

GLOBAL INFORMATION SOCIETY WATCH 2020

*Technology, the environment and
a sustainable world: Responses from
the global South*



ASSOCIATION FOR PROGRESSIVE COMMUNICATIONS (APC)
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Global Information Society Watch 2020

Technology, the environment and a sustainable world: Responses from the global South

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Introduction

We study sustainability in the context of technology design for smart cities, their legal and policy implications, and are now leading a new programme of investigation into more-than-human futures and post-anthropocentric approaches to sustainability.¹ Sustainable development is often defined in a way that presents technological progress geared for incremental improvements and small efficiency gains as humanity’s response to the imminent planetary ecocide. Critics claim that this is too simplistic, because it does not account for the complex entanglements of Earth’s ecosystems. It also relegates responsibility away from systemic economic frameworks and onto ordinary people making everyday consumption choices.² We use the notion of the Capitalocene³ to critique these conventional views, and present an alternative, more-than-human perspective.

We highlight the widespread co-option of the original conceptualisation of “sustainable development”, and the erosion of its emphasis on social justice, grassroots participation, equality and low-impact development by market forces. This co-option, we argue, has taken place under the banner of “green growth” and the current conceptualisation of “smart cities”. In response, we provide three examples of alternative approaches to “green growth”-based smart cities: planning, design and regulation. Cutting across all three practices, we posit the case for more-than-human principles to be more broadly embraced. (1) We focus on the

potential role of more-than-human principles in planning for smart cities. Here, we discuss technological issues and examples of implementing Indigenous data sovereignty⁴ and implications for smart cities and the people, plants and animals that live in them. (2) We grapple with the socio-cultural dimensions of a more-than-human approach, such as new participatory methods of decentring humans in the design of smart city technology.⁵ (3) We then discuss regulatory and governance issues such as active resistance to planned obsolescence of digital devices and people’s right to repair. More broadly, we discuss how more-than-human perspectives may centre ecosystems in the approach to the planning, design, regulation and governance of urban space.

Why a more-than-human approach is required: The myth of “green growth”

We suggest that a primary shift is required in smart city thinking away from the concept of humans as consumers of the smart city (and its services and supply chains), to producers of spaces and services that provide ecosystemic benefits within and beyond city boundaries. In the absence of this objective, cities risk becoming:

[A] digital marketplace where citizen-consumers’ participation is increasingly involuntary and the hegemony of global technology firms is inflated. What follows is that the city’s “intelligent systems” are defined through a digital consumer experience that has inherent biases and leaves parts of the city and its population unaccounted for. This renders the city less resilient in the face of future social and climatic risks.⁶

Instead, we argue, as producers of the more-than-human smart city, humans who live, breathe and eat

1 <https://research.qut.edu.au/morethanhuman>

2 Lukacs, M. (2017, 17 July). Neoliberalism has conned us into fighting climate change as individuals. *The Guardian*. <https://www.theguardian.com/environment/true-north/2017/jul/17/neoliberalism-has-conned-us-into-fighting-climate-change-as-individuals>

3 Moore, J. W. (2017). The Capitalocene, Part I: on the nature and origins of our ecological crisis. *Journal of Peasant Studies*, 44(3), 594-630. <https://doi.org/10.1080/03066150.2016.1235036>

4 Kukutai, T., & Taylor, J. (Eds.). (2016). *Indigenous Data Sovereignty: Toward an Agenda*. Australian National University Press. <https://doi.org/10.22459/CAEPR38.11.2016>

5 Clarke, R., Heitlinger, S., Light, A., Forlano, L., Foth, M., & DiSalvo, C. (2019). More-than-human participation: design for sustainable smart city futures. *Interactions*, 26(3), 60-63. <https://doi.org/10.1145/3319075>

