Health Care Without Harm

TACKLING AMR IN THE ENVIRONMENT

How the EU Can Lead the Way

INTRODUCTION

The role of the environment in the development, spread and acceleration of antimicrobial resistance (AMR) is often underestimated in the big picture of AMR. Growing evidence suggests that the environment can act as a major reservoir for resistant bacteria, posing a risk for public health.

Antibiotic residues have been found in various environmental matrices, including rivers, soils, and groundwater, even in remote areas of Antarctica with no apparent human or animal presence.[1] The limited understanding of how antimicrobial residues interact with the environment hinders a comprehensive One Health approach to tackling AMR.

The recent UNEP "Bracing for Superbugs" report highlights the crucial role of the environment in the AMR crisis. It identifies pharmaceutical and chemical manufacturing, food production, and healthcare delivery as key sectors driving antibiotic resistance.

Antibiotic residues discharged into aquatic ecosystems through sewage can disrupt various organisms, from microorganisms to fish.[2]

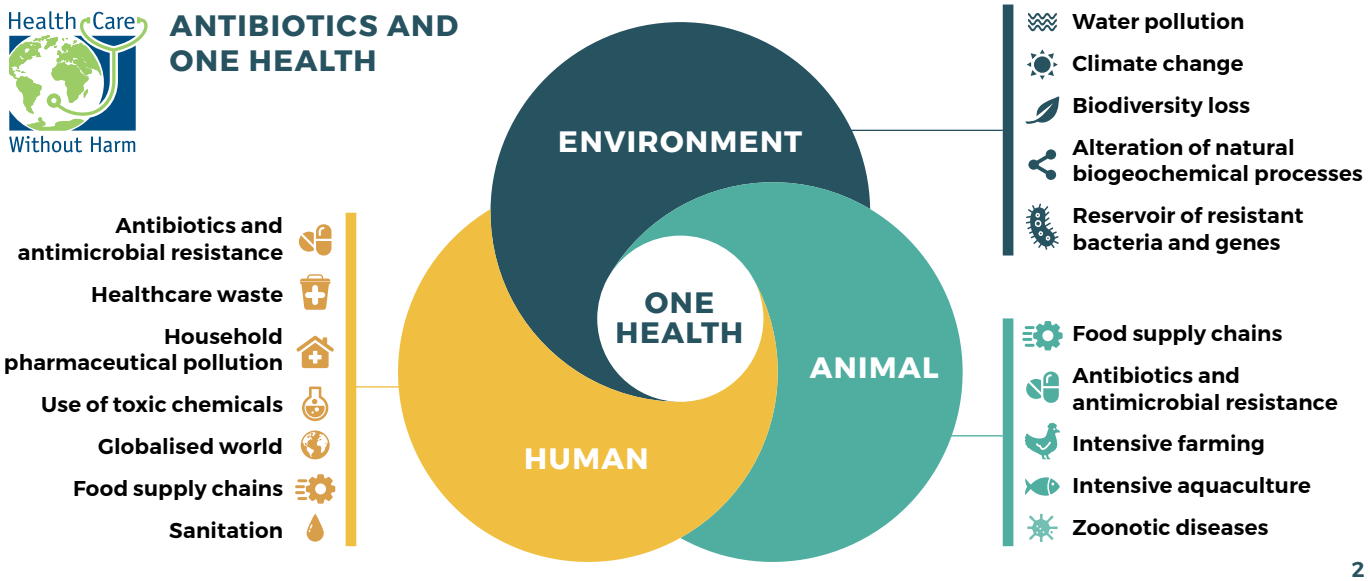
Even at low concentrations, antibiotics can disrupt the delicate balance of ecosystems, affecting essential biogeochemical processes in nature, such as nitrogen cycling.[2,3]

Antibiotic residues have been found in the remote waters of Antarctica, in areas with no apparent human or animal presence.

Bacteria can also share resistant genes with each other through a process called horizontal gene transfer.[4] The environment, and wastewater, in particular, can be a significant hotspot for AMR acceleration through horizontal gene transfer.

AMR claims 35,000 lives annually in Europe, with healthcare costs and productivity losses estimated at €1.5 billion annually. Without further action, this number could soar to 390,000 deaths per year – equivalent to the entire population of Florence, Bilbao, or Tallinn.

