



University of
Zurich^{UZH}

ETH zürich



University
of Basel

Zurich-Basel Plant Science Center

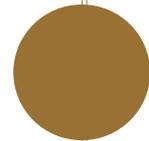
Going transdisciplinary

*How to implement impactful
transdisciplinary research and
education programs in
plant sciences*

Manuela Dahinden
Bianca Vienni Baptista
Melanie Paschke

**STIFTUNG
MERCATOR
SCHWEIZ**

Evaluation report
PSC-Mercator Fellowship Program (2011–2021)





Going transdisciplinary...

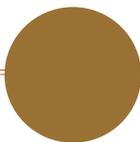
Fellows of the PhD Program Science & Policy

Eight fellows of the PhD Program Science & Policy share their insights and experiences

Linda Brodnicke, Danli Fei, Katharina Jung, Tiago Meier,
Arianna Nigro, Bessie Noll, Charlotte Pavageau, Kevin Vega

<https://video.ethz.ch/events/psc/veranstaltungen/transdisciplinary/77da0fd5-4025-4510-8433-8a35bfb15de0.html>

Film production: Dubravka Vrdoljak and Anja Hürlimann <https://www.video-geschichten.ch> (© PSC)



WHY?

Solutions to complex societal challenges, such as those embedded in the Sustainable Development Goals, cannot be generated solely on the basis of disciplinary research but require a paradigm shift in research practice.

OECD Global Science Forum (2020). Addressing societal challenges using transdisciplinary research.

The complex global challenges around environmental and climate change – we face today – require expertise and collaboration across disciplines and different sectors of society. Notably, plant science provides critical research insights that contribute to evidence-based decision-making in all areas of the UN Sustainable Development Goals (SDGs). For example, evaluating the capacity of soils and forests to store carbon and, subsequently, limit global warming can enhance climate action. Monitoring the effects of the exploitation of natural resources and habitat degradation on biodiversity can help inform policies on sustainable resource use.

While scientific and technological solutions are needed – on their own they will not suffice – they must be linked to social change and economic development if they are to yield transformative innovations (Smith & Stirling, 2007).

Universities, as institutions where knowledge is produced, are called to contribute to sustainable development and inclusive societal change. Higher education can achieve this, by providing incentives and support mechanism for transdisciplinary research, as well as by developing new concepts and formats of teaching and teaching-learning environments. These might include curricula for transnational collaboration respecting social, and cultural aspects (Caniglia et al., 2018) or curricula that teach methods and tools to integrate social and environmental expertise in the design, execution and regulation of technology (Loewe et al., 2013). Today, learning increasingly takes place in a situational manner. It is embedded in concrete experience contexts that are increasingly also outside the institutional boundaries of the university: in real laboratories, FabLabs, open workshops and maker cultures, in informal, medialized and hybrid learning spaces (Schmohl & Philipp, 2021).

The Zurich-Basel Plant Science Center (PSC) has implemented various research programs that provide new dimensions of curriculum development and stakeholder engagement. PSC graduate education programs aim at building a dialogue between science and policy, and co-production of knowledge through competence-oriented transdisciplinary teaching (Paschke & Zurgilgen, 2019). Thus, the programs increase students' capacity to act as socially engaged scientists. Transdisciplinarity, in this context, is defined as a mean to cross both disciplinary and institutional boundaries, involving research partners beyond the academy in the active co-production of research; and thus, facilitating a systemic approach to research and problem-solving.

More than 100 PhD students have been enrolled in the *PhD Program Science and Policy* since its launch in 2010. Ten of these PhD students have received a fellowship from the Mercator Foundation Switzerland.

On conclusion of the PSC-Mercator Fellowship Program in spring 2021, the PSC has set out to evaluate its long-term efforts.

This best-practice report addresses two main questions: (i) How effective has been the competence-oriented transdisciplinary teaching? (ii) What worked well and what can be improved? The aim was to identify: (i) the impact of the PSC graduate fellowship programs, and (ii) the implementation measures that may improve future programs.

The report aims to stimulate thinking and action on such questions. It also serves as a guidance to which curricular planning efforts, grant proposals, and articles can be connected.

AUTHORS



Dr. Manuela Dahinden

Zurich-Basel Plant Science Center

Manuela is managing director of the Plant Science Center's research and outreach activities. She develops inter- and transdisciplinary research programs in collaboration with industry, federal offices and international organizations. She is an expert in science communication and public engagement.



Dr. Melanie Paschke

Zurich-Basel Plant Science Center

Melanie is managing director of PhD and career programs at the Plant Science Center. She is a lecturer at the University of Zurich and ETH Zurich with expertise in ethics, system thinking, science and policy, and sustainable education. Melanie has built up the curriculum of the *PhD Program Science and Policy*.

Manuela and Melanie are co-founders of the *PhD Program Science and Policy*.



Dr. Bianca Vienni Baptista

Transdisciplinarity Lab, D-USYS, ETH Zurich

Bianca is a senior researcher at the Transdisciplinarity Lab at ETH Zurich with focus on interdisciplinary and transdisciplinary knowledge production processes.

Bianca served as a external evaluator of the PSC-Mercator Fellowship Program. She co-designed and conducted the interview and evaluation process. The results are presented here in the following sections: Reflections, Recommendations, and Next Steps.

CONTENTS

Why?	3
<hr/>	
What is transdisciplinary research and why is it worthwhile?	
<hr/>	
How?	6
<hr/>	
Vision and curriculum of the <i>PhD Program Science and Policy</i> <i>How to create collaborative environments? How to co-create a successful research project? How to facilitate evidence-based policymaking?</i>	
<hr/>	
Workbooks	10
<hr/>	
Reflections	12
<hr/>	
Lessons learnt from the PSC graduate fellowship and education programs <i>We present the main findings under five headings: Challenges in transdisciplinary research, Collaboration with stakeholders, Support for students, PIs' roles, and Institutional support structures.</i>	
<hr/>	
Recommendations	18
<hr/>	
Recommendations for future transdisciplinary fellowship and education programs <i>What steps can institutions take in order to catalyse or support long-term transdisciplinary capacity building? What learning formats support tackling problems through co-producing knowledge and deliberative decision-making? How to fund, support and evaluate this type of research?</i>	
<hr/>	
Next Steps	20
<hr/>	
How can the Plant Science Center advance its programs?	
<hr/>	
Outcomes	22
<hr/>	
Outcomes of the PSC-Mercator Fellowship Program <i>We present and discuss the links between research and evidence-based policy-making and how both can support and facilitate change towards more sustainable futures.</i>	
<hr/>	
References	40
<hr/>	
Acknowledgements	41

HOW?

The PhD Program Science and Policy

The PhD Program Science and Policy is a specialized training program for graduate students of the ETH Zurich, University of Zurich and University of Basel. The program is open to talented young scientists who are motivated to carry out research in any field of natural science and to take responsibility at the interface between policy, public interest, and research in future.

Our research projects address socially relevant topics. Fellows learn how to integrate methods and perspectives from different academic disciplines and in collaboration with at least one stakeholder. The desired outcome is an inclusive and solution-oriented approach to research, bridging plant science and society.

The PSC supports the 4-year research projects with a training and mentoring framework for research and knowledge sharing at the interface of plant science and policy. Participants in this program receive an introduction to policy implementation and transdisciplinary research. They acquire competencies that will help them in dealing with policymakers and stakeholders, as well as advocating dialogue with the media and public.

Curriculum

Tools and skills for policy work are introduced in six block courses and applied in various case studies. Each block course is organized as a series of lectures, literature studies, and group work. Scientists with policy experience, national and international experts from governmental offices, NGOs, private organizations and politicians contribute to the lectures, workshops and real-life case studies. With their practical expertise, they add to the hands-on course experience. Students get direct insights into the world of policymaking.

Block Courses

2 ECTS each, 4 out of 6 mandatory

- 1–Evidence-based policymaking
- 2–Stakeholder engagement
- 3–Communicating science
- 4–Communicating risks and uncertainties
- 5–Building political support
- 6–Understanding policy evaluation

Introduction to political sciences

Lecture or course, 1 ECTS

Skill training

1 ECTS each, 3 mandatory

- Transdisciplinary research methods
- System thinking
- Strategic foresight and scenario building

Transferable skills training

(e.g., scientific writing, statistics, etc.)

Presentation at international conferences

Organization of events

(e.g., public round table)

TOTAL 12 ECTS

Table 1.- Educational objectives.

DIMENSIONS	COMPETENCIES AND CONCEPTS DEVELOPED. <i>EARLY-STAGE RESEARCHERS WILL:</i>
Scientific knowledge	<ul style="list-style-type: none"> • Build scientific knowledge in the context of participants' disciplines • Apply methods for co-producing knowledge
Knowledge of political system	<ul style="list-style-type: none"> • Understand policymaking processes and policy culture • Recognize polity, politics and policy as aspects of the political system • Interact with these elements • Learn various ways science impacts policy
Development of attitude	<ul style="list-style-type: none"> • Define roles of scientists in science-policy boundary work; act accordingly • Know the norms of science-policy boundary work: credibility, salience, legitimation toward science, policy and public; and • Apply them in practice • Respond to the values and needs of policymakers and society and appreciate all those engaged with a problem as both producers and users of knowledge • Develop an attitude of social learning; reflect with stakeholders and policymakers on the use of evidence in policy options
Ability to act in policymaking	<ul style="list-style-type: none"> • Recognize different stages in the policy cycle. Know how scientific evidence is useful in each stage; be able to apply methods to interact with these stages • Present findings in policy-friendly formats • Develop participatory skills • Contribute unique skill sets (participatory skills, communication skills, incl. risk and uncertainty communication, scenario building and foresight, skills for impact generation) and expertise to policymaking • Engage in dialogue about policy options with the public, stakeholders and policymakers in inclusive environments

Transdisciplinary research is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem.

www.hsph.harvard.edu/trec/about-us/definitions

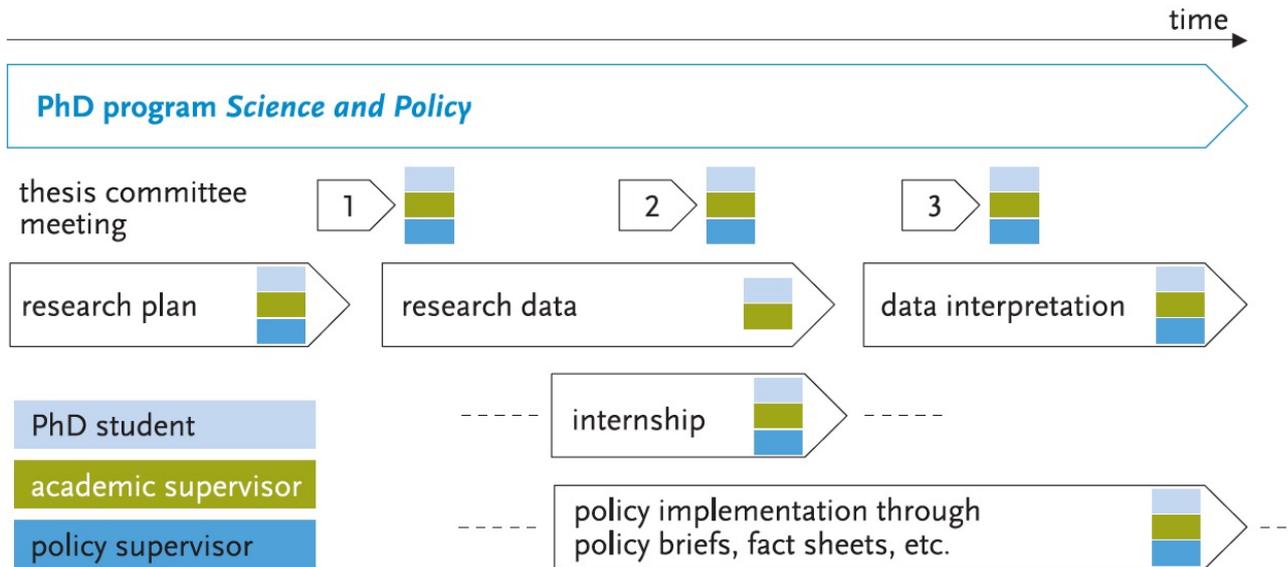
Internships

Internships of 1 up to 10 months are a central element of the PSC fellowships. Experiential learning or real-world practice enables early-stage scientists to understand the policy environment and how research can be applied to policy and societal questions. PhD students receive co-supervision from academic supervisors and representatives of policy institutions including governmental, nonprofit and international organizations.

Both internships and co-supervision broaden PhD students' learning experience through direct involvement in policymaking environments. Interns can work on policy outcomes through contributions to stakeholder meetings, policy briefs, fact sheets, recommendations for practice, or scenarios for deciding on different policy options.

From 101 students registered 2010–2021 in the *PhD Program Science and Policy*, 48 had internships or close collaborations with policy partners. These include, for example, the International Union for Conservation of Nature (IUCN, CH), the Swiss Federal Office for the Environment (FOEN, CH), the Swiss Federal Office for Agriculture (FOAG, CH), the Swiss Biodiversity Forum (CH), and the Ashoka Trust for Research in Ecology and the Environment (ATREE, India).

Figure 1.- Integration of internships in research projects.



Mentoring

The Plant Science Center offers additional training courses and peer-mentoring that allowed students to discuss their research projects with different experts.

Problem-framing workshop

During this one-day workshop with PD Dr. Christian Pohl and PD Dr. Pius Krütli from the Transdisciplinary Lab of ETH Zurich, fellows applied the “10-step approach” – a systematic procedure for thinking through ways to better link research to societal problem-solving. Ten questions guide discussions between transdisciplinarity experts and researchers to identify and review specific societal problems, identify relevant actors and disciplines, and clarify the purpose and form of interaction.

Ten Reflective Steps for Rendering Research Societally Relevant.
<https://doi.org/10.14512/gaia.26.1.10>

Impact generation workshop

During this one-day workshop with Dr. Brian Belcher from the Royal Roads Canada and PD Dr. Christian Pohl and PD Dr. Pius Krütli from the Transdisciplinary Lab of ETH Zurich, fellows applied the “Theory of change” approach to their projects and developed realistic expectations, indicators and strategies for project outcomes and outreach.

Careers in Science or Policy, or both?

This peer-mentoring course offers a perspective on possible career paths at the interface of science with policy and/or society. Recent graduates from the *PhD Program Science and Policy*, as well as professionals, relate to their career paths in government, politics, NGOs or private companies – skills, experiences and responsibilities. Some of the peers shared their experiences at our blog. blogs.ethz.ch/Science_and_Policy

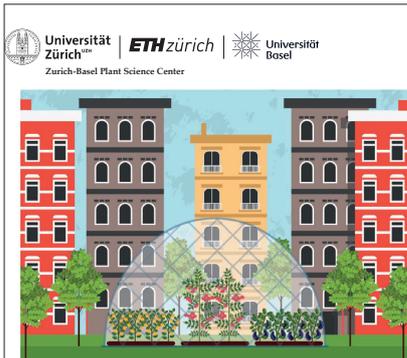
Retreats

In June 2014 and October 2019, we organized one-day retreats where the Mercator fellows, alumni fellows and invited speakers and practice partners discussed tools, methods and experiences increasing the impact of science towards policymaking and practice. In April 2021, we discussed with fellows, experts from Social Sciences and Humanities and members of the Plant Science Center: How to implement impactful transdisciplinary research and mentoring in educational programs.

Outreach

The Plant Science Center has built up outreach formats for different target groups. Formats include public round tables (see right) and expert conferences, science engagement programs for schools and holiday providers, exhibitions, as well as public dialogue formats. PSC staff has expertise in science communication and public engagement and helps students tap into existing resources and optimize their outreach efforts.

Students are encouraged to attend at least one national or international conference addressing policy topics in natural sciences. Moreover, they are invited to host national and international guests and involve them actively in discussions by organizing and moderating public events such as panel discussions or round tables.



Universität Zürich | ETH zürich | Universität Basel
Zürich-Basel Plant Science Center

Urban Agriculture

Fad or Future: Should tomorrow's cities grow their own food?

24th Oct. 2018, ETH Zurich, LEE E 101, 5-7 pm
Public Round Table & Apéro

Supported by:
Zürich-Basel Plant Science Center
Mercator Stiftung
Schweiz

Organized by:
Tiago Meier, U Zurich
Sergei Schaub, ETH Zurich
Kevin Vega, ETH Zurich
Eva Maria Vorkauf, U Basel

Invited speakers
Giorgio Gianquinto, University of Bologna
Heidrun Moschitz, FiBL
Joëlle Salomon Cavin, University of Lausanne
Fabian Weinaender, Urban Farmers

Urban agriculture has the potential to contribute to food security and social well-being in cities while simultaneously increasing overall sustainability of food production. However, many uncertainties remain with respect to potential risks, limitations, and overall feasibility. During this Public Round Table, experts will discuss future opportunities and challenges in order to inform the public about the manifold aspects of urban agriculture.

