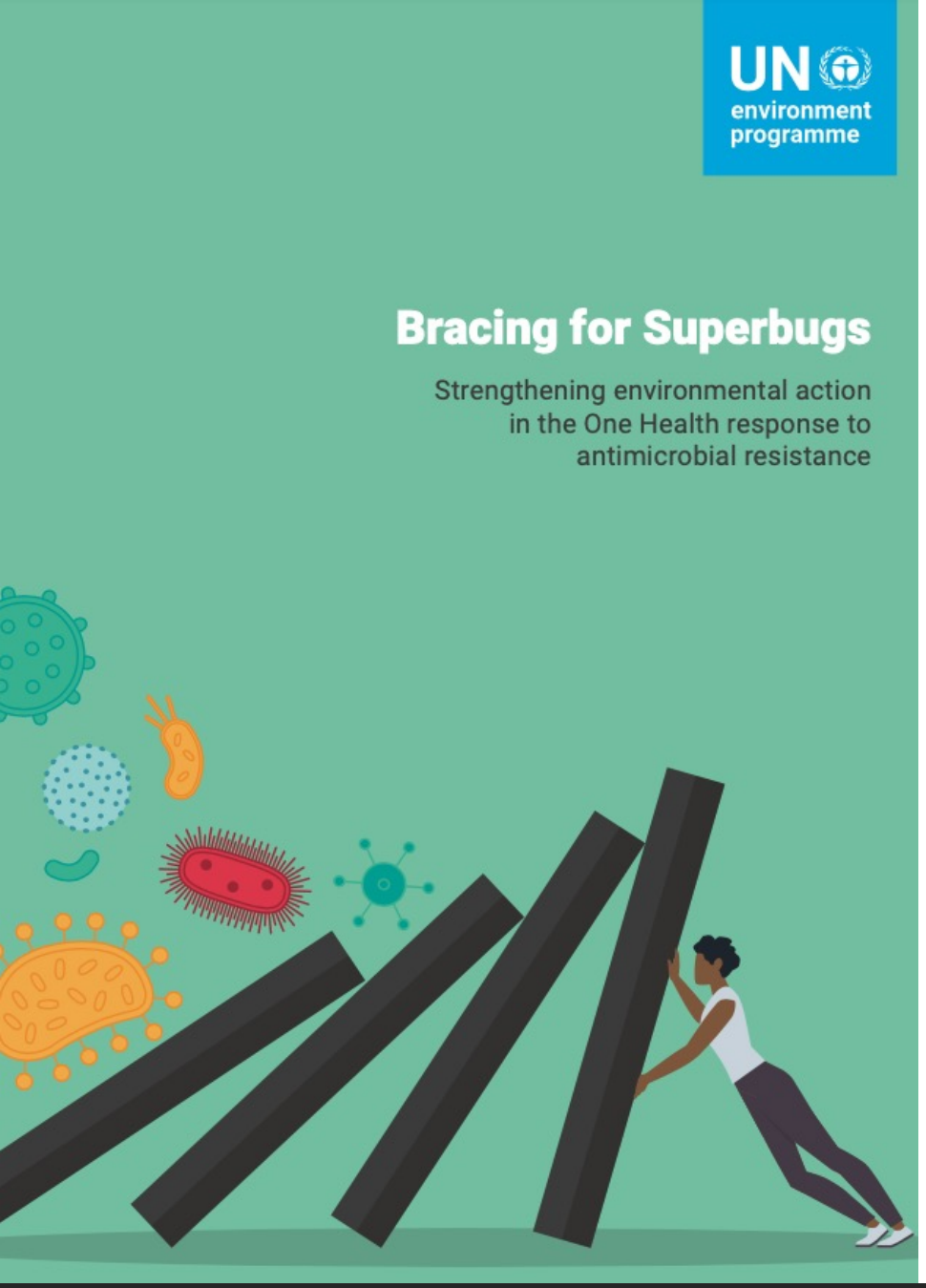

Strengthening Environmental Action in the One Health Response to Antimicrobial Resistance

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Innovation+Design Enabling Access (IDEA) Initiative

Johns Hopkins Bloomberg School of Public Health

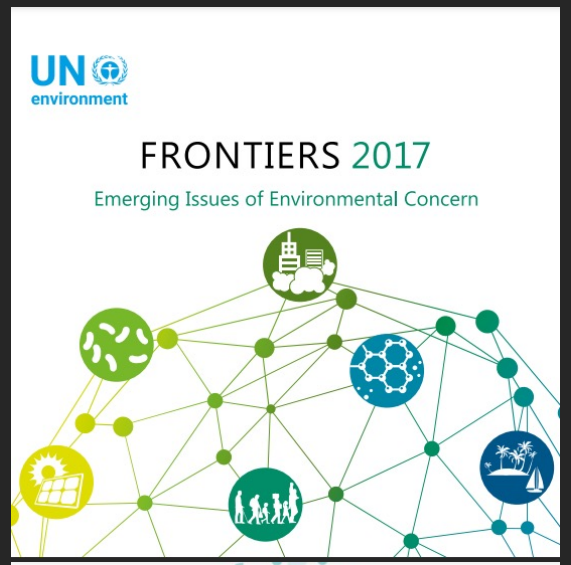
South Centre – Environmental Aspects of Antimicrobial Resistance Virtual Workshop

