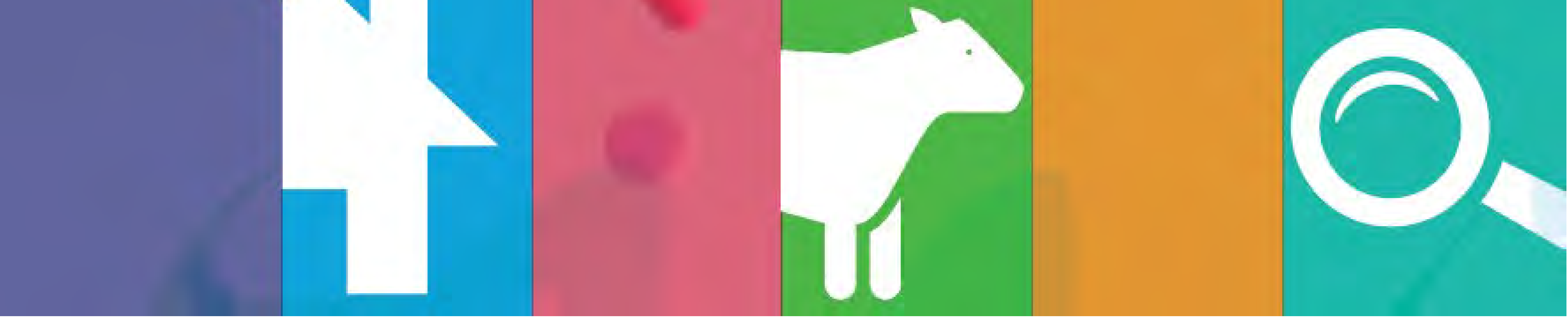


TECHNICAL BRIEF:

WATER, SANITATION, HYGIENE AND WASTEWATER MANAGEMENT TO PREVENT INFECTIONS AND REDUCE THE SPREAD OF ANTIMICROBIAL RESISTANCE

Food and Agriculture Organization of the United Nations
WORLD ORGANISATION FOR ANIMAL HEALTH
World Health Organization

Outline

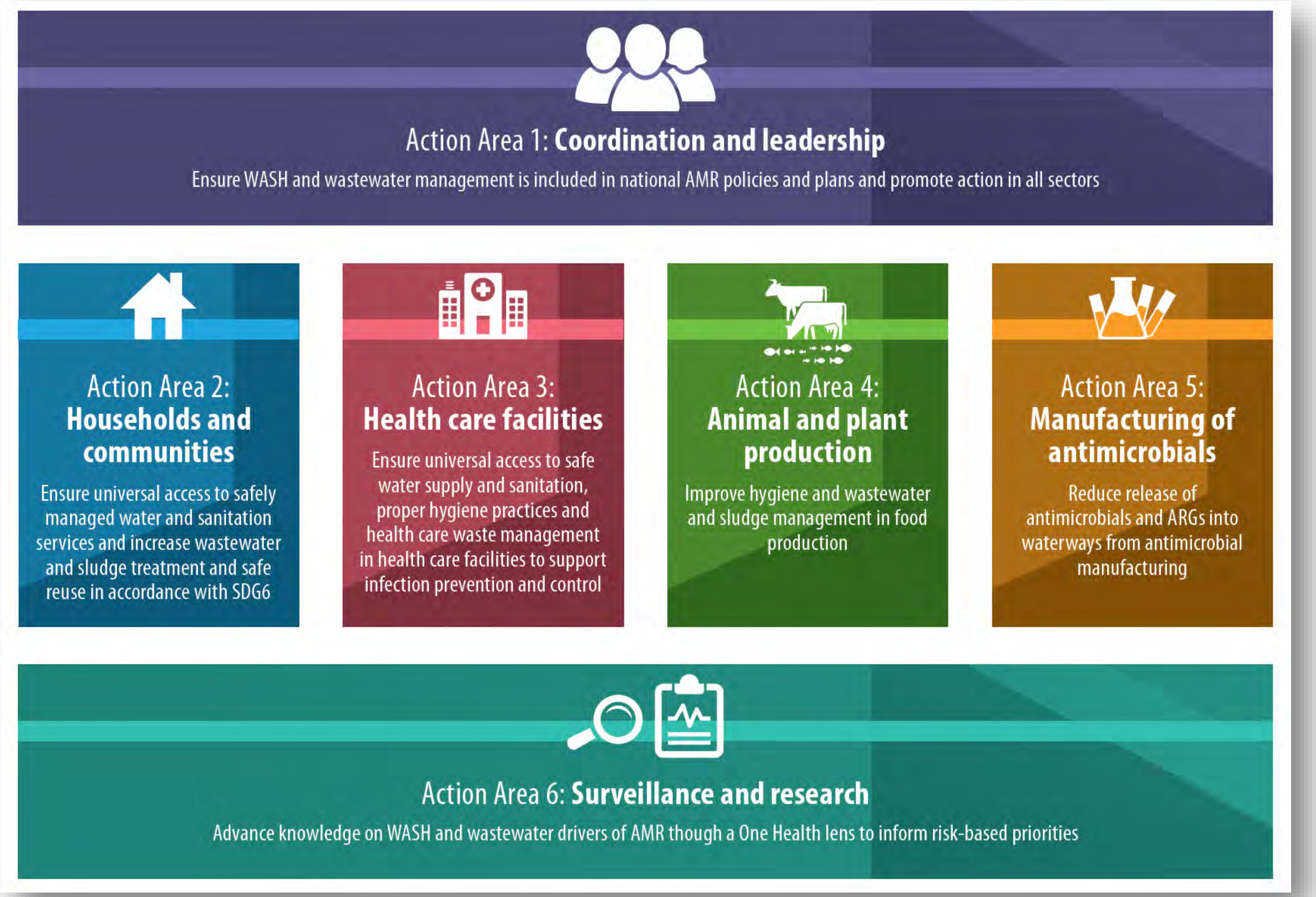
- Purpose
- 5 key messages and 6 action areas
- Background – AMR global action plans and inter-agency coordination group
- How does WASH and WASH water contribute to AMR?
- 6 action areas – evidence, options for action and supporting resources
- What to do next

