Digital platforms
for sustainability governance

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Researchers of the Wageningen Centre of Sustainability Governance (WCSG) have rich experience in co-producing knowledge with stakeholders involved in different areas and forms of sustainability governance. Increasingly, processes of co-production revolve around the study or development of digital infrastructure and platforms. Facilitated by cheap sensors, citizen science, and increasing internet coverage, digital platforms are enabling new ways of monitoring environmental phenomena. Digital platforms are also reconfiguring the provisioning of sustainable products and services, for example by enabling the tracing of (sustainable) food products in food supply chains or facilitating peer-to-peer exchange of renewable energy.

This e-booklet presents an overview of the various WCSG research projects that engage with digital platforms and their implications for the governance of environmental issues. It is based on a workshop organised in November 2017 in which WCSG researchers discussed their role in the co-production and analysis of digital platforms for sustainability governance, with a special emphasis on the methodological challenges entailed in this type of research. The booklet highlights the specific approaches and methods used by the WCSG researchers to analyse and/or co-create digital platforms. It concludes with a comparative analysis of the projects and an overview of joint lessons learned.

What are digital platforms?

Digital platforms re-organise many societal processes and practices. Social media platforms such as Facebook and Twitter have changed the ways in which we interact with friends and colleagues, and how we access news and information. The sharing economy platforms BlaBlaCar and AirBnB allow us to use a stranger's car or apartment. From the literature on sharing economy platforms and social media, we may deduce that platforms are digital spaces where users can a) communicate and interact with one another and b) get (temporary or permanent) access to products, services, or, more broadly, 'resources' provided by peers or organisations. A key feature of platforms is thus their 'capacity, through digital means, to link different groups, individuals and organisations either with each other or with goods and services'.

In the field of sustainability governance too, digital platforms are reshaping the way sustainability information is collected, analysed, accessed, and used for decision making. For example, the widespread use of mobile phones means that a range of actors –including citizens – can now collect information about the environment, such as photographs of certain species, information about weather conditions, or the location of plastic waste, and upload this to 'the cloud'. New technologies such as sensors and satellites enable the real-time and detailed monitoring of environmental conditions, such as deforestation or climate change impacts.

In many of these monitoring platforms, algorithms operate on the data to analyse, predict, and forecast sustainability issues.

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Digital platforms are also reconfiguring the (sustainable) provisioning of products and services, for example in the domains of food, energy, and mobility. Here, smart technologies are used to enhance transparency and traceability in food supply chains, to enable the recording of (green) energy flows, or to match drivers and passengers in ride-sharing schemes. For example, citizen-consumers can use apps to view sustainability information about food products and use this information to make decisions about their everyday consumption practices and behaviours.

Methodological challenges for environmental social scientists

The proliferation of digital platforms in the field of sustainability governance entails new research challenges for environmental social scientists. How can we understand the impact of digital platforms on power relations in sustainability governance? On the one hand, environmental information systems are becoming part of a more polycentric monitoring landscape, whereby traditional information providers are increasingly confronted by 'counter-production'.

On the other hand, environmental information systems are used to further empower the already powerful actors, by standardising and controlling. How are digital platforms reconfiguring our system of provision and the

ways in which people can engage with sustainability issues around food, energy, water, waste, and mobility? These questions about the implications of digital platforms for (environmental) knowledge production and decision making are accompanied by specific methodological challenges. For example, what are the potentials and the limitations of translating social scientific findings into design requirements for platforms? How can social scientists engage users/stakeholders in discussions about opaque, complex, and often automated information systems, and how can the co-production of digital platforms between a variety of stakeholders be optimised?

We describe seven WCSG projects in this e-booklet:

1. **Emerging energy practices in the Smart Grid**
2. **MinkApp**
3. **Hydroclimatic EVOs**
4. **Environmental migration**
5. **SALIENSEAS**
6. **Landslide EVO**
7. **NextGVC**

Each of these seven WCSG projects that seek to co-create or analyse digital platforms deals with these methodological challenges in its own way. Finally, based on a comparative discussion of these seven projects, we draw key joint lessons learned.

