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A Digital Ecosystem For The Planet

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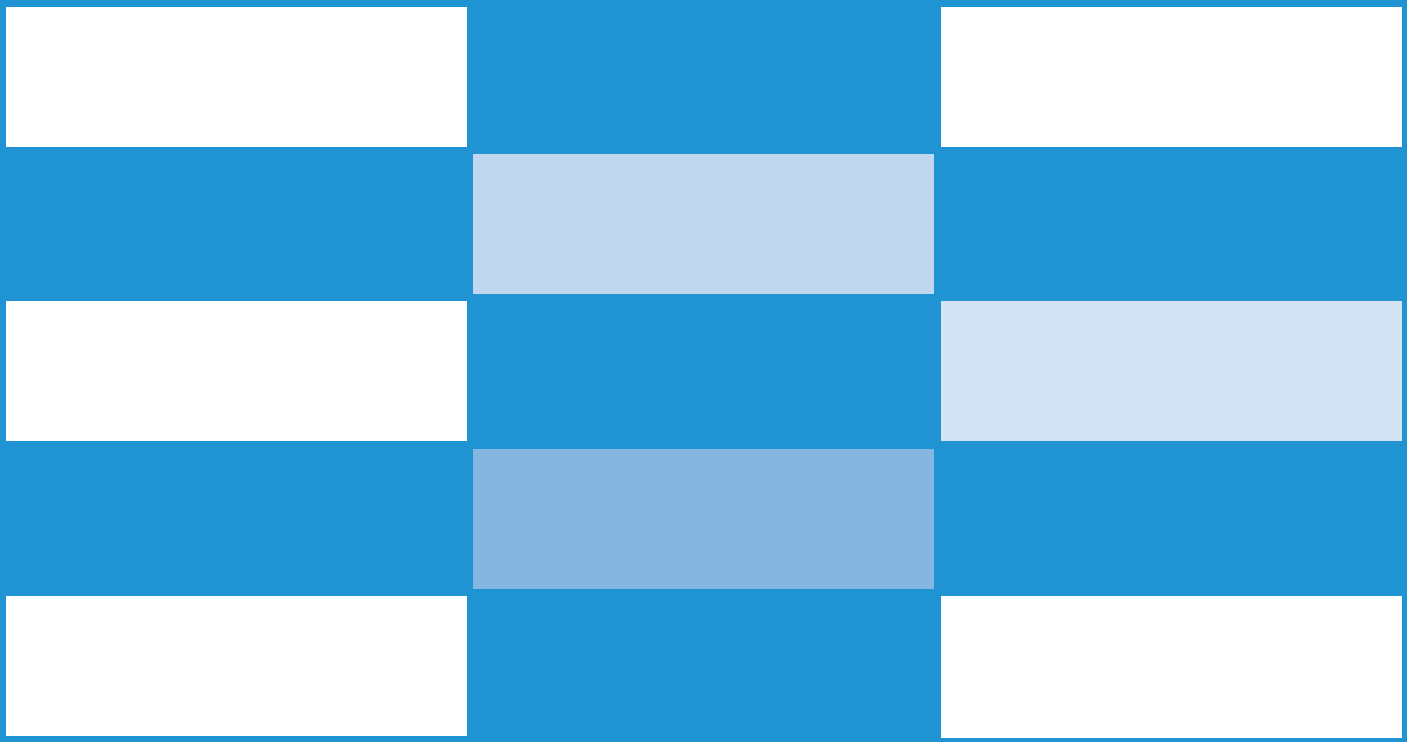

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Table of Contents

1. The Promise And Peril Of A Digital Ecosystem For The Planet

Key decisions are needed in the next 12 months to set in motion a robust architecture and governance framework

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The promise and peril of a digital ecosystem for the planet

1.1 Introduction

A range of frontier and digital technologies have dramatically boosted the ways in which we can monitor the health of our planet. And sustain our future on it (Figure 1).

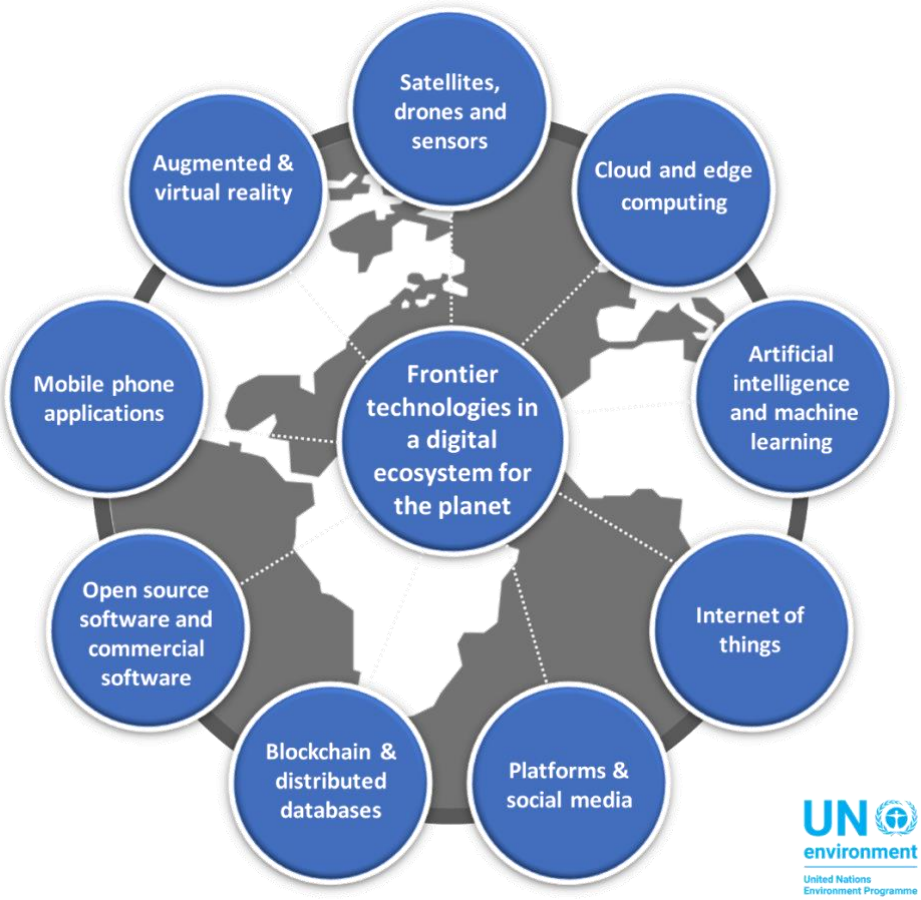


Figure 1. A range of frontier an digital technologies can be combined to monitor our planet and the sustainable use of natural resources.

If we can leverage this technology effectively, we will be able to assess and predict risks, increase transparency and accountability in the management of natural resources and inform markets as well as consumer choice. These actions are all required if we are to stand a better chance of achieving the Sustainable Development Goals (SDGs).

However, for this vision to become a reality, public and private sector actors must take deliberate action and collaborate to build a global digital ecosystem for the planet—one consisting of data, infrastructure, rapid analytics, and real-time insights. We are now at a pivotal moment in the history of our stewardship of this planet. A “tipping point” of sorts. And in order to guide the political action which is required to counter the speed, scope and severity of the environmental and climate crises, we must acquire and deploy these data sets and frontier technologies. Doing so can fundamentally change our economic trajectory and underpin a sustainable future.

This article shows how such a global digital ecosystem for the planet can be achieved—as well as what we risk if we do not take decisive action within the next 12

months. This is an extended version of the Foresight Brief issued by the UN Environment Programme in September 2019.

We human beings have given ourselves 10 more years to achieve the SDGs. But the next 12 months will be critical. During this short period of time the following determinative events will take place:

- The Climate Summit in New York in September 2019 will set the agenda for the next decade on climate change.
- The Climate COP in the UK in 2020 will revise the Paris Agreement.
- The Kunming COP on biological diversity will set new 20-year targets for the "more silent crisis" of the slow loss of nature.
- Finally, the UN Convention on the Law of the Sea will set the agenda for the hydrosphere through a new global oceans treaty.

All available evidence shows that we are not on track to avert the two greatest existential environmental challenges on our doorstep: the climate crisis and the nature crisis (2). We are not even effectively measuring global progress against the SDGs. A total of 68% of the 93 environmental SDGs indicators cannot yet be measured due to a lack of data (Figure 2) (3). All efforts to marshal knowledge and action are thus required. Having a digital ecosystem in place will be absolutely critical to what happens to our home on this planet in the coming decades.

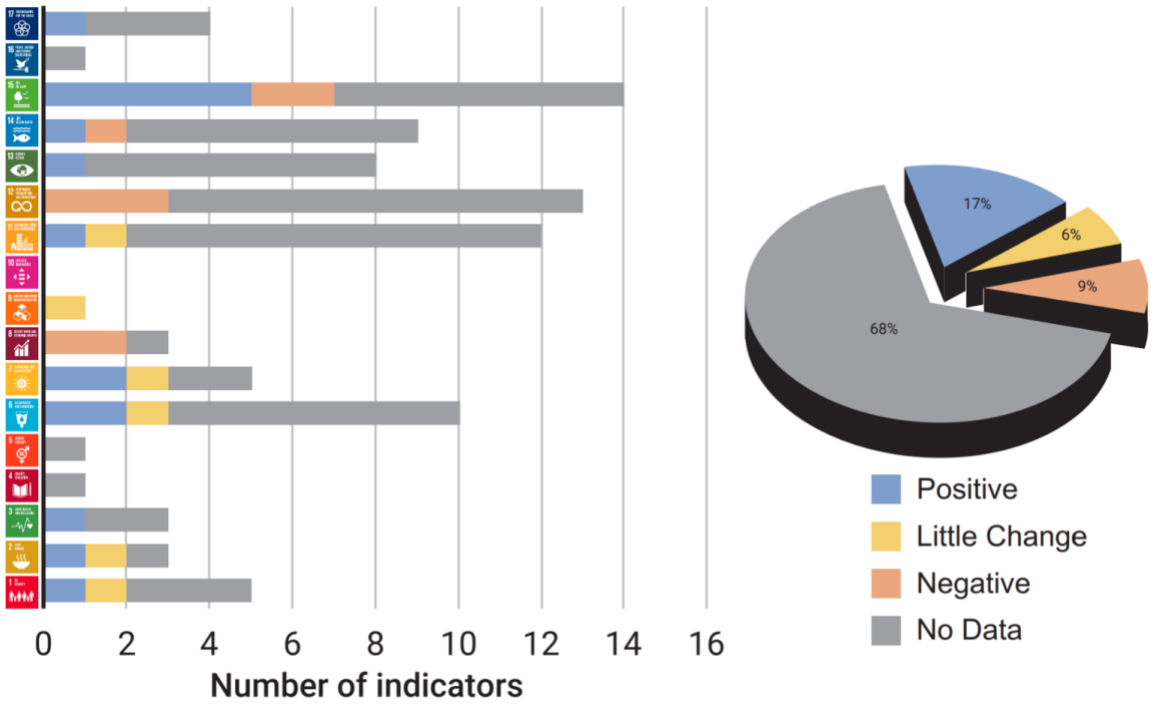


Figure 2. 68% of the environmental SDG indicators cannot yet be measured due to a lack of data.

1.2 What's at stake?

Our world is undergoing dramatic digital transformations (Figure 3)(4). Over 90% of all the world's data has been generated during the last two years (5). Mobile devices connect five billion people on the planet (6). New satellite technologies image the entire surface of the Earth every day down to a resolution of three meters (7). New cloud computing and artificial intelligence algorithms allow us to monitor, detect and predict environmental and climate threats based on a stream of earth observations, ground sensors and other data points (8, 9, 10). On top of all this, social media has become a political force. It shapes perceptions. It influences the fabric of civil discourse and dialogue on environmental challenges and climate change (11). And it also permits the acquisition of additional knowledge on the extent, shape and pattern of environmental challenges we face all across the planet.

In order to reach the point where we marshal the digital ecosystem to our advantage (28), policy makers, businesses and citizens need to more actively embrace the complexity, scale and magnitude of these changes and their consequences.

The challenge is that while there is broad recognition that humanity must capitalize on this massive increase in data generation and processing power (figure 3) to help monitor and manage the state of our planet, there is no common vision, directed strategy or governance framework (29). We still lack a planetary dashboard to monitor our critical natural resources and ecosystem services at the global, national and local levels. Moreover, we cannot capture the promise of frontier technologies for the planet if we don't also address the potential perils and pitfalls.

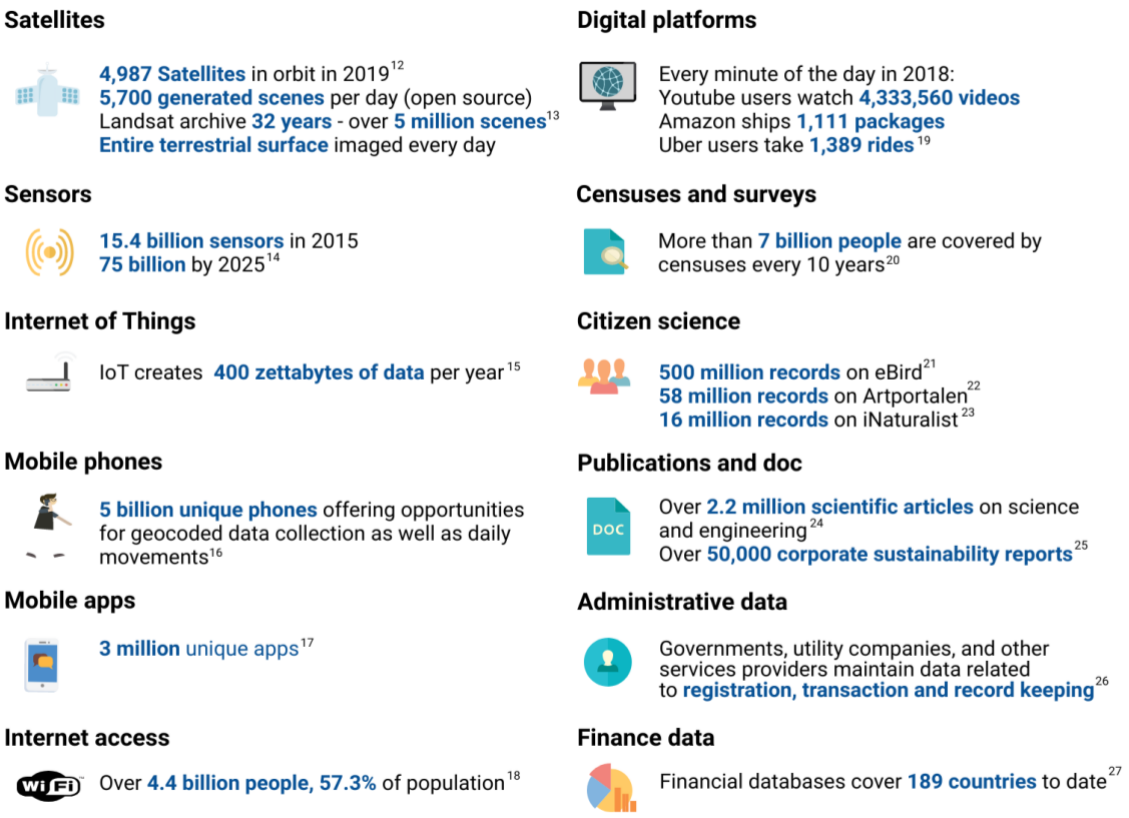


Figure 3: Sources of data that can power a digital ecosystem for the planet. (Piktochart)

Currently, a myriad of public and private sector actors is building data sets, digital infrastructure, algorithms and insights for the environment. But these actions are haphazard and fragmented. In a new—and welcome—development, private sector actors are beginning to offer digital public goods and related analysis (30). But this is happening without a broader understanding of the long-term business models and incentives that should sustain and finance these services. A global conversation is therefore needed to determine how these efforts can best sustain global public goods, protect privacy, achieve inter-operability and keep quality standards high. Finally, we need to decide how to govern and pay for this digital ecosystem. This will yield answers to the question of how to maintain a balance between public and private sector interests and incentives.

But the first step is to start ratcheting-up talk about our digital ecosystem for the planet.