6 Viitanen, J., & Kingston, R. (2014). Smart Cities and Green Growth: Outsourcing Democratic and Environmental Resilience to the Global Technology Sector. *Environment and Planning A: Economy and Space*, 46(4), 803-819. <https://doi.org/10.1068/a46242>

within a city will seek to break down the false binary between technology and nature – and between city and non-city spaces. We argue that wresting control of conceptualisation of the design and development of the smart city away from its people (and into the hands of the market, digital development companies and technocrats) erodes an already fragile and atomised public sphere, increases inequality and environmental injustice. Rather than information sharing, civic engagement and community development being fostered by smart city development, technological advances are co-opted and used by state-corporate power to destabilise, divide, confuse, depersonalise and atomise. They decrease freedom by increasing the efficiency of government bureaucratic control and exclude considerations of human and non-human inhabitants in the design of their spaces, processes and relationships. Here, humans and nature are commodified: humans are reduced to workers and consumers, nature to a series of assets, resources or ecosystem services, “mobilized to defend productivity gains, minimize costs of capital expansion, and stave off crises of reproduction.”⁷ In the alienated “smart city”, nature is – at best – a “specific type of capital, which needs to be measured, conserved, produced, and even accumulated,”⁸ as long as it meets the threshold of market value.

We agree that cities are fundamental to mitigating widening social inequality, ecological collapse, and climate change. We suggest, however, that they will only play this role in steering back from a planetary ecocide if they rapidly decouple from globalised market-led growth and move away from human exceptionalism towards ecologically just solutions.⁹

More-than-human futures

Having set the background, we explore three interrelated practices – planning, design and regulation – relevant to technology for sustainable development. Together, they afford a discussion of how a more-than-human perspective offers a different way of thinking about smart cities in the Capitalocene, which decouples human well-being from market-led growth and reconnects humans to their ecosystems.

- 7 Lohmann, L. (2016). What is the “green” in “green growth.” In G. Dale, M. V. Mathai, & J. A. Puppim de Oliveira (Eds.), *Green Growth: Ideology, Political Economy and the Alternatives*. Zed Books.
- 8 Kenis, A., & Lievens, M. (2015). *The Limits of the Green Economy: From re-inventing capitalism to re-politicising the present*. Routledge. <https://doi.org/10.4324/9781315769707>
- 9 Yigitcanlar, T., Foth, M., & Kamruzzaman, M. (2019). Towards post-anthropocentric cities: Reconceptualizing smart cities to evade urban ecocide. *Journal of Urban Technology*, 26(2), 147-152. <https://doi.org/10.1080/10630732.2018.1524249>

Planning

Planning the more-than-human city transcends the “citizen-consumer” participatory modes touted by smart city technocrats and requires deeper engagement and recognition of the entanglement with multiple species which cohabit urban space.¹⁰ We have an opportunity to decentre humans in city design and place-making processes and consider multiple perspectives, including those of non-humans, such as the migratory patterns of wildlife, the lives of ecosystem services, and Indigenous knowledge systems and cultures of managing land.¹¹ A more-than-human conceptualisation of the processes and technologies implicated by urban planning regimes opens up to diversity and cosmopolis,¹² allows us to measure urban sustainability beyond efficiency gains,¹³ and eventually realise the “right to the city”.¹⁴ A more-than-human approach to planning for sustainability also entails learning from Indigenous cultures of land stewardship and caring for country, and implementing Indigenous data sovereignty.¹⁵

Realising Indigenous data sovereignty is an emerging agenda aimed at nation building and protecting the data rights of Indigenous people. An example from New Zealand – but with relevance to Australia – relating to urban planning processes is found in the Māori Plan of the Independent Māori Statutory Board (IMSB), a statutory advisory board to the Auckland Council, drafted in 2011. This Plan has a 30-year vision with key directions and actions required of multiple agencies. In New Zealand, organs of state have a duty to consult Indigenous people under two primary pieces of legislation (Local Government Act 2002; Resource Management Act 1991). Within the IMBS, a Data Strategy Expert Panel was responsible for drafting indicators for which data did not yet exist in an attempt to measure progress, considering that “existing regional development frameworks and measures had failed