Renewable energy intermittency challenges the stability of the electricity grid at a time when more aspects of daily life – mobility, cooking – are becoming electrified. 'Smart grids' are heralded as a comprehensive solution, giving both utility providers and householders tools to manage a greener, affordable, and reliable energy grid.

The aim of this research project, funded by the URSES programme of the Netherlands Organisation for Scientific Research (NWO), is to understand how households appropriate and use (smart) energy technologies such as solar panels, home energy management systems, household batteries, and smart heat pumps. How will the daily lives of householders change in the smart grid? What new energy practices will emerge or not emerge? The project follows several smart grid pilot projects in which such technologies are implemented in households, including *Jouw Energy Moment* and *City-zen Virtual Power Plant*.
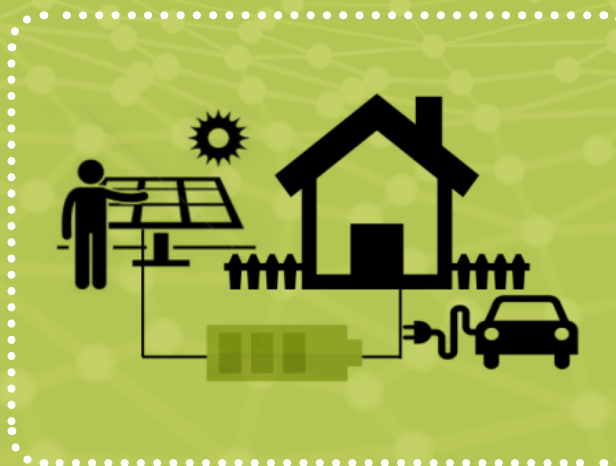
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1

Emerging energy practices in the
Smart Grid

WCSG RESEARCHERS
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Bas van Vliet and Gert Spaargaren

STATUS: IN PROGRESS
2014 - 2018

The platform

The City-zen smart grid pilot case consists of a Virtual Power Plant, which is a platform for the exchange of energy. This Virtual Power Plant connects 50 households with solar panels, smart meters, and home batteries to one another. Through this Virtual Power Plant, the householders can exchange energy within the collective, trade on the energy market, and contribute to the net balance.

The role of the researchers

The role of the social scientists is to examine how householders use energy in their homes, and whether and how this changes when smart technologies are introduced. In the City-zen project, the researchers are actively engaged in examining different types and forms of social organisation of energy systems with storage. In this project, one of the aims is to examine how householders experience being part of the City-zen energy exchange platform, but also how their requirements can be incorporated in the design of such platforms.

"Social knowledge, for instance about the users' desires and needs, can be very useful in the design process"

Sanneke Kloppenburg

Innovative approach

As part of the project, workshops with householders and smart grid developers are organised. Because smart energy technologies (including energy exchange platforms) often do not require householders' active participation, their exact workings might remain abstract to users. To foster insight and discussion about energy platforms, the project develops a serious game for householders.

The goal of the game is to lead and spark a discussion in which the participants debate the aspects and qualities that an energy-exchange platform should or should not have. Topics addressed by the participants include, for instance, what a platform should look like, what objectives should be set, which parties should be involved in administering a platform, how generated value is distributed, and what behaviours are expected. The insights thus generated are discussed with smart grid developers in order to foster the development of energy platforms that take householder needs and interests into account.

"One of the key challenges of this project is therefore to have people engaged in a discussion about a technology that they are not actively using themselves"

Sanneke Kloppenburg

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Digital conservation

MinkApp and community-based nature conservation

WCSG RESEARCHER
Koen Arts

Volunteers in Scotland monitor the presence of the American mink (Neovison vison), an invasive species which poses a threat to native species. When the volunteers spot traces of mink, they notify the Scottish Mink Initiative and set a trap to catch it.