1.3 Building a Digital Ecosystem for the Planet

Some of this work has already started. The UN Science-Policy Business Forum established a working group on "Data, Analytics and AI" back in May 2018. The aim was to kick-start a global conversation to seize opportunities and establish appropriate safeguards and effective governance. Over 100 stakeholders were involved. Among them were scientific and citizen-science research communities, government and policy institutions, a variety of technology companies and non-governmental organizations. Early in 2019, the working group produced a number of clear ideas making a strong case for a digital ecosystem. These are contained here "The Case for a Digital Ecosystem on the Environment" (31, 32).

The remaining sections of this article summarize the arguments in that paper. Again, these are perspectives from a cross-section of thought leaders determined to secure a solid evidentiary basis for fixing our planet's environmental crises.

The main **call to action** of this article is for public and private sector actors to continue building on this common vision.

The global digital ecosystem should consist of four elements: a) raw data, b) a supporting technological infrastructure, c) algorithms and analytics; d) insights and applications. All this will then be used to support a transformation in our thinking and behavior. One which produces a social tipping point and delivers different sustainability outcomes (see Figure 4).

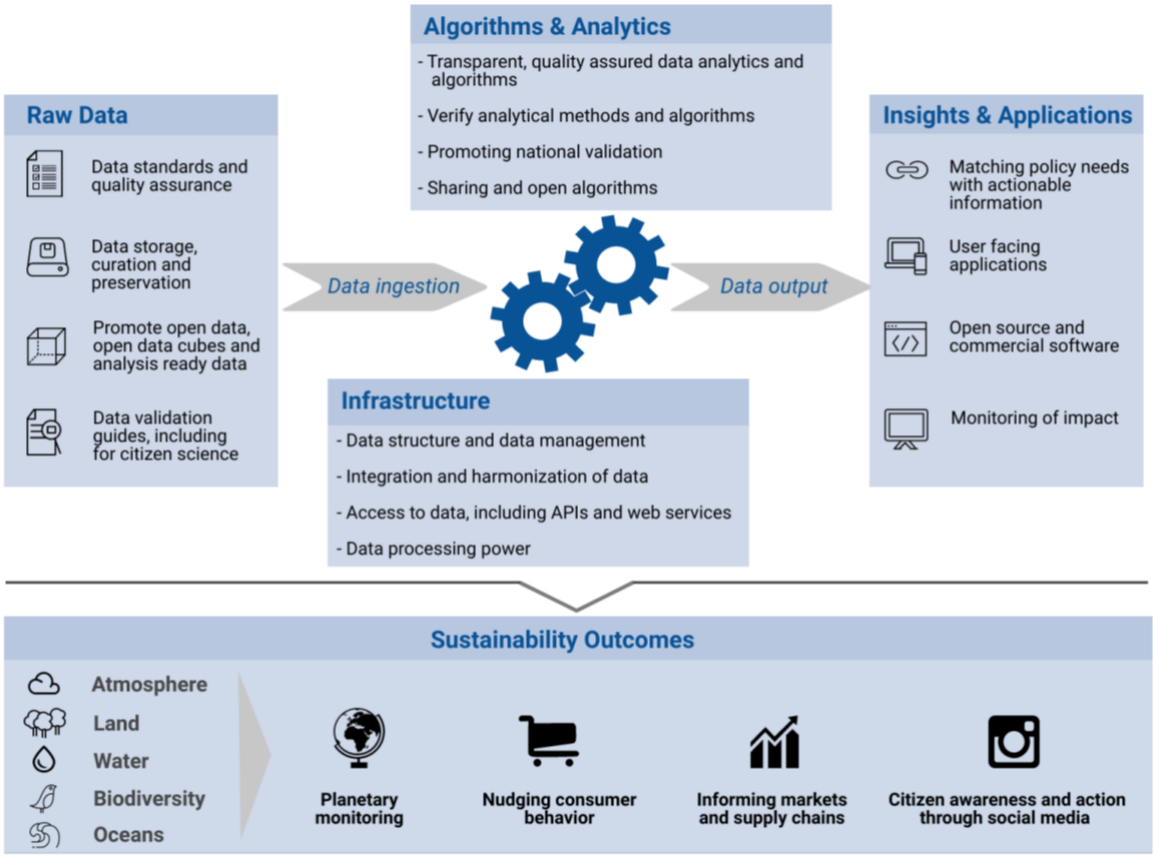


Figure 4. A digital ecosystem for the planet integrates data, infrastructure, algorithms and insights to achieve different sustainability outcomes (33) (Piktochart)

A digital ecosystem can be defined as ***'a complex distributed network or interconnected socio-technological system'***. It features adaptive properties like self-organization and scalability. In this sense, a digital ecosystem, much like natural ecosystems, is characterized by both competition and collaboration among its many diverse public and private sector components.

But it is the numerous interactions and linkages between these seemingly individual or autonomous entities that make an ecosystem functional. Similarly, a digital ecosystem for the planet must connect individual data sets with algorithms and analysis in order to create robust and timely environmental insights and intelligence. It must generate the correct insights at the right scale. It must deliver these at the right time and in the right format. Their goal must be to influence decision-making, action and—crucially—future investment.

As data flows through the ecosystem, it is eventually transformed into insights that can be used for decision making to achieve other sustainability outcomes (Figure 3). Governance strategies and standards will be needed for each step of the transformation process:

- **Raw Data:** The foundation of a digital ecosystem is numerous data sources, including small and big data on environment. These must be collected through various methodologies including official statistical reporting, earth observations, *in-situ* sensors, citizen science, commercial datasets and other

relevant data streams. The ecosystem will include essential information such as metadata documentation and provenance, licensing, collection methodologies and peer review. It will need to delimit for potential biases, confidence levels and relevant use constraints. For each type of data source, standards and guidance will need to be adopted for quality assurance, data labeling and inter-operability (34,35,36,37). This will also require investments to ensure that data models are developed in a way that informs policy and that data is structured and managed in a way that allows high-quality, comparable and trusted analysis. At a minimum, contributors to scientific data pools must be required to publish FAIR data (Findable, Accessible, Interoperable and Reusable) (38).

- **Infrastructure:** The infrastructure for a digital ecosystem will store, process and connect existing databases. It must seek to improve metadata, discoverability and accessibility. For obvious reasons, due to the volume and complexity of such data, it will be impossible to host it centrally. But an ecosystem does not require that all data be pulled into a single central location. Rather the focus will be on bringing data, algorithms and processing power together in various clouds. These will be connected in a manner where data can flow and interoperate seamlessly. But this will require compliance with open application programming interfaces (APIs) and other emerging standards. For this reason, all actors contributing to the digital ecosystem will be obliged to publish information on the infrastructure they are using together with information about their open source and commercial software.

- **Algorithms and Analytics:** Data and supporting infrastructure are, together, the backbone of the digital ecosystem. But these will require algorithms and analytics in order to extract actionable insights and business intelligence. Data science and artificial intelligence (AI) algorithms are already available and growing in number and quality. These will be used to yield data insights. But processes are needed to ensure quality and transparency while avoiding bias and protecting privacy. Peer reviews, open algorithms, and public documentation of processing methods will be essential to ensure public trust.

- **Insights and Applications:** The final part of the process is to transform the knowledge thus generated into actionable insights and evidence. End users need to integrate multiple information streams into metrics and performance dashboards. Such insights and evidence must be made comprehensible to decision-makers, investors, consumers and citizens alike. Timing is essential if public participation, accountability and market pressure is to be sustained in pursuit of the sustainability goal. So is placement, scale and format. Public trust in the resulting insights will be best assured when applications are co-designed together with end users and related institutions. Increasingly, we are witnessing calls for companies to publish information on the business models they are using. This will be needed if potential conflicts of interest can be identified and managed.

The aim is to eventually use the insights to produce outcomes that power sustainability for people and planet. These can include:

- real-time planetary monitoring and predictive analytics for global and national environmental targets—a basic planetary dashboard;
- environmental risk information to markets and commodity supply chains;
- product sustainability information to inform and nudge consumers; and
- verified scientific information for social media to educate and engage citizens.

1.4 What is already being done?

The foundations of a global digital ecosystem for the planet are already being built and tested by a variety of public and private sector actors. The following examples point the way. They show how a combination of data sets and new technologies can provide environmental insights and intelligence that are better, faster, cheaper and easier to access when compared with business as usual. They also show how new sources of data can be collected from a combination of public and private actors as well as citizens. Importantly, these examples are committed to publishing derived data products in an open format as a **digital public good**, contributing to open source software and adopting important global standards and transparency measures.

1.4.1 Global Forest Watch and Resource Watch

The World Resources Institute (WRI) is one of the leading non-governmental organizations to leverage the power of frontier technologies for monitoring the pulse of the planet. Global Forest Watch (GFW) is an open-source web application to monitor global forests in near real-time using satellite images and AI. The GFW is an initiative of the World Resources Institute, with partners including Google, USAID, the University of Maryland, Esri, Vizzuality, GEF, UNEP and many other academic, non-profit, public, and private organizations.

More recently, Resource Watch was established to extend the monitoring capabilities to other natural resources using open geospatial data and statistics. Resource Watch provides journalists, analysts, decision makers, and students the opportunity to explore more than 200 available data sets on the state of the environment, including access to an open API for data sharing. Collaboration with Resource Watch has also enabled the National Geographic Society to launch EarthPulse—a data-driven platform that enables the operational monitoring of key global ecosystems across the planet for decision-makers. Summary dashboards provide actionable information that are updated with the best scientific datasets. The dashboards are augmented with emotionally engaging storytelling and photos to bring the data to life.

1.4.2 Global Surface Water Extent—SDG 6.6.1 app

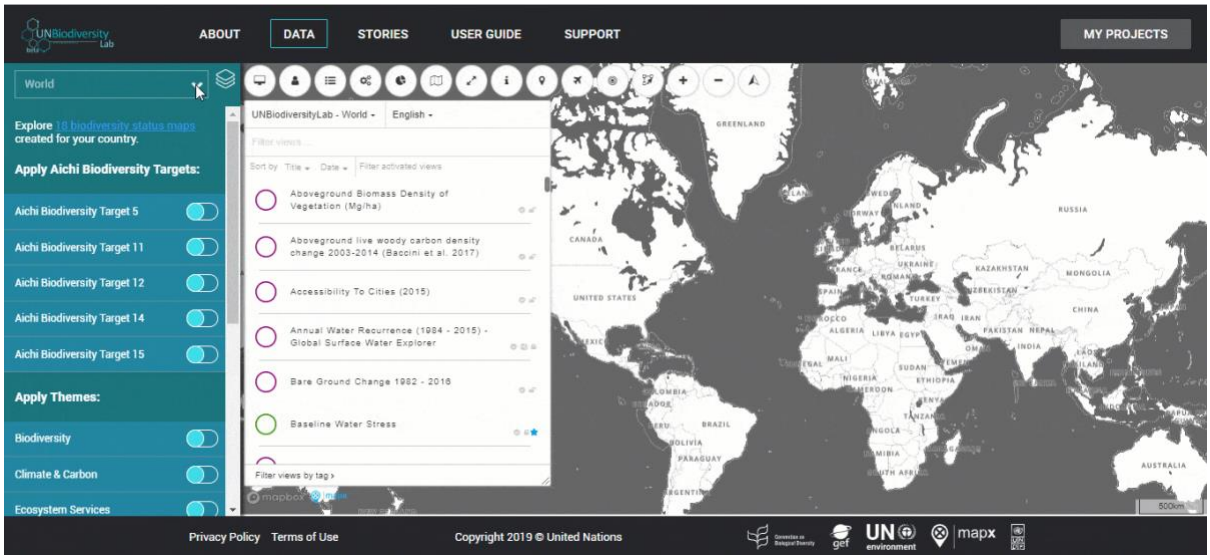
The European Commission's Joint Research Centre (JRC), Google Earth Engine and UNEP teamed up to develop the sdg661.app for Water-Related Ecosystems. The Surface Water Viewer shows changes in global water extent based on satellite images and AI. The period covered is 1984 to 2018. It uses interactive maps, graphs and full-data downloads. This yields a globally consistent and robust set of critical statistics for every country's annual surface water. The platform relies on machine-learning algorithms to automatically detect the presence or absence of surface water and it highlights changes over time. This data is currently being used as a globally consistent baseline for SDG indicator 6.6.1 (change in extent of water-related ecosystems over time) with UNEP offering quality control and data custodianship.

1.4.3 UN Biodiversity Lab

The UN Biodiversity Lab aims to help countries increase the amount of spatial data and analysis used in their 6th National Reports to the Convention on Biological Diversity (CBD). The Lab combines over 100 global high-quality spatial datasets with analysis, visualization, and storytelling tools. It has been designed specifically for policymakers with the aim of helping them make evidence-based decisions for conservation and sustainable development. All reporting countries are provided with customized private cloud workspaces for uploading and analyzing national data in the context of broader global datasets. The tool is simple and easy to use. It does not require any previous experience in mapping software.

A powerful partnership funded by the GEF and the UNDP Innovation Facility, the Lab brings together technical partners including the UN Environment World Conservation Monitoring Centre, NASA, IUCN, and MapX, an open source web mapping architecture developed by UNEP and GRID-Geneva. Countries that used the UN Biodiversity Lab to help them monitor and report on the status of nature increased their use of spatial data by over 200 percent.

The UN Biodiversity Lab continues to evolve. It plans to support countries to move beyond reporting to identify nature-based solutions that can safeguard biodiversity while combating the climate crisis and fostering sustainable development. As part of this agenda, it will upgrade its interoperability with other biodiversity and protected areas platforms including Protected Planet, the Digital Observatory for Protected Areas (DOPA), the Biodiversity Indicators Partnership (BIP) Dashboard and the Global Biodiversity Information Facility (GBIF).



1.4.4 Space Climate Observatory

The Space Climate Observatory (SCO) is an international initiative set in motion at the end of 2017 by France on the eve of the One Planet Summit. Its goal is to combine satellite and field data with scientific research to model, predict and track climate change and its impact. It does so at national, regional and local levels. It harvests information from 20 space agencies including: Europe, China, India, Mexico, Brazil, France, UAE. The SCO programme is expected to play a key role in monitoring the implementation of a number of SDGs.

SCO uses a combination of space technologies, targeted measurements and relevant models cross-referenced with socio-economic data. The ultimate goal is to provide climate change impact scenarios for decision-makers to respond to the challenges of adapting to and coping with these impacts. The SCO was officially launched by President Emmanuel Macron in June of 2019 during the Paris Air Show. On this occasion more than 20 space agencies and international organizations (UNDP and UNOOSA) signed a Joint Declaration of Interest for the creation of the SCO.

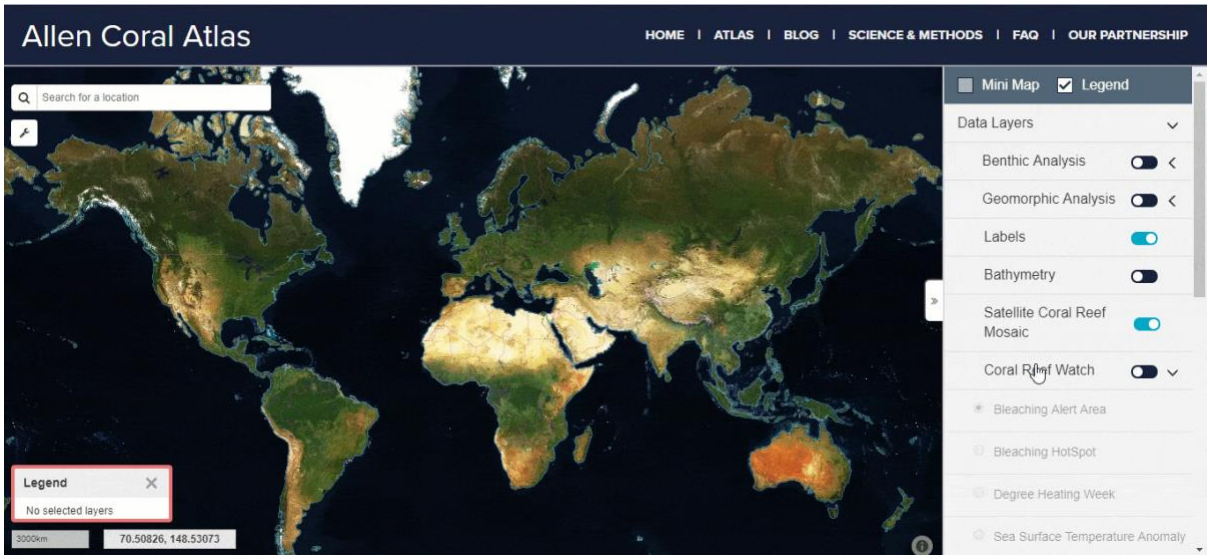
1.4.5 The Open Data CubeThe Open Data Cube

Geoscience Australia developed and released the Open Data Cube technology and it has subsequently been supported, developed and promoted by the Committee on Earth Observation Satellites and the Group on Earth Observations (Figure 4). It has been modified and deployed in Colombia and Switzerland with approximately 50 other countries at different levels of maturity and use. Digital Earth Africa will build on Open Data Cube (39) technology to deliver a unique continental-scale platform.