- 10 Franklin, A. (2017). The more-than-human city. *The Sociological Review*, 65(2), 202-217. <https://doi.org/10.1111/1467-954X.12396>
- 11 Robertson, S. A. (2018). Rethinking relational ideas of place in more-than-human cities. *Geography Compass*, 12(4). <https://doi.org/10.1111/gec3.12367>
- 12 Metzger, J. (2016). Cultivating torment: The cosmopolitics of more-than-human urban planning. *Cityscape*, 20(4), 581-601. <https://doi.org/10.1080/13604813.2016.1193997>
- 13 Loh, S., Foth, M., Amayo Caldwell, G., Garcia-Hansen, V., & Thomson, M. (2020). A more-than-human perspective on understanding the performance of the built environment. *Architectural Science Review*, 63(3-4), 372-383. <https://doi.org/10.1080/00038628.2019.1708258>
- 14 Shingne, M. C. (2020). The more-than-human right to the city: A multispecies reevaluation. *Journal of Urban Affairs*, 1-19. <https://doi.org/10.1080/07352166.2020.1734014>
- 15 Kukutai, T., & Taylor, J. (Eds.). (2016). *Op. cit.*

to adequately provide for Māori identity and well-being.”¹⁶ The Māori Plan in Auckland is an example of how Indigenous data sovereignty is conceptualised, captured and translated into planning processes.

Such lessons have the potential to also unlearn the colonial histories, trajectories and cultures of colonialism, and transform planning praxis.¹⁷ In Australia, Aboriginal and Torres Strait Islander populations have intimate connections with country, and their land management practices have inspired intercultural planning practices around (1) health and well-being benefits, (2) cultural and socio-political benefits, (3) economic benefits, and (4) environmental benefits.¹⁸ The Planning Institute of Australia¹⁹ has over the past decade grappled with the ways in which planning reforms could centrally embed the concept of “caring for country” and introduce new planning methodologies, theories, communication ethics and needs assessments.²⁰ Civil society organisations such as the Australian Earth Laws Alliance²¹ and New Economy Network Australia²² are actively seeking ways to match the emerging Earth jurisprudence movement to Indigenous cultures of land stewardship.²³

Design

Design practice plays a crucial role in creating technology for sustainable development and the smart cities that employ them. While concerns for sustainability have been long established in the field of design, the artefacts and outputs have largely remained in the pursuit of consumerism and commercial growth expectations. More recently, the complicity of design in accelerating the planetary ecocide has been pointed out, which ignited

a healthy debate in the community.²⁴ In response, commentators suggest to re-think design practice in three ways:

- The conventional focus on usability in design practice is too narrow. Implementing an aspirational shift from “users” to “citizens” broadens the scope in order to encompass societal rights and responsibilities.²⁵
- The so-far limited focus on designing technology solutions geared towards individuals making “sustainable” consumption choices, which are often informed by persuasive technology, behavioural economics and nudge theory, has also been criticised, because it largely ignores the responsibility of the Capitalocene’s economic framework. This has prompted a call for designers to overcome the limited focus on individual consumerism and in turn create technology solutions that support community advocacy, activism, and the scale making required to build effective political movements.²⁶ As part of this process, “institutioning” has been proposed as a new design avenue on the basis of the recognition that “a re-engagement with institutions is necessary if we are to re-politicise”²⁷ design. Considering the political and institutional context that technology for sustainability is embedded in, institutioning has received increasing attention in the smart cities space.²⁸

16 Hudson, J. (2016). The World’s Most Liveable City—for Māori: Data Advocacy and Māori Wellbeing in Tāmaki Makaurau (Auckland). In T. Kukutai & J. Taylor (Eds.), *Indigenous Data Sovereignty: Toward an Agenda*. Australian National University Press. <https://press-files.anu.edu.au/downloads/press/n2140/pdf/ch10.pdf>

17 Porter, L. (2010). *Unlearning the Colonial Cultures of Planning*. Ashgate.

18 Weir, J., Stacey, C., & Youngetob, K. (2011). *The Benefits Associated with Caring for Country*. Australian Institute of Aboriginal and Torres Strait Islander Studies. <https://aiatsis.gov.au/publications/products/benefits-associated-caring-country>

19 <https://www.planning.org.au>

20 Wensing, E. (2011). Improving Planners’ Understanding of Aboriginal and Torres Strait Islander Australians and Reforming Planning Education in Australia. Paper presented at the 3rd World Planning Schools Congress, Perth, Australia, 4-8 July. <https://www.planning.org.au/documents/item/3320>

21 <https://www.earthlaws.org.au>

22 <https://www.neweconomy.org.au>

23 Graham, M., & Maloney, M. (2019). Caring for Country and Rights of Nature in Australia: A Conversation between Earth Jurisprudence and Aboriginal Law and Ethics. In C. La Follette & C. Maser (Eds.), *Sustainability and the Rights of Nature in Practice*. CRC Press.