Previously, volunteers recorded their findings on paper. These data would then be sent to the local coordinator, who would compile all the data from all volunteers in the region. The aim of this project is to implement a digital system which works more efficiently and faster. In addition, as a result of the system, volunteers get immediate feedback as a reward. This happens by means of Natural Language Generation (NLG): computer-written texts on the basis of dynamic datasets. Previously, volunteers would only receive information in a periodic newsletter. Now, they may receive instantaneous feedback, specific to each volunteer's context.

The project also aims to understand the consequences of digitalising volunteer work in nature conservation. Gains in efficiency and decreased costs may have to be weighed against changes in volunteer dynamics.

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**STATUS: IN PROGRESS
2015 - 2018**

The platform

The platform was developed by an interdisciplinary team of ecologists, social scientists, computer scientists, and programmers at dot.rural (University of Aberdeen), in collaboration with the Scottish Mink Initiative. The platform takes the shape of a regular website but boasts various additional functions such as the NLG feedback system. Employment of the system beyond the project phase is currently being considered.

The role of the researchers

Firstly, it was important to understand the requirements of the coordinators employed by the Scottish Mink Initiative, who engage with the volunteers. Using various techniques, the researchers mapped and analysed the understandings, expectations, and views of these coordinators. This was then translated into concrete recommendations for software development.

In addition, several forms of co-development meetings fed into the platform construction. After various tests and reiterations in terms of platform improvement, the platform went 'live' with a controlled experiment involving volunteers using versus not using the system. End-usage analysis was also performed, as well as appreciation surveys of the platform.

"One of the reasons people do volunteering work is social interaction. People may enjoy having an actual chat with the coordinator of the project who comes by to ask about the mink. Digital platforms, such as MinkApp, affect that relationship"

Koen Arts

Innovative approach

The project is innovative in its interdisciplinary approach. The project brings together a team of computer specialists, ecologists, and social scientists to work on a real-world problem; this may well be an inspiration to many other projects in natural resource management around the world.

The project therefore tackles important questions:

1. How does digital innovation influence people's relationships with nature and nature management?
2. How can knock-on consequences of the implementation of the digital platform be understood and conceptualised?
3. What role can digital technology play in volunteer retention, and can digital tools – for instance immediate, computerised feedback – stimulate volunteers when there are fewer mink to catch?

PARTNERS
Wageningen University and Research
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dot.rural

Farmers in Ghana suffer from erratic weather conditions, with visible effects on water availability for farming. Climate variability thus poses high levels of uncertainty for which farmers are required to adapt their seasonal and daily decisions. Hydroclimatic Environmental Virtual Observatories (EVOs) are developed to support adaptive ways of dealing with climate variability and change in Kumbungu and Ada East districts in Northern and Southern Ghana, respectively. These digital platforms seek to bring together scientists and decision makers through information gatherings, knowledge sharing, learning, and decision support. The research project aims to diagnose current information challenges and design a functional platform to manage hydroclimatic conditions in crop farming systems.

The study addresses a key question:
How can a hydroclimatic EVO make local governance of crop framing more adaptive by providing actionable knowledge?

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3

Hydroclimatic EVOs

to support crop farming in Ghana

WCSG RESEARCHERS IN THE EVOCA AND WATERAPPS PROJECTS

Andy Bonaventure Nyamekye, Rebecca Sarku, Art Dewulf, Robbert Biesbroek, Katrien Termeer

**STATUS: IN PROGRESS
2016 - 2020**

"Accessibility and digital literacy are key issues. The platform will most likely operate mainly through mobile phones. Some farmers will not be able to read the messages on the phones and will have to consult others to interpret information"

Andy Bonaventure Nyamekye

The platform

Hydroclimatic EVOs aim to combine both indigenous forecasts and scientific forecasts. The platform integrates mobile phone technology and other intermediaries that enable information dissemination and knowledge co-creation. The system enables a two-way interactive process in which scientists and decision makers can collate data on observed and predicted weather conditions, as well as co-produce knowledge for adaptive management of synergies and trade-offs between water and food in irrigated and rain-fed rice production systems. The platform interface adopts local languages and symbols.