The aim is to “democratize” access to operational and analysis-ready satellite data. It will track changes across Africa in the following areas: soil and coastal erosion, agriculture, forest and desert development, water quality and changes to human settlements. And it will do so in unprecedented detail. A Steering Committee for Phase I of Digital Earth Africa was formed in 2018 and has broad representation, including Ghana, Kenya and South Africa, as well as from the World Economic Forum, the Global Partnership for Sustainable Development Data and the Group on Earth Observations.

1.4.6 The Allen Coral Atlas

Given the massive threats to coral reefs from climate change, pollution and acidification, a number of global efforts are underway to monitor their health. These efforts use frontier technology and data integration from multiple sources. One of these is the Allen Coral Atlas. This is a global coral conservation effort to map all of the world’s shallow-water coral reefs in unprecedented detail. The process involves continuous monitoring for change using high-resolution satellites, field data and artificial intelligence. The effort is a collaboration between Vulcan, Planet, Arizona State University, University of Queensland and the National Geographic Society.

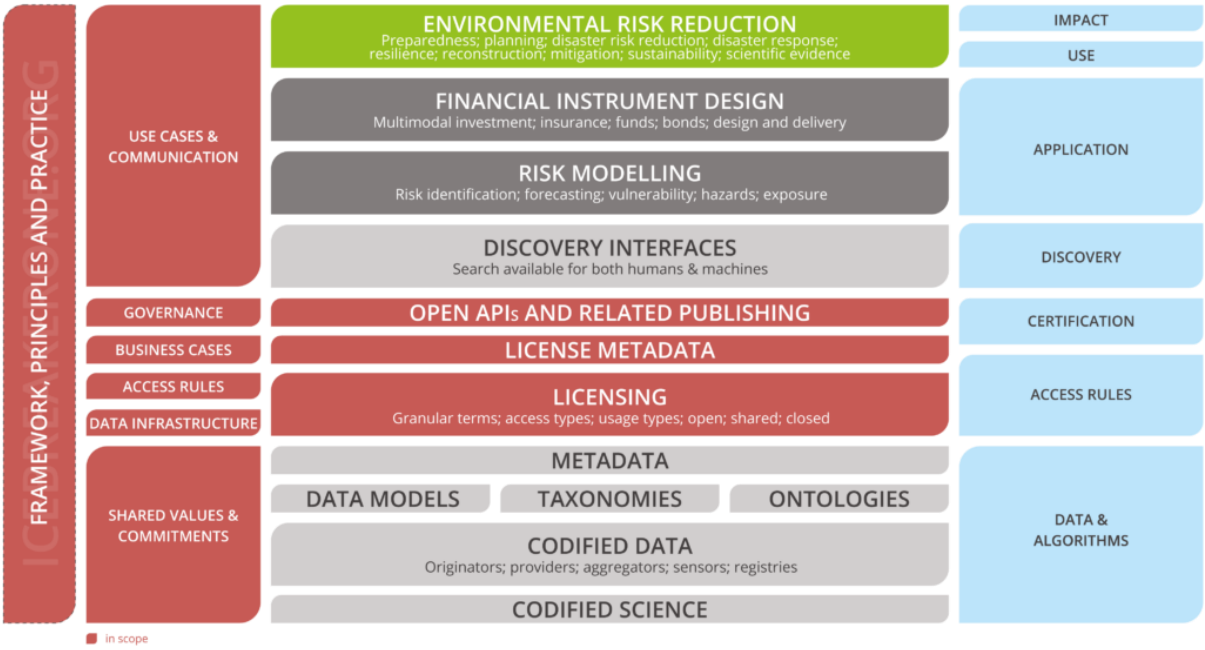


1.4.7 Earth Challenge 2020

Earth Challenge 2020 will help engage millions of global citizens in collecting and sharing one billion open and interoperable data points. These cover: air and water quality, pollution, biodiversity, food systems and climate change. Citizen science volunteers from around the world, working with professional scientists, will collect and share earth science data in their local communities. This will be done through a massive campaign leveraging mobile apps and other sensors. Earth Challenge is a partnership between the Earth Day Network, the Woodrow Wilson International Center for Scholars and other partners to be powered by Amazon Web Services using in-kind credits.

1.4.8 Icebreaker One

Icebreaker One—named after the workshop process of bringing people together—gathers financial markets, public sector institutions, asset owners and the science community into a common space. It aims to unlock the finance, data and innovation needed to address our climate and biodiversity emergencies. Icebreaker One is focussed on the cultural mechanics of data publishing and use: developing common principles and practice. It builds on existing work (e.g. in Geospatial, IoT), bringing together initiatives and organisations to demonstrate the investment case for development, and on specific interventions—such as data licensing—that require cross-sector action. Icebreaker One aims to unlock and integrate the data that can influence investment decisions of $3.6T/year to deliver net-zero or net-negative outcomes, unlocking a marketplace for data sharing through common principles and practice, and $50M/year in leveraged finance for innovation.



1.5 Overcoming the risks

A digital ecosystem for the planet will not come easily. How to build, finance and maintain such a “digital public good” will be a challenge. As will how to harness it as an accountability mechanism for achieving the SDGs. Four key governance risks need to be addressed.

1. **Monopolies linked to global datasets:** Currently, much of the big data and technological infrastructure are held by a handful of companies. This creates a market risk in terms of who has access to use data to make decisions, influence markets and determine investments. It also creates concerns in terms of privacy, data security and dependencies. As companies release a swarm of satellites, drones, sensors and mobile applications to capture information on the earth’s natural resources, it is important to ask how this wealth of data will be governed, how power asymmetries will be mitigated and how anti-trust regulations will be updated (40). We need to understand what incentives, safeguards and standards are needed to ensure that environmental data and processing power are used to help humanity solve long-term global environmental challenges rather than exacerbate existing inequalities and digital colonialism.

2. **Quality, transparency and openness of data and algorithms**: As mentioned, this includes metadata standards, data licensing, provenance and traceability, interoperability and disclosure of potential biases and confidence limits. As companies take an increasing role in the generation of digital public goods, we need to ensure that the quality of data and algorithms are not compromised by the allure of short-term profits. Or the influence of biased and erroneous data as well as misinformation, fake news and “alternative facts”. The potential role of actors such as the UN to serve as impartial honest brokers of data in non-commercial settings should be explored.

3. **Protecting individual privacy, data security and intellectual property**. There are privacy risks related to data which is collected on (or from) individuals. Protecting privacy, intellectual property and security must be core to the design criteria in building the digital ecosystem. There must also be a recognition that some data will, of necessity, remain only at the national level and be governed by national priorities, context and culture. Existing frameworks such as the EU General Data Protection Regulation (GDPR) can help build such protection frameworks within the global digital ecosystem. Increasingly, as algorithms begin to manipulate human agency and exploit human vulnerabilities, we also need to protect against a scenario of hyper consumption fueled by surveillance capitalism (41) and persuasive technologies (42). The privacy and security implications of national regulatory regimes that govern cloud-based data centers also needs serious consideration.

4. **Direct environmental impacts:** as reliance on computers and data centers grows, governments and technology companies need to implement measures to **reduce their direct environmental impact**. This includes using renewable energy solutions across the data ecosystem, addressing e-waste management and improving responsible supply chain sourcing.

Finally, and although this is not a “risk” in the strict sense of the term, the effort to build a digital ecosystem will come to nothing unless governments, academics, the media and citizens **build their own capacity** to engage, use and communicate environmental insights in a meaningful way. This is necessary to avoid the significant risks, commercial dependencies and power asymmetries that could follow if they do not. A global ecosystem for data, infrastructure, algorithms and insights must foster national engagement and buy-in for data to be used for SDGs implementation, policy development and evidence-based behaviors. This must go hand in hand with agile governance models as well as new norms, ethics and values that can guide how the technology sector can contribute positively to sustainability and digital public goods. Above all, we need to learn how to overcome the echo chambers, toxic digital discourse and perverse incentives in the “attention economy” that tend to undermine collective action on the environment (43). We must also learn how to combat digital addiction by putting down our phones and seeking experiences that reconnect us with the natural world.

1.6 What needs to happen next

To move forward with a digital ecosystem for our planet, we need to improve on this vision. We need to develop the business case, new business models and public-private partnership frameworks. We need to combine existing and new standards. More than this, we need to do the following:

- The **UN Science-Policy Business Forum’s Working Group** on Data, Analytics and AI must continue to address these challenges. It must come with an action plan by the next meeting in September 2020—adopt it—and then start implementing it.

- **All UN member states**, international institutions and relevant non-governmental organizations must clarify their own policy positions on how a digital ecosystem for the planet can be built, paid-for and governed in the next 12 months. There is an urgent need for international leadership that can offer a vision, a coordinated strategy and funding to connect the environmental community and policy-makers with technologists and coders (44) (45).

- The Global Environment Outlook and World Environment Situation Room of UN Environment Programme should be powered by frontier technologies and big data. A special debate and resolution on this topic should be considered for the next **UN Environment Assembly** and in the implementation of the global environmental data strategy (46).

- Different funding bodies such as the **Global Environment Facility, the Green Climate Fund,** and **the World Bank** should consider how they can leverage existing and future investments to positively influence the shape of the emerging digital ecosystem for the planet.

- **The private sector and experts in frontier technologies** must continue to work hand in hand with domain experts from different environmental fields as well as end users of environmental data such as banks, pension funds and

insurance companies. They must explore practical applications and use cases for solving different environmental and climate challenges while using technology to drive sustainability(47).

- **Citizens will need to be engaged** in using and collecting data in order to make better environmental decisions and to better engage in a dialogue on the environment with companies and political actors.

- These efforts should be connected to the UN Global Pulse initiative and the work of the **UN High-Level Panel on Digital Cooperation**, including the to the recent report of the panel "The Age of Digital Interdependence" (48). We need to define environmental data streams that comprise digital public goods and imagine new multi-lateral multi-stakeholder processes and institutions that can govern these challenges with coalitions of the willing.

We may worry that building a digital ecosystem for the planet sounds like an ambitious dream. But humanity has successfully come together to achieve similar fantastic visions. The Large Hadron Collider at CERN (estimated to cost USD 1 billion per year) is one example. The Human Genome Project (estimated at USD 200 million per year) is another. These are impressive examples of international cooperation at-scale. They have generated global public goods which continue to propel human knowledge and well-being.

In many ways, we have invested at the atomic, genetic and cellular levels in global cooperation frameworks on a grand scale. Similar cooperation is now needed to build a digital ecosystem for our planet. This is the next logical progression. Our planetary security depends on it.

So here is the call to action. It is time for stakeholders in all domains to unite in building a common vision for a digital ecosystem of data, infrastructure, algorithms and insights to provide actionable evidence on our collective progress towards sustainable development.

A future that leverages the digital revolution for the planet is ours to imagine and create. The future is what we make it. And it is happening now.

1.7 Acknowledgements

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1.8 References

1. The full range of frontier technologies addressed by this brief includes satellites, drones and in situ sensors, cloud and edge computing, artificial intelligence and machine learning, social media and platforms, the internet of things, blockchain and distributed databases, virtual reality, augmented reality and a range of open source and commercial software together with mobile phone applications.
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2. Are These The 20 Top Priorities In 2020 For Building A Digital Ecosystem For The Planet?

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Are these the 20 top priorities in 2020 for a digital ecosystem for Earth?

2.1 A digital revolution for the environment is needed

New Year's 2019 was a harbinger of things to come. As unprecedented fires raged in Australia, equally unprecedented floods inundated Jakarta, the capital of Indonesia. Many linked these events to climate change and called urgently for action by the global community. Yet only a month prior, the latest round of international climate talks in Madrid ended with a deadlock. Despite record-high carbon emissions levels, and in the face of warningsfrom climate scientists about risky, abrupt, and irreversible climate tipping points, the international community failed to act decisively.

Photo by Markus Spiske on Unsplash.

While the youth climate strikes caught the attention of government representatives (even meriting a mention in the conference's final declaration), and half a million people joined the protests in Madrid, the conference ended in a stalemate, as delegates headed home without an agreement. To meet their targets, countries would have to reduce their emissions by an average of 7.6 percent per year over the coming decade: Mission Impossible, according to many commentators. Meanwhile, scientists are also sounding the alarm on the planet's biodiversity crisis: more than 1 million animal and plant species are now threatened with extinction, and the rate of species extinction is accelerating, with grave impacts on the health of ecosystems on which we all depend.

As we consider this situation, three things become clear:

First, business as usual isn't working for global environmental governance.

International and multilateral processes are designed to reflect the aggregation of national interests, but this is not aligned with our collective global interest in achieving sustainability on our planet. Although we have been trying to address existential threats such as climate change for decades, our global carbon emissions have continued to increase. Rates of biodiversity loss have continued to accelerate. A stark picture of "nature's dangerous decline" is painted by recent scientific and multilateral reports — including the new UNEP emissions gap report and the recent reports on climate from the IPCC, biodiversity from the IPBES and our overall environmental outlook (GEO-6). Our global international governance regimes are clearly unable to keep pace with planetary changes and associated social challenges. They are not equipped to move rapidly enough, nor to engage the full range of diverse stakeholders as necessary. Perhaps EO Wilson said it best: "*The real problem of humanity is the following: we have paleolithic emotions; medieval institutions; and god-like technology.*" As the scientists overseeing the recent IPBES report on biodiversity phrased it in a recent article in Science: the pervasive human-driven decline of life on Earth points to the need for transformative change.

Second, we have not yet fully harnessed digital technologies to address our most pressing global environmental challenges.

Digital technologies can support sustainability in a number of ways: for example, through enhancing both monitoring and management, or by facilitating direct payments for ecosystem services to the field practitioners and communities involved. Access to data is a key barrier to environmental management; with digital technology, we can envision integrating local data silos into higher-quality, more comprehensive (and comprehensible) global data sets through augmented data analytics and modeling capacity. This can improve our understanding of the complexity of the Earth system through better monitoring and reporting on the environmental impacts of our society.

Digital technologies can also empower new environmentally-smart solutions, for example by optimizing ecological resource use efficiency. Of particular importance will be automated assessment of environmental data to trigger direct payments for ecosystem services, whether to rural farmers, entrepreneurs or companies implementing ecosystem restoration. Thousands of digital applications now exist for optimizing resource efficiency, though many are in their infancy. There are, however, very few, if any, applications that assess environmental data and then disburse payments accordingly. Similarly, our attempts at data integration are very rudimentary; for example, despite calls for a data revolution for sustainable development, two-thirds of the environmental indicators in the Sustainable Development Goals (Sustainable Development Goal) framework lack global data sets for monitoring progress.

Sustainable Development Goals projected on the UN Headquarters. Photo by UN Photo/Cia Pak on Flickr.

We are flying across the cosmos on Spaceship Earth with no planetary instrumentation panel to measure the state of our life support system, or a flight plan to collaboratively strategize about how our everyday choices and routines shape where we are going together. Reasonable people reading this article would not risk taking a flight on an airplane if it lacked a basic instrumentation panel and intended flight plan, yet we do so every day on Spaceship Earth. Although 2019 was the 50th anniversary of Buckminster Fuller's Operating Manual for Spaceship Earth, it seems we have made relatively little progress in many areas.