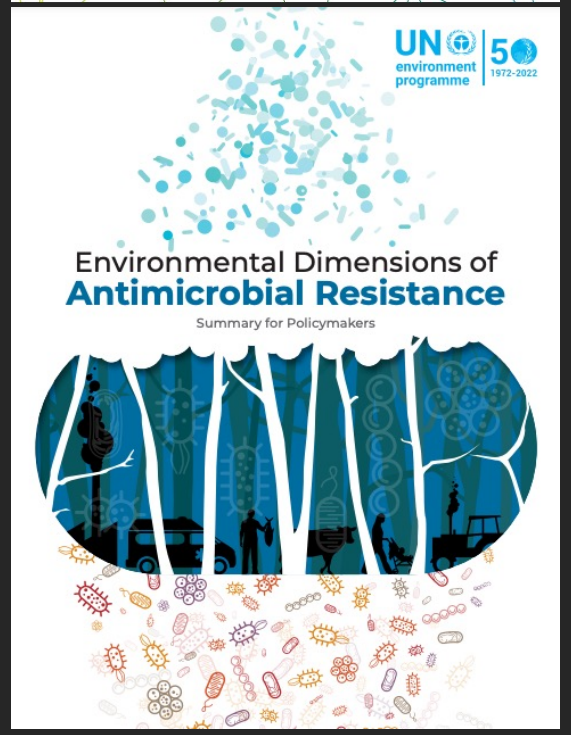
March 28, 2023

Significance of UNEP's *Bracing for Superbugs*

Global spotlight report that drew clearer linkage between tackling antimicrobial resistance (AMR) and environment

Environmental dimensions of AMR, while complex, still afford opportunity to take steps actionable on today's evidence





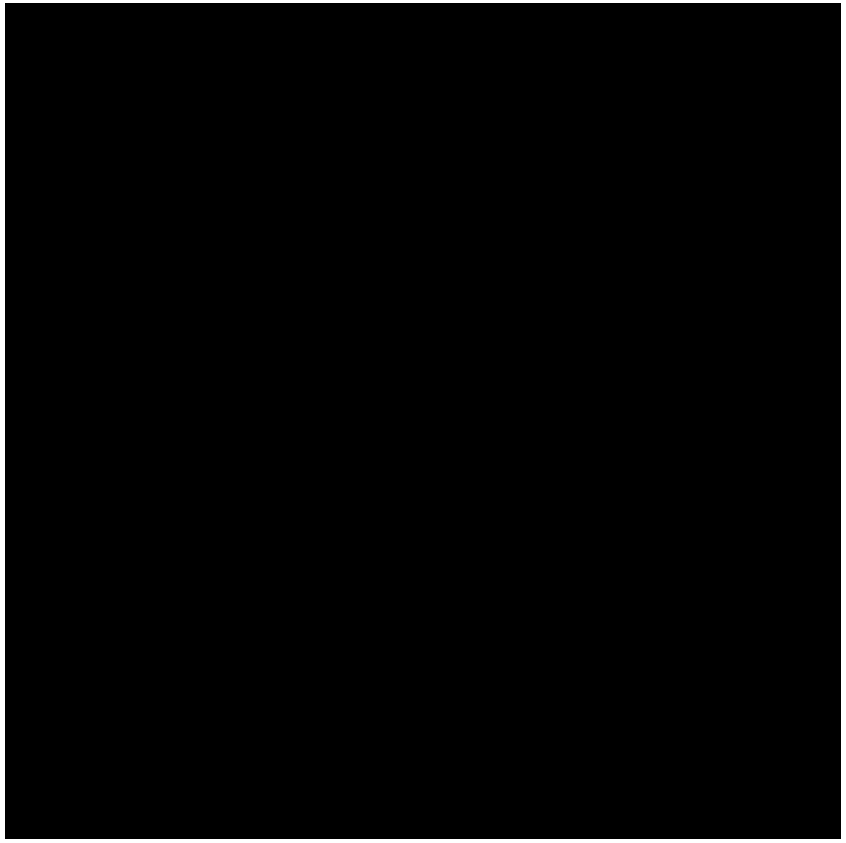
Why Environment Matters in Tackling AMR

UNEP joining the Tripartite agencies (WHO, FAO, WOAH) in 2022 to form a Quadripartite

The lens of environment and AMR:

-- Broadens the range of Ministries and movements to which AMR finds relevance

-- Brings a unifying systems frame to addressing the challenge of AMR



Magnitude of AMR Challenge

Lancet GRAM study (2022):

- 1.27 M deaths attributable to bacterial AMR in 2019

- Global deaths attributable to AMR greater than HIV/AIDS, breast cancer or malaria

