UNEP's contribution to Round Table 1B on Digital Public Goods

Environmental data as digital public goods within a digital ecosystem for the planet

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UNEP's contribution to Round Table 1B on Digital Public Goods: Environmental data as digital public goods within a digital ecosystem for the planet

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Executive Summary

This paper builds a case for a governance framework that will support the development of an equitable, open-access digital ecosystem of environmental data as a digital public good. Credible multidisciplinary environmental data, and the applications of this data, are digital public goods which are necessary conditions for an equitable, sustainable and resilient society. The pace and rapidity of the development of data technologies, both in terms of scale,scope and quantity of data gathered, requires a governance framework to ensure that this data enhances and does not undermine planetary wellbeing. Concerted efforts are needed to establish and implement a digital ecosystem governance framework. Some of the key messages in this paper include:

1. **Environmental data are digital public goods and a necessary precondition to achieve human rights and the Sustainable Development Goals:**

   - The availability of various types of data on the environment (referred to in this document as Environmental Data), including on critical issues such as biodiversity and climate, is crucial to measure progress towards achieving the SDGs.

   - Environmental data are crucial for the management of environmental capital, which supports all other forms of capital, e.g. human and financial.

   - Access to Environmental Data is a precondition for other human rights, and may also be conceived as a distinct human right.

   - Human rights law imposes specific procedural obligations on States concerning access to environmental information.

2. **Environmental digital public goods are a distinct category of public goods requiring a specific governance framework, which includes (but is not limited to):**

   - **Standards and interoperability:** The generation of insights on our planet's environmental health requires different actors to access, exchange, integrate and cooperatively use data in a coordinated and collaborative manner.

   - **Quality control:** Environmental data must be curated and processed appropriately to warrant an optimal quality level, to ensure that it takes into account the ecological and social complexity of its processes, and to promote trust in end-users.

- **Cross- and intersectionality**: Environmental processes are interrelated with social, economic and cultural issues. The provision of environmental digital public goods must also take intersectionality into account, and address equity, diversity and inclusion issues in order to avoid deepening the digital divide.

- **Safeguards:** Environmental data and insights are often produced in public-private partnerships. These need a safeguards framework to ensure they are conducted in the public interest, including appropriate capture, storage and access to personal information, and to avoid any potential conflicts of interest.

- **Specific risks and negative externalities:** Environmental digital public goods must not produce more negative impact than the value they add. This includes considering the energy and materials footprint of Information and Communications Technology (ICT) infrastructure, data sets, and algorithms. Open access to Environmental Data can exacerbate the risk of negative externalities, including land speculation, illegal mining, or poaching.

3. **There are a number of key challenges to overcome in order to implement a governance framework that will achieve equitable coverage of and open-access to Environmental Data:**

   - **Financing and business models:** There are a lack of sustainable business models that can pay for data collection, storage, processing, analysis of digital public goods. and the lack of global financing strategies for essential Environmental Data sets.

   - **Data governance:** Several problems must be addressed, including norms, access, licensing, taxonomies, fragmentation, sovereignty, monopolies, mining, curation, custodianship, stewardship, cybersecurity, algorithmic bias, quality control and capacity building.

   - **Resource efficiency:** Multiple actors are investing in open data products, algorithms, and software, leading to duplication, incoherent outcomes, and inefficient use of resources. A coherent governance framework is needed in order to foster collaboration and mitigate inefficiencies in resource allocations, while allowing for a decentralized loosely coordinated approach.

   - **Use of data:** Environmental digital public goods and services that will be used for profit purposes must be governed with policies to maintain the quality, transparency, and availability of products.

   - **Safeguards and standards:** Public-private partnerships need safeguards and standards so that they can maintain public trust and avoid conflicts of interest.

4. The following Environmental Data outcomes and outputs are proposed in the digital public goods action agenda and roadmap:

A. **Digital Ecosystem for the Planet Partnership (DEPP):** Establish a multi-stakeholder engagement platform to:
   - Promote dialogue among public,private, and civil society actors
   - Contribute to the Global Environmental Data Strategy, the Digital Charter for Environmental Data and the Global Data Commons initiatives
   - Build stakeholder capacity for policy engagement and use of Environmental Data as a digital public good
   - Foster a culture of data generation, sharing, collaboration, use and trust
   - Broker collective leadership and collaborative policy analysis among stakeholders
   - Develop a human-centered design approach to capturing, managing and achieving the goals of the DEPP

B. **Environmental Data Strategy and World Environment Situation Room:** An actively managed digital platform curated by UNEP to monitor global environmental issues and risks, as well as identify gaps in technology, solutions and data by:
   - Curating, aggregating and visualizing the best available public Environmental Data
   - Developing and implementing the global Environmental Data strategy
   - Supporting predictive analysis and real-time analysis of hazards and environmental crises
   - Providing customized analysis to UN Resident Coordinators, UN Common Country Assessments and UN Development Cooperation Frameworks