To further strengthen the **One Health's response to AMR**, this report aims to evaluate the environmental aspects of the European Commission's Communication in 2017, "A European One Health Action Plan against AMR," and offer specific recommendations for its review from an environmental perspective.



ENHANCING EU EFFORTS TO ADDRESS THE ENVIRONMENTAL DIMENSION OF ANTIBIOTIC RESISTANCE

1. REDUCTION OF ANTIBIOTIC POLLUTION FROM FOOD PRODUCTION

As highlighted in the Bracing for Superbugs report, the use of antibiotics in food production is one of the three main sources – together with pharmaceutical and chemical manufacturing and healthcare delivery – of environmental contamination with antibiotic residues, which poses significant risks to ecosystems.

Up to 90% of the active ingredients of certain antibiotics administered to animals can be excreted unchanged, leading to the release of residues into soil and aquatic systems through manure or uneaten medicated feed in aquaculture. These residues can persist in the environment, disrupting ecosystems and contributing to the spread of resistance.[6]

The Veterinary Medicines Legislation, which came fully into force in February 2022, together with Member States' efforts, has greatly contributed to the 53% reduction in antimicrobial use (AMU) in Europe's agricultural food production systems between 2011 and 2022.[7] This new legislation proposes, for the first time, a ban on the prophylactic use of antibiotics in farming, which would lead to major reductions in AMU in Europe. However, since 2022, the implementation of this ban has not been monitored. The latest ESVAC report shows no significant reduction in the proportion of antibiotics used for group treatments, which accounts for around **80% of total antibiotic use** in animal production across Europe.

Moreover, the European Commission failed to preserve the use of **critically important antibiotics** for human health in animal production. The list drawn up in 2022 includes only antibiotics **not currently used in European animal production**. This is difficult to justify solely because the list applies to third countries where these antibiotics are still in use.

There has been a 53% reduction in veterinary antibiotic sales, but 80% of the antibiotics used are still in forms suitable for group treatment.

Considering that the use of antibiotics like **colistin** in European hospitals has increased by more than **67%** in recent years[8], the European Commission should intensify its efforts to reduce the unnecessary use of these types of antibiotics in animal production and curb the release of these compounds into the environment, which we know can act as a reservoir for resistant bacteria.

Improved animal welfare can significantly reduce the reliance on antibiotics, addressing one of the root causes of antimicrobial resistance (AMR) in the environment.[9,10]

While it is appropriate for animals to receive antibiotics when genuinely needed, the widespread subministration of these drugs to healthy animals in intensive farming systems is a key driver of AMR. Raising welfare standards decreases stress and disease prevalence, reducing the need for antibiotic interventions and thus curbing the spread of resistant bacteria.

The JIACRA (Joint Interagency Antimicrobial Consumption and Resistance Analysis) reports published by the ECDC, EFSA, and EMA have reinforced the link between antimicrobial consumption (AMC) by humans and animals and the emergence of resistant bacteria. The most recent report on 2019-21 highlights that resistance in humans can be correlated with antimicrobial use in food-producing animals, particularly for certain antibiotics that are critically important to human health. The report showed that progress has been made in some EU Member States, where a reduction in antibiotic use in both animals and humans has been associated with a decline in resistant Escherichia coli bacteria.

There is a notable gap in current policies regarding the animal welfare improvements necessary to reduce the need for antimicrobials.[11] Work is ongoing on legislative proposals to revise current EU rules on the welfare of animals at the farm level and at the time of the killing, as well as to establish minimum standards for the protection of hens, broilers, pigs and calves. These initiatives are essential to address systemic welfare deficiencies, reduce the reliance on antibiotics, and mitigate the environmental impacts of AMR.

Aquaculture, another critical and fast-growing segment of food production, plays a key role in global food security.[12] However, it has been largely overlooked in the governance of AMR despite its significant contribution to its spread.[13] Antibiotics are often misused in aquaculture, with water systems acting as major vectors and reservoirs for antibiotic residues and resistant bacteria.[14] Strengthened efforts in this sector are essential to mitigate AMR's impact on health and the sustainability of the aquaculture industry.