Third, the digital economy itself is not yet being leveraged for a sustainable future.

Digitization and the development of digital infrastructures have been accompanied by increasing energy consumption, as well as global consumption patterns that place an even greater burden on ecosystems. Although attempts to green the digital sector are underway, technical innovation surges do not automatically translate into sustainability transformations. And the issues are far broader than greening the ICT sector (although this is important). As technological solutions utilizing digital services are developed, insufficient attention is being given to a number of pressing environmental concerns. For example, data infrastructure is as important as the physical infrastructure for achieving the Sustainable Development Goals, but it is being neglected in current debates. And this is just one example of a missed opportunity; the digital economy includes much more than data.

"The digital economy is generating opportunities to fully integrate information on the current and forecast state of the Earth into all aspects of decision making, from national strategic planning, through to day-to-day actions of individual businesses. [We] resolve to work, individually and through GEO, to encourage use of Earth observations in an inclusive digital economy that promotes sustainable economic and social development." The Group on Earth Observations, Canberra Declaration, 2019

2.2 A global agenda for a digital ecosystem for Earth

In light of the above, we believe the time is right for the creation of a digital ecosystem for Earth: a set of nested, fully integrated global environmental monitoring, data-sharing, and decision-support systems designed to enhance precautionary, predictive, and adaptive environmental governance. In our vision, a digital ecosystem for Earth is built to support constructive action towards sustainability, and is both co-designed and consulted by governments, large organizations, as well as individual citizens.

This is not a simplistic techno-utopian vision. Enormous challenges exist with respect to privacy, security, and the future of frontier technologies like artificial intelligence. Concerns raised about an emerging surveillance society are, we feel, valid. The basic fact is that the digital economy is moving faster than our ability to govern it, and the critical question of where it is headed remains unanswered. We need to balance our optimism about technical solutions with realism about the limits of technology, appropriate skepticism about over-hyped solutions, and a healthy dose of anticipatory caution about unintended consequences.

Despite these potential pitfalls, we believe that we are at a pivotal moment in history: mobilizing the tools of the Digital Age to address our most pressing environmental threats will be critical for ensuring a more sustainable future.

In our first collaborative article on Medium, we proposed that the ongoing digital revolution needs to be harnessed to drive forward a transformation towards global sustainability, environmental stewardship, and human well-being. We called on public, private, civil society and international actors to take deliberate action and collaborate to enable a global digital ecosystem for the planet, mobilizing infrastructure, software, and data analytics to generate real-time insights that can power the structural transformations needed to achieve sustainable development goals.

Based on the responses to our first article, we are publishing two new articles (both on Medium): (1) this "priorities" article, which addresses the *what* and the *why* of a digital revolution for the environment, and sets out 20 critical goals for 2020; and (2) a companion "multi-stakeholder processes" article, which will address the *who* and *how* by highlighting 20 of the most important multi-stakeholder initiatives to engage and influence in 2020.

Our primary target audiences for these pieces are:

1. **Decision-makers on environment and digital policy:** including nation-states, multi-laterals, regional unions, not-for-profits engaged in multilateral dialogue governance on digital and environmental issues, and those charged with crafting digital system architecture and environmental policy.

2. **Practitioners, end-users, and citizen scientists:** including earth and environmental scientists, boots-on-the-ground conservationists, private sector companies (including tech companies) of all sizes, conservation tech innovators, together with end-users.

3. **Youth and the next generation of influencers:** the growing environmental youth movement and the next generation of citizens, scientists, engineers, coders, and policymakers — the future stakeholders of our planet.

4. **Indigenous and Tribal Peoples**: managers and protectors of natural resources, and guardians of biodiversity, for whom Indigenous data sovereignty and data rights are key issues.

2020 will be a critical year for action before the window of opportunity closes to influence the future configuration of the digital economy, for two reasons. First, many national and international initiatives are moving ahead to strengthen governance of the digital economy. It is essential that these processes also include a focus on environmental sustainability issues, and begin to embed the idea of a digital ecosystem for the planet. Second, the environmental clock is ticking: we only have 10 years left to achieve the Sustainable Development Goals, strive to keep the average global temperature increase within 1.5 degrees, and foster resilience. Decisions and investments are needed now in order to scale to meet these 2020 goals.

Given this urgency, our vision for 2020 is that a digital ecosystem for the planet becomes a key outcome for digital governance initiatives and a key mechanism for environmental agendas to be achieved. This vision is closely aligned with the UN Decade on Ecosystem Restoration (2021-2030) which seeks to have long-term decision-making in societies worldwide — whether in urban, suburban, agricultural or industrial landscapes — underpinned by quantitative analysis of all the social, economic and environmental benefits emanating from ecosystem restoration.
We hope that substantive advances can be made on a digital ecosystem for Earth. We discuss *how* and *who* could take this agenda forward in a separate companion article on multi-stakeholder processes, to be published on Medium next week. The rest of this article focuses on *what* we should aim to achieve and explores *why* the time is right for a global digital Earth agenda. *You can interact with the below map to explore more about our vision for a Digital Ecosystem for the Planet and to access the other articles (article #3 to be released week of January 20, 2020).*

2.3 Why build a digital ecosystem for Earth? Why now?

In short: because we need it now, and it is feasible to a degree that was not possible even five years ago in terms of scale, cost and usability.

The basic idea of building a digital ecosystem for the planet has been around since at least the launch of the first satellite solely dedicated to Earth observation in 1972. NASA's Earth Observing System Data Information System (EOSDIS) was one of the first space-based programs for assessing humanity's impact on the global environment. Key pieces of our envisioned digital ecosystem for Earth, such as the first digital networks of meteorological data, were put in place even earlier. Since that day, Earth Observing systems have returned petabytes of data, approximately 90% in the last 5 years, and super-computing systems have become one billion times faster.

Today, we have the ability to extend this digital ecosystem to integrate a broad range of variables, both biotic and abiotic, from the depths of the oceans to the edges of space. We also have the ability to create decision-support systems that enable dynamic governance: spatially and temporally responsive environmental management on ecologically appropriate time scales. This newfound ability is due to the exponential increase in environmental data from satellites, drones, sensors and in situ data through methods like citizen science; combined with the advent of relatively inexpensive, cloud-based storage and data-adjacent compute this has created a literal tsunami of environmental data. Although many organizations still manage this data using spreadsheets (and we have a mountain to climb to reach our goal of accessible, transparent data governance), our ability to extract insights from this data has expanded exponentially thanks to advances in machine learning and massively-parallel scientific computing (and, in the future, quantum computing).

Photo by NASA/Larry Kepko on Flickr.

In developing these new techniques, technologies, and opportunities, bottom-up leadership and cross-disciplinary collaboration have emerged from a variety of sectors and institutions. For example, researchers from computer science and engineering have been collaborating with ecologists and biologists to create entirely new disciplines like computational sustainability, ecological informatics, and digital earth studies. Innovative hackathons, such as GEOHACK19, are harnessing the collective intelligence of the crowd to co-design innovative solutions with and for Indigenous peoples, that combine traditional knowledge and science across cultural and generational lines. Artificial intelligence (AI) researchers, cognizant of the highly energy-intensive nature of machine learning, have recently launched an agenda tackling climate change with machine learning. Academic initiatives like DataOne, which enable data sharing between Earth and environmental scientists, provide inspiration for the agenda we are now proposing: building a digital ecosystem for the entire planet, in a dialogue-based process which brings together public, private and civil society actors together with academics, in a multi-stakeholder process that creates and enables a common vision. Digital technologies can also be incorporated into this international dialogue, enabling humanity to enhance its collective intelligence and collaboration in a more inclusive manner.

We believe that the way we decide to deploy frontier digital technologies (e.g. artificial intelligence, machine learning, cloud computing, the Internet of Things, distributed ledger technology) combined with innovations in governance (e.g. safeguards for privacy, security, licensing, transparency and accessibility) will shape the evolution of the digital age and our ability to build a sustainable future. Human culture is fundamentally shaped and influenced by technology — we are “designed” by that which we design. Choices must, therefore, be made that will drive positive environmental outcomes, for all species on Earth (humans and non-humans) as well as the ecosystems upon which they depend. In making this observation, we are mindful of the differential rates of adoption and access around the world, and unequal access to digital technology globally. We acknowledge that individual citizens are also taking action, and wish to avoid top-down or ‘baked-in’ one-size-fits-all solutions. And we are keen to avoid over-hyping technological solutions, which are embedded in socio-economic and political contexts, and are not a magic bullet.

Tech companies could be leaders in advancing this digital ecosystem for Earth agenda. Some companies, including “Big Tech” companies, have advanced a green energy agenda, reducing carbon emissions and investing in renewable energy. Many technology companies have also begun exploring how to support and enhance sustainability across their entire supply chains, innovate in environmental data infrastructure. We can expect more engagement on these issues in the future; senior tech leaders like Microsoft’s Brad Smith have identified sustainability as a top tech issuefor the 2020s. Much attention has been focused on reducing carbon emissions, which is encouraging; DeepMind, for example, has been used to cut the amount of electricity needed for cooling Google’s data centers by 40% and is also being used to predict the energy output of wind farms up to 36 hours ahead, enabling the optimization of energy deliveries to the grid. However, the range of conservation technology applications is much broader than this (for a review, see this article on Smart Earth technologies). Indeed, an emerging ecosystem of ‘conservation technology’ companies is entirely focused on creating an environmentally-friendly and

environmentally-focused digital economy, aligned with longstanding efforts in the scientific community.

Our vision aligns more closely with this broader 'conservation technology' agenda. Experts from a range of disciplines have put forward bold new visions for a digital ecosystem for the planet — albeit using slightly different terms and metaphors along an ambition continuum. These include aplanetary computer, earth optimization, design for planetary health, anoosphere for collective intelligence, smart earth, digital earth, platform planet, digital ecology, fourth wave environmentalism, and a central nervous system for the planet. In many cases, academics are collaborating with the private and not-for-profit sectors to jointly create an artificial intelligence platform for the planet to fundamentally revolutionize the fight against global challenges, such as climate change, biodiversity loss, and water scarcity, to name a few. The need for a common, coordinated observation and analysis global solution becomes even more obvious when these challenges are brought together in a nexus of interactions between water, energy and food security.

Building a digital ecosystem for Earth will be one of the most ambitious visions ever undertaken by humanity. We believe it can be accomplished because we have already set important precedents for this kind of global collective action. The large hadron collider at CERN (USD 5 billion), the Human Genome Project (USD 3 billion), the International Space Station (USD 150 billion), the Global Positioning System (USD 5 billion) and the Internet itself are all examples of public and private sector actors collaborating at scale to achieve a transformational global public good.
A healthy digital ecosystem not only offers insights we need for coherent decision making but also recognizes the human implications of the structure and use of this technology. This includes consideration of

1. **Ownership:** the structure and ownership/custodianship of the hardware systems, software systems, and data;
2. **Inclusion and accessibility:** how we co-design, engage, navigate and promote such an ecosystem;
3. **Science-policy interface:** how the information and insights from that ecosystem are linked to credible science and scientific review processes, and how these are articulated with policy;
4. **Data sharing:** how access to rapid insights from a wealth of information and the practice of widespread collaboration can support augmented and collective intelligence; and
5. **Digital environmental justice:** how diverse, inclusive and equitable commitment to environmental justice should be reflected in the processes and priorities of a digital ecosystem, drawing inspiration from digital environmental justice methods such as community informatics and participatory mapping[6].

In making this call for action, we are mindful of issues of environmental justice. The digital divide (e.g. unequal access to digital technology, and exclusion from design) and algorithmic bias are of concern. We are also mindful of the vulnerability of environmental data (see the work of the Environmental Data and Governance Initiative). Meaningful inclusion of a diverse range of stakeholders is, in our opinion, a prerequisite for moving forward.

Photo by Vlad Tchompalov on Unsplash.

In particular, as we move towards a digital ecosystem for Earth, recognizing the vision, worldviews, ecological knowledge, and the rights of Indigenous and Tribal Peoples (including their right to Free, Prior and Informed Consent under the UN Declaration on the Rights of Indigenous Peoples) will be key to protecting the natural world. Indigenous peoples make up less than 5% of the world's population, yet their traditional lands are home to 80% of the world's biodiversity. Some indigenous communities are already innovating with technology for a broad range of environmental sustainability goals, as well as Indigenous-led AI [7]. The digital economy raises some fundamental questions about Indigenous data storage, ownership, access, and consent. Any framework that is developed for a digital ecosystem for Earth should affirm Indigenous peoples' rights, including their right to set their data agenda, and the right to choose the conditions of Internet connectivity. It is imperative to engage, learn from and co-design digital solutions with Indigenous communities.

Another key issue is data architecture and governance. This issue continues to be a significant focus for both academic researchers and practitioners, as well as international and multilateral organizations; summarizing their activities is beyond the scope of this article. Instead, we emphasize the importance of accessible, transparent data, and an overhaul of digital data governance, as a precursor to the specific targets identified below. Unless data-related governance issues (including data discovery, open licensing regimes, intellectual property, and user co-design) are addressed, the potential of a digital ecosystem for Earth will be limited.

2.4 Three priority engagement tracks for 2020

A digital ecosystem for the planet is the next logical step forward for humanity to unleash a new era of digital public goods at a planetary scale. But conceptualizing a digital ecosystem for the planet is the easy part. The hard part is dividing up and sequencing the necessary actions that must be undertaken by different coalitions of public and private sector actors together with civil society.

We believe that action can be broken down into three main tracks, which we explore below. The tracks are further broken down into twenty preliminary targets, which are intended to be actionable goals. These twenty targets have been identified through a collective intelligence process involving 70 experts from the environment and technology sectors. We view this list as a first iteration that we anticipate will evolve as the dialogue continues. To enable this dialogue we are also publishing an Annex that provides more substantive detail on each of the targets.

Track 1: Data/System Architecture

The first track is the system architecture of a digital ecosystem of data, infrastructure, and algorithms that can generate and deliver real-time insights about our environment and the health of our planet at any scale. This is largely a technical track that focuses on building on existing or establishing new standards, policies and basic architecture to link the various components and ensure it can be directed towards important public policy questions and the generation of digital public goods on the environment.
Within the emerging digital economy, these public goods will largely be produced by a combination of public and private sector actors. If we truly want to harness the potential of data to manage the planet, we need to understand and find ways to unlock and reuse private data, as well as platform-based user-generated data for the public good and for advancing sustainability. Especially for environmental and natural resource challenges, it will be essential to share and integrate various forms of public, private, platform-based user-generated and citizen science data that can speak to environmental change, socioeconomic patterns as well as human behaviors, networks, perceptions, and sentiments.

This track is largely the technical domain of coders, data scientists, statisticians, and computer engineers combined with experts from the natural sciences including ecologists, geographers, biologists, hydrologists, climatologists, and remote sensing scientists. Precedents and potential collaborators include the work of policy networks, such as the Internet & Jurisdiction Network, academic data-sharing initiatives such as DataOne, collaborative public-private partnerships such as NOAA's cloud-based open environmental data access initiative, the collaborative networks to analyze massive astronomy and other science datasets, and the Global Indigenous Alliance, an international network promoting Indigenous control of Indigenous data.

In 2020, we need to strategically target the initiatives which ensure transparency, accessibility and quality control for environmental data. We believe the following targets can be achieved:

● **Target 1 // Measuring SDG indicators:** A method is developed for monitoring of Sustainable Development Goals, including an integrated, accessible dashboard at the global level. Over 95% of the environmental indicators in the Sustainable Development Goals can be measured and monitored on a global level using data-sharing methods adopted through the use of regional, sub-regional and country-level mechanisms.

● **Target 2 // Open Data:** Environmental data held by governments and multilateral organizations needed to measure progress against the Sustainable Development Goal indicators is made open and released into the public domain in an accessible and interoperable manner. Data is consistently open and findable, accessible, interoperable, and reusable (FAIR). Documentation of data quality is sufficient for secondary users to assess fitness for use in research and policy purposes.

● **Target 3 // Data Discovery, Access, Licencing and APIs:** An international framework is proposed to enable the discovery, access, license and use of environmental data originating from different data custodians and regimes. This includes both governmental and commercial providers of Earth Observation data and analysis products. The framework includes a common code of conduct for partnerships with public institutions and civil society, focusing on adequate monitoring data for the Sustainable Development Goals. We need to build systems of data production that are more frequent and globally complete together with standardized “APIs for Earth” (application programming interfaces).