C. **Digital Charter for Environmental Data:** An international framework enabling data discovery, access, licencing and "APIs for Earth" by:
   - Supporting the implementation of a global Environmental Data strategy
   - Addressing federated data sharing through the creation of open standards, safeguards, and scorecards
   - Establishing an Open Source for Earth Foundation and "APIs for Earth" standards
   - Endorsing a safeguard framework for the digital ecosystem

D. **An underpinning conceptual model** that considers the global Environmental Data platforms and their management, maintenance and usability for all stakeholder groups. This should consist of 7 distinct layers:
   - physical (hardware, cloud)
   - data (of all variety)
   - semantic (defining the objects) and ontological (the relations of objects)
   - evidential (proofs of data provenance and methods)
   - application (processing data)
   - interface (contextual to the user)
   - ethical (including inclusion, diversity, equity, and Indigenous data sovereignty)

A. Background

1. This paper is a response to the Report of the High-Level Panel on Digital Cooperation. In particular, the report recognized that many types of digital technologies and content – from data to apps, data visualisation tools to educational curricula – could accelerate the achievement of the SDGs. When they are freely and openly available, with minimal restrictions on how they can be distributed, adapted and reused, they can be considered "digital public goods". Combinations of digital public goods can create "common rails" for innovation of inclusive digital products and services.[1]

2. Based on this finding, the High-Level Panel issued recommendation 1B "*We recommend that a broad, multi-stakeholder alliance, involving the UN, create a platform for sharing digital public goods, engaging talent and pooling data sets, in a manner that respects privacy, in areas related to attaining the SDGs.*"

3. As a follow-up to recommendation 1B, a Round Table on Digital Public Goods was established to develop a UN policy framework and roadmap for 2020 to be released by the UN Secretary-General in May 2020.

4. The Digital Public Goods Alliance[2] was also established by Norway, Sierra Leone, UNICEF and iSPIRT to focus on the implementation of recommendation 1B. The alliance aims to facilitate the discovery, development, use of, and investment in, openly licensed technologies, data models, and content of high relevance for the attainment of the SDGs.

5. This document reflects an ongoing dialogue process with stakeholders from the public and private sectors together with civil society on how to build and govern a digital ecosystem for the planet[3]. It is responding to a call for inputs to the draft UN policy framework and roadmap by the Round Table for submission on 3 March. It will also be submitted to the Digital Public Goods Alliance as an input to shaping their work plan linked to digital public goods on the environment and climate change. The content of this input has been drafted by UNEP in consultation with a selected group of international experts representing different stakeholder communities from the environmental digital public goods sector. It will eventually be published as a self-standing article within the Medium series on a Digital Ecosystem for the Planet.[4]

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[1] https://www.un.org/en/pdfs/DigitalCooperation-report-for%20web.pdf
[2] https://digitalpublicgoods.net/
[3] https://www.un-spbf.org/wp-content/uploads/2019/03/Digital-Ecosystem-final-2.pdf
[4] (1st) The promise and peril of a digital ecosystem for the planet, (2nd) Are these the 20 top priorities in 2020 for a digital ecosystem for Earth?, (3rd) Are these the 20 top multi-stakeholder processes in 2020 to advance a digital ecosystem for the planet?. Downloadable PDF version of all 3 Medium articles.

B. Environmental Data are an enabling foundation for the SDGs and human rights

6. **Credible multidisciplinary environmental data and application of this data are digital public goods with the potential to create a more equitable, sustainable and resilient society**. The pace and rapidity of the development of data technologies, both in terms of scaled-up scope and quantity of data gathered, requires a governance framework to ensure that this data enhances and does not undermine the wellbeing of humanity. Concerted efforts are needed to establish and implement a digital ecosystem governance framework.

7. **The world has entered a new age for digital innovation and frontier technology and is characterised by a new playing field.** Over the past decade, the falling costs of computer hardware and cloud-based computing, the availability of new satellite networks, smart drones and the Internet of Things (IoT) have created an unprecedented capacity for monitoring and data-gathering. This is allowing humanity to digitally instrument Earth's ecosystems, climate and natural resources. The resulting, and exponentially growing, mass of data, coupled with advancements in big data, analytics, visualizations and Artificial Intelligence (AI) means there are now widely accessible and sophisticated capabilities for extracting insights, assessing risks, developing predictions and evaluating scenarios. This creates enormous potential for advancing how we evaluate human and environmental welfare, and how we conceive, facilitate, and measure related policies and actions to advance sustainability. A global digital public goods framework and "digital ecosystem" approach must be developed around this powerful and important capability, also encompassing the associated data, technological, infrastructural, and socio-economic, and cultural elements. Mainstreaming the use of this data in society can make the public stewards of their own environment with an active role in its monitoring and input into decision-making.[5]

8. **This paper builds a case for a governance framework that will lead to an equitable, open-access ecosystem of environmental data as a digital public good**. The goals of this paper are to a) define environmental digital public goods as a distinct class of digital public goods; b) make recommendations about how to address the governance issues that arise in the Environmental Data domain that will not be addressed by solutions for the more general issue of digital public goods.