Purpose of this briefing

- To explain how WASH and wastewater contribute to AMR
- To summarize evidence and rationale for action in all sectors;
  Leadership and coordination, households and communities, healthcare facilities, animal and plant production, manufacturing of antimicrobials, surveillance and research
- To present options for action in each sector to include in AMR national action plans (NAPs) and sector policy
- To point to more in-depth technical resource to support action in each sector
- To mobilize and enable WASH and wastewater actors to contribute in multi-sectoral planning and implementation to combat AMR

5 key messages

1. WASH and wastewater are **not well represented** in AMR national action plans (NAPs). Where WASH and wastewater are include, actions tend to focus on a specific technical issue **without considering the broader context of all environmental drivers** of AMR.
2. Despite evidence gaps, **enough is already known to take action** on many WASH and wastewater management activities to combat AMR
3. **All sectors have a role to play** – attribution of cause by sector is less important than taking practical, achievable actions in all sectors that will combat AMR and have wider co-benefits for health
4. WASH and wastewater **stakeholders need to contribute to AMR multi-stakeholder platforms** to strengthen WASH and wastewater actions in AMR NAPs and in water and waste sector policy.
5. This briefing presents evidence and options for actions by sector to **inform national planning and more in-depth work** on selected actions.



6 Action Areas to include WASH and wastewater management in AMR National Action Plans (NAPs) and sector policies and plans

Background

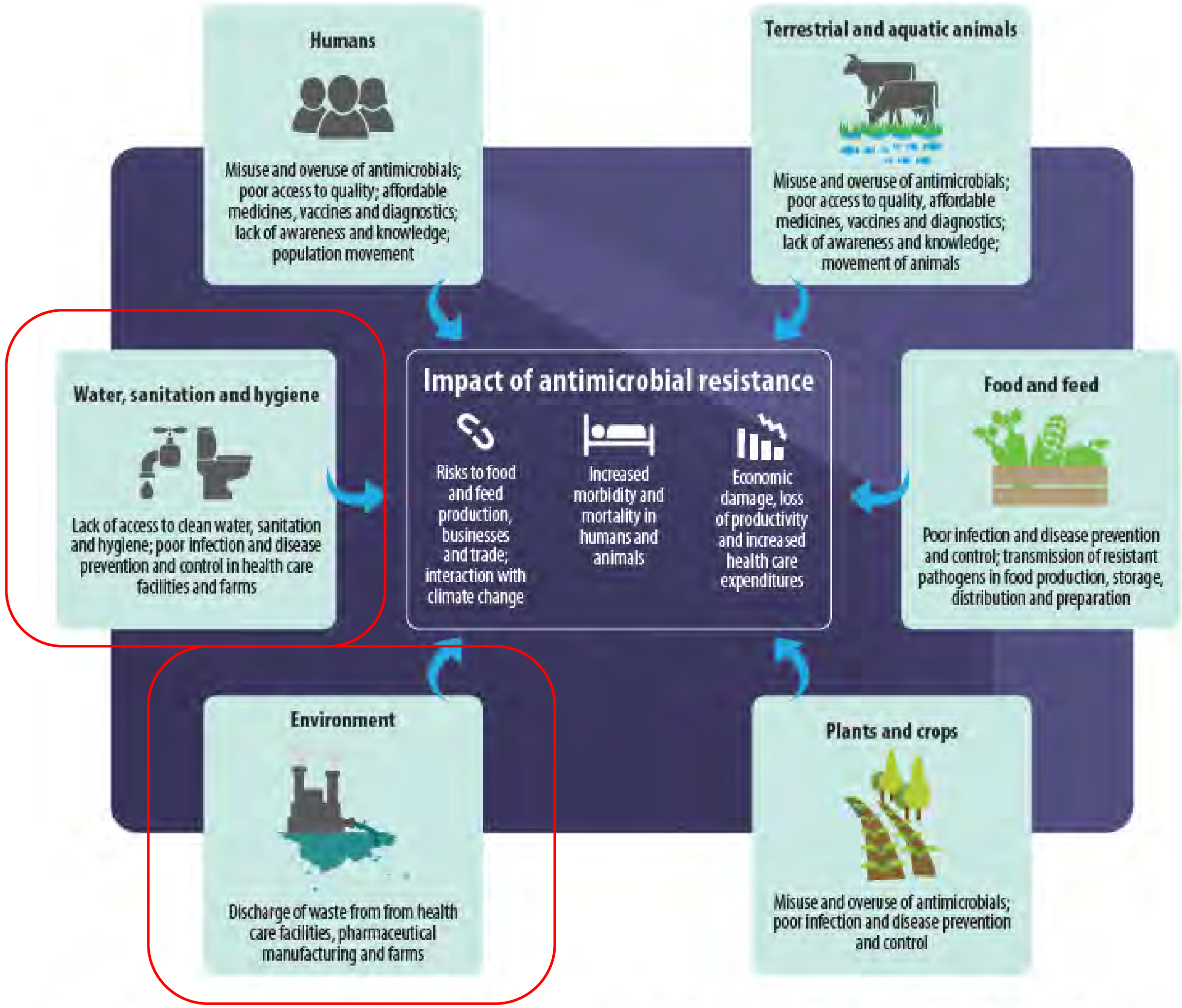
WASH and Wastewater management contribute to all objectives of the AMR Global Action Plans (2015)