Improved animal welfare can significantly reduce the reliance on antibiotics

2. ADVANCING ONE HEALTH EDUCATION AND TRAINING FOR HEALTHCARE PROFESSIONALS

Educating healthcare workers (HCWs) is a cornerstone of efforts to improve prescribing practices and reduce behaviours that contribute to antimicrobial resistance (AMR) overuse.

A recent analysis of One Health curricula across six EU countries (Spain, Portugal, Greece, Lithuania, Italy, and Hungary) revealed that current AMR education for healthcare professionals often fails to incorporate One Health approaches into healthcare training at all levels, from undergraduate to postgraduate and continuing professional development.[14] Additionally, professionals in these countries reported low levels of awareness regarding this essential concept.[15] This gap in knowledge presents a crucial opportunity for action.

The EU's One Health Action Plan against Antimicrobial Resistance emphasises the need for education in the fight against AMR. In line with this, the European Commission has funded several training programmes in recent years that are aligned with the One Health Concept. One of the most ambitious efforts is the second phase of the European Joint Action on Antimicrobial Resistance and Healthcare-Associated Infections (EU-JAMRAI). This initiative targets professionals from diverse fields, including healthcare, veterinary medicine and wastewater management, among others.

Another significant EU-funded project, AMR EDUCare, delivers targeted AMR training to healthcare professionals in six EU countries with some of the highest antimicrobial resistance rates: Spain, Portugal, Greece, Lithuania, Italy, and Hungary. Through this initiative, over 4,000 healthcare professionals will be trained in antimicrobial stewardship, waste management, and patient empowerment, focusing on the One Health approach. Additionally, various online resources for AMR education are available in Europe, such as those produced by the ECDC and other EU-based institutions.

There still needs to be standardised European curricula outlining what should be included in healthcare worker education on AMR, particularly with respect to the role of the environment in the spread of resistance and the One Health approach.

To address this, healthcare education must evolve to include mandatory, cross-sectoral training on the One Health approach, focusing on how the overuse and misuse of antimicrobials impact the environment and drive the spread of antimicrobial resistance. This shift would ensure that professionals across sectors have the knowledge and tools to fight AMR comprehensively, fostering collaboration and a unified response to this global threat. Tools like the Antimicrobial Resistance Curriculum Assessment Tool for Medical Education launched by WHO in October 2024 should be designed and implemented at the EU level to develop new training.

3. ENHANCING ENVIRONMENTAL PARTICIPATION IN EU ONE HEALTH AMR ACTIONS

Since 2011, the European Medicines Agency (EMA), the European Food Safety Authority (EFSA), and the European Centre for Disease Prevention and Control (ECDC) have collaborated to analyse data from humans and food-producing animals, resulting in the JIACRA report. While this collaboration offers valuable insights, it largely overlooks the crucial role of the environment in the spread and acceleration of antimicrobial resistance).

To strengthen the One Health approach, it is essential to expand the scope of these inter-agency reports by including input from environmental bodies like the European Environment Agency (EEA) and the European Chemical Agency (ECHA). Their involvement would help create a more comprehensive, evidence-based response to AMR, aligning with the Council's recommendations to step up actions to address AMR in the environment.

The European Commission's EU One Health Network is also playing a key role in addressing AMR from a One Health perspective by engaging experts, organisations, and Member State authorities. One of its primary goals is to assist DG Health and Food Safety (DG SANTE) and other relevant DGs in identifying and shaping policy initiatives on AMR.

Positively, the EU One Health Network has already begun integrating the environmental dimension of AMR into its regular meetings. As of November 2024, three stakeholder meetings have addressed the environmental dimension of AMR, either as a primary focus or as a cross-cutting issue.

However, there is still room for improvement in ensuring stronger environmental representation. Of the 35 participating organizations (Type C members), only one organisation focusing on health and the environment—Health Care Without Harm Europe—is currently involved. Additionally, among the seven individual experts (Type A members) in this group, there is no direct evidence indicating an explicit environmental science background or expertise. The focus of these individuals typically aligns with Bio-engineering, Veterinary bacteriology, Epizootiology, Disease Control, Mechanical Engineering, Infectious Diseases and Immunology, and Pharmacy. Expanding the network to include stakeholders such as environmental NGOs, public water operators, hydrogeologists, ecotoxicology experts, and other relevant researchers and institutions would ensure a more balanced and comprehensive approach to AMR that incorporates the role of the environment in accelerating this public health threat.