Registration: info-plantsciences@ethz.ch

Picture © Shutterstock

The public round table "Urban Agriculture: Fad or Future – should tomorrow's cities grow their own food?" reached out to 160 participants from the public, media, NGOs, governmental organisations. Urban agriculture has the potential to contribute to food security and social well-being in cities, while simultaneously increasing overall sustainability of food production. However, many uncertainties remain with respect to potential risks, limitations, and overall feasibility.

The event was organized and moderated by PSC-Mercator fellows Maria Vorkauf, Sergei Schaub, Tiago Meier, and Kevin Vega on October, 24, 2019. Invited speakers: Prof. Giorgio Gianquinto, Bologna, IT; Dr. Heidrun Moschitz, Research Institute of Organic Agriculture (FiBL), Frick, CH; Dr. Joëlle Salomon Cavin, U Lausanne, CH; Mark Zahan, Architect, CH.

The public round table: *Skigebiete in der Schweiz – Visionen für die Zukunft* reached out to 85 participants from the media, tourism, NGOs and the public. The online event took place on February 3, 2021. See page 28.

WORKBOOKS

Our workbooks are targeted towards researchers in life science who aim to communicate research findings to policymakers and society. They offer close insight into theory, processes and tools for evidence-based policymaking. These are core elements of the Science and Policy PhD program. Educators can use them as a learning resource to advance education in life sciences at the science-policy interface.

www.plantsciences.uzh.ch/en/publications/sciencepolicyworkbooks.html

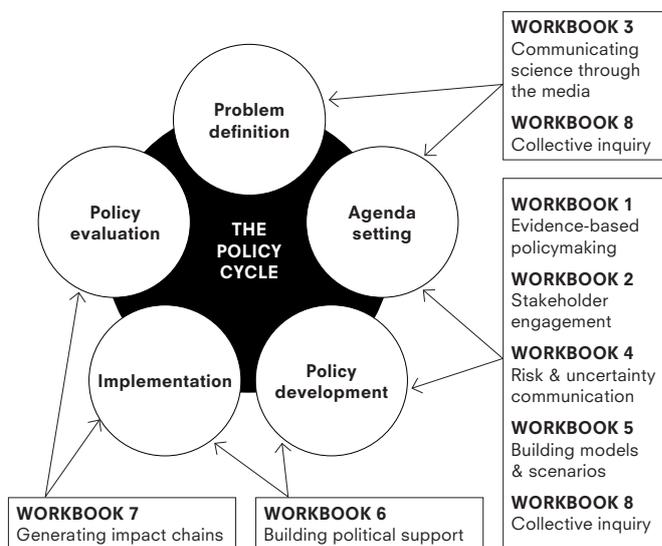


Figure 2. Engaging in the science-policy dialogue at different stages of the policy cycle.

Scientists can contribute to the policymaking process by providing scientific evidence. The challenge for scientists, however, is to link scientific evidence with the available range of choices or policy options. In the workbooks the authors discuss the role of science in the policymaking context and present methods and tools to enter the different stages of a policy cycle. The workbooks provide a guiding framework for improving science communication: Acknowledging values, understanding complexities of decisionmaking, strategies to deal with uncertainty and social inquiry through diversifying expertise.

Paschke, M. and Dahinden, M. (eds.). Engaging in the science-policy dialogue. Workbooks, Zurich-Basel Plant Science Center. Palsweis, Zurich: Idea Verlag GmbH.



Workbooks are available for download at ETH Zurich research collection. Printed editions CHF 20 per workbook. We offer PhD students the opportunity to purchase all books for a reduced package price: CHF 105 instead of CHF 140. Get your copies at: pssc_phdprogram@ethz.ch

1–Evidence-based policymaking

Pfisterer, A. and M. Paschke (2019). With contributions by McNally, K., Herrendörfer, R., Hirschi, C., Last, L., Pauli, D., Studer, B. and J. Schubert

www.research-collection.ethz.ch/handle/20.500.11850/308533

This workbook introduces the concepts of evidence-based policymaking and discusses the role of science in the policymaking context. It reflects on the methods and tools of evidence-based policymaking aiming to empower decision-making. Scientific evidence can be produced with different tools, from experimentation to interviews. Scientific evidence needs to be communicated in forms that are accepted by policymakers. We provide two instruments that can facilitate the communication process in a timely manner: the policy brief and fact sheet.

2–Stakeholder engagement

Hemmati, M. (2020). With contribution by B. Maier

www.research-collection.ethz.ch/handle/20.500.11850/308464

This workbook introduces methods, tools for multi-stakeholder engagement. Participatory methods are important tools for making scientific expertise heard. Based on how we define our role as scientists, we will participate in different forms of stakeholder engagement. These might range from negotiation and advocacy to a setting where diverse expertise is valued in order to find new cooperative ways to reframe problems and create new options.

3–Communicating science through the media

Pfisterer, A., Paschke, M. and J. Pasotti (2019)

www.research-collection.ethz.ch/handle/20.500.11850/314920

This workbook introduces methods, tools and competencies useful for communication with and through the media, including storytelling and press releases. The media act as translators between government action and public opinion. Hence they are an important communication channel for scientists. In order to maximize the chances of getting research into the media, scientists have to provide information in a timely and targeted manner.

4–Risk and uncertainty communication

Beuttler, C., Paschke, M. (2020)

www.research-collection.ethz.ch/handle/20.500.11850/340471

This workbook offers guidelines for students and scientists on how to communicate risk and uncertainties to policymakers and to the public, focusing on different areas such as public health and climate change. The authors argue for the need for deliberation at the science-society interface and provide tools and methods for the design of public engagement processes.

5–Building models and scenarios

In preparation.

6–Building political support

Bütikofer, S. (2019). With contributions by Falk, M., Last, L., Neu, U., Paschke, M., Pavageau, C. and C. Rey

www.research-collection.ethz.ch/handle/20.500.11850/312492

The workbook provides an overview of the most important elements of the Swiss political system. It outlines its general structure and law-making processes and discusses how scientific experts can impact political processes and decisions. The authors discuss the role of advocacy and lobbying in the Swiss policymaking process and present tools that can be used to interact with stakeholders. Parliamentary meetings and/or formal events set up at the center of the policymaking process can influence agenda setting, policy formulation and policy development. The world café offers the opportunity to interact with policymakers and parliamentarians early in the problem definition stage.

7–Generating impact chains

Paschke, M. and S. Studer (2019). With contribution by K. McNally

www.research-collection.ethz.ch/handle/20.500.11850/315536

This workbook reflects on how to generate impact chains. For monitoring and evaluating of policies, it is useful to conceptualize impact chains in order to contrast the intended with observable impacts. 'Logic models' and 'theories of change' are commonly used tools to illustrate impact chains and develop indicators for the assessing the effectiveness of policies. Policy evaluation is seen as the last step of the policy cycle; however, policy evaluation can inform any step in the cycle and support ongoing planning, adaptation and learning.

8–Collective inquiry

Paschke, M. and A. Pfisterer (2019). With contributions by Backhaus, J., de Carteret, R., Damerius, L., Huang, Y.-Y., Huppenbauer, M., Pöll, C., Rahn, E., Reynolds, M., Wallimann-Helmer, I.

www.research-collection.ethz.ch/handle/20.500.11850/315545

This workbook explains fundamental concepts of systems thinking and boundary work. With systems thinking we can analyze the nature of relationships and dependencies between the elements of a system, engage with multiple world-views in order to understand their relations with and within the system, and reflect on the boundaries of our own system. Collective inquiry can be facilitated by different tools. Systemic complexity games help participants to explore how complex systems operate. Systems thinking can be carried out through critical systems heuristics. Ethical analysis using the five-step model allows one to identify and analyze ethical challenges as part of systems thinking.

REFLECTIONS

Methodological approach

Applying a qualitative strategy, the following data sources were systematized: (i) results from a Delphi study conducted by PSC coordinators (Paschke & Zurgilgen, 2019), (ii) a video on students' insights from their fellowship edited by the PSC team, (iii) internal reports of the PSC-Mercator Fellowship Program and teaching evaluations (seven documents in total), (iv) semi-structured interviews with PSC team members (three in total) (Brinkmann, 2014); and (v) recordings and notes from the PSC Educational Retreat "Going transdisciplinary". The data sources were analyzed using content-analysis (Schreier, 2014) and Grounded-Theory (Corbin & Strauss, 1998). To substantiate observations on common topics, we analyze these data in the light of academic literature on transdisciplinarity. References and verbatim quotes are included as necessary, complying with ethical parameters for qualitative research (Traianou, 2014).

PSC program coordinators elaborated a set of questions that were discussed during the Retreat with students and PIs. These offered the basis for elaborating five dimensions that guided the analysis (Table 2).

The PSC Educational Retreat «Going transdisciplinary. How to implement impactful transdisciplinary research, mentoring and education programs», was held online on April 14th, 2021. It offered three input talks together with a workshop (fishbowl) inviting participants to reflect on the lessons learnt from the PSC graduate fellowship programs.

Table 2.- Guiding questions and dimensions of analysis for this study.

DIMENSION OF ANALYSIS	GUIDING QUESTIONS
Overcoming challenges of transdisciplinary research	<ul style="list-style-type: none">•What changes in knowledge, skills, attitudes, relationships, and behaviors have participants experienced during the program?•What did participants do differently due to the transdisciplinary program / research projects?
Collaboration with stakeholders	<ul style="list-style-type: none">•How did students and PIs experience the collaboration with stakeholder partners?
Support for students	<ul style="list-style-type: none">•What do PhD students expect to get as support from a supervisor, a mentor, a partner or from the program?
PIs' roles	<ul style="list-style-type: none">•How did PIs see their role as supervisor in a transdisciplinary program? How did their role change during the program?
Support structures	<ul style="list-style-type: none">•What support structures do students want to see in the PSC programs in future to be able to do good transdisciplinary research projects?

Overcoming challenges of transdisciplinary research through the fellowship program

Transdisciplinarity, as a scientific response to pressing societal problems, has been gaining more relevance in science policy discourse in recent years (Graf, 2019). Nevertheless, despite this popularity, transdisciplinarity is still far from being fully institutionalized, and current funding practices do not effectively support it at universities (Jahn et al., 2012). This imposes specific challenges among those practicing transdisciplinarity, such as the lack of policy learning about how to facilitate transdisciplinary research, leading to frequent repetition of recommendations about how to do this (Vienni Baptista et al., 2020).

In this respect, the PSC graduate fellowship and education programs overcome a first barrier by providing students a supporting learning environment that cares for specific conditions of collaboration (Student 4, 2021). Students are exposed to transdisciplinary practices, caring for equity together with a critical perspective on scientific effectiveness (Garrett, PSC Retreat, 2021).

Transdisciplinary skills are seen as fundamental to help students in the next steps of their career. As previous studies have confirmed, students from inter- and transdisciplinary programs are highly skilled in negotiating perspectives, practicing team-science skills, and eliminating the frustration and confusion commonly encountered in research teams (Killion et al., 2018). As one student acknowledged:

[The PSC program helped me to] deal with uncertainties at multiple levels. It is very hard to plan in advance the complexities of this type of research. It also requires a breadth and depth of knowledge of different disciplines together with the ability to integrate them in order to tackle real world problems (Student 3, 2021).

Students and PIs involved in PSC graduate fellowship programs agree that transdisciplinarity positively influences their vision and goals for research. It enables them to achieve novel and impactful results, while requiring good communication and attentive listening skills. As main changes during the program, students call for more opportunities to meet up with each other and contrast different research areas and backgrounds. This would allow them to share strategies and lessons on how to handle challenges in relation to transdisciplinary research processes. Among these, building a trustful relationship with stakeholders is a demanding but rewarding factor (Student 4, 2021).

Killion et al. (2018) have identified similar challenges to conducting integrative research in training programs. Most common are: (1) lack of exposure to epistemological frameworks and team-science skills; (2) challenges to effectively include stakeholder perspectives in research; and (3) variable levels of committee support to conduct integrative research. As an asset, all students agree that training courses within PSC programs are useful in this last respect, especially those focusing on stakeholder engagement. As reflected in this quote:

Everyone benefits from getting involved with the communities – it builds trust and understanding in the community and the perspectives of the community have also shaped the research in useful ways (Fishbowl, PSC Retreat, 2021).

Coordinators and PIs (supervisors) emphasize the relevance of the projects and impact developed in PSC programs. These require time for individual input and support and are mainly driven by participants and their commitment to the programs (Interview 2, 2021).

REFLECTIONS

Collaboration with stakeholders

PSC graduate fellowship and education programs promote policy work as boundary work, bringing together the scientific and policy domains, and fostering connections between different value systems (Paschke & Zurgilgen, 2019). To implement this concept, students gain experience in practicing transdisciplinary research “on-the-ground” – involving a wide range of stakeholders, whether government organizations, NGOs or institutions that offer internships as opportunities for “doing transdisciplinarity” at the science-policy interface (Paschke, PSC Retreat, 2021).

Students are confronted with the need to develop concepts and competencies in the fields of knowledge, attitude and action (Paschke & Zurgilgen, 2019). Alignment, compatibility, and flow of knowledge between student-researchers, policymakers, and PIs was often demanding, requiring greater time investment and trustful relationships. Cultural differences and working philosophies between these groups magnified the challenge (Roux et al., 2006). In the words of one PhD student:

The crucial step is to define your question from a bottom-up approach by consulting all stakeholders about what is for them the problem rather than imposing on them your idea of what the problem should be (Student 4, 2021).

According to a previous Delphi study (Paschke & Zurgilgen, 2019), internships are an opportunity to practice science-policy dialogue, while providing training in new skills and knowledge. Internships come with limitations that are well-known in the literature such as the discrepancies between the different reward systems of science and policy, the limited time frame for policy work, and difficulties integrating policy work in research plans (Mielke et al., 2016).

One relevant challenge identified in the PSC programs was the interaction between the supervisors (PIs), students and stakeholders. If not accompanied by sustained support, this relationship may lead to conflicts (in relation to priorities, time commitment, resources rooted in the process of transdisciplinarity rather than in the research itself); and these conflicts may accumulate if the student is the only gatekeeper facilitating interaction with stakeholders (Interviews 1 & 2, 2021). Nevertheless, this situation may also constitute an asset as well as a constraint for students, allocating the role of “in-between” dealing with PIs, PSC coordinators and stakeholders (Interview 2, 2021). Such a setting demands a rewarding system that includes framing relevant topics for impact generation, defining the right channels and activities, and spotlighting topics for broader discussion. It should also be recognized that there are different types of researchers and stakeholders, and that hidden research agendas are sometimes in tension with stakeholders’ interests and availability (Mielke et al., 2016).

Important to note is that the student cannot build up the connections to stakeholders alone, but the student must be able to interact in existing relationships/network with stakeholders, otherwise there is also a risk of the student being overwhelmed. The most effective strategy for engaging stakeholders and partners in the research process is grounded on a humble, respectful, and sustained engagement with local communities and stakeholders (Student 3, 2021). A key to success has been the implementation of meetings, workshops, and participatory field trials early in the research process (Student 5, 2021). These factors have gone hand in hand with support for students in planning necessary resources to implement their projects and sharing time with the various parties in the research process.

Support for students

PSC graduate fellowship programs seek to provide students with a platform for their academic or professional careers (Interview 1, 2021). In order to build a suitable setting for transdisciplinary research, adequate time frames are required both for research and training (Killion et al., 2018). Supervisors need to invest both time and effort (Rogga & Zscheischler, 2021). To ensure better working conditions, thereby countering constraints at the institutional level (Lyll et al., 2015) and allowing early-career researchers to envision academic pathways and joint academic agendas (Rogga & Zscheischler, 2021).

An additional challenge of the PSC programs was the goal of embedding research into policy – a process that might take years (Lyll, PSC Retreat, 2021). One example is indicated in this quote:

Policymakers also need quick answers due to the dynamics of their work and this does not always match the time needed for a research process (PI, PSC Retreat, 2021).

The converse is, however, also true, as experience shows that implementation of a complete policy cycle may take between ten and fifteen years.