1. Improve awareness through effective communication, education and training
2. Strengthen knowledge and evidence through surveillance and research
3. **Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures**
4. Optimize use in human and animal health
5. Develop the economic case for sustainable investment


GLOBAL ACTION PLAN
ON ANTIMICROBIAL
RESISTANCE

Background

- The UN Inter-Agency Coordination Group (IACG) on AMR identified WASH and environment (discharge of waste from health care facilities, pharmaceutical manufacturing and farms) as 2 of 6 key drivers of AMR (2019)



Source: Adapted from Inter-Agency Coordination Group (2019). No time to wait: Securing the future from drug-resistant infections. Report to the Secretary-General of the United Nations.

How does WASH and wastewater contribute to AMR?

1. Dispersal via water, sludge and manure potentially resulting in the transmission of **disease-causing pathogens** to humans, animals and plants increasing the need for treatment with antimicrobial agents.

2. Silent transmission of resistant **microorganisms with low pathogenicity** that only become evident when they infect particularly vulnerable populations or their genes are transferred to pathogens causing infection.

3. Release of faecal and other pollutants, including **antimicrobial compounds** into the environment (excreta from use in humans or in terrestrial or aquatic animals or plants; from disposal of unused antimicrobials; or from antimicrobial manufacturing waste and wastewater) may promote resistance by creating conditions favorable to the transfer or emergence of new resistance genes.

Each year hundreds of millions of cases of diarrhoea in humans are treated with antimicrobials. Universal access to WASH could reduce this by 60%.

14% of people globally carry *E.coli* in their faeces that produce extended spectrum beta-lactamase (ESBL) enzymes which provide resistance to antibiotics such as penicillins, cephalosporins, cephamycins, and to some extent carbapenems.

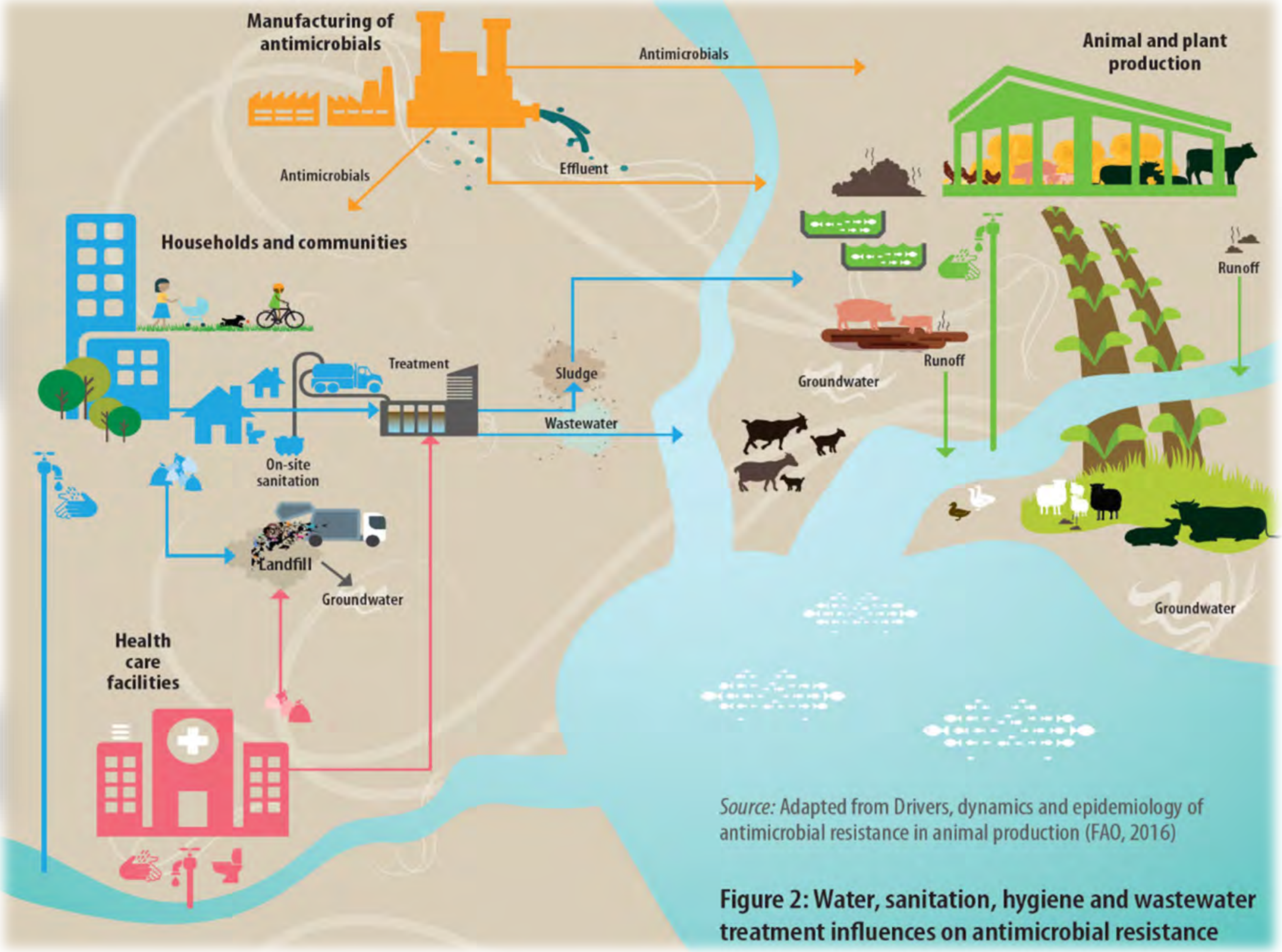
Up to 80% of the antimicrobial dose administered can be excreted as the active compound or metabolites depending on the class of antimicrobial and how it is used, and wastewater treatment is often insufficient or not possible. Similarly, antimicrobials in water downstream of some antimicrobial manufacturing sites have been found at concentrations higher than in the blood of patients taking medicines.

