UN environment programme 50 1972-2022

Environmental Dimensions of Antimicrobial Resistance

Summary for Policymakers

Suggested citation: United Nations Environment Programme (2022). *Environmental Dimensions of Antimicrobial Resistance: Summary for Policymakers*.

Production: United Nations Environment Programme

URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/38373/antimicrobial_R.pdf.

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Background

Global attention to antimicrobial resistance (AMR) has been dominated by a focus on the health and agriculture sectors. However, the environment is also key to the development, transmission and spread of AMR to humans, animals and plants. In 2017 this fact was recognized by the United Nations Environment Assembly (UNEA-3), which requested a report on the environmental impacts of AMR and the causes of the development and spread of resistance in the environment, including the gaps in understanding those impacts and causes. This paper presents highlights from a full report that will be released later this year, which was prepared through a consultative process that engaged more than 50 experts and stakeholders from countries around the world, including from the Tripartite organizations the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO).

Many human activities create pollution which promotes the emergence of AMR in the environment. AMR in the environment can cause animal or plant diseases or soil biodiversity loss that can lead to further use of antimicrobials (a negative feedback from initial use) that only increases the selective pressure further. The environmental dimensions of AMR are characterized by cyclic interrelationships, their complexities, and multiple causalities and dynamics. A systems approach, such as 'One Health', is required to better understand the environmental dimensions of AMR and inform science-based decisions and actions.

The environmental impacts of AMR, and the causes of the development and spread of resistance in the environment are complex. However, there is evidence that both biological and chemical pollutants, which enter the environment, can fundamentally influence and change what is happening in the environment, especially AMR development, transmission and spread. Human activity and increasing populations are damaging the natural microbial world – the very foundation of global ecology.

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A call to **strengthen environmental action** within the 'One Health' response to AMR

The world has not taken the threat of zoonotic diseases, pandemics and their environmental dimensions seriously enough. The COVID-19 pandemic is a wake-up call to better understand and improve all areas of preparedness for and prevention of infectious diseases, including their environmental dimensions (Pachauri *et al*. 2021).

Such lack of preparedness cannot be allowed to happen again. The COVID-19 pandemic provides lessons learned, one of which is the need to prevent and tackle various health threats concurrently, especially their environmental dimensions.

Another pandemic is hiding in plain sight. Antimicrobial resistance (AMR) is already a leading threat to global health and risks adversely affecting the environmental sustainability of the planet (Murray *et al*. 2022). The consequences of the continuing development and spread of AMR could be catastrophic.

1.1 The effectiveness of antimicrobials is in jeopardy

For decades antimicrobials have contributed to the reduction of infectious diseases in humans, animals and plants, saving lives and increasing productivity. Their effectiveness is now in jeopardy. As microbes evolve and become resistant, antimicrobial treatments are rendered less effective. Antimicrobial compounds released into the environment, together with other factors, create a selection pressure on natural microbial communities such that those with inherited or acquired resistance have evolved and proliferated. Pollution containing minimal selective concentration of antimicrobial compounds contributes to antimicrobial resistance development in the environment.

Box 1

What is antimicrobial resistance (AMR) and how does it develop?

Antimicrobials are agents intended to kill or inhibit the growth of microbes. They include antibiotics, fungicides, antiviral agents and parasiticides. Disinfectants, antiseptics, other pharmaceuticals and natural products may also have antimicrobial properties.

AMR occurs when microbes such as bacteria, viruses, parasites and fungi are, or become, resistant to antimicrobial treatments to which they were previously susceptible. Antimicrobials are widely used in human and animal healthcare, and in crop and animal production.

Acquired resistance is an evolutionary response by microbes, which genetically change their DNA in such a way that they are no longer inhibited or killed by antimicrobials. AMR can be intrinsic or acquired; the latter can occur through mutations, the acquisition of DNA from different microbes, or, in the case of bacteria, horizontal gene transfer (HGT) of mobile genetic elements (MGEs) (Levy and Marshall 2004; Martínez *et al*. 2015).