- One in five people who died due to AMR were children

- Highest rate of AMR burden was in sub-Saharan Africa, followed by South Asia

Regional Analysis

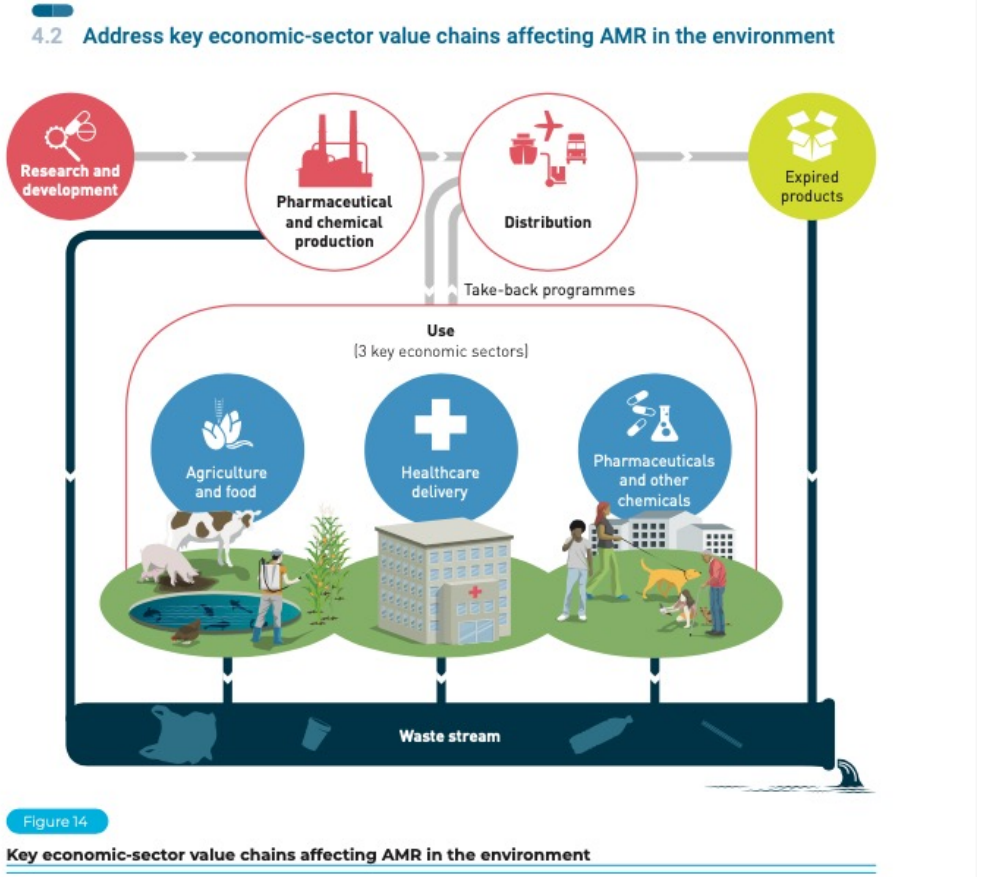
	Attributable to resistance				Rates, per 100,000			
	Deaths	YLLs	DALYs	YLDs				
Counts, thousands								
Global	1270 (911–1710)	47 600 (35 000–63 400)	47 900 (35 300–63 700)	275 (161–439)	16·4 (11·8–22·0)	615·1 (452·4–819·1)	618·7 (455·7–823·2)	3·6 (2·1–5·7)
Central Europe, eastern Europe, and central Asia	73·7 (48·7–105)	1980 (1350–2790)	1990 (1360–2800)	9·95 (4·79–16·8)	17·6 (11·7–25·3)	474·3 (323·0–667·3)	476·7 (325·2–671·0)	2·4 (1·1–4·0)
High income	141 (98·6–197)	2390 (1620–3400)	2410 (1640–3420)	20·2 (12·7–31·2)	13·0 (9·1–18·2)	220·4 (149·9–314·0)	222·3 (151·5–315·9)	1·9 (1·2–2·9)
Latin America and Caribbean	84·3 (60·3–117)	2370 (1660–3310)	2380 (1680–3330)	16 (9·79–24·9)	14·4 (10·3–20·0)	405·3 (284·8–566·6)	408·1 (286·9–570·0)	2·7 (1·7–4·3)
North Africa and Middle East	68·3 (45·6–99)	2590 (1770–3700)	2610 (1790–3720)	20·7 (12–33·5)	11·2 (7·5–16·3)	425·6 (291·2–608·4)	429·0 (293·7–611·5)	3·4 (2·0–5·5)
South Asia	389 (273–538)	16 000 (11 500–21 600)	16 100 (11 600–21 700)	111 (58·5–188)	21·5 (15·1–29·8)	885·8 (636·3–1194·6)	892·0 (643·1–1200·2)	6·2 (3·2–10·4)
Southeast Asia, east Asia, and Oceania	254 (167–369)	6830 (4620–9840)	6870 (4670–9890)	45·6 (25–80·1)	11·7 (7·8–17·1)	316·1 (213·9–455·7)	318·2 (216·1–458·0)	2·1 (1·2–3·7)
Sub-Saharan Africa	255 (196–331)	15 400 (11 700–19 900)	15 500 (11 800–20 000)	51·1 (30·2–81·8)	23·7 (18·2–30·7)	1432·0 (1084·6–1848·1)	1436·7 (1090·0–1853·5)	4·7 (2·8–7·6)

Source: Global burden of antimicrobial resistance in 2019: a systematic analysis. *Lancet*, 2022.