The time frames of stakeholders are different from those of academia and publishing (Felt et al., 2013). This is not particularly encouraging for transdisciplinary research, which also requires extra time for building a common understanding among societal actors involved in the research process. Together with the fact that transdisciplinary research is usually ranked lower in the hierarchy of science (Student 6, 2021), these challenges need to be clearly addressed in PhD programs (Killion et al., 2018).

Lack of adequate support for PhD students in transdisciplinary programs is still a much-discussed topic in the literature (Klein & Falk-Krzesinski, 2017). There are no adequate indicators for transdisciplinary programs that would offer students constructive feedback on their performance and a suitable reward system. These are usually built ad hoc and tailored to each program (Rogga & Zscheischler, 2021). In this respect, the PSC programs are acknowledged for their mentoring and caring environment (Student, PSC Retreat, 2021). The PSC team accompanied research projects case by case in order to build trustful relationships that sought to align research and policy agendas (Interview 2, 2021).

REFLECTIONS

Principal Investigators' (PIs') roles

PIs in the PSC programs were asked to accompany the development of an interdisciplinary process (i.e. one that integrates different disciplines), and a transdisciplinary one (i.e. one that finds common ground with stakeholders in the science-policy interface). In doing so, the PSC programs pursued projects that could have an impact on society while pursuing methods that could advance transdisciplinary research (Interview 1, 2021).

Following previous studies on transdisciplinary PhD programs, it is acknowledged that supervisors initiate projects together with PhD students as early as the application phase (Rogga & Zscheischler, 2021). In the words of one PhD student:

We discussed a lot from basic to applied research and also the policy level. These exchanges on the one-one level were really helpful (Student, PSC Retreat, 2021).

PIs acknowledged changes in their own understanding of the policy process while participating in the program (Fishbowl, PSC Retreat, 2021). Changes in their research practice induced new ways of working with different stakeholders and co-producing knowledge (Fishbowl, PSC Retreat, 2021). The following quote is indicative:

[I perceived a] change in my own research, when we do a stakeholders workshop, stakeholders provide me with other insights that I did not take into consideration with my own understanding of the setting. They provide me with a context. It also changes the basic questions of my research (Fishbowl, PSC Retreat, 2021).

As supervisors, PIs stressed the need to also ask for help to improve the outcomes of future research, especially seeking support in the tools and methods for transdisciplinary research (Fishbowl, PSC Retreat, 2021). For example, methods and tools to integrate social and environmental expertise in the design, execution and regulation of technology. One PI suggested that having a seminar to reflect on the impact of their research would be very useful (Fishbowl, PSC Retreat, 2021).

PIs emphasized the need to ask for help when the methods to be applied by students are new to them. In this regard, universities are building up structures to guide and support choice of methodologies through, for example, the Transdisciplinarity Lab (D-USYS, TdLab) at ETH Zurich and the 'Partizipative Wissenschaftsakademie' at the University of Zurich (Fishbowl, PSC Retreat, 2021). The PSC also offers workshops and mentoring events with guidance on methods for transdisciplinary research. Building up such infrastructures in the long-term is identified as a positive feature in most institutions supporting transdisciplinary programs (Caniglia et al., 2017).

Support structures

Key support structures in PSC transdisciplinary programs can involve: (i) networking to find the right stakeholders and help; (ii) offering training for PIs; and (iii) providing a longer time horizon and funding support for collaborative research for students (Fishbowl, PSC Retreat, 2021). Communication and policy training are assets already implemented by PSC programs, supporting students in their future academic or professional pathways (Students 1, 3, & 6, 2021).

To (i): The implementation of a “PSC In-house mentor” for future programs was welcomed by almost all participants (PSC Retreat, 2021). Examples from other Higher Education institutions, like Trinity College Dublin (Wallace et al., 2021), show how the implementation of policy mentors in the academic institution helped with the pursuit of specific tasks, such as: offering guidance in distributing time between research and policy work, providing methodological support in policy work, and facilitating outreach, dialogue and planning. This can be accompanied by advisors in the policy organization offering guidance on in-house processes (Lyall, PSC Retreat, 2021).

To (ii): Interdisciplinary courses at both graduate and undergraduate level should include non-academic actors (Student, PSC Retreat, 2021). Practitioner-led learning can build a culture of accountability where research is undertaken with and for the ultimate beneficiaries. Harnessed with practical know-how and intuition, scientific R&D can yield solutions that are better suited to their particular context and are more quickly implemented.

To (iii): Long-term approaches with several fellowships in a row, would secure transfer of knowledge and resources to finalize policy work (Lowe et al., 2013). Currently, a long-term systems-oriented, transdisciplinary field research approach is lacking. Instead, current knowledge and research systems promote fragmented short-term output (Edwards & Roy, 2017).

Besides providing adequate long-term funding for transdisciplinary research, it is also crucial to break down institutional silos. Cross-departmental fellowship programs not only increase the visibility of transdisciplinary research but also broaden transdisciplinary approaches, experimental know-how, framings and product formats (Interview 1, 2021).

RECOMMENDATIONS

Based on the findings and insights from the PSC graduate fellowship and education programs, the following recommendations for future transdisciplinary programs have been identified. These are related to the recommendations elaborated by Pascke & Zurgilgen (2019) summarizing key aspects for this type of program.

0.1 Impact

Define, together with all participants, the policy impact and outcomes to be achieved in the process (Interview 2, 2021; Fishbowl, PSC Retreat, 2021). To do so, focus on the processes rather on the products that the programs develop (Belcher, PSC Retreat, 2021). “Building a mutual understanding for policy work is an important part of scientific work and *vice versa*” (Interview 2, 2021). Include, for example, non-academic partners in the design and performance of training courses (Student, PSC Retreat, 2021).

0.2 Capacity building

Be mindful of the impact transdisciplinary programs have on the careers of early stage researchers. Although transdisciplinary research is promoted at policy level, it remains poorly rewarded at the University levels. The current focus on “excellence with impact” discourages many other worthwhile forms of knowledge production and exchange and places emphasis on generating new knowledge (Lyll, PSC Retreat, 2021). Offer training in transdisciplinary methods and tools for PIs, too (Fishbowl, PSC Retreat, 2021). Consider cross-departmental research and training programs that increase visibility and transdisciplinary research capacity (Interview 1, 2021).

0.3 Best practices and failing stories

Provide “hands-on” examples of successful PhD projects to motivate students to experiment with transdisciplinary research. Stories of failures early on in the training process are also a useful resource (Interviews 1 & 2, 2021). Include formats for peer-learning at the very beginning of the fellowship program (Student, PSC Retreat, 2021).

0.4 Commitment and engagement

Design the program together with the PI for him/her to fully commit to it from the beginning (Interviews 1 & 3, 2021). Transdisciplinary programs rely individual commitment and build on such relationships (Interviews 1 & 2, 2021). “Partners should define their responsibilities at the beginning of the project by mutual agreement” (Interview 2, 2021).



0.5 Time frames

Allocate enough time to build connections and commitments before the project starts. This implies dealing with expectations from stakeholders, the PI and the student (Interviews 1, 2 & 3, 2021; Paschke & Zurgilgen, 2019). Make sure that all collaborations are established before the project is launched (Interview 3, 2021). Consider follow up projects or mechanisms to secure knowledge beyond the fellowship duration.

0.6 In-house advisor

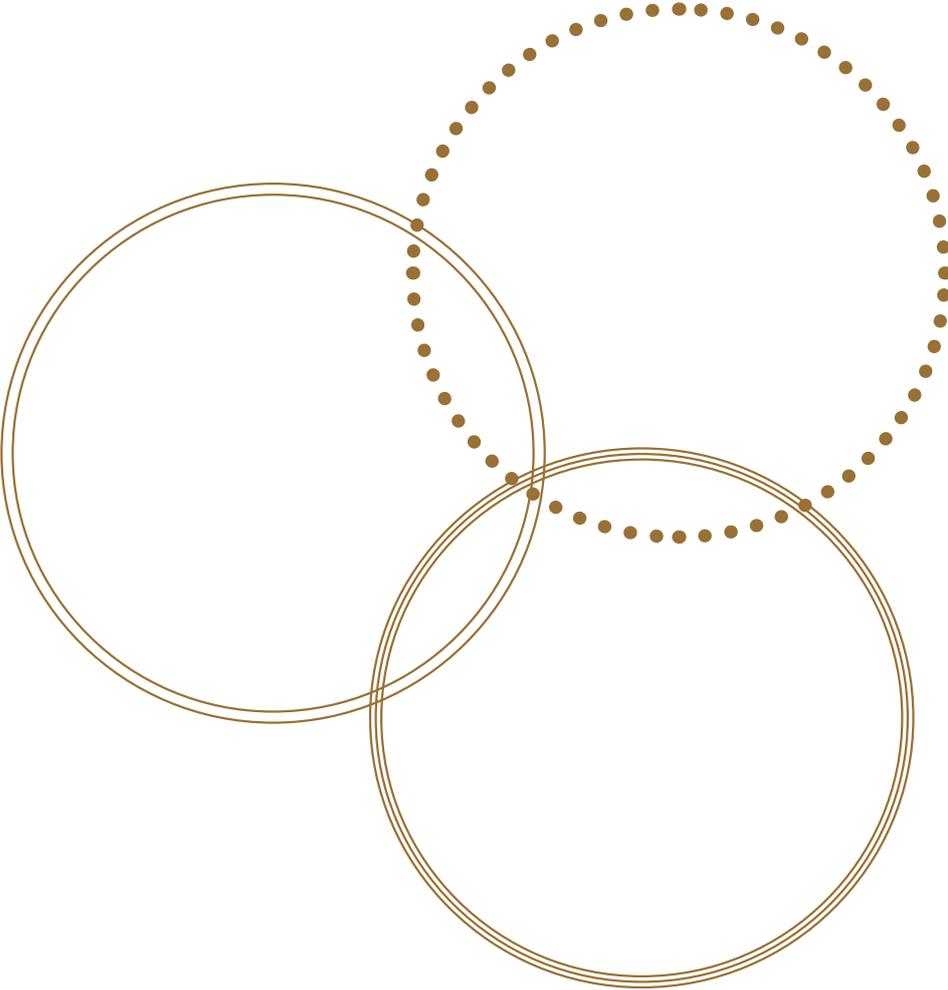
Allow time and resources for an “in-house advisor”. His/her role is to accompany the scientific and policy processes, while “helping the parties in their integrative efforts and mentoring. During the research process, this advisor will ensure that the participatory process is fair” (Interview 2, 2021).

0.7 Long-term institutional support

Emphasize the need for continuous institutional support and reasonable time frames in view of coordinating and accompanying required for transdisciplinary processes (Fishbowl, PSC Retreat, 2021; Interviews 1 & 2, 2021; Paschke & Zurgilgen, 2019). These tasks require more resources to be allocated to the program to cope with separate roles (project manager, in-house advisor) and specific tasks. Long-term approaches, with several fellowships in a row, would secure transfer of knowledge and resources to finalize policy work (Lowe et al., 2013).



NEXT STEPS



1	For students	Provide examples of best practices from case studies at the beginning of the program to be inspired by them.
2		Exchange with role models from PSC Alumni to gain insights on how to overcome barriers and constraints in the transdisciplinary process.
3		Plan community building activities, inviting students from the Humanities and Social Sciences (HSS).
4		Establish peer mentoring groups between students right at the beginning of the research projects.
5		Allow some freedom to adapt project performance and objectives during the PhD fellowships.
6	For principal investigators	Organize networking activities between researchers and stakeholders.
7		Offer opportunities to make transdisciplinary research expertise within the PSC more visible.
8		Work together with HSS researchers to integrate public knowledge systematically within research projects.
9		Provide training for transdisciplinary methods and tools.
10		Reflect regularly on the collaborative process between the partners. Discuss with PIs: How can transdisciplinary research improve basic research?
11	For stakeholders	Invite practitioners to training workshops and other PSC activities.
12		Promote strategies to engage stakeholders: co-authorship, data sharing, involve local universities, stakeholders when working abroad.
13		Define policy-relevant research questions together with all involved parties.
14		Give visibility to integrative efforts and successful research-policy processes.

PSC-MERCATOR FELLOWS

PSC-Mercator-Fellowship Program
«Bridging Plant Science and Policy»
(2011–2016)

John Garcia-Ulloa

Comprehensive trade-off analysis of REDD+ (Reducing Emissions from Deforestation and Forest Degradation) implementation

PIs: Prof. Jaboury Ghazoul, ETH Zurich, Ecosystem Management; Dr. Lian Pin Koh (former ETH Zurich)

Practice Partner: International Union for Conservation of Nature (IUCN)

Tobias Bühlmann

The Alnus shrub proliferation problem and exceeding critical nitrogen load in the Alps (ALNEX)

PIs: Prof. Christian Körner & Dr. Erika Hiltbrunner, Plant Ecology, University of Basel

Practice Partners: Federal Office for Environment (FOEN), Forum Biodiversity Switzerland

Sonja Hassold

Development and validation of a novel barcoding strategy to support identification, tracing and trade regulation of precious timber trees

PIs: Prof. Alex Widmer, ETH Zurich, Plant Ecological Genetics; Martin R. Bauert, Zurich Zoo

Practice Partners: Zurich Zoo, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Wildlife Conservation Society (WCS), Silo National des Graines Forestières (SNGF) in Madagascar

Elena Perez

Environmental controls on forest growth in Switzerland

PIs: Prof. Nina Buchmann, ETH Zurich, Grassland Sciences; Prof. Werner Eugster ETH Zurich; Roman Zweifel, Swiss Federal Institute for Forest, Snow and Landscape Research (WSL)

Practice Partners: Federal Office for Environment (FOEN), <https://treenet.info/switzerland/>

Maria Vorkauf

Changing snow loads and summer drought pressurize alpine plants and force economy

PIs: Dr. Erika Hiltbrunner & Prof. Ansgar Kahmen, Plant Physiology, University of Basel; Prof. Bruno Abegg, University of Innsbruck, Economic Geography; Dr. Christop Marty, WSL Institute for Snow and Avalanche Research (SLF), Davos, Climatology

Practice Partners: Sport AG Andermatt Sedrun, Korporation Ursern (Andermatt), Interacademic Commission for Alpine Studies (ICAS)

Sergei Schaub

Values of species diversity in grassland production: An ecological economic assessment

PIs: Prof. Nina Buchmann, Grassland Sciences, ETH Zurich; Prof. Robert Finger, Agricultural Economics and Policy, ETH Zurich

Practice Partners: Agridea, Arbeitsgemeinschaft zur Förderung des Futterbaus (AGFF), Agroscope

Kevin Vega

Maintaining plant biodiversity in cities

PIs: Prof. Christoph Kueffer, Urban Ecology, ETH Zurich and Ostschweizer Fachhochschule Rapperswil (OST); Prof. Dominik Siegrist, Landscape Architecture, Ostschweizer Fachhochschule Rapperswil (OST)

Practice Partner: Grün Stadt Zürich

Tiago Meier

Papaya: History of its agricultural use and improvements to adapt to a changing climate

PIs: Prof. Ueli Grossniklaus, Plant Development, University of Zurich; Prof. Dr. Jean-Philippe Vielle-Calzada, Plant Genetics, Langebio Cinvestav; Prof. Jorge Manuel Santamaria, Biotechnology, Centro de Investigación Científica de Yucatán (CICY), Mexico

Practice Partner: Mexican network for papaya production, propapaya.org

OUTCOMES

Maintaining biodiversity and managing oil palm expansion

John Garcia-Ulloa

Expanding oil palm plantations remain an important environmental topic, given the large negative impacts they can have on tropical biodiversity. During his PhD, John Garcia-Ulloa developed models and scenarios to understand biodiversity change in oil-palm landscapes under REDD+ initiatives (Reducing Emissions from Deforestation and Forest Degradation). During his policy internship at the (International Union for Conservation of Nature (IUCN) he convened a stakeholder meeting with the oil palm sector in order to discuss the impacts of oil palm expansion and to develop IUCN guidelines to mitigate the impact on biodiversity.

Interview with John

What was the main impact for policy?

The process resulted in a resolution (WCC-2016-Res-061-EN, <https://portals.iucn.org/library/node/46478>) approved at the IUCN World Conservation Congress 2016. Accordingly, the IUCN Oil Palm Task Force was set up to conduct a situation analysis of the implications for biodiversity conservation from the expansion of oil palm, and to review and define best practices in the industry. The results were published by Meijaard, Garcia-Ulloa et al., in 2018. It is the most complete report on oil palm and biodiversity to date.

How was the scientific evidence translated in policy outcomes?