9. **The importance of the environment to sustainable development and human wellbeing is enshrined within the SDGs.** Out of the 232 unique indicators for the SDGs, there are a total of 93 indicators on the environment - roughly 40%. This not only reflects the overall importance of the environment to sustainable development but also demonstrates how environment often underpins the achievement of other goals. Without data (and derived knowledge and insights), the most critical environmental challenges of our time cannot be assessed, solutions cannot be effectively and efficiently deployed, and

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[5] This is aligned with the findings of the recent D^2S Agenda report, which indicate that a) the rise of digital informational governance has the potential to accelerate action in terms of sustainability and social justice, b) new climate mitigation strategies could emerge from the rise of intelligent systems and enhanced transparency, c) digitally enabled collaboration facilitates voluntary climate governance systems that could accelerate climate action, and d) digitally empowered intelligent systems allow decision-makers to understand and foresee the high risks and uncertainties of climate change.

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progress cannot be measured. The availability, quality, and interconnectivity of the data are critical to this mission. In this age, this inevitably means data in digital format.

10. **Not only is data essential to achieving the SDGs, but lack of access to data is a fundamental driver of inequity, exclusion and marginalization.** As environmental degradation, biodiversity loss, and climate change is already disproportionately impacting the most vulnerable people, further denying them access to Environmental Data as digital public goods will widen the gap and exacerbate inequality. All people need to be empowered to participate in and benefit from the digital revolution, and to be able to use it to guarantee their health, safety and wellbeing. Moreover, the current structure of the data ecosystem can exacerbate a number of existing equity gaps. These include issues like uneven internet coverage and reliable power, the commercial models and price points that control access to data and analytics, and the level of awareness and expertise to identify and use Environmental Data. In addition, the patchy existence, richness and quality of available data sets can introduce discrimination bias into algorithms that can result in further exclusion.

11. **Environmental data as a human right and precondition for other rights.** Given the importance of the environment to human health, livelihoods and security, access to environmental information is often regarded as a human right[6]. It is enshrined in many national constitutions as well as reflected in the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters[7,8]. Access to environmental information is not only regarded as a standalone human right but also as an essential precondition for the exercise of other human rights, such as the right to life, the right to the highest attainable standard of health, and the right to participation in decision-making, the right to access to justice, and others[9].

12. **Human rights law also imposes certain procedural obligations on States in relation to access to environmental information.** A recent independent expert review requested by the Human Rights Commission also found that "*human rights law imposes certain procedural obligations on States in relation to environmental protection. They include duties: (a) to assess environmental impacts and make environmental information public; (b) to facilitate public participation in environmental decision-making, including by protecting the rights of expression and association; and (c) to provide access to remedies for harm.*"[10]

13. **With respect to Indigenous peoples, the right of Free, Prior and Informed Consent (FPIC) also includes a specific component on Environmental Data.** FPIC is a specific right that pertains to Indigenous peoples and is recognised in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). This enables Indigenous peoples to exercise sovereignty on their territories, including giving or withholding consent to a project that may affect them or their territories. FPIC hinges on access to socio-economic and Environmental Data about the benefits and risks of different development projects, including environmental impacts and cumulative effects. Furthermore, FPIC

6 https://wedocs.unep.org/bitstream/handle/20.500.11822/27279/Environmental_rule_of_law.pdf
7 https://docs.wixstatic.com/ugd/80f01c_751ca12a36424f328aed4f37e8e76f74.pdf
8 https://www.unece.org/env/pp/introduction.html
9 https://www.ohchr.org/EN/Issues/Environment/SREnvironment/Pages/MappingReport.aspx
10 https://www.ohchr.org/EN/HRBodies/HRC/RegularSessions/Session25/Documents/A-HRC-25-53_en.doc

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enables Indigenous peoples to negotiate the conditions under which the project will be designed, implemented, monitored and evaluated, including the environmental components of these processes; Environmental Data are crucial to the fulfilment of this right

14. **Data as infrastructure for the knowledge economy.** Making well-curated Environmental Data widely accessible should not only be viewed as an enabler of the SDGs and human rights, but also as crucial infrastructure in the knowledge economy. Simply put "*our physical infrastructure underpins our goods economy; our internet infrastructure underpins our digital economy; our data infrastructure underpins our knowledge economy.*" [11] If the knowledge economy is going to drive forward our transition towards collective intelligence and sustainability, Environmental Data must be integrated in the thinking and design from the outset. Indeed, the environmental and climate challenges that we need to overcome are so enormous, that only collective intelligence and collective action powered by an integrated data infrastructure can make a holistic difference.