Action Area 5:
Manufacturing of antimicrobials

Action Area 2:
Households and communities

Action Area 3:
Health care facilities
Ensure universal access to safe

Action Area 4:
Animal and plant production



Source: Adapted from Drivers, dynamics and epidemiology of antimicrobial resistance in animal production (FAO, 2016)

Figure 2: Water, sanitation, hygiene and wastewater treatment influences on antimicrobial resistance

* *NB: Large proportions or wastewater and sludge globally from all sectors receives little or no treatment. Refer facts and figures on following slides.*

Action Area 1. Leadership and coordination

Ensure WASH and wastewater management is included in national AMR policies and plans and promote action in all sectors

Leadership and Coordination

Evidence and co-benefits

- Coordinated leadership to engage WASH and wastewater actors in AMR and vice versa can be a powerful lever to increase investment and accelerate action co-benefits for health, wellbeing and the environment.
- There is not yet concrete evidence on what proportion of AMR risks come from human, animal, plant and environmental sectors. Nonetheless, improvement in WASH and wastewater management in each sector, can be pursued. Lack of scientific certainty should not be used as a reason not to take action.
- Research needs are summarized in Action Area 6.
- Actions in Areas 2-5 are typically led by different sectors with their own budgets. Actions are complementary and can be pursued concurrently.

Action options

- Ensure representatives from Action Areas 2-5 are included in AMR national multi-stakeholder platforms.
- Develop and update national and regional AMR action plans and AMR-sensitive sector policies and plans based on a national risk assessment (Action Area 6) to address priority national risks and international obligations.
- Support implementation across the health, water, sanitation, animal, plant, and industrial sectors through AMR-sensitive strategies, policies, planning, legal frameworks and standards.
- Encourage practical and affordable surveillance systems both to track AMR spread within environmental media.
- Support workforce education to implement WASH and wastewater management across all sectors.

Leadership and Coordination

Resources to support action

- Water, sanitation, hygiene and health: A primer for health professionals www.who.int/water_sanitation_health/publications/water_sanitation_hygiene-primer-for-health-professionals/en/
- WHO /UNICEF Joint Monitoring Programme (JMP) website www.washdata.org
- UN-Water SDG6 data portal www.sdg6data.org
- GLAAS country data and external support agency (ESA) data www.who.int/water_sanitation_health/monitoring/investments/glaas-2018-2019-cycle/en/
- TrackFin initiative www.who.int/water_sanitation_health/monitoring/investments/trackfin/en/
- Global Antimicrobial Resistance Surveillance System (GLASS report) www.who.int/glass/resources/publications/en/

Action Area 2. Households and communities

Ensure universal access to safely managed water and sanitation services and increase wastewater and sludge treatment and safe reuse in accordance with SDG6

Facts and Figures

- Worldwide, in 2016, 1.9 million deaths and the loss of 123 million disability adjusted life years (DALYs) could be prevented with adequate WASH. Almost 830,000 of WASH-related deaths are from diarrhoeal disease.
- Globally, at least 2 billion people use a drinking water source contaminated with faeces.
- 71% of the global population (5.3 billion people) used a safely managed drinking-water service. 90% of the global population (6.8 billion people) used at least a basic service. 785 million people lack even a basic drinking-water service.
- Globally 2 billion people still do not have basic sanitation facilities. Of these, 673 million still defecate in the open.
- 45% of the global population (3.4 billion people) use a safely managed sanitation service of which two thirds are connected to sewers from which wastewater is treated. The remaining third use toilets or latrines where excreta are disposed of in situ.
- 3 billion people still lack basic handwashing facilities at home. 1.6 billion have limited facilities lacking soap or water, and 1.4 billion have no facility at all.

