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EDITORIAL

Antimicrobial Resistance: Just Transitions for Shared Futures*

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In the last decade, we have seen escalating warnings of a looming "antibiotic apocalypse"—a future where antimicrobial resistance (AMR) overtakes modern medicine and routine procedures such as minor surgery or uncomplicated childbirth become costly and life-threatening.[1] For much of the world, this is already happening. In many lower- and middle-income countries, the threat of drug-resistant infections is an everyday reality—antimicrobial drugs have long since lost their effectiveness or were never accessible in the first place.[2] While this health crisis is being linked to AMR, it reflects deeper structural inequalities and unseen injustice.[3] Narratives of AMR as a "silent pandemic" or looming global health threat obscure these realities and fail to recognise that drug-resistance is already exacting a profound and uneven toll on human health and development, particularly among vulnerable and marginalised communities.[4]

In truth, our interdependence with the microbial world is far more complex, and the implications of AMR extend well beyond the clinical setting and economic burden of drug resistance in humans.[5] Microbes are the basis of all life on Earth. Microbes are key to sustaining the biosphere, regulating planetary biogeochemical cycling, and constitute 70%–90% of all cells within the human body.[6] Maintaining healthy, sustainable, and diverse microbial environments is essential for all life.[7]

AMR is itself a naturally occurring process within microbial ecosystems: microbes produce antimicrobial substances to compete or communicate with each other and have evolved complex resistance mechanisms to survive exposure to organic and inorganic antimicrobial

* This article has been updated since original publication. A notice detailing the change has also been published.
[1] Murray et al. 2022; Naghavi et al. 2024.
[2] World Health Organization 2025.
[3] Varadan et al. 2024.
[4] Davis et al. 2025.
[5] Kirchhelle 2023.
[6] Rappuoli et al. 2023.
[7] Ibid.

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substances.[8] Greater exposure to antimicrobials increases selection for resistant organisms and AMR genes. The short-term challenge posed by AMR is that many of the antimicrobial substances we rely on to control microbial environments in medicine, agriculture, and industry (antibiotics, antimalarials, antiparasitics, and antifungals) become less effective.[9] According to the most recent estimates, over 4 million human deaths were associated with bacterial AMR in 2019—and the number is set to rise further.[10]

Beyond the immediate threat of treatment failure, growing selective pressures–be they pharmaceutical or non-pharmaceutical, such as biocides, disinfectants, and industrial pollutants—also pose a major threat to the functioning of microbial ecosystems that humans and all other life rely upon.[11] Seen from this angle, AMR is not just a public health challenge, but also a wider signal of planetary stress linked to an accelerating microbial ecocrisis.[12] This ecocrisis is intimately entwined with the wider triple planetary crisis of biodiversity loss, climate change, and pollution.[13] There is also a growing body of evidence showing the long-term impact of human-induced environmental destruction (i.e. protracted armed conflict) on microbial environments.[14]

Increasingly, AMR is being recognised as a "superwicked" problem, given its immediacy and magnitude, multifactorial drivers, lack of clear solutions or coordinated policy responses, and interconnectivity with other global crises.[15] However, unlike climate change, where discourse has centred around societal transitions towards more sustainable and low-carbon economies, there has been little discussion within AMR governance about the widescale changes needed for the longer-term management of AMR and microbial environments.[16]

Until now, the global governance framework for AMR has taken a predominantly public health and individual behaviour-focused approach aimed at reducing the clinical burden of drug-resistant infections.[17] The WHO Global Action Plan on AMR (WHO GAP), adopted in 2015, articulated its primary goal as "ensur[ing], for as long as possible, continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured...and accessible to all who need them."[18] It laid out five key objectives: (1) improving awareness and understanding of AMR through effective communication, education, and training; (2) strengthening surveillance of AMR by strengthening knowledge and the evidence-base; (3) reducing incidence of infection by strengthening infection prevention; (4) optimising use of antimicrobials through stewardship programmes; (5) investing more in new medicines, diagnostic tools, vaccines, and other interventions aimed at mitigating AMR.[19] That the 2015 WHO GAP did not consider the environmental dimensions of AMR, nor the socio-economic inequities driving antimicrobial-use made it self-limiting from its onset—a "damage-control" rather than longer-term strategy for the sustainable management of AMR and microbial environments.[20]

[8] Kirchhelle and Roberts 2025; Rappuoli et al. 2023.
[9] UNGA Resolution on AMR 2024.
[10] Naghavi et al. 2024.
[11] United Nations Environment Programme 2023.
[12] Kirchhelle and Roberts 2025.
[13] Van Bavel et al. 2024.
[14] Abbara et al. 2025.
[15] Littmann, Viens, and Silva 2020.
[16] Varadan et al. 2024.
[17] Gradmann and Kirchhelle 2023.
[18] World Health Organization 2015; Ibid., 8.
[19] Ibid., 8–12.
[20] Kirchhelle et al. n.d.

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Attempts to integrate the environment into antimicrobial policy-making have only recently gathered momentum.[21] In 2022, the "Tripartite" led by the World Health Organization, the Food and Agriculture Organisation, and the World Organisation for Animal Health joined with the UN Environmental Programme, becoming the "Quadrapartite" and formally adding the environmental dimension to AMR governance.[22] International organisations have also begun to issue guidelines for AMR-sensitive treatment of pharmaceutical and urban waste.[23] At the national level, major manufacturing hubs such as India have attempted to introduce stricter guidelines for substances that select for AMR—albeit with limited success.[24] However, new environmental AMR mitigation measures have also triggered resistance from industry groups, including the use of counter-science and the creation of international non-governmental standards that limit sustainability criteria to carbon-focused metrics.[25] Meanwhile, the breakdown of multilateralism and the recent downturn in funding for international surveillance and stewardship initiatives pose serious challenges for coordinated action against the accelerating antimicrobial challenge.

Compounding these complexities are the structural inequalities that drive antimicrobial use and exacerbate vulnerability to disease and exposure to antimicrobials.[26] Such challenges are specific to particular communities and contexts, and policies to address antimicrobial use in such contexts often exacerbate existing inequalities, introducing ethical issues.[27] Communities living with poor sanitation, polluted water systems, contaminated land, or unsafe working conditions are disproportionately exposed to resistant pathogens. Often, these same communities also face the greatest challenges in accessing effective treatment.[28] Environmental determinants intersect with poverty and marginalisation, creating layered or structural vulnerabilities that current AMR governance does not address.[29] Overlooking these structural inequalities risks reinscribing the same inequities that AMR governance should be seeking to address.

Faced with these entrenched and accelerating challenges, a new approach to AMR governance is urgently needed—one that embraces interdisciplinarity and allows for a more diverse range of perspectives, knowledge, and evidence to inform AMR discourse and governance.[30] Rather than being on the sidelines, equity needs to be at the heart of AMR governance and policy moving forward. With a humanities and social sciences lens, we are able to confront the uncomfortable questions: Who bears the heaviest burden of AMR? Who stands to lose the most in AMR-related interventions? Whose knowledge counts in AMR governance? Whose voices are heard and what evidence is valued in the design of AMR interventions? How do power, financial, and special interests shape policy? And how should we manage our relationship with microbes and microbial environments?

[21] UN General Assembly 2024, see paras 9, 74–76, 77, 78.

[22] "Memorandum of Understanding between the Food and Agricultural Organization of the United Nations and the World Organization for Animal Health and the World Health Organization and the United Nations Environmental Programme regarding Cooperation to Combat Health Risks at the Animal–Human–Ecosystems Interface in the Context of the 'One Health' Approach and Including Antimicrobial Resistance," 17 March 2022, see Article 2(1), Article 3(1). https://openknowledge.fao.org/server/api/core/bitstreams/0b6a5a41-4383-4840-acf0-ef374e07a4b3/content.

[23] World Health Organization 2024.

[24] Center for Infectious Disease Research and Policy 2022.

[25] Bjerke 2025.

[26] Davis et al. 2025; Tompson and Chandler 2021.

[27] Tegama et al. 2025.

[28] Davis et al. 2025.

[29] Ibid.; Keenan et al. 2025.

[30] Ibid.

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Drawing on Just Transitions from climate change, we make a case for prioritising justice, equity, inclusivity, and sustainability in AMR decision-making and governance, placing process over outcome, bottom-up approaches over top-down solutions, and long-term strategies over one-off technical fixes.[31] Applying Just Transitions widens our perspective, allowing for a deeper inquiry into how AMR impacts the lives of communities around the world, and what processes are needed to forge a sustainable and equitable shared future with microbial environments.

1. What is Just Transitions?

The concept of Just Transitions emerged in the United States in the 1970s, when labour organiser Tony Mazzochi of the Oil Chemical and Atomic Workers' Union sought compensation for workers adversely impacted by the ban on toxic chemicals and coal.[32] Mazzochi called on "society to pay workers not to make poisons"—drawing attention to vulnerable communities in societal transitions.[33] Rather than actively resisting transitions to low-carbon energy, Mazzocchi and others saw an opportunity to embed social justice and equity in grassroots environmental movements, linking equitable transitions to environmental justice.[34]

From its inception, Just Transitions was a battle cry for those adversely impacted by societal changes—calling for a just, equitable, and inclusive process to navigate the hard decisions and trade-offs needed to effect radical transformations. Just Transitions has since become a cornerstone in climate justice, providing a platform for the unseen to be heard, and ensuring steps are taken to avoid "creating new injustices and vulnerabilities" while redressing "pre-existing structural drivers of injustice" in the widescale transitions towards low-carbon economies.[35] However, Just Transitions has also transcended climate justice discourse, embodying a wider framework for justice, equity, and inclusivity in societal transformations.[36] Lenihan-Ikin et al. propose an expansive framework for Just Transitions that offers "a viable avenue to address a multiplicity of co-existing and related inequities."[37] It encompasses four characteristics: (1) relationality; (2) systems-thinking; (3) place-based; and (4) intergenerational thinking.[38] Wang and Lo identify five different framings of Just Transitions: (i) a labour-oriented concept; (ii) an integrated framework for justice; (iii) a theory of socio-technical transition; (iv) a governance strategy; and (v) public perception.[39] Though sometimes criticised for being overly broad and not sufficiently transformative, Just Transitions nonetheless finds currency in policy frameworks, offering a flexible and multifaceted framework to advance societal change through social justice, equity, and inclusivity.[40]

2. Just Transitions for AMR

In this issue, we use Just Transitions as a framing to probe narratives and practices in AMR discourse and governance. We posit that Just Transitions offers a novel and unique

[31] Lenihan-Ikin, Ariana, and Atuire 2025.
[32] Laurent 2024; Stambe et al. 2025.
[33] Lenihan-Ikin, Ariana, and Atuire 2025; Stambe et al. 2025; Stevis and Felli 2020.
[34] Eisenberg 2019.
[35] Savaresi et al. 2024.
[36] Wang and Lo 2021, 2.
[37] Lenihan-Ikin, Ariana, and Atuire 2025, 3.
[38] Ibid., 2–5.
[39] Wang and Lo 2021, 2.
[40] Ibid., 9.

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vantage point to re-evaluate AMR, shifting attention from the immediacy of averting drug-resistance to the longer-term strategies for shared futures with AMR and microbial environments. We also critique Just Transitions as a conceptual framework, examining its adequacy in addressing the multiplicity of voices and competing interests that need to be negotiated and considered in AMR governance. The articles in this Issue centre around four broad themes of Just Transitions: (1) Justice, (2) Equity, (3) Inclusivity, and (4) Governance.

First, justice is interrogated. Tegama et al. call for a wider conception of justice in "just" transitions, so that marginalised knowledge systems are not overlooked, animals and the environment are considered as moral subjects, historical inequities are acknowledged, and no community is left to bear the disproportionate burden of AMR.[41] Ho extends this conversation to non-human justice, exploring the idea of microbial rights as part of a broader ecological framing.[42] Boucrot et al. explore how the right to a healthy environment could be leveraged in AMR to widen its narrative from a public health threat to an environmental and human rights crisis, and in the process advance justice and accountability in AMR governance.[43] Rekers and Marinova consider how transitional justice frameworks could be applied to AMR governance to address past and ongoing injustices.[44]

Second, equity is examined. Batheja et al. underscore how intersectionality—particularly gender and caste—shapes vulnerability and contributes to structural inequalities in access to treatment and AMR-related decision-making.[45] Yellappa et al. highlight inequitable access to treatment for drug-resistant tuberculosis, pointing to the need for resilient, community-based health systems.[46] The scoping review by Mutua et al. reveals how structural inequities in governance and the overreliance on global action plans and donor priorities risk entrenching gaps between global and local contexts, calling for locally grounded, sustainable, and equitable approaches to AMR governance.[47]

Third, inclusivity is discussed. Ngo et al. show the benefits of participatory practices and how public engagement can enhance understanding and efficacy of national policies at the local level.[48] Ethnographic work by Rangel-Gutiérrez and Gerrets demonstrates how informal medicine sellers are able to adapt antibiotic practices to reflect community needs, revealing the opportunities that context-sensitive and inclusive governance may hold for AMR "solutions."[49] Joubert and Botes argue for moving beyond expert-led AMR-awareness campaigns in public communication towards more inclusive, participatory, culturally grounded, and creative approaches built on dialogue, trust, and co-creation with local communities.[50]

Finally, governance is explored. Kirchhelle calls for a paradigm shift in international legal frameworks from antimicrobial stewardship to the governance of microbial commons, embedding microbial and environmental conservation into international legal

[41] Tegama et al. 2025.
[42] Ho 2025.
[43] Boucrot et al. 2025.
[44] Rekers and Marinova 2025.
[45] Batheja et al. 2025.
[46] Yellappa et al. 2025.
[47] Mutua et al. 2025.
[48] Ngo et al. 2025.
[49] Rangel-Gutiérrez and Gerrets 2025.
[50] Joubert and Botes 2025.

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frameworks.[51] Wells et al. historicise the "empty pipeline" narrative in antibiotic innovation, revealing how market-oriented R&D models entrench inequities, and calling for alternative governance models that foreground public interest and global access.[52] Giri et al., in their review of AMR National Action Plans in the Western Pacific Region, reveal a consistently top-down technocratic governance model that gives little consideration to procedural fairness or local participation.[53] Fortané shows how narrow and technocratic approaches to AMR governance, such as antimicrobial reduction targets in livestock farming, cannot address the structural drivers and infrastructures surrounding antimicrobial use, and thus do not achieve the longer-term transformations needed to sustainably manage AMR and microbial environments.[54] Mutua et al. argue that governance structures must move beyond the isomorphic mimicry of global action antimicrobial reduction policies and plans to embrace locally grounded strategies that strengthen institutional commitment, equitable stakeholder involvement, and sustainability of resources in low- and middle-income settings.[55]

While this Special Issue primarily focuses on antibiotic resistance, we recognise that AMR manifests in other forms—antifungal, antiviral, and antiparasitic resistance—which also raise similar scientific, socio-economic, and governance challenges and which could also merit further exploration through the lens of Just Transitions.

3. Towards shared futures

Applying Just Transitions to AMR gives us an opening to change the narrative in AMR, from a war against microbes to a transition towards a more just, sustainable, and equitable relationship with microbial environments in the management of AMR. It does not demand "solutions" but rather embraces an open-ended process of negotiation and renegotiation, acknowledging that a diversity of perspectives, knowledge, practices, and contexts will be needed to guide this process. It means not pitting "humans" against nature, but acknowledging the inseparable connections between human life and other forms of life—while also pulling the focus towards intrahuman inequalities.

Anticipating a future with AMR need not be dictated by fear, scarcity, and apocalyptic predictions. It can be shaped by justice, equity, and sustainability—where healthy microbes, ecosystems, and societies thrive together in shared futures.

Sheila Varadan is a human rights and children's rights legal scholar based at Leiden Law School and the African Studies Centre Leiden. Her work explores how human rights law can be used to advance justice and equity in global health challenges and planetary environmental crises such as antimicrobial resistance and climate change.

Sara de Wit is an anthropologist and social historian, at with a focus on climate change and global health in Africa. Her work explores how technologies and scientific discourses are translated by different communities of expertise and how participatory approaches can enhance inclusivity and climate justice from the bottom-up.

Miriam Waltz is an anthropologist based at the Institute for Cultural Anthropology & Development Sociology and the African Studies Centre at Leiden University. Her research examines the intersection between health technologies, agricultural change, environmental exposures, and gender justice in African contexts.

[51] Kirchhelle 2025.
[52] Wells et al. n.d.
[53] Giri and Lewycka 2025.
[54] Fortané 2025.
[55] Mutua et al. 2025.

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