24 Monteiro, M. (2019). *Ruined by Design: How Designers Destroyed the World, and What We Can Do to Fix It*. Independently published. <https://www.ruinedby.design>

25 Foth, M., Tomitsch, M., Satchell, C., & Haeusler, M. H. (2015). From Users to Citizens: Some Thoughts on Designing for Polity and Civics. *OzCHI '15: Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction*, 623-633. <https://doi.org/10.1145/2838739.2838769>; Foth, M. (2018). Participatory urban informatics: Towards citizen-ability. *Smart and Sustainable Built Environment*, 7(1), 4-19. <https://doi.org/10.1108/SASBE-10-2017-0051>

26 Dourish, P. (2010). HCI and environmental sustainability: the politics of design and the design of politics. *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS)*, 1-10. <https://doi.org/10.1145/1858171.1858173>; Frauenberger, C., Foth, M., & Fitzpatrick, G. (2018). On scale, dialectics, and affect: pathways for proliferating participatory design. *Proceedings of the 15th Participatory Design Conference*. <https://doi.org/10.1145/3210586.3210591>; Boyd, A., & Mitchell, D. O. (2013). *Beautiful Trouble: A Toolbox For Revolution*. OR Books. <https://beautifultrouble.org>

27 Huybrechts, L., Benesch, H., & Geib, J. (2017). Institutioning: Participatory Design, Co-Design and the public realm. *CoDesign*, 13(3), 148-159. <https://doi.org/10.1080/15710882.2017.1355006>

28 Foth, M., & Turner, T. J. (2019). The Premise of Institutioning for the Proliferation of Communities and Technologies Research. *Proceedings of the 9th International Conference on Communities & Technologies (C&T)*, 24-28. <https://doi.org/10.1145/3328320.3328398>; Teli, M., Foth, M., Scianamblo, M., Anastasiu, I., & Lyle, P. (2020). Tales of Institutioning and Commoning: Participatory Design Processes with a Strategic and Tactical Perspective. *Proceedings of the 16th Participatory Design Conference*, 159-171. <https://doi.org/10.1145/3385010.3385020>

- The recent push away from techno-centric and towards human-centred smart cities was aimed at increasing the participation of diverse, often marginalised citizens in the design and use of urban technology. Nonetheless, this shift – while admirable – continues the traditional view of urban space as separate from nature, and ready to be optimised for human comfort and convenience. In recognition of a more-than-human perspective, designers have started to contemplate how to decentre the human in the design of smart cities and what new participatory design methods are required to account for humans and more-than-humans alike.²⁹

Regulation

We illustrate regulatory and governance practices with a discussion of planned obsolescence of digital technologies limiting the right to repair. Planned obsolescence is a tactic in industrial manufacturing to shorten the lifespan of a product so that it becomes obsolete or non-functional after a defined expiration date, so that consumers purchase new products. It may also involve designing for limited repair where products must be replaced entirely.³⁰ Intentionally shortening the lifespan of products by design, especially electronic devices, has significant environmental impacts as more waste is created and disposed. This applies to personal consumer products, but it entails an exponential scale factor in the context of technology for sustainability deployments in smart cities such as internet of things (IoT) devices and sensors.

The European Union (EU) has made some initial moves towards limiting e-waste through the EU Directive on Waste Electrical and Electronic Equipment (WEEE). The WEEE Directive aims to:

[C]ontribute to sustainable production and consumption by, as a first priority, the prevention of WEEE and, in addition, by the re-use, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste

and to contribute to the efficient use of resources and the retrieval of valuable secondary raw materials.³¹

In addition, the EU has recently ratified a “Right to Repair” Directive that will enter into force in 2021. It will apply to lighting, washing machines, dishwashers, refrigerators and televisions, but not smartphones and laptops. It will require manufacturers to design products with longer life cycles, and supply spare parts for up to a decade.³² However, it will only apply to professional repairs, not repairs conducted by consumers themselves.³³

In Australia there are protections under the Australian Consumer Law that require businesses to repair faulty products.³⁴ In 2019, the Australian consumer affairs minister agreed to consider introducing right to repair laws, yet it is unclear if and when these will be introduced.³⁵ Despite the lack of formal right to repair laws, there are numerous examples of social enterprises concerned with electronic waste recycling,³⁶ reuse and repair centres,³⁷ and local repair cafés³⁸ that provide avenues for individuals to repair or re/upcycle electronic products rather than dispose of them. These initiatives are more aligned with moving away from a consumption model and towards a circular economy where resources are re/used and re/upcycled.