C. Environmental digital public goods are a distinct category of digital public goods

15. **Broadly speaking, the environmental data that are needed to enable the SDGs and advance human rights, equity and dignity can be divided into the following four categories.** These are collectively referred to in this document as Environmental Data:

   a. Data that tracks the **biophysical status of the environment, ecosystems, biodiversity and climate** (for example forest cover, rainfall), including both biotic and abiotic variables, as well as ecosystem services.

   b. Data linked to **actions by different actors** - including laws, policies, projects and actions in the public and private sectors as well as academia and civil society. This data can facilitate rapid, efficient and tailored learning from each other's successes and failures, as well as to foster collaboration and collective intelligence while creating synergies in innovation and spread of solutions.

   c. Data linked to **technology, funding sources, experts** - this data can facilitate flows of knowledge and resources, removing information barriers and market failures in expediting the matchmaking of problems and solutions as well as enabling scalability.

   d. Data linked to **monitoring impacts and evaluating progress** - coupled with the previous three data types, the availability of this data is key to developing assessment frameworks on the effectiveness of different approaches, and to assessing remaining resource and action gaps.

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[11] https://medium.com/@agentGav/data-as-infrastructure-14bd3fa1febc

16. **Different levels of Environmental Data and insights are under different governance regimes:** Environmental Data increases in value the more it is connected and insights are extracted.[12] Many business models are driven by the value that can be added by transforming Environmental Data into information and insights. Some companies also invest in raw Environmental Data collection as part of their business operations, supply chain management and risk assessments. While not all of these commercial Environmental Data sets and insights can be automatically transferred into the public domain as digital public goods - incentives and compensation measures are needed to transfer some of the more strategic insights without undermining commercial competitiveness. These can include data anonymization, tax breaks, time-delayed release of insights, restriction of commercial liabilities, publication of data into the public domain with non-commercial use restrictions etc, as well as direct payment.

17. **UNEP believes that Environmental Data should be treated as a distinct category of digital public goods** for the following reasons:

    a. **Need for global data aggregation across multiple data custodians and scales:** Generating insights about the health and regeneration of the planet and different global ecosystems often requires the aggregation and integration of multiple data sets held by a combination of public and private actors acting at different scales and across administrative boundaries. There is a fundamental need for a global framework that enables aggregation, interoperability, provenance, licencing, and quality control to ensure that the parts can be combined into a global view and inform a holistic response.

    b. **Need to ensure Environmental Data are "fit for purpose" for a specific analysis or application:** Ecosystems are complex systems that are difficult to understand and model. By definition, they have high levels of unpredictability, uncertainty, and interdependencies. There is a need to ensure that digital public goods about the environment follow the best available science, do not oversimplify this complexity and that certain data sets are not used out of context or in inappropriate ways. We need quality control processes to ensure Environmental Data are "fit for purpose" for a specific analysis, and that the appropriate resolution of data is used (e.g. global scale data cannot be used for local scale decision making).

    c. **Need to integrate environmental and socio-economic data:** The very complexity and dynamic nature of ecosystems and environmental resources means that it is often impossible to take decisions around one environmental challenge without needing to access other Environmental Datasets as well as socio-economic data.

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[12] A widely used hierarchy differentiates between data, information, and knowledge (or insights). Data are the 'raw' facts or signals - conceived of as symbols or signs, that have no use until they are put in a relevant form. Information (of which the building blocks are data) is the useful or relevant meaning assigned to data, making the data useful or valuable for a specific context, decision or action. This often results from intentional structuring of data (for example, a set of data points on temperatures in different days or locations). Knowledge is a higher level of extracting insights or applications from information - it is the meaningful internalising of input.

Environmental challenges can rarely be treated in isolation, suggesting that a digital ecosystem approach to data management is often needed.

d. **Discrete risks with some environmental public good data sets need to be considered and mitigated.** In some cases, such data could trigger: short-term financial speculation, land grabbing and squatting, resource looting, poaching and other illegal activities as well as potentially undermine national sovereignty and security. There is a need to consider safeguards for fragile states that do not have full control over their sovereign territories, as well as safeguarding provisions for Indigenous groups and for minorities.

e. **Mitigating potential environmental impacts of the digital revolution:** The international community also needs to ensure that the generation and use of environmental digital public goods (as well as any public goods) do not create new sources of environmental impact that are out of proportion to the value gained from the public good. This includes considering the energy and materials footprint of Information and Communications Technology (ICT) infrastructure, data sets, and algorithms. Consequently, it is essential to establish some basic environmental procurement and environmental efficiency standards and ratings to enable comparability and monitoring.