All data at www.washdata.org and in Safer water, Better health

Evidence and co-benefits

- Access to safe water and sanitation is a human right.
- SDG targets for universal access to safe WASH by 2030 offer health co-benefits beyond combatting AMR. Safe WASH in communities reduces faecal-oral infections, contributes to better nutrition and improves social and economic wellbeing and is a precondition for development.
- Antimicrobial use explains some AMR variation, but levels of AMR are also strongly correlated with socio-economic, health and environmental factors, especially low levels of sanitation which correlate with higher levels of AMR.
- Globally hundreds of millions of cases of diarrhoea are treated each year with antibiotics. Safe WASH in communities can prevent infection and avoid 60% of WASH-related antibiotic use.
- Safely-managed water supply and sanitation reduces transmission of faecal-oral pathogens. Resistant faecal-oral pathogens follow the same paths as non-resistant strains. Sanitation and drinking-water treatment technologies are similarly effective against resistant and non-resistant strains.
- Available studies of pharmaceuticals in drinking-water sources and supplies indicate that the very low levels typically found are unlikely to pose a risk to human health (although where hotspots have been identified, further investigation may be needed and further research is needed on the potential effects of chronic exposure and in relation to vulnerable groups).
- Therefore, efforts to limit AMR emergence and spread in environmental media should focus primarily on improving management of sanitation systems and treatment of wastewater and sludge., Nonetheless improvements in drinking-water quality and research on AMR risk for drinking-water remain important.
- Some but not all studies have found that biological processes in wastewater treatment plants promote gene transfer and higher proportion of resistant bacteria in effluent. However, well-functioning secondary biological treatment processes reduce bacterial concentrations 3 log10-units or 99.9% and therefore the benefits of treatment outweigh the risk.
- Since typical secondary wastewater treatment effluents still contain some pathogens (~10^3-10^5 per litre), risk reduction measures (e.g. limiting recreational use or irrigation of fresh produce) to prevent exposure in the disposal/end use stage need to be considered.
- Tertiary processes which include a disinfection step inactivate most pathogens but reducing ARGs in effluent may require higher doses and might still transfer ARG to non-resistant bacteria in receiving waters.
- Unused and expired medicines are commonly disposed of with general waste or discarded into toilets. Source control (e.g. consumer education and take-back schemes for unused medicines) is needed to reduce pharmaceutical compounds in leachate from landfills and dumpsites and in wastewater effluent and sludge from sanitation systems.

Action options

- Rapidly accelerate WASH investments in countries without universal access to safely managed water and sanitation services.
- Target stepwise improvements based on national level risk assessment targeting investments to areas of highest risk (e.g. unserved communities and areas of recurrent WASH-related disease) to achieve safely managed sanitation for all.
- In all countries implement the core recommendations of the WHO Guidelines on Sanitation and Health.[2]
    - Sanitation improvements should cover entire communities with a minimum level of service with progressive improvement to reach safely managed services
    - A mix of sewered, on-site (pits, septic tanks and container-based collection with on- or off-site treatment of sludge) technologies is needed
    - Implement local-level risk assessment (i.e. sanitation safety planning) to improve and sustain sanitation services and support safe reuse
    - Ensure the health sector fulfils core functions for sanitation (Sanitation and Health Guidelines recommendation 4)
- Once safe sanitation for all is achieved, deploy advanced wastewater treatment technologies to highest risk areas.
- Develop policies, plans and mechanisms to return unused antimicrobials from households (e.g. to pharmacies) for safe disposal.
- Improve drinking water safety following the WHO Guidelines on drinking-water quality, prioritizing implementation of water safety plans and strengthened surveillance. Routine monitoring of antimicrobial resistant bacteria in drinking water is not recommended. Investigative studies may periodically measure concentrations of ARB, ARGs or antimicrobial compounds and their metabolites.
- Incorporate AMR risks into Water Safety Plans and Sanitation Safety Plans.

Resources to support action

- WASH coverage data (SDG6.1 and 6.2) - WHO /UNICEF Joint Monitoring Programme - www.washdata.org
- WASH systems and financing data (SDG6a and 6b) (GLAAS) www.who.int/water_sanitation_health/publications/glaas-report-2019/en/
- Wastewater treatment data (SDG6.3.1) www.who.int/water_sanitation_health/publications/progress-of-wastewater-treatment/en/
- WHO / UN-Water (2019), National systems to support drinking-water, sanitation and hygiene - Global status report 2019 www.who.int/water_sanitation_health/publications/glaas-report-2019/en/
- WHO Guidelines on Sanitation and Health www.who.int/water_sanitation_health/sanitation-waste/sanitation/sanitation-guidelines/en/
- Sanitation Safety Planning www.who.int/water_sanitation_health/sanitation-waste/wastewater/sanitation-safety-planning/en/
- Guidelines on Drinking-water Quality www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines-4-including-1st-addendum/en/
- Water Safety Planning https://www.who.int/water_sanitation_health/water-quality/safety-planning/en/
- Pharmaceuticals in drinking-water https://www.who.int/water_sanitation_health/publications/pharmaceuticals-in-drinking-water/en/

Action Area 3. Health care facilities

Ensure universal access to safe water supply and sanitation, proper hygiene practices and health care waste management in health care facilities (HCFs) to support infection prevention and control

Health Care Facilities

Facts and Figures

- Around 1 in 4 health care facilities lack basic water services. That means 2 billion people (or more during periods of water scarcity) are going to HCFs without an on-site protected source of water.
- Around 1 in 5 health care facilities have no sanitation service. That means over 1.5 billion people are going to health care facilities without toilets.
- Globally, 42% of health care facilities lack hand hygiene facilities at the point of care and 40% do not have systems to segregate waste.
- Compared to hospitals, smaller health centres and clinics are twice as likely to lack water or sanitation services.
- More people die every year from unsafe care than lack of care. Between 5.7 and 8.4 million deaths are attributable to poor quality care each year. WASH is fundamental to the provision of safe, quality care.
- An estimated 15% of patients in low- and middle-income countries acquire one or more infections during a hospital stay. Infections associated with unclean births account for 26% of neonatal deaths and 11% of maternal mortality; together these account for more than 1 million deaths each year.
- Almost one third of sepsis-related neonatal deaths worldwide each year may be attributable to resistant pathogens.