● **Target 4 // Standards and Scorecard:** Leveraging existing frameworks and tools, like DOIs, a set of international technology standards, norms and best practices for a digital ecosystem for the planet are adopted, and a scorecard methodology is developed. These standards include crowdsourcing and citizen science, as well as the use of passive monitoring data.

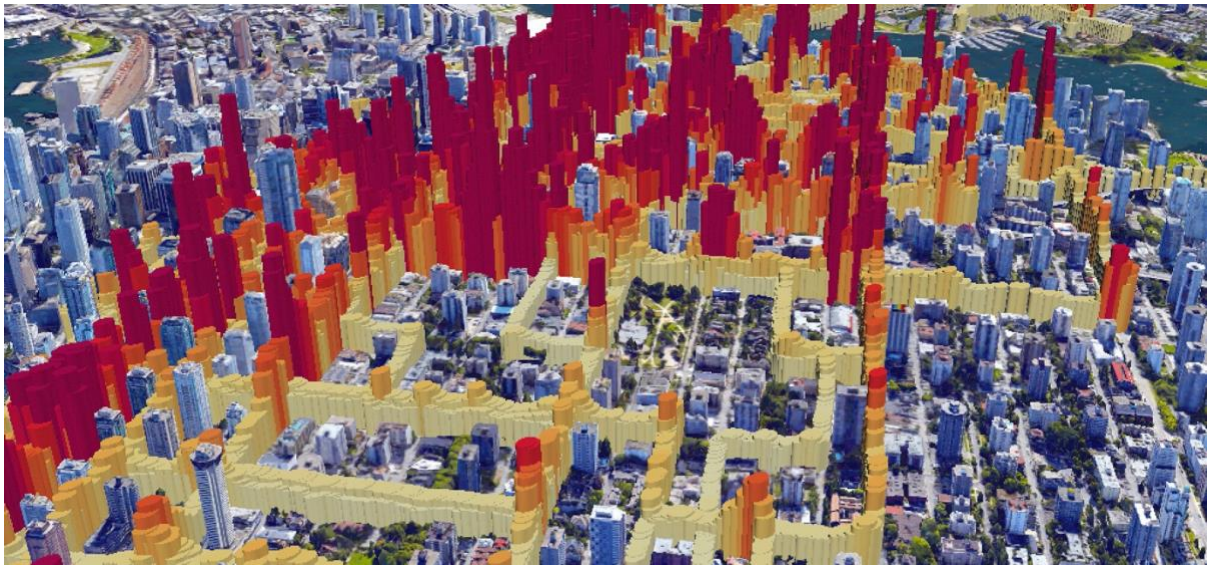
● **Target 5 // Data Collaborations, Commons and Trusts**: Clear guidelines and decision-making processes are available for public-private collaborations on data commons, data trusts, and data aggregation to address different global environmental challenges.

● **Target 6 // Indigenous Data Governance:** Indigenous Peoples are engaged and active participants in the data space. Indigenous Data Sovereignty, the process by which Indigenous Peoples govern and control all aspects of their data, is embraced by both public and private entities. The CARE principles for Indigenous Data Governance (**C**ollective benefit, **A**uthority to control, **R**esponsibility, and **E**thics) is a recognized international framework, complementing the existing FAIR standards by ensuring data guidelines address power imbalances.

Track 2: Applications

The second track focuses on transformative applications that will exponentially enhance monitoring and regulatory capacity, as well as the capacity of buyers of ecosystem services to purchase the services directly from field practitioners. This should lay the foundation for accelerating action on specific environmental targets, ranging from consumption patterns to conservation targets and the Sustainable Development Goals.For example, it has been estimated that digital information and communications technologies (ICT) can enable a 20% reduction of global CO2e emissions by 2030 when strategically applied to five sectors: mobility, manufacturing, agriculture, energy, and buildings.

Leading AI researchers have recently published an ambitious agenda for machine learning and climate change and AI's role in achieving the Sustainable Development Goals. For example, machine learning and game theory are now being applied for predictive poaching prevention; one system, Protection Assistant for Wildlife Security (PAWS), is being integrated into the world's largest digital conservation monitoring network (the SMART network) and applied in over 600 wildlife sanctuaries in 55 countries around the world [8]. Transformative applications supporting circular economies, cradle to cradle design, supply chain sustainability and the like are already in use by behavioral psychologists, economists, financial and insurance experts and government decision-makers. This ecosystem of applications supporting sustainability should be mapped and supported.



Visualization of measured carbon-dioxide mixing ratios in Downtown Vancouver. Photo by the University of British Columbia on Flickr.

Social scientists have thoroughly documented some of the pitfalls of data infrastructures and planetary computerization; insights from their incisive critiques should be incorporated [9]. Most importantly, there is a need to focus on end-users' needs and pathways for capacity building. We have chosen four sectors and allocated two targets per sector: urban, fintech, citizen science, and environmental stewardship. In 2020, we need to strategically target the sectors where the largest sustainability gains can be achieved from frontier technology, develop an inclusive dialogue with a diverse set of actors and environmental stewards, and take a "nature first" approach.

Urban

● **Target 7 // SMART Cities:** A global protocol and standard are proposed for publishing environmental and climate data generated through SMART city applications, designed in a manner enabling input into national and global Sustainable Development Goal monitoring processes

● **Target 8 // Digital Twins: "**Digital twins"[10] are adopted as a planning and sustainability optimization tool for 10 of the 100 cities with the largest emissions footprints.

FinTech

● **Target 9 // Fintech and SDGs:** Establish principles, standards and targets for the integration of Sustainable Development Goals with emerging financial technologies, with specific focus on government, corporate and private equity finance stakeholders that are funding this transition.

● **Target 10 // Environmental Footprints of Products:** At least one global e-commerce platform and one leading Fintech firm offer consumers information on the supply chains and environmental footprints of products using standard metrics that enable comparability and sustainability nudging.

Citizen Science

● **Target 11 // Consumer Awareness and Behavior:** Mobile phone apps are used at scale to help individuals seamlessly calculate their individual environmental footprints. Nudge technologies push citizens to improve their sustainable consumption choices and as well as contribute data to citizen science.

● **Target 12 // Extended reality**: International organizations release at least 3 new extended reality applications that allow users to downscale global reports and data on environmental degradation and climate change to the community level to understand the projected impacts as well as practical solutions.

Environmental Stewardship

● **Target 13 // Accessible Digital Resource Management Tools:** Users in underserved communities are able to trial digital technologies as inputs for different low-cost commercial resource management applications. We suggest that this can be achieved through Open Data Cubes being completed for the world, focusing on Africa and Latin America.

● **Target 14 // Applications for Indigenous Peoples:** ICTs are used by Indigenous peoples to maintain and strengthen their culture through the use of earth observation data and in-situ observations. Further, Indigenous communities that share data on in-

situ environmental monitoring maintain control and governance over their information, in line with the UN Declaration on the Rights of Indigenous Peoples.

Track 3: Governance and Policy

The third track is about the governance of the digital ecosystem for the planet. This is largely about governing the distribution of power over decision making, benefits-sharing and accountability across the public and private sectors. This also tackles a range of fundamental issues at the global level linked to data ownership, sovereignty, privacy, and security.

If information is power in the digital economy, then who controls access to environmental data, insights and processing infrastructure is a fundamental consideration. Indeed, the success of the most valuable tech companies in the world is now underpinned by a sophisticated capacity to collect, organize, control, analyze and commercialize stores of user-generated data.These companies have amassed more data about people (and their behaviors) than many governments and organizations around the globe. They also control much of the cloud infrastructure required to process, integrate and extract “public good” insights. But much of this analytical capacity also relies on publicly-funded data sets, including satellite images, census, surveys, and others. In short, building a digital ecosystem for the planet is going to inherently involve public-private partnerships. Improving global governance over data goes hand in hand with adopting a shared set of values and ethics to underpin a more agile approach to digital governance and digital humanism.

Arguably, this is the most difficult track to implement. It is much easier to develop a data infrastructure than have data providers agree, for example, on data license concerns, including privacy. But such agreements are fundamentally necessary in order to allow data to flow to end-users with minimum friction. This track is also the most political of the tracks, and largely involves high-level, plurilateral decision-makers, lawyers, and policy experts operating at an international level, balancing geopolitical and commercial concerns and interests.

In 2020, we need to strategically target key multilateral processes on digital technologies and on the environment, and ensure that they have acknowledged and incorporated the necessary conditions and frameworks for a digital ecosystem for Earth, while developing a set of “model protocols” that enable data sharing, applications/use and safeguards.

● **Target 15 // Global Commitment for Digital Cooperation:** The environmental governance and sustainability agenda is integrated with the “Global Commitment for Digital Cooperation” by the UN’s 75th birthday in 2020, together with concrete actions and financing.

● **Target 16 // Digitization Strategy for Global Environmental Institutions:** At least 90% of the key global environmental institutions, agreements and strategies complete a Digital Review, adopt a digitalization strategy and hire a Chief Data Officer or Chief Digital Officer.

● **Target 17 // Global Environmental Data Strategy:** International consultations are initiated towards the adoption of an inclusive Global Environmental Data Strategy.

● **Target 18 // Digital Charter:** An international Digital Charter for Environmental Sustainability is initiated, as an inclusive process which co-defines, with a diverse set of users, an ethical framework to guide the development of digital technology and applications.

● **Target 19 // Indigenous Inclusion:** Indigenous data sovereignty is incorporated into the preceding targets, through inclusive dialogue with Indigenous communities and initiatives.

● **Target 20 // Detecting Fake Environmental News:** Methods are identified and vetted for detecting information on social media platforms about the environment that are either fake, biased, discriminatory or scientifically unsound, and a user-friendly repository of these methods is shared with the international community, as the first step towards action on digital misinformation on environmental issues.

Table created by Douglas Robb (UBC).

A digital ecosystem for the planet is an ambitious idea. It will require us to build a global network that integrates petabytes of data points about our environment with the computing power, networks, and infrastructure to process them into actionable insights. These insights will enable decision-makers from all sectors to integrate sustainability and environmental stewardship.

We believe the best way to advance a digital ecosystem for the planet is to start now and break down the required actions into a series of concrete actions and targets. We have listed 20 specific targets (as well as rationales and baselines) that we believe can be achieved by the end of 2020 in the Annex to this article. These targets should be understood as preliminary, and as a starting point for dialogue.

They were developed through a rapid collective intelligence process that included policymakers, scientists, and representatives of the public, private, and not-for-profit sectors at national and multilateral scales. However, we are aware that this group (diverse though it is) is still insufficiently inclusive. A key next step will be to consult with a broader range of environmental stewards, including Indigenous peoples, local communities and citizens — core end-users of this technology. An example of an initiative already underway is the GEO Indigenous Alliance, which engages Indigenous communities around the world in challenges that can be addressed using open Earth Observation data. The UN Decade on Ecosystem Restoration will also be providing a digital platform and developing a global movement to bring a wide range of stakeholders together for cross-sectoral dialogue on how to catalyse large-scale ecosystem restoration globally, including through innovative technology. Finally, we also believe that the ICT sector has a key role to play in this transition; we plan to publish a follow-up article focused on this topic.

Photo by Ravi Kumar on Unsplash.

The nature of the digital economy and the global reach of different platforms demands a multi-scalar, multi-stakeholder and cross-sectoral response at the international level. Individual regulatory actions on the national scale won't amount to a global solution. Together, these technologies can illuminate the scale of the challenges we face as never before, enable us to undertake faster and more agile interventions, measure and monitor the actions we take more effectively, enable new stakeholders to participate, and bring revolutionary levels of transparency to the entire enterprise. That transparency will, in turn, drive greater accountability and promote trust.

Public and private sectors must join forces to forge the digital future that we want, and not allow private capital to dictate our future based on short-term profit. We have already seen the consequences of a digital world that are largely driven by algorithms designed to maximize revenues and return on investment (ROI) rather than human values. The unsustainability of our current linear economic systems will only be amplified by digital technology and exponential business models. We must use technology to move towards green, circular and regenerative economies that actually protect and enhance natural, social and human capital. We must build a future where business opportunities and incentives in the digital space also advance our collective environmental and climate goals and sustainability values.

Building an initiative on a global scale requires leadership. We view the UN's role as a catalyst, helping to highlight the challenges and bring a diverse range of people and organizations into dialogue. The digital tech sector is clearly instrumental in the creation, support, and sustainability of this digital ecosystem. However, unlike industries such as finance, insurance, agriculture, pharmaceuticals and energy, the tech sector has not yet been brought into international agreements on environmental issues. We believe that the UN has a key role to play in catalyzing and incentivizing the more direct integration of the tech sector into international environmental fora. This dialogue must also incorporate public and not-for-profit actors, as well as citizen scientists, land stewards, and civil society more broadly, collaborating to create a shared strategy for the future of our digital environmental commons.

A revolution is underway in environmental governance. A growing movement is using the tools of the digital age to address the most critical threats of the Anthropocene. We intend to take forward these ideas via dialogue with the international community throughout 2020. **Join us and email us**.

To explore all three papers and learn more about the various priorities and processes we have identified for 2020, we invite you to play around with the interactive ecosystem map below. *Please note that this is best used on a desktop, and is not particularly mobile-friendly.* Alternatively, you can access the first paper here and we will soon add a link to our processes article here and in the interactive maps within this paper once it is released.

Interactive Ecosystem Mapping is led by Christina Bowen with support from Digital Life Collective. To open this map in a new tab, click here.

2.5 Footnotes & Appendix

[1] Authorship for the article is based on the CRediT (Contributor Roles Taxonomy) protocol. This includes 14 roles typically played by contributors to scientific scholarly output: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing — original draft, Writing — review & editing.

[2] UNEP: Conceptualization, formal analysis, writing — original draft, review & editing.

[3] UBC: Conceptualization, formal analysis, visualization, writing — review & editing.

[4] UBC: Visualization, formal analysis, writing — review & editing.

[5] Everyone in the group of *contributors* assisted in the writing, review, and editing process. Within *Graphics/Visualizations*, Christina created the interactive ecosystem maps, Kristen created the cover image and Doug created the graphics within the sidebars of the ecosystem maps, as well as the top 20 targets graphic in the article. The group of *peer reviewers* assisted by reviewing the final draft and double-checking the accuracy of claims.

[6] **Digital environmental justice.** See, for example, de Moor, A., 2018. A Community Network Ontology for Participatory Collaboration Mapping: Towards Collective Impact. *Information*, *9*(7), p.151; Dunn, C.E., 2007. Participatory GIS — a people's GIS?. *Progress in human geography*, *31*(5), pp.616–637. See also: Walker, D., E. Nost, A. Lemelin, R. Lave, and L. Dillon. 2018. Practicing environmental data justice: From DataRescue to Data Together. *Geo: Geography and Environment* 5 (2):e00061.