The role of the researchers

Social scientists contribute to the co-design and operationalisation of the platform by inquiring into the information needs and functioning of existing information systems, the configuration of local governance arrangements, and the ways in which information use affects decision making. Both researchers and practitioners are actively involved in diagnosing the problem and defining technological solutions through a simulation game as part of the co-production process. A major objective of the researchers is to test a hydroclimatic EVO prototype and contribute to developing a mobile app linked to the platform.

Innovative approach

The project adopts a novel approach by harnessing and combining indigenous and scientific forecasts for improved climate-sensitive decision making. Farmers and water managers are also engaged directly in data gathering using the Sapelli app: a simple data collection tool that employs graphics and allows for the easy and interactive engagement of less literate participants in the data collection process. Using an action research approach, the project adopts a systematic process of observation of conditions, knowledge co-creation, and co-design of the hydroclimatic platform. The use of gaming as a methodology allows for observing how farmers interact with information and what adaptive decisions they take. The output of the game will inform the design of the platform.

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Environmental migration
in the digital age

WCSG RESEARCHER
Ingrid Boas

Environmental impacts are a growing factor in human migration. Since 1970, the likelihood of being displaced by an environmental disaster has risen by 60%. Since 2008, each year more than 25 million people have been forced to migrate because of environmental impacts such as floods or droughts. Climate change is expected to make this worse.

Although much scholarly research has been conducted on environment-related migration, the role of information and communication technologies (ICTs) remains a blind spot. ICTs – such as mobile phones and smart phones – and related information exchanges play a crucial role in migrants' decisions and practices.

The central aim of this project is therefore to provide a fundamental understanding of the ways in which ICT-enabled information exchange shapes practices and flows of environment-related migration. In Bangladesh, the project analyses how ICT-enabled information exchange shapes migration in the context of erosion, floods, and storms. In Kenya, this is analysed in the context of drought.

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STATUS: IN PROGRESS
2016 - 2020

The platform

The project examines the everyday usage of mobile technologies amongst local communities affected by environmental change, with a central focus on how it shapes their decisions to stay or move, or to return to places of origin after a disaster has passed. The main focus is on how mobile technologies – including smart phones (with access to Facebook) and phones without internet access – facilitate or shape social connections that people draw on for information, advice, or support.

"Environmental migrants are not passive victims. The Hackathon for Environmental Migrants focuses on how technology could further empower rural communities to help one another, to ensure that they can better mitigate risks and that those who have to leave their homes or are staying in cyclone shelters can still rely on their community for support"

Ingrid Boas

The role of the researchers

The role of the researcher in this project is to uncover the role that ICTs play in environment-related migration. This is largely undertaken through a mobile ethnographic approach via which the researcher examines a set of representative migration narratives. For each narrative, the researcher traces the social network connections that are set in motion by the usage of mobile technologies by the individual migrant or family being researched. In this way, a range of migration narratives are being reconstructed, with a central focus on the role of social networks, the information exchanged within these networks, and the role of mobile technologies in shaping social networks and narratives.

Innovative approach

To actively engage in ICT-enabled solutions to assist those displaced by environmental impacts, the researcher together with the project partners organised a Hackathon for Environmental Migrants in the autumn of 2017 in Bangladesh. Eight teams from four top universities in Dhaka participated in this Hackathon (Dhaka University; Bangladesh University of Engineering and Technology (BUET); North-South University; and UIU), each trying to come up with an innovative though pragmatic ICT-enabled proposal to better assist these migrants. This resulted in applications that enable easier access to local information for aid workers and concerned relatives or crowd-sourced emergency helplines, including efforts to make these applications accessible to people who are illiterate or have no internet on their phones. Their solution building was informed by the research findings and local workshops with communities in affected areas, which aimed to get an overview of their central needs. On this basis, a set of user stories was constructed reflecting different types of affected groups, each having specific needs that could potentially be met (in part) by ICT-enabled solutions.