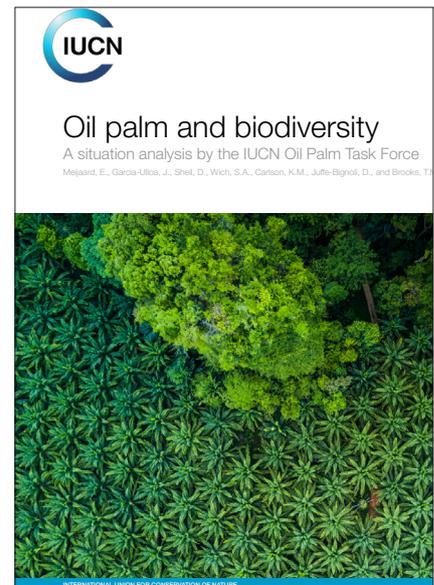
The situation analysis was consulted and reviewed by 43 organizations and individuals. More than 600 comments from this process were incorporated in the final report. The situation analysis provides a common framework

for IUCN and all its members, as well as any other stakeholders, to understand the impacts and implications from oil palm expansion and to find constructive solutions for the sector. After publication of the report, the IUCN task force is looking at developing a similar analysis for the implications of oil palm development on social and economic aspects in producing countries.

John Garcia-Ulloa completed his PhD (2012–2016) at the Institute of Terrestrial Ecosystems at ETH Zurich, in the research group of Professor Jaboury Ghazoul. John is currently a senior scientist at ETH Zurich, where he conducts governance and ecological analysis of oil palm landscapes in the tropics. John is an invited lecturer at the PSC Science and Policy Workshop: Understanding Policy Evaluation where he contributes with his case study: Ex-ante analysis and impact studies, challenges of policy evaluation as perceived by a natural scientist.

PhD Thesis: John Garcia-Ulloa (2016). Improving conservation perspectives of land-use change policies in the tropics. ETH Zurich.
<https://doi.org/10.3929/ethz-a-010798265>

Interview with John: https://blogs.ethz.ch/Science_and_Policy/2019/08/20/maintaining-biodiversity-and-managing-oil-palm-expansion/



Meijaard, E., Garcia-Ulloa, J., Sheil, D., Wich, S., Carlson, K., Juffe-Bignoli, D., Brooks, T. (2018). Oil palm and biodiversity: a situation analysis by the IUCN Oil Palm Task Force.

<https://doi.org/10.2305/IUCN.CH.2018.11.en>

Detection tool for illegally transported Malagasy rosewoods

Sonja Hassold

The massive overexploitation of Madagascar's tropical woods is endangering the island's unique flora and fauna. 90 per cent of Malagasy wood is shipped to Asia to manufacture expensive furniture, and 5 per cent to Europe and the USA, where the guitar industry in particular creates a large demand for tropical woods. The illegal wood trade is flourishing, with a turnover of hundreds of millions – annually.

Interview with Sonja

What was the main impact for policy?

Madagascar is a biodiversity hotspot and its forests harbor a vast diversity of precious woods. For decades, ever increasing demand for timber on the international market and its high commercial value have led to massive illegal exploitation of rosewood, palisander and ebony species in Madagascar. Controlling the international trade of illegally logged timber is challenging. One reason is that logs and sawn wood are difficult to assign to species or geographic origin (provenance).

During my PhD, I developed a method allowing the genetic material to be isolated from heartwood, to analyze it and to set up genetic 'barcodes' for each species. I collaborated with the Zoo Zurich and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as well as the Wildlife Conservation Society (WCS) and the Silo National des Graines Forestières (SNGF) in Madagascar. This opened up a new dimension in follow-up projects and cooperation for the prosecu-

tion and prosecution of illegal timber trade on a global scale.

What evidence is useful for policy-making?

A very valuable database for molecular identification of Malagasy rosewood through DNA marker analysis was established during the PhD thesis. In a follow-up project Hassold established a fully documented reference sample collection of CITES-listed Malagasy *Dalbergia* (rosewood) species with a standardized sampling protocol together with CITES, Missouri Botanical Garden (MBG) and Partners of the Department of Plant Biology and Ecology (DBEV) at the University of Antananarivo. The availability of a collection of linked and carefully vouchered samples that could, for the first time ever, be used by different disciplines in order to compare results and assess the power and suitability of different methods allows one now to analyze trunk samples and match them with species in the established databases. Test cases will still have to demonstrate feasibility and precision on the global market and in prosecution, but the project is now closer than ever to implementing the developed methodologies on an international level.

*Sonja Hassold completed her PhD (2011–2015) at the Institute of Integrative Biology at ETH Zurich, in the research group of Professor Alex Widmer. As a postdoc she developed molecular tools to identify Malagasy *Dalbergia* species. Together with a colleague she founded the start-up Botanik Exkursionen, training students and professionals in systematic botany, doing vegetation assess-*



Hassold, S., Cramer, S., Ravaomanalina, H., Lowry II, P. P., Widmer, A. (2018). Creating a base for rosewood identification. ITTO Tropical Forest Update: 27 (3), 4–30. Yokohama: International Tropical Timber Organization.

<https://doi.org/10.3929/ethz-b-000454212>

PhD Thesis: Sonja Hassold (2015). Molecular identification of Malagasy *Dalbergia* species (rosewoods) for biodiversity conservation.

ETH Zurich.

<https://www.research-collection.ethz.ch/handle/20.500.11850/106147>

Interview with Sonja: https://blogs.ethz.ch/Science_and_Policy/2019/07/11/sonja-hassold/

OUTCOMES

Management options to reduce the expansion of *Alnus* species

Tobias Bühlmann

In Switzerland, atmospheric N deposition represents large N inputs across many close to natural ecosystems and may induce indirect NO and N₂O emissions from soils in these ecosystems. During his PhD, Tobias Bühlmann assessed how higher soil temperatures and increased nitrogen availability, mediated by the N₂ fixation of different *Alnus* species, affect soil nitrous oxide (N₂O) emissions. The N₂-fixing shrub *Alnus viridis* is encroaching on montane grasslands in the Alps as a result of reduced land management and complete abandonment. *Alnus* introduces large amounts of nitrogen (N) into these formerly N-poor grasslands and restricts the succession to montane forests. Tobias analyzed the causes of the rapid encroachment of *Alnus viridis* into grassland across the entire Alps, and its effects on biodiversity, ecosystem properties, and the economy. He developed management options to reduce the expansion of this shrub. The fieldwork was conducted along a West–East gradient in three valleys in central Switzerland.

Interview with Tobias

What was the main impact for policy?

My work in cooperation with the University of Basel and the Forum Biodiversity Switzerland resulted in the change of the subsidy system of the cooperation Urseren favoring Engadine sheep in 2013. Furthermore, the Federal Office for the Environment (FOEN) adjusted the model for calculation of indirect NO and N₂O emissions from close to natural ecosystems in Switzerland.

What evidence was useful for policy-making?

Where farming on montane pastures is reduced, green alder (*Alnus viridis*)

forms dense, monoculture-like thickets with low biodiversity. Because these shrublands are so dense, succession toward montane forests is blocked. Green alder fixes nitrogen through a symbiosis with Frankia. Therefore, nitrogen accumulates in the soil, pollutes surface water and induces intense emission of the greenhouse gas N₂O. Grazing and browsing by Engadine sheep prove to be very efficient in reducing the land cover by green alder.

In a second part of the project, the indirect emissions of the air pollutant NO and the greenhouse gas N₂O induced by atmospheric nitrogen deposition was modeled for close to natural ecosystems in Switzerland. This model is now used in the Swiss emission inventory.

What are the outputs of the research for policy and how are they translated?

The scientific evidence for the impact of green alder on soil, water, air quality, climate and biodiversity was communicated in cooperation with the Forum Biodiversity Switzerland in a fact sheet released by SCNAT (2013) and addressed to administrations, policymakers and to the public and taken up by 26 press articles as well as radio and television. This was very important to make the problem visible for the public and policymakers.

Tobias Bühlmann completed his PhD (2013–2017) at the Department of Environmental Sciences at University of Basel, in the research group of Professor Christian Körner and Professor Ansgar Kahmen. Tobias is currently working as a research scientist in the Gas Analysis Laboratory at METAS. He is developing traceable reference gas mixtures to support atmospheric monitoring worldwide.



Bühlmann, T., Hiltbrunner, E., Körner, C. (2013). Die Verbuschung des Alpenraums durch die Grünerle. Swiss Academies of Arts and Sciences, Bern. <https://natural-sciences.ch/service/publications/6034-die-verbuschung-des-alpenraums-durch-die-grunerle>

PhD Thesis: Tobias Bühlmann (2017). The influences of N₂-fixing *Alnus* and atmospheric nitrogen deposition on the nitrogen balance in close to natural ecosystems. University of Basel, Faculty of Science. http://edoc.unibas.ch/diss/DissB_12430

Interview with Tobias: https://blogs.ethz.ch/Science_and_Policy/2019/09/24/the-green-alder-problem-and-too-much-nitrogen-in-the-alps/

Environmental controls on forest growth in Switzerland

Elena Perez

The long-term aim of this project was to identify how climate change impacts the carbon (C) cycle of forest ecosystems. To achieve this goal, different data sets have been used. Long-term meteorological data were employed to assess trends in air temperature, precipitation and extreme climate events. Extreme climate events were calculated following international definitions of extreme indices and standardised to allow for comparison between the two sites. Quality checked CO₂ flux data from the mixed forest Lägeren (2004–2015) and the spruce forest Davos (1997–2015) were used to analyse the effects of air temperature, precipitation and extreme climate events on net ecosystem CO₂ exchange (NEE).

What evidence was useful for policy-making?

The growth of Swiss forests is currently being assessed based on infrequent forest inventories from the Landesforstinventar (LFI; about every 10 yrs). Thus, forest growth information is available to the decision-makers at cantonal and national levels only with a rather coarse temporal resolution and a substantial time lag (about 4 yrs after the inventory is completed), which prohibits annual reporting (e.g. for the Kyoto protocol), but also limits an advanced understanding of the environmental controls of forest growth in Switzerland at inter- or even intra-annual time scales.

At the same time, 17 long-term monitoring sites (LWF, LTER) are equipped with different types of stem growth bands, so-called dendrometers, which record tree stem growth at different temporal resolutions, from annual to 30 min time spans, since 1998/2001. At one of these sites, a CO₂ flux tower is running since 1997, providing ecosystem C budget information. Although all of these data could act as a great data "treasure" to estimate past

and to measure and understand current forest growth, a comprehensive, Swiss-wide assessment of these dendrometer data has not been done so far. Thus, this „treasure“ is heavily underused.

What are the outputs of the research for policy and how are they translated?

In collaboration with stakeholders (WSL, FOEN), we compiled and quality checked different data sources on forest growth. We assessed environmental controls as well as interacting stresses on forest tree growth at different temporal scales (30 min to decade). The results provide knowledge on cause-effect relations in Swiss forests – important to define policy demands for FOEN and Swiss policy options arising from two conventions (UNFCCC; CLRTAP).

References

Churakova OV (Sidorova), Eugster W, Etzold S, Cherubini P, Zielis S, Saurer M, Siegwolf R, Buchmann N (2014). Increasing relevance of spring temperatures for Norway spruce trees in Davos, Switzerland, after the 1950s. *Trees* 28: 183–191. https://doi.org/10.1007/s00468-013-0941-6call_made

Zielis S, Etzold S, Zweifel R, Eugster W, Haeni M, Buchmann N (2014). NEP of a Swiss subalpine forest is significantly driven not only by current but also by previous year's weather. *Biogeosciences* 11: 1627–1635. https://doi.org/10.5194/bg-11-1627-2014call_made

Wolf S, Eugster W, Ammann C, Haeni M, Zielis S, Hiller R, Stieger J, Imer D, Merbold L, Buchmann N (2013). Contrasting response of grassland versus forest carbon and water fluxes to spring drought in Switzerland. *Environmental Research Letters* 8: 035007. https://doi.org/10.1088/1748-9326/8/3/035007call_made

Zielis S, Etzold S, Zweifel R, Eugster W, Haeni M and Buchmann N (2013). Forest NEP is significantly driven by previous year's weather. *Biogeosciences Discussions* 10: 15587–15611. https://doi.org/10.5194/bgd-10-15587-2013call_made

<https://gl.ethz.ch/research/pro/forest-ch.html>

Interview with Elena

What new competencies did you develop in the training program?

I could greatly expand my capacities for creative and analytic thinking and gain knowledge of climate change, plant science and forest ecology. Furthermore, my participation in the *PhD Program Science and Policy* has provided me with the opportunity to learn more about stakeholder processes and obtain a better insight into the crucial aspects of involving local stakeholders in every step of the decision-making process.

What is your planned next career step?

I feel passionately about the potential for sustainable solutions to improve smallholder livelihoods in the developing world. I am very much interested in the approach of locally controlled forestry. This approach provides a dual solution: on the one hand, preventing forest loss and degradation, while on the other hand, helping secure the livelihoods of local communities' dependent on the ecosystem services those forests provide.

What activity and training is needed to attain these goals?

Obtaining practical experience in the field is thus critical for this next step. Communication and conflict-resolution skills as well as the ability to translate complex scientific and technical information into language in a manner that conveys the key points with clarity.

Elena Perez joined the lab of Professor Nina Buchmann at ETH Zurich from 2011 to 2016.

OUTCOMES

Model for future water management in alpine ski areas

Maria Vorkauf

Climate change is particularly rapid above the natural tree line. How quickly do the results of my research show: Between 1985 and 2019, the date of snowmelt advanced by 2.8 days per decade, and this process will accelerate with unchecked greenhouse gas emissions. By the end of the 21st century, the growing season for alpine plants will begin around a month earlier.

Interview with Maria

What are the economic consequences of climate change?

Based on the climate scenarios for Switzerland, I analyzed for the ski area "Andermatt + Sedrun + Disentis" how the availability of snow will change during the 21st century. A particular focus was on the amount of water that the ski area will have to use in the future in order to remain profitable.

Elevated temperatures threaten the very foundation of every ski area - the snow. Artificial snow is already being produced in many places to enable a profitable ski season. Elevated temperatures increase water consumption considerably or make the production of snow impossible. In collaboration with the Andermatt + Sedrun + Disentis ski area, I predicted the availability of snow during the 21st century. The SkiSim 2.0 model used (developed at the University of Innsbruck) takes into account the production of artificial snow and I was also able to estimate the future water consumption of the ski area up to the end of the 21st century.

It turned out that the Andermatt + Sedrun + Disentis ski area is relatively well armed against the expected climatic changes. Even towards the end of the 21st century, modern artificial snow systems will enable skiing in this

area. Only over the Christmas holidays will parts of the area remain closed.

Without a reduction in our greenhouse gas emissions, however, the water consumption for artificial snow in the entire ski resort will increase by around 80% by the end of the 21st century. In the lower elevations below 1800 to 2000 m above sea level, water consumption will even triple. Today's water resources will not be sufficient and another reservoir will be needed at the end of the 21st century. It is therefore important to develop a water management plan that takes into account the future needs of all stakeholders.

What are results for society and how are they implemented?

The results of my models show where water consumption will increase the most. On the basis of the results, the management of the ski area can roughly estimate whether the current water availability will also be sufficient for the future. The results can also serve as the basis for water management plans that regulate water access for all stakeholders. My results show the future water consumption for three different emission scenarios. If the stakeholders and politicians agree on a usage plan at an early stage, any usage conflicts over water resources can be avoided.

Maria Vorkauf completed her PhD in the group of Professor Ansgar Kahmen and Dr. Erika Hiltbrunner at the University of Zurich. She received a PSC_Mercator fellowship from 2016–2020. Maria carried out the field research at the Alpine Research and Education Station Furka (Alpfor). Collaborations with the WSL Institute for Snow and Avalanche Research SLF, University of Innsbruck and the Ski resort "Andermatt+Sedrun+Disentis" highlight her trans-disciplinary approach.



The flyer is for a public round table discussion titled "CH-Skigebiete 2050" (Ski areas in Switzerland - visions for the future). It is organized by the Zurich-Basel Plant Science Center, in collaboration with the University of Zurich (ETH Zurich) and the University of Basel. The event took place online on February 3, 2021, from 17:15 to 19:00. The flyer lists several speakers and moderators, including Dr. Maria Vorkauf, Prof. Bruno Abegg, Thomas Egger, Dr. Boris Previsic, and Lena Wilczek. It also provides a registration link: www.plantsciences.uzh.ch/en/outreach/roundtable.html. The logo of the Stiftung Mercator Schweiz is visible in the bottom right corner.