Use and misuse of antimicrobials and other stressors (e.g. the presence of heavy metals and other pollutants) create favourable conditions for resistant microbes to develop (Levy and Marshall 2004; Wales and Davies 2015). This can happen in the digestive tracts of humans and animals or in environmental media (e.g. water, sewage, soil and air) (Baquero *et al*. 2019). Resistant microbes can subsequently spread and be transmitted to humans, food animals, plants and wildlife because of complex interconnections across nature (Graham *et al*. 2019). There is strong evidence that antimicrobials are increasingly failing to cure infections, the pipeline of novel antimicrobials to take their place has faltered, and AMR therefore poses a significant threat to human, animal and plant health, and food security.

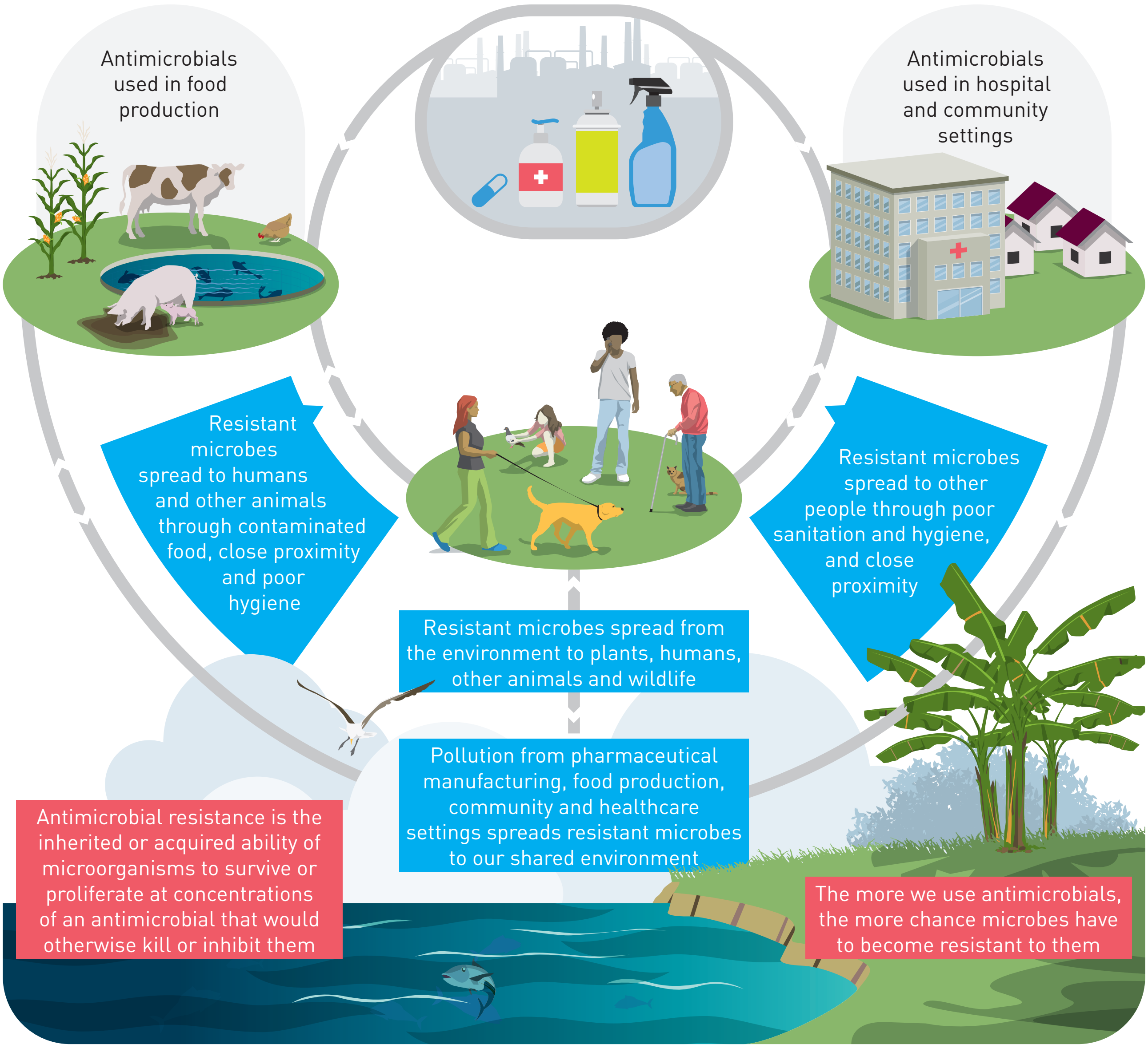

Figure 1

How antimicrobial resistance can spread (adapted from Government of Australia 2017)