SALIENSEAS

Enhancing the saliency of climate services for marine mobility sectors in European Arctic seas

WCSG RESEARCHERS

Machiel Lamers and Berill Blair

STATUS: IN PROGRESS 2017 - 2020

The arctic region is changing rapidly as a result of climate change impacts. Particularly in maritime settings, this is creating opportunities and expectations, but also uncertainties as the biophysical environment becomes less predictable. Through tailored weather, sea-ice, and climate information services, maritime sectors, such as tourism, shipping, and fisheries, are better equipped to tackle these uncertainties.

SALIENSEAS aims to co-produce such tailored services built on an understanding of the contexts and conditions in which sectors experience risk and vulnerability. The project, funded through the European ERA4CS programme, aims to evaluate the role of environmental forecasts in decision making and use those insights to co-design information services with end-user groups from the maritime Arctic.

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The platform

SALIENSEAS focuses on existing and planned environmental forecasting services of public meteorological agencies in support of maritime users in the European Arctic Ocean. These forecasting services for weather, sea-ice, and climatic conditions are shared digitally through the MET services' websites and specialised platforms.

The role of researchers

The role of social scientists is to organise a co-production process that facilitates a multi-stakeholder, user-focused evaluation of Arctic weather, water, ice, and climate information services. This is achieved by first mapping the spatial and temporal parameters of the supporting role played by these services in the mobile marine sectors and in subsistence activities that rely on sea-ice system services. Using this knowledge, the project then creates a computer-assisted simulation of the communication pathways between providers and users to highlight ways in which services with varying temporal outlooks impact strategic and operational decision making in Arctic marine settings. With these results, social scientists facilitate the co-design process between the meteorological services of Denmark and Norway and a range of maritime sectors to produce better-tailored environmental forecasting products.

"Effectively involving stakeholders or end-users is difficult. In our case, the end-users are at sea and stakeholder representatives are spread across Europe; bringing them together is challenging"

Machiel Lamers

Innovative approach

To capture the dynamic and elusive nature of information needs in uncertain and extreme conditions, SALIENSEAS employs participatory mapping, serious gaming, and computer simulation to engage with stakeholders. In its first phase, the project assembled experienced mariners and representatives of maritime sectors in a workshop to assess the network of metocean data users and providers that most prominently impact Arctic maritime operations. Stakeholder interviews conducted with maritime representatives, and upcoming workshops, will engage Master Mariners in structured table-top exercises to assess decisions taken in routine operations, practices, and itineraries, as well as how these routines change based on the availability of salient metocean services. In the final phases, the project relies on agent-based computational models (ABM) to simulate the use of Arctic metocean data networks and their impact on maritime operations. ABM was chosen because the multiple stake-holders involved in the project each represent unique decision-making units, but together they also form a complex adaptive system with its own unique, emergent qualities. SALIENSEAS thus seeks to uncover how decisions are adapted to changing environmental conditions, and how information platforms may support or impede decision makers. ABM is a functional tool that models the flow of information in the provider–user network, the spatial and temporal dimensions of decisions in maritime operations, and emergent uncertainties that arise at the interface of the two.

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Greenland Pilot Service
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Landslides are among the most societally disrupting natural hazards worldwide. The Himalayan Arc is a top global landslide hotspot. In Western Nepal, the acute data scarcity about landslide-driving processes and population vulnerability, and the high diversity and number of actors involved in disaster preparedness, response, and recovery, make disaster risk reduction in this environment a formidable challenge. Lack of scientific evidence is a major obstacle to improving local policymaking to support resilience building, and this is further hindered by the combination of acute poverty and weak governance structures.

The Landslide-EVO (L-EVO) project, funded by NERC (Natural Environment Research Council) and DFID (Department for International Development) under the UK SHEAR (Science for Humanitarian Emergencies and Resilience) programme, aims to increase local disaster resilience in remote mountainous environments. The objective is to deliver an end-to-end solution for the generation of locally actionable knowledge for disaster risk reduction, addressing the full workflow of information generation, processing, and communication to decision makers.