Significantly, planned obsolescence relates not only to individual consumers but also the infrastructures that underpin smart cities at a larger scale. This systemic technological foundation of smart cities means the magnitude of the impacts of planned obsolescence at city level are significant. While initiatives such as the right to repair are beginning to emerge at the individual consumer level, there is also a need to incorporate these considerations into procurement arrangements between cities and vendors, especially in relation to lifetime optimisation, maintenance and repair rights.

31 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0019>

32 Industry Europe. (2019, 2 October). “Right to Repair” rules to be adopted in EU from 2021. <https://industryeurope.com/right-to-repair-rules-to-be-adopted-in-eu-from-2021>

33 Harrabin, R. (2019, 1 October). EU brings in ‘right to repair’ rules for appliances. *BBC*. <https://www.bbc.com/news/business-49884827>

34 <https://www.accc.gov.au/consumers/consumer-rights-guarantees/repair-replace-refund>

35 Lowrey, T. (2019, 29 August). ‘Right to repair’ laws for fixable electronics pushed forward after agreement at consumer affairs meeting. *ABC*. <https://www.abc.net.au/news/2019-08-30/smartphone-electronics-right-to-repair-request-ministers/11462572>

36 <https://substation33.com.au>

37 <https://bower.org.au>

38 The Rogue Ginger. (2020, 16 February). Repairing Australia: The rise of repair cafes. <https://www.therogueginger.com/2020/02/repairing-australia-rise-of-repair-cafes.html>

29 Forlano, L. (2016). Decentering the Human in the Design of Collaborative Cities. *Design Issues*, 32(3), 42-54. https://doi.org/10.1162/DESI_a_00398; Clarke, R., Heitlinger, S., Light, A., Forlano, L., Foth, M., & DiSalvo, C. (2019). Op. cit.

30 Rivera, J. & Lallmahomed, A. (2016). Environmental implications of planned obsolescence and product lifetime: A literature review. *International Journal of Sustainable Engineering*, 9(2), 119-129. <https://doi.org/10.1080/19397038.2015.1099757>; Gultinan, J. (2009). Creative destruction and destructive creations: Environmental ethics and planned obsolescence. *Journal of Business Ethics*, 89, 19-28. <https://doi.org/10.1007/s10551-008-9907-9>

Conclusion

Our capitalocentric review of technology for sustainable development has raised a number of issues. While climate and environmental emergencies have gained mainstream attention, the associated responses and technology solutions are largely framed by a conventional neoliberal growth paradigm. Not only does this risk everyday citizens wanting to do the right thing yet inadvertently buying into greenwashing, it also allows overall consumption and resource depletion to continue, accelerating the planetary ecocide. Smart cities are a specific case in point due to the stark contrast between “green growth” and sustainability marketing rhetoric on the one side and their actual detrimental impact on the environment on the other side, including energy use, rare earth metal depletion, land clearing, and e-waste.³⁹ Additionally, the global smart city market is driven by global corporations and geopolitical agendas that can jeopardise not just environmental outcomes but also human rights and social justice aspirations of the global South.⁴⁰ Yet, environmental rights are human rights,⁴¹ and it is imperative to consider them interlinked.

The more-than-human perspective explored in this report offers an alternative approach to the design of technology for sustainable development. It requires us to ponder our complex entanglements with ecological systems. It reminds us to recognise the merits of relationalist worldviews pioneered by Indigenous and First Nations peoples and learn from them. It also prompts a reflection on how technology, data, regulation and governance can be reimagined to bring about a future that is ecologically healthy and just for both humans and more-than-humans. Perhaps the current COVID-19 pandemic is the crisis humanity needed to radically rethink the purpose of our existence and create more-than-human futures.⁴²

Action steps

We suggest the following action steps:

- Realise that using technology to drive efficiency gains while trapped inside a capitalist growth-oriented system will not save the planet.⁴³ Design technology for sustainability grounded in the recognition that the sustenance and prosperity of humans and more-than-humans are profoundly interdependent within the nature-technology continuum.⁴⁴
- Demand legislators to implement a formal right to repair in law for individual consumers and at city level through procurement arrangements between cities and vendors, especially in relation to lifetime optimisation, maintenance, and repair rights.⁴⁵
- Learn from and be guided by Indigenous and First Nations peoples to foster a more-than-human worldview and engage in a deeper understanding of relationalist cosmologies, ontologies and epistemologies.⁴⁶
- Build effective partnerships⁴⁷ between government, industry, academia and civil society to advocate for an urgent transition to a new economic framework that creates an ecologically healthy and socially just society.⁴⁸
- Design and use technology to strengthen community advocacy, activism, and building the scale of the progressive political movement.⁴⁹

39 <https://interactive.aljazeera.com/aje/2015/e-waste>

40 Datta, A. (2019). Postcolonial urban futures: Imagining and governing India's smart urban age. *Environment and Planning D: Society and Space*, 37(3), 393-410. <https://doi.org/10.1177/0263775818800721>; Watson, V. (2014). African urban fantasies: dreams or nightmares? *Environment and Urbanization*, 26(1), 215-231. <https://doi.org/10.1177/0956247813513705>

41 <https://www.foei.org/resources/publications/publications-by-subject/human-rights-defenders-publications/our-environment-our-rights>

42 Allam, Z., & Jones, D. S. (2020). Pandemic stricken cities on lockdown. Where are our planning and design professionals [now, then and into the future]? *Land Use Policy*, 97. <https://doi.org/10.1016/j.landusepol.2020.104805>; Loker, A., & Francis, C. (2020). Urban food sovereignty: urgent need for agroecology and systems thinking in a post-COVID-19 future. *Agroecology and Sustainable Food Systems*, 44(9), 1118-1123. <https://doi.org/10.1080/21683565.2020.1775752>; Batty, M. (2020). The Coronavirus crisis: What will the post-pandemic city look like? *Environment and Planning B: Urban Analytics and City Science*, 47(4), 547-552. <https://doi.org/10.1177/2399808320926912>

43 Kolinjivadi, V. (2019, 6 June). Why a hipster, vegan, green tech economy is not sustainable. *Al Jazeera*. <https://www.aljazeera.com/indepth/opinion/hipster-vegan-green-tech-economy-sustainable-190605105120654.html>

44 Abram, D. (1997). *The Spell of the Sensuous: Perception and Language in a More-than-human World*. Vintage Books; Wiesel, I., Steele, W., & Houston, D. (2020). Cities of care: Introduction to a special issue. *Cities*, 105. <https://doi.org/10.1016/j.cities.2020.102844>

45 Wiseman, L., & Kariyawasam, K. (2020, 2 February). US and EU laws show Australia's Right to Repair moment is well overdue. *The Conversation*. <https://theconversation.com/us-and-eu-laws-show-australias-right-to-repair-moment-is-well-overdue-127323>

46 <https://www.futuredreaming.org.au>

47 Foth, M., & Adkins, B. (2006). A Research Design to Build Effective Partnerships between City Planners, Developers, Government and Urban Neighbourhood Communities. *Journal of Community Informatics*, 2(2), 116-133. <http://ci-journal.net/index.php/ciej/article/view/292>

48 <https://www.neweconomy.org.au>

49 <https://progressive.international>

Technology, the environment and a sustainable world: Responses from the global South

The world is facing an unprecedented climate and environmental emergency. Scientists have identified human activity as primarily responsible for the climate crisis, which together with rampant environmental pollution, and the unbridled activities of the extractive and agricultural industries, pose a direct threat to the sustainability of life on this planet.

This edition of Global Information Society Watch (GISWatch) seeks to understand the constructive role that technology can play in confronting the crises. It disrupts the normative understanding of technology being an easy panacea to the planet's environmental challenges and suggests that a nuanced and contextual use of technology is necessary for real sustainability to be achieved. A series of thematic reports frame different aspects of the relationship between digital technology and environmental sustainability from a human rights and social justice perspective, while 46 country and regional reports explore the diverse frontiers where technology meets the needs of both the environment and communities, and where technology itself becomes a challenge to a sustainable future.

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