Transmission of AMR through the Environment

- Natural vs. acquired resistance
- Antimicrobial drugs vs. Antibiotic-resistant genes vs. Drug-resistant pathogens
- AMR hotspots

- Urbanization
- Globalization
- Economic value chains



Source: UNEP, *Bracing for Superbugs*, 2023.

SDG 12: Responsible consumption and production

Inputs → Carrying Capacity → Outputs

Key Economic Sector Value Chains

Pharmaceutical manufacturing
Food production systems
Healthcare delivery

Waste Stream

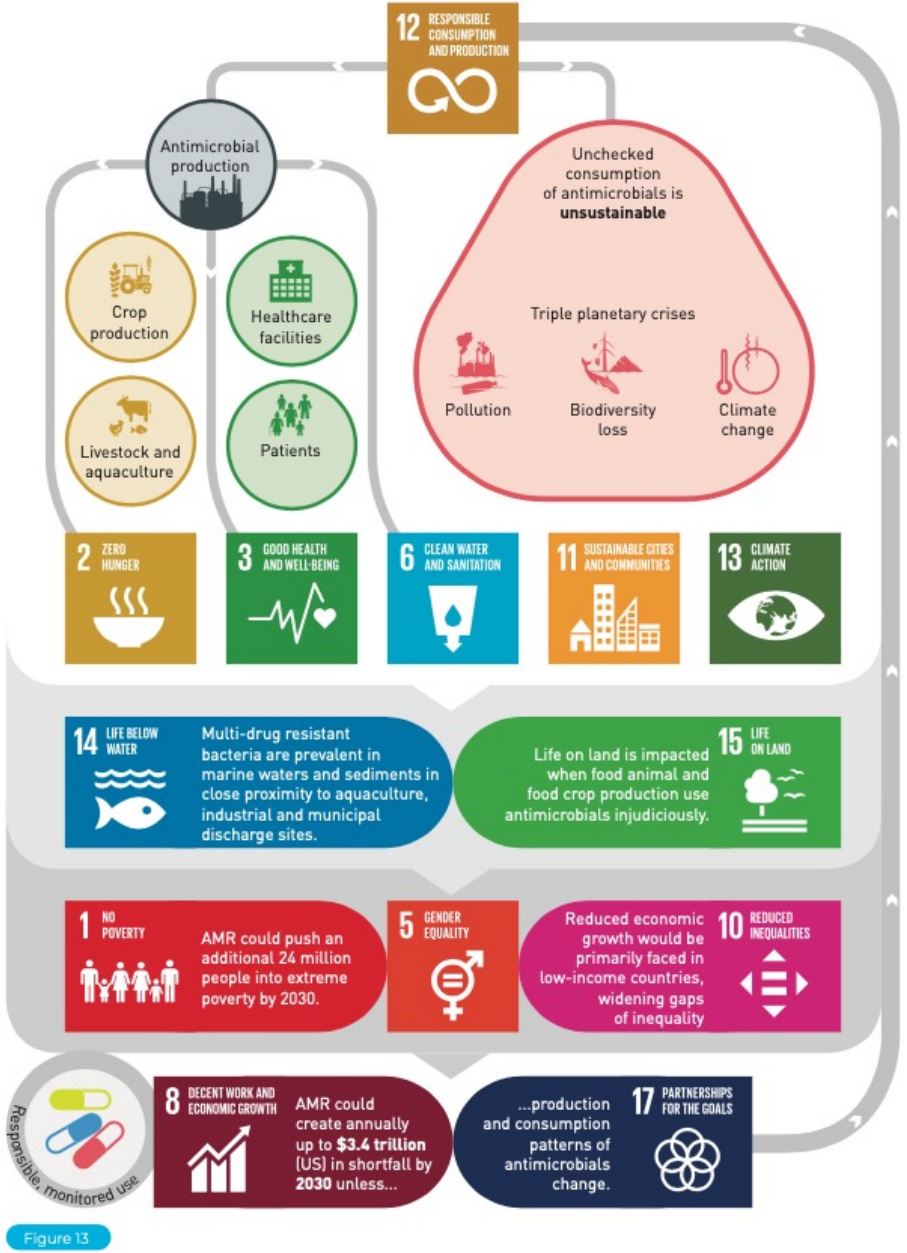


Figure 13

Sustainable production and consumption of antimicrobials can impact many other SDGs

Source: UNEP, *Bracing for Superbugs*, 2023.