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Landslide-EVO
Building resilience to landslides in Western Nepal

WCSG RESEARCHERS
Katarzyna Cieslik, Art Dewulf

STATUS: IN PROGRESS
2017 - 2021

The platform

Distributed sensor networks, participatory monitoring, and citizen science hold great potential to complement official monitoring networks and remote sensing by generating site-specific information. Although the quality and the availability of remotely sensed data are increasing, ground-based observations, such as rainfall, river flows, soil properties, and disaster damage, are still needed for calibration and to resolve small-scale spatiotemporal patterns and processes, especially in complex mountain regions. Open source, cloud-based risk analysis platforms (Landslide Environmental Virtual Observatory) can support the construction of a modular, distributed, and potentially decentralised data processing workflow. Linking data analysis platforms to social networks and ICT (mobile phones, tablets) allows for building tailored interfaces for people-centred decision making and policy support systems.

"At first, people are excited. However, after the first couple of months, the initial enthusiasm wears off. Citizen-science projects, like L-EVO, therefore require constant on-site facilitation"

Katarzyna Cieslik

The role of researchers

The L-EVO team brings together world-leading scientists on mountain hydrometeorology and landslide risk with experts on citizen science, participatory approaches to knowledge generation, and risk governance. By combining participatory mapping, community-based environmental sensing, and satellite data, the team aims to increase local disaster resilience on the Seti River in the Karnali Basin. Apart from scientific insights, L-EVO aims to develop tools for communicating landslide risk.

Innovative approach

The project draws upon recent scientific insights in the governance of natural resources, and specifically on the use of polycentric approaches to data collection and knowledge generation. Thus, L-EVO sets out to develop and implement a framework for landslide risk reduction and disaster resilience building in mountain regions, by combining:

1. State-of-the-art research on the physical and social processes that determine hazard, exposure, and vulnerability,
2. New technologies for sensing, data processing, and communication, and
3. New insights into polycentric risk governance, knowledge co-generation, and disaster resilience.

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Voluntary sustainability standards (VSSs) aim to fill the void left by traditional state-centred governance systems to effectively tackle the transnational problem of the sustainability of global value chains (GVCs).

Despite their relative success, VSSs face some serious challenges affecting their effectiveness and legitimacy. One of the challenges is the need to improve transparency in GVCs. This is generally addressed by developing advanced information technologies to enable product traceability and to monitor key sustainability indicators to assess the conditions of production, trade, and consumption.

This project investigates this central role of technology by analysing various GVCs, among which palm oil and seafood. If these challenges are properly addressed, VSSs can become part of 'next generation' solutions for a better future.

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Transparency and traceability

Next Generation Governance Arrangements for Sustainable Global Value Chains (NextGVC)

WCSG RESEARCHERS

Bas Arts, Simon Bush, Jonna Gjaltema, Otto Hospes, Peter Oosterveer, Martin Skrydstrup, Katrien Termeer, Hilde Toonen and Esther Turnhout

STATUS: IN PROGRESS
2014 - 2018

The platform

The palm oil supply chain study focuses on the ways in which mobile devices are used to gather data on land-use practices and ownership in Indonesia. The analysis centres around the use of an app that enables farmers and other involved actors to transfer files and data without using a cloud. The findings show, however, that there seems to be a glitch in expectations, for example between farmers and an NGO involved in the development of the tool. The fisheries supply chain study revolves around a new wave of technologies expected to enable more (detailed) monitoring and surveillance. Drones and satellites, for instance, can be helpful in spotting and highlighting illegal, unregulated, and unreported (IUU) fisheries. The project explores the role of these novel technologies in improving fishery surveillance in terms of (shifts in) responsibility, accountability, and inclusion/exclusion of involved actors.

"Digital platforms serve multiple purposes. Farmers thought that the app was supposed to help them improve their agricultural practices. The aim of the NGO, on the other hand, is to enhance palm oil traceability"

Martin Skrydstrup

The role of researchers

It is generally assumed that traceability systems will enhance the sustainability of global value chains. The researchers in the NextGVC programme aim to understand these relationships. In the palm oil case, researchers carry out field work in Indonesia to uncover the complexities of land-use data through a practice-based approach, focusing on different institutional logics, embedded practices, and discursive fields.