Evidence and co-benefits

- WASH services are essential for preventing a wide range of hospital-associated infections.
- Antimicrobials are often used as a “quick fix” for fractured health systems. Conversely, investments in WASH-related inventions are “best-buys” in reducing AMR in HCFs.
- Prophylactic use of antibiotics during childbirth is common in many countries where WASH is inadequate and infectious disease risks are high. In some countries, 90% of women giving birth vaginally receive antibiotics in hospital.
- Known WASH and IPC interventions in health care facilities are on the whole effective against AMR. AMR adds urgency to ensure universal WASH in HCF as called for by the 2019 World Health Assembly Resolution (WHA72.7).
- Frequent hand washing remains the most important intervention in infection control.
- Wastewater from HCF frequently has higher concentrations of ARB, ARGs and antimicrobial compounds and their metabolites, particularly related to antimicrobials of last resort, than wastewater from communities which can create AMR “hotspots” if not adequately treated. However, due to the higher volume of wastewater from communities, the overall load entering the environment from communities is higher.[32]
- Unused and expired medicines are commonly disposed of with general waste or discarded into wastewater systems, thus polluting waterbodies and groundwater. Source control is needed to reduce the need for treatment downstream.

Action options

- Follow WHO/UNICEF's eight practical steps to achieve WASH in HCFs.
- HCFs without access to WASH should prioritize immediate low-cost interventions such as basic hand hygiene stations, regular cleaning, improved drinking-water, and improved and accessible toilets.
- Increase isolation of patients between units or points of exposure to reduce local transmission.
- Focus attention on possible in-facility reservoirs of infectious bacteria and AMR, such as plumbing (including showers), water sinks, surfaces, and infectious waste disposal bins.
- HCF wastewater treatment may not be essential where wastewater goes to central community secondary wastewater treatment.
- If wastewater from HCFs does not go to a central community secondary treatment plant, pre-treatment is needed to reduce pathogen and AMR concentrations before release into the environment.
- Minimize antimicrobial waste through good antimicrobial inventory control and develop supportive policies, plans and accountability mechanisms. Antimicrobial waste should be segregated from other wastes, and encapsulated and buried, incinerated or returned to the manufacturer.
- Incorporate information on environmental risks of AMR in guidelines and training for healthcare professionals.

Resources to support action

- WASH in health care facilities website - The issue, commitments, resources and stories www.washinhcf.org
- WHA72.7 Resolution on WASH in HCF https://www.washinhcf.org/wp-content/uploads/2019/07/A72_R7-en.pdf
- Flyer -Tackling Antimicrobial resistance: Supporting national measures to address infection prevention and control and water, sanitation and hygiene in health care settings www.who.int/water_sanitation_health/facilities/amr-ipc-wash-flyer-nov16.pdf
- Access to WASH in Health care Facilities: Global Baseline report www.who.int/water_sanitation_health/publications/wash-in-health-care-facilities-global-report/en/
- WASH in health care facilities: Practical steps to achieve universal access to quality care www.who.int/water_sanitation_health/publications/wash-in-health-care-facilities/en/
- WASH FIT: A practical guide for improving quality of care through water, sanitation and hygiene in health care facilities www.who.int/water_sanitation_health/publications/water-and-sanitation-for-health-facility-improvement-tool/en/
- Safe management of health care wastes from health care activities https://www.who.int/water_sanitation_health/publications/wastemanag/en/

Action Area 4. Animal and plant production

Improve hygiene and wastewater and sludge management in food production

Facts and Figures

- It is estimated that globally higher quantities of antimicrobials are used in terrestrial and aquatic animals than in humans. Use is higher in countries where antimicrobials are used for growth promotion and/or where animals are raised intensively.
- Antimicrobials can be excreted virtually unchanged as the parent compound since frequently they are only partially metabolized in livestock and poultry.
- If no action is taken, antimicrobial use is predicted to rise by more than 50% from 2015-2030 largely driven by consumer demand for livestock products.
- Both treated and untreated manure and wastewater from livestock operations are commonly used as a fertilizer and soil conditioner on farms to support food and feed production. When not managed properly, wastewater and manure, also from grazing animals, can contribute to pollution of ground and surface waters.
- Cropland in peri-urban areas irrigated by mostly untreated urban wastewater has reached about 36 million hectares globally, equivalent to the size of Germany .
- By 2025, half of the world's population will be living in water-stressed areas increasing the demand for direct and indirect use of wastewater.
- At least 10% of the world's population is thought to consume food from plants irrigated by wastewater.
- Soils are contaminated by antimicrobial treatments used for disease control in plant production, and by active antimicrobial compounds and their metabolites in manure and wastes applied to cropland without proper management as organic fertilizers.

Animal and Plant Production

Animal and Plant Production

Evidence and co-benefits

- Food animals produce about four times more faecal matter, in total, than humans.
- If not managed appropriately wastewaters and manure from intensive livestock raising and from aquaculture systems can be a source of pathogens, ARB, ARGs, antimicrobial compounds and their metabolites.
- 10% to over 80% of antimicrobials administered to animals are absorbed or metabolized depending on the animal species treated and the particular antimicrobial used, with the remainder excreted as active compounds through urine and faeces.[22]
- Antimicrobials could have negative effects on the functional, structural and genetic diversity of soil microbial communities, even causing temporary loss of soil functionality, at least at concentrations in the mg/kg range.
- Waste streams from humans, animals and plants that have been treated with antimicrobials are also enriched with resistant microorganisms and ARGs.
- Although acquired AMR in livestock, aquaculture and plant production systems primarily derives from antimicrobial use, spread of AMR is fuelled by inadequate waste management, pollution, and other non-use factors.
- Relative contributions to AMR from antimicrobial use in humans, animals and plants and related wastes varies from region to region, depending upon local human, animal and plant health, and livestock, aquaculture and plant production practices.
- Use of antimicrobials for non-veterinary medical use, such as in animal and fish feed as a growth promoter or to mitigate effects of poor husbandry practices, might increase AMR in wastes and manure from such operations.
- Runoff waste from slaughterhouses is a potential source of contamination of antimicrobial compounds and their metabolites and possibly ARBs.
- Aquaculture ponds can release antimicrobial compounds into the aquatic environment through the leaching from unconsumed feeds, intentional or unintentional release of effluent water and the presence of residues in faecal material.