D. Integrating environmental digital public goods within a digital ecosystem for the planet

18. **Building a digital ecosystem for the planet as a digital public good to address these specific characteristics and governance needs:** UNEP's consultation with over 200 stakeholders[13] from the environment and digital sectors reveals broad support for building and governing a Digital Ecosystem for the Planet as a digital public good. This must mobilize hardware, software and digital infrastructures together with data analytics and social coordination processes to generate dynamic, real-time, contextual and transcontextual insights that can power various structural transformations needed to advance the environmental dimensions of the SDGs.These include changes in individual consumer behaviors, market economies, key infrastructure, societies and institutions, and global environmental governance that must be informed by real-time, relevant, and accessible Environmental Data and insights. In building a digital ecosystem for people and planet, we have the opportunity to support the innovation of further digital public goods needed in other sectors.

19. **The Digital Ecosystem for the Planet should be used to achieve seven major outcomes** that will underpin the transformation to sustainable development and a regenerative economy. It should enable all stakeholders to have open digital access to:

a. data about the status of their immediate environment and their impact on it, including air quality, water quality, soil quality, climate change and biodiversity.

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[13] https://www.un-spbf.org/wp-content/uploads/2019/03/Digital-Ecosystem-final-2.pdf

b. data about the environment, biodiversity impacts and climate footprint of commercial products and services to enable informed consumption choices that support sustainability.

c. national and global data on environmental and climate security risks, including predictive analysis of hazards and environmental crises.

d. environmental and climate data that can be used for integrated risk assessments, financial risk modelling and impact monitoring.

e. data about public law and policy making (national, subnational, local) that are relevant to mitigating environmental and climate risks and can be used to understand what regulatory frameworks, obligations and commitments are already in place, and facilitate policy learning and exchange to expedite solutions.

f. national and global environmental data that can be easily visualized and used for prioritization, innovation and policy-making, together with common processes to close the understanding gap that often exists between science, policy, and business.

g. national and global environmental data that can be used to monitor key environmental SDG indicators, multilateral environmental agreements and cases of successful regeneration.

20. **Governing environmental digital public goods in the digital ecosystem for the planet:** This ambitious vision and change-making agenda will require an aligned, cohesive data culture, global digital public goods framework and governance landscape that addresses a number of critical issues:

a. Understanding how environmental digital public goods are a distinct category of public goods that require a unique and sustainable governance framework and funding solution.

b. Establishing the minimum set of essential environmental digital public good data that should be funded, produced and maintained at the global, national, subnational, and localaccc levels.

c. Ensuring that local and national level digital public good data on the environment contribute to a global scientific view on the health of the planet and on different ecosystem services.

d. Creating safeguards, standards and licencing regimes for public-private partnerships that co-generate environmental digital public goods and data products to ensure maximum transparency and public accountability.

e. Building a governance framework and set of standards for public good data trusts, data commons and data collaboratives on the environment.

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f.   Ensuring that data sets and technology tools aspiring to be part of a global digital ecosystem understand and adopt the processes and standards of the governance framework, including the use of a performance scorecard.

g.   Establishing licencing regimes for environment data products and derived environmental analysis that rely on multiple input data streams from public and private sources (including citizen science, and user-generated data).

h.   Building an aligned and cohesive culture, norms and practice of recognizing Environmental Data as a digital public good, thereby making such data open and available for interpretation, analysis, and innovation.

i.   Providing all actors generating environmental digital public goods with access to a digital facility to bundle their research data with their publications, including raw and processed data files, software, code, models, algorithms, protocols, and methods.

j.   Minimizing unintended consequences from the public release of different Environmental Data sets as well as mitigating the potential environmental impacts from the Information and Communications Technology (ICT) sector.

k.   Ensuring that historical data are preserved, archived, and remains discoverable and usable.

E. The case for investing in Environmental Data as digital public goods

21. **Directing global financial capital to transform Environmental Data into insights and meaningful outcomes.** The financial system lies at the core of our economy and therefore is a crucial element of how we respond to short term shocks as well as a transition to long term sustainability and the regeneration of ecosystem services. Financial instruments and incentives that can drive forward sustainable investments and markets as well as protect our financial system from environmental risks will require access to trusted Environmental Data at different scales. Increasingly, economic risk assessments also need to take into account the potential for large concurrent environment and climate impacts across the world that would cause mass migration, displacement and conflict, with huge loss of life. In our global economy, mutualizing the cost of high-quality Environment data and equalizing access by all stakeholders is a shared investment in risk reduction and prevention.[14]

22. **Improving transparency and accountability in the digital age:** Environmental data can also support a critical enabling condition for better governance: the principle of transparency. Environmental transparency is a fundamental precondition and catalyst towards sustainability because it generates the data needed to achieve accountability, regulatory compliance, public participation and market pressure. The more that private and public sector actors publish data on progress towards the achievements of their environmental targets and commitments, the more we can track what is working, as well as identify failure points. Requirements to generate and publish this performance data are at

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[14] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/09/The-missing-economic-risks-in-assessments-of-climate-change-impacts-2.pdf

the heart of how citizens can hold their public institutions and private companies more accountable – while also offering further opportunities for innovation.