4. PRIORITISING ENVIRONMENTAL SURVEILLANCE OF ANTIMICROBIAL RESISTANCE

Effective action against AMR requires surveillance to track its emergence and spread. While surveillance of AMR in human and animal health is relatively well-established, environmental surveillance remains underdeveloped. This is a critical gap, given the environment's role as a reservoir of resistance genes and a potential route for transmission to humans and animals.[6]

Medicinal residues are widely found in various environmental matrices.[16] They are detected in groundwater and surface waters, as well as in aquaculture systems, manure, sewage sludge, and even living organisms. **Environmental surveillance** can help pinpoint AMR hotspots, such as wastewater treatment plants, pharmaceutical manufacturing sites, and agricultural areas with high antimicrobial usage.[17] This targeted surveillance enables focused interventions and mitigation strategies, such as improved wastewater treatment processes and stricter regulations on pharmaceutical waste disposal. Environmental monitoring could also detect changes in AMR over time, which can be used to assess if measures to reduce AMR in the environment have been effective and would allow for temporary interventions.

Despite recognising the need for a "One Health" approach to AMR in the Council Recommendation of 2023, encompassing human, animal, and environmental health, **the EU lacks a cohesive system for monitoring antimicrobial compounds, resistant bacteria and genes in environmental matrices**.

This underscores the need for a more systematic approach to environmental monitoring, particularly in European waters, which are already under significant pressure.[18] A recent report by the European Environment Agency (EEA) highlights **significant knowledge gaps** in the presence of antimicrobial residues, resistant pathogens, and genes in the environment, stressing the need for standardised monitoring protocols, harmonised data collection and analysis, and increased investment in research.

In addition to the lack of systematic monitoring data, there is **limited information on many pharmaceuticals' ecotoxicology**, their fate and behaviour in the environment, and possible mixture effects.[19] This knowledge gap further complicates the assessment of environmental risks associated with antimicrobial pollution. For example, understanding how different antimicrobials interact with each other and with other environmental pollutants is crucial for developing effective risk assessment models and predicting the long-term impacts of antimicrobial pollution.

POLICY DELAYS AND THE NEED FOR INTEGRATED SURVEILLANCE

Technical files on environmental monitoring are not prioritised and face significant adoption delays, potentially impacting their effectiveness. For instance, the list of priority pollutants in surface and groundwater, due for an update at least every 6 years, has not been revised since 2013 for surface water and 2014 for groundwater. Despite the European Commission's proposal in 2022 to add three macrolide antibiotics to the surface water priority list, among other pharmaceuticals, trilogue negotiations had yet to start by late 2024. While the existing priority substance list has proven useful for regulating known pollutants, such as heavy metals, its delayed update undermines efforts to address AMR by failing to include critical emerging contaminants like antibiotic residues.

A study on the barriers to the effective development and implementation of national policies on antimicrobial resistance emphasised the urgent need to implement **integrated surveillance** in the EU.[20] This should encompass human, animal, and plant health, food production, wastewater, and the environment. An integrated surveillance system could detect and prevent outbreaks, guide policy action, and minimise the acceleration and spread of AMR across all these sectors. By integrating data from different sectors, a more holistic picture of AMR dynamics can be obtained, enabling the identification of key drivers and the development of targeted interventions.

Prioritising environmental surveillance is crucial for understanding and addressing the spread of AMR. To develop an integrated approach to AMR surveillance, The EU must overcome current challenges, including knowledge gaps, policy delays, and a lack of cohesive monitoring systems.

The addition of pharmaceuticals to the list of pollutants to be monitored in surface and groundwater is facing several unjustified delays.

5. INTEGRATING THE ENVIRONMENT INTO AMR AWARENESS CAMPAIGNS

Most AMR awareness campaigns primarily target human and animal health, focusing on responsible antibiotic use and infection prevention. While crucial, this approach doesn't take into consideration environmental factors contributing to AMR development and spread. In particular, the environment plays a role as both a reservoir and transmission route for drug-resistant bacteria, with agricultural runoff, wastewater, and pharmaceutical waste all contributing to the spread of resistance.