The public round table: Skigebiete in der Schweiz – Visionen für die Zukunft reached out to 85 participants from the media, tourism, NGOs and the public. The online event took place on February 3, 2021. The discussions were moderated by Lena Wilczek. Invited speakers: PSC-Mercator fellow Dr. Maria Vorkauf, Universität Basel, CH; Prof. Dr. Bruno Abegg, IMP-HSG (Research Center Tourism and Transport), Universität St. Gallen, CH; Thomas Egger, Direktor der Schweizerische Arbeitsgemeinschaft für die Berggebiete, Visp, CH; Dr. Boris Previsic, Universität Luzern, CH; Lois Hechenblaikner, Tirol, AT; Marie-Claire Graf, Swiss Youth for Climate, Zurich, CH.

Summary of the discussions (in German): <https://www.plantsciences.uzh.ch/dam/jcr:e1e24904-28db-4dd9-9371-0f1ecdd-ca12a/Abschlussbericht.pdf>

Recordings (in German): <https://video.ethz.ch/events/psc/skigebiete.html>

Interview with Maria: https://blogs.ethz.ch/Science_and_Policy/2021/04/09/die-okologischen-und-okonomischen-konsequenzen-des-klimawandels-in-den-alpen-und-den-schweizer-skigebieten/

Values of species diversity in grasslands

Sergei Schaub

Grasslands cover a large portion of the global land area and are essential for global food security and the agricultural economy. Grasslands provide many ecosystem services in addition to forage production, such as biodiversity, pollination, carbon sequestration, and outdoor recreation. Changes in agricultural production, biodiversity loss, and climate change (and hence, for example, increased droughts) are increasing pressure on grasslands and grassland-based production. This increasing pressure requires farmers to make adjustments.

Farmers have several instruments at their disposal to adapt their grasslands, including enhanced (plant) species diversity. Species diversity can increase yields and grassland stability, as well as reducing the adverse effects of weather extremes (e.g., drought). A key challenge is to economically quantify these species diversity benefits for farmers. These realities gave rise to the central question of my dissertation: 'What is the value of species diversity for farmers in grasslands?'

Interview with Sergei

What evidence is useful for policy-making?

In my thesis, I showed that species diversity can increase yields without negatively affecting forage quality, both in intensively and semi-natural managed grasslands. Thus, species diversity can increase revenues from milk production. Additionally, I found that species diversity can reduce production risk in intensively managed grasslands. These benefits were also present under climate change conditions, i.e., increasing drought probability. My thesis results show that species diversity can be an economically relevant production factor and that increasing species diversity in grasslands can contribute to sustainable intensification of grassland-based production.

Additionally, other studies indicate that species diversity can also support other important ecosystem services and functions (e.g., biodiversity, pollination, and cultural ecosystem services), which I did not consider in my thesis. One key challenge to benefit from species diversity (especially for semi-natural grasslands) will be to develop management systems that allow plant diversity to be maintained over time in more intensively managed grasslands.

Throughout my PhD, I (and my co-authors) published blog articles and press releases to make my PhD project, its results, and my other projects available to the general public and attract attention from policy-makers and journalists. During my PhD, the work contributed to an Arbeitsgemeinschaft zur Förderung des Futterbaus (AGFF) infosheet, and ongoing research at Agroscope.

Sergei Schaub completed his PhD (2016–2020) in the Agricultural Economics and Policy Group at ETH Zurich, supervised by Professor Robert Finger and in collaboration with the Grassland Sciences Group at ETH Zurich, supervised by Professor Nina Buchmann.

PhD Thesis: Sergei Schaub (2020). Economic perspective on grasslands, biodiversity and weather extremes. ETH Zurich. <https://doi.org/10.3929/ethz-b-000447273> (limited access)

Interview with Sergei: https://blogs.ethz.ch/Science_and_Policy/2021/02/26/the-value-of-species-diversity-in-grasslands/



For example, Schaub, S., Buchmann, N., Lscher, A., & Finger, R. – Agrarpolitik Blog (Jan 2020). Der ökonomische Mehrwert von Diversität im intensiven Grasland. <https://agrarpolitik-blog.com/2020/01/15/der-oekonomische-mehrwert-von-diversitaet-im-intensiven-grasland/>

OUTCOMES

Maintaining plant biodiversity in cities

Kevin Vega

What evidence is useful for policy-making?

Understanding the effects of urban design on plant species composition in cities is essential for maintaining biodiversity overall, promoting urban resilience in the face of climate change, and improving the life quality of residents. Functional ecosystems can benefit pollinators, reduce urban flooding, and improve air quality – and at the same time look aesthetically pleasing.

We found green space size to be the most important factor affecting biodiversity, larger green spaces must be a cornerstone of any species conservation endeavor while also providing ecosystem services to local communities. Furthermore, we must ensure that these spaces are equitably distributed within the city and not only placed in wealthy areas. However, another key insight of my research is that small green patches also matter considerably for wildflower biodiversity in cities. These small spaces “punch above their weight” and can have remarkably high diversities given their sizes. This supports biodiversity policies such as the greening of streets and tramways, green facades and roofs, and wildflower sowing – even in small areas such as in tree discs or permeable surfaces in parking lots. The key is to connect these spaces so they can support one another. Important synergies can result from such initiatives improving the ability of cities to cope with climatic warming and increased flooding by providing shade/cooling and retaining rain water.

Cities are mosaics of both cultivated and spontaneous environments. As seen in our citizen science project working together with Plant Science Center outreach manager Juanita Schläpfer Miller, “Where Seeds Fall” – whenever we leave a tray with soil

outside on the balcony/garden or when we look between the gaps of a sidewalk, plants sprout spontaneously. Plants in cities behave as they do in more natural ecosystems: they spread, colonize, and reproduce independently. To maintain this biodiversity in the city of Zurich, well planned urban ecological design is the best way to support this dynamic system and the wildlife which relies on these self-dispersing plants. We must become better at identifying species that can survive and flourish in cities on their own or with minimal assistance from us. This requires that we know which species are adapted to the conditions of densely built urban areas and can maintain ecosystem services in these often harsh ecological situations. Science can help to identify such candidate species for a future partly-designed urban flora: intending for the unintentional. To give an example based on data from our survey, we created a model which can identify target species based on their observed dispersal ability in the field. Such species could be focal species for urban management.

What are the outputs for society and how are they translated?

Long-term urban planning can reduce fragmentation and increase ecological value. To better conserve this ecosystem with its plants and wildlife, innate in parks and open green spaces, we developed an ecological planning tool together with landscape architects, to help answer future questions about the role of biodiversity. We developed maps that take ecological, creative, and social aspects into consideration and will be used as a baseline for new settlement spaces. Together, our results suggest that wildflower diversity can be successfully promoted even in densely built up areas. Substantial progress might be reachable at low cost, especially given

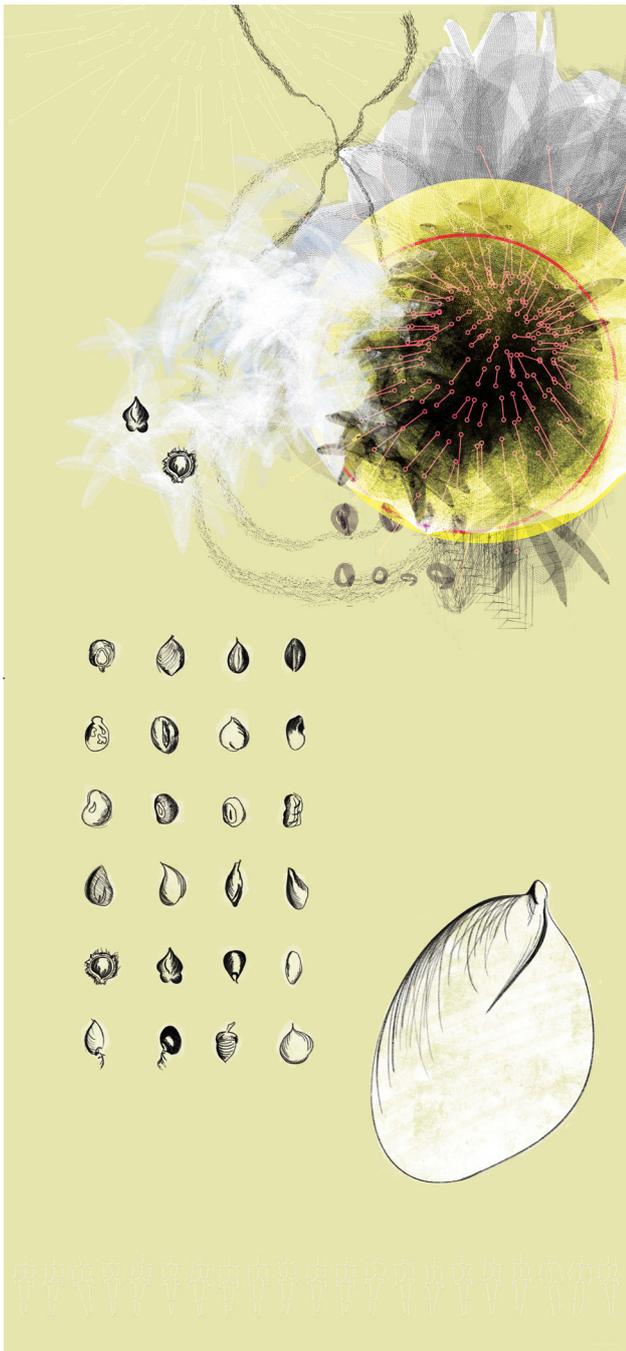
that the promotion of wildflowers and wild bees in cities has recently become relatively widespread and accepted in response to both the acknowledged biodiversity crisis and the recent rise in popularity of natural or near-natural gardening. This marks an unprecedented window of opportunity for both applied researchers and practitioners, within which public and administrative wills are broadly aligned toward the goal of creating greener and more diverse cities. We must not let this opportunity pass by.

Our work was made possible through the close collaboration with the ecologists of ETH Zurich, landscape architects and designers of Ostschweizer Fachhochschule Rapperswil (OST) and Grün Stadt Zurich.

Kevin Vega completed his PhD (2016–2020) at the Institute of Integrative Biology at ETH Zurich, in the research group of Professor Christoph Küffer and Professor Alex Widmer.

PhD Thesis: Kevin Vega (2020). Maintaining wildflower biodiversity in cities. ETH Zurich. <https://www.research-collection.ethz.ch/handle/20.500.11850/456762>

Interview with Kevin: https://blogs.ethz.ch/Science_and_Policy/2020/09/16/maintaining-plant-biodiversity-in-cities/



Citizen Science: Where seeds fall

If a piece of uncovered soil is left to itself, plants begin to sprout even in the busiest of city streets. The city air carries seeds that land somewhere, germinate, and become a new plant. The citizen science project «Where seeds fall» examined the survival chances of urban plant populations and their genetic diversity. The goal was to document which plants are growing spontaneously in the city of Zurich and how they are influenced by the surrounding biodiversity. The more flowers in the vicinity, the more flowers reach your own garden. We distributed plant trays to participants which they filled with soil and set out on their balcony or garden. Between 2017 and 2019 around 90 people took part and sent in photos of seeds landing and germinating. The photos were uploaded onto a citizen science platform 'Stadt, Wild, Tier' on their own dedicated page and the platform functioned as a point of exchange for the participants. We presented the project at the UZH Graduate Campus Annual Ceremony on 13 July 2017, Scientifica on 1–3 Sep 2017 and Treffpunkt Science City on 19 Nov 2017.

Vega, K.A., Schläpfer, J., Küffer, C. (2021). Discovering the wild side of urban plants through public engagement. *Plants, People, and Planet*: 3 (4), 389–401. <https://doi.org/10.1002/ppp3.10191>



In this video Kevin Vega presents his research project (in German). <https://www.youtube.com/watch?v=Z7CM9j7d4es>
Film production: Dubravka Vrdoljak and Anja Hürliemann <https://www.video-geschichten.ch>
© PSC

OUTCOMES

Papaya growing guide

Tiago Meier

Who does not know the pear-like shape, yellow-orange color, and sweet taste - all hallmarks of the papaya fruit. Tiago Meier, PhD student at the Institute for Plant and Microbiology in the group of Professor Ueli Grossniklaus set out on the trail of the papaya fruit. He traveled to Mexico, the Maya kingdom, to discover the origins of the plant, and came across clues that point to an early cultivation of the plant. The Maya chose papaya plants with beneficial properties, namely hermaphroditic plants that fertilize themselves. The Spaniards distributed papaya throughout their colonial empire, making it an important crop. However, the changing climate on our planet also has consequences for papaya. A sex reassignment from hermaphrodites to males caused by environmental influences leads to sterility and hence impairs papaya production.

Tiago is studying the flower development of the plant to better understand the sex change problem and to contribute to possible solutions.

Interview with Tiago:

What evidence is important for political action?

In order to convince farmers and politicians to change something, a variety of approaches is required. We used three approaches to look at the problem from different angles. First, we looked for a difference between the papaya plants on a molecular level in order to understand the sex reassignment processes in the plants. We then explored the causes of the changes in the plants and identified global warming as the cause. At the same time, we looked for varieties in which the environmentally-related sex change does not take place, in order not only to report on the problem, but also to offer solutions.

Finally, I went to search for clues in the National Museum of Mexico City and showed that the initiation of the cultivation and breeding of the papaya began as early as the pre-Columbian Mayan culture. The examination of the history of the fruit illustrates its long tradition and importance for farmers. I was allowed to investigate the history of the papaya plant together with locals. This transdisciplinary work has enabled our research results to reach those most affected – the farmers of Mexico.

What are results for society and how are they implemented?

Knowing the exact time of floral induction, the duration of flower development, and a floral staging system may be of use for stakeholders like breeders and researchers. Knowing these parameters may facilitate the planning of crosses and allow an optimization of the planting process as papayas are usually transferred to the field after they start to flower, when the growers know whether they are hermaphrodites (i.e., requested for high yielding production). Precise estimates for the duration of the vegetative phase and the duration of flower development could allow the temporal optimization of papaya growing. This information on how to grow papaya is useful for people working with this plant. The data they obtain could be included in a "Papaya Growing Guide".

Together with the Plant Science Center Tiago prepared an explanatory video illustrating the complexity of the papaya problem. In the resulting video, the findings are conveyed not only to a German-speaking, but also to a Spanish-speaking audience.

Tiago Meier is completing his PhD in the group of Professor Ueli Grossniklaus at the University of Zurich. He received a PSC-Mercator fellowship from 2016–2020. He collaborates with the "Labo-

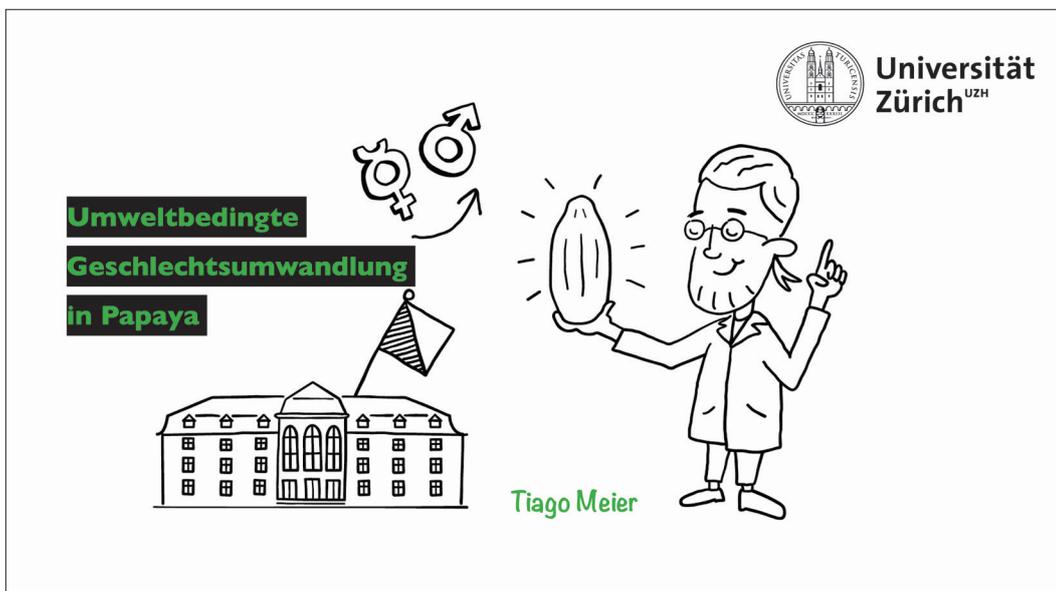
ratorio Nacional de Genomica para la Biodiversidad" (LANGEBIO) and the "Centro de Investigación Científica de Yucatán" (CICY). CICY provides the public with direct knowledge and provides support in economic decision-making and in the design of agri-environmental programs.