Pharmaceutical Manufacturing

SETTING DISCHARGE TARGETS – PNECS

IMPROVING SUPPLY CHAIN TRANSPARENCY

PROMOTING SUSTAINABLE PROCUREMENT AND REIMBURSEMENT SYSTEMS

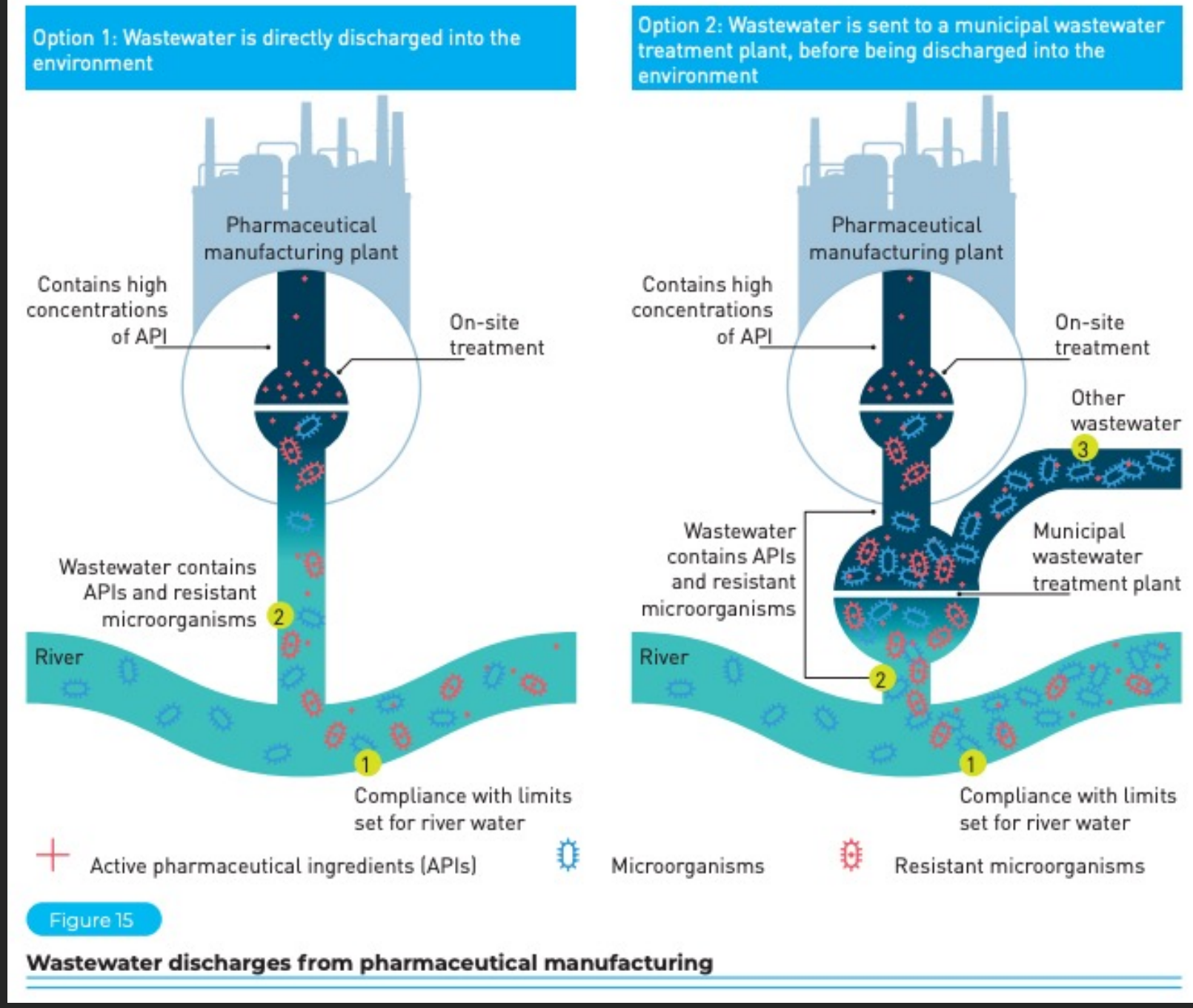


Figure 15

Wastewater discharges from pharmaceutical manufacturing

Source: UNEP, *Bracing for Superbugs*, 2023.

Healthcare Delivery System

Hospitals: Waste treatment, greening programs, procurement

Community disposal of expired antibiotics

AMR Surveillance: Piggybacking on Poliovirus Lab Network and COVID-19 wastewater surveillance