Action options

- Use of antimicrobials and other chemical supplements should be minimised to the extent possible in livestock, aquaculture and plant production operations in line with good production practices and animal health and welfare standards.
- Antimicrobials should only be used in animal, fish and plant production systems when needed for animal and plant health and welfare, such as the prevention, treatment and control of infectious disease in a responsible and prudent manner.
- Apply good husbandry practices and veterinary oversight in terrestrial and aquatic animal production.
- If circumstances demand higher antimicrobial use in intensive livestock and fish production systems, animal and aquaculture waste management and treatment should be considered aiming at large reduction in pathogens and stability of antimicrobials in wastewater systems as an important part of animal and aquaculture WASH.
- Implement responsible and prudent use of antimicrobials in livestock farming and collect and treat waste whenever possible.
- Practice integrated manure management to optimize handling of terrestrial animal manure from collection, through storage and treatment up to application (plants and aquaculture). Through this process it is possible to achieve a negative impact on survival of pathogens and stability of antimicrobials and to prevent nutrient losses to a large extent under the site-specific circumstances.
- Collect and treat the wastewater and manure produced in large-scale livestock operations and in aquaculture systems before reusing or disposing of them.
- Promote improved manure treatment practices and treatment facilities, and develop and implement national standards.
- The multiple barrier concept should be adopted whenever wastewaters are used in plant irrigation and aquaculture. The number of barriers (one to three) depends on the level of wastewater treatment and nature and use of the plant.
- Ensure maximum use of integrated pest management to minimise the use of antimicrobials in plant production.
- Develop mechanisms to return unused antimicrobials from farms to the supplier for safe disposal and develop behaviour change approaches to ensure return mechanisms are used.

Animal and Plant Production

Resources to support action

- Drivers, dynamics and epidemiology of antimicrobial resistance in animal production (FAO, 2016) http://www.fao.org/feed-safety/resources/resources-details/en/c/452608/
- Prudent and efficient use of antimicrobials in pigs and poultry. FAO Animal Production and Health Manual 23. http://www.fao.org/3/ca6729en/CA6729EN.pdf
- OIE List of Antimicrobial Agents of Veterinary Importance (July 2019) www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/A_OIE_List_antimicrobials_July2019.pdf
- The OIE Strategy on Antimicrobial Resistance and Prudent Use of Antimicrobials www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE-AMRstrategy.pdf
- OIE Annual report on Antimicrobial agents intended for use in animals - Better understanding of the global situation – 4th report https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/A_Fourth_Annual_Report_AMU.pdf
- OIE terrestrial animal health code: Chapter 6.10 Responsible and prudent use of antimicrobial agents in veterinary medicine www.oie.int/en/standard-setting/terrestrial-code/access-online/
- OIE aquatic animal health code: Chapter 6.2 Principles for responsible and prudent use of antimicrobial agents in aquatic animals www.oie.int/en/standard-setting/aquatic-code/access-online/

Action Area 5. Manufacturing of antimicrobials

Reduce releases of antimicrobials and ARGs into waterways from antimicrobial manufacturing

Facts and Figures

- The majority of antimicrobials, particularly generics, and active pharmaceutical ingredients (APIs) are manufactured in India and China.
- Antimicrobial compounds and their metabolites can be found in the wastewaters from manufacturing sites for medicines and APIs. In extreme cases, levels of antimicrobial compounds in water downstream of manufacturing sites have been found at concentrations higher than therapeutic concentrations in the blood of patients taking medicines. [5]
- Currently there are no global effluent water quality guidelines based on health risk assessment or best available technologies.
- Voluntary industry initiatives are establishing a common framework for managing discharge of antimicrobial compounds into waterways and applying it across manufacturing and supply chains among their members.
- Countries are introducing measures to limit emissions. For example, by introducing measures to restrict antibiotic emissions from manufacturing plants by including waste antibiotic residue in the national hazardous waste list, and by adding emission control as part of antimicrobial procurement criteria.
- The Good Manufacturing Practice (GMP) initiative currently focuses on the quality standards appropriate to the intended use of antimicrobials and as required by the product specification. GMP is considering options to strengthen and broaden the environmental component of inspections.

Evidence and co-benefits

- Inadequate waste management prevails along many supply chains in the local and international manufacturing of antimicrobials.
- Untreated wastewater and sludge discharges from antimicrobial production can be a hotspot for ARGs development.
- High concentrations of antimicrobials downstream of active pharmaceutical ingredient manufacturing plants can select for AMR in the local environment.
- Pre-treatment of production wastewater to remove antimicrobials is the best way to control the development of ARGs.
- Inadequate public data exist on AM manufacturing processes, including waste treatment and management, which makes it difficult to develop mitigation interventions.