Interview with Tiago: https://blogs.ethz.ch/Science_and_Policy/2021/09/29/umweltbedingte-geschlechtsumwandlung-in-papaya-als-transdisziplinaires-forschungsprojekt/

Science and Policy blog

The Science and Policy blog of the Plant Science Center presents research outcomes of program participants at the science and policy interface. The blog posts highlight results and also trends in the areas of agroecology, resource efficiency, land use and ecosystem changes, alternative food systems and related participatory research methods. They offer additional background for the interested public. The interviews in this report were published in the Science and Policy blog.

blogs.ethz.ch/Science_and_Policy



In this video, Tiago Meier presents his research project (in German). <https://youtu.be/uPxcjYhSCRM>

Film production: Dubravka Vrdoljak and Christian Büttiker
Illustrations: Patrick Baumann. © PSC

OUTCOMES

Stakeholder engagement

Sergei Schaub – Oral presentation at the XVI Congress of the European Association of Agricultural Economists: Raising the Impact of Agricultural Economics: Multidisciplinarity, Stakeholder Engagement and Novel Approaches (July 20–23, 2021). <http://www.eaae2021.org>

Kevin Vega – World Biodiversity Forum, Davos (Feb 2020). Project presentation and participation in the roundtable discussions that was followed 500 participants at the conference. <https://www.worldbiodiversityforum.org/>

Kevin Vega – Oral presentation of the project and lead of a discussion of its results at the newly established ongoing science-practice working group on wildflower promotion and biodiversity in the green industry (Nov 2019, 35 participants). <https://www.docdroid.net/Cf8Gh3w/programm-groupe-de-reflexion-pdf>

Kevin Vega and Christoph Küffer – Organising the 'Wildpflanzen im Siedlungsraum' conference at the HSR Rapperswil in Sep 2019. This conference brought together over 120 practitioners and researchers from the fields of landscape architecture, ecology, horticulture, seed cultivation, and biodiversity conservation to discuss the potential of promoting wild plants in cities, the difficulties faced by practitioners, and the ways in which research can help alleviate these issues and inform practice.

Sergei Schaub – Oral presentation at the BIOECON (Biodiversity and Economics for Conservation) Conference (Sep 2019). http://www.bioecon-network.org/pages/21th_2019/21th_2019.html

Sergei Schaub – Oral presentation at the EGF-EUCARPIA Joint Symposium: **Improving sown grasslands through breeding and management** (June 2019). <https://www.egfeucarpia2019.ch/>

Maria Vorkauf – Oral presentation at the EGU General Assembly in Vienna (April 7–12, 2019, 16.000 participants). Title: Opportunistic alpine plant species profit from earlier growing season. <https://www.egu2019.eu/>

Maria Vorkauf – Poster presentation at the 20th Swiss Global Change Day in Berne (Feb 7, 2019). <https://naturwissenschaften.ch/service/events/103449-20th-swiss-global-change-day>

Sergei Schaub – Oral presentation at the at the 30th International Conference of Agricultural Economics (July 28 to Aug 2, 2018). **Economic benefits from higher species diversity in intensively managed grasslands**. <http://www.icae2018.com/>

Sergei Schaub – Oral presentation at the at the 27th European Grassland Federation General Meeting **Sustainable Milk and Meat Production from Grasslands**. Presentation was held by Sebastian T. Meyer an associated researcher (June 2018). <https://www.egf2018.com/>

Kevin Vega – Poster presentation at the The Nature of Cities Summit in Paris (June 5 to 8, 2019). **Sowing, Mowing, Blowing, and Growing: Supporting plant biodiversity in Zurich and understanding the processes that shape it**.

Kevin Vega and Christoph Küffer – Co-organizing the **Daylight and Green Cities Workshop** at the HSR Rapperswil in March 2019. Funded by the Velux Foundation, 20 international ecologists, city planners, landscape architects, architects and health specialists discussed the role of daylight in architecture and urban design. At this event, Kevin Vega highlighted the importance of green spaces in conjunction with daylight for human health and the oft-ignored importance of daylight for the health of the green spaces themselves.

Kevin Vega – Oral presentation at the 1. Nationaler Landschaftskongress in Luzern (Aug 23, 2018). **Förderung und Vernetzung von Biodiversität in Siedlungsräumen**. <https://naturwissenschaften.ch/service/events/95819-1.-schweizer-landschaftskongress---schoene-aussichten->

Kevin Vega – Poster presentation at the Swiss Inter- and Transdisciplinarity Day in Lausanne (Nov 15, 2018). **Wo Samen fallen – a GIS-based citizen science project about ecological connectivity in cities**. <http://www.transdisciplinarity.ch/en/td-net/Veranstaltungen/ITD-CH-2018.html>

Tiago Meier – Poster presentation at the Annual Symposium of the World Food System Center in Zurich (Nov 8, 2018). **Sex reversal in papaya**. <https://worldfoodsystem.ethz.ch/outreach-and-events/past-events/symposium-2018.html>

Tiago Meier – Poster presentation at URPP Evolution in Action Site Visit (May 28 and 29, 2018).

Sergei Schaub – Poster presentation at the Annual Symposium of the World Food System Center in Zurich (Oct 25, 2017). **The value of species diversity in grasslands (DIVERSGRASS)**. <http://www.worldfoodsystem.ethz.ch/outreach-and-events/past-events/symposium-2017.html>

Nina Buchmann – ETH Klimarunde (Nov 8, 2016). **Der globalisierte Klimawandel: Wie betrifft er uns?**

Tobias Bühlmann – Project presentation at the 16th joint meeting of the EIONET and UN/ECE Task Force on Emissions Inventories and Projections (May 11–12, 2014) in Milano, Italy. **Indirect NO and N2O emissions induced by atmospheric N deposition in (semi-)natural ecosystems in Switzerland**.

Tobias Bühlmann – Project presentation at the GfÖ Annual Meeting (Sep 8–12, 2014) in Hildesheim, Deutschland. **Alnus viridis encroachment contributes to excess reactive nitrogen in high montane ecosystems of the Alps**.

Sonja Hassold organized a one-day workshop on: **Identification techniques for Dalbergia and Diospyros** in Hamburg, Germany in June 2014.

John Garcia-Ulloa – Oral presentation at the 3rd Species Survival Commission Leaders' Meeting in Abu Dhabi, UAE (2015). **IUCN SSC situation analysis on oil palm expansion and biodiversity**.

John Garcia-Ulloa – Oral presentation at the Annual Meeting of the Society for Tropical Ecology in Zurich, Switzerland (2014). **Context-specific and data-efficient approach for quantifying biodiversity benefits and impacts of land-use policies**.

Garcia-Ulloa J – Oral presentation at the 51st Annual Meeting of the Association for Tropical Biology and Conservation. Cairns, Australia (2014). **Modelling avoided biodiversity losses under REDD+ implementation**.

Tobias Bühlmann – Der Bauer geht – die Grünerle kommt, „16 Uhr-Veranstaltung“ Bundesamt für Landwirtschaft, 30. Oktober 2013, Bern

Tobias Bühlmann – Project presentation at the CLIMMANI-ESF workshop (Sep 18–21, 2012) Furka Pass, Switzerland. **Encroachment of Alnus viridis alters nitrogen pools and fluxes in the Swiss Alps, CLIMMANI-ESF workshop “N-fixing plant invasion in cold climates**.

John Garcia-Ulloa – co-organized a roundtable: REDD+ as a catalyst to a green economy (2012) and presented methods for **Conserving Forests, Expanding Sustainable Palm Oil Production** at the 4th International Conference on Oil Palm and the Environment in Bali, Indonesia (2012) and to representatives of the DRC at expert meeting on REDD+ Scenarios. Nairobi, Kenya (2011).

Factsheets

In collaboration with Agroscope and AGFF (Arbeitsgemeinschaft zur Förderung des Futterbaues), Sergei Schaub is contributing to the AGFF factsheet '**Artenvielfalt als Produktionsfaktor**' (to be published).

Bühlmann, T., Hiltbrunner, E., Körner, C. (2013). **Die Verbuschung des Alpenraums durch die Grünerle**. Factsheet (D/F), Akademien der Wissenschaften Schweiz. <https://naturalsciences.ch/service/publications/6034-die-verbuchung-des-alpenraums-durch-die-grunerle>

Prizes

Kevin Vega – received the **ETH Medal award** 2021 (Outstanding Doctoral thesis).

Maria Vorkauf – received the Poster Award at the 18th Swiss Global Change Day in Berne (April 11, 2017). Title: **The influence of snow cover duration on alpine plant phenology**.

Sergei Schaub – received the Best Overall Poster Award at the Annual symposium of the World Food System Center in Zurich (October 25, 2017). Title: **The value of species diversity in grasslands**.

Sonja Hassold – received the Best Talk Award at the Conference “EC-BOL’3” in Brussels (Sep 17–20, 2012). Title: **Development and validation of a barcoding strategy to support identification, tracing and trade regulation of Malagasy rosewood**.

Garcia-Ulloa J – was nominated for the **ETH Medal award** (Outstanding Doctoral thesis).

Publications

Robledo-Abad, C., H.J. Althaus, G. Berndes, S. Bolwig, E. Corbera, F. Creutzig, J. Garcia-Ulloa, A. Geddes, J. S. Gregg, H. Haberl, S. Hanger, R.J. Harper, C. Hunsberger, R. K. Larsen, Ch. Lauk, S. Leitner, J. Lilliestam, H. Lotze-Campen, B. Muys, M. Nordborg, M. Ölund, B. Orłowski, A. Popp, J. Portugal-Pereira, J. Reinhard, L. Scheffle, P. Smith (2017). **Bioenergy production and sustainable development: science base for policy-making remains limited**. *Global Change Biology Bioenergy*: 9, 541–556. <https://doi.org/10.1111/gccb.12338>

Ghazoul, J., Burivalova, Z., Garcia-Ulloa, J., King, L. (2015). **Conceptualising forest degradation**. *Trends in Ecology and Evolution*: 30 (10), 622–632. <https://doi.org/10.1016/j.tree.2015.08.001>

Abood, S. A., Lee, L. S. H., Burivalova, Z., Garcia-Ulloa, J., Koh, L. P. (2015). Relative contributions of the logging, fiber, oil palm and mining industries to forest loss in Indonesia. *Conservation Letters* 8 (1): 58–67. <https://doi.org/10.1111/conl.12103>

Lee, J. S. H., Garcia-Ulloa, J., Ghazoul, J., Obidzinski, K., Koh, L. P. (2014). **Modelling environmental and socio-economic trade-offs associated with land-sparing and land-sharing approaches to oil palm expansion**. *Journal of Applied Ecology*: 51 (5), 1366–77. <https://doi.org/10.1111/1365-2664.12286>

Savilaakso, S., Garcia, C., Garcia-Ulloa, J., Ghazoul, J., Groom, M., Guariguata, R., Laumonier, Y., Nasi, R., Petrokofsky, G., Snaddon, J., Zrust, M. (2014). **Systematic review of effects on biodiversity from oil palm production**. *Environmental Evidence*: 3 (4). <https://doi.org/10.1186/2047-2382-3-4>

Wich, S. A., Garcia-Ulloa, J., Kühl, H. S., Humle, T., Lee, J. S. H., Koh, L. P. (2014). **Will oil palm's homecoming spell doom for Africa's great apes?** *Current Biology*: 24 (14), 1659–63. <https://doi.org/10.1016/j.cub.2014.05.077>

Garcia-Ulloa, J., Sloan, S., Pacheco, P., Ghazoul, J., Koh, L. P. (2012). **Lowering environmental costs of oil-palm expansion in Colombia**. *Conservation Letters*: 5, 366–375. <https://doi.org/10.1111/j.1755-263X.2012.00254.x>

Hassold, S., Lowry, P. P., Bauert, M. R., Razafintsalama, A., Ramamonjisoa, L., Widmer, A. (2016). **DNA Barcoding of Malagasy Rosewoods: Towards a molecular identification of CITES-listed *Dalbergia* species**. *PLOS ONE*: 11 (6). <https://doi.org/10.1371/journal.pone.0157881>

Burivalova, Z., Bauert, M. R., Hassold, S., Fatroandrianjafinonjasolomiovazo, N. T., Koh, L. P. (2015). **Relevance of global forest change data set to local conservation: Case study of forest degradation in Masoala National Park, Madagascar**. *Biotropica*: 47, 267–274. <https://doi.org/10.1111/btp.12194>

Bühlmann, T., Caprez, R., Körner, C., Hiltbrunner, E., Niklaus, P. A. (2017). **Nitrogen fixation by *Alnus* species boosts soil nitrous oxide emissions**. *European Journal of Soil Science*: 68 (5), 740–748. <https://doi.org/10.1111/ejss.12457>

Bühlmann, T., Körner, C., Hiltbrunner, E. (2016). **Shrub expansion of *Alnus viridis* drives former montane grassland into N saturation**. *Ecosystems*: 19, 968–985. <https://doi.org/10.1007/s10021-016-9979-9>

Bühlmann, T., Hiltbrunner, E., Körner, C., Rihm, B., Achermann, B. (2015). **Induction of indirect N₂O and NO emissions by atmospheric nitrogen deposition in (semi-)natural ecosystems in Switzerland**. *Atmospheric Environment*: 103, 94–101. <https://doi.org/10.1016/j.atmosenv.2014.12.037>

Hiltbrunner, E., Aerts, R., Bühlmann, T., Huss-Danell, K., Magnusson, B., Myröld, D., Reed, S., Sigurdsson, B., Körner, C. (2014). **Ecological consequences of the expansion of N₂-fixing plants in cold biomes**. *Oecologia*: 176, 11–24. <https://doi.org/10.1007/s00442-014-2991-x>

Bühlmann, T., Hiltbrunner, E., Körner, C. (2014). ***Alnus viridis* expansion contributes to excess reactive nitrogen release, reduces biodiversity and constrains forest succession in the Alps**. *Alpine Botany*: 124, 187–191. <https://doi.org/10.1007/s00035-014-0134-y>

Vorkauf, M., Marty, C., Kahmen, A. and Hiltbrunner, E. (2021). **Past and future snowmelt trends in the Swiss Alps: the role of temperature and snowpack**. *Climatic Change*: 165, 44. <https://doi.org/10.1007/s10584-021-03027-x>

Vorkauf, M., Kahmen, A., Körner, C. and Hiltbrunner, E. (2021). **Flowering phenology in alpine grassland strongly responds to shifts in snowmelt but weakly to summer drought**. *Alpine Botany*: 131(1), 73–88. <https://doi.org/10.1007/s00035-021-00252-z>

Schaub, S., (2022). **Global relationships between time preference and environmental policy performance**. *Environmental Science & Policy*: 128, 102–109. <https://doi.org/10.1016/j.envsci.2021.11.017>

Schaub, S., Finger, R., Buchmann, N., Steiner, V., Klaus, V. H. (2021). **The costs of diversity: higher prices for more diverse grassland seed mixtures**. *Environmental Research Letters*: 16, 094011. <https://iopscience.iop.org/article/10.1088/1748-9326/ac1a9c/pdf>

Schaub, S., Buchmann, N., Lüscher, A., Finger, R. (2020). **Economic benefits from plant species diversity in intensively managed grasslands**. *Ecological Economics*: 168, 106488. <https://doi.org/10.1016/j.ecolecon.2019.106488>

OUTCOMES

Schaub, S., Finger, R., Leiber, F., Probst, S., Kreuzer, M., Weigelt, A., Buchmann, N., Scherer-Lorenzen, M. (2020). **Plant diversity effects on forage quality, yield and revenues of semi-natural grasslands.** *Nature Communications*: 11, 1–11. <https://doi.org/10.1038/s41467-020-14541-4>

Schaub, S., Huber, R., Finger, R. (2020). **Tracking societal concerns on pesticides – A Google Trends analysis.** *Environmental Research Letters*: 15, 084049. <https://doi.org/10.1088/1748-9326/ab9af5>

Schaub, S., Finger, R. (2020). **Drought effects on hay and feed grain prices.** *Environmental Research Letters*: 15, 034014. <https://doi.org/10.1088/1748-9326/ab68ab>

Data sets and open sources

Schaub, S. (2020). **Robustness checks for omitted variable bias.** The package includes robustness checks proposed by Oster (2019). 'robomiti' replicates (and extends) function available in Stata (closed source) for use in R (open source). <https://www.research-collection.ethz.ch/handle/20.500.11850/447754>

Schaub, S., Finger, R. (2019). **Dataset: Feed price and SPEI data of South Germany and whole Germany.** We provide here data on 1) monthly hay, feed wheat and feed barley prices in South Germany (=Bavaria and Baden-Wuerttemberg) from August 2002 to March 2019 and 2) monthly Standardized Precipitation Evapotranspiration Index (SPEI) values for South Germany and in whole Germany from January 1991 to April 2019. <https://www.research-collection.ethz.ch/handle/20.500.11850/385361>

Schaub, S., Finger, R., Leiber, F., Probst, S., Kreuzer, M., Weigelt, A., ... Scherer-Lorenzen, M. (2019). **Data: forage quality and biomass yield of the Management Experiment set up within the Jena Experiment.** This dataset contains measurements of above ground biomass yield and various forage quality variables of the subplots of the Management Experiment set up within the Main Experiment plots of a large grassland biodiversity experiment (the Jena Experiment; Roscher et al. 2004, Weigelt et al. 2009). <https://www.research-collection.ethz.ch/handle/20.500.11850/374100>

Vega, K., Kueffer, C. (2021). **Promoting wildflower biodiversity in dense and green cities: The important role of small vegetation patches.** *Urban Forestry and Urban Greening*: 62. <https://doi.org/10.1016/j.ufug.2021.127165>

Vega, K. A., Schlaepfer, J., Kueffer, C. (2021). **Discovering the wild side of urban plants through public engagement.** *Plants, People, and Planet*: 3 (4), 389–401. <https://doi.org/10.1002/ppp3.10191>

Kueffer, C., Vega, K., Bai, C., Karn, S., Schlaepfer, J. (2019). **Urban ecology meets architecture and urban planning.** [L'écologie urbaine rencontre l'architecture et l'aménagement]. *Études urbaines* 4: 52–54.