For instance, Eurobarometer surveys, while valuable for gauging public opinion on various issues, do not adequately address the environmental dimension of AMR. A review of reports from 2016 and 2018 reveals a lack of questions specifically focused on the environment, with the 2018 survey mentioning One Health but primarily concentrating on human and animal health, such as antibiotic use in farming.

Also, the European Antibiotic Awareness Day (EAAD) annual campaign aims to raise awareness about the threat of antibiotic resistance. Still, while mentioning the One Health approach, predominantly focuses on human health and antibiotic use in healthcare settings.

Furthermore, while all National Action Plans (NAPs) include awareness campaigns, with some strong examples of collaborative campaigns involving the environment sector, further efforts are needed. A 2022 European Commission report reveals that only 8 out of 13 One Health NAPs encompassing the environment include awareness campaigns specifically targeting environmental issues.[20] This gap in targeted messaging means that the public is rarely informed about crucial environmental actions they can take, such as properly disposing of unused medications, to help combat AMR.

Raising awareness campaigns rarely focus on the environmental dimension of AMR and the role of the public in addressing pharmaceutical pollution

6. INTEGRATING THE ENVIRONMENTAL SECTOR IN EU NATIONAL ACTION PLANS ON ANTIMICROBIAL RESISTANCE

While some progress has been made in recognising the role of the environment in the development and spread of AMR, challenges remain in effectively integrating the environmental sector into NAPs within the EU.

CURRENT STATUS OF ENVIRONMENTAL INTEGRATION IN NAPS

Although NAPs are in place across 28 EEA/EU countries, a significant gap exists in integrating environmental considerations.[20] Many NAPs focus primarily on human and animal health, neglecting or insufficiently covering the environmental dimension.

Several factors contribute to this inadequate integration. Roughly half of the Member States consider including environmental authorities in NAP development to be "problematic".[21] **Environmental authorities lack clear mandates and roles** within NAPs, and guidance on integrating environmental health considerations is missing. Resource constraints and limited expertise within the environmental sector further hinder its involvement in AMR mitigation strategies.[21]

In some Member States, a **low level of AMR awareness** within the environmental sector and **limited systematic surveillance** contribute to poor data availability and understanding of the issue. For instance, Ireland faces challenges with awareness, while Czechia and Estonia grapple with limited surveillance and data.[21]

A critical area for improvement in current NAPs is the absence of essential components for effective implementation and impact assessment. Many NAPs lack operational plans that detail the specific activities needed to achieve strategic goals, as well as monitoring and evaluation plans to track progress and measure impact.[21]

Furthermore, some Member States rely only on sectoral plans that address AMR in human health, animal health, or the food sector but fail to address AMR in the environment comprehensively. Although intersectoral teams are often established to develop NAPs, these teams frequently do not have dedicated environmental representation and are often disbanded after NAP approval. Moreover, no dedicated body oversees NAP implementation across all sectors, including the environment.[21] Consequently, the level of enforcement of NAPs across Europe has been relatively modest since 2017.

There is limited expertise from the environmental sector involved in the development and monitoring of AMR national action plans in the EU.

EVIDENCE OF DISPARITIES IN INTERSECTORAL COORDINATION

The Tracking Antimicrobial Resistance Country Self-Assessment Survey (TrACSS) is a tool for countries to self-assess and monitor their progress in combating AMR. It provides a framework for global benchmarking and encourages a One Health approach by encompassing surveillance data from human, animal, agri-food, and environmental sectors.

Despite the 2020-2021 TrACCS survey indicating active involvement of environmental sectors in multi-sectoral coordination in most countries, a concerning disparity persists within the WHO European Region. While some countries demonstrate strong collaborative mechanisms, **approximately 40% of respondents report limited or non-existent coordination between human health and other relevant sectors, including the environment.**[21] This highlights the need for improved collaboration and communication across sectors.

