

GAIiA

3 | 2016

ECOLOGICAL PERSPECTIVES FOR SCIENCE AND SOCIETY
ÖKOLOGISCHE PERSPEKTIVEN FÜR WISSENSCHAFT UND GESELLSCHAFT



- CULTURAL VALUES AND CLIMATE CHANGE
- ECONOMIC VALUATION OF ECOSYSTEM SERVICES
- EXEMPLARY TRANSDISCIPLINARY PROJECTS

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SCIENCE AND SOCIETY
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CONTENTS | INHALT 3 | 2016

EDITORIAL

- 145 *Hans-Jochen Luhmann*
Stickstoffemissionen aus Abgasen:
eine Failed-State-Situation

MAGAZINE | MAGAZIN

- 148 GAIASKOP
149 TOOLKITS FOR TRANSDISCIPLINARITY #5
150 12 QUESTIONS TO ... Robert O. Keohane

FORUM

** double-blind peer review*

- 152 *Adelheid Biesecker, Sarah Breitenbach, Uta von Winterfeld*
Bürger ohne Eigenschaften? Die Weltbürgerbewegung
gendersensibel verstehen
- 156 *Harald Wieser*
Beyond Planned Obsolescence. Product Lifespans and
the Challenges to a Circular Economy*

- 161 *Katharina Helming, Johanna Ferretti, Katrin Daedlow,
Aranka Podhora, Jürgen Kopfmüller, Markus Winkelmann,
Jürgen Bertling, Rainer Walz*
Forschen für nachhaltige Entwicklung. Kriterien für
gesellschaftlich verantwortliche Forschungsprozesse*

RESEARCH | FORSCHUNG

** double-blind peer review*

- 166 *Rory Walshe, Alejandro Argumedo
Ayni, Ayllu, Yanantin and Canincha.* The Cultural Values
Enabling Adaptation to Climate Change in Communities
of the Potato Park, in the Peruvian Andes*
- 174 *Bernd Hansjürgens, Christoph Kehl, Lasse Loft*
The Economic Approach to Ecosystem Services and
Biodiversity: Policy Design and Institutions Matter*

SPECIAL: TD-AWARD

- 182 *Jakob Zinsstag, Pasqualina Perrig-Chiello,
Theres Paulsen, Bernhard Truffer*
Exemplary Transdisciplinary Projects – *swiss-academies
award for transdisciplinary research 2015*
- 185 *Emmanuel Rey, Sophie Lufkin*
GREEN DENSITY. A Transdisciplinary Research and
Teaching Project for the Design of Sustainable
Neighbourhoods
- 191 *Flurina Schneider, Mariano Bonriposi, Olivier Graefe, Karl
Herweg, Christine Homewood, Matthias Huss, Martina
Kauzlaric, Hanspeter Liniger, Emmanuel Rey, Emmanuel
Reynard, Stephan Rist, Bruno Schädler, Rolf Weingartner*
MontanAqua: Tackling Water Stress in the Alps.
Water Management Options in the Crans-Montana-
Sierra Region (Valais)
- 194 *Kai M. Udert, Bastian Etter, Teddy Gounden*
Promoting Sanitation in South Africa through
Nutrient Recovery from Urine
- 197 *Kaspar Burger*
A Transdisciplinary Approach to Research on
Early Childhood Education
- 201 *Sabine Hoffmann*
Transdisciplinary Knowledge Integration within
Large Research Programs
- 204 *Marcel Tanner*
A Harmonic Way to Transdisciplinarity. Experience
from Global Health Development

The *td-award* is financially supported by

**STIFTUNG
MERCATOR
SCHWEIZ**

Bernd Hansjürgens et al.

ECONOMIC VALUATION OF ECOSYSTEM SERVICES

What are ecosystems worth? Can the destruction of one habitat be compensated for by the conservation of an equivalent one elsewhere? Capturing the economic value of ecosystems and their services in decision making seems to be a promising approach, but only if instruments are designed properly.



174–181

Miscellaneous Authors

EXEMPLARY TRANS-DISCIPLINARY PROJECTS

Transdisciplinarity, still a young field, thrives on innovations. Researchers and research funders need encouragement to contribute to the maturation of the field. To this end, the 2015 *td-award* showcased six exemplary transdisciplinary projects which are featured in this *GAIA* special.



182–206

COMMUNICATIONS | MITTEILUNGEN

- 207 *NaWis*
“The Woodstock of Sustainability Science”.
Impulses from the Wuppertal *Making Utopia Possible*
Conference Week
- 210 *Sozial-ökologische Forschung*
Mit der Sektorkopplung die Wärmewende einleiten.
Ein sozial-ökologischer Aufriss
- 212 *DGH*
Humanökologie und Ernährungsökologie.
Auf der Suche nach gemeinsamen Lösungen
- 214 *Allianz Nachhaltige Universitäten in Österreich*
Kompetent in die Zukunft. Die Forschungs-Bildungs-
Kooperation zur Klimawandelbildung *k.i.d.Z.21* und
k.i.d.Z.21-Austria
- 217 *saguf*
Die Energienachfrage steuern. Handlungsempfehlungen
zur Nutzung von Smart-Meter-Daten

- 220 *MWK Baden-Württemberg*
BaWü-labs on Their Way. Progress of Real-world
Laboratories in Baden-Württemberg
- 222 *Helmholtz-Allianz ENERGY-TRANS*
Die Energiewende im Ländervergleich. Deutschland
und das Vereinigte Königreich verfolgen eigene
Transformationspfade
- 224 **IMPRESSUM**

COVER PICTURE © Asociación Pukllasunchis, Cusco/Vadim Zignaigo

Selecting coca leaves and giving thanks, a couple celebrates the *Papawatay* potato ceremony in Pampallaqta, Potato Park, Peru. Rory Walshe, winner of the 2016 *GAIA Masters Student Paper Award*, has focused his studies on the rural communities of Potato Park. His research shows the crucial relation between cultural values and effective strategies for adapting to the challenges of climate change (pp. 166–173).

