



# AKADEMIE IM DIALOG | 18

GLOBAL SUSTAINABLE DEVELOPMENT GOALS IN  
A MEDIATIZED WORLD

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# **GLOBAL SUSTAINABLE DEVELOPMENT GOALS IN A MEDIATIZED WORLD**

**INTERNATIONAL SYMPOSIUM, 4–5 APRIL 2019  
AUSTRIAN ACADEMY OF SCIENCES**

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# FOREWORD

## MICHAEL ALRAM

The Agenda 2030 challenges the world to achieve 17 Sustainable Development Goals (SDGs). This challenge asks people and institutions to change, to innovate, to rethink. If we are to accomplish the ambitious goals laid out in the Agenda 2030, we need all the brainpower we can get. As Austria's largest non-university research and science institution, many of the brightest minds in Austria work in institutes of the Austrian Academy of Sciences and many of the brightest minds around the world are part of our membership.

The OeAW took stock and looked at what its members, institutes, and researchers are already contributing; only to discover that all 17 SDGs are being already addressed in one form or another. Needless to say, much more should be done.

In the spring of 2018, the Presidency of the Academy formed a program committee of four members (Simone Gingrich, Matthias Karmasin, Wolfgang Lutz, and Verena Winiwarter) to orga-

nize an international symposium to show how science contributes to achieving the Agenda 2030. The committee identified a novel dimension to SDG-driven research: the interaction between mass media, social media, and the Agenda 2030. For two days in April 2019, over 300 participants asked questions, exchanged ideas, and communicated across disciplines and beyond the academic world about the SDG agenda and the challenges and opportunities it offers for scholarship. Questions of how to effectively communicate scientific results to policy makers and to a broader audience were also addressed. One critical prerequisite for sustainable development in all the 17 areas of the Agenda 2030 is evidence-based decision-making for which trustworthy scholarly knowledge is required. Such evidence rests firmly on the full freedom of the scientific world. This symposium showed that a free and independent media and the ability and willingness to engage in dia-

logue between the disciplines and beyond, with stakeholders outside of the academic world, are needed. In the final round of the symposium, of which two contributions are included in this volume, it became clear that the data challenge cannot be met if the commitment of governments to funding statistical data collection and interpretation wanes. Public interest needs public funding, in science and beyond.

The symposium encompassed various interactive formats, a poster session and an exhibition. It led to an episode of the Academy's podcast MIKRO-MAKRO and attracted a lot of media attention. By hosting this symposium, the OeAW has shown its pro-active approach towards the scholarly agenda arising from the SDGs. It remains committed to the science-society interface and will continue to play an agenda-setting role in processes such as the SDGs.





*OeAW President Anton Zeilinger welcomes Dr. Heinz Fischer, Co-Chair of the Ban Ki-moon Centre who delivered a greeting address to the symposium.*





# INTRODUCTORY REMARKS

For all the rich research and discussion that the SDGs ignited, no scholarly exchange had yet taken place to ask what the ‘mediatization’ of society would and could mean for the implementation of the Agenda 2030. However, this permeation of mass and social media discourses into all areas of society and the changes of communication due to the availability of information almost anytime and anywhere is clearly important in the context of sustainable development. Thus, the international symposium “Global Sustainable Development Goals in a Mediatized World”, organized by the Austrian Academy of Sciences, initiated a much-needed discourse that will need to be continued. Achieving the goals laid out in the Agenda 2030 in a mediatized world poses new challenges and opportunities for all stakeholders, including the scientific community. Mediatization shapes public discourses and thus influences the way in which the Agenda 2030 is implemented,

reflected, and criticized. Communication plays an important and sometimes decisive role in the individual and public awareness and acceptance, as well as the political and economic legitimation of the SDGs. Currently, digitalization, convergence, and globalization of the societal environment rapidly change ‘landscapes of communication’. The symposium highlighted these aspects, discussed the consequences across disciplines, and elaborated on the implications of research related to the implementation of the Agenda 2030.

The Austrian Academy of Sciences intended focus on the contributions that scientists can make to the SDGs and deepen the interdisciplinary dialogue among scientists and beyond. International scholarly discussion on the SDGs would benefit from scientists in all fields, and in particular the less present in the international scholarly discussion on the SDGs, colleagues with areas of expertise not typically considered when discussing the



*Program Committee (from left to right):  
Wolfgang Lutz, Simone Gingrich, Verena  
Winiwarter, Matthias Karnasin*

SDGs were particularly invited to take part.

A combination of plenary presentations, posters, interactive formats, and an art exhibition enabled the more than 300 participants to engage with research related to any of the 17 SDGs and to communicate their own research results that contribute to implementing the Agenda 2030. The feedback from the attendees shows that the congress was timely and valuable.

This volume of “Akademie im Dialog” captures some highlights of the symposium. In his introductory remarks, Matthias Karmasin lays out the challenges and possibilities of mediatization for society in general and for the scientific community in particular. The contributions by Nebojsa Nakićenovic, the public evening speaker, and Wolfgang Lutz, the opening keynote presenter, show the scholarly breadth of the SDG agenda. Simone Gingrich presents the diverse communicative formats of the symposium in her reflections, which are accompanied by images and text snippets from the facilitators of the group discussions. The final panel discussion of the symposium asked about lessons learned for various action fields of society. The head of

the Austrian Public Radio’s Science program, Martin Bernhofer, reflects on the role of media, while Marina Fischer-Kowalski discusses the SDG agenda in the light of many decades of research in the sustainability sciences. Verena Winiwarter spoke at the opening of the art exhibition, which took place as an integral, non-traditional part of the symposium. Her remarks on the art of sustainability close these glimpses from an event that of course, was more than can be captured in these pages.

The SDGs are not an abstract plan, they are meant as guidelines to a changed practice of society. Therefore, the symposium strived to meet the criteria of the Austrian Eco-Label for Green Meetings and Green Events within the constraints that a historic building like the Austrian Academy’s main building carries: The registration process was 100 percent paperless, registration for breaks was required to minimize food waste, badges and lanyards could be dropped for reuse. Participants were encouraged to opt for an environmentally friendly way of travelling to Vienna by public transport or carpool, or to make up for the CO<sub>2</sub> emissions by paying a compensation. The use of bicycles was encouraged.

The program committee wishes to express its gratitude to the presidency of the ÖAW for the initiative, to all colleagues, and in particular to the staff of the Academy of Sciences for the support and co-operation that made this success possible.

In many ways, this symposium was a beginning, not an end. While the notion of “*Fallaciloquence*”, deceitful speech, (as explained in Blount’s *Glossographia* of 1656), might be registered as obsolete in the Oxford English Dictionary, the practice of such speech is unfortunately alive and well. It will remain an important task for scholars to engage in research and public outreach to offer facts against fallacious factoids, to support evidence-based policies but also to develop the inter- and transdisciplinary approaches needed to support society on its path towards a more sustainable future. The SDG’s will stay on the agenda – not only – but also of the Austrian Academy of Sciences.

# THE SDGs IN A MEDIATIZED WORLD – INTRODUCTORY REMARKS

MATTHIAS KARMASIN

## 1. MEDIATIZATION AND CHANGING LANDSCAPES OF COMMUNICATION

Mediatization is one of the meta-processes<sup>1</sup> such as globalization, urbanization, individualization, demographic change, and climate change that shape global societies. The omnipresence of media and the possibility to be online almost anytime and anywhere – not only in the global north – has fundamentally changed how we live and interact in today’s world. A decade

ago, Lievrouw/Livingstone (2009) prefaced the volume *Major Works in New Media* by stating: “No part of the world, no human activity, is untouched by the new media. Societies worldwide are being reshaped, for better or for worse, by changes in the global media and information environment. So, too, are the everyday lives of their citizens. National and subnational forms of social, political and economic inclusion and exclusion are reconfigured by the increasing reliance on information and communication technologies in mediating almost every dimension of social life.”<sup>2</sup> This process has continued, at an even higher pace

via digitalization and networking. In mediatized social worlds,<sup>3</sup> the changes affect almost every aspect of interaction – the economy, politics, sports, healthcare, the arts, science, education, the family, to name just a few – and hence it is not far fetched to conclude they also affect the way we perceive and realize the SDGs on every level of social aggregation. So this holds not only on the societal or the macro level when it comes to political decisions concerning how to realize the SDGs (if at all), as opposed to merely committing to them as sunshine values, and how to set priorities regarding what has to be done and what has to be done first, how much

<sup>1</sup> Krotz, F., Despotović, C., & Kruse, M.-M., (eds.) (2017). *Mediatisierung als Metaprozess: Transformationen, Formen der Entwicklung und die Generierung von Neuem*. Wiesbaden: VS.

<sup>2</sup> Lievrouw, L. & Livingstone, S. (eds.) (2009). *Major Works in New Media*. London: Sage.

<sup>3</sup> Hepp, A. & Krotz, F. (eds.) (2014). *Mediatized Worlds*. Houndsmills: Palgrave.

risk we want to take as a society and how safe is safe enough – but also in which direction we should motivate or, in newspeak, “nudge” people. This is also an issue of relevance on the level of organizations and especially corporations. The question whether they merely pursue shareholder interests or whether they also take broader responsibility for stakeholders and future generations, even if they are not forced to do so by politics, is also decided in mediated communicative processes, as the debate on corporate social responsibility has clearly shown.<sup>4</sup> Certainly, there are indeed corporations using greenwashing and their self-description in promoting the SDGs as part of their branding strategies – but there are also organizations trying to promote responsible growth – even if it is costly.

<sup>4</sup> Visser, W. (2014). *CSR 2.0: Transforming Corporate Sustainability and Responsibility*. Heidelberg/New York/Dordrecht/London: Springer.

Crane, A. & Matten, D. (2016). *Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalization*. Oxford: Oxford University Press.

Diehl, S., Karmasin, M., Mueller, B., Terlutter, R., & Weder, F. (eds.) (2017). *Handbook of Integrated CSR Communication*. Heidelberg/New York/Dordrecht/London: Springer.

And also, on the level of families and individuals, decisions like consumption, mobility behaviour, investments and, of course, political choices are dependent on mediated information and whether individuals are willing to act rationally with a long-term orientation or just emotionally and guided by hedonistic utilitarianism. This, of course, also has something to do with the question as to what information we rely on, especially when the message is somehow disturbing and causes dissonance, as it implies not only a change in attitude alone but also a change in behaviour.

## 2. CONVEYING “AN INCONVENIENT TRUTH”<sup>5</sup>

So, whom can we trust on these matters? The overflow of information – and indeed we can find almost any piece of information on anything and its opposite out there –, the rise of the

<sup>5</sup> An Inconvenient Truth is a 2006 American Academy Award-winning documentary directed by Davis Guggenheim about former United States Vice President Al Gore’s campaign to educate people about global warming, which has become a reference project for communicating sustainable development.

“prosumer” due to the dismantling of the division between producer and consumer and the algorithmic production of content have not made the question easier to answer in the view of the general public, it seems. Empirical studies like the Edelman trust barometer<sup>6</sup> clearly show that mediatization has shaken the foundations of trust and the hierarchies of knowledge in politics, legacy media and even science.

This makes trust and reliability an essential part of successful communication – especially when the message is not easy to convey. And in the context of the SDGs it’s not always a story of synergies, technological and social innovation which benefits everybody and opportunities for present and future generations but also one of rising costs, redistribution and loss of welfare (at least according to the traditional operationalizations of welfare) for the so-called first world,<sup>7</sup> and the need for a change

<sup>6</sup> [www.edelman.com/trust-barometer](http://www.edelman.com/trust-barometer)

<sup>7</sup> The Eurostat Report e.g. clearly shows that there is a tendency for mere economic growth to endanger the achievement of various SDGs (especially in the context of the environment). [ec.europa.eu/eurostat/documents/3217494/9940483/KS-02-19-165-EN-N.pdf](http://ec.europa.eu/eurostat/documents/3217494/9940483/KS-02-19-165-EN-N.pdf)

of lifestyle (consumption, mobility behaviour), a story of restraint, modesty and responsibility and challenging the concept of the nation state, as in many cases the SDGs require global efforts.

This also makes it clear that communicating the SDGs is communication in a disputed arena of conflicting interests and tradeoffs.

How comforting it is when we can leave things as they are – as we can always find a piece of information calling even scientific evidence into question and telling us that the empirical evidence (especially in the context of climate change) cannot be trusted. Not to forget that the spreading of misinformation and the production of doubt is also a prominent lobbying strategy in framing scientific evidence – because when there is doubt, nothing has to be done, or changed.<sup>8</sup>

<sup>8</sup> The book *Merchants of Doubt* by Naomi Oreskes and Erik M. Conway (Oreskes, N. & Conway E. (2010). *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. London/New York: Bloomsbury) and the research of Riley E. Dunlap e.g. on the climate denial movement reconstruct this strategy. Dunlap, R. (2014). Clarifying anti-reflexivity: conservative opposition

But this is not only a dystopian view of mediatization movements like Fridays for Future and initiatives addressing the responsibility of scientists as scientists for the future; SDGs' grassroots initiatives all around the globe, organized beyond the scope of legacy media, show that.

### 3. COMMUNICATING THE SDGS IN A MEDIATIZED WORLD

Summarizing, we wish to highlight two aspects in the context of communicating the SDGs in a mediatized world: when it comes to realizing the SDGs, it seems obvious that the first aspect is that communication is essential – on the macro, mezzo and micro levels – yet this aspect seems to be underrated in the SDGs. Goal no. 4 might also mean media literacy, as part of quality education; goal no. 10 might also include bridging the digital divide and distributing

to impact science and scientific evidence. *Environmental Research Letters* 9. 021001. Dunlap, R., McCright, A. & Yarosh, J. (2016). The Political Divide on Climate Change: Partisan Polarization Widens in the U.S. In: *Environment Science and Policy for Sustainable Development*. Volume 58, Issue 5, (p. 4–23). 10.1080/00139157.2016.1208995.

access to information more equally; goal no. 12, responsible production and consumption, might also include responsible production and consumption of media, and goal no. 16, peace, justice and strong institutions, might also include a strong and independent fourth estate but only entail stretching the limits of interpretation a little and not displaying it prominently.<sup>9</sup>

But the standard reaction of “more communication” is not the answer; it is about the right communication as the second aspect. The European Sustainable Development Network addressed the issue of communication in its latest quarterly report published recently, *Communicating Sustainable Development and the SDGs in Europe*: “Knowledge alone does not motivate action. Communication needs to take into account everyday concerns of people and decision-makers, encourage social norms and identities that promote desired actions, increase perceptions of response-efficacy, and move from

<sup>9</sup> Communication briefs are underway but only on the level of processes, not goals: [www.sd-network.eu/pdf/policy\\_briefs/16th%20ESDN%20Workshop%20Policy%20Brief\\_Final.pdf](http://www.sd-network.eu/pdf/policy_briefs/16th%20ESDN%20Workshop%20Policy%20Brief_Final.pdf)

communications of sustainability to promoting communication *about* sustainability.”<sup>10</sup> This is a challenge not only for policy-makers and administrators (at least if they intend to contribute to the life of future generations), but also for scientific communities, as the question of factfulness is the starting point and it *is* disputed what the scientific evidence behind the SDGs is and whether scientists can be trusted at all; this is exactly what the spreading of misinformation intends, and it has many forms,

<sup>10</sup> [www.sd-network.eu/quarterly%20reports/report%20files/pdf/2019-January-Communicating\\_Sustainable\\_Development\\_and\\_the\\_SDGs\\_in\\_Europe.pdf](http://www.sd-network.eu/quarterly%20reports/report%20files/pdf/2019-January-Communicating_Sustainable_Development_and_the_SDGs_in_Europe.pdf)

This is also argued by many scholars in the field, such as Cox, J. R. (2012). *Environmental Communication and the Public Sphere* (3rd ed.). Thousand Oaks, CA: Sage Publications. Fischer, D., Lüdecke, G., Godemann, J., Michelsen, G., Newig, J., Rieckmann, M., & Schulz, D. (2016). *Sustainability Communication*. In Heinrichs, H., Martens, P., Michelsen, G., & Wiek, A. (Eds.). *Sustainability Science: An Introduction* (pp. 139–148). Dordrecht: Springer. Anderson, A. (2014). *Media, Environment and the Network Society*. Houndmills: Palgrave Macmillan. Godemann, J. & Michelsen, G. (eds.) (2011). *Sustainability Communication: Interdisciplinary Perspectives and Theoretical Foundation*. Dordrecht: Springer Science & Business Media.

as McCright/Dunlap (2017) point out.<sup>11</sup> Misinformation, they argue, is not always a systemic lie, but also bullshit (in the sense of Harry Frankfurt’s only caring about the effect<sup>12</sup>) and a misinterpretation of certain scientific theories by claiming that all statements are *equally* valid and accepted “facts” are the outcomes of power and epistemic procedures. Countering misinformation and taking a stand for scientific evidence is one of the first and most prominent tasks in communicating the SDGs – especially for scientific communities. The All European Academies organization ALLEA has published a discussion paper entitled *Trust in Science in Changing Landscapes of Communication* and this paper concludes: it is a crucial task for researchers and communicators of research to safeguard and reinforce the pillars of trust, which are integrity, transpar-

<sup>11</sup> McCright, A. & Dunlap, R. (2017). *Combating Misinformation Requires Recognizing Its Types and the Factors That Facilitate Its Spread and Resonance*. In: *Journal of Applied Research in Memory and Cognition*. Volume 6, Issue 4, (pp. 389–396).

<sup>12</sup> Frankfurt, H.G. (2005): *On Bullshit*. Princeton, New Jersey: Princeton University Press.

ency, autonomy and accountability, in order to counter a loss of trust in and a decline in the perceived trustworthiness of science and research. “They need to convincingly prove that a free and just society means a society in which all people are equal but not all expressions are equally true.”<sup>13</sup>

In terms of communication studies, communicating the SDGs thus requires a combination of science communication (addressing the fact that it is true) and strategic communication (addressing that it might be inconvenient but still necessary and responsible to act) not only via established channels of legacy media and political institutions, not only via lobbying and convincing CEOs, but also via engagement with civil society and via social media, gamification<sup>14</sup> and direct interaction and by fostering media literacy and media accountability.

But this challenge is not limited to media and communication studies; it

<sup>13</sup> [www.allea.org/wp-content/uploads/2019/01/ALLEA\\_Trust\\_in\\_Science\\_and\\_Changing\\_Landscapes\\_of\\_Communication-1.pdf](http://www.allea.org/wp-content/uploads/2019/01/ALLEA_Trust_in_Science_and_Changing_Landscapes_of_Communication-1.pdf)

<sup>14</sup> See e.g. [www.digitalsustainability.com](http://www.digitalsustainability.com) and Bendor, R. (2018). *Interactive Media for Sustainability*. Basingstoke: Palgrave.

is a challenge for scientific communities engaging with the SDGs globally, and it is their responsibility to take up this challenge in changing landscapes of communication. Now.

## MATTHIAS KARMASIN

### Current Positions

- Director of the Institute for Comparative Media and Communication Studies of the Austrian Academy of Sciences and the Alpen-Adria-University Klagenfurt
- Full Professor and Chair for Media and Communications Sciences at the University of Klagenfurt

### Expertise

- Media development, organizational communication, political communication, communication theory, media ethics and media practice

### Qualifications

- 1999 Habilitation for Media and Communication Sciences, Vienna University
- 1991–1996 Dr. rer. soc. oec., Business Administration and International Management, Vienna University of Economics and Business Administration
- 1983–1992 Dr. phil., Communication Sciences, Political Sciences and Philosophy, University of Vienna
- 1983–1990 Mag. rer. soc. oec., Business Administration, Vienna University of Economics and Business Administration

### Career

- Since 2013 Director of the Institute for Comparative Media and Communication Studies of the Austrian Academy of Sciences and the Alpen-Adria University Klagenfurt
- Since 2001 Full Professor and Chair for Media and Communications Sciences at the University of Klagenfurt
- 2000–2001 Visiting Professor for Media Studies at the Karlsruhe Institute of Technology (Institut für angewandte Kulturwissenschaft)
- 1999–2001 Professor (Tenure Track) at the Institute for Media and Communication Studies of the TU Ilmenau (Technische Universität Ilmenau)

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# THE WORLD IN 2050 AND THE SIX GRAND TRANSFORMATIONS TOWARDS THE SUSTAINABLE DEVELOPMENT GOALS\*

NEBOJSA NAKICENOVIC

Humanity is at a crossroads. One possibility is the transformation towards a sustainable future for all and the other fundamentally different alternative is the continued transgression of planetary boundaries with affluence for a few while billions are left behind (TWI2050 2018). In other words, this would mean continuing current, unsustainable development patterns.

A transformation towards an equitable and just future for all is in

principle reachable (TWI2050 2018), especially with the global community's adoption of the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda (UN 2015) and the Paris Climate Agreement in 2015 (UNFCCC 2015). This could be the third revolution in human development, comparable in significance and fundamental changes with those that occurred during the Neolithic Revolution initiated some 10,000 years ago and the Industrial Revolution some two centuries ago, with truly explosive developments. For example, life expectancy throughout the world doubled during the last century to over 70 years. This is due to a whole

host of achievements from education, food and health to better working and living conditions. A particularly impressive development is the long-term decline of war and violence, and yet more people die from suicide than from war and violence combined. Thus, the impressive achievements are interlaced with inequities, deep inequalities and numerous concerning developments. Today, almost a billion people go hungry every night and the number is increasing while nearly two billion are overweight. So, on average enough food is produced but this great human achievement is not shared by all. There are more telephones in the world than people,

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\* This manuscript is based on two reports by the initiative "The World in 2050" (TWI2050) (2018, 2019) and a lecture on this topic at the Austrian Academy of Sciences in April 2019.

meaning that in theory everyone has access to one, and this is close to the factual reality, but one billion do not have electricity at home to charge their phone. Human advances are ever increasing but are not shared equally. Disparities remain large and pervasive throughout the world and even across generations, as illustrated in Figure 1.

## NEOLITHIC AND INDUSTRIAL REVOLUTIONS

Early humans lived as hunters and gatherers but this all changed with the two major transformations – the Neolithic and Industrial Revolutions. They were possible because the Earth's support systems were kind to humanity. Figure 2 shows the climate during the last 120,000 years. Time before the present is represented on the horizontal scale and average global temperature on the vertical. Some 120,000 years ago, the last interglacial period came to an end and was followed by a continued cooling accompanied by significant variability. This ended with the last ice age some 20,000 years ago. Thereafter, the Earth warmed very, very rapidly in terms of geo-

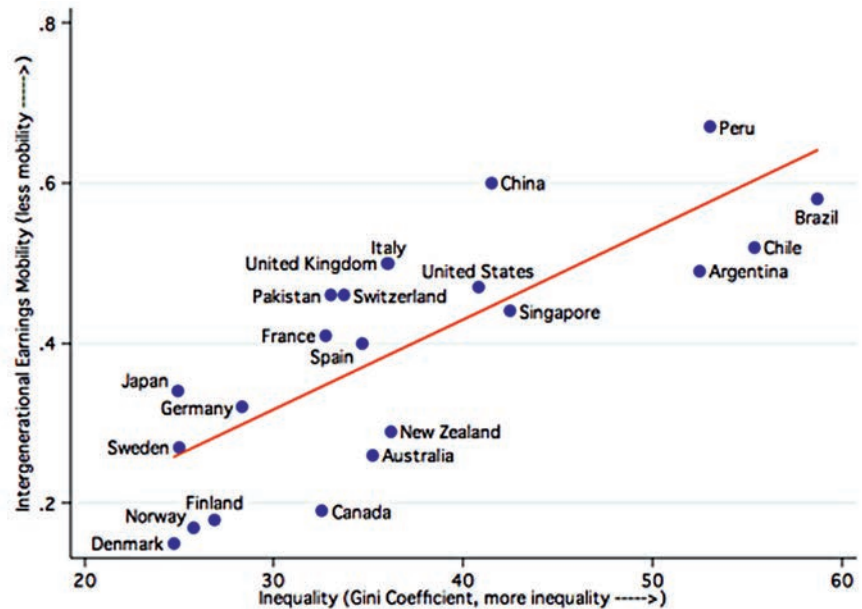


Fig. 1: Great Gatsby Curve. The horizontal axis shows the Gini Coefficient as an indicator of inequality; a value of 0 would indicate perfect equality, a value of 1 the very opposite. The vertical axis shows the elasticity of children's income compared to that of their parents. Countries in the lower left-hand corner are more equitable while those with high inequalities also tend to display the same situation across generations, namely the income of children is a function of parents' affluence. A particularly striking aspect is that some of those countries are moving toward the right. Source: Corak (2013).

logical scales and then something unique happened: the period of the last ten thousand years, known as the Holocene, brought very stable and warm temperatures, almost 8°C above the Ice Age lows. Homo

sapiens developed agriculture and settled down and the first civilizations emerged. This development period is called the Neolithic Revolution and was the "cradle" of modern civilizations.

During the Neolithic Revolution, the global population increased 100-fold to about one billion by the onset of the Industrial Revolution. The relatively benign changes in the global mean temperature are shown in Figure 3. Also, shown compared to this historical backdrop are future possibilities assessed by the Intergovernmental Panel on Climate Change in its Fifth Assessment Report (IPCC 2014) based on the scenarios in the literature (Nakicenovic

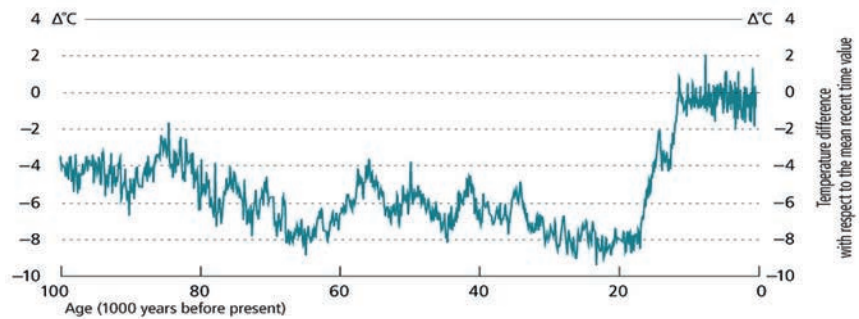


Fig. 2: Shown is the mean global temperature of the Earth during the last 100 thousand years. Time before the present is represented on the horizontal scale and the temperature on the vertical scale. 120 thousand years ago, the last interglacial period was over and was followed by a continued cooling accompanied by significant variability. This ended with the last ice age some 20,000 years ago during the period known as the Holocene. The Earth warmed very rapidly in terms of geological scales and thereafter there ensued a stable period with less variability. Source: data from Petit et al. (1999), labeled as in Young and Steffen (2009).

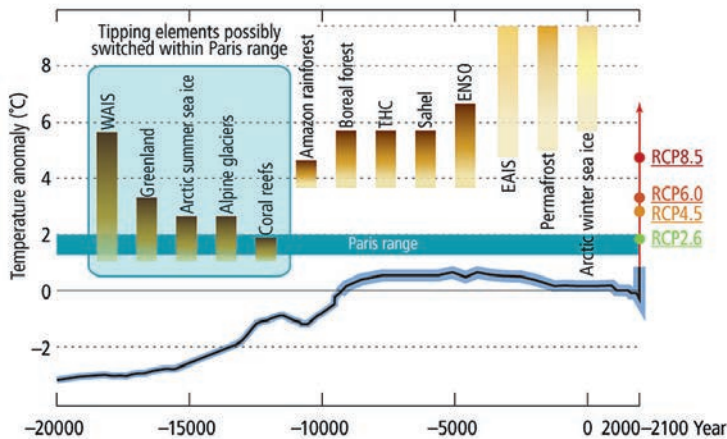


Fig. 3: Shown are the global mean temperatures during the last 20 thousand years together with the range agreed during the Paris Conference of the Parties to the Climate Convention of below 2 °C and down to 1.5 °C if possible. Also shown are possible tipping points of the Earth system as a function of the increasing temperatures together with pathways developed for the IPCC by the scientific communities. Source: adapted from Schellnhuber et al. (2016).



Fig. 4: The 17 Sustainable Development Goals (SDGs) of the 2030 Agenda adopted by all nations during the 2015 United Nations General Assembly. They represent an aspirational vision and a transformational agenda for a sustainable future for all. The 2030 Agenda represents a holistic agenda in the sense that all 17 SDGs need to be achieved simultaneously without leaving a single one behind. The relationships among the SDGs have been studied extensively, including trade-offs and synergies. Source: UN DESA (2015).

et al. 2000, IPCC 2014, Riahi et al. 2017, van Vuuren et al. 2017). Only what is known as the RCP2.6 pathway, which stabilizes global mean temperature at below 2°C (corresponding to radiative forcing of 2.6 W/m<sup>2</sup>, thus the name), is consistent with the range agreed in 2015 at the Paris Conference of the Par-

ties to the Climate Convention in order to stabilize the global mean temperature below 2°C and if possible down to 1.5°C (UNFCCC 2015).

Also shown are possible tipping points of the Earth systems, represented by “amber” colors, much like a thermometer that gets redder the

higher the danger. In particular, the West Antarctic Ice Sheet, Greenland, the Arctic summer sea ice, Alpine glaciers and coral reefs are already endangered because the global mean temperature has exceeded 1°C above the pre-industrial levels.

Two important findings are that even climate stabilization between 2°C and 1.5°C would be associated with tipping points and irreversibilities in the Earth’s systems. The Holocene stability is threatened in the Anthropocene, the new era in Earth history with one species, *Homo sapiens*, to a large extent determining the future of the planet.

## SUSTAINABLE DEVELOPMENT GOALS

The world is at a crossroads because current development trends are endangering Earth systems on which humanity depends while inequities and inequalities are increasing, with the effect that billions with the least capability to adapt and mitigate the adverse developments are left behind. In this sense, the 2030 Agenda and its 17 SDGs adopted by all nations of the world in 2015 (UN 2015) are an aspirational vision of how to achieve

sustainability for all and avoid the continuation of the current unsustainable direction of development. The SDGs are shown in Figure 4 and represent a holistic agenda in the sense that all 17 SDGs need to be achieved simultaneously without leaving a single one behind. The relationships among the SDGs have been studied extensively, including trade-offs and synergies (e.g., TWI2050 2018, 2019, Miola 2018).

A good example of synergies is that if energy systems are transformed towards decarbonization (SDG7), there would be multiple benefits for the climate (SDG13), as shown in Figure 5 (McCollum et al. 2013). Improving energy security is an important priority worldwide and eliminating indoor and regional air pollution is essential for human health and the environment. Together, the average costs are estimated at some \$700 billion per year, stabilizing climate change on average by about \$1 trillion per year. Analysis with integrated assessment models indicates that the total average costs would be about 40% lower if all three important objectives for sustainable development were implemented in unison and holistically. This finding has been corroborated in the IPCC Fifth Assessment Report (IPCC 2014).

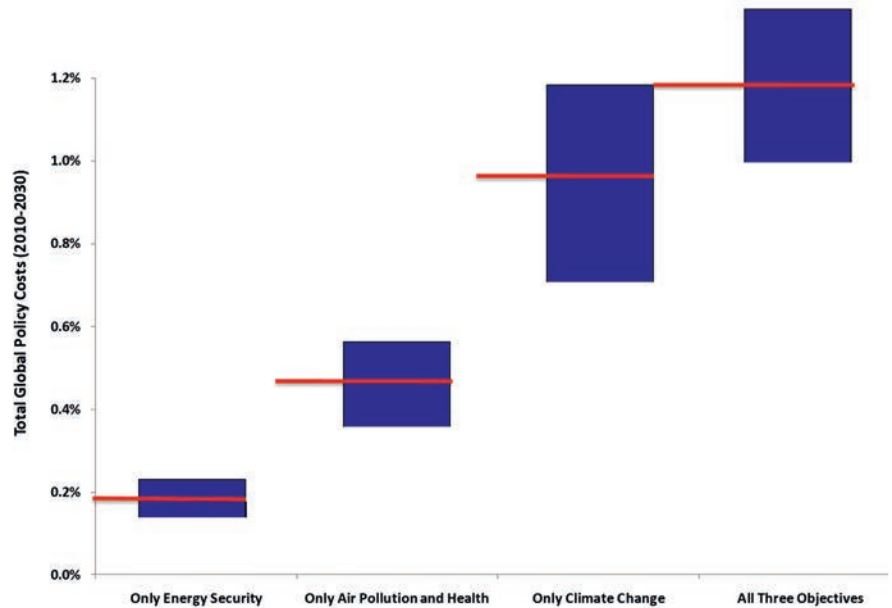


Fig. 5: The vertical axis shows the current global economic output of some hundred trillion dollars per year (in terms of purchasing power parities). On the horizontal axis are three important objectives of sustainable energy futures: the first improvement of security with an average value of about 0.2 percent or two hundred billion per year; next is the elimination of air pollutants with an average of some five hundred billion dollars and finally the mitigation of climate change to below 2 °C with an average of about one trillion dollars per year. The costs would be about forty percent lower if these three objectives of sustainable energy futures were pursued simultaneously with integrated policies and in a holistic manner. Source: adapted from McCollum et al. (2013) and IPCC (2014).

Sustainable Development Goals	
1	No Poverty
2	Zero Hunger
3	Good Health and Well-being
4	Quality Education
5	Gender Equality
6	Clean Water and Sanitation
7	Affordable and Clean Energy
8	Decent Work and Economic Growth
9	Industry, Innovation and Infrastructure
10	Reduced Inequalities
11	Sustainable Cities and Communities
12	Responsible Consumption and Production
13	Climate Action
14	Life below Water
15	Life on Land
16	Peace, Justice and Strong Institutions
17	Partnerships for the Goals



Fig. 6: The nature of the interactions between SDG 7 (Energy) and the non-energy SDGs. Licensed under CC-BY 3.0 by McCollum et al. (2018). The relationships may be either positive (left panel) or negative (right panel) to differing degrees. See Nilsson et al. (2016) for definitions pertaining to the 7-point scale, each score ranging from +3 (positive) to -3 (negative) in integer increments. The absence of a colored wedge in either the left or right panels indicates a lack of positive or negative interactions respectively; if wedges are absent in both panels for a given SDG, this indicates a score of 0 ('consistent'). Only one positive or negative score is shown per SDG; in instances where multiple interactions are present at the underlying target level (positive and negative treated separately), the individual score with the greatest magnitude is shown. Note that, while not illustrated by this figure, some SDG linkages may involve more than simple two-way interactions (e.g. the energy–water–land “nexus”). No scoring is done for the “means of implementation” SDG 17. Source: adapted from McCollum et al. (2018).

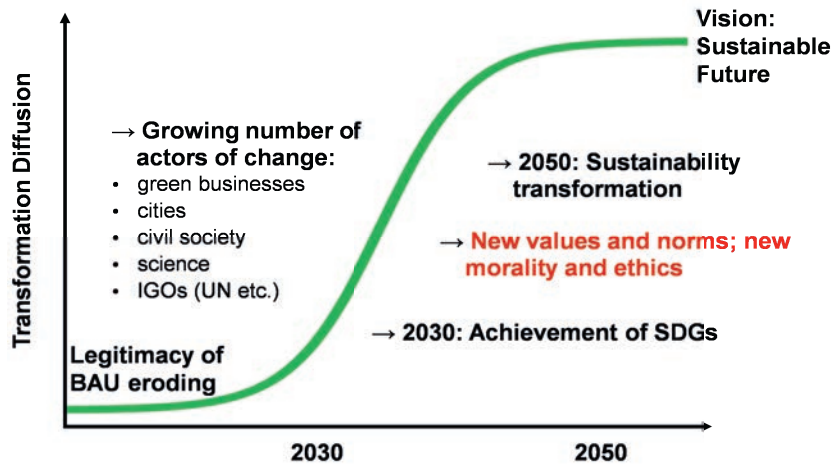


Fig. 7: Illustration of The World in 2050 conceptual framework. The legitimacy of business-as-usual (BAU) is eroding because major actors of change see a need for a fundamental transformation toward achievement of the Sustainable Development Goals (SDGs) as a vision for humanity's future. The vertical axis shows the degree of transformation. Initially, most of the changes would be incremental, but even for the achievement of the SDGs by 2030, disruptive and radical change might be needed. In the longer term, the radicality of these changes would be superseded by the emergence of transformational, new systems, but also new behaviors, values and norms. Source: TWI2050 (2018, 2019).

This and other results in the scientific literature (e.g. TWI2050, 2018, 2019) emphasize the need to achieve multiple benefits minimizing the costs of implementing 2030 Agenda and avoiding conflicts associated with trade-offs. There are many examples of multiple benefits. Figure 6 shows

on a seven-point scale possible synergies and conflicts between SDG7 on energy and the other 16 SDGs (McCollum et al. 2018). For example, the right-hand panel in Figure 6 shows that potential trade-offs and conflicts among SDGs do exist, especially regarding possible land-use

to produce food (SDG2) or biomass for energy purposes (SDG7). There are other potential but less intensive conflicts and trade-offs with water systems (SDG6), poverty (SDG1), health (SDG3) and so on. What is significant is that the synergies shown in the left-hand panel of Figure 6 far outweigh all trade-offs and conflicts both in significance and in relation to the number of other SDGs.

Providing the integrated scientific basis for identifying synergies among the SDGs was the main objective of The World in 2050 (TWI2050) initiative. It is a global research initiative supporting successful implementation of the 2030 Agenda and its 17 SDGs. Its goal is to provide fact-based knowledge to support the policy process on the 2030 Agenda. TWI2050 aims to address the full spectrum of transformational challenges related to achieving the 17 SDGs in an integrated manner so as to minimize potential conflicts among them. One of the main work streams of TWI2050 is to develop future scenarios concerning the implementation of the SDGs.

Figure 7 schematically shows the conceptual framework of TWI2050. The transformation to achieve SDGs is needed because the legitimacy of business-as-usual (BAU) is eroding.





Fig. 8: TWI2050 focuses on Six Transformations that capture much of the global, regional, and local dynamics and encompass major drivers of future changes: (i) Human capacity & demography; (ii) Consumption & production; (iii) Decarbonization & energy; (iv) Food, biosphere & water; (v) Smart cities; and (vi) the Digital Revolution. The Six Transformations reduce the complexity of 17 SDGs and their 169 Targets. Because they are interdependent and synergetic, achieving the Six Transformations would also lead to the 2030 Agenda becoming a reality. Source: TWI2050 (2018, 2019).

The metaphor of the crossroads means in this context that humanity would take a turn from business-as-usual towards the vision of a sustainable future for all. This implies the eventual emergence of new values and norms, a new morality and new ethics. The

SDGs would thereby become the new “social contract”.

The adoption of Agenda 2030 and its 17 SDGs is in itself an indication that the world must change. The vertical axis in Figure 7 illustrates the degree of transformation. Initially, most of

the changes would be incremental, but even for the achievement of the SDGs by 2030 disruptive and radical change might be needed. In the longer term, the radicality of these changes would be superseded by the emergence of transformational, new systems, but also new behaviors, values and norms. A major conclusion of TWI2050 (2018, 2019) is that a transformational agenda is needed to achieve the 17 SDGs. Incremental change will be not enough. Figure 7 illustrates how such transformational and deep change could be achieved. There are a growing number of actors of change from science and civil society to the private sector and government. They operate from the local to the global level and will help make it clear to all that pervasive and urgent action is needed to implement the 2030 Agenda.

## SIX MAJOR TRANSFORMATIONS

The 17 SDGs of the 2030 Agenda and their 169 Targets are comprehensive but thus also very complex. Given this complexity, communicating how synergies leading to multiple benefits can be achieved is non-trivial. TWI2050 (2018) identified Six Major Transfor-

mations necessary to achieve the 17 SDGs. The Six Transformations help realize synergies among the SDGs. Shown in Figure 8, they are: (i) Human capacity and demography; (ii) Consumption and production; (iii) Decarbonization and energy; (iv) Food, biosphere and water; (v) Smart cities; and (vi) the Digital Revolution. Together, they provide a people-centered perspective, enabling the building of local, national, and global societies and economies that secure the wealth creation, poverty reduction, fair distribution, and inclusiveness necessary for human prosperity. They are necessary and potentially sufficient for achievement of the 17 SDGs if addressed holistically and in unison (TWI2050 2018, 2019).

All Six Major Transformations are needed for achieving SDGs. Here we will focus on three exemplary illustrations only, but the full descriptions and evidence are provided in TWI2050 (2018, 2019).

## HUMAN CAPACITY AND EDUCATION

The first exemplary case is education (Figure 9). It is self-evident that

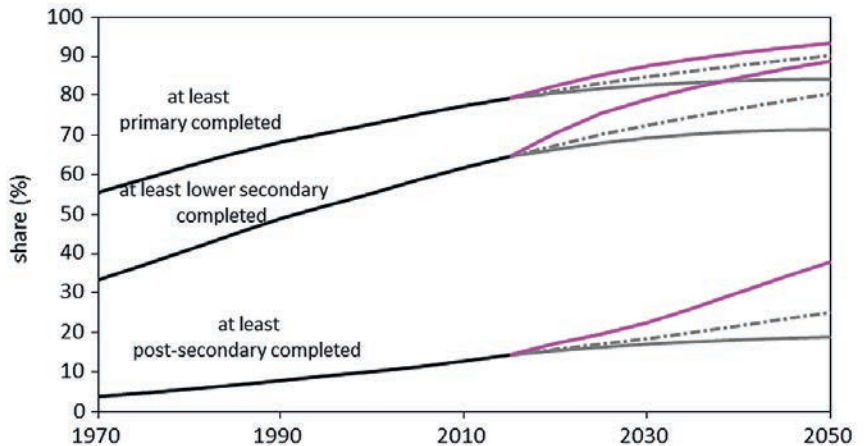


Fig. 9: About 80% of the global population over the age of 15 have at least primary education, up from just over 56% in 1970 and 43% in 1950. Three shared socioeconomic pathways (SSP) developed for the IPCC by the scientific communities are shown: SSP1 is an ambitious pathway and a proxy for sustainable development for all. SSP2 is the current-trends scenario. In SSP1 and SSP2, the historical trend continues toward almost universal primary education, but sustainable development for all calls for universal secondary education. SSP3 portrays little improvement. Source: data from the Wittgenstein Centre for Demography and Global Human Capital (2018) and Lutz et al. (2018).

human capacity and knowledge are the key for achieving sustainability for all. One important measure is education. Today, about 80% of the global population over the age of 15 have access to at least primary education, up from just over 56% in 1970 and 43% in 1950. The Shared Socioeconomic Pathways (SSP) developed

for the IPCC by the scientific communities indicate future developments, only some of which are consistent with the Six Major Transformations (Riahi et al. 2017, van Vuuren et al. 2017, TWI2050 2018). In particular, SSP1 is an ambitious pathway and a proxy for sustainable development futures. SSP2 is the current-trends

scenario and in many ways the future that has to be avoided in the sense of the crossroads. In SSP1 and SSP2, the historical trend continues toward almost universal primary education, but sustainable development for all calls for universal secondary education. SSP3 displays little improvement and is the least desirable future development.

The share of the world's population over 15 years of age to have attained at least secondary education has doubled from some 30% to 60%. SSP1 portrays a significant acceleration, reaching over 85% by mid-century. In contrast, SSP3 portrays a deterioration leading to higher birth rates and a higher global population. Most importantly, post-secondary attainment increases in SSP1 and almost stagnates in SSP3. Even in SSP1, the mid-century level is just over 30% and not very different from secondary education attainment in 1970. This is a huge challenge for knowledge societies in times of digitalization. Achievement of sustainable development for all would definitely need higher educational attainment if no one is to be left behind (Lutz et al. 2018, TWI2050, 2018, 2019).

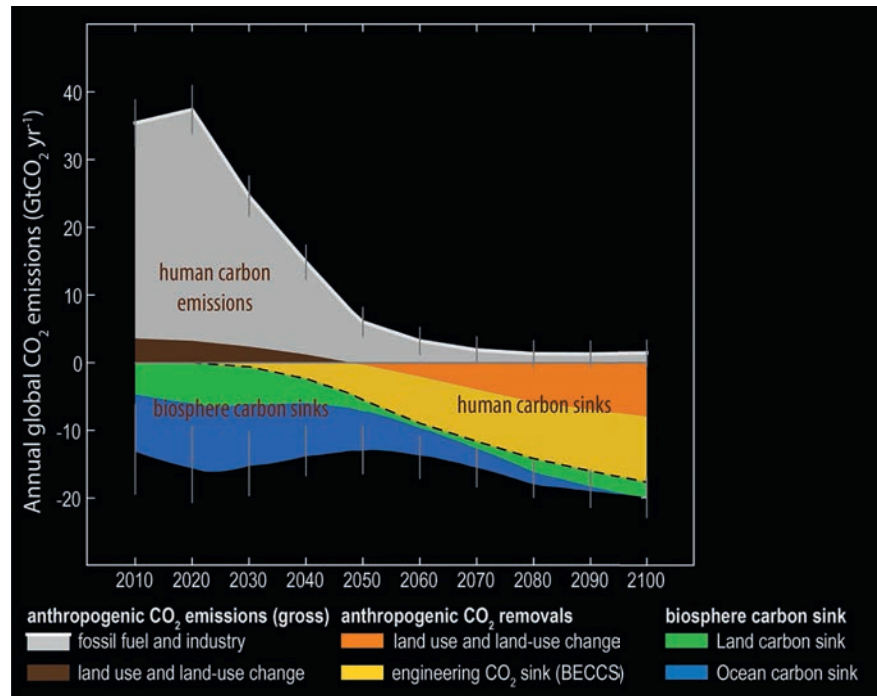


Fig. 10: Cumulative and annual emissions and sinks of CO<sub>2</sub> are shown for stabilizing the global climate at below 2°C and 1.5°C. Energy-related and land-use emissions need to decline toward zero by mid-century. The figure is called “Carbon Law”, in allusion to Moore’s Law of semiconductors, which observed that the number of transistors on a chip doubles every 2.5 years. Essentially, emissions need to be halved every decade. In addition, human carbon sinks need to increase to almost half the magnitude of current positive emissions. Thirdly, biosphere carbon sinks need to be maintained as atmospheric concentrations decline. The vertical grey bars show cumulative emissions since the beginning of the industrial revolution of some 2,000 billion tons of CO<sub>2</sub>. Net negative emissions are required to stay within the 1.5°C stabilization budget. Should the remaining budget for stabilizing at 2°C be a little more generous, the demand for net-negative emissions could be significantly reduced. Source: After Rockström et al. (2017).



Fig. 11: The rapid progress of information and telecommunication technologies is illustrated by an enormous efficiency potential offered compared with traditional alternatives. A smartphone requires between 2.2 Watts in standby mode to some 5 Watts in use, while the numerous devices portrayed in the figure that it replaces need up to a hundred times more power. There is about a factor 25 reduction of embedded energy required to produce the devices and a proportional reduction in emissions. The bundling of services from various devices in the smartphone can be regarded as an example of the power of the Digital Revolution and its huge potential to increase resource efficiencies through new technologies and behaviors. Source: Nuno Bento, based on data in Grubler et al., (2018) and visualization by Tupy (2012).

## DEEP DECARBONIZATION TOWARD NET-ZERO BY MID-CENTURY

Another exemplary case considered here is the need for deep decarbonization of all human activities. Cumulative and annual emissions and sinks of carbon dioxide (CO<sub>2</sub>) are

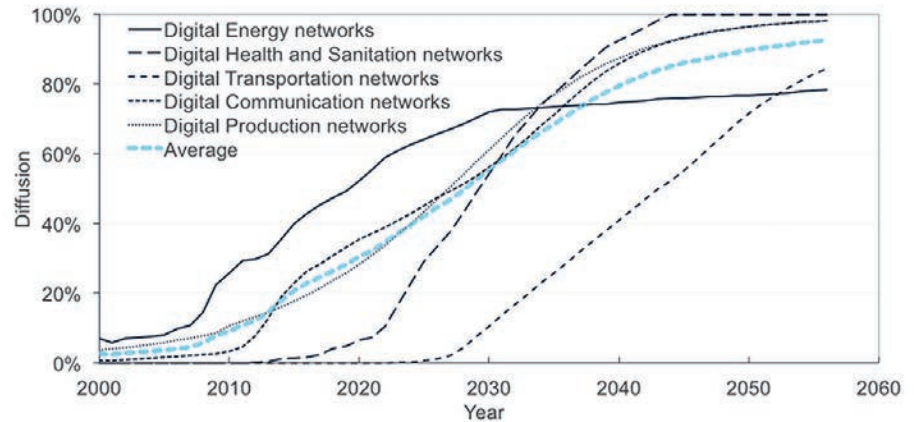
exceedingly limiting factors concerning possible future emissions, given that globally they are still increasing at historical rates of more than 2 percent per year. In comparison, stabilizing the global climate at below 2°C and down to 1.5°C means immediate emissions would peak and decline to net-zero emissions by mid-century.

Most of the carbon emissions shown in Figure 10 in grey are energy-related. Together with land-use emissions, they need to decline toward zero by mid-century from the current level of some 40 billion tons of carbon dioxide (GtCO<sub>2</sub>) per year. Deep decarbonization is called for as an essential process for achieving the 17 SDGs and the Paris Agreement.

The illustration in Figure 10 is called “Carbon Law”, in allusion to Moore’s Law of semiconductors, which observed that the number of transistors on a chip doubles every 2.5 years (Rockström et al. 2017). Carbon Law indicates that global emissions need to be halved every decade to achieve net-zero by mid-century. In addition, human carbon sinks need to increase to almost half the magnitude of current positive emissions a tall order. Carbon capture from biomass (BECCS), afforestation and land-use change are the key here. Thirdly, biosphere carbon sinks need to be maintained as atmospheric concentrations decline.

The vertical grey bars in Figure 10 show cumulative emissions since the beginning of the Industrial Revolution of some 2,000 GtCO<sub>2</sub>. This budget, or carbon endowment of humanity, will be exhausted

shortly as the remaining emissions for achieving stabilization at below 1.5°C are essentially nil while we still emit some 40 GtCO<sub>2</sub> per year. Net-negative emissions are needed to stay within this budget. The remaining budget for stabilizing at 2°C is a little more generous, so that the demand for net-negative emissions can be reduced. In all cases, the emission of other greenhouse gases such as methane and nitrous oxides also needs to be reduced to zero at an even faster rate. Elimination of particulate matter and aerosols is essential for avoiding deadly impact on human health and the environment, but this would add to global warming, as these radiatively active substances cool today. The Carbon Law can be seen as a roadmap towards making the Paris Agreement and the SDGs a reality. In 2018, the IPCC confirmed this result in its Special Report on 1.5°C (IPCC 2018) based on a comprehensive review of the scientific literature. This all exemplifies the urgency of the immediate and deep decarbonization of all human activities as an integral part of achieving a sustainable future for all.



*Fig. 12: Future diffusion of exemplary and enabling digital infrastructures and technologies. By 2030, most of these networks, including the average of all (shown as blue dotted line), would exceed 50% diffusion, or the inflection point, meaning that the increase until then would be exponential. This illustrates the possibility of a very vigorous growth of digitalization in the world along with the emergence of new activities and behaviors. The opportunities and potential dangers are high and related to all SDGs. Source: Sanjeev et al. (2017).*

## DIGITAL REVOLUTION AND HOMO DIGITALIS

The third exemplary Major Transformation discussed here and perhaps the most challenging is the Digital Revolution. After the Neolithic and the Industrial Revolution it could indeed be the third in human history. The Neolithic Revolution brought agriculture and early civilizations, the Industrial Revolution led to the

explosive development of humanity and by replacing human labor with machines also ended slavery and created wealth for many but left billions behind. The Digital Revolution could “liberate” humanity from many cognitive functions through digital enhancement, but it is also challenging the absorptive capacity of our societies – it is by no means clear that it will foster social steering towards sustainability for all.

It could be said that the digital age began some three decades ago with the introduction of the mobile (cellular) phone. The first GSM phone was the Motorola 3200, introduced in 1992, and what followed was an explosive diffusion. As mentioned previously, there are more phones in the world than people. The change was disruptive in the sense that the “copper wire” phones were abruptly replaced, especially as smart phones started providing many services from banking and access to internet-related information, replacing many other digital and analogue devices. Figure 11 compares some 50 or so devices that used to provide services now offered by smart phones. The efficiency improvement of smart phones compared to the traditional devices it potentially replaces is hundred-fold and the reduction of embedded energy and emissions needed for production is about 25-fold. This is a good example of the huge efficiency improvement along with enormous technological improvement leading to better and cheaper services. At the same time, the co-evolution of people, technology and institutions has led to new forms of behavior and lifestyles.

The possible rapid progress of digital technologies shown in Figure 12 could be an indication of the path-breaking potential of next-generation digital technologies, the clustering in new activities and associated behaviors. TWI2050 (2019) report summarizes the positive impacts of digitalization on the SDGs as follows: “better and lower cost services improve access and affordability and hence contribute toward reduction of poverty and inequality. Better asset utilization and virtualization increase resource efficiency and can reduce the resource and ecological footprint of human activities, thus positively contributing to a range of SDGs”.

Potential negative effects are grouped in TWI2050 (2019) into four clusters:

1. Lack of access to digital infrastructure and services compounds the negative impacts of the digital divide, potentially opening up a digital consumption divide. For example, someone who does not own a smartphone could no longer use public transport options organized under a pervasive shared mobility model.
2. Big data applications centred on private consumption and services raise data privacy con-

cerns and present risks of social control by governments and/or large multinational firms. Also, the fundamental nature of network externalities (benefits grow exponentially with the degree of interconnectedness and information sharing) almost automatically lead to natural monopolies.

3. Cost reductions in services could lead to ‘take-back’ (or economic ‘rebound’) effects in which cost savings lead to further increases in the same or substitute demands. For example, cost reductions from shared mobility models for urban commuting to work could lead to increased demands for (long-distance) recreational travel trips on weekends and during holidays.
4. Negative impacts on employment: better asset utilization in a sharing economy and increasing virtualization, despite reducing resource use and waste, will impact manufacturing through lower demand for devices, vehicles, and physical goods, and hence negatively impact employment. Moreover, increasing digitalization of service provision, such as autonomous vehicles in public transport fleets, reduces the need for human labour, again negatively impacting

employment. Concerns are also voiced that continued digitalization in manufacturing could render the traditional comparative advantage of emerging economies in manufacturing (lower labour costs) increasingly obsolete. This could lead to a relocation of industrial and manufacturing activities back to industrialized countries, or it could create an additional entry barrier for resource-based economies that currently benefit from the international division of labour in their efforts to industrialize.

Figure 13 offers an additional perspective of the digitalization challenges in the short and long term. It focuses on artificial intelligence, but the wider convergence of digital technologies would involve deep learning, big data, additive manufacturing, robotics and blockchains, to mention just a few. In the short term, structural unemployment is perhaps the biggest challenge. However, all are relevant. For example, the proliferation of autonomous weapons is a huge danger for the world, as it would expand the portfolio of possibilities from cruise missiles and drones to weapons with enhanced

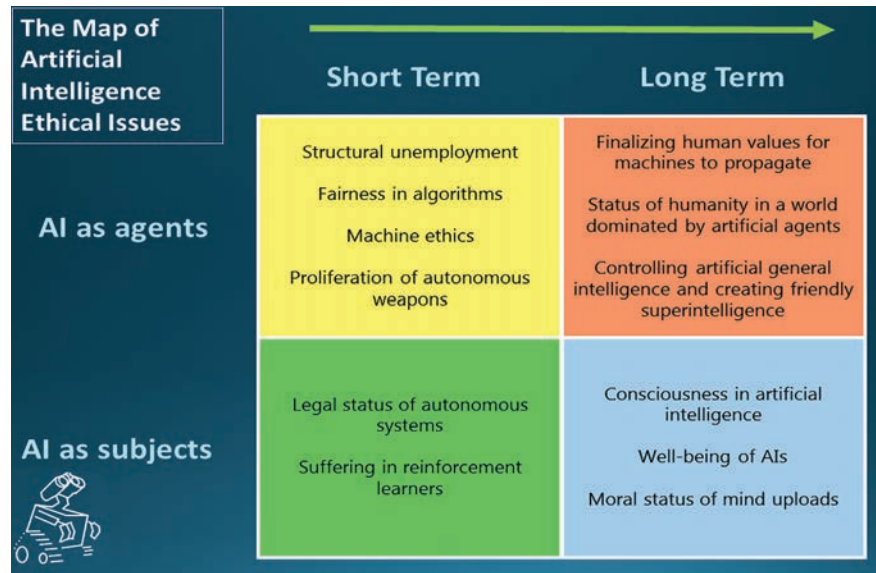


Fig. 13: Major ethical challenges of artificial intelligence (AI) in the short and long term. A major concern among others is the possibility of structural unemployment or proliferation of autonomous weapons as the result of AI diffusion along with other digital systems. Another example is that the legal status of autonomous systems such as self-navigating cars or aircraft is largely unclear. In the long run, issues are even more challenging, such as the status of humans in a world dominated by artificial agents or the possibility of emerging consciousness in AI. Source: x/Futurology (i.imgur.com/13CNnD1.png).

analytic and cognitive characteristics. The manufacture of 'home-made' weapons with additive (3d) manufacturing is already a deplorable reality. Suffice it to also mention here the legal challenges of autonomous systems such as self-driving cars.

In the long term, challenges become even more pronounced, ranging from the question of human enhancement to the status of humanity in a world dominated by artificial agents and how to create friendly superintelligence in machines. Finally, perhaps

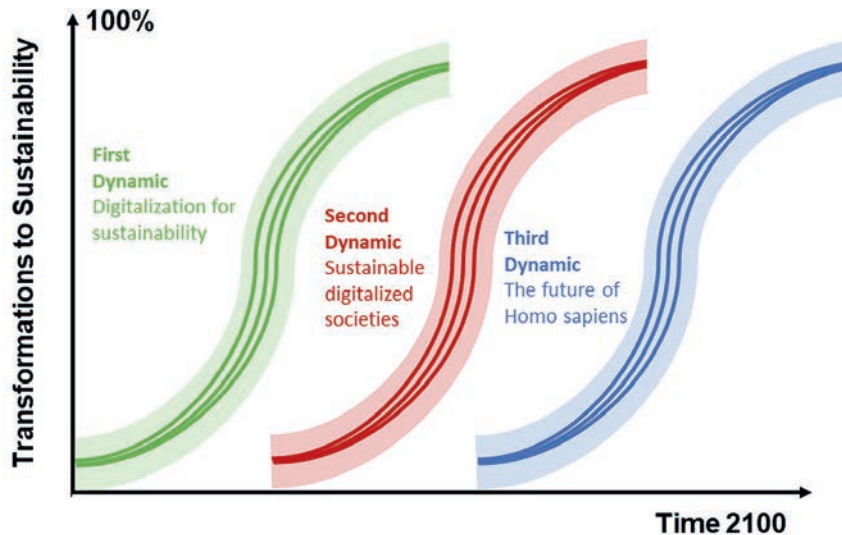


Fig. 14: Three possible Dynamics of the Digital Age. All three are already emerging in parallel, albeit with different levels of intensity, so there is no strict chronological sequence involved. Each dynamic consists of multiple pathways that follow different technology trajectories. The name given to each dynamic reflects the priorities for action required in each case. For illustrative purposes, we show a simplified version that does not cover all emerging technology clusters and possible pathways. Source: TWI2050 (2019) adapted from WBGU (2019).

the biggest question is the possibility of consciousness in artificial systems. This question was described in a visionary way by Alan Turing in 1951, almost 70 years ago: “It seems probable that once the machine thinking method had started, it would not take

long to outstrip our feeble powers. They would be able to converse with each other to sharpen their wits. At some stage therefore, we should have to expect the machines to take control” (Alan Turing during a lecture broadcasted on 15 May 1951 by the BBC).

The full consequence of the evolutionary process leading the Digital Age that could also be called the Digital Anthropocene (WBGU 2019, TWI2050 2019) to signify that one single species, *Homo sapiens*, is likely to increase its influence on Earth systems and determine the nature of the next era in the Earth’s future after the Holocene. The power of the possible changes would fully emerge through a confluence and co-evolution of whole clusters of digital technologies and human behaviors (Figure 14). Digitally enhanced humans or homo digitalis would have the capacity of directing the Six Major Transformations toward a sustainable future for all but also into the undesirable future of inequity and inequality with further dangerous transgression of planetary boundaries.

## TRANSFORMATIONAL CHALLENGES AND OPPORTUNITIES

The world is at a crossroads, as we are currently experiencing signs of counter-transformations away from a sustainable future for all – for example CO<sub>2</sub> emissions and inequality are continuing to increase transcending





*Fig. 15: Science provides urgently needed knowledge to achieve the transformation. People know this, as illustrated here by a participant at the 2017 March for Science in India saying that “cutting science budget is killing the future” and thus also sustainable development for all. Source: courtesy of Souvik Mandal.*

planetary and human-development boundaries. The transformation toward a sustainable future for all is possible but ambitious and urgent action is needed now, as is a continued people-and-planet focus beyond 2030. Continuation of incremental change will not be enough. The key would be the Six Major Transformations needed to enable the world to meet the 17

SDGs. For this to become reality, it will be essential to achieve synergies with multiple benefits among the SDGs. With the Digital Revolution, a new era in human history is emerging after the Neolithic and Industrial Revolution. Digitalization can enable a disruptive revolution toward a Digital Anthropocene – a quantum leap for civilization.

The paradox of the Digital Anthropocene is that digitalization is essential for achieving the Six Major Transformations yet it is also endangering them, for example through the digital divide and because it is challenging the absorptive capacity of society. Building responsible knowledge societies capable of acting towards sustainability in the Digital Age is essential. Achieving a Digital Anthropocene sustainable for all is really the only option, especially compared to undesirable futures of inequity and inequality with further dangerous transgression of planetary boundaries. There is no silver bullet to shape and govern the Digital Revolution toward sustainability, because the future is inherently indeterminate (TWI2050 2019).

We will only be able to exploit the opportunities of digitalization, virtual realities, and artificial intelligence, curb their potential risks and link the digital and the sustainability transformations if the digital and sustainability research communities converge and if science is consulted and trusted by policymakers and society (Figure 15). However, such a convergence and consultative status is still a long way off. Connecting

the greatest innovative dynamics in human history with the major transformation toward sustainability, in order to stabilize the planet and enable a good life for 9 to 10 billion people in the 21<sup>st</sup> century, will require tremendous efforts, swift actions, institutional changes, huge investments, patience, and a clear normative framework. People need to be enabled to understand and shape the emerging digital shifts. New knowledge networks must create transformative knowledge to integrate digital and sustainability-oriented transformations, avoid the digital tipping points, and build normative frameworks for the epoch of convergence between human and machine intelligence (TWI2050 2019).

## REFERENCES

- Corak M (2013). Inequality from generation to generation: The United States in comparison. In *The Economics of Inequality, Poverty, and Discrimination in the 21<sup>st</sup> Century*, ed. Rycroft R. Santa Barbara, USA: ABC-CLIO.
- Grubler, A., Wilson, C., Bento, N., Boza-Kiss, B., Krey, V., McCollum, D. L., Rao, N. D., Riahi, K., Rogelj, J., De Stercke, S., Cullen, J., Frank, S., Fricko, O., Guo, F., Gidden, M., Havlík, P., Huppmann, D., Kiesewetter, G., Rafaj, P., Schoepp, W. & Valin, H. (2018). A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies. *Nature Energy*, 3, 515–527.
- Lutz, W., Goujon, A., KC, S., Stonawski, M. & Stilianakis, N. (2018). *Demographic and Human Capital Scenarios for the 21<sup>st</sup> Century: 2018 assessment for 201 countries*, Luxembourg, Publications Office of the European Union, N 978-92-79-78024-0.
- IPCC (2014). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2018). *Global warming of 1.5 °C*. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. In press.
- McCollum DL., Krey V., Riahi K., Kolp P., Grubler A., Makowski M., & Nakicenovic N. (2013). Climate policies can help resolve energy security and air pollution challenges. *Climatic Change* 119 (2): 479–494. DOI:10.1007/s10584-013-0710-y.
- McCollum DL., Gomez Echeverri L., Busch S., Pachauri S., Parkinson S., Rogelj J., Krey V., Minx J.C., et al. (2018). Connecting the sustainable development goals by their energy inter-linkages. *Environmental Research Letters* 13 (3): 033006. DOI:10.1088/1748-9326/aaafe3.
- Miola A., Borchardt S., Neher F., Buscaglia D., (2019). Interlinkages and policy coherence for the Sustainable Development Goals implementation: An operational method to identify trade-offs and co-benefits in a systemic way, EUR 29646 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-99556-9, DOI:10.2760/472928, JRC115163.

- Nakicenovic N, Alcamo J, Grubler A, Riahi K, Roehrl RA, Rogner H-H, & Victor N (2000). Special Report on Emissions Scenarios (SRES), A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press. ISBN 0-521-80493-0.
- Petit, J. R., Jouzel, J., Raynaud, D., Barkov, N. I., Barnola, J. M., Basile, I., Bender, M., Chappellaz, J., Davis, M., Delaygue, G., Delmotte, M., Kotlyakov, V. M., Legrand, M., Lipenkov, V. Y., Lorius, C., Pepin, L., Ritz, C., Saltzman, E. and Stievenard, M. (1999) 'Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica', *Nature*, 399(6735), 429–436.
- Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J. C., Kc, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., Ebi, K., Hasegawa, T., Havlik, P., Humpenöder, F., Da Silva, L. A., Smith, S., Stehfest, E., Bosetti, V., Eom, J., Gernaat, D., Masui, T., Rogelj, J., Strefler, J., Drouet, L., Krey, V., Luderer, G., Harmsen, M., Takahashi, K., Baumstark, L., Doelman, J. C., Kainuma, M., Klimont, Z., Marangoni, G., Lotze-Campen, H., Obersteiner, M., Tabeau, A. & Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, 42, 153–168.
- van Vuuren, D. P., Stehfest, E., Gernaat, D. E. H. J., Doelman, J. C., van den Berg, M., Harmsen, M., de Boer, H. S., Bouwman, L. F., Daioglou, V., Edelenbosch, O. Y., Girod, B., Kram, T., Lassaletta, L., Lucas, P. L., van Meijl, H., Müller, C., van Ruijven, B. J., van der Sluis, S. & Tabeau, A. (2017). Energy, land-use and greenhouse gas emissions trajectories under a green growth paradigm. *Global Environmental Change*, 42, 237–250.
- Rockström, J., Gaffney, O., Rogelj, J., Meinshausen, M., Nakicenovic, N. & Schellnhuber, H. J. (2017). A roadmap for rapid decarbonization. *Science*, 355, 1269–1271.
- Sanjeev, I., Kamat, S., Prakash, S., & Weldon, M. (2017). Will productivity growth return in the new digital era? An analysis of the potential impact on productivity of the fourth industrial revolution. Bell Labs Technical Journal, 1-1. DOI:10.15325/BLTJ.2017.2714819.
- Schellnhuber, H. J., Rahmstorf, S. and Winkelmann, R. (2016) 'Why the right climate target was agreed in Paris', *Nature Clim. Change*, 6(7), 649–653.
- Tupy, M. L. (2012). *Dematerialization (update)* [Online]. Available: <https://www.cato.org/blog/dematerialization-update> [Accessed 25 June 2018].
- TWI2050 - The World in 2050 (2018). Transformations to Achieve the Sustainable Development Goals. Report prepared by the World in 2050 initiative. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. [www.twi2050.org](http://www.twi2050.org). Available at: <http://pure.iiasa.ac.at/15347>

- TWI2050 - The World in 2050 (2019). The Digital revolution and Sustainable development: Opportunities and Challenges. Report prepared by the World in 2050 initiative. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. [www.twi2050.org](http://www.twi2050.org). Available at: [pure.iiasa.ac.at/15913/](http://pure.iiasa.ac.at/15913/)
- WBGU (2019). *The Sustainability Transformation in the Digital Age*. Berlin (forthcoming).
- Wittgenstein Centre for Demography and Global Human Capital 2015. Wittgenstein Centre Data Explorer Version 1.2. Available at: <http://dataexplorer.wittgensteincentre.org/shiny/wic/>
- UN (2015). Transforming our world: The 2030 Agenda for Sustainable Development. New York: United Nations General Assembly.
- UNFCCC (2015). Adoption of the Paris Agreement. Paris: United Nations Framework Convention on Climate Change.
- Young, O. and Steffen, W. (2009) 'The Earth System: Sustaining planetary life support systems.', in F. S. Chapin III, G. P. K., and C. Folke (ed.) *Principles of ecosystem stewardship: Resilience-based resource natural resource management in a changing world*. New York: Springer-Verlag, 295–315.

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# YEARS OF GOOD LIFE (Y<sub>o</sub>GL)

## A NEW COMPREHENSIVE INDICATOR OF HUMAN WELLBEING FOR ASSESSING SUSTAINABLE PROGRESS

WOLFGANG LUTZ

The Sustainable Development Goals (SDGs) consist of 17 goals with 169 targets and 230 indicators. They have been defined in one of the most inclusive global consultation processes in human history to date. In preparation for their final publication in the “Agenda 2030” agreed by the UN General Assembly in 2015, workshops were held in all corners of the world, involving most international agencies and NGOs. While this process has been widely praised for its inclusive and comprehensive nature, it has also resulted in a rather heterogeneous and wide-ranging set of partly overlapping and partly contradictory social, economic and environmental goals. They are all important in their own right, but are

almost impossible to measure in their entirety when it comes to assessing whether overall progress has or has not been made.

In terms of assessment of progress, one problem with this comprehensive set of goals and targets lies in the fact that there is a great deal of overlap as well as evident contradictions and synergies between them. One example of this overlap is gender equity, which is both given in a separate goal (SDG5) and repeated in almost identical form in several specific targets under education, health and other goals. An evident problem or trade-off lies in the fact that with current technologies, poverty eradication (SDG1) and economic growth (SDG8) cannot be achieved with lower green-

house gas emissions (SDG13). Similar trade-offs exist between food security (SDG2) and protection of biodiversity (SDG15). And finally, there are some SDGs that are so closely intertwined that they can hardly be separated, such as health (SDG3) and education (SDG4) in the context of human capital formation. The newly published Global Sustainable Development Report 2019 identifies such synergies and trade-offs among the SDGs as an important priority for future scientific work.

What is also lacking in this complex web of SDG interactions is an overall compass, i.e. a clear indicator of overall direction, whether – all things considered together – the world is moving in the right direction. There

is no shortage of indicators that attempt to cover different aspects of sustainable development but there is currently no comprehensive indicator that could serve as an overall criterion for judging whether progress has been made or not. In the general field of social indicators or quality of life indicators, there has also been much recent progress even in the field of comprehensive composite indicators, but none of them are fit for serving as a comprehensive sustainability criterion. Moreover, in the development of indicators, the tendency has recently been to try to include more and more dimensions – as in the case of the multi-dimensional poverty index – which makes them richer and to an extent more informative, but due to their high reliance on empirical data they are ultimately less appropriate for modelling long-term trends in different populations.

The effort reported here – part of my ERC Advanced Grant Project on “The Demography of Sustainable Human Wellbeing” – proposes the opposite approach by defining one quantitative indicator of overall quality of life whose change over time for any sub-population of humans can be used as a criterion

for judging whether there is genuine progress or not. Importantly, this indicator uses a long time horizon that also allows inclusion of feedback from environmental change; only trends that result in a long-term increase in the indicator for all sub-populations considered can be viewed as sustainable. This indicator is called Years of Good Life (YoGL), considering the basic but often overlooked fact that in order to be able to enjoy any quality of life, one must be alive. While life expectancy is at the basis of this indicator, it also reflects the notion that mere survival is not enough but that life years need to be good years as measured by subjective and objective factors. The objective variables considered are being out of absolute poverty and being in acceptable mental and physical health. In addition, reflecting the subjective dimension, one must be above a minimal level in overall life satisfaction.

In the following, I will first discuss the criteria that any such wellbeing indicator needs to meet in order to be able to serve as a sustainability criterion. The indicator will then be introduced, discussed and illustrated with examples for selected countries on different continents.

## THE “WELLBEING PRODUCTION FUNCTION” IN SUSTAINABILITY SCIENCE

The emerging scientific field of sustainability science addresses the interactions between natural and social systems in the most comprehensive way possible. Yet, in the words of one of its founders, Robert W. Kates, any comprehensive quantitative operationalization of the concept still suffers from the “ambiguity of sustainable development, the plurality of purpose in characterizing and measuring sustainable development, and the confusion of terminology, data, methods and measurement” (Parris and Kates 2003, 559). Given this “confused” state of affairs even before the definition of the 17 goals, 169 targets and 230 official SDG indicators, what can be done that the rapidly expanding body of literature in the field of sustainability science has not been able to achieve so far? In short, the answer is that here the focus is on defining one ultimate target of sustainable human wellbeing in the form of one quantitative indicator that can be empirically measured for variable sub-populations and forecast as a function of a set of drivers that can be specified and modelled.

When trying to define indicators of human wellbeing it is useful to follow the distinction between means and ends made by Herman Daly and later elaborated by Donella Meadows, who distinguishes between ultimate ends (human well-being) and means (economic, human, social and natural capital) (Meadows 1998). Following this approach, here we are looking for an indicator of ultimate ends. Many of the existing aggregate indicators used in sustainable development analysis tend to mix ends and means and are often difficult to interpret. It is also intellectually unsatisfactory to synthesize many different aspects into a single number when arbitrary weights are given to the different aspects. Finally, it is undesirable that an abstract index number has no substantive interpretation in terms of an analogy to something in real life such as the money we have or the years of life we can expect to live.

The Human Development Index (HDI by UNDP) is the best known example of such an index that gives equal weight to education, health, and income indicators and works on a relative scale, and hence cannot be compared over time (UNDP 2011). It also mixes means (such as school enrollment) with ends (such as sur-

vival as measured by life expectancy). While very useful for comparing countries at any point in time, it has no equivalent on the individual level and cannot be applied flexibly for sub-populations. And it uses equal weights when combining its different dimensions, which makes implicit assumptions about trade-offs, such as how much income is equivalent to a year of life expectancy in producing the same HDI level (Ghislandi, Sanderson, and Scherbov 2018).

Many of the newly proposed indicators are driven by the well-justified desire to go beyond GDP, which until recently had been the hegemonic indicator of progress in policy circles, business communities and the public at large. The need to go beyond GDP has been highlighted by the prominent study “Mis-Measuring our Lives”, in which the economists Stiglitz, Sen and Fitoussi (2010) discuss appropriate metrics other than GDP per person and suggest either opting for a possibly single new metric or a “dashboard” of different indicators. The OECD Better Life Index follows the dashboard approach (Lorenz, Brauer, and Lorenz 2017) and offers the user eleven domains ranging from current conditions in housing and income to life satisfaction and work-life balance,

and allows the user to freely use the weights he/she wants to attach to each domain when producing an aggregate indicator across domains. What it also shares with other broadly based multi-dimensional indicators, such as the multi-dimensional poverty index, is that it depends on a large number of empirical measurements collected by surveys and thus can hardly be projected into the future on the basis of a model. Any forecast of an indicator requires a model because of the necessary absence of empirical measurements for the future. And in general, it is true that the simpler the indicator, e.g. just one number, the better one can define a model for forecasting it under certain constraints and assumptions, including possible feedback. For this reason, meaningful model-based long-term scenarios exist e.g. for life expectancy and even GDP per person, but it would be almost impossible to come up with a forecasting model for the Better Life Index.

The approach chosen for YoGL takes the opposite direction by defining one indicator consisting of only one number with substantive meaning (instead of just an abstract index) and is limited to only five essential prerequisites for wellbeing that must all be met at any point in time and for any population



or sub-population: survival, a minimal level of life satisfaction, being out of absolute poverty and being without cognitive or physical disability.

The main prerequisite for any indicator of sustainable human well-being is that it can stand alone on the left-hand side of a “well-being production function”. As described by Clark (2012), it should be a quantitative estimate of the variable  $W$  in the formulation of a function relating wellbeing to a combination of independent factors, in Clark’s study human capital, manufactured capital, natural capital and institutions and knowledge.

$$W = f(C_i, I, K)$$

$W$  is “human well-being”  
(intra and inter-generational)

$C_i$  are “capital assets”  
(from which services flow)

- $C_m$  is “manufactured capital”  
(factories, homes, roads)
- $C_h$  is “human capital”  
(population, health, education)
- $C_n$  is “natural capital”  
(ecosystem and their services)
- $I$  is “institutions”  
(laws, rules, norms, expectations)
- $K$  is “knowledge”  
(scientific, practical, innovative)

While much of the literature in sustainability science so far has placed the focus on studying the right-hand side of this equation, i.e. the determinants of wellbeing, including environmental services (Levin and Clark 2010), the constituents of wellbeing on the left-hand side have received less systematic attention and studies often only refer to the unspecific notion of utility. Based on a rich body of economic theory, this focus on determinants has led to the concept of “inclusive wealth”, which can be used to assess whether a society is on a sustainable development trajectory in terms of the productive base necessary for maintaining a high standard of living in the future (Managi 2018). In the following, we focus directly on assessing  $W$  and first define six criteria that any quantitative indicator of  $W$  should meet:

It needs to describe something as the ultimate end that has the potential to be universally shared across all cultures as a highly desirable state.

It needs to be based on characteristics of people that can be flexibly aggregated to sub-populations.

It needs to have a meaning in its absolute value in order to make the indicators comparable over time and across sub-populations.

It should be theory-based and parsimonious, covering only the most essential dimensions, the combination of which should not be based on implicit trade-off assumptions or arbitrary weighting schemes.

It needs to be based on a sufficiently large empirical dataset for different populations and fit for serving as the dependent variable in international regression models (“wellbeing production functions”).

If possible, it should have a substantive interpretation in terms of some real-life analogy rather than just being an abstract index.

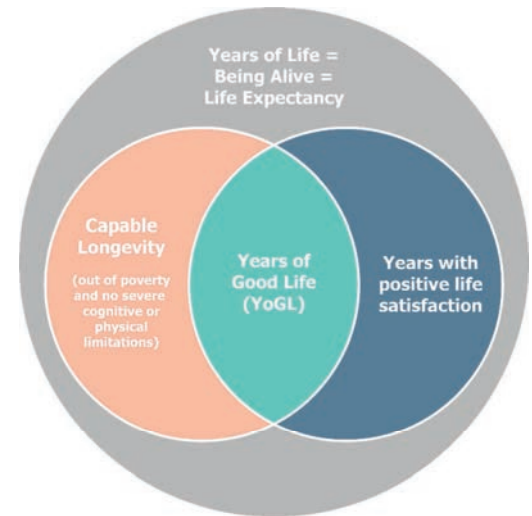
## YEARS OF GOOD LIFE (YoGL)

When constructing YoGL to meet the criteria described above, we established a clear hierarchy of dimensions to be covered on theoretical grounds. First and foremost, we consider survival the most essential prerequisite for enjoying any quality of life. But since mere survival is not considered good enough by many people, in a next step we define years of good life as those in which people are above a minimal level both in terms of objectively observable conditions and in terms of subjective life satisfaction.

On a third level, the objective conditions that should cover capable longevity are further broken down into three dimensions: being out of poverty, being cognitively able and having no serious physical disabilities. Figure 1 summarizes this structure and basic logic of YoGL. The large grey circle corresponds to the overall years of life that summarize the life expectancy of a person based on the currently observed survival conditions in the chosen (sub-) population. The Years of Good Life are a subset of these overall years of life depicted by the turquoise area indicating the intersection of capable years of life (orange circle, defined by three objective criteria) and years with subjective life satisfaction above a minimal level (blue area). More detailed information about the theoretical foundations, data requirements and methods for calculating the indicator can be found in Lutz et al. (2018). There is little doubt that the avoidance of pre-mature death for oneself or the people one cares about is a value shared universally across all cultures. But at the same time, mere survival cannot be the ultimate end for human life on earth. All cultures tend to believe that there must be more to it. But what is this more?

There clearly is a subjective element to this, with different people valuing different aspects of life differently, and there are also some differences among the cultures in which individuals are embedded. In other words, while avoidance of premature death is a widely accepted value, there seems to be less consensus as to what constitutes a good life. For this reason, the literature on the topic suggests that any indicator covering the topic of good life must have a subjective dimension. Only people themselves can judge whether they are satisfied with their lives according to whatever their own criteria are. That is why subjective life satisfaction is a constituent element of YoGL. The literature on subjective indicators to measure well-being (or subjective well-being) is rapidly increasing and attracts more and more attention even among quantitative social scientists and policy makers, with an average of 14,000 publications a year (Diener et al. 2017). A review of this extensive literature relevant for the development of YoGL as a wellbeing indicator is given elsewhere (Lijadi 2018). The most widely recognized scales for measuring subjective wellbeing are the one single item of the Life Satisfaction Scale by Diener

(Diener 1984; Diener et al. 1985) and the one single item of the Happiness Scale (Bradburn 1969), which are used in reputable international surveys such as the World Value Survey and the European Social Survey, to name just two examples.



*Fig. 1: Years of Good Life (YoGL) as those years of total life expectancy that are above critical levels in three objective indicators (capable longevity) and in subjective life satisfaction.*

The literature recommends using some caution concerning the concept of “happiness”; there is conjecture as to whether the concept has the same meaning across culture and time (Carlquist et al. 2017) and whether there are notable differences in how people present themselves and response styles (Diener et al. 2017; Oishi 2010). The concept of “happiness” tends to have different meanings in different languages, to be more volatile and directly dependent on emotions (Delle Fave et al. 2011; Mogilner, Kamvar, and Aaker 2011). Moreover, the European Social Survey revealed that people answer differently and inconsistently when asked “Thinking of your life in general, are you happy?” or “Thinking of your life in general, are you satisfied with your life” (Becchetti and Conzo 2017). In YoGL, we only count a year of life as a good year of life if the score that people provide on subjective wellbeing in terms of overall life satisfaction is above a certain minimum level.

Another strain of the literature on human wellbeing stresses the objective preconditions and dimensions of what constitutes a good life that can be assessed independently of subjective life satisfaction. In particular, the

highly influential writings by Martha Nussbaum and Amartya Sen have approached this issue by identifying basic capabilities characterizing a good and successful life. In some early writings by Sen and colleagues on indices of wellbeing (Desai, Sen, and Boltvinik 1992), there was a discussion concerning which are the most fundamental objective aspects of capability and empowerment. They identify basic health, some basic material subsistence level and cognitive functioning and empowerment as the three areas that jointly determine a person’s capability, which can also be viewed as the freedom to achieve wellbeing. This general approach has then prominently been translated into the HDI (Human Development Index), whose three components (health, income and education) directly reflect the three aspects of capability. Nussbaum and Sen even suggest combining these three dimensions with longevity to produce an indicator called “capable longevity” (Kelley 1991). This is directly in line with the approach chosen for YoGL.

For these reasons we chose the following four items assessed in surveys for covering the three domains of capable longevity:

- Being out of absolute poverty, which in poor countries is assessed via the presence of certain facilities such a flush toilet or a solid floor in the living room. In industrialized countries it is assessed via household income and consumption data.
- Being able to read a simple sentence is the cognitive empowerment indicator of choice. It is assessed via a standard test of functional literacy. It is worth noting that this does not only refer to different degrees of literacy across individuals, but should also capture the cognitive decline that can be observed in advanced stages of physical and mental ageing.
- Having no serious physical activity limitation is assessed with respect to activities of daily life (ADL) and in particular using a test as to whether the respondent is able to get up from his/her chair, something that can be objectively verified. There will also be a standard question as to whether the person has had a serious disability during the last six months.

## EMPIRICAL APPLICATIONS FOR EUROPE

The calculation of YoGL is based on an expansion of the basic demographic life table method which is used to calculate regular life expectancy. The Sullivan method multiplies the number of person years lived at every age by a certain proportion of those life years that are considered to be in the category of interest. To calculate the frequently used disability-free or healthy life expectancy simply, the proportions of men and women without disabilities in each age group are multiplied by the person years lived in that age group. Summing up all these weighted person years over all ages and dividing them by the number of people at the starting age (births in the case of life expectancy at birth or ages 20 or 50 in the case of remaining life expectancies at ages 20 or 50). In the case of YoGL, the proportions of people are applied that are above the critical minimal levels in all four dimensions: life satisfaction, out of absolute poverty and above minimal levels in physical and cognitive health.

When it comes to the empirical estimation of YoGL, so far survey data providing reliable information for

the same individuals for all four dimensions of YoGL (subjective life satisfaction, being out of poverty, being without disability and being cognitively able to read) are sparse. The broadest survey data with all this information are found in the set of SHARE surveys for female population aged 50 years and above for 17 countries. The SHARE survey (Börsch-Supan 2018) is representative only of the population above the age of 50. So rather than starting at birth or at age 20, the life table used in this exercise starts at age 50. We can use the following variables available in SHARE to construct YoGL: for the subjective dimension, we use the survey item on life satisfaction with possible answers ranging from 0 to 10. The cut-off line is drawn at 4, meaning that all respondents who report life satisfaction higher than 4 score positively on the subjective dimension. Regarding the three objective dimensions, respondents are considered to be out of poverty based on the World Bank poverty line for upper-middle income countries if their equalized consumption expenditure is higher than US\$ 5.50 (PPP) per day. Respondents who have “poor” reading or writing skills are considered illiterate, and those

with “fair” and above skills are considered literate. For health, individuals who have one or more limitations in ADLs (Activities of Daily Life) are considered to be in bad health and those with no limitation are considered to be in good health.

An important feature of YoGL that follows from the second of the criteria specified above is that it can be flexibly calculated for different sub-populations of interest. One important human characteristic which can also be influenced by education policies is the level of educational attainment. Since the multiple benefits of education ranging from health to income to participation in society have been extensively documented (Lutz 2017, PNAS Inaugural), it is also of interest how education affects the different dimensions of YoGL. Figure 3 clearly shows that in all countries listed, both men and women can expect more remaining years of good life at age 50 if they belong to higher educational attainment groups. But it is interesting to see that the differentials by education group differ across countries. In Italy there is only very little difference between the medium and the high education groups, while in Denmark and Estonia the differences are more pronounced. Further analy-

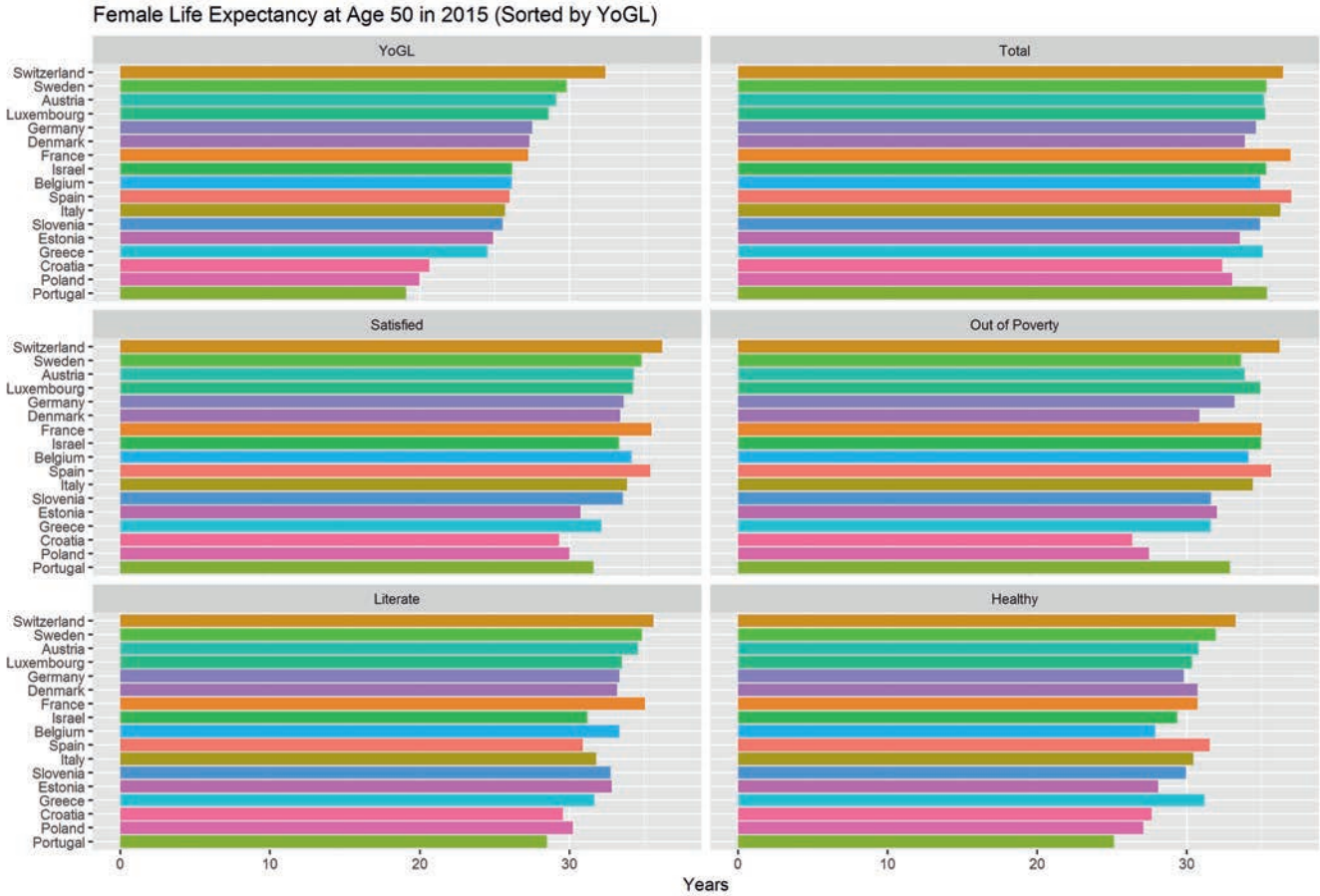


Fig. 2: Female Life Expectancy, YoGL and its different constituents (satisfied life expectancy, literate life expectancy, healthy life expectancy and out of poverty life expectancy) at the age of 50 in 17 European countries, based on SHARE data.

sis is needed to better understand the reasons for these differences between countries.

The examples presented here only refer to European countries because of the better availability of data. Currently, a massive research effort is underway to estimate the indicator for most countries in the world and for longer time series using indirect estimation methods and making certain assumptions on correlations among the different components of YoGL. As a next step, the social, economic, institutional and environment determinants of YoGL in different parts of the world will be analysed statistically to make progress in estimating the abovementioned “human wellbeing production function”. The most difficult following step will then be to quantitatively assess the possible feedbacks from environmental changes on the different components of YoGL and define alternative future pathways in long-term human wellbeing and thus sustainable development that follow from alternative near-term policy and behavioural choices. This future analysis will greatly benefit and build on the already established narratives of the SSPs (Shared Socioeconomic Pathways) describing the mitigative and

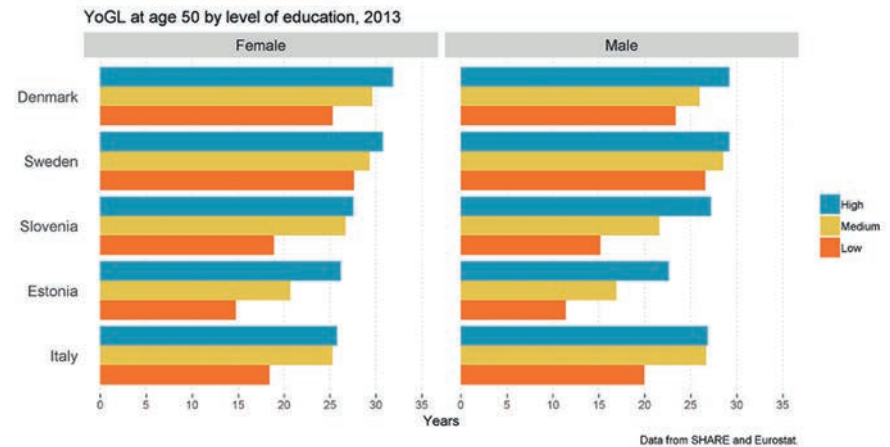


Fig. 3: YoGL for men and women for selected European countries by level of education.

adaptive capacities of societies with respect to climate change (Riahi et al. 2017).

Notwithstanding the remaining challenges in this highly ambitious effort, the definition and empirical estimation of a tailor-made wellbeing indicator as the dependent variable in the analysis is a decisive first step. If the definitions proposed here are accepted by a broader research community, this can also lead to more and better data collection via the inclusion of the specified items in major ongoing international surveys. YoGL

has the potential to become a broadly used currency in which the costs and benefits of certain developments and actions can be expressed, competing with the still ubiquitous purely monetary units. For example, the social costs of carbon could potentially be assessed in terms of years of good life lost among future generations, rather than the conventional dollar terms (Scovronick et al. 2017; Lutz 2017).

This research effort is fully congruent with the conclusions of the Global Sustainable Development Report 2019 entitled “The Future is Now:

Science for Achieving Sustainable Development” (Independent Group of Scientists 2019). This was the first ever high-level report commissioned by the UN General Assembly from a group of 15 independent scientists without being negotiated by governments, and thus marks a milestone in the role of independent science in the UN system. The report calls for strong efforts on the part of the world’s scientific community to further strengthen inter- and cross-disciplinary studies on the interactions among the different Sustainable Development Goals and further develop sustainability science as a scientific field in its own right, combining the strongest scientific rigor with a systemic focus on the determinants of future human wellbeing on this planet. As one of the authors of this report I wish to conclude with my personal hope that the Austrian Academy of Sciences will also take up this important challenge and endeavor to invest in an initiative in this field.

## ACKNOWLEDGEMENT

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## REFERENCES

- Becchetti, Leonardo, and Pierluigi Conzo. 2017. "Preferences for Well-Being and Life Satisfaction." *Social Indicators Research*, February. <https://doi.org/10.1007/s11205-017-1566-8>
- Börsch-Supan, Axel. 2018. "Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 6." SHARE-ERIC. <https://doi.org/10.6103/SHARE.w6.611>
- Bradburn, N. M. 1969. *The Structure of Psychological Well-Being*. Chicago, USA: Aldine. [http://www.norc.org/PDFs/publications/BradburnN\\_Struc\\_Psych\\_Well\\_Being.pdf](http://www.norc.org/PDFs/publications/BradburnN_Struc_Psych_Well_Being.pdf)
- Carlquist, Erik, Pål Ulleberg, Antonella Delle Fave, Hilde E. Nafstad, and Rolv M. Blakar. 2017. "Everyday Understandings of Happiness, Good Life, and Satisfaction: Three Different Facets of Well-Being." *Applied Research in Quality of Life* 12 (2): 481–505. <https://doi.org/10.1007/s11482-016-9472-9>
- Clark, William C. 2012. "Sustainability Science: Its Origins, Evolution and Challenges. IIASA 40<sup>th</sup> Anniversary Conference. Laxenburg and Vienna: Austria." presented at the IIASA 40<sup>th</sup> Anniversary Conference, Vienna, Austria, October 25. <http://conference2012.iiasa.ac.at/person.html?code=clark&scode=s2s7>
- Delle Fave, Antonella, Ingrid Brdar, Teresa Freire, Dianne Vella-Brodrick, and Marié P. Wissing. 2011. "The Eudaimonic and Hedonic Components of Happiness: Qualitative and Quantitative Findings." *Social Indicators Research* 100 (2): 185–207. <https://doi.org/10.1007/s11205-010-9632-5>
- Desai, Meghnad, Amartya Sen, and Julio Boltvinik. 1992. *Social Progress Index: A Proposal*. Bogota: United Nations Development Programme.
- Diener, Ed. 1984. "Subjective Well-Being." *Psychological Bulletin* 95 (3): 542–75. <https://doi.org/10.1037/0033-2909.95.3.542>
- Diener, Ed, Robert A. Emmons, Randy J. Larsen, and Sharon Griffin. 1985. "The Satisfaction With Life Scale." *Journal of Personality Assessment* 49 (1): 71–75. [https://doi.org/10.1207/s15327752jpa4901\\_13](https://doi.org/10.1207/s15327752jpa4901_13)
- Diener, Ed, Samantha J. Heintzelman, Kushlev Kostadin, Louis Tay, Derrick Wirtz, Lesley D. Lutes, and Shigehiro Oishi. 2017. "Findings-All-Psychologists-Should-Know-From-the-New-Science-on-Subjective-Well-Being.Pdf." *Canadian Psychology* 58 (2): 87–104. <https://doi.org/10.1037/cap0000063>
- Ghislandi Simone, Sanderson Warren C., and Sergei Scherbov. 2018. "A Simple Measure of Human Development: The Human Life Indicator." *Population and Development Review* 45 (1): 219–233. <https://doi.org/10.1111/padr.12205>



- Independent Group of Scientists appointed by the Secretary-General. 2019. Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development. New York: United Nations. [https://sustainabledevelopment.un.org/content/documents/24797GSDR\\_report\\_2019.pdf](https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf)
- Kelley, Allen C. 1991. "The Human Development Index: 'Handle with Care.'" *Population and Development Review* 17 (2): 315. <https://doi.org/10.2307/1973733>
- Levin, Simon A., and William C. Clark, eds. 2010. *Toward a Science of Sustainability*. Center for International Development Working Papers 196, John F. Kennedy School of Government, Harvard University.
- Lijadi, Anastasia A. 2018. "Theoretical Foundations to Outline Human Well-Being: Metaanalytic Literature Review for Defining Empowered Life Years." IIASA Working Paper WP-18-002. Laxenburg, Austria: International Institute for Applied Systems Analysis (IIASA). <http://pure.iiasa.ac.at/15119/1/WP-18-002.pdf>
- Lorenz, Jan, Christoph Brauer, and Dirk Lorenz. 2017. "Rank-Optimal Weighting or 'How to Be Best in the OECD Better Life Index?'" *Social Indicators Research* 134 (1): 75–92. <https://doi.org/10.1007/s11205-016-1416-0>
- Lutz, Wolfgang. 2017. "How Population Growth Relates to Climate Change." *Proceedings of the National Academy of Sciences* 114 (46): 12103. <https://doi.org/10.1073/pnas.1717178114>
- Lutz, Wolfgang, Lijadi Anastasia A., Striessnig Erich, Dimitrova Anna, and Melissa Caldeira Brant de Souza Lima. 2018. "Years of Good Life (YoGL): A new indicator for assessing sustainable progress." IIASA Working Paper WP-18-007. Laxenburg, Austria: International Institute for Applied Systems Analysis (IIASA). <http://pure.iiasa.ac.at/id/eprint/15402/>
- Managi, Shunsuke. 2018. *Inclusive Wealth Report 2018 (Open Access): Measuring Progress towards Sustainability*. [https://nls.ldls.org.uk/welcome.html?ark:/81055/vdc\\_100063219481.0x000001](https://nls.ldls.org.uk/welcome.html?ark:/81055/vdc_100063219481.0x000001)
- Meadows, Donella. 1998. "Indicators and Information Systems for Sustainable Development." Hartland Four Corners, USA: Sustainability Institute.
- Mogilner, Cassie, Sepandar D. Kamvar, and Jennifer Aaker. 2011. "The Shifting Meaning of Happiness." *Social Psychological and Personality Science* 2 (4): 395–402. <https://doi.org/10.1177/1948550610393987>
- Oishi, Shigehiro. 2010. "Culture and Well-Being: Conceptual and Methodological Issues." In *International Differences in Well-Being*, 34–69. Series in Positive Psychology. Oxford University Press.
- Parris, Thomas M., and Robert W. Kates. 2003. "Characterizing and Measuring Sustainable Development." *Annual Review of Environment and Resources* 28 (1): 559–86.

- Riahi, Keywan, Detlef P. van Vuuren, Elmar Kriegler, Jae Edmonds, Brian C. O'Neill, Shinichiro Fujimori, Nico Bauer, et al. 2017. "The Shared Socioeconomic Pathways and Their Energy, Land Use, and Greenhouse Gas Emissions Implications: An Overview." *Global Environmental Change* 42 (January 1, 2017): 153–68. <https://doi.org/10.1016/j.gloenvcha.2016.05.009>.
- Scovronick Noah, Mark B. Budolfson, Francis Dennig, Marc Fleurbaey, Asher Siebert, Robert H. Socolow, Dean Spears, and Fabian Wagner. 2017. "Impact of population growth and population ethics on climate change mitigation policy." *Proceedings of the National Academy of Sciences* 114 (46): 12338–12343. <https://doi.org/10.1073/pnas.1618308114>.
- Stiglitz, Joseph E., Amartya K. Sen, and Jean-Paul Fitoussi. 2010. "Report by the Commission on the Measurement of Economic Performance and Social Progress." Paris: Commission on the Measurement of Economic Performance and Social Progress. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.215.58&rep=rep1&type=pdf>
- UNDP. 2011. "Human Development Index (HDI)." United Nations Development Program. <http://hdr.undp.org/en/statistics/hdi/>.

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- Director, World Population Program, IIASA (International Institute for Applied Systems Analysis)
- Scientific Director, Vienna Institute of Demography (VID) of the Austrian Academy of Sciences
- Professor of Demography, University of Vienna
- Founder and Director of the Wittgenstein Centre for Demography and Global Human Capital

### Expertise

- Population forecasting, population–development–environment interactions, demography of human capital formation and the benefits of education, indicators of sustainable human wellbeing

### Qualifications

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|-----------|--|
| 1988      | Habilitation in Demography and Social Statistics at the University of Vienna                         |
| 1983      | PhD in Demography at the University of Pennsylvania  |
| 1982      | MA in Demography at the University of Pennsylvania, USA  |
| 1975–1980 | Studies in Philosophy, Mathematics, Statistics and Theology at the Universities of Munich and Vienna |

### Career

- |            |  |
|------------|--|
| 2017–2019  | Member of independent group of scientists commissioned to draft the UN Global Sustainability Development Report 2019 |
| Since 2016 | Chair of the Scientific Advisory Board, Asian Demographic Research Institute, Shanghai, China                        |
| 2015       | Research Fellow, Stellenbosch Institute for Advanced Study (STIAS), South Africa                                     |
| 2013       | NUSS Distinguished Visiting Professor, National University of Singapore (NUS)  |

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# COMMUNICATING FOR SUSTAINABILITY

## INTERACTIVE SETTINGS AT THE SYMPOSIUM “GLOBAL SUSTAINABLE DEVELOPMENT GOALS IN A MEDIATIZED WORLD”

SIMONE GINGRICH

Communicating the challenges of sustainable development is not only a matter of providing information, but also about conveying messages. Global environmental problems, such as the climate crisis, are still often perceived as abstract, detached from personal lives and experiences. The images that are commonly used in sustainability communication, such as the lonely, meagre polar bear on a melting ice floe, may briefly catch attention, but do not usually induce lasting concern or even behavioural change.

In her lecture “What is ‘sustainability communication’ and why

is it relevant in the context of the SDGs?” Jasmin Godeman discussed the difference between “communication about sustainability” and “communication for sustainability” (see Godemann & Michelsen, 2011 or Newig et al., 2013). The polar bear represents the former: experts present sustainability problems, and listeners possibly even understand them. However, the listeners do not link what they hear to their individual lived experience, and soon the problem is forgotten. “Communication for sustainable development”, on the other hand, actively engages recipients in the communication pro-

cess and enables them to establish direct references to their lived experience. This creates personal concern, and the messages stand much higher chances of being remembered and potentially guiding future action.

In the context of the symposium “Global Sustainable Development Goals in a Mediatized World”, the programme committee aimed at enabling both types of sustainability communication. “Communication about sustainability” includes the traditional forms of communication at scientific events, such as plenary lectures or poster sessions. These formats serve to disseminate new

## HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY ROSANNA KRAL

The group agreed that virtual communication will be increasing in the future; perhaps facilitators will also be non-human, for example on the news. There will be real free access to publications and the metrics will likely change from the number of citations to how often one's work is shared. Non-institutional knowledge creation will increase, as will the share of knowledge that is created by machines or robots. We will communicate more with devices than with other humans, and communication through words will be increasingly replaced by image-mediated forms. However, the social divide between the "traditionalists" and the "technology freaks" will also grow.

The group came up with two metaphors. One was the "ivory tower network". This metaphor describes how communication is increasingly driven away from face-to-face interactions to mediated forms of communication. While scientists have already been portrayed in the past and the present as sometimes working in ivory towers, disconnected from the outside world and the societies they live in, this vision is likely to increase in the future. Computers and other devices increasingly relieve us of having to leave that ivory tower/thinking space, so seclusion is a real threat, while virtual communication and the possibilities to link people over vast distances, time zones etc. contribute to a highly interconnected network.

The second metaphor was "shopping centre shrinkage", or change of function. As communication becomes increasingly virtual, this could lead to a drive for more social, face-to-face interactions. Shopping centres could either foster the commodification of human interaction (e.g. offering psychiatric care, etc.), disappear to make way for more communicative spaces, or be re-assigned other functions. The shopping centre shrinkage metaphor was coupled in the group discussion to a revalorization of face-to-face relations among human beings.

The trans-cultural team that worked in this group was incredibly quick to proceed to discussion and synthesis in what to me, as a facilitator, felt like a very partner-like, respectful way that sought to integrate the visions of all participants of the group and to develop these further. This exercise was very motivating; I have regained my belief that we can transform our world together.

research and establish a common body of knowledge among participants. In the context of the symposium, this aspect had two specific objectives: firstly, in plenary presentations, novel high-level research on the Sustainable Development Goals was presented, with a particular focus on the context of a mediated world. One session explicitly addressed the question as to how mediated societies affect the possibilities of achieving the Sustainable Development Goals, among them the aforementioned lecture by Jasmin Godeman. Matthias Karmasin presented introductory remarks to these lectures (Karmasin, this issue, p. 11–15).

Secondly, a poster session displayed ongoing research in Austria on the broad topic of the Sustainable Development Goals. Researchers presented a total of 46 posters developed at 13 different institutions (Figure 1). Funders of the research presented included European and national funding bodies, but a significant number of contributions were produced without any third-party funding. The poster session highlighted the diversity of research topics, researchers and institutions and served as a basis for future collabo-

ration and integration of previously largely unrelated activities. In addition to these formats, the symposium also made room for the less common, but potentially more effective way of sustainability communication (“communication for sustainability”). During plenary sessions, facilitators made sure that diverse opinions were heard. The programme included sufficient time for breaks enabling informal discussion, and an art exhibition (Winiwarter, this issue, p. 71–74) encouraged creative engagement with issues of sustainability. During the entire event, “resonance walls” were available at the back of the hall (Figure 2). Participants were invited to post their ideas, comments or open questions on these walls or send messages by email, which were then printed out and put up. In total, 154 notes were attached to the resonance walls, only 14 of which had been sent via email. The content of the messages ranged from free associations (“Agroforestry”) to critical remarks (“Taking into account today’s programme I have really missed social media interaction”) to open questions (“role of yellow press?”). The format of “resonance walls” was unknown to many participants, and the content

of the messages only partly entered the plenary discussions. However, these walls created a physical space where reflexive participants could put their thoughts in writing, read other people’s comments and discuss their considerations informally. Such a space for exchange in small groups, beyond established peer groups, may also prove successful for other events. The second way in which the symposium created “communication for sustainability” was its contribution to university courses. Two members of the programme committee taught courses at the University of Applied Arts Vienna (S. Gingrich)

and University of Klagenfurt (V. Winiwarter), during which students attended the symposium. The units after the symposium could be used to discuss open questions, reflect on the event and establish reference to the students’ study programmes or research. With suitable preparation and follow-up, scientific conferences may be fruitful events even for students in early semesters, as demonstrated by a fitting analogy on the Sustainable Development Goals proposed by a student in a reflection paper: “[The SDGs remind] me of a group work at university: everybody wants to do something else, interests

#### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY HARALD PAULI

The group’s vision for now, in 2050:

- Access to academic education and scientific publications is free (although with variants with high fees in some countries where academic degrees are easier to obtain via promising offers in India);
- Digital innovations facilitate participation in academic work and thus include people with impairments; a common world-brain is under construction, but may take another one or two decades to become reality;
- The number of scientific disciplines has increased (for example, microbiome research has split into ten different disciplines), but exchange among them is more straightforward.

Or ... something like that – but as they say, “the process is the product”.

### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY JOSEF SEETHALER

Pursuing the goals laid out in the Agenda 2030 means creating knowledge and communicating knowledge. It's a long time until 2030 (or even 2050), and at first the question about future forms of knowledge creation and knowledge communication caused some irritation. After a short discussion, the members of our group agreed to a high degree that artificial intelligence will play an increasingly important role in knowledge creation (but nevertheless differ in assessing the relationship between human and artificial intelligence). However, the nature of knowledge communication was controversially discussed in two respects: on the one hand, the spectrum of visions for the future ranged from the continued existence of personal communication as the ultimately successful form of communication to an ever-increasing importance of (hitherto partly unknown) virtual forms and even communication directed through thoughts. On the other hand, because of the networking capabilities of future knowledge communication technologies, some group members expected them to enhance learning as community belonging and, subsequently, enable civic engagement in a diverse society, while other members feared that there will be an increasingly fragmented society without a commonly accepted knowledge base and that, due to this fragmentation, it will be prone to control by oppressive regimes, global corporations, and "Big Brother". Finally, there was widespread consensus that – perhaps after a purely technology-driven transition phase – the need for a human (and not digital) social experience will prevail: this is and will be the key to knowledge creation and communication.

are conflicting, in the end the group still does something (more or less), but nobody knows if it is going to be sufficient for a positive grade." (Michaela Koffler, student, University of Applied Arts Vienna).

Embedding the symposium in university courses had the additional benefit of involving a significant number of students among the participants. They engaged actively in discussions and shared their valuable perspec-

tives as young, politically motivated people. For example, several students addressed the issue of sustainable food consumption because they felt it was not sufficiently considered in the plenary lectures and event management (in particular, in the catering on the first day).

The third and most obvious way of fostering "communication for sustainability" during the symposium was a break-out session facilitated by Riel Miller (Figure 3). Prior to the symposium, ten participants had volunteered to act as facilitators. After a briefing during the lunch break on the second day of the event, they facilitated discussion in groups of around 15 on the question: "How will knowledge be produced in 2050?" The aim was to collect ideas and merge them into metaphors, which were then presented to the plenary (Fig. 4). The second part of the break-out session (addressing the question "How will we get there?") could not be conducted due to time constraints. Nevertheless, the participants were visibly engaged during the group work, with many ideas being developed and discussed. Communication in the groups took place across hierarchical levels and disciplinary boundaries. Metaphors emerged as

a suitable means for productive integration of diverse perspectives. The experience of the symposium confirms that successful sustainability communication needs to do more than just provide information. New, experimental communicative settings are also needed. These experiments require careful preparation, planning, and professional facilitation, and they don't always succeed. However, they are definitely worth a try, as the reports from the break-out sessions demonstrate.<sup>1</sup>

#### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY ANDREAS BAUMGARTEN

We are all sitting together in a wonderful meadow in the shadow of a big old tree, the sun is shining in a bright, blue sky, and we are looking into a crystal ball with a tag on it saying "INTEL inside".



Fig. 1: The poster session enabled communication across disciplines and showed the world-wide reach of Austrian SOG-related research.

<sup>1</sup> The visions created by the groups are found in the text boxes spread through these pages.



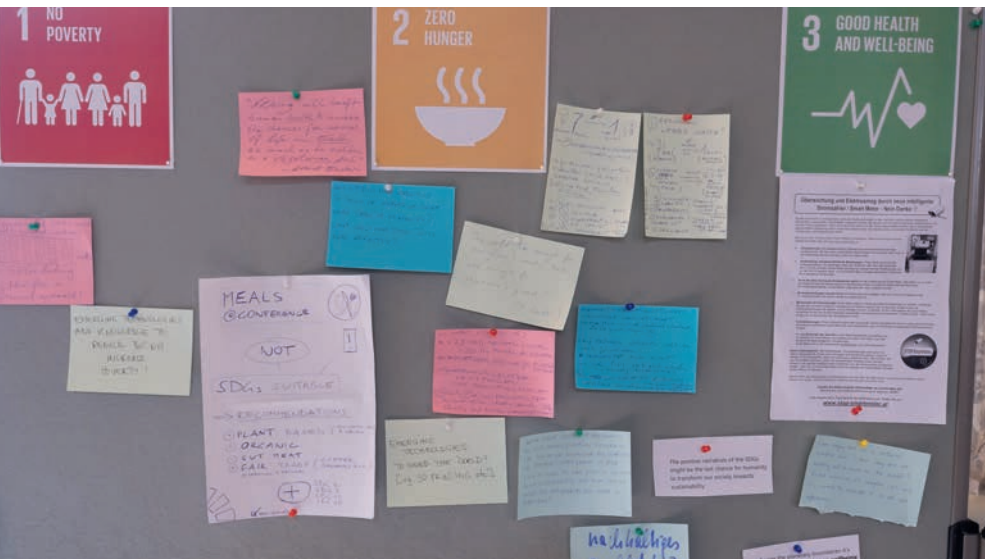


Fig. 2: One of the resonance walls, with printouts of emails, handwritten comments and other contributions by participants.

### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY ANDREAS MELCHER

The group came up with the idea of “Flexibility Schools”, dedicated to green/environmental matters and art, based on open, transparent, quality education and taking into account governance issues. The question/idea of a socio-ecological, “smart” dictatorship as a governance model for society was discussed. The schools for such a society would be built in open-access scholarship, they would be neighbourhood-based and would be part of blue-green, circular, technology-driven cities. Collaboration and connections would increase society’s power. The school would reflect their aims in the design of the area, encompassing green spaces, and space for art.

### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY SOFIE MITTAS

In our group, we discussed the future of communication. We had a broad range of opinions and ideas. Trust played an important role and this was expressed in the idea of a “Rotten Tomatoes for Science” system, creating the possibility to rate scientific output. The review process was highly disputed and the idea that computers and algorithms will rate science emerged. On the other hand, the idea of a “One World Living Lab” where everyone can participate in scientific research was expressed. The future of communication of scientific results was seen in a somewhat pessimistic light and was summarized as Snap Chat Science, where everything has to be highly visualized or even accessible in virtual reality and in easily digestible portions of three-minute videos.

### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY SIMONE GINGRICH

The group developed two visions.

**“Ocean of knowledge”** Many different fish are swimming in an ocean of knowledge. There are some coral reefs. Some sharks are swimming around. You have access to the sea of knowledge, can benefit from it and get back out, if you know how to swim and don’t get eaten by a shark.

**“Shopping mall of knowledge”** In the shopping mall of knowledge, knowledge is a commodity which is controlled by more and less powerful actors. Many options for creating and accessing knowledge coexist, like corporate warehouses, small shops and creative spaces/ ateliers, and online shopping is of course also an option. People enter and make use of the shopping mall for several reasons, including purchasing knowledge, spending their leisure time, or going about their work.



Fig. 3: Impression from a breakout group.

### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY SIBEL EKER

The group discussed the future of scholarship, in particular what the practice of scholarship, the problems it deals with and the methods it uses will look like in 2050. Regarding the practice of scholarship, the participants mentioned working in large open spaces, having flexible working environments and schedules, and travelling more frequently. Travelling, however, was foreseen as the activity of a small privileged group. Regarding the problems and methods, data-driven research employing big data and related mining methods, and further digitalization with artificial intelligence were identified as the main approaches of future scholarship. The participants repeatedly mentioned interdisciplinarity or transdisciplinarity as the guiding principle of scholarship, scholars moving beyond their disciplines and adjusting their methods according to the problem at hand. On the basis of these themes, the group chose a **chameleon looking at a crystal ball** as the allegory representing future scholarship. In this picture, while the crystal ball refers to the data-driven approaches for predicting the future, the chameleon represents the flexibility of scholars not only in terms of their work environment and schedule, but also in terms of scientific disciplines.



Fig. 4: Simone Gingrich presents results from a breakout group.

#### HOW WILL KNOWLEDGE BE PRODUCED IN 2050? GROUP REPORT BY FRANZ MICHAEL FEHR

Sustainability in 2050 will entail:

- A food system based on locally available foods; people will eat a “planetary diet” – current negative trends that need to be counteracted include a growing lack of water and more meat and dairy consumption.
- Knowledge will be available from digital storage and learning will be interactive, with a better understanding of planetary capacities as an important outcome.
- Technology will be designed for sustainable development, but it remains a challenge that digitalization is energy-intensive.
- Governance remains a field of multiple challenges. Unbalanced power distribution and a divided society have to be overcome. How this can happen remains unclear.
- Work is based on a basic income for all, and working times have dropped considerably by 2050.

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**REFERENCES**

- Godemann, J., Michelsen, G. (Eds.), 2011. Sustainability communication: Interdisciplinary perspectives and theoretical foundation. Springer Science & Business Media.
- Karmasin, M. The SDGs in a mediatized world – introductory remarks, this issue, p. 11–15.
- Newig, J., Schulz, D., Fischer, D., Hetze, K., Laws, N., Lüdecke, G., Rieckmann, M., 2013. Communication Regarding Sustainability: Conceptual Perspectives and Exploration of Societal Subsystems. *Sustainability* 5, 2976–2990. <https://doi.org/10.3390/su5072976>
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**SIMONE GINGRICH****Current Position**

- Senior Researcher and lecturer, Institute of Social Ecology, Department of Economics and Social Sciences, University of Natural Resources and Life Sciences, Vienna

**Expertise**

- Long-term socio-ecological research, material environmental history, land and energy use, socio-ecological metabolism, inter- and transdisciplinary sustainability research

**Qualifications**

- |      |   |
|------|---|
| 2010 | PhD in Social Ecology, University of Klagenfurt |
| 2004 | Mag. in Ecology, University of Vienna           |

**Career**

- |            |   |
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| Since 2018 | Senior Researcher and Lecturer, Institute of Social Ecology, Department of Economics and Social Sciences, University of Natural Resources and Life Sciences, Vienna |
| Since 2018 | Member of the Young Academy, Austrian Academy of Sciences   |
| 2017       | ERC Starting Grant  |
| 2005–2018  | Researcher and Lecturer at Institute of Social Ecology, Faculty for Interdisciplinary Studies, Klagenfurt University  |
| Since 2005 | Member of the Center for Environmental History  |
| 2003–2005  | Freelance Researcher and Curator at the Technical Museum Vienna   |

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# INFORMATION OR PARTICIPATION?

## OPPORTUNITIES AND CHALLENGES FOR SUSTAINABILITY COMMUNICATION IN CURRENT MEDIA TRENDS

MARTIN BERNHOFER

Radio Ö1 has a daily coverage of about 700.000 listeners. In our department “Science, Education and Society” we produce an output of 24 hours a week. Especially in educational formats like “Radiokolleg”, in science formats like “Dimensionen”, or in phone-in discussions like “Punkt 1”, many programs are focused on topics related to sustainability.

Nevertheless, we would be wise to consider the challenges we face. The term “Sustainable Development” itself is a challenge. It is quite abstract, complex and technical, not only in the context of media logic.

This may be one of the reasons why the concept – and its goals – are still unknown to a majority in our society. The main challenge is complexity. It is difficult to define a specific “news focus” and to grasp the complex dimensions of many themes. Shorter media formats can only point to the bigger picture behind the details. The breaking news of natural disasters, flood risks or growing deserts and famine only tell one part of the story. The correlations between the SDGs are even more complex. And they sometimes contradict each other. A barrier to understanding, making it harder to change people’s

thinking and habits. It is a complex matter which takes more time to understand, and more time for investigation, for finding experts and for telling stories between the lines. This means having a big enough budget and qualified teams. There is enough personal engagement in the editorial boards, but it has to be supported in the right way. What is required is a framework for “quality journalism.” Sustainability does not have a “home-base” as a specialist unit on many editorial boards. Themes can also be focused on the economy or international affairs, even on culture. Interdisciplinary approaches are required.





*From left to right: Martin Bernhofer, Karl Kienzl, Riel Miller, Konrad Pesendorfer, Marina Fischer-Kowalski, Michael Alram*

And another key requirement is trained and personally engaged science journalists and editors. This should not be confused with journalism that spreads personal “world views”, or ideologies. The key is always fact-based informa-

tion without personal bias. Personal engagement in SDGs should not be perceived by the public as a personal campaign. The mainstreaming of Sustainability in Media is necessary. But the audience should also be able to find questions and answers of

their own. On the other hand, it is not possible to be well balanced in any case. If you place a fact-based analysis of climate change on the same level with the claims of a “climate change denier”, you are not contributing to the search for truth. This will confuse people and is not responsible journalism.

Storytelling relating a complex matter needs time. It needs media formats that can explain facts and contexts in a profound, interdisciplinary way that shows correlations, interdependences and rebound effects. Extended and reflexive formats like “Ö1 Radiokolleg” can help to explain complexity, by connecting scientific knowledge with personal questions and every day-experiences. They should translate and reduce complexity and tell stories that are easy to understand. And they should be combined in a program matrix with topical (science) news of high quality.

Sustainability won’t scare off audiences. It is not a “ratings killer”. But it needs special narration. And it should not focus predominantly on negative aspects. Or threats. It should be integrative and open, and change the direction: from “niche” to the mainstream of lifestyle aspects

that concern everybody. In this sense, it should also not only focus on the “talking heads” of scientific experts and their theoretical analysis. It should also include new kinds of expertise in other fields, find new role models and success stories of change makers in civil society.

This brings me to my main point: the Complexity of Sustainability (the SDGs) calls for a new kind of communication and interaction with the public. The problems we have to deal with are similar to “lessons learned” from science communication in media in general. Merely increasing the amount and frequency of science information does not automatically guarantee better-informed citizens. It does not guarantee an enlightened knowledge society with a positive understanding of science and technology. The same will apply to information about sustainability.

My personal experience – but also studies in science communication – have shown that interactive formats and the participation of the audience in debates, projects and knowledge-building processes can lead to a more profound public engagement in science. A range of tools can be used for this purpose: from open innovation (Ö1 has carried out some

projects) to citizen science initiatives, especially involving younger media generations and the scientists of tomorrow.

I am convinced that public media can play a very important role in this process. They should define their role not only as a broadcaster and channel, but also as a “platform” for information, innovation and the participation of society striving to achieve the Sustainable Development Goals. A platform is not just a metaphor. It can be implemented with interactive, participative projects involving people and including open knowledge bases that the public media in particular can provide with their programmes and archives.

In a time of personalized media and filter bubbles, a common and transparent media sphere is essential. This could be the basis for a new kind of learning and cooperation between public institutions and public media. They have the best facilities and capacities to support the Sustainable Development Goals with a common space for information and participation.

**MARTIN BERNHOFER****Current Position**

- Programme Manager (Channel Manager) of the radio station Ö1
- Head of Department “Science, Education, Society”, ORF/Ö1

**Expertise**

- Science Journalism, Science Communication, Media Management

**Qualifications**

1984 Dr. phil, Spanish and Theatre Studies, University of Vienna

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Since 2019 Programme Manager (Channel Manager) of the radio station Ö1  
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 Since 1985 Editor at the editorial office for science and education of the Austrian National Radio. Along with other programmes, series in “Dimensionen”, “Salzburger Nachtstudio” and “Radiokolleg”, moderator of different live shows

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# SUSTAINABLE DEVELOPMENT GOALS

## REFLECTIONS FROM SOCIAL ECOLOGY

MARINA FISCHER-KOWALSKI

The role of a commentator is a difficult one. From a Social Ecology perspective, this has been a very rich and multifaceted conference. A number of presenters have offered concrete interpretations and proposals that I feel tempted to comment upon, emphasise, and in some cases add specific knowledge and insights from my field. This, necessarily, will be a fairly selective exercise.

I very much agree with Simone Gingrich that it has been fossil fuels that allow the progress and its benefits for humanity that Nakicenovic enumerated. With respect to the adoption of fossil fuels: Where do we stand now internationally? Let me add some concrete findings from Social Ecology, looking at the period 1970–2015.

40 countries (3,1 bio inhabitants, 42% of the world population) are currently energy underdogs: they have only started their access to fossil fuels after 1970, and their fossil fuel use slowly slowly has been rising up to 2015. (to 16 GJ/cap on average.)

In the same period, 60 countries (1,5 bio, 21%) have fully made the transition to fossil fuels and could count on more than 50 GJ<sub>FF</sub>/cap during the whole period 1970–2015. These industrial cheerleaders now use 160 GJ<sub>FF</sub>/cap on average, and had been up to 185. (Slight decline of direct use; increase in indirect use via importing commodities in the same period).

It took these cheerleaders on average 105 years to make the transition from an „energy underdog“ to achieve

50 GJ<sub>FF</sub>/cap, and this did not get any faster across the centuries. (e.g. it took France 123 years to achieve 50 GJ<sub>FF</sub>/cap by 1908, USA & Germany 85 years by 1910, Portugal 162 years by 1990, China 95 years by 2005 ...)

Thus we live in an age that is marked by an **increasing access to fossil fuel use** – hard to deny to the energy underdogs taking into account the SDGs.

The challenge therefore is, as UN Environment’s International Resource Panel frames it: Contraction & Convergence.

With reference to Wolfgang Lutz on the key role of education, I fully agree. But I would like to give this a bit of a twist, which also relates to our Session 3 on Communication. Education

and Sustainability Communication share a certain paternalistic touch: people should be taught something they might resist to.

I think the real concern is **enhancing peoples' learning chances**. How can this happen?

- People learn most from making **experiences**
- They learn even more when they get a chance to **critically reflect their experiences, and exchange that with others**.

How can that, say, for the energy underdogs, be enhanced in the digital age? This is where the billions of profits from IT companies should be invested in, instead of them idling around in financial speculation. These investments would be risky and not pay off fast, but in the long term ... How about a joint initiative from UNESCO and Google?

In the same vein, is it a good idea to **just replicate the European formal education model** (8 year olds in Ethiopia learning to read from schoolbooks portraying British suburban life, hardly relating to their own)? Should not be there, under the header of promoting the SDGs, a strong science effort to comparatively study and question the child

education modes and syllabi worldwide, and develop new models, utilizing the opportunities of the digital age and, again, the money IT has generated?

In this conference, a similar idea resonated with the high share of Citizen Science activities among the posters exhibited – a model for learning science by experience. I dealt with „creative learning“ and the organizational structures this requires. I treated this as an empirical challenge in my PhD thesis in the Seventies – in terms of practical realization we still not seem to have advanced very far since that time.

With reference to Nakicenovic's comment on „rampant inequality“, and last night's discussion on capitalism: In a resource-constrained world, in a world in which human physical expansionism must come to an end, where **only zero sum games** are on offer, there is the need for a new mode of operation: A shift from the (allow me: **male**) **pattern of competition** towards a (more **female**) **pattern of collaboration and sharing**. Not only capitalism is at stake, but also the policy games for national superiority. Currently, it does not look as if we were on the right path in this direc-

tion, quite to the contrary. But the path we are on will lead towards wars, not towards achieving SDGs.

With reference to the introductory statements by the Austrian administration: Research for the SDGs is part of the service agreement between the Education & Science Ministry and the universities. Universities name the subjects they are going to deal with. But, unfortunately, there is **no research fund** for research teams to apply to, **no cross-cutting evaluation of research needs and achievements**. This arrangement is not likely to lead to a broad research effort, but will rather lead to numerous non-committal lists of university activities that would have happened anyway – and not to a major bundling of forces to achieve scientific breakthroughs.

## MARINA FISCHER-KOWALSKI

### Current Positions

- Senior Researcher at the Institute for Social Ecology, University of Natural Resources and Life Sciences Vienna
- Senior Lecturer in environmental sociology at the University of Vienna
- Expert member of UN Environment’s International Resource Panel

### Expertise

- Sociology, social ecology and ecological economics, especially social metabolism and sustainability studies

### Qualifications

- 2003 Full Professor of Social Ecology at Klagenfurt University
- 1986 Habilitation in Sociology at the University of Graz
- 1970–1972 Postgraduate degree in the Social Sciences at the Institute for Advanced Studies, Vienna
- 1971 Postgraduate in Sociology, Psychology and History of Art (PhD, University of Vienna)

### Career

- Since 2018 Professor Emeritus of Social Ecology at the Alpen Adria University, researcher at the University of Natural Resources and Life Sciences (BOKU)
- 2014–2015 President of the International Society of Ecological Economics (ISEE) (pres. elect 2012–2013)
- 2007–2009 President of the International Society for Industrial Ecology (ISIE)
- 2003–2015 Full Professor of Social Ecology at the Alpen Adria University
- 2002–2010 Chair of the scientific advisory board of the Potsdam Institute on Climate Impact Research (PIK)
- 2000–2003 Director of the Institute for Interdisciplinary Studies of Austrian Universities (IFF), Vienna node

Please see [www.aau.at/en/social-ecology/team/fischer-kowalski-marina/](http://www.aau.at/en/social-ecology/team/fischer-kowalski-marina/) for more information about the author.



# HUMAN NATURE. THE ART OF SUSTAINABILITY\*

## REFLECTIONS BY VERENA WINIWARTER

The art exhibition “Human Nature. The Art of Sustainability” was conceived as part of the symposium “Global Sustainable Development Goals in a Mediatized World”. The inclusion of art signals that the Sustainable Development Goals are not merely a scientific programme, but an all-encompassing agenda comprising art, the sciences and education in a unifying endeavour.

Anna Artaker began working on her nature self-prints in 2017 with a process in which the plant is used to create an impression on a lead plate, so that not only does the artwork depict nature, but the depiction is also created through nature itself. The artist used the same plants with which

William Henry Fox Talbot showcased his photographic process in 1844–46. The title of her work, “The Pencil of Nature”, is taken from Talbot to emphasize the connection. The creative process makes a powerful statement on human entanglement with the natural world. The plants to be printed – nettles, butterburs, forest ferns, to name just three – are pressed directly into the soft metal and a two-fold galvanoplastic process is then used to produce the copper plate from which the prints are taken. This destroys the original, the plant, and resurrects it, transformed to art in its fragile tenderness, in almost translucent pictures which also speak to the fragility of their beauty.

The work also speaks to the figure of Homo faber, the active human being. Through her artistic creation, Anna Artaker tells the story of the search for beauty in nature, a search that

strongly links her work to the sustainability debate. The artist is active herself, destroys the precious living plants for the sake of conserving their image and uses toxic substances without which printing would not be possible: lead, the ingredients of the galvanic baths, copper and more. Her work thus stands at the centre of an art of sustainability that does not ignore paradoxes and contradictions, but embraces and reflects them.

Uwe Sleytr’s colourful, large pictures adorn, among other places, a building of the University of Natural Resources and Life Sciences, where for decades he taught as professor of microbiology. His work is a different “art of sustainability”.

Rather than directly introducing Uwe Sleytr’s work, I want to highlight a connection between his artistic statements and that of a group of British artists who wrote *The Dark Mountain*

\* A prior version of this talk was delivered in German as an introduction to the opening of the exhibition at the OeAW. The oral form has been slightly edited.



*Manifesto*, a 20-page reflection situating art in the current world. This text, written in 2008 at the height of the global financial crisis, allows us to link evolution and civilisation, a link that is pertinent to human survival and ties in with Uwe Sleytr's work. Paul Kingsnorth's and Dougald Hine's manifesto is called *Uncivilisation*. The text starts with two quotations, one of them by Ralph Waldo Emerson, "The end of the human race will be that it will eventually die of civilisation", and continues with a text entitled "Walking on Lava":

"Those who witness extreme social collapse at first hand seldom describe any deep revelation about the truths of human existence. What they do mention, if asked, is their surprise at how easy it is to die.

The pattern of ordinary life, in which so much stays the same from one day to the next, disguises the fragility of its fabric. How many of our activities are made possible by the impression of stability that pattern gives? So long as it repeats, or varies steadily enough, we are able to plan for tomorrow as if all the things we rely on and don't think about too carefully will still be there. When the pattern is broken, by civil war or natural disaster or the smaller-scale

tragedies that tear at its fabric, many of those activities become impossible or meaningless, while simply meeting needs we once took for granted may occupy much of our lives.

What war correspondents and relief workers report is not only the fragility of the fabric, but the speed with which it can unravel. As we write this, no one can say with certainty where the unravelling of the financial and commercial fabric of our economies will end. Meanwhile, beyond the cities, unchecked industrial exploitation frays the material basis of life in many parts of the world, and pulls at the ecological systems which sustain it."

The authors observe that an awareness of the fragility of "civilisation" is not new.

"'Few men realise,' wrote Joseph Conrad in 1896, 'that their life, the very essence of their character, their capabilities and their audacities, are only the expression of their belief in the safety of their surroundings.' Conrad's writings exposed the civilisation exported by European imperialists to be little more than a comforting illusion, not only in the dark, unconquerable heart of Africa, but in the whited sepulchres of their capital cities. The inhabitants of that

civilisation believed 'blindly in the irresistible force of its institutions and its morals, in the power of its police and of its opinion,' but their confidence could be maintained only by the seeming solidity of the crowd of like-minded believers surrounding them. Outside the walls, the wild remained as close to the surface as blood under skin, though the city-dweller was no longer equipped to face it directly."<sup>2</sup>

The wilderness still lies under our skin, as close as blood, experienced by every abrasion, and yet is willingly ignored for survival's sake. Uwe Sleytr forms masks from clay with his hands, masks reminding me of vertebral structures, reminding me that we are vertebrates too. He covers them with gold, in fire they are transformed. Then coloured liquid is splashed against them or they are photographed in front of distorted mirrors to express the coincidences of evolution. Uwe Sleytr, himself a biologist, poses a fundamental question with his works. With our human cognitive horizon and despite all the information and data that we have and still produce, can

<sup>2</sup> [dark-mountain.net/about/manifesto/](http://dark-mountain.net/about/manifesto/)

we seriously consider or even plan a next stage of evolution derived from us? As a biologist he knows, and as a human being and artist he feels, "It is not only our destiny that we are the first life form that has the ability to change its own genome, but that at the same time we cannot generate appropriate rules for all visionary concepts of the evolution of our species. Humanity is in the process of developing the ability to separate the evolution of life from its previous evolutionary rules." So Uwe Sleytr, the artist-scientist, asks, "Are we in a position as primates who are supposed to invent man?" His art deals with the interfaces between the body and technology. These precarious places of translation between evolutionary and technical code are revealed. This links him with the manifesto of *Uncivilisation* and shows his profound contribution to an art of sustainability.

A third, and entirely different work of art floated under the ceiling of the Academy's festive hall. At the suggestion of and under the guidance of their teacher Peder Hill, students of a class at the bilingual grammar school in Draschestraße in Vienna built a humpback whale out of plastic bottle waste, which, titled "The Last

Whale", is intended to remind us of the danger human intervention poses to the ecosystems of the oceans. The whale is an intervention in itself. The act of hanging 5 metres' worth of plastic waste turned art under the fresco ceiling of the OeAW's festive hall gives it a new role in the context of knowledge production. Since April 2 and until the beginning of May 2019, this role has been to remind scientists of their responsibility for the future of the world. The initiative "kidsfor-oceans", founded by Peder, is a recommendation that is certainly worth following up on.

Just as "Fridays for Future" and "Scientists for Future" bear witness to new alliances, just as art and science come together in a new alliance in the two artists featured in the exhibition side by side, both at home in both worlds, just as Anna Artaker and Uwe Sleytr together with Peder Hill, who expresses a new, interdisciplinary alliance, just as all this is the expression of new connections, the Presiding Committee of the Austrian Academy of Sciences has entered into an alliance with the students from Draschestraße. In the festive hall, two different art worlds entered into dialogue with each other. Whales and frescoes mediate over time, delicate

leaves painted with nature's pencil and powerful, gilded clay sculptures in their colourful reflections mediate between human natures, between ages and sexes.

Art eludes verbal interpretation in a certain respect: as art is always created in the observer, in the observer who resonates with the work of art, writing about art is always writing on the edge of this experience. Writing about art cannot replace looking, experiencing, immersing, being touched. It can, however convey how many references there are between the works of art and invite readers into conversation with the artists.

In the spirit of sustainability as a different kind of awareness, appreciating art should include an appreciation of the crew mounting the works, their diligent use of screws and steel cables, measuring tapes and water spirit levels. Art allows a profound conversation of how all beings are connected and a joint reflection about human nature, about the art of sustainability and about the connections that are needed for it. It is an important contribution to the implementation of the Sustainable Development Goals in the minds and hearts of people.

## VERENA WINIWARTER

### Current Positions

- Professor of Environmental History at the Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna, Austria
- Immediate Past President of the International Consortium of Environmental History Organizations (ICEHO)
- Chairperson of the Commission for Interdisciplinary Ecological Studies, Austrian Academy of Sciences
- Head of the ZUG, the Centre for Environmental History at the Institute for Social Ecology

### Expertise

- Environmental history, history of landscapes, in particular rivers, images, and the environmental history of soils and legacies

### Qualifications

- |      |  |
|------|--|
| 1981 | Engineer (Ing.) in technical chemistry, (HTLBVA 17, Vienna)                      |
| 1991 | MA in history, University of Vienna  |
| 1998 | PhD in Environmental History, University of Vienna                               |
| 2003 | Habilitation in Human Ecology, University of Vienna, Faculty of Natural Sciences |

### Career

- |           |  |
|-----------|--|
| 2010–2015 | Dean of the Faculty of Interdisciplinary Studies   |
| 2003      | Research Fellow St. Gallen University, Switzerland   |
| 2003–2006 | APART Fellow of the Austrian Academy of Sciences. With this funding, research fellow at the Institute for Soil Research, University of Natural Resources and Applied Life Sciences and at the Faculty of Interdisciplinary Studies |
| 1999–2002 | Firnberg Research Fellow, University of Vienna, Institute for Anthropology   |
| 1993–1999 | Faculty of Interdisciplinary Studies of Austrian Universities: team member   |

Please see [www.boku.ac.at/zentrum-fuer-umweltgeschichte/mitglieder/verena-winiwarter](http://www.boku.ac.at/zentrum-fuer-umweltgeschichte/mitglieder/verena-winiwarter) for more information about the author.





## PROGRAM

## APRIL 4, 2019

09:00–09:45

**Welcoming remarks**

**Anton Zeilinger** | President, Austrian Academy of Sciences  
**Heinz Fischer** | Former Federal President, Republic of Austria and Co-chair, Ban Ki-moon Centre  
**Martin Netzer** | Secretary General, Austrian Federal Ministry of Education, Science and Research  
**Josef Plank** | Secretary General, Austrian Federal Ministry for Sustainability and Tourism

09:45–10:15

**Introduction**

**Wolfgang Lutz** | Austrian Academy of Sciences and Wittgenstein Center for Demography and Global Human Capital (ÖAW, IIASA, WU)  
*Global Sustainable Development Goals and what they mean for the countries of the Global North*

10:15–10:45

COFFEE BREAK

10:45–12:30

**SESSION 1****Implementing the Agenda 2030 in a Mediatized World**

*Chair: Matthias Karmasin | Austrian Academy of Sciences and Alpen-Adria-University Klagenfurt*

*Introductory remarks by Matthias Karmasin*  
*Conveying inconvenient truths – the relevance of communication for sustainable development*

**Jasmin Godemann** | Justus Liebig University Giessen  
*What is “sustainability communication” and why is it relevant in the context of the SDGs?*

**Roy Bendor** | Delft University of Technology  
*Transition or Transformation? The Meanings of Sustainability in a Mediatized World*

**Alison Anderson** | University of Plymouth and Monash University, Melbourne  
*SDGs, Media and the Network Society*

12:30–14:00

LUNCH BREAK

14:00–15:30

**SESSION 2****Meeting the challenges of SDG 15: Life on land**

*Chair: Albert van Jaarsveld | International Institute for Applied Systems Analysis (IIASA)*

**Eric A. Davidson** | University of Maryland Center for Environmental Science

*The Sustainable Agriculture Matrix*

**Laura Bertha Reyes Sánchez** | National and Autonomous University of Mexico and International Union of Soil Sciences

*Educating and raising awareness by practicing sciences to achieve SDG 15 in a mediatized world*

15:30–16:00

COFFEE BREAK

16:00–17:30

**SESSION 3****The SDGs as a technological challenge particularly in the field of energy and smart grids**

*Chair: Georg Brasseur | Austrian Academy of Sciences and Technical University Graz*



**Lucy Y. Pao** | University of Colorado Boulder

*Boosting Wind and Solar Energy (SDG 7): Opportunities and Technological Challenges*

**Niyazi Serdar Sarçiftçi** | Austrian Academy of Sciences and Johannes Kepler University Linz

*Carbon dioxide recycling to useful chemical products and synthetic fuels*

17:30–18:00

**Community Resonance**

18:00–18:30

BREAK

18:30–19:30

**The World in 2050 and the Six Transformations**

**Nebojsa Nakicenovic** | International Institute for Applied Systems Analysis (IIASA)

*Introduction*

**Verena Winiwarter** | Austrian Academy of Sciences and University of Natural Resources & Life Sciences, Vienna

*Commentary*

**Simone Gingrich** | Austrian Academy of Sciences and University of Natural Resources & Life Sciences, Vienna

19:30

**Human Nature: The Art of Sustainability***Exhibition curated by:**Anna Artaker | Austrian Academy of Sciences and Academy of Fine Arts Vienna**Uwe B. Sleytr | Austrian Academy of Sciences and University of Natural Resources & Life Sciences, Vienna*

EVENING RECEPTION

**APRIL 5, 2019**

09:00–10:30

**SESSION 4****Good Health and Well-Being***Chair: Wolfgang Lutz | Austrian Academy of Sciences and Wittgenstein Center for Demography and Global Human Capital (ÖAW, IIASA, WU)***Gabriele Doblhammer** | University of Rostock and German Center for Neurodegenerative Diseases (DZNE), Bonn  
*Dementia in an Ageing World***Nyovani Janet Madise** | African Institute for Development Policy, Malawi Office  
*25 years after Cairo. How can the Sustainable Development Goals agenda help to close the gaps in reproductive health and reproductive rights?*

10:30–11:00

COFFEE BREAK

11:00–12:30

**SESSION 5****Implementing the Sustainable Development Goals on a global basis***Chair: Verena Winiwarter | Austrian Academy of Sciences and University of Natural Resources & Life Sciences, Vienna***Linxiu Zhang** | United Nations Environment Programme – International Ecosystem Management Partnership  
*Calling for a nexus approach to achieve Sustainable Development Goals***Vladimír Šucha** | Joint Research Center, European Commission  
*TBA*

12:30–14:00

LUNCH BREAK



14:00–15:00 **SESSION 6**  
Poster Session

15:00–16:30 **Rethinking the Future, Science, and the SDGs**  
*Moderator: Riel Miller | UNESCO*



**Facilitators:**

**Andreas Baumgarten** | Austrian Agency for Health and Food Safety  
**Sibel Eker** | International Institute for Applied Systems Analysis (IIASA)

**Franz Michael Fehr, Georg Gratzer, Rosanna Kral, Andreas Melcher** | University of Natural Resources & Life Sciences, Vienna

**Sofie Mittas** | Johannes Kepler University Linz

**Simone Gingrich, Harald Pauli** | Austrian Academy of Sciences and University of Natural Resources & Life Sciences, Vienna

**Josef Seethaler** | Austrian Academy of Sciences and Alpen-Adria-University Klagenfurt

16:30–17:00 COFFEE BREAK

17:00–18:00 **SESSION 7**  
**Lessons learned**  
*Moderator: Riel Miller | UNESCO*



**Marina Fischer-Kowalski** | University of Natural Resources & Life Sciences, Vienna

**Martin Bernhofer** | Austrian Broadcasting Corporation – Program Radio 1

**Karl Kienzl** | Environment Agency Austria

**Konrad Pesendorfer** | Statistics Austria

**Michael Alram** | Austrian Academy of Sciences

## LIST OF POSTERS

- 1 Neonatal and under-five mortality rate in Indian districts with reference to Sustainable Development Goal 3  
**Jayanta Kumar Bora\* and Nandita Saikia**
- 2 Sustainable development of degraded land through transdisciplinary and participatory activities in Burkina Faso – SUSLAND  
**Christina Bouissou\*, Dominique Ouédraogo, Kathiana Aznarán, Guibien Cleophas Zerbo, Greta Dobetsberger and Andreas Melcher**
- 3 Philosophical Inquiry: Sustainability  
**Daniela G. Camhy\* and Anja Lindbichler**
- 4 Addressing Malaria in Angola through Effective Altruism  
**Mrinalini Cariappa\*, Melanie Trupkat and Andreas Melcher**
- 5 Working together towards reaching the SDGs: Public-private development partnerships in vocational training  
**Jelena Cerar\*, Michael Friedl and Nora Gobel\***
- 6 WebGIS for communicating Alpine ecosystem services and sustainability indicators  
**Oliver Bender, Andreas Cziferszky\*, Andreas Haller, Nadine Houbé and Annemarie Poldermann**
- 7 SmarterLabs: Improving Anticipation and Social Inclusion in Living Labs for Smart City Governance  
**Mario Diethart\* and Petra Wlasak\***
- 8 The Contribution of Citizen Science to the SDGs in Austria  
**Daniel Dörler\* and Florian Heigl**
- 9 A widespread shift to sustainable diets requires rapid risk perception  
**Sibel Eker\*, Gerhard Reese and Michael Obersteiner**
- 10 Social proximity in the coffee sector. A comparative analysis of conventional and relational coffee value chains  
**Hanna Forster\***

\* Presenter

- 11 Land based climate change mitigation within the agenda for sustainable development  
**Stefan Frank\***, Mykola Gusti, Petr Havlík, Pekka Lauri, Fulvio DiFulvio, Nicklas Forsell, Tomoko Hasegawa, Amanda Palazzo and Hugo Valin
- 12 The Agenda 2030 as a challenge to Life Science Universities  
**Georg Gratzner\***, Andreas Muhar, Verena Winiwarter, Thomas Lindenthal, Verena Radinger-Peer and Andreas Melcher
- 13 The stock-flow-service nexus approach: conceptual advances and first empirical examples in tackling systemic interactions between the SDGs  
**H. Haberl\***, D. Wiedenhofer, G. Kalt, C. Görg and F. Krausmann
- 14 Contributing to the SDGs via citizen collected data on road-killed animals  
**Florian Heigl\*** and Daniel Dörler
- 15 Citizen science as a means to achieve the United Nations' Sustainable Development Goals exemplified by a project in the field of linguistics  
**Barbara Heinisch\***
- 16 Using crop residues for household biochar production and subsequent sequestration of carbon in agricultural soils of Uganda, address swathe of SDGs.  
**Hood-Nowotny R.\***, Nakubulwa D., Tumuhairwe JB, Majaliwa M., Ndawula I., Vanlauwe B. and Roobroeck D.
- 17 A new scenario resource for integrated 1.5°C research in the context of climate change and sustainable development  
**Daniel Huppmann\***, Joeri Rogelj, Elmar Kriegler, Volker Krey and Keywan Riahi
- 18 Soil Nitrogen Budgets on a Global Grid Identify Regions Critical to Planetary Boundaries  
**Katrin Kaltenegger\*** and Wilfried Winiwarter
- 19 Snail or bullet train: how fast is the EU moving towards achieving the SDGs?  
**Markus Hametner** and **Mariia Kostetckaia\***
- 20 Designing Sustainable Health Communication Campaigns as Exemplified by HIV/AIDS campaigns in the German-speaking area  
**Sandra Diehl** and **Isabell Koinig\***
- 21 ‚Role Model‘, Agony Aunt or Just a Legal Requirement? Employee Representative's Roles in Securing the Good Life at Work  
**Isabell Koinig\*** and **Franzisca Weder**

- 22 **Learning Together: Farmers Train for Soil Health, Researchers for Facilitating Transitions**  
**Rosana Maria Kral\***, Axel Mentler, Sabine Homann-Kee Tui, Cláudio Sixpence and Katharina Maria Keiblinger
- 23 **Water-Energy-Food: A cross-sectoral perspective to facilitate the effective implementation of SDGs**  
**Bernadette Kropf\***, Hermine Mitter, Katrin Karner and Erwin Schmid
- 24 **Chemical synthesis in hot water – a method for sustainable chemical production?**  
**Marianne Lahnsteiner\***, Hipassia M. Moura , D. Alonso Cerron-Infantes , Musthafa M. Iqbal, Elias K. Bumbaris, Olivier Gazil, Patrick Fritz and Miriam M. Unterlass
- 25 **Towards Global Scenarios of Biological Invasions in the 21st Century**  
**Bernd Lenzner\***, David Leclère, Oskar Franklin, Hanno Seebens, Núria Roura-Pascual, Michael Obersteiner, Stefan Dullinger and Franz Essl
- 26 **The role of social entrepreneurship as a key driver of the Agenda 2030**  
**Peter Kovač Vujasinović, Sofiya Lipenkova\* and Elisa Orlando\***
- 27 **Maps as Storytellers of the Sustainable Development Goals**  
**Jakob Listabarth\***, Georg Gartner and Silvia Klettner
- 28 **Lack of thermal comfort as a dimension of energy poverty: Towards a SDG for space cooling?**  
**Alessio Mastrucci\***, Edward Byers, Narasimha D. Rao<sup>1</sup>, Shonali Pachauri and Keywan Riahi
- 29 **Modeling Farmer’s Decision-Making to integrate climate, agricultural production and biodiversity**  
**Andreas Mayer\***, Claudine Egger, Anja Freudenberg, Veronika Gaube, Christoph Plutzer, Helmut Haberl, Iwona Dullinger, Stefan Dullinger, Franz Essl, Andreas Gattringer and Andreas Böhner
- 30 **Blockchain and SDGs: Programming a Sustainable World**  
**Alberto Medina Islas\***, Mirna Smoljan\* and Sofia Parvenova
- 31 **A Partnership for a Common Goal: how Farmers and Scientists Work towards Re-cultivating Soils on Bangka Island, Indonesia**  
**Axel Mentler\***, Rosana Maria Kral, Rizki Maftukhah, Ngadisih, Murtiningrum and Katharina Maria Keiblinger

- 32 Effectively Communicating the SDGs: Experiences and Innovative Approaches in European Countries  
**Eric Mulholland\* and Gerald Berger**
- 33 Addressing Emission Reduction, Inequalities and Responsibilities to Act on Climate (SDG13): A Modelling Analysis for Austrian Households  
**Stefan Nabernegg\***
- 34 Pollution optimization by means of “N load permit” trade along Farming activities: a new approach aiming sustainability  
**Andreas Nascimento\*, Elena Rovenskaya, Tatiana Ermolieva and Julian Hunt**
- 35 Behavioral Nudging Towards Sustainable Mobility  
**Elisabeth Oberzaucher\*, Kathrin Masuch and Susanne Schmehl**
- 36 Wanted: Micronutrients! Phytosiderophore-mediated acquisition strategies in grass crops  
**Eva Oburger\***
- 37 Global imprints of anthropogenic climate change on the biodiversity of cold habitats  
**Harald Pauli\*, Katrin Wilfing, Manfred Bardy-Durchhalter, Katrin Euler, Andrea Lamprecht, Klaus Steinbauer and Manuela Winkler**
- 38 Monitoring by Earth Observation for Sustainable Landslide Hazard Management using Nature-based Solutions in Mountain Areas  
**Jan Pfeiffer\*, Martin Rutzinger, Annemarie Polderman and Thomas Zieher**
- 39 Leveraging Mobile Phones to Attain Sustainable Development  
**Valentina Rotondi\***
- 40 Analysis of scientific publications on the Sustainable Development Goals in Engineering Research Field  
**Adriana V. Saraceni\*, Luis Mauricio Resende, Viliam Makis, Marcos William and Kaspchak Machado**
- 41 Evaluation of interactions between climate policy measures and the targets of the sustainable development goals  
**M. Schlatzer\*, D. Fitz and B. Becsi**
- 42 Five Challenges for the SDGs and their Success  
**Gottfried Schweiger\***
- 43 Biological Catalysts for Electrochemical Synthesis of Fuels and Chemicals Using CO<sub>2</sub> Recycling  
**H. Seelajaroen\*, M. Haberbauer, L. M. Dumitru and N. S. Sariciftci**

- 44 Active Public Access to Information: Successfully Communicating Research to the Public  
**Maren Beaufort and Josef Seethaler\***
- 45 The TrustPoint Model: A new communication structure in food systems  
**Mahshid Sotoudeh\***
- 46 Using Virtual Reality to Improve Citizen Participation  
**Stefan Suetter\*, Georg Regal, Johann Schrammel and Helmut Schrom-Feiertag**
- 47 A Future Caravan for Austria: How to Address Sustainable Development Goals in Small Towns and Villages  
**Michael Anranter, Ella Brandner, Heidi Dumreicher, Ina Ivanceanu, Barbara Smetschka and Katharina Tiran\***
- 48 Education (SDG 4) is a key for sustainable agriculture to achieve SDG 2 (zero hunger): insights from the Indonesian Dieng plateau  
**Sara Andrea Vaca Sanchez\*, Katharina Maria Keiblinger, Axel Mentler, Michael Gartner, Andreas Gschaider, Joep van der Poel, Ngadisih and Rosana Maria Kral**
- 49 Eating healthy and sustainable. How fruits and vegetables contribute to the global food system  
**Marie-Theres Wandl\*, Karlheinz Erb and Helmut Haberl**
- 50 Designing Humanity Centered Innovation against the Background of Digital Humanities  
**Eveline Wandl-Vogt\***
- 51 Handbook of Sustainability Communication  
**Franziska Weder\*, Larissa Krainer and Matthias Karmasin**
- 52 (Re)storying Sustainability  
Understanding individual's perception of sustainable resource use with a focus on water  
**Franziska Weder\*, Amornpan Tungarat and Stella Lemke**
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**Veronika Wittmann\***
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**Caroline Zimm\* on behalf of 60+ TWI2050 authors**







## **GYMNASIUM DRASCHESTRASSE WITH PEDER HILL THE LAST WHALE**

The humpback whale floating under the ceiling in the festive hall of the Academy was built by twelve-year-olds in their art class at Draschestraße Vienna Bilingual School to bring attention to plastic ocean pollution. Dissatisfied with their impact, they collaborated with their teacher Peder Hill to approach the UN about hosting the world's first Children's Clean Ocean Summit. Their Summit, run entirely by the kids in 2018, has been recognized in articles in eight languages and by heads of states. Their whale sculpture was exhibited at the United Nations. That spirited seed grew into the non-profit organization Kids Save Ocean (KSO), which is now collaborating with volunteer developers to build the app Fat-changer. This is a platform for students and teachers that immerses youth in the reality and complexity of ocean pollution and sustainability, and gives kids a mechanism to do something, facilitating a global letter-writing campaign to lobby governments to bring their policies in line with environmental reality. KSO's goal is to give kids a real voice in the world via formal inclusion in the United Nations.

More information at [www.kidssaveocean.com](http://www.kidssaveocean.com)

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**EDITORIAL OFFICE**

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