The map below provides a snapshot from the 2024 Global Database for Tracking AMR and visualises the presence (or absence) of regular monitoring systems for antimicrobial compounds and their metabolites (or residues) and resistant bacteria or antimicrobial resistance genes (ARGs) in water quality.

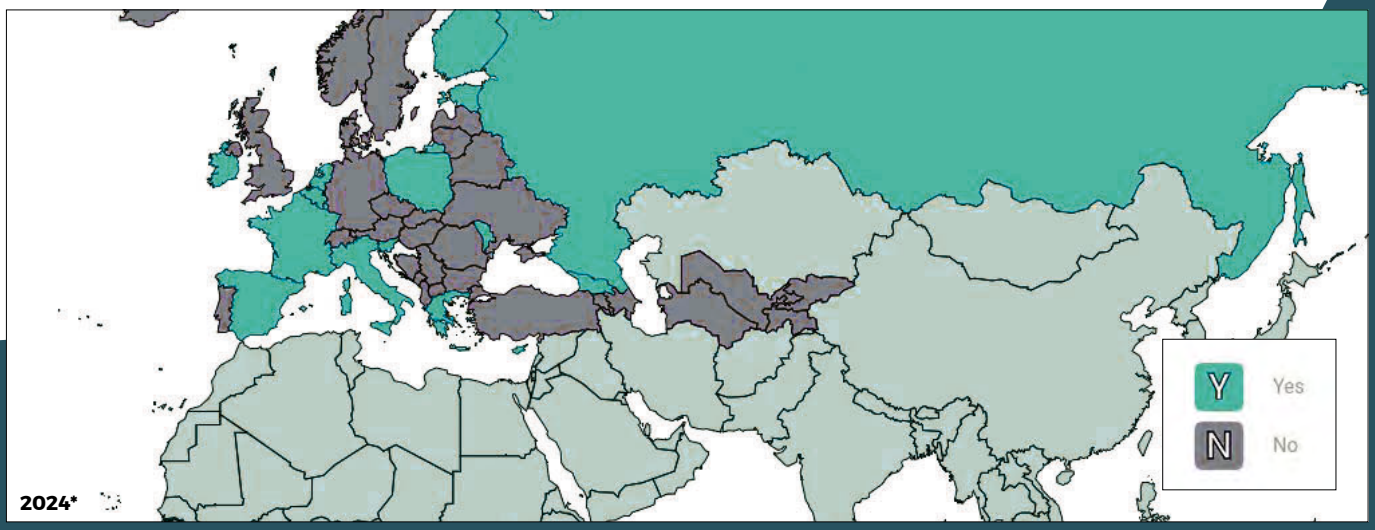
Most European countries, shaded in grey, indicate they do not have such a monitoring system in place. This suggests a potential gap in efforts to understand and address the environmental spread of antimicrobial resistance.

STRENGTHENING ENVIRONMENTAL INTEGRATION

Defining clear mandates and roles for environmental authorities within NAPs is crucial, prioritising integrating environmental health considerations.

Equally important is investing in **capacity building within the environmental sector**, focusing on AMR surveillance, risk assessment, and mitigation strategies. NAPs should consist of **concrete, actionable plans** with defined roles, responsibilities, targets, and timelines supported by dedicated structures and resources to ensure effective implementation and long-term commitment.

Is there a system for regular monitoring (passive surveillance) of antimicrobial compounds and their metabolites (or residues) and resistant bacteria or antimicrobial resistance genes (ARGs) in water quality?



This map shows data from the Global Database for TrACSS. Copyright WHO 2018 – 2024.
Learn more at https://new.amrcountryprogress.org/map/?regions

CONCLUSIONS AND RECOMMENDATIONS

The environment can act as a reservoir for resistant bacteria and accelerate the spread and development of resistant pathogens. Understanding the environmental dimension of AMR and its interlinkage with animal and human health will be essential to address this public health issue, which is projected to kill more people than cancer and diabetes combined by 2050.[22]

THE EU ONE HEALTH ACTION PLAN

While the EU has demonstrated leadership in combating AMR, significant progress is needed to integrate environmental considerations fully. This report has highlighted critical gaps in environmental surveillance, policy implementation, and awareness campaigns, underscoring the need for a more holistic and integrated approach.

