that in my PhD and afterwards" – this is how one of the participants of the CCES Winter School 2012 describes the benefits of having gone through an intensive two weeks program with conceptual inputs, individual and group work, reflection, stakeholder meetings, and media training.

Stakeholder meeting during the second Winter School 2012. Photo: C. Zingerli, CCES.

After the success of the first two editions, the CCES Winter School will take place again in 2013. It is designed for PhD students from environmental and natural sciences, engineering, and social sciences working in the fields of sustainability and sustainable development. Its main goal is to enhance the capability to create interactions beyond the scientific community and to show ways to create and manage fruitful dialogue with stakeholders outside science.
The CCES Winter School 2013 will take place from January 7 to 10 and from February 4 to 7, 2013 at 'Propstei Wislikofen' (to be reached by public transportation from Zurich in 50 minutes). The application deadline is October 31, 2012. Flyer, application form, and further information are available at www.cces.ethz.ch/winterschool.

Contact: Claudia Zingerli, claudia.zingerli@sl.ethz.ch, phone: 044 633 92 75, or
Michael Stauffacher, michael.stauffacher@env.ethz.ch, phone: 044 632 49 07.

Winter school on landscape genetics

Landscape genetics amalgamates the fields of landscape ecology and population genetics. While landscape ecology assesses the configuration and composition of landscapes, population genetics uses various genetic techniques to measure how organisms (and their genes) move across landscapes and to study interactions between the environment and adaptive genetic variation. Landscape genetics is a new scientific field with great potential for conservation management, as it provides assessments of landscape barriers or corridors for movement or studies the effects of translocation or artificial seed mixes on the genetic variation of natural populations. Recently, adaptive genetic variation has become affordable through molecular techniques, which allow analyzing interactions between adaptive genetic variation and the environment (landscape genomics).
ETH Zurich is now offering a one-week winter school on landscape genetics on a yearly basis. The course location is at WSL, Birmensdorf ZH. The winter school was initiated by members of two CCES projects, ENHANCE and BioChange. The course is free of charge and structured into lectures and hands-on exercises for about ten Master and PhD students.
Information available at www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=73870&semkez=2011W&lang=de.

Janine Bolliger, Rolf Holderegger, Felix Gugerli, Swiss Federal Research Institute WSL
Contact: janine.bolliger@wsl.ch

Research

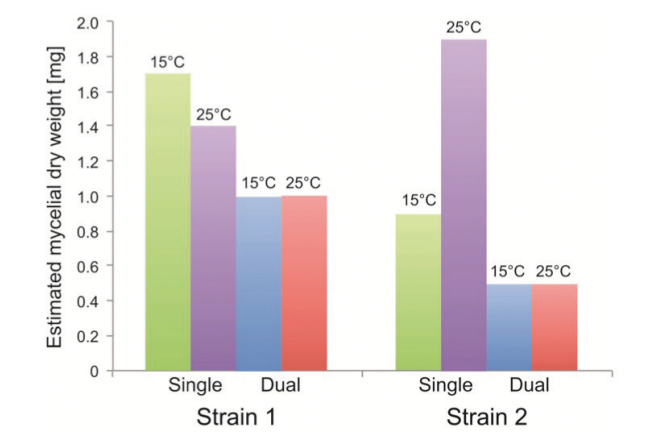
High genotypic diversity of fungal root-endophyte communities is leveling out global warming effects on growth of endophytic mycelia