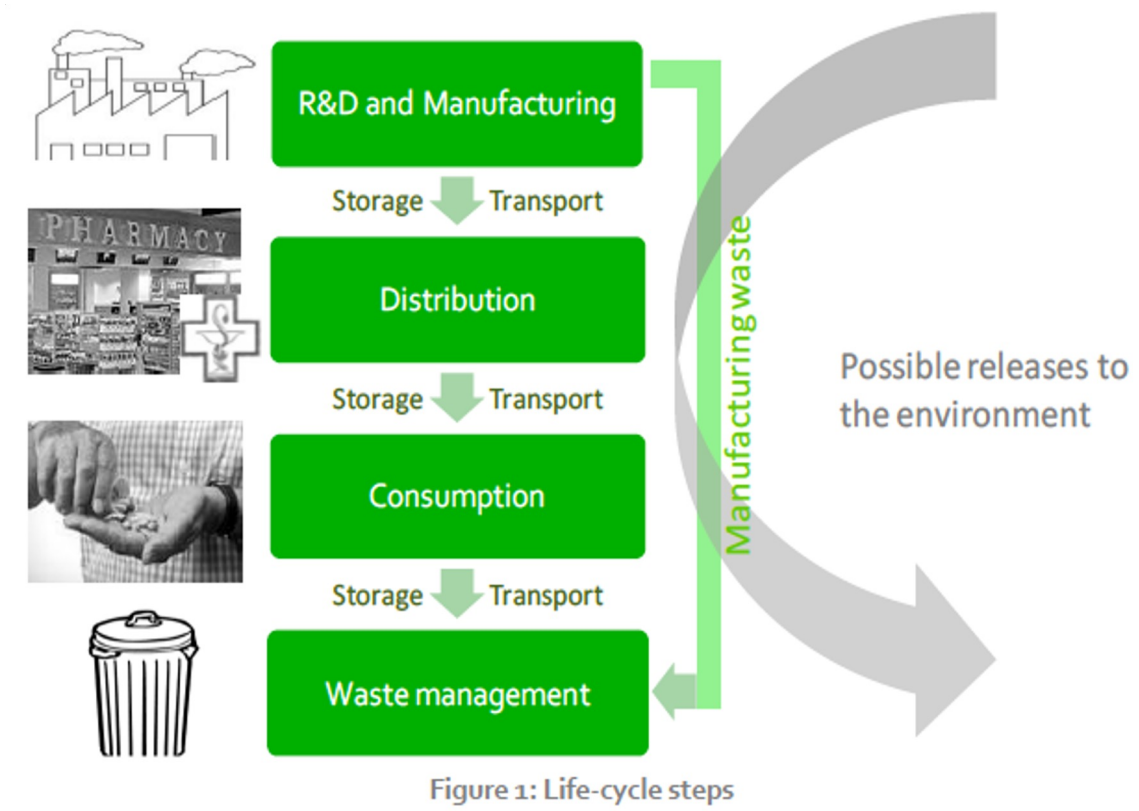


Figure 1: Life-cycle steps

Source: Bio Intelligence Service, 2013

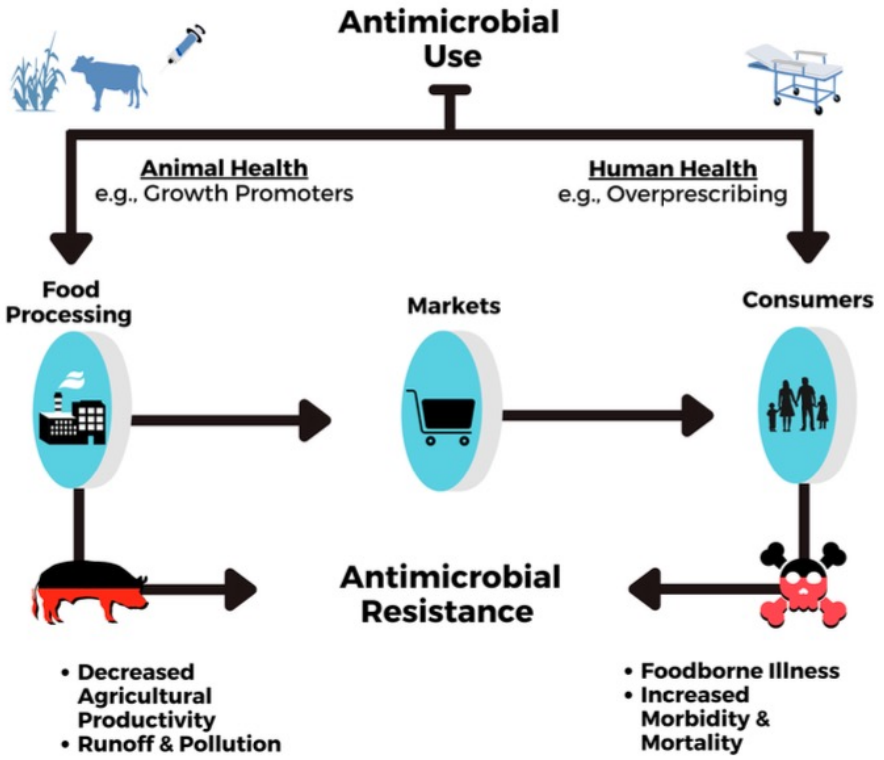
Food Systems

Antibiotic growth promoters and routine use of antimicrobials in livestock production