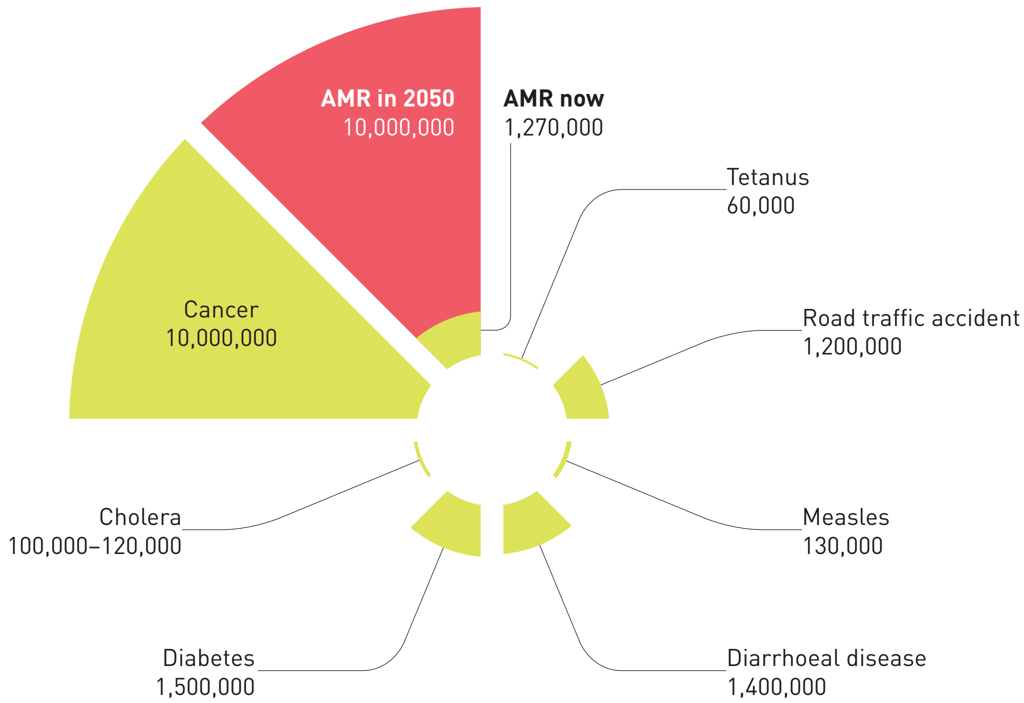

Figure 2

Predicted mortality from AMR compared to common causes of death today (adapted from O'Neill 2016)

In 2019, antibiotic-resistant infections were responsible for the deaths of 1.27 million people, with an overall 4.95 million deaths associated with complications from resistant bacterial infections (Murray *et al*. 2022). Immediate action is needed to tackle AMR or by 2050 it could cause up to 10 million deaths globally per year (O'Neill 2016), on par with the 2020 death toll from cancer (Ferlay *et al*. 2020). The economic impact is also likely to be significant. By 2050 it is estimated that AMR could be responsible for a loss of 3.8% of the US$3.4 trillion per year, while 24 million more people could be pushed into extreme poverty (Jonas *et al*. 2017).

Given the wide prevalence of infectious diseases (Shallcross *et al*. 2015), antimicrobials play an essential role in protecting people, animals and plants (Hernando-Amado *et al*. 2019; Joint Programming Initiative on Antimicrobial Resistance 2019). Failing to address the global burden of AMR, including its environmental dimensions, could take