In the fisheries case, researchers demonstrate that, although technologies are portrayed as neutral devices, they have inherent socio-political implications. For example, depending on their specific spatial reach, they highlight some features and practices but leave others unrevealed. Also, the particular constellation of expert communities around these technologies has an important impact on who is in and who is out of fisheries governance.

Innovative approach

Using these insights, the researchers provide feedback to their societal and sectoral project partners working on the design and application of technologies to detect and reveal sustainability concerns in global processes of production, trade, and consumption. Analysis of the innovative insights reveals that co-creation takes place in workshops and discussions to co-design a 'next generation' arrangement aimed at sustainable governance of GVCs. In addition, an innovative approach is used in the palm oil study whereby a practice-based approached is used based on anthropological methods, such as life histories, transect-walks, and ethnography.

PARTNERS
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Marine Stewardship Council (MSC)
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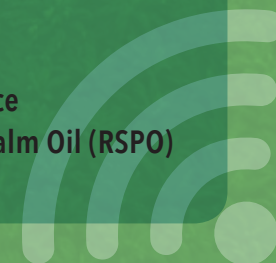
Lessons learned

Researchers at the WCSG are gaining experience and expertise in analysing and co-producing different forms of digital platforms for sustainability governance in a wide range of fields, such as energy, nature conservation, agriculture, watermanagement, tourism, migration, and fisheries. The selection of the current projects presented in this publication attest to that (see Table 1 for overview). A range of commonalities and differences can be identified.

The projects focus on platforms in different stages of development. As digital platforms are a fairly new actor in environmental governance, their role and potential are increasingly being explored, and applications are continuously evolving and taking shape. In fact, most of the platforms are in the process of being developed as the project unfolds, whereby research carried out contributes to the development process or evaluates the role or implications of usage. In some cases, the project revolves around the role of pre-existing or well-established applications (migration) or the establishment of new services within formal platforms (SALIENSEAS).

Digital platforms for sustainability governance may focus on the provision of different types of services. Most of the platforms aim to provide services to end-users by integrating various types of data and sharing new information services, such as environmental forecasts or monitors, through online applications. In the emerging energy practices case, the platform also enables the trading of energy.

Social scientists take various roles in such projects. In most of the projects, an important task is reserved for researchers to understand information needs, user requirements, and use of digital platforms as input in co-production or evaluation. In some projects, researchers are actively organising stakeholder or end-user participation, co-designing and testing prototypes, or critically evaluating implications or knock-on effects.

WCSG researchers are developing innovative approaches to carrying out these roles. To capture the complex and dynamic nature of digital platforms in sustainability governance settings, many projects experiment with forms of serious gaming, participatory methods, and social simulation. Conceptually, many projects rely on contextualised perspectives, such as practice theory, while developing innovative and matching methodologies, including ethnographic fieldwork approaches.

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Based on our joint experience and discussions during a workshop, here we draw some of the key lessons learned.

1 In the projects presented, social scientists take on different roles in interdisciplinary projects that aim to co-produce digital information platforms. We emphasise that it is important to be clear at all times about these roles in co-production processes. What role do we assume in such projects? Are we representing the end-user? Do we design and facilitate the interaction between developers and end-users? Is our role only to study the process of developing the platform? Clearly defining our role in relation to the natural scientists, platform developers, and other stakeholders in the project is crucial, not only at the start but throughout the project.

2 Nearly all projects involve a process of co-production, relying on regular interaction of social scientists and their research insights, platform developers, and end-users. We find that such iterative processes are central to effective digital information platforms, as users typically find it difficult to imagine what platform developers can offer, and developers sometimes have a hard time knowing what users need. Co-production tends to be effective when interaction between developers and users is organised early, clearly, and regularly.
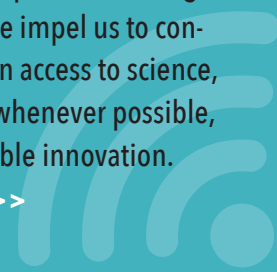
3 Differences in the configuration and services provided by the platforms included in this publication makes us conceive of digital platforms as plural entities composed of a set of interlinked elements with wide-ranging relevance for sustainability governance. Platforms may consist of online databases, mechanisms to feed data into the database, mechanisms for processing data, and different user interfaces ranging from text messages to mobile applications or fully-fledged interactive websites. Because of the diversity of platforms in various fields, we argue that contextual and dynamic research approaches are needed, including serious gaming, focus groups, or hackathons.