- Need for transparency of WOAH country-level data on antimicrobial consumption

Use of antimicrobials in crop production

Trade in food products



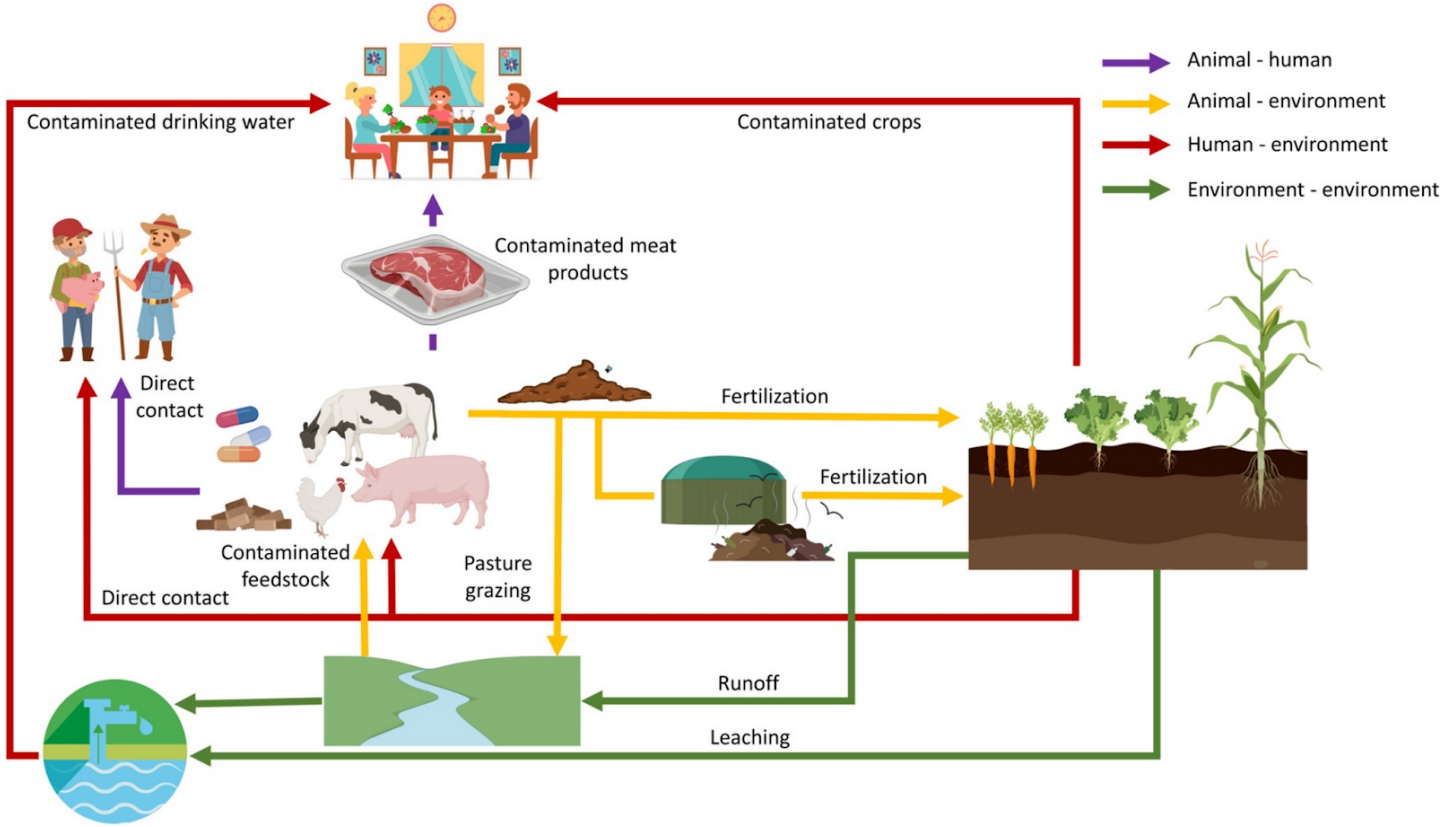
Pathways from Agri-Food Systems to Human Medicine: From Farm to Fork

Annually, 600 million cases of foodborne diseases, with 420,000 deaths (WHO, 2015)

- Extensively-drug resistant (XDR) typhoid in Pakistan
- Pork from UK supermarkets

Urinary tract infections from retail poultry meat (Liu CM, et al., 2018)

Plasmid-mediated resistance to colistin, a last-line antibiotic in China (Liu YY, et al., 2016)



Source: Jadeja NB, Worrich A. From gut to mud: dissemination of antimicrobial resistance between animal and agricultural niches. Environ Microbiol. 2022 Feb 16. (CC license)

Climate Change and AMR

Climate Change → Antimicrobial Use

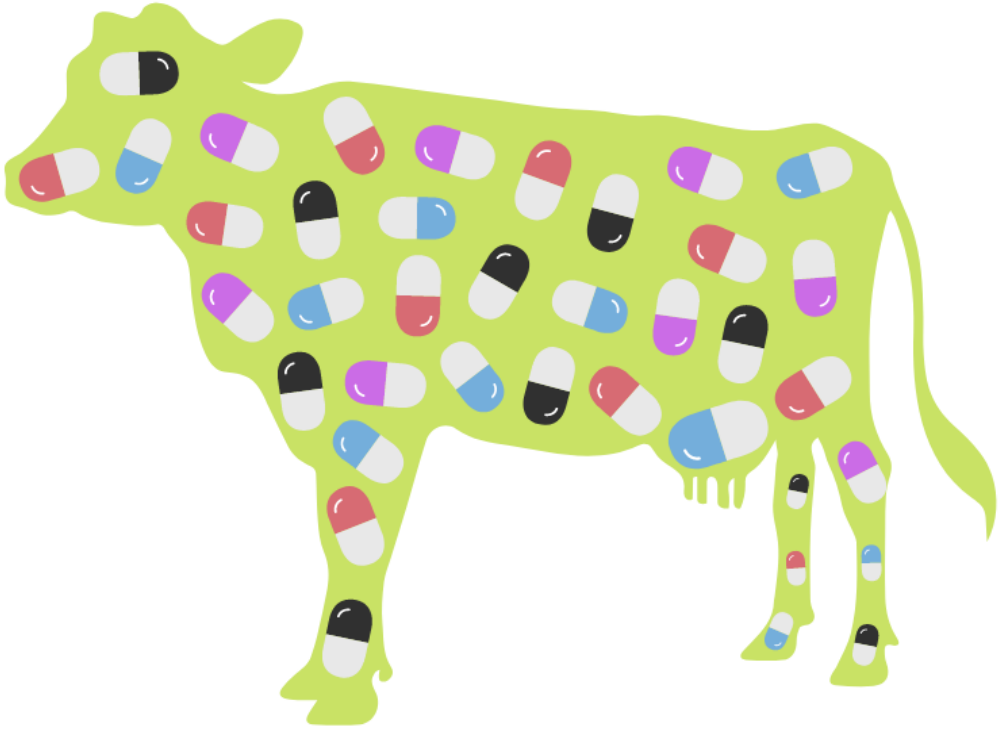
Higher temperature associated with greater antibiotic resistance