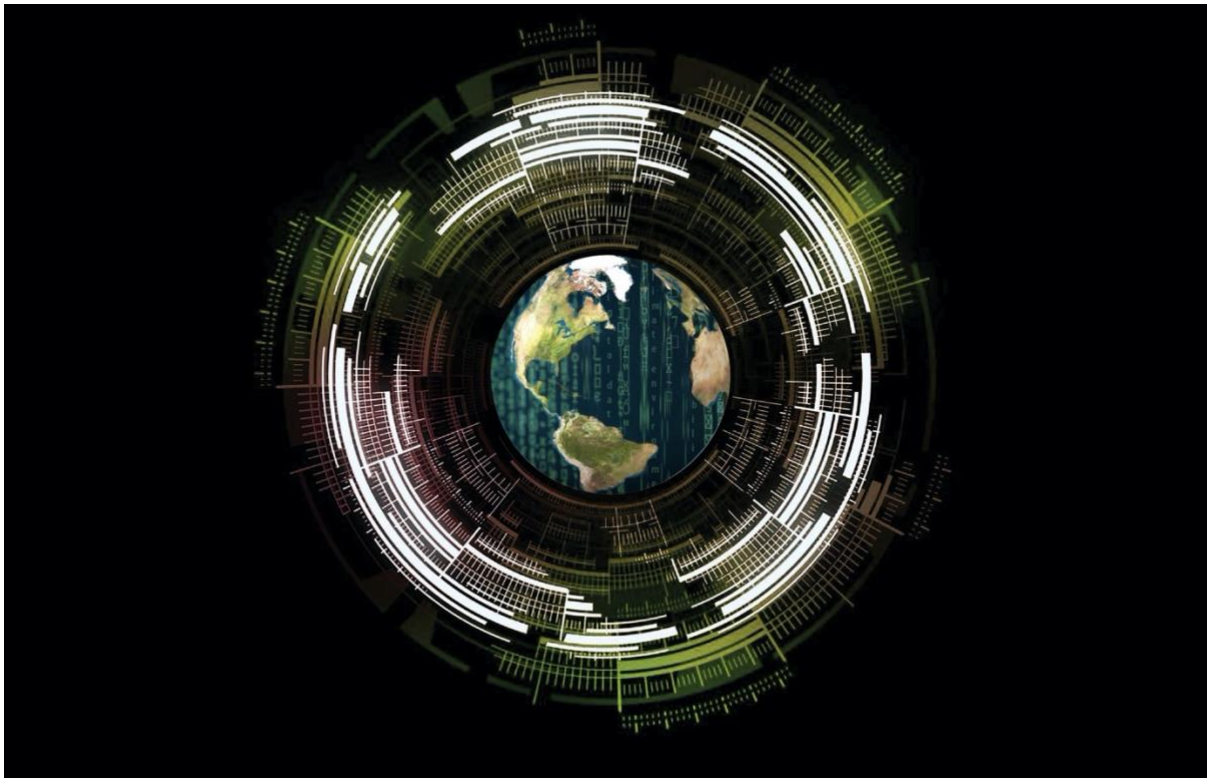
[7] **Indigenous digital strategies.** CyberTracker technology has been used for decades by Indigenous communities around the world. In Australia, for example, CyberTracker technology is being used for on-the-ground resource management by Indigenous rangers, and a range of geolocalized databases have been developed to house Traditional Environmental Knowledge. See: Ansell, Shaun, and Jennifer Koenig. "CyberTracker: An integral management tool used by rangers in the Djelk Indigenous Protected Area, central Arnhem Land, Australia." *Ecological Management & Restoration* 12, no. 1 (2011): 13–25; Pert, Petina L., Emilie J. Ens, John Locke, Philip A. Clarke, Joanne M. Packer, and Gerry Turpin. "An online spatial database of Australian Indigenous Biocultural Knowledge for contemporary natural and cultural resource management." *Science of the Total Environment* 534 (2015): 110–121.

[8] **AI and game theory for conservation.** See Fang, Fei, Thanh Hong Nguyen, Rob Pickles, Wai Y. Lam, Gopalasamy R. Clements, Bo An, Amandeep Singh, Brian C. Schwedock, Milind Tambe, and Andrew Lemieux. "PAWS-A Deployed Game-Theoretic Application to Combat Poaching." *AI Magazine* 38, no. 1 (2017): 23–36; Fang, Fei, Thanh H. Nguyen, Rob Pickles, Wai Y. Lam, Gopalasamy R. Clements, Bo An, Amandeep Singh, Milind Tambe, and Andrew Lemieux. "Deploying PAWS: Field optimization of the protection assistant for wildlife security." In *Twenty-Eighth IAAI Conference*. 2016.

[9] **Surveillance capitalism and critiques of digital earth technologies.** See Shoshona Zuboff's recent publication: *The age of surveillance capitalism: The fight for a human future at the new frontier of power*. Also see: Arts, K., van der Wal, R. and Adams, W.M., 2015. Digital technology and the conservation of nature. *Ambio*, *44*(4), pp.661–673; Büscher, B., 2016. Nature 2.0: Exploring and theorizing the links between new media and nature conservation. *new media & society*, *18*(5), pp.726–743; Gabrys, J., 2016. *Program earth: Environmental sensing technology and the making of a computational planet* (Vol. 49). U of Minnesota Press; Jepson, P. and Ladle, R.J., 2015. Nature apps: Waiting for the revolution. *Ambio*, *44*(8), pp.827–832; Sandbrook, C., 2015. The social implications of using drones for biodiversity conservation. *Ambio*, *44*(4), pp.636–647; Walker, D., Nost, E., Lemelin, A., Lave, R. and Dillon, L., 2018. Practicing environmental data justice: From DataRescue to Data Together. *Geo: Geography and Environment*, *5*(2), p.e00061.

[10] **Digital twins.** A digital replica of a living or non-living physical entity (including a process, product, infrastructure, service), a digital twin is a bridge between the physical and digital world. The pairing of the virtual and physical worlds allows for monitoring and data analysis in order to anticipate problems, prevent downtime, plan for the future by using simulations. For more information see: Grieves, M. and Vickers, J., 2017. Digital twin: Mitigating unpredictable, undesirable emergent behavior in complex systems. In *Transdisciplinary perspectives on complex systems* (pp. 85–113). Springer, Cham.

3. Are These The 20 Top Multi-Stakeholder Processes In 2020 To Advance A Digital Ecosystem For The Planet?



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Contributors [5]: Christina Bowen (***Digital Life Collective***), Anne Bowser (***Wilson Center***), Steven Brumby (***National Geographic Society***), Anthony Cabraal (***Greaterthan***/***Enspiral***), Frank Dehnhard (***One Planet Network***), Simon Gardner (***Natural Environment Research Council***), Pablo Hinojosa (***APNIC***), Cyrus Hodes (***The AI Initiative***), Tiare Irvine (***InnerPlanet***), Jovan Kurbalija (***DiploFoundation***), Alison Lowndes (***Nvidia***), Jacob Malthouse (fmr ***ICANN***), Nicholas Niggli (***Republic and State of Geneva***), Tim Nixon (***Constellation Research***), David Oehmen (***UNFCCC***), Paul Quaiser (***Human Sustainability Institute***), Steven Ramage (***Group on Earth Observations***), Xiao Wang (***UNEP-DTU***).

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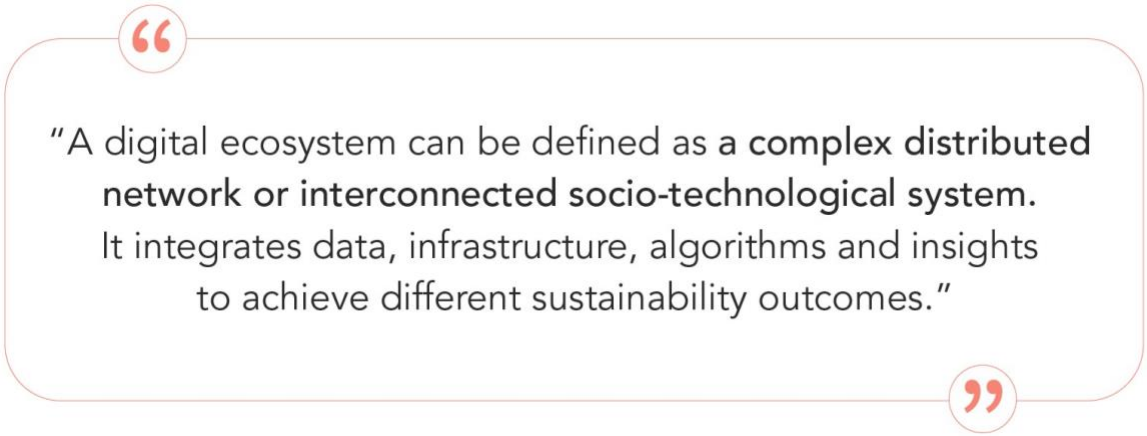
Peer review [5]: Hamed Alemohammad (***Radiant Earth Foundation***), Brian Sullivan (***Google Earth Engine***), Ivan Zhdanov (***UNEP***), Andrew Zolli (***Planet***), Annie Virnig (***UNDP***).

Originally published on Medium on 11 September 2019, at:
Are these the 20 top multi-stakeholder processes in 2020 to advance a digital ecosystem for the planet?

3.1 Why a Digital Ecosystem for the Planet?

As outlined in our recent article, The promise and peril of a digital ecosystem for the planet, we propose that the ongoing digital revolution needs to be harnessed to drive a transformation towards global sustainability, environmental stewardship, and human well-being. Public, private and civil society actors must take deliberate action and collaborate to build a global digital ecosystem for the planet. A digital ecosystem that mobilizes hardware, software and digital infrastructures together with data analytics to generate dynamic, real-time insights that can power various structural transformations are needed to achieve collective sustainability.



Created by Douglas Robb (UBC).

The digital revolution must also be used to abolish extreme poverty and reduce inequalities that jeopardize social cohesion and stability. Often, these social inequalities are tied to and overlap with ecological challenges. Ultimately, then, we must do nothing less than direct the digital revolution for planet, people, prosperity and peace.

To achieve this goal, we must embed the vision of a fair digital ecosystem for the planet into all of the key multi-stakeholder processes that are currently unfolding. We aim to do this through two new articles on Medium: a companion article on Building a digital ecosystem for the planet: 20 substantive priorities for 2020, and this one. In the companion article, we identify three primary engagement tracks: system architecture, applications, and governance. Within these three tracks, we outline 20 priorities for the new decade. Building from these priorities, **our focus for this article is to identify a preliminary list of the top 20 most important multi-stakeholder processes that we must engage and influence in 2020.**

Thus, while the companion article outlines *what* we should aim to achieve and *why*, this article focuses on *how* and *who* could be undertaking specific, substantive actions to advance our vision in 2020.

3.2 Potential high-impact multi-stakeholder processes for engagement

There are currently more than 1,000 digital policy mechanisms being tracked by the Digital Watch Observatory. These range from open data initiatives and technical standards to interoperability policies and privacy protection. Yet, one of the current challenges in taking forward a vision for a digital ecosystem for Earth is understanding where and how to engage with the range of different multi-stakeholder processes and policy making efforts currently underway. Given the growing geopolitical importance of the digital economy and the frontier technology landscape, there has been a proliferation of efforts that have the potential to shape policies, governance models and infrastructure investment priorities. But it is often difficult for many stakeholders in the public and private sectors to identify and focus on those processes with the highest potential for global influence and transformative impact.

Photo by Li-An Lim on Unsplash.

The purpose of this article is to map the 20 most important global multi-stakeholder processes in 2020 where the concept of a digital ecosystem for the planet can be firmly anchored, positioned and elaborated. In line with the framework used in our companion article to categorize priorities for the digital ecosystem, each multi-stakeholder process has been categorized into one of three tracks: system architecture, applications, and governance. Key outcomes per track (that align with our 20 priorities) were developed. This structure enabled us to classify processes we encountered and establish boundaries. The tracks and their outcomes are outlined in the following page.

Created by Douglas Robb (UBC).

To arrive at a top 20 list, the authors began by undertaking a collective intelligence exercise involving 70 experts from the environment and technology sectors to jointly identify the processes that have the potential to achieve or influence at least two or more of the outcomes listed above. These experts included policymakers, scientists, and representatives of the public, private, and not-for-profit sectors at national and multilateral scales. For processes that span multiple tracks, we placed them into a single track representing what we saw as the bulk of their work. In addition to assigning each process a track, we also categorized them by their composition: a) international processes led by multilateral or regional public institutions; b) private-sector led initiatives; and c) nationally-driven initiatives that have an international scope. Below is a comprehensive landscape of the processes that we identified during this exercise.

POTENTIAL PROCESSES TO ADVANCE A DIGITAL ECOSYSTEM FOR THE PLANET

	TRACK 1 SYSTEM ARCHITECTURE	TRACK 2 APPLICATIONS	TRACK 3 GOVERNANCE AND POLICY
INTERNATIONAL AND REGIONAL INTER-AGENCY / GOVERNMENTAL INITIATIVES	ITU Focus Group: Environmental Efficiency for Artificial Intelligence and Other Emerging Technologies Inter-Agency and Expert Group on SDG Indicators Global Environmental Data Strategy Committee of Experts on Global Geospatial Information Management Internet Engineering Task Force Internet Corporation for Assigned Names and Numbers Regional Internet Registries	Group on Earth Observations Data4Now Initiative World Data Forum Global Partnership for Sustainable Development Data Thematic Research Network on Data and Statistics Open Data for Development Internet & Jurisdiction Policy Network UN Decade on Ecosystem Restoration UNDP Accelerator Labs	European Green Deal / Digital Europe Programme UN High-Level Panel on Digital Cooperation Internet Governance Forum & World Summit on the Information Society Forum Secretary General's Task Force on Digital Financing of the SDGs UN Science Policy Business Forum: Working Group on Big Data and Frontier Technology The UN Commission on Science and Technology for Development Resilience Frontiers Initiative
PRIVATE SECTOR AND/OR CIVIL-SOCIETY-LED INTERNATIONAL INITIATIVES	Global Data Commons Icebreaker One Decentralized Web (DWeb) Open Data Barometer Open Data Inventory	World Economic Forum / Center for the Fourth Industrial Revolution Global Enabling Sustainability Initiative Sustainable Digital Finance Alliance Digital Impact Alliance	Future Earth: Sustainability in the Digital Age Initiative Internet Society Internet Corporation for Assigned Names and Numbers The Internet Engineering Task Force
NATIONALLY-DRIVEN INITIATIVES WITH INTERNATIONAL SCOPE	German Advisory Council on Global Change (WBGU): Towards Our Common Digital Future The Swiss Digital Initiative	One Planet Summit (France)	

Table created by Douglas Robb (UBC).

From the processes shown above, we narrowed down to a list of 20 processes. These processes were favored for their formal mandates or conferred legitimacy from intergovernmental processes, UN decisions, industry consortiums, and public-private partnerships. We also considered the volume and level of engagement, documentation of decision-making processes, and any relevant precedent-setting publications, innovations or financial investments. Those selected are either explicitly working on environmental data-related issues or have the potential to significantly influence environmental data flows in the future.

In addition to the top 20 list, we have included a few honorable mentions. We felt that these processes have yet to rise to the point of global multi-stakeholder process and/or did not meet as many criteria as the others; however, they remain important and are gaining traction.

Track 1: Data/System Architecture

The first track is the system architecture of a digital ecosystem of data, infrastructure, and algorithms that can generate real-time insights about our environment and the health of our planet at any scale. This is largely a technical track that focuses on establishing the standards, policies and basic architecture to link the various components and ensure it can be directed towards important public policy questions and the generation of digital public goods on the environment. It also focuses on environmental efficiency and minimizing the direct impact of digital technology on the environment in terms of materials, energy, and waste.

Based on the rapid collective intelligence process undertaken, we identified the following 8 initiatives in this track as the most important for engagement in 2020:

1.ITU focus group: Environmental Efficiency for Artificial Intelligence and other Emerging Technologies: This is a technical group for pre-standardization discussions with industry and government representatives as well as academics. In 2020, it aims to deliver over 20 outputs through a multilateral process to support global stakeholders toward the strategic and environmentally conscious implementation of emerging technologies in alignment with the SDGs.