Frey, D., Vega, K., Zellweger, F., Ghazoul, J., Hansen, D., Moretti, M. (2018). **Predation risk shaped by habitat and landscape complexity in urban environments.** *Journal of Applied Ecology*: 55, 2343–235 <https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/1365-2664.13189>

Book chapters

Schläpfer-Miller, J. and Dahinden, M. (2020). **Creative Camps – Verknüpfung von Kunst- und Wissenschaftsvermittlung.** Zurich-Basel Plant Science Center. <https://doi.org/10.3929/ethz-b-000421727> (Maria Vorkauf contributed to pages 56 and 70)

Sergei Schaub – **SGA Jahrbuch Agrarwirtschaft und Agrarsoziologie** (2017). Only as hard copy available. http://www.sse-sga.ch/-/jahrbuch_agrarwirtschaft_und_agrarsoziologie/index.html

Lee, J. S. H. and Garcia-Ulloa, J. (2016). **A Review on the Environmental Impacts of Oil Palm Expansion in the Developing Tropics.** In: Nuth TK (eds.), *The Developing Tropics in Monoculture Farming: Global Practices, Ecological Impact and Benefits/Drawbacks.* Nova Science Publishers Inc, NY. Chapter 4 pp. 75–98.

Garcia-Ulloa, J. and Koh, L. P. (2016). **Payment for ecosystem services: the role of REDD+ in primate conservation.** In: Wich SA & AJ Marshall (eds.) *An introduction to primate conservation.* Oxford University Press.

Press and media

Küffer, Ch., Vega, K. – *Der Gartenbau* (10/ 2021). **Förderung von Wildpflanzen in verdichteten Siedlungsräumen.** https://www.plant-sciences.uzh.ch/dam/jcr:90b4874d-b709-4918-90eb-73aa109db825/Kueffer_Vega_gartenbau_2021.pdf

Sergei Schaub – *NZZ* (Oct 12, 2021). **Artenreichtum wird in der modernen Landwirtschaft oft mit geringer Produktivität in Verbindung gebracht. Tatsächlich lässt sich zeigen: Mehr Kräuter bedeuten fettere Milch.** https://ethz.ch/content/dam/ethz/special-interest/mtec/aecp-dam/documents/Media/Artikel_Sergei.pdf

Maria Vorkauf – *Medien release. Informationsdienst Wissenschaft* (April 16, 2021). **Alpine Pflanzen verlieren zunehmend weissen «Schutzmantel».** <https://idw-online.de/de/news?print=1&id=766913>

Maria Vorkauf – *Andermatt* (Mar 17, 2021). **Enviro Freeride Days: Busting powder with a purpose.** <https://www.ander-matt-swissalps.ch/en/news/enviro-freeride-days-busting-powder-with-a-purpose>

Sergei Schaub – *Die Grüne* (Mar 4, 2021). **ETH Zürich: Ist Artenvielfalt im Grasland ökonomisch?** <https://www.diegruene.ch/artikel/pflanzenbau/eth-zuerich-ist-artenvielfalt-im-grasland-oekonomisch-353598>

Sergei Schaub – *SchweizerBauer* (Mar 8, 2020). **Studie: Biodiversität lohnt sich finanziell auf intensiven Flächen.** <https://www.bauernzeitung.ch/artikel/studie-biodiversitaet-lohnt-sich-finanziell-auf-intensiven-flaechen>

Erika Hiltbrunner – *Urner Wochenblatt* (Feb 2021). **Wie verändert sich die Schneesicherheit künftig im Gebiet Andermatt-Sedrun-Disentis?** https://www.plantsciences.uzh.ch/dam/jcr:a9007e94-b16c-4358-98b5-b140e12ff38d/20210213_UrnerWochenblatt_SkigebieteSchweiz_Hiltbrunner.pdf

Sergei Schaub – *ETH News* (Feb 7, 2020). **Biodiversity yields financial returns.** <https://ethz.ch/en/news-and-events/eth-news/news/2020/02/biodiversity-yields-financial-returns.html>

Interview with Bruno Abegg – *NZZ* am Sonntag (Feb 6, 2021). **Auf Tal-fahrt: Corona gewährt uns einen Blick in die düstere Zukunft des Schweizer Skitourismus.** <https://nzzas.nzz.ch/hintergrund/wintertourismus-die-duestere-zukunft-der-schweizer-skigebiete-ld.1600433>

Sergei Schaub – *SchweizerBauer* (Feb 2, 2020). **Preserving or restoring rich grasslands can lead to a win-win situation.** <https://www.schweizerbauer.ch/pflanzen/futterbau/mehr-pflanzenarten-mehr-umsatz-55505.html>

Interview with Christoph Küffer – *SRF* (June 2019). **Wo Samen fallen.** <https://www.srf.ch/news/regional/basel-baselland/samen-per-post-bevoelkerung-soll-wildblumen-saeen-und-artenvielfalt-ernten>

Erika Hiltbrunner, Christian Körner – *image: Das Urner Magazin* Nr. 27 (Dec 2017). **Forschung am Dach des Kanton Uri.** https://issuu.com/baumannfryberg.ch/docs/image_27

Sonja Hasshold – *20 Minuten* (Sep 21, 2014). **Mit DNA-Analyse gegen den Tropenholz-Schmuggel.**

Interview with Garcia-Ulloa – CIFOR news (2013). **Colombia's palm oil boost must account for environment and human rights concerns.** <http://blog.cifor.org/14267/colombias-palm-oil-boost-must-account-for-environment-and-human-rights-concerns#.VVmhXfmqBc>

Interview with Erika Hiltbrunner – SRF4 (2013). **Bauern ziehen sich von der Alpweid zurück.**

Interview with Tobias Bühlmann – Tagesschau (2013). **Grünerlen Alarm.**

Bühlmann T, Hiltbrunner E, Körner C. (2013). **Verbuschung. Der Bauer geht – die Grünerle kommt.** Hotspot 27: 18.

Sonja Hassold – WDR TV documentation Xenius (June 19, 2012). **Tatort Regenwald undercover gegen die Holzmafia.**

Sonja Hassold – Radio deutsche Welle (Oct 28, 2012). **Der Raubbau am Rosenholz.** <http://www.dw.de/der-raubbau-am-rosenholz/a-16336629>

Tobias Bühlmann – Medienmitteilung des Schweizerischer Nationalfonds SNF (2012). **Nur zuschauen ist die schlechteste Option.** <http://www.snf.ch/de/fokusForschung/newsroom/Seiten/news-121218-medienmitteilung-nur-zuschauen-ist-die-schlechteste-option.aspx>

Sonja Hassold – Tagesanzeiger (Aug 9, 2012). **Zoo zwingt Gitarrenbauer Gibson in die Knie.** <http://www.tagesanzeiger.ch/zuerich/region/Zoo-Zuerich-gewinnt-zwingt-Gitarrenbauer-Gibson-in-die-Knie/sto-ry/31819433>

Blogs

Sergei Schaub – Agrarpolitik Blog (Nov 2021). **Setzen mehr zukunftsorientiert Länder mehr auf umweltpolitische Leistungen?** <https://agrarpolitik-blog.com/2021/11/30/setzen-mehr-zukunftsorientiert-lander-mehr-auf-umweltpolitische-leistungen/>

Schaub, S., Finger, R., Buchmann, N., Steiner, V., & Klaus, V. H. – Agrarpolitik Blog (Sep 2021). **Der Preis der Biodiversität.** <https://agrarpolitik-blog.com/2021/09/20/der-preis-der-biodiversitat/>

Tiago Meier – PSC Blog Engaging in the Science and Policy Dialogue (Sep 2021). **Umweltbedingte Geschlechtsumwandlung in Papaya als transdisziplinäres Forschungsprojekt.** https://blogs.ethz.ch/Science_and_Policy/2021/09/29/umweltbedingte-geschlechtsumwandlung-in-papaya-als-transdisziplinares-forschungsprojekt/

Maria Vorkauf – PSC Blog Engaging in the Science and Policy Dialogue (April 2021). **Die ökologischen und ökonomischen Konsequenzen des Klimawandels in den Alpen.** https://blogs.ethz.ch/Science_and_Policy/2021/04/09/die-okologischen-und-okonomischen-konsequenzen-des-klimawandels-in-den-alpen-und-den-schweizer-skigebieten/

Sergei Schaub – PSC Blog Engaging in the Science and Policy Dialogue (Feb 2021). **The value of species diversity in grasslands.** https://blogs.ethz.ch/Science_and_Policy/2021/02/26/the-value-of-species-diversity-in-grasslands/#respond

Kevin Vega – PSC Blog Engaging in the Science and Policy Dialogue (Sep 2020). **Maintaining plant biodiversity in cities – Using urban design for a better green infrastructure in Zurich.** https://blogs.ethz.ch/Science_and_Policy/2020/09/16/maintaining-plant-biodiversity-in-cities/

Schaub, S., Huber, R., & Finger, R. – Agrarpolitik Blog (Aug 2020). **Google Trends für die Agrarpolitik – Illustriert am Beispiel von Pestiziden.** <https://agrarpolitik-blog.com/2020/08/20/google-trends-fuer-die-agrarpolitik-illustriert-am-beispiel-von-pestiziden/>

Schaub, S., Finger, R. – Agrarpolitik Blog (Jan 2020). **Wie wirkt sich Dürre auf Futterpreise aus?** <https://agrarpolitik-blog.com/2020/01/28/wie-wirkt-sich-duerre-auf-futterpreise-aus/>

Schaub, S., Buchmann, N., Lüscher, A., & Finger, R. – Agrarpolitik Blog (Jan 2020). **Der ökonomische Mehrwert von Diversität im intensiven Grasland.** <https://agrarpolitik-blog.com/2020/01/15/der-oekonomische-mehrwert-von-diversitaet-im-intensiven-grasland/>

Sergei Schaub – Food System Stories (Nov 2018). **The value of species diversity in grassland meets Vancouver, Canada.** <http://www.foodsystemstories.org/blog/2018/11/2/the-value-of-species-diversity-in-grassland-meets-vancouver-canada>

Kevin Vega – Atlas Obscura (June 14, 2018). **The many reasons biologists eat their study subjects.** <https://www.atlasobscura.com/articles/biologists-eat-research-subjects>

Sergei Schaub – Agrarpolitik Blog (Dec 2017). **Ist Diversität im Grasland ökonomisch wertvoll?** <https://agrarpolitik-blog.com/2017/12/11/ist-diversitaet-im-grasland-oekonomisch-wertvoll/>

John Garcia-Ulloa – ETH Zukunftblog (2015). **Of pastures and oil palm.** <https://www.ethz.ch/en/news-and-events/eth-news/news/2015/03/of-pastures-and-oil-palm.html>

Garcia-Ulloa, J., Lee, J. S. H. – ETH Zukunftblog (2014). **Oil palm in Africa: an opportunity too good to miss?** <https://www.ethz.ch/en/news-and-events/eth-news/news/2014/10/oil-palm-in-africa-an-opportunity-too-good-to-miss.html>

Sonja Hassold – ETH Life (April 13, 2012). **Globetrotter. Auf Sammeltour im Masoala-Nationalpark.** https://www.ethlife.ethz.ch/archive_articles/120413_globetrotter1_s_hassold/index.html

ETH Life (Oct 14, 2011). **Mit genetischem Strichcode gegen Holzfrev-el.** https://www.ethlife.ethz.ch/archive_articles/111014_raubbauholz_strichcodes_per/index.html

Web portals

Vega, K., Küffer, Ch. – **Urban Nature Atlas. Maintaining plant biodiversity in cities.** <https://una.city/nbs/zurich/maintaining-plant-biodiversity-cities>

Profiling over 1000 projects worldwide, the Urban Nature Atlas (UNA) is considered to be the most comprehensive database of urban nature-based solutions to date.

Buchmann, N. – **TreeNet: The biological drought and growth indicator network.** <https://treenet.info>
TreeNet turns automatically measured stem radius changes of trees (in a micrometer resolution!) into growth patterns and drought stress indicators of forests in Switzerland and elsewhere.

Public engagement (exhibitions, science fairs)

Maria Vorkauf – **Public Round table: Skigebiete in der Schweiz. Vision für die Zukunft** (Feb. 3, 2021).

Maria Vorkauf, Kevin Vega, Sergei Schaub, Tiago Meier – **Public round table: Urban Agriculture: Fad or Future – should tomorrow's cities grow their own food?** (October, 24, 2019).

Kevin Vega – Exkursion for ETH Netzwerk Nachhaltigkeit at ETH Höggerberg (June 19, 2019).

Kevin Vega – Public discussion at the 13. Grünforum des VLZ Verbund Lebensraum Zürich (May 23, 2019). **Mehr Natur vor der Haustür – Was Vermieter und Mieter tun können.** Stadtgärtnerei Zürich

Kevin Vega – Public talk at Treffpunkt Science City (2018). In collaboration with Dr. Alessia Guggisberg of the ETH Herbarium. **The history and ecology of wild plants in the city of Zurich.** https://ethz.ch/content/dam/ethz/main/news/veranstaltungen/treffpunkt/Broschueren/2018_Herbst_Meine_Stadt.pdf (Page 20)

OUTCOMES

Tiago Meier – Pop up stand at the Fascination of Plants Day (May 18, 2018). **Green pioneers of the land: mosses and liverworts.** <https://plantday18may.org/category/europe/switzerland/>

Kevin Vega – Pop up stand **Stadtnatur** at Zürcher Festspiele (April 2018). <https://www.festspiele-zuerich.ch>

Tiago Meier – Public talk at the Scientifica (Sep 3, 2017). **Ge-schlechtsumwandlung in Papayas.** <https://archiv.scientifica.ch/archiv/scientifica-2017/events/kurzvorlesungen/geschlechtsumwandlung-papayas/index.html>

Sergei Schaub – **OLMA Sonderschau** (Oct 2017). Project presentation in collaboration with the PUBLIFARM project. <https://www.olma-messen.ch/de/messen/olma/besucher/programm/sonderschauen>

Kevin Vega – Market stand **Wo Samen fallen – ein Citizen Science-Projekt zum Mitmachen** at Scientifica (Sep 1–3, 2017). <https://archiv.scientifica.ch/archiv/scientifica-2017/natur-kultur/wo-samen-fallen/index.html>

Kevin Vega – Poster at the «Citizen Science – Ausstellung» zur partizipativen Forschung. **Wo Samen fallen - Förderung und Vernetzung von Biodiversität in Städten** (July 2017). <http://www.grc.uzh.ch/de/focus/exhibition/CitizenScience/wosamenfallen.html>

Maria Vorkauf – Project presentation at the field site (ALPFOR research station, Furka Pass) for **Gymnasium Menzingen** (July 6, 2017)

Kevin Vega – Pop up stand at **Määrt-Fäscht** des Quartiervereins Oberstrass (June 16 and 17, 2017). <https://www.ethz.ch/services/de/news-und-veranstaltungen/intern-aktuell/archiv/2017/06/die-eth-als-nachbar.html>

About the program

Webpage – PSC-Mercator Fellowships (regularly updated) <http://www.plantsciences.uzh.ch/en/research/fellowships/mercator.html>

Video about fellows of the PSC Phd Program Science and Policy (April, 2021) – current and former students of the Science and Policy Phd program at the Plant Science Center in Switzerland talk about their experiences of transdisciplinary research including key challenges and lessons learnt. The movie became part of the SHAPE-ID Toolkit developed by the SHAPE-ID project in Horizon 2020. The aim of the project was to review understandings and best practice of doing and supporting interdisciplinary and transdisciplinary research involving Arts, Humanities and Social Sciences disciplines alongside societal partners and researchers from the Sciences, Technology, Engineering and Mathematics (STEM) disciplines. This toolkit aims to provide guidance for policymakers, funders, research performing organisations, researchers and research partners to help make better decisions and promote change in policymaking, funding and educational institutions.