Action options

- Foster cooperation across public and private sectors to enhance commitment to and innovation for reducing pollution throughout the supply chain using a combination of technological, behavioural, market-based and regulatory mechanisms.
- Promote and incentivize investment in life cycle analysis, green technology and efficient operation of wastewater and sludge treatment within antimicrobial manufacturing operations – e.g. by revising national generic substitution systems so that not only low(est) price but also pollution control during manufacturing is valued when determining which antibiotic products should be reimbursed to the consumer.
- Strengthen procurement systems to include aspects of waste stream analyses and waste management within supply chains.
- Develop antimicrobial manufacturing pollution standards, based on best available treatment technology and strengthen the capacity of environmental authorities to issue and enforce adequate discharge permits. Where feasible, incorporate checks on permit compliance and treatment technologies in third-party inspections of manufacturing practice.
- Establish a recommended list of technologies for industrial operators to guide waste management decisions.
- Strengthen onsite inspections and the assessment of manufacturers' dossiers under GMP environmental procedures.
- Contribute to and promote wider membership of the pharmaceutical industry's own stewardship framework.
- Promote greater public access to waste and wastewater management data from AM manufacturers.
- Support the development of pharmaceuticals intrinsically less harmful for the environment taking into consideration public health priority needs and access to medicines principles.

Resources to support action

- WHO Good Manufacturing Practices for pharmaceutical products: main principles https://www.who.int/medicines/areas/quality_safety/quality_assurance/production/en/
- AMR Industry Alliance Roadmap www.amrindustryalliance.org/industry-roadmap-for-progress-on-combating-antimicrobial-resistance/
- OECD Report: Pharmaceutical residues in fresh water www.oecd.org/environment/pharmaceutical-residues-in-freshwater-c936f42d-en.htm

Action Area 6. Surveillance and research

Advance knowledge on WASH and wastewater drivers of AMR though a One Health lens to inform risk-based priorities

Leadership and coordination:

- Raise awareness among politicians and health officials of the importance of all WASH and wastewater management actions evoking the existing evidence and co-benefit arguments presented.
- Conduct a national risk assessment to identify and quantify primary sources occurrence, and transport of antimicrobials and ARGs in different geographies and sectors to identify priority WASH and wastewater risks and hotspots and associated risk-reduction interventions to be addressed in AMR NAPs and sectoral policy.
- Involve WASH, wastewater, sludge and solid waste-management professionals in the review of existing sectoral policies and plans and the selection of risk-reduction actions, and determine their feasibility and cost effectiveness to address priority risks.
- Incorporate surveillance in wastewater (from sectors below) into national AMR surveillance activities according to the recommendations of Global AMR Surveillance System (GLASS)
- If feasible, quantify relative exposure of humans, animals and plants from identified environmental sources of antimicrobials, ARGs and ARB.
- Establish and support a national research agenda based on knowledge gaps identified in the national risk assessment above.

Examples of research and surveillance needs for communities and households:

- Quantify the number and context of barriers including WASH, needed to reduce AMR spread.
- Determine the efficiency of different water and wastewater treatment technologies, both onsite and offsite, at removing ARB, ARGs and antimicrobial compounds and their metabolites, and use the information to assess the potential and the worth of upgrading existing plants to more advanced technologies.
- Develop a cost-benefit analysis approach for various intervention options. Develop criteria and guidance for wastewater-treatment plant operators and municipalities on AMR risk and provide practical guidance on and tools to incorporate risk reduction in operations.

Surveillance and research

Examples of research and surveillance needs for WASH in health care facilities:

- Compliance with WHO/UNICEF surveillance of WASH aspects.
- Determine the need for additional AMR related barriers, including local wastewater treatment at HCFs.
- Identify HCFs where wastewater treatment is needed to reduce AMR exposure.
- Stimulate the development of innovative WASH and wastewater technologies tailored to different contexts and trialled with user involvement.
- Conduct/support operational research on behaviour-change approaches to increase compliance with WASH and IPC measures in different contexts.
- Strengthen accountability and rewards for staff, patients and community members to demand better services.

Surveillance and research

Examples of research and surveillance needs for animal and plant production:

- Identify best practices to decrease ARB, and antimicrobial compounds and their metabolites in animal waste before application to crop and pasture lands.
- Quantify the stability and subsequent impact on local environments from antimicrobials used in animals, aquaculture and plant production.
- Improve the understanding of how ARB, ARG, antimicrobial compounds and their metabolites move (in soil and water).
- Identify innovative surveillance approaches to AMR in the environment.
- Determine best practices when and how to apply antimicrobials to minimise spread from aquaculture and plant production systems.
- Identify cost effective best management options to mitigate/stop ARB, ARG development and movement via wastewater from terrestrial and aquatic animal and manure runoff from plants.

Examples of research and surveillance needs for manufacturing of antimicrobials:

- Conduct risk assessment to identify acceptable environmental concentrations or minimum selective concentrations.
- Identify best available treatment technology for groups of antimicrobial agents.
- Support research into designing “greener” pharmaceuticals.

Resources to support action

- Towards a research agenda for water, sanitation and antimicrobial resistance - https://iwaponline.com/jwh/article/15/2/175-184/28255
- European Union Strategic Approach to Pharmaceuticals in the Environment https://ec.europa.eu/environment/water/water-dangersub/pdf/strategic_approach_pharmaceuticals_env.PDF

What can you do next?

- Convene a meeting to share with stakeholders
- Review status of national policies and plans
- Set up a process for review and update to strengthen WASH and wastewater to combat AMR

Thank you