Integrating the environmental sector in the decision-making process will be key in the years to come to minimise the risk of AMR development and transmission.

KEY RECOMMENDATIONS
TO ADDRESS THE ROLE OF THE ENVIRONMENT IN THE ACCELERATION OF AMR INCLUDE:

1. **Monitor antibiotic residues in EU water.** Update the list of priority pollutants in surface and groundwater to include relevant antimicrobials, ensuring regulations keep pace with the evolving AMR threat.

2. **Improve animal health conditions to reduce antibiotic use in farming.** Interventions such as reducing weaning periods in piglets, reducing stocking density or boosting vaccination can significantly reduce antibiotic pollution from farming and its contribution to AMR.

3. **Prioritise environmental surveillance.** This includes developing standardised monitoring protocols, harmonising data collection, and increasing investment in research to close knowledge gaps in antimicrobial residues and resistance genes in the environment.

4. **Incorporate the EEA and the ECHA into drafting inter-agency reports such as the JIACRA report.** Integrate environmental considerations and closer collaboration with the EEA in future reports to enhance efforts to address AMR from a One Health perspective.

5. **Raise awareness of the role of the environment in AMR transmission and acceleration.** Expand public awareness campaigns beyond human and animal health to emphasise the environment's role in AMR development and spread.

6. **Support the integration of the environmental sector in NAPs across the EU.** Help Member States ensure clear mandates and roles for environmental authorities, provide guidance on integrating environmental health considerations, invest in capacity building within the environmental sector, and fully incorporate aquaculture into NAPs, with specific guidelines on antimicrobial use and resistance management.

7. **Include environmental experts in EU AMR networks and actions.** Strengthening the inclusion of environmental expertise within EU AMR governance structures by expanding representation from organisations and experts in environmental science.

8. **Develop and implement harmonised and comprehensive One Health Education and Training in the EU.** Addressing the lack of focus on environmental drivers of AMR by developing cross-sectoral and standardised One Health curricula across the EU and at all educational levels.

REFERENCES

1. Postigo, C., Moreno-Merino, L., López-García, E., López-Martínez, J., & López de Alda, M. (2023). Human footprint on the water quality from the northern Antarctic Peninsula region. Journal of Hazardous Materials, 453, 131394. doi:10.1016/j.jhazmat.2023.131394

2. Néstor, M. C., & Mariana, C. (2019). Impact of pharmaceutical waste on biodiversity. Ecopharmacovigilance: Multidisciplinary Approaches to Environmental Safety of Medicines, 235-253.

3. Alexandre, C. M., Artur, R., Vitoria, A., Barbosa, A. V., Leite, J. M., Mendes-Marques, C. L., & Betânia, M. (2021). Effects of antibiotics on impacted aquatic environment microorganisms. IntechOpen EBooks. https://doi.org/10.5772/intechopen.93910

4. Martínez, J. L. (2008) 'Antibiotic resistance genes in natural environments', Environmental Microbiology, 10(12), pp. 3231–3248.

5. Rizzo, L., Manaia, C., Merlin, C., Schwartz, T., Dagot, C., Ploy, M.C., Michael, I., and Fatta-Kassinos, D. (2013). Urban wastewater treatment plants as hotspots for antibiotic resistant bacteria and genes spread into the environment: a review. Sci. Total Environ. 447, 345–360.

6. European Environment Agency (2024). Veterinary antimicrobials in Europe's environment: a One Health perspective. https://www.eea.europa.eu/publications/veterinary-antimicrobials-in-europes-environment

7. European Medicines Agency, European Surveillance of Veterinary Antimicrobial Consumption, (2022). Sales of veterinary antimicrobial agents in 31 European countries in 2022 (EMA/299538/2023).