23. **Increasing scale and impact through more effective matchmaking between environmental problems and digital solutions.** A global commitment to Environmental Data as a digital public good also creates the opportunity for better matchmaking between environmental problems and the deployment of available "solution assets" including approaches, experts, funds, data, software, etc. Opportunities also exist for new tools and technologies to facilitate such matchmaking processes as well as help robust solutions be disseminated and scaled.

24. **Efficiently allocating resources to avoid overlaps and fragmentation.** An international effort is needed to ensure that individual national initiatives and private sector investments contribute to an open global digital ecosystem of Environmental Data rather than a patchwork of fragmented efforts and closed "walled digital gardens". This must be an inclusive vision and process, which brings together public and private sectors, citizen science and a broad range of civil society actors. Unless action is taken to agree on best practices for a "digital ecosystem" approach, we run the risk of fragmented efforts, building overlapping and non-aligned solutions and allocating capital and resources in an inefficient manner. A coherent governance framework is needed in order to foster collaboration and mitigate inefficiencies in resource allocations, while allowing for a decentralized loosely coordinated approach. This will encourage innovation, allow for course correction and acknowledge a plethora of possible solutions.

25. **Enabling coalitions of the willing to take action and share results.** In recent years "coalitions of the willing" from the public and private sectors and civil society have increased in number and motivation. As such, they are actively seeking out guidance on key environmental priorities to tackle as well as formal ways to share valuable Environmental Data and lessons learned on innovative projects they have undertaken. Such digital public goods need to feed into a global framework so they can inspire other actors and be replicated and scaled.

26. **Reducing inequality and contributing to overall prosperity**. As described above, existing inequalities can be exacerbated by gaps in data access and use. Closing these gaps has the potential to contribute to an overall increase in sustainable development and human wellbeing. Hence, any action taken to advance the digital ecosystem should consider inclusion and equity of access to the digital public goods and services, aiming to bridge the digital divide and enabling underrepresented groups to have a voice in these platforms.

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F. Key governance, finance, technical and cultural challenges with environmental digital public goods

27. **Addressing issues of data availability, discoverability and usability:** In many areas, Environmental Data simply does not exist or is patchy. For example, we currently lack global Environmental Data for 63 out of the 93 environmental indicators for the SDGs (a measurement gap of 68%[15]). Where data does exist, much of it is not easily discoverable, not clearly licenced for use, and is not in formats that people or computers can easily manipulate. We need better ways to gather, ingest, store, find, use and share data, robustly, legally, securely, equitably, and at scale to create value for all.

28. **Financing and business models to generate digital public goods:** One of the main challenges in the generation of environmental digital public goods relates to the lack of sustainable business models that can pay for data collection, storage, processing, analysis etc. and the lack of global financing strategies for essential Environmental Data sets. Most Environmental Data sets continue to be developed in an ad hoc manner, cobbling together multiple sources of funding and always teetering on the edge of insolvency.

29. **Environmental data sets with non-commercial use restrictions:** Many Environmental Data sets are treated as digital public goods but do not come with fully open and unrestricted licenses. Instead, they are licenced with non-commercial use restrictions. This means they can be freely used by actors operating in the public interest, but that licenses must be purchased by private sector actors for commercial applications. This business model is used to generate the revenues necessary to pay the development and operating costs of the digital public good while protecting the commercial value of the data asset. The "copyfair" license also adopts a similar practice. Under these provisions, anybody can use the code base of the license, but persons or companies that want to make profit without making any contributions, need to make another contribution to the common effort, for example by paying for the license. This type of licensing agreement aims to re-introduce the principle and practice of reciprocity in markets that use mutualized knowledge (commons), by regulating contributions to these commons for those that commercialize it.

30. **Harmonization, interoperability and quality control:** Given the number of potential contributors of Environmental Data to a Digital Ecosystem for the Planet, one of the key challenges is establishing a set of global standards and protocols linked to harmonization, interoperability and quality control. This includes consistent ways to onboard data custodians, manage data provenance and associated metadata as well as data integrity metrics for specific data sets. It should also include protocols for flagging datasets that do not meet the minimum guidelines or are considered tainted, biased, fake and/or ill-intentioned. All of these measures will be needed to ensure these diverse data holdings can contribute to a global view as well as maintain public trust.