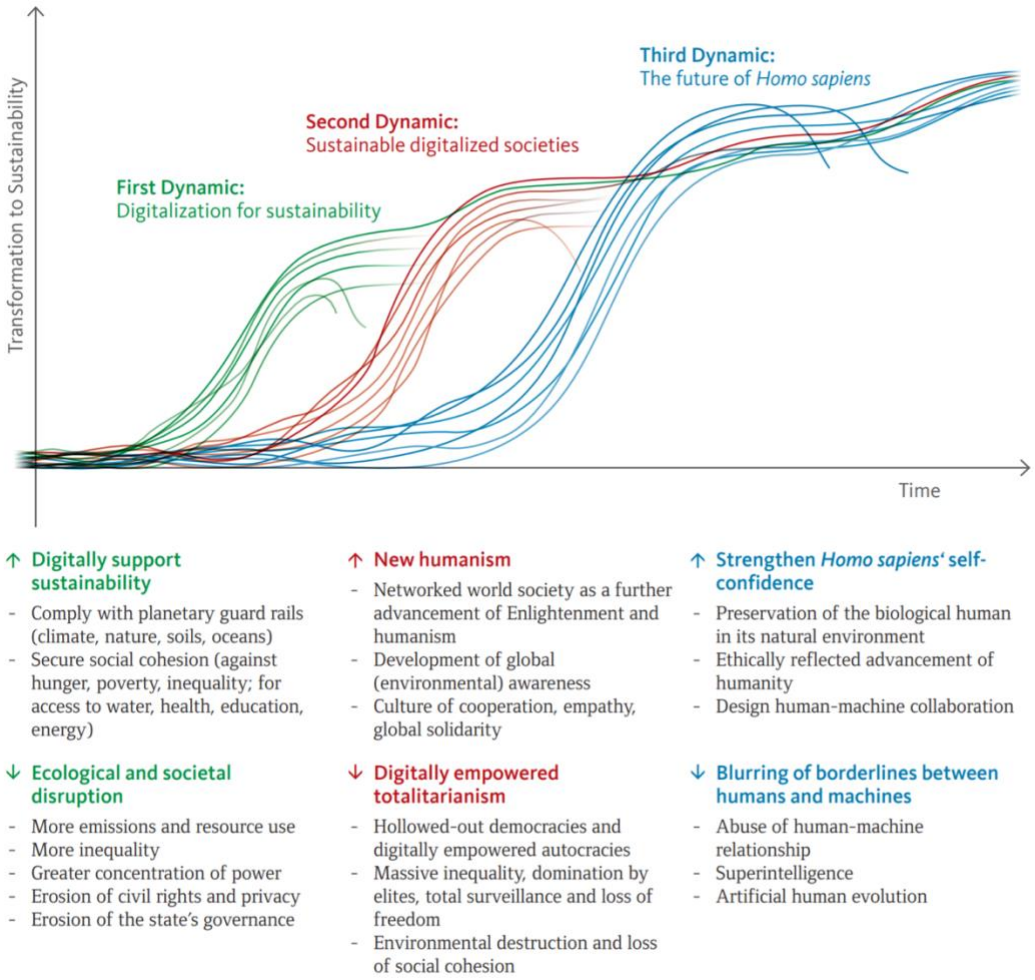
2. Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs): This group is tasked to develop and implement the global indicator framework for the SDGs, including all of the environmental indicators. The IAEG-SDGs formed three working groups to address specific areas relevant to SDG implementation: Statistical Data and Metadata Exchange (SDMX), Geospatial Information, and Interlinkages. It will be essential to adopt methodologies for all of the environmental indicators by the end of 2020.

3. Global Environmental Data Strategy (UNEP/EA.4/RES.23): In 2019, UNEP was mandated to develop a global environmental data strategy through an international multi-stakeholder process. The objective of the strategy is to support regular regional and global analysis of the state of and trends in environmental parameters, including the Global Environment Outlook (GEO) and the World Environmental Situation Room (WESR).

4. Committee of Experts on Global Geospatial Information Management (UN-GGIM): This committee aims to address global challenges regarding the use of geospatial information, including in the SDGs, and to serve as a body for global policymaking in the field of geospatial information management. It is currently supporting the implementation of the Integrated Geospatial Information Framework(IGIF). One of the most critical needs is agreement on a common set of international boundaries to use in global, regional and national web mapping and digital environmental reporting.

5. German Advisory Council on Global Change (WBGU): Towards Our Common Digital Future: Has undertaken a flagship process to assess how frontier technologies and the digital revolution can advance sustainability. They issued a 486-page flagship report "Our Common Digital Future" together with a summary version and a draft "Charter for a Sustainable Digital Age". The WBGU has also issued

recommendations on a proposed focus for the German EU presidency in July-December of 2020 onDigitalization and Sustainability. These products will need focused implementation in 2020, including potential adoption of the charter by UN agencies such as UNDP and UNEP.



The three dynamics of the digital age. German Advisory Council on Global Change.

6. Icebreaker One: Gathers financial markets, public sector institutions, asset owners and the science community to develop standards, principles, and practices that will make it easier to share data. It aims to unlock enable global data marketplaces that will help investors deliver innovative financing to address the climate and biodiversity crises. Icebreaker One is focused on the cultural mechanics of data sharing: developing common principles, practices, incentives, and safeguards that can influence investment decisions of USD 3.6 trillion per year.

7. The Swiss Digital Initiative: A long-term and sustainable process for safeguarding ethical standards in the digital world. In particular, it seeks to strengthen trust in digital technologies as well as in the actors involved in ongoing digital transformation as outlined in their policy statement. The SDI is intended to lead to a self-commitment to ethical standards and conduct such as transparency, non-discrimination, and sustainability. Conversations brokered by the SDI may also explore the international political appetite for a new global digital convention.

Copyright: Swiss Digital Initiative.

We also feel that a few initiatives in this track deserve honorable mention:

➔ **Global Data Commons:** This initiative aspires to set in motion a global movement to significantly scale-up responsible access to open data, empowering public, private and social sector actors to use data for the public good. This global data commons concept is being developed as a follow-up track to the UN High-level Panel on Digital Cooperation. In particular, recommendation 1b on digital public goods. It will be essential to ensure that any global data commons concept firmly reflects the needs of a digital ecosystem for the planet.

➔ **Open Data Barometer:** A global measure of how governments are publishing and using open data for accountability, innovation, and social impact. The Leaders Edition looks at the 30 governments that have adopted the Open Data Charter and those that, as G20 members, have committed to G20 Anti-Corruption Open Data Principles.

➔ **Decentralized Web (DWeb):** A community, a social movement, an emerging suite of practices for effective participatory governance, and a set of technologies aimed at re-decentralizing web technologies and architecture. Decentralization is a process of redistributing functions, people, powers or things away from a central authority, including extensive use of peer-to-peer protocols and corresponding open-source software. The DWeb community is increasingly interested in applications of decentralized digital technology for the environment.

Track 2: Applications

The second track is about the transformative applications of environmental insights and digital public goods towards changing consumption patterns, markets, economies, and policy-decisions. It is about transforming insights into exponential impacts — and monitoring outcomes to support adaptive management

Based on the rapid collective intelligence process undertaken, the following 6 initiatives in track 2 were identified as the most important for engagement in 2020.

8. Group on Earth Observations (GEO): An intergovernmental organization of 108 member countries and 100+ partners that works to improve the availability, access, and use of Earth observations for the benefit of society. It coordinates international efforts to build a Global Earth Observation System of Systems (GEOSS) and a member-driven three-year GEO work programme supporting earth observation programs and related infrastructures, such as Copernicus, Landsat and others from Asia Pacific valued at over EUR 50 billion, with a broader value of total activities in the trillions. In many cases, partnerships brokered by GEO establish de facto governance models for environmental data and various field applications.

9. Data4Now Initiative: This initiative is supported by the Global Partnership for Sustainable Development Data (GPSDD), the United Nations Statistics Division, the World Bank, and the Thematic Research Network on Data and Statistics (TReNDS) at the Sustainable Development Solutions Network. It is a tailored and collaborative process for aggregating, amplifying and scaling-up data solutions for the SDGs. One of the key outputs of this work should be adopting guidelines and safeguards for public-private partnerships generating digital public goods by the end of 2020.

Global Partnership for Sustainable Development Data.

10. World Data Forum: An international platform for intensifying data cooperation among various professional groups, such as information technology, geospatial information managers, data scientists, and users, as well as civil society stakeholders. The next meeting will be hosted from 18–21 October 2020 in Bern, Switzerland with

up to 2,000 people expected to attend. It will be essential to use this opportunity to advance global conversations and awareness around the digital ecosystem for earth concept.

11. World Economic Forum / Center for the Fourth Industrial Revolution: Partners with governments, leading companies, civil society and experts from around the world to co-design and pilot innovative new approaches to policy and governance in the Fourth Industrial Revolution. WEF also acts as the secretariat for the G20 Global Smart Cities Alliance on Technology Governance that aims to create global norms and policy standards for the use of connected devices in public spaces. The various WEF processes and reports offer a critical space for conversations and consensus-building around the governance mechanisms and safeguards for public-private partnerships linked to leveraging a digital ecosystem for the planet.

12. Global Enabling Sustainability Initiative (GESI): consists of 75 companies and partners. The primary goal is to consider how Information and Communications Technologies (ICT) can advance sustainability and the SDGs. In 2019, GESI and Deloitte issued a flagship report entitled "Digital with purpose: delivering a SMARTer2030". GESI could be used as a key dialogue and implementation platform with members for advancing a planetary digital ecosystem.

13. One Planet Summit (France): An international forum for mobilization and action to implement the Paris Agreement on a schedule compatible with the accelerated pace of climate change. It brings together over 4000 participants from 150 countries, including State and non-State stakeholders, the world's major sovereign funds, institutional investors, development banks and major companies to speed up the global transition to a low-carbon economy dedicating resources to 12 different action commitments.

One Planet Summit.

Also in this track, we feel that a few initiatives deserve honorable mention:

➔ **Digital Impact Alliance (DIAL):** A multi-stakeholder partnership among USAID, the Bill & Melinda Gates Foundation, the Swedish government and the United Nations Foundation. DIAL works to identify the most effective and efficient digital solutions to speed service delivery to reach many more people and position countries to achieve the SDGs.

➔ **Sustainable Digital Finance Alliance:** Aims to leverage digital technologies & innovations to enhance financing for sustainable development. Currently convened by ANT Financial and UNEP, it is currently building a network of fintechs, financial players, policymakers and other stakeholders that can collaborate and promote sustainable digital finance practices at national and international levels.

➔ **UNDP Accelerator Labs:** The Accelerator Labs are UNDP's new way of working in sustainable development. 60 labs serving 78 countries will work together with national and global partners to find radically new approaches that fit the complexity of current development challenges. The Labs will analyze challenges within local contexts to identify connections and patterns in search of new avenues of work to act effectively in addressing wicked development challenges, including environmental sustainability. The Labs currently cover the full range of Sustainable Development Goals, though there is a critical mass of labs working on circular economy and youth employment problems.

➔ **UN Decade on Ecosystem Restoration (2021–2030):** A vision of long-term decision-making in societies worldwide — whether in urban, suburban, agricultural or industrial landscapes — being underpinned by quantitative analysis of all the social, economic and environmental benefits emanating from ecosystem restoration. The Decade will include developing a digital global movement that catalyzes large-scale restoration by: developing bankable business plans, using digital tools for monitoring the effects of restoration, connecting buyers/funders with restoration practitioners on the ground, developing technical capacity of stakeholders, and raising awareness on the wide-ranging benefits of ecosystem restoration globally.

Track 3: Governance and Policy

The third track is about the governance of the digital ecosystem for the planet. This is largely about governing the distribution of power over decision-making, benefits-sharing, and accountability across the public and private sectors. This also tackles a range of fundamental issues at the global level linked to data ownership, sovereignty, privacy, and security.

Based on the rapid collective intelligence process undertaken, the following 6 initiatives in track 3 were identified as the most important for engagement in 2020:

14. European Green Deal / Digital Europe Programme: The overall value of the Green Deal is EUR 1.1 trillion — with EUR 9.2 Billion to be earmarked for Digital Europe Programme to cover the deployment of innovative digital technologies in five

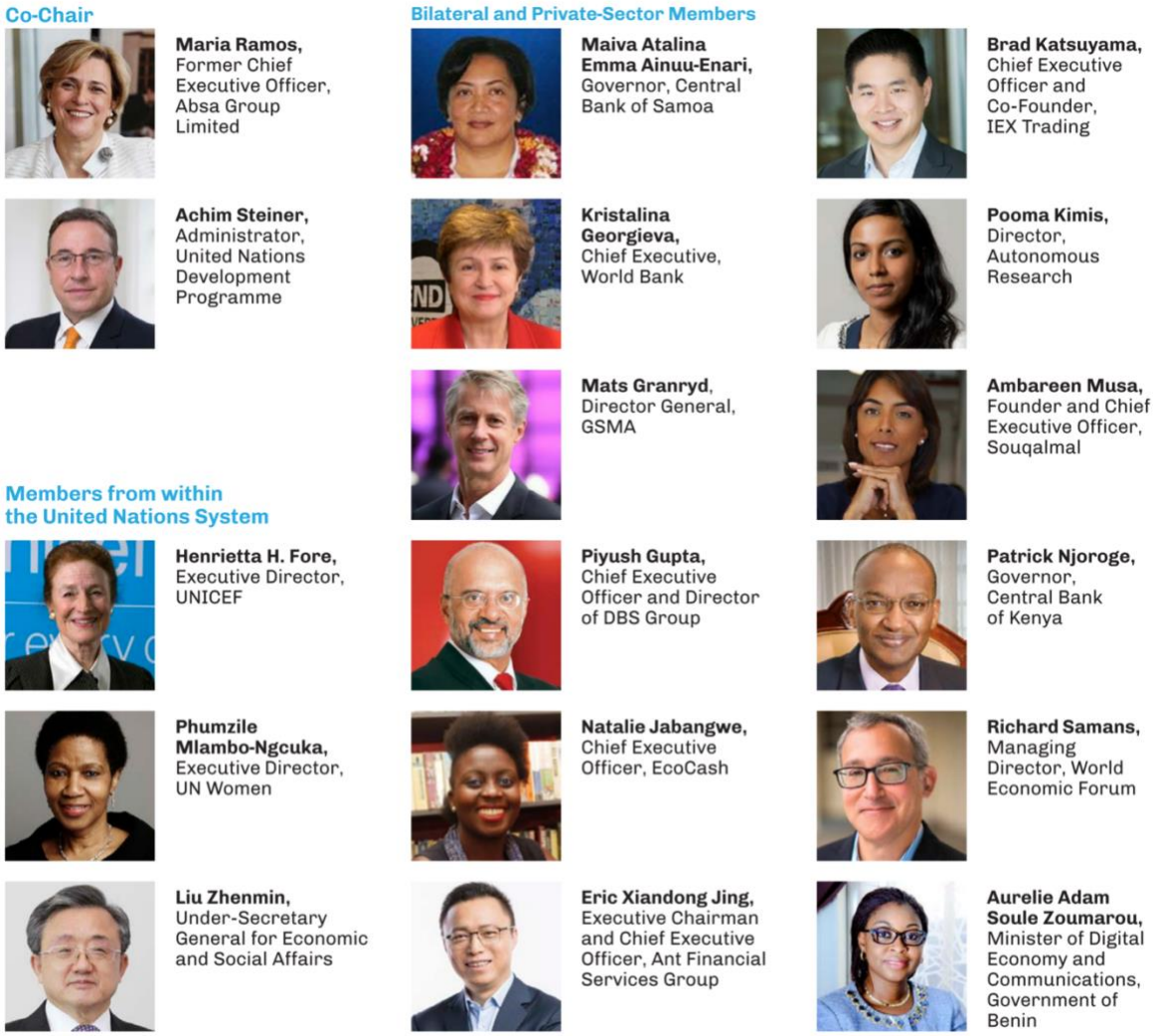
key areas: supercomputing, artificial intelligence, cybersecurity, advanced digital skills and ensuring a wide use of these digital technologies across the economy and society to enable to EU Green Deal. While regional in nature — the Digital Europe Programme could be instrumental in setting the architecture and governance foundation for a digital earth ecosystem.

15. UN High-Level Panel on Digital Cooperation: The panel was convened by the UN Secretary-General to provide recommendations on how the international community could work together to optimize the use of digital technologies and mitigate the risks. Its final report "The Age of Digital Interdependence" makes five sets of recommendations: (1) build an inclusive digital economy and society; (2) develop human and institutional capacity; (3) protect human rights and human agency; (4) promote digital trust, security and stability; and (5) foster global digital cooperation. There are three important follow-up tracks that link directly to establishing a digital ecosystem for the planet, including achieving a "Global Commitment for Digital Cooperation" by the UN's 75th birthday in 2020.

UN High-Level Panel on Digital Cooperation.

16. Internet Governance Forum (IGF) & World Summit on the Information Society Forum (WSIS): The WSIS Forum 2020, to be held in Geneva from 6–9 April 2020, will represent the world's largest annual gathering of the 'ICT for development' community. It is a key forum for discussing the role of ICTs as a means of implementation of the SDGs.The IGF is one of the three key follow-up tracks to the World Summit on the Information Society (WSIS). Discussions are underway on how to strengthen the role of the IGF as the global policy forum for internet governance-related issues and as a follow-up track for the report of the UN High-Level Panel on Digital Cooperation (a proposal known as IGF Plus). There is a proposal on the table to ensure that the environment is one of the pillars addressed by the IGF Plus process.