8. ECDC, EFSA, EMA, (2024). Antimicrobial consumption and resistance in bacteria from humans and food-producing animals: Fourth joint inter-agency report on integrated analysis of antimicrobial agent consumption and occurrence of antimicrobial resistance in bacteria from humans and food-producing animals in the EU/EEA JIACRA IV – 2019–2021, https://www.ecdc.europa.eu/sites/default/files/documents/antimicrobial-consumption-resistance-bacteria-humans-food-producing-animals-2019-2021_0.pdf

9. HCWH Europe (2022). Reducing antimicrobial resistance in food production: How healthcare professionals can help. https://europe.noharm.org/media/4570/download?inline=1

10. World Animal Protection (2020). Fuelling the Pandemic Crisis: Factory farming and the rise of superbugs. www.worldanimalprotection.ca/our-work/animals-farming/factory-farming-and-the-rise-of-superbugs

11. Pegger, T., Haager, D., Jamal, N., Heidbuechel, K., (2023). How the EU animal welfare legislation can tackle AMR – a One Health perspective, European Journal of Public Health, Volume 33, Issue Supplement_2, ckad160.081, https://doi.org/10.1093/eurpub/ckad160.0

12. Caputo, A., Bondad-Reantaso, M. G., Karunasagar, I., Hao, B., Gaunt, P., Verner-Jeffreys, D., Fridman, S., Dorado-Garcia, A., (2022). Antimicrobial resistance in aquaculture: A global analysis of literature and national action plans. https://onlinelibrary.wiley.com/doi/10.1111/raq.12741

13. Caputo, A., Bondad-Reantaso, M.G., Karunasagar, I., Hao, B., Gaunt, P., Verner-Jeffreys, D., Fridman, S. & Dorado-Garcia, A. (2022). Antimicrobial resistance in aquaculture: A global analysis of literature and national action plans. *Reviews in Aquaculture*. Available at: https://doi.org/10.1111/raq.12741

14. Health Care Without Harm Europe (2023). State of the art and needs analysis on AMR training in Europe: A review of antimicrobial resistance education for healthcare professionals across six countries of the European Union: Greece. Hungary, Italy, Lithuania, Portugal and Spain. https://www.amreducare.eu/education-on-amr-in-europe/

15. Health Care Without Harm Europe (2020). Antimicrobial resistance in European medical schools: Assessing the needs of medical students and identifying best practice. https://europe.noharm.org/sites/default/files/documents-files/6591/2020-11-18-Antimicrobial-resistance-in-European-medical-schools_WEB.pdf

16. JPIAMR. (2022). Towards developing an international environmental AMR surveillance strategy. Available at: https://www.jpiamr.eu/app/uploads/2022/08/Towards-developing-an-international-environmental-AMR-surveillance-strategy_report-2022-08-04.pdf

17. Bengtsson-Palme, J., Abramova, A., Berendonk, T.U., Coelho, L.P., Forslund, S.K., Gschwind, R., Heikinheimo, A., Jarquín-Díaz, V.H., Khan, A.A., Klümper, U., Löber, U., Nekoro, M., Osińska, A.D., Perovic, S.U., Pitkänen, T., Rødland, E.K., Ruppé, E., Wasteson, Y., Wester, A.L., and Zahra, R. (2023). Towards monitoring of antimicrobial resistance in the environment: For what reasons, how to implement it, and what are the data needs? Environment International 178, 108089.

18. European Environment Agency (EEA) (2024). Europe's state of water 2024. Available at: https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024

19. European Commission (2019). European Union Strategic Approach to Pharmaceuticals in the Environment. Available at: https://op.europa.eu/en/publication-detail/-/publication/5371e7bd-25db-11e9-8d04-01aa75ed71a1/language-en

20. European Commission (2022). Study on the barriers to effective development and implementation of national policies on antimicrobial resistance. Available at: https://health.ec.europa.eu/system/files/2022-11/amr_onehealth_naps_rep_en.pdf

21. European Commission (2022). Antimicrobial Resistance: National Action Plans in the EU/EEA – A One Health Approach. Available at: https://health.ec.europa.eu/system/files/2022-11/amr_onehealth_naps_rep_en.pdf

22. O'Neill, J. (2014). Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations. Review on Antimicrobial Resistance. https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf

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Health Care Without Harm (HCWH) Europe is the European arm of a global not-for-profit NGO whose mission is to transform the healthcare sector so that it reduces its environmental footprint, becomes more resilient, and establishes itself as a leader for sustainable development in Europe. HCWH's vision is that healthcare mobilises its ethical, economic, and political influence to create an ecologically sustainable, equitable, and healthy world.

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