31. **Safeguards and standards for public-private partnerships:** While various public organisations, including UNEP, generate a number of digital public good data sets themselves, they increasingly work with the private sector to generate these products due to the compute demands associated with processing global environmental datasets. This

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[15] https://wedocs.unep.org/bitstream/handle/20.500.11822/27627/MeaProg2019.pdf

trend will likely continue in the digital age given that the private sector has increasing access to data, processing infrastructure, algorithms and talent pool (e.g. best data scientists, AI specialists, etc.). We need safeguards and standards to ensure these partnerships are conducted in the public interest together with sustainable sources of funding to avoid any conflicts of interest or perverse incentives. We have also seen that in many cases, complex analysis and derived Environmental Data products rely on a combination of public and private data, algorithms and analysis. We need clarity on the licencing regime that can be used for these hybrid products consisting of public and private data assets.

32. **Maintaining fairness and quality in the monetization of digital public goods by private sector actors:** There is an increasing trend in terms of private sector actors finding ways to monetize digital public goods produced by public actors as part of their service model. It would be appropriate to consider introducing a fair profit share and/or fee for service model that required these commercial actors to contribute toward the costs associated with the supply of these digital public goods. Some private sector actors are also aiming to develop and maintain digital public goods "reference data sets and analytics" on different environmental themes. In such cases, it is essential to ensure that such digital public goods undergo multi-stakeholder peer review and quality control to ensure scientific quality, the protection of the public interest and adherence to international standards.

33. **Data and server sovereignty and regulatory regimes:** Another trend is the increasing concern over the sovereignty of different digital public goods linked to Environmental Data and the national regulatory regimes which govern different data centers and servers. For example, global Environmental Data contributed by multiple governments but residing on corporate servers in the US are subject to US national laws. This might act as a disincentive for data sharing on a global level. Solutions are needed for the storage of global public good Environmental Data that are not subjected to a single national regulatory regime - such as residing within a UN data center which has the privileges and immunities of the UN. Data sovereignty to measures that ensure equal benefits sharing, as in the Nagoya Protocols, must also be respected.

34. **Data monopolies and data mining:** One major challenge is that commercial cloud storage solutions for global environment public goods can lead to data monopolies, and open up the potential for data mining once different public good databases are connected. At the same time, global level environmental analysis can only be conducted using data sets that are co-located within large, typically commercially-operated cloud infrastructure. Guidance is needed to determine how best public institutions can leverage commercial cloud computing capacities without contributing to data monopolies and the potential for future data mining and monetization of those insights. Cloud-based infrastructure solutions offered by public sector actors, international organizations or data trusts should also be considered.

35. **Capacity gaps to engage in the digital ecosystem:** There is also significant variation between on-ground technical capacity and expertise of various environmental organisations where they simply do not have access to the appropriate equipment or level of expertise on hand to be able to access and use digital public goods effectively. It also inhibits their ability to gather and share their datasets in a way that would comply with any new standards or frameworks that would be introduced. This can complicate cooperation

among stakeholders and, most importantly, may result in the exclusion of underrepresented groups that might not have the technical capacity or expertise to engage at this level.

36. **Inclusion of underrepresented groups:** Rights of access and sovereignty in the digital world can be easily marginalized for underrepresented people and groups. Therefore, it is imperative to co-design inclusive processes to ensure their data sovereignty, ownership, and access to the infrastructure. Some local initiatives are already taking action to secure these rights for Indigenous peoples[16], but this should be mainstreamed in global policy recommendations, including processes to improve digital literacy, reduce the cost of devices and data, and translate content to local languages.

37. **Moving from practice to principles in an agile manner:** Technological change and innovation occur at a speed and scale which is far beyond the capacity of many governments and international institutions to comprehend, influence and regulate. For example, the computational power used to train the largest AI models has doubled every 3.4 months since 2012.[17] By the time lengthy government regulatory processes have kicked in, the technology has often moved on. One of the main challenges in the application of Environmental Data is that governance needs are often particular to a specific use case and combination of data and technologies used. Especially for emerging technologies, it is often impossible to predict, in an apriori fashion, governance needs until use cases are implemented, and lessons can be learned. This speaks to the need for more agile policy development processes where lessons from a set of practices can inform policies and principles in a bottom-up manner.

G. Solutions and next steps

38. **Conceptual model:** We suggest the following seven separate layers in forming the conceptual model underpinning global Environmental Data platforms and the digital ecosystem for the planet:

   - physical (hardware);
   - data (of all variety);
   - semantic (defining the objects involved) and ontological (relations of objects);
   - evidential (proofs of data provenance and methods);
   - application (processing data);
   - interface (contextual to the user);
   - ethical (including inclusion, diversity, equity, and ensuring that specific groups, e.g. Indigenous peoples) with distinct rights (e.g. Indigenous data sovereignty) are included in the conceptualization and design from the outset.