Exemplary Transdisciplinary Projects – *swiss-academies award for transdisciplinary research 2015*

Jakob Zinsstag, Pasqualina Perrig-Chiello,
Theres Paulsen, Bernhard Truffer
Members of the Jury of the Swiss td-award

The Network for Transdisciplinary Research (td-net) of the Swiss Academies of Arts and Sciences seeks to foster transdisciplinary research and showcase new approaches addressing topics of societal relevance and impact. The Jury honours the awardees and encourages them to go on contributing to the maturation of their fields.

Exemplary Transdisciplinary Projects – *swiss-academies award for transdisciplinary research 2015* | GAIA 25/3 (2016): 182–184 | Keywords: architecture, environmental sanitation, international health, public engagement of science, sustainability, transdisciplinary research, water resource management

During the most recent *International Transdisciplinary Conference*, from 8 to 10 September 2015 in Basel, Switzerland, the *swiss-academies award for transdisciplinary research* was presented to innovative projects in Switzerland (see figure 1). Included were the **main research award**, **young career awards** and an **award for life-time achievement**. Mercator Foundation Switzerland supports the Swiss Academies of Arts and Sciences to promote transdisciplinary research. In total, 75,000 Swiss francs were awarded to the 2015 winners.

Intense Competition for the Main Prize

The 2015 **transdisciplinary award** was won by architect **Emmanuel Rey** and his team from the Federal Institute of Technology in Lausanne (EPFL). Architecture is not often considered as a science per se. However, with its foundation in geometry, mathematics, physics, chemistry, social science and philosophy being well established, architecture can be considered as a meta-science which reaches beyond pure knowledge to connect with esthetics and the prevailing “Zeitgeist”. As one of the most ancient cultural expressions of humanity, architecture implies a societal engagement of architects, engineers and builders. In current times, there

is more than ever a need for innovative, sustainable urban planning. In this sense, architecture is a key field of transdisciplinarity, engaging academic and nonacademic actors as part of the research process for societal problem solving.

You will read in this issue of *GAIA* how the team of Emmanuel Rey engaged in a scenario process with sixty students and integrated authorities and other stakeholders in order to explore urban densification issues. They elaborated six urban and architectural visions, using a multi-criteria catalogue of social, ecological and economic criteria, in order to optimise all of these barely comparable dimensions.

This project shows the strength of transdisciplinarity because it ultimately relates interdisciplinary science with a societal perspective, extending a purely academic point of view. The developed method was applied to other community projects, and the Jury expects that building projects and urban planning will enter a new era of integrated transdisciplinary development aimed at an optimal technical and societal consensus. To cite Emmanuel Rey: “Ultimately, synthesising multiple constraints into a unifying spatial concept has always been an essential element of an architectural or urban project. Therefore, from our viewpoint, transdisciplinarity is by no means revolutionising the foundation of architecture or urbanism. Rather, it makes it possible to enrich

Contact: Theres Paulsen, Diploma in Environmental Sciences ETH | td-net, Network for Transdisciplinary Research | Haus der Akademien | Laupenstr. 7 | Postfach | 3001 Bern | Switzerland | Tel.: +41 31 3069360 | E-Mail: theres.paulsen@scnat.ch

Prof. Dr. Jakob Zinsstag | Swiss Tropical and Public Health Institute | Basel | Switzerland | E-Mail: jakob.zinsstag@unibas.ch

Prof. Dr. Pasqualina Perrig-Chiello | University of Bern | Institute for Psychology | Bern | Switzerland | E-Mail: pasqualina.perrigchiello@psy.unibe.ch

Prof. Dr. Bernhard Truffer | Swiss Federal Institute of Aquatic Science and Technology (eawag) | Environmental Social Sciences | Dübendorf | Switzerland | E-Mail: bernhard.truffer@eawag.ch

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practices and research in these two fields with new inputs, on the environmental, sociocultural or economic levels. In order to tackle the complexity and the multiplicity of these parameters, architects are definitely expected to master transdisciplinarity if they are to assume their role of central coordinator of the project”.

Future generations of architects and urban planners should profit from this new approach of “jointly designing for urban sustainability”. *td-net* expects strong leadership in training and education in the sense of a transdisciplinary perspective.

Two additional research teams were nominated for **outstanding achievements in transdisciplinary practice**.

In the framework of the *National Research Programme Sustainable Water Management (NRP 61)*, **Rolf Weingartner** and the team from the University of Bern investigated the options for sustainable water management strategies to cope with future possibility of water scarcity in the region Crans-Montana-Sierre, Canton of Valais, Switzerland (see box 1, p. 184).