17. Secretary General's Task Force on Digital Financing of the SDGs: Mandated to identify how digitalization will reshape finance and to identify, theorize, and propose how best this transformation can support the financing of the SDGs. The interim report of the task force was titled "Harnessing Digitization in the Financing of the Sustainable Development Goals". It will be essential to ensure that the final report considers how digital financing and related tools could contribute to a digital ecosystem for the planet.



Secretary General's Task Force on Digital Financing of the SDGs.

18. UN Commission on Science and Technology for Development(CSTD): This Commission holds an annual intergovernmental forum for discussing pertinent issues affecting science, technology, and development. Its members are composed of national Governments, with civil society also contributing to discussions. The twenty-third session of CSTD will be held in Geneva from 23 to 27 March 2020. The Commission will address two priority themes: harnessing rapid technological change for inclusive and sustainable development; and exploring space technologies for sustainable development and the benefits of international research collaboration.

19. UN Science Policy Business Forum: A UN-hosted multi-sectoral platform designed to strengthen cooperation among stakeholders working on the intersection of frontier technology and the environmental dimensions of the SDGs. The overall objective of the working group is to influence the form, function and governance model of the emerging digital ecosystem for the planet so that it achieves key environmental sustainability goals and generates important digital public goods. The first discussion paper of the working group was published in March 2019. It will be essential to continue advancing this work at the next meeting of the Forum is scheduled for September 2020 so that it could potentially inform the deliberations of the UN Environmental Assembly in February 2021.

20. Future Earth: Sustainability in the Digital Age Initiative: During 2019, this initiative convened more than 200 diverse experts from over 30 countries to consider how the digital age can steer societal transformations towards sustainability. The final policy report “Digital Disruptions for Sustainability Agenda (D²S Agenda) lays out the research, innovation, and actions needed to take forward this vision. The flagship report from this process will be released in February of 2020 and should trigger a series of follow-up actions and opportunities for multi-stakeholder engagement.

Also in this track, we feel that a few initiatives deserve honorable mention:

➔ **Resilience Frontiers Initiative**: A foresight-driven interagency initiative, led by the UNFCCC secretariat, to address long-term global resilience to climate change beyond 2030 by following 8 pathways around the three main objectives: fostering a “nature-first” global culture to ensure environmental stewardship; retooling global cooperation to effectively respond to future climate risks; and transforming sectoral approaches to sustain long-term regenerative resilience. By the end of 2020, it aims at defining policy-relevant roadmaps that identify milestones for the achievement of these visions during the next decade.

➔ **Internet Society:** One of the principal goals is to provide an organizational home and financial support for the Internet standards process and developing multi-stakeholder governance processes. The Internet Society also publishes concise policy briefs on critical Internet issues. The Internet Society should consider how internet architecture needs to be shaped to contribute to a digital ecosystem for the planet.

3.3 Conclusions and moving the conversation forward

We acknowledge precedents for multi-stakeholder collaboration at a global scale, such as the Open Educational Resources movement, and LTI/LMS integration in the educational technology sector. We also acknowledge that we devote insufficient attention in this paper to regional initiatives, entrepreneurial ecosystems, and existing international partnerships like Global Earth Observation System of Systems (GEOSS). Finally, there is another recent article on processes for internet governance more broadly. At a later stage, mapping these initiatives would be a useful contribution. However, our focus in this first phase is to identify those processes where the different elements of a digital ecosystem for the planet can be directly addressed by multi-stakeholder actors.

In addition to wanting your feedback, we would also like to share a few of our own observations and conclusions from this review.

First, the community of experts and practitioners dealing with digitalization, sustainability, and the environment does not yet have a strategic or coordinated approach to engaging in each of these important multi-stakeholder processes. As engagement is still ad hoc, siloed, and largely uncoordinated, our ability to integrate our vision into these processes remains weak. In 2020, our community must double down on our efforts to improve our internal coordination and our external strategic engagement. While it is necessary for different processes to focus on key issues, the strategic connection between processes and the need to ensure they drive forward specific outcomes is critical. The global environmental community must adopt a digital diplomacy strategy and coordination process by the end of 2020 to drive forward the concept of a digital ecosystem for the planet in all relevant multi-stakeholder processes.

Second, our approach to building a digital ecosystem for the planet must be mission-led and fundamentally multi-stakeholder at the global level. We need to identify opportunities and new ways to define a market which, through an inspirational vision setting, can crowd in investments from various actors such as businesses, public institutions, and philanthropic actors and citizens. We must establish new ways of collaboration between public and private sector actors that create public trust, prevent lock-in dependencies, regulate antitrust risks and generate win-win outcomes together with critical digital public goods. At the same time, many formal multilateral processes are moving too slowly relative to the pace of digital technology and private investment. Many processes continue to talk at the expense of concrete action. We need to recall that in the absence of clear global policies and governance frameworks, de facto approaches and precedents will emerge and take root. Many coalitions of the willing are coming forward to fill the vacuum — but these eventually need to connect to multilateral processes in order to achieve global reach and legitimacy. Building a digital ecosystem for the planet will inherently involve a delicate balance act between bottom-up and top-down, just like the early governance of the internet.

Third, many of these processes treat ‘data’ as a generic term. While ‘data’ may have technical similarities, its use and ‘life cycle’ is often very diverse. For example, personal health data requires strict privacy protection, e-commerce data has a focus on intellectual property protection while many types of climate and environmental data can be openly shared. The same could be said for the data spectrum in terms of open, shared and closed data. The lack of clarity we have on the potential uses and life cycle of environmental data as well as the data licensing regime could lead to policy confusion. It would be helpful to adopt a data taxonomy and clear definitions for the categories of data on the data spectrum. We should also understand the massive potential for data to help bridge and overcome policy silos. Indeed, data sharing has been dubbed a “gateway” for better collaboration — and nowhere does this ring truer than across the different environmental domains. Currently, many organizations and big systems are adjusting to digital challenges by recalibrating their mandates and roles around the question of data and digital technology. If there is not timely and smart action, an opportunity to bridge policy silos via data could be easily turned into the opposite — the use of data to fortify policy silos and turfs. In this regard, while it is important to build a digital ecosystem for the planet, this must also be able to interact with and leverage other types of socio-economic data and avoid becoming its own silo.

Fourth, conversations about a global multi-stakeholder governance framework for a digital ecosystem for the planet are still in their infancy. The UN Science Policy Business Forum certainly raised this idea for the digital ecosystem — but the future work plan remains uncertain. It is therefore important to solve this vacuum, to avoid de facto governance decisions being made on an ad hoc basis largely by projects and partnerships operating in this space. These are establishing important precedents with unintended consequences and should not evolve into a governance framework by default. The biggest risk is that the key multi-stakeholder processes currently unfolding adopt a vision for the digital transformation which falls short of laying the necessary foundation for a digital ecosystem for the planet and a digital drive towards environmental sustainability. Such oversight could lock in an investment and policy framework that fails to achieve the global environmental sustainability goals we have set for ourselves. Hence a wider process needs to be established coupled with strong institutional leadership. In particular, a leadership dialogue is needed with the CEOs of the 20 top technology companies by market capitalization to agree on a common vision to advance sustainability through their respective platforms.

Photo by Markus Spiske on Unsplash

Fifth, although the European Green New Deal is regional in nature — the fact that it addresses all three tracks of our outcome framework (architecture, applications, and governance) places it in a league of its own. Clearly, the Green New Deal has the potential to drive a new set of values, ethics, and outcomes into the European digital space. If these can be operationalized, and offer a viable alternative vision for economic development, they have the potential for global influence — especially for companies and countries wanting to do business with the EU. The work of the Group on Earth Observations falls into a similar category-spanning two of our tracks and potentially influencing billions of investment in the digital ecosystem. Many of the projects in the GEO work plan are also establishing de facto governance precedents for public-private partnerships that warrant greater attention.

Sixth, one of the most important application frontiers to leverage the environmental insights from a digital ecosystem for the planet is in the field of consumer behavioral influence. There are massive opportunities to help consumers make more sustainable consumption choices using mobile applications, digital nudging algorithms, and micro marketing. However, this potentially raises some ethical issues that need to be resolved around human agency, privacy, and psychographic profiling. Only a few of the processes reviewed in this article are addressing this space such as Future Earth and Towards Our Common Digital Future. These efforts should be further supported and scaled, with policy guidance issued by the end of 2020.

Finally, a key process that is currently missing from the mix is a dedicateddigital ecosystem X prize, or global grand challenge competition as well as connecting the existing competitions to the broader vision of a digital ecosystem for the planet. The recent announcement of the Earthshot prize by Sir David Attenborough and Prince William, Duke of Cambridge certainly moves in this direction. It will be essential to connect the scope of this Earthshot prize to a digital ecosystem for the planet and to the 20 key priorities laid out in our companion paper. Other more thematically oriented initiatives, challenges, and funding opportunities should also include criteria to ensure that the resulting projects benefit from and contribute to a digital ecosystem for the planet. These include XPrizes such as Rainforest or the IBM Watson AI Prize, dedicated grants such as the UK's Constructing a Digital Environment Strategic Priorities Fund, Microsoft's AI for Earth, the GEO-Google Earth Engine Programme, or Earth on AWS and on-going global grand challenges such as Saving Water for Nature by Conservation X as well as the Earth Challenge 2020, the EarthTech Challenge, and Reboot the Earth coding challenge by UN Tech Innovation Labs.

In 2020, the most critical need is for governments and philanthropic foundations to fund leaders to participate and engage on these issues in a more coordinated and strategic manner. We urgently need to build the capacity for public environmental institutions and civil society actors to conduct digital diplomacy and to position environmental and sustainability outcomes as priorities. Too often, digital is seen as the realm of the IT department. But these departments often have little policy or diplomatic expertise. Often, government and civil society lack the resources to engage in what is an overwhelming number of technical processes spanning way beyond their comfort levels. But digital technologies will soon infuse almost every aspect of human existence. Every last natural resource on earth is being digitally indexed and modeled. Ignoring this massive trend will either lead to the marginalization of the environment,

or a failure to establish the right architecture, applications, and governance processes to enable a digital ecosystem for the planet.

A global alliance of philanthropies and policy leaders — similar to the Global Alliance for the Future of Food — is necessary to stimulate and direct public policy and civil society engagement in all areas of digital diplomacy linked to the environment. A dedicated global governance framework that connects digital processes with planetary priorities can provide a platform to engage not only across the players within these disparate conversations, but also launch collaborations and interventions into other aspects of digital diplomacy where planetary priorities are not being expressed or understood. This includes forums like the Internet Corporation for Assigned Names and Numbers (ICANN), the Regional Internet Registries (RIRs), the Internet Engineering Task Force (IETF), and the Internet Society (ISOC) and the Internet & Jurisdiction Policy Network.

2020 is the year to position our vision at the highest political level and advance a series of 20 concrete goals that we propose in our companion paper on Medium. As outlined here, we can begin to do this by acting on and influencing these 20 multi-stakeholder processes. Or, perhaps a different group of processes? Regardless, we all need to come together to make an equitable digital ecosystem for the planet a reality. **Join us**. To explore all three papers and learn more about the various priorities and processes we have identified for 2020, we invite you to play around with the interactive ecosystem map below. *Please note that this is best used on a desktop, and is not particularly mobile-friendly.* Alternatively, you can access the first paper here, and the companion article on priorities here.

3.4 Footnotes & Appendix

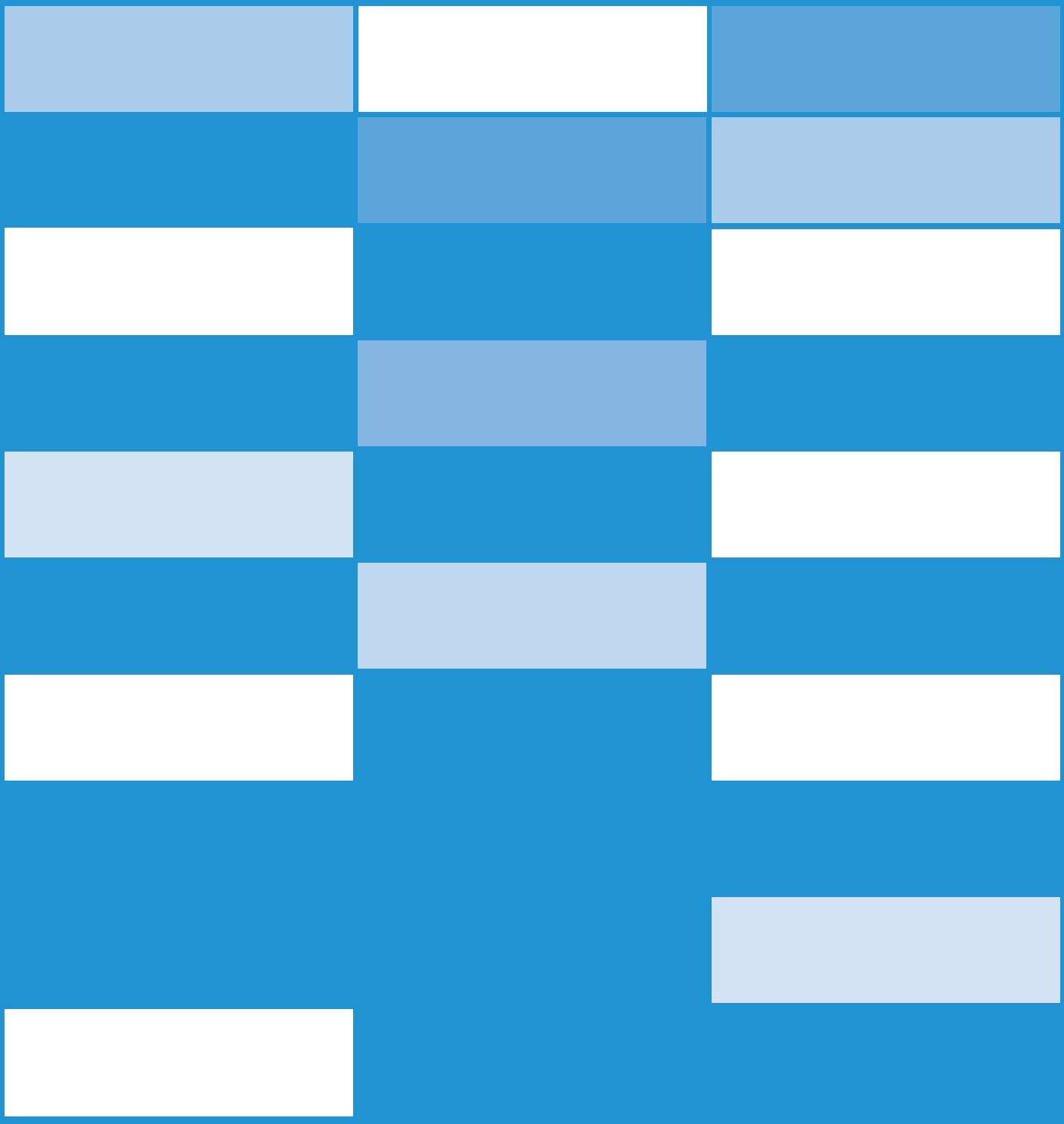
[1] Authorship for the article is based on the CRediT (Contributor Roles Taxonomy) protocol. This includes 14 roles typically played by contributors to scientific scholarly output: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing — original draft, Writing — review & editing.

[2] UNEP: Conceptualization, formal analysis, writing — original draft, review & editing.

[3] UBC: Conceptualization, formal analysis, visualization, writing — review & editing.

[4] UBC: Visualization, formal analysis, writing — review & editing.

[5] Everyone in the group of *contributors* assisted in the writing, review, and editing process. Within *Graphics/Visualizations*, Christina created the interactive ecosystem maps, Kristen created the cover image and Doug created the graphics within the sidebars of the ecosystem maps as well as the static graphics within the article. The group of *peer reviewers* assisted by reviewing the final draft and double-checking the accuracy of claims.



UN environment programme

UBC