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[16] For example, the Australian National Data Science (ANDS) institution, the Indigenous Data Network (IDN), and the Indigenous Governance Database (IGD).
[17] https://www.technologyreview.com/s/614700/the-computing-power-needed-to-train-ai-is-now-rising-seven-times-faster-than-ever-before/

39. **Digital Ecosystem for the Planet Partnership:** A global programme of action is needed to support a stakeholder movement to build and govern a Digital Ecosystem for the Planet that mobilizes hardware, software and digital infrastructures together with data analytics to generate dynamic, real-time insights that can power various structural transformations needed to advance the environmental dimensions of the sustainable development goals. These include changes in individual consumer behaviors and other user culture changes, market economies, key infrastructure, societies and institutions, and global environmental governance that must be informed by real-time Environmental Data and insights. An international effort is needed to ensure that individual national initiatives and private sector investments contribute to a common global ecosystem rather than a patchwork of fragmented efforts and "walled digital gardens". This must be an inclusive vision and process, which brings together public, private and a broad range of civil society actors as well as Indigenous perspectives.

40. **Data Discovery, Access, Licencing and "APIs for Earth":** An international framework is needed 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).

41. **Digital Charter for Environmental Data**: A Digital Charter for Environmental Data should be initiated, as an inclusive process which co-defines, with a diverse set of users, an ethical and governance framework to guide the development of environmental data as a digital public good, taking into account the intended outcomes and governance challenges defined in this document. It should help establish an international framework enabling data discovery, access, licencing and "APIs for Earth" together with the creation of open standards, safeguards and scorecards. It should also support the implementation of the UNEP Environmental Data strategy, the Open Source for Earth Foundation, the Global Data Commons & other initiatives.

42. **UNEP Environmental Data Strategy:** The UN Environment Assembly requested UNEP[18] to develop and prioritize a long-term environmental data strategy by 2025 to enable regular regional and global analysis of the state of and trends in environmental parameters, including geospatial data and statistics aligned to the SDG indicators. The strategy should include the identification of comparable methods for data collection and analysis and the promotion of their harmonization, taking into account existing standards. It should also help improve digital platforms that provide a repository function, to allow open access to up-to-date, quality-assured, credible and relevant data. It should also provide tools and policy advice for integrated approaches to support evidence-based decision-making. Member States should also be supported in developing their national environmental data management capacities and their environmental monitoring systems with regard to air and water quality, deforestation, marine litter and environmental security. The data strategy should improve the coordination of efforts with the Group on Earth Observations to fully utilize Earth observations as well as with the citizen science community to fill potential data

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[18] http://wedocs.unep.org/bitstream/handle/20.500.11822/28486/K1901170.pdf

gaps. Finally, it should enable robust environmental analysis to UN Resident Coordinator offices, as well as to UN Common Country Analyses and United Nations Development Cooperation Frameworks.

43. **World Environment Situation Room:** A World Environmental Situation Room is needed to aggregate the best available open-source environmental datasets into a single authoritative and non-commercial platform backed by the neutrality of the UN in order to monitor key environmental issues at a global level as a digital public good. UNEP was requested by the UN Environmental Assembly to develop this capacity as part of a new mandate to promote the use, sharing and application of Environmental Data (UNEA/EA.4/Res. 23[18]).

44. **Open Source for Earth Foundation:** Establish, fund, and staff an umbrella organization - drawing on models such as the Linux Foundation - that can support and ensure sustainability of new open source projects to fill in technological gaps in the ecosystem as they arise and provide governance for technical ecosystem elements. This organization would provide the origination point for standards related to the ecosystem as well as the software components that implement them. Foundational work for this organization would include establishing a technical architecture for the ecosystem, and definition and development of required protocols, data formats, APIs, reference implementations, compliance suites, etc.

45. **Global Data Commons (GDC):** Aims at leveraging the revolution in advanced analytics and Artificial Intelligence to support the achievement of the SDGs. It has been envisioned as a precursor for the AI for SDGs Center (AI4SDG) and is a part of the AI Commons initiative. Environmental Data as a digital public good should be a discrete theme within ongoing efforts to build the GDCs.

46. **Safeguard framework for the generation of Environmental Data:** Environmental data and insights are often produced in public-private partnerships. These need a safeguards framework to ensure they are conducted in the public interest, including appropriate capture, storage and access to personal information, and to avoid any potential conflicts of interest**.** This digital safeguard framework must be the result of an open multi-stakeholder governance discussion agreeing on establishing a contextual data culture, including a collection of policies that layout standards for accessibility, inclusion, quality, and trustworthiness.

47. **Capacity building:** Support capacity building within public organizations, NGOs, Indigenous communities and other stakeholders who are the providers of Environmental Data, or guardians of territories from which Environmental Data is gathered, but lack skills or resources to fulfill the role and task. Areas of focus for capacity building could include digital and data literacy and stewardship, technology development, and organizational design. In areas where limited public or private sector capabilities exist to generate required ecosystem data, or other challenges exist that constrain the availability of data, support citizen/community science and enabling technologies through support for associated open-source software and hardware projects, downstream programming, and connectivity infrastructure.