<https://www.shapeidtoolkit.eu/guided-pathways/develop-a-career-in-inter-and-trans-disciplinary-research/>

Melanie Paschke, Karina Zurgilgen (2019). **Science-policy boundary work by early-stage researchers. Recommendations for teaching, internships and knowledge transfer.** GAI: 28 (3), 310–315. <https://doi.org/10.14512/gaia.28.3.13>

Melanie Paschke, ed. (2018) Agriculture in transformation. **Concepts for agriculture production systems that are socially fair, environmentally safe and economically viable –Proceedings of the PSC Summer schools 2014 and 2016**, Zurich-Basel Plant Science Center. <https://doi.org/10.3929/ethz-b-000218321>

Mercator Magazin (No 1, 2015). Dialog, Zusammenarbeit, praktische Lösungen. **Erlebnisse für Politik und Praxis.** https://www.plantsciences.uzh.ch/dam/jcr:e6844577-00f2-4962-b0b2-2e324b36a169/2015_01_Mercator_Magazin_Wissenschaft_und_Gesellschaft.pdf

UZH News (2013). **Jeder hat etwas Anderes im Kopf.** Melanie Keim, participant of the PSC Summer School. <https://www.news.uzh.ch/de/articles/2013/jeder-was-anderes-im-kopf.html>

European Plant Science Organization (EPSO) News (Feb 29, 2013). **Working in science or policy – or both?**

UZH Journal (May 3, 2013). **Gut gerüstet für die Praxis.** <https://issuu.com/uzhch/docs/uzh-journal-2013-3/5>

Events organized by the program

PSC Summer School (Sep 13–17, 2021). **Responsible research, innovation and transformation in food, plant and energy sciences** in Wislikofen, Switzerland

PSC Educational Retreat (April 14, 2021). **How to implement impactful transdisciplinary research and mentoring in educational programs** (online)

PSC Mentoring seminar series (2017, 2019): **Careers in Science a Policy, or both?**

PhD Retreat together with fellows of the Mercator Fellowship Program of the World Food System Center at ETH Zurich (Oct 2, 2019)

PSC Summer School (Sep 10-14, 2018). **Responsible research and innovation in plant sciences** in Einsiedeln, Switzerland

PSC Summer School (May 29–June 2, 2017). **Understanding risks and resilience in plant systems** in Einsiedeln, Switzerland

PSC Symposium (April 10, 2017). **Public engagement with science – relevance and methods.** During this one day symposium 29 students and science communicators discussed relevance, approaches and examples of successful public engagement. In addition, two workshops for practicing methods and one generic discussion on benefits and limitations to public engagement with science were conducted.

IDP BRIDGES Final Event (April 5, 2017). **Bridging Science and Policy.** Invited speaker: Dr. Marco Lambertini, General Director WWF International, 60 participants

PSC Summer School (Sep 11–14 and 19, 2016). **Agriculture in transformation – New concepts for an agriculture production that is socially fair, environmentally safe and economically viable** in Einsiedeln and Agroscope Reckenholz, Switzerland

PSC Summer School (Sep 21–25, 2015). **Tackling wicked problems** in Einsiedeln, Switzerland

PSC Summer School (Sep 7–12 and Oct 31, 2014). **Green revolution reloaded – emerging technologies for sustainable crop production** in Einsiedeln and Frick, Switzerland

PSC-Mercator think tank event (June 2, 2014). **How can we increase the impact of research on policy-making and practice?**

PSC Summer School (Aug 20–23, 2013). **Governing the transition to a bio-based economy** in Einsiedeln, Switzerland

PSC Summer School (Sep 6, 2011). **Food security – How can science and policy contribute?** in Klewenalp, Switzerland


University of Zurich | **ETH zürich** |  **University of Basel**

Zurich-Basel Plant Science Center

IDP BRIDGES Final Event
5 April 2017
University of Zurich, Aula



Bridging Science and Policy

Do not miss the closing ceremony of the IDP BRIDGES Innovative Doctoral Program. 10 PhD students will present their outcomes. For example, key factors influencing the success of biofertilization, assessment of forest policy design to mitigate climate change, the use of RNAi as fungicide, potential of epigenetics for the organic sector, drafting a patent landscape for the use of apomixis as a technology.

Keynote talk
Marco Lambertini, Director General at WWF International, will present highlights of the Living Planet Report 2016.

→ www.plantsciences.ch

Picture: Alex Hyde - alexhyde.co.uk


University of Zurich | **ETH zürich** |  **University of Basel**

Agriculture in Transformation

Proceedings of the PSC Summer Schools 2014 and 2016
Zurich-Basel Plant Science Center
Melanie Paschke (ed.)

Concepts for agriculture production systems that are socially fair environmentally safe and economically viable


University of Zurich | **ETH zürich** |  **University of Basel**

Zurich-Basel Plant Science Center

Mini Symposium
Monday, 10 April 2017, 9:15 - 16:00
ETH Zürich, MM C78.1 (Alumni-Pavillon)



Lemons or Lemonade?
Public engagement with science: relevance and methods

Public engagement with science strengthens the legitimacy of research and will contribute to a more sustainable future. The kind of future researchers want to contribute to is a matter of normative values and social responsibility. Consequently, research is socially, politically and ethically entangled. Because the credibility of science is at stake, public dialogue is imperative and should not be just promises to funding agencies. In this one-day symposium, relevance, approaches and examples of successful public engagement with science will be presented. In workshops, we will discuss what can be gained for science in general and for research projects of participants.

For participating please register here by latest 3rd of April: <http://ethz.doodle.com/poll/fdwyyn8ia2md4y9>

Program

09:15-09:45 **Christoph Beuttler, Stiftung Risiko Dialog:** Risk perception and public engagement. Best practice and success factors

09:50-10:20 **Melanie Paschke, Zurich-Basel Plant Science Center:** Narratives and Worldviews – How to deal with thought patterns on sustainable lifestyle, global footprint and agriculture

Coffee Break

10:40-11:25 **Brian Wynne, University of Lancaster (UK):** How can we help public engagement with science and responsible research and innovation reinforce each other?

11:30-12:15 **Two parallel workshops**
Workshop 1: Identifying social dimensions of own research
Workshop 2: Practice on public engagement

Lunch Break (Complimentary)

13:15-13:45 **Antoinetta Di Giulio, University of Basel:** Consumption corridors – who to engage when? Work in progress in the involvement of policy makers, stakeholders, and the general public in transitions towards sustainable consumption

13:50-14:20 **Juanita Schläpfer, Zurich-Basel Plant Science Center:** Engaging in a useful dialogue with the public - The Climate Garden 2085 experiment

14:25-14:45 **Sascha Ismail, Zurich-Basel Plant Science Center:** Reasons for minimal engagement of the public in research: An example on conservation genetics of valuable timber trees

Coffee Break

15:00-15:45 **Workshop: Benefits and limitations of public engagement with research**

15:45-16:00 **Concluding remarks and wrap-up**

Link to abstracts and bio sketches
http://www.plantsciences.ethz.ch/dam/jcr:6c580a9f-7952-425b-b7f9-92956753426d/Abstracts_PSC_SymposiumOnPublicEngagement.pdf

Picture source: creative commons/Paul Keller


University of Zurich | **ETH zürich** |  **University of Basel**

Zurich-Basel Plant Science Center



Trends in Plant Science

Volume 29 Number 8
August 2018
ISSN 1380-1385

Special Lecture

High-impact science communication in the 21st century – a Cell Press perspective

6 Dec 2018, ETH Zurich, LEE E 101, 9:15–11:00
Lecturer: Susanne Brink

REFERENCES

- Brinkmann, S. (2014). Unstructured and semi-structured interviewing. In Leavy, P. (ed.) *The Oxford Handbook of Qualitative Research*. Oxford: Oxford University Press, pp. 277–299.
- Caniglia, G., John, B., Bellina, L., Lang, D.J., Wiek, A., Cohmer, S., Laubichler, M.D. (2018). The glocal curriculum: A model for transnational collaboration in higher education for sustainable development. *Journal of Cleaner Production* (171): 368–376. <https://doi.org/10.1016/j.jclepro.2017.09.207>
- Corbin, J. M., & Strauss, A. L. (1998). *Basics of qualitative research: techniques and procedures for developing grounded theory*. Thousand Oaks: Sage.
- Edwards, M.A. & Roy, S. (2017). Academic research in the 21st century: maintaining scientific integrity in a climate of perverse incentives and hypercompetition. *Environmental Engineering Science* 34: 51–61. <https://doi.org/10.1089/ees.2016.0223>
- Fam, D., Neuhauser, I. & Gibbs, p. (eds.) (2018). *The Art of Collaborative Research and Collective Learning: Transdisciplinary Theory, Practice and Education*. Dorschet: Springer.
- Graf, J. (2019). Bringing Concepts Together: Interdisciplinarity, Transdisciplinarity, and SSH Integration. *fteval Journal for Research and Technology Policy Evaluation* (48): 33–36.
- Killion, A. K., K. Sterle, E. Bondank, J. Drabik, A. Bera, S. Alian, K. Goodrich, M. Hale, R. A. Myer, Q. Phung, A. M. Shew, & Thayer A. W. (2018.) Preparing the next generation of sustainability scientists. *Ecology and Society* 23(4): 39.
- Klein, J. T., & Falk-Krzesinski, H. J. (2017). Interdisciplinary and collaborative work: Framing promotion and tenure practices and policies. *Research Policy* (46/6): 1055–1061. <https://doi.org/10.1016/j.respol.2017.03.001>
- Lowe, P., Phillipson, J., & Wilkinson, K. (2013). Why social scientists should engage with natural scientists. *Contemporary Social Science* (8/3): 207–222. <https://doi.org/10.1080/21582041.2013.769617>
- Lyall, C. (2019). *Being an interdisciplinary academic. How institutions shape university careers*. London: Palgrave Pivot.
- Lyall, C., Meagher, L., Bandola Gill, J. & Kettle, A. (2015). *Interdisciplinary provision in higher education*. Edinburgh: University of Edinburgh. Retrieved from: https://www.pure.ed.ac.uk/ws/portalfiles/portal/23462207/Lyall_et_al_2015.pdf
- Mielke, J., Vermaßen, H., Ellenbeck, S., Milan, B. F., & Jaeger, C. (2016). Stakeholder involvement in sustainability science—A critical view. *Energy Research & Social Science* (17): 71–81.
- National Academies of Science, Engineering, and Medicine. (2014). *Convergence: Facilitating transdisciplinary integration of life sciences, physical sciences, engineering, and beyond*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/18722>
- Paschke, M. & Zurgilgen, K. (2019). Science-policy boundary work by early-stage researchers. Recommendations for teaching, internships and knowledge transfer. *GAIA* (28/3): 310–315.
- Rogga, S. & Zscheischler, J. (2021). Opportunities, balancing acts, and challenges – doing PhDs in transdisciplinary research projects. *Environmental Science & Policy* (120): 138–144. <https://doi.org/10.1016/j.envsci.2021.03.009>
- Roux, D. J., Rogers, K. H., Biggs, H. C., Ashton, P. J., & Sergeant, A. (2006). Bridging the science–management divide: moving from unidirectional knowledge transfer to knowledge interfacing and sharing. *Ecology and Society* (11:1).
- Schmohl, T. & Philipp, T. (2021). *Handbuch Transdisziplinäre Didaktik*. transcript Verlag, Bielefeld. <https://doi.org/10.14361/9783839455654>
- Smith, A., Stirling, A. (2007). Moving outside or inside? Objectification and reflexivity in the governance of socio-technical systems. *Journal of Environmental Policy and Planning* 9(3): 351–373.
- Schreier, M. (2014). *Ways of Doing Qualitative Content Analysis: Disentangling Terms and Terminologies* (15:1). <https://doi.org/10.17169/fqs-15.1.2043>
- Traianou, A. (2014). The Centrality of Ethics in Qualitative Research. In Leavy, P. (ed.) *The Oxford Handbook of Qualitative Research*. Oxford: Oxford University Press, pp. 62–77.
- Vienni Baptista, B., Maryl, M., Wciślik, P., Fletcher, I., Buchner, A., & Pohl, C. (2020). Final report on understandings of interdisciplinary and transdisciplinary research and factors of success or failure. Report: Shaping Interdisciplinary practices in Europe. <https://doi.org/10.5281/zenodo.3760417>
- Wallace, D., de Moura Rocha Lima, G., Sessa, C., & Ohlmeyer, J. (2021). Maximising Arts, Humanities and Social Sciences integration in inter- and transdisciplinary research for effective responses to societal challenges – SHAPE-ID Policy Brief. <https://doi.org/10.5281/zenodo.4442373>

ACKNOWLEDGEMENTS

We would like to say thank you to all those, who contributed to the PSC-Mercator Fellowship Program in many different roles.



Dr. Luisa Last is the coordinator of the *PhD Program Science & Policy*. She has a background in agricultural sciences and has supported course organization, recruitment processes, and outreach events as well as program reporting since 2016.



Dr. Andrea Pfisterer was the coordinator of the *PhD Program Science & Policy* from 2011 to 2016. She has a background in ecology and contributed to the curriculum design. She is co-author of two workbooks.



Dr. Brian Belcher is a social scientist at Royal Roads University. Brian leads the Sustainability Research Effectiveness program that aims to develop theory and methodology for evaluating research in complex transdisciplinary contexts. Brian teaches in the Doctor of Social Sciences program and supervises master's and doctoral students. He is also a senior associate scientist with the Centre for International Forestry Research (CIFOR). Brian contributed as mentor and advisor to the PSC-Mercator Fellowship Program.

TdLab ETH Zurich

The Transdisciplinary Lab (TdLab) at the Department of Environmental Systems Science at ETH Zurich conceptualizes and tests educational and research approaches to tackle the complexities of sustainable development. **Dr. Christian Erik Pohl** and **Dr. Pius Krüttli** contributed as mentors with expertise in problem-framing and knowledge integration.

Participants on the Final Event

On April 14, 2021, 29 participants (PIs, PhDs and stakeholders) discussed how to implement impactful transdisciplinary research and mentoring in educational programs. Keynote speakers Prof. Dr. Catherine Lyall, University of Edinburgh and Prof. Dr. Rachael Garrett, ETH Zurich gave an insight in their personal experience with transdisciplinary research. Two fishbowl workshops were conducted in order to generate discussion and ideas. In the first fishbowl, the needs of PhD students and the role and importance of supervision, mentoring and education within transdisciplinary programs were discussed. In the second fishbowl, the needs of researchers and organizations especially the role of partners and stakeholder in transdisciplinary programs and the role of supporting structures were analyzed.

Mercator Foundation Schweiz

The Mercator Foundation Switzerland supported four fellowships of the «Bridging Plant Science and Policy» Program (2011–2016) and four fellowships of the «Bridging Plant Science and Society» Program (2016–2021) as well as training and outreach activities.

Additional funding resources

The *PhD Program Science & Policy* received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no PITN-GA-2013-608422 – IDP BRIDGES.

© Plant Science Center

Publisher

Zurich-Basel Plant Science Center

Management Office

Tannenstrasse 1, ETH Zurich, TAN D5.2

8092 Zurich, Switzerland

Phone +41 (0)44 632 23 33

info-plantscience@ethz.ch

www.plantsciences.ch

Citation

Dahinden, M., Vienni Baptista, B., Paschke, M. (2021). Going transdisciplinary. How to implement impactful transdisciplinary research and education programs in plant sciences. Evaluation Report. Zurich-Basel Plant Science Center, Zurich. <https://doi.org/10.3929/ethz-b-000526113>