This team, uniting members from the universities of Bern, Fribourg, and Lausanne, engaged stakeholders from communities, local authorities and scientists, in an exemplary way. Weingartner explained in the application the “co-production of knowledge as a process in which scientists, experts and other nonacademic actors co-construct systems, target and transformation knowledge with a view to finding solutions to concrete lifeworld problems related to sustainable development”. Moreover, he emphasised that “non-academic knowledge is systematically integrated by continuously encouraging dialogue between different actors”.

Certainly the inclusion of nonacademic knowledge is critical for finding acceptable solutions within a given context. This remains true even when communities insist on autonomy and the solutions which are acceptable from a societal perspective are not those which seem optimal from an academic point of view.

The Jury also recognised **Kai M. Udert** from the Swiss Federal Institute of Aquatic Science and Technology (eawag) with a **token**

of appreciation. He led a research partnership between South African and Swiss teams on the recycling of human urine as crop fertilizer. The work was composed of a technical and a societal component showing that technological development in recycling of nutrients alone is not sufficient but needs to be embedded into a societal process of socially and culturally acceptable practices. Their transdisciplinary approach and project guidelines are also described in this issue of *GAIA*.

Promising Young Academics

Over the years, *td-net* became more and more aware that distinguished achievements were generally awarded to senior researchers. Most of the awards were granted to quite encompassing research programmes, which spanned several years to include a large number of subprojects from different disciplines. It is understandable that excelling in such programmes necessitates considerable experience and seniority.

On the other hand, transdisciplinarity is still a young field, which needs innovative ideas and fresh perspectives. Young people should gain visibility, as they develop new ideas that may not immediately result in expansive, integrated programmes. With the **award for early career achieve-**

Emmanuel Rey, Sophie Lufkin: **GREEN DENSITY. A Transdisciplinary Research and Teaching Project for the Design of Sustainable Neighbourhoods**
▶ p. 185

Flurina Schneider, Maria-no Bonriposi, Olivier Graefe, Karl Herweg, Christine Homewood, Matthias Huss, Martina Kauzlaric, Hanspeter Liniger, Emmanuel Rey, Emmanuel Reynard, Stephan Rist, Bruno Schädler, Rolf Weingartner: **MontanAqua: Tackling Water Stress in the Alps. Water Management Options in the Crans-Montana-Sierre Region (Valais)**
▶ p. 191

Kai M. Udert, Bastian Etter, Teddy Gounden: **Promoting Sanitation in South Africa through Nutrient Recovery from Urine**
▶ p. 194
>



FIGURE 1: *td-award* 2015 award ceremony in Basel (from left to right): Theres Paulsen, Bernhard Truffer, Jakob Zinsstag (jury members), Sabine Hoffmann (awardee), Guy Morin (laudation, President of the Executive Council of the Canton of Basel-Stadt), Marcel Tanner (awardee), Pasqualina Perrig-Chiello (jury), Emmanuel Rey, Kaspar Burger (awardees), Kai M. Udert, Flurina Schneider for Rolf Weingartner (shortlisted projects).

BOX 1: The “Holy Waters” in the Canton of Valais

The Canton of Valais is situated between two alpine mountain chains which divert rain so that irrigation is required for agricultural production. Dealing with water resources is a century-old community-based activity because the water has to be collected from glacier sources into canals, made from dug-out logs set along steep cliffs, to provide it to meadows and grain fields in the mountain villages. Many men died during these building operations; therefore, the irrigation system is also called the “Holy Waters”. Not surprisingly, **Elinor Ostrom** started her research work in Valais, specifically in Törbel, studying the community dynamics and economics of decentralised natural resource management for which she later won the *Nobel Prize in Economics*.

Kaspar Burger:

A Transdisciplinary Approach to Research on Early Childhood Education
► p. 197

Marcel Tanner:

A Harmonic Way to Transdisciplinarity. Experience from Global Health Development
► p. 204

Sabine Hoffmann:

Transdisciplinary Knowledge Integration within Large Research Programs
► p. 201

ments, we seek to identify exemplary scholars who fulfill these conditions.

This year two researchers were encouraged to continue contributions towards the maturation of their fields, and it is intended that this will inspire their academic careers and the institutes where they will work in the coming years. **Kaspar Burger** from the University of Geneva is honoured for his doctoral thesis on *Early Childhood Care, Education and Equality of Opportunity*. In this work, he assembled an impressive range of insights from different social science disciplines in order to analyse the challenges of early childhood education in an integrative way. He focused on conditions for the well-being and development of children in educational institutions and also derived implications of early childhood care on broader societal domains. For this, he leveraged theories and methods from educational sciences, psychology and sociology as well as linguistics and literature studies. The Jury viewed this study as an exemplary way for conducting transdisciplinary research in the realm of social sciences.

Sabine Hoffmann is awarded for her project *Knowledge Integration for Sustainable Urban Water Management*. She analysed the five overarching synthesis processes in the context of the *National Research Programme Sustainable Water Management (NRP 61)*. She identified the different methods for knowledge integration in transdisciplinary research in these various processes and assessed their strengths and weaknesses. In addition, she provided a useful entry point for young scholars entering the transdisciplinary field and, therefore, contributes to further professionalise the management of td projects. The award committee con-

sidered this to be one of the key challenges for building up transdisciplinary competence in the Swiss academic field.

Honouring Personal Commitment

Personalities who have dedicated their professional career to establish interdisciplinary and transdisciplinary research are important role models in the scientific community. The *td-net life-time award* recognises long-lasting personal commitment to transdisciplinary research. It honours outstanding scientists who step out of the laboratory, engage perspectives of various disciplines and include nonacademic players in the research process.

“We need to have dirt on our shoes”. This is the motto of **Marcel Tanner**, former director of the Swiss Tropical and Public Health Institute (Swiss TPH). It is difficult to summarise the very rich vitae and his outstanding achievements in a few lines. He is a personality who has always been committed to reform of the academic system. As head of the Swiss TPH, he helped the institution to gain international acclaim. He not only promoted a culture of interdisciplinarity at his institute, but was also one of the first to combine cutting-edge disciplinary research with inter- and transdisciplinary approaches and initiate new research projects in various regions of the world in close contact with the local populations. With his international engagement in global research partnerships, he gave transdisciplinary research a new dimension of “mutual learning for change”. He promoted intercultural exchange among experts in various, equally valuable knowledge systems, helping to create great added value through mutual learning, in order to better meet the challenges associated with global change.

A Glance into the Future

The strengthening of transdisciplinary research approaches will continue to require commitment in funding, and *td-net* contributes by promoting appropriate funding policies. This is well documented by the *Swiss National Science Foundation's National Research Programmes* and *research for development (r4d)* funding lines.

Switzerland, although a small country with a limited research community, is active in transdisciplinary research at an internationally outstanding level. To avoid repetition and loss of excellence, the *td-net* of the Swiss Academies are considering development of the award into a new motivation for scientists to perform transdisciplinary research with methodological excellence. *td-net* continues to seek solutions to close gaps in academic careers. Our explicit aim is to further develop new theoretical foundations and methods and to promote transdisciplinary research in various fields. This will strengthen the scientific base and the excellence of future approaches of research for societal problem solving.

td-net aims to strengthen the position and expertise of the transdisciplinary community – in one way or another, we will find new ways to showcase innovative projects, thoughts and approaches and provide the community with trend setting role models.

GREEN DENSITY

A Transdisciplinary Research and Teaching Project for the Design of Sustainable Neighbourhoods

The GREEN DENSITY transdisciplinary research and teaching project focuses on the Waldstadt sector, a strip of forest bordering the city of Bern. This strategic site, likely to host new inhabitants and jobs close to public transport, is particularly adapted to explore urban densification issues. The objective is to experiment, compare and evaluate diverse possible urban forms for the development of such a site.

The process includes the elaboration of six urban and architectural visions from students' projects developed within Rey's studio at Ecole polytechnique fédérale de Lausanne (EPFL) and their transdisciplinary multi-criteria assessment.

Emmanuel Rey, Sophie Lufkin

GREEN DENSITY. A Transdisciplinary Research and Teaching Project for the Design of Sustainable Neighbourhoods
GAIA 25/3 (2016): 185–190 | **Keywords:** multi-criteria assessment, sustainable architectural design, sustainable design education, transdisciplinary approaches

To achieve a more efficient use of resources and to strengthen the attractiveness of future urban territories, inventing appropriate design strategies to reclaim urban spaces has become a top priority (Rey and Lufkin 2015). As a genuine tool for exploring spatial, typological and technical alternatives, the architectural and urban design is called to play an essential role and is likely to promote the evolution of the built environment towards increased sustainability (Rey 2014). The inherent holistic nature of sustainability, based on the simultaneous and optimal consideration of a wide range of environmental, sociocultural and economic parameters, induces an increased complexity, which enforces the need to develop new transdisciplinary approaches, both in the architectural practice and in the built environment academic world.

The *GREEN DENSITY* transdisciplinary research and teaching project provides an innovative framing of these complex issues. It aims to design, optimise and assess urban and architectural visions by exploring novel ways to integrate transdisciplinary and evaluative approaches into the project's process. This paper presents an application of the *GREEN DENSITY* experience to six original visions developed for Waldstadt sector. Located in close proximity to the city centre of Bern (Switzerland), this emblematic site is particularly adapted to explore urban densification strategies aiming at increasing inhabitants' global quality of life in a holistic sustainability perspective.

Need for Innovative Transdisciplinary Approaches

Indeed, in a context of reconsideration of urban sprawl, there is certain consensus on the necessity to promote densification processes in European urban territories (Newman and Kenworthy 1999, Williams et al. 2000). Sites such as Waldstadt sector, likely

to host new inhabitants and jobs close to public transport, are becoming highly strategic to promote qualitative densification processes. Their development can potentially allow for the construction of new dense and mixed neighbourhoods (Rogers 1998), which fit in with broader sustainability perspectives targeting more efficient use of resources and increasing attractiveness of the entire urban region.

These sustainability perspectives involve finding a long-term balance between environmental, sociocultural and economic objectives. On an operational level, the main challenge is to imagine concrete actions that foster the simultaneous emergence of positive effects in more than one of these dimensions. Regarding the urban and architectural design, it is a question of implementing coherent strategies that are technically appropriate, environmentally friendly, economically viable and value-adding on a sociocultural level (Rey 2012).

The complex and significant scope induced by this holistic approach involves integrating an increased number of competencies into the architectural and urban project's process, which consequently translates into implementing and coordinating transdisciplinary collaborations (Darbellay and Paulsen 2008). In a sustain-

Contact: Prof. Dr. Emmanuel Rey | Tel.: +41 21 6930881 |
E-Mail: emmanuel.rey@epfl.ch

Dr. Sophie Lufkin | E-Mail: sophie.lufkin@epfl.ch

both: Ecole polytechnique fédérale de Lausanne (EPFL) |
Laboratoire d'architecture et technologies durables (LAST) | BP 2225/
Station 16 | 1015 Lausanne | Switzerland

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FIGURE 1: Exploring urban densification strategies under broader sustainability perspectives. Plans of the six visions developed for the Waldstadt site (from top to bottom): *Transition*, *Interface*, *Outposts* (left column), *Checkerboard*, *Continuities* and *Hyperdensities* (right column). Source: Rey (2013).

ability perspective, the latter are not limited to traditional practices of technical coordination. Indeed, current design practices are characterised by a certain disconnection between the design process, conducted by the architect, and the specialised inputs, realised by engineers and specialists. Knowledge and know-how thus tend to remain parallel and partitioned. Iterations between disciplines are few, and most responses are limited to minimal coordination, which fails to truly nourish the design process. However, the significance and the complexity of the issues encourage built environment practitioners and researchers to explore new avenues for cooperation, according to the specific issues raised by each project (Rey 2015 a).

Our transdisciplinary approach goes beyond a simple addition of sectorial logics: it aims to transcend disciplinary boundaries to integrate diverse inputs into a common spatial strategy. The project's process can thus be nourished by considerations from disciplines other than urban planning and architecture, without ignoring spatial coherence and adapted expression of the final realisation. This suggests increased communication between the various involved stakeholders and intense coordination between their respective areas of expertise. Therefore, to support the dialogue be-

tween experts from different fields and nonprofessional actors from the civil society, it is essential to develop simple, efficient and synthetic visual methods to represent the current complexity of transformation processes in urban contexts at all stages of the project: design, realisation, operation and monitoring.

In reaction, built environment researchers and practitioners are currently developing a wide range of transdisciplinary sustainability assessment tools to aid decision-making at neighbourhood scale. Generic examples include the *One Planet Living* and its ten principles (Bioregional 2015), stemming from Bioregional's experience of working on the eco-village of BedZED, UK, or the *SPeAR*[®] methodology (*Sustainable Project Appraisal Routine*), developed by Arup (2012), which appraises urban projects based on key themes such as transport, biodiversity, culture, employment and skills. More specific approaches can also be mentioned, such as the *SIPRIUS* tool, an indicator system for the integration of sustainability into the design process of urban disused areas (Laprise et al. 2015) or the *URBIUS* tool, a multi-criteria decision support methodology for urban renewal strategies at neighbourhood scale (Gracia Riera Pérez and Rey 2012).

In parallel to these efforts towards the integration of transdisciplinary evaluative approaches into the urban and architectural project's process, innovative education methods also have to be developed to make future architects aware of the multiplicity of environmental, sociocultural and economic parameters (Roulet 2006). This is precisely the focus of the *GREEN DENSITY* project (Rey and Lufkin 2014, Rey 2013), which aims to design, optimise and assess urban and architectural projects while enriching the education of future architects.

Development of Six Visions for the Waldstadt Sector

The first application of the *GREEN DENSITY* approach was carried out on the Waldstadt sector, a strip of forest bordering the city of Bern and separated from the Bremgarten forest by a highway. Given the high demographic growth of the Bern urban region, this strategic sector, which measures 46 hectares, is likely to attract several thousand new inhabitants and jobs in close proximity to public transport and a well-preserved natural landscape (Kaufmann et al. 2000).

The project's methodology includes four major steps. The first one was achieved within the framework of Rey's architectural design studio at Ecole polytechnique fédérale de Lausanne (EPFL) in 2010/2011 and 2011/2012. The remarkable commitment of students and assistants, as well as the valuable contribution of external lecturers, allowed for production of approximately 60 projects, from urban form to constructive detail. Confronting the students with representatives from disciplines related to architectural design during their learning process allowed for simultaneous integration of architecture and sustainability issues.

The second phase took the form of two summer workshops, organised in 2011 and 2012. Guided by the studio assistants, a doz-



FIGURE 2: Visualisation of the *Checkerboard* vision, a new urban polarity developed for the Waldstadt sector. Source: Rey (2013).

en motivated students developed and improved the most promising projects. The results from four design studio semesters were thus optimised and radicalised to elaborate six synthetic visions, respectively titled *Transition*, *Interface*, *Outposts*, *Checkerboard*, *Continuities* and *Hyperdensities* (figure 1).

The *Transition* project involves the development of a series of medium-sized buildings and systems at the domestic scale. Private balconies, shared terraces (for use by two dwellings) and neutral, sunny designs with open views onto the forest target households of all kinds of people in search of calm, tranquil and secure housing in the heart of the forest.

Interface promotes conviviality and social exchange through its system of passageways, community rooms and collective terraces on each floor, and series of three-sided interior courtyards. These courtyards are easily used, as are the upper floors, with wide-open spaces that are conducive to family life and children's games.

The *Outposts* project features more anonymous buildings. Their large size gives them an imposing character, and their layout leaves little possibility for use of outdoor spaces. This project is adapted to singles or couples seeking luxury apartments overlooking the forest, with a guarantee of anonymity.

Checkerboard and *Continuities* are projects with a maximum of six floors (figure 2). The closed or semi-open island design supports intense neighbourly relations, where exchanges can take

place in both the outdoor spaces and the passageways. The projects also allow residents to enjoy their privacy, thanks to private balconies. The inner courtyards can easily be used as play areas or urban vegetable gardens.

Hyperdensities is a very compact project that is strongly geared to households who want to experience a sense of "urbanity", where one can observe or bump into one's neighbours without necessarily having exchanges with them. The outdoor areas are very open and only partially connected to the dwellings. The project is more suited to single people or couples without children, who are seeking to live in a lively, trendy urban environment.

Multi-criteria Assessment of the Visions

Subsequently, the third phase consisted of the thematic analysis of the visions. Several experts from diverse disciplinary backgrounds, based at the School of Architecture, Civil and Environmental Engineering (ENAC) of EPFL, were invited to take a critical look at the visions. Their contributions highlight various environmental, energetic, sociological or economic aspects. Thanks to a coordinated work between architecture teachers and different specialists, it was possible to gain some perspective – enriched by manifold dimensions – on the different urban visions. In addition, the organisation of a series of iterative meetings made pos-

TABLE 1: Transdisciplinary multi-criteria assessment. Five categories, as well as their respective indicators, are used to evaluate environmental, economic and sociocultural parameters of the six urban densification visions of the Waldstadt sector.

CATEGORY	INDICATOR 1	INDICATOR 2
density and mix	land use index	functional mix
energy gains and losses	compactness	solar potential
biodiversity and water	preserved forest	permeable soil
lifestyles	level of conviviality	family friendliness
economic return	profit	profitability

sible the emergence of a common language, which continues to enrich exchanges between all *GREEN DENSITY* project contributors.

The last phase was dedicated to the transdisciplinary multi-criteria assessment of the six visions. As previously mentioned, the creation of a sustainable neighbourhood involves searching for global quality and therefore taking into consideration a broad number of environmental, economic and sociocultural parameters, which requires transdisciplinary evaluation.

The assessment methodology is built around five main categories (as shown in table 1, each category includes two relevant indicators):

1. density and mix,
2. energy gains and losses,
3. biodiversity and water,
4. lifestyles,
5. economic return.

Ultimately, a synthetic representation is realised (figure 3): the ten thematic indicators are grouped in a radar diagram, revealing the *sustainability profile* of each vision. These diagrams enable the direct, graphical multi-criteria evaluation and comparison of the six visions. For each of the ten indicators, the centre of the radar diagram is equivalent to the minimum value while the end of the axis corresponds to the maximum value.

Transdisciplinary approaches, both quantitative and qualitative, are crucial to fully grasp the inherent complexity of urban densification processes.

This graphical representation emphasises the strong heterogeneity of the visions, highlighting their respective assets and limitations. It also uncovers several interesting tendencies – in relative terms – among the different projects. Two distinct groups of projects can thus be identified.

The first group consists of projects with a radical profile, which tend to privilege one dimension of sustainability at the expense of others. The *Transition*, *Interface* and *Outposts* projects, for example, systematically emphasise environmental or energy-related as-

pects. Indicators such as *solar potential*, *preserved forest* and *permeable soil* receive favourable evaluations. On the flip side, the density of these three visions is relatively low, which explains why they remain clearly below the theoretical profitability threshold. By contrast, the very radical *Hyperdensities* project, as its name suggests, presents an increased *land use index*, and therefore better economic performances (*profit* and *profitability* indicators) as the previously cited visions. Its environmental evaluation, logically, is significantly less favourable, in particular in terms of *permeable soil* and *preserved forest*.

Furthermore, it is interesting to note that even the most dense vision, *Hyperdensities* (land use index = 2.8), remains almost two times less dense than the historical centre of Bern (land use index = 4.7). This observation is useful to put in perspective several stereotypes about density and highlights the need for sound evaluation methods to assess architectural projects, both quantitatively and qualitatively.

The second group of projects is composed of visions with a more balanced profile, which reconcile different aspects of sustainability in a holistic optimisation process. The *Checkerboard* and *Continuities* projects, even if they are not characterised by top performances, receive good evaluations for an important amount of indicators.


Global Quality through Transdisciplinary Strategies

As illustrated by the Waldstadt case study, the creation of a sustainable neighborhood involves a search for global quality by implementing transdisciplinary strategies that are technically adapted, environmentally friendly, economically viable and which create added value at the sociocultural level. Synthesising multiple constraints into a unifying spatial concept has always been an essential element of an architectural or urban project. Therefore, from our viewpoint, transdisciplinarity is by no means revolutionising the foundation of architecture or urbanism. Rather, it makes it possible to enrich practices and research in these two fields with new

inputs, on environmental, sociocultural or economic levels. In order to tackle the complexity and the multiplicity of these parameters, architects are definitely expected to master transdisciplinarity if they are to assume the role of central coordinator of the project.

Transdisciplinary approaches, both quantitative and qualitative, are crucial to fully grasp the inherent complexity of urban densification processes. By its effectiveness and clarity, the transdisciplinary evaluative approach developed within the framework of the *GREEN DENSITY* project provides a powerful critical analysis,


DENSITY AND MIX

 land use index

 functional mix

ENERGY GAINS AND LOSSES

 compactness

 solar potential


BIODIVERSITY AND WATER

 preserved forest

 permeable soil

LIFESTYLES

 level of conviviality

 family friendliness

ECONOMIC RETURN

 profit

 profitability

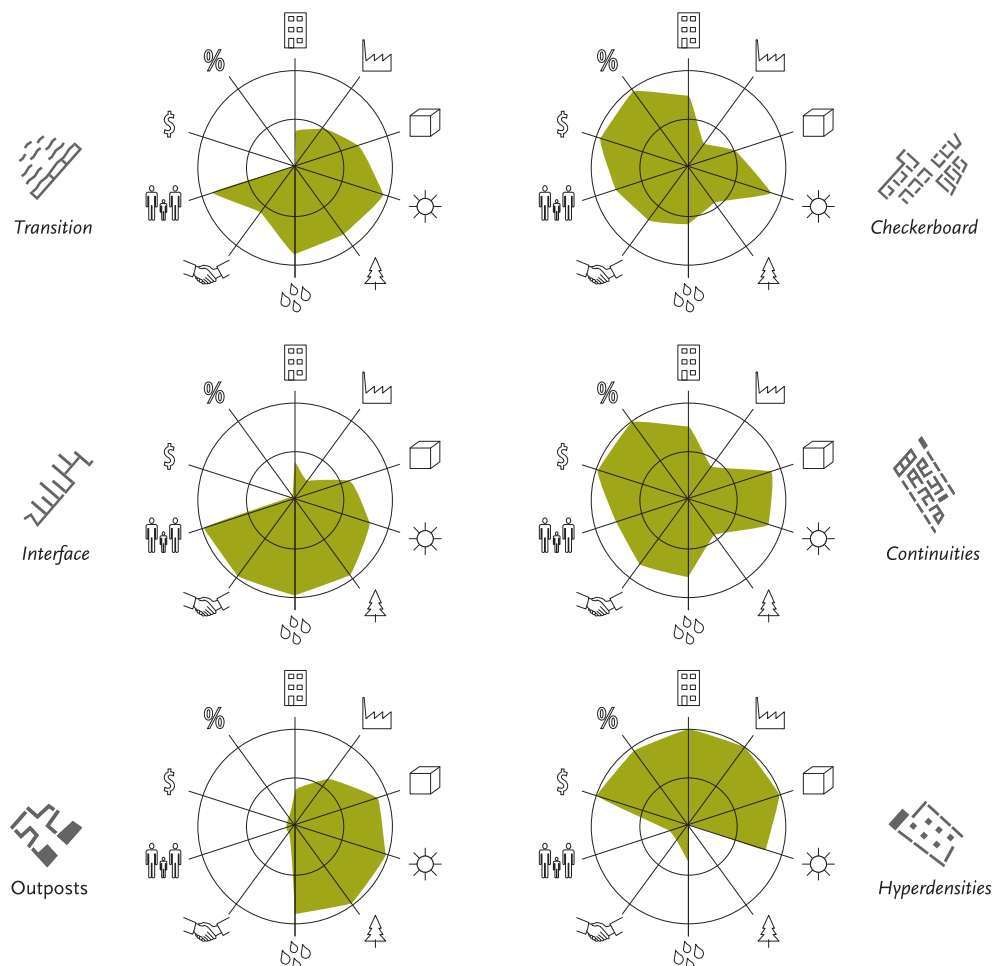


FIGURE 3: Synthetic representation of the sustainability profile of the six visions developed for the Waldstadt site. For each indicator, the center of the radar diagram is equivalent to the minimum value while the end of the axis corresponds to the maximum value. With regard to different sustainability aspects, two of the six visions, *Checkerboard* and *Continuities*, show a more balanced profile than the other four.

decision-making and communication tool. Going beyond traditional educational methods, which maintain the gap between architects and experts from other fields, it explores innovative ways to integrate holistic, transdisciplinary and evaluative approaches in urban and architectural project teaching. By strengthening the links between the often separate worlds of education and research, it heightens the awareness and enriches the education of future architects.

To make sure that the results of the *GREEN DENSITY* experience found their way into society at large, a book was published in the *Architecture Album* collection of the Presses polytechniques et universitaires romandes (PPUR). Entitled *Green Density*, it presents each vision in a specific sequence with numerous colour illustrations (plans, sections, model photographs, 3D visualisations). Texts presenting the thematic insights are intertwined with the six visions. To valorise the outcomes of the *GREEN DENSITY* project and to increase its societal impact, a public exhibition was also organised from 22nd November to 8th December 2013 at the *Forum d'architectures de Lausanne*¹. The opening of the exhibit,

which took place on November 19th, included short speeches by Marilyne Andersen, Dean of the ENAC School, Luca Ortelli, Head of the Institute of Architecture and the City (IA), and Emmanuel Rey, Head of the Laboratory of Architecture and Sustainable Technologies (LAST).

Ultimately, in order to apply the *GREEN DENSITY* experience to other case studies, a methodology named *Neighbourhood-scale Evaluation to Benchmark the Integration of Urban Sustainability (NEBIUS)* was developed. As an extension of the *GREEN DENSITY* approach, this methodology represents a baseline from which other sustainable neighbourhoods, located in other urban areas, can be compared and assessed, whether in academic or operational contexts. Other application case studies proving the value of the approach have already been carried out in Yverdon-les-Bains, Canton of Vaud (Rey 2015 b), and are currently being conducted in West Lausanne (Rey forthcoming).

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¹ www.archi-far.ch

The authors would like to thank the *td-net award* committee for the recognition of their work, which confirms the viability of the approach and validates the relevance of the experience conducted over a four-year period, from architectural design studio to multi-criteria assessment, including summer workshops and thematic analyses by experts. They also express their gratitude to the Ecole polytechnique fédérale de Lausanne, which has provided an appropriate framework for the development of the *GREEN DENSITY* research and teaching project, as well as to all researchers, lecturers and students who contributed to this innovative transdisciplinary experience.

References

- Arup. 2012. *SPeAR® Handbook 2012*. Arup Version 1.1, May.
- Bioregional. 2015. *One planet action plan summary*. White Gum Valley by LandCorp. www.bioregional.com/wp-content/uploads/2015/06/Zibi-One-Planet-Action-Plan_2015.pdf (accessed July 26, 2016).
- Darbellay, F., T. Paulsen. 2008. *Le défi de l'Inter- et transdisciplinarité. Concepts, méthodes et pratiques innovantes dans l'enseignement et la recherche*. Lausanne: Presses polytechniques et universitaires romandes (PPUR).
- Gracia Riera Pérez, M., E. Rey. 2012. Comparative multi-criteria assessment of urban renewal scenarios for existing neighborhoods. Paper presented at the 28th International Conference on Passive and Low Energy Architecture (PLEA), Lima, Peru, 7–9 November.
- Kaufmann, V. et al. 2000. *Coordonner transports et urbanisme*. Lausanne: Presses polytechniques et universitaires romandes (PPUR).
- Laprise, M., S. Lufkin, E. Rey. 2015. An indicator system for the assessment of sustainability integrated into the project dynamics of regeneration of disused urban areas. *Building and Environment* 86: 29–38.
- Newman, P., J. Kenworthy. 1999. *Sustainability and cities: Overcoming automobile dependence*. Washington, D. C.: Island.
- Rey, E. 2012. *Régénération des friches urbaines et développement durable. Vers une évaluation intégrée à la dynamique du projet*. Louvain-la-Neuve, BE: Presses universitaires de Louvain.
- Rey, E. (Ed.). 2013. *Green Density*. Lausanne: Presses polytechniques et universitaires romandes (PPUR).
- Rey, E. 2014. *From spatial development to detail*. Lucerne: Quart Publishers, coll. Notatio.
- Rey, E. 2015 a. Sustainable architecture: Towards integrated strategies from urban design to building component. In: *Architecture and sustainability: Critical perspectives for integrated design*. Edited by A. Z. Khan, K. Allacker. Leuven, BE: ACCO. 53–58.
- Rey, E. (Ed.). 2015 b. *Urban recovery*. Lausanne: Presses polytechniques et universitaires romandes (PPUR).
- Rey, E. (Ed.). Forthcoming. *Suburban polarity*. Lausanne: Presses polytechniques et universitaires romandes (PPUR).
- Rey, E., S. Lufkin. 2014. Green Density: Towards new interactions between city and nature? Paper presented at the 17th International Conference of the European Forum on Urban Forestry (EFUF). Lausanne, Switzerland, June 3–7.
- Rey, E., S. Lufkin. 2015. *Des friches urbaines aux quartiers durables*. Lausanne: Presses polytechniques et universitaires romandes (PPUR).
- Rogers, R. 1998. *Cities for a small planet*. London: Faber and Faber.
- Roulet, C.-A. 2006. Architectural education for sustainable design: A proposal for improving indoor environment quality. Paper presented at the 23rd International Conference on Passive and Low Energy Architecture (PLEA). Geneva, Switzerland, 6–8 September. I-653. <http://plea-arch.org/ARCHIVE/2006> (accessed July 26, 2016).
- Williams, K., E. Burton, M. Jenks (Eds.). 2000. *Achieving sustainable urban form*. London: E & FN Spon.

Submitted May 27, 2016; revised version accepted July 26, 2016.

Emmanuel Rey



Born 1971 in Sion, Switzerland. 1997 architecture degree, 2006 PhD. Since 2010 head of the Laboratory of Architecture and Sustainable Technologies (LAST) at Ecole polytechnique fédérale de Lausanne (EPFL). In parallel, since 2004, partner of Bauart, an architectural firm based in Bern, Neuchâtel, Zurich. Research interests: sustainable architectural design, particularly the transcription of the principles of sustainability at different scales of intervention.

Sophie Lufkin



Born 1980 in Geneva, Switzerland. 2005 MA architecture, 2010 PhD. Currently working as a scientist and lecturer at the Laboratory of Architecture and Sustainable Technologies (LAST) at Ecole polytechnique fédérale de Lausanne (EPFL). Research interests: densification potential of disused railway areas, sustainable and symbiotic neighbourhoods, which follow basic industrial ecology principles to increase exchanges and synergies at neighbourhood scale.