Plants do not only have mycorrhizae, they also have "endophyte-roots", i.e. symbioses between roots and non-mycorrhizal fungi. One group of such symbionts are ascomycetes of the *Phialocephala fortinii* s.l. – *Acephala applanata* species complex (PAC) which comprises more than 20 closely related species. PAC are abundant root endophytes of woody plants in the Northern hemisphere. They can behave as commensals, mutualists, or opportunistic pathogens depending on genetic traits and environment according to the literature. However, mutualistic behavior in terms of growth promotion was not exhibited by any PAC strain (genotype) during a recent study that included more than 30 strains from Europe and North America (Tellenbach et al., 2011). All strains reduced the host's growth increment, and a few strains were virulent leading to high mortality. "PAC husbandry" is costly, but PAC fungi provide protection against serious root pathogens (Tellenbach, 2011). Moreover, there is "self control" among PAC genotypes, i.e. pathogenic strains are controlled by non-pathogenic strains as demonstrated recently by Reininger et al. (2012). Interestingly, plant biomass correlated negatively with the amount of endophytic PAC biomass in the roots of plants inoculated with a single PAC strain, whereas biomass of plants inoculated with two strains did not correlate, indicating that non-pathogenic PAC strains successfully compete with pathogenic strains probably by space occupation, thereby keeping endophytic biomass of pathogenic strains below the threshold above which plant growth is inhibited significantly (Sieber, 2007). PAC self-control *in planta* seems to work independently on temperature (Reininger et al., 2011a; Reininger et al., 2012), an important finding particularly with regard to global warming. This opens up new questions: Is the PAC-PAC or the PAC-plant interaction or both responsible for this effect?

The temperature effect on the PAC-PAC interaction was tested in a plant-free system on an artificial nutrient medium (malt extract agar; MEA) to exclude plant effects (Hugentobler, 2011). MEA was inoculated with constant amounts of blended PAC mycelium originating either from one single strain (single-strain inoculation) or two different strains (dual-strain inoculation) and incubated at 15°C and 25°C. Approximately 1-mm-high 1x2 cm areas of MEA completely colonized with PAC mycelium were collected after eight weeks and the amount of mycelium of each strain determined adapting a previously developed micro-satellite-based quantification method (Reininger et al., 2011b). Preliminary results indicate that without competition (single-strain inoculations), strains reacted differently to temperature with some having the growth optimum closer to 15°C than 25°C and others with an optimum closer to 25°C than 15°C (figure). In contrast, temperature had no differential effect on biomass accumulation of strains exposed to competition with another strain (dual-strain inoculations), i.e. fungal biomass was the same independently on the temperature, indicating that PAC-PAC interaction is leveling out temperature effects. In the field, genotypic diversity of PAC is high even within small root fragments. The effects of global warming on PAC are probably limited due to competition among PAC strains, mitigating the adverse effects on plant growth.

References available from the authors.

Vanessa Reininger, Ivo Hugentobler & Thomas N. Sieber,
ETH Zurich, Institute of Integrative Biology (IBZ),
Forest Pathology & Dendrology Group
Contact: vanessa.reininger@usys.ethz.ch
This study forms part of the GEDIHAP project:
www.cces.ethz.ch/projects/feh/gedihap



Effects of temperature and presence (Dual) / absence (Single) of a competing PAC strain on the biomass of two different PAC strains. Source: data: Hugentobler, 2011; diagram: TN Sieber

Pre-combustion CO_2 capture modeling, analysis and optimization

Within the global challenge of energy supply and greenhouse gas mitigation, carbon capture and storage (CCS) is considered a promising technological alternative to reduce CO_2 emissions on the way to achieve global CO_2 reduction targets. In power plants, CO_2 can be captured by three different ways: post-combustion (end-of-pipe CO_2 separation), oxy-fuel combustion (pure O_2 combustion), and pre-combustion (syngas intermediate). The pre-combustion process, H_2 route, generating power and/or hydrogen from natural gas, coal or renewable biomass is modeled, analyzed, and optimized at the Industrial Energy Systems Laboratory (LENI) at EPFL in the frame of the CCEM/CCES CARMA project.

The different technological options for the conceptual pre-combustion process design are summarized in Figure 1. These process configurations are compared systematically with regard to energy efficiency, cost and environmental impacts by applying flowsheeting, energy integration techniques, life-cycle assessment, and multi-objective optimization. Through optimization the trade-offs are assessed and optimal process configurations with regard to the polygeneration of H_2, electricity, and captured CO_2 are identified. The system's performance is improved by introducing process integration maximizing the heat recovery and valorizing the waste heat, and optimizing the polygeneration of hydrogen, captured CO_2, heat and electricity. The potential for greenhouse gas mitigation is assessed based on the CO_2 capture rate and the CO_2 avoidance cost. The trade-off between efficiency, CO_2 capture rate, and production cost is illustrated in Figure 2 for the power generation with CO_2 capture by chemical absorption with amines using natural gas steam reforming, autothermal reforming, and biomass gasification.

It is shown that the competitiveness strongly depends on the resource price, the imposed CO_2 taxes, and the technology's development. Considering resource price variations between 5 and 18CHF/GJ, efficiencies up to 56%, production costs of 71-162 CHF/MWhe and CO_2 avoidance cost of 12-276 CHF/$CO_{2,avoided}$ are computed for 90% CO_2 capture in pre-combustion power generation using natural gas resources, compared to 28% efficiency, 149-312 CHF/MWhe and 65-198 CHF/t$CO_{2,avoided}$ for biomass processes with 65% CO_2 capture. Comparing these results with post-combustion and oxy-fuel processes' performance, no clear decision in favor of one specific technology can be made at this point.

References available from the authors.

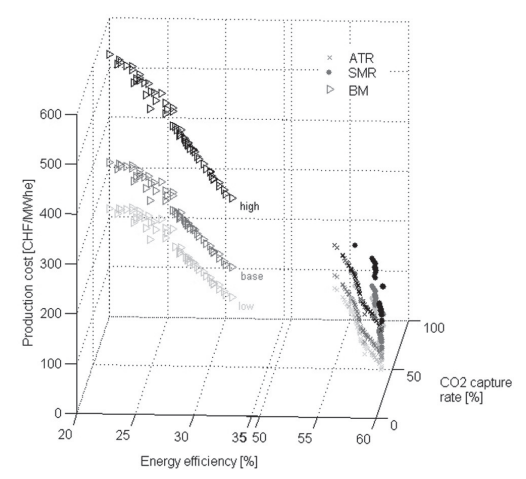


Figure 2: Trade-off between efficiency, CO_2 capture rate, and production cost for pre-combustion processes using natural gas steam reforming (ATR), autothermal reforming (ATR), or biomass gasification (BM) for syngas generation and chemical absorption with amines for CO_2 capture. Economic scenarios: Operation 7500 h/y, lifetime 25 years, interest rate 6%, resource price 8.8 CHF/GJ (base), 5 CHF/GJ (low), 18 CHF/GJ (high). Source: LENI EPFL

Laurence Tock, François Maréchal, Industrial Energy Systems Laboratory, EPFL
Contact: francois.marechal@epfl.ch
This study forms part of the CARMA project:
www.cces.ethz.ch/projects/nature/carma

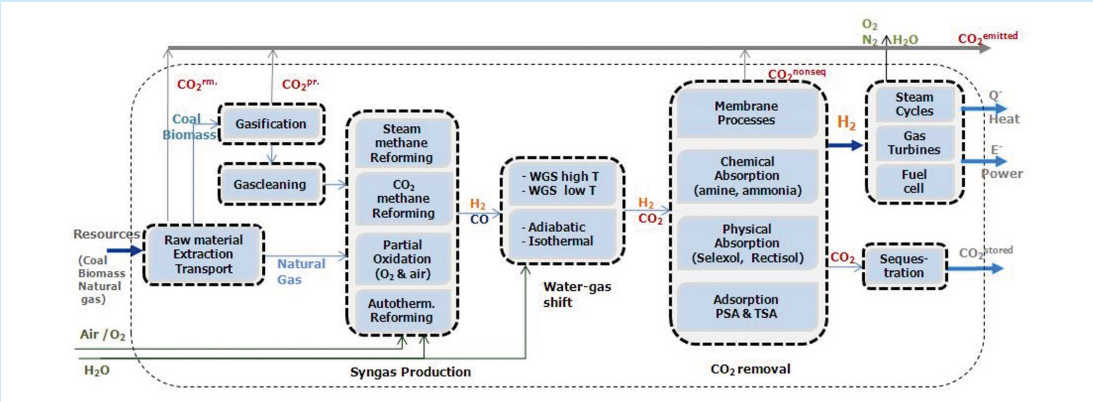


Figure 1: Pre-combustion process superstructure including the different technological options. Source: LENI EPFL