Infectious diseases increase → Antimicrobial use increases

Pressure on food production systems → Increased use of antimicrobials

Antimicrobial Use → Climate Change?

Cattle treated with antibiotics produced 1.8 times more methane, a potent greenhouse gas (Hammer TJ, et al., 2016)



Source: Hammer TJ, Fierer N, Hardwick B, et al. Treating cattle with antibiotics affects greenhouse gas emissions, and microbiota in dung and dung beetles. *Proc R. Soc. B* 2016; 283: 20160150

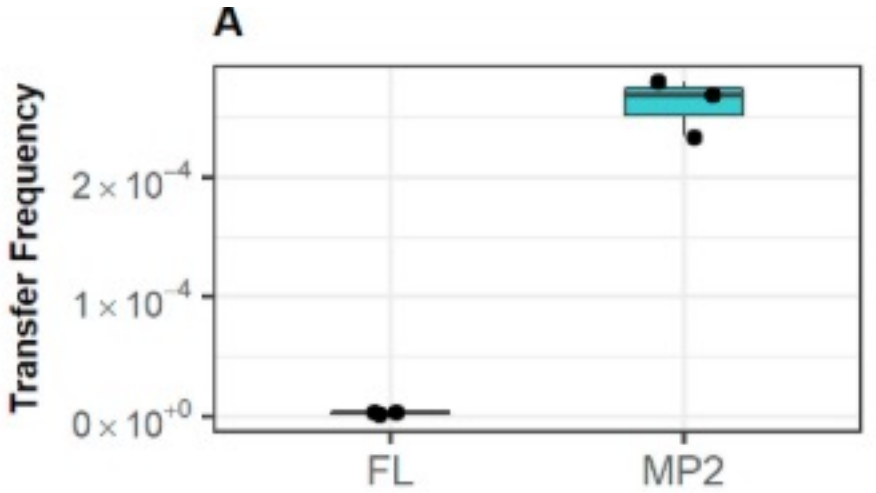
Other Environmental Exposures and AMR

Herbicides and AMR

Herbicides (glyphosate, 2,4-D and dicamba) can induce greater tolerance to antibiotics (Kurenbach, et al., 2015).

Glyphosate, glufosinate and dicamba increase the prevalence of antibiotic resistance genes in agricultural soils (Liao, et al., 2021)

Microplastics and AMR (Arias-Andres, et al. 2018)

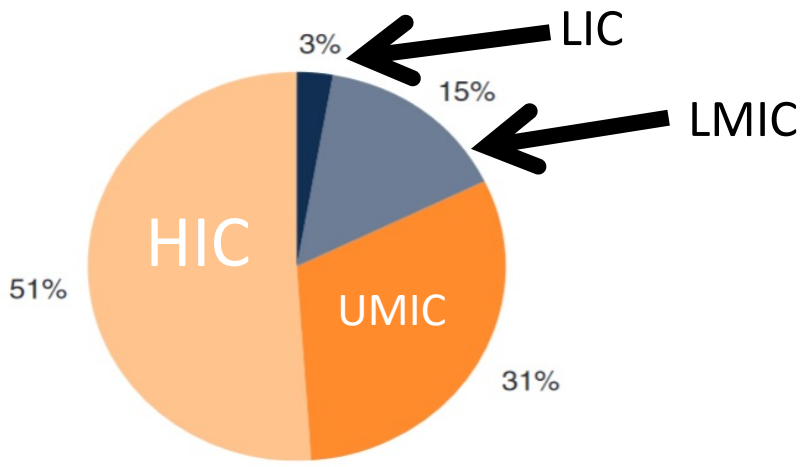


→ Plasmid uptake frequency by bacteria on microplastic biofilms is two orders of magnitude higher than by free-living bacteria (Arias-Andres, et al., 2018)

AMR Containment: “one of the highest-yield investments countries can make”

- Up to **24 million** more people would be forced into extreme poverty by 2030 (World Bank, 2017)
- In high AMR-impact scenario, **3.8% loss of annual GDP** by 2050, with annual shortfall of $3.4 trillion by 2030
- “putting resources into AMR containment now is one of the highest-yield investments countries can make.”

Figure: Where global AMR containment benefits accrue



Source: World Bank, *Drug-Resistant Infections: A Threat to Our Economic Future*, March 2017.

Making the case for investing to address AMR

Averting the human and economic toll

Synergy with COVID-19

Co-Benefits, from Health Care to Sustainable Food Systems

Connection with other movements

A MULTI-BILLION-DOLLAR OPPORTUNITY

Repurposing agricultural support to transform food systems