4 Digital platforms for sustainability governance typically often aim to reach out to actors not previously connected. This means that co-producing digital platforms requires involving stakeholders and end-users that may not be reachable in similar ways. For example, users that are mobile (e.g. ships' captains) or reside in remote areas (e.g. high seas, mountain areas) are difficult and expensive to involve in co-production processes, whereas city dwellers may be easier to reach and involve in participatory settings. Similarly, in remote developing contexts, end-users may be subject to different levels or forms of literacy (illiteracy, language issues, digital literacy) that affect their capacity to participate in co-production. Ample resources, time, and expertise will have to be available to overcome these challenges.

5 In co-production processes of digital platforms for sustainability governance, experts from various backgrounds and disciplines are typically involved, as well as stakeholders and end-users from various fields. Each of these groups may have a different perspective, stake, or expectation when participating in a co-production process, regarding the quality and the timing of the results or the approach followed. It is important to be consistent and clear about the aims of the project. Will the project really and completely solve the problems experienced by end-users, or will it merely enable experimenting with, and learning the potential of, digital platforms? It is also important to be aware of our current bias towards digital platforms and applications, as not every societal problem would need a new platform to solve it. In order not to lose buy-in, it is important to manage expectations and options well throughout the project.

6 Digital platforms enable actors to act differently, but this may have unintended as well as intended consequences. We argue that this requires critical thinking about possible unintended uses and abuses of the data gathered on the platform. It also requires forward thinking about incentives or new dependencies that might be created for platform users. Such ethical implications of digital platforms for sustainability governance impel us to connect to ideas and mechanisms for open access to science, open data, and open source software whenever possible, and to heed the principles of responsible innovation.

	SECTOR / ISSUE	PLATFORM	ROLE OF SOCIAL SCIENTISTS	INNOVATION
1. Emerging energy practices	Energy supply	New platform that exchanges and trades energy	Understand use and role of smart technology	Serious game on features of the platform
2. MinkApp	Nature conservation	New platform that organises participants, reports results, and provides feedback	Understand requirements, recommendations, software development, co-production meetings, experiment, and end-usage analysis	• Digital innovation in nature conservation • Conceptualisation of knock-on consequences • Potential of digital technology in volunteer retention
3. Hydroclimatic EVOs	Water for agriculture	New platform that integrates different data sources and shares hydroclimatic forecasts	• Understand information needs, use of existing services, role of governance arrangements for decision making • Joint problem diagnosis • Develop and implement a gaming approach • Test a prototype	• Combine indigenous and science-based forecasts • Action research: co-creation of knowledge and co-design of the platform • Gaming approach to inform final design
4. Environment-related migration	Migration	Information sharing platform through existing mobile technologies	Understand the use and role of mobile technologies among communities affected by environmental change	• Reconstruction of narratives through a mobile ethnographic approach • Hackathon for developing ICT tools to assist environmental migrants
5. SALIENSEAS	Arctic shipping and tourism	Developing and sharing environmental forecasts through existing web-based interface	• Understand user–provider interface • Organise co-production process • Participatory mapping of uses and needs • Simulate communication pathways	• Participatory geographic information system • Serious gaming and agent-based modelling • Exploring demonstration services
6. Landslide-EVO	Disaster risk reduction	New platform that integrates different data sources and maps landslide risks	• Interdisciplinary analysis to increase local disaster resilience • Develop tools for risk communication	• Polycentric approaches to data collection and knowledge generation • Application of new sensing, data processing, and communication technologies
7. NextGVC	Global value chains	Information sharing to increase traceability through existing mobile devices and novel technologies	Understand interlinkages between traceability, transparency, and sustainability in global value chains	Practice-based approach through life histories